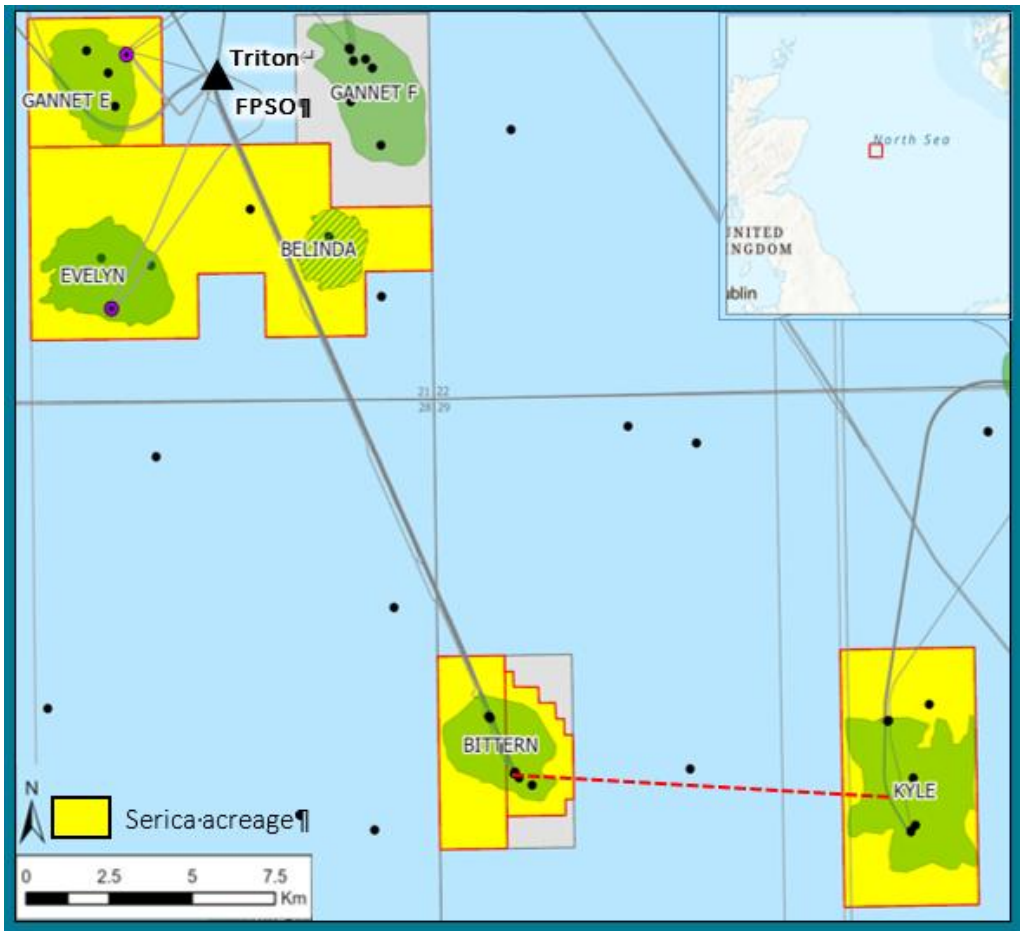
SERICAENERGY

Serica Energy Chinook Limited

Kyla Field Development Environmental Statement



OPRED Ref No: ES/2025/021

Serica Doc. No: KYL-SECL-HSE-DOC-0001

March 2026

ENVIRONMENTAL STATEMENT DETAILS

Section A: Administrative Information

A1 – Project Reference Number

Number: ES/2025/021

A2 – Developer Contact Details

Company Name: Serica Energy Chinook Limited

Contact Name: [redacted]

Contact Title: HSE Lead

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	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	Over 20 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	Senior Consultant	Over 12 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	Over 3 years environmental consultancy experience in the oil and gas industry. She has a B.Sc (Hons) degree in Marine Biology.
[redacted]	Orbis Energy Limited	Consultant	Over 2 years environmental consultancy experience in the oil and gas industry. She has a B.Sc (Hons) degree in Environmental Management.
[redacted]	Orbis Energy Limited	Consultant	Over 2 years environmental consultancy experience in the oil and gas industry. He has a first class B.Sc (Hons) degree in Geography.

A5 – Licence Details

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

Licence number(s): P.2616

b) Please confirm licences and current equity

Licence Number: P.2616	
Licensee	**Percentage Equity**
Serica Energy Chinook Limited	100%

Section B: Project Information

B1 – Nature of Project

a) Please specify the name of the project.

Name: Kyla 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:

Serica Energy Chinook Limited (hereafter referred to as 'Serica') is planning to develop the Kyla oil field located in United Kingdom Continental Shelf (UKCS) Block 29/2c in the Central North Sea (CNS), approximately 196 kilometres (km) to the southeast of Peterhead on the Scottish coastline and 72 km to the south west of the UK/Norway transboundary line. Kyla (previously developed as 'Kyle') is a ceased-production oil field which sits within Licence P.2616 at a water depth of approximately 90 m. Serica was awarded 100% equity and operatorship of Licence P.2616 in the 33rd Licence Round on 1st December 2023.

The Kyle field was originally developed via four subsea production wells, with first oil achieved in 2000. The wells were tied back to the Curlew Floating Production Storage and Offloading (FPSO) facility before being re-tied back to the Banff FPSO in 2005. The Kyle field ceased production following sand control issues with one of the wells and was decommissioned, along with the Banff FPSO, in 2020.

Serica is proposing to develop the Kyla field via a single subsea well tied back via 12 – 13.2 km long production pipeline, gas lift pipeline and umbilical to one of the existing Bittern drill centre manifolds (either DCA or DCB). Tie-in to the Bittern DCA manifold is the base case, however the DCB manifold has been considered as the back-up case option. The Bittern manifolds are in turn tied back to the Triton FPSO, with both assets operated by Dana Petroleum (E&P) Limited (hereafter referred to as 'Dana'). Kyla hydrocarbons will be processed on the Triton FPSO with Kyla oil exported as part of the Triton FPSO blend via shuttle tanker and sales gas routed with other Triton area gas to the St Fergus terminal onshore via the Fulmar gas pipeline.

Production from Kyla will be from an 8 inch pipeline with a piggybacked 3 inch gas lift pipeline, with gas supplied from Triton via Bittern. An electro/chemical/hydraulic and control umbilical will also be extended from Bittern to Kyla, which will run adjacent to the pipelines.

Subject to the necessary permits and consents being in place, development drilling is scheduled to be undertaken between Q4 2027 and Q1 of 2028 and subsea installation activities to be undertaken between Q2 and Q3 of 2028. First oil is targeted for end of Q3 2028.

Kyla production rates are anticipated to peak in 2029 at 928 tonnes (1,112 cubic metres) of oil per day and 144,720 cubic metres (5.11 million cubic feet) of gas per day (High case).

The Kyla field is expected to produce hydrocarbons for 8 years, depending on the reserves, the production rate and the life of the Triton FPSO. On cessation of production (CoP), the Kyla 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	Kyla Drill Centre	Kyla Valve Skid	Bittern Drill Centre Tie-in Location (existing)	
			Manifold A (existing)	Manifold B (existing)
Location (Lat/Long) [1]	56° 53′ 01.13″N; 01° 13′ 50.70″E	56° 53′ 0.43″N; 01° 13′ 49.04″E	56° 54′ 10.88″N; 01° 02′ 14.02″E	56° 55′ 2.93″N; 01° 01′ 32.60″E
UKCS Block	29/2		29/1	
ICES Rectangle	42F1		42F1	
Distance to nearest coastline (Peterhead)	196 km	196 km	183 km	182 km
Distance to nearest median line (UK / Norway)	72 km	73 km	83 km	84 km
Nearest Marine Protected Area	13 km SW of East of Gannet and Montrose Fields NCMPA	13 km SW of East of Gannet and Montrose Fields NCMPA	17 km SW of East of Gannet and Montrose Fields NCMPA	16 km SW of East of Gannet and Montrose Fields NCMPA

[1] ED50 TM 0 N.

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

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Abbreviations

µg.g^{-1}	Micrograms per gram
µm	Micrometres
"	Inch
%	Percentage
˚C	Degrees Celsius
‰	Parts per thousand
3D	Three-dimensional
ACA	Action Co-ordinating Authority
AET	Apparent Effects Threshold
AHV	Anchor Handling Vessel
AIS	Automatic Identification System
Al	Aluminium
ALARP	As Low as Reasonably Practicable
API	American Petroleum Institute
APS	Announced Pledges Scenario
AR5	Assessment Report Five
AR6	Assessment Report Six
ARPA	Automatic Radar Plotting Aids
As	Arsenic
AUV	Autonomous underwater vehicle
Ba	Barium
BAC	Background Assessment Criteria
BAOAC	Bonn Agreement Oil Appearance Code
bbl	Barrels
BC	Background Concentration
BEIS	Department for Business, Energy & Industrial Strategy
BGS	British Geological Survey
BoCC	Birds of Conservation Concern
boe	Barrel of Oil Equivalent
BOP	Blowout Preventer
Bscf	Billion Standard Cubic Feet
Ca	Cadmium
ca.	Circa
CAPEX	Capital Expenditure
CB	Carbon Budget
CBGDP	Carbon Budget and Growth Delivery Plan
CCC	Climate Change Committee
CCS	Carbon Capture and Storage
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CFU	Compact Flotation Unit

CH_4	Methane
CHARM	Chemical Hazard Assessment and Risk Management
cm	Centimetres
CNS	Central North Sea
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e/boe	Carbon Dioxide equivalent per Barrel of Oil Equivalent
CO_2e	Carbon dioxide equivalent
COLREG	International Regulations for Preventing Collisions at Sea
COP	Conference of the Parties
CoP	Cessation of Production
cP	Centipoise
CPI	Carbon Preference Index
Cr	Chromium
CSV	Construction Support Vessel
CtL	Consent to Locate
Cu	Copper
Dana	Dana Petroleum (E&P) Limited
dB	Decibel
dB re 1µPa @ 1 m	Decibels relative to one micro-Pascal
DCA	Drill Centre A
DCB	Drill Centre B
DESNZ	Department for Energy Security and Net Zero
DP	Dynamically Positioned
DSV	Diving Support Vessel
EBS	Environmental Baseline Survey
EC	European Commission
ECMWF	European Centre for Medium-Range Weather Forecasts
EDGAR	Emissions Database for Global Atmospheric Research
EDR	Effective Deterrent Range
EEMS	Environmental Emissions Monitoring System
EHC	Electro-hydraulic control
EIA	Environmental Impact Assessment
EJ	Exajoules (10^{18} J)
EMODnet	European Marine Observation and Data Network
EMS	Environmental Management System
ENVID	ENVironmental impact IDentification
EOL	End of Line
EPO	Environmental Protection Objective
EPS	European Protected Species
ERAP	Emissions Reduction Action Plan
ERL	Effects Range Low

ERM	Effects Range Median
ERRV	Emergency Rescue and Recovery Vessel
ES	Environmental Statement
ESAS	European Seabirds at Sea
ESG	Environmental, Social and Governance
ESP	Electrical Submersible Pump
ETS	Emissions Trading Scheme
EU	European Union
EUNIS	European Nature Information System
F	Far-field
FCS	Favourable Conservation Status
FeAST	Feature Activity Sensitivity Tool
FDP	Field Development Plan
FLO	Fisheries Liaison Officer
FO	First Oil
FPSO	Floating Production, Storage and Offloading
FRP	Favourable Reference Population
Ft	Feet
g/cm^3	Grams per cubic centimetre
GBS	Gravity-based Structure
GCB	Global Carbon Budget
GEBCO	General Bathymetric Chart of the Oceans
GHG	Greenhouse Gas
GML	Global Monitoring Laboratory
GOR	Gas to Oil Ratio
GST	Global Stocktake
Gt	Gigatonnes (10^{12} kg)
GWP	Global Warming Potential
H	Height
HA	Habitat Assessment
HC	Hydrocarbon
HD	High Definition
HF	Hydrofluoric acid
HF	High Frequency
Hg	Mercury
HM	Heavy Metal
HMCS	Harmonised Mandatory Control Scheme
hMPA	historic Marine Protected Areas
HMW	High Molecular Weight
HPAI	Highly Pathogenic Avian Influenza
HPHT	High Pressure High Temperature
HSE	Health, Safety and Environment

HSEQ	Health, Safety and Environmental Quality
HYCOM	Hybrid Coordinate Ocean Model
HYDROMAP	Tidal and Hydrodynamic Modelling System
Hz	Hertz
I	Intermediate-field
ICES	International Council for the Exploration of the Seas
IEA	International Energy Agency
IEMA	The Institute of Environmental Management and Assessment
IFT	Interfacial Tension
IMO	International Maritime Organization
INTOG	Innovation and Targeted Oil and Gas
IOGP	International Association of Oil and Gas Producers
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
ISO	International Standards Organisation
ITOPF	International Tanker Owner Pollution Federation
IUCN	International Union for the Conservation of Nature
J	Joule
JNCC	Joint Nature Conservation Committee
JV	Joint Venture
kg	Kilograms
kg/m^3	Kilograms per cubic metre
kHz	Kilohertz
kJ	Kilojoules
km	Kilometres
Km^2	Square kilometres
KPIs	Key Performance Indicators
kt	Kilotonnes (10^6 kg)
L	Length
LE,p	Sound Exposure Level
LE,p,ss	Sound Exposure Level, single strike
LF	Low Frequency
Li	Lithium
LMW	Low Molecular Weight
LNG	Liquified Natural Gas
LOC	Loss of Containment
Log Pow	Octanol-water partition coefficient
Lp,pk	Sound Pressure Level peak
LTOBM	Low toxicity oil based mud
m	Metres
m^2	Square metres
m^3	Cubic metres

MARPOL	International Convention for the Prevention of Pollution from Ships
MAT	Master Application Template
MPS	Marine Policy Statement
Mbbl	Million barrels (10^6 bbl)
MCA	Maritime and Coastguard Agency
MCZ	Marine Conservation Zones
MD	Measured Depth
MEG	Monoethylene Glycol
MEI	Major Environmental Incident
MER	Maximising Economic Recovery
mg/cm^2/day	Milligrams per centimetre squared per day
mg/L	Milligrams per litre
mm	Millimetres
Mm^3	Million cubic metres (10^6 m^3)
MMMU	Marine Mammal Management Unit
MMO	Marine Mammal Observer
MMscf	Million standard cubic feet
MMstb	Million Standard Barrels
mN/m	Dynes
MNCR	Marine Nature Conservation Review
MODU	Mobile Offshore Drilling Unit
mol	Moles
MPA	Marine Protected Area
ms^{-1}	Metres per second
Mt	Megatonnes (10^9 kg)
MU	Management Unit
MUDMAP	Three-dimensional dispersion model
MW	Megawatt
N	Near-field
N_2O	Nitrous Oxide
NAC	North Atlantic Current
NAEI	National Atmospheric Emissions Inventory
NAVAREA	Navigational Area
NAVGEM	Navy Global Environmental Model
NAVTEX	Navigational Telex
NC MPA	Nature Conservation Marine Protected Area
NCODA	Navy Coupled Ocean Data Assimilation
NCPs	National Contingency Plans
NDC	Nationally Determined Contribution
NE	No Exceedance
Ni	Nickel
NMFS	National Marine Fisheries Service

NM	Nautical mile
NMP	National Marine Plan
NMPi	National Marine Plan Interactive
NOAA	National Oceanic and Atmospheric Administration
NORM	Naturally Occurring Radioactive Material
NO_x	Nitrogen Oxides
NPD	Naphthalenes, phenanthrenes and dibenzothiophene
NPT	Non-Productive Time
NPV	Net Present Value
NSTA	North Sea Transition Authority
NSTD	North Sea Transition Deal
NZE	Net Zero Emissions by 2050 Scenario
OBM	Oil Based Mud
OESEA	Offshore Energy Strategic Environmental Assessment
OGA	Oil and Gas Authority
OGMP	Oil and Gas Methane Project
OIW	Oil in Water
OMAR	Offshore Major Accident Regulator
OMS	Operations Management System
OOC	Oil on cuttings
OPEP	Oil Pollution and Emergency Plan
OPOL	Offshore Pollution Liability Agreement
OPRED	Offshore Petroleum Regulator for Environment & Decommissioning
OSPAR	Oslo and Paris Commission
OSRL	Oil Spill Response Limited
PAHs	Polycyclic Aromatic Hydrocarbons
PAM	Passive Acoustic Monitoring
PARLOC	Pipeline and Riser Loss of Containment
Pb	Lead
PCW	Phocid Carnivores in Water
PE	Parabolic Equation
PETS	Portal Environmental Tracking System
Pg	Petagrams
PGR	Production Gap Report
PIG	Pipeline Integrity Gauge
PLONOR	Pose Little or No Risk
PMF	Priority Marine Feature
PON	Petroleum Operations Notice
ppb	Parts per billion
ppm	Parts per million
PSA	Particle Size Analysis
PSD	Particle Size Distribution

PTS	Permanent Threshold Shift
PWA	Pipeline Works Authorisations
RCP	Representative Concentration Pathway
REF	Reference
ROV	Remotely Operated Vehicle
RQ	Risk Quotient
RVP	Reid Vapour Pressure
SAC	Special Area of Conservation
SAT	Subsidiary Application Template
SCANS	Small Cetacean Abundance of the North Sea
SCR	Safety Case Regulations
SDG	Sustainable Development Goal
SEL	Sound Exposure Level
SEPA	Scottish Environmental Protection Agency
Serica	Serica Energy Chinook Limited
SFF	Scottish Fishermen's Federation
SFGT	St. Fergus Gas Terminal
SGMD	Scottish Government Marine Directorate
SIMOPS	Simultaneous Operations
SIMPROF	Similarity Profile Analysis
SNCBs	Statutory Nature Conservation Bodies
SNS	Southern North Sea
SO_2	Sulphur Dioxide
SOL	Start of Line
SOPEP	Ship Oil Pollution Emergency Plan
SOSI	Seabird Oiling Sensitivity Index
SO_x	Sulphur Oxides
SPA	Special Protection Area
SPL	Sound Pressure Level
SSD	Species Sensitivity Distribution
SSP	Shared Socio-economic Pathways
SUB	Substitution
t	Tonne (10^3 kg)
TCFD	Taskforce on Climate-related Financial Disclosures
TD	Total Depth
THC	Total Hydrocarbon Concentration
Tm^3	Trillion cubic metres (10^{12} m^3)
TOC	Total Organic Carbon
TOG	Targeted Oil & Gas
TOM	Total Organic Matter
TS	Threshold Shift
TSS	Total Suspended Solids

TTS	Temporary Threshold Shift
TVDss	True Vertical Depth Below Sea Level
UHB	Upheaval Buckling
UK	United Kingdom
UK BAP	United Kingdom Biodiversity Action Plan
UKCS	United Kingdom Continental Shelf
UKETS	UK Emissions Trading Scheme
UKHO	United Kingdom Hydrographic Office
UKOOA	UK Offshore Operators Association
UN	United Nations
UNEP	United Nations Environmental Programme
UNFCCC	UN Framework Convention on Climate Change
VHF	Very High Frequency
VMS	Vessel Monitoring System
VOCs	Volatile Organic Compounds
W	Width
W/m^2	Watts per square metre
WBM	Water Based Mud
WMO	World Meteorological Organization
WMP	Waste Management Plan
WOAD	Worldwide Offshore Accident Database
WOC	Waiting on Cement
yr	Year
Zn	Zinc
ZRF	Zero Routine Flaring

Non-Technical Summary

Introduction

Serica Energy Chinook Limited (hereafter referred to as 'Serica') is planning to develop the Kyla oil field located in United Kingdom Continental Shelf (UKCS) Block 29/2c in the Central North Sea (CNS), approximately 196 kilometres (km) to the southeast of Peterhead on the Scottish coastline and 72 km to the south west of the UK/Norway transboundary line (Figure 1). Kyla is a ceased-production oil field which sits within Licence P.2616. Serica was awarded 100% equity and operatorship of Licence P.2616 in the 33rd Licence Round on 1st December 2023.

The Kyla field is located within a water depth of approximately 90-95 m. Previously known as 'Kyle', the field was discovered in 1993, with field development activities taking place from 2000 to 2002. The Kyle field was initially tied back to the Curlew Floating Producing Storage and Offloading (FPSO) before being re-tied back to the Banff FPSO in 2005, where it produced oil and gas until 2018 when sand control issues caused one of the production wells to fail leading to the field being decommissioned in 2020. Serica is now proposing to develop the Kyla field and is aiming to deliver first oil by the end of Q3 2028.

An Environmental Statement (ES) has been prepared to present the findings of the Environmental Impact Assessment (EIA) carried out for the proposed Kyla 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 Serica in conjunction with Orbis Energy Limited (the EIA Consultant). This section forms the non-technical summary of the ES. The EIA has been undertaken with reference to the new supplementary guidance for assessing the effects of downstream scope 3 emissions on climate from offshore oil and gas projects (DESNZ, 2025c).

Project Description

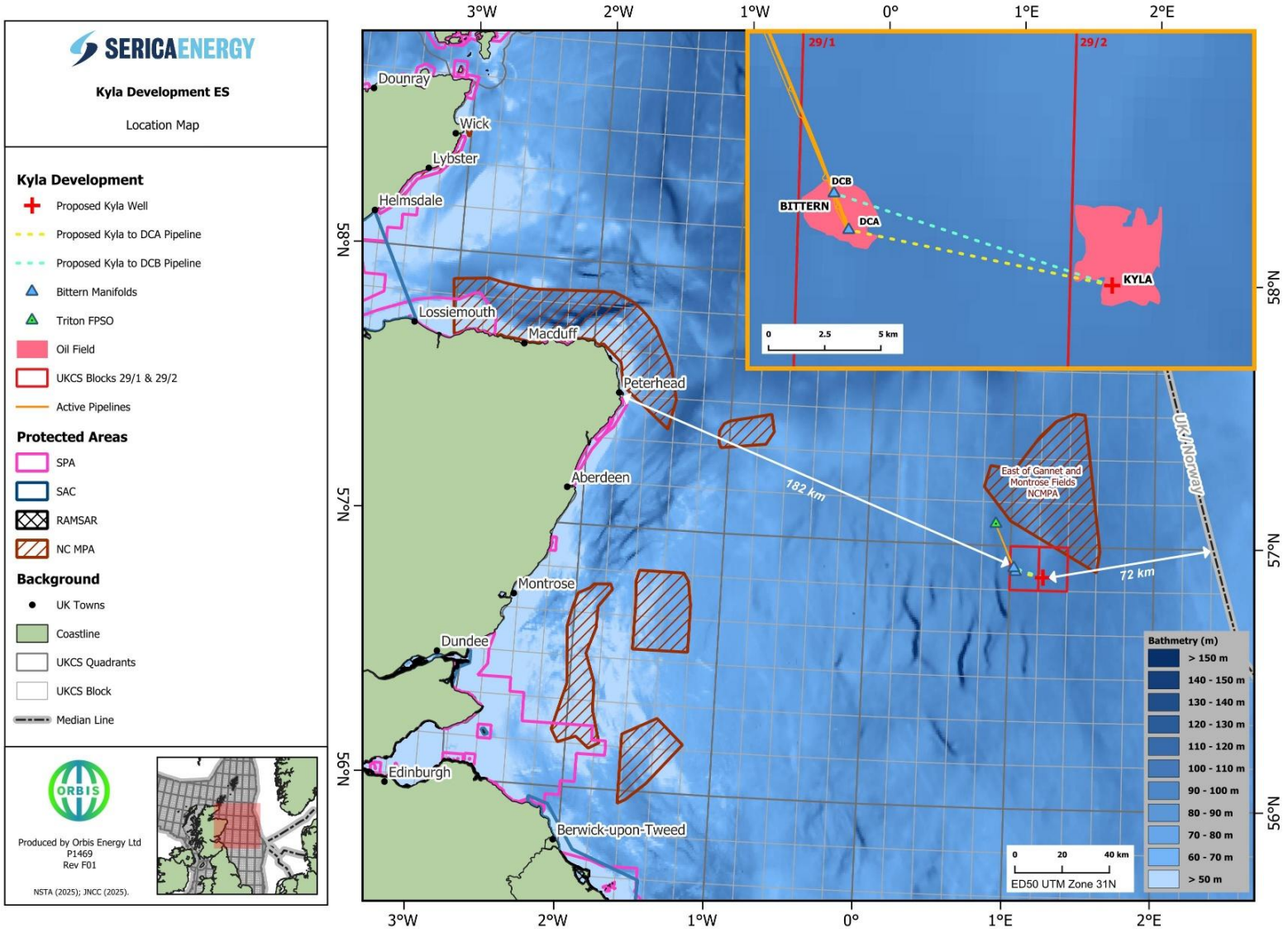
The Kyla field will be developed as a single subsea well tied back via 12 – 13.2 km long 8-inch production and 3-inch piggybacked gas lift rigid pipelines to one of the existing Bittern drill centre manifolds (either DCA or DCB). The base case is to tie-back to the DCA manifold, but this will be confirmed during detailed design. The Bittern manifolds are located approximately 2 km from each other and are both suitable for connecting the Kyla production, gas lift and electro/chemical/hydraulic and control umbilical services. For the purposes of this ES, the longest tie-back which is to the DCB manifold has been assessed as this represents the worst case scenario in terms of impact to the seabed.

The Bittern manifolds are in turn tied back to the Triton FPSO, with both assets operated by Dana Petroleum (E&P) Limited (hereafter referred to as 'Dana'). An electro/chemical/hydraulic and control umbilical will be extended from Bittern to Kyla, which will run adjacent to the pipelines, 50 - 75 m apart. Kyla hydrocarbons will be processed on the Triton FPSO, with Kyla oil exported as part of the Triton FPSO blend via shuttle tanker and sales gas routed with other Triton area gas to the St Fergus Gas Terminal (SFGT) onshore for onwards transmission to the UK's National Transmission System.

Serica proposes to drill and complete one subsea horizontal production well (29/02c-K16) in the Kyla field targeting the Palaeocene sandstone. By using a single, high-productivity horizontal well with existing lift gas, the development avoids the need for multiple wells reducing drilling activity, subsea infrastructure, and associated seabed disturbance compared with the alternative designs.

The proposed tophole location for this well sits within UKCS Block 29/2c at 56° 53' 01.13"N, 01° 13' 50.70"E (ED50 TM 0 N). A mobile offshore drilling unit (MODU) has yet to be contracted for the project but given the water depth at Kyla (ca. 90 m), it is expected that the subsea well will be drilled and completed from a semi-submersible drilling rig which will be held in position over the Kyla location by anchors and chains.

Figure 1: Location of the Proposed Kyla Development



The top two hole sections of the well will be drilled using a water-based fluid, before being lined with steel casings that are cemented in place. Cuttings from these top-hole sections will be discharged directly from the wellbore at the seabed.

Offset well experience within the Triton area has shown that water-based muds have limited performance in the deeper formations. The use of low toxicity oil base mud (LTOBM) is therefore considered the most suitable and lowest-risk fluid system for the deeper hole sections of the proposed Kyla well. LTOBM contaminated cuttings will either be skipped and shipped to shore for disposal or thermally treated offshore to an acceptable overboard disposal limit (<1% oil on cuttings) and discharged from the MODU. For the purposes of this ES, modelling of the discharge of the drill cuttings has been carried out to support the impact assessment, assuming the treatment and discharge of the LTOBM contaminated cuttings.

It is anticipated that it will take up to 100 days to drill and complete the well. Once drilling operations are completed and the production equipment has been installed downhole, a vertical Xmas tree will be landed on top of the wellhead, installed directly from the MODU. The Xmas tree will sit above the seabed, locked onto the wellhead as it emerges from the seabed. Once the tree is secure on top of the wellhead, four telescopic legs will be lowered to the seabed. These are designed to deflect any fishing lines or trawl boards over the tree and prevent any lines or trawl boards getting into the wellhead / conductor area, negating the need for a specific Xmas tree protection structure. This tree will remain on the seabed for the life of the field (ca. 8 years), providing well control and supporting the production of hydrocarbons.

The Kyla pipelines and umbilical are likely to be installed by a reel-lay vessel and will be surface laid on the seabed prior to trenching and burial, similar to the other pipelines which form part of the Triton area. The umbilical will be trenched and buried separately to the pipelines. Trenching can be achieved by towed plough, with a separate backfill pass, or by tracked vehicle either jetting to fluidise the soil or mechanical cutting. The final trenching method for Kyla will be selected by the installation contractor. For the purposes of this ES, trenching and backfilling via a plough has been assessed, as this represents the worst case scenario for seabed disturbance and fuel consumption by vessels.

Boulders inhibit the use of the trenching equipment and therefore some boulders may need to be removed from the lay corridor prior to trenching. Boulder clearance will be minimised as far as practical via pipeline routing exercises as part of the detailed design process. If any boulders are removed from the lay corridor they will be relocated to the edges of the installation corridor, ideally within a 5 m corridor downstream of the prevailing current to minimise likelihood of scour developing on the route, with the as-left position of each boulder recorded.

Burial of the pipelines will assist in protection against upheaval buckling, where temperature changes cause the pipeline to move to relieve the expansion forces. Rock is considered the most appropriate mitigation measure for upheaval buckling. Based on experience from the wider Triton area, it has been calculated that up to 26,000 tonnes of rock may be needed to mitigate for upheaval buckling along the pipelines. The requirement for rock to be deposited along the pipelines will be determined by reviewing as-trenched and as-backfilled survey data against the critical trench imperfection criteria defined during detailed design. The umbilical will not require any rock placement provided it is suitably trenched below mean seabed level. However, as a contingency it is assumed up to 10,000 tonnes of rock may be deposited if target trenching isn't achieved. Additional rock (up to 30,000 tonnes) will need to be deposited where the pipelines and umbilical exit the trenches at Kyla and Bittern. Rock and concrete mattresses are also required to be deposited along the proposed route of the Kyla pipelines and umbilical cross the existing 44-inch Langeled and the 36-inch CATS gas export pipelines, both of which are surface laid and exposed. Any rock required will be deposited by a rock placement vessel. The spread of rock placement will be restricted through the use of a fall pipe system held a few metres above the seabed to accurately place rock material.

A valve skid ('fishing friendly') will be installed at Kyla to route gas lift and production fluids to and from the Kyla well and Bittern manifold and act as the connecting point for the Kyla umbilical. There may also be a requirement to install a separate tie-in structure ('fishing friendly') at Bittern, depending on the tie-in arrangement. Two foundation concepts, piled versus gravity-based, are currently being considered for these structures. For the purposes of this ES, a piled structure foundation concept has

been assumed as worst case for the underwater noise assessment and a gravity-based structure (GBS) has been assumed as worst case for the seabed disturbance assessment

As Kyla will be a subsea development, production from the field will be processed offshore at the Triton FPSO with processing equipment and support facilities shared with several other producing assets. As such, there will be no emissions and discharges to the marine environment during routine production operations at the Kyla well location, although there will be incremental emissions and discharges at the Triton host facility as a result of Kyla coming online.

Power generation on the Triton FPSO supports operations of major seawater pumps, compressors, accommodation, utilities, and various other pumping systems. Once online, Kyla will only impact export compressors operational loads and will not impact on power increase for other requirements (refer to Section 3.5.5 of the ES). There will be no increase in flaring or diesel use at Triton due to Kyla coming online, but some additional gas will be cold vented from the oil storage tanks on Triton as a result of Kyla production (refer to Section 3.5.4). There is no produced water reinjection on the Triton FPSO, so produced water from Kyla shall be treated by the existing Triton produced water system where it will be discharged to sea (in accordance with the Triton Oil Discharge Permit), with the monthly average oil concentration not exceeding 30 mg/l (refer to Section 3.5.3 of the ES). It is anticipated that chemicals required for the production of hydrocarbons from Kyla will be the same as those being used at Triton at the time of first oil, although quantities used are likely to increase.

The Kyla subsea infrastructure is expected to produce hydrocarbons for 8 years depending on the reserves, the production rate and the life of the Triton infrastructure. On CoP, the Kyla facilities will be decommissioned in accordance with the requirements of the prevailing UK and International law.

Concept Selection

The selected concept for the Kyla Development project is a single subsea well tied back to a suitable host facility. A standalone development concept is not economically viable for Kyla and has been discounted. Concept select work therefore focused on screening hosts which could support the development of Kyla as a subsea tie-back.

Several potential host facility and tie-back route options were explored during the project feasibility/pre-concept phase conducted in 2024, as illustrated in Figure 2, namely:

- Tie-in to Triton FPSO (operated by Dana) via:
  - Direct tie-in at the Triton FPSO riser base;
  - Tie-back to Evelyn or Belinda manifolds;
  - Tie-back to one of the Bittern Drill Centre manifolds (DCA or DCB);
- Tie-in to Gannet Alpha platform (operated by Adura);
- Tie-in to Catcher FPSO (operated by BW Offshore);
- Tie-in to Anasuria FPSO (operated by Anasuria Operating Company).

The outcome of the assessments conducted during the project feasibility/pre-concept phase resulted in the direct tie-back options to Gannet Alpha, Catcher and Anasuria being discounted and recommended that Kyla be redeveloped as a subsea tie-back to the Triton FPSO via one of the Bittern manifolds (DCA or DCB).

The Bittern DCA/DCB manifolds are located the shortest distance from Kyla (12 – 13.2 km), with the other tie-back options entailing longer pipelines (ranging from 24 km to 50 km), thereby minimising seabed impact and construction and installation emissions.

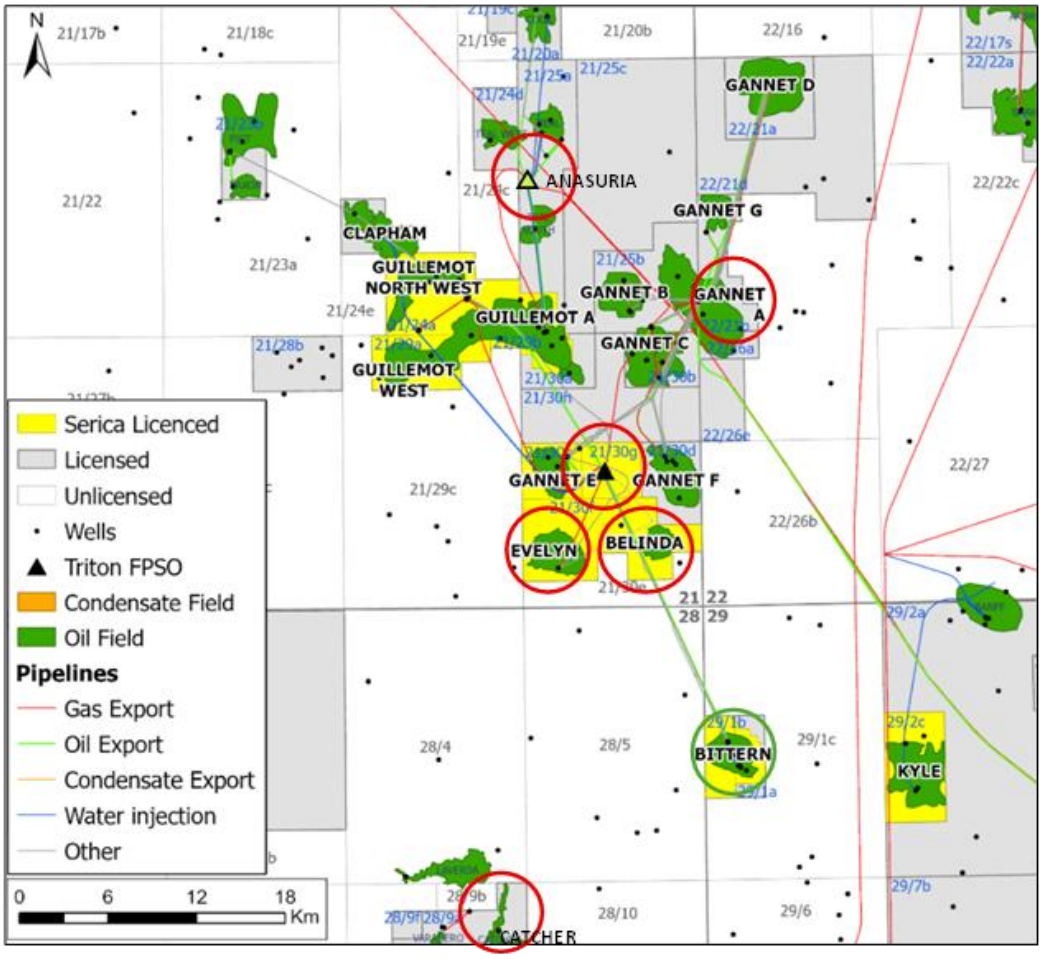
Aligned with the North Sea Future Plan (DESNZ, 2025b) and in accordance with the Oil and Gas Authority (OGA) Strategy and OGA Plan to reduce UKCS Greenhouse Gas (GHG) emissions from oil and gas extraction, the selection of the development concept for Kyla has been informed by carbon intensity and infrastructure reuse considerations. Key benefits of the chosen concept include:

- Reuse of existing subsea and topsides facilities, avoiding the need for new-build processing or export infrastructure;

- Low incremental power requirements, Triton FPSO has sufficient capacity within existing power generation systems;
- Optimisation of gas management, with produced gas used for fuel and lift, and surplus gas exported, minimising flaring;
- Estimated 20% reduction in carbon intensity across Triton FPSO production when Kyla comes onstream, through economies of scale.

In summary, the selected development concept reflects the optimal development plan for Kyla, maximising hydrocarbon recovery whilst minimising capital risk and costs, maximising use of existing North Sea oil and gas infrastructure, and significantly reduces the carbon footprint of production when compared with standalone or long-distance tie-back alternatives.

Figure 2: Location of the Proposed Kyla Development



[1] Red circles indicate potential/discounted tie-back options. Green circle indicates selected tie-back option

Project Schedule

The indicative timeline for the proposed Kyla Development is provided in Figure 3.

Figure 3. Indicative Timeline for the Kyla Development

	2027				2028			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Topside Modifications								
Development Drilling								
Subsea Installation								
First Oil								

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 Kyla Development area is provided below.

The description of the baseline environment is largely based on data provided in the UK Offshore Energy Strategic Environmental Assessment (OESEA) Reports (BEIS and predecessors) (2003-2016), as well as other published data sources, supported by site-specific survey data as detailed below.

To inform the EIA, a habitat assessment (HA) (Gardline, 2025a) and environmental baseline survey (EBS) (Gardline, 2025b) was carried out within the proposed Kyla Development area by Gardline, on behalf of Serica, between the 15th and 20th July 2025. The survey included a total of 18 sampling stations, co-located with camera transects ranging in length from 80 to 100 m, arranged in tidally aligned cruciform pattern centred on a proposed Kyla well location and along the proposed Kyla to Bittern pipeline route at 5 km intervals, as well as along a now discounted route between Kyla to Triton (refer to Figure 4). In addition, historic site environmental data exits for the field from the Kyle pre-decommissioning survey conducted in 2020 (Fugro, 2020; CNRI, 2021).

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 Kyla Development area, including historic surveys at Bittern (as illustrated in Figure 4), and have therefore been used to inform the environmental baseline description, where relevant.

Physical Environment

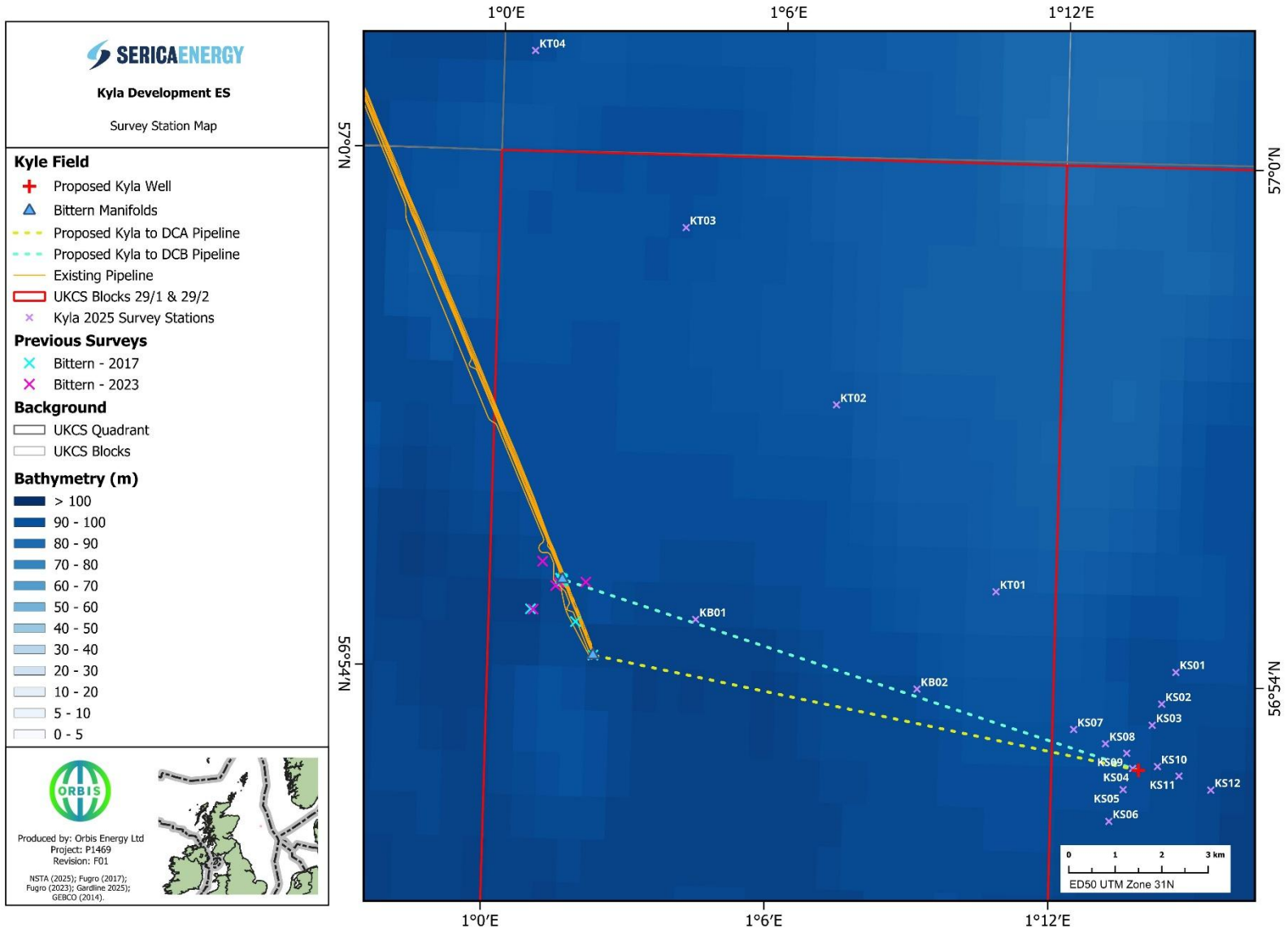
The bathymetry at both Kyla and Bittern and along the proposed pipeline route is relatively flat with water depths in the range of 90-95 m (CNRI, 2021; Fugro, 2017; Fugro, 2023; Gardline, 2025a).

The seabed imagery collected during the 2025 survey indicates that the seabed habitat in the proposed development area predominantly consists of a homogeneous sediment type, characterised by silty fine sand with varying proportions of shell fragments (Gardline, 2025a). This is similar to surveys of Bittern which found the seabed sediment to be poorly to very poorly sorted fine to very fine sand (Fugro, 2017; Fugro, 2023).

Sediment samples gathered from the proposed Kyla Development area were subjected to particle size analysis (PSA). The results of the PSA indicated that in the vicinity of both the proposed well location and along the proposed Kyla to Bittern pipeline route the sediment types were generally homogenous, comprising sand, fines and gravel (Gardline, 2025a, 2025b). Folk Classification identified 'Muddy sand' and 'Slightly gravelly muddy sand'. Previous surveys confirm that the samples taken from proposed Kyla Development area are broadly consistent with the seabed sediment types previously found. Total organic carbon (TOC) and total organic matter (TOM) for the majority of sampling stations was typical of background levels.

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). Within the vicinity of the proposed Kyla well location and along the proposed pipeline route the mean Total Hydrocarbon Concentrations (THCs) was 8.86 micrograms per gram ($\mu g.g^{-1}$). To put this into context, UKOOA (2001) reported a mean THC concentration of 9.51 $\mu g.g^{-1}$. All stations in the current survey recorded THC concentrations below the UKOOA (2001) 95th percentile and can therefore be considered consistent with background concentrations (BC). The overall mean n-alkane concentration within the vicinity of the proposed Kyla well location and pipeline route was 0.307 $\mu g.g^{-1}$. To put these results into context, UKOOA (2001) recorded a mean total n-alkane concentration of 0.40 $\mu g\ g^{-1}$. As all concentrations were below the UKOOA (2001) 95th percentile, they can be considered consistent with the wider area. PAH concentrations at the proposed Kyla well location and along the pipeline route were also consistent with the UKOOA (2001) CNS mean, suggesting limited contamination and confirming that the overall hydrocarbon profile is typical of background conditions for the region.

Figure 4: Location of Kyla Site Specific Survey Stations



Barium (Ba) is a key tracer for anthropogenic pollution, specifically from drilling activities, as it is used as barite in drilling fluids. Since barite is largely insoluble, its presence in sediments provides a reliable indicator of drilling mud dispersion after discharge. The Kyla Development area mean for Ba was above that of the CNS UKOOA (2001) background stations and above the 95th percentile for most of the stations sampled. Concentrations of Ba can therefore be considered above the background levels for the Kyla area. This is not unexpected as Kyla is a redevelopment of the decommissioned Kyle field. Concentrations of other heavy and trace metals were considered consistent with background for sediments in the wider area with some localised elevation in Lead (Pb) and Zinc (Zn).

The hydrodynamics of the CNS are primarily driven by the North Atlantic Current (NAC), which introduces warm, subtropical water into the region (DESNZ, 2022). Tidal currents are generally weak and atypical, being easily overridden by winds and density circulation; modelled peak flows in the Kyla area range from 0.007 metres per second (ms^{-1}) and 0.054 ms^{-1} for neap and spring peak flows respectively (ABPMer 2008). Prevailing winds are from the south-west and north-north-east, although anticyclones over Europe can establish persistent south/south-easterly winds (DESNZ, 2022; UKHO 2013). Winter wind strengths typically fall between Beaufort 4-6 (6-11 ms^{-1}) with higher winds of force 8-12 (17-32 ms^{-1}) being much less frequent. Winds of force 5 (8 ms^{-1}) and greater are recorded 60-65% of the time in winter and 22-27% of the time in summer (DESNZ, 2022). Furthermore, the wave climate for the Kyla area is dominated by west and south-west directions, with the annual mean significant wave height around the proposed development area being approximately 2.11 m to 2.4 m (NMPi, 2025).

Climate Change and GHG Emissions

Over recent decades, scientific consensus has confirmed that the Earth's climate is undergoing significant change, largely driven by anthropogenic GHG emissions. Global mean concentrations for well-mixed GHGs (carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O)) in 2019 correspond to increases of about 47%, 156%, and 23%, respectively, above the levels in 1750 (representative of the pre-industrial era) (high confidence) (IPCC, 2023) and in nearly all considered scenarios and modelled pathways, global warming is predicted to continue to increase in the near term (2021–2040) (IPCC, 2023b).

The United Nations Framework Convention on Climate Change (UNFCCC) commits countries to stabilise GHG levels, with the Conference of the Parties (COP) as its decision-making body. COP21 in 2015 created the Paris Agreement, requiring nations to limit warming to well below 2°C and pursue 1.5°C through nationally determined contributions (NDCs). Progress against the Paris Agreement is reviewed every five years via the Global Stocktake (GST) process, which at COP28 in 2023 showed warming projections of 2.4–2.6°C, above the 1.5°C goal, demanding rapid cuts of 43% by 2030 and Net Zero CO_2 by 2050. It is still considered technically possible that we can limit long-term global temperature rise to 1.5^{o}C (WMO, 2025), however, at the recent COP30 in Brazil it was acknowledged that the world is likely to breach this threshold in the next decade, at least temporarily.

The GST process was informed by the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6) cycle. AR6 defines five plausible future storylines (SSP1-5) describing global societal development (population, economy, technology and energy) to understand challenges for climate mitigation/adaptation. These are combined with Representative Concentration Pathways (RCPs), which define different levels of GHG forcing, to create scenarios like SSP1-2.6 (sustainable world with strong climate action) or SSP5-8.5 (fossil-fuelled world with high emissions), used in IPCC reports to model future climate impacts and vulnerability.

Biodiversity

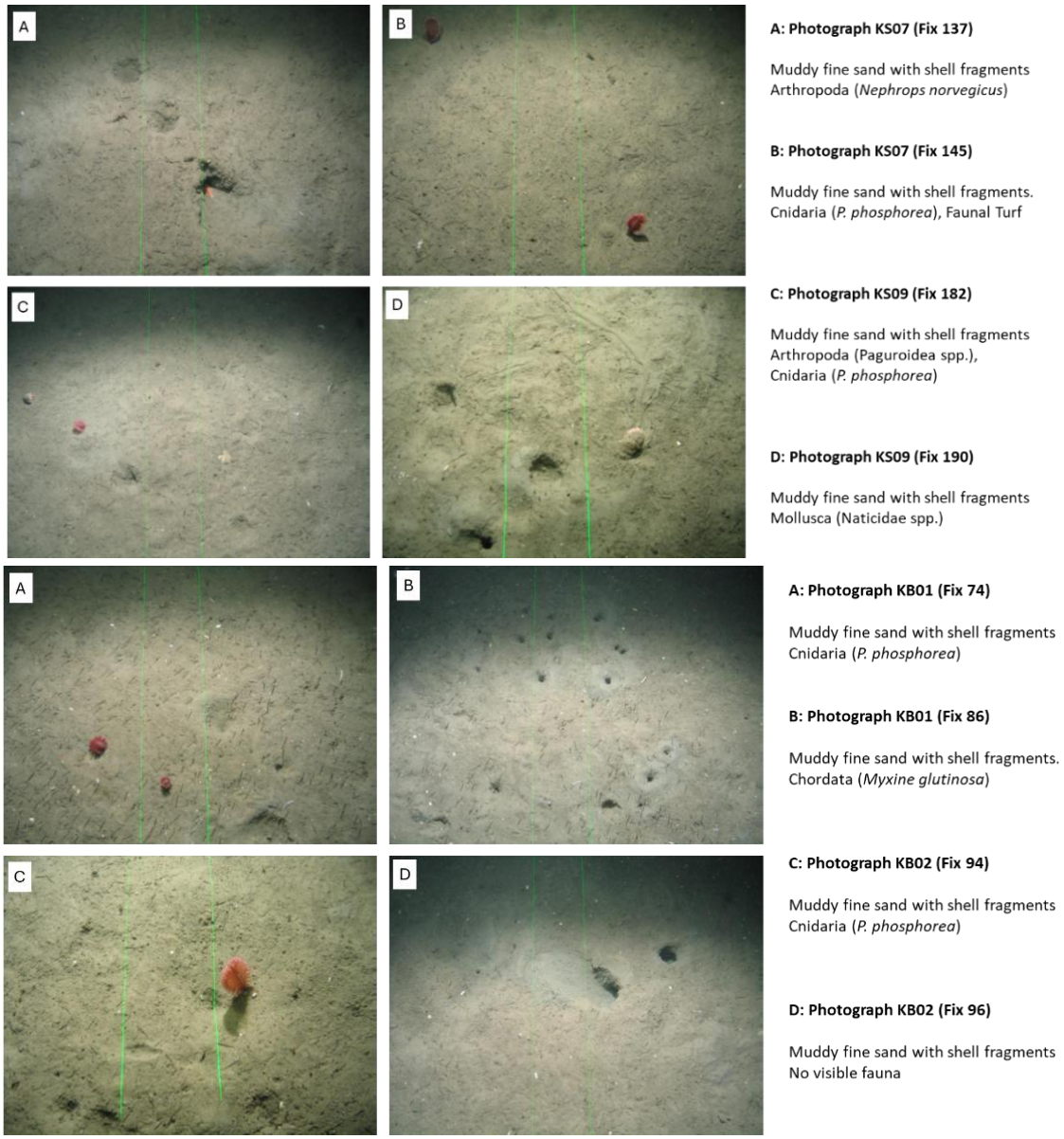
The collective term plankton describes the plants (phytoplankton) and animals (zooplankton) that live freely in the water column and drift passively with the water currents. The Scottish continental shelf typically exhibits a spring phytoplankton bloom, sometimes followed by a smaller autumn peak (DESNZ, 2022).

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). The habitat investigation of the proposed Kyla Development area, based on a detailed review of the seabed imagery (refer to Figure 5) and analysis of the sediment samples, classified the entire survey area into the Level 4 European Nature Information System (EUNIS) biotope complex MD621: Faunal communities of Atlantic circalittoral mud . This deep, relatively stable mud habitat is generally characterized by the presence of sea pens (*Virgularia mirabilis* and *Pennatula phosphorea*), the burrowing anemone *Cerianthus lloydii*, and the brittlestar *Amphiura spp.*, often supporting communities of burrowing megafauna like the prawn *Nephrops norvegicus* (EEA, 2022). Additionally, three stations in the vicinity of the proposed Kyla well location were classified further to level five as EUNIS biotope MD6216: Seapens and burrowing megafauna in Atlantic circalittoral fine mud, reflecting the high visual presence of sea pens (most commonly *P. phosphorea*) and faunal burrows.

Across the entire survey, *P. phosphorea* was the most frequently observed species, while other common fauna included various crabs, shrimps, faunal turf (Hydrozoa/Bryozoa), and flatfish, with burrows and faunal turf present at the majority of locations (Gardline, 2025a). Overall, the benthic community showed high species richness, dominated by Annelids, with community structure primarily driven by natural physical characteristics.

Figure 5: Example Seabed Images within the proposed Kyla Development Area (Gardline, 2025a)



The Kyla HA and EBS paid particular attention to establishing whether or not the following habitats and/or species occurred within the survey area:

- Seapen and burrowing megafauna communities (Burrowed mud);
- Ocean quahog (*Arctica islandica*);
- Herring Spawning Grounds;
- Sandeel Spawning Grounds.

The Kyla survey confirmed the presence of the Seapen and burrowing megafauna habitat, classified as an OSPAR threatened and/or declining habitat across all stations, with sea pen and burrow density reaching the OSPAR "frequent" threshold at most sites, although the specific burrowing megafauna species were rarely confirmed.

The sea pen and burrowing megafauna communities habitat is also listed as a key component biotope within the broader Burrowed mud habitat, which is designated as a Priority Marine Feature (PMF) in Scottish waters. Sediments across the Kyla survey area were classified as muddy sand to slightly gravelly muddy sand, suggesting some ecological similarities to the Burrowed mud PMF.

Ocean quahog (*A. islandica*) is listed as an OSPAR Threatened and/or Declining species and is a PMF in Scottish waters. Thirty-one juvenile *A. islandica* individuals were recorded across the Kyla survey area, with no adults observed within samples.

The Kyla survey determined that the site was unsuitable for both herring and sandeel spawning due to the sediment composition (lack of gravel for herring and high fine content for sandeel).

No other sensitive habitats or species of conservation interest were observed within the Kyla survey area.

The North-East Atlantic and North Sea is split into statistical grids called International Council for the Exploration of the Sea (ICES) Rectangles in order to map statistical information about the area. A number of fish species are likely to be present within the Kyla Development area within ICES Rectangle 42F1. Species that may spawn within the vicinity include cod, lemon sole, mackerel (high intensity), Norway pout (high intensity), and sandeel (although, as noted above, the Kyla survey indicates the area is unsuitable for sandeel spawning). The area surrounding the Kyla Development may also act as a nursery grounds for Anglerfish, blue whiting, cod (high intensity), European hake, haddock, herring, ling, mackerel, Norway pout, plaice, sandeel, spurdog (also known as spiny dogfish) and whiting (Coull et al., 1998; Ellis et al., 2012b). Species of sharks, skates and rays may also be present in the vicinity of the Kyla Development, including cuckoo skate, lesser-spotted dogfish (small spotted catshark), spurdog (spiny dogfish) and starry ray / thorny skate.

A number of seabird species are present in the vicinity of the Kyla Development area throughout the year; including fulmar, kittiwake and guillemot over winter, and fulmar during the breeding season. The proposed Kyla Development area is located approximately 182 km from the nearest UK coast and is therefore remote from sensitive seabird breeding areas. Seabird Sensitivity to Oiling in the Kyla Development area is low all year round, bar November, where no data was available for any block (Webb et al., 2016).

Species of marine mammals likely to be present in the waters of the CNS, and the vicinity of the proposed Kyla Development include bottlenose dolphin, harbour porpoise, Risso's dolphin, common dolphin, minke whale, white-beaked dolphin and white-sided dolphin (IAMMWG, 2022; Reid et al., 2003). Additionally, fin whale have been observed in the waters surrounding the proposed development (Gilles et al., 2023). The distribution of grey and harbour seals in the proposed Kyla Development area is predicted as very low (Carter et al., 2022).

The proposed Kyla Development area is located 13.4 km south of the East of Gannet and Montrose Fields Nature Conservation Marine Protected Area (NC MPA), designated for the protection of ocean quahog (*Arctica islandica*) aggregations. No other MPAs are located within 40 km of the proposed Kyla Development area.

Human Environment

The North Sea has important fishing grounds and is fished throughout by UK and international fishing fleets, targeting a mix of demersal, shellfish and pelagic fish stocks. Commercial fishing can be quantified by landings (catch weight and monetary value) and effort (days fished). The proposed Kyla Development is located within ICES Rectangle 42F1. Across a ten year period from 2015 – 2024 the most valuable species caught in terms of average weight and monetary value from ICES Rectangle 42F1 were *Nephrops* (Norway Lobster), herring and Monks or Anglers (Marine Scotland, 2015; Marine Scotland, 2020; SG-MD, 2025). Fishing effort within ICES Rectangle 42F1 is low, with the most popular gear used to target fisheries being trawls. A regional fishing intensity study focused on the Bittern to Triton FPSO pipeline also indicates that fishing activity is relatively low in the area (Xodus, 2025).

The Kyla Development is located within an area which experiences moderate volumes of routine shipping traffic compared to the other North Sea areas. Shipping lane traffic (including cargo vessels and tankers) and in-field traffic (defined as vessels operating within the hydrocarbon field complex) contribute almost equally to the routine traffic in the area.

Apart from Bittern, the closest producing field to Kyla is the Starling subsea gas field (operated by Adura), located in UKCS Block 29/3a approximately 12 km to the northeast, which is tied back to the Shearwater platform. The nearest FPSO is the Triton FPSO (operated by Dana) which is located approximately 20 km northwest of the Bittern DCB manifold and 30 km northwest of the proposed Kyla well. The nearest platform to the proposed Kyla well is the West Franklin platform (operated by Total Energies) which is located approximately 36 km northeast. The nearest platform to the Bittern DCB manifold is the Gannet A platform (operated by Adura) located approximately 30 km north. The Belinda field which is currently in development (expected to be producing in Q1 2026) is located approximately 14 km north of the Bittern DCB manifold and 24 km northwest of the proposed Kyla well.

Two active pipelines cross with the proposed Kyla pipeline route, the CATS pipeline (PL774) operated by the Wood Group and the Langeled pipeline (PL2071) operated by GASSCO AS (NSTA, 2025c). No submarine cables cross the proposed Kyla Development area.

There are currently no carbon storage licensing blocks or carbon storage licensing round blocks on offer in the vicinity of the proposed Kyla Development (Crown Estate Scotland, 2025; NMPi, 2025).

There are no dredging or aggregate activities in the vicinity of the proposed Kyla Development (Crown Estate Scotland, 2025).

There are no operational, under construction or consented offshore windfarms in the vicinity of the proposed Kyla Development. The closest offshore windfarm is the Cerulean Winds Cedar Project, currently in the pre-planning stage, located approximately 9.5 km southwest of the Kyla Development which is an Innovation and Targeted Oil and Gas (INTOG) offshore wind project (Crown Estates Scotland, 2025).

In addition, there are no military Practice and Exercise Areas or wrecks designated as historic Marine Protected Areas, scheduled monuments or war graves within the vicinity of the proposed Kyla Development.

The risk of interaction with tourism and leisure-based activities is extremely low given the far offshore location of the proposed Kyla Development (ca. 182 km from Peterhead on the eastern Scottish coastline).

Identification and Assessment of Potentially Significant Impacts

The EIA process undertaken for the Kyla 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 Kyla 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 commercial fishing).

The temporary presence of the MODU and other working vessels, at the surface can pose a navigation hazard, and may lead to an accidental event such as a collision. The greatest increase in vessel presence in the Kyla Development area will be before and during drilling operations, during installation of the subsea infrastructure and, following CoP, during decommissioning operations. However, any discernible increase in vessel presence in the area will be temporary in nature. The risk of a collision will be minimised by implementing measures, including temporary establishing a 500 m safety zone around the MODU during the proposed drilling operations, which will be patrolled by an Emergency Rescue and Recovery Vessel (ERRV) equipped with an Automatic Identification System (AIS) and/or Automatic Radar Plotting Aids (ARPA). Notifications to other sea users will be issued via Notices to Mariners and Kingfisher Bulletin to communicate the location of the works.

Although the 500 m safety zone around the MODU will be temporary, Serica will apply for a 500 m safety zone to be in place around the subsea infrastructure at Kyla drill centre once the drilling operations are complete. Vessels will therefore be excluded from an area of 0.8 km^2 throughout the life of the field, however, this represents a very small proportion of the entire fishing area available in the CNS. To further reduce the risk of snagging; the Kyla xmas tree and Kyla valve skid, as well as the potential tie-in structure at Bittern (which will be located within an existing 500 m safety zone) will be designed to be 'fishing friendly'. Where concrete mattresses are used as part of the pipeline crossings design, or in other open wate relocations outside the 500 m safety zones at Bittern and Kyla, rock cover will be provided to minimise risk of snagging with fishing gear.

Fishing vessels (particularly benthic trawlers and those with pelagic mobile gear) may also be temporarily displaced from a slightly larger area of ca. 8 km^2 as a result of the MODU anchors and ground chains, which will extend outside the 500 m safety zone. 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. The MODU anchors and mooring lines will be pre-laid on the seabed up to 20 days ahead of MODU arrival and will remain in place for up to 20 days following the MODU departure. To reduce the snagging risk during this period, if required a guard vessel will be used to deter vessels from the area, thereby preventing potential interaction with the mooring lines while the MODU is not on location.

During subsea installation activities, the main risk of snagging will be after pipe lay, pending trenching and burial. To minimise this risk, whilst installation activities are ongoing, a guard vessel will be used to patrol the length of the lines. Following pipeline trenching and burial operations, Serica will liaise with the Scottish Fishermen's Federation (SFF) to ameliorate any safety risks for the fishermen in the event mud berms are left behind, although this is considered unlikely given the sandy nature of the seabed sediments within the Kyla Development area.

In conclusion, no significant adverse residual effects to other sea users (shipping and commercial fishing) are predicted as a result of the physical presence of the MODU (including pre-laid anchors and ground chains) and vessels during drilling, installation, inspection and maintenance and decommissioning activities or the long-term presence of the Kyla subsea infrastructure and associated rock cover and concrete mattress protection.

Seabed Disturbance

The seabed will be disturbed through the mooring of semi-submersible MODU (anchors and ground chains), deposit of drill cuttings and cement and installation of the Kyla subsea infrastructure, including pipelines, umbilical and rock and concrete mattresses for protection, stability and trench transitions. 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. Of note, the Kyla Development area is not located within or near to a MPA. The closest site, the East of Gannet and Montrose Fields NC MPA, designated for the protection of ocean quahog (*Arctica islandica*) aggregations, is located 13.4 km north of the Kyla location.

The Kyla well will be drilled from a semi-submersible drilling rig, which will be held in position over the Kyla location using anchors and mooring chains. It is assumed that the MODU mooring system will consist of eight anchors and mooring lines, with all anchors laid up to a distance of 1,600 metres (m) from the rig centre. The total area of seabed which will be temporary disturbed from the mooring of the MODU is estimated to be ca. 76,272 m^2 (0.0763 km^2). Direct impacts include the compression of the seabed where anchors settle, and localised abrasion damage to habitats and species caused by the continuous sweeping motion of mooring lines (ground chains and pennant wires). Furthermore, the retrieval process can leave scars and anchor mounds on the seabed. Indirect effects involve sediment re-suspension and subsequent smothering of seabed habitats and species. However, impacts to seabed sediments and communities will be localised and are only predicted to persist in the short to medium term given the sediment type and moderate energy environment of the Kyla location.

As a worst case, it has been assumed that the drill cuttings discharged from the Kyla well (up to 2,387 tonnes) have the potential to be deposited within an area of up to 0.12 km^2 surrounding the release location (based on a threshold for bottom deposition of 1.0 mm) (RPS, 2025). Any cement pumped to the seabed during cementing operations will also be deposited within this area. In the CNS, near-bed current velocities and sediment mobility are generally sufficient to prevent detectable local accumulation of cuttings, as seen during the pre-decommissioning survey for the Kyle field, which did not identify a discernible physical cuttings pile. For the Kyla well, the deeper wells sections will be drilled with LTOBM. In the event that the LTOBM contaminated cuttings are discharged, thermal cuttings treatment will be used to treat the cuttings to an acceptable overboard disposal limit (<1% oil on cuttings), thereby resulting in no significant changes to the natural benthic community or re-colonisation of the seabed.

Installation of the Kyla subsea infrastructure, particularly the trenching and backfill operations during pipeline and umbilical installation, will also result in temporary disturbance to seabed from sediment suspension and re-settlement within an area of ca. 0.623 km^2. However, given the relatively fine nature of the sediment at Kyla any sediment plumes or re-suspended sediment will tend to settle quickly and will not be prolonged or affect large areas. It is acknowledged that the Kyla survey confirmed the presence of the seapen and burrowing megafauna habitat, classified as an OSPAR threatened and/or declining habitat within the proposed Kyla Development area. However, the species that inhabit this type of benthic habitat are deemed to be highly recoverable and the area impacted will be relatively small. In addition, high rates of siltation may adversely affect ocean quahog, an OSPAR threatened and/or declining species, but any mortality caused to individual specimens as a result of the proposed operations is not considered to be significant given that impacts will be highly localised.

Exposure to increased turbidity caused by the proposed Kyla Development operations may also 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. 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 nursery areas in adjacent locations.

Installation of the Kyla subsea infrastructure will result in the loss of some sandy and muddy sediment habitat, and also the introduction of novel hard substrata. The total area of sandy sediment habitat permanently lost is estimated to be approximately 0.115 km^2 for the life of the Kyla Development (ca. 8 years) and beyond depending on how the infrastructure is decommissioned. This area is small in comparison to the area of similar habitat available across the wider area. The area beneath the subsea infrastructure, rock and concrete mattresses will become unavailable for re-colonisation by sandy and muddy 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 Kyla 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.

In summary, no significant adverse residual effects to seabed sediments, seabed communities and fish are predicted from seabed disturbance associated with the Kyla Development operations.

Underwater Noise Emissions

Underwater noise emissions generated during the proposed Kyla Development have the potential to disturb, or cause injury to, a number of species in the marine environment, particularly fish and marine mammals. However, the only Kyla Development activity which results in underwater noise emissions with the potential to result in significant effects on marine fauna is the potential piling operations during the installation of the valve skid at the proposed Kyla well location and the tie-in structure, if required, at the Bittern manifolds (DCA or DCB). The maximum piing duration per structure is anticipated to be up to 8 hours. It is acknowledged that the vessels associated with drilling, subsea installation, inspection and maintenance and decommissioning operations will generate underwater noise of a continuous nature, but this will only cause temporary and localised changes in distribution of marine mammals and fish in the immediate vicinity of the vessel. In addition, the noise emissions from construction activities e.g. trenching or rock placement, are usually dwarfed by the noise emissions from the vessels themselves.

To reduce the risk of injury or behavioural disturbance to marine mammals and fish from the proposed piling operations, Serica will ensure that the Joint Nature Conservation Committee (JNCC) protocol for minimising the risk of injury to marine mammals from piling noise is followed (JNCC, 2010b). Piling operations will therefore not commence until monitoring confirms that a 500 m “mitigation zone” is clear of marine mammals and soft-starts will be incorporated into the piling schedule design. As such, it is possible that marine fauna may be subject to short term behavioural effects as a result of the underwater noise emissions generated from the proposed Kyla Development, but impacts will be mitigated such that any residual effects are not predicted to be significant.

Greenhouse Gas Emissions

GHG emissions to the atmosphere will be produced during the life of the Kyla Development. These emissions can be categorised into:

- Scope 1 emissions, the direct GHG emissions a company produces from its own operations;
- Scope 2 emissions, GHG emissions associated from the energy a company purchases (non-applicable to this ES); and
- Scope 3 emissions, which include other GHG emissions upstream (indirect) (from e.g. transportation) and downstream (indirect) (e.g. end use of sold products).

During the development of the Kyla field, combustion of hydrocarbons for power generation on the MODU, vessels, and helicopters, will result in atmospheric emissions, referred to as ‘indirect, upstream scope 3 emissions’.

During the production phase, hydrocarbons from the Kyla field will be processed at the Triton FPSO with processing equipment and support facilities shared with several other producing assets. This minimises the incremental energy demand caused by the development. The incremental GHG emissions associated with processing at Triton as a result of Kyla coming online, for the purposes of this assessment, are identified as ‘Scope 1 emissions’ as Kyla production is controlled by Serica. In addition, Serica has significant interest in Triton (holding a 46% equity interest in the asset) and therefore has influence over the operator of Triton (Dana).

Once the hydrocarbons have been processed on Triton, oil is typically tankered to Rotterdam where oil volumes are integrated into the wider European oil sales market and converted into usable fuels such as gasoline, diesel, and jet fuel. Gas is piped from Triton to the St Fergus terminal where it enters the UK’s national transmission system and is delivered to end users, such as gas-fired power stations, large industrial users, or regional gas distribution networks that connect to individual homes and businesses.

Once the Kyla hydrocarbons have been processed at the Triton FPSO and sold, further GHG emissions will arise from transportation, further processing and distribution, as well as from the end use of the sold product (namely, the presumption that all end use Kyla hydrocarbons are eventually combusted). Collectively, these emissions are referred to as 'indirect downstream Scope 3 emissions'.

In summary, the total gross GHG emissions generated over the life of the Kyla Development are estimated to be ca. 7,134.45 kilotonnes of carbon dioxide equivalent (CO_2e), based on the High production case (P10 profile), which represents the highest emissions generated from the Kyla P10 production profiles. It should be noted, however, that there is only a 10% probability that recovered volumes will meet or exceed the P10 case estimate. Scope 3 emissions represent by far the largest component of the total GHG emissions generated over the life of the field (ca. 81%).

The total gross GHG emissions generated as a result of the proposed Kyla Development are considered to be compatible with global emissions reduction pathways and targets, including those set out by The Paris Agreement. The Paris Agreement is a legally binding international treaty adopted in 2015 that commits countries to limit global warming to under 2°C above pre-industrial levels and pursue efforts to keep it below 1.5°C. Future global GHG emissions will be dependent on the success of international collaborative efforts to decarbonise the global energy system; however, Kyla's contribution represents a very small fraction of projected global GHG emissions under the IPCC's low (SSP1-2.6) emissions pathway consistent with limiting warming to 2°C (ca. 0.00320% of median global GHG emissions in 2030). Kyla will also contribute a very small percentage towards predicted global oil and gas production rates in international pathways consistent with limiting warming to under 2°C (ca. 0.00602% in 2030 and ca. 0.00321% in 2035 of global oil production and ca. 0.00113% in 2030 and ca. 0.00059% in 2035 of global gas production). Of note, Kyla will cease production in or before 2038, well before the global target for Net Zero emissions by 2050. Development of the Kyla field is therefore not expected to affect the trajectory of global temperature rise or the achievement of international climate targets in a significant way on its own.

In a national context, the GHG emissions associated with the Kyla development represent a small proportion of GHG emissions typically arising from oil and gas developments in the UKCS and will contribute a small fraction of CO_2e emissions towards future UK carbon budget targets (ca. 0.28549% of Carbon Budget 5 and ca. 0.21826% of Carbon Budget 6) and the UK's Nationally Determined Contribution (NDC) commitments (ca. 0.50692% of the 2030 NDC inventory target and ca. 0.41615% of the 2035 NDC inventory target). Given these non-significant proportions, the GHG emissions generated by the Kyla Development would have no material influence on the UK's ability to meet its Carbon Budget and NDC emissions reduction targets.

Notwithstanding the above, it is recognised that the proposed Kyla Development will contribute to global GHG emissions in combination with the other projects and activities emitting GHG emissions. Serica is committed to minimising the amount of GHG emissions produced, with the chosen development concept for Kyla representing one of the lowest carbon emissions impact means of recovering the remaining hydrocarbons in the Kyla field. During drilling and installation operations, vessel days and fuel consumption will be reduced, as far as practicable. Responsibility for identification and implementation of emissions reduction initiatives at Triton resides with the Triton FPSO operator (Dana). However, Serica (as the operator of Kyla) will support Dana as they continue to assess and implement reasonable decarbonisation strategies for Triton FPSO. Since the use of the produced products is not within the control of Serica, no mitigation measures that could be taken by the Kyla Development to reduce Scope 3 downstream emissions are available to implement.

The UK Net Zero Growth Plan (DESNZ, 2023b) acknowledges that fossil fuels will retain a crucial role in the energy system until there are credible clean energy alternatives that can replicate their role. The Independent Review of Net Zero (Mission Zero, 2023) also recognises that in the short term the UK will still need oil and gas to secure our energy independence and as transition fuels towards 2050. In addition, the global demand for oil, particularly for use in petrochemical feedstocks and heavy transport, is forecast to persist through the energy transition period (IPCC, 2022; IEA, 2025). Furthermore, the UK is the second largest oil producer in Europe, a market with a massive oil supply deficit, meaning the UK is critical to Europe's integrated energy system exporting crude oil and importing refined oil products largely within the Northwest European market (OEUK, 2025c).

Over the life of the Kyla field, the Triton FPSO with the input of Kyla will have an average carbon intensity of 29.9 kg carbon dioxide per barrel of oil equivalent (CO_2/boe) in the unabated scenario, decreasing to 23.3 kgCO_2/boe if all abatement projects identified in the Triton Emissions Reduction Action Plan (ERAP) are implemented over the period from 2028 to 2035. In comparison, the average carbon intensity for FPSOs in the CNS in 2024 was 30.5 kg CO_2/boe. When filtering by installation age (>25 years old) this increases to 37.5 kgCO_2/boe (NSTA, 2025b). The emissions intensity for UKCS offshore fields in 2024 was 24.0 kg CO_2/boe (NSTA, 2025a).

By operating within an already-licensed area (the previously decommissioned Kyle field) and maximising use of existing North Sea oil and gas infrastructure, Kyla contributes to maintaining secure domestic supply during the UK's broader energy transition while ensuring responsible stewardship of remaining offshore reserves.

Given the above, in a Paris Aligned oil and gas production pathway, the effect of the Kyla Development's GHG emissions on the global climate is therefore not considered to be significant.

Marine Discharges

The main operational discharges into the marine environment from the proposed Kyla Development will occur as a result of the discharge of drill cuttings, muds and cement during drilling, the discharge of chemicals during drilling, hook-up and commissioning of subsea infrastructure, subsea intervention activities and decommissioning operations, as well as the incremental increase in produced water discharges at the Triton FPSO (host facility) as a result of Kyla coming online.

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.

Serica 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.

For assessment purposes, thermal cuttings treatment is being evaluated to treat the LTOBM contaminated cuttings to an acceptable overboard disposal limit (<1% oil on cuttings). If not selected / considered to be feasible, the LTOBM contaminated cuttings would be skipped and shipped onshore for disposal.

During the production operations, any discharges of residual reservoir hydrocarbons in the produced water stream will be treated to meet oil in water limits of the Triton Oil Discharge Permit SAT. The discharge streams will also be monitored and sampled in accordance with the permit conditions.

Accidental Events

All offshore activities associated with the Kyla 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, Serica'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 Kyla Development would be an uncontrolled and unmitigated subsea blowout scenario from the Kyla well, releasing ca. 867,861 m^3 of crude oil to the marine environment over 132 days (time it takes to drill a relief well). Oil spill modelling has been conducted to determine the fate of Kyla hydrocarbons released from this worst case scenario. Given the proximity to the UK/Norway median line, located approximately 72 km east of Kyla, there is a 100% probability for a surface slick of oil to cross the median line in all seasons. Other median lines which could be crossed include Denmark (83% in winter), Germany (56% in winter), Sweden (54% in winter) and the

Netherlands (41% in winter). The highest probability of shoreline oiling on the UK mainland is 39% in spring, with the shortest arrival time after 23 days in summer, although the risk of shoreline oiling is highest in Denmark in the winter (57%), with beaching occurring after 34 days. However, the Kyle crude is an ITOPF Group 2 (37.8° API) oil that undergoes rapid evaporation, dispersion and biodegradation upon release, and concentrations decline quickly following cessation of any blowout, and the oil is not predicted to persist in the water column, at the sea surface, or on the shoreline.

The risk of an accidental release occurring from the Kyla Development will be minimised through the implementation of physical barriers such as downhole safety valves, maintenance and inspection to minimise the risk of any leaks, and the development and implementation of handling and operational procedures and training. Measures to respond to a spill from the MODU or the Kyla subsea facilities once operational will be covered in approved oil pollution emergency plans (OPEP), 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 Kyla Development is considered to be Medium to Low depending on the receptor impacted, but in all cases the risk has been reduced through mitigation measures and good industry practice and is therefore not considered to be significant.

Waste Management

Several different waste streams will be generated throughout the lifespan of the Kyla Development. Waste management will be undertaken in compliance with current environmental legislation and Serica's own waste procedures which includes the waste hierarchy; Prevent, Re-use, Recycle, Recover, Disposal (from most favourable to least favourable). The management of offshore waste generated on the UKCS is strictly regulated and the UK has well-established infrastructure in place to manage this waste effectively.

Environmental Management

Serica Energy Chinook Limited is a subsidiary of Serica Energy plc and operates under the Group's policies. Serica's Operations Management System (OMS) provides the framework for systematic management of Health, Safety, Environmental and Quality (HSEQ) across the Serica organisation and is designed to ensure the delivery of safe, environmentally responsible, and reliable operations in accordance with defined policies, practices, procedures and standards.

The structure and content of the OMS recognises the principles of ISO 14001 (Environmental Management Systems) and ensures that risks to the environment are reduced to As Low as Reasonably Practicable (ALARP). This system provides the structured management framework within which environmental impacts are identified, assessed, controlled, and monitored.

Serica's Environmental Management System (EMS) was successfully verified against the requirements of OSPAR 2003/5 in April 2025. The Serica 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 Kyla Development are detected.

Conclusion

In summary, it is concluded that the proposed Kyla Development will not result in any significant environmental effects provided that all identified mitigation measures are implemented. Serica's 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 Kyla Development In addition, no significant in-combination, cumulative or transboundary effects are considered likely to arise from the proposed Kyla Development.

1 Introduction

1.1 Background

Serica is planning to develop the Kyla oil field located in UKCS Block 29/2c in the CNS, approximately 196 km to the southeast of Peterhead on the Scottish coastline and 72 km to the south west of the UK/Norway transboundary line (Figure 1.1). Kyla (previously developed as 'Kyle') is a ceased-production oil field which sits within Licence P.2616 at a water depth of approximately 90 m. Serica was awarded 100% equity and operatorship of Licence P.2616 in the 33rd Licence Round on 1st December 2023.

The Kyle field was originally developed via four subsea production wells, with first oil achieved in 2000. The wells were tied back to the Curlew FPSO facility before being re-tied back to the Banff FPSO in 2005. The Kyle field ceased production following sand control issues with one of the wells and was decommissioned, along with the Banff FPSO, in 2020. All textual references within this ES have been updated to reflect the fact that the Kyle field has been renamed the Kyla field, although some diagrams, and drawings may still display the former Kyle field name.

Serica is proposing to develop the Kyla field via a single subsea well tied back via a 12 – 13.2 km (depending on the precise tie-in point) long production pipeline, gas lift pipeline and umbilical to one of the existing Bittern drill centre manifolds (either DCA or DCB). Tie-in to the Bittern DCA manifold is the base case, however the DCB manifold has been considered as the back-up case option.

The Bittern manifolds are in turn tied back to the Triton FPSO, with both assets operated by Dana. Kyla hydrocarbons will be processed on the Triton FPSO with Kyla oil exported as part of the Triton FPSO blend via shuttle tanker and sales gas routed with other Triton area gas to the St Fergus terminal onshore via the Fulmar gas pipeline.

In order to obtain a Development and Production Consent for the Kyla Development project, Serica is required to submit a Field Development Plan (FDP) to the North Sea Transition Authority (NSTA). As the proposed Kyla Development will extract more than 500 tonnes of oil per day, the FDP must be supported by an ES, which needs to be submitted to the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) for approval under The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020.

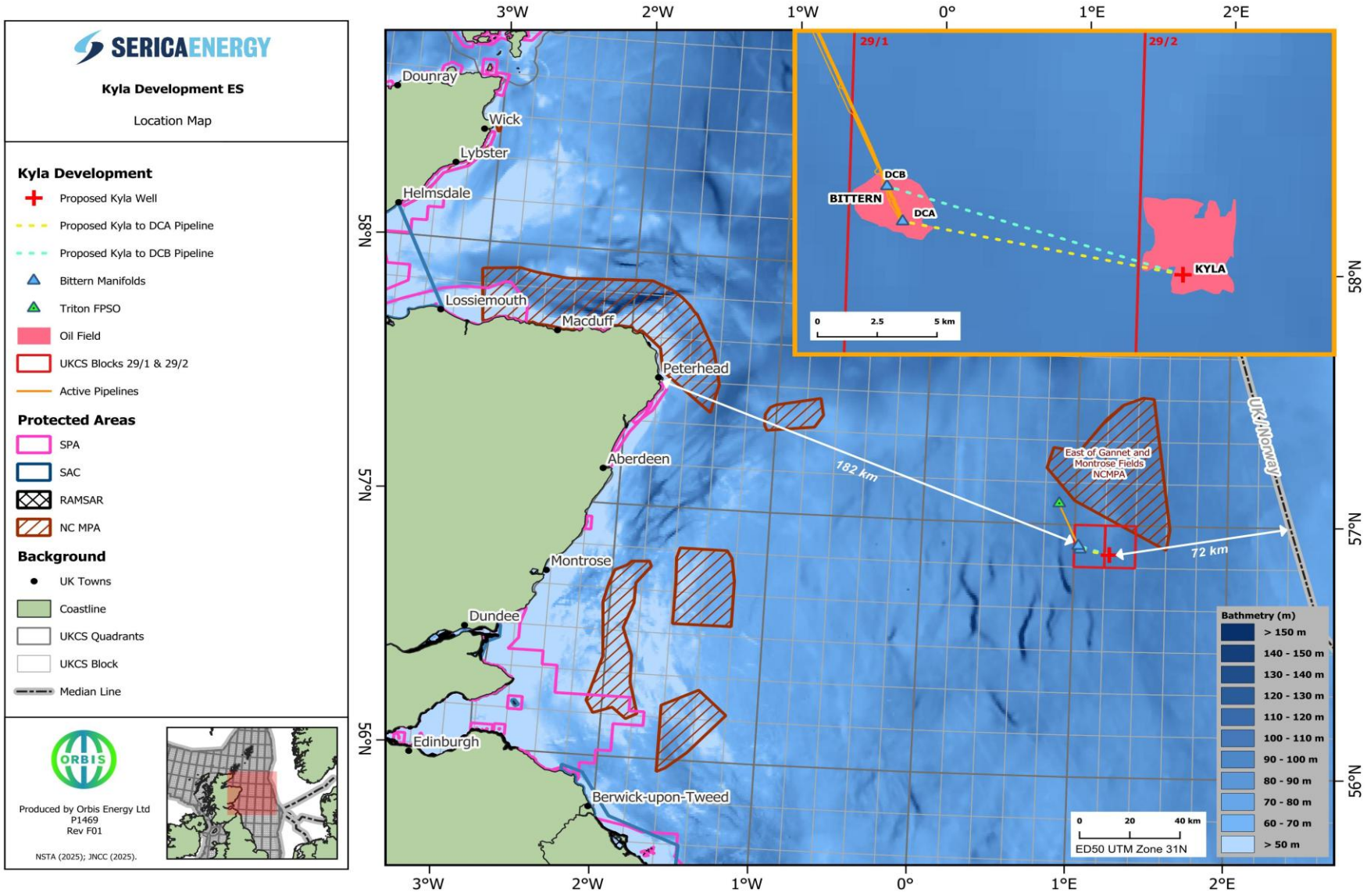
This document is the ES for the proposed Kyla Development (the "Project") and presents the findings of the EIA undertaken to determine if the Project is likely to have any significant effects on the environment.

1.2 Project Overview

It is proposed to develop Kyla via a single subsea horizontal well located in UKCS Block 29/2c, drilled from a semi-submersible MODU.

Kyla production fluids will be exported via a new 12 to 13.2 km long 8-inch production carbon steel pipeline to either the Bittern DCA (base case) or Bittern DCB manifold located in UKCS Block 29/1. From Bittern, Kyla production will be co-mingled with Bittern production and routed via the existing Bittern pipelines to the Triton FPSO located in UKCS Block 21/30. The Triton FPSO is operated by Dana (52% equity), with joint venture partners Serica (46%) and Waldorf Petroleum Resources Limited (2%). The Triton FPSO has suitable process facilities and spare capacity to support and service Kyla with relatively minor topsides modifications. Kyla production will be processed on Triton with oil exported as part of the Triton FPSO blend via shuttle tanker and sales gas routed to the St Fergus terminal, located near Peterhead on the North East coast of Scotland, via the Fulmar gas pipeline.

Figure 1.1: Location of the Proposed Kyla Development Infrastructure



Production from Kyla will require artificial lift (gas lift), with gas supplied from Triton via Bittern. A 3-inch gas lift carbon steel pipeline will be piggybacked to the Kyla production pipeline to supply gas lift to the Kyla well. An electro/chemical/hydraulic and control umbilical will also be extended from Bittern to Kyla, which will run adjacent to the pipelines.

A 'fishing friendly' valve skid will be installed at Kyla to route gas lift and production fluids to and from the Kyla well and Bittern manifold (DCA or DCB) and act as the connecting point for the Kyla umbilical. There may also be a requirement to install a separate 'fishing friendly' tie-in structure at Bittern, depending on the tie-in arrangement.

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

Table 1.1. Location of Proposed Kyla Development Infrastructure

Aspect	Kyla Drill Centre	Bittern Drill Centre Tie-in Location	
		Manifold A	Manifold B
Location (Lat/Long)	56° 53' 01.13"N; 01° 13' 50.70"E	56° 54' 10.88"N; 01° 02' 14.02"E	56° 55' 2.93"N; 01° 01' 32.60"E
UKCS Block	29/2	29/1	
ICES Rectangle	42F1	42F1	
Distance to nearest coastline (Peterhead)	196 km	183 km	182 km
Distance to nearest median line (UK / Norway)	72 km	83 km	84 km
Nearest Marine Protected Area	13 km SW of East of Gannet and Montrose Fields NCMPA	17 km SW of East of Gannet and Montrose Fields NCMPA	16 km SW of East of Gannet and Montrose Fields NCMPA

[1] ED50 TM 0 N

First oil is currently targeted for Q3 2028. Subject to the necessary permits and consents being in place, drilling, completion and subsea installation activities will be undertaken between Q4 2027 and Q3 2028.

The field is expected to produce hydrocarbons for circa eight years, until 2035, depending on the reserves, the production rate and the life of the Triton FPSO (refer to Appendix G).

On cessation of production, the Kyla infrastructure will be decommissioned in accordance with the requirements of the prevailing UK and International law.

1.3 Scope and Purpose of the ES

The scope of the EIA and resultant ES includes the following Project phases:

- The drilling and completion of the single subsea well at the Kyla field;
- Installation of subsea infrastructure, including production pipeline, piggybacked gas lift pipeline and umbilical, valve skid (at the Kyla well location) and tie-in structure at Bittern to support tie-back of the well to the Bittern drill centre manifold (A or B);
- Operation, maintenance and inspection of the Kyla subsea facilities, including incremental operational greenhouse gas emissions at the Triton FPSO due to Kyla coming online;
- Decommissioning of the Kyla infrastructure on cessation of production.

The purpose of the ES is to provide an assessment of the likely significant environmental effects that may arise from the proposed Kyla Development and to identify the measures which will be put in place to minimise these effects.

The following Project activities have been subject to detailed assessment, as justified in Section 5:

- Physical presence:
  - Presence of drilling rig and/or vessels during drilling, installation, inspection and maintenance and decommissioning activities;
  - Ongoing presence of subsea infrastructure and associated material (rock / concrete mattresses) for protection, stability and trench transitions.
- Seabed disturbance:
  - Mooring of drilling rig and deposit of drill cuttings and excess cement on the seabed during drilling operations;
  - Installation of subsea infrastructure (pipelines and umbilical, valve skid and tie-in structure) and deposit of material (rock / concrete mattresses) for protection, stability and trench transitions.
- Underwater noise emissions:
  - Piling operations to install the Kyla valve skid and tie-in structure.
- Greenhouse gas emissions:
  - Fuel consumed for power generation on the drilling rig, vessels and helicopters during drilling, installation, inspection, maintenance and decommissioning activities;
  - Incremental emissions from the Triton FPSO as a result of processing Kyla fluids;
  - Further refinement, transportation and distribution of Kyla hydrocarbons once they leave Triton, but prior to end use of sold products;
  - Burning of the extracted Kyla hydrocarbons (i.e. end use of sold products, based on the presumption that all end use Kyla hydrocarbons are eventually combusted).
- Marine Discharges:
  - Discharge of drill cuttings at the sea surface;
  - Discharge of drilling, cementing, completion and rig chemicals during drilling operations;
  - Discharge of chemicals during hook-up and commissioning of subsea infrastructure, including commissioning and preservation fluids;
  - Incremental increase in produced water discharges at the Triton FPSO (host facility) as a result of Kyla coming online and discharge of entrained reservoir hydrocarbons and production chemicals;
  - Discharge of chemical or hydrocarbons during subsea intervention activities and during decommissioning operations.
- Accidental Releases:
  - Well blowout (releasing large quantities of oil) in the event of a loss of well control;
  - Drilling rig or vessel collision (loss of diesel inventory);
  - Production pipeline rupture and subsequent release of hydrocarbons to sea.

1.4 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 Kyla Development (the Project) and its main environmental impacts and proposed mitigation measures.
Main Document	
Section 1: Introduction	Introduces the Project, outlines the scope and purpose of the ES, lists applicable environmental legislation, identifies areas of uncertainty and summaries the key issues raised during the stakeholder engagement process.
Section 2: Project Alternatives	Outlines the main concept options (alternatives) considered for the Project.
Section 3: Project Description	Describes the subsea infrastructure to be installed for the Project and provides an overview of each lifecycle phase of the Kyla Development, including drilling, installation, production, inspection and maintenance, and decommissioning activities.
Section 4: Existing Environmental Baseline	Describes the baseline environment in the Project area, with particular emphasis on those aspects which are likely to be affected by the proposed development activities.
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: Waste Management	Provides a high-level description of Serica's waste management strategy for the Project.
Section 13: Environmental Management	Describes Serica's EMS and the management processes that will be applied throughout the Project to ensure adverse impacts on the environment are minimised. Includes a register of Project commitments.
Section 14: Conclusions	Reports the conclusions of the EIA process.
Section 15: References	List sources of information referenced throughout the ES.
Section 16: Glossary	A list of a list of technical terms with definitions.
Appendices	
Appendix A: Legislation and Marine Policy	Provides a summary of applicable environmental legislation and marine policy pertinent to the Project.
Appendix B: ENVID Registers	Presents the results from the ENVID workshop undertaken for the Project.
Appendix C: Drill Cuttings Modelling	Presents the results of the drill cuttings and muds dispersion modelling study undertaken for the Project.
Appendix D: Underwater Noise Modelling	Presents the results of the underwater noise modelling study undertaken for the Project.
Appendix E: Quantification of GHG Emissions	Sets out the methodology (calculations, emissions factors and assumptions) used to quantify the total greenhouse gas (GHG) emissions generated from the Project.
Appendix F: Oil Spill Modelling	Presents the results of the oil spill modelling study undertaken for the Project.
Appendix G: Production Profile Tables	Presents the Kyla Development high, low and mid case production profiles.

1.5 Legislation and Policy Framework

1.5.1 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 regulate and influence the UK oil and gas industry, supporting UK energy security and helping to drive North Sea energy transition.

The Petroleum Act is supplemented by various environmental Acts and Regulations. 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 Energy Security and Net Zero (DESNZ).

The EIA undertaken for Kyla as reported in this ES has been carried out 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 a development and production consent must be supported by an ES. The Kyla Development qualifies as a Schedule 1 project as it will involve the extraction of oil for commercial purposes where the amount extracted exceeds 500 tonnes per day. The EIA has been undertaken with reference to the Offshore EIA Regulations Guidance (DESNZ, 2021), as well as the new supplementary guidance for assessing the effects of downstream scope 3 emissions on climate from offshore oil and gas projects (DESNZ, 2025c).

Other environmental Acts and Regulations pertinent to the proposed Kyla 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 (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 this 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.

1.5.2 Marine Planning Policy

The Marine and Coastal Access Act 2009 and The Marine (Scotland) Act 2010 established a 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 (nm).

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;
- 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 Kyla Development has been assessed against all relevant NMP objectives and policies (see Appendix A for further details).

1.5.3 UK Government's Energy Policy and Net Zero Target

The UK's Climate Change Act 2008 (as amended) sets a legal requirement to achieve a 100% reduction in net greenhouse gas (GHG) emissions by 2050 relative to 1990 levels ('Net Zero'). This delivers on the commitment that the UK made by signing the Paris Agreement[1].

The North Sea Transition Deal (BEIS, 2021) sets out a plan for how the UK's offshore oil and gas sector and the UK Government will work together to meet certain GHG emissions reduction targets, including development and implementation of the NSTA's Net-Zero Asset Stewardship Expectation 11 (NSTA, 2021). The deal includes reductions in offshore production emissions of 25% by 2027; and 50% by 2030, against a 2018 baseline, in line with the aim of creating a Net Zero basin by 2050.

Further requirements for the oil and gas industry to meet the UK's Net Zero obligation are outlined in the OGA Plan to reduce UKCS GHG emissions (NSTA, 2024a), which builds on and consolidates guidance on flaring and venting and the NSTA's Net-Zero Asset Stewardship Expectation 11.

In October 2025, the UK Government published the Carbon Budget and Growth Delivery Plan (CBGDP) (HM Government, 2025) which sets out how the government plans to meet its statutory carbon budgets (five-year caps on emissions levels set under the Climate Change Act 2008).

Following this, in November 2025, the UK Government published the North Sea Future Plan (DESNZ, 2025b), which outlines a comprehensive strategy aimed at managing the North Sea's oil and gas resources while transitioning to clean energy. Further information on UK climate legislation and policies designed to reduce GHG emissions and reach Net Zero by 2050, including sector specific strategies of relevance to the proposed Kyla Development, is provided in Section 9.3.

1.6 Areas of Uncertainty

This ES has been prepared prior to detailed engineering studies being conducted. As a result, some uncertainties have been carried during the EIA process, including:

- The Kyla Development well (via Kyla valve skid) will be tied back to the Bittern DCA manifold (base case) however the DCB manifold has been considered as a back-up case option. This will be confirmed during detailed design. The Bittern manifolds are located approximately 2 km from each other and are both suitable for connecting the Kyla production, gas lift and electro/chemical/hydraulic and control umbilical services. For the purposes of this ES, the

[1] The Paris Agreement aims to restrict global temperature change to well under 2°C, and pursue efforts to keep it below 1.5°C.

longest tie-back which is to the DCB manifold has been assessed as this represents the worst case scenario.

- LTOBM will be used to drill the lower sections of the Kyla Development well. For the purposes of the ES, thermal cuttings treatment is being evaluated to treat the LTOBM contaminated cuttings to an acceptable overboard disposal limit (<1% oil on cuttings). If not selected / considered to be feasible, the LTOBM contaminated cuttings would be skipped and shipped onshore for disposal.
- Depending on the tie-in arrangement, there may be a requirement to install a 'fishing friendly' tie-in structure at Bittern. The potential tie-in structure at Bittern and the proposed valve skid at Kyla will either be piled or gravity based structures. For assessment purposes, a piled structure has been assessed from an underwater noise perspective and the gravity based structure has been assessed for seabed disturbance as it has a larger footprint.
- The pipeline and umbilical will be trenched and buried, similar to the other lines which form part of the Triton area. Trenching may be carried out using a pipeline plough (worst case), jet trenching tool or mechanical cutter.
- To assess the effects of downstream scope 3 emissions on climate from the Kyla Development, Serica has made the assumption that all end use Kyla hydrocarbons are eventually combusted (refer to Section 9). This assumption is consistent with the guidance for assessing the global environmental impacts of proposed oil and gas projects issued by DESNZ in June 2025.

1.7 Key Stakeholder Engagement

In September 2025, as part of the informal stakeholder engagement process, Serica issued a Scoping Report to OPRED, JNCC, SFF and the Scottish Government Marine Directorate (SGMD). The Scoping Report provided an overview of the Project and the impacts to be assessed in the ES, with recipients of the report invited to comment on the Project and scope of the ES. The feedback received and how the issues raised have been considered during the EIA process and, where applicable, addressed in this ES are detailed in Table 1.3.

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

Organisation	Comments Raised	Considered by the Project / Addressed in ES
OPRED	Serica should ensure there is clear and appropriate demonstration of the reasonable alternatives for the development in the assessment.	Concept Screening for Host Facility and Tie-Back Options is detailed in Section 2.2.
	Whilst exact detail is not required, OPRED expect a submission to provide a high-level overview of decommissioning considerations and a written commitment that any infrastructure installed is capable of being removed at end of field life. Particularly, you should note the UK's clear seabed policy and be fully familiar with the Department's decommissioning guidance. OPRED (ODU) expect that all new bundles are to be removed at end of field life (i.e. they are not subject to comparative assessment). Please consider whether your proposals would fit that category and be subject to that particular obligation. In additional, given the short life of the field (8 years), the ES should also consider what design and/or construction methods have been considered with easier and perhaps less damaging decommissioning in mind (such as minimising rock dumping so that pipelines can more easily be removed, post operational phase).	Decommissioning considerations for the Kyla Development are identified in Section 3.6
	Serica's consideration of Net Zero and their policies/practices etc. for achieving this will need to be included for construction/drilling and commissioning and operational phases, for example emissions reduction opportunities, flaring and venting, power generation (electrification opportunities, if relevant). Emissions should be calculated and assessed on a worst case (likely to be high case production) and an assessment provided in the context of Net Zero. Power demand increases should be considered on a cumulative basis to determine significance. In addition, minor topside modifications are noted for Triton. Please ensure sufficient clarity is provided (whether scoped in or out) in terms of quantifying 'minor' or 'minimal' changes. For example, minimal additional power generation requirements should be clarified and set into context of all other developments that are requiring 'minimal' power gen requirements. Are they utilising existing ullage/capacity to run more efficiently or do they collectively require additional kit to be run, for example? Any other impacts of increased operational demands would similarly need to be considered and assessed with cumulative impacts in mind (e.g. produced water discharges).	The increased operational demands at the host facility (Triton FPSO) are identified in Section 3.5 and resulting impacts assessed in Section 9 (GHG Emissions) and Section 10 (Marine Discharges). Net zero considerations are discussed in Sections 1.5.3 (UK Government's Energy Policy and Net Zero Target), Section 2.2.4 (Development Concept Net Zero Considerations) and Section 9 (GHG Emissions). Appendix E sets out the methodology used to calculate the total quantity of GHG emissions generated from the Project – a high case P10 scenario has been assumed as worst case.

Organisation	Comments Raised	Considered by the Project / Addressed in ES
OPRED	It would be useful to provide a short section or table in the ES to demonstrate why some aspects have been scoped out from detailed assessment. Furthermore, you should ensure that the ES appropriately assesses the impact of all phases of the Project (i.e., construction, commissioning, operation and maintenance) and include any in-combination or cumulative impacts as part of that assessment (as mentioned elsewhere). It is advised that no effects are scoped out of the ES assessment with regards to shipping and navigation pending the outcome of a navigational risk assessment (expected within the ES) and further stakeholder consultation.	A justification for aspects scoped out from detailed assessment has been provide in Section 5.2.2. All phases of the Project and, where relevant, in-combination or cumulative impacts have been assessed in Sections 6 to 11.
	Environmental impacts should cover the full scope of activities that are intended to be consented (NSTA). For example, any proposed modelling of cuttings will need to include the potential to undertake one re-spud and a mechanical sidetrack, to reflect the (standard) NSTA well consent, with the mechanical sidetrack being based on the section which generates that largest volume of cuttings. Similarly, Serica should ensure alignment with the development and production consent application and supporting FDP. Alignment with the Pipeline Works Authorisations (PWA) is also likely to be needed, given anticipated consenting timelines (we are aware that this timeline often results in the PWA likely to be provided ahead of some key engineering information). Where alternative engineering options have not yet been decided, the ES must describe and assess the worst-case options that can result from either option being selected (i.e. whether the pipeline routes to DCA or DCB);	The drill cuttings and muds dispersion modelling study has considered the potential to undertake one re-spud and a mechanical sidetrack (refer to Appendix C ad Section 3.3.4). Serica also confirms that the information presented in the ES aligns with the development and production consent application and supporting FDP. Where alternative engineering options still remain, the environmental worst-case option has been assessed, as identified in Section 1.6 (Areas of Uncertainty).
	The ES will need to demonstrate how the proposed project accords with any of the constraints and objectives of any relevant marine plans and the underlying policies.	This has been demonstrated in Appendix B.
	Serica may wish to consider the supplementary guidance by JNCC guidance for the use of Passive Acoustic Monitoring in UK waters, published in December 2023.	This has been considered in Section 8 (underwater noise emissions).
	Survey data (including pipeline routing) will need to be presented in sufficient detail to support the assessment being made. This is often best served by appropriate figures to demonstrate the nature of the habitats and/or seabed, such as side-scan sonar or bathymetry data.	Survey data has been presented in Section 4 (The Existing Environment).

Organisation	Comments Raised	Considered by the Project / Addressed in ES
OPRED	We would expect to see a variety of visual clarifications for the extent of relevant attributes (such as spawning areas, ICES rectangles, Scans IV survey areas, seal satellite tracking, shipping risk and oil and gas and other industry locations) to provide clear evidence of extent of such things in the baseline information section.	Maps have been included, where relevant, in Section 4 (The Existing Environment).
	In respect of Ocean Quahog and Seapen habitats, we would like to clarify generic advice from JNCC. Neither the OSPAR nor PMF definition explicitly states that only aggregations of Ocean Quahog are protected and therefore, we would consider this species to be present where any individuals are found (adult or juvenile). Similarly, "sea pen and burrowing megafauna communities" cannot be dismissed just because sediments are within an area classified, say, as very fine sand or fine sand. At a meeting of the OSPAR Contracting Parties in Bergen in November 2011, a key recommendation was that the relevant biological communities may sometimes be found on "sandy muds" as well as "fine muds" and therefore, it is important to present the survey data with this in mind.	This advice has been considered when drafting the baseline text in Section 4 (The Existing Environment) and when undertaking the Seabed Disturbance impact assessment documented in Section 7.
	If necessary, fisheries data should be updated before submission to reflect any publication of full statistics. https://www.gov.scot/publications/provisional-scottish-sea-fisheries-statistics-2024/, for example, are provisional statistics, and the full data was due to be updated in Sept 25. Serica should ensure that they refer to as complete figures as possible, given our understanding that the ES is due to be submitted sometime after this	Up-to-date fisheries data (at the point of ES submission) has been presented in Section 4.4.1 (Commercial Fisheries).
	The ES should consider and justify the choice of pipeline (such as whether the umbilical can be laid within the same trench as the production line and the gas-lift line or whether the chosen option is likely to result in a higher likelihood of rock dump requirements). The use of evidence from previous operations in the area would be valuable evidence to demonstrate expectations of burial success and/or frequency or volumes of rock dump required.	The feasibility of different pipeline installation methods has been discussed in Section 2.4 (Pipeline / Umbilical Route Selection and Installation).
	The ES would be expected to clearly specify the history of the area and confirm the presence or absence of any remaining cuttings piles.	This has been discussed in Section 4.4.4 (Offshore Oil and Gas Activity).

Organisation	Comments Raised	Considered by the Project / Addressed in ES
	We note that the operator has found juvenile ocean quahog (*Arctica islandica*) during surveys. The wording within the scoping report suggests that these juveniles have not been considered by the operator as an OSPAR threatened and/or declining species or as a PMF under Scottish legislation. Ocean quahog is a declining species in the North Sea region and there is uncertainty in its ability to recover. We would like to highlight that protection is afforded to quahog at all life stages, including juvenile quahog, and it is classed as an OSPAR threatened and/or declining species (and PMF in Scottish waters). The presence of juveniles in an area can be an indication of a wider population, therefore impacts should be avoided wherever possible to allow the population to grow.	This advice has been considered when drafting the baseline text in Section 4 (The Existing Environment) and when undertaking the Seabed Disturbance impact assessment documented in Section 7.
	JNCC note that the top two sections of the well will be drilled riserless and cuttings discharged to seabed, while LTOBM will be used for the other sections with cuttings either thermally treated or skipped and shipped to shore. For discharges to sea, we would expect to see detailed drill cuttings dispersion modelling that identifies the thickness/radius of the dispersion, and the possible impact that might have on the surrounding benthic environment.	A copy of the drill cuttings and muds dispersion modelling study has been provided in Appendix C. The results have been used to inform the impact assessment documented in Section 7 (Seabed Disturbance) and Section 10 (Marine Discharges).
JNCC	JNCC acknowledge that both the production and gas lift pipeline and the umbilical will be trenched and buried either by plough, jet trencher or mechanical cutter. Rock placement will be required at crossings, trench transitions and potentially to mitigate buckling. We encourage the operator to continue to minimise the amount of hard substrate material used. We note that the long-term effect of the introduction of hard substratum into muddy seabeds is not fully understood at present and should be carefully considered. Where stabilisation material cannot be avoided, we recommend using a targeted placement method, e.g. fallpipe vessel rather than using vessel-side discharge methods. JNCC expect detail commentary on stabilisation operations to be included, to understand the potential nature conservation impacts. This should include: • Location of deposit sites • Size/grade of rock to be used • Tonnage/volume to be used • Contingency tonnage/volume to be used • Method of delivery to the seabed • Footprint of rock • Assessment of the impact • Expected fate of deposit after end of production, i.e. will it be left in situ or recovered	Details on the installation method for the pipelines and umbilical, including requirements for stabilisation material, are provided in Section 3.4.3.

Organisation	Comments Raised	Considered by the Project / Addressed in ES
JNCC	JNCC note that a new habitat assessment and environmental baseline survey was conducted in July 2025. We would request the operator provide detail on what was carried out during the survey and where. In particular, we would expect to see a map detailing site locations in relation to proposed activities and what types of sampling occurred at those locations (e.g. drop-down video transects, number of grab samples etc.).	Survey data has been presented in Section 4 (The Existing Environment). In particular, refer to location maps in Section 4.1
	JNCC considers it best practice to consider the full worst-case scenario to enable a meaningful assessment of the full environmental impacts of a project. It is understood that activities evolve over time, and that subsequent stages are often contingent on the outcome of the earlier activities. However, every effort should be made to predict the likely outcome and carry out an assessment on that basis so that all the elements have been assessed and presented in the ES. We would also expect that subsequent licence applications associated with the proposed works include an assessment of the worst-case scenario and, where this includes the possible use of anchored vessels or rigs, this should include the impact of potential associated seabed disturbance.	Serica acknowledges this advice. Where assumptions have been made, the environmental worst-case option has been assessed, as identified in Section 1.6 (Areas of Uncertainty).
SFF	Considering the soft nature of seabed sediment in the project area (comprised of sand and muddy sand, we propose that where the pipelines and umbilical are going to be rock protected, the rock placement to be carried out to industry standards, in respect of size of rock (1”-5”) and rock berm profile (1:3) followed by an over-trawl sweep and long term monitoring to ensure no snagging risk is posed to fishing gears.	Serica confirms that rock placement will be carried out to industry standards, as documented in Section 3.4.3. An over-trawl sweep has previously not been conducted for other projects in wider Triton area and is not planned for the Kyla Development.
	Where any an electro/chemical/hydraulic and control umbilicals are laid adjacent to pipelines, a minimum separation distance of 50 m should be maintained. This precaution is necessary to prevent destabilisation and reduce the risk of snagging by fishing gear—particularly trawl doors.	Typically, with trenched and backfilled pipelines and umbilical’s trawl gear destabilisation and snagging is avoided. A 50 m separation would be more appropriate for surface laid products. However, in this instance the sperate distances between the proposed pipelines and umbilical will be at least 50 m.
	Being concerned of fishing vessels safety, SFF is against use of protection materials such as concrete mattresses and grout/rock bags in open waters (< 800m depth). Where use of concrete mattresses is inevitable e.g. in crossing points, we would recommend that any such mattresses installed in open waters are subject to a covering of rock dump.	All mattresses in open water outwith 500m safety zones, for example at crossing locations, will be covered by rock placement where required.

Organisation	Comments Raised	Considered by the Project / Addressed in ES
SFF	Over the years fishermen have voiced serious safety concerns over mud berms being left behind following pipeline trenching operations. Therefore, we would propose appropriate embedded mitigations to be carried out to eliminate safety risk for the fishermen.	The likely soil conditions and trenching methods are unlikely to leave any significant mud berms as evidenced by the numerous trenched and buried pipelines in the Triton area. Nevertheless, following pipeline trenching operations, Serica will liaise with the SFF to ameliorate any safety risks for the fishermen from mud berms being left behind (refer to Section 6.3).
	To safeguard fishermen, and mitigate snagging risks, SFF propose the deployment of a guard vessel in the following scenarios: • Where pipeline trenching activities are scheduled but not carried out concurrently, increasing the risk of exposed infrastructure • Where pre-lay anchors are required for well intervention and either a 500m safety zone has not been issued, or the anchor footprint extends beyond the designated 500m safety zone	Serica commits to the deployment of a guard vessel in these scenarios as documented in Section 6.3.
	The monetary value of commercial fisheries landings from ICES rectangle 42F1 should be included within the ES. In addition, there is the potential for displacement impacts associated with the ban on bottom trawling within Scottish Marine Protected Areas which came into effect on 16 October 2026. This could reduce the availability of fishing grounds, potentially redirecting fishing efforts towards the Kyla project area. In addition, SFF's plotter data confirms active *Nephrops* fishing within the project area, located ca. 700 m from the Kyla drill centre.	The monetary value of commercial fisheries landings from ICES rectangle 42F1 has been documented in Section 4.4.1, along with a discussion on potential displacement implications. This data has been considered when assessing the potentially significant impacts to commercial fisheries from the proposed Kyla Development in Section 6.
	The commercial fisheries baseline data used to inform the EIA should span a ten-year period. This allows consideration of fisheries activity that may have temporarily ceased due to Brexit-related disruptions from 2016 onward. Additionally, commercial fisheries plotter data should be incorporated into the baseline description to provide a more accurate and detailed picture of fishing activity within the project area.	This advice has been considered when drafting the baseline text in Section 4 (The Existing Environment).

Organisation	Comments Raised	Considered by the Project / Addressed in ES
SFF	SFF note that boulders of different size have been noticed during surveys conducted for Bittern and Belinda. It is requested that efforts be made to not relocate any boulders observed within the Kyla project area as these activities can significantly alter seabed habitats and create new snagging hazards for fishing gear. Where relocation occurs, boulder coordinates should be shared in a format compatible with fishing plotters (DD° MM.MMM, WGS 84).	Boulder removal / relocation will be minimised as far as practical via pipeline routing exercises as part of the design process and potentially local the pipeline micro routing prior to pipe or umbilical lay. However, boulder relocation cannot be 100% ruled out. As such, where boulder relocation occurs these will be documented as part of the as built construction information and shared in a DD° MM.MMM, WGS 84 co-ordinate system.
	To avoid the risk of juvenile fish and shellfish mortality, it is proposed that all construction activities be scheduled outwith the spawning and nursery periods of the relevant species present within the project area. This precautionary approach is essential to protect sensitive life stages and maintain the ecological integrity of commercially important stocks. Additionally, the ICES Advice on Fishing Opportunities, Catch, and Effort for the Greater North Sea Ecoregion, published on 30 April 2025, advises that no activities should be permitted on spawning habitats unless their effects have been thoroughly assessed and demonstrated to be non-detrimental.	This advice has been considered in Section 7 (Seabed Disturbance) when assessing the potential impacts to juvenile fish and shellfish from seabed disturbance resulting from proposed Kyla Development construction activities.
	SFF proposes the following embedded mitigations to be considered to eliminate any snagging risks to fishermen and mitigate any disruptions to the fishing industry during the project lifespan: • Issue Notice to Mariners with sufficient time ahead of any construction and decommission work • Comply with the ColReg to mitigate risk of collision with fishing vessels • Remove all development related subsea infrastructure (including drill cuttings) during decommissioning period followed by overt-trawl sweep to make sure the project area is safe for fishing operations to resume.	These measures have been considered in Section 6 (Physical Presence) when assessing the potential impacts to commercial fisheries from the Kyla proposed Development.

2 Project Alternatives

2.1 Introduction

Serica has explored various concepts during the planning process to develop the Kyla oil field. This section of the ES 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 Kyla Development Concept Select Report (Serica, 2025), which was undertaken to determine the optimum development plan for the field in terms of economics, technical risk and environmental impact.

The proposed Kyla Development concept has been selected and defined with consideration to:

- The central obligation of the NSTA Strategy (OGA, 2020), namely to secure the maximum value of economically recoverable hydrocarbon reserves and take appropriate steps to assist the Secretary of State in meeting the Net Zero target;
- The OGA Plan (NSTA, 2024a) to reduce UKCS GHG emissions from oil and gas extraction.

And with cognisance of the requirements of NSTA's Net Zero Stewardship Expectation 11 (NSTA, 2021).

The NSTA provided its non-objection to the selected concept on 21 October 2025.

2.2 Development Concept

2.2.1 Subsea Tie-back

The selected concept for the Kyla Development project is a single subsea well tied back to a suitable host facility. A standalone development concept is not economically viable for Kyla and has been discounted. Concept select work therefore focused on screening hosts which could support the development of Kyla as a subsea tie-back.

Concept Decision: Subsea tie-back

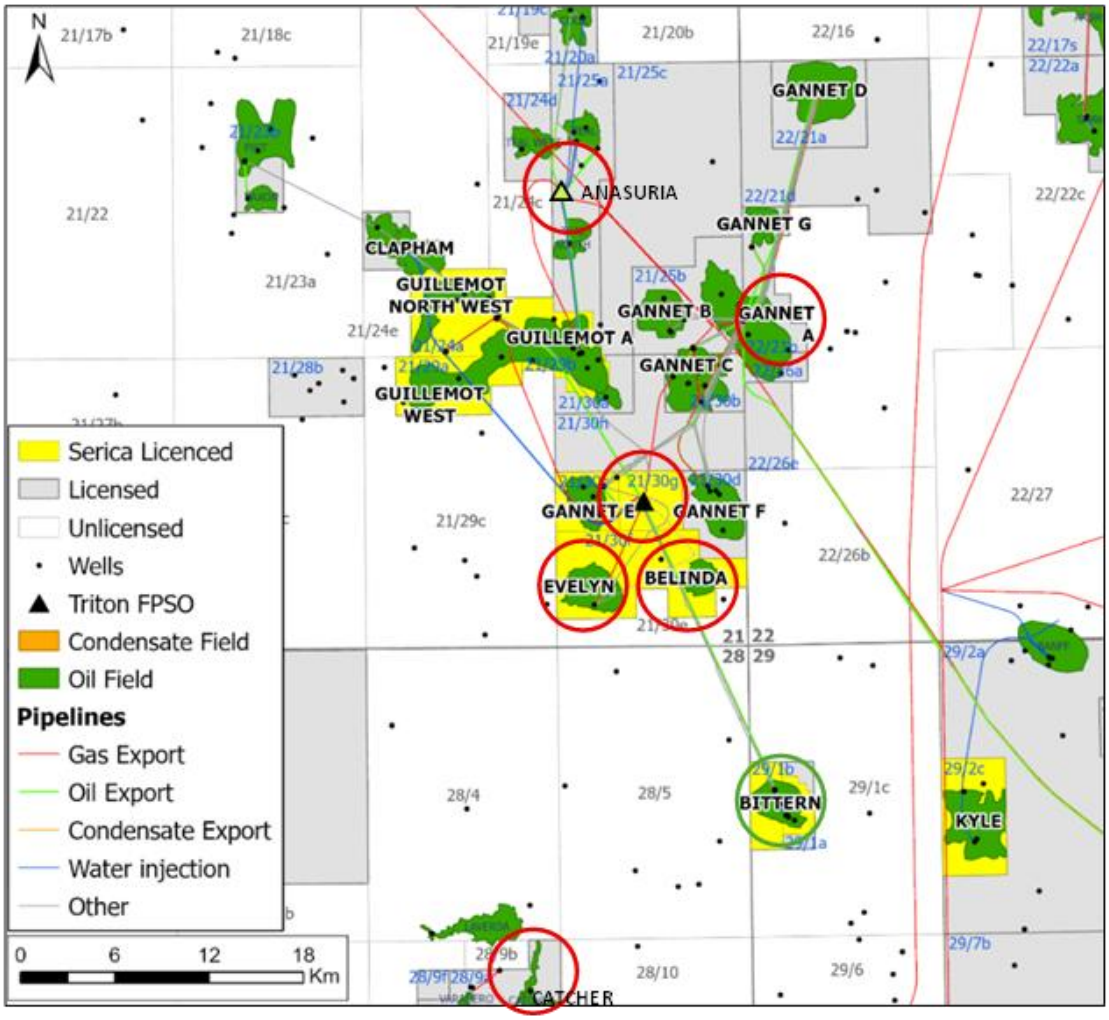
2.2.2 Host Facility / Tie-back Screening

Several potential host facility and tie-back route options were explored during the project feasibility/pre-concept phase conducted in 2024, namely:

- Tie-in to Triton FPSO (operated by Dana) via:
  - Direct tie-in at the Triton FPSO riser base;
  - Tie-back to Evelyn or Belinda manifolds;
  - Tie-back to one of the Bittern Drill Centre manifolds (DCA or DCB);
- Tie-in to Gannet Alpha platform (operated by Shell UK);
- Tie-in to Catcher FPSO (operated by BW Offshore);
- Tie-in to Anasuria FPSO (operated by Anasuria Operating Company).

Figure 2.1 illustrates the location of the Kyla field in relation to the potential host tie-in points.

Figure 2.1: Kyla Development Host Facility and Tie-back Route Options [1]



[1] Red circles indicate potential tie-back options. Green circle indicates selected tie-back option

During this stage of the Project, numerous subsurface, subsea and topside evaluation and optioneering assessments were conducted, the results of which are summarised in Table 2.1.

To enable a comparative evaluation of the key aspects influencing the selection of a development option for Kyla, Table 2.1 adopts a Red-Amber-Green scoring methodology. The following key selection criteria were considered when assigning a Red-Amber-Green score:

- Capital Expenditure (CAPEX) (£ million)
- Maximisation of Existing Infrastructure
- Environmental Impact (subsea, construction, and production emissions)
- Impact on Other Fields / Kyla Recovery
- First Oil (FO) Schedule
- Host Facility Modifications

Where data was unavailable for a specific criterion due to schedule constraints a neutral score has been assigned. This score matches that of the optimal option, ensuring the development option is not unfairly penalised due to the absence of information.

The outcome of the assessments, as shown in Table 2.1, resulted in the direct tie-back options to Gannet Alpha, Catcher and Anasuria being discounted and recommended that Kyla be redeveloped as a subsea tie-back to the Triton FPSO via one of the Bittern manifolds.

Of note, minimal incremental production related emissions are identified for all host facility options shown in Table 2.1. Processing of Kyla hydrocarbons via Triton existing processes were evaluated during the concept select phase and were considered to be minimal due to the following factors:

- No impact on flaring or diesel use;
- Very low level of incremental cold venting from oil storage tanks, which in Triton overall trend is declining as other fields production is in downward trend;
- Low level of fuel gas use for processing of Kyla gas via the export compressors, which will not be any different from processing via any of the other host facility options.

From an operational emissions point of view, it is not believed that the emissions forecasts for the other host facility options would be any lower than the Triton option and therefore all have been ranked as 'minimal' in the concept screening table (Table 2.1).

2.2.3 Selected Host Facility / Tie-back Option

The base case concept for the Kyla Development project is a single subsea well tied back via the Bittern DCA manifold which will route Kyla production, co-mingled with Bittern production, to the Triton FPSO via the existing Bittern pipelines. There is also an option to tie-back to the Bittern DCB manifold, this has been considered in the ES as the back-up case option. The two Bittern manifolds (DCA and DCB) are approximately 2 km distance from each other and are both suitable for connecting the Kyla production, gas lift and electro/chemical/hydraulic and control umbilical services. The Triton FPSO has suitable process facilities and spare capacity to support and service Kyla with relatively minor topsides modifications. Kyla oil will be exported as part of the Triton FPSO blend via shuttle tanker and sales gas will be routed with other Triton area gas to St Fergus terminal via the Fulmar gas pipeline.

The selected development concept reflects the optimal development plan for Kyla, maximising hydrocarbon recovery whilst minimising capital risk and costs, maximising use of existing North Sea oil and gas infrastructure, and significantly reduces the carbon footprint of production when compared with standalone or long-distance tie-back alternatives.

The Bittern DCA/DCB manifolds are located the shortest distance from Kyla (12 – 13.2 km), with the other tie-back options entailing longer pipelines (ranging from 24 km to 50 km), thereby minimising seabed impact and construction and installation emissions.

Kyla fluids will be processed within the existing power generation capacity of the Triton FPSO with minimal additional power generation requirements. Kyla produced gas will be used for fuel and gas lift, with surplus gas exported via the existing gas export system. Consequently, Kyla production via existing Triton processes is not deemed to result in additional flared carbon emissions from the Triton FPSO.

Serica has significant interest in Triton (holding a 46% equity interest in the asset) and have a proven partnering experience with Dana in delivery of other similar Triton projects, namely Evelyn, Gannet E Expansion and Belinda. Routing Kyla via Triton will also contribute towards the life extension of the Triton FPSO.

Host / Tie-back Decision: Tie-back to one of the Bittern manifolds (DCA or DCB), with Kyla production processed on the Triton FPSO

Table 2.1: Concept Screening for Host Facility / Tie-Back Options

Parameter Assessed	Host Facility / Tie-Back Option					
	Direct Tie-In at Triton FPSO Riser Base	Tie-in to Evelyn or Belinda manifolds and Process via Triton FPSO	Tie-in to Bittern manifolds and Process via Triton FPSO	Tie-in to Gannet Alpha Platform	Tie-in to Catcher FPSO	Tie-in to Anasuria FPSO
Key: **Red = Score of 0.** Indicates the development option performs significantly worse than alternatives for the given criterion. Example: CAPEX is approximately twice that of the least capital-intensive option, or pipeline lengths exceed twice the distance of the shortest option. **Amber = Score of 5.** Indicates moderate underperformance compared to other options. Example: CAPEX is around 1.5 times higher than the lowest-cost option, or pipeline length is 1.5 to 2 times longer than the shortest development option. **Green = Score of 10.** Indicates the development option performs optimally against the criterion. Example: It has the lowest CAPEX or shortest pipeline requirement among all options.						
CAPEX £mm/ Maximising Existing Infrastructure Use	>£300mm ~30km long pipelines & umbilical. Work required on Triton Riser Base. All subsea infrastructure will be new and thus not maximising existing infrastructure use.	>£250mm ~24km long pipelines & umbilical. Does not maximise the use of existing infrastructure.	~£185mm (Lowest CAPEX option) ~12km to 14km long pipelines and umbilical. Maximises use of existing infrastructure.	>£300mm ~35km long pipelines & umbilical. All subsea infrastructure will be new and thus not maximising existing infrastructure use.	>£300mm ~30km long pipelines & umbilical. All subsea infrastructure will be new and thus not maximising existing infrastructure use.	>£300mm ~50km long pipelines & Umbilical. All subsea infrastructure will be new and thus not maximising existing infrastructure use.
Environmental Impact	Minimal incremental production related emissions from Triton as no change to Triton operations due to inclusion of Kyla. Moderate seabed impact and construction emissions as pipelines and umbilical are more than twice the distance of the shortest option (tie-in to Bittern).	Minimal incremental production related emissions from Triton as no change to Triton operations due to inclusion of Kyla. Moderate seabed impact and construction emissions as pipelines and umbilical are more than twice the distance of the shortest option (tie-in to Bittern).	Minimal incremental production related emissions from Triton as no change to Triton operations due to inclusion of Kyla. Least seabed impact and construction emissions as shortest distance pipelines and umbilical.	Minimal incremental production related emissions from Gannet Alpha assumed. Moderate seabed impact and construction emissions as pipelines and umbilical are more than twice the distance of the shortest option (tie-in to Bittern).	Minimal incremental production related emissions from Catcher assumed. Moderate seabed impact and construction emissions as pipelines and umbilical are more than twice the distance of the shortest option (tie-in to Bittern).	Minimal incremental production related emissions from Anasuria assumed. Significant seabed and construction emissions impact as longest pipelines and umbilical route in this option.

Parameter Assessed	Host Facility / Tie-Back Option					
	Direct Tie-In at Triton FPSO Riser Base	**Tie-in to Evelyn or Belinda manifolds and Process via Triton FPSO**	**Tie-in to Bittern manifolds and Process via Triton FPSO**	**Tie-in to Gannet Alpha Platform**	**Tie-in to Catcher FPSO**	**Tie-in to Anasuria FPSO**
Key: **Red = Score of 0.** Indicates the development option performs significantly worse than alternatives for the given criterion. Example: CAPEX is approximately twice that of the least capital-intensive option, or pipeline lengths exceed twice the distance of the shortest option. **Amber = Score of 5.** Indicates moderate underperformance compared to other options. Example: CAPEX is around 1.5 times higher than the lowest-cost option, or pipeline length is 1.5 to 2 times longer than the shortest development option. **Green = Score of 10.** Indicates the development option performs optimally against the criterion. Example: It has the lowest CAPEX or shortest pipeline requirement among all options.						
Back-out/ Kyla Recovery	Direct Tie-in at P2 riser base leads to least back-out of Bittern & Gannet E production (~0.5 million stock tank barrels (MMstb)). Delivers Kyla fluids to ca. 12MMstb.	Significantly backs-out Belinda, Gannet E & Evelyn production (ca. 3.5MMstb)	Tie-in at one of the Bittern manifold leads to low level back-out of Bittern production (0.4 to 0.7MMstb). Delivers Kyla fluids to ca. 12MMstb.	Unlikely to be significantly different than Kyla recovery from the tie-back directly to Triton.	Unlikely to be significantly different than Kyla recovery from the tie-back directly to Triton.	Given the length of pipelines (ca. 50km), recovery of Kyla fluids is likely to be lower than the tie-back to Triton.
FO Schedule	FO in Q3 2028 may not be possible due to extensive work required at Triton riser base and within Triton Swing Circle.	FO in Q3 2028 is possible, based on previous experience of Evelyn, Gannet E Expansion & Belinda Projects	FO in Q3 2028 is possible, based on previous experience of Evelyn, Gannet E Expansion & Belinda Projects	The extent of the subsea scope and work required with the Host is likely to push FO oil into 2029, which on its own erodes project Net Present Value (NPV).	The extent of the subsea scope and work required with the Host is likely to push FO oil into 2029, which on its own erodes project NPV.	The extent of the subsea scope and work required with the Host is likely to push FO oil into 2029, which on its own erodes project NPV.
Host Facility Mods and Cessation of Production	Minimal modifications expected on Triton. Kyla fluids will be processed via Bittern Separation train. Triton Life Extension project looking at 2035 and 2040. Q3 2028 FO allows Kyla mid to high case recovery by 2035.	Minimal modifications expected on Triton. Kyla fluids will be processed via Bittern Separation train. Triton Life Extension project looking at 2035 and 2040. Q3 2028 FO allows Kyla mid to high case recovery by 2035.	Minimal modifications expected on Triton. Kyla fluids will be processed via Bittern Separation train. Triton Life Extension project looking at 2035 and 2040. Q3 2028 FO allows Kyla mid to high case recovery by 2035.	Host facility mods for tie-in of Kyla alone are not expected to be prohibitive. Gannet A life to 2035 is assumed for this screening exercise.	Host facility mods for tie-in of Kyla alone are not expected to be prohibitive. Catcher life to 2035 is assumed for this screening exercise.	Host facility mods for tie-in of Kyla alone are not expected to be prohibitive. Anasuria Life Extension project looking at life extension to 2040.

Parameter Assessed	Host Facility / Tie-Back Option					
	Direct Tie-In at Triton FPSO Riser Base	Tie-in to Evelyn or Belinda manifolds and Process via Triton FPSO	Tie-in to Bittern manifolds and Process via Triton FPSO	Tie-in to Gannet Alpha Platform	Tie-in to Catcher FPSO	Tie-in to Anasuria FPSO
Key: **Red = Score of 0.** Indicates the development option performs significantly worse than alternatives for the given criterion. Example: CAPEX is approximately twice that of the least capital-intensive option, or pipeline lengths exceed twice the distance of the shortest option. **Amber = Score of 5.** Indicates moderate underperformance compared to other options. Example: CAPEX is around 1.5 times higher than the lowest-cost option, or pipeline length is 1.5 to 2 times longer than the shortest development option. **Green = Score of 10.** Indicates the development option performs optimally against the criterion. Example: It has the lowest CAPEX or shortest pipeline requirement among all options.						
Overall Score	**30/50**	**30/50**	**50/50**	**30/50**	**30/50**	**20/50**
Justification	**Not selected due to impact on schedule and extensive CAPEX and moderate subsea environmental impact.**	**Not selected due to significant back-out of Belinda, Ganne E and Evelyn fields and moderate subsea environmental and CAPEX impact.**	**Selected as the base case. Delivers Kyla production with minimal back-out of other fields, with least subsea and environmental impact, maximise re-use of existing infrastructure and least CAPEX intensive option.**	**Not selected due to impact on schedule and extensive CAPEX and moderate subsea environmental impact.**	**Not selected due to impact on schedule and extensive CAPEX and moderate subsea environmental impact.**	**Least attractive option – not selected.**

2.2.4 Net Zero Considerations

Aligned with the North Sea Future Plan (DESNZ, 2025b) and in accordance with the OGA Strategy and OGA Plan to reduce UKCS GHG emissions from oil and gas extraction, the selection of the development concept for Kyla has been informed by carbon intensity and infrastructure reuse considerations. Key benefits of the chosen concept include:

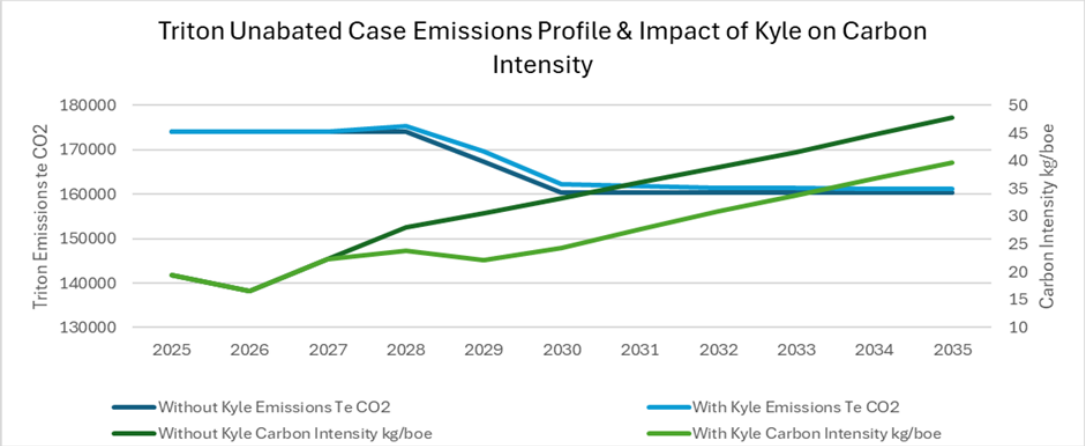
- Reuse of existing subsea and topsides facilities, avoiding the need for new-build processing or export infrastructure;
- Low incremental power requirements, Triton FPSO has sufficient capacity within existing power generation systems;
- Optimisation of gas management, with produced gas used for fuel and lift, and surplus gas exported, minimising flaring;
- Estimated 20% reduction in carbon intensity across Triton FPSO production when Kyla comes onstream, through economies of scale.

Carbon intensity is the total mass of CO_2 emitted per barrel of oil equivalent produced. This metric is a key performance indicator for UKCS installation operators and allows comparison with other installations or country averages.

Figure 2.2 and Figure 2.3 below shows Triton emissions and carbon intensity forecasts for unabated and max value abatement scenario with and without Kyla. This clearly shows the benefit in Triton carbon intensity once Kyla comes online, with a reduction over the remaining field life. It should be noted that unabated Triton FPSO emissions profiles in Figure 2.2, includes for the successful implementation of Triton Zero Routine Flaring Project. Emissions forecast and carbon intensity profiles due to maximum value abatement scopes, which are not all approved as yet (as per Triton Emissions Reduction Action Plan, which is discussed below) are shown in Figure 2.3.

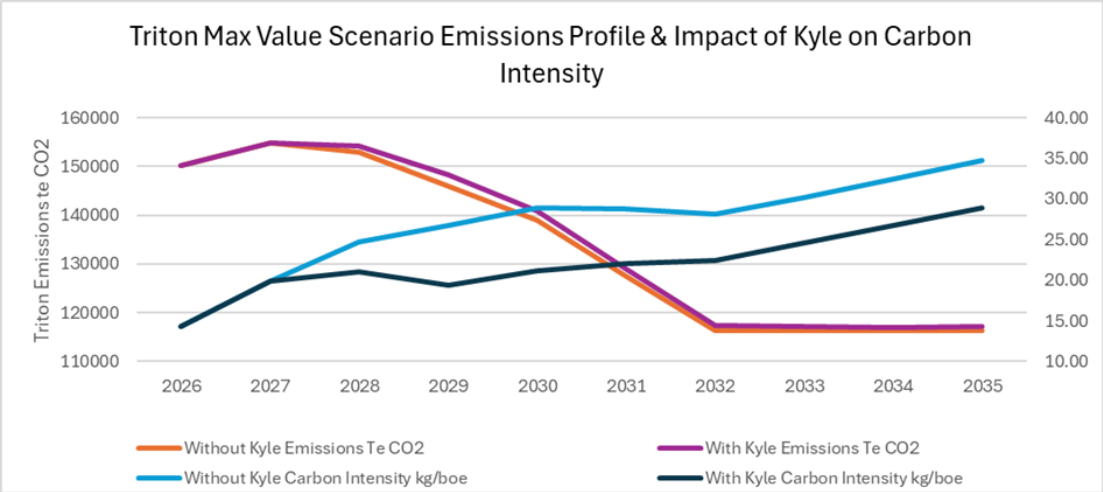
As reported in the NSTA (2025a) Emissions Monitoring Report, the average carbon intensity of UKCS offshore fields in 2024 is expected to have remained at 24 $kgCO_2e$/boe. The NSTA UKCS Emissions Monitoring Dashboard reports the average carbon intensity for FPSOs in the CNS in 2024 at 30.5 $kgCO_2e$/boe. When filtering by installation age (>25 years old) this increases to 37.5 $kgCO_2e$/boe (NSTA, 2025b). In comparison, over the life of the field, the Triton FPSO with Kyla will have an average carbon intensity of 29.9 $kgCO_2e$/boe in the unabated scenario, decreasing to 23.3 $kgCO_2e$/boe under the maximum value case over the period from 2028 to 2035.

Figure 2.2: Triton Unabated Case Emissions & Carbon Intensity profile with & without Kyla [1]



[1] The unabated Triton FPSO emissions profiles include for the successful implementation of the Triton Zero Routine Flaring Project.

Figure 2.3: Triton Max Value Case Emissions & Carbon Intensity profile with & without Kyla [1]



[1] The max value case for Triton FPSO emissions profiles include all Net Present Value positive projects detailed in the Triton ERAP.

In its capacity as one of Triton FPSO owners, Serica is fully engaged with the operator of Triton (Dana), on the ERAP for the FPSO. This engagement includes sharing Serica's experience on Bruce (a North Sea production platform operated by Serica) and providing support, especially sharing engineering knowledge and learning related to flare gas and vents recovery systems to meet the World Bank's requirements of zero routine Flaring and Venting by 2030. Dana also has relevant experience implementing a flare gas recovery system, having designed and installed this at their Western Isles operated asset and are utilising this knowledge for Triton.

Prior to implementation of the ERAP, the following emissions reduction initiatives were completed on Triton, resulting in a 21% decrease in CO_2 emissions from 2019 to 2021:

- Focus on plant and production reliability, reducing process upsets and flaring;
- Overhaul of gas compressors to reduce outages and subsequent flaring;
- Tuning of separator and export compressor controls, reducing outages and subsequent flaring;
- Anti-surge logic changes to flash gas compressor, reducing outages and subsequent flaring;
- Adjustment of Compact Flotation Unit (CFU) gas rates to aid flash gas compressor operation, reducing outages and subsequent flaring.
- Pot water maker steam driven unit replacement with electrical driven Restriction Orifice maker.
- Level 2 process trip modification.

Dana submitted the Triton ERAP in Q1 2023 as per Stewardship Expectation 11 to meet NSTD emissions reduction targets. The ERAP is updated on a yearly basis with the latest version issued in July 2025. To date, considerable work has been undertaken to analyse the opportunities for Triton and focus on a single target scenario for emissions reduction. In total, 73 emissions reduction opportunities were reviewed and updated. Of these, 39 remain as "live" opportunities in the hopper, 26 are in the "archived" status and 8 have been implemented.

The main work streams for the FPSO under various project phases are listed below:

- Power generation accounts for the majority of the asset's emissions, as fuel gas or diesel is burned in one of two dual-fuel turbines. An ongoing project is currently reviewing options to replace these turbines with more efficient alternatives.
- Development work is ongoing to assess the feasibility of partially electrifying Triton FPSO (this is not dependent on tie-back of the proposed Kyla field). Full electrification has been ruled out for further study due to technical constraints.

- Flaring emissions are also a key area for reduction. An ongoing Zero Routine Flaring and Venting project aims to meet the Zero Routine Flaring target by 2030, primarily addressing Category A flaring. Additional efforts to minimise non-routine flaring (Categories B and C) are also under investigation.
- The primary source of venting on Triton is from the crude oil tanks. Work is ongoing to evaluate options to change the blanketing medium from an inert gas to hydrocarbon gas to allow recovery, considering both technical feasibility and impacts to the FPSO safety case.

It is widely acknowledged that on the pathway to Net Zero emissions, oil and gas will continue to play an important part of the energy mix for the foreseeable future. Moreover, according to the Climate Change Committee (CCC), the UK will require 13–15 billion barrels of oil and gas equivalent in the period 2025 to 2050 but is currently only forecast to produce 4 billion (CCC, 2025; NSTA, 2025a). In a time of historically low domestic energy production with more than 40% of the UK's energy now imported (DESNZ, 2025), responsible development of UKCS oil and gas fields ensures that the UK meets its energy demand while retaining control over emissions.

The selected development concept for Kyla makes maximum use of existing oil and gas infrastructure and will be a contributor in the life extension of Triton FPSO. While the development represents one of the lowest carbon intensity means of recovering remaining hydrocarbons in the Kyla field. Opportunities for further emissions reductions, including electrification of offshore assets and low-carbon logistics, will be assessed as part of ongoing asset stewardship and future investment planning.

Section 9 of this ES assesses the impact of the upstream and downstream GHG emissions generated from the proposed Kyla Development on the climate and the significance of any likely effects.

2.3 Well Design

A range of conceptual well design options were assessed as part of the concept select process as summarised in Table 2.2.

Table 2.2: Well Design Options Summary

Option	Description	Evaluation
Vertical Well	Simple well geometry, limited reservoir contact	Lower recovery efficiency; not sufficient to meet development objectives
Deviated Well	Inclined trajectory through reservoir	Moderate reservoir contact, higher costs than vertical; less recovery than horizontal
Horizontal Well (ESP)	Horizontal trajectory with ESP artificial lift	Higher productivity, but ESPs less reliable for subsea wells; additional topside requirements
Horizontal Well (Gas Lift) Selected Option	**Horizontal trajectory with gas lift completion, tie-back to Triton using existing lift gas facilities**	**Maximises recovery, proven reliability, integrates with existing infrastructure; selected base case**

Vertical and deviated wellbores were ruled out due to limited reservoir contact and reduced recovery efficiency, while a horizontal well with an Electrical Submersible Pump (ESP) lift was discounted due to reliability concerns for subsea tie-backs and the requirement for additional topside modifications.

The selected option ‘a single horizontal well with gas lift’ offers the optimal balance of reservoir performance, operability, and integration with existing Triton infrastructure. This design maximises recovery of remaining Palaeocene reservoir while minimising technical risks such as well intervention frequency and well underperformance, and the associated environmental risks including additional vessel activity, higher emissions, and increased subsea footprint. By using a single, high-productivity horizontal well with existing lift gas, the development avoids the need for multiple wells reducing

drilling activity, subsea infrastructure, and associated seabed disturbance compared with the alternative designs.

The feasibility of a slimhole design for the well, which would help reduce the volume of drilling mud needed, the quantity of cuttings and other waste material generated, as well as the drilling time, will be evaluated in the detailed well design phase.

2.4 Pipeline / Umbilical Route Selection and Installation

2.4.1 Route Selection

Kyla production fluids will be exported via a new 12 to 13.2 km long 8-inch production carbon steel pipeline to one of the Bittern drill centre manifolds (either DCA or DCB). A direct pipeline route has been selected for both manifold options, minimising seabed disturbances as much as possible. A 3-inch gas lift carbon steel pipeline will be piggybacked to the production pipeline to supply gas lift to the Kyla well. An electro/chemical/hydraulic and control umbilical will be extended from Bittern to Kyla, which will run adjacent to the pipelines, 50 - 75 m apart. The exact separation distance between the lines will be dependent on the chosen trenching solution.

2.4.2 Installation Method

The pipelines and umbilical are likely to be installed by a reel-lay vessel and will be surface laid on the seabed. The lines will then be trenched and buried, similar to the other pipelines which form part of the Triton area. For Kyla, trenching will be carried out using a pipeline plough, jet trenching tool or mechanical cutter. The umbilical will be trenched and buried separately to the pipelines.

Although technically feasible, laying the umbilical within the piggybacked pipeline system trench is currently not considered practical as it precludes the use of jet trenching and mechanical cutting trenching methods. Laying the umbilical in the same trench as the piggybacked production and gas lift pipeline is only possible when a ploughed trenching technique is used whereby the umbilical is laid into a pre-cut trench after this is formed by the plough when trenching the piggyback pipeline into place. The subsequent backfill operation would then cover both the piggyback pipeline and umbilical in the same trench. A combined pipeline and umbilical trench can restrict the use of the backfill plough when redepositing the spoil heaps, created by ploughing, back into the trench depending upon the as laid position of the umbilical within the trench profile. The backfill plough cannot be used in areas where the umbilical is positioned high up the trench side wall and at risk of damage. The net result is that these potential areas leave trench spoil on the seabed and also require rock placement for protection and upheaval buckling mitigation of the pipeline system.

Both ploughing and jetting solutions have been successfully used on previous Triton area pipelines. Evelyn pipelines were trenched and backfilled using a pipeline plough and the Belinda pipelines were installed using a jet trenching tool.

Depending on the soil conditions and based on previous experience in the Triton Area, mechanical ploughing and backfill potentially has a higher likelihood of achieving greater depth of cover thus potentially a reduced requirement for remedial rock. If a jetted or mechanically cut trenching solution is selected additional rock contingency may be required for potential variability in trenching performance to address the risk of achieving less than the planned backfill/depth of cover However, the mechanical ploughing operation itself has a larger impact on seabed area versus jetting/mechanical cutting.

The final method will be selected by the installation contractor; however, for the purposes of this ES, trenching and backfilling via a plough has been assessed, as this is considered to represent the worst-case scenario for seabed disturbance and fuel consumption by vessels.

2.5 Subsea Structures

As part of the concept select process, the subsea architecture has been defined to include one or two subsea structures: a manifold (valve skid) at the Kyla drill centre and, if required, a tie-in structure at Bittern. The requirement for a structure at Bittern is dependent on the tie-in arrangement and will be confirmed during detailed design.

Two foundation concepts are currently being considered for the structures:

- A piled structure with indicative dimensions of approximately 9 m × 6 m × 3.3 m and a dry weight of ca. 55 tonnes, installed using four x 24-inch diameter steel piles.
- A GBS with indicative dimensions of approximately 16.6 m × 6.5 m × 3.7 m and a dry weight of ca. 124 tonnes. A GBS would be placed directly on the seabed and stabilised by self-weight, avoiding the need for piling.

Both options will result in localised seabed disturbance. The piled structure has a relatively small footprint (ca. 54 m² for the structure itself, plus localised disturbance from piles), whereas the GBS option has a larger footprint (ca. 108 m²) but avoids seabed penetration and piling activity. For assessment purposes, a piled structure has been assessed from an underwater noise perspective and the GBS has been assessed for seabed disturbance.

2.6 Drilling Operations

2.6.1 MODU Type

Drilling of the Kyla development well will be undertaken using a moored semi-submersible drilling rig. A heavy-duty jack-up rig was considered but discounted. The Kyla location lies in approximately 90 m water depth in the CNS, where semi-submersibles provide superior operational reliability and station-keeping compared with jack-ups operating close to their technical depth limits. The development concept requires drilling and completion of a horizontal subsea producer well and installation of a subsea tree and manifold; semi-submersibles are better suited to the deployment of this subsea hardware and to subsequent well testing and completion activities. In addition, seabed geotechnical conditions in the Kyla area are more favourable to moored semi-submersibles than to jack-up spudcan foundations, which carry an increased risk of punch-through. The semi-submersible drilling rig option therefore represents the safest and most technically robust solution, with reduced seabed disturbance, greater flexibility for workover and intervention, and proven application in the Triton area.

2.6.2 Drill Fluids and Cuttings Disposal

For the top two hole sections (36" and 26"), the 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 17½, 12¼" and 9½ 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 MODU. These sections will be drilled with LTOBM.

Offset well experience within the Triton area has shown that water-based muds can be effective for the 17½" section but have limited performance in the deeper formations. In particular, previous drilling through the Lark formation encountered significant hole stability challenges, including tight hole conditions, gumbo clay build-up, and shaker screen blinding. Based on this operational experience, the Kyla planning design recommends the use of LTOBM for drilling these unstable formations to improve wellbore stability and drilling performance. This approach provides effective inhibition of reactive clays, reduces the risk of stuck pipe and hole collapse, and ensures safe casing installation through problem zones. The use of LTOBM is therefore considered the most suitable and lowest-risk fluid system for the lower hole sections, leveraging proven performance in nearby wells and minimising operational and environmental risk through improved well control and reduced non-productive time.

It is not yet known if the LTOBM contaminated cuttings from the lower sections will be skipped and shipped to shore for disposal or if they would be thermally treated offshore to an acceptable overboard disposal limit (<1% oil on cuttings) and discharged from the MODU. However, for the purposes of this ES, modelling of the discharge of the drill cuttings has been carried out to support the impact assessment, assuming the treatment and discharge of the LTOBM contaminated cuttings.

3 Kyla Development Project Description

3.1 The Kyla Field and Development Overview

The Kyla field was discovered in 1993 and was subsequently appraised in 1994 and 1995. Wells 29/02-12 and -12Z were drilled, tested and suspended as a future producer (termed in K12) in 1998. Field development activities took place from 2000 to 2002 with the drilling of three further production wells (K13, K14 and K15). The field was initially tied back to the Curlew FPSO before being re-tied back to the Banff FPSO in 2005, where it produced oil and gas until the K14 well failed in 2018 following sand control issues which led to decommissioning in 2020. All four production wells were plugged and abandoned.

Two distinct reservoirs are present at Kyla: Cretaceous chalk and the shallower Palaeocene sandstone. Historically, three production wells (K12, K13 and K15) targeted the chalk, with one well (K14) producing from the sandstone. The proposed Kyla Development concept will target the western flank of the reservoir, where historically the Palaeocene sandstone production has come from as the remaining chalk recoverable volumes are interpreted to be very small.

Whilst a small (<1 bscf) free gas cap exists at Kyla, the Kyla fluids are almost entirely in a liquid oil phase, with a 38.1 API and Gas to Oil Ratio (GOR) of 799.

Serica is proposing to develop the Kyla field via a single subsea well tied back via 12 – 13.2 km long 8-inch production and 3-inch piggybacked gas lift rigid pipelines to one of the existing Bittern drill centre manifolds (either DCA or DCB) via a tie-in structure. The Bittern manifolds are in turn tied back to the Triton FPSO, with both assets operated by Dana. An electro/chemical/hydraulic and control umbilical will be extended from Bittern to Kyla, which will run adjacent to the pipelines, 20 - 75 m apart.

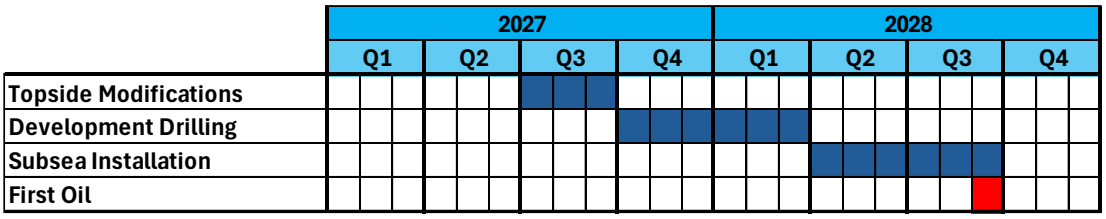
Kyla hydrocarbons will be processed on the Triton FPSO. The Triton FPSO has suitable process facilities and spare capacity to support and service Kyla with relatively minor topsides modifications. Kyla oil will be exported as part of the Triton FPSO blend via shuttle tanker and sales gas routed with other Triton area gas to the St Fergus terminal onshore via the Fulmar gas pipeline for onwards transmission to the National Transmission network.

The Kyla Development is expected to produce hydrocarbons for ca. 8 years, until 2035, depending on the reserves, the production rate and the life of the Triton FPSO.

3.2 Project Schedule

A provisional project schedule for the offshore activities associated with the Kyla Development is shown in Figure 3.1. First oil is targeted for Q3 2028.

Figure 3.1: Indicative Timeline for Proposed Kyla Development Project



The following sections provide a detailed description of the current base-case design for the project. Some design parameters will be further refined during the detailed design phase and may therefore be subject to change. However, the design parameters presented are deemed realistic, yet conservative (i.e. worst-case) with regards to the potential environmental impacts, based on the current project scope and definition.

3.3 Drilling Operations

3.3.1 Overview

Serica proposes to drill and complete one subsea horizontal production well (29/02c-K16) in the Kyla field targeting the Palaeocene sandstone. The proposed tophole location for this well sits within UKCS Block 29/02 at 56° 53' 01.13"N, 01° 13' 50.70"E (ED50 TM 0 N).

The development well will consist of the following sections: 36", 26", 17½", 12¼" and 9½" sections, with contingency for a re-spud scenario and a 17½" sidetrack to account for any unforeseen mechanical issues. The top two well sections will be drilled using a water-based fluid, before being lined with steel well casings that are cemented in place. The deeper well sections will be drilled with a low toxicity oil base mud (LTOBM) system.

On completion of the 17½" section, a 12¼" pilot hole on Kyla will also be drilled and logged to optimise the placement of the horizontal production well. It will be abandoned by pumping two cement plugs. The first plug is planned to be set on bottom and tagged after waiting on cement (WOC) to confirm there is a minimum of 200 ft (ca. 60 m) of good cement above the reservoir. The second plug will be set in open hole, acting as a kick-off plug for the development wellbore. It is currently anticipated that the total depth (TD) of the pilot hole will be 2,407 m true vertical depth subsea (TVDss), and the measured depth (MD) will be up to 2,755 m.

It is currently anticipated that the TD of the development well will be 2,190 m TVDss and the actual well length will be up to 3,603 m MD, assuming no contingent sections are drilled.

In order to prepare the well for production, upper and lower completion equipment will be run. Due to the unstable nature of the sand in the reservoir, the lower completion equipment will include sand exclusion.

Upon completion of the drilling operations, a 'fishing friendly' Xmas tree designed to control flow will be installed on top of the wellhead directly from the MODU. The well will be temporarily suspended through the valves in the tree until it can be connected to the production jumpers.

3.3.2 Drilling Unit, Logistics and Support

A MODU has yet to be contracted for the project, but given the water depth at Kyla (ca. 90 m), it is expected that the subsea well will be drilled and completed from a semi-submersible drilling rig, which will be held in position over the Kyla location by anchors and chains.

For the purpose of this ES, it is assumed that the MODU mooring system will consist of eight anchors and mooring lines, with all anchors laid up to a distance of 1.6 km from the rig centre. Each anchor typically weighs around 15 tonnes, with outer dimensions measuring approximately 7.5 m (W) x 4.5 m (L), equating to a seabed footprint of ca. 34 m^2. A length of steel chain, typically 750 m in length and 3" (76 mm) in diameter, will be attached to each of the anchors. To complete the mooring lines, pennant wire, typically 200 m in length, will be connected to the inboard end of each ground chain to facilitate subsequent connection to the MODU. Fibre rope inserts may also be added to some of the mooring lines, connecting the anchor ground chain and paid-out rig wire. These inserts allow the central sections of the lines to be buoyed and lifted into the water column, preventing interaction with seabed infrastructure. As such, only part of each mooring line will come into contact with the seabed once the MODU is connected. However, to represent a worst case scenario, it is assumed that the total length of each ground chain (750 m) and pennant wire (200 m) will be in contact with the seabed. Therefore, the combined length of line that may interact with the seabed once the MODU is on location and connected to the mooring system is 7,600 m. In the event there is a requirement to re-spud the well, the anchor pattern arrangement would not change.

To avoid potential delays associated with poor weather conditions or the competitive support vessel market, the anchors and a proportion of the mooring lines will be pre-laid ahead of MODU arrival using two anchor handling vessels (AHVs). The pre-laid elements of the mooring system may therefore sit on the seabed for a number of weeks without the MODU. The process of connecting the MODU to the pre-laid components of the mooring system will be supported by a further two AHVs. When the MODU

moves off site, the same elements of the mooring system may be left on the seabed for a number of weeks, to be collected at a later date by AHVs.

The pre-laid anchors and chains may pose a snagging risk to fishing vessels in the area before the arrival of the MODU at Kyla and once the MODU has moved off location. A guard vessel may therefore be deployed to warn passing vessels of their presence.

Once the MODU is in place at Kyla and connected to the mooring system, a 500 m safety zone will be imposed around it for safety reasons. An Emergency Rescue and Recovery vessel (ERRV) will be stationed in the vicinity of the MODU to enforce the 500 m safety zone and assist in the event of an emergency. The MODU and its associated 500 m safety zone will be in place throughout the proposed drilling operations, which are currently anticipated to last up to 100 days.

The MODU will also be supported by two supply vessels, used to transport drilling equipment, supplies, water, fuel and food to the well location from a supply base in north east Scotland and return waste and surplus equipment to shore.

Personnel will be transferred to the MODU via helicopter from Aberdeen. Typically, up to four scheduled flights will be made to the MODU per week throughout the proposed drilling operations.

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

Table 3.1: Vessel and Helicopter Requirements for Kyla Development Drilling Campaign

Vessel	Function / Assumptions	Total No. of Vessel Days	Fuel Type	Fuel Consumption Rate	Total Fuel Consumption (tonnes)	GHG Emissions (tonnes of CO_2e) [2]
2 x AHVs	10 days to lay anchors, 10 days to connect and disconnect rig, 10 days to recover anchors	60	Diesel	30 tonnes/day	1,800	5,841.55
MODU	Transit to / from Kyla	1	Diesel	34 tonnes/day	34	110.34
	Drill and complete the well on location at Kyla	100	Diesel	21 tonnes/day	2,100	6,734.48
ERRV	Assist in the event of an emergency	100	Diesel	2 tonnes/day	200	649.06
Supply vessels	Logistic support and transportation of goods, tools, equipment and LTOBM cuttings[1]	400	Diesel	8 tonnes/day	3,200	10,384.97
Guard vessel	28 days on site with pre-laid mooring system and 28 days after operations	56	Diesel	2 tonnes/day	112	363.47

Vessel	Function / Assumptions	Total No. of Vessel Days	Fuel Type	Fuel Consumption Rate	Total Fuel Consumption (tonnes)	GHG Emissions (tonnes of CO_2e) [2]
Helicopter	Transfer crew to and from MODU (2.5hr round trip)	4 return flights per week	Aviation fuel	0.655 tonnes/hour	93	300.70
				Totals:	**7,539**	**24,384.58**

[1] It is assumed that supply vessels will either be on location at the MODU or transiting for the duration of the proposed drilling operations (100 days). It has been assumed, as a worst case scenario in terms of vessel days and fuel consumption, that LTOBM contaminated cuttings will be skipped and shipped to shore for appropriate treatment and disposal. However, the option remains to treat and discharge the cuttings offshore, as detailed in Section 3.3.4.

[2] Refer to Appendix E for details on the methodology used to calculate the quantity of GHG emissions produced.

3.3.3 Well Design

An indicative profile for the Kyla Development well is detailed in Table 3.2 and illustrated in the well schematic provided in 1 Refer to Section 3.3.1 for pilot hole description and justification.

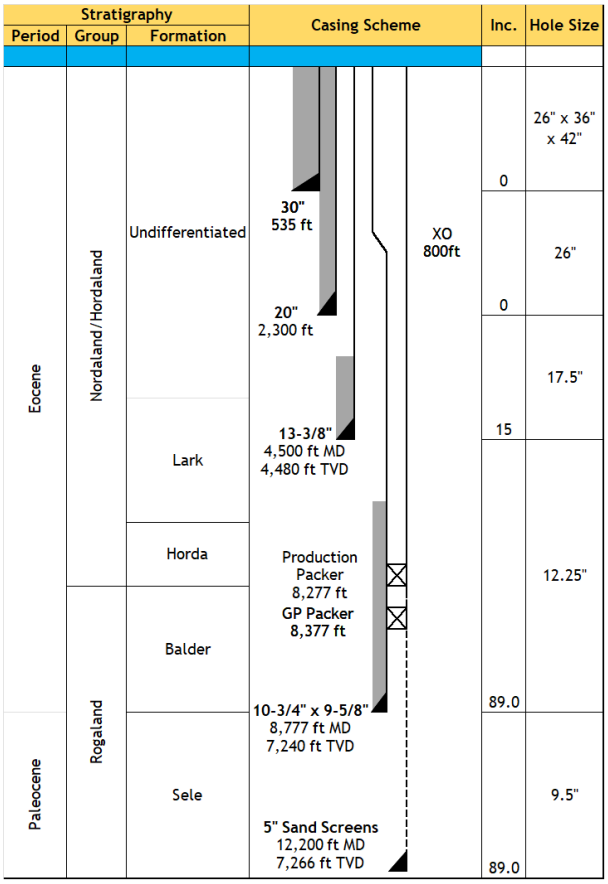
Figure 3.2. A 36" diameter top-hole section will be drilled into the seabed, into which the 30" diameter conductor pipe is cemented. The second (26") section will then be drilled through the conductor and a 20" surface casing installed and cemented into place. The casings of the two top-hole sections, firmly cemented into the borehole, will then provide a firm foundation for the Blowout Preventer (BOP), which will be installed on the drilling riser at the seabed. The drilling riser connects the well to the MODU, therefore providing a conduit to return the mud and cuttings from the deeper sections of the well back up to the MODU. The deeper 17½", 12¼" and 9½" sections of the well will then be drilled with the drilling fluids circulated back to the MODU.

Table 3.2: Indicative Well Profile

Hole Diameter (inches)	Casing Diameter (inches)	Casing Type	Section Length (ft)	Section Length (m)
36	30	Conductor	145	45
26	20	Surface casing	1,765	540
17½	13⅜	Intermediate casing	2,200	671
12¼ PH	N/A	N/A	4,618	1,408
12¼ Dev	10¾ x 9⅝	Production liner	4,277	1,304
9½	-	-	3,423	1,043
Total (Development Well excluding Pilot Hole [1])			**11,810**	**3,603**

[1] Refer to Section 3.3.1 for pilot hole description and justification.

Figure 3.2: Provisional Kyla Development Well Schematic



3.3.4 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 MODU 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 well, Serica 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 substitution (SUB) warnings will be avoided where technically possible.

Drilling Mud and Cuttings

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 26"), the 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 17½, 12¼" and 9½ sections, a marine riser will be situated between the wellhead and MODU so that cuttings and drilling fluid are circulated back up to the MODU. These sections will be

drilled with LTOBM. It is not yet known if the LTOBM contaminated cuttings from the lower sections will be skipped and shipped to shore for disposal or if they would be thermally treated offshore to an acceptable overboard disposal limit (<1% oil on cuttings) and discharged from the MODU. However, for the purposes of this ES, modelling of the discharge of the drill cuttings has been carried out to support the impact assessment, assuming the treatment and discharge of the LTOBM contaminated cuttings.

In the event the LTOBM cuttings are thermally treated offshore, the LTOBM cuttings will be crushed and heated to a temperature which is high enough for oil and water to vaporise and thereby disappear from the cuttings. The liquid is separated from the solids, with oil and water condensed later in the treatment process. Recovered oil will be pumped back into the mud system and recovered water will be disposed overboard if the oil in water content is < 30 mg/l. The resulting rock powder / solids, with a hydrocarbon content of <1%, will be discharged to sea.

Table 3.3 provides an estimate of the quantity of cuttings generated and discharged for the Kyla Development well. To account for any unforeseen mechanical or geological issues, a re-spud scenario and contingency 17½" sidetrack have been added to represent a worst case scenario. The total amount of cuttings discharged in the event all contingent well sections are drilled is 2,387,000 kg (2,387 tonnes).

Table 3.3: Estimated Mass of Cuttings Generated

Hole Diameter (inches)	Fluid Type	Section Length (m)	Section Volume (m^3)	Total Muds Volume (m^3)	Weight of Cuttings (kg)	Discharge Point
36	Seawater sweeps	45	30	125*	75,500	Seabed
36 (re-spud)		45	30	125*	72,500	
26		540	185	670**	459,900	
26 sidetrack		540	185	670**	459,900	
17½	LTOBM	671	105	341	259,700	Surface (<1% oil on cuttings)[3]
17½ sidetrack [1]		671	105	341	259,700	
12¼ (PH)		1,408	107	449	361,600	
12¼ (Dev)		1,304	100	441	283,400	
9½ [2]		1,043	48	489	154,800	
Total:		**6,267**	**895**	**3,651**	**2,387,000**	

[1] Considered to be the worst-case mechanical sidetrack for the well as it accommodates the worst case trajectory change from the current planned reservoir target.
[2] Reservoir hole section likely to be 8.5" under reamed to 9.5" as per previous Triton wells.
[3] LTOBM cuttings will be thermally treated offshore to an acceptable overboard disposal limit (<1% oil on cuttings) and discharged.
* 36" hole: this assumes 50 bbl sweeps every half a stand drilled + 200 bbl sweeps for hole cleaning at TD + 1.5 x hole volume displacement at TD
** 26" hole: this assumes 50 bbl sweeps every half a stand drilled + 200 bbl sweeps for hole cleaning at TD + 1.5 x hole volume displacement at TD

Cementing Operations

The casings used to prevent the well from collapsing will be cemented into place inside the borehole. The conductor will be cemented into the top hole section of the well. In this case an allowance will be made to pump up to 300% excess cement to allow for washout and cratering of the wellbore. However, a Remote Operated Vehicle (ROV) will monitor the return flow at the seabed and all attempts will be made to identify returns and reduce the pumped slurry volume when possible and safe to do so. A dye will be added to the cement spacer to assist in visually identifying the returns from the wellhead. At this point the remaining cement in the drill string will have to be circulated out, and it is estimated this may result in a discharge of ca. 48 m^3 (300 bbl) of cement being pumped out to the seabed. The cementing of the 20" casing will be very similar to that of the conductor option, using 100% open hole

excess cement, which will amount to a theoretical maximum of ca. 75 m^3 (473 bbl) of mixed cement being pumped out to the seabed. Hence, up to ca. 123 m^3 (773 bbl) cement slurry may be pumped out to the seabed.

In the event that a problem is encountered when drilling one of top hole sections, and a re-spud scenario is required, 300% and 100% excess cement quantities would again be used for the conductor and surface casing, respectively. Hence, as a worst case, a further 123 m^3 (773 bbl) of cement slurry could possibly be discharged to the seabed from the re-spud tophole operations.

The cementing of the 13⅜" and 9⅝" casings, as well as the pilot hole abandonment, will be engineered so that the cement will not reach to top of the casing, and thus no cement is expected to be returned to the surface from these sections. Any cement dressed off during the sidetrack kick off will be treated in the same manner as cuttings.

The only potential discharge during this part of the cementing operations, would be from an unplanned event, such as an aborted cement job due to technical or mechanical failures. If for any reason cement is circulated back to the MODU, it would need to be discharged to sea before it solidifies.

No unmixed cement will be discharged overboard. In addition, in between cementing operations, there will be a requirement to discharge small, residual volumes of cement, associated with cleaning of cement tanks between the cementing applications.

3.3.5 Well Clean-up and Completion Operations

Once drilling operations are finished, the well will be completed and readied for production. Before production begins, the well will undergo a thorough clean-up to eliminate any residual LTOBM drilling fluids and debris in the wellbore. The lower completion is then installed and a gravel pack operation is carried out. Once the gravel pack is completed, the area above the lower completion is displaced using a suitable brine (this may be mixed with viscosified pills, solvents, and surfactants; these will be segregated and if contaminated will be transported onshore for disposal). Finally, the upper completion will be installed. Throughout this process, it is estimated that approximately ca. 477 m^3 (3,000 bbl) of completion brine will be discharged. Prior to discharge, the brine will be filtered until the fluids are below 30 mg/l LTOBM hydrocarbons, with a maximum total of 14.3 kg of LTOBM hydrocarbon discharged. No well test is planned.

3.3.6 Xmas Tree Installation

Once drilling operations are completed and the production equipment has been installed downhole, a vertical xmas tree will be landed on top of the wellhead, installed directly from the drilling rig (Section 3.4.2). The xmas tree will sit above the seabed, locked onto the wellhead as it emerges from the seabed. This tree will remain on the seabed permanently, providing well control and supporting the production of hydrocarbons. Based on the life of the field, this tree will remain in place for ca. 8 years.

3.4 Subsea Installation Operations

3.4.1 Overview

The new subsea infrastructure proposed to be installed as part of the Kyla Development is summarised in Table 3.4 and discussed in the following subsections.

Table 3.4: Summary of Kyla Development Infrastructure

Subsea Item	Dimensions	Installation Method
Kyla Development Drill Centre (see Figure 3.3)		
Xmas tree	5.1 m (L) x 4.8 m (W) x 6.3 m (H)	Installed directly from the MODU
Valve skid	Piled structure: 9 m (L) × 6 m (W) × 3.3 m (H) or GBS: 16.6 m (L) × 6.5 m (W) × 3.7 m (H)	Installed from CSV
Rigid tie-in spools	Production spools: 100 m (L) Gas lift spools: 100 m (L)	Installed from DSV and mattresses protected
EHC jumpers / EHC control umbilical tie-in loop	EHC jumpers (bundled): 50 m (L) Tie-in loop: 75 m (L)	
Pipelines and Umbilical (see Figure 3.6)		
8" production pipeline	13.2 km in length	Reel laid, trenched and buried. Rock protection required for trench transitions, pipeline crossing and mitigation of upheaval buckling
3" gas lift pipeline	13.2 km in length	
Electro-hydraulic control umbilical	13.2 km in length	
Bittern Tie-in Arrangement (see Figure 3.8; Figure 3.9) [1]		
Tie-in Structure	Piled structure: 9 m (L) × 6 m (W) × 3.3 m (H) or GBS: 16.6 m (L) × 6.5 m (W) × 3.7 m (H)	Installed from CSV
Rigid tie-in spools and pipeline ends	Production: 300 m (L) Gas lift: 150 m (L)	Installed from DSV and mattresses protected
EHC jumpers / EHC control umbilical tie-in loop	EHC jumpers (bundled): 150 m (L) Tie-in loop: 240 m (L)	

[1] The new subsea infrastructure at Bittern will be installed within the existing Bittern 500m safety zone.

3.4.2 Kyla Development Drill Centre

The proposed Kyla Development drill centre layout is illustrated in Figure 3.3.

The subsea infrastructure to be installed at Kyla includes a 'fishing friendly' Xmas tree, which will be placed on top of the wellhead and a 'fishing friendly' valve skid, which would be located ca. 35 m from the proposed Kyla well location.

Serica will apply for a 500 m safety zone to be in place around the Kyla wellhead location before the MODU arrives on location.

Xmas Tree

Upon completion of the proposed drilling operations, a vertical Xmas tree, an arrangement of valves, gauges, chokes and connection pieces used to regulate the flow of produced oil to the surface and lift gas or chemicals into the well, will be installed on top of the wellhead directly from the MODU. The vertical xmas tree is roughly cube shaped, and once landed on top of the wellhead, the highest point of the overall structure will sit approximately 6.3 m above the seabed surface.

Once the tree is secure on top of the wellhead, four telescopic legs will be lowered to the seabed. These are designed to deflect any fishing lines or trawl boards over the tree and prevent any lines or trawl boards getting into the wellhead / conductor area, negating the need for a specific Xmas tree protection structure. Once in position and the legs are lowered, the outermost dimensions of the xmas tree will be 5.1 m long by 4.8 m wide.

Kyla Valve Skid

A 'fishing friendly' valve skid will be installed at Kyla to route gas lift and production fluids to and from the Kyla well and Bittern manifold and act as the connecting point for the Kyla umbilical.

Two foundation concepts, piled versus gravity-based, are currently being considered for the structure. For the purposes of this ES, a piled structure foundation concept has been assumed as worst case for the underwater noise assessment and a gravity-based structure (GBS) has been assumed as worst case for the seabed disturbance assessment (refer to Section 2.5).

The piled structure has approximate dimensions of approximately 9 m (L) × 6 m (W) × 3.3 m (H), a dry weight of ca. 55 tonnes and a seabed footprint of ca. 54 m² for the structure itself, plus localised disturbance from piles (Figure 3.4). It is assumed that the valve skid would be held in place by four tubular piles, one at each corner, each with a diameter of 24-inch and length of up to 24 m. The piles would be secured into the seabed using a maximum hammer blow energy of 90 kJ, with a maximum blow rate of 50 blows per minute. It is expected that the hammering operations for each pile will be ongoing for up to two hours. A soft start is assumed with a ramp up from 30% energy to full energy over 5 minutes, with a reduced blow rate of 6 strikes per minute. Each pile is estimated to take 2 hours to install, giving a total maximum piling duration of 8 hours.

The GBS has dimensions of approximately 16.6 m (L) × 6.5 m (W) × 3.7 m (H) and a dry weight of ca. 124 tonnes. It would be placed directly on the seabed and stabilised by self-weight, avoiding the need for piling. The GBS has a seabed footprint of ca. 108 m².

Regardless of the foundation concept, the valve skid will be installed from a construction support vessel (CSV).

Tie-in Spools and Umbilical Jumpers

The proposed Kyla tie-in line lengths and protection requirements are detailed in Table 3.5.

Rigid tie-in spools will connect the Kyla well to the Kyla valve skid and the Kyla valve skid to the 8-inch production pipeline and 3-inch gas lift pipeline. These tie-in spools will be surface laid installed from a DSV and protected by concrete mattresses, with each concrete mattress having dimensions of 6 m x 3 m x 0.15 m.

The Kyla umbilical will connect directly into the valve skid. The untrenched sections of the umbilical will be protected with concrete mattresses, similar to the tie-in spools. An electro-hydraulic control (EHC) bundled jumper will be DSV installed and connect the Kyla valve skid to the Kyla xmas tree. EHC jumper protection will be via concrete protection mattresses.

Table 3.5: Kyla Development Drill Centre Tie-in Details

Spool Type	Length (m)	From	To	Protection Material [1]	Seabed Footprint (m^2)
8" production pipeline tie in spools	50	8" pipeline	Kyla Valve Skid	16 x concrete mattresses (covering both 8" and 3" spools and pipeline ends)	288
3" gas lift pipeline tie in spools	50	3" pipeline	Kyla Valve Skid		
6" Xmas tree spools	50	Kyla Valve Skid	Kyla Xmas tree	9 x concrete mattresses (covering 8" / 3" spools and EHC jumper)	162
3" Xmas tree spools	50	Kyla Valve Skid	Kyla Xmas Tree		
Xmas tree EHC jumpers (bundled)	50	Kyla Valve Skid	Kyla Xmas Tree		
EHC control umbilical tie-in loop	175	Kyla Valve Skid	Start of Trench	26 x concrete mattresses	468

[1] Mattress dimensions are assumed to be 6 x 3 x 0.15 m.

Seabed Footprint

An estimate of the total area of seabed directly impacted by the installation of subsea infrastructure and associated protection material at the Kyla drill centre is presented in Table 3.6.

Table 3.6: Estimated Seabed Footprint of Subsea Infrastructure at Kyla Development Drill Centre

Subsea Item	Assumptions	Total Seabed Footprint (m^2)
Xmas tree / wellhead [1]	Outermost dimensions of the xmas tree, including telescopic legs will be 5.1 m (L) x 4.8 m (W)	24.5
Kyla valve skid	GBS has dimensions of ca. 16.6 m (L) × 6.5 m (W)	108
Tie-in spools, pipeline ends and control jumpers	Pipeline ends, spools and jumpers will be surface laid and protected with concrete mattresses (see assumptions in Table 3.5)	450
Untrenched Umbilical Section	Umbilical tie-in loop will be surface laid and protected with concrete mattresses (see assumptions in Table 3.5)	468
	Total Seabed Footprint at Kyla Drill Centre	**1,050.50**

[1] Xmas tree will be located on top of the wellhead.

Figure 3.3: Kyla Development Drill Centre Layout

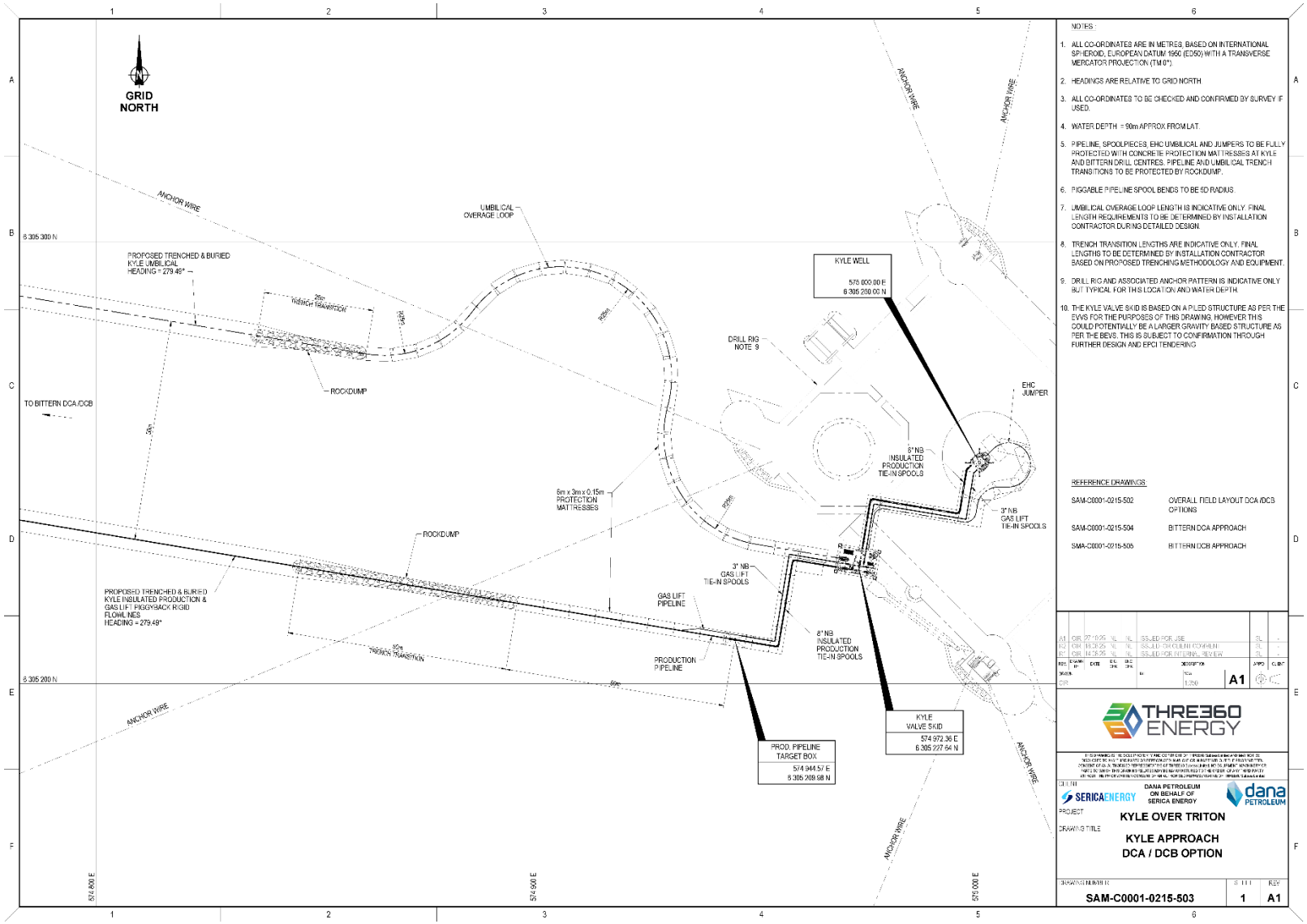
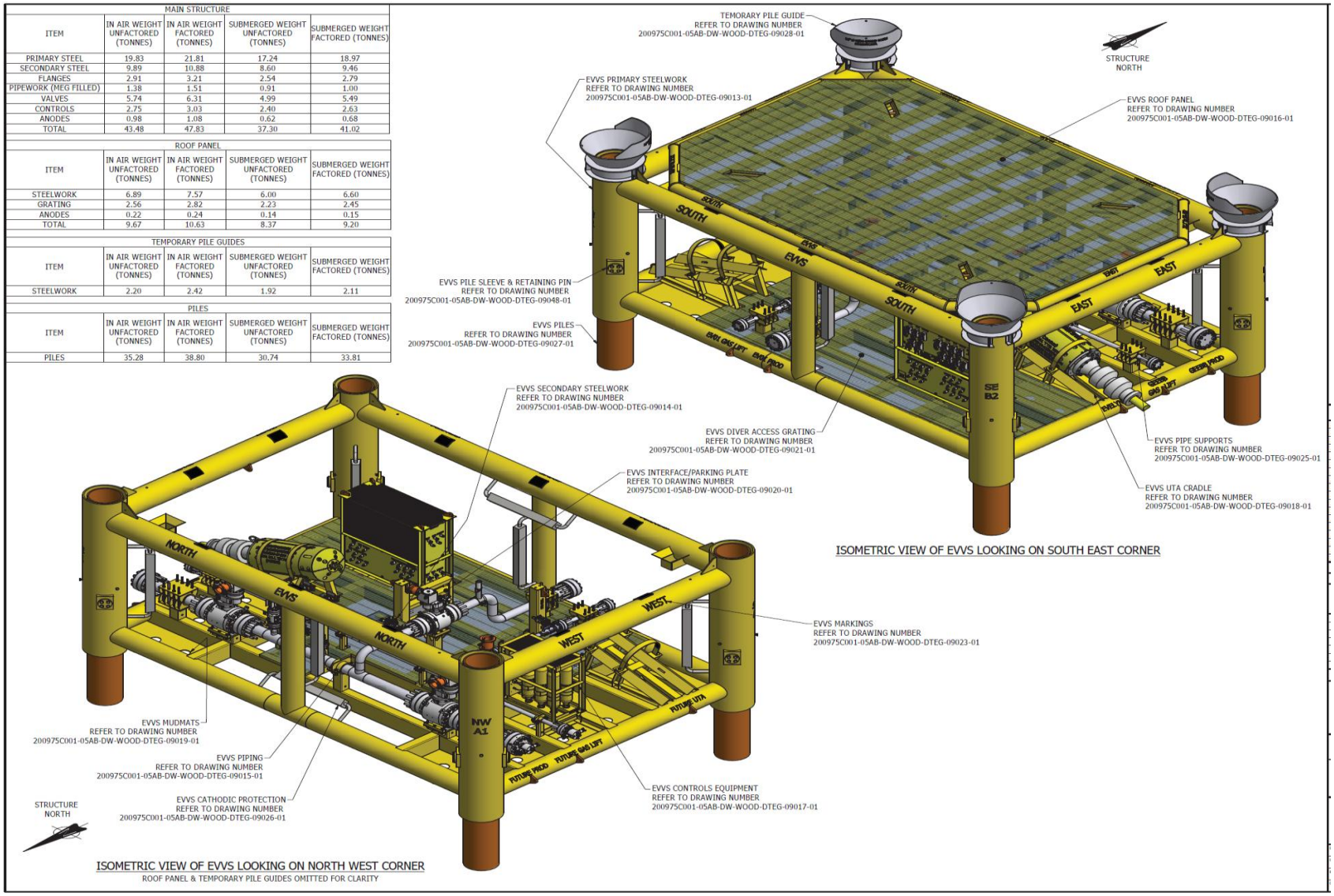


Figure 3.4: Example Piled Valve Skid Structure



MAIN STRUCTURE				
ITEM	IN AIR WEIGHT UNFACTORED (TONNES)	IN AIR WEIGHT FACTORED (TONNES)	SUBMERGED WEIGHT UNFACTORED (TONNES)	SUBMERGED WEIGHT FACTORED (TONNES)
PRIMARY STEEL	19.83	21.81	17.24	18.97
SECONDARY STEEL	9.89	10.88	8.60	9.46
FLANGES	2.91	3.21	2.54	2.79
PIPEWORK (MEG FILLED)	1.38	1.51	0.91	1.00
VALVES	5.74	6.31	4.99	5.49
CONTROLS	2.75	3.03	2.40	2.63
ANODES	0.98	1.08	0.62	0.68
TOTAL	43.48	47.83	37.30	41.02

ROOF PANEL				
ITEM	IN AIR WEIGHT UNFACTORED (TONNES)	IN AIR WEIGHT FACTORED (TONNES)	SUBMERGED WEIGHT UNFACTORED (TONNES)	SUBMERGED WEIGHT FACTORED (TONNES)
STEELWORK	6.89	7.57	6.00	6.60
GRATING	2.56	2.82	2.23	2.45
ANODES	0.22	0.24	0.14	0.15
TOTAL	9.67	10.63	8.37	9.20

TEMPORARY PILE GUIDES				
ITEM	IN AIR WEIGHT UNFACTORED (TONNES)	IN AIR WEIGHT FACTORED (TONNES)	SUBMERGED WEIGHT UNFACTORED (TONNES)	SUBMERGED WEIGHT FACTORED (TONNES)
STEELWORK	2.20	2.42	1.92	2.11

PILES				
ITEM	IN AIR WEIGHT UNFACTORED (TONNES)	IN AIR WEIGHT FACTORED (TONNES)	SUBMERGED WEIGHT UNFACTORED (TONNES)	SUBMERGED WEIGHT FACTORED (TONNES)
PILES	35.28	38.80	30.74	33.81

3.4.3 Production Pipeline, Gas Lift Pipeline and Control Umbilical

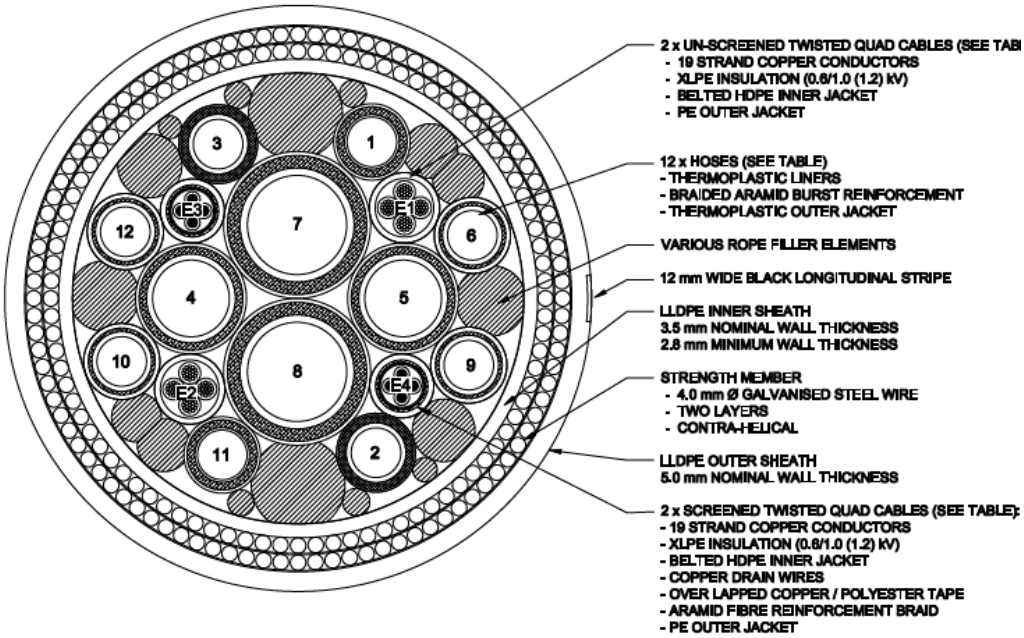
Kyla production fluids will be exported via a new 12 to 13.2 km long 8-inch production carbon steel pipeline to one of the Bittern manifolds (either DCA or DCB). A 3-inch gas lift carbon steel pipeline will be piggybacked to the production pipeline to supply gas lift to the Kyla well. The proposed pipeline details are provided in Table 3.7.

Table 3.7: Pipeline Details

Parameter	Unit	Production Pipeline	Gas Lift Pipeline
Outside diameter	mm	219.1	88.9
Wall thickness	mm	14.3	7.6
Material	-	Carbon steel	Carbon steel
Design pressure	barg	200bar	200bar
External corrosion coating	-	Thermotite ULTRA Insulation	3LPP
External coating thickness	mm	38.0	1.5

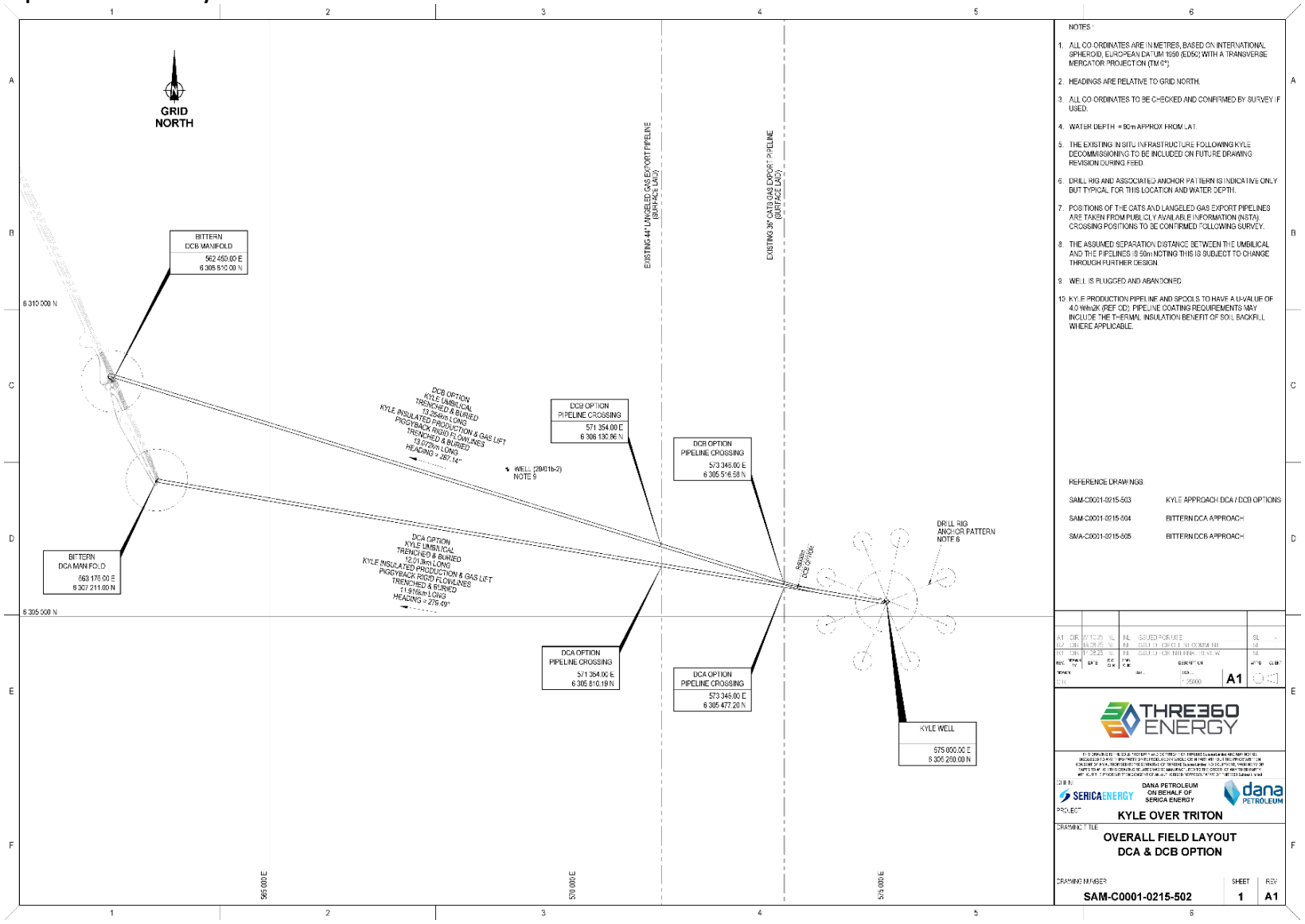
A 12 to 13.4 km long umbilical will be extended from Bittern to Kyla, running adjacent to the pipelines, ca. 50 m apart. The umbilical will provide electrical power/signal functions, hydraulic functions and chemicals (scale inhibitor, corrosion inhibitor, methanol and provision for wax inhibitor) to the Kyla well. A preliminary cross section of the umbilical is depicted in Figure 3.5.

Figure 3.5: Kyla Umbilical Provisional Cross Section



The proposed pipeline and umbilical routes between Kyla and Bittern DCA or Bittern DCB are illustrated in Figure 3.6. The routes cross the existing 44-inch Langeled and the 36-ich CATS gas export pipelines, both of which are surface laid.

Figure 3.6: Pipeline Route from Kyla to Bitten DCA or DCB Manifold



The Kyla pipelines and umbilical are likely to be installed by a reel-lay vessel and will be surface laid on the seabed prior to trenching. For reel-lay installation, long pipe segments are welded, tested and coated onshore and then spooled onto a large, usually vertically oriented pipe reel, in one continuous length. Once the reel-lay vessel is in position, the pipe is unspooled, straightened and then lowered to the seabed as the vessel moves forward. As-laid surveys would be performed by the vessel to confirm the lines have been installed in the correct position.

In order to initiate pipelaying, temporary laydown areas will be required for initiation anchors (as a worst case it is assumed that drag embedment anchors would be used) and initiation wire, the length of which is assumed to be up to 100 m. Following installation of the pipelines, the anchors and wire will be recovered. There may also be a requirement to temporarily wet store subsea facilities and protection materials, as well as ROV tooling and baskets. The dimensions of any temporary laydown area are unlikely to exceed 20 m x 10 m based on maximum tie-in spool dimensions. It is assumed up to six temporary laydown areas will be required for the Kyla Development, impacting a total seabed area of 1200 m^2 (0.0012 km^2). No turning bollards are anticipated to be required along the route.

Once surface laid, the lines will be trenched and buried, similar to the other pipelines which form part of the Triton area. The umbilical will be trenched and buried separately to the pipelines as it is not considered feasible to install the umbilical in the same trench as the piggybacked production and gas lift pipelines.

Seabed sediments along the proposed pipeline/umbilical route are mainly poorly sorted muddy sand and are considered suitable for all three trenching techniques. Both ploughing and jetting solutions have been successfully used on previous Triton area pipelines. Depending on the soil conditions, ploughing potentially has a higher likelihood of achieving greater depth of cover thus potentially a reduced requirement for remedial rock versus jetting. If a jetted or mechanically cut trenching solution is selected additional rock contingency may be required to address the risk of achieving less than planned depth of cover (variability in trenching performance) the following will be considered:

- Not all subsea installation contractors have access to conventional plough equipment;
- The high bollard pull (>300Te) vessels required to pull a conventional plough are now in short supply in the North Sea and may attract a significant premium depending on market conditions;
- Recent project experience of a jetted trenching solution in the Triton Area required significant additional rock since it achieved less than planned depth of backfill cover;
- Note that a surface laid pipeline with blanket rock placement only (i.e. no trenching) would require significantly more rock than any of the trenched solutions.

The final trenching method will be selected by the subsea installation contractor. However, for the purposes of this ES, trenching and backfilling via a plough has been assessed, as this represents the worst-case scenario for seabed disturbance and fuel consumption by vessels. If a jetted or mechanically cut trenching solution is selected, the items listed above will also apply; therefore, additional rock contingency has been included in the assessment to allow for this.

A pipeline plough creates an open V shaped trench in the seabed and spoil heaps either side. Backfilling is subsequently carried out using a mechanical backfill plough to redeposit the spoil heaps above the trenched pipe. If ploughed, the trench for the pipelines will have a width of ca. 5.0 m and depth of 1.8 m, with a target cover depth of 1 m. The backfilling equipment is expected to disturb up to 11 m of seabed on each side of the pipelines. A similar disturbance corridor is assumed for the umbilical. As a worst case, it is therefore anticipated that, as a maximum, 0.616 km^2 of seabed would be directly impacted, assuming a line length of ca. 14 km and two 22 m wide corridors.

Boulders of different sizes have previously been recorded during surveys conducted for Bittern and Belinda. Sidescan sonar data has not yet been collected along the route of proposed pipelines and umbilical and, therefore, the number and location of boulders in the Kyla Development area is not known. Boulders inhibit the use of the trenching equipment, and boulder clearance may therefore be required prior to trenching. Boulder clearance will be minimised as far as practical via pipeline routing exercises as part of the design process and potentially local the pipeline micro routing prior to pipe or umbilical lay. However, the need for boulder relocation cannot currently be ruled out. If required,

boulder clearance will be achieved through use of a grab or bumper bar. All boulders greater than 0.5m would typically be removed from the lay corridors for the pipelines and umbilical and relocated to the edges of the installation corridor, ideally within a 5 m corridor downstream of the prevailing current to minimise likelihood of scour developing on the route. The as-left position of each boulder will be recorded. In the event that up to ten boulders may need to be removed from the lay corridors a conservative estimate of the seabed impact resulting from this would be 10 m^2.

Burial of the pipelines will assist in protection against upheaval buckling, where temperature changes cause the pipeline to move to relieve the expansion forces. The potential for upheaval buckling is directly related to the as-trenched shape of the pipeline where deviations in height away from a perfectly straight pipe are susceptible to upheaval buckling. The target pipeline burial depth should be sufficient to prevent upheaval buckling for the majority of deviations in height. However, for larger imperfections, the backfill cover height provided by the backfilled sediment may not, on its own, be sufficient to resist upheaval buckling and at these locations placement of rock may be required.

Rock is considered the most appropriate mitigation measure for upheaval buckling. Based on experience from the wider Triton area, it has been calculated that up to 25,000 tonnes of rock may be needed to mitigate for upheaval buckling along the pipeline. This allows for contingency to account for the fact that data from the detailed engineering surveys is still pending. Any rock required for upheaval buckling will be sited within a ca. 10m wide corridor centred above the pipeline.

The requirement for rock to be deposited along the pipelines will be determined by reviewing as-trenched and as-backfilled survey data against the critical trench imperfection criteria defined during detailed design. As a contingency it is assumed up to 65,000 tonnes of rock may be deposited on the pipelines if target trenching is not achieved.

The umbilical will not require any rock placement provided it is suitably trenched below mean seabed level. However, as a contingency it is assumed up to 10,000 tonnes of rock may be deposited on the umbilical if target trenching is not achieved.

Additional rock will also need to be deposited where the pipelines and umbilical exit the trenches at Kyla and Bittern (50 m sections for the pipelines and 25 m sections for the umbilical). It is estimated that up to 2,000 tonnes of rock may need to be deposited over the lines for protection at these locations.

In addition, as shown in Figure 3.6, the proposed route of the Kyla pipelines and umbilical cross the existing 44-inch Langeled and the 36-ich CATS gas export pipelines, both of which are surface laid and exposed. Crossing designs are not yet matured, but are likely to entail concrete mattresses/plinths and rock placement. The impact assessment presented in this ES is based on the worst case assumption of 34,100 tonnes of rock required for the pipeline and umbilical crossings, including trench transition, and up to 54 concrete mattresses to accommodate both the Kyla pipelines and Kyla umbilical crossing Langeled and CATS. Where concrete mattresses are used as part of the crossings design, or in other open wate relocations outside the 500m safety zones at Bittern and Kyla, rock cover will be provided over the mattresses to minimise risk of snagging with fishing gear.

Figure 3.7 shows a schematic of this type of pipeline crossing arrangement.

Any rock required will be deposited by a rock placement vessel. The vessel will survey the seabed as the rock placement installation progresses to determine the exact location of the rock material and to confirm that the design requirements have been met. The spread of rock placement will be restricted through the use of a fall pipe system held a few metres above the seabed to accurately place rock material. The rock material deposited will comprise inert rock material, containing minimal fines.

Table 3.8 provides a worst case estimate of the total quantity of rock which will be required to be deposited on the seabed to install the Kyla pipelines and umbilical. As detailed design work has not yet commenced, the quantity of rock detailed in Table 3.8 is subject to change but is based on information from previous rock placement campaigns in the area undertaken for the Evelyn, Belinda and Bittern projects, with credible worst case contingencies applied.

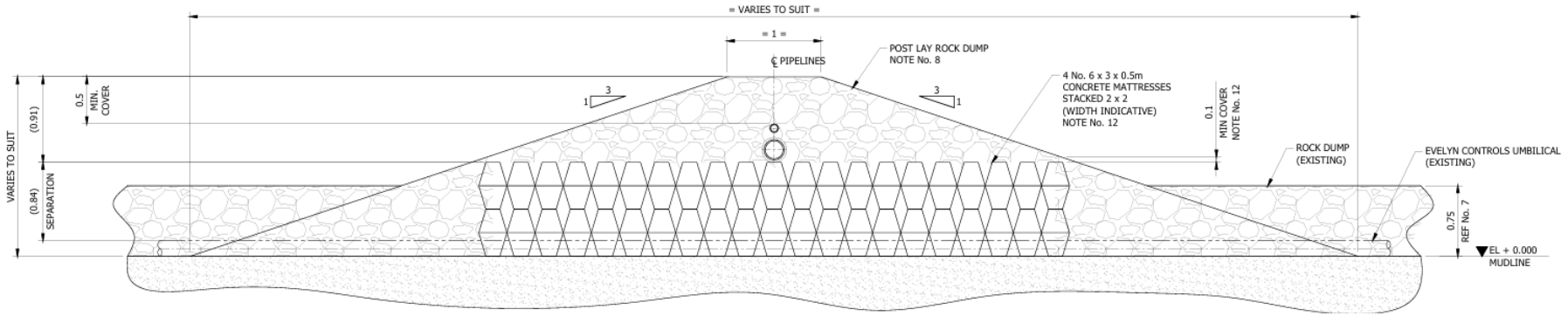
Table 3.8: Rock Quantity Estimate (worst case)

Requirement	Quantity of rock to be deposited (tonnes)		Seabed Footprint (m^2)	Justification
	Pipelines	Umbilical		
Upheaval buckling (UHB) mitigation [1]	25,000	N/A	32,500	Rock placement requirements for UHB mitigation assume: • 66 imperfections requiring additional rock for UHB mitigation (5 per km); • 250 tonnes of rock used per imperfection (with 50% contingency applied); • Footprint based on 5 tonnes per m placed giving a length of 5,000 m. Total berm height of 0.75 m with 2.0 m crown and 1:3 side slopes giving a total width of berm of 6.5 m and area of 32,500m^2.
Trenching performance contingency	65,000	10,000	66,450	Rock placement requirements for pipeline UHB mitigation and protection assume: • Blanket rock required over full length based on mitigating pipeline imperfections less than 0.1m; • Allowing for rock dumping tolerances 6.2 tonnes per m assumed as upper bound giving 74,400 tonnes. Upper bound rock placement tolerances assumed to mitigate 0.2 m imperfections and less. Thus 74,400 tonnes reduced by 9,400 tonnes of spot rock which is included in the 25,000 tonnes allocated to UHB mitigation, giving 65,000 tonnes for the pipeline; • Footprint based on 8 tonnes giving a berm height of 0.85 m with 2.0 m crown and 1:3 side slopes giving a total width of berm of 7.1 m and area of 85,200m^2 over the full pipeline length of 12,000m. To avoid inclusion of the footprint allocated to upheaval buckling mitigation twice, where blanket rock placement is used, the total 85,200m^2 has been reduced by 90% of 32,500m^2 (UHB mitigation total) giving a total of 55,950m^2. Rock placement requirements for umbilical protection assume: • Rock required over 2,500 m where target trenching isn't achieved; • 4 tonnes of rock per metre assumed, thus a total of 10,000 tonnes. • Footprint based on berm height of 0.6 m with 1.0 m crown and 1:3 side slopes giving a total width of berm of 4.2 m and area of 10,500m^2.

Requirement	Quantity of rock to be deposited (tonnes)		Seabed Footprint (m^2)	Justification
	Pipelines	Umbilical		
Pipeline crossings [2]	24,600	9,500	11,300	Rock placement requirements for pipeline crossings assume: • Total length of 2 crossings plus transitions is 600 m with an average of 20.5 tonnes per metre over the crossing length. Rock placement requirements for umbilical crossings assumes: • Total length of 2 crossings plus transitions is 450 m with an average of 10.6 tonnes per metre over the crossing length.
Trench transition [1]	1,200	800	1,500	Rock placement requirements for trench transition assume: • Pipelines: total length of transition is 150 m with a footprint width of 6 m. • Umbilical: total length of transition is 100 m with a footprint width of 6 m.
Total:	**136,100**		**111,750**	

[1] As a worst case, includes for a contingency of 100% to account for the fact that data from the detailed engineering surveys is still pending.
[2] As a worst case, includes for a contingency of 100% to account for the fact the crossing design is not yet matured

Figure 3.7: Typical (Example) Pipeline Crossing Design



3.4.4 Bittern Tie-in Arrangement

The proposed tie-in arrangement options at Bittern are illustrated in Figure 3.8 (DCA) and Figure 3.9 (DCB). The tie-in arrangement to the DCB manifold requires a separate 'fishing friendly' tie-in structure to be installed, which would be located within the existing Bittern 500 safety zone.

Tie-in Structure

If tie-back to the Bittern DCB manifold is selected over the DCA manifold, a separate 'fishing friendly' tie-in structure will be installed, ca. 60 m north of the DCB manifold. The purpose of the tie-in structure is to provide valve and piping arrangements at DCB for pipeline isolation and routing selection such that Kyla flow can be routed to any of the existing Bittern pipelines. The DCA tie-in option does not require this facility as it already exists as part of the spare tie-in slot on the DCA manifold.

Two foundation concepts, piled versus gravity-based, are currently being considered for the tie-in structure. For the purposes of this ES, a piled structure foundation concept has been assumed as worst case for the underwater noise assessment and a GBS has been assumed as worst case for the seabed disturbance assessment (refer to Section 2.5).

The piled structure has approximate dimensions of approximately 9 m (L) × 6 m (W) × 3.3 m (H), a dry weight of ca. 55 tonnes and a seabed footprint of ca. 54 m² for the structure itself, plus localised disturbance from piles (Figure 3.4). It is assumed that the valve skid would be held in place by four tubular piles, one at each corner, each with a diameter of 24-inch and length of up to 24 m. The piles would be secured into the seabed using a maximum hammer blow energy of 90 kJ, with a maximum blow rate of 50 blows per minute. It is expected that the hammering operations for each pile will be ongoing for up to two hours. A soft start is assumed with a ramp up from 30% energy to full energy over 5 minutes, with a reduced blow rate of 6 strikes per minute. Each pile is estimated to take 2 hours to install, giving a total maximum piling duration of 8 hours.

The GBS has dimensions of approximately 16.6 m (L) × 6.5 m (W) × 3.7 m (H) and a dry weight of ca. 124 tonnes. It would be placed directly on the seabed and stabilised by self-weight, avoiding the need for piling. The GBS has a seabed footprint of ca. 108 m².

Regardless of the foundation concept, the tie-in structure will be installed from a CSV.

Tie-in Spools and Jumpers

The proposed Bittern tie-in line lengths and protection requirements are detailed in Table 3.9.

Rigid tie-in spools will connect the 8-inch production pipeline and 3-inch gas lift pipeline either directly into the Bittern DCA manifold or into the new Bittern tie-in structure, which in turn will be connected by tie-in spools to the DCB manifold.

The Kyla umbilical will either connect directly into the Bittern DCA manifold or into the new Bittern tie-in structure. Jumpers will connect the Bittern tie-in structure to the DCB manifold.

These lines will be surface laid, installed from a DSV, and protected by concrete mattresses, assumed to have dimensions of 6 m x 3 m x 0.15 m.

Table 3.9: Bittern Manifold Tie-in Details

Spool Type	Length (m)	From	To	Protection Material [1]	Seabed Footprint (m^2)
Bittern DCA Manifold					
8" production pipeline tie in spools	100	8" pipeline	Bittern DCA	27 x concrete mattresses (covering both 8" and 3" spools and pipeline ends)	486
3" gas lift pipeline tie in spools and pipeline end	100	3" pipeline	Kyla Valve Skid		
EHC control umbilical tie-in loop	100	DCA Manifold	Start of Trench	15 x concrete mattresses	270
Bittern DCB Manifold					
8" production pipeline tie in spools and pipeline end	300	Tie In Valve Skid	DCB manifold	58 x concrete mattresses (covering both 8" and 3" spools, pipeline ends and EHC jumper bundle)	1,044
3" gas lift pipeline tie in spools and pipeline end	150	Tie In Valve Skid	DCB manifold		
EHC jumper bundle	150	Tie In Valve Skid	DCB manifold		
EHC control umbilical tie-in loop	240	Bittern Tie-in Structure	Start of Trench	40 x concrete mattresses	720

[1] Mattress dimensions are assumed to be 6 x 3 x 0.15 m.

Seabed Footprint

An estimate of the total area of seabed directly impacted by the installation of new subsea infrastructure and associated protection material at Bittern is presented in Table 3.10.

Table 3.10: Estimated Seabed Footprint of New Subsea Infrastructure at Bittern [1]

Subsea Item	Assumptions	Total Seabed Footprint (m^2)
Bittern tie-in structure	GBS has dimensions of ca. 16.6 m (L) × 6.5 m (W)	108
Tie-in spools, pipeline ends and control jumpers	Lines will be surface laid and protected with concrete mattresses (see assumptions in Table 3.9)	1,044
Untrenched umbilical section	Umbilical tie-in loop will be surface laid and protected with concrete mattresses (see assumptions in Table 3.9)	720
	Total Seabed Footprint at Bittern	**1,872**

[1] Seabed footprint is worst case, based on the tie-in arrangement at Bittern DCB manifold.

Figure 3.8: Approach to Bittern DCA Manifold

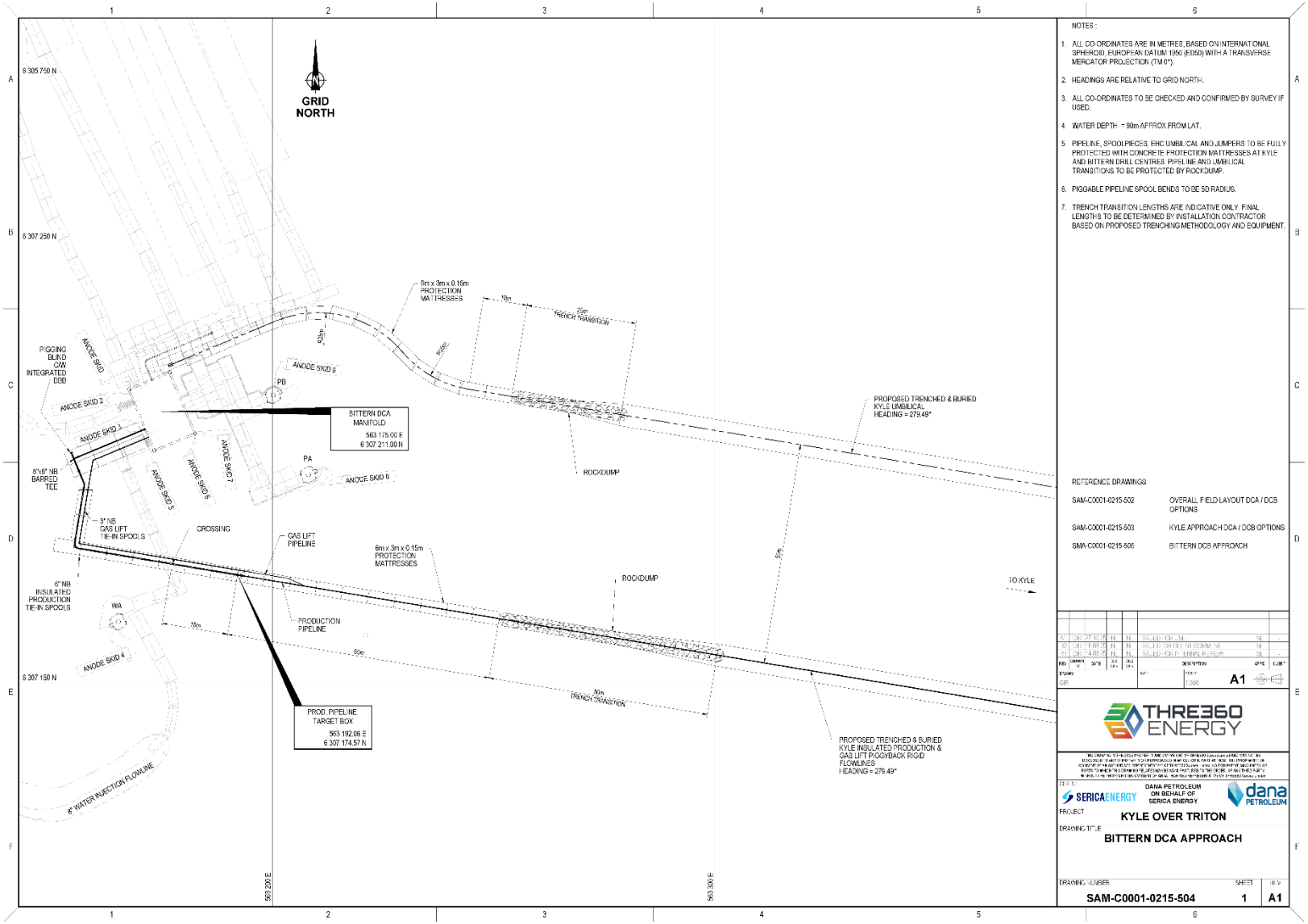
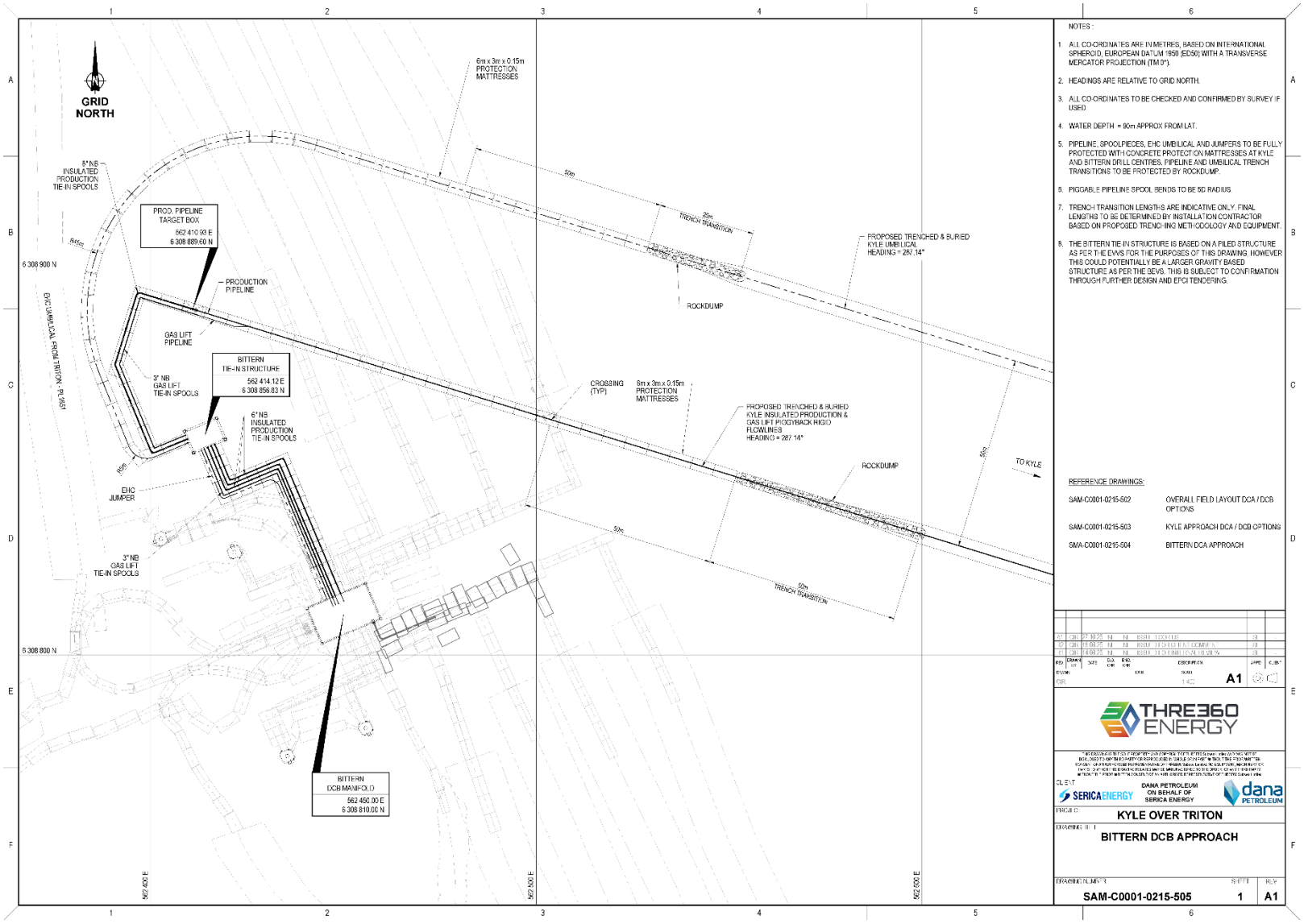


Figure 3.9: Approach to Bittern DCB Manifold



3.4.5 Pre-Commissioning

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 control 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/Water or a suitable spacer chemical.

The production and gas lift pipelines will be installed air filled or allowed to free flood during installation. For the former case, the air will be displaced by flooding with chemically treated fresh water (e.g., oxygen scavenger (to prevent oxygen induced corrosion), biocide (to prevent bacterial growth), corrosion inhibitor and dye (which would be visible in the water column if the production pipeline leaked). A pipeline integrity gauge (PIG) will be pushed through the lines to detect any dents or defects in the pipeline surface that might have been caused during installation (called 'gauging') and to clean the inside of the lines as part of the flooding process.

Once the pipelines are water filled, the pressure within the pipelines will be slowly raised to help confirm that the pipeline structure is intact (hydrotesting/strength testing). Once the pressure has been raised to the intended pressure, it will be held for a period sufficient to determine that the pipeline demonstrates the required strength and integrity in accordance with the pipeline design Codes and Standards.

Following testing and installation of all the spool pieces, jumpers, etc., the gas lift pipeline will be dewatered into the production pipeline driven by lift gas from the Triton FPSO and the production pipeline is expected to be subsequently dewatered back to Triton, driven by production fluids upon start-up of the Kyla well. It is anticipated that up to a maximum of 400 m^3 of treated seawater will be discharged to the marine environment at the Triton FPSO during the de-watering phase.

The use and discharge of chemicals during pre-commissioning 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.

3.4.6 Vessel Requirements

A summary of the vessel requirements and durations associated with the Kyla subsea installation operations, along with typical fuel consumption rates, are provided in Table 3.11. All installation vessels will use DP to maintain position and will not be anchored.

Table 3.11: Vessel Requirements for Kyla Subsea Installation Operations

Operation	Vessel Type	Total No. of Vessel Days [1]	Typical Fuel Consumption (tonnes per day)	Total Fuel Consumption (tonnes)	GHG Emissions (tonnes of CO_2e) [2]
Survey Work (pre-execution and preparatory works)	Remotely Operated Vehicle Survey Vessel	83	8	664	2,154.88
Pipelay activities	Reel Lay Vessel	20	35	700	2,271.71
Trenching and backfill operations	Trenching Support Vessel	32	50	1,600	5,131.04
Installation of subsea structures	CSV	30	16	480	1,557.75

Operation	Vessel Type	Total No. of Vessel Days [1]	Typical Fuel Consumption (tonnes per day)	Total Fuel Consumption (tonnes)	GHG Emissions (tonnes of CO_2e) [2]
Tie-in activities	DSV	35	16	560	1,817.37
Rock placement operations	Rock Placement Vessel	14	25	350	1,135.86
Guard vessel	Guard vessel for pipeline / umbilical installation	50	3	150	486.80
	Totals:	**264**	**153**	**4,504**	**14,555.40**

[1] Includes an allowance for vessel mobilisation, transit and demobilisation.
[2] Refer to Appendix E for details on the methodology used to calculate the quantity of GHG emissions produced.

3.5 Production

This section provides an overview of the oil and gas production expected from the Kyla Development and any associated effects this will have on the Triton FPSO host facility, including produced water and chemical usage, incremental power demand and associated atmospheric emissions.

3.5.1 Triton FPSO

It is proposed that Kyla production fluids will be routed to the Triton FPSO (Figure 3.10) via Bittern and enter the FPSO via the Bittern risers for processing via the Bittern separation train. Production from Kyla will require artificial lift, i.e. gas lift, with gas lift supplied from Triton via Bittern.

Minor modification of the chemical injection systems (i.e. new control panels for Corrosion Inhibitor, Scale Inhibitor and Wax Inhibitor injection, tubing installation and re-instatement of existing Wax Inhibitor pumps and tanks), existing Triton controls and shutdown systems software and logic updates for inclusion of Kyla will be required at Triton to accommodate Kyla. These will be undertaken by Dana, as the operator of Triton. Changes to the Triton main process systems are not required for inclusion of Kyla.

By utilising the existing Bittern process train located at Triton, the incremental emissions arising from Kyla production will be minimal and consistent with the targets of the NSTD. In comparison with current levels of CO_2 emissions, average Kyla incremental emissions from the combustion of fuel gas in the turbines is estimated to be ca. 2.5% relative to current Triton (unabated) emissions of ca. 85,000 tonnes per year. This drops to less than 1% in the later years. There will also be low level incremental emissions from cold vented gas from Kyla oil stored in the cargo tanks (refer to Section 3.5.5).

There will be no measurable increase in flaring or diesel use at Triton as a result of the Kyla Development coming online.

Figure 3.10: Triton FPSO

3.5.2 Kyla Development Oil and Gas Production

The oil, gas and water production figures for the Kyla Development are presented in Table 3.12 and illustrated in Figure 3.11 (P10, High case), with high, mid and low case production figures provided for comparison in Appendix G.

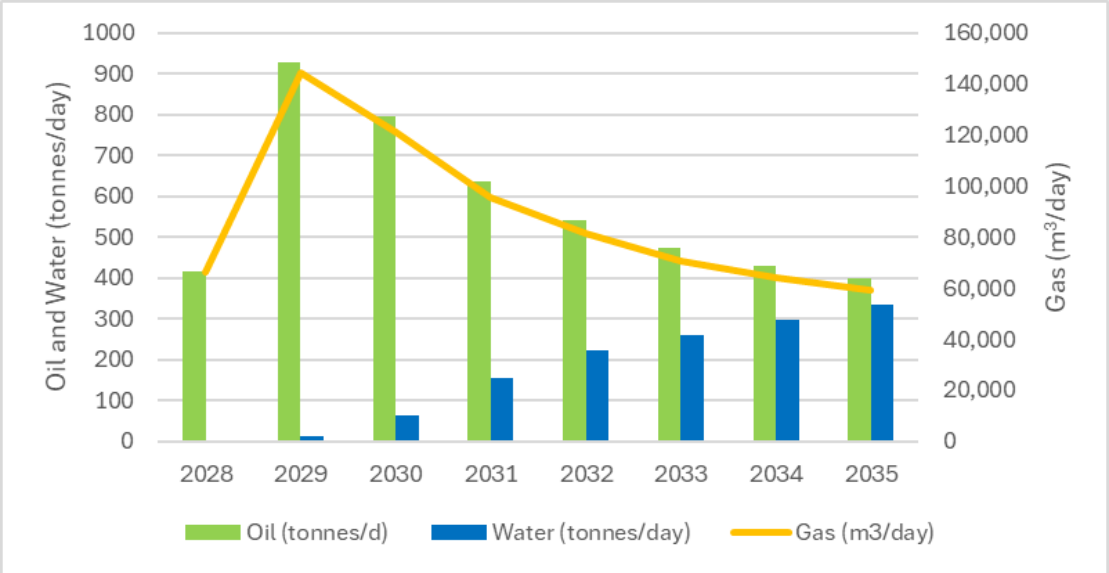
The P10, High case presents the highest estimate of recoverable and/or potentially recoverable volumes from the Kyla Development. There is a 10% probability that recovered volumes will meet or exceed the high case estimate. The impact assessment presented in this ES (and all associated calculations for emissions and discharges) has therefore been carried out using the High case. The production predictions are based on an ensemble of reservoir models which reflect the identified range of uncertainty in reservoir parameters and align with the application for development and production consent which will be submitted to the NSTA.

First oil is currently targeted for Q3 2028, with rates anticipated to peak in 2029, the first full year of production, at 928.2 tonnes (1,112.5 m^3) of oil per day and 144,720 m^3 (5.1 million cubic feet (MMscf)) of gas per day (High case). Post 2029, there is a steady decline over the life of the field. The field is expected to produce hydrocarbons for circa eight years, until 2035, depending on the reserves, the production rate and the life of the Triton FPSO.

Table 3.12: Kyla Gas, Oil and Water Production Volumes, High case [1]

Year	Oil (tonnes/d)	Oil (m^3/d)	Gas (m^3/d)	Gas (MMscf/d)	Water (m^3/day)	Water (bbl/d)
2028	415.6	498.1	66,564	2.4	2.3	14.5
2029	928.2	1,112.5	144,720	5.1	11.0	69.0
2030	795.5	953.5	120,940	4.3	64.1	403.2
2031	635.9	762.1	95,705	3.4	154.6	972.5
2032	541.2	648.6	81,265	2.9	224.0	1,409.0
2033	472.5	566.3	70,684	2.5	261.4	1,643.9
2034	431.0	516.6	64,194	2.3	296.1	1,862.3
2035	400.3	479.8	59,288	2.1	333.4	2,097.2

Figure 3.11: Kyla Development Production Profile (P10 – High case)



3.5.3 Produced Water

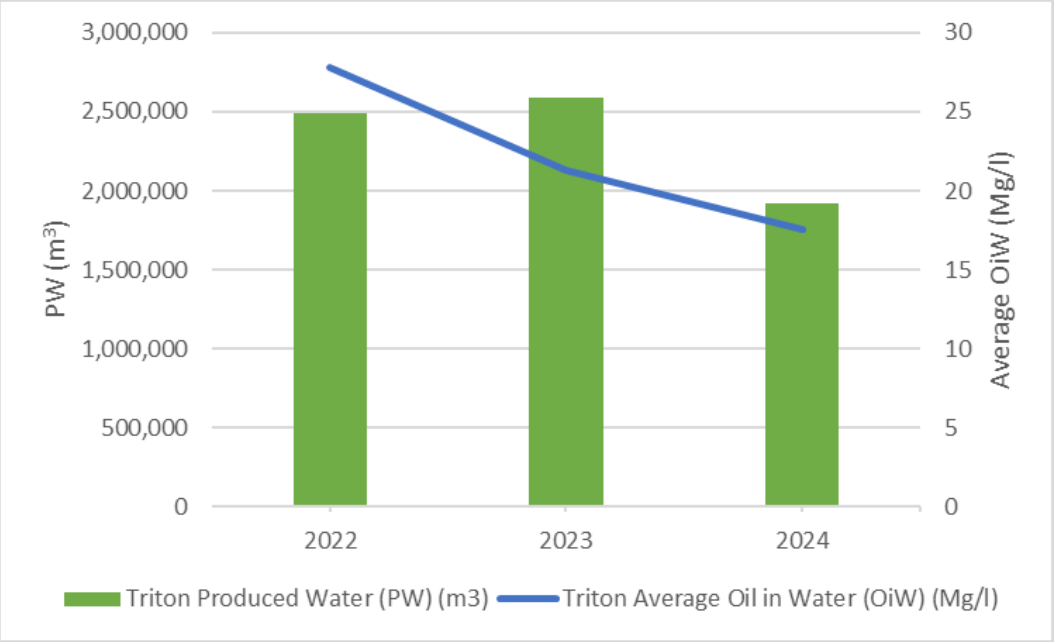
There is no produced water reinjection on the Triton FPSO, so produced water from the Kyla Development shall be treated by the existing Triton produced water system where it will be discharged to sea, provided the monthly average oil concentration does not exceed 30 mg/l in accordance with the OPRED OPPC Guidance Notes (February, 2022).

The Triton inlet facilities consist of a dedicated inlet heater and a 1st stage separator arrangement for each of the Bittern and the Guillemot West fields. The oil from each 1st stage separator co-mingles downstream of the respective oil side level control valves and is routed via the Crude Oil Heaters to the 2nd stage separator. The separated water from each 1st stage separator is routed to dedicated Bittern and Greater Guillemot Area produced water treatment trains. The 2nd stage separator removes the remaining bulk water from the oil. The oil is then routed to the 3rd stage separator which operates close to atmospheric pressure to ensure the final flashing of the light-ends from the bulk oil to meet the oil Reid Vapour Pressure (RVP) specification. The stabilised oil is pumped through the Coalescer where the oil base sediment and water specification is met. The dry oil is then routed via the crude oil coolers to the crude oil storage tanks in the hull.

Produced water from the Bittern 1st stage separator is routed through a single dedicated hydrocyclone unit to the Bittern de-gasser where dissolved gases in the produced water are flashed-off to flare. The water from the Bittern de-gasser is routed to the Bittern OSPAR system. This system consists of two CFUs configured series and two Polishing Units also in series located downstream of the CFU units.

During 2024, the total volume of produced water discharged from Triton was ca. 1,919,234 m^3, which resulted in approximately 33.6 tonnes of oil being discharged to sea. Figure 3.12 shows the downward trend of the total amount of oil in produced water discharged at Triton since 2022.

Figure 3.12: Average oil in produced water discharged and Volume of produced water discharged for 2022 – 2024 for Triton



Kyla Development produced water in the high case is initially low for the first years of production but reaches 154.6 m^3 per day (972.5 bbl per day) in 2031 and gradually increases to reach a peak of 333.4 m^3 per day (2,097.2 bbl per day) in 2035 at the end of field life.

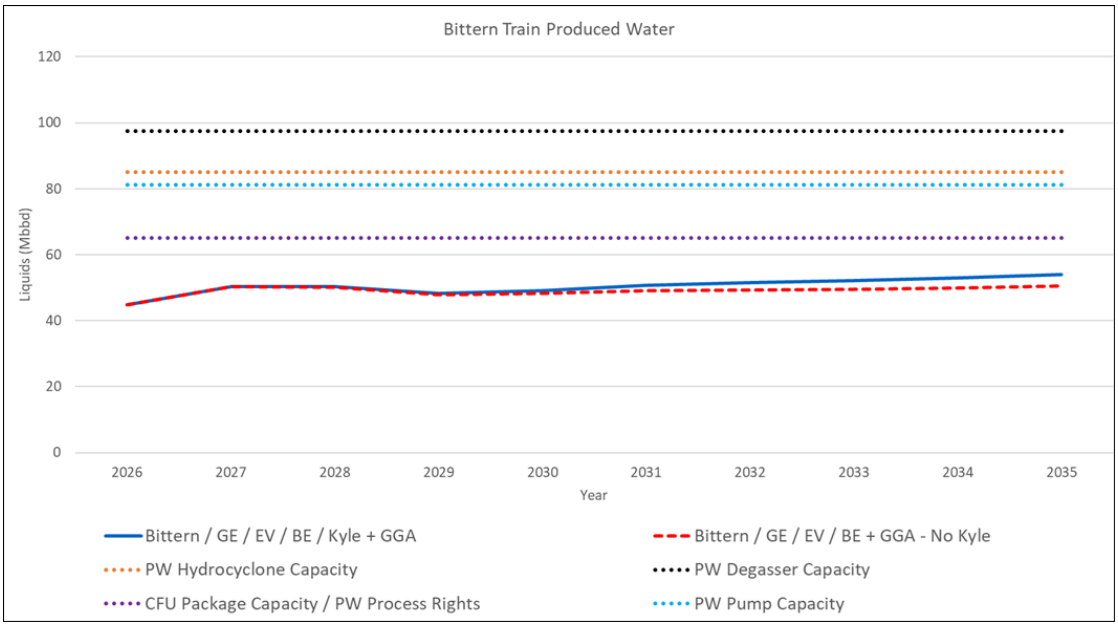
Assuming an oil concentration of 30 mg/l, the amount of additional oil that would be discharged per day at the Triton FPSO due to the Kyla Development is detailed in Table 3.13. This equates to a total of ca. 14.75 tonnes of oil being discharged over the life of the field.

Table 3.13: Kyla Development Incremental Estimated Oil Discharged at Triton FPSO

Year	Water (m^3/day)	Average OIW (mg/l)	Kyla Incremental Estimated Oil Discharged	
			(tonnes per day)	(tonnes per year)
2028	2.3	30	0.0001	0.03
2029	11	30	0.0003	0.12
2030	64.1	30	0.0019	0.70
2031	154.6	30	0.0046	1.69
2032	224	30	0.0067	2.45
2033	261.4	30	0.0078	2.86
2034	296.1	30	0.0089	3.24
2035	333.4	30	0.0100	3.65
			Total:	14.75

Processing of Kyla fluids will not exceed Triton's current produced water processing capacity, as illustrated in Figure 3.13, which shows life of field Triton produced water rates to be processed via the Bittern produced water system with and without Kyla. As such, no modification or upgrades are required to the Bittern produced water facilities on Tritton to accommodate Kyla Development produced water.

Figure 3.13: Bittern Train Produced Water [1]



[1] 2026 includes all field operating assets, first oil from Kyla Development is expected to start in Q3 2028.

3.5.4 Flaring, Venting and Fugitive Emissions

It is projected that the flaring load of current Triton Scope 1 emissions without Kyla is approximately 27,000 tonnes per year of CO_2. No change to flaring on Triton is expected, as Kyla fluids are to be processed through the existing Bittern process and therefore will not change demand on current and future, routine flaring, operational up-sets or emergency flaring. However, it should be noted that if the Kyla Development is consented, Kyla would pick up an allocated share of the existing Triton flare in terms of any flare consent.

The primary source of venting on Triton is from the crude oil tanks. The Triton FPSO has a segregated cargo storage which offloads approximately twice per month via shuttle tanker. Some additional gas will therefore be cold vented from the oil storage tanks as a result of Kyla production, as detailed in Table 3.14. This would be reduced, if Triton achieves zero venting by 2030.

At Triton, the ongoing Zero Routine Flaring and Venting project aims to meet the World Bank's requirements of zero routine flaring and venting by 2030, primarily by addressing Category A (routine) flaring. Additional efforts to minimise non-routine flaring (Categories B (operational upset) and C (safety)) are also under investigation. Flare gas recovery technologies are well established and therefore options at Triton that are currently under consideration include a gas ejector or compression option. An additional option is to combine the new flare gas recovery compressor with the flash gas compressor on Triton. All of these will require shutting in the flare and converting it into a closed system and therefore impacts on the FPSO safety case need to be considered.

The crude oil tanks on Triton are blanketed with inert gas, which is post combustion gas generated by a diesel burning boiler. Some hydrocarbon gas is evaporated off of the oil in the tanks during the filling and is mixed with the inert gas and vented. The combined vented gas is therefore of a very low quality for repurposing as a fuel. Most technologies for recovering this vented gas are applicable when a hydrocarbon gas is used for blanketing, resulting in a richer gas which can be recovered and burned. Work is currently ongoing to evaluate options to change the blanketing medium from an inert gas to hydrocarbon gas to allow recovery, considering both technical feasibility and impacts to the FPSO safety case.

Table 3.14: Kyla Development Incremental Vented Gas at Triton FPSO [1]

Year [2]	Triton Vented Gas - Without Kyla (tonnes per year)	Kyla Incremental Vented Gas at Triton	
		(tonnes per day)	(tonnes per year)
2028	607	0.37	45.10
2029	543	0.83	301.58
2030	482	0.71	258.47
2031	446	0.57	206.61
2032	416	0.48	175.83
2033	388	0.42	153.52
2034	362	0.38	140.04
2035	337	0.36	130.08
Total:	**3,581**	-	**1,411.24**

[1] Values based on Triton EEMS records, which indicate 0.000118 tonnes of gas are vented per barrel of oil stored. Values shown are based on Kyla high case (P10).
[2] Assumes Kyla production starting in September 2028 and cessation of production in December 2035.

No impact on fugitive emissions from Triton is envisaged, as Kyla fluids will be processed through existing Bittern process equipment and pipework and therefore Kyla processing will not change or add to fugitive leak paths.

3.5.5 Power Generation

Power generation on Triton supports operations of major seawater pumps, compressors, accommodation, utilities, and various other pumping systems. Once online, Kyla will only impact export compressors operational loads and will not impact on power increase for other requirements.

Power generation on Triton is provided by dual (42MW each) fuel turbines. The existing maximum Triton power requirements are in the range of 22 to 34 MW, depending upon single or dual export compressor operation. Dual export compressor mode of operation is the base case for Triton (without Kyla) for the foreseeable future due to high gas production rates. Kyla will add ca. 0.6MW to this load (peak Kyla gas 2029). This represents a 1.8% increase over the peak Triton power requirement and is well within the existing power turbine limit of 42 MW per power turbine.

The incremental fuel gas requirements on Triton once the Kyla Development is online are detailed in Table 3.15.

Table 3.15: Kyla Development Incremental Fuel Gas Usage at Triton FPSO [1]

Year [2]	Kyla Incremental Fuel Gas Usage at Triton	
	(tonnes per day)	(tonnes per year)
2028	1.39	169.56
2029	3.02	1103.69
2030	2.53	922.33
2031	2.00	729.88
2032	1.70	619.75
2033	1.48	539.06
2034	1.34	489.56
2035	1.24	452.15
Total	-	**5,025.98**

[1] Incremental Triton Export gas compressors power increase for processing of Kyla gas is estimated as ca. 0.115MWh (2.75MWh/d) for processing of 1 MMSCFD of Kyla gas. Associated fuel gas requirement is based on ca. 0.215te/MWh of incremental power required for Triton Export Gas Compressors for processing Kyla gas. Values shown are based on Kyla high case (P10).

[2] Assumes Kyla production starting in September 2028 and cessation of production in December 2035.

No change to diesel usage on Triton is expected as a result of the Kyla Development. Diesel is used as a back-up fuel for power generation in case of operational up-sets and use for steam generation in the boilers. These uses do not change due to the processing of Kyla fluids through existing Bittern process.

3.5.6 Production Chemical Requirements

Chemicals are used during the production of hydrocarbons to maintain process efficiency, for example: demulsifiers improve the separation of oil and water; scale inhibitors slow down the build-up of scale in pipework and valves and biocides reduce microbial growth.

Chemical usage and discharge will be captured in an update to the Triton Production Chemical Permit prior to production commencing from the Kyla Development. It is anticipated that chemicals required for the production of hydrocarbons from the Kyla Development will be the same as those being used at Triton at the time of first oil, although quantities used are likely to increase. The following chemicals are therefore expected to be utilised:

- Corrosion inhibitor to be injected at Kyla wellhead to form a protective layer on metal surfaces;
- Scale inhibitor to be injected at Kyla valve Skid to prevent the formation of scale;
- Wax inhibitor to be injected at Kyla Valve Skid to mitigate risk of operational issues due to wax formation and build up;
- Methanol required for hydrate control during well start-ups;
- Demulsifier to be injected at Bittern 1st Stage Separator to assist in the oil water separation by breaking up emulsions;
- Deoiler to be injected at Bittern 1st Stage Separator to help in the efficient removal of oil from produced water;
- Antifoam injected at Bittern 1st Stage Separator to prevent the formation of excessive foam bubbles.

The proposed chemical injection design basis for Kyla is provided in Table 3.16.

Those chemicals which partition to the oil phase will be exported along with the oil, whereas aqueous phase chemicals will partition into the produced water and discharged to sea.

Table 3.16: Kyla Chemical Injection Requirements

Chemical Function	Proposed Product	Dosage Rate	Injection Point
Corrosion Inhibitor	CRW88015	ca. 211 parts per million (ppm) - dosed into produced water	Kyla wellhead
Scale Inhibitor	SCW88002	ca. 70ppm - dosed into total fluids	Kyla valve skid
Wax Inhibitor	-	ca. 500ppm - dosed into oil	Kyla valve skid
Methanol	-	$1m^3$ per start-up	Kyla wellhead
Demulsifier	DM086101	ca. 15ppm - dosed into total fluids	Bittern 1st Stage Separator
Deoiler	RBW88077	ca. 30ppm - dosed into produced water	Bittern 1st Stage Separator
Antifoam	DFO85853	ca. 30ppm - dosed into total fluids	Bittern 1st Stage Separator

3.5.7 Inspection and Maintenance

An integrity management system will be developed and inspection programmes implemented for the Kyla subsea system. However, in general, the subsea equipment is designed for the field life time such that no maintenance is required.

External inspection will take place through a combination of ROV/ Autonomous Underwater Vehicle (AUV) and towed sonar. The frequency of such maintenance will be determined by ongoing risk assessment. In terms of internal maintenance, the pipelines will be designed to accommodate intelligent pigging inspection, if necessary, whereby a remote sensing PIG will be conveyed through the pipelines to undertake checks on and confirm pipeline integrity and condition.

It is anticipated that 5 vessel days per year will be required for inspection and maintenance of the subsea infrastructure over the life of the Kyla Development as detailed in Table 3.17.

Table 3.17: Vessel Requirements for Maintenance of Subsea Infrastructure (over life of the field)

Vessel	Function	Total No. of Vessel Days [1]	Fuel Type	Fuel Consumption Rate (tonnes per day) [1]	Total Fuel Consumption (tonnes)	GHG Emissions (tonnes of CO_2e) [2]
ROVSV	Inspection and maintenance of subsea infrastructure	40	Diesel	25	1,000	3,245.30

[1] Includes an allowance for vessel mobilisation, transit and demobilisation

[2] Refer to Appendix E for details on the methodology used to calculate the quantity of GHG emissions produced.

3.6 Decommissioning of the Kyla Development

On CoP, the Kyla Development will be decommissioned in accordance with the requirements of the prevailing UK and international law.

The main obligations for decommissioning offshore oil and gas operations are set out in OSPAR decision 98/3 (the "Decision 98/3") which specifically prohibits the dumping or leaving in place of installations in the marine environment. However, the OSPAR provisions do not directly apply to pipelines and there are no international guidelines on the decommissioning of disused pipelines. Therefore, pipeline and umbilical decommissioning options will be subject to comparative assessment and assessed in accordance with UK legislation and policy in place at the time of decommissioning, noting the UK's policy objective of aiming to achieve a clear seabed.

It is currently anticipated that the well will be disconnected from its subsea architecture and will be plugged and abandoned, as per regulatory guidelines at the time, using an anchored MODU or vessel with well intervention capabilities. The conductor and wellhead would then be cut at a depth of 3 m below the mudline and removed.

All subsea infrastructure will be depressurised and flushed to remove residual hydrocarbons and chemicals and left flooded with seawater prior to abandonment. The Kyla Development subsea structures (Kyla xmas tree, valve skid and Bittern tie-in structure) will be designed to be capable of being removed at the end of their service life, leaving no obstructions above the mud line.

Note, as the pipelines and umbilical will be trenched and buried it currently assumed these would remain *in situ*, along with any rock deposited on the seabed as part of the Kyla Development. The pipelines and umbilical would be isolated and flushed and any above seabed sections will be removed including protection mattresses and grout bags. The proposed Kyla pipelines will be of standard reel lay design with wet insulation and are not of a bundle design. OPRED's expectation that pipeline bundles must be removed at end of field life is therefore not applicable.

Serica's final decommissioning programme (under section 29 of the Petroleum Act 1998) for the Kyla infrastructure will take account of the following:

- Applicable regulations
- Environmental appraisal
- Specialist vendor services
- Re-use and re-purposing
- Use of industry specific decommissioning experiences and lessons learnt, especially related to CNS facilities
- New technology and innovations available at the time

Typical vessels likely to be required to decommission the Kyla Development subsea infrastructure are detailed in Table 3.18.

Table 3.18: Vessel Requirements for Decommissioning the Subsea Infrastructure

Vessel	Function	Duration (days)	Fuel Type	Fuel Consumption Rate	Total Fuel Consumption (tonnes)	GHG Emissions (tonnes of CO_2e) [1]
Well Plug & Abandonment						
AHVs	10 days to lay anchors, 20 days to connect and disconnect rig, 10 days to recover anchors	40	Diesel	30 tonnes/day	1,200	3,894.37
MODU	Transit to / from Kyla	3	Diesel	34 tonnes/day	102	331.02
	P&A Well	40	Diesel	21 tonnes/day	840	2,693.79
ERRV	Patrol 500 m zone during P&A activities	40	Diesel	2 tonnes/day	80	259.62
Supply vessels	Logistic support and transportation of goods, tools, equipment [1]	24	Diesel	8 tonnes/day	192	623.10
Survey vessel	Rig site survey	15	Diesel	15 tonnes/day	225	730.19
Helicopter	Transfer crew to and from MODU	4 return flights per week	Aviation fuel	0.655 tonnes/hour	22	71.13
Subsea Infrastructure Removal						
CSV	Pipeline flushing, remove subsea infrastructure, cutting and removal of spool pieces, jumpers and protective material, pipeline / umbilical end removal and remediation	35	Diesel	16 tonnes per day	560	1,817.37
Pre and Post-decommissioning Surveys						
Survey Vessel	Decommissioning surveys (multiple campaigns)	12	Diesel	15 tonnes/day	180	584.15

[1] Refer to Appendix E for details on the methodology used to calculate the quantity of GHG emissions produced.

When designing the Kyla Development, consideration was given to the future re-use and/or repurposing of the reservoir. However, Serica understand that there are no plans for Triton to be re-purposed for Carbon Capture, Usage, and Storage, hydrogen or renewables and, hence, Kyla also has no opportunity in these areas either.

4 The Existing Environment

4.1 Introduction

This section describes the current environment at the proposed Kyla Development location, which encompasses the proposed Kyla drill centre and Kyla to Bittern pipeline route situated within UKCS Blocks 29/1 and 29/2. The description is largely based on data provided in the OPRED OESEA Reports (2003-2022), as well as other published data sources, supported by site-specific survey data as detailed below. The proposed Kyla Development is located within CNS region of the OESEA Regional Sea 1 (DESNZ, 2022).

4.1.1 Kyla Site-Specific Data

To inform this ES, a HA (Gardline, 2025a) and EBS (Gardline, 2025b) was carried out within the proposed Kyla Development area by Gardline, on behalf of Serica, between the 15th and 20th July 2025.

The scope of the survey included a total of 18 sampling stations, co-located with camera transects ranging in length from 80 to 100 m, arranged as follows:

- 12 x stations arranged in tidally aligned cruciform pattern centred on a proposed Kyla well location,
- 2 x stations along the proposed Kyla to Bittern pipeline route at 5 km intervals;
- 4 x stations situated along a now discounted route between Kyla to Triton, again at 5 km intervals.

The location of the Kyla sampling stations and camera transects are illustrated in Figure 4.1. Note, since the survey was conducted by Gardline, the proposed Kyla well location has moved ca. 267 m south of the well location used to centre the cruciform sampling points.

A full suite of faunal and physico-chemical samples was retrieved from all 18 sampling stations using a grab sampler, with:

- 1 x 0.00024 m^3 physico-chemical replicate subsampled for particle size distribution (PSD), heavy and trace metals (HM), and hydrocarbons (HC) at a single surface depth of 0-2 cm;
- 3 x 0.001 m^3 macro-invertebrate replicate samples processed over a 0.5 mm aperture sieve in the field.

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 data from the UK Offshore Operators Association (UKOOA, 2001), Long et al. (1995) effect range low (ERL) and effect range median (ERM) levels, and apparent effect thresholds (AETs) as detailed by Buchman (2008).

The data collected from the stations along the discounted Kyla to Triton route have, where relevant, been included in this baseline description as it is representative of the wider region.

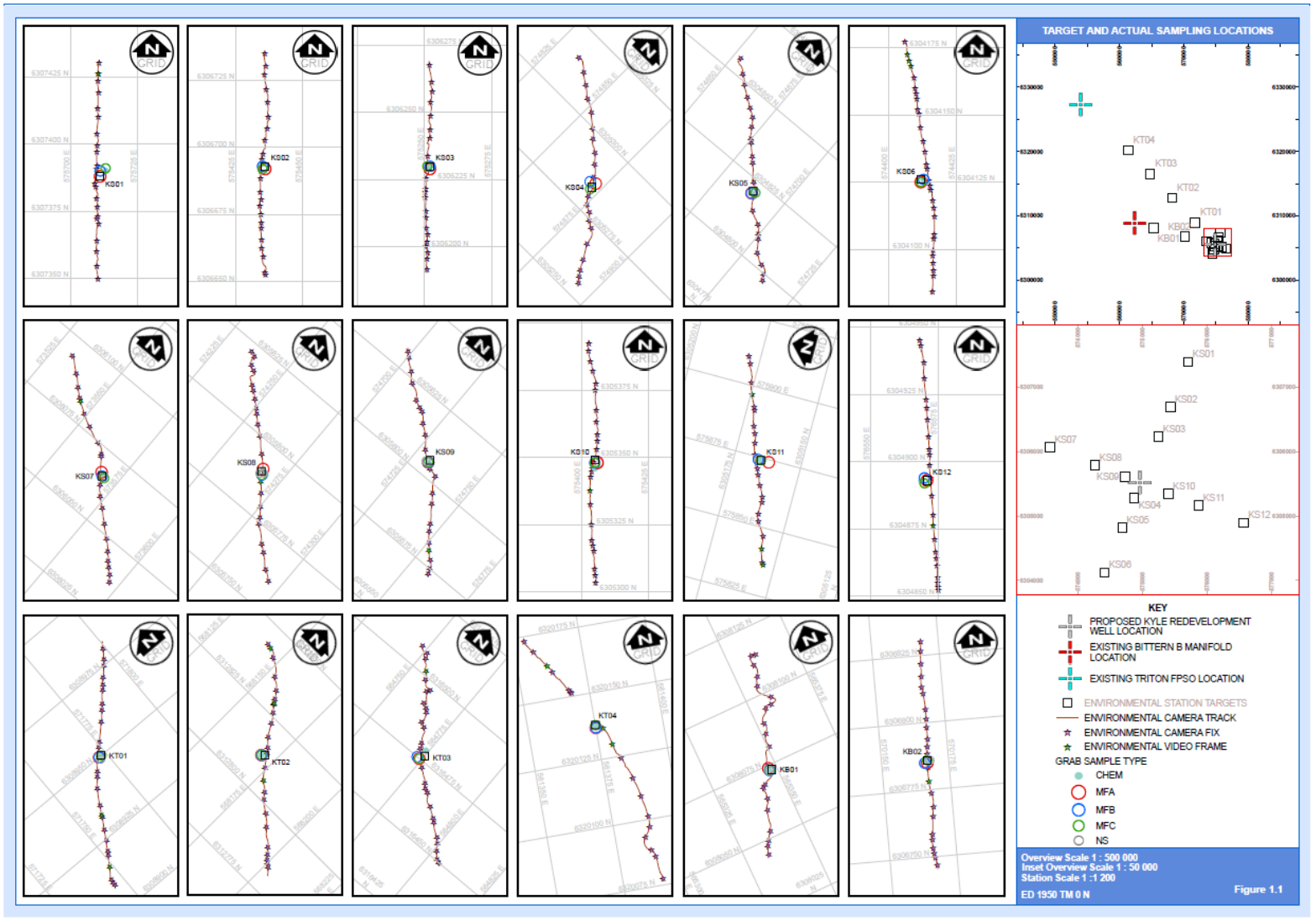
In addition, a pre-decommissioning survey involving geotechnical, geophysical and environmental operations was undertaken at the historic Kyle field in 2020 (Fugro, 2020; CNRI, 2021). Twenty-four stations were sampled across the Kyle survey area. Twelve sites were arranged in a cruciform pattern around both the Kyle North and Kyle South drill centres. A total of three survey transects were undertaken; one at Kyle North and a further two at Kyle South. The Kyle development consisted of the K12, K13, K14 and K15 development wells. The proposed Kyla well is located ca. 0.30 km southwest of the K12 well, 0.33 km southwest of the K15 well and over 3 km south southeast of the K13 and K14 wells (NSTA, 2025c).

4.1.2 Environmental Surveys in the Wider Area

The results of the Kyla site specific surveys described above are supported by the environmental survey work conducted in 2017 and 2023 around the Bittern Manifolds and Wells (Fugro, 2017; Fugro, 2023). These surveys consisted of grab samplings and seabed imagery operations. These operations were

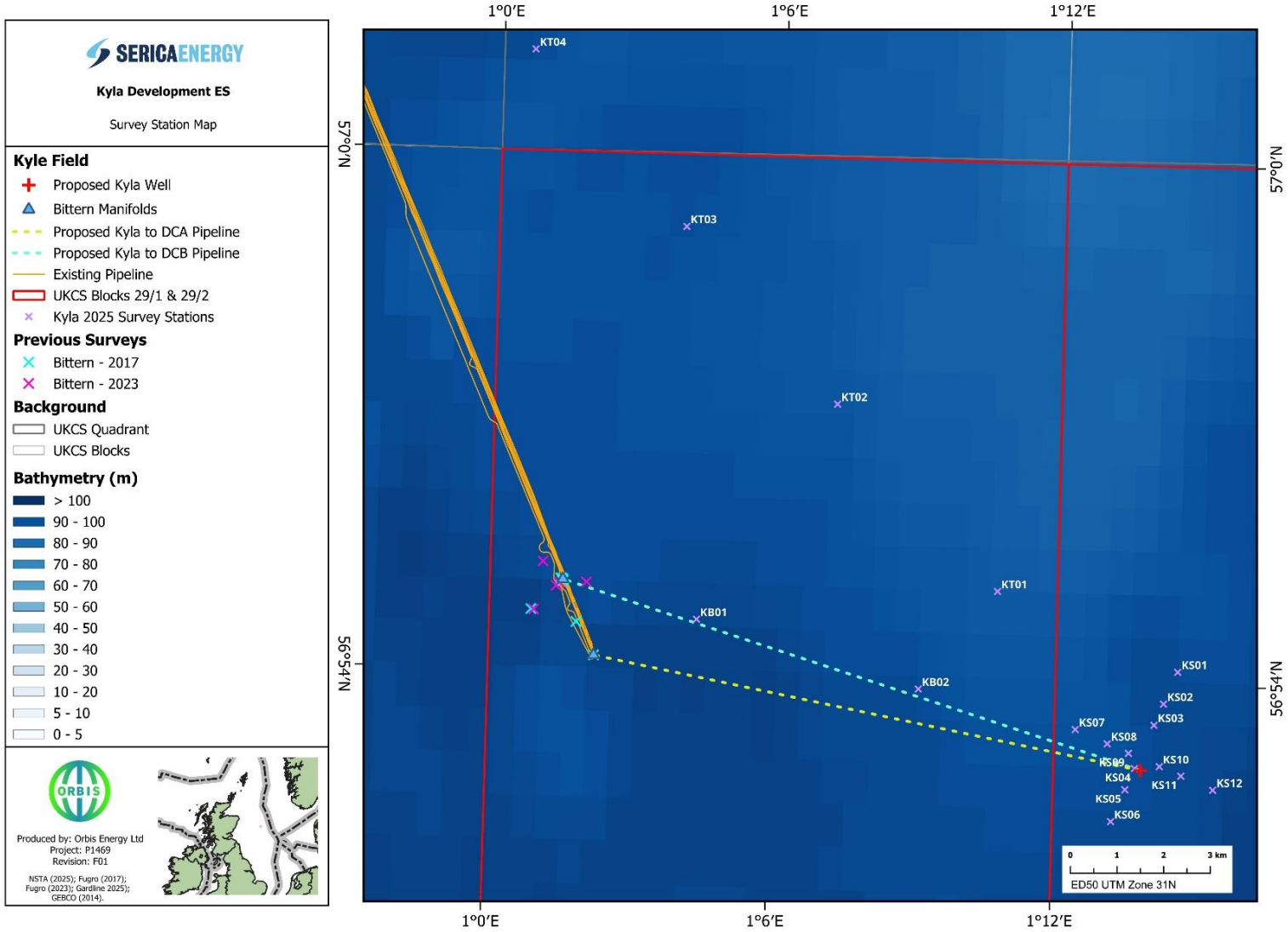
performed at 9 locations in 2017 and 5 locations in 2023. In addition, the stations along the discounted Kyla to Triton route (KT01, KT02, KT03, KT04) in the 2025 Gardline survey provide data for the wider region (Gardline, 2025a; 2025b). The locations of these sampling stations in relation to the proposed Kyla Development are presented in Figure 4.2.

Figure 4.1: Environmental Sampling Strategy for the Kyla Development Survey Area (Gardline, 2025a) [1]



[1] The 'Proposed Kyle Redevelopment Well Location' is a previous proposed well location for the Kyla Development located ca. 267 m north of the confirmed proposed Kyla well location

Figure 4.2: Location of 2025 Kyla Survey Stations and Bittern Survey Stations in relation to the Proposed Kyla Development (Gardline, 2025a; 2025b; Fugro, 2017; Fugro, 2023)



4.2 Physical Environment

4.2.1 Bathymetry and Seabed Features

The proposed Kyla Development is located within the shallower waters of Regional Sea 1, referred to as the CNS, which are generally deeper compared to the Southern North Sea (SNS) (DESNZ, 2022). The North Sea in general is a large shallow water body with a surface area of around 750,000 km^2.

The bathymetry at both Kyla and Bittern and along the proposed pipeline route is relatively flat with depths in the range of 90-95 m (CNRI, 2021; Fugro, 2017; Fugro, 2023; Gardline, 2025a).

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).

British Geological Survey (BGS) seabed sediment data indicates that the seabed within the proposed Kyla Development area is comprised of sand and muddy sand (BGS, 2015).

The seabed imagery collected during the 2025 survey indicates that the seabed habitat in the proposed development area predominantly consists of a homogeneous sediment type, characterised by silty fine sand with varying proportions of shell fragments (Gardline, 2025a). Given the relative proportions of sand, fines and gravel, sediments were classified as poorly sorted muddy sand at all stations, except Station KB01 which was classified as poorly sorted slightly gravelly muddy sand (Gardline, 2025a).

This is similar to surveys of Bittern which found the seabed sediment to be poorly to very poorly sorted fine to very fine sand (Fugro, 2017; Fugro, 2023). Boulders have been observed at Bittern, but as sidescan sonar was not part of the Bittern survey operations, the number and location of these in the wider field area was not recorded. In addition, sidescan sonar was not carried out as part of the 2025 Kyla survey operations, therefore the number and location of any boulders present has not been quantified.

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 proposed Kyla Development area were subjected to particle size analysis (PSA). The results of the PSA indicated that in the vicinity of both the proposed well location and along the proposed Kyla to Bittern pipeline route the sediment types were generally homogenous; the stations (KS01 to KS12; KB01 to KB02) were likely to be dominated by sand (mean 78.72%) with fines content also contributing significantly (mean 21.16%), this value is higher than the CNS mean background value (17.38%); gravel was absent at the majority of stations, except for station KB01 (1.6%; mean 0.11%). Sand content ranged from 71.4% to 84.1%, fines content ranged from 15.9% to 27.0%, and gravel content ranged from 0.0% to 1.6% (see Table 4.1; Gardline, 2025a, 2025b; UKOOA, 2001).

The mean particle size within the vicinity of the proposed well location and along the proposed pipeline route (KS01 to KS12; KB01 to KB02) ranged from 77 micrometre (µm) to 141 µm (very fine sand to fine sand; Wentworth, 1922), with a mean of 95.86 µm and low variability (SD 17.55) (Table 4.1; Gardline, 2025a, 2025b).

The samples collected within the vicinity of the proposed well location (KS01 to KS12) were all represented by the Folk Classification 'Muddy sand' (Folk, 1954). The samples collected along the proposed pipeline route were represented by two Folk classifications with station KB01 classified as 'Slightly gravelly muddy sand', and station KB02 is classified as 'Muddy sand' (See Table 4.1; Gardline, 2025a, 2025b). This is consistent with the sediment of the wider area that includes Kyla and Bittern.

Within the stations sampled in the wider region (KT01 to KT04), the results of the PSA also indicated that the sediment types were generally homogenous; the stations were also likely to be dominated by

sand (mean 82.04%) with fines content contributing significantly (mean 17.95%), this value is marginally higher than the CNS mean background value (17.38%); gravel was absent at all stations. Sand content ranged from 77.1% to 84.1%, and fines content ranged from 15.9% to 22.9%. The mean particle size at these stations ranged from 89 µm to 148 µm (very fine sand to fine sand; Wentworth, 1922); and all stations were represented by the Folk classification 'Muddy sand' (Folk, 1954; Gardline, 2025a, 2025b).

Previous surveys confirm that the samples taken from proposed Kyla Development area are broadly consistent with the seabed sediment types previously found. The sediments at Kyle North were found to be fine to very fine sands (average 88.33% sand, 11.59% fines and <1% coarse), with those at Kyle South being similar in composition (average 84.31% sand, 15.51% fines and <1% coarse), with fines in most samples not exceeding the CNS mean of 17.38% (Fugro, 2020; CNRI 2021). The proposed Kyla well will be located near to the Kyle South Well cluster. At Bittern, the sediments have been found to be very fine sand (mean 78.75% sand; 20.78% fines; <1.64% gravel); these values are comparable to those found at stations KB01 and KB02 along the proposed Kyla to Bittern pipeline route (Fugro, 2017; 2023; Gardline 2025a, 2025b).

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.

TOM content within the vicinity of the proposed well location and along the pipeline route (KS01 to KS12; KB01 to KB02) ranged from 2.9% to 4.7% at Stations KS05 and KB01, which were identified as high outliers. With a mean TOM content of 3.8% (±0.5SD), these concentrations were comparable to those reported by UKOOA (2001) for CNS sediment, with all but the two high outliers recording a TOM content below the 95th percentile of 4.5% (see Table 4.1; Gardline, 2025b).

TOC content within the vicinity of the Kyla Development ranged from 0.17% at Station KS03 to 0.33% at Station KS10, with a mean concentration of 0.25% (±0.04SD) (see Table 4.1; Gardline, 2025b). These TOC concentrations were lower than the comparison survey (Fugro, 2020; CNRI, 2021).

In addition, within the stations sampled in the wider region (KT01 to KT04), the TOM ranged from 3.3% to 3.9%, with a mean of 3.6%; and the TOC ranged from 0.17% to 0.24%, with a mean of 0.21% (see Table 4.1; Gardline, 2025b). These concentrations are similar to those within the vicinity of the proposed Kyla Development area.

Table 4.1: Summary of Sediment Characteristics (Gardline, 2025a; 2025b)

Station	Water Depth (m)	Mean Particle Diameter		TOM (%)	TOC (%)	Fractional Composition			Folk Classification
		µm	Wentworth Classification			Fines (%)	Sand (%)	Gravel (%)	
Cruciform Stations									
KS01	93	92	Very fine sand	4.0	0.23	21.8	78.2	0.0	Muddy sand
KS02	93	90	Very fine sand	3.4	0.22	21.3	78.7	0.0	Muddy sand
KS03	92	80	Very fine sand	3.3	0.17	24.3	75.7	0.0	Muddy sand
KS04	92	96	Very fine sand	2.9	0.21	22.1	77.9	0.0	Muddy sand
KS05	93	96	Very fine sand	4.7	0.26	19.9	80.1	0.0	Muddy sand
KS06	93	89	Very fine sand	3.9	0.29	20.3	79.7	0.0	Muddy sand
KS07	91	141	Fine sand	3.8	0.31	15.9	84.1	0.0	Muddy sand
KS08	92	123	Very fine sand	3.6	0.26	17.6	82.4	0.0	Muddy sand
KS09	92	108	Very fine sand	3.8	0.27	18.9	81.1	0.0	Muddy sand
KS10	93	86	Very fine sand	3.8	0.33	22.6	77.4	0.0	Muddy sand
KS11	93	93	Very fine sand	3.7	0.24	21.0	79.0	0.0	Muddy sand
KS12	94	80	Very fine sand	3.9	0.23	22.2	77.8	0.0	Muddy sand
Pipeline Routes									
KB01	93	77	Very fine sand	4.7	0.23	27.0	71.4	1.6	Slightly gravelly muddy sand
KB02	92	91	Very fine sand	3.9	0.29	21.4	78.6	0.0	Muddy sand
Stations in the Wider Region									
KT01	89	148	Fine sand	3.3	0.19	15.9	84.1	0.0	Muddy sand
KT02	89	147	Fine sand	3.5	0.17	16.2	83.8	0.0	Muddy sand
KT03	93	89	Very fine sand	3.5	0.22	22.9	77.1	0.0	Muddy sand

Station	Water Depth (m)	Mean Particle Diameter		TOM (%)	TOC (%)	Fractional Composition			Folk Classification
		µm	Wentworth Classification			Fines (%)	Sand (%)	Gravel (%)	
KT04	91	127	Fine sand	3.9	0.24	16.8	83.2	0.0	Muddy sand
Mean		103	Very fine sand and fine sand	3.8	0.24	20.5	79.5	0.1	Muddy sand and slightly gravelly muddy sand
SD		24		0.4	0.04	3.1	3.3	0.4	
Minimum		77		2.9	0.17	15.9	71.4	0.0	
Maximum		148		4.7	0.33	27.0	84.1	1.6	
Historic Survey Data (Fugro, 2020; CNRI, 2021)									
Mean		181	Very fine to medium sand	-	0.33	13.5	86.3	0.1	Muddy sand to sand
SD		54		-	0.06	3.1	3.1	0.2	
Minimum		93		-	0.24	9.1	78.9	0.0	
Maximum		285		-	0.43	21.0	90.9	0.7	
Key:									
Above UKOOA (2001) 50th percentile		-	-	1.63	-	17.38	-	-	-
Above UKOOA (2001) 95th percentile		-	-	4.48	-	77.56	-	-	-

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, 2001a). A summary of the sediment hydrocarbon concentrations recorded in the proposed Kyla Development area are presented in Table 4.2.

Within the vicinity of the proposed Kyla well location and along the pipeline route the THCs ranged from 7.5 micrograms per gram ($\mu g.g^{-1}$) to 11.4 $\mu g.g^{-1}$. Overall, the mean THC concentration was 8.86 $\mu g.g^{-1}$. Concentrations of THC in the Gardline (2025b) survey were higher than those recorded in the previous Kyle surveys (see Table 4.2; Fugro, 2020; CNRI, 2021) and there were no significant correlations with the analysed sediment characteristics. Within the wider region (KT01 to KT04), the THC concentrations ranged from 5.87 $\mu g.g^{-1}$ at KT01 to 8.77 $\mu g.g^{-1}$ at KT04, with a mean of 7.27 $\mu g.g^{-1}$ (see Table 4.2; Gardline, 2025b). These concentrations are similar to those within the vicinity of the proposed Kyla Development area (Gardline, 2025b).

To put these results into a wider context, UKOOA (2001) reported a mean THC concentration of 9.51 $\mu g.g^{-1}$ (n=159 stations) and a 95th percentile of 40.10 $\mu g.g^{-1}$ for CNS stations. Further, a subset of stations with sandy sediments (n=115 stations) recorded a mean THC concentration of 11.13 $\mu g.g^{-1}$. All stations in the current survey recorded THC concentrations below the 95th percentile and can therefore be considered consistent with background concentrations.

It has previously been shown that benthic macrofauna suffer adverse effects when THC is in excess of 50 $\mu g.g^{-1}$ (Kjeilen-Eilertsen et al., 2004; UKOOA, 2002; 2005) and as such, this concentration represents the threshold above which hydrocarbons are expected to have a significant environmental impact. Kingston (1992) also previously reported that benthic macrofauna suffer adverse effects, namely reduced biodiversity, when THC is more than 50 to 60 $\mu g.g^{-1}$ and that specific sensitive species may be impacted at levels greater than 10 $\mu g.g^{-1}$. Mair et al. (1987) observed a noticeable increase in the dominance of opportunistic species at THC levels greater than 291.4 $\mu g.g^{-1}$. The THC concentrations across the survey area were well below thresholds expected to significantly impact faunal communities but were sufficient at Stations KS01, KS03 and KS05 (located 2.3 km northeast, 1 km northeast and 531 m southwest from the proposed Kyla well respectively) to potentially affect specific sensitive species (Gardline, 2025b).

Total n-alkane concentrations within the vicinity of the proposed Kyla Development area (KS01 to KS12; KB01 to KB02) ranged from 0.205 $\mu g.g^{-1}$ to 0.399 $\mu g.g^{-1}$. The overall mean concentration within the vicinity of the proposed Kyla well location and pipeline route was 0.307 $\mu g.g^{-1}$. Within the wider region (KT01 to KT04), total n-alkane concentrations ranged from 0.189 $\mu g.g^{-1}$ to 0.254 $\mu g.g^{-1}$, with an overall mean concentration of 0.213 $\mu g.g^{-1}$ (see Table 4.2; Gardline, 2025b).

To put these results into a wider context, UKOOA (2001) recorded a mean total n-alkane concentration of 0.40 $\mu g\ g^{-1}$ (n=307 stations) and a 95th percentile of 1.18 $\mu g\ g^{-1}$ for CNS stations. Further, a sub-group of stations (n=206) with sandy sediments recorded a mean total n-alkane concentration of 0.38 $\mu g\ g^{-1}$. As all concentrations were below the UKOOA (2001) CNS 95th percentile, they can be considered consistent with the wider area.

The ratio of odd to even numbered n-alkanes within the High Molecular Weight (HMW) range nC26-30, commonly referred to as the carbon preference index (CPI; Farrington & Tripp, 1977), can provide further insight into the origins of alkanes in marine sediments. Marine sediments containing high levels of biogenic (odd carbon number) n-alkanes are known to have CPI values of ≥2.0, with values ≥4.0 suggesting a virtual absence of petrogenic hydrocarbons (McDougall, 2000). CPI values close to 0 indicate a predominance of petrogenic hydrocarbons.

Within the vicinity of the proposed Kyla Development area (KS01 to KS12; KB01 to KB02) and the wider region (KT01 to KT04), stations were dominated by odd-numbered HMW n-alkanes and presented the highest peaks at nC_{29} and nC_{31}. This profile is characteristic of low-level sedimentary biogenic hydrocarbons from a higher terrestrial plant waxes and marine macrophytes (Bouloubassi et al., 2001;

Zhang et al., 2024; Gardline, 2025b). The Low Molecular Weight (LMW) n-alkanes (nC_{10-20}) accounted for 6 to 16% of the total n-alkanes with peaks observed at nC_{15}, nC_{17} and nC_{19}, which is consistent with phytoplankton (Zhang et al., 2024; Gardline, 2025b). Within this area, CPI values ranged from 1.8 to 2.9 and suggested a biogenic input with some presence of petrogenic hydrocarbons. Within the wider region (KT01 to KT04) CPI values were similar to those within the proposed Kyla Development area, ranging from 1.8 to 2.4 (see Table 4.2; Gardline, 2025b).

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.

Pristane to phytane ratios within the proposed Kyla Development area ranged from 2.0 to 8.8, which is significantly lower than those recorded in the pre-decommissioning survey at the historic Kyle field (see Table 4.2; Gardline, 2025b; Fugro, 2020; CNRI, 2021), due to lower pristane concentrations. Ratios at all stations were ≥2.0, indicating the presence of primarily biogenic hydrocarbons. Within the wider region (KT01 to KT04), pristane to phytane ratios ranged from 1.2 to 18.7, which is also lower than those recorded in the comparison survey (see Table 4.2; Gardline, 2025b; Fugro, 2020; CNRI, 2021), due to lower pristane concentrations. Ratios at all of these stations excluding Station KT02 were ≥2.0, indicating the presence of primarily biogenic hydrocarbons, with a greater petrogenic input at Station KT02 (Gardline, 2025b).

PAHs are largely formed by the incomplete combustion of organic matter. This includes the combustion of organic material such as forest fires (Youngblood and Blumer, 1975), the burning of fossil fuels and, in the case of offshore oil fields, flare stacks. Within the vicinity of the proposed Kyla well location and pipeline route (KS01 to KS12; KB01 to KB02), total PAH concentrations ranged from 0.151 $\mu g.g^{-1}$ to 0.418 $\mu g.g^{-1}$, with a mean of 0.218 $\mu g.g^{-1}$. Total naphthalenes, phenanthrenes and dibenzothiophenes (NPDs) concentrations ranged from 0.017 $\mu g.g^{-1}$ to 0.052 $\mu g.g^{-1}$ with a mean of 0.027 $\mu g.g^{-1}$ (see Table 4.2; Gardline, 2025b). Within the wider region (KT01 to KT04), total PAH concentrations ranged from 0.087 $\mu g.g^{-1}$ to 0.141 $\mu g.g^{-1}$, with a mean of 0.115 $\mu g.g^{-1}$. Total NPD concentrations ranged from 0.013 $\mu g.g^{-1}$ to 0.021 $\mu g.g^{-1}$ with a mean of 0.018 $\mu g.g^{-1}$ (see Table 4.2; Gardline, 2025b).

In a wider context, UKOOA (2001) reported a mean total PAH concentration of 0.287 $\mu g.g^{-1}$ for CNS stations with a 95th percentile of 0.899 $\mu g.g^{-1}$, whilst the average NPD concentration was 0.105 $\mu g.g^{-1}$ with a 95th percentile of 0.316 $\mu g.g^{-1}$. Concentrations of total PAHs and NPD at all stations were consistent with their respective UKOOA (2001) means.

Available data also suggests that there is limited hydrocarbon contamination at Bittern, with values similar to those within the proposed Kyla Development area (Fugro, 2017; Fugro 2023).

Table 4.2: Summary of Seabed Sediment Hydrocarbon (Gardline, 2025b)

Station	Water Depth (m)	THC (µg.g^{-1})	Total n-alkanes (µg.kg^{-1})	CPI	Pristane/ Phytane Ratio	Total PAHs (µg.g^{-1})	NPD (µg.g^{-1})
Cruciform Stations							
KS01	93	10.02	0.348	2.3	5.5	0.182	0.028
KS02	93	9.9	0.297	2	4.7	0.191	0.03
KS03	92	11.02	0.385	2.3	4.8	0.219	0.034
KS04	92	9.88	0.318	2	5	0.191	0.028
KS05	93	11.4	0.399	2.9	3.6	0.248	0.036
KS06	93	7.8	0.205	2.4	4.3	0.15	0.021
KS07	91	7.84	0.303	2	3.8	0.156	0.019
KS08	92	8.62	0.247	2.7	5.3	0.153	0.023
KS09	92	9.12	0.282	2	6.4	0.286	0.052
KS10	93	9.76	0.305	2.4	7.4	0.418	0.025
KS11	93	8.93	0.309	1.8	2	0.384	0.021
KS12	94	7.5	0.264	2.8	6.3	0.155	0.017
Pipeline Routes							
KB01	93	9.57	0.333	2.5	4.7	0.167	0.026
KB02	92	9.09	0.303	2	8.8	0.151	0.022
Stations in the Wider Region							
KT01	89	5.87	0.189	2.1	4.7	0.087	0.013
KT02	89	6.21	0.201	2.4	1.2	0.141	0.021
KT03	93	8.22	0.207	1.8	18.7	0.105	0.016
KT04	91	8.77	0.254	1.8	12	0.125	0.02
Mean		8.86	0.286	2.2	6.1	0.195	0.025
SD		1.47	0.061	0.3	4.0	0.089	0.009
Minimum		5.87	0.189	1.8	1.2	0.087	0.013
Maximum		11.40	0.399	2.9	18.7	0.418	0.052
Historic Survey Data (Fugro, 2020)							
Mean		4.22	-	-	14.0	-	-
SD		2.48	-	-	6.8	-	-
Minimum		2.3	-	-	3.0	-	-
Maximum		13.0	-	-	31.0	0.23	0.045
Key:							
Above UKOOA (2001) Mean		9.51	0.4	2.0	-	0.287	0.105
Above UKOOA (2001) 95th percentile		40.10	1.18	2.79	-	0.899	0.316

Heavy and Trace Metals

Heavy metals such as copper (Cu), Pb and 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).

Ba can be an important element in the detection of localised anthropogenic sediment pollution. It is often used in the form of barite (barium sulphate) as a weighting agent in drilling fluids. Barite is predominantly insoluble in oxic seawater, although it may be mobilised under anoxic conditions and therefore can provide a useful indication of drilling mud dispersion since discharge. Table 4.3 presents a summary of total heavy and trace metal analysis from the Kyla environmental baseline survey.

Within the vicinity of the proposed Kyla well location and pipeline route (KS01 to KS12; KB01 to KB02), concentrations of Ba following Hydrofluoric acid (HF) digest ranged from 421 $\mu g.g^{-1}$ to 8,190 $\mu g.g^{-1}$, with a mean of 1,773 $\mu g.g^{-1}$ (see Table 4.3; Gardline, 2025b). Within the wider region (KT01 to KT04), concentrations of Ba ranged from 111 $\mu g.g^{-1}$ to 6,510 $\mu g.g^{-1}$ with a mean concentration of 2,419 $\mu g.g^{-1}$ (see Table 4.3; Gardline, 2025b). These concentrations were similar to those previously recorded within the Kyla Development area (decommissioned Kyle field) (Fugro, 2020).

To put these results into a wider context, the Kyla Development area mean for Ba was above that of the CNS UKOOA (2001) background stations (348 $\mu g\ g^{-1}$; n=164 stations), and above the 95th percentile (720 $\mu g\ g^{-1}$) with individual values below the 95th percentile only recorded at Stations KS02, KS06 and KS07. Concentrations of Ba can therefore be considered above the background levels for the area. Furthermore, Neff (2004) suggested that sediments not contaminated by drilling cuttings may contain Ba concentrations of up to 2,000 $\mu g\ g^{-1}$, a concentration that was exceeded at Station KS08 (located 935 m from the closest historic well), but most notably at Stations KS10 and KS12 (located 287 m and 1,489 m from the closest historic wells respectively) (Gardline, 2025b). There were no significant correlations with the analysed sediment characteristics or hydrocarbon concentrations.

The Kyla Development is a redevelopment of the decommissioned Kyle field. Drilling history at the Kyla field suggests that discharges of oil-based drilling muds and synthetic based drilling muds occurred during the 1990s and 2000s, with the cuttings pile at the field previously estimated to cover ca. 0.0043 km^2 (Fugro, 2020). As concentrations of Ba are known to remain elevated for long periods after the discharge of drilling fluids (Ellis et al., 2012a), this may explain the high concentrations recorded at Stations KS10 and KS12. The Fugro (2020) comparison survey also reported that total barium concentrations indicated some dispersion of drilling muds around two drill centres surveyed within the Kyla field. However, the cuttings piles were not observed in camera footage during the Kyle pre-decommissioning survey (Fugro, 2020).

Of the eight other analytes, within the vicinity of the proposed well location and pipeline route (KS01 to KS12; KB01 to KB02), four (As, Cr, Pb, and Ni) also recorded the highest concentrations at Station KS10 and Pb concentrations at Station KS10 were identified as a high outlier and Cd at Station KS12 (Gardline, 2025b). Within the wider region (KT01 to KT04), high outlier concentrations of Cu were identified at Station KT01.

More widely, concentrations of these eight metals were below their respective UKOOA (2001) 95th percentile for CNS background stations other than Pb at Stations KS10, KS12 and KT01 and Zn at Stations KS08, KS12, KT01, KT02 and KT03. This suggests that the metal concentrations can be considered consistent with background for sediments in the wider area with some localised elevation in Pb and Zn.

With the exception of Ba, concentrations of all analytes were higher than those recorded in the comparison survey (Fugro, 2020). This is likely due to the differing extraction methods used; the comparison survey (Fugro, 2020) used aqua regia extraction which is a weaker solvent than hydrofluoric acid used in the current survey. Cd, Cu, Hg, Pb and Zn exceeded their respective Background Concentration (BC) values at several stations, with the survey average for Pb also above Background

Assessment Criteria (BAC). This further suggests that concentrations of Pb across the survey area are above background.

All metal concentrations were below their respective ERL (Long et al., 1995), except Pb at Station KS10, located 417 m southeast of the proposed Kyla well, and KT01 which is located 2.7 km northeast of the proposed Kyla Development, which exceeded the ERL but were below the ERM. All other concentrations were below their respective AETs, indicating that adverse effects on fauna were unlikely to occur (see Table 4.3; Gardline, 2025b).

At Bittern higher levels of barium were recorded along with higher concentrations of chromium and zinc, reflecting the localised influence of drilling (Fugro, 2023). Elevated barium levels were also recorded at the historic Kyle North and South drill centres during the pre-decommissioning survey, consistent with the drilling of wells at these locations (Fugro, 2020; CNRI, 2021).

Table 4.3: Total Heavy and Trace Metal Concentrations (µg.g^{-1}) (Gardline, 2025b)

Station	Depth (m)	Al	As	Ba	Cd	Cr	Cu	Pb	Hg	Ni	Li	Zn
Cruciform Stations												
KS01	93	25300	6	650	0.05	24.8	4.4	14.1	<0.01	8.6	15.9	28.5
KS02	93	25300	5.3	548	0.05	23.9	3.9	12.5	<0.01	7.7	15.4	21.4
KS03	92	27600	5.3	782	0.06	26.9	4.5	13.9	<0.01	8.6	17.6	23.8
KS04	92	27700	4.7	749	0.05	24.3	4.6	13	<0.01	8.3	17.8	22
KS05	93	29500	4.4	886	0.07	27.2	4.7	15.6	<0.01	8.8	18.6	23.9
KS06	93	26400	4.2	431	0.06	24.2	5.3	12.9	<0.01	8.5	15.8	40.8
KS07	91	23900	5.2	421	0.04	20.6	3.7	11.9	<0.01	7	14.1	19.2
KS08	92	27200	6.5	1980	0.08	20.4	4.6	19.6	<0.01	7.5	15.9	70.3
KS09	92	26000	6.2	1620	0.06	26.1	5.7	22.2	0.05	8.8	16.3	25.1
KS10	93	26300	7.8	8190	0.12	27.8	7.6	**64.8**	0.04	9.7	17.5	42.8
KS11	93	28300	4.8	840	0.06	25.2	4.3	13.9	<0.01	8.2	17.6	23.2
KS12	94	23900	5.3	5940	0.19	25.9	5.8	38.2	<0.01	9	14.9	49
Pipeline Route												
KB01	93	25300	5.4	805	0.07	24.6	5.5	14.5	<0.01	9.2	16.4	27.1
KB02	92	24400	4.3	975	0.05	23.9	4.6	14.1	<0.01	8.2	15.6	24.9
Stations in the Wider Region												
KT01	89	25100	7.1	6510	0.12	24.5	17	**48.9**	0.05	8.9	15.8	74.5
KT02	89	21900	5.3	2700	0.07	22	10.2	19.7	0.04	6.9	12.1	46.5
KT03	93	24600	4.4	111	0.07	22	4.3	13.5	0.02	7.2	14.8	65.5
KT04	91	21300	4.4	356	0.05	18.8	3.3	11.6	<0.01	6.6	11.4	19.2
Mean		25556	5.4	1916	0.07	24.1	5.8	20.8	-	8.2	15.8	36.0
Standard Deviation		2109	1.0	2400	0.04	2.5	3.2	14.7	-	0.9	1.9	18.3
Minimum		21300	4.2	111	0.04	18.8	3.3	11.6	<0.01	6.6	11.4	19.2
Maximum		29500	7.8	8190	0.19	27.8	17.0	64.8	0.05	9.7	18.6	74.5
Historic Survey Data (Fugro, 2020)												
Mean		4179	4.0	690	-	14.7	1.7	7.8	-	4.7	5.2	12.6
Standard Deviation		985	0.6	971	-	1.8	0.6	1.4	-	1.0	1.3	2.8

Station	Depth (m)	Al	As	Ba	Cd	Cr	Cu	Pb	Hg	Ni	Li	Zn
Minimum		2420	3.1	74	<0.08	11.8	1.0	6.2	<0.04	3.3	3.2	8.4
Maximum		6660	5.7	3600	<0.08	19.4	3.8	11.8	0.05	7.2	8.4	20.1
Reference Values												
UKOOA (2001) CNS 50th %ile		-	-	348	0.76	23.9	6.3	12.6	0.17	11.5	-	21.3
Above UKOOA (2001) CNS 95th percentile		-	-	720	1.0	54.0	18.0	26.8	0.58	21.8	-	43.4
OSPAR ERL (Long et al., 1995)		-	8.2	-	1.2	81	34	46.7	0.15	20.9	-	150
OSPAR ERM (Long et al., 1995)		-	70	-	9.6	370	270	218	0.71	51.6	-	410
AET (Buchman, 2008)		18000	35.0	-	3.0	62.0	390.0	400.0	0.41	110.0	-	410.0

[1] Values in **Bold** are greater than Long et al. (1995) ERL values
Note: Al = Aluminium, As = Arsenic, Cd = Cadmium, Cr = Chromium, Hg = Mercury, Ni = Nickel, Li = Lithium.

4.2.3 Hydrography and Metocean Conditions

Currents and Tides

The CNS is influenced by the NAC, which transports warm subtropical water into the wider North Sea (DESNZ, 2022). The currents broadly follow the 200 m depth contour to the north of the Shetland Islands after which they travel southwards along the western shelf edge. The tidal currents in the CNS area are generally weak and are readily influenced by other factors such as winds and density driven circulation. This results in a relatively atypical pattern to the tidal currents. Modelled data indicates tidal rates are 0.007 metres per second (ms^{-1}) and 0.054 ms^{-1} for neap and spring peak flows respectively (ABPMer 2008).

Significant Wave Height

Wave conditions in the North Sea are strongly influenced by seasonal changes, with maximum wave heights peaking around January, although extreme waves may also be encountered at other times, most notably between November and March. The North Sea is generally more sheltered than the Western Isles, however, localised North Sea storms and swells can result in relatively large wave heights (DESNZ, 2022). Wave direction is predominantly from the west and south-west. Annual mean significant wave height in the vicinity of the proposed development area is approximately 2.11 m to 2.4 m (NMPi, 2025).

Wind Regime

Wind speed and direction directly impacts the transport and dispersion of atmospheric emissions, and indirectly marine discharges through wind effects on surface currents. It can also influence vessel and helicopter support requirements to offshore operations. In this region of the CNS, prevailing winds are from the south-west and north-north-east. South and south-easterly winds may become established for as long as several weeks if an anticyclone develops over Europe (DESNZ, 2022; UKHO 2013). Wind strengths in winter are typically in the range of Beaufort scale 4-6 (6-11 ms^{-1}) with higher winds of force 8-12 (17-32 ms^{-1}) being much less frequent. Winds of force 5 (8 ms^{-1}) and greater are recorded 60-65% of the time in winter and 22-27% of the time in summer. In April and July, winds in the open, central to northern North Sea, are highly variable and there is a greater incidence of north-westerly winds (DESNZ, 2022).

Temperature and Salinity

The CNS is more saline than the SNS due to the absence of receiving significant freshwater input from rivers along its eastern boundary unlike the SNS. Annual mean surface salinity in the vicinity of the proposed Kyla Development area ranges from 35.1 parts per thousand (‰) to 34.8 ‰, while annual mean near seabed salinity ranges from 35.1‰ and 34.9‰ (NMPi, 2025). Monthly mean surface temperatures in the vicinity of the proposed Kyla Development area range from 5.8 Degrees Celsius (°C) to 14.7°C, while Monthly mean near seabed temperatures range from 6.0°C to 9.3°C (NMPi, 2025).

4.2.4 Climate Change and GHG Emissions

The DESNZ supplementary guidance for assessing the effects of downstream scope 3 emissions on climate from offshore oil and gas projects (DESNZ, 2025c), requires a global baseline scenario of greenhouse gases to be presented in the ES.

Over recent decades, scientific consensus has confirmed that the Earth's climate is undergoing significant change, largely driven by anthropogenic (human induced) GHG emissions (IPCC, 2023; IPCC, 2019a; WMO, 2023; WMO, 2019; UNEP; 2024).

A variety of robust up-to-date data sources have been examined for this section of the ES to characterise the current state of global GHG emissions in the atmosphere (expressed in carbon dioxide equivalent (CO_2e)[1] where available), analyse historical trends, review effects and look at future projections, including:

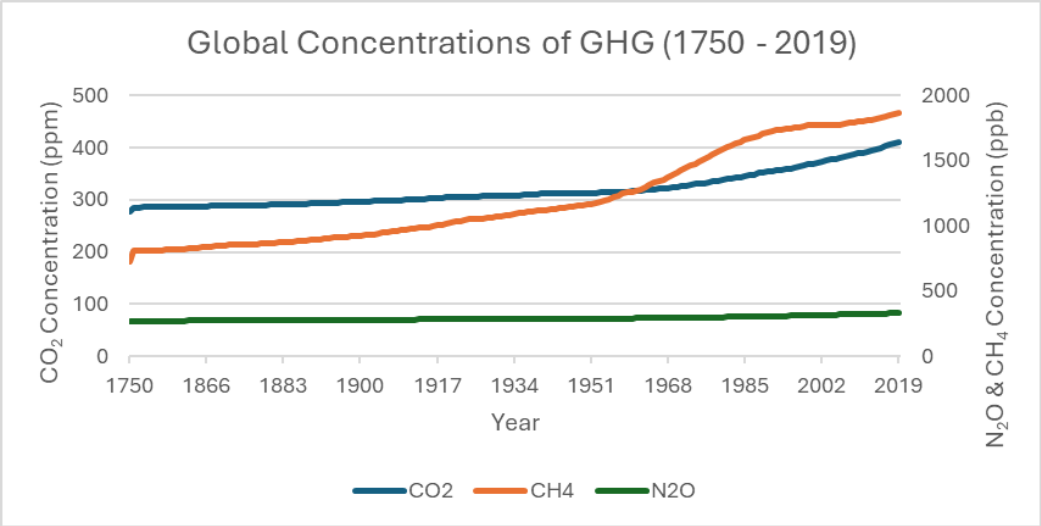
- The Intergovernmental Panel on Climate Change (IPCC) – Sixth Assessment Report 'AR6' (IPCC, 2023)
- United Nations Environment Programme (UNEP) – Emissions Gap Report 2024 (UNEP, 2024)
- Emissions Database for Global Atmospheric Research (EDGAR) (EDGAR, 2025)
- World Meteorological Organization (WMO) – WMO Greenhouse Gas Bulletin (WMO, 2023)
- National Oceanic and Atmospheric Administration (NOAA) – Global Monitoring Laboratory measurements (Lan et al., 2025)
- *Indicators of Global Climate Change 2024* (Forster et al., 2025)

Global GHG Emissions - Current Status, Trends and Effects

Since 1850, human activities, including the combustion of fossil fuels, land-use change, and industrial activity have resulted in rapidly increasing concentrations of GHGs in the atmosphere, most notably CO_2, CH_4 and N_2O (Figure 4.3). Global mean concentrations for well-mixed GHGs (CO_2, CH_4 and N_2O) in 2019 correspond to increases of about 47%, 156%, and 23%, respectively, above the levels in 1750 (representative of the pre-industrial era) (high confidence) (IPCC, 2023). This has unequivocally caused global warming.

[1] CO_2e is a metric used to express the impact of different greenhouse gases in terms of the amount of carbon dioxide that would produce the same global warming effect.

Figure 4.3: Global GHG Emissions from 1750 to 2019 [N1]



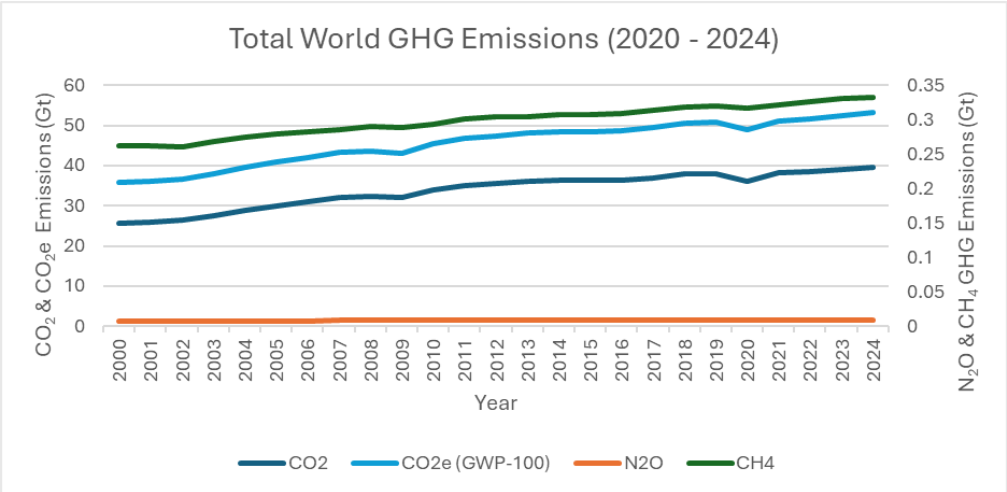
[N1] Data obtained from IPCC (2023) Working Group 1 (WG1) Sixth Assessment Report (AR6) Annex III Extended Data

Over the past two decades (2000–2020), CO_2 emissions to the atmosphere from the burning of fossil fuels generally have risen year-on-year, starting at 6.8 petagrams (Pg) of carbon[2] per year in 2000 and reaching a maximum of 10.1 Pg of carbon in 2019 (Jacobson, 2023).

Over the period 2014–2023, it is estimated that the annual release rate of GHG emissions into the atmosphere averaged 53.6 ± 5.2 Gigatons (Gt)[3] CO_2e per year (Forster et al., 2025), with the latest data from EDGAR (2025) indicating that 53.2 Gt CO_2e was released in 2024 (Figure 4.4; EDGAR, 2025). In 2024, global energy-related GHG emissions reached 42.6 Gt CO_2e (IEA, 2025).

In 2023, global GHG emissions set a new record of ca. 57.1 Gt CO_2e (UNEP, 2024), a 1.3% increase (0.7 $GtCO_2e$) from 2022 levels, with the power sector (i.e. fossil fuel combustion to generate electricity and heat in power plants) the largest global contributor to emissions at 15.1 $GtCO_2e$, followed by transport (8.4 $GtCO_2e$), agriculture (6.5 $GtCO_2e$) and industry (i.e. fossil fuel combustion to drive on-site industrial processes, such as heating furnaces) (6.5 $GtCO_2e$). The 1.3% increase in emissions above 2022 levels, is higher than the average rate in the decade preceding the COVID-19 pandemic (2010–2019), when GHG emissions growth averaged 0.8% per year (UNEP, 2024).

Figure 4.4: Total Global GHG Emissions by CO_2, N_2O, CH_4 and CO_2e (GWP-100 'AR5') [N1]



[N1] Data obtained from EDGAR (2025) GHG total datasets (1974 – 2024), represented to show Gt of GHG, manipulated from base unit of Gg, to show period 2000 – 2024 (the past two decades).

[2] One petagram of carbon is equal to one billion metric ton of carbon or 3.67 billion metric ton of CO_2.
[3] One gigaton is equivalent to one billion metric tons (1,000,000,000 tons)

The effects of climate change have been observed both quantitatively, i.e. global mean surface temperature rise, sea level rise, ocean heat content, sea ice extent; and qualitatively, i.e. coral bleaching, extreme weather patterns, seasonal shifting, and migratory species changes (IPCC, 2023; 2019a; 2019b). Global surface temperature averaged over the decade 2011-2020 was 1.1°C warmer than the 1850-1900 average and the past ten years (2015-2024) were the warmest ten years on record (Met Office, 2025). Over the past two decades, the rate of ocean warming has increased to 0.66 ± 0.10 watts per square metre (W/m^2), with global mean sea level increasing by 0.20 m between 1901 and 2018 (IPCC, 2023; IOC-UNESCO, 2024). The ocean has also absorbed enough CO_2 to lower its pH by 0.1 units, a 30% increase in acidity (Lindsey, 2025).

Projected Global GHG Emissions and Possible Future Climate Scenarios

Over the life of the Kyla Development (2028 up to 2035), the quantity of global GHGs affecting climate will be subject to both natural and anthropogenic change. In nearly all considered scenarios and modelled pathways, global warming is predicted to continue to increase in the near term (2021–2040) mainly due to increased cumulative CO_2 emissions (IPCC, 2023).

The UNFCCC is an international agreement that commits countries to efforts to stabilise GHG concentrations to prevent dangerous, human-induced climate change. The COP is the main decision-making body of the UNFCCC. In 2015, COP21 created the Paris Agreement, a global treaty that commits countries to limit global average temperature to well below 2°C above preindustrial levels and pursuing efforts to limit temperature increase to 1.5°C above preindustrial levels. At the heart of the Paris Agreement are NDCs, which embody efforts by each country to reduce national emissions and adapt to the impacts of climate change. Each country must submit a NDC to the UNFCCC secretariat every five years.

The Paris Agreement's GST process is designed to evaluate progress on climate action at the global level every five years. The first-ever GST, which concluded at COP28 in December 2023, highlighted that whilst progress has been made since the Paris Agreement — global temperatures are now expected to rise by 2.4-2.6°C by the end of the century, compared to 3.7-4.8°C in 2010 – the world is still not on track to limit global warming to 1.5°C (CCC, 2024). It concluded that to keep 1.5°C in reach, deep rapid and sustained reductions in global GHG emissions are required (43% by 2030 and 60% by 2035 from 2019 levels, aiming for net zero CO_2 by 2050). Following this at COP29 in November 2024, the global community acknowledged that the world is already crossing critical temperature thresholds – 2024 is expected to mark the first year that the global average temperature exceeds 1.5 °C above pre-industrial levels. (CCC, 2024).

The GST process was informed by the IPCC AR6 cycle, completed in July 2023. AR6 defines a core set of five illustrative Shared Socio-economic Pathways (SSP) scenarios combined with Representative Concentration Pathways (RCP) scenarios – SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0 and SSP5-8.5. The SSP-RCP scenarios combine baseline socio-economic narratives (the SSPs; SSP1 to SSP5[4]), which incorporate assumptions about future socioeconomic developments (e.g. population growth, economic trends, and technological advancements), with different emissions trajectories informed by the RCP scenarios[5] which impose a level of radiative forcing in 2100, corresponding to a related level of global warming (refer to Table 4.4).

[4] Five pathways have been developed by the international scientific community – sustainable development (SSP1), middle-of-the-road development (SSP2), regional rivalry (SSP3), inequality (SSP4) and fossil-fuelled development (SSP5).

[5] RCP scenarios were defined in the IPCC's fifth assessment reporting cycle (AR5) and show how GHG concentrations can affect global temperatures. For example, RCP 8.5 represents a high-emissions pathway, while RCP 2.6 assumes strong mitigation efforts.

Table 4.4: Shared Socioeconomic Pathways and Changes in Global Surface Temperatures (IPCC, 2023)

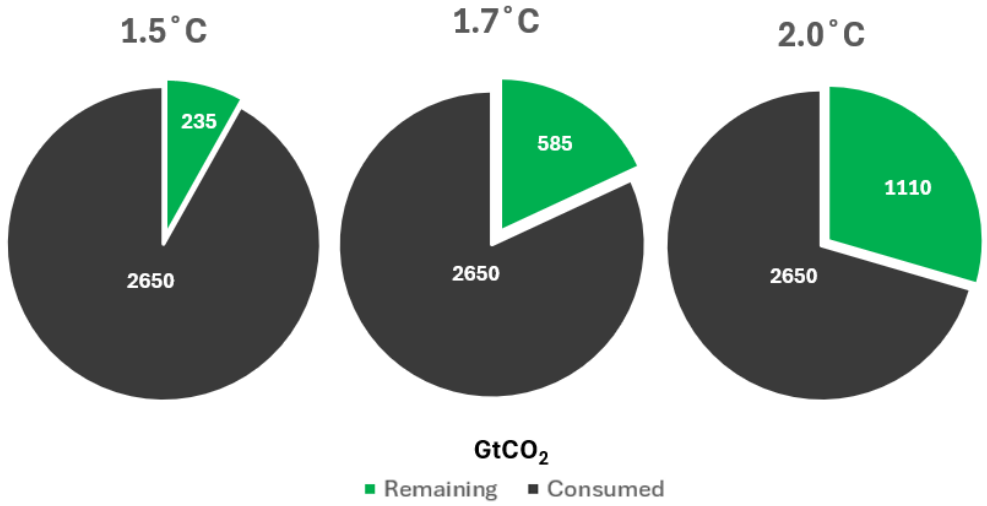
GHG Emissions Scenario [N1]	Description	Change in Global Surface Temperature (°C) [N2] Best Estimate [and very likely range]			Key Assumptions
		Near term (2021 – 2040)	Mid-term (2041 – 2060)	Long-term (2081 – 2100)	
SSP1-1.9 (Very Low)	limit warming to 1.5°C (>50%) with no or limited overshoot	1.5 [1.2 to 1.7]	1.6 [1.2 to 2.0]	1.4 [1.0 to 1.8]	Rapid decarbonisation, societies switch to more sustainable practices, inequality falls. Net zero CO_2 achieved in ca. 2050.
SSP1-2.6 (Low)	limit warming to 2°C (>67%)	1.5 [1.2 to 1.8]	1.7 [1.3 to 2.2]	1.8 [1.3 to 2.4]	Socioeconomic shifts towards sustainability, but reduction in CO_2 emissions is slower than SSP1-1.9. Net zero CO_2 achieved in ca. 2070.
SSP2-4.5 (Intermediate)	limit warming to 3°C (>50%)	1.5 [1.2 to 1.8]	2.0 [1.6 to 2.5]	2-7 [2.1 to 3.5]	Current policies continue. Slow progress toward sustainability and development and income grow unevenly. CO_2 emissions hover around current levels before starting to fall mid-century. Net zero CO_2 is not achieved by 2100.
SSP3-7.0 (High)	limit warming to 4°C (>50%)	1.5 [1.2 to 1.8]	2.1 [1.7 to 2.6]	3.6 [2.8 to 4.6]	Fragmented, high fossil use, inequality. CO_2 emissions roughly double from current levels by 2100
SSP5-8.5 (Very High)	exceed warming of 4°C (>50%)	1.6 [1.3 to 1.9]	2.4 [1.9 to 3.0]	4.4 [3.3 to 5.7]	Rapid economic growth without mitigation, fuelled by exploiting fossil fuels and energy-intensive lifestyles. Current CO_2 emissions roughly double by 2050.

[N1] Scenarios relate to SSPs + "forcing", where the number refers to the radiative forcing level in W/m² in the year 2100. For example, 'SSP1-1.9' is a scenario that combines SSP1 with 1.9 W/m² radiative forcing in 2100 (RCP1.9)
[N2] Temperature differences relative to the average global surface temperature of the period 1850-1900.

Remaining Global Carbon Budget

The Global Carbon Project produces an annual Global Carbon Budget (GCB), which tracks the trends in global carbon emissions and sinks and is a key measure of the progress towards the goals of the Paris Agreement. The 2024 GCB projects fossil CO_2 emissions of 37.4 Gt CO_2[6], up 0.8% from 2023 and concludes that there are no clear signs that the world has reached a peak in fossil CO_2 emissions. If current trends continue, from January 2025, the remaining carbon budget for a 50% likelihood to limit global warming to 1.5°C, 1.7°C and 2°C has respectively been estimated at 235 Gt CO_2 (which would be exceeded in 6 years at 2024 emissions levels), 585 Gt CO_2 (14 years) and 1,110 Gt CO_2 (27 years) (Figure 4.5; GCP, 2024). For comparison, for the period 1850–2019, a total of 2,390 ± 240 Gt CO_2 has been emitted (IPCC, 2021).

Figure 4.5: Remaining Carbon Budget (GCP, 2024) [1]



[1] Data represented from GCP (2024). Data represents 50% likelihood to achieve SSP.

4.3 Biodiversity

4.3.1 Plankton

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. Typically, on the Scottish continental shelf, a phytoplankton bloom occurs every spring, generally followed by a smaller peak in the autumn (DESNZ, 2022).

This region is influenced by the warm waters of the continental shelf current and the currents entering the North Sea from the north-east Atlantic and the Norwegian Sea (JNCC, 2004). The phytoplankton community in these waters is dominated by the dinoflagellate genus Tripos (mainly *T. fusus*, *T. furca* and *T. muelleri*), with diatoms such as *Thalassiosira spp.* and *Chaetoceros spp.* also abundant to the west of Scotland, diatoms such as *Rhizosolenia spp.* and *Fragillariopsis spp.* and coccolithophores increase in abundance towards the shelf edge, while dinoflagellates such as *Protoperidinium*, *Gymnodinium* and *Scripsiella* are also abundant in late summer (DESNZ, 2022).

The zooplankton communities are dominated in terms of biomass and productivity by calanoid copepods, particularly *Calanus spp*. (*finmarchicus* and *helgolandicus*), *Paracalanus spp.* and *Pseudocalanus spp*. Meroplanktonic echinoderm larvae and decapod larvae are also abundant. Other

[6] Global fossil CO_2 emissions include the cement carbonation sink.

important taxa in the region include *Acartia spp., Evadne spp., Oithona spp*. and *Metridia lucens* (DESNZ, 2022).

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 of 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 European Marine Observation and Data Network (EMODnet) broad-scale seabed habitat map for Europe (EUSeaMap2), indicates that the proposed Kyla Development area is located within the following European Nature Information System (EUNIS) habitat classifications (see Figure 4.6 and EMODnet, 2021; EEA, 2022):

- Offshore circalittoral sand (MD5) – these habitats are likely to be more stable than their shallower counterparts and characterised by a diverse range of polychaetes, amphipods, bivalves and echinoderms;
- Offshore circalittoral mud (MD6) – these habitats are quite diverse featuring a variety of faunal communities depending upon the level of silt/clay and organic matter in the sediment. Communities are typically dominated by polychaetes but often with high numbers of bivalves such as *Thyasira spp*., echinoderms and foraminifera.

The habitat investigation undertaken for Kyla used a combination of field observations, detailed review of photographic data and analysis of sediment samples to identify the habitat types across the survey area (Gardline, 2025a).

Biotope classification following the EUNIS hierarchy was primarily based on seabed imagery, depth and PSA. All stations, including those in the wider region (KT01 to KT04) were classified to the level four EUNIS biotope complex MD621: Faunal communities of Atlantic circalittoral mud. Additionally, Stations KS01, KS04 and KS08 were classified further to level five as EUNIS biotope MD6216: Seapens and burrowing megafauna in Atlantic circalittoral fine mud, reflecting the presence of sea pens and/or faunal burrows in the majority of the images at these stations (Gardline, 2025a).

Faunal communities of Atlantic circalittoral mud (MD621)

Example seabed images of the EUNIS habitat type 'Faunal communities of Atlantic circalittoral mud' (MD621); which were observed on all transects within the Kyla Development survey area, including stations in the wider region (KT01 to KT04); are presented in Figure 4.8 and Figure 4.9. Generally, the seapens *Virgularia mirabilis* and *Pennatula phosphorea* are characteristic of this habitat type together with the burrowing anemone *Cerianthus lloydii* and the ophiuroid *Amphiura* spp. The relatively stable conditions often lead to the establishment of communities of burrowing megafaunal species, such as *Nephrops norvegicus* (EEA, 2022).

The most commonly observed fauna on the seabed photographs and video were the seapens *Pennatula phosphorea*. Fauna including crabs and shrimp (*Paguroidea* spp. and *Caridea* spp.), faunal turf (Hydrozoa/Bryozoa), *Pleuronectiforme* spp., molluscs (*Naticidae* spp., *Nudibranchia* spp.), hermit crab fur (*Hydractinia echinata*) and sea pens (*Funiculina quadrangularis, Virgularia* spp.) were also widely seen. Other, less regularly observed fauna included fish species (*Actinopterygii* spp., *Glytocephalus cynoglossus*, *Callionymus lyra*, *Myxine glutinosa*, *Microstomus kitt*), mollusc species (*Pseudamussium peslutrae*, Scaphopoda spp., Anomiidae spp., *Buccinum undatum*), cnidaria (*Alcyonium digitatum*, *Lytocarpia myriophyllum*, *Hormanthia digitata*, Anthozoa spp.), arthropods (*Atelecyclus rotundatus*, Galatheidae spp., *Nephrops norvegicus*), sponges (*Porifera* spp.) and annelids (*Annelida* spp.). Faunal turf and burrows were also present at the majority of stations (Gardline, 2025a).

Seapens and burrowing megafauna in Atlantic circalittoral fine mud (MD6216)

Example seabed images of the EUNIS habitat type 'Seapens and burrowing megafauna in Atlantic circalittoral fine mud' (MD6216), which were observed at stations KS01, KS04 and KS08 within the Kyla Development survey area, are presented in Figure 4.7.

This habitat type consists of plains of fine mud at depths greater than about 15 m which may be heavily bioturbated by burrowing megafauna. Burrows and mounds may form a prominent feature of the sediment surface with conspicuous populations of seapens, typically *Virgularia mirabilis* and *Pennatula phosphorea*. The burrowing crustacea present typically include *Nephrops norvegicus*, which is frequently recorded from surface observations although grab sampling may fail to sample this species. The burrowing anemone *Cerianthus lloydii* and the epibenthic scavengers *Asterias rubens*, *Pagurus bernhardus* and *Liocarcinus depurator* are present in low numbers in this biotope whilst the brittlestars *Ophiura albida* and *Ophiura ophiura* are sometimes present, but are much more common in slightly coarser sediments. The infauna may contain significant populations of the polychaetes *Pholoe* spp., *Glycera* spp., *Nephtys* spp.; spionids *Pectinaria belgica* and *Terebellides stroemi*; the bivalves *Nucula sulcata*, *Corbula gibba* and *Thyasira flexuosa*; and the echinoderm *Brissopsis lyrifera* (EEA, 2022).

The most commonly observed fauna on the seabed photographs and video were the seapens *Pennatula phosphorea*. Fauna including crabs and shrimp (*Paguroidea* spp. and *Caridea* spp.), faunal turf (Hydrozoa/Bryozoa), molluscs (*Nudibranchia* spp.), and sponges (*Porifera* spp.) were also widely seen. Other, less regularly observed fauna included fish species (*Actinopterygii* spp., *Callionymus lyra*), mollusc species (Anomiidae spp., *Buccinum undatum*), cnidaria (*Hormanthia digitata*), arthropods (*Polybius depurator*), and annelids (*Serpulidae* spp.). Faunal turf and burrows were present at the majority of stations (Gardline, 2025a).

Figure 4.6: Predicted Seabed Habitats in the Vicinity of the Kyla Development (EMODnet, 2021)

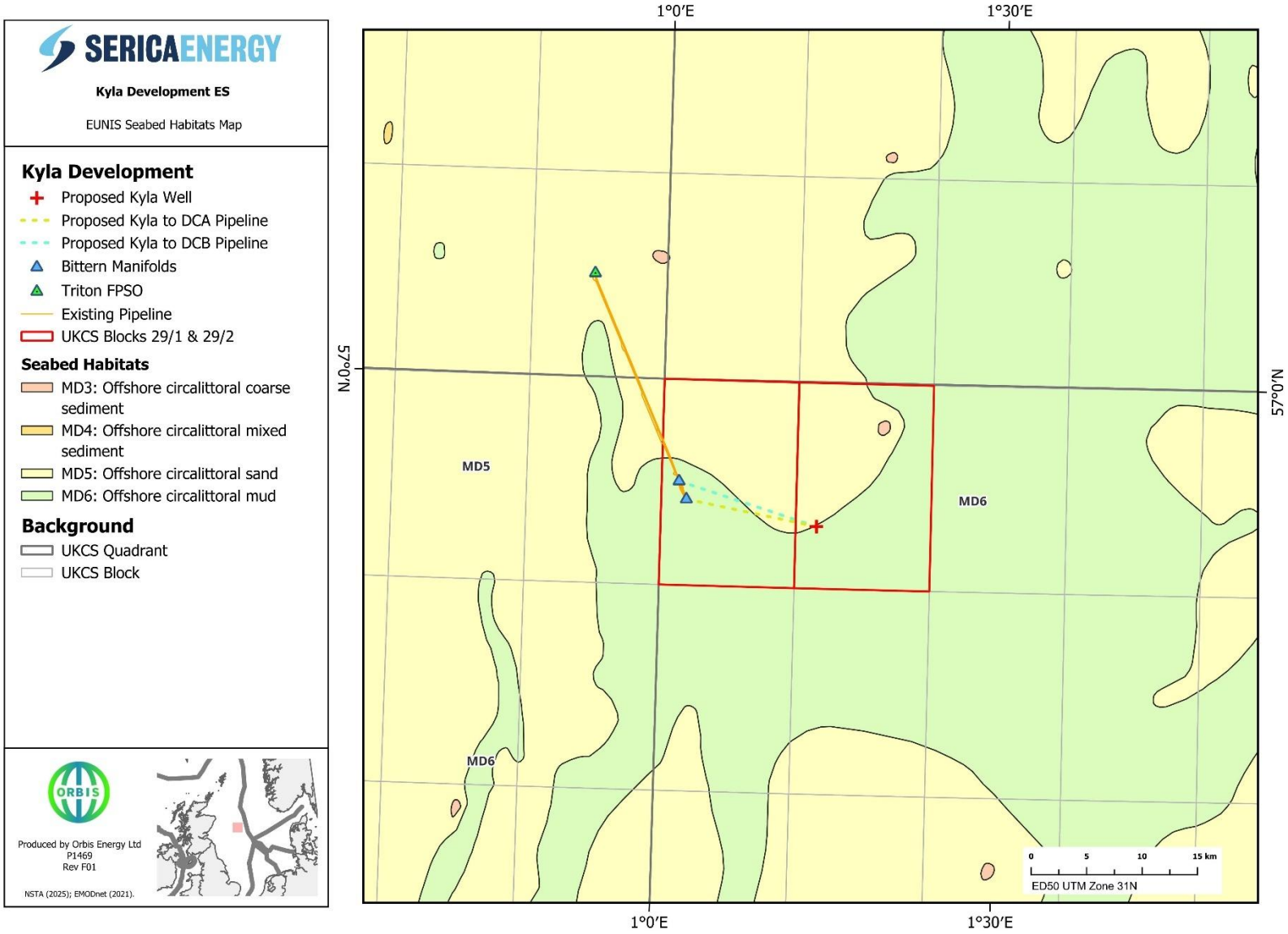
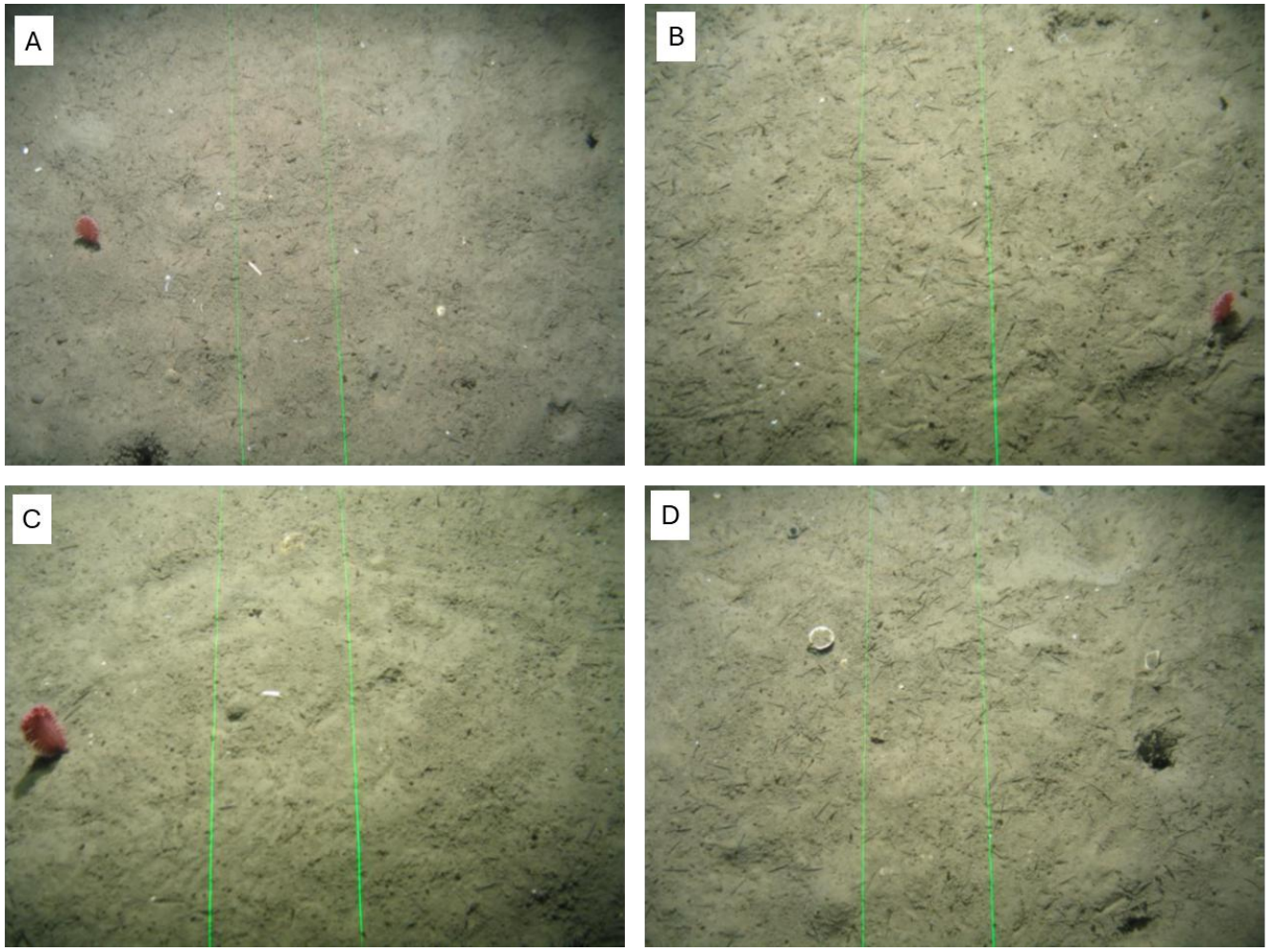


Figure 4.7: Example Seabed Images of the 'Seapens and burrowing megafauna in Atlantic circalittoral fine mud (MD2616)' habitat type within the vicinity of the proposed Kyla well location (Gardline, 2025a)



A: Photograph KS01 (Fix 397)

Muddy fine sand with shell fragments
Cnidaria (*Pennatula phosphorea*)

B: Photograph KS04 (Fix 202)

Muddy fine sand with shell fragments.
Cnidaria (*P. phosphorea*)

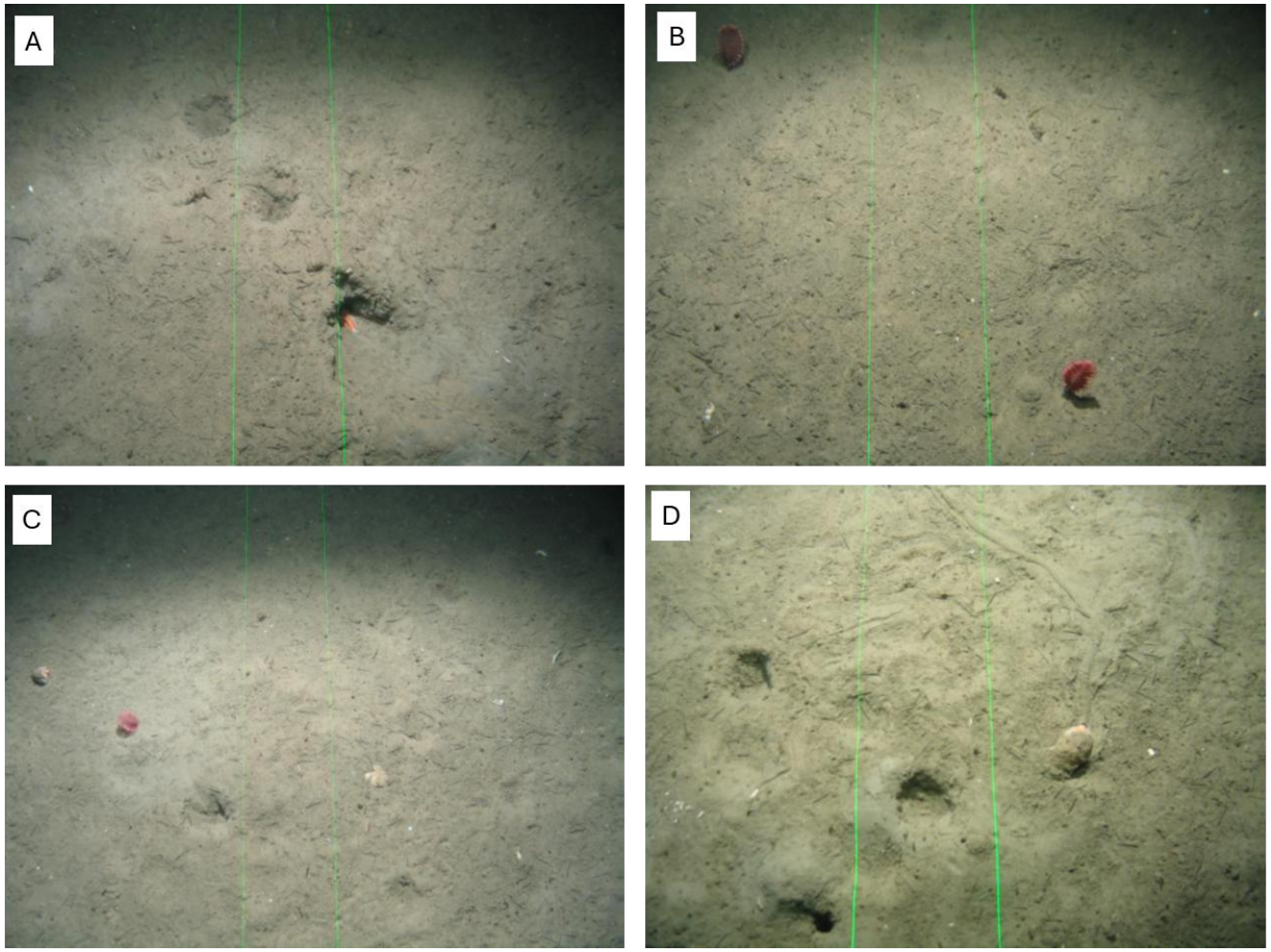
C: Photograph KS04 (Fix 209)

Muddy fine sand with shell fragments
Cnidaria (*P. phosphorea*)

D: Photograph KS08 (Fix 164)

Muddy fine sand with shell fragments
No visible fauna

Figure 4.8: Example Seabed Images of the 'Faunal communities of Atlantic circalittoral mud (MD621)' habitat type within the vicinity of the proposed Kyla well location (Gardline, 2025a)



A: Photograph KS07 (Fix 137)

Muddy fine sand with shell fragments
Arthropoda (*Nephrops norvegicus*)

B: Photograph KS07 (Fix 145)

Muddy fine sand with shell fragments.
Cnidaria (*P. phosphorea*), Faunal Turf

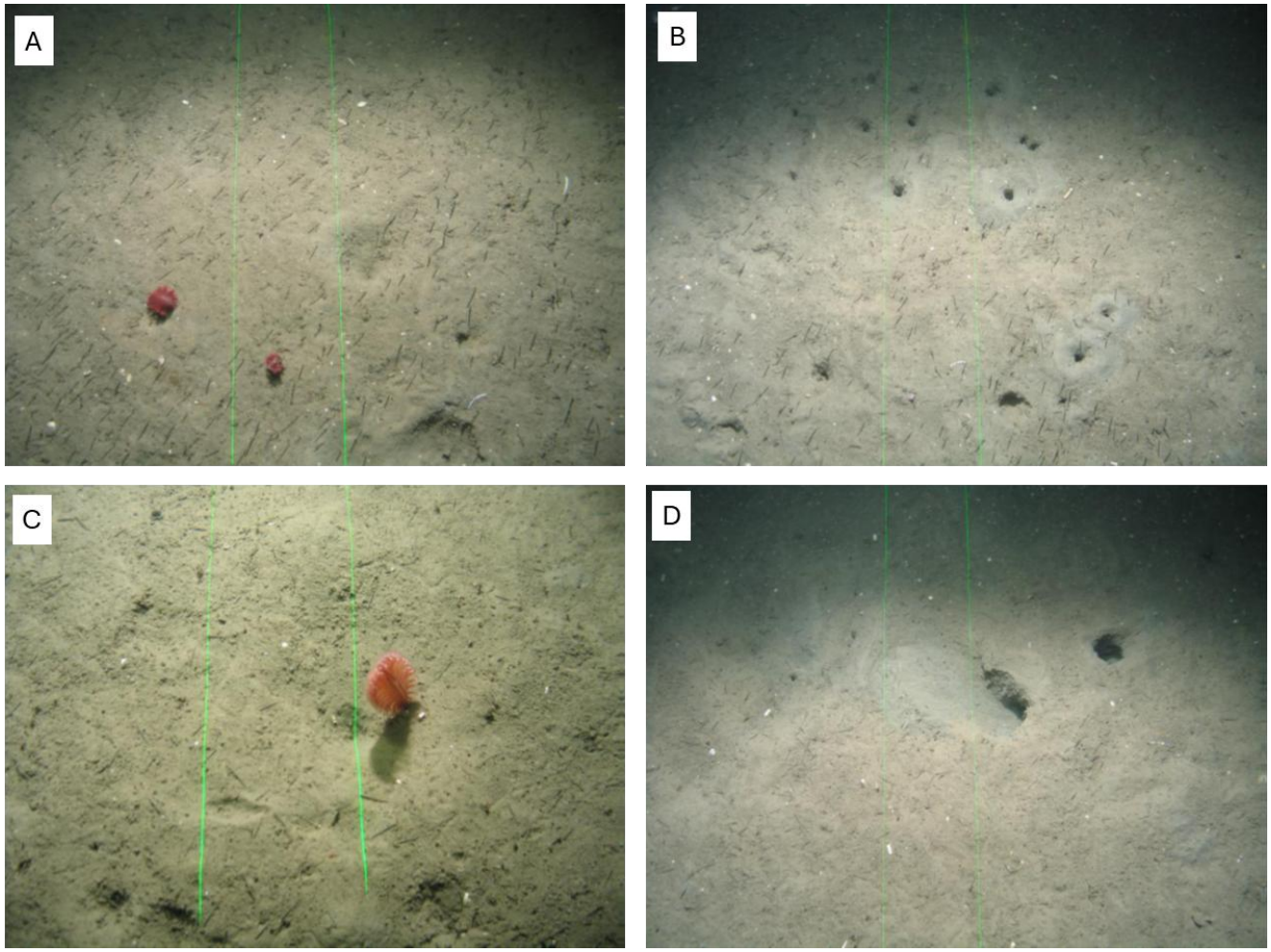
C: Photograph KS09 (Fix 182)

Muddy fine sand with shell fragments
Arthropoda (Paguroidea spp.),
Cnidaria (*P. phosphorea*)

D: Photograph KS09 (Fix 190)

Muddy fine sand with shell fragments
Mollusca (Naticidae spp.)

Figure 4.9: Example Seabed Images of the 'Faunal communities of Atlantic circalittoral mud (MD621)' habitat type along the proposed Kyla to Bittern pipeline route (Gardline, 2025a)



A: Photograph KB01 (Fix 74)

Muddy fine sand with shell fragments
Cnidaria (*P. phosphorea*)

B: Photograph KB01 (Fix 86)

Muddy fine sand with shell fragments.
Chordata (*Myxine glutinosa*)

C: Photograph KB02 (Fix 94)

Muddy fine sand with shell fragments
Cnidaria (*P. phosphorea*)

D: Photograph KB02 (Fix 96)

Muddy fine sand with shell fragments
No visible fauna

Potential Sensitive Habitats and Species

The following potential sensitive habitats and species are known to occur in the wider region (CNS) (See Section 4.3.6), including:

- Seapen and burrowing megafauna communities (Burrowed mud);
- Ocean quahog (Arctica islandica);
- Herring Spawning Grounds;
- Sandeel Spawning Grounds.

The Kyla HA and EBS paid particular attention to establishing whether or not any of the above habitats and/or species occurred within the survey area, as discussed below.

No other sensitive habitat or species of conservation interest was observed during the Kyla Development survey.

Seapen and burrowing megafauna communities;

A seapen and burrowing megafauna communities habitat is classified as a threatened and/or declining habitat (OSPAR, 2008). It is defined by OSPAR (2010) as plains of fine mud, extending over an area of at least 25 m^2 and at water depths ranging from 15 m to 200 m or more. These areas are defined as being heavily bioturbated by burrowing megafauna including *Nephrops norvegicus*, *Calocaris macandreae* or *Callianassa subterranea*, with burrows and mounds typically forming a prominent feature of the sediment surface, and which may include conspicuous populations of seapens (Pennatuloidea); typically, *Virgularia mirabilis* and *Pennatula phosphorea*. Despite its classification as a threatened and/or declining habitat (OSPAR, 2008); this habitat is widespread throughout the CNS, around the south and west coasts of Norway and around the north of the British Isles (OSPAR, 2010).

Within Scottish waters, the PMF broad habitat burrowed mud is defined as areas of finer sediment with burrows and mounds forming a prominent component of the habitat (Tyler-Walters et al., 2016). In some areas burrowed mud may support conspicuous populations of seapens; typically, *V. mirabilis* and *P. phosphorea*. This habitat is typically found in environments of fine mud, sandy mud and muddy sand in water depths ranging from 10 m to greater than 500 m. The burrowed mud PMF supports the component biotope seapens and burrowing megafauna in circalittoral fine mud. This is defined as stable circalittoral mud with populations of distinctive seapens, which occurs in relatively shallow but sheltered muddy bottoms at depths from 500 m in full or variable salinities.

Seabed imagery revealed that burrows were present in 5 and 39% of analysed images at all stations and three species of sea pens (*F. quadrangularis*, *P. phosphorea* and *Virgularia*) were present in 13 to 60% of analysed images from all stations. Therefore, a detailed assessment of the sea pen and burrowing megafauna community habitat as defined by OSPAR (2010) was conducted, referring to the Marine Nature Conservation Review (MNCR) SACFOR abundance scale (JNCC, 2013; Gardline, 2025a). The results of the assessment are summarised in Table 4.5.

A total of four *F. quadrangularis*, 127 *P. phosphorea* and two *Virgularia* individuals were recorded across all stations. Total Pennatuloidea densities ranged from 0.6 to 2.8 individuals per m^2 with observed specimens measuring between 0.4 and 12.6 cm. When categorised using the SACFOR scale, all stations recorded abundances reaching or encompassing the frequent category, with six stations surrounding the around the proposed Kyla well location (Stations KS02 to KS05, KS07 and KS12) recording categories of frequent or above (Table 4.5; Gardline, 2025a).

A total of 96 burrows were observed across all stations, with diameters ranging from 0.8 to 10.8 cm. Burrow densities varied between 0.2 burrows per m^2 at Station KS04, to 1.8 burrows per m^2 at Station KS12. These densities correspond to SACFOR categories reaching frequent at all stations except Station KS01 (Table 4.5; Gardline, 2025a).

The Joint Nature Conservation Committee (JNCC) (2014) clarification report states that to be considered a sea pen and burrowing megafauna communities habitat, densities of burrows and/or mounds, together with sea pens, if present, should be classified as frequent or above on the SACFOR scale. Therefore, across the survey area, some similarity to this habitat was observed at all stations

except Station KS01 and when considering the survey data overall, burrows were classified as rare to frequent, suggesting that there is some similarity to a sea pen and burrowing megafauna communities habitat, as per OSPAR (2010). Although burrows were present, burrowing fauna were rarely sighted with only a single individual of *N. norvegicus* observed across the survey area to confirm the burrow inhabitants, therefore burrows could not confidently be attributed to any of the classified megafauna species within the seapen and burrowing megafauna community habitat classification (Gardline, 2025a).

The sea pen and burrowing megafauna communities habitat has also been found to likely be present within the Bittern Field Development area (Fugro, 2017; 2023).

Table 4.5: Sea Pen and Faunal Burrow SACFOR Assessment (Gardline, 2025a)

Station	Number of Images	Total Area Assessed	Number of F. quadralangaris	Number of P. phosphorea	Number of Virgularia	Total Pennatuloidea			Faunal Burrows			
						Density (individuals m^2)	Size Range (cm)	SACFOR Range[1]	Number of Burrows	Density (individuals m^2)	Size Range (cm)	SACFOR Range[1]
Kyla Cruciform Stations												
KS01	22	4.9	0	3	0	0.6	1.5 to 3.6	O to F	3	0.6	1.1 to 2.7	O to O
KS02	23	5.5	0	11	0	2	2.9 to 6.7	F to C	8	1.5	0.8 to 4.0	O to C
KS03	22	5.8	0	8	1	1.5	1.9 to 4.9	F to C	2	0.3	2.3 to 3.0	O to F
KS04	20	4.3	0	5	0	1.2	2.1 to 4.0	F to C	1	0.2	5	F
KS05	21	6	0	6	0	1	2.4 to 6.5	F to C	10	1.7	1.1 to 4.2	F to C
KS06	28	8.3	0	11	0	1.3	0.9 to 5.9	O to C	5	0.6	2.6 to 3.5	O to F
KS07	21	5.1	0	7	0	1.4	3.5 to 5.5	C to C	4	0.8	2.2 to 10.8	O to F
KS08	22	4.8	0	4	0	0.8	1.3 to 4.6	O to F	5	1	2.7 to 5.7	F to C
KS09	21	5.8	0	4	0	0.7	1.5 to 4.6	O to F	4	0.7	1.8 to 4.9	O to F
KS10	24	4.7	0	3	0	0.6	0.9 to 4.1	R to F	2	0.4	2.3 to 3.2	O to F
KS11	21	7.1	0	5	1	0.8	2.8 to 5.1	O to F	6	0.8	1.2 to 4.3	O to F
KS12	23	5	0	13	0	2.6	1.4 to 6.1	F to C	9	1.8	1.4 to 7.4	F to C
Kyla to Bittern Pipeline Route												
KB01	20	5.6	0	16	0	2.8	0.5 to 5.0	O to C	7	1.2	0.9 to 4.8	O to C
KB02	23	6.4	0	4	0	0.6	2 to 3.7	O to F	11	1.7	1.3 to 6.7	F to C

Key: (Application of SACFOR Abundance Ranges to OSPAR (2010) Sea Pen and Burrowing Megafauna Communities Habitat)

< Frequent = No similarity	≤ Frequent = Some similarity	< and > Frequent = Some Similarity	≥ Frequent = Greatest similarity

[1] SACFOR classification scale S = superabundant, A = abundant, C = common, F = frequent, O = occasional and R = rare. Classification is based on minimum and maximum estimated size of seapen and burrows and the respective mean density at each station and transect.

The sea pen and burrowing megafauna communities habitat is also listed as a key component biotope within the broader Burrowed mud habitat, which is designated as a PMF (NatureScot, 2022). This is defined by Scottish Natural Heritage (2016) as fine mud, sandy mud and muddy sand in water depths ranging from 10 m to greater than 500 m, characterised by a range of burrowing crustaceans. Burrows and mounds are a prominent feature of this habitat, while sea pens and anemones may also be present. Sediments across the survey area were classified as muddy sand to slightly gravelly muddy sand, suggesting some ecological similarities to the Burrowed mud PMF.

Whilst this habitat is on the list of threatened and/or declining species and habitats, it is widespread throughout the CNS, around the south and west coasts of Norway and around the north of the British Isles (OSPAR, 2010; Hill et al., 2022).

Ocean quahog (*Arctica islandica*)

Ocean quahog (*A. islandica*) is listed as a PMF in Scottish waters and is listed as an OSPAR Threatened and/or Declining species. This species of bivalve mollusc is long-lived with a slow growth rate and is generally found partially buried in sandy and muddy sediments. Thirty-one juvenile *A. islandica* individuals were recorded across the survey area, with no adults observed within samples (Gardline, 2025b).

In addition, during a historic survey at the Kyla field, no adult *A. islandica* (> 1 cm) were recovered from the grab stations. However juvenile *A. islandica* were found within all but one of the macrofaunal samples ranging between 1 and 22 juveniles per 0.1 m^2 (mean 8 per 0.1 m^2) (Fugro, 2020). Furthermore, during historic surveys at Bittern, no adult individuals of *A. islandica* were present, but juvenile individuals were recorded (Fugro, 2017; 2023).

Herring Spawning Grounds

The proposed Kyla Development area coincided with a potential herring nursery ground area according to Cefas (2010). Water depths across the survey area ranged from 89 to 94m which is deeper than the suitable depth range (15 to 40 m) though within the maximum depth (200 m) for herring spawning according to the International Council for the Exploration of the Sea (ICES) (2024). Consequently, all stations were reviewed for the spawning potential of each relevant aspect, using the Reach et al. (2013) criteria, with results displayed in Table 4.8 (Table 4.7; Gardline, 2025a).

Table 4.6: Herring Spawning ground assessment categories specified by Reach et al. (2013)

Percent Contribution of Mud & Gravel	Folk (1954) Descriptions	Habitat Sediment Preference
<5% mud, >50% gravel	Gravel and part of Sandy Gravel	Prime
<5% mud, >25% gravel	Part of Sandy Gravel and part of Gravelly Sand	Sub-prime
<5% mud, >10% gravel	Part of Gravelly Sand	Suitable
>5% mud, <10% gravel	All other Folk sediment categories	Unsuitable

Table 4.7: Herring Spawning Ground Assessment results using Reach et al. (2013) (Gardline, 2025a)

Station	Coarse Sand to Gravel (%)	Fines (%)	Gravel (%)	Modified Folk Scale	Habitat Sediment Preference	Habitat Sediment Classification
Kyla Cruciform Stations						
KS01	1	21.8	0	Muddy Sand	Unsuitable	Unsuitable
KS02	0.1	21.3	0	Muddy Sand	Unsuitable	Unsuitable
KS03	0.01	24.3	0	Muddy Sand	Unsuitable	Unsuitable
KS04	0.4	22.1	0	Muddy Sand	Unsuitable	Unsuitable
KS05	0.8	19.9	0	Muddy Sand	Unsuitable	Unsuitable
KS06	0.2	20.3	0	Muddy Sand	Unsuitable	Unsuitable
KS07	0.3	15.9	0	Muddy Sand	Unsuitable	Unsuitable
KS08	1.3	17.6	0	Muddy Sand	Unsuitable	Unsuitable
KS09	0.5	18.9	0	Muddy Sand	Unsuitable	Unsuitable
KS10	0.01	22.6	0	Muddy Sand	Unsuitable	Unsuitable
KS11	0.2	21	0	Muddy Sand	Unsuitable	Unsuitable
KS12	0.03	22.2	0	Muddy Sand	Unsuitable	Unsuitable
Kyla to Bittern Pipeline Route						
KB01	3.3	27	1.6	Slightly gravelly muddy sand	Unsuitable	Unsuitable
KB02	0.2	21.4	0	Muddy Sand	Unsuitable	Unsuitable

Although all stations (KS01 to KS12, KB01 to KB02) were of a suitable Wentworth classification (1922)(Table 4.1), the near ubiquitous absence of gravel, excepting the minimal contribution at Station KB01, was below the 10% threshold and therefore the stations were deemed unsuitable for herring spawning in terms of habitat sediment preference. Furthermore, the modified Folk (1954) classifications of muddy sand and slightly gravelly muddy sand also indicated the habitat to be unsuitable for herring spawning based on habitat sediment classification (Gardline, 2025a).

As acknowledged by Reach et al. (2013 in; MarineSpace Ltd et al., 2013) and as previously defined by Cefas (2001b), use of the modified Folk classification alone may over-estimate the suitability of an area in terms of its herring spawning potential as further consideration should be given to other environmental (physical, chemical and abiotic) parameters such as oxygenation, siltation, micro-scale morphological features (e.g. ripples and ridges). Furthermore, the area must be exposed to the main flow of water and the sediments wells sorted to ensure maximum oxygenation of the sediment and hence the lower layers of herring eggs; the area should be elevated with respect to the surrounding seabed. Therefore, the proposed Kyla Development area can be considered unsuitable as a herring spawning ground (Gardline, 2025a).

Sandeel Spawning Grounds

The proposed Kyla Development area coincides with a potential low intensity sandeel spawning and nursery ground (Cefas, 2010). Water depths across the survey area ranged from 89 to 94 m, overlapping the 15 to 120 m depth range which is within which sandeels are frequently encountered (Wright et al., 2000). Therefore, PSA results from all stations have been reviewed for their spawning ground potential based on criteria defined by Latto et al. (2013) (Table 4.8), with results displayed in Table 4.9 (Gardline, 2025a).

Table 4.8: Sandeel Spawning Potential Criteria adapted from Latto et al. (2013) (Gardline, 2025a)

Habitat Sediment Preference	Prime	Sub	Suitable	Unsuitable
% Particle contribution preference	<1% muds, >85% sand, <15% gravel (inferred)	<4% muds, >70% sand, <35% gravel	<10% muds, >50% sand, <35% gravel	>10% muds, <50% sand, >35% gravel
Folk classification based on % particle contribution preferences above	Part S, part (g)S, and part gS	Part S, part (g)S, and part gS	Part S, part (g)S, part gS, part sG, part mS, part (g)mS, part gmS and part msG.	All others (including mS, (g)mS, part gmS, part msG and part sG)

Habitat Sediment Class	Preferred	Marginal	Unsuitable
Folk classification generalised	Sand, slightly gravelly sand and gravelly sand	Sandy gravel	All others

Table 4.9: Sandeel Spawning Ground Assessment Results using Latto et al. (2013) (Gardline, 2025a)

Station	Habitat Sediment Preference			Habitat Sediment Classification	
	Fines (%)	Sand (%)	Suitability	Modified Folk Classification	Suitability
Kyla Cruciform Stations					
KS01	21.8	78.2	Unsuitable	Muddy sand	Unsuitable
KS02	21.3	78.7	Unsuitable	Muddy sand	Unsuitable
KS03	24.3	75.7	Unsuitable	Muddy sand	Unsuitable
KS04	22.1	77.9	Unsuitable	Muddy sand	Unsuitable
KS05	19.9	80.1	Unsuitable	Muddy sand	Unsuitable
KS06	20.3	79.7	Unsuitable	Muddy sand	Unsuitable
KS07	15.9	84.1	Unsuitable	Muddy sand	Unsuitable
KS08	17.6	82.4	Unsuitable	Muddy sand	Unsuitable
KS09	18.9	81.1	Unsuitable	Muddy sand	Unsuitable
KS10	22.6	77.4	Unsuitable	Muddy sand	Unsuitable
KS11	21	79	Unsuitable	Muddy sand	Unsuitable
KS12	22.2	77.8	Unsuitable	Muddy sand	Unsuitable
Kyla to Bittern Pipeline Route					
KB01	27	71.4	Unsuitable	Slightly gravelly muddy sand	Unsuitable
KB02	21.4	78.6	Unsuitable	Muddy sand	Unsuitable

Although the dominance of sand was consistent with sub-prime conditions, the prevalence of fines (>10%) rendered all stations unsuitable in terms of both habitat sediment preference and classifications

with modified Folk (1954) of muddy sand or slightly gravelly muddy sand. Sandeels were found by Holland et al. (2005) to prefer medium to coarse sand (250 to 1000 µm), which constituted 3.5 to 25 % of the sampled sediment within the 2025 Gardline survey. Latto et al. (2013) bases its categorisation of the sediment on the modified Folk (1954) classification for comparison to the pre-existing BGS charts to allow a broadscale assessment of potential sandeel spawning suitability and this method is likely to overstate the suitability of sediment to support populations of sandeel.

No sandeels or eggs were observed within seabed imagery during the 2025 Gardline survey, however this was conducted in July which falls outside the typical sandeel spawning period of November and February making the low observations of sandeels expected (Gardline, 2025a).

Other Potential Sensitive Habitats and Species

The Kyla habitat assessment survey surrounding the proposed well location and along the proposed pipeline route (KS01 to KS12; KB01 to KB02) found that the EUNIS level 5 habitat type 'Seapens and burrowing megafauna in Atlantic circalittoral fine mud' (MD6216) and EUNIS level 4 habitat type 'Faunal communities of Atlantic circalittoral mud' (MD621) are present (Gardline, 2025a). These are component biotopes of 'Burrowed Mud', which is a designated priority habitat within Scottish waters, and 'Mud habitats in Deep Water', which is a designated United Kingdom Biodiversity Action Plan (UK BAP) priority habitat (Tyler-Walters et al., 2016; BRIG, 2011).

No other Annex I habitats, Annex II species, OSPAR listed as threatened and/or declining habitats or species, UK Biodiversity Action Plan (BAP) priority habitats and species or PMF habitats or species were observed within the Kyla survey area (Gardline, 2025a; 2025b).

Benthic Infaunal Communities

Both within the vicinity of the proposed Kyla well location and pipeline route (KS01 to KS12; KB01 to KB02), and within the wider region (KT01 to KT04), there was a high species richness, with similar species dominating throughout. Macrofaunal analysis was carried out on 36 grab samples obtained at twelve environmental stations within the proposed Kyla Development area and the wider region (see Figure 4.1 and Figure 4.2 in Section 4.1.1).

A total of 22,861 individuals from the samples taken from within the vicinity of the proposed Kyla Development area (KS01 to KS12; KB01 to KB02) were analysed. Overall, 257 taxa were recorded; the taxa consisted of 111 annelid species, which dominated the community, accounting for 66.97 % of the total individuals. There were 70 species of arthropods recorded (4.08 % of the total individuals), 54 species of molluscs (10.05 % of the total individuals), 13 species of echinoderms (17.69 % of total individuals), and one species of nemerteans (0.89 % of total individuals). The other phyla (Phoronida, Foraminifera, Hemichordata, Platyhelminthes, Actinaria and Chordata) were represented by eight species, accounting for 0.32 % of the total individuals. The most abundant phyla from the Kyla Development area are listed in Table 4.10 (Gardline, 2025b).

Within the wider region (KT01 to KT04), a total of 5,783 individuals from the samples taken were analysed. Overall, 179 taxa were recorded; the taxa consisted of 85 annelid species, which dominated the community, accounting for 82.03 % of the total individuals. There were 38 species of arthropods recorded (4.7 % of the total individuals), 36 species of molluscs (4.53 % of the total individuals), nine species of echinoderms (6.74 % of total individuals), and one species of nemerteans (1.07 % of total individuals). The other phyla (Phoronida, Foraminifera, Hemichordata, Platyhelminthes, Actinaria and Chordata) were represented by ten species, accounting for 0.92 % of the total individuals. The most abundant phyla from the wider region are listed in Table 4.11 (Gardline, 2025b).

Table 4.10: Summary of Macrofaunal Analysis within the vicinity of the proposed Kyla Development area (KS01 to KS12; KB01 to KB02) (Gardline, 2025b)

Phylum	Kyla Development Survey [1]			
	Number of Taxa	Composition of Taxa (%)	Abundance	Composition of Individuals (%)
Annelida	111	43.19	15,309	66.97
Echinodermata	13	5.06	4,044	17.69
Mollusca	54	21.01	2,297	10.05
Arthropoda	70	27.24	932	4.08
Nemertea	1	0.39	205	0.89
Other[2]	8	3.11	74	0.32
Total	**257**	**100**	**22,861**	**100**

[1] Kyla Development area survey sampled using a 0.5 mm mesh sieve;
[2] Other phyla included Phoronida, Foraminifera, Hemichordata, Platyhelminthes, Actinaria and Chordata.

Table 4.11: Summary of Macrofaunal Analysis within the wider region surrounding the Kyla Development area (KT01 to KT04) (Gardline, 2025b)

Phylum	Wider Region Survey [1]			
	Number of Taxa	Composition of Taxa (%)	Abundance	Composition of Individuals (%)
Annelida	85	47.49	4,744	82.03
Echinodermata	9	5.03	390	6.74
Arthropoda	38	21.23	272	4.70
Mollusca	36	20.11	262	4.53
Nemertea	1	0.55	62	1.07
Other[2]	10	5.59	53	0.92
Total	**179**	**100**	**5,783**	**100**

[1] Kyla Development wider region sampled using a 0.5 mm mesh sieve;
[2] Other phyla included Phoronida, Foraminifera, Hemichordata, Platyhelminthes, Actinaria and Chordata.

The species identified during the Kyla Development survey, both within the vicinity of the development area (KS01 to KS12; KB01 to KB02) and in the wider region (KT01 to KT04) were ranked in terms of dominance, ranking the taxa has made it possible to examine which were consistently dominant throughout the survey area. The ranking of taxa in terms of abundance and dominance is presented in Table 4.12 (Gardline, 2025b).

Of the top ranked adult taxa, seven were Annelida, two were Mollusca and one each were Echinodermata, Arthropoda and Others (Nemertea). *Paramphinome jeffreysii* was the dominant taxon in both the adult only and full fauna datasets. When including juvenile taxa there were two (Echinoidea and Ophiuroidea) among the top ranking, displacing *Notomastus*, Nemertea and *Lumbrineris aniara agg* (Gardline, 2025b). The top-ranking adult taxa were broadly aligned with those previously recorded within the decommissioned Kyle field, (proposed Kyla field) (Fugro, 2020; CNRI, 2021), indicating that the faunal community remained relatively consistent over time.

Table 4.12: Species Ranking across the Kyla Development Area and the Wider Region (Gardline, 2025b)

Species / Taxon	Phylum	Kyla Development Survey [1]		
		Rank Dominance	Present at No. of Stations (Frequency %)	Rank Abundance
Paramphinome jeffreysii	Annelida	1	18	1
Ampharete falcata	Annelida	2	18	2
Ophiuroidea (juv.)	Echinodermata	3	18	4
Echinoidea (juv.)	Echinodermata	4	18	3
Eclysippe vanelli	Annelida	5	18	6
Axinulus croulinensis	Mollusca	6	18	5
Galathowenia	Annelida	7	16	7
Adontorhina similis	Mollusca	8	18	8
Aricidea (Acmira) catherinae	Annelida	9	18	9
Urothoe elegans	Arthropoda	10	18	13
Ophiocten affinis	Echinodermata	12	16	10

[1] Kyla Development area sampled using a 0.5 mm mesh sieve

Primary and Univariate Analyses

Stations both within the vicinity of the proposed Kyla Development (KS01 to KS12; KB01 to KB02) and within the wider region (KT01 to KT04) presented relatively consistent diversity, dominance and evenness values. Shannon-Wiener diversity values ranged from 2.56 to 4.69, with a mean of 3.60 (Gardline, 2025b). This is slightly lower than the mean value of 4.36 (n=111 replicates) for fauna retained using a 0.5mm sieve in the CNS (UKOOA, 2001) and lower than the mean previously recorded in the Kyla region (Fugro, 2020; CNRI, 2021).

Pielou's evenness suggested the adult community was more even than uneven at most stations, with values ranging from 0.38 to 0.70 with a mean of 0.55 (Gardline, 2025b). The least even communities were recorded at Stations KS07, KT02 to KT04 and KB02, where Pielou's evenness was <0.5 and *P. jeffreysii* accounted for at least 57% of the community. The overall lack of dominance, aside from *P. jeffreysii*, was further supported by the low Simpson's dominance values, which ranged from 0.10 to 0.52, with only Stations KS07, KT02 to KT04 and KB02 recording Simpson's dominance ≥0.3 (Gardline, 2025b). Samples in the current Kyla survey generally exhibited an adult faunal community that was less even and more dominated than the previous surveys at Kyla (Fugro, 2020; CNRI, 2021), and that was reported for the CNS (UKOOA, 2001), reflecting the increased dominance of *P. jeffreysii*.

The number of taxa both within the vicinity of the Kyla Development and within the wider region ranged from 21 to 35 for the adult only dataset, which was lower than the previous survey at Kyla (Fugro, 2020; CNRI, 2021).

Multivariate Analyses

Multivariate analyses were performed on the rationalised data taken from stations both in the Kyla Development area (KS01 to KS12; KB01 to KB02) and within the wider region (KT01 to KT04) using PRIMER v7.

The CLUSTER analysis identified six similarity profile (SIMRPOF) groups comprising one outlier (Station KB01), three closely associated pairs (SIMPROF Groups b, c and d) and two clusters (SIMPROF Groups e and f). All stations joined at a similarity of 59%, showing that stations were more similar than dissimilar. Much of the separation can be attributed to variations within the top ten most dominant taxa, mostly *P. jeffreysii*, *A. falcata* and *Galathowenia* (Gardline, 2025b). With the inclusion of juveniles,

all stations were identically grouped and all stations joined together at a similarity of 59%. The clusters and the stations they encompass are summarised below:

- Cluster A – KB01;
- Cluster B – KS06 and KS12;
- Cluster C – KS01 and KS05;
- Cluster D – KS07 and KB02;
- Cluster E – KS02 to KS04, KS08 to KS11;
- Cluster F – KT01 to KT04 (wider region).

When comparing the adult only macrofaunal community dataset to the physico-chemical data a 70% correlation was identified between the percentage of fines and concentrations of LMW alkanes, pristane, Cu and Li. This result supports the interpretation that the faunal community across the survey area (the Kyla Development area and wider region) varied naturally with physical sediment characteristics and there was no evidence of any anthropogenic impacts associated with chemical variables (Gardline, 2025b).

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 landings and effort data suggests that adult populations of demersal species such as haddock (*Melanogrammus aeglefinus*) and whiting (*Merlangius merlangus*) make up a large proportion of catches in the vicinity of the proposed Kyla Development (SG-MD, 2025). Species diversity within the fish community is not as great in the CNS and northern North Sea as in the SNS, with the exception of some areas of the Scottish coast (Callaway et al. 2002; DESNZ, 2022).

The highest richness of northerly species is found in waters off the north-east of Scotland, including Orkney and Shetland (Daan 2006). Statistical analyses of North Sea fish assemblages using data collected in groundfish surveys (Callaway et al. 2002, Reiss et al. 2010) found that the 50 m depth contour that separates the SNS from the CNS and northern North Sea acts as a boundary between different fish assemblages. Within the CNS, a number of assemblages were identified, with divisions typically occurring at the 100 m depth contour. At depths between 50-100 m, the benthic community was dominated by dab (*Limanda limanda*) and long rough dab (*Hippoglossoides platessoides*). Of species more loosely associated with the seabed, haddock, whiting, herring (*Clupea harengus*) and plaice (*Pleuronectes platessa*) were dominant. At depths of between 100-200m, the community was characterised by long rough dab, hagfish (*Myxine glutinosa*) and Norway pout (*Trisopterus esmarkii*) (DESNZ, 2022).

Spawning and Nursery Grounds

The North-East Atlantic and North Sea is split into statistical grids called ICES Rectangles in order to map statistical information about the area. The proposed development area is located within ICES Rectangle 42F1.

Spawning Grounds

Data from Coull *et al*., 1998 and Ellis *et al.,* 2012 indicates that fish species that use ICES Rectangle 42F1 as spawning grounds include cod (*Gadus morhua*), lemon sole (*Microstomus kitt*), mackerel (high intensity) (*Scomber scombrus*), Norway pout (high intensity), and sandeel (*Ammodytes* spp.) (Table 4.13; Coull *et al*., 1998; Ellis *et al*., 2012b).

However, the Marine Scotland National Marine Plan Interactive (NMPi) Map (2025) illustrates the likely spawning grounds of Atlantic cod, as predicted by González-Irusta and Wright (2016), taking account

of certain environmental influences. This indicates that the proposed Kyla Development area is located in an area which is 'Unfavourable' for spawning cod.

The Marine Scotland NMPi (2025) also illustrates the probability of presence and predicted density of buried sandeels modelled by Langton *et al*. (2021). The proposed Kyla Development area contains habitat that is not suitable for sandeels, with low densities predicted. This was confirmed by analysis carried out following the Kyla survey operations stating that all sediment was 'unsuitable' (Latto et al., 2013; Gardline, 2025a; Gardline, 2025b).

Nursery Grounds

Fish species utilising ICES Rectangle 42F1 for nursery grounds include anglerfish (*Lophius piscatorius*), blue whiting (*Micromesistius potassou*), cod (high intensity), European hake (*Merluccius merluccius*), haddock, herring, ling (*Molva molva*), mackerel, Norway pout, plaice, sandeel, spurdog (also known as spiny dogfish; *Squalus acanthias*), and whiting (*Merlangius merlangus*) (Table 4.13; Coull *et al*., 1998; Ellis *et al*., 2012b).

Juvenile Fish

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., 2012b) 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.

Based on spatial modelling of 0 group fish the proposed Kyla Development area is not considered to be of high importance to 0 group fish, being within an area of moderate probability of 0 group aggregations of anglerfish, European hake, haddock, cod, herring, Norway pout, and whiting and low probability of 0 group aggregations of blue whiting, horse mackerel (*Trachurus trachurus*), mackerel, plaice, sole (*Solea solea*), sprat (*Sprattus sprattus*), and whiting (Figure 4.11 and Figure 4.12; Aires *et al*., 2014). However, 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 (Figure 4.11 and Figure 4.12; Aires *et al.,* 2014).

Table 4.13: Fish Spawning and Nursery Species within the Proposed Kyla Development Area (ICES Rectangles 42F1) (Coull *et al.*, 1998; Ellis *et al.*, 2012; Aires et al., 2014)

Species	J	F	M	A	M	J	J	A	S	O	N	D
Anglerfish	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ
Blue Whiting	N	N	N	N	N	N	N	N	N	N	N	N
Cod	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ
European Hake	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ
Haddock	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ
Herring	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ
Lemon Sole												
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	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ
Plaice	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
Spurdog	N	N	N	N	N	N	N	N	N	N	N	N
Whiting	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ

Key

N = High intensity nursery as per Ellis *et al.*, 2012

Species = High intensity spawning as per Ellis *et al.*, 2012

J = Moderate or higher probability of juvenile fish species as per Aires *et al*., 2014

	Peak Spawning		Spawning	N	Nursery		No Activity

A number of the fish species identified above are listed as Scottish PMFs, including anglerfish, blue whiting, cod, herring, ling, mackerel, Norway pout, sandeels, spurdog and whiting (NatureScot, 2022). Cod and spurdog are on the OSPAR List of Threatened and/or Declining Species and Habitats (OSPAR, 2024). In addition, cod, spurdog and haddock is listed as 'Vulnerable' globally on the International Union for the Conservation of Nature (IUCN) Red List and European populations of spurdog are listed as 'Endangered'. These species should therefore be considered as priorities for protection. All other species identified in Table 4.13 are listed as Least Concern (IUCN, 2025). Of note, 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 (DESNZ, 2022).

Figure 4.10: Fish Spawning and Nursery Areas across the Proposed Kyla Development Area (Coull et al., 1998; Ellis et al., 2012)

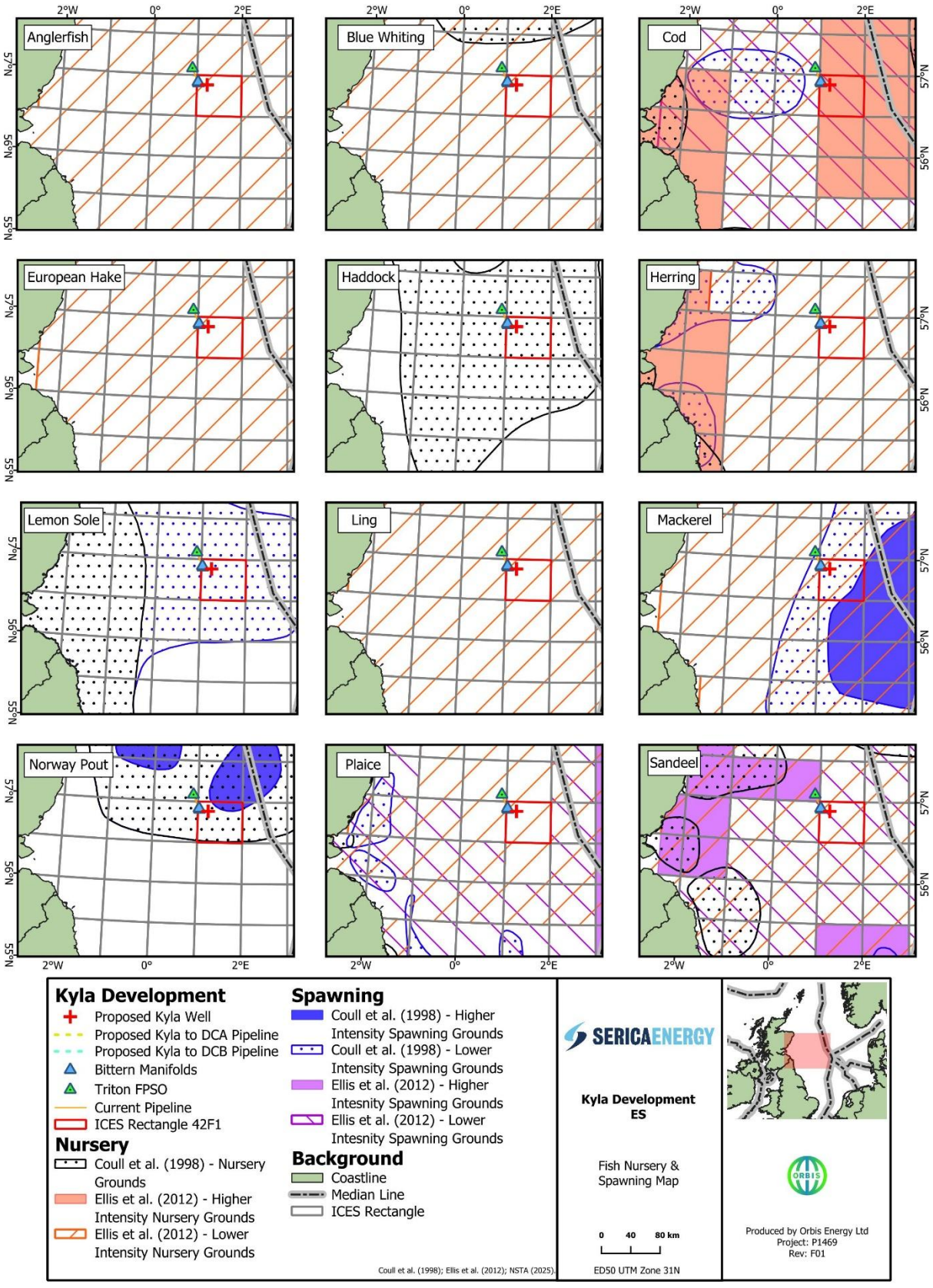


Figure 4.11: Fish Spawning and Nursery Areas across the Proposed Kyla Development Area (Coull et al., 1998; Ellis et al., 2012)

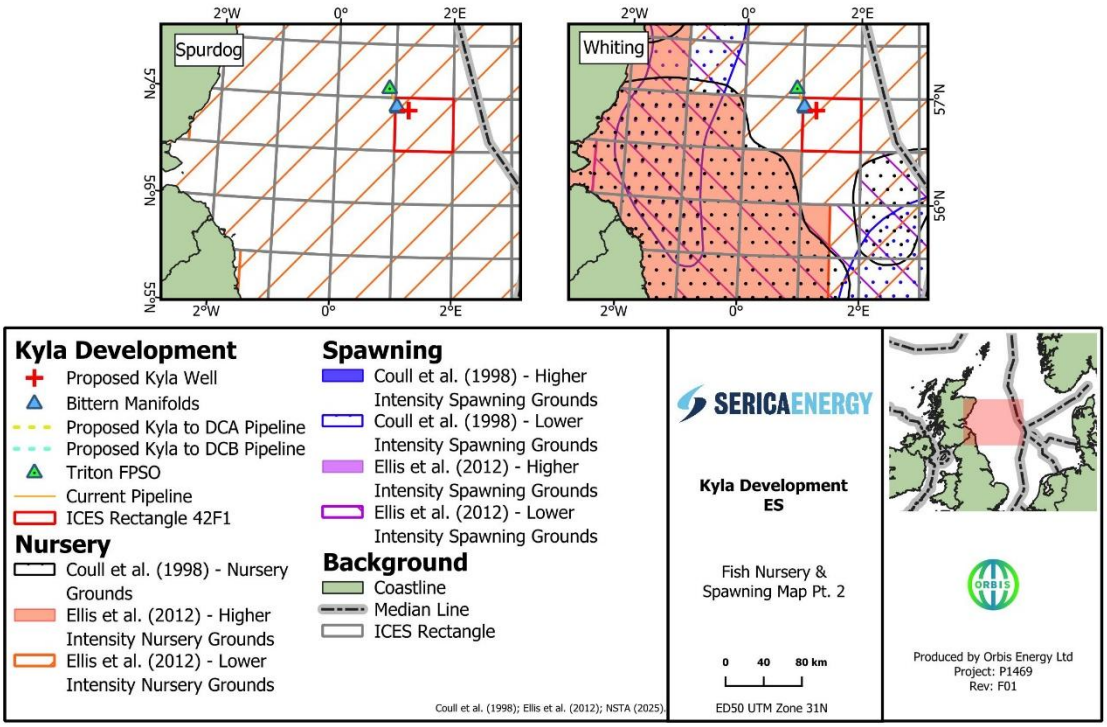
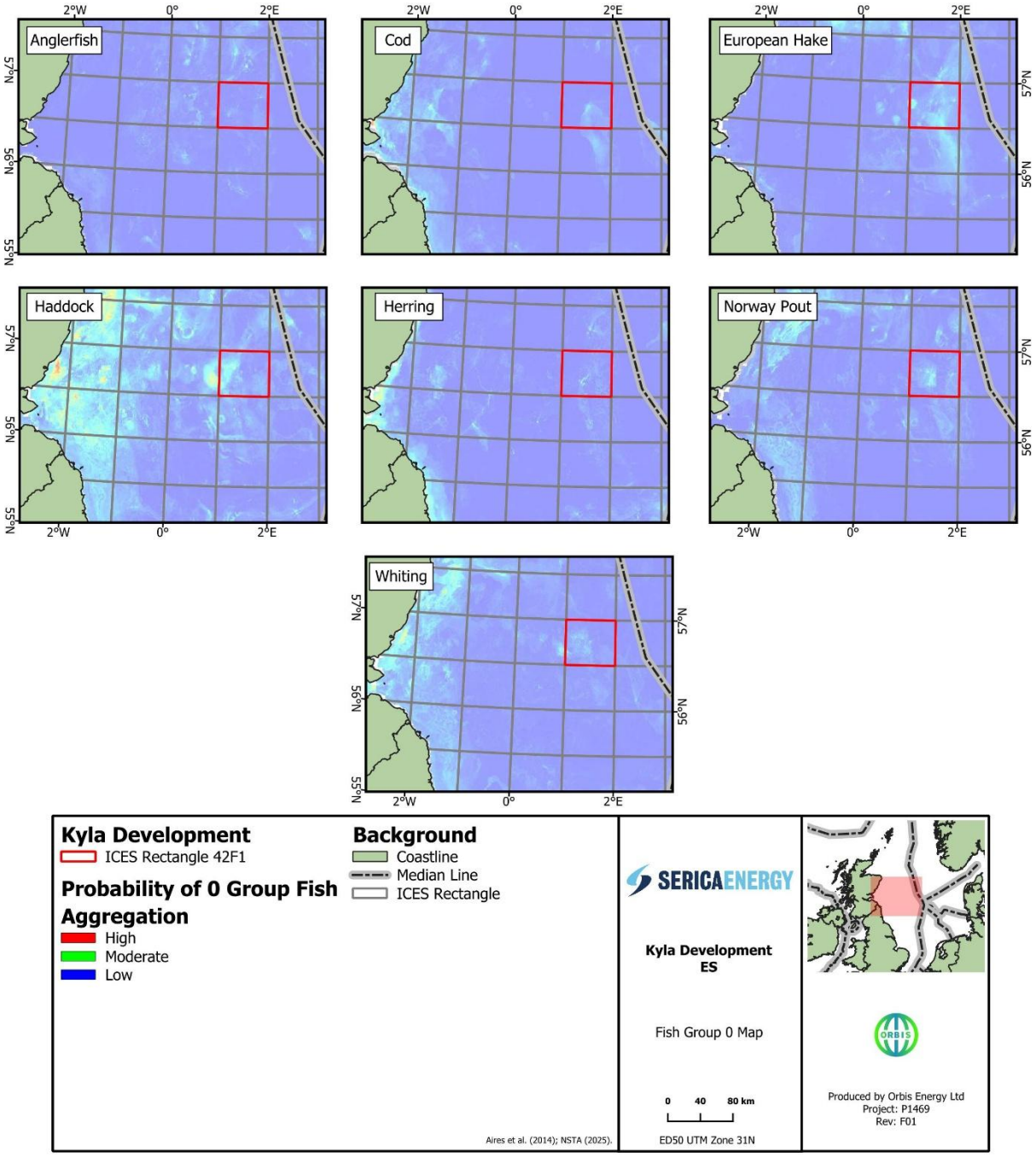


Figure 4.12: Probability of 0 Group Fish Aggregations in the Vicinity of the Kyla Development Area (Aires et al., 2014)



Elasmobranchs

Elasmobranch species (sharks, skates, and rays) are also an important component of the North Sea ecosystem. Elasmobranchs have a low fecundity and slow growth rate, leaving them vulnerable to over-fishing pressures and pollution events, and subsequent recovery of populations in response to disturbance events is low.

A survey of the distribution of elasmobranchs in UK waters was undertaken by Ellis *et al*. in 2004. A total of 26 elasmobranch species were recorded throughout the North Sea and surrounding waters. Species which have been recorded in the CNS at various times throughout the year and may therefore be present in the vicinity of the proposed Kyla Development, are listed in Table 4.14 (Ellis et al., 2004).

Table 4.14: List of Elasmobranch Species Likely to be found in the Vicinity of the Kyla Development (Ellis *et al.,* 2004; IUCN, 2025)

Common Name	Latin Name	Depth Range (m)	Global IUCN Status [N1]	European IUCN Status [N1]
Cuckoo skate	*Leucoraja naevus*	12 - 290	Least Concern	Least Concern
Lesser-spotted dogfish / Small spotted catshark	*Scyliorhinus canicula*	6 - 308	Least Concern	Least Concern
Spurdog / Spiny dogfish	*Squalus acanthias*	15 - 528	Vulnerable	Endangered
Starry ray / Thorny skate	*Amblyraja radiata*	32 - 209	Vulnerable	Least Concern

[N1] Status as of September 2025

Of these species, the spurdog / spiny dogfish is listed as a PMF (NatureScot, 2022). In addition, spurdog / spiny dogfish is also listed on the OSPAR List of Threatened and/or Declining species and habitats (OSPAR, 2024). All the species listed in Table 4.14, excluding starry ray / thorny skate, spurdog / spiny dogfish and European populations of spurdog / spiny dogfish, are of least concern (IUCN, 2025). Spurdog / spiny dogfish and starry ray / thorny skate are of most concern, due to their unfavourable conservation status (IUCN, 2025).

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. The offshore waters of the SNS are visited by seabirds mainly for feeding purposes in and around the shallow sandbanks (DESNZ, 2022). Individuals may originate from the onshore colonies, particularly around the Firth of Forth, or may be migrants through the area.

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. The proposed development area is not located within a hotspot area for seabirds. The predicted at-sea seabird density in the proposed development area is shown in Table 4.16. The data predicts a density of less than two seabirds per km^2 during the breeding season (March – September), increasing to less than four seabirds per km^2 in winter (November – March). The most abundant species present are Fulmar, and Gannet in the breeding season; Fulmar, Guillemot and Kittiwake over winter and Guillemot during the post-breeding dispersal period (JNCC, 2019; Kober *et al*., 2010). Of these species, kittiwake surface feed and shallow dive for fish and shrimp; fulmar surface feed in flocks on fish waste, crustaceans and sand eels; gannets fly high and circle before plunging into the sea to feed on fish (RSPB, 2025). Guillemots are excellent diving seabirds, they can dive to depth of a few hundred metres and feed on fish and crustaceans (RSPB, 2025).

The proposed development area is located approximately 182 km from the nearest UK coast and is therefore remote from sensitive seabird breeding areas. However, based on mean max +1SD foraging ranges reported by Woodward *et al*. (2019), the following species may forage within the proposed development area during the breeding season, which coincides with the proposed development operations: Northern fulmar (*Fulmarus glacialis*) and black-legged kittiwake (*Rissa tridactyla*) (see Table 4.15). Following the breeding season, large numbers of moulting auks, including common guillemot, razorbill (*Alca torda*) and Atlantic puffin disperse from their coastal colonies and into the offshore waters. Kittiwake, Gannet, and Fulmar are also present in sizable numbers during the post breeding season (DESNZ, 2022).

Table 4.15: Seabirds Potentially Foraging in the Proposed Kyla Development Area during the Breeding Bird Season (JNCC, 2025; Woodward *et al*., 2019; Woodward et al., 2024; RSPB, 2025)

Species	Mean Maximum +1SD Foraging Range (km)	Potential Originating Special Protection Area (SPA) / Ramsar	Type of Feeder
Northern Fulmar	542.3±657.9	Fowlsheugh SPA, Buchan Ness to Collieston Coast SPA	Surface
Black-legged kittiwake	156.1±144.5	Fowlsheugh SPA, Buchan Ness to Collieston Coast SPA	Surface

Table 4.16: Predicted At-Sea Seabird Density in the Vicinity of the Proposed Kyla Development Area (UKCS Blocks 29/1 and 29/2) (Number of Individuals per km^2) (JNCC, 2019; Kober et al., 2010)

Species	Season	Predicted Density in the Blocks of Interest [1]												Predicted Density Range Across UK Waters [N1]
		J	F	M	A	M	J	J	A	S	O	N	D	
Fulmar	Breeding			1.12										0 - 582.6
	Winter	3.37							3.37					0 - 239.2
Storm petrel	Breeding						< 0.01							0 - 24.9
Gannet	Breeding					0.50								0 - 110.5
	Winter	0.06									0.06			0 - 24.9
Great skua	Breeding					< 0.01								0 - 1.6
Kittiwake	Breeding					0.26								0 - 185.0
	Winter	1.22									1.22			0 - 306.8
Common gull	Breeding					<0.01								0 - 2.6
Great black-backed gull	Breeding				0.02									0 - 4.8
	Winter	0.19								0.19				0 - 19.5
Herring gull	Winter	0.19								0.19				0 - 101.9
Guillemot	Breeding					0.03								0 - 713.4
	Winter	1.79									1.79			0 - 62.7
	Other								1.02					0 - 254.8
Little auk	Winter	0.10										0.10		0 - 13.4
Razorbill	Winter	0.01									0.01			0 - 15.8
Atlantic Puffin	Breeding				0.23									0 - 162.4
	Winter	0.31							0.31					0 - 0.14

Key (Number of individuals per km^2)

1.0 - ≤ 4.0	0.2 - < 1.0	0.01 - < 0.2	< 0.01	No Occurrence

[N1]: The predicted at-sea seabird density for each seabird species/season was calculated from ESAS transect data using the spatial interpolation technique Poisson kriging (Kober et al., 2010)

The JNCC prepares the latest analysed trends in abundance, productivity, demographic parameters, and diet of breeding seabirds, from the Seabird Monitoring Programme (JNCC, 2023). This data provides at-a-glance UK population trends as a percentage of change in breeding numbers from complete censuses. From the year 2015 to 2021, 25 species were monitored, and there is confidence in the trends of 21 of these species, with 11 of these 21 having declined in population since the 1998-2002 census. Species with declining population trends include Arctic skua (-66%), common gull (-49%), black- legged kittiwake (-42%), northern fulmar (-35%), and great black- backed gull (-40%). Breeding seabird numbers of some species have shown a long-term decline, probably as a result of a shortage of key prey species such as sandeel associated with changes in oceanographic conditions (DESNZ, 2022). This is further exacerbated by fish stock depletion by commercial fisheries, meaning there's not enough food to go around during the important breeding season.

The trend in declining UK seabird populations is also seen in the research comparing the Seabird 2000 consensus with the 2015 - 2021 UK Seabirds Count (Burnell et al., 2023). Britain and Ireland account for 64% to 67% of the global population of great skuas. However, the outbreak of Highly Pathogenic Avian Influenza (HPAI) caused a substantial mortality of great skua during the 2021 and 2022 breeding seasons, with Tremlett et al. (2024) finding a 76% decline in 2023 great skua colony counts, which represents 83% of the UK Seabirds Count population. This resulted in the reclassification of great skuas

from the UK Birds of Conservation Concern (BoCC) 'Amber' to 'Red' list. The effects of HPAI have also contributed to a 7% and 25% decline in the breeding populations of herring gulls and lesser black-backed gulls, respectively, at selected natural nesting sites, based on pre- and post-HPAI counts (Tremlett et al., 2024). The impact of HPAI on their winter populations, however, remains uncertain. Other noteworthy decreases include a 52% drop in common gulls, a 79% decline in Leach's storm-petrels, and a 43% reduction in great black-backed gulls. As a result, five new species have been added to the UK BoCC 'Red' list, indicating they are now at significant risk of local extinction. These species include great skuas, Leach's storm-petrels, common gulls, great black-backed gulls, and Arctic terns. They join the previously listed kittiwakes, herring gulls, roseate terns, Arctic skuas, and puffins, all of which are also highly threatened.

In contrast, the Seabird Monitoring Programme indicates that some species have increasing population trends, including razorbill (+18%) and northern gannet (+38%). Species that remained stable (change within +/- 10%) include common guillemot, common tern, and sandwich tern (JNCC, 2023).

Seabird Sensitivity to Oiling

Seabird populations are particularly vulnerable to surface pollution. The sensitivity of bird species to oil pollution 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. Species considered most sensitive to sea surface pollution are those which spend a great deal of time on the sea surface, for example puffin, guillemot, and razorbill. Species considered to be at lower risk, due to spending less time on the sea surface, include gannet and kittiwake.

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 the proposed Kyla Development and the surrounding blocks indicates that the sensitivity of seabirds to oil pollution is generally low year-round (Table 4.17; Webb *et al*., 2016). For the UKCS Blocks 29/1 and 29/2 where infrastructure is proposed to be installed, sensitivity is low all year round, bar November, where no data was available for any block.

Table 4.17: Seabird Sensitivity to Oiling within the Proposed Kyla Development Area (Webb et al., 2016)

UKCS Blocks	J	F	M	A	M	J	J	A	S	O	N	D
21/30	5	5	5	5	5	5	5	5	5	5	N	5
22/26	5	5	5	5	5	5	5	5	5	5	N	5
22/27	5	5	5	5	5	5	5	5	5	5	N	5
22/28	5	5	5	5	5	5	5	5	5	5	N	5
28/5	5	5	5	5	5	5	5	5	5	5	N	5
29/1	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**N**	**5**
29/2	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**N**	**5**
29/3	5	5	5	5	5	5	5	5	5	5	N	5
28/10	5	5	5	5	5	5	5	5	5	5	N	5
29/6	5	5	5	5	5	5	5	5	5	5	N	5
29/7	5	5	5	5	5	5	5	5	5	5	N	5
29/8	5	5	5	5	5	5	5	5	5	5	N	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 and dark grey indicate the Kyla Development area

4.3.5 Marine Mammals

Cetaceans

Cetacean abundance in the CNS is relatively high compared to the SNS, and broadly in line with the northern North Sea. Twenty-three species of cetacean have been recorded in Scottish waters over the last 25 years. Harbour porpoise (*Phocoena phocoena*) and white-beaked dolphin (*Lagenorhynchus albirostris*) are the most widespread and frequently encountered species, occurring regularly throughout most of the year. Minke whales (*Balaenoptera acutorostrata*) are regularly recorded as frequent seasonal visitors. The coastal waters of the Moray Firth and the east coast of Scotland also support an important population of bottlenose dolphins (Tursiops truncatus), while killer whales (*Orcinus orca*) are sighted with increasing frequency towards the north of the area. Atlantic white-sided dolphin (*Lagenorhynchus acutus*), Risso's dolphin (*Grampus griseus*) and long-finned pilot whale (*Globicephala melas*) can be considered occasional visitors, particularly in the north of the area (DESNZ, 2022).

The UK Statutory Nature Conservation Bodies (SNCBs) have published Marine Mammal Management Units (MMMUs) 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 Management Units (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, 2022). The MUs within which the proposed Kyla Development area is located, along with the corresponding abundance of animals within these units, are presented in Table 4.18 below and Figure 4.13 (IAMMWG, 2022).

Table 4.18: Estimates of Cetacean Abundance in the Relevant MMMUs (IAMMWG, 2022)

Species	Management Unit	Abundance of Animals	95 % Confidence interval	Density [N1]
Bottlenose dolphin	Greater North Sea (639,886 km^2)	2,022	548 – 7,543	0.003
Harbour porpoise	North Sea (678,206 km^2)	346,601	289,498 – 419,967	0.511
Risso's dolphin	Celtic and Greater North Seas (1,560,875 km^2)	12,262	5,227	0.007
Common dolphin		102,656	58,932 – 178,822	0.065
Minke whale		20,118	14,061 – 28,786	0.012
White-beaked dolphin		43,951	28,439 – 67,924	0.028
White-sided dolphin		18,128	6,049 – 54,323	0.011

[N1] Density (individuals per km) was calculated using the total area of the MU and the abundance of animals within that MU

It is evident that harbour porpoise are the most abundant species in the North Sea compared to other species identified in Table 4.18, despite its MMMU being smaller in area than all species, apart from bottlenose dolphin.

The relative abundance and density of cetaceans in the vicinity of the Kyla Development can also be derived from data obtained during the Small Cetacean Abundance of the North Sea (SCANS-IV) aerial and ship-based surveys. This project identified the abundance and density of cetacean species within predefined sectors of the North Sea and North-East Atlantic. The proposed Kyla Development is situated within SCANS-IV Block NS-D in which harbour porpoise, minke whale, fin whale (*Balaenoptera physalus*) and white-beaked dolphin have been recorded (Table 4.19; Gilles et al., 2023).

Table 4.19: Estimated Abundance and Density of Cetaceans in UK Waters from the SCANS IV Aerial Survey Area Block NS-D (Gilles et al., 2023)

Species	SCANS-IV Block 'NS-D'		Total (Aerial Survey Blocks)	
	Abundance	Density [N1]	Abundance	Density [N1]
Harbour Porpoise	38,577	0.5985	409,244	0.279
White-beaked Dolphin	5,149	0.0799	67,138	0.046
Minke Whale	2,702	0.0419	12,417	0.009
Fin Whale	57	0.0009	2,515	0.0017

[N1] Density is the number of animals per km^2

As the SCANS-IV survey area encompasses a relatively large geographical area and is therefore unlikely to accurately reflect the abundance and densities of cetaceans which may be present within the vicinity of the proposed development area, data from the JNCC Atlas of Cetacean Distribution in northwest European Waters has been used to give a more localised indication of the seasonal distribution of cetaceans. The seasonal sightings data for ICES Rectangle 42F1 are summarised in Table 4.20, which indicates that harbour porpoise, common dolphin, minke whale, white beaked dolphin and Atlantic white-sided dolphin have been observed in the area (Reid *et al*., 2003). However, it is important to note that the lack of recorded sightings does not necessarily preclude the presence of a species at a certain time of year. In addition, the highly mobile nature of cetaceans means that species that are found within the area in general may be present at other times of the year.

Table 4.20: Cetacean Sightings in ICES Rectangles 42F1 (Reid *et al.*, 2003)

Species	J	F	M	A	M	J	J	A	S	O	N	D
Common Dolphin												
Harbour Porpoise												
Minke Whale												
White Beaked Dolphin												
White Sided Dolphin												

Key (Number of individuals per hour of sightings effort)								
	High (>100)		Medium (10 – 100)		Low (1 – 10)		Very Low (0 – 1)	No sightings

All cetaceans (whales, dolphins, and porpoises) are listed as European Protected Species (EPS) under Annex IV of the Habitats Directive. Harbour porpoise is also listed on the OSPAR List of Threatened and/or Declining Species (OSPAR, 2024) and harbour porpoise is listed under Annex II of the Habitats Directive. In addition, harbour porpoise, minke whale and white beaked dolphin are listed as PMFs (NatureScot, 2022). All species mentioned are regarded as being of Least Concern in terms of their population threats (IUCN, 2025).

Of note is that there has been a change in the overall conservation status of cetaceans in UK waters from favourable to unknown since 2013. This is due to the implementation of a more robust assessment methodology, supported by updated European Union (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 (DESNZ, 2022).

Multiple studies have been undertaken that aim to predict the future distributions, behaviours and health of cetacean populations (DEFRA, 2024). In general, they note that, in the UK and wider north-west European waters, the main effects of climate change on cetaceans will be:

- Geographical range shifts appear to be occurring, with northward extensions of the range of warmer water species, such as striped dolphin, short-beaked common dolphin, and possible range contractions of cold-water species such as white-beaked dolphin.

- Continued rises in sea temperature could result in a shift in the species composition for cetaceans around the British Isles, with increased biodiversity particularly of subtropical and warm temperate pelagic species.
- Species that traditionally make long-distance seasonal migrations (e.g. most baleen whales) will likely arrive earlier or remain in high latitudes for longer, with increased breeding attempts.
- Ecosystem regime shifts in UK waters may result in lower food availability for a number of marine mammal species, and lead to re-distribution of some regional populations.
- In low latitude, warm water regions, some species have experienced occasional mass die-offs linked to the presence of algal toxins. These may now also be affecting marine mammal species in mid-latitudes, including harbour seals.
- Responses of marine mammals to climate change, both at individual and population levels, remain poorly understood. Predicting future impacts is challenging, and it is currently unrealistic to assess these for specific time horizons beyond the likely continuations of range shifts which are already being observed.

Pinnipeds

Two species of seals; grey seal (*Halichoerus grypus*) and the harbour (or common) seal (*Phoca vitulina*) live and breed in the UK. Grey and harbour seals are both listed under Annex II of the EU Habitats Directive, requiring the designation of Special Areas of Conservation (SACs) in order to protect these species. In addition, harbour and grey seals are protected under the Conservation of Seals Act 1970 (DTI, 2004), and are listed as Scottish PMFs (NatureScot, 2022).

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 (DESNZ, 2022).

Grey Seals

Approximately 70% of the UK population breeds in Scotland, largely in the Western Isles and Orkney (SCOS, 2024). Major colonies are also present on Shetland and along the east coast of Scotland including the Isle of May and Fast Castle. Breeding takes place in the autumn between September and November. Pup production has continued to increase exponentially at colonies in the North Sea; elsewhere, it is stable or increasing (DESNZ, 2022).

Most of the grey seal population will be on land for several weeks from October to December during the pupping and breeding season, and again in February and March during the annual moult. Densities at sea are likely to be lower during this period than at other times of the year. They also haul-out and rest throughout the year between foraging trips to sea (DESNZ, 2022). Studies have shown some mature seals to return year after year to particular breeding sites and foraging season haul-outs (Pomeroy *et al*., 2000; Vincent *et al*., 2005).

Grey seal are generalist feeders, foraging mainly on the seabed at depths up to 100 m, although likely capable to feed at all depths found across the continental shelf (SCOS, 2024). Their foraging movements are on two geographical scales: long and distant trips from one haul-out site to another; and local repeated trips to discrete foraging areas (McConnell *et al*., 1999). Foraging areas can be up to 100 km offshore and connected to haul-out sites by prominent high-usage corridors (Jones *et al*., 2015). As such, the distribution of grey seals in the proposed Kyla Development area is predicted as very low with less than 0.001% of the total seal population present at any given time per 25 km^2 (Figure 4.15; Carter *et al*., 2022)

Harbour Seals

The UK is home to approximately 30% of the European population of harbour seals, with Scotland holding approximately 85% of the UK harbour seal population (SCOS, 2024). Harbour seals are widespread around the west coast of Scotland, throughout the Hebrides and around Shetland and Orkney (SCOS, 2024), 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 *et al*., 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 seals spend a high proportion of time ashore during the pupping and moulting seasons from June to August. Satellite tagging studies have observed that foraging trips around Orkney and Shetland are generally within 40 – 50 km of haul out sites; although 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. Tracking studies indicate the at-sea distribution of harbour seals in the vicinity of the proposed Kyla Development area is very low with less than 0.001% of the total seal population present at any given time per 25 km^2 (Figure 4.15; Carter *et al*., 2022).

Management Units

The UK SNCBs have defined MUs for grey and harbour seals in inshore UK waters in order to provide an understanding of their geographical range, and abundance of their populations, and subpopulations, to aid conservation and management purposes. The proposed Kyla Development is not located within a MU for seals as these are specific to inshore waters (IAMMWG, 2013). However, it is noted that the seaward extent of these MUs is illustrative and not definitive, as seals will cross MU boundaries on a regular basis. Table 4.21 therefore lists the MU for seals which is adjacent to the proposed Kyla Development, along with the corresponding abundance of animals within this unit.

Table 4.21: Population Sizes of Seals in MUs relevant to the Kyla Development Area defined by SCOS (2024)

Species	Management Unit	Seal Count	Estimated UK Population Size	Survey Year
Harbour Seal	East Coast Scotland	276	40,525	2021, 2023
Grey Seal		1,584	168,400	2021, 2023

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 (DESNZ, 2022).

Figure 4.13: Marine Mammal Management Units in the Vicinity of the Proposed Kyla Development (IAMMWG, 2022)

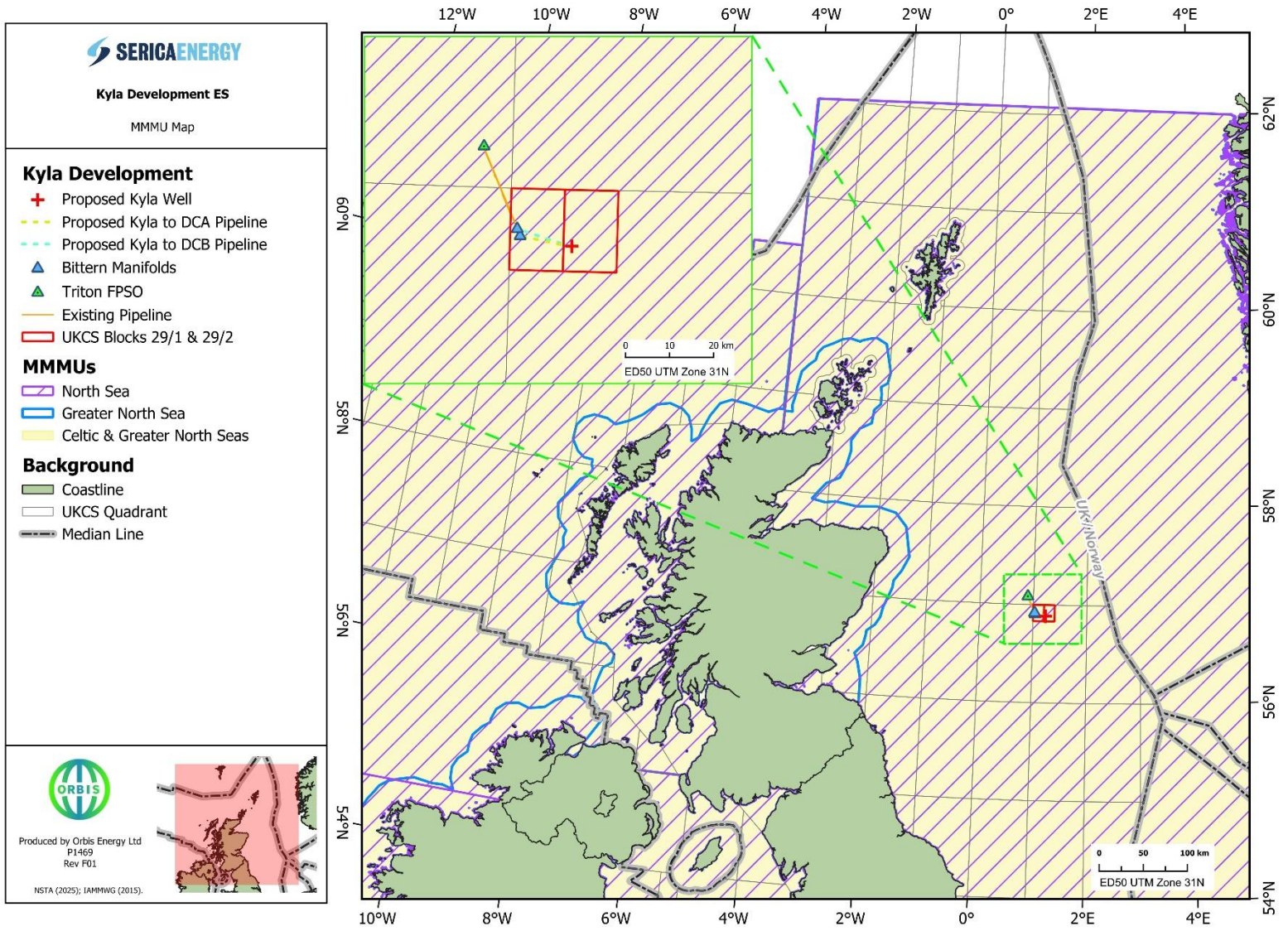


Figure 4.14: SCANS IV Blocks in the Vicinity of the Proposed Kyla Development (Gilles et al., 2023)

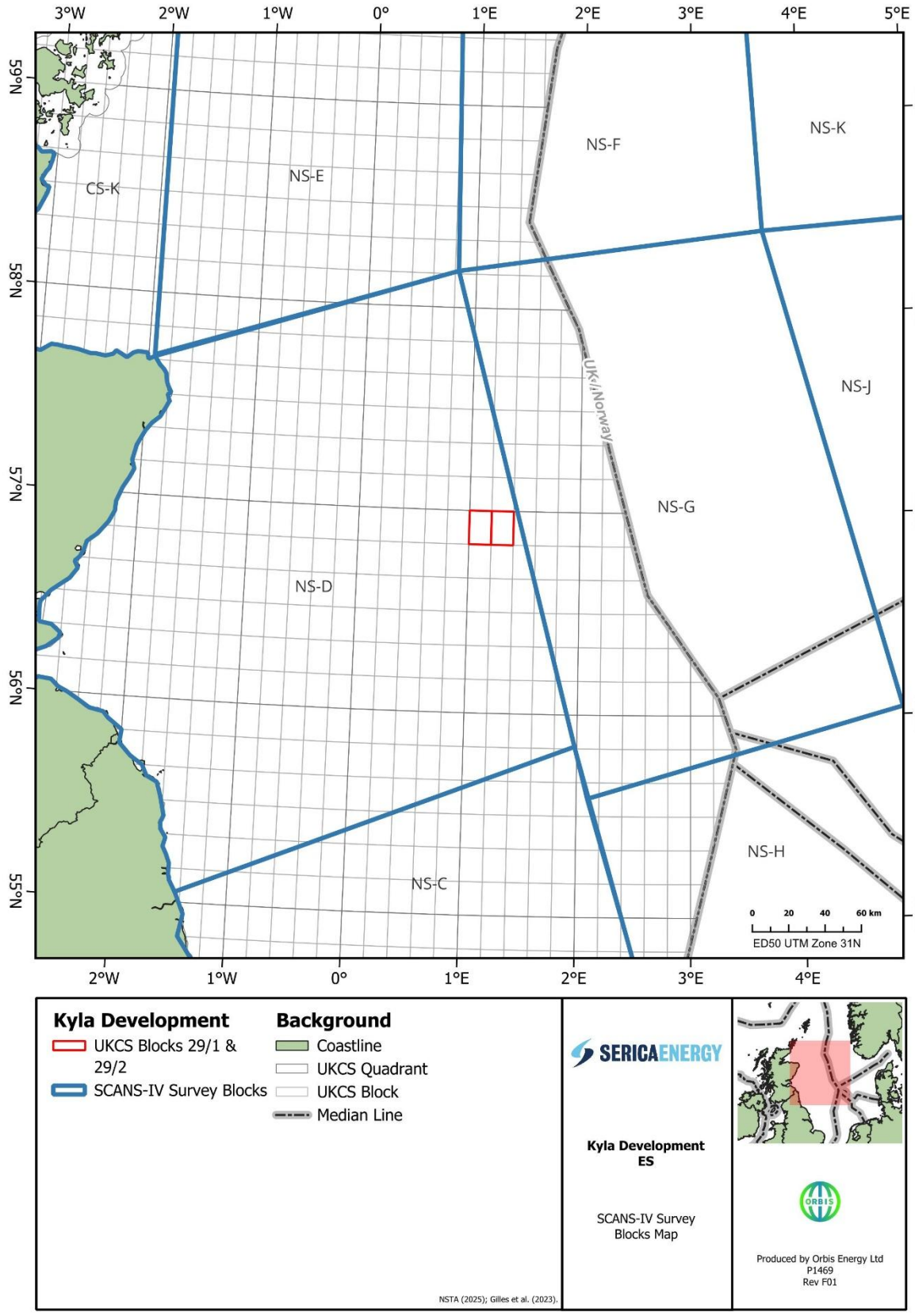
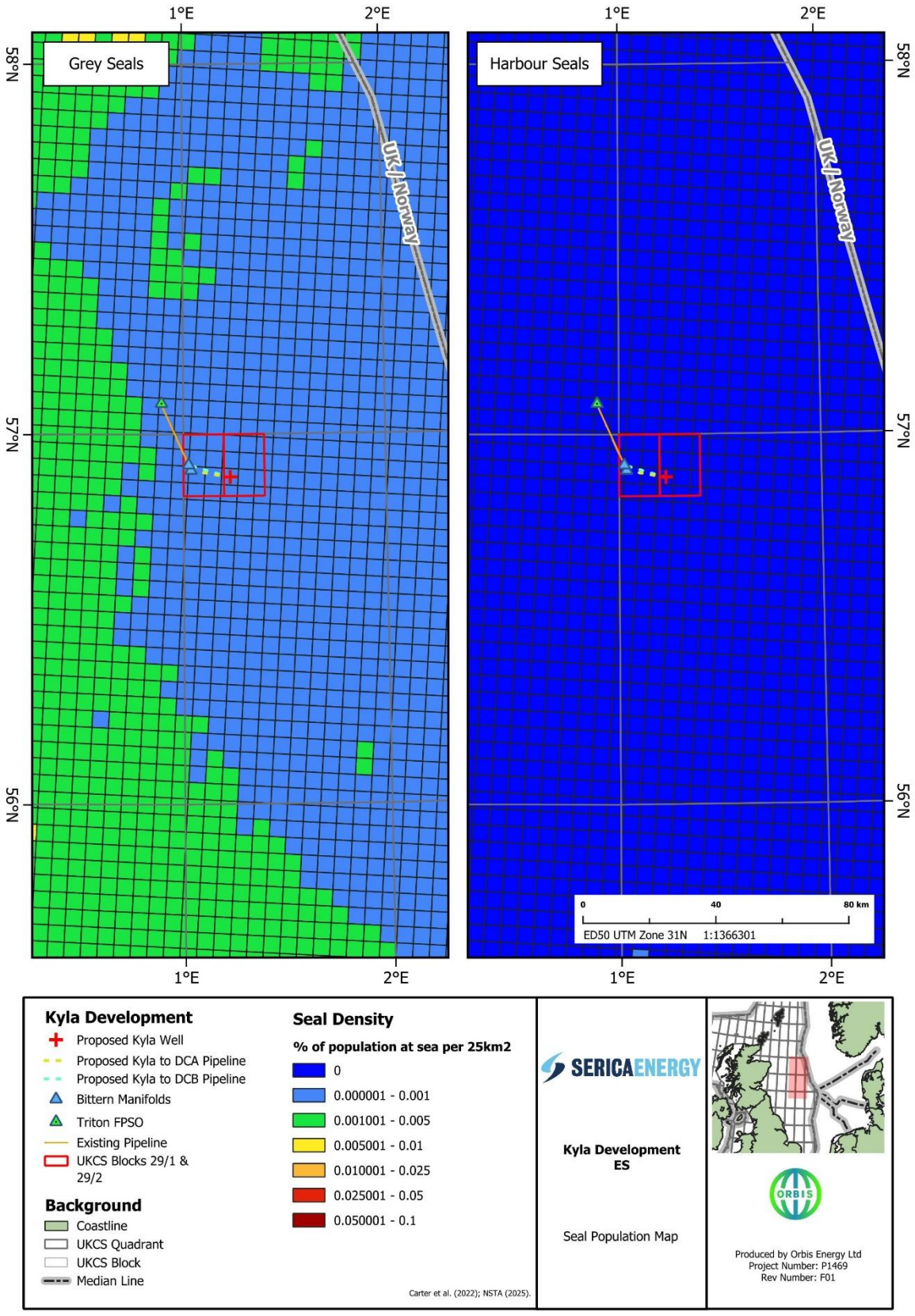


Figure 4.15: Seal Density in the vicinity of the Kyla Development (Carter *et al*., 2022)



4.3.6 Marine Protected Areas

The proposed Kyla Development area is located 13.4 km south of the East of Gannet and Montrose Fields NC MPA, designated for the protection of ocean quahog (*Arctica islandica*) aggregations (JNCC, 2024a). No other MPAs are located within 40 km of the proposed Kyla Development area (Refer to Figure 4.16).

East of Gannet and Montrose Fields NC MPA

The East of Gannet and Montrose Fields NC MPA lies within a relatively shallow sediment plain comprised mainly of sand and gravel habitats that support a range of benthic species. One such species is the ocean quahog (*Arctica islandica*), which is considered Threatened and/or Declining across the North-east Atlantic by the OSPAR Commission. This species of clam is typically found beneath the surface of sandy sediments, in water depths from 4 m to over 400 m. Ocean quahog filter food from passing currents and use their shovel-like 'foot' to bury into the sediment. Ocean quahog are an important food source for several species of fish, including cod, and can live buried deep in the sand for long periods of time without food or oxygen to escape predators. They can live for more than 400 years and are one of the longest living creatures on Earth. The Norwegian Boundary Sediment Plain NC MPA and Firth of Forth Banks Complex NC MPA are also located within the CNS biogeographic region and designated for ocean quahog aggregations, increasing the replication and, therefore, the resilience of this protected feature in the MPA network (JNCC, 2024b).

The MPA also protects the full extent of an area of offshore deep-sea mud. By protecting the full extent of the deep-sea mud in this area, the MPA protects a coherent, rather than fragmented, example of this habitat. This is one of the few examples of Atlantic-influenced offshore deep sea mud habitats on the continental shelf in the region. Furthermore, East of Gannet and Montrose Fields NC MPA is the only MPA designated in the CNS region for the protection of offshore deep-sea muds. The deep-sea muds occur across the south-east half of the MPA, approximately 100 m deep. Ocean quahogs are distributed across the entire site, with the supporting habitat for this feature occurring across the north-west half of the MPA. There is limited evidence of the composition and diversity of the biological communities present in this habitat, but evidence from the monitoring survey in 2015 showed this to be colonised by animals such as seapens.

The conservation objectives of The East of Gannet and Montrose Fields NC MPA are to ensure that the integrity of the site is maintained and that it makes the best possible contribution to maintaining both the Favourable Conservation Status (FCS) of the NC MPA site (JNCC, 2024b).

In the context of the sites change, this will be achieved by ensuring that:

- 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.

With respect to the Offshore deep-sea muds within the NC MPA, this means that:

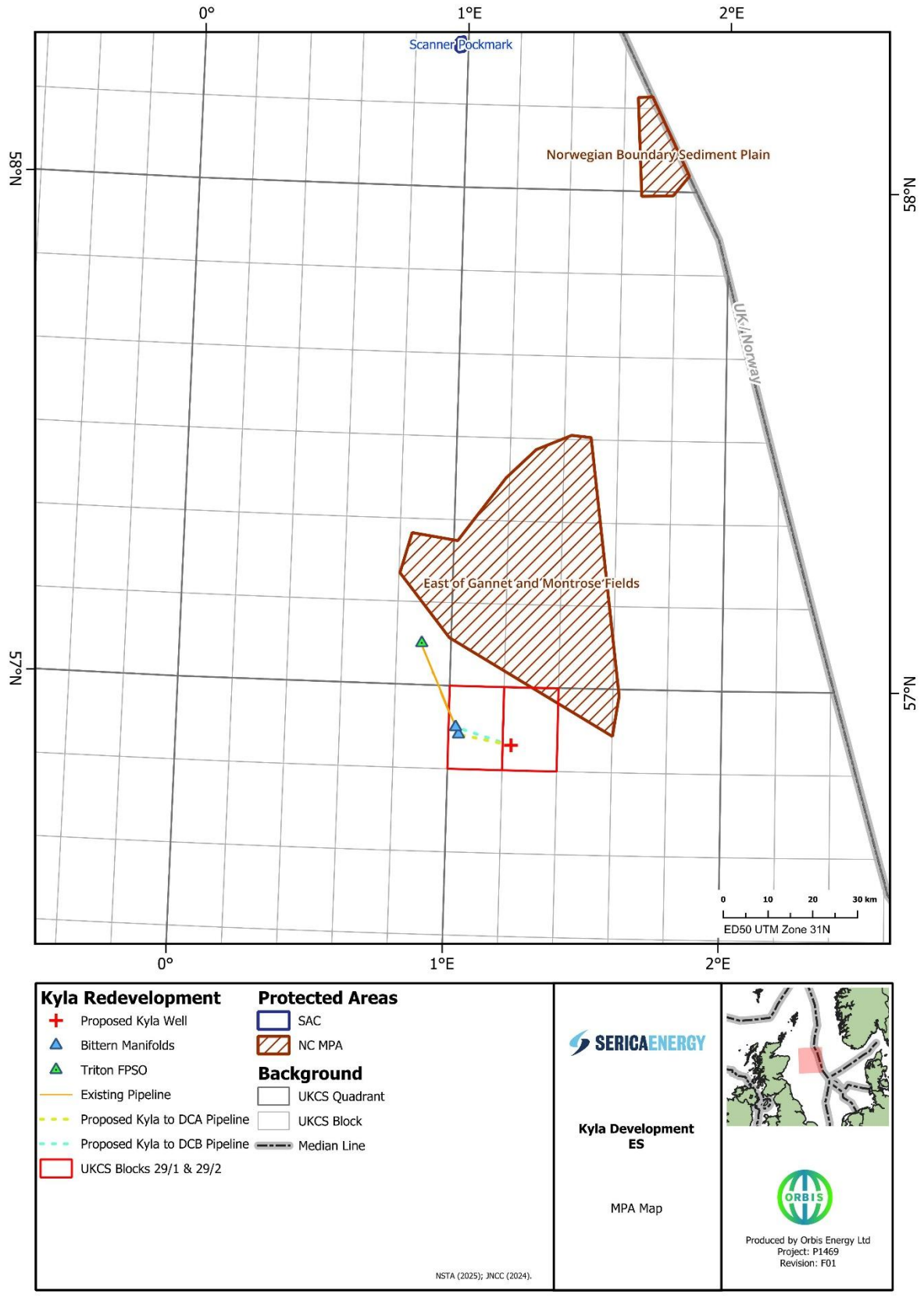
- extent is stable or increasing; and
- structures and functions, quality, and the composition of characteristic biological communities (which includes a reference to the diversity and abundance of species forming part of or living within the habitat) are such as to ensure that they remain in a condition which is healthy and not deteriorating;

With respect to the Ocean quahog aggregations (including supporting sedimentary habitats) within the NC MPA:

- This means that the quality and quantity of its habitat and the composition of its population in terms of number, age and sex ratio are such as to ensure that the population is maintained in numbers which enable it to thrive.

Any temporary deterioration in condition is to be disregarded if the habitat is sufficiently healthy and resilient to enable its recovery from such deterioration. Any alteration to that feature brought about entirely by natural processes is to be disregarded.

Figure 4.16: MPAs within the Vicinity of the Kyla Development (JNCC, 2024; NSTA, 2025c)



4.4 Human Environment

4.4.1 Commercial Fisheries

The North Sea has important fishing grounds and is fished throughout by UK and international fishing fleets, targeting a mix of demersal, shellfish and pelagic fish stocks.

As previously noted, the proposed development area is located within ICES Rectangle 42F1. The SG-MD provides landings data, including the live weight (tonnes) and value of sea fish by UK vessels into the UK and abroad, and landings into the UK by foreign vessels with a primary focus on Scottish waters. The data for ICES Rectangle 42F1 is shown in Table 4.24, Table 4.25, Table 4.26 and Table 4.27 (Marine Scotland, 2015; Marine Scotland, 2020; SG-MD, 2025).

Fishing Landings

Table 4.24 and Table 4.26 summarise monthly fisheries landings data (live weight and sales value, respectively) from ICES Rectangle 42F1 over a ten year period from 2015 to 2024. Across the ten year period, the live weight landings fluctuate, but, on average were highest in January at 56.92 tonnes and lowest in April at 7.78 tonnes. The most commonly fished months were January and June, landings were reported in these months for 7 out of the 10 years in Table 4.24. The mean sales value also fluctuates, but were highest in January at £188,955.46, and lowest in April at £18,041.93.

Table 4.25 and Table 4.27 summarise the fisheries landings data (live weight and sales value, respectively), from ICES Rectangle 42F1 for a ten year period from 2015 to 2024 by species type. It can be seen from this that shellfish fisheries dominate the landings data from ICES Rectangle 42F1, with *Nephrops norvegicus* the first greatest component in terms of value and in terms of weight (tonnes) of the fishery (see Table 4.22 and Table 4.23). The total live weight and sales value fluctuates over the ten year period, with the highest value recorded in terms of weight in 2016 at 604.14 tonnes and in terms of value in 2023 at £1,505,781.44. The lowest values recorded in terms of weight in 2015 at 149.55 tonnes and in terms of value in 2015 at £391,673.89 respectively.

Table 4.22: Catch Composition by Weight (tonnes) between 2015 and 2024 within ICES Rectangle 42F1 (Marine Scotland, 2015; Marine Scotland, 2020; SG-MD, 2025)

Number	Average Quantity (tonnes)	Species
1	208.23	*Nephrops* (Norway Lobster)
2	75.43	Herring
3	33.39	Haddock
4	23.57	Whiting
5	16.19	Monks or Anglers
6	9.74	Gurnards - Grey
7	6.78	Witch
8	6.23	Plaice
9	6.07	Lemon Sole
10	3.28	Squid

Table 4.23: Catch Composition by Value (£) between 2015 and 2024 within ICES Rectangle 42F1 (Marine Scotland, 2015; Marine Scotland, 2020; SG-MD, 2025)

Number	Average Value (£)	Species
1	820,563.48	*Nephrops* (Norway Lobster)
2	44,644.64	Monks or Anglers
3	36,731.25	Herring
4	18,917.69	Halibut
5	17,932.60	Haddock
6	16,909.69	Whiting
7	14,545.78	Lemon Sole

Number	Average Value (£)	Species
8	10,726.58	Squid
9	7,180.15	Witch
10	5,051.07	Plaice

Fishing Effort

Table 4.28 summarises the fishing effort (days) in ICES Rectangle 42F1 during the 2015-2024 period. It can be seen that fishing effort within ICES Rectangle 42F1 is low, with an average annual effort of 304 days recorded per year. January is the month with the highest effort on average for any given year, and January, May and August are the most consistent months within the period an average effort of 55, 32 and 30 days respectively. There is a net increase since 2015 in terms of days fished within 42F1. The data features a lot of disclosive identifiers 'D', which further indicates a low level of fishing activity where data has been disclosed (Marine Scotland, 2015; Marine Scotland, 2020; SG-MD, 2025; Table 4.28).

Within ICES Rectangle 42F1 the most popular gear used to target fisheries is trawls, these accounted for 100% of the effort within the period between 2015-2024 records. Traps are also recorded as being utilised in 42F1, however the data is disclosive for all years, which further indicates a low level of fishing activity using this gear type (Marine Scotland, 2015; Marine Scotland, 2020; SG-MD, 2025).

In addition, fishing vessel density data shows that within the Kyla Development area the annual average hours per km^2 is very low (< 0.3) (EMODnet, 2024; Figure 4.18).

Table 4.24: Total Monthly Fishing Landings (by live weight) by Vessels between 2015 and 2024 within ICES Rectangle 42F1 (Marine Scotland, 2015; Marine Scotland, 2020; SG-MD, 2025)

Month	42F1 - Fishing Landings (tonnes)										
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Mean
Jan	D	D	32.05	84.32	52.07	35.62	D	136.69	191.64	36.83	56.92
Feb	-	D	D	4.18	27.42	11.04	16.11	D	13.48	26.02	9.82
Mar	D	67.24	-	D	46.08	D	D	D	D	3.34	11.67
Apr	12.78	D	D	D	18.98	D	36.74	D	-	9.32	7.78
May	15.25	87.38	D	D	D	D	D	142.96	21.13	5.8	27.25
Jun	14.43	73.19	43.14	4.44	D	D	159.97	43.97	14.21	D	35.33
Jul	-	D	D	D	11.51	D	D	D	93.96	24.51	13.0
Aug	-	D	93.64	53.7	25.63	201.03	D	D	14.03	1.94	39.0
Sept	34.57	111.98	D	D	30.77	-	D	D	3.02	45.6	22.59
Oct	31.0	D	D	D	D	D	27.7	D	39.33	70.75	16.88
Nov	29.29	10.62	D	D	69.04	20.46	D	D	74.2	122.0	32.56
Dec	D	91.07	D	D	25.44	19.55	18.28	38.06	33.78	D	22.62

Note: '-' = no data, 'D' = Disclosive data (indicating very low effort).

Table 4.25: Weight of landings (by species type) for ICES Rectangle 42F1 between 2015 and 2024 (Marine Scotland, 2015; Marine Scotland, 2020; SG-MD, 2025)

Species	42F1 - Fishing Landings (tonnes)									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Demersal	66.48	153.27	67.32	53.24	99.69	71.04	77.98	110.17	230.9	175.42
Pelagic	0.33	214.99	1.34	26.55	0.42	5.22	0.21	0.13	0.11	0.03
Shellfish	82.73	235.88	140.28	115.12	242.47	281.17	284.35	308.16	267.83	175.65
Total	**149.55**	**604.14**	**208.93**	**194.91**	**342.57**	**357.43**	**362.54**	**418.46**	**498.84**	**351.09**

Table 4.26: Total Monthly Fishing Landings (by value) by Vessels between 2015 and 2024 within ICES Rectangle 42F1 (Marine Scotland, 2015; Marine Scotland, 2020; SG-MD, 2025)

Month	42F1 - Fishing Landings (value in £)										
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Mean
Jan	D	D	104,921.57	303,565	150,217.21	91,357.59	D	479,796.82	653,588.02	106,108.35	188,955.46
Feb	-	D	D	6,798.52	64,107.80	33,153.11	42,873.48	D	36,196.30	100,810.53	28,393.97
Mar	D	174,218.84	-	D	121,988.87	D	D	D	D	10,099.48	30,360.72
Apr	20,653.03	D	D	D	58,170.28	D	81,305.19	D	-	20,290.77	18,041.93
May	36,098.75	244,807.22	D	D	D	D	D	555,811.18	71,541.04	14,482.92	92,274.11
Jun	28,626.28	42,450.29	143,022.75	13,072.01	D	D	450,188.80	173,067.40	67,000.36	D	91,742.79
Jul	-	D	D	D	36,585.05	D	D	D	252,455.39	83,552.79	37,259.32
Aug	-	D	331,044.66	93,270.51	80,157.27	432,963.49	D	D	47,931.85	5,623.01	99,099.08
Sept	101,735.30	371,298.29	D	D	77,574.27	-	D	D	2,958.61	128,530.20	68,209.67
Oct	88,463.38	D	D	D	D	D	75,945.40	D	117,396.21	257,847.81	53,965.28
Nov	86,449.73	45,621.06	D	D	214,341.51	46,602.09	D	D	196,053.54	323,857.00	91,292.49
Dec	D	369,974.52	D	D	78,004.36	46,904.79	56,197.91	105,718.02	60,631.68	D	71,743.13

Note: '-' = no data, 'D' = Disclosive data (indicating very low effort).

Table 4.27: Value of landings (by species type) for ICES Rectangle 42F1 between 2015 and 2024 (Marine Scotland, 2015; Marine Scotland, 2020; SG-MD, 2025)

Species	42F1 - Fishing Landings (value in £)									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Demersal	70,310.57	202,600.63	112,475.13	75,048.65	121,310.86	90,698.83	113,785.69	168,681.63	255,694.95	168,839.08
Pelagic	361.60	104,582.01	1,301.12	10,620.06	349.20	2,916.63	255.86	197.00	128.95	0.14
Shellfish	321,001.72	1,080,619.90	602,734.50	484,343.95	842,305.49	689,308.50	857,272.56	1,319,680.57	1,249,957.54	890,962.60
Total	**391,673.89**	**1,387,802.54**	**716,510.75**	**570,012.66**	**963,965.55**	**782,923.96**	**971,314.11**	**1,488,559.20**	**1,505,781.44**	**1,059,801.82**

Table 4.28: Number of Days Fished per Month (All Gears) in ICES Rectangles 42F1 from 2015-2024 (Marine Scotland, 2015; Marine Scotland, 2020; SG-MD, 2025)

ICES Rectangle 42F1													
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total [N1]
2024	41	33	7	10	4	D	26	4	29	65	65	D	287
2023	160	6	D	D	31	18	93	11	7	47	61	20	456
2022	102	D	D	D	139	23	17	D	D	9	D	23	352
2021	22	6		28	14	126	D	9	34	24	10	11	289
2020	27	18	16	D	D	D	D	129		D	25	9	265
2019	45	9	42	24	D	D	23	D	18	23	42	17	251
2018	98	11	D	D	D	D	D	42	D	D	D	31	210
2017	51	D	D	D	D	43	34	72	D	D	D	D	222
2016	D	D	100	15	94	10	14	47	101	8	18	99	512
2015	D		D	D	14	20			39	37	51	D	195

Note: Monthly fishing effort by UK vessels landing into Scotland: Blank = no data, D = Disclosive data (indicating very low effort),

[N1] Includes any days that cannot be disclosed in the monthly figures

green = 0-100 days fished, yellow = 101-200, orange =201-300, red = ≥301

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) and shellfish fisheries (crab, lobster, scallops and squid). For the proposed Kyla Development area, Figure 4.17 shows that there is a low intensity of demersal fisheries (mobile and static gears), crab fisheries, lobster fisheries, mackerel fisheries, scallop fisheries and squid fisheries; and a moderate intensity of *Nephrops norvegicus* fisheries (mobile gears) and herring fisheries in the vicinity of the proposed Kyla Development (Kafas *et al*., 2012).

Figure 4.17: Fishing Intensity in the Vicinity of the Proposed Kyla Development (Kafas et al., 2012)

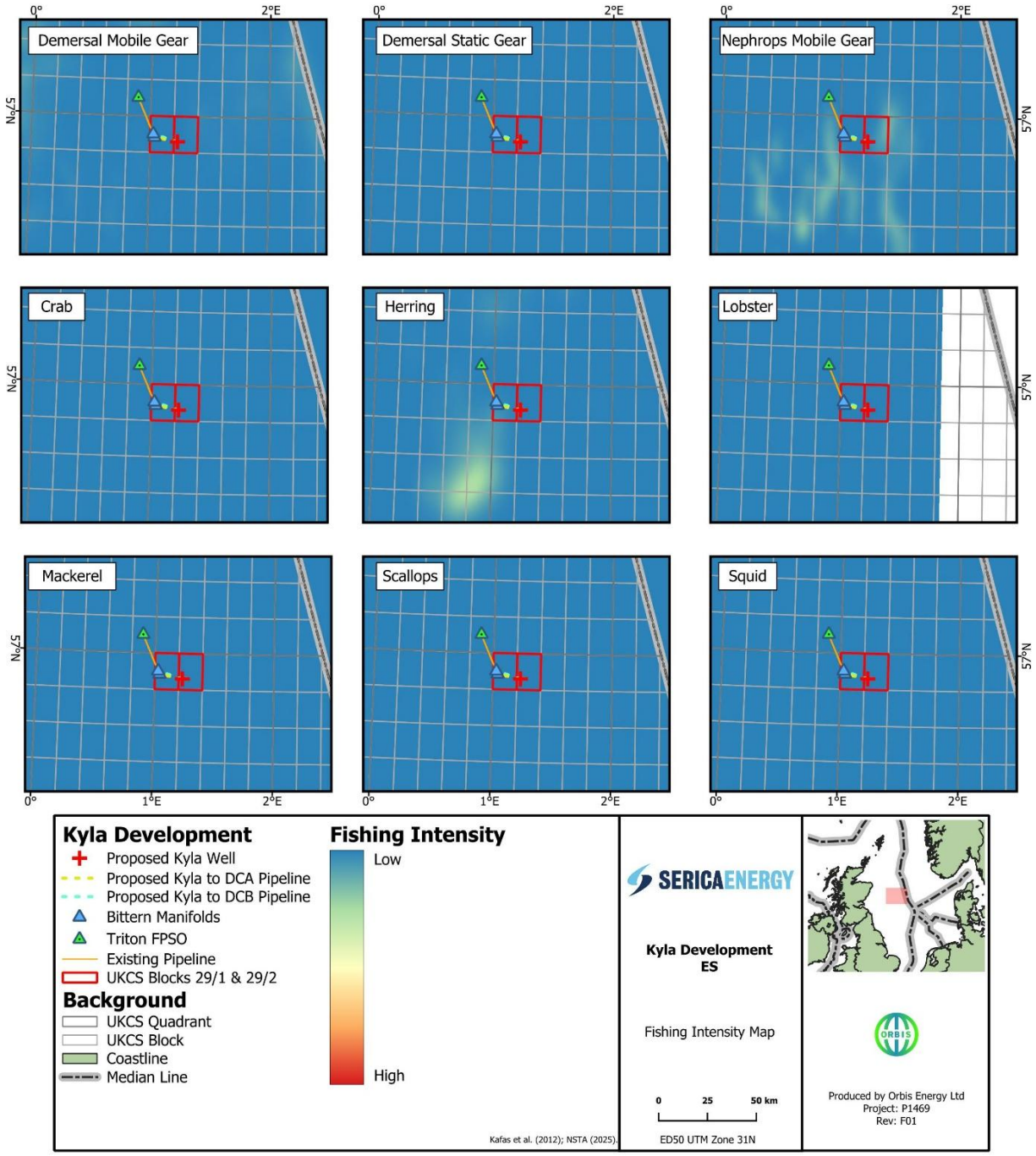
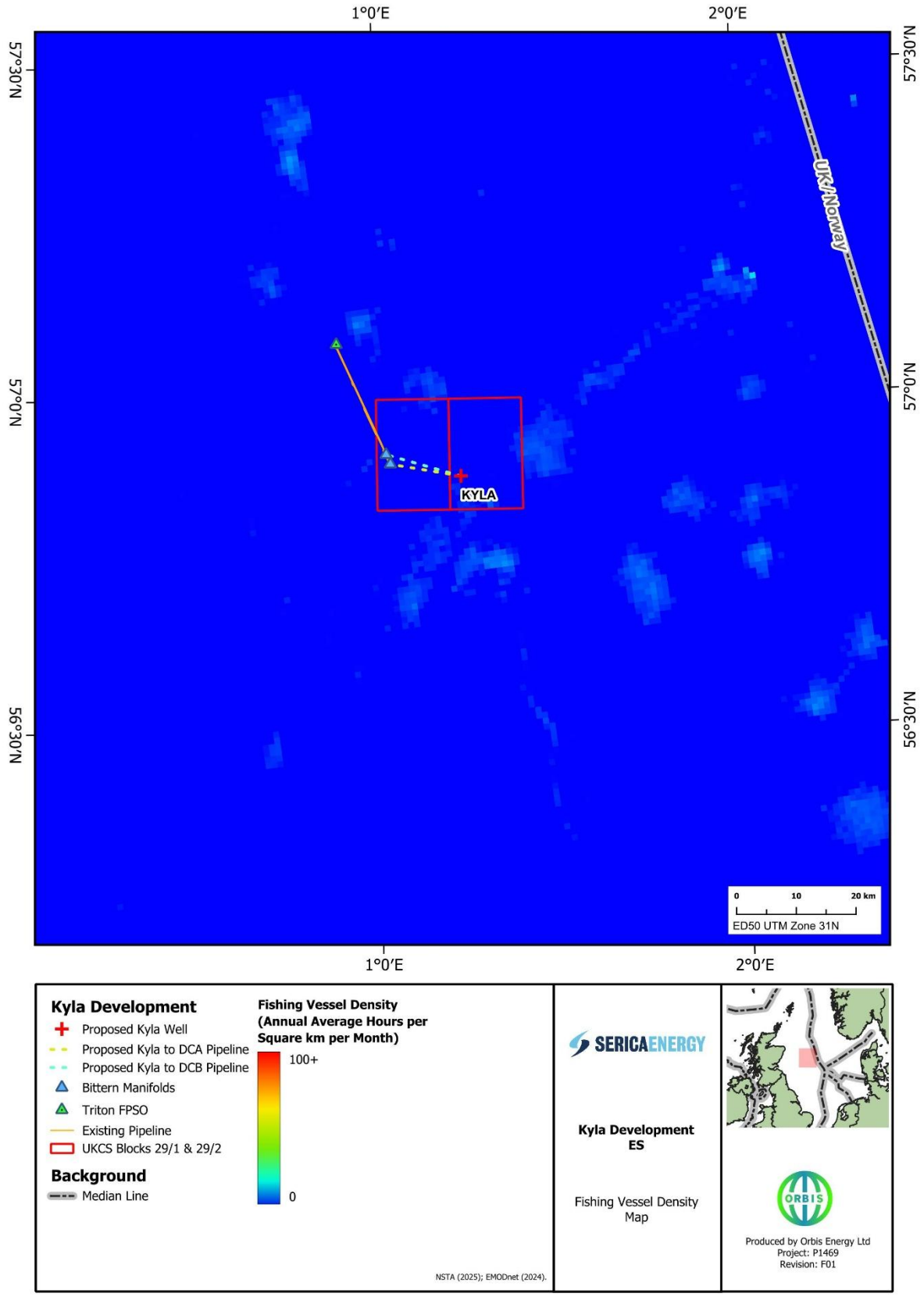


Figure 4.18: Fishing Vessel Density in the Vicinity of the Proposed Kyla Development (EMODnet, 2024)



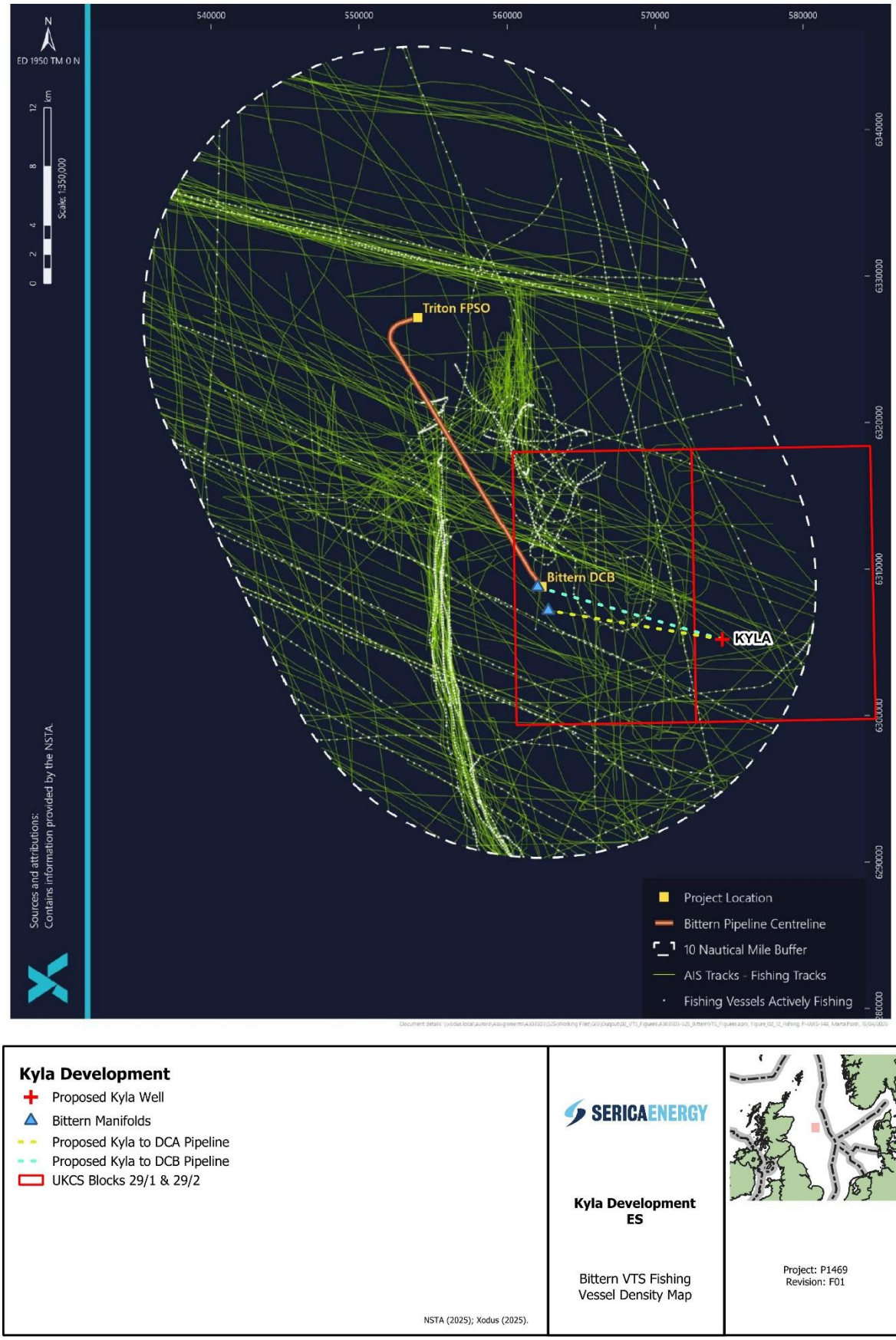
Regional Fishing Intensity Study

A vessel traffic survey focused on the Bittern to Triton FPSO pipeline was previously conducted; this study is focussed on a 10 nautical mile (NM) radius zone around the pipeline (Xodus, 2025). As the proposed Kyla well location and proposed pipeline route sit within this 10 NM boundary from Bittern (the proposed Kyla well is ca. 6.4 NM from the Bittern manifolds and pipeline), the results of this survey are applicable to the proposed Kyla Development.

Figure 4.19 shows vessel tracks from all fishing vessels identified within the 10 NM study area. It should be noted that the presence of fishing vessels does not necessarily indicate the presence of fishing activity in the study area and may represent vessels in transit.

There were 262 tracks associated with fishing vessels in the study area. Figure 4.19 shows the distribution of fishing tracks in the area. Fishing activity is relatively low across the study area, although fishing patterns are visible on both sides of the Bittern pipeline and across it. There is evidence of active fishing along two main routes: one north of the Triton FPSO (located ca. 20 km from the proposed Kyla Development), running west to east, and another originating in the southern part of the study area, moving northward to intersect the Bittern to Triton FPSO pipeline approximately 5.5 km south of the Triton FPSO (Xodus, 2025).

Figure 4.19: Fishing activity within Bittern Pipeline 10 NM study area (Xodus, 2025)



4.4.2 Aquaculture and Shellfish Water Protected Areas

There are no aquaculture sites or shellfish protected areas within the vicinity of the proposed Kyla Development due to the large distance from the nearest coastline at Peterhead (184 km) (NMPI, 2025).

4.4.3 Shipping

The density of shipping traffic in the CNS is relatively high due to the presence of fishing vessels, some ferries between the UK and the rest of Europe and cargo and offshore support vessels (DESNZ, 2022). Within UKCS Blocks 29/1 and 29/2 (i.e. the Blocks encompassing the proposed Kyla drill centre and Kyla to Bittern pipeline route) shipping activity is considered to be low, with EMODnet (2024) showing a generally low vessel density, with discrete higher densities areas associated with existing oil and gas infrastructure (OGA, 2016; EMODnet, 2024).

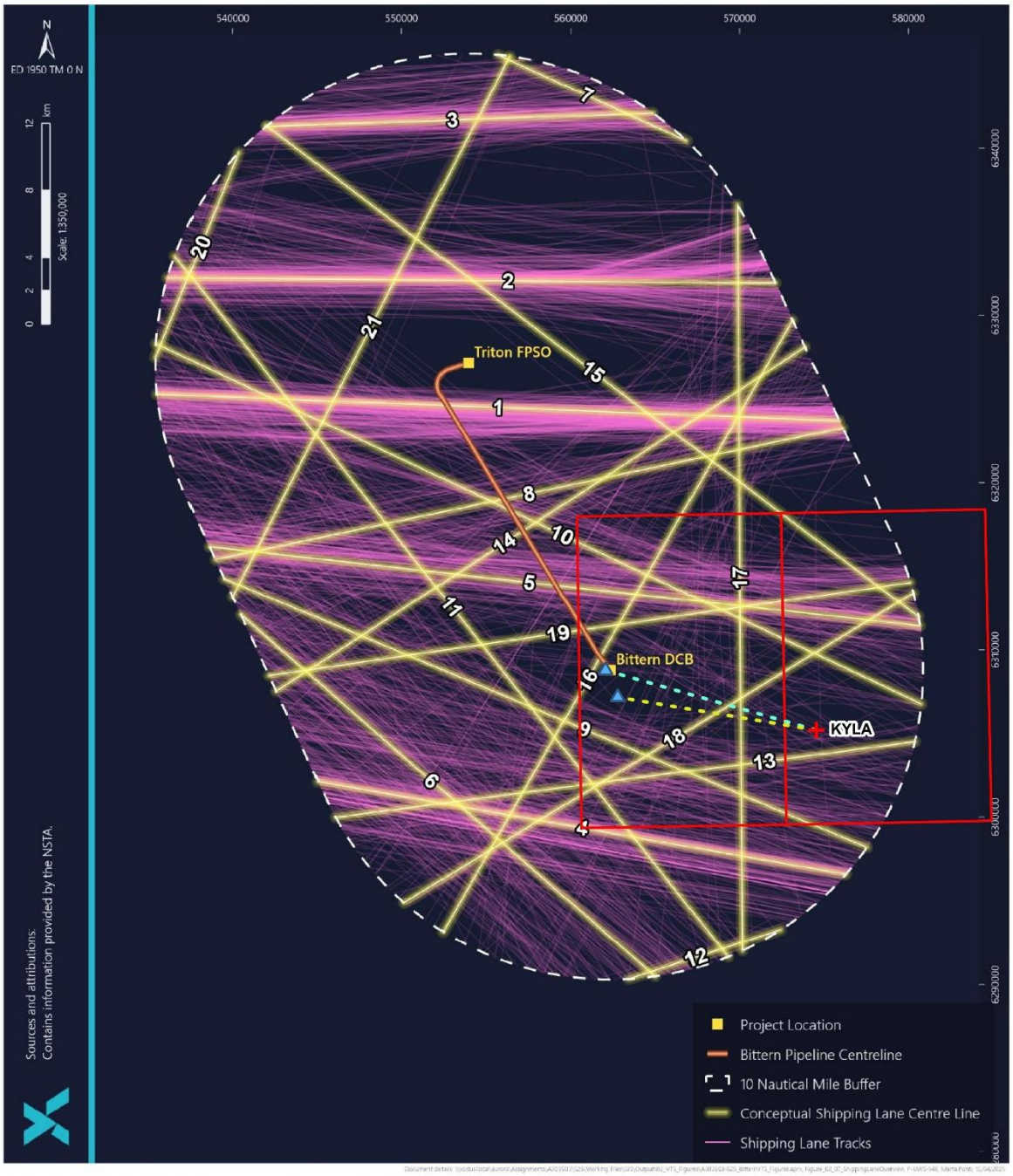
A vessel traffic survey has recently been conducted for the Bittern development project (Xodus, 2025). This study focussed on a 10 NM) radius zone surrounding the proposed Bittern to Tritton pipeline route. As the proposed Kyla Development infrastructure sits within this 10 NM boundary (the proposed Kyla well is ca. 6.4 NM from the Bittern manifolds and pipeline), the results of this survey are applicable to this assessment.

Figure 4.20 illustrates the shipping lanes identified within 10 NM of the Bittern to Triton pipeline. It should be noted that vessels within a given lane may have different ports of origin / destination, while sharing a common routing pattern within the study area, and as such, behave as a single conceptual lane at the closest point of approach to the asset (Xodus, 2025).

There were 21 shipping lanes in total identified within 10 NM of the Bittern pipeline. Across all shipping lanes within 10 NM of the Bittern pipeline, the most frequent port of origin was Aberdeen (Scotland) with 1,390 tracks (67.9% of all shipping lane tracks) marking this as their previous port. The most frequent destination port was also Aberdeen, with 1,405 tracks (68.6% of all shipping lane tracks) with this as their next port (Xodus, 2025). Within the combined 10 NM study area, the AIS vessel tracks data was filtered to routine traffic only. Routine traffic typically includes cargo vessels, tankers and other vessels but excludes fishing vessels, military operations, tugs, dredgers, pleasure craft and sailing vessels. The study area contains a total of 4,058 routine vessel tracks associated with 440 different vessels, which corresponds to an estimated 11.1 vessel transits per day. These indicate moderate, consistent traffic, with a clear west–east transit pattern across the area. Additionally, there are clusters of activity around the Bittern infrastructure, Triton FPSO, and just west of the Gannet A platform (see Figure 4.21; Xodus, 2025).

Shipping lane and in-field traffic (defined as vessels operating within the hydrocarbon field complex) contribute almost equally to the routine traffic in the study area, with shipping lane traffic accounting for 50.4% and in-field traffic for 49.6% of the total. This similar proportion of in-field and shipping lane traffic suggests that the region has a moderate level of both active surface infrastructure and international shipping activity. Amongst shipping lane traffic, cargo vessel traffic accounts for 6.8% of all routine vessel tracks while tanker vessel traffic in the study area were significantly lower, at 0.8% (Xodus, 2025).

Figure 4.20: Theoretical centre lines of shipping lanes within 10 NM of the Bittern pipeline (Xodus, 2025)



Kyla Development

- Proposed Kyla Well
- Bittern Manifolds

Proposed Pipeline Routes

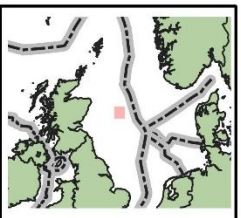
- Proposed Kyla to DCA Pipeline
- Proposed Kyla to DCB Pipeline
- UKCS Blocks 29/1 & 29/2

NSTA (2025); Xodus (2025).

SERICAENERGY

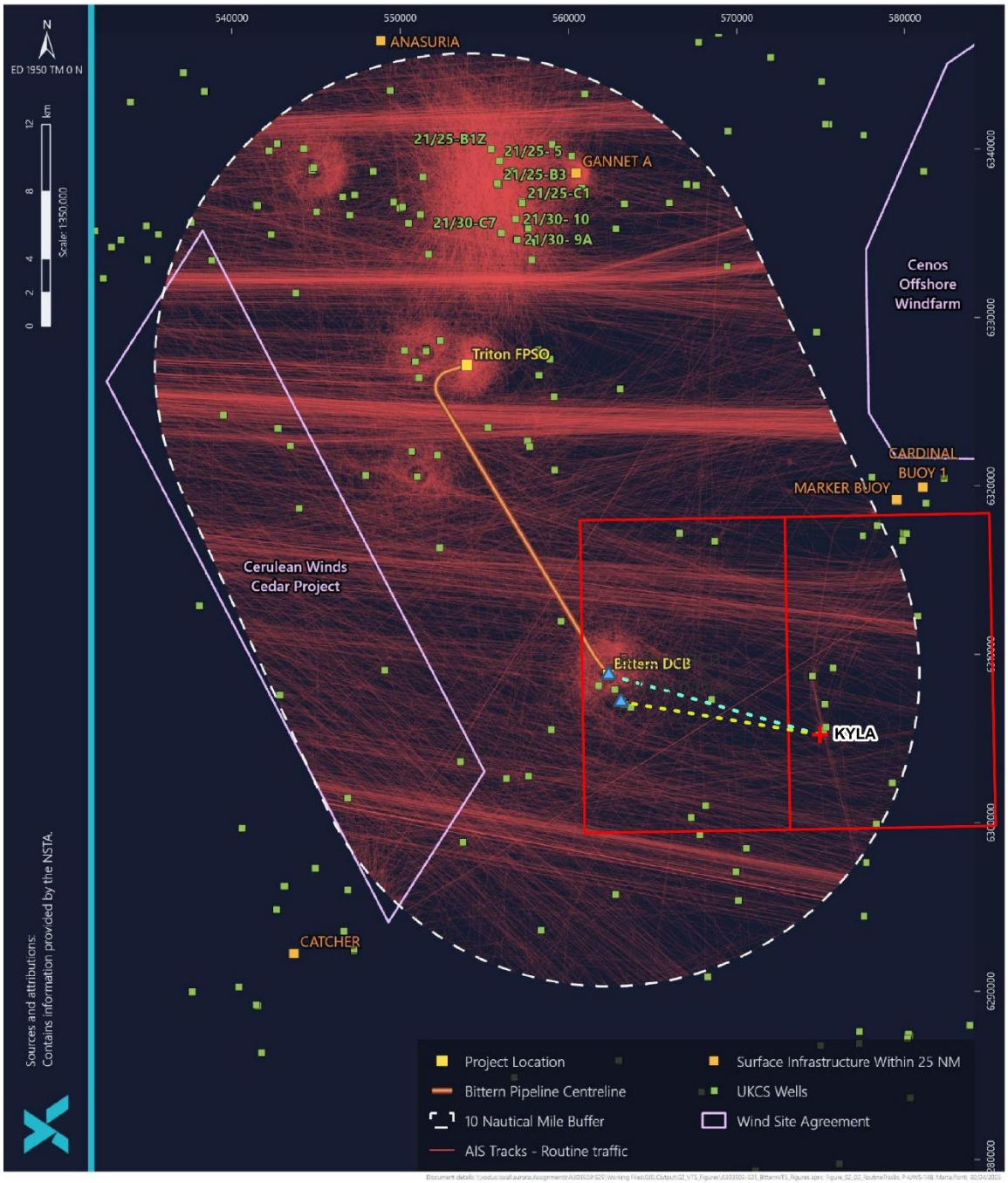
Kyla Development ES

Bittern VTS Shipping Route Map



Project: P1469
Revision: F01

Figure 4.21: Routine vessel tracks within 10 NM of the Bittern pipeline (Xodus, 2025)



Kyla Development

- Proposed Kyla Well
- Bittern Manifolds

Proposed Pipeline Routes

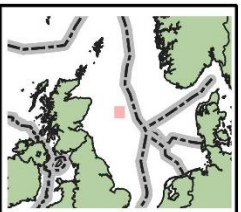
- Proposed Kyla to DCA Pipeline
- Proposed Kyla to DCB Pipeline
- UKCS Blocks 29/1 & 29/2

NSTA (2025); Xodus (2025).

SERICAENERGY

Kyla Development ES

Bittern VTS Routine Vessel Tracks Map



Project: P1469
Revision: F01

4.4.4 Offshore Oil and Gas Activity

The proposed Kyla Development will tie-back to the Bittern Manifold (DCA or DCB) located approximately 12 to 14 km west of the proposed Kyla well location, which produces to the Triton FPSO. Dana operates the subsea and surface infrastructure relating to this export route.

As discussed in Section 1.1, the original Kyle field development was decommissioned in 2020. A multibeam echosounder geophysical survey of the Kyle field undertaken as part of the pre-decommissioning survey scope did not identify a discernible physical cuttings pile. The historic cuttings piles are believed to have dispersed and now lie flush with the seabed. However, seabed samples taken during the survey of the area show a chemical footprint (elevated THC levels) covering an area of 1,432 m^2 (CNRI, 2021). The proposed Kyla well is located ca. 0.30 km southwest of the K12 well, 0.33 km southwest of the K15 well and over 3 km south southeast of the K13 and K14 wells (NSTA, 2025c). All stations sampled during the 2025 Kyla survey display THC concentrations consistent with the wider area (background concentrations), however, concentrations of Ba can were found to be above the background levels for the area (refer to Section 4.2.2) (Gardline, 2025b).

Apart from Bittern, the closest producing field to Kyla is the Starling subsea gas field (operated by Shell UK), located in UKCS Block 29/3a approximately 12 km to the northeast, which is tied back to the Shearwater platform (NSTA, 2025c).

The nearest FPSO is the Triton FPSO (operated by Dana) which is located approximately 20 km northwest of the Bittern DCB manifold and 30 km northwest of the proposed Kyla well. The next nearest FPSO is the Catcher FPSO (operated by BW Offshore) which is located approximately 24 km southwest of the Bittern DCA manifold (NSTA, 2025c).

The nearest platform to the Bittern DCB manifold is the Gannet A platform (operated by Adura) located approximately 30 km north. The nearest platform to the proposed Kyla well is the West Franklin WHP (operated by Total Energies) which is located approximately 36 km northeast (NSTA, 2025).

The Belinda field is located approximately 14 km north of the Bittern DCB manifold and 24 km northwest of the proposed Kyla well (NSTA, 2025c).

Two active pipelines cross with the proposed Kyla pipeline route, the CATS pipeline (PL774) operated by the Wood Group and the Langeled pipeline (PL2071) operated by GASSCO AS (NSTA, 2025).

There are 30 wells within 5 km of the proposed Kyla Development infrastructure. Of these, 9 are appraisal wells, 17 are development and 4 are exploration. Of the 30 wells, 22 are Abandoned (4 Abandoned Phase 1; 18 Abandoned Phase 3), 7 are Completed (Operating) and 1 is plugged (NSTA, 2025c).

Table 4.29: Well Information for wells within 1 km from the Kyla Development (NSTA, 2025c)

Operator	OGA Well Origin Wellbore Name	Well Origin Spud Date	Spud Completion Date	Original Well Intent	Current Status	Water Depth (m)	Distance to Proposed Kyla Development (km)
CNR International (U.K.) Limited	29/02c- 12	21/07/1998	13/08/1998	Appraisal	Abandoned Phase 3	91.14	0.30
CNR International (U.K.) Limited	29/02c-12J	17/07/1998	21/07/1998	Appraisal	Abandoned Phase 3	91.14	0.30
CNR International (U.K.) Limited	29/02c-12Z	13/08/1998	04/10/1998	Appraisal	Abandoned Phase 3	91.14	0.30
CNR International (U.K.) Limited	29/02c- 15	19/04/2002	03/07/2002	Development	Abandoned Phase 3	91.14	0.33
CNR International (U.K.) Limited	29/02c- 8	04/07/1993	29/08/1993	Exploration	Abandoned Phase 3	92.05	0.53
CNR International (U.K.) Limited	29/02c- 8Z	06/09/1993	11/11/1993	Appraisal	Abandoned Phase 3	92.05	0.53
Dana Petroleum (E&P) Limited	29/01b- B6	12/05/2024	16/07/2024	Development	Completed (Operating)	92.66	0.01
Dana Petroleum (E&P) Limited	29/01b- B5	18/09/2020	13/10/2020	Development	Completed (Operating)	92.96	0.01
Dana Petroleum (E&P) Limited	29/01b-B4Z	26/09/2006	20/01/2010	Development	Abandoned Phase 1	92.66	0.07
Dana Petroleum (E&P) Limited	29/01b-B4Y	20/01/2010	15/02/2010	Development	Completed (Operating)	92.66	0.07
Dana Petroleum (E&P) Limited	29/01b- B4	02/09/2006	26/09/2006	Development	Abandoned Phase 1	92.66	0.07
Dana Petroleum (E&P) Limited	29/01b- B3	28/04/1998	12/07/1999	Development	Completed (Operating)	92.66	0.05
Dana Petroleum (E&P) Limited	29/01b- B2	24/04/1998	02/07/1999	Development	Abandoned Phase 1	92.96	0.01
Dana Petroleum (E&P) Limited	29/01b- B1	20/04/1998	17/06/1999	Development	Plugged	92.66	0.02

Operator	OGA Well Origin Wellbore Name	Well Origin Spud Date	Spud Completion Date	Original Well Intent	Current Status	Water Depth (m)	Distance to Proposed Kyla Development (km)
Dana Petroleum (E&P) Limited	29/01b- 5	14/05/1996	14/07/1996	Exploration	Abandoned Phase 3	92.96	0.89
Hess Limited	29/01b- 2	03/04/1986	22/04/1986	Exploration	Abandoned Phase 3	89.31	0.22
Serica Energy Mistral Limited	29/01a-A3Z	02/12/2010	19/12/2010	Development	Completed (Operating)	92.66	0.02
Serica Energy Mistral Limited	29/01a-A3	07/09/1998	02/12/2010	Development	Abandoned Phase 1	92.66	0.02
Serica Energy Mistral Limited	29/01a-A2	03/09/1998	11/01/1999	Development	Completed (Operating)	92.66	0.1
Serica Energy Mistral Limited	29/01a-A1	29/08/1998	03/03/1999	Development	Completed (Operating)	92.96	0.1
Serica Energy Mistral Limited	29/01a- 8	31/07/1997	05/09/1997	Appraisal	Abandoned Phase 3	92.96	0.11
Serica Energy Mistral Limited	29/01a- 7	01/10/1996	04/11/1996	Appraisal	Abandoned Phase 3	92.35	0.25

4.4.5 Renewable Energy, Carbon Capture & Storage and Subsea Cables

The nearest submarine cable to the proposed Kyla Development is the North Sea Link North power cable, operated by the National Grid, located approximately 7.28 km south east from the proposed Kyla Development at its nearest point (see Figure 4.23; KIS-ORCA, 2025).

There are currently no carbon storage licensing blocks or carbon storage licensing round blocks on offer in the vicinity of the proposed development area (Crown Estate Scotland, 2025; NMPi, 2025). The nearest site is CNS Area 2, located approximately 135 km north of the Kyla Development area.

There are no operational, under construction or consented offshore windfarms in the vicinity of the proposed Kyla Development area. The closest offshore windfarm is the Cerulean Winds Cedar Project, currently in the pre-planning stage, located approximately 9.5 km southwest of the Kyla Development (Crown Estate Scotland, 2025). The next closest windfarm is the Cenos Offshore Wind Farm, currently in the planning stage, which would be located approximately 15.5 km northeast of the Kyla Development. Both of these proposed wind farm projects are Innovation and Targeted Oil and Gas (INTOG) offshore wind projects (Crown Estates Scotland, 2025).

4.4.6 Aggregate Dredging and Disposal Activity

There are no dredging or aggregate activities in the vicinity of the proposed Kyla Development area (Crown Estate Scotland, 2025).

Figure 4.22: Oil and Gas Infrastructure in the Vicinity of the Proposed Kyla Development (NSTA, 2025c)

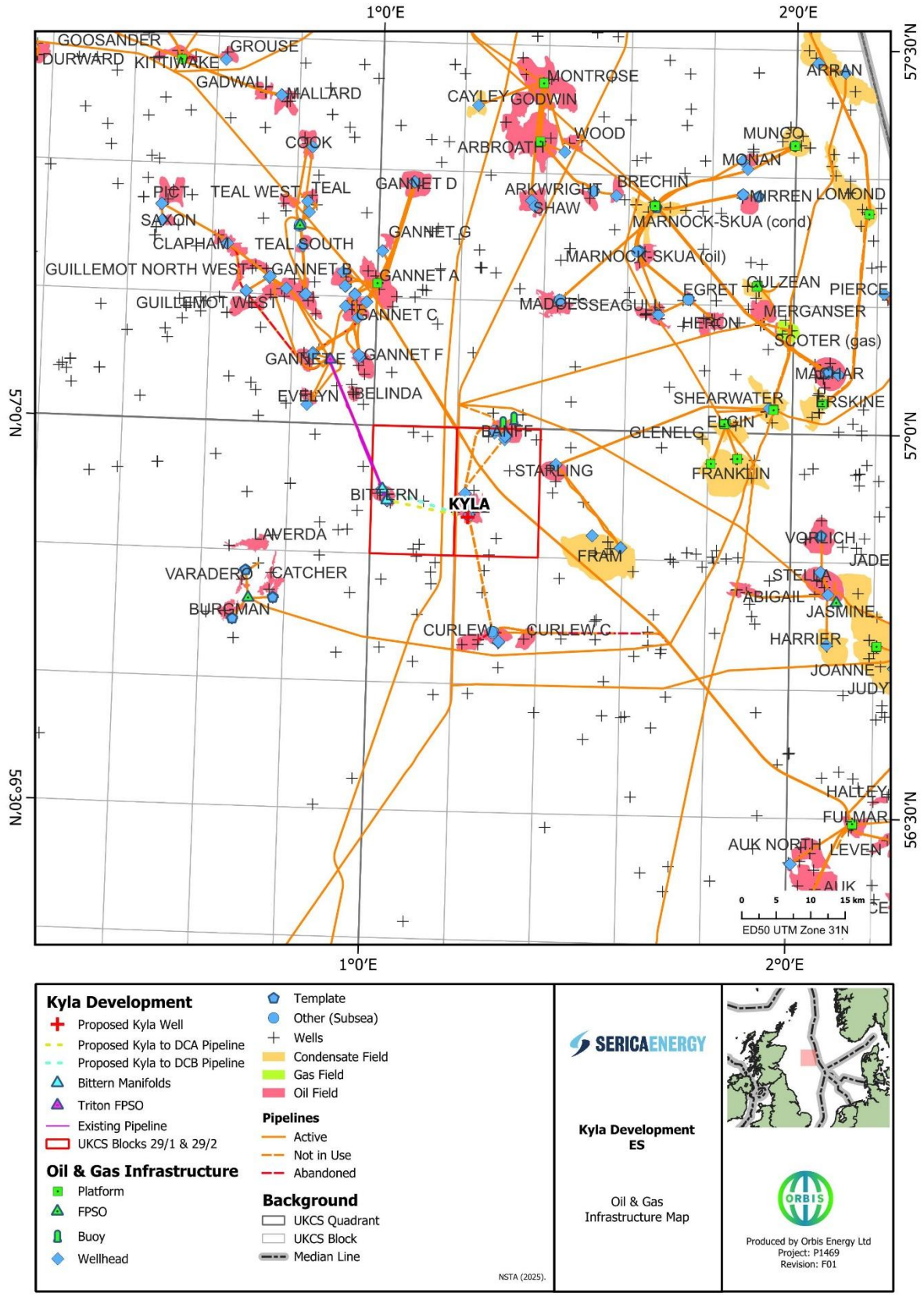
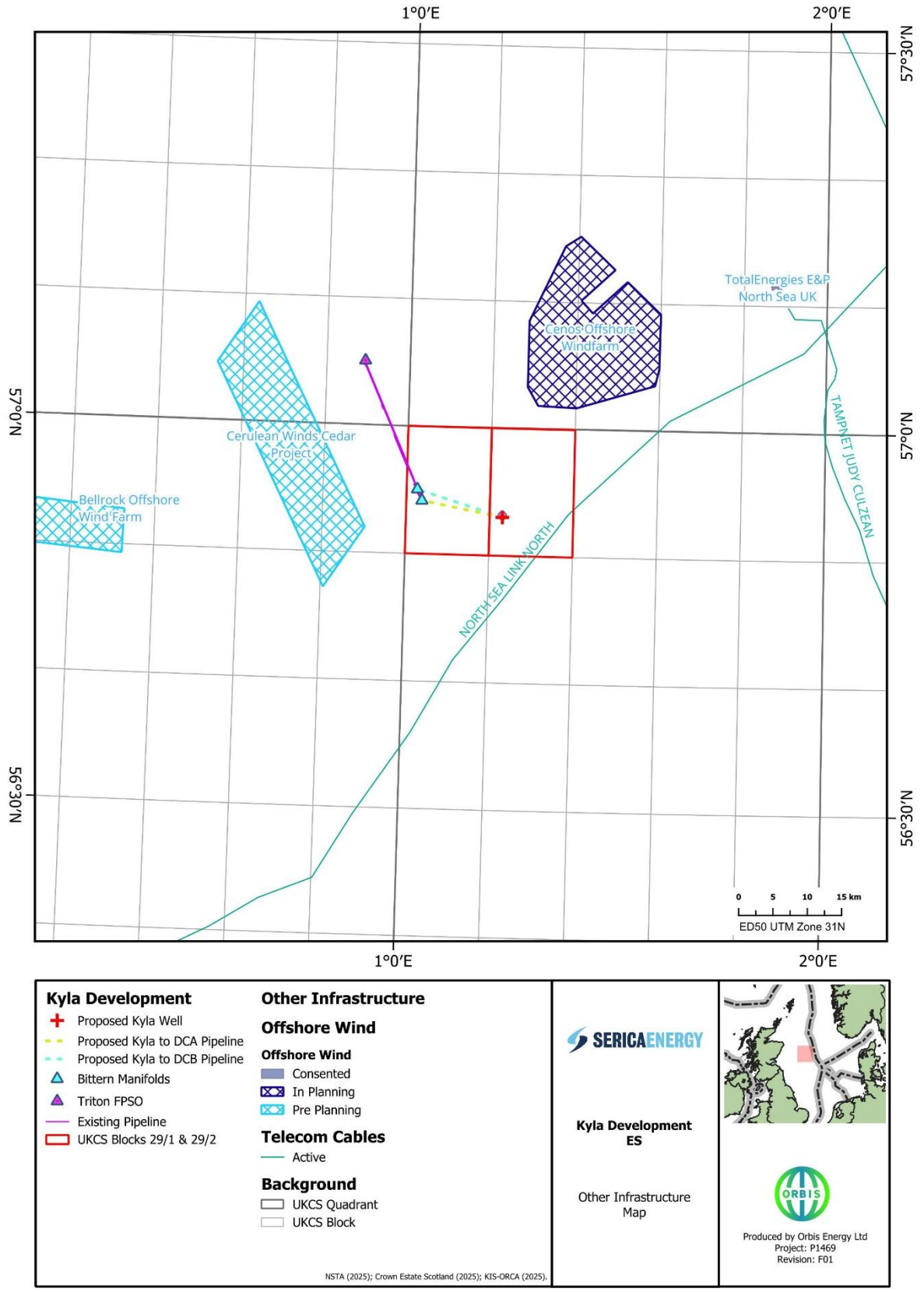


Figure 4.23: Other Infrastructure in the Vicinity of the Proposed Kyla Development (Crown Estate Scotland, 2025; KIS-ORCA, 2025)



4.4.7 Military Activity

There are no military practise and exercise areas in the vicinity of the proposed Kyla Development area and there are no licence conditions applied to UKCS Blocks 29/1 and 29/2 on behalf of the Ministry of Defence (OGA, 2019; NMPi, 2025).

4.4.8 Wrecks

There are no wrecks designated as historic Marine Protected Areas (hMPAs), scheduled monuments (including wrecks) or war graves within the vicinity of the proposed Kyla Development area (NMPi, 2025), nor are there any charted wrecks (UKHO, 2024).In addition, no wrecks were observed during either the 2025 Kyla survey camera footage or the Kyle pre-decommissioning survey camera footage (Gardline, 2025a; Gardline, 2025b; Fugro, 2020; CNRI, 2021).

4.4.9 Tourism and Leisure

The risk of interaction with tourism and leisure-based activities is extremely low given the far offshore location of the proposed Kyla Development (ca. 182 km from Peterhead on the eastern Scottish coastline), however, these activities could be threatened in the event of a major accidental spill approaching the coast.

4.4.10 Natural Disasters

Due to the very low likelihood of occurrence of natural disasters in the North Sea, such as earthquakes of major magnitude, tsunamis or tornados, this event has been scoped out for this assessment.

5 Assessment Methodology

5.1 Introduction

The method used in this ES to determine if the proposed Kyla 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 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.
- **Transboundary:** extending beyond the boundaries of the UKCS (i.e. impacting on other countries).

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, 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 possible, 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 have been reviewed by Serica to confirm that the Project complies with environmental regulations and does not adversely impact Marine Planning policies and objectives (refer to Appendix A).

5.2 Identification of Environmental Impacts

In order to identify the environmental impacts which could arise from the Kyla Development, an ENVironmental and socio-economic impact IDentification (ENVID) workshop was undertaken by Serica and the EIA team on 22nd September 2025. The purpose of the ENVID was to identify potentially significant aspects requiring detailed assessment in the ES, along with any project specific mitigation measures for consideration. The results of the ENVID workshop are documented in the ENVID Registers provided in Appendix B.

5.2.1 Aspects Subject to Further Assessment

Serica has determined that the aspects listed in Table 5.1 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 6 to 12 of the ES.

Table 5.1: Aspects Subject to Further Assessment

Assessment Topic	Potentially Significant Aspects	Receptors	ES Section
Physical Presence	• Presence of semi-submersible MODU (including pre-laid anchors and ground chains) and support vessels during drilling operations • Presence of vessels during installation, inspection, maintenance and decommissioning activities • Ongoing presence of subsea infrastructure and protection / stabilisation material (rock and mattresses)	Shipping, Commercial Fisheries	Section 6
Seabed Disturbance	• Mooring of semi-submersible MODU (anchors and ground chains) • Deposit of drill cuttings, muds and cement on the seabed • Installation of 'fishing friendly' xmas tree and valve skid at Kyla and tie-in structure at Bittern • Laying of pipelines and umbilical on the seabed, including pre-lay boulder clearance • Trenching and burial / protection of pipelines and control umbilical • Installation of tie-in spools and jumpers at Kyla and Bittern • Laying of rock and concrete mattresses for protection / stability / trench transitions • Construction of pipeline crossings (Langeled and CATS pipelines)	Water Quality, Seabed Sediments, Benthic Communities, Fish	Section 7
Underwater Noise Emissions	• Piling operations to install valve skid at Kyla and tie-in structure at Bittern	Fish, Marine Mammals, Seabirds	Section 8

Assessment Topic	Potentially Significant Aspects	Receptors	ES Section
Atmospheric Emissions	• Fuel consumed for power generation on the MODU, vessels and helicopters during drilling, installation, inspection, maintenance and decommissioning activities • Incremental atmospheric emissions at the Triton FPSO as a result of Kyla coming online • Further refining, transportation and distribution of Kyla hydrocarbons after Triton, but prior to end use of sold products; • End use emissions from burning the extracted hydrocarbons	Air Quality, Climate	Section 9
Marine Discharges	• Discharge of LTOBM cuttings at the sea surface • Discharge of drilling, cementing, completion and rig chemicals during drilling operations • Discharge of chemicals during hook-up and commissioning of subsea infrastructure, including commissioning and preservation fluids • Incremental increase in production chemicals and produced water discharges at the Triton FPSO as a result of Kyla coming online • Discharge of chemical or hydrocarbons during subsea intervention activities and decommissioning operations	Water Quality, Plankton, Fish, Benthic Communities	Section 10
Accidental Releases	• Well blowout (releasing large quantities of oil) in the event of a loss of well control • MODU or vessel collision (loss of diesel inventory) • Production pipeline rupture and subsequent release of hydrocarbons to sea • Large release of gas due to rupture of gas lift pipeline	Water Quality, Seabed Sediments, Plankton, Benthic Communities, Fish and Shellfish, Seabirds, Marine Mammals, Marine Protected Areas, Shipping, Commercial Fishing, Tourism and Leisure, Air Quality, Climate	Section 11
Waste Management	• Onshore disposal of general operational solid waste (non-hazardous & hazardous).	Population and Human Health	Section 12

5.2.2 Aspects Scoped Out of Assessment

A number of aspects were not considered to result in significant environmental effects and were scoped out from further assessment. A justification for this is provided in Table 5.2.

Table 5.2: Aspects Scoped out of Further Assessment

Topic	Aspect	Receptors	Justification / Control Measures
Physical Presence	Presence of AHVs during the pre-lay, hookup and removal of MODU anchors and ground chains	Commercial Fishing, Shipping	Main operators of vessels passing in proximity to Kyla will be provided with advanced notice of the proposed operations; Notification to Kingfisher Bulletin.
	Presence of MODU and vessels	Marine Mammals, Seabirds	The physical presence of the semi-submersible MODU and vessels has the potential to disturb or displace seabirds. However, the temporary presence of a small number of vessels is unlikely to result in significant disturbance or displacement of seabirds from the area and alternative foraging habitat is available in the surrounding area. The risk of injury to marine mammals from collision with the MODU or a vessel is low as they will be travelling below the speed threshold where most lethal and serious injuries occur (Laist et al., 2001; Neilson et al., 2012).
	Artificial light emitted from the MODU and vessels	Seabirds	Kyla is remote from sensitive seabed breeding areas on the coast.
Seabed Disturbance	Inspection, maintenance and repair of subsea infrastructure	Water Quality, Seabed Sediments, Benthic Communities, Fish	The subsea equipment is designed for the field life time such that no maintenance is required. Any disturbance to the seabed resulting from the repair of subsea infrastructure, if required, would be small scale and localised.
Underwater Noise Emissions	Use of propellers / Dynamically Positioned (DP) thrusters on MODU and vessels including general noise and vibration of equipment whilst operating	Fish, Marine Mammals, Seabirds	Noise and vibration may cause localised, temporary changes in the distribution of sensitive marine fauna in the immediate vicinity of the MODU / vessel. However, the limited temporal scale of vessel use during the Kyla Development means any changes would be small-scale and would not result in population level effects (refer to Section 8 for further justification).

Topic	Aspect	Receptors	Justification / Control Measures
	Operation of equipment on MODU (e.g. rotating machinery)		Scheduling will minimise MODU / vessel offshore durations. Operational and maintenance procedures will aim to optimise the efficiency of equipment.
Airborne Noise Emissions	Use of helicopters	Seabirds	Helicopter movements will be optimised by careful planning. Any impacts to seabirds from airborne noise emissions will therefore be short term, limited to temporary disturbance and/or displacement from foraging areas. Alternative foraging habitat is available to seabirds in the wider area.
Marine Discharges	Routine discharges to sea (grey/blackwater, food waste) from MODU and vessels	Water Quality, Plankton, Fish, Seabirds, Marine Mammals	Waste water and food waste will be disposed of in accordance with the requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) convention and UK regulations.
	Discharge of ballast water (potential for introduction of alien species) from MODU and vessels		MODU and vessels will comply with the IMO Ballast Water Management Convention.
	Oily water discharges from deck drainage on MODU		Deck drainage water will be sampled prior to discharge to ensure the oil in water concentration is <40 mg/l. An Oil Discharge Permit will also be in place.
Accidental Events	Subsea control system failure resulting in a minor release of hydraulic / control fluid to sea	Water Quality, Plankton, Fish & Shellfish, Seabirds, Marine Mammals	Any impacts on water quality and marine fauna will be localised and temporary. Appropriate maintenance, and pre-use checks on hydraulic equipment and ROVs will be undertaken.
	Small 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 from a small release of hydrocarbons / chemicals to sea will be localised and temporary. MODU / vessels are designed and will be managed and maintained to prevent spills. Crews will be adequately trained, and regular exercises will be held. Bunkering procedures will be put in place. All releases to sea of oil and offshore chemicals that occur during offshore oil and gas activities will be immediately reported to the regulator (via a PON1).
Accidental Events	Dropped objects resulting in unplanned disturbance to seabed	Oil and Gas, Commercial Fishing	Dropped objects may pose a risk to subsea infrastructure or present a snagging risk to trawlers. However, any dropped objects will be immediately

Topic	Aspect	Receptors	Justification / Control Measures
			reported to the regulator (via a PON2) and procedures will be in place to recover objects, where possible. Debris will be identified during post work surveys and anything that cannot be recovered will be reported to the relevant authorities to be included on navigation charts. Subsea infrastructure will be designed for dropped objects as applicable.
Use of Resources	Resource use during drilling, installation, inspection, maintenance and decommissioning activities	Population and Human Health	The use of natural resources will be minimised, as far as practicable. Subsea structures will be designed with consideration to decommissioning. Decommissioned structures will be recovered and recycled onshore.
Natural Disasters	Some natural disasters could increase the risk of a major pollution event occurring at the Kyla field. For example, an earthquake could lead to damage to the subsea infrastructure and potential loss of well control	Water Quality, Seabed Sediments, Plankton, Benthic Communities, Fish and Shellfish, Seabirds, Marine Mammals, Marine Protected Areas, Shipping, Commercial Fishing, Tourism and Leisure, Air Quality, Climate, Population and Human Health	The probability of an earthquake of sufficient magnitude occurring on the UKCS impacting seabed infrastructure is extremely rare. Climate change effects, such as sea level change and extreme weather events, are not considered to significantly alter the range of effects considered.

5.3 Significance Evaluation

This section describes the criteria used in this ES for determining the likely significance of effects on the environment to ensure the assessment process is as transparent and consistent as possible. Where uncertainty exists, this has been acknowledged in the assessment text in Sections 6 to 12.

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, having regard to:

- The magnitude and spatial extent of the impact (geographical area and size of the population likely to be affected)
- The nature of the impact
- The transboundary nature of the impact
- The intensity and complexity of the impact
- The probability of the impact
- The expected onset, duration, frequency and reversibility of the impact
- The cumulation of the impact with the impact of other existing and / or approved projects and / or projects not yet approved, but that Serica is aware of
- The possibility of effectively reducing the impact

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 5.3 has been used as a guide to determine the sensitivity of receptors.

Table 5.3: 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 (Tolerance) and Resilience (Recovery)					
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 (e.g. a function of the spatial extent, duration, reversibility and likelihood of occurrence of the impact) and can be adverse or positive. Where it is not possible to quantify impacts, a qualitative assessment has been carried out, based on best available scientific evidence and professional judgement. The criteria presented in Table 5.4 has been used as a guide to define the magnitude of impact.

Table 5.4: Determining Magnitude of Impact

Magnitude	Definition
Substantial	Widespread long-term change in baseline environmental conditions, with poor potential for recovery. Impact may be one-off, intermittent or continuous and/or experienced over a very wide area (i.e. international in nature). Impact will result in environmental quality standards or threshold criteria being routinely exceeded. The Project's GHG emissions are not compatible with international climate agreements and emissions reduction pathways that aim to hold the global average temperature to well under 2°C. The Project is not aligned with UK sector-specific Net Zero strategies and reduction trajectories.
Major	Widespread medium to long-term, but reversible change in baseline environmental conditions. Impact may be one-off, intermittent or continuous and/or experienced over a wide area (i.e. national in scale). Impact is likely to result in exceedance of environmental quality standards or threshold criteria. The Project's GHG emissions are not compatible with international climate agreements and emission reduction pathways that aim to hold the global average temperature to well under 2°C. The Project is only partially aligned with the requirements of UK sector-specific Net Zero strategies and reduction trajectories.
Moderate	Medium-term, temporary change in baseline environmental conditions or longer-term changes in areas surrounding the immediate footprint of the Project. 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 could result in one-off exceedance of environmental quality standards or threshold criteria. The Project's GHG emissions are consistent with international climate agreements and emission reduction pathways that aim to hold the global average temperature to well under 2°C. The Project is not fully aligned with the requirements of UK sector-specific Net Zero strategies and reduction trajectories.
Minor	Short-term, temporary change in baseline environmental conditions or localised longer-term changes within the footprint of the Project. Impact may be one-off, intermittent and/or localised in scale. Impact would not result in exceedance of environmental quality standards or threshold criteria. The Project's GHG emissions are consistent with international climate agreements and emission reduction pathways that aim to hold the global average temperature to well under 2°C. The Project is aligned with the requirements of UK sector-specific Net Zero strategies and reduction trajectories.

Magnitude	Definition
Negligible	Immeasurable or undetectable changes (i.e. within the range of normal natural variation). The Project's GHG emissions are consistent with international climate agreements and emissions reduction pathways, which aim to restrict global temperature to under 1.5°C above pre-industrial levels. The Project goes beyond the requirements of UK sector-specific Net Zero strategies and reduction trajectories.

[1] Further detail on how the magnitude of impact of the proposed Kyla Development's GHG emissions on the global climate has been determined in this Assessment is provided in Section 9.5.2.

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 5.5.

Table 5.5: 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.

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 5.6 as a guide.

Table 5.6: 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 x 10^{-4}.
Rare	Event is very unlikely to occur during the Project, given good industry practice. Frequency of event: 1 x 10^{-3}.
Unlikely	Event is unlikely to occur during the Project, given good industry practice. Frequency of event: 1 x 10^{-2}.
Possible	Event could occur during the Project, based on industry data. Frequency of event: 1 x 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 5.7.

Table 5.7: 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.

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, control 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.

6 Physical Presence

6.1 Introduction

The temporary presence of the MODU (including pre-laid anchors and ground chains) and vessels and the long-term presence of the Kyla subsea infrastructure once installed have the potential to obstruct or exclude other sea users. This section therefore assesses the potentially significant impacts on other sea users, namely shipping and commercial fisheries, which could arise from:

- Presence of semi-submersible MODU (including pre-laid anchors and ground chains) and support vessels during drilling operations;
- Presence of vessels during installation, inspection, maintenance and decommissioning activities;
- Ongoing presence of subsea infrastructure and protection / stabilisation material (rock and mattresses).

6.2 Assessment of Impacts

6.2.1 Shipping

The density of shipping traffic in the CNS is relatively high due to the presence of fishing vessels, some ferries between the UK and the rest of Europe and cargo and offshore support vessels (refer to Section 4.4.3) (DESNZ, 2022). A Vessel Traffic Survey and Collision Risk Assessment (CRA) Report (Xodus, 2025) was undertaken for the Bittern Development project (pipeline and Bittern Drill Centre B manifold). The Bittern development is located ca. 13 km north west of Kyla. The report indicates that Kyla is located within an area which experiences moderate volumes of routine traffic compared to the other North Sea areas (refer to Section 4.4.3).

The Kyla Development has the potential to interact with shipping through the temporary presence of the MODU and vessels resulting in increased vessel traffic and collision risk. Shipping may also be excluded from areas of sea, potentially resulting in increased steaming times.

The greatest increase in vessel presence in the Development area will be before and during drilling operations, during installation of the subsea infrastructure and, following cessation of production, during decommissioning operations. However, any discernible increase in vessel presence in the area will be temporary in nature.

The proposed Kyla Development drilling phase will involve the use of a MODU, which will be on location at Kyla for a period of up to 100 days. A number of support vessels will also be on location or transiting to / from the Kyla location during this period, including AHVs, Emergency Rescue and Recovery Vessel (ERRV) and supply/support vessels. In addition, to avoid potential delays associated with poor weather conditions or the competitive support vessel market, the anchors and a proportion of the mooring lines will be pre-laid ahead of MODU arrival using two AHVs. When the MODU moves off site, the same elements of the mooring system will be collected at a later date by AHVs (refer to Section 3.3.2).

A 500 m safety zone, patrolled by an ERRV equipped with an AIS and/or ARPA, will be in place around the MODU for the duration of the proposed drilling operations (up to 100 days), which will minimise the potential for collision risk between the MODU and third-party vessels. Notwithstanding this, a Vessel Traffic Survey will be undertaken to inform the Consent to Locate (CtL) permit application, required under Part 4a of the Energy Act 2008 to site the MODU at Kyla. If necessary, a Collision Risk Assessment may also be undertaken if vessels pass within 3.7 km of the site. In addition, notifications to other sea users will be issued via Notices to Mariners and Kingfisher Bulletin to communicate the location of the pre-lay works.

During installation of the Kyla Development subsea infrastructure, a number of DP vessels will be on location for a period of around six months, with metocean conditions likely to drive operations to be conducted in the summer weather window. The main navigational hazard during this phase will be associated with the installation of the pipelines and control umbilical. However, vessels will be moving along the pipeline route, and therefore, will not be in any one area for any significant length of time.

Notifications to other sea users will be issued via Notices to Mariners and Kingfisher Bulletin to communicate the location of the works. Following installation, the pipelines and control umbilical will be subject to routine inspections and maintenance, although vessel requirements for this will be minimal.

During decommissioning, it is anticipated that DP vessels will be used to either fully or partially remove the subsea infrastructure (excluding the pipeline and umbilical which will be subject to a comparative assessment), with the wells plugged and abandoned using a MODU. Any potential impacts to shipping as a result of decommissioning operations will therefore be similar to those described above for drilling and installation operations.

The sensitivity of shipping to displacement as result of the Kyla 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, based on the results of the Bittern Vessel Traffic Survey (Xodus, 2025), there is sufficient sea room for shipping to re-route or avoid the Kyla Development location, as necessary, particularly as the area experiences moderate volumes of routine vessel traffic compared to other North Sea aeras (refer to Section 4.4.3). The magnitude of impact is predicted to be **Minor** as any impact will be localised and temporary in nature. Effects on shipping from the physical presence of the MODU and vessels during drilling, installation, inspection and maintenance and decommissioning activities, 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 proposed Kyla Development is located with ICES Rectangle 42F1, which is subject to relatively low levels of fishing activity. The main fishing method (gear type) is trawls. Traps are also recorded as being used, however the data for this gear type is disclosive, indicating very low levels of activity. Species targeted include *Nephrops*, herring, halibut, haddock, monk fish and whiting (refer to Section 4.4.1).

During the proposed drilling operations, the presence of the MODU and support vessels has the potential to interact with commercial fishing vessels through displacement. As described above, while the MODU is on location, a 500 m safety zone will be in place, which will be patrolled by an ERRV. Although the 500 m safety zone around the MODU will be temporary, Serica will apply for a 500 m safety zone to be in place around the subsea infrastructure at Kyla prior to installation. Fishing vessels will therefore be excluded from an area of 0.8 km^2 throughout the life of the field i.e. Q3 2028 to 2035. To further reduce the risk of snagging; the Kyla xmas tree and valve skid will be designed to be 'fishing friendly'.

Notwithstanding the above, fishing vessels (particularly benthic trawlers and those with pelagic mobile gear) may be temporarily displaced from a larger area as a result of the MODU anchors and ground chains, which will extend outside the 500 m safety zone. For the purpose of this ES, it is assumed that the MODU mooring system will consist of eight anchors and mooring lines, with all anchors laid up to a distance of 1,600 m from the rig centre.

As noted above, all eight anchors and up to 750m (100%) of the mooring lines will be pre-laid on the seabed for a number of weeks ahead of MODU arrival and will remain in place for a number of weeks following the MODU departure. As a result, fishing vessels may be displaced from a larger area during the drilling phase, in the region of ca. 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.

To reduce the snagging risk, before the MODU moves onto location and after it departs, if required a guard vessel will be used to deter vessels from the area, thereby preventing potential interaction with the mooring lines while the MODU is not on location. In addition, information on the location of the MODU and associated anchor pattern and 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. Note, the formation of anchor mounds is considered unlikely for this development, given the sandy nature of the sediments at the Kyla location (see Section 4.2.2).

The presence of installation vessels for the pipelines and control umbilical may also temporarily displace fishing vessels from the proposed development area. This would be in the immediate vicinity of the installation vessels that will be travelling along the proposed pipeline route. Therefore, the nature of displacement will be transient and highly localised.

Prior to pipelay activities commencing, there may be a requirement to remove boulders (>0.5 m) from the lay corridors for each line and relocate these to the edges of the installation corridor (refer to Section 3.4.3). In the event this is required, the as-left position of any relocated boulders would be recorded, with the data provided to SFF.

Once installed the pipelines and control umbilical may pose a snagging risk to fishing gear, such as nets. Fishing gear can become trapped on subsea infrastructure, resulting in loss of fishing gear or potentially posing a threat to the safety of the fishing vessel and crew, or damage the asset. The main risk of snagging will be after pipe lay, pending trenching and burial. To minimise this risk, whilst installation activities are ongoing, a guard vessel will be used to patrol the length of the lines.

In the event the lines are trenched using a pipeline plough, trenching berms could be formed by cohesive clay sediments, which are most likely to generate resistance to fishing gear (Rouse et al., 2020). However, sandy sediments such as those present at the Kyla location (refer to Section 4.2.2) are expected to provide little resistance to demersal towed gear which is likely to be able to pull through the sediment and wash out. Nevertheless, Serica will liaise with the SFF following the results of post lay surveys to ensure that if mud berms are present, they do not represent a safety risk for fishermen.

Rock will need to be deposited on the seabed where the pipelines and umbilical exit the trenches at Kyle and Bittern (50 m sections for the pipelines and 25 m sections for the umbilical) and will also be required for upheaval buckling mitigation along the pipelines. The umbilical will not require any rock mitigation provided it is suitably trenched below mean seabed level. However, to account for the possibility that suitable trenching is not achieved over the full umbilical length a contingency length of 2,500 m requiring additional rock for protection purposes has been assumed. The berm profile of any rock deposited on the seabed will be overtrawlable.

In addition, the proposed route of the Kyla pipelines and umbilical cross the existing 44-inch Langeled and the 36-ich CATS gas export pipelines, both of which are surface laid and exposed. Crossing designs are not yet matured, but are likely to entail concrete mattresses and rock placement (refer to Section 3.4.3). Where concrete mattresses are used as part of the crossings design, or in other open water relocations outside the 500m safety zones at Bittern and Kyla, rock cover will be provided to minimise risk of snagging with fishing gear.

At the tie-in to Bittern, the DP vessels used to install the Kyla subsea structures will be operating within an existing 500 m safety zone. Therefore, there will be no additional loss of access to fishing grounds as a result of the Kyla Development. The existing safety zone also minimises any potential snagging risk, however, the tie-in structure, if required, will be designed to be 'fishing friendly'.

During the life of the field external inspection of the lines will take place at a frequency determined by ongoing risk assessment. Any free spans recorded that present a potential hazard to fishing will be rectified by rock placement.

Given the above, the sensitivity of commercial fishing to displacement is considered to be **Low.** The Kyla Development area is subject to relatively low levels of fishing activity (refer to Section 4.4.1). The receptor is of regional importance, classed as Medium value, but resistance and resilience is Very High as fishing vessels are able to switch to alternative fishing grounds. The magnitude of impact is predicted to be **Minor**, restricted to the Kyla drill centre location, with the risk of snagging considered to be low. In the long term, fishing vessels will only be prevented from entering an area of 0.8 km^2 at the Kyla 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 to other sea users from the physical presence of the MODU (including pre-laid anchors and ground chains) and vessels and the long term presence of the Kyla Development subsea infrastructure will be minimised by the implementation of the following mitigation measures:

- If required, a guard vessel will be implemented to protect the pre-laid anchors and mooring chains from interaction with fishing vessels.
- 500 m safety zone will be designated around the MODU and a dedicated ERRV, equipped with AIS and/or ARPA will be present during the drilling operations to monitor movements of other vessels in the area and prevent them entering the safety zone.
- A Vessel Traffic Survey and, if necessary, a Collision Risk Assessment, will be prepared to support the CtL permit applications required to site the pre-laid anchors and mooring chains, MODU and subsea infrastructure at the Kyla Development location and all vessels will comply with the International Regulations for Preventing Collisions at Sea (COLREG).
- Information on the location of the MODU, MODU anchor positions, 500m safety zone, subsea infrastructure (i.e. wellhead/tree, valve skid and pipelines) and vessel operations will be communicated to other sea users via the UKHO, Maritime and Coastguard Agency (MCA), FishSAFE, Kingfisher Information Services, Notices to Mariners and Radio Navigation Warnings.
- Serica will continue to consult with SFF during the detailed design phase and planning process for the subsea infrastructure installation activities. A Fisheries Liaison Officer (FLO) will be appointed to maintain good communication with local fisheries and co-ordinate activities, particularly during installation of the pipelines and umbilical.
- Through careful planning, the number of vessels and length of time they are required on site for installation operations, will be reduced as far as practicably possible.
- Where boulders (>0.5 m) are required to be removed from the pipeline lay corridors, the as-left position of any relocated boulders will be recorded and reported via Kingfisher.
- 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.
- Pipeline working corridors will be minimised, as far as possible.
- Prior to installation, Serica will apply for a 500 m safety zone to be in place around the subsea infrastructure at the Kyla well location. The subsea infrastructure at the Kyla well location will be designed to be 'fishing friendly'.
- Following pipeline trenching and burial operations, Serica will liaise with the SFF to ameliorate any safety risks for the fishermen from mud berms being left behind.
- During the life of the field, external inspection of the pipelines and control umbilical will take place at a frequency determined by ongoing risk assessment. Any free spans recorded that present a potential hazard to fishing will be rectified by rock placement.

6.4 Residual Effects

No significant residual effects on other sea users are predicted as a result of the physical presence of the semi-submersible MODU (including pre-laid anchors and ground chains) and / or vessels during drilling, installation, inspection and maintenance and decommissioning activities or the long-term presence of the Kyla subsea infrastructure and associated protection / stabilisation material. There is adequate sea room for shipping to re-route or avoid the Kyla location, as necessary, particularly given that Kyla is subject to only moderate volumes of routine vessel traffic compared to other North Sea areas. Fishing vessels will be temporarily displaced from the Kyla Development area for several months in 2027 and 2028 during the drilling and installation phases, with an area of 0.8 km^2 at the Kyla well location 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 CNS area.

6.5 Transboundary Impacts

The Kyla field is located approximately 72 km to the south west of the UK/Norway median line. Although fishing activity in the Kyla Development area is generally low, foreign vessels are known to fish in the wider region (refer to Section 4.4.1). Information on the location of the MODU (including anchor positions), 500m safety zone, subsea infrastructure and vessel operations will be communicated to international fishing organisations, with known vessels working in the area. The area which will be lost to fisheries for the life of the Kyla field (0.8 km^2 at the well location) represents a small fraction of the total sea available. Furthermore, non-UK fishing vessels will be made aware of the Kyla Development through adequate charting of infrastructure. On this basis it is considered that there will be no significant transboundary impacts on other sea users.

6.6 Cumulative Impacts

Currently there is an existing 500 m safety zone around each of the Kyle South and Kyle North Drill Centres, initiated by CNRI when they were the licence field Operator. CNRI have some remaining decommissioning scope within these areas, which includes debris clearance, removal of debris mats and spools, work on pipeline ends, post decommissioning survey and over trawlable seabed clearance (note: debris is located approx. 150 m north of the proposed Kyla well location). CNRI intend to execute their decommissioning activities in Q2 2028. Serica is in consultation with CNRI regarding the timing of this work, which is currently scheduled to take place following completion of the Kyla development drilling operations. Serica will apply for a 500 m safety zone at Kyla which will be partly over the 500 m safety zone around the Kyle South Drill Centre. This will temporarily exclude fishing vessels from a slightly larger area, estimated to be ca. 1.1 km^2, until CNRI have completed their decommissioning activities and the safety zones are removed.

Apart from Bittern, the closest producing field to Kyla is the Starling subsea gas field (operated by Adura), located in UKCS Block 29/3a approximately 12 km to the northeast, which is tied back to the Shearwater platform. The nearest FPSO is the Triton FPSO (operated by Dana) which is located approximately 20 km northwest of the Bittern DCB manifold and 30 km northwest of the proposed Kyla well. The next nearest FPSO is the Catcher FPSO (operated by BW Offshore) which is located approximately 25 km southwest of the Bittern DCB manifold 34km southwest of the proposed Kyla well. The nearest platform to the proposed Kyla well is the West Franklin WHP (operated by Total Energies) which is located approximately 36 km northeast. The West Franklin WHP is located approximately 48 km east of the Bittern DCB manifold. The nearest platform to the Bittern DCB manifold is the Gannet A platform (operated by Adura) located approximately 30 km north. The Gannet A platform is located approximately 36 km north-northwest of the proposed Kyla well. The Belinda field which is currently in development (expected to be producing in Q1 2026) is located approximately 14 km north of the Bittern DCB manifold and 24 km northwest of the proposed Kyla well (refer to Section 4.4.4).

There are no operational, under construction or consented offshore windfarms in the vicinity of the proposed Kyla Development area. The closest offshore windfarm is the Cerulean Winds Cedar Project, currently in the pre-planning stage, located approximately 9.5 km southwest of the Kyla Development (refer to Section 4.4.5). The next closest windfarm is the Cenos Offshore Wind Farm, currently in the planning stage, which would be located approximately 15.5 km northeast of the Kyla Development. Construction at this wind farm is not scheduled to begin until 2030.

The other oil and gas developments in the area will also utilise vessels which have the potential to act cumulatively in increasing vessel collision risk. However, given the mitigation measures which will be in place for the Kyla Development and other oil and gas operations, increased vessel presence should not act in combination with any other development to increase collision risk.

Given the low levels of fishing effort recorded in the vicinity of the proposed Kyla Development and the temporary nature of the drilling, installation, inspection and maintenance and decommissioning activities, it is considered that there will be no significant cumulative impact on commercial fishing. Long-term loss of access is restricted to an area totalling 0.8 km^2 at the proposed Kyla well location for the life of the field development, although vessels will temporarily be restricted from a slightly larger (ca. 1.1 km^2) until the 500 m subsea safety exclusion zone around the Kyle South Drill Centre has been

removed. This is very small in comparison to the fishing grounds available in the wider CNS area. In addition, the Kyla subsea infrastructure will be designed to be 'fishing friendly'; the pipelines and umbilical will be trenched and buried, and the berm profile of any rock placement will be designed to be overtrawlable. A significant cumulative increase in snagging risk with other oil and gas development in the area is therefore not anticipated.

7 Seabed Disturbance

7.1 Introduction

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

- Mooring of semi-submersible MODU (anchors and ground chains)
- Deposit of drill cuttings, muds and cement on the seabed
- Installation of 'fishing friendly' xmas tree and valve skid at Kyla and tie-in structure at Bittern
- Laying of pipelines and umbilical on the seabed, including pre-lay boulder clearance
- Trenching and burial / protection of pipelines and control umbilical
- Installation of tie-in spools and jumpers at Kyla and Bittern
- Laying of rock and concrete mattresses for protection / stability / trench transitions
- Construction of pipeline crossings (Langeled and CATS pipelines)

7.2 Quantification of Impact Area

7.2.1 Mooring of Semi-submersible MODU (Anchors and Ground Chains)

The Kyla well will be drilled from a semi-submersible drilling rig, which will be held in position over the Kyla location using anchors and mooring chains. It is assumed that the MODU mooring system will consist of eight anchors and mooring lines, with all anchors laid up to a distance of ca. 1.6 km from the rig centre.

The dimensions of each anchor are approximately 7.5 m Width (W) x 4.5 m Length (L), equating to a seabed footprint of circa 34 m^2. Therefore, the deployment of eight anchors will disturb an area of seabed equal to 272 m^2 (0.0003 km^2). To represent a highest impact scenario, it is assumed that the total length of each ground chain connected to each anchor (750 m) and pennant wire (200 m), which is connected to the inboard end of each ground chain to facilitate subsequent connection to the MODU, will be in contact with the seabed. Therefore, the maximum length of mooring line to touchdown on the seabed once the MODU is on location and connected to the mooring system is 7,600 m. It has been assumed that a 10 m wide corridor of seabed will be disturbed per mooring chain. This is a highest impact 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 76,000 m^2 (0.076 km^2).

The total seabed disturbance area from MODU anchor and mooring lines is equal to circa. 76,272 m^2 (0.0763 km^2). In the event there is a requirement to re-spud the well, the anchor pattern arrangement would not change.

7.2.2 Deposit of Drill Cuttings, Muds and Cement on the Seabed

For the purpose of the ES, it is assumed that all cuttings will be discharged from the drilling operations. For the two top-hole sections (36" and 26"), the 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 (535.4 tonnes) will be discharged directly from the wellbore at the seabed and will form a cuttings pile in the immediate vicinity of the proposed Kyla well location.

For the deeper 17½", 12¼" (pilot hole), 12¼" (development) and 9½" sections, a marine riser will be situated between the wellhead and MODU so that cuttings and drilling fluid are circulated back up to the MODU. These sections will be drilled with LTOBM, and in the highest impact scenario for seabed disturbance, the LTOBM contaminated cuttings from the lower sections will be thermally treated

offshore to an acceptable overboard disposal limit (<1% oil on cuttings) and discharged from the MODU.

In the case of any unforeseen mechanical or geological issues, a re-spud scenario (36" and 26" sections) and contingency 17½" sidetrack have been added to the well profile to represent a highest impact scenario. The overall combined amount of drill cuttings discharged in the event the well is drilled with the re-spud and contingency sidetrack is 2,387,000 kilograms (kg) (2,387 tonnes).

Simulations of the drilling releases in relation to the Kyla site have been completed using the three-dimensional dispersion model (MUDMAP) by RPS on behalf of Serica. Ten years (2010 to 2019 (inclusive)) of Hybrid Coordinate Ocean Model (HYCOM) current data and HYDROMAP tidal data was generated. The current data is suitably long enough to be indicative of interannual variability in ocean currents. As the spud date may vary, 100 simulations were modelled for the release location with varying start dates to assess a range of current conditions. Results from these simulations were overlaid to identify the maximum thicknesses on the seabed in each grid cell.

A conservative low exposure threshold of 10 milligrams per centimetre squared per day (mg/cm²/day) has been applied for this study. Accordingly, moderate and high exposure thresholds are set at ≥30 mg/cm²/day and ≥100 mg/cm²/day, respectively. Equivalent sediment thicknesses were calculated based on the anticipated total discharge period of 26.4 days and an assumed in-situ bulk density of 2,600 kilograms per cubic metre (kg/m³). The low exposure threshold of 10 mg/cm²/day corresponds to approximately 1.0 millimetres (mm) of sediment accumulation (sediment thickness) over this period (RPS, 2025).

Thresholds of 3.0 mm and above 10.2 mm were then used to define moderate and high exposure levels, respectively. These thresholds align with literature findings such as Gilmour (2002), who observed that older corals suffer injury from 2 mm sediment layers applied every two days, with larger polyps showing damage at 5 mm and 10 mm sediment layers. Mesocosm experiments by Trannum et al. (2010) showed that cuttings layers as thin as 3 mm cause gradual community declines over six months in soft-sediment communities.

Figure 7.1 presents the maximum thicknesses in each grid cell from all 100 simulations to define the potential exposure from the discharge of cuttings and muds during the modelled operational period. The drill cuttings and muds predominantly settled along the south-west to north-east, coinciding with the dominant current directions at the release location.

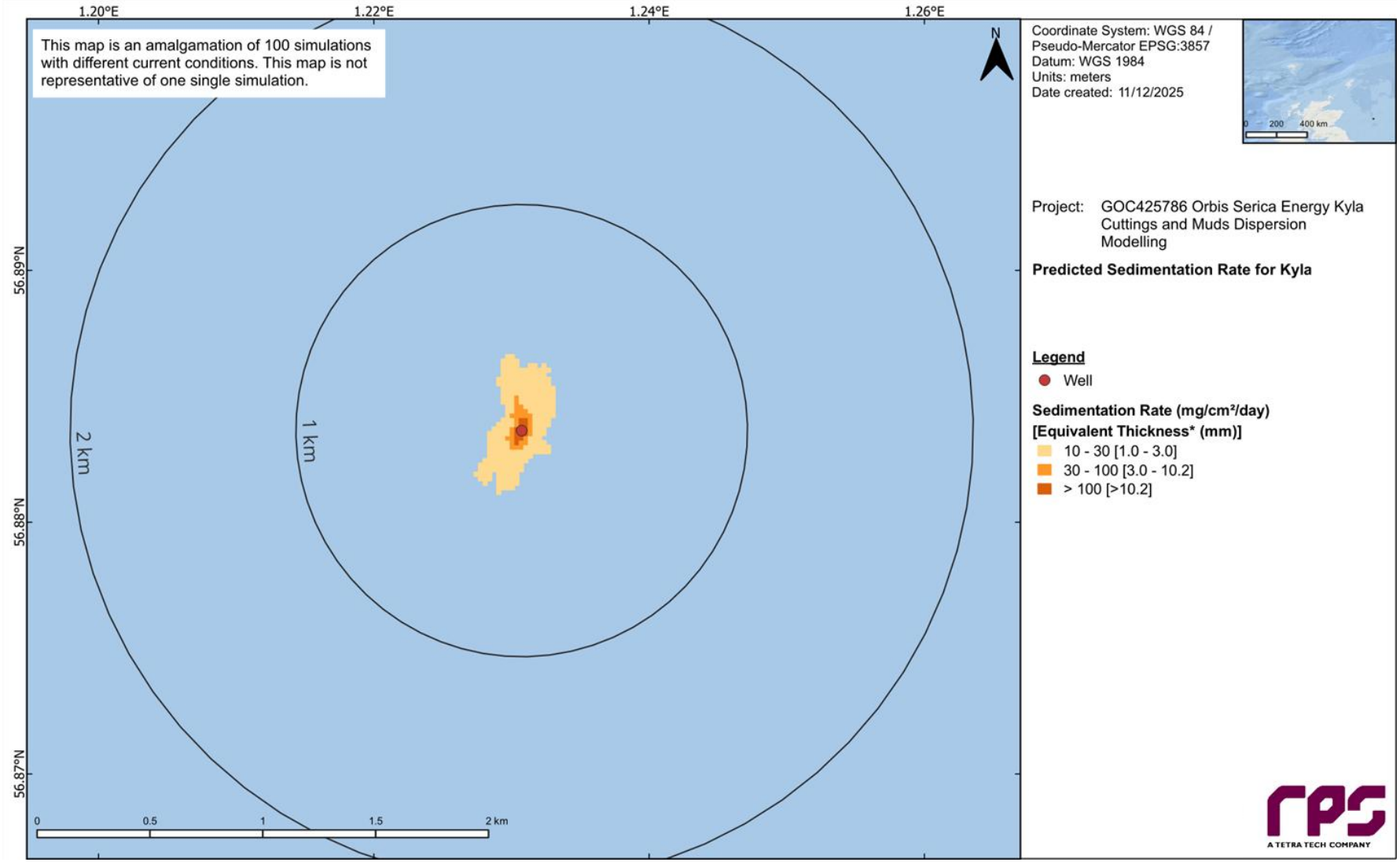
The maximum predicted thickness of deposited cuttings and muds was predominantly associated with the drilling of the 36" and 26" sections, which were returned directly to seafloor from a discharge height of 2 m above the seafloor. A maximum thickness of 0.57 m was predicted within 50 m of the discharge location (RPS, 2025).

Table 7.1 summarises the total area of coverage and the maximum distances from the release location for each sedimentation rate (and equivalent total bottom thickness) of 10 mg/cm²/day (1.0 mm), 30 mg/cm²/day (3.0 mm) and ≥100 mg/cm²/day (≥10.2 mm) for the modelled 26.4 day discharge programme. It can be seen from this that based on the assessment of 100 simulations the maximum distances from the Kyla release location to the edge of the low exposure, moderate exposure and high exposure thresholds were 0.33 km, 0.15 km and 0.06 km, respectively. The total area of coverage for the low exposure threshold, or greater, was 0.12 km² (Table 7.1). Of note, any cement that is pumped to the seabed (refer to Section 3.3.4) will remain within the area impacted by the cuttings pile.

Table 7.1: Predicted areas of coverage and maximum distances from the release location for each reporting threshold based on the results of all 100 simulations. (RPS, 2025)

Reporting Criteria	Total area of coverage (km²)	Maximum distance (km) from the release locations
1.0 mm (low exposure)	0.12	0.33
3.0 mm (moderate exposure)	0.02	0.15
≥10.2 mm (high exposure)	0.01	0.06

Figure 7.1: Combined predicted maximum sedimentation rate and equivalent thickness from the discharge of drill cuttings and muds at the Kyla location. Results are based on 100 simulations (RPS, 2025)



7.2.3 Installation of the Pipelines and Umbilical

Table 7.2 summarises the total area of seabed that may be disturbed during installation of the pipelines and umbilical (based on the project description in Section 3.4.3).

Table 7.2: Estimated Extent of Disturbed Seabed from Pipelines and Umbilical Installation Operations

Activity	Estimated Area of Seabed Disturbance				Total Area of seabed Impacted	
	Temporary Impact		Long Term Impact			
	m^2	km^2	m^2	km^2	m^2	km^2
Boulder Clearance Operations [1]	-	-	10	0.00001	10	0.00001
Laying and Trench and Burial of Production Pipeline, Gas Lift Pipeline and Umbilical [2]	616,000	0.616	-	-	616,000	0.616
UHB mitigation / umbilical protection [3]	-	-	32,500	0.0325	32,500	0.0325
Trenching performance contingency	-	-	66,450	0.0665	66,450	0.0665
Pipeline Crossings [3]	-	-	11,300	0.0113	11,300	0.0113
Trench Transition [3]	-	-	1,500	0.0015	1,500	0.0015
Temporary Initiation Anchors, Wire and Temporary Laydown Areas [4]	1,672	0.0017	-	-	1,672	0.0017
Total	**617,672**	**0.62**	**111,760**	**0.11**	**729,432**	**0.73**

[1] Assumes up to ten boulders may need to be removed from the lay corridors.
[2] Assumes two separate trenches with a width of 22 m each and a line length of ca. 14 km.
[3] See assumptions in Table 3.8 of Section 3.4.3.
[4] Assumes anchor dimensions of ca. 6 m by 6 m, impacting an area of 72 m^2 for the pipelines and umbilical, an initiation wire length for the pipelines and umbilical of 100 m with a 2 m wide disturbance corridor, impacting an area of ca. 400 m^2 and six temporary laydown areas (20 m x 10 m) impacting an area of 1,200 m^2.

Although the majority of the impact from pipeline installation operations is temporary, there is potential for long term seabed disturbance. Boulder clearance will be minimised as far as practical via pipeline routing exercises as part of the design process and potentially local pipeline micro routing prior to pipe or umbilical lay. However, the need for boulder relocation cannot currently be ruled out. If required, boulder clearance will be achieved through use of a grab or bumper bar. All boulders greater than 0.5 m would typically be removed from the lay corridors for the pipelines and umbilical and relocated to the edges of the installation corridor, ideally within a 5 m corridor downstream of the prevailing current to minimise likelihood of scour developing on the route. The as-left position of each boulder will be recorded. In the event that up to ten boulders may need to be removed from the lay corridors, the seabed disturbance from these operations has been estimated to total to approximately 10 m^2 (0.00001 km^2).

It is also estimated that 25,000 tonnes of rock berm may need to be deposited in order to mitigate upheaval buckling. The assumption is that 66 imperfections along the pipelines will require additional rock for UHB mitigation (5 imperfections per km), approximately 250 tonnes of rock will be used per imperfection (with 50% contingency applied). Any rock required for upheaval buckling will be sited within a ca. 10 m wide corridor centred above the pipelines.

As a contingency it is assumed that up to 65,000 tonnes of additional rock may be deposited on the pipelines if target trenching isn't achieved. The estimated total additional disturbance arising from this rock is 55,950 m^2 (0.056 km^2).

The umbilical will not require any rock placement provided it is suitably trenched below mean seabed level. However, as a contingency it is assumed up to 10,000 tonnes of rock may be deposited if target trenching isn't achieved. The estimated total disturbance arising from the rock contingency is 10,500 m^2 (0.0105 km^2).

Additional rock will also need to be deposited where the pipelines and umbilical exit the trenches at Kyla and Bittern (50 m sections for the pipelines and 25 m sections for the umbilical). It is estimated that up to 2,000 tonnes of rock may need to be deposited over the lines for protection at these locations. The total length of the pipelines transition will be 150 m and the total length of the umbilical transition will be 100 m. Each trench transition rock placement will have a width of 6 m. The estimated total disturbance arising from these trench transitions is 1,500 m^2 (0.0015 km^2).

In addition, the proposed route of the Kyla pipelines and umbilical cross the existing 44-inch Langeled and the 36-ich CATS gas export pipelines, both of which are surface laid and exposed. Using the highest impact assumption of 34,100 tonnes of rock being required for both crossings, including trench transition, and up to 54 concrete mattresses to accommodate both the Kyla pipelines and Kyla umbilical crossing Langeled and CATS. The estimated total disturbance arising from the pipeline crossings is 11,300 m^2 (0.0113 km^2).

Finally, the initiation of the pipelines and umbilical will require the installation of a temporary initiation anchor (drag embedment anchors would be used as a highest impact, assumed to have dimensions of ca. 6 m by 6 m) and the use of an initiation wire, which will connect between the anchor and the end of the pipelines / umbilical. The anchor is estimated to impact 36 m^2 of seabed for the two pipelines and umbilical respectively. The initiation wire for both the pipelines and umbilical is expected to be no longer than 100 m in length. To allow for the lateral movement of the wire on the seabed during installation and retrieval, a 2 m wide disturbance corridor has been assumed, with ca. 200 m^2 of seabed impacted per pipeline. In total, therefore, deployment and retrieval of the initiation anchor and wire will temporarily disturb an area of approximately 472 m^2. Following the installation of the pipelines/umbilical the anchor and wire will be recovered.

There may also be a requirement to temporary wet store subsea facilities and concrete mattresses, as well as ROV tooling and baskets. The dimensions of any temporary laydown area are unlikely to exceed 20 m x 10 m based on maximum tie-in spool dimensions. It is assumed up to six temporary laydown areas will be required for the Kyla Development, impacting a total seabed area of 1,200 m^2 (0.0012 km^2).

The total seabed disturbance area from boulder clearance; laying and trenching and burial of the pipelines and umbilical; installation of protection for UHB mitigation and trench transition; the construction of pipeline crossings; and the use of temporary initiation anchors and wires, and temporary laydown areas is equal to circa. 729,432 m^2 (0.73 km^2); with 111,760 m^2 (0.112 km^2) of this disturbance causing a long term impact and remaining 617,672 m^2 (0.62 km^2) a temporary impact (see Table 7.2).

7.2.4 Installation of Subsea Infrastructure at the Kyla Drill Centre

The total seabed footprint caused by the installation of seabed infrastructure at the proposed Kyla drill centre is summarised in Table 7.3 (based on the project description in Section 3.4.2). In total, the seabed disturbance associated with the installation of infrastructure at the Kyla drill centre is estimated to be 2,246.5 m^2 (0.00225 km^2), with the long term loss of available seabed estimated to be 1,050.5 m^2 (0.0011 km^2) and the temporary area of seabed impacted estimated to be 2,246.5 m^2 (0.0022 km^2).

Table 7.3: Estimated Area of Seabed Occupied by Subsea Infrastructure at Kyla Drill Centre

Subsea Item	Assumptions	Temporary Disturbance Area (m^2) [3]	Long Term Disturbance Area (m^2)	Total Seabed Footprint (m^2)
Xmas tree / wellhead [1]	Outermost dimensions of the xmas tree, including telescopic legs will be 5.1 m (L) x 4.8 m (W)	23.8	24.5	48.3
Kyla valve skid	GBS (highest impact) has dimensions of ca. 16.6 m (L) × 6.5 m (W)	50.2	108	158.2
Tie-in spools, pipeline ends and control jumpers	Pipeline ends, spools and jumpers will be surface laid and protected with concrete mattresses [2]	550	450	1,000.0
Untrenched Umbilical Section	Umbilical tie-in loop will be surface laid and protected with concrete mattresses [2]	572	468	1,040.0
Total Seabed Footprint at Kyla Drill Centre		**1,196.0**	**1,050.5**	**2,246.5**

[1] Xmas tree will be located on top of the wellhead.
[2] See assumptions in Table 3.5 of Section 3.4.2
[3] A 1 m corridor of temporary disturbance surrounding each item is assumed when the infrastructure is initially placed on the seabed.

7.2.5 Installation of Subsea Infrastructure at the Bittern Manifold

The highest impact total seabed footprint caused by the installation of seabed infrastructure at the Bittern manifold is summarised in Table 7.4 (based on the project description in Section 3.4.4). In total, the installation of subsea infrastructure at Bittern is estimated to impact an area of seabed of 4,078.2 m^2 (0.0041 km^2), with the long term loss of available seabed estimated to be 1,872 m^2 (0.0019 km^2) and the temporary area of seabed impacted estimated to be 2,206.2 m^2 (0.0022 km^2).

Table 7.4: Estimated Area of Seabed Occupied by Subsea Infrastructure at Bittern Manifold [1]

Subsea Item	Assumptions	Temporary Disturbance Area (m^2) [3]	Long Term Disturbance Area (m^2)	Total Seabed Footprint (m^2)
Bittern tie-in structure	GBS (highest impact) has dimensions of ca. 16.6 m (L) × 6.5 m (W)	50.2	108	158.2
Tie-in spools, pipeline ends and control jumpers	Lines will be surface laid and protected with concrete mattresses [2]	1,276	1,044	2,320
Untrenched umbilical section	Umbilical tie-in loop will be surface laid and protected with concrete mattresses [2]	880	720	1,600
Total Seabed Footprint at Bittern		**2,206.2**	**1,872**	**4,078.2**

[1] Seabed footprint is highest impact, based on the tie-in arrangement at Bittern DCB manifold
[2] See assumptions in Table 3.9 of Section 3.4.4
[3] A 1 m corridor of temporary disturbance surrounding each item is assumed when the infrastructure is initially placed on the seabed.

7.2.6 Estimated Total Seabed Disturbance Area

Table 7.5 summarises the highest impact total area of seabed that could be disturbed as a result of the Kyla Development. The estimated highest impact total temporary area of seabed disturbed from the Kyla Development is 817,346 m^2 (0.819 km^2). The highest impact total area of seabed disturbed in the long term by the subsea infrastructure, rock protection and concrete mattresses for the life of the Kyla Development is estimated to be 114,683 m^2 (0.115 km^2).

Areas of seabed subject to temporary disturbance will begin to recover on completion of the operations as discussed in Section 7.3. In contrast long term impacts to the seabed are associated with infrastructure that will be in place for the duration of the Kyla Development (ca. 8 years). Long term impacts may extend beyond the field life of the Kyla Development, depending on the methods and options available at the time of decommissioning.

Table 7.5: Estimated Extent of Seabed Disturbed from the Kyla Development (Assessing the Highest impact Options)

Aspect	Assumptions	Estimated Area of Seabed Disturbance (Highest impact)			
		Temporary Impacts		Long Term Impacts	
		m^2	km^2	m^2	km^2
Mooring of the MODU (Section 7.2.1)	• MODU mooring system will consist of eight anchors and mooring lines, with all anchors laid up to a distance of 1,600 m from the rig centre. • Each anchor: 7.5 m (W) x 4.5 m (L) = 34 m^2. • Maximum length of mooring line on the seabed = 7,600 m. 10 m wide corridor of mooring chain lateral movement.	76,272	0.076	-	-
Drill Cuttings, Muds and Cement (Section 7.2.2)	• The majority of drill cuttings, as well as the cement, will be deposited out to a maximum distance of 0.54 km from the release location, aligned with the direction of the current	120,000	0.12	-	-
Installation of the Pipelines and Umbilical (Section 7.2.3)	• Boulder Clearance Operations: 10 m^2 • Laydown and Trench and Burial of Production Pipeline, Gas Lift Pipeline and Control Umbilical: 528,000 m^2 • Rock Cover: 98,950 m^2 • Pipeline Crossings: 11,300 m^2	617,672	0.62	111,760	0.112

Aspect	Assumptions	Estimated Area of Seabed Disturbance (Highest impact)			
		Temporary Impacts		Long Term Impacts	
		m^2	km^2	m^2	km^2
	• Trench Transition: 1,500 m^2 • Temporary Initiation Anchors and Wires and Temporary Laydown Areas: 1,672 m^2				
Installation of Subsea Infrastructure (Sections 7.2.4 & 7.2.5)	• Installation of subsea infrastructure at Kyla ('fishing friendly' Xmas tree, 'fishing friendly' valve skid, tie-in spools, umbilical jumpers and concrete mattresses): 2,246.5 m^2 in total, with 1,050.5 m^2 being long term • Installation of subsea infrastructure at Bittern (tie-in structure, tie-in spools, jumpers and concrete mattresses): 4,078.2 m^2 in total, with 1,872 m^2 being long term	3,402.2	0.0034	2,922.5	0.003
	Total	**817,346**	**0.819**	**114,683**	**0.115**

7.3 Assessment of Impacts

7.3.1 Mooring of Semi-submersible MODU (Anchors and Ground Chains)

The total seabed disturbance area from MODU anchors and mooring lines is equal to circa. 76,272 m^2 (0.076 km^2). 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 (ground chains and pennant wires) 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

Mooring of the semi-submersible MODU 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.

The Kyla Development is located in an area containing potential cuttings piles associated with the prior Kyle field. These historic cuttings piles have the potential to be disturbed by the anchoring of the MODU. However, a multibeam echosounder geophysical survey of the Kyla Field undertaken as part of the Kyle pre-decommissioning survey scope did not identify a discernible physical cuttings pile. The historic cuttings piles are believed to have dispersed and now lie flush with the seabed, although seabed samples taken during the pre-decommissioning survey of the Kyle area show a chemical footprint (elevated THC levels) covering an area of 1,432 m^2 (CNRI, 2021). The proposed Kyla Development well is located ca. 0.30 km southwest of the K12 well, 0.33 km southwest of the K15 well and over 3 km south southeast of the K13 and K14 wells; these are the development wells at the historic Kyle field. Therefore, dependent on the anchor, the mooring of the MODU has the potential to disturb any contaminated sediment present. However, results from the 2025 survey show all stations within the vicinity of the proposed Kyla Development area have recorded THC and heavy metal concentrations that are considered consistent with background concentrations (Gardline, 2025b), indicating that disturbance of contaminated sediment is unlikely.

As discussed in Section 4.2.2, seabed sediments within the Kyla Development area have been identified as being sandy, showing moderate amounts of fines and a negligible gravel content (Gardline, 2025a; 2025b). The Kyla Development is also located within a seasonally influenced dynamic area (DESNZ, 2022). Consequently, any seabed scarring resulting from the anchoring of the MODU at the proposed Kyla well location have the potential to persist only in the short to medium term and the likelihood of anchor mounds forming is very low. No evidence of scarring in the seabed at the historic Kyle field was found during the pre-decommissioning survey (Fugro, 2020).

The sensitivity of seabed sediments to the mooring of the MODU as a result of the Kyla 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. 0.076 km^2), with any change to

baseline conditions predicted to be temporary in nature. Effects on seabed sediments from the mooring of the semi-submersible MODU are therefore assessed as **Minor** and not significant.

Benthic 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. Annelid species dominated the infaunal community at the proposed Kyla Development area accounting for 66.97% of the total individuals. These species were followed by Arthropods, molluscs, and echinoderms (refer to Section 4.3.2; Gardline, 2025b).

Sessile epifauna, and a proportion of the infauna (animals that burrow into the sediment or form tubes within it) such as polychaete worms and burrowing species in the direct footprint area of the MODU mooring system (ca. 0.076 km^2) may experience injury and mortality from compression and abrasion. However, recovery is expected to occur once the MODU has moved off 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 (Neal and Avant, 2008). Where sedimentation does impact negatively on benthic species, consequences are likely to be short-lived for the majority of species as most of the smaller sedentary species (such as polychaete worms) have short lifecycles and recruitment of new individuals from outside of the disturbed area will be rapid (Tillin and Tyler-Walters, 2014).

The seapens and burrowing megafauna communities habitat, an OSPAR Threatened and/or Declining Habitat, has been reported to occur within the wider region surrounding the proposed Kyla Development. Across the Kyla survey area, some similarity to this habitat was observed at the majority of stations and when considering the survey data overall, burrows were classified as rare to frequent, suggesting that there is some similarity to a sea pen and burrowing megafauna communities habitat, as per OSPAR (2010). Although burrows were present, burrowing fauna were rarely sighted with only a single individual of *N. norvegicus* observed across the survey area to confirm the burrow inhabitants, therefore burrows could not confidently be attributed to any of the classified megafauna species within the seapen and burrowing megafauna community habitat classification. The sea pen and burrowing megafauna communities habitat is also listed as a key component biotope within the broader Burrowed mud habitat, which is designated as a PMF (NatureScot, 2022). Sediments across the Kyla survey area were classified as muddy sand to slightly gravelly muddy sand, suggesting some ecological similarities to the Burrowed mud PMF (refer to Section 4.3.2).

Abrasion and physical disturbance of surface of seabed is likely to affect mobile and sessile epifaunal and shallow burrowers. Damage to seapen species is likely to take place as a result of greater sediment disturbance as a result of the anchors being placed on the seabed and the lateral movement of the mooring chains. However, experimental studies have shown that all three species of seapen can re-anchor themselves in the sediment if dislodged (Eno et al., 1996). Eno et al. (1996) also found that even if damaged *Funiculina quadrangularis* appeared to remain functional and this could also be true of the other sea pens. Tuck et al. (1998) found that abrasion and physical disturbance had no effect on *Virgularia mirabilis* populations and Kinnear et al. (1996) found that sea pens were quite resilient to being smothered, dragged or uprooted. Using both the Feature Activity Sensitivity Tool (FeAST), and the resistance of this habitat to sub-surface abrasion (e.g. anchors on the seabed), surface abrasion (e.g. mooring chains on the seabed) and physical disturbance is assessed as low and recovery is medium, therefore overall sensitivity is assessed as medium (Hill et al., 2023; FeAST, 2025).

Ocean quahog (*Arctica Islandica*), listed as listed as a PMF in Scottish waters and an OSPAR Threatened and/or Declining species, has also been reported to inhabit the wider region surrounding the proposed Kyla Development. More specifically the East of Gannet and Montrose Fields NC MPA, located approximately 13.4 km north of the proposed Kyla Development area is designated for the conservation of *A. islandica*. Thirty-one juvenile *A. islandica* individuals were recorded across the Kyla Development area, although no adult specimens were observed within samples (refer to Section 4.3.2).

The ocean quahog is of conservation importance due to its slow growth, late age of reaching reproductive maturity and vulnerability to disturbance (JNCC, 2014). FeAST indicates that ocean quahog has high sensitivity to sub-surface abrasions / penetration (i.e. anchor placement) and low sensitivity to surface abrasion (i.e. MODU mooring line touchdown) (FeAST, 2025; Tillin et al. 2010).

In summary, the sensitivity of seabed communities to the footprint of the MODU is considered to be **High to Very High**. Some of the receptors are of international importance and are of Very High value, but for the majority of species the overall resistance and resilience is High as recoverability of benthic communities is expected in the short to medium term. Sea pen and burrowing megafauna habitat and ocean quahog (*A. islandica*) are the exception to this. The sea pen and burrowing megafauna habitat has a Low to Medium resistance and resilience to disturbance arising from the mooring of the MODU and ocean quahog has a Low resistance and resilience to the movement of the mooring chains on the seabed (FeAST, 2025). The magnitude of impact is predicted to be **Minor** as any impacts will occur over a relatively small area (ca. 0.076 km^2) and will be temporary in nature, with recovery likely occurring in the short to medium term. Effects on seabed communities from mooring of the MODU are therefore assessed as **Minor** and not significant.

Fish and Shellfish

The Kyla Development area is located within the spawning and nursery 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 and herring are also Scottish PMFs and UK BAP species (NatureScot, 2020; JNCC, 2007). Fish egg development and hatching success is vulnerable to the effects of sediment smothering and abrasion (DESNZ, 2022). However, as discussed in Section 4.3.2, the proposed Kyla Development area contains habitat that is 'unsuitable' for both herring and sandeels.

Exposure of fish to increased turbidity reducing visual acuity and reduction of available habitat caused by mooring of the MODU at the proposed Kyla drill centre location may affect foraging behaviour (Bakke et al., 2013) and temporarily displace fish from their spawning and nursery areas. However, given the localised area of impact (ca. 0.076 km^2) and the mobile nature of the species, any displaced fish are likely to find foraging opportunities, as well as suitable spawning and nursery areas in adjacent locations. The spawning grounds within which the Kyla Development area is located are part of wider spawning grounds within the CNS and, as such, Kyla is not considered to be a key habitat for these fish species.

In summary, the sensitivity of fish and shellfish to the mooring of the MODU is considered to be **High**. The majority of receptors are of national importance and are of High value. The exception to this is the species likely to be present in the Kyla development area classified as PMFs; these species have a Very High value. The overall resistance and resilience is 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 fish and shellfish from the from the mooring of the MODU on the seabed are therefore assessed as **Negligible** and not significant.

7.3.2 Deposit of Drill Cuttings, Muds and Cement on the Seabed

As discussed in Section 7.2.1, as a highest impact, it has been assumed that the drill cuttings discharged from the Kyla Development well (2,387,000 kg (2,387 tonnes)) have the potential to be deposited within an area of up to 0.12 km^2 surrounding the drilled well location (based on a threshold for bottom deposition of 1.0 mm) (RPS, 2025). A high exposure level of drill cuttings (based on a threshold for bottom deposition of ≥10.2 mm mm) is likely to be deposited within an area of 0.01 km^2 (RPS, 2025). Any cement discharged at the seabed during cementing operations will also be deposited within this area.

Research has shown that the effects on seabed fauna from the deposition of drill 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). Barium (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.

For assessment purposes, thermal cuttings treatment is being evaluated to treat the LTOBM contaminated cuttings from Kyla to an acceptable overboard disposal limit (<1% oil on cuttings). A joint study including eight research papers reported to The Oil Industry International Exploration and Production Forum (E&P Forum) in 1996 found no evidence of significant changes to the natural benthic community or re-colonisation of the seabed when exposed to low oil on cuttings concentrations (<1%) (E&P Forum, 1996). Furthermore, the same report found that the impact of LTOBM on benthic communities was directly related to the oil concentration, with a lower concentration reducing the impacts. Given that the discharge of LTOBM cuttings from Kyla will be treated to an oil on cuttings concentration to <1 %, this aspect has been scoped out from detailed assessment. The remainder of this section therefore concentrates on impacts relating to the deposition of Water Based Mud (WBM) drill cuttings on the seabed.

Drilling history at the Kyla field location suggests that discharges of oil-based drilling muds and synthetic based drilling muds occurred during the 1990s and 2000s, with the cuttings piles at the field previously estimated to cover over 0.0043 km^2. However, as noted above, these cuttings piles are no longer visible (Fugro, 2020). During the 2025 Kyla survey, all stations within the vicinity of the proposed Kyla Development area have recorded THC and heavy metal concentrations that are considered consistent with background concentrations, although concentrations of Ba were found to be above the background levels for the area (Gardline, 2025b) (refer to Section 4.2.2).

Seabed Sediments

The seabed sediments at the Kyla well location were interpreted to be represented by the Folk Classification 'muddy sand' and 'slightly gravelly muddy sand'. The discharge of drill cuttings, muds and cement from the Kyla Development well will initially alter the seabed topography and sediment structure of a small area close to the well. The material deposited will be a mixture mostly of cuttings (rock fragments and sediment removed from the well) of various sizes and drilling mud including particles of barite (barium sulphate). It is feasible that changes in sediment particle size characteristics could affect the suitability of the seabed for re-colonisation by species normally characteristic of the area, although it is anticipated that the sediments will return to their original composition under the influence of seabed currents and natural sedimentation.

In the CNS, near-bed current velocities and sediment mobility are generally sufficient to prevent detectable local accumulation of cuttings, as noted during the Kyle pre-decommissioning survey which did not identify any discernible physical cuttings piles. It has been predicted that any surface-hole cuttings piles in the SNS and CNS area will be dispersed typically over a timescale of one to five years, mainly through re-suspension and bedload transport due to tidal and wave-induced currents (DTI, 2001; Breuer et al. 2004).

The sensitivity of seabed sediments to the discharge of drill cuttings, muds and cement as a result of the Kyla Development wells 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 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 Kyla well location. Effects on seabed sediments from the discharge of drill cuttings, muds and cement are therefore assessed as **Minor** and not significant.

Benthic Communities

The accumulation of drill cuttings, mud and cement at the Kyla well 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. 150 m of the wellhead (the area experiencing moderate to high exposure to cuttings) (RPS, 2025). However, as the main impact is primarily 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 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).

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 CNS (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).

The habitats and species present at the proposed Kyla well location are typical of the CNS region. Annelids dominated within the infaunal community, making up five of the top 10 ranked species (Gardline, 2025b). The most abundant species was the polychaete *Paramphinome jeffreysii*. The next most dominant taxon was the polychaete *Ampharete falcata*.

As noted in Section 7.3.1, across the Kyla survey area, some similarity to the seapens and burrowing megafauna communities (burrowed mud) habitat (an OSPAR Threatened and/or Declining Habitat and Scottish PMF) was observed (refer to Section 4.3.2). Data taken from FeAST indicates that high rates of siltation may adversely affect this habitat type, with the habitat having low tolerance and medium recovery to the pressure and therefore a medium sensitivity (Tillin et al. 2010; FeAST, 2025). As such, there is a possibility that this habitat type could be adversely impacted by siltation caused by the discharge of cuttings, muds and cement. However, the species that inhabit this type of benthic habitat are deemed to be highly recoverable (Hill et al., 2023). In addition, studies on the reproduction of *Pennatula phosphorea* (sea pens) suggest that these species have lecithotrophic larvae which have the ability to remain in the water column until suitable habitat is located, thus possibly avoiding settlement on sediment that has been disturbed (DECC, 2016).

Ocean quahog (*A. islandica),* an OSPAR Threatened and/or Declining species and Scottish PMF, have also been recorded across the Kyla Development area (refer to Section 4.3.2). 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; FeAST, 2025). As such, there is a possibility that ocean quahog could be adversely impacted by siltation caused by the discharge of cuttings, muds and cement.

In summary, the sensitivity of seabed communities to the discharge of drill cuttings, muds and cement as a result of the Kyla Development is considered to be **High** to **Very High**. Some of the receptors are of international importance and are therefore of Very High value, but the overall resistance and

resilience is High for the majority of species as recoverability of benthic communities is expected in the short term. Ocean quahog are the exception to this as they have a Low resistance and resilience to high rates of siltation. 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 Kyla well location (out to a maximum distance of 0.33 km from the release location based on a sediment bottom thickness of 1 mm). Effects on seabed communities from the discharge of drill cuttings, muds and cement are therefore assessed as **Minor** and not significant.

Fish and Shellfish

As discussed in Section 4.3.3, a number of fish species are known to use the waters in the vicinity of the Kyla Development location, and some use the area as a spawning and / or nursery ground. The Kyla field is located in an area which has been identified as a potential spawning ground for cod, lemon sole, mackerel (high intensity), Norway pout (high intensity), and sandeel; with the area also acting as a nursery area for anglerfish, blue whiting, cod (high intensity), European hake, haddock, herring, ling, mackerel, Norway pout, plaice, sandeel, spurdog, and whiting. However, the Kyla 2025 survey found the habitat was 'unsuitable' for both spawning herring and sandeels (refer to Section 4.3.2).

Exposure to increased turbidity caused by the discharge of drill cuttings and muds may reduce the visual acuity of fish utilising the area potentially affecting foraging behaviour (Bakke et al., 2013). Fish may also be temporarily displaced from their spawning and nursery areas due to the settlement of drill cuttings, muds and cement 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 nursery areas in adjacent locations.

In summary, the sensitivity of fish and shellfish to the discharge of drill cuttings, muds and cement as a result of the Kyla Development is considered to be **High**. The species present are typical of the wider area in this region of the CNS, although anglerfish, blue whiting, cod, herring, ling, mackerel, Norway pout, sandeels, spurdog and whiting are listed as PMFs in Scottish waters, whereby this designation should seek to protect these features (see Section 4.3.3) and, as such, are of Very High value, but the overall resistance and resilience is High as recoverability is expected in the short to medium 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 Kyla well location (out to a maximum distance of 0.33 km from the release location based on a sediment bottom thickness of 1 mm). Effects on fish and shellfish from the discharge of drill cuttings, muds and cement are therefore assessed as **Minor** and not significant.

7.3.3 Installation of Subsea Infrastructure

Water Quality

There is a potential that the installation of the subsea infrastructure required for the proposed Kyla Development could result in a reduction of water quality. This could arise from the resuspension of sediment during the installation of the subsea infrastructure at the Kyla and Bittern locations, and the installation of the production pipeline, gas lift pipeline and umbilical leading to increased turbidity and a higher concentration of contaminated sediments in the water column. The greatest amount of sediment resuspension will take place during the pipeline and umbilical trench and burial operations.

Suspended sediment is not expected to persist within the water column beyond a day following the completion of subsea infrastructure installation activities (Dale et al., 2011; Black and Parry, 1999).It is worth noting that during pipeline and umbilical installation, increased suspended sediment in the water column is unlikely to occur across the full length of the pipeline and umbilical trenches (ca. 14 km) during a 24 hour period. These operations will take place over several days focussing on smaller segments of the route each day (refer to Section 3.4.6). In addition, at stations within the vicinity of and along the proposed pipeline route (KS04, KS07 to KS09, KB01 to KB02), Effects Range Low (ERL) values were not exceeded for any heavy metals. Therefore, heavy metal concentrations will not be elevated to point of affecting the water quality when the sediment becomes suspended (See Section 4.2.2). The heavy metal concentrations along the pipeline route and within the vicinity of the pipeline route were also similar to background levels (See Section 4.2.2). In summary, the resuspension of

sediments arising from the installation of subsea infrastructure is unlikely to result in high turbidity for a prolonged period or a significant concentration of contaminants entering the water column.

The sensitivity of water quality to the increase turbidity as a result of the Kyla Development is considered to be **Low**. The receptor has a Low value; as only the water column in relatively close proximity to the installation operations will be impacted, hence it is considered to be of local importance;, 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 pertaining to water quality. Effects on water quality from the installation of subsea infrastructure are therefore assessed as **Negligible** and not significant.

Seabed Sediments

Temporary Impact

There will be temporary disturbance arising from the trenching and backfill operations during pipeline and umbilical installation, temporary initiation anchors and wires, the use of temporary laydown areas for wet storage and installation of subsea infrastructure at both Kyla and Bittern estimated to amount to approximately 0.623 km^2 (see Section 7.2.6).

It is likely that a proportion of the sediments displaced for the purpose of pipeline laying and burial, and the installation of subsea infrastructure at the Kyla and Bittern locations will become suspended in the bottom few metres of the water column. Within the vicinity of the proposed Kyla Development (KS01 to KS12, KB01 to KB02), the sediments are relatively fine (sandy and muddy) in nature which means that plumes or re-suspended sediment will tend to re-settle within 24 hours. The trench and burial operations may also result in the temporary formation of mounds either side of the pipelines and umbilical during the trenching phase which will be replaced during the burial phase.

Furthermore, the operations to install the subsea infrastructure at Kyla and Bittern, the use of the temporary initiation anchors and wires, and temporary laydown areas for wet storage will physically disturb the sediment. However, as discussed in Section 7.3.1, it is likely that any seabed scarring will persist only in the short to medium term and given the sandy sediment type at Kyla the likelihood of anchor mounds forming is very low.

In summary, sensitivity of seabed sediments to the temporary seabed disturbance as a result of the Kyla subsea infrastructure installation 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 seabed currents and nature of the sediment means that plumes or re-suspended sediment will tend to re-settle quickly (within 24 hours) and will not be prolonged or affect large areas. In addition, quick recovery following any scarring is predicted. The magnitude of impact is predicted to be **Minor** given the relatively small highest impact area for temporary seabed disturbance (0.623 km^2) which will be impacted and the temporary nature of any impacts. Effects on seabed sediments from the temporary seabed disturbance as a result of the Kyla Development seabed infrastructure installation are therefore assessed as **Minor** and not significant.

Long Term Impact

Installation of the subsea infrastructure will result in the loss of sandy and muddy sediment habitat from the area, and the introduction of novel hard substrata. This will mostly comprise of subsea infrastructure items, rock cover and concrete mattresses. In the highest impact case, the total area of long-term sandy sediment habitat loss is estimated to amount to approximately 0.115 km^2 for the life of the Kyla Development (ca. 8 years) and beyond depending on how the infrastructure is decommissioned. This area is small in comparison to the area of similar habitat available across the wider area.

In summary, the sensitivity of seabed sediments to the long term disturbance from the installation of subsea infrastructure and rock cover and concrete mattresses as a result of the Kyla Development is considered to be **Medium** in the vicinity of the proposed Kyla Development. The receptor is of local importance for sediment type, classed as Low value, but the overall resistance and resilience is Medium, as there will be a permanent change to the habitat type, which will last for as long as the subsea infrastructure, rock cover and concrete mattresses remain in place. The magnitude of impact,

however, is considered to be **Negligible** given the small highest impact area (0.115 km^2) which will be impacted compared to the available sandy sediment habitat type. Effects on seabed sediments from the subsea infrastructure installation activities are therefore assessed as **Negligible** and not significant, particularly as the impacted sediment is characteristic of the wider area.

Benthic Communities

Temporary Impact

The installation of the pipelines and umbilical, and subsea infrastructure will also 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 proposed Kyla Development (KS01 to KS12, KB01 to KB02), the sediments are relatively fine (sandy and muddy) in nature which means that plumes or re-suspended sediment will tend to re-settle within 24 hours 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 had the most rapid recovery rate following disturbance and mud the slowest. The sediment type that is prevalent within the proposed Kyla Development is muddy sand, which has a slower recovery rate following disturbance.

As noted above, the Kyla survey area shows some similarity to the seapens and burrowing megafauna communities (burrowed mud) habitat (an OSPAR Threatened and/or Declining Habitat and Scottish PMF) (refer to Section 4.3.2). The sea pen and burrowing megafauna communities habitat has also been found to likely be present at the Bittern field (Fugro, 2017; 2023). Data taken from FeAST indicates that high rates of siltation may adversely affect this habitat type, with the habitat having low tolerance and medium recovery to the pressure and therefore a medium sensitivity (Tillin et al. 2010; FeAST, 2025). In addition, the resistance of this habitat to sub-surface abrasion (e.g. the use of temporary initiation anchors and temporary laydown areas) and physical disturbance is assessed as low and recovery is medium, therefore overall sensitivity is assessed as medium (FeAST, 2025). As such, there is a possibility that this habitat type could be impacted by siltation and abrasion caused by the installation of the pipelines and umbilical, subsea infrastructure at the Kyla and Bittern locations, as well as the use of temporary anchors and initiation wires and temporary laydown areas.

The OSPAR Threatened and/or Declining species, ocean quahog (*A. islandica)* have also been recorded across the Kyla Development area (refer to Section 4.3.2). During historic surveys at Bittern, no adult individuals of *A. islandica* were present, but juvenile individuals were recorded (Fugro, 2017; 2023). 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; FeAST, 2025). In addition, the species has a high sensitivity to sub-surface abrasions / penetration. As such, ocean quahog could be adversely impacted by the installation of subsea infrastructure.

In summary, the sensitivity of seabed communities to the temporary seabed disturbance as a result of installation of the Kyla subsea infrastructure is generally considered to be **High**. The majority of the receptors are of national importance and are of High value, with High overall resistance and resilience as recoverability of benthic communities is expected in the short term. Ocean quahog and the seapens and burrowing megafauna habitat are the exception to this, being of **Very High** sensitivity, with Very High value. They also have a Low and Medium resistance and resilience respectively to sub-surface

abrasion and siltation. 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 limited to a relatively small area (ca. 0.623 km^2) in the highest impact case. Effects on seabed communities from the temporary seabed disturbance as a result of the installation of the Kyla subsea infrastructure are therefore assessed as **Minor** and not significant.

Long Term Impact

The seabed beneath the subsea infrastructure and rock cover and concrete mattress protection 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 Kyla Development 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 (Gardline, 2025b). The most abundant species was the polychaete *Paramphinome jeffreysii*. The next most dominant taxon was the polychaete *Ampharete falcata*.

The physical presence of the subsea structures and the rock protection over the pipelines and umbilical, will introduce a new stable hard substrata to the area and over time a new rocky substrate habitat will become established. Seabed animals within the direct footprint of the protective rock material will be damaged, displaced or smothered resulting in the mortality and loss of individuals of species but the material itself could, over time, function as reef habitat providing additional attachment sites for the indigenous sessile communities, such as sponges or hydrozoans, as well as refugia for mobile epibenthos such as Paguroidea or fish. Pidduck et al. (2017) highlight that rock dump material has the potential to act as an artificial reef supporting reef communities. The rate of colonisation of the rock protection material, if used, will be dependent on recruitment rates from local reproducing populations but is expected to be slow due to the slow growth, low recruitment rates and late maturity of deep, cold water assemblages (Cordes, 2016; Jones et al., 2012). However 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 CNS area.

Data taken from FeAST indicates that the resistance of seapens and burrowing megafauna communities (burrowed mud) habitat to sub-surface abrasion (e.g. the placement of subsea infrastructure, rock cover and concrete mattresses) and physical disturbance is assessed as low and recovery is medium, therefore overall sensitivity is assessed as medium (FeAST, 2025). In addition, FeAST indicates that the sensitivity of this habitat type to the physical change of habitat (e.g. long term presence of subsea infrastructure, rock and concrete mattresses) is high with a low tolerance and very low recovery potential (FeAST, 2025). As such, it is likely that the seapens and burrowing megafauna communities (burrowed mud) habitat could be adversely impacted by abrasion and habitat change caused by the installation of the subsea infrastructure, rock cover and concrete mattresses at Kyla, Bittern and along the proposed pipeline route.

With regards to ocean quahog, data taken from FeAST indicates that the species has a high sensitivity to sub-surface abrasions / penetration (i.e. installation of subsea infrastructure, rock cover and concrete mattresses). In addition, FeAST indicates that the sensitivity of this species to the physical change of habitat (e.g. long term presence of subsea infrastructure, rock and concrete mattresses) is high as the change in habitat is likely to result in the habitat being unsuitable (Tillin et al., 2010; FeAST, 2025). As such, there is a possibility that ocean quahog could be impacted by the installation of subsea infrastructure, rock cover and concrete mattresses.

Overall, the introduction of novel hard substrata by the Kyla Development is very small and localised (confined to an area of ca. 0.115 km^2 in the highest impact case) 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 the majority of seabed communities to long term impacts from the installation of seabed infrastructure, rock cover and concrete mattresses as a result of the Kyla Development is considered to be **High** 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

Medium as there will be a permanent change to the habitat type, which will last for as long as the subsea infrastructure, rock cover and concrete mattresses remain in place. Ocean quahog and the seapens and burrowing megafauna habitat are the exception to this, being of **Very High** sensitivity, with Very High value. They also have a Low resistance and resilience respectively to sub-surface abrasion and physical change to the habitat (the installation of seabed infrastructure, rock cover and concrete mattresses). The magnitude of impact is predicted to be **Minor** as although the impact will last the duration of the Kyla Development, these effects will be limited to a very small area (0.115 km^2). Effects on seabed communities from installation of seabed infrastructure, rock cover and concrete mattresses are therefore assessed as **Minor** and not significant, given that any change to the benthic environment will be localised and is not expected to cause any widespread changes to the marine life present in the area.

Fish and Shellfish

Temporary Impact

Increased turbidity caused by seabed disturbance from the installation of subsea infrastructure at the Kyla and Bittern locations, the installation of the pipelines and umbilical, the temporary initiation anchors and wires and the use of temporary laydown areas for wet storage in the proposed Kyla Development area may affect foraging behaviour of fish due to reduced visual acuity (Bakke et al., 2013) and could temporarily displace fish from their spawning and nursery areas. However, given the localised area of impact (ca. 0.623 km^2) and the mobile nature of the species, any displaced fish are likely to find foraging opportunities, as well as suitable spawning and nursery areas in adjacent locations. The spawning grounds within which the Kyla Development area is located is part of wider spawning grounds within the CNS and, as such, is not considered to be a key habitat for these fish species. As noted above, the Kyla 2025 survey also found the habitat was 'unsuitable' for both spawning herring and sandeels.

The sensitivity of fish and shellfish to the temporary seabed disturbance as a result of the Kyla subsea infrastructure installation is therefore considered to be **High**. Although the species present are typical of the wider area in this region of the CNS, anglerfish, blue whiting, cod, herring, ling, mackerel, Norway pout, sandeels, spurdog and whiting are listed as PMFs in Scottish waters, whereby this designation should seek to protect these features (see Section 4.3.3) and, as such, are of Very High value, but the overall resistance and resilience is also 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 a relatively small area (0.623 km^2). Effects on fish and shellfish from the temporary seabed disturbance as a result of the Kyla Development are therefore assessed as **Minor** and not significant.

Long Term Impact

The physical presence of the Kyla Development subsea infrastructure, pipelines, rock and concrete 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. 0.115 km^2. However, the spawning grounds within which the Kyla Development area is located are part of wider spawning grounds and, as such, the area is not considered to be a key habitat for these fish species. In addition, the habitat within the proposed Kyla Development area is considered to be 'unsuitable' for both spawning herring and sandeels (refer to Section 4.3.2).

The sensitivity of spawning fish to the long term disturbance as a result of the installation of seabed infrastructure pipelines, rock cover and concrete mattresses as a result of the Kyla Development is considered to be **High** Although the species present are typical of the wider area in this region of the CNS, anglerfish, blue whiting, cod, herring, ling, mackerel, Norway pout, sandeels, spurdog and whiting are listed as PMFs in Scottish waters, whereby this designation should seek to protect these features (see Section 4.3.3) and, as such, are of Very High value, but the overall resistance and resilience is also 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 due to the very small area affected (0.115 km^2). Effects on spawning fish from the installation of subsea infrastructure, rock cover and concrete mattresses are therefore assessed as **Negligible** and not significant.

7.4 Mitigation Measures

Seabed disturbance impacts as a result of the proposed Kyla Development will be minimised by the implementation of the following mitigation measures:

- Use the optimised number of MODU anchors and length of ground chains to maintain stability and integrity.
- MODU anchors will be set at the optimum angle for the local seabed sediments, reducing the potential drag across the seabed and helping them to become suitably embedded;
- The MODU mooring system (anchors and chains) will be placed in accordance with site survey results so as to prevent damage to sensitive seabed habitats.
- 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).
- If deemed feasible, thermal cuttings treatment will be used to treat the LTOBM contaminated cuttings from Kyla to an acceptable overboard disposal limit (<1% oil on cuttings) or alternatively LTOBM cuttings will be skipped and shipped for disposal onshore.
- A ROV and chemical dye will be used to monitor cement returns when cementing both the conductor and 20" casing to help ensure the volume of cement discharged to the seabed is kept at a minimum.
- Route selection and optimisation will be based on acquired Environmental, Geophysical, and Geotechnical survey data.
- The width of the working corridors during pipeline and umbilical installation operations will be minimised as far as possible.
- Any boulders removed from the pipelines and umbilical lay corridors will be placed appropriately on the seabed to avoid a snag hazard and their as-left position recorded.
- Use of DP installation vessels (where applicable) as opposed to anchored vessels.
- Rock will be deployed from a DP rock dumping vessel using a fall pipe and the rate and locations of deployment will be controlled on board the vessel and monitored using high resolution survey / sonar equipment.
- Size of subsea infrastructure will be optimised for the Kyla Development.
- Subsea infrastructure layout, trench transitions and pipeline crossing designs optimised to minimise material deposited.
- Monitoring of integrity of subsea infrastructure, including the pipelines / umbilical and stabilisation material throughout production operations and taking remedial action, if required.
- 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 water quality, seabed sediments, seabed communities or fish are predicted as a result of disturbance to the seabed during the life of the Kyla Development. The highest impact case total area of seabed that will be directly impacted temporarily by the Kyla Development is estimated at around 0.819 km^2, and the highest impact case total area of seabed that will be directly impacted in the long term by the Kyla Development is estimated at around 0.115 km^2. This is a relatively small area in comparison to the seabed available in the CNS region, with similar water depths, sediment types and benthic communities. It is, however, recognised that some aspects associated with the Kyla Development (i.e. installation of the subsea structures, UHB mitigation and rock / mattress protection) 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 Kyla Development lies approximately 72 km to the south west of the UK / Norway median line at its closest point. The environment within which the proposed Kyla Development area is located is relatively stable compared to other more heterogeneous and transient areas such as the SNS. In the highest impact case, impacts arising from the Kyla Development extend out to 0.33 km from the east most point within the development area (drill cuttings from the well location) and therefore will not cross over the transboundary line. As such, significant transboundary impacts caused by seabed disturbance are not predicted.

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 Kyla Development is located within an area of low fishing intensity for demersal species. However, the majority of fishing activities are carried out using demersal gear, 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 (DESNZ, 2022).

The proposed Kyla Development lies within an area of moderate to high oil and gas activity (refer to Section 4.4.3) and will tie back into an existing Bittern subsea manifold located 12 to 13.2 km northwest of the proposed Kyla well location. Apart from Bittern, the closest producing field to Kyla is the Starling subsea gas field (operated by Shell UK), located in UKCS Block 29/3a approximately 12 km to the northeast, which is tied back to the Shearwater platform (refer to Section 4.4.4). The nearest Floating Production, Storage and Offloading Facility (FPSO) is the Triton FPSO (operated by Dana) which is located approximately 20 km northwest of the Bittern DCB manifold and 30 km northwest of the proposed Kyla well. The next nearest FPSO is the Catcher FPSO (operated by BW Offshore) which is located approximately 24 km southwest of the Bittern DCA manifold. The nearest platform to the Bittern DCB manifold is the Gannet A platform (operated by Shell UK) located approximately 30 km north. The nearest platform to the proposed Kyla well is the West Franklin WHP (operated by Total Energies) which is located approximately 36 km northeast. The Belinda field which is currently in development is located approximately 14 km north of the Bittern DCB manifold and 24 km northwest of the proposed Kyla well (refer to Section 4.4.4).

As the majority of these fields are currently producing, excluding Belinda which will achieve first oil before the Kyla Development operations begin, 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.

In addition, the Kyla Development will take place within the vicinity of the historic Kyle field. The proposed Kyla Development is located ca. 0.3 km from the closest historic Kyle well (refer to Section 4.4.4). Although the cuttings discharge may extend out to 0.33 km, it is unlikely that significant cumulative impacts will arise as a multibeam echosounder geophysical survey of the Kyle Field undertaken as part of the pre-decommissioning survey scope did not identify a discernible physical

cuttings pile. The historic cuttings piles are believed to have dispersed and now lie flush with the seabed. Seabed samples taken during the pre-decommissioning survey of the Kyle field do show a chemical footprint (elevated THC levels) covering an area of 1,432 m^2; however, this elevation is not considered to be significant contamination (Fugro, 2020; CNRI, 2021). In addition, recent survey results show all stations within the vicinity of the proposed Kyla Development area have recorded THC and heavy metal concentrations that are considered consistent with background concentrations (Gardline, 2025b).

There are no operational, under construction or consented offshore windfarms in the vicinity of the proposed Kyla Development area. The closest offshore windfarm is the Cerulean Winds Cedar Project, currently in the pre-planning stage, located approximately 9.5 km southwest of the Kyla Development (refer to Section 4.4.5). The next closest windfarm is the Cenos Offshore Wind Farm, currently in the planning stage, which would be located approximately 15.5 km northeast of the Kyla Development. Construction at this wind farm is not scheduled to begin until 2030, which would be after first gas is achieved at the Kyla Development. As such it is unlikely that there will be any significant cumulative impacts with respect to seabed disturbance and offshore wind development activities.

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.

This section assesses whether the underwater noise emissions generated by the Kyla Development has the potential to result in a significant disturbance, or cause injury to, sensitive marine fauna.

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 therefore also assesses if the Kyla Development 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 Kyla Noise Sources

Development activities identified in the ENVID workshop which result in underwater noise emissions with the potential to result in significant effects on marine fauna were limited to the noise generated from potential piling operations during the installation of the valve skid at the proposed Kyla well location and the tie-in structure, if required, at the Bittern manifold.

It is assumed that both the valve skid and tie-in structure would be held in place by four tubular piles each, one at each corner, each with a diameter of 24-inch and length of up to 24 m. The piles would be secured into the seabed using a maximum hammer blow energy of 90 kJ, with a maximum blow rate of 50 blows per minute. It is expected that the hammering operations for each pile will be ongoing for up to two hours. A soft start is assumed with a ramp up from 30% energy to full energy over 5 minutes, with a reduced blow rate of 6 strikes per minute. Each pile is estimated to take 2 hours to install, giving a total maximum piling duration of 8 hours for each structure.

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.

It is acknowledged that the vessels associated with drilling, subsea installation, inspection and maintenance and decommissioning for the Kyla Development will also generate underwater noise of a continuous (non-impulsive) nature.

The MODU used to drill the Kyla well will be held in place through the use of anchors and mooring chains, but will also operate a DP system, when necessary. The DP thrusters continually produce cavitation bubbles that, when they implode, leads to the generation of underwater noise (Fischer, 2000; Wyatt, 2008). In addition to the noise produced from the thrusters, sound will also propagate from rotating machinery such as generators, pumps and the drilling unit and risers (McCauley, 1994). 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.

For other vessels, sound levels and frequency characteristics are roughly related to ship size and speed, but there is significant individual variation among vessels of similar classes. Large vessels (greater than 100 m length) typically have sound pressure levels (SPLs) 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, 2009). 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 kilohertz (kHz), typically within the 50-300 hertz (Hz) range, although cavitation from propellers produces sounds at frequencies of between 1 kHz and 125 kHz (Genesis 2011; Hermannsen et al. 2014).

The noise emissions from construction activities e.g. trenching or rock placement, are usually dwarfed by the noise emissions from the vessels themselves (DECC, 2011).

There is evidence that vessel traffic may influence marine mammals in several ways, with reported responses including avoidance, changes in swimming and surfacing patterns, alteration of the intensity and frequency of calls and increases in stress-related hormones (Erbe et al., 2019, Veirs et al. 2016, Rolland et al. 2012 and Dyndo et al. 2015). Harbour porpoise and minke whale have been shown to respond to vessels by moving away from them, while some other species, such as common dolphin, have shown attraction (Palka & Hammond, 2001). In addition, fish have been shown to avoid vessel traffic through diving, horizontal movements and tilting behaviours (De Robertis and Handegard, 2013). However, although vessel noise may cause localised changes in distribution of marine mammals and fish in the immediate vicinity of the vessel, the limited temporal scale of vessel use means these small-scale changes will not result in population level effects and therefore no significant impacts are predicted.

Given the above, this assessment is focused on the potential impact to marine fauna from the proposed piling operations as the impulsive nature of the sound produced from 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. The modelling has assumed that piling operations will adhere to the following schedule for each pile:

- 15 blows at 30% energy (27 kJ), delivered at a strike rate of 6 strikes per minute, over a period of 2.5 minutes;
- 15 blows at 60% energy (54 kJ), delivered at a strike rate of 6 strikes per minute, over a period of 2.5 minutes;
- 5,750 blows at 100% energy (90 kJ), delivered at a strike rate 50 strikes per minute, over a period of 1 hour and 55 minutes.

Within a 24-hour period, this schedule is repeated 4 times (once for each pile), giving a total maximum piling duration of 8 hours. The apparent source levels, based off direct measurements of similar piling operations, are presented in Table 8.1.

Table 8.1: Piling Source Levels for different impact piling energies used in the piling sequence (Subacoustech, 2025)

Blow Energy	Estimated Source Level (@ 1m) Note 1, Note 2	
	$L_{p,pk}$ (dB re 1 µPa)	$L_{E,p,ss}$ (dB re 1 µPa^{2}s)
30 % (27 kJ)	204.2	189.6
60 % (54 kJ)	211.9	192.7
100 % (90 kJ)	216.7	194.8

Note 1 $L_{p,pk}$ = Sound Pressure Level peak, the highest (zero-peak) positive or negative sound pressure, in decibels. $L_{E,p,ss}$ = Sound Exposure Level (SEL), single strike, calculation of the sound exposure level representative of a single noise impulse.

Note 2 "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.

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.

In order to estimate the received sound pressure levels from the proposed piling operations in the waters surrounding Kyla and Bittern, 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). A copy of the underwater noise modelling report is provided for reference in Appendix D.

Modelling of underwater noise is complex and can be approached in several different ways. For this assessment, a numerical approach has been used based on two different solvers using the dBSea modelling software:

- A parabolic equation (PE) method for lower frequencies (12.5 Hz to 250 Hz); and
- A ray tracing method for higher frequencies (315 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, 1991).

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, 2025). A summary of the key input parameters is provided in Table 8.2.

Table 8.2: Modelling Input Parameters

Input Parameter	Kyla Piling Data
Modelling Location [1]	56°53'0.43"N; 1°13'49.04"E (ED50)
Location Depth	91 m
Piling Parameters	Pile: 0.61 m (24-inch) diameter x 24 m length, installed to a depth of 20 m. Maximum hammer blow energy: 90 kJ
Source Depth Below Surface	79 m (midpoint of pile above the seabed)
Source Level (Maximum)	$L_{p,pk}$: 216.7 dB re 1 µPa @ 1 m $L_{E,p,ss}$: 194.8 dB re 1 µPa^{2}s @ 1 m

[1] Modelling was undertaken at the proposed Kyla valve skid location only. However, the results are also applicable to the proposed tie-in structure location given the similarity in water depth and the homogeneous nature of the sediment type at the Kyla and Bittern locations.

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 swim bladder, 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 Kyla Development is dominated by demersal species such as dab, long rough dab, whiting, haddock and plaice. Species such as anglerfish, blue whiting, European hake, haddock, herring, lemon sole, ling, mackerel, Norway pout, plaice, spurdog, and whiting are also predicted to have nursery and spawning grounds within the vicinity of the Kyla Development area. Although Ellis *et al.,* 2012 show mapped spawning areas for cod and sandeels, the Scottish NMPi indicates that the Kyla area is unlikely to offer suitable spawning habitat for these species. In addition, elasmobranch species such as cuckoo skate, lesser-spotted dogfish / small spotted catshark and starry ray / thorny skate may be present in the area (see Section 4.3.3).

The majority of the above listed species have a swim bladder which is either in close proximity, or mechanically connected to the ears and would therefore be classified as Category III fish. Category III fish that utilise the Kyla Development area include blue whiting, cod, European hake, haddock, herring, ling, Norway pout, sprat and whiting. Although, Category III fish are more sensitive to noise, in general, marine species 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).

Potential effects on fish from impulsive noise sources, such as those from piling operations, 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 criteria from Popper et al. (2014) for pile driving (see Table 8.3).

Table 8.3: Popper *et al.* (2014) Criteria for Pile Driving – Quantitative and Qualitative [1, 2, 3]

Fish Category	Mortality and Potential Mortal Injury	Impairment			Behaviour
		Recoverable Injury	Temporary Threshold Shift (TTS)	Masking	
Category I fish	>219 $L_{E,p}$ >213 $L_{p,pk}$	>216 $L_{E,p}$ >213 $L_{p,pk}$	>>186 $L_{E,p}$	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Category II fish	210 $L_{E,p}$ >207 $L_{p,pk}$	203 $L_{E,p}$ >207 $L_{p,pk}$	>186 $L_{E,p}$	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Category III fish	207 $L_{E,p}$ >207 $L_{p,pk}$	203 $L_{E,p}$ >207 $L_{p,pk}$	186 $L_{E,p}$	(N) High (I) High (F) Moderate	(N) High (I) High (F) Moderate
Eggs and larvae	>210 dB $L_{E,p}$ >207 $L_{p,pk}$	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low

[1] N = Near-field, I = Intermediate-field, F = Far-field

[2] Where insufficient data on impacts are available (which is the case for masking and behavioural effects from pile driving), 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 not investigated further.

[3] $L_{p,pk}$ = peak SPL and $L_{E,p}$ = SEL

Where cumulative thresholds are required for fish, both a stationary and fleeing animal model has been used. Most species described by Popper et al. (2014) are likely to move away from a sound that is loud enough to cause harm (Dahl et al., 2015; Popper et al., 2014). For those species that flee, a speed of 1.5 ms^{-1} (based on Hirata, 1999) is considered a conservative speed at which to base a fleeing animal model. However, considering the diversity of species described by Popper et al. (2014), whether an animal flees or remains stationary in response to a loud noise will differ between species. It is recognised that there is limited evidence for fish fleeing from high level noise sources in the wild. Those species that are likely to remain stationary are thought more likely to be benthic species or species without a swim bladder, due to their reduced hearing capabilities making these species the least sensitive to noise (e.g., Goertner et al., 1994, 1978; Stephenson et al., 2010; Halvorsen et al., 2012). Despite this, including only a stationary animal model as a worst-case scenario is likely to greatly overestimate the potential risk to fish species. Therefore, this assessment considers impact ranges from both fleeing and stationary receptors.

Table 8.4 gives the predicted maximum impact ranges for species of fish as a result of the underwater noise generated from the proposed piling operations, using the Popper et al. (2014) criteria. The peak SPL ($L_{p,pk}$) maximum impact ranges have been modelled for the first strike of the piling operations (30 % energy) and a strike a maximum energy (100 % energy) (Subacoustech, 2025).

Table 8.4: Predicted Maximum Impact Ranges for Fish (from Pile Driving), based on Popper et al., 2014 Thresholds (Subacoustech, 2025) [1]

Criteria [3]	Maximum Impact Range [2]		
	Category I fish	Category II fish	Category III fish
Mortality and Potential Mortal Injury			
$L_{p,pk}$ at first strike (30 % Energy)	< 10 m	< 10 m	< 10 m
$L_{p,pk}$ at maximum energy (100 % Energy)	< 10 m	< 10 m	< 10 m
$L_{E,p,24h}$ (Fleeing 1.5 ms^{-1})	< 10 m	< 10 m	< 10 m
$L_{E,p,24h}$ (Stationary)	30 m	110 m	180 m
Recoverable Injury			
$L_{p,pk}$ at first strike (30 % Energy)	< 10 m	< 10 m	< 10 m
$L_{p,pk}$ at maximum energy (100 % Energy)	< 10 m	< 10 m	< 10 m
$L_{E,p,24h}$ (Fleeing 1.5 ms^{-1})	< 10 m	< 10 m	< 10 m
$L_{E,p,24h}$ (Stationary)	40 m	310 m	310 m
Temporary Threshold Shift (TTS)			
$L_{p,pk}$ at first strike (30 % Energy)	-	-	-
$L_{p,pk}$ at maximum energy (100 % Energy)	-	-	-
$L_{E,p,24h}$ (Fleeing 1.5 ms^{-1})	10 m	10 m	10 m
$L_{E,p,24h}$ (Stationary)	3,900 m	3,900 m	3,900 m

Notes

[1] For Popper et al., 2014 Thresholds see Table 8.3.

[2] Values and impact ranges below 10 m have not been presented as the modelling processes are unable to specify any greater level of accuracy at these ranges with confidence.

[3] $L_{p,pk}$ = peak SPL and $L_{E,p}$ = SEL

It can be seen from Table 8.4 that according to the peak sound pressure level ($L_{p,pk}$) metric, the largest predicted range for the threshold of mortality does not differ between fish categories and is predicted at less than 10 m from the piling operations.

Using the sound exposure level (SEL) across the entire piling sequence ($L_{E,p,24h}$) metric (8 hours of piling in 24 hours), the largest predicted range for the threshold for mortality also does not differ between fish categories and is predicted at less than 10 m from the piling operations if they are assumed to flee from the source. If they are assumed to remain stationary, the largest predicted range for mortality is for fish with a swim bladder involved in hearing (Category III fish) at 180 m from the piling operations.

Using the sound exposure level ($L_{E,p,24h}$) metric, the largest predicted range for the threshold for recoverable injury is predicted for fish with a swim bladder (involved and not involved in hearing) at 310 m from the piling operations, if they are assumed to remain stationary. Using the sound exposure level ($L_{E,p,24h}$) metric, the largest predicted range for the threshold of Temporary Threshold Shift (TTS) is at 10 m (all fish categories), if they are assumed to flee from the source, and is at 3.9 km from the piling operations (all fish categories), if they are assumed to remain stationary. However, it is worth noting 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, 2025).

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 Kyla Development have been

identified as spawning and nursery grounds for a number of fish species (refer to Section 4.3.3). However, the area likely to be impacted by the proposed piling operations 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 approximately 48 hours) they will not be conducted over an entire spawning / nursery 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 many of the species that may be present in the Kyla Development area (e.g. anglerfish, blue whiting, cod, herring, ling, mackerel, Norway pout, sandeels, spurdog and whiting) are listed as Priority Marine Features (PMFs) in Scottish waters (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 short, with piling operations anticipated to only be ongoing for approximately 48 hours in total, with only 8 hours of piling per 24-hour period. With the implementation of a soft-start procedure (refer to Section 8.3), it is expected that the majority of fish in the area would be able to 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.

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 Impacts 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 in the CNS.

Table 8.5: Marine Mammal Hearing Groups and their Generalised Hearing Range (Southall et al., 2019)

Functional Group	Estimated Auditory Bandwidth	Marine Mammal Species Found in the CNS [1]
Low-frequency (LF) cetaceans	7 Hz – 35 kHz	Minke whale, fin whale
High-frequency (HF) cetaceans	150 Hz – 160 kHz	White-sided dolphin, white-beaked dolphin, common dolphin, Risso's dolphin, killer whale, bottlenose dolphin
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 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, whereas drilling, as well as other more low-level, continuous noises, such as that generated by vessel activity, are considered non-impulsive. These differences are important to consider regarding the potential for auditory injury, as impulsive noise is generally more injurious than non-impulsive noise.

Southall et al. (2019) also presents single pulse, unweighted peak sound pressure level ($L_{p,pk}$) and cumulative weighted sound exposure level ($L_{E,24h,wtd}$) criteria for both onset of PTS and TTS . To account for the fact that different species groups use and hear sound differently, the thresholds in the cumulative weighted sound exposure level 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.

The predicted maximum PTS and TTS impacts ranges using the impulsive criteria for marine mammals for the noise associated with the proposed piling operations are summarised in Table 8.6. The $L_{p,pk}$ maximum impact ranges have been modelled for the first strike of the piling operations (30 % energy) and a strike a maximum energy (100 % energy) (Subacoustech, 2025).

Hastie et al. (2019) found that impulsive sound can be considered non-impulsive 3.5 km from the source, while Southall (2021) suggests noise should be non-impulsive if energy above 10 kHz is absent. Since impact piling is an impulsive noise source that is likely to propagate more than 3.5 km from the source, the true impact range is likely to lie between the impulsive and non-impulsive ranges. Thus, this study considered the impulsive and non-impulsive sound criteria for marine mammal PTS and TTS thresholds from Southall et al. (2019).

Table 8.6: Predicted Marine Mammal PTS / TTS Maximum Impact Ranges, based on Southall et al. (2019) Impulsive and Non-impulsive criteria (Subacoustech, 2025) [1]

Hearing Group [2]	Threshold (Unweighted $L_{p,pk}$)	Max Impact Range (30 % Energy)	Threshold (Unweighted $L_{p,pk}$)	Max Impact Range (Maximum Energy)	Impulsive Threshold (Weighted $L_{E,24h,wtd}$) [4]	Max Impact Range	Non-impulsive Threshold (Weighted $L_{E,24h,wtd}$) [4]	Max Impact Range
PTS Onset (Impulsive)								
LF cetaceans	219 dB	NE	219 dB	NE	183 dB	10 m	199	< 10 m
HF cetaceans	230 dB	NE	230 dB	NE	185 dB	< 10 m	198	< 10 m
VHF cetaceans	202 dB	< 10 m	202 dB	20 m	155 dB	10 m	173	< 10 m
PCW	218 dB	NE	218 dB	NE	185 dB	10 m	201	< 10 m
TTS Onset (Impulsive)								
LF cetaceans	213 dB	NE	213 dB	< 10 m	168 dB	8,800 m	179	80 m
HF cetaceans	224 dB	NE	224 dB	NE	170 dB	< 10 m	178	< 10 m
VHF cetaceans	196 dB	< 10 m	196 dB	40 m	140 dB	3,400 m	153	30 m
PCW	212 dB	NE	212 dB	< 10 m	170 dB	70 m	181	< 10 m

[1] Values and impact ranges below 10 m have not been presented as the modelling processes are unable to specify any greater level of accuracy at these ranges with confidence.
[2] LF = Low-frequency, HF = High-frequency, VHF = Very high-frequency and PCW = Phocid carnivores in water (see generalised hearing ranges in Table 8.5).
[3] NE = No Exceedance
[4] For the $L_{E,24h,wtd}$ modelling a fleeing animal model has been assumed. The fleeing animal model assumes that marine mammals flee from the source at a constant rate of 1.5 ms^{-1} (Otani et al., 2000), with the exception of LF cetaceans, which flee at a rate of 3.25 ms^{-1} (Blix and Folkow, 1995).

Using the unweighted peak sound pressure level ($L_{p,pk}$) criteria, the very high frequency (VHF) cetacean group are predicted to have the largest PTS impact ranges, with animals within 20 m of the proposed piling operations at maximum energy likely to exceed the PTS threshold for VHF cetaceans.

When the weighted cumulative sound exposure level ($L_{E,24h,wtd}$) criteria for impulsive noise is applied to the predicted noise contours, the low frequency (LF) and VHF cetacean groups and PCWs are predicted to have the largest PTS impact ranges. Animals within 10 m of the piling operations are predicted to exceed the PTS threshold for LF and VHF cetaceans and PCWs, under the impulsive criteria. This assumes that the pile driving equipment is continuously operational for 24 hours, and that the animals flee away from the noise source at a constant speed.

When the weighted cumulative SEL ($L_{E,24h,wtd}$) criteria for non-impulsive noise is applied to the predicted noise contours, the LF and VHF cetacean groups and PCWs are predicted to have the largest PTS impact ranges. Animals within less than 10 m of the piling operations are predicted to exceed the PTS threshold for LF and VHF cetaceans and PCWs, under the non-impulsive criteria. This assumes that the pile driving equipment is continuously operational for 24 hours, and that the animals flee away from the noise source at a constant speed.

To put the modelling results into context, Table 8.7 calculates the number of animals which may be exposed to PTS / TTS onset using the density and abundance estimates from the MMMU of relevance to the Kyla Development (refer to Section 4.3.5). Note estimated density and abundance is only available for those species which are commonly observed in this region of the North Sea. The number of harbour seals and grey seals has not been calculated due to the extremely low density (0.00% of the at-sea population per 25 km^2) found in the vicinity of Kyla.

It can be seen from Table 8.7 that for the majority of 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. However, using the impact ranges from the weighted cumulative impulsive criteria, ca. 19 harbour porpoises and 3 minke whales could experience a temporary, recoverable reduction in hearing sensitivity (TTS). These numbers are small enough that there would be no effect at the population level, based on the percentage of the corresponding reference population potentially impacted, and the fact that these individuals are likely to recover.

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 **Moderate**, 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 48 hours, with piling operations occurring for only 8 hours within a 24-hour 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 **Moderate** 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. Soft-starts will also be incorporated into the piling schedule design (see Section 8.3). Residual effects on marine mammals are therefore reduced to **Minor** and would not be significant.

Table 8.7: Estimated Number of Animals Potentially Experiencing PTS / TTS from the proposed Kyla Piling Operations [1, 2, 3, 4]

Species	Management Unit	Abundance	Estimated Density in Area (animals / km²)	Southall et al. (2019) Unweighted $L_{p,pk}$ criteria (Maximum Energy)				Southall et al. (2019) Impulsive Weighted $L_{E,24h,wtd}$ criteria (fleeing)				Southall et al. (2019) Non-impulsive Weighted LE,24h,wtd criteria (fleeing)			
				PTS		TTS		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	Max number of animals impacted	Approx. % of reference population	Max number of animals impacted	Approx. % of reference population
Harbour porpoise	North Sea (678,206 km²)	346,601	0.511	< 1	<0.0003	< 1	<0.0003	< 1	<0.0003	< 19	<0.005	< 1	<0.0003	< 1	<0.0003
Bottlenose dolphin	Greater North Sea (639,886 km²)	2,022	0.003	NE	0	NE	0	< 1	< 0.05	< 1	< 0.05	< 1	< 0.05	< 1	< 0.05
Risso's dolphin	Celtic and Greater North Seas (1,560,875 km²)	12,262	0.007	NE	0	NE	0	< 1	<0.008	< 1	<0.008	< 1	<0.008	< 1	<0.008
Common dolphin		102,656	0.065	NE	0	NE	0	< 1	< 0.001	< 1	< 0.001	< 1	< 0.001	< 1	< 0.001
Minke whale		20,118	0.012	NE	0	< 1	<0.005	< 1	<0.005	< 3	< 0.02	< 1	<0.005	< 1	<0.005
White-beaked dolphin		43,951	0.028	NE	0	NE	0	< 1	<0.002	< 1	<0.002	< 1	<0.002	< 1	<0.002
White-sided dolphin		18,128	0.011	NE	0	NE	0	< 1	<0.006	< 1	<0.006	< 1	<0.006	< 1	<0.006

Notes

[1] See Section 4.3.5 for MMMU abundance and population data; taken from IAMMWG (2022).

[2] Calculation method based on Southall et al. (2007) as recommended by JNCC (2010a): impact area x density

[3] Max number of animals impacted has been rounded up to a whole number.

[4] NE = No exceedance

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. For Special Areas of Conservation (SACs) in UK waters, a minimum Effective Deterrent Range (EDR) of 20 km has been proposed by the Joint Nature Conservation Committee (JNCC) for assessing the significance of noise disturbance to harbour porpoise (VHF cetacean) from pin piling operations (JNCC, 2025). This value is based on a review study carried out by Brown et al. (2025). In the absence of agreed metrics for measuring marine mammal disturbance outside of SACs, an EDR of 20 km has been applied for all species in this assessment.

Using an EDR of 20 km, Table 8.8 calculates the number of animals which may experience some sort of behavioural impact using the density and abundance estimates from the MMMUs of relevance to the Kyla Development area.

Table 8.8: Estimated Number of Animals Potentially Experiencing Behavioural Impacts from the Proposed Kyla Piling Operations [1,2]

Species	Management Units	MMMU Data (IAMMWG, 2022)		Behavioural Changes	
		Abundance	Estimated Density in Area (animals / km^2)	Max number of animals impacted	Approx. % of reference population
Harbour porpoise	North Sea (678,206 km^2)	346,601	0.511	< 643	0.186
Bottlenose dolphin	Greater North Sea (639,886 km^2)	2,022	0.003	< 4	0.198
Risso's dolphin	Celtic and Greater North Seas (1,560,875 km^2)	12,262	0.007	< 9	0.073
Common dolphin		102,656	0.065	< 82	0.080
Minke whale		20,118	0.012	< 16	0.080
White-beaked dolphin		43,951	0.028	< 36	0.082
White-sided dolphin		18,128	0.011	< 14	0.077

[1] See Section 4.3.5 for MMMU abundance and population data.
[2] Calculation method based on Southall et al. (2007) as recommended by JNCC (2010a): impact area x density

It can be seen from Table 8.8 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 4 for bottlenose dolphin to less than 643 for harbour porpoise, the percentage of the corresponding reference population impacted is comparatively low (less than 1%) for all species.

It should be noted, however, that the proposed piling operations will only be ongoing for approximately 48 hours, with pile driving occurring for only 8 hours within each 24-hour 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 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, mitigation measures will be implemented, as outlined in Section 8.3, to ensure behavioural impacts are minimised as much as possible.

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, Serica will ensure that the JNCC protocol for minimising the risk of injury to marine mammals from piling noise is followed (JNCC, 2010b).

With regards to a disturbance offence, this 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 proposed Kyla piling operations. 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. However, in order to minimise the risk of disturbance to an EPS, mitigation measures have been proposed in Section 8.3.

Given the above, the proposed Kyla piling operations will therefore not constitute an offence under The Conservation of Offshore Marine Habitats and Species Regulations 2017.

8.2.6 Potential Impacts on Seabirds

Direct effects on seabirds from the underwater noise generated during the proposed piling operations could occur through physical damage, or through disturbance of normal behaviour. The proposed Kyla Development is located within an important area for black-legged kittiwake, Atlantic puffin, northern gannet and northern fulmar in the breeding season. During the winter months, black-legged kittiwake, common guillemot, Atlantic puffin and northern fulmar are predicted to be found in comparatively higher densities within the vicinity of proposed Kyla Development, with guillemot also present during the post-dispersal period (refer to Section 4.3.4).

There is little information on the ability of seabirds to hear underwater, although it is thought that they have relatively poor hearing, with peak hearing sensitivity below 2 kHz (Dooling and Therrien, 2012). Surface diving seabirds are considered to be more at risk of underwater noise emissions as they spend longer periods of time below the water compared to seabirds which forage by surface feeding or plunge diving.

There is little research available regarding the impact of piling operations on seabirds. However, monitoring conducted during the construction of the Offshore Wind Farm Egmond aan Zee in the Dutch section of the North Sea demonstrated that pile driving activities caused temporary disturbance to local seabird populations, with diving species such as auks, divers, and sea ducks showing the strongest

avoidance behaviour. Terns and gulls were far less affected due to their feeding strategies and coastal distribution. Importantly, once pile driving ceased, seabirds returned to the area, and no evidence of long-term displacement or population decline was detected. The study concluded that while pile driving can disrupt seabird activity in the short term, it did not result in lasting ecological harm to seabird communities in the region (Leopold and Camphuysen, 2009).

Given the above, the sensitivity of seabirds to underwater noise from the proposed piling operations has been evaluated as **High**; seabirds are of international importance (Very High value) but any impacts are likely to be temporary caused by displacement, with the majority of birds likely to have vacated the area due to disturbance before the piling reaches maximum energy (High resistance and resilience). The magnitude of impact is predicted to be **Negligible** due to the short duration (48 hours, with only 8 hours of piling per 24-hours period) and limited scale of the proposed piling operations, with evidence indicating that seabirds will return to the area once the piling operations have ceased. In addition, there is alternative foraging habitat available to the seabirds in the wider area. Effects on seabirds as a result of the underwater noise emissions generated from the proposed piling operations are therefore **Negligible**.

8.3 Mitigation Measures

As noted in Section 8.2.4, the use of soft start procedures and at least a 500 m mitigation zone is important to reduce the overall impact of the proposed piling operations on marine mammals. Serica will therefore ensure that the piling operations follow the JNCC protocol for minimising the risk of injury to marine mammals from piling noise (JNCC, 2010b). Specifically, this will involve applying the following measures:

- Use of properly qualified, trained and equipped marine mammal observers (MMOs) or passive acoustic monitoring (PAM) operatives to detect marine mammals within a 500 m "mitigation zone" and potentially recommend a delay to piling operations. MMOs / PAM operatives 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;
- If piling is to be carried out at night or in poor visibility, PAM will be used to carry out the 30-minute pre-piling survey;
- If deploying PAM, Serica will also ensure that contractors implement the JNCC guidance for the use of Passive Acoustic Monitoring in UK waters (JNCC, 2023);
- 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; and
- Repeat of the pre-piling survey and soft-start whenever there is a break in piling of more than 10 minutes.

The use of soft-start procedures, as described above, is also likely to reduce the impact of acoustic emissions on other marine species as it allows mobile species, such as fish, to move out of the area of greatest impact.

8.4 Residual Effects

In summary, it is possible that short term behavioural effects may be observed among marine mammals, fish and seabirds as a result of the underwater noise emissions generated from the proposed Kyla Development, 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** to **Negligible** and not significant.

8.5 Transboundary Impacts

The Kyla Development lies approximately 72 km to the south west of the UK / Norway median 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 anticipated.

8.6 Cumulative Impacts

There is the potential for underwater noise emissions to have a cumulative impact on marine fauna, particularly on marine mammals, if impulsive noise was generated from other anthropogenic sources (e.g. seismic or piling from other CNS oil and gas activity or renewable energy activity) within a similar timeframe.

There are no operational, under construction or consented offshore windfarms in the vicinity of the proposed Kyla Development area. The closest offshore windfarm is the Cerulean Winds Cedar Project, currently in the pre-planning stage, located approximately 9.5 km southwest of the Kyla Development (refer to Section 4.4.5). The next closest windfarm is the Cenos Offshore Wind Farm, currently in the planning stage, which would be located approximately 15.5 km northeast of the Kyla Development. Construction at this wind farm is not scheduled to begin until 2030.

The other oil and gas developments in the area may also be undertaking noisy activities which have the potential to act cumulatively with the Kyla Development in increasing injury risk to fish, marine mammals and seabirds. However, given the mitigation measures which will be in place for the Kyla Development, simultaneous noisy activity should not act in combination with any other development to produce significant cumulative effects.

9 Greenhouse Gas Emissions

9.1 Introduction

This section assesses the significance of the likely effects of GHG emissions generated by the proposed Kyla Development, namely CO_2, CH_4 and N_2O, on the climate. This is in accordance with the DESNZ supplementary EIA guidance for assessing the effects of downstream Scope 3 emissions on climate from offshore oil and gas projects (DESNZ, 2025c), published following the Finch judgment, 2024[1].

This section is structured as follows:

- **Section 9.2 (GHG Emissions Sources):** defines the direct and indirect GHG emissions sources arising from the Kyla Development.
- **Section 9.3 (Environmental Protection Objectives):** sets out the key international climate change agreements and UK climate legislation and policies designed to reduce GHG emissions and reach net zero by 2050.
- **Section 9.4 (UK Oil & Gas Industry - Net Zero Targets and Progress to Date):** describes the NSTD, a strategic partnership between the UK government and the offshore oil and gas industry to support the sector's shift toward net zero.
- **Section 9.5 (Serica's Approach to Decarbonisation):** presents Serica's approach to decarbonisation.
- **Section 9.6 (Assessment of Impacts):** assesses the impact of the GHG emissions generated from the proposed Kyla Development on the climate and the significance of any likely effects, using the principles set out in IEMA (2022). GHG emissions have been evaluated in the context of a global baseline scenario of GHGs, as described in Section 4.2.6, with consideration given to international climate change agreements, UK climate legislation and their associated emissions reduction pathways. The alternative concept options considered for the Kyla Development are explored in Section 2, but these would not materially affect the estimate of GHG emissions to be generated.
- **Section 9.7 (Mitigation measures):** identifies the measures available to Serica to avoid or reduce the GHG emissions generated by the Kyla Development.
- **Section 9.8 (Other Relevant Considerations):** provides information on how the proposed Kyla Development would contribute to the UK's energy security and economic growth, align with the UK Government's stated objectives for the future of the North Sea and enable a managed transition to net zero.
- **Section 9.9 (Residual Effects):** presents the residual effects which will remain after the implementation of the proposed mitigation measures.

9.2 GHG Emissions Sources

To help delineate direct and indirect emission sources, the GHG Protocol; a widely used international accounting tool for government and business leaders to understand, quantify, and manage GHG emissions, categorises GHG emissions into the following three 'scopes':

- Scope 1 covers direct GHG emissions from sources that are owned or controlled by the company;
- Scope 2 covers indirect GHG emissions generated from purchased or acquired electricity, steam, heat and cooling;

[1] Finch Judgment, 2024: UK's Supreme Court ruling in 2024 that a decision to grant planning permission for an onshore oil development project at a site in Surrey was unlawful, because downstream GHG emissions from the combustion of the oil produced were not assessed in the EIA as part of the planning decision.

- Scope 3 emissions include all other indirect GHG emissions that occur in a company's value chain, which are not directly controlled or owned by the company.

Table 9.1 categorises the GHG emissions which will be generated from the proposed Kyla Development into the relevant GHG Protocol scope, noting that Serica has control over its direct emissions and has limited or no influence over its indirect emissions, particularly those associated with the end use of sold hydrocarbons.

Table 9.1: GHG Emission Types, Scopes and Kyla Development Sources

Emissions Type	GHG Protocol Scope	Definition	Kyla Development GHG Emissions Sources
Direct emissions	Scope 1	Emissions from sources that are owned or controlled by the reporting company	• The incremental emissions from the Triton FPSO as a result of Kyla coming online, including fuel combustion for power generation and venting.
Indirect emissions	Scope 2	Emissions generated from purchased or acquired electricity, steam, heat and cooling	• Not applicable as electricity will not be purchased or acquired by Serica for the Kyla Development.
	Scope 3	All indirect emissions (not included in scope 2) that are a consequence of the activities of the reporting company, but occur at sources owned or controlled by another company	• Fuel burnt for power generation on the MODU, vessels and helicopters during drilling, installation, inspection, maintenance and decommissioning activities; • Further refinement, transportation and distribution of Kyla hydrocarbons once they leave Triton, but prior to end use of sold products; • Burning of the extracted Kyla hydrocarbons (i.e. end use of sold products, based on the presumption that all end use Kyla hydrocarbons are eventually combusted).

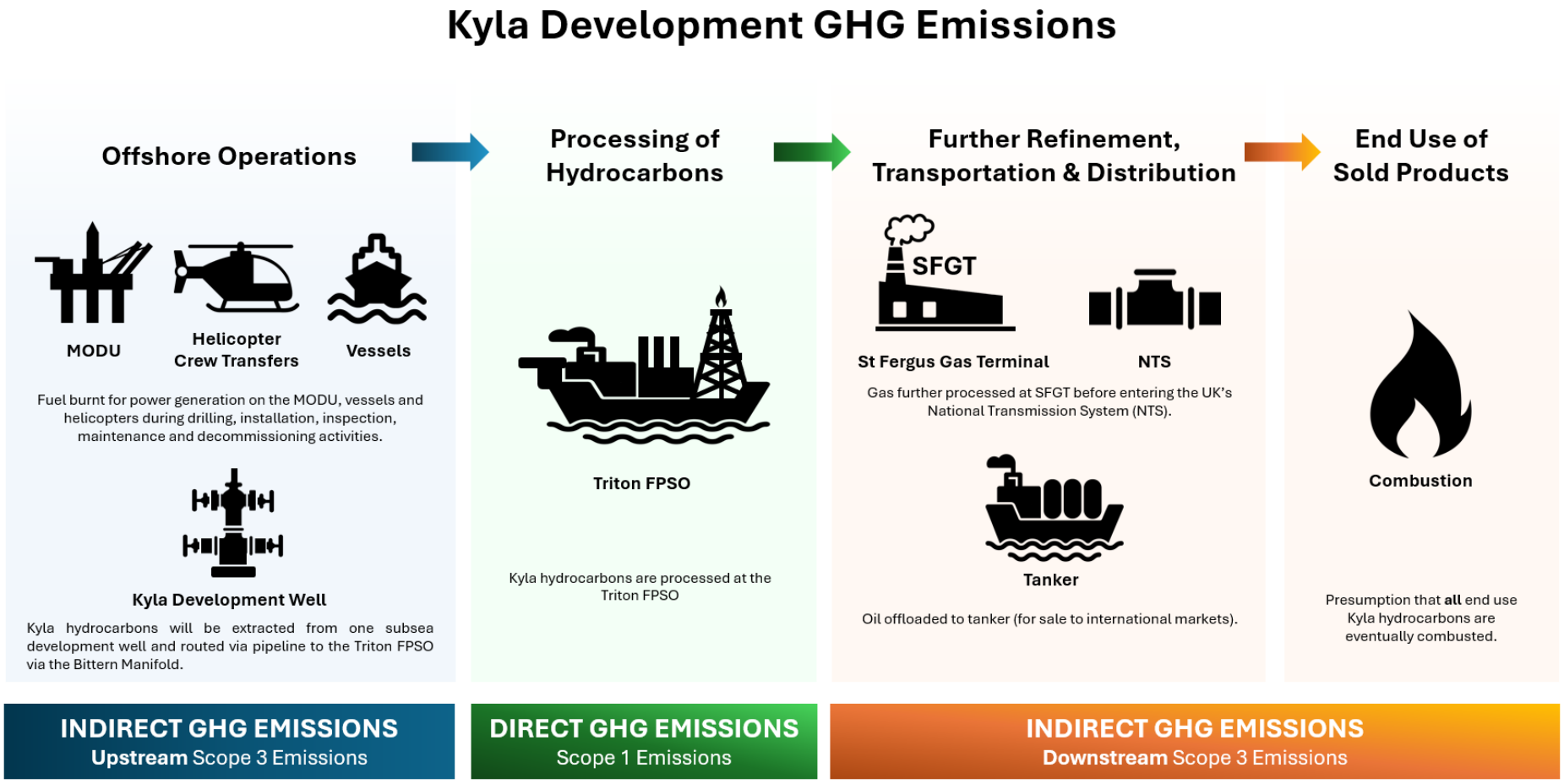
The GHG Protocol further divides Scope 3 emissions into distinct categories split between two main groups: upstream and downstream emissions.

For Kyla, Scope 3 upstream emissions are the indirect emissions which will be generated by Serica's contractors offshore when extracting, producing and exporting Kyla hydrocarbons to the Triton FPSO, as well as during offshore decommissioning operations upon cessation of production.

Scope 3 downstream emissions are the indirect emissions which will be generated once the Kyla hydrocarbons have been processed at the Triton FPSO and sold, including from transportation, further processing and distribution, as well as from the end use of the sold product (namely, the presumption that all end use Kyla hydrocarbons are eventually combusted). Of note, oil from Triton is typically tankered to Rotterdam where oil volumes are integrated into the wider European oil sales market. Gas from Triton is piped to the St Fergus terminal where it enters the UK's national transmission system.

Figure 9.1 provides an overview of the GHG emissions sources and GHG Protocol scopes relevant to the proposed Kyla Development value chain.

Figure 9.1: Overview of Kyla Development GHG Emission Sources and GHG Protocol Scopes over the Project Value Chain



9.3 Environmental Protection Objectives

Environmental Protection Objectives (EPOs) related to climate change are the international agreements and national legislation, which aim to mitigate climate change, with a target of reaching net zero[2] global GHG emissions. A summary of key climate change EPOs relevant to oil and gas projects has been provided below, along with applicable UK Government Net Zero strategies and sector specific policies and plans. These have been considered when assessing the impact of the proposed Kyla Development's GHG emissions on the global climate.

9.3.1 International Agreements

The UNFCCC signed in 1992, is the principal global treaty for coordinating international responses to climate change. It entered into force in March 1994 and has been ratified by 197 countries. COP, which meets annually, is the supreme decision-making body of the UNFCCC and relies on the scientific assessments of the IPCC to inform its decisions and guide negotiations. The IPCC produces co-ordinated assessments of climate science, the social and economic impacts of climate change, and potential response strategies, achieving this through a series of assessment cycles. The 6th IPCC assessment report cycle concluded in March 2023, the conclusions from which have been used to inform this assessment.

The Kyoto Protocol was the first global initiative to minimise GHG emissions, adopted at COP3 in 1997 and ratified by the UK in May 2002. It set legally binding targets for developed, industrialised countries to reduce their GHG emissions on average by 5% by 2012 (in relation to 1990), followed by a second commitment period to reduce emissions on average by 18% by 2020 (in relation to 1990).

Building upon this, the Paris Agreement was adopted in 2015 and requires all major GHG emitting countries to reduce their emissions. The aim of the Paris Agreement is to restrict global temperature change to well under 2°C above pre-industrial levels and pursue efforts to keep it below 1.5°C. The Agreement also established NDCs, which describe individual countries' climate action plans. The UK ratified the Paris Agreement in November 2016.

The United Nations SDGs were established to promote peace, prosperity, and environmental protection by 2030. These goals were adopted by all UN Member States in 2015 as part of the 2030 Agenda for Sustainable Development. The Paris Agreement is explicitly referenced in SDG 13 (Climate Action), which is focused on limiting and adapting to climate change (United Nations, 2025).

9.3.2 UK Climate Change Legislation

The Climate Change Act 2008 (as amended) sets a legal requirement to achieve a 100% reduction in net GHG emissions by 2050 relative to 1990 levels ('net zero') and delivers on the commitment that the UK made by ratifying the Paris Agreement. The Act also established the CCC, an independent statutory body set up to advise the UK government on setting and meeting GHG reduction goals.

The Climate Change Act requires the UK government to set five-yearly legally-binding carbon budgets, twelve years in advance, from 2008 to 2050, which restrict the amount of GHGs the UK can emit (Table 9.2). The UK is currently in the Fourth Carbon Budget period (2023 - 2027).

Under the Paris Agreement, the UK has also set two NDC emissions reduction targets, as detailed in Table 9.2.

[2] A state where the amount of GHGs emitted is balanced by the amount removed from the atmosphere.

Table 9.2: UK Carbon Budgets & NDCs

Carbon Budget / NDC	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	Yes
4th Carbon Budget (2023 to 2027)	1,950 $MtCO_2e$	51% by 2025	In progress
NDC (2030)	-	68% by 2030	In progress
5th Carbon Budget (2028 to 2032)	1,725 $MtCO_2e$	57% by 2030	-
6th Carbon Budget (2033 to 2037)	965 $MtCO_2e$	78% by 2035	-
NDC (2035)	-	81% by 2035	-
7th Carbon Budget (2038 to 2042) [1]	*535 $MtCO_2e$*	*87% by 2040*	-

[1] Published by the CCC in February 2025. The UK Government will respond to the CCC's advice and set the seventh carbon budget in law by 30 June 2026.

9.3.3 UK Net Zero Strategies and Sector Specific Policies and Plans

In 2021, the UK submitted its Net Zero Strategy: Build Back Greener (HM Government, 2021) to the UNFCCC, which set out how it proposes to deliver the Fourth, Fifth and Sixth Carbon Budgets and the 2030 NDC, as well as Net Zero GHG emissions by 2050. However, following the energy security crisis and rising gas and fossil fuel prices in 2022, an Independent Review of Net Zero (DESNZ, 2023) was commissioned to make recommendations on how the UK could achieve its legally binding Net Zero target in a way that drives economic growth, energy security, and affordability.

Powering Up Britain, The Net Zero Growth Plan (DESNZ, 2023) builds on the Net Zero Strategy, and responds to the recommendations made in the Independent Review of Net Zero. It acknowledges that fossil fuels will retain a crucial role in the energy system until there are credible clean energy alternatives that can replicate their role, with natural gas playing a role for years to come, particularly in the hardest to decarbonise sectors. Following this, the UK Government has published the Clean Power 2030 Action Plan (DESNZ, 2024a), which outlines the UK government's strategy to achieve a fully decarbonised electricity system by 2030 and the Carbon Budget and Growth Delivery Plan (HM Government, 2025), which sets out how the UK will continue to reduce emissions in line with the Climate Change Act.

The 'Balanced Pathway' Scenario (CCC, 2025a) is a framework proposed by the CCC for the UK's approach to achieving Net Zero emissions by 2050. In the Net Zero aligned Balanced Pathway scenario, there is a declining but continued demand for oil and gas through 2050 which requires that the UK imports oil and gas given the projected levels of UK production.

The UK's Net Zero targets and strategies are supported by sector-specific policies and plans. Both the North Sea Transition Deal (refer to Section 9.4) and the British Energy Security Strategy (HM Government, 2022) are predicated on continuing UK North Sea oil and gas production alongside mandating GHG emissions reductions and decarbonisation. The OGA Strategy (OGA, 2021) maintained MER of hydrocarbons as the NSTA's Central Obligation and clarified that this included the objective of net zero by 2050. In November 2025, the UK Government published the North Sea Future Plan (DESNZ, 2025b), which also recognised the important role that oil and gas will play in the UK's energy mix for decades.

To promote industry good practice, MER and efforts to achieve net zero by 2050, the NSTA has produced a set of stewardship expectations. Stewardship Expectation 11 'Net Zero' sets out NSTSA's view as to how UK North Sea companies can reduce their GHG emissions and support delivery of the UK's net zero target. Building on Stewardship Expectation 11, in March 2024 the NSTA published the OGA Plan (NSTA, 2024c), which sets out the requirements for industry to meet the requirement, as set out in the OGA Strategy, for GHG emissions reductions from the production of oil and gas.

The ZRF Initiative, introduced by the World Bank in 2015, also commits the UK government and industry to end routine flaring at production sites no later than 2030 and to ensure that new developments are designed without the need for routine flaring of any associated gas which may be produced from the field.

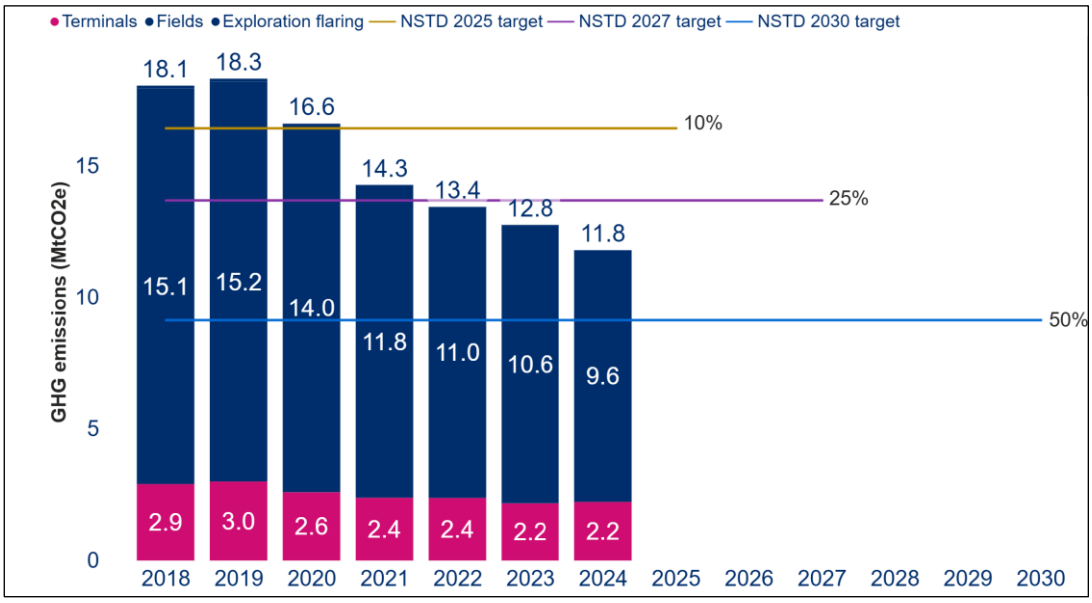
The UK is also a member of the Global Methane Pledge, to collectively reduce global methane emissions by at least 30% by 2030 compared to 2020 levels.

The majority of upstream GHG emissions generated offshore during the development of the Kyla field will be as a result of vessel usage. In 2023, the IMO adopted the IMO 2023 Strategy (IMO, 2023). This envisages an average reduction in carbon intensity of international shipping of least 40% by 2030 (as compared to 2008). It also sets out an ambition that zero or near-zero GHG emission technologies, fuels and/or energy sources represent at least 5% of the energy used by international shipping by 2030.

9.4 UK Oil & Gas Industry - Net Zero Targets and Progress to Date

The NSTD prescribes reductions against a 2018 baseline in offshore production GHG emissions of 10% by 2025, 25% by 2027 and 50% by 2030, pursuant to creating a net zero basin by 2050. To date the UK's oil and gas industry has successfully reduced upstream emissions by 34%, surpassing the 2027 target (Figure 9.2). Based on the current trajectory, the target of halving emissions between 2018 and 2030 is well within reach (OEUK, 2025a; NSTA, 2025a).

Figure 9.2: Progress of UK upstream oil & gas GHG emissions against NSTD targets (NSTA, 2025a)



In 2024, GHG emissions from the production of UK oil and gas, which includes emissions from offshore oil and gas fields, onshore processing terminals and oil and gas exploration activity, totalled an estimated 11.8 Mt CO_2e. To put this in content, GHG emissions from upstream oil and gas activity accounted for 3.3% of net UK territorial GHG emissions in 2023, according to data from NAEI (NSTA, 2025a).

The majority of GHG emissions from the production of UK oil and gas are generated from the offshore installations, with the largest contributors being gas and diesel combustion for power generation, followed by flaring and venting (NSTA, 2025a). Emissions from offshore installations fell in 2024, down 5% compared to 2023 and 34% against the 2018 baseline year, driven by improvements in power efficiency and management, reductions in venting and flaring and asset decommissioning (OEUK, 2025a).

Methane emissions from offshore installations have reduced substantially since the NSTD was agreed, down by 57% against a 2018 baseline, delivering a reduction of 0.85 million tonnes of CO_2e and exceeding the original target of 50% by 2030 (OEUK, 2025a).

Beyond 2030, absolute emissions associated with oil and gas production are predicted to fall due to a combination of lower output, a reduction in flaring and venting and production from lower-emission installations replacing production from older installations (OEUK, 2024).

9.5 Serica's Approach to Decarbonisation

This section outlines Serica's approach to decarbonisation. Serica Energy Chinook Limited is a subsidiary of Serica Energy plc and operates under the Group's policies.

9.5.1 Serica's Commitment to Reduce GHG Emissions

Serica is aligned to the objectives and targets of the NSTD. The following summary are examples of Serica's decarbonisation strategy and activities:

- Serica is executing an ERAP for the Bruce hub located in the UK Northern North Sea, which it operates.
- In the joint ventures (JVs) in which it is a non-operating partner, Serica seeks to influence and support the operators to identify and implement projects to reduce emissions from the relevant assets.
- Specifically in relation to the Triton FPSO, the proposed host for the Kyla field, Serica is engaged with Dana, the operator, on the development and implementation of the Triton ERAP (see section 9.5.3).
- Serica engages with its suppliers to promote initiatives that reduce the impact on the environment, such as vessel sharing, waste reduction and enhanced emissions monitoring.

9.5.2 Emissions Reporting and Governance

Robust emissions reporting is central to Serica Energy's environmental governance framework. Serica reports GHG emissions under several schemes:

- UK ETS — for installations regulated under emissions permits;
- EEMS — annual environmental reporting;
- OGMP 2.0 – for improving the reporting and verification of the Company's methane emissions data, so that they may identify areas for further methane reduction and mitigation;
- ESG reporting – scope 1, 2 and 3 emissions are reported annually in Serica's ESG disclosures.

Responsibility for emissions quantification and regulatory reporting lies with Serica's HSE Team, while Board-level accountability is maintained through quarterly HSE performance reviews with the Sustainability Committees.

9.5.3 Triton Emissions Reduction Action Plan

The Triton FPSO will serve as the infrastructure host for the Kyla field. Serica is engaged with Dana, the operator of the Triton FPSO, on the Triton ERAP. Serica is contributing its operational experience from the Bruce asset, specifically sharing engineering knowledge and lessons learned regarding flare gas and vents recovery systems. Dana own expertise, gained in large part through the design and installation of a successful flare gas recovery system on its previously operated Western Isles asset, also informs the Triton ERAP (refer to Section 9.7).

9.6 Assessment of Impacts

The Supplementary EIA Guidance (DESNZ, 2025c) mandates an assessment of the significance of the likely effects of Scope 3 emissions, including those resulting from the cumulation of effects with other existing or approved projects, at both a global and national level.

The significance of the Kyla Development's GHG emissions has been assessed using a matrix-based approach, in which receptor sensitivity and impact magnitude are combined to determine the overall level of significance. The assessment methodology is detailed in Section 5 and further contextualised for GHG emissions in Section 9.6.2. Appendix E provides a breakdown of the emissions generated from the sources identified in Section 9.2 and outlines the method, assumptions and GHG conversion factors used to quantify the emissions.

9.6.1 Quantification of GHG Emissions

Total GHG Emissions

Table 9.3 quantifies the GHG emissions (expressed in terms of kilotonnes (kt) of CO_2e) arising from the proposed Kyla Development, over the life of the field in three production case scenarios: P10 (High), P50 (Mid) and P90 (Low).

Scope 3 emissions are estimated on the assumption of end use combustion of all the extracted Kyla hydrocarbons. This represents by far the largest component of the total GHG emissions generated over the life of the field (ca. 81%). However, the actual end-use of the Kyla hydrocarbons may vary. Gas from the Kyla field will enter the UK's NTS via the St Fergus terminal to be transported through a network of pipelines across the UK. The gas is delivered to end users, such as gas-fired power stations, large industrial users and regional gas distribution networks that connect to individual homes and businesses. The oil exported by tanker from the Triton FPSO is typically taken by tanker to Rotterdam and integrated into the wider European oil sales market. Oil volumes are converted into usable fuels such as gasoline, diesel and jet fuel, with byproducts from this process often serving as raw materials for chemical productions, generating plastics, fertilizers, and pharmaceuticals. Consequently, it is possible that not all Kyla hydrocarbons will be combusted.

Table 9.3: Kyla Development Total GHG Emissions

Emissions Category	Total GHG Emissions (kt CO_2e) [1]		
	P10 (High)	P50 (Mid)	P90 (Low)
Total Direct GHG Emissions (Scope 1)	50.36	35.72	20.31
Total Indirect Upstream GHG Emissions (Scope 3)	53.19	53.19	53.19
Total Indirect Downstream GHG Emissions (Scope 3)	7,030.90	5,000.23	2,807.61
Grand Total	**7,134.45**	**5,089.14**	**2,881.11**

[1] Refer to Appendix E for the methodology used to estimate GHG emissions.

Carbon Intensity

Over the life of the Kyla field, the Triton FPSO including Kyla throughput will have an average carbon intensity of 29.9 kg carbon dioxide per barrel of oil equivalent (CO_2/boe) in the unabated scenario, decreasing to 23.3 kgCO_2/boe if all abatement projects identified in the Triton Emissions Reduction Action Plan are implemented over the period from 2028 to 2035. In comparison, the average carbon intensity for FPSOs in the CNS in 2024 was 30.5 kg CO_2/boe. When filtering by installation age (>25 years old) this increases to 37.5 kgCO_2/boe (NSTA, 2025b). The emissions intensity for UKCS offshore fields in 2024 was 24.0 kg CO_2/boe (NSTA, 2025a).

No Project ('Do Nothing') Scenario

The non-development of the Kyla field (the 'do nothing' scenario) would result in the non-recovery of a viable domestic hydrocarbon resource and associated project related GHG emissions.

The IPCC indicates that global demand for oil and gas is expected to persist as the world works towards net zero. Consequently, combustion of hydrocarbons and their associated GHG emissions will be prevalent across future climate pathway scenarios.

The Kyla Development involves bringing the previously decommissioned Kyle field back into production through the utilisation of existing North Sea oil and gas infrastructure (principally the Triton FPSO). The project will contribute to the UK meeting its energy requirements through domestic resources during the energy transition and is consistent with responsible stewardship of remaining offshore reserves (refer to Section 9.8).

9.6.2 Evaluating Significance

The principles set out in IEMA (2022) have been used to help evaluate the significance of the effects of the GHG emissions generated from the proposed Kyla Development on the global climate, whereby the sensitivity of the receptor (i.e. the global climate) and magnitude of impact have been combined to derive the overall significance level.

As the assessment of impact significance is an inherently difficult process involving the projection of potential climate futures, consistent criteria (as defined in Section 5.3.1) have been applied to the process, noting that the key consideration when evaluating significance is not simply whether the project results in GHG emissions, or the absolute volume of those emissions, but whether the project aligns with the global and national emission reduction pathways required to meet the goals of the Paris Agreement.

In order to contextualise and evaluate the significance of the Kyla Development's GHG emissions, the following key data sources have been used:

- IPCC AR6 (IPCC, 2022) which explores the projected climate response to five emissions scenarios based on SSPs. The SSPs are baseline narrative scenarios that identify socio-economic and geopolitical assumptions and economic and technological trends. These are then combined with different emissions trajectories, based on the RCP scenarios from the IPCC's AR5, to explore climate outcomes consistent with specific global warming levels.
- IEA World Energy Outlook Scenarios (IEA, 2024; IEA, 2025), which model future global energy demand and supply under different policy scenarios, including:
    - The Announced Pledges Scenario (APS) which assumes governments will meet, in full and on time, all the climate-related commitments that they have announced, such as NDCs, to achieve net zero emissions by 2050. Note, IEA (2025) does not include for APS as at the time of publication insufficient countries had submitted their 2035 NDCs.
    - The Net Zero Emissions by 2050 Scenario (NZE) which shows a global pathway to reach net zero emissions from the energy sector by 2050 without offsets from other sectors. This emissions trajectory is consistent with keeping the temperature rise in 2100 below 1.5°C (with at least a 50% probability).
- UK carbon budgets, NDCs and the CCC's 'Balanced Pathway' scenario (CCC, 2025), which is a framework for the UK's approach to achieving net zero emissions by 2050. The 'Balanced Pathway' scenario includes future projections for UK oil and gas demand and production based on NSTA production projections of existing and future developments (including sanctioned but not yet producing fields).
- Production Gap Report (2025), which assesses the disparity between governments' planned fossil fuel production and production levels consistent with pathways limiting global warming to 1.5 °C and 2 °C. The report provides forward-looking projections of global oil and gas production based on governments' plans and policies, highlighting the extent to which existing and proposed developments exceed levels aligned with internationally agreed climate targets.

As global reduction pathways have been used to contextualise the impact the Kyla Development's GHG emissions will have on the climate, this approach is considered to be inherently cumulative as these pathways take into account a wide range of existing and planned projects and other activities. These forward-looking pathways provide a proxy for the evolving baseline, as they incorporate anticipated GHG emissions from existing and planned oil and gas developments, such as Kyla, as well as broader sectoral and policy trends, including those relating to future oil and gas development and consumption.

9.6.3 Sensitivity of the Global Climate

The sensitivity of the global climate to GHG emissions is **Very High**. The receptor has a Very High value, given the global effect of GHG emissions. The current state of the climate and the concentration of CO_2 and other GHGs in the atmosphere is described in Section 4.2.6. The Earth's climate is changing. Global temperatures continue to increase, with 2024 the warmest year on record, at 1.6°C above pre-industrial average levels. The IPCC AR6 states that it is "unequivocal that human influence has warmed the atmosphere, ocean and land". Estimates of current human-induced long-term global warming are around 1.31°C above pre-industrial levels and are rising at 0.26°C per decade (Foster, 2024). It is still considered technically possible, however, that the rise in long-term global temperature can be limited to 1.5°C (WMO, 2025), although at the recent COP30 in Brazil it was acknowledged that the world is likely to breach this threshold in the next decade, at least temporarily. Accordingly, Resistance and resilience is Medium.

9.6.4 Kyla in the Context of the Paris Agreement and Global Emissions Reduction Pathways

As noted in Section 4.2.6, the IPCC's SSP scenarios, combined with RCP scenarios - SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0 and SSP5-8.5 - provide a framework for assessing future global GHG emissions trajectories under differing socio-economic and policy assumptions. These pathways illustrate how emissions may evolve under varying levels of climate ambition; from very low (SSP1-1.9) pathways consistent with limiting warming to 1.5°C, to very high (SSP5-8.5) pathways associated with continued fossil fuel use and limited mitigation.

To place the Kyla Development in this global context, Table 9.4 compares the total GHG emissions predicted to be generated by the Development in the reference year (2030) with the median global GHG emissions projected under each SSP scenario. Of note, cessation of production for Kyla is predicted to occur in or before 2035, in which case the Project will not contribute to the global GHG emissions in 2040 and 2050.

In 2030, Kyla's projected GHG emissions are estimated to represent between 0.00388% and 0.00180% of median global GHG emissions, depending on the SSP pathway considered (refer to Table 9.4). The proportion is highest under the SSP1-1.9 (very low) scenario, where global GHG emissions are projected to decline rapidly to around 33 $GtCO_2e$ (median) per year in 2030, and lowest under the SSP5-8.5 (very high) scenario, where emissions reach approximately 71 $GtCO_2e$ (median) per year in 2030. This variation reflects the differing assumptions about future global energy use and mitigation policy embedded within each pathway. Regardless, Kyla's contribution represents a very small fraction of projected global totals under all SPP scenarios. This comparison provides context for the Project's scale relative to global GHG emissions trajectories, resulting in a **Minor** magnitude of impact.

This point is further illustrated by the fact that the P10 case total GHG emissions generated from the Kyla Development over the life of the field (ca. 2028 – 2035) represent less than 0.00304% of the remaining global carbon budget under a 1.5°C scenario (235 $GtCO_2e$; GCP, 2024), 0.00122% under a 1.7°C scenario (585 $GtCO_2e$; GCP, 2024), and less than 0.00064% under a 2.0°C scenario (1,110 $GtCO_2e$; GCP, 2024). Given this proportional impact, development of the Kyla field will have a negligible impact on global temperatures.

Table 9.4: Kyla Development in the context of Future Global Shared Socioeconomic Pathways (IPCC, 2022)

Parameter	Reference Year			Key Assumptions of SSP
	2030	2040	2050	
GHG Emissions Scenario: SSP 1 – 1.9 (Very Low), limit warming to 1.5°C				
Median Global GHG Emissions ($GtCO_2e/yr$) [1]	33 (22 – 37)	18 (6 – 24)	8 (0 – 15)	Rapid decarbonisation, societies switch to more sustainable practices, inequality falls. Net zero CO_2 achieved in ca. 2050.
Kyla projected proportion [2]	0.00388%	N/A	N/A	
GHG Emissions Scenario: SSP 1 – 2.6 (Low), limit warming to 2°C				
Median Global GHG Emissions ($GtCO_2e/yr$) [1]	40 (30 – 49)	29 (21 – 36)	20 (14 – 27)	Socioeconomic shifts towards sustainability, but reduction in CO_2 emissions is slower than SSP1-1.9. Net zero CO_2 achieved in ca. 2070.
Kyla projected proportion [2]	0.00320%	N/A	N/A	
GHG Emissions Scenario: SSP 2 – 4.5 (Intermediate), limit warming to 3°C				
Median Global GHG Emissions ($GtCO_2e/yr$) [1]	54 (50 – 62)	53 (48 – 61)	52 (45 – 57)	Current policies continue. Slow progress toward sustainability and development and income grow unevenly. CO_2 emissions hover around current levels before starting to fall mid-century. Net zero CO_2 is not achieved by 2100.
Kyla projected proportion [2]	0.00237%	N/A	N/A	
GHG Emissions Scenario: SSP 3 – 7.0 (High), limit warming to 4°C				
Median Global GHG Emissions ($GtCO_2e/yr$) [1]	62 (53 – 69)	67 (56 – 76)	70 (58 – 83)	Fragmented, high fossil use, inequality. CO_2 emissions roughly double from current levels by 2100
Kyla projected proportion [2]	0.00206%	N/A	N/A	
GHG Emissions Scenario: SSP 5 – 8.5 (Very High), exceed warming of 4°C				
Median Global GHG Emissions ($GtCO_2e/yr$) [1]	71 (69 – 81)	80 (78 – 96)	88 (82 – 112)	Rapid economic growth without mitigation, fuelled by exploiting fossil fuels and energy-intensive lifestyles. Current CO_2 emissions roughly double by 2050.
Kyla projected proportion [2]	0.00180%	N/A	N/A	

[1] Data source (IPCC, 2022; Chapter 3, Table 3.2), median data shown with (Lower Range – Upper Range) of harmonised GHG emissions across the pathways.

[2] Based on the P10-case total gross GHG emissions generated from the Kyla Development in 2030 of 1,278.77 kt CO_2e. This assumes the high production case (P10 profile) and is based on the total direct GHG emissions (scope 1) and total indirect downstream GHG emissions (scope 3) generated in 2030.

9.6.5 Kyla in the Context of Future Global Oil and Gas Production Demand

The IPCC indicates that there is global demand for oil and gas in all future climate scenarios. Success in decarbonisation will reduce the demand for fossil fuels, however not all end-uses are expected to be commercially electrifiable in the short to medium term (i.e. within the life of Kyla Development) and many will require low GHG liquid and gaseous fuels (IPCC, 2023).

The UNEP Production Gap Report (PGR) (SEI, 2023; PGR; 2025) evaluates the fossil fuel production outlooks of twenty major producing countries, including the UK, and benchmarks these against climate model projections aligned with the Paris Agreement's temperature objectives. The "production gap" represents the shortfall between governments' planned fossil fuel output and the production levels consistent with pathways limiting global temperature change to 1.5°C or well below 2°C above pre-industrial levels.

Table 9.5 and Table 9.6 compare the proposed Kyla production rates in five reference years during the period from 2030 to 2050 with predicted future global oil and gas production rates under different international energy demand pathway scenarios, assuming that Kyla will cease production in or before 2035. Table 9.7 compares the proposed Kyla production rates during this period with predicted future global energy demand for total energy, oil, and gas.

It can be seen from Tables 9.6 to 9.8 that the proposed Kyla Development contributes a very small percentage towards predicted global oil and gas production rates and forecasted demand. As such, production from the Kyla field will have negligible impact on the pathways consistent with restricting global temperature change to well under 2°C above pre-industrial levels, resulting in a **Minor** magnitude of impact.

Table 9.5: Kyla Development in the context of Future Global Oil Demand across International Pathways (PGR, 2025)

Parameter	Reference Year				
	2030	2035	2040	2045	2050
IEA Announced Pledges Scenario (APS) [3]					
Global Oil Production Value (Mbbl/d) [1]	90.50	79.98	68.47	59.06	52.16
Kyla projected proportion [2]	0.00663%	0.00377%	N/A	N/A	N/A
Pathways Consistent with 2℃ (Median)					
Global Oil Production Value (Mbbl/d) [1]	99.65	94.00	83.03	69.78	57.83
Kyla projected proportion [2]	0.00602%	0.00321%	N/A	N/A	N/A
Pathways Consistent with 1.5℃ (Median)					
Global Oil Production Value (Mbbl/d) [1]	88.55	78.92	63.32	45.85	32.20
Kyla projected proportion [2]	0.00677%	0.00382%	N/A	N/A	N/A

[1] Data source (PGR, 2025), values converted from exajoules (EJ) per year (EJ/yr) to Oil using a factor of million barrels per day (Mbbl/d)

[2] Based on Kyla High Case (P10) production profile for Oil in the reference year (2030 = 5,997.00 bbl/d; 2035 = 3,018.00 bbl/d) – Refer to Appendix G.

[3] An IEA scenario that models future energy demand and supply based on governments' announced climate pledges, even if not yet backed by detailed policies.

Table 9.6: Kyla Development in the context of Future Global Gas Demand across International Pathways (PGR, 2025)

Parameter	Reference Year				
	2030	2035	2040	2045	2050
IEA Announced Pledges Scenario (APS) [3]					
Global Gas Production Value (Tm^3/yr) [1]	4.03	3.51	3.08	2.76	2.48
Kyla projected proportion [2]	0.00110%	0.00062%	N/A	N/A	N/A
Pathways Consistent with 2℃ (Median)					
Global Gas Production Value (Tm^3/yr) [1]	3.91	3.67	3.46	3.32	3.34
Kyla projected proportion [2]	0.00113%	0.00059%	N/A	N/A	N/A
Pathways Consistent with 1.5℃ (Median)					
Global Gas Production Value (Tm^3/yr) [1]	2.72	2.37	2.20	1.99	1.78
Kyla projected proportion [2]	0.00162%	0.00091%	N/A	N/A	N/A

[1] Data source (PGR, 2025), values converted from exajoules (EJ) per year (EJ/yr) to Gas using a factor of 0.029 trillion (Tera, 10^{12}) cubic metres per year (Tm^3/yr).
[2] Based on Kyla High Case (P10) production profile for Gas in the reference year (2030 = 44,173,335.00 m^3; 2035 = 21,654,942.00 m^3) – Refer to Appendix G.
[3] An IEA scenario that models future energy demand and supply based on governments' announced climate pledges, even if not yet backed by detailed policies.

Table 9.7: Kyla Development in the context of Future Global Energy Supply (IEA, 2025)

Parameter	Reference Year		
	2035	2040	2050
IEA Net Zero Emissions by 2050 Scenario [5]			
Natural Gas World Energy Supply ($GtCO_2e$) [1]	5.12	3.49	1.69
Kyla projected Gas proportion [2]	0.00136%	N/A	N/A
Oil World Energy Supply ($GtCO_2e$) [1]	9.50	6.74	3.33
Kyla projected Oil proportion [3]	0.00607%	N/A	N/A
Total World Energy Supply ($GtCO_2e$) [1]	42.74	41.26	42.72
Kyla projected Total proportion [4]	0.00151%	N/A	N/A

[1] Source IEA World Energy Outlook 2025 Report (IEA, 2025), reference year values were calculated from EJ to Gt CO_2e using IPPC (2006) conversion factor (kg CO_2/GJ, kg CH_4/GJ and kg N_2O/GJ) alongside relevant AR5 GWP Values (CO_2 = 1, CH_4 = 28, N_2O = 265).
[2] Gas comparison based on the P10-case total GHG emissions generated from the Kyla Development in 2035 of 69.67 kt CO_2e, assuming Kyla high production case for Gas (P10 profile) The total is based on the total direct GHG emissions (scope 1) and total indirect downstream GHG emissions (scope 3) generated in 2035, with the Scope 1 emissions adjusted based on Gas:Oil production ratio of 86.11:13.89
[3] Oil comparison based on the P10-case total GHG emissions generated from the Kyla Development in 2035 of 576.61 kt CO_2e, assuming the Kyla high production case for Oil (P10 profile). The total is based on the total direct GHG emissions (scope 1) and total indirect downstream GHG emissions (scope 3) generated in 2035, with the Scope 1 emissions adjusted based on Gas:Oil production ratio of 86.11:13.89.
[4] Total World Energy Comparison based on the P10-case total gross GHG emissions generated from the Kyla Development in 2035 of 646.28 kt CO_2e, assuming the Kyla high production case (P10 profile). The total is based on the total direct GHG emissions (scope 1) and total indirect downstream GHG emissions (scope 3) generated in 2035.
[5] An IEA Scenario where net zero emissions by 2050 are consistent with a pathway well below 2°C.

9.6.6 Kyla in the Context of UK Carbon Budgets, NDCs and Emissions Reduction Pathways

CCC's Balanced Pathway

The CCC's Balanced Pathway, an emissions reduction pathway from 2025 to net zero by 2050, is in line with all of the UK's legislated carbon budgets and stated NDCs. The Balanced Pathway involves a steep decline in the consumption of oil and gas, reducing by 84% and 77% from 2025 levels respectively by 2050. Nonetheless, in this scenario, demand for oil and gas continues through 2050. The UK will continue to require gas for a variety of purposes, including the heating of buildings and marginal production within the power sector (NESO, 2025) and while demand for petroleum products is likely to fall in some parts of the economy such as road transport (i.e. a shift towards electric vehicles), all major forecasters expect resilient or even growing demand for other uses of hydrocarbons such as petrochemicals (IEA, 2018).

The majority of fuels currently used in the UK are traded internationally and the UK is a net importer of both oil and gas (PGR, 2025; CCC, 2025), which is projected to remain the case in the Balanced Pathway.

According to The Seventh Carbon Budget (CCC, 2025): declining production from the UK's North Sea basin indicates that GHG emissions will fall in the baseline pathway[3] by around 40% by 2040 compared to 2025 levels, including the production emissions from potential new oil and gas fields. After taking account of the reduction in production and refining emissions due to declining baseline activity and cross-economy fuel switching, only around 13 $MtCO_2e$ of emissions remain by 2040. In the Balanced Pathway, around 60% of these remaining emissions are abated. For oil and gas platforms, the majority of abatement results from electrification of offshore oil and gas platforms, and from reducing methane flaring and venting (CCC, 2025).

UK Carbon Budgets

As noted in Section 9.3.2, the Climate Change Act requires the UK government to set five-yearly legally binding carbon budgets, 12 years in advance, from 2008 to 2050. UK Carbon Budgets are economy-wide emissions limits, and do not prohibit oil and gas production.

To place the Kyla Development in the context of the UK carbon budgets, Table 9.8 compares the GHG emissions predicted to be generated by the Kyla Development with the fifth and sixth carbon budget allowances (i.e. the budgets which cover the period when the Kyla field is likely to be in production). As oil from the Kyla field will be exported to European markets, the carbon budget allowances have been compared with both the total gross GHG emissions (likely to be a very conservative overestimation of emissions as not all Kyla hydrocarbons will be combusted in the UK) and with direct (scope 1) emissions, which will occur in the UK.

Table 9.8: Kyla Development Emissions in the context of UK Carbon Budgets (CCC, 2025)

Carbon Budget (Period)	Carbon Budget Allowance (Mt CO_2e)	Kyla Projected Proportion of Carbon Budget	
		Kyla Total Gross GHG Emissions [1]	Kyla Scope 1 Emissions [2]
Carbon Budget 5 (2028 to 2032)	1,725	0.28549% (4,924.68 ktCO_2e)	0.00205% (35.32 ktCO_2e)
Carbon Budget 6 (2033 to 2037)	965	0.21826% (2,106.22 ktCO_2e)	0.00156% (15.04 ktCO_2e)

[1] Based on the P10-case total GHG emissions (Scope 1 + Scope 3 Upstream & Downstream) generated from the Kyla Development for the relevant CB period (4,924.68 kt CO_2e for CB5 and 2,106.22 kt CO_2e for CB6), assuming the Kyla max production case (P10 profile). Noting that emissions from Kyla will start in September 2028, and end in December 2035 for the P10 case.

[2] Based on the total direct (Scope 1) GHG emissions generated from the Kyla Development for the relevant CB period (35.32 kt CO_2e for CB5 and 15.04 kt CO_2e for CB6), assuming the Kyla max production case (P10 profile). Noting that emissions from Kyla will start in September 2028, and end in December 2035 for the P10 case.

[3] A hypothetical baseline pathway that does not include further climate action.

Given this insignificant proportion of the budgets as shown in Table 9.8, the GHG emissions generated by the Kyla Development would have no material influence on the UK's ability to meet its statutory carbon budget targets, resulting in a **Minor** magnitude of impact.

UK Nationally Determined Contribution (NDC)

The UK's 2030 NDC commitment is to reduce all GHG emissions by at least 68% by 2030 compared to 1990 levels, which is aligned with the Paris Agreement pathway for 1.5°C. Since submitting the NDC in December 2020, the UK has published a range of sectoral strategies and plans and has signed up to numerous pledges and actions to deliver on the 2030 target. The target was updated in 2022 but remains at an allowance of 254.08 $MtCO_2e$ (UK Government, 2025). The UK's 2035 NDC target to reduce all GHG emissions by at least 81% by 2035, compared to 1990 levels (excluding international aviation and shipping emissions) was announced at COP29. The UK NDC was subsequently presented to Parliament in January 2025 (UK Government, 2025). The UK NDC is a 1.5°C aligned, economy-wide absolute emissions reduction target, covering all GHGs, sectors and categories which aims to achieve a target of 254.08 Mt CO_2e by 2030, and 155.3 $MtCO_2e$ by 2035 (UK Government, 2025). The rate of GHG emissions reduction seen in 2023 is roughly in line with the annual pace of change needed to meet the 2030 NDC target (CCC, 2025).

The NDCs, as defined under the Paris Agreement and UNFCC, track progress based on territorial emissions (UNFCCC, 2021). As oil from the Kyla field will be exported to European markets, the NDC allowances have been compared with both the total gross GHG emissions (likely to be a very conservative overestimation of emissions as not all Kyla hydrocarbons will be combusted in the UK) and with direct (scope 1) emissions, which will occur in the UK.

Table 9.9: Kyla Development Emissions in the context of UK NDC targets (UK Government, 2025)

NDC Target	NDC Allowance (Mt CO_2e)	Kyla Projected Proportion of NDC Allowance	
		Kyla Total Gross GHG Emissions [1]	Kyla Scope 1 Emissions [2]
NDC 2030	254.08	0.50692% (1,287.99 $ktCO_2e$)	0.00363% (9.23 $ktCO_2e$)
NDC 2035	155.3	0.41615% (646.28 $ktCO_2e$)	0.00297% (4.61 $ktCO_2e$)

[1] Based on the P10-case total GHG (Scope 1 + Scope 3 Upstream & Downstream) emissions generated from the Kyla Development for the relevant NDC period (1,287.99 kt CO_2e for NDC2030 and 646.28 kt CO_2e for NDC2035), assuming the Kyla production case (P10 profile). Noting that emissions from Kyla will start in September 2028, and end in December 2035 for the P10 case.

[2] Based on the total direct (Scope 1) GHG emissions generated from the Kyla Development for the relevant NDC period (9.23 kt CO_2e for NDC2030 and 4.61 kt CO_2e for NDC2035), assuming the Kyla production case (P10 profile). Noting that emissions from Kyla will start in September 2028, and end in December 2035 for the P10 case.

Given these insignificant proportions, Kyla's direct operational emissions would have no material influence on the UK meeting its NDC targets resulting in a **Minor** magnitude of impact.

9.7 Mitigation Measures

As recognised in the supplementary EIA guidance, Serica as the developer does not have direct control over oil and gas end-use scope 3 emissions. Serica's emission reduction initiatives are, therefore, focused on reducing indirect Scope 3 upstream GHG emissions during the development execution and production phases.

Development execution

The following scopes for reducing emissions will be included in the development execution phase.

Drilling

- The proposed drilling project management contractor (Petrofac) includes within its standard procedures emissions reduction measures such as minimising unplanned sailings and flights.

- The contracts evaluation process will include emissions information from potential suppliers.
- The drilling rig selection process will factor in whether an energy control system is installed. The rig operator is required to be ISO 140001 (Environmental Management) and ISO 50001 (Energy Management) certified by DNV.
- The drilling rig will be moored during operations which has a lower fuel usage than operating on dynamic positioning.
- Electrical powerpacks, instead of diesel powerpacks, will be used for all services on the rig where these are compatible and available.

The well will be planned and designed to minimise Non-Productive Time (NPT) and Waiting on Weather (WoW).

Subsea facilities construction

- It is intended to install the Kyla production and gas lift pipelines and umbilicals by reel lay. This method is considered the most efficient for installing rigid pipelines, with reduced vessel time and vessel size (minimising atmospheric emissions), compared to other methods such as J-lay and S-lay.
- The production and gas lift pipelines will be installed in a piggyback arrangement to minimise the number of lay operations and to install both pipelines in a single trench. This reduces vessel time for both pipelay and trenching operations, thus minimising fuel consumption/carbon emissions.
- The selected base case development tie-ins are such that installation vessels are not required to enter the FPSO 500m zone, which would normally incur significant Non-Productive Time (NPT). Minimising NPT thus minimises vessel time and associated fuel usage/carbon emissions.
- The selected subsea layout design minimises the volume of rock required, thus minimising rock placement vessel time and associated fuel usage/carbon emissions.
- Only Tier 1 subsea installation contractors will be included in the tendering process. Tier 1 contractors have high specification vessels both in terms of fuel efficiency and vessel working limits (minimising waiting on weather time). These features minimise fuel usage and hence carbon emissions. Vessels proposed to be used will be assessed against fuel consumption as part of the tendering process.

Triton FPSO ERAP

With regards to direct (Scope 1) GHG emissions, responsibility for identification and implementation of emissions reduction initiatives at the Triton FPSO resides with the operator (Dana). Serica, as the operator of Kyla, will support the Triton FPSO operator as they continue to assess and implement reasonable decarbonisation strategies (see section 9.5.3).

In line with Stewardship Expectation 11, Dana, with support from Serica, is committed to reducing emissions from Triton as far as reasonable in the circumstances. Significant work has been undertaken to identify, assess and prioritise emissions reduction opportunities at Triton, with the aim of front end loading the engineering work and select feasible and deliverable projects (refer to Section 2.2.4).

Current ongoing projects to reduce emissions at Triton include:

- **Flare Gas and Venting Reduction Projects:**
    - An ongoing Zero Routing Flaring and Venting project aims to meet the ZRF&V target by 2030, primarily addressing Category A flaring and venting
    - Optimising existing asset operations to minimise non-routine flaring (Categories B and C) are also under investigation.

- **Fuel Gas Reduction Projects:**
    - An ongoing assessment is currently reviewing options to optimise the onboard gas turbine generators and electric-drive gas export compression facilities with more efficient alternatives which may includes:
        - Reduction in demand from individual users (compressors & pumps)
        - Turbine replacement/ resizing for increased operating efficiency

9.8 Other Relevant Considerations

As noted in Section 9.3.2, the UK Net Zero Growth Plan (DESNZ, 2023b) acknowledges that fossil fuels will retain a crucial role in the energy system until there are credible and sufficient low carbon energy alternatives. The Independent Review of Net Zero (Mission Zero, 2023) recognises that the UK will still need oil and gas to secure its energy security and as transition fuels and in a net zero aligned Balanced Pathway scenario (CCC, 2025a).

The UK is the second largest oil producer in Europe (excluding Russia), which has a massive oil supply deficit importing 80% of its crude oil supply. Consequently, the UK is critical to Europe's integrated energy system as an exporter of crude oil and importer of refined oil products largely within the northwest European market (OEUK, 2025c). Consistent with this pattern of trade, oil lifted from the Triton FPSO - of which production from Kyla will become part - is offloaded to tankers and predominantly delivered to Rotterdam.

All the gas produced from the Kyla field will be delivered into the NTS via the SFGT and will be consumed in the UK, which is projected to remain a substantial net importer of gas.

Production from the Kyla field will displace oil and gas imports. Other than gas delivered by pipeline from Norway, such imports typically have higher carbon intensity than domestic production once the emissions associated with transportation to the UK are included.

Moreover, Kyla hydrocarbons, when produced using existing infrastructure via Triton FPSO, have a forecasted carbon intensity between 6.78 kg CO2e/boe and 7.48 kg CO2e/boe (depending on the production case), which is well below the UKCS average carbon intensity of 24 kg CO_2e/boe (NSTA, 2025a).

In addition to its energy system role, the Kyla field will provide an economic contribution to the UK, through capital investment, supply chain activity and continued use of existing UK offshore infrastructure.

The development phase of the project has an estimated capital expenditure of approximately £185 million, supporting UK-based engineering, drilling, fabrication, marine and logistics activities. The Kyla Development will have a strong focus on UK content. Serica achieved the majority of the spend in the UK on the development of the Gannet E, Evelyn and Belinda fields which - like Kyla - are tie-backs to the Triton FPSO and is targeting a similar outcome for the Kyla Development. This project will, therefore, help to sustain employment, skills and capability within the UK offshore supply chain during the energy transition.

The Kyla field will also contribute to the broader financial resilience of the Triton hub throughput its productive life. This will help safeguard jobs associated with managing and operating the Triton FPSO and associated facilities.

As described above, the development of the Kyle field will have positive impacts on UK and European energy security, economic growth and jobs in the UK and net carbon emissions.

9.9 Residual Effects

Scope 3 emissions represent by far the largest component of the total GHG emissions which will be generated by the Kyla Development over the life of the field (ca. 81%). Serica as the developer does not have direct control over oil and gas end-use scope 3 emissions. Regardless, the GHG emissions associated with the Kyla Development represent a very small fraction of projected global GHG emissions under the IPCC's low (SSP1-2.6) emissions pathway consistent with limiting warming to 2°C (ca. 0.00320% of median global GHG emissions in 2030). Kyla will cease production in or before 2038, well before the global target for net zero emissions by 2050. In a Paris aligned oil and gas production pathway, the residual effects of the Kyla Development's GHG emissions on the global climate are considered to be **Minor**. In addition, the GHG emissions generated by the Kyla Development would have no material influence on the UK's ability to meet its Carbon Budget and NDC emissions reduction targets.

10 Marine Discharges

10.1 Introduction

Serica 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 and local flora and fauna that may arise from the following planned operational discharges associated with the proposed Kyla Development:

- **Discharge of Drill Cuttings and Muds**
  - Dispersion of Suspended Solids.
- **Discharge of Fluids Contaminated with Residual Hydrocarbons**
  - Thermally Treated LTOBM Cuttings Water.
  - Well Clean-up and Completion Brines.
  - Produced Water Discharge from Triton FPSO.
  - Subsea Intervention and Future Decommissioning Activities.
- **Discharge of Chemicals**
  - Discharge of Drilling, Cementing, Completion and Rig Chemicals during Drilling Operations.
  - Discharge of Subsea Commissioning Chemicals.
  - Discharge of Production Chemicals.
  - Subsea Intervention and Future Decommissioning Chemical Discharges.

Unplanned discharges leading to accidental releases to the sea are discussed in Section 11.

10.2 Assessment of Impacts

10.2.1 Discharge of Drill Cuttings and Muds

As described in Section 3.3.4, the Kyla development well will be drilled conventionally, with the upper hole sections (36" and 26", including respud options) drilled riserless using seawater with frequent bentonite sweeps circulated downhole to clean the wellbore. Without a marine riser in place, cuttings from these top-hole sections will be discharged directly from the wellbore at the seabed. For the deeper 17½", 12¼" and 9½" (under-reamed from 8½") sections (including contingency sidetrack options), a marine riser will be installed between the wellhead and MODU to allow cuttings and drilling mud to be circulated back to the MODU. These sections will be drilled using LTOBM. Although the final cuttings management approach has not yet been confirmed, for the purposes of this ES a precautionary worst-case assumption has been adopted whereby LTOBM-contaminated cuttings returned to the MODU are thermally treated offshore to achieve <1% oil-on-cuttings before being discharged to sea just below the surface. This scenario has therefore been used to support the cuttings dispersion modelling and associated impact assessment. A total of 895 m^3 of cuttings and 365.1 m^3 of drilling-mud solids have been modelled, representing the maximum worst-case discharge scenario for the Kyla well.

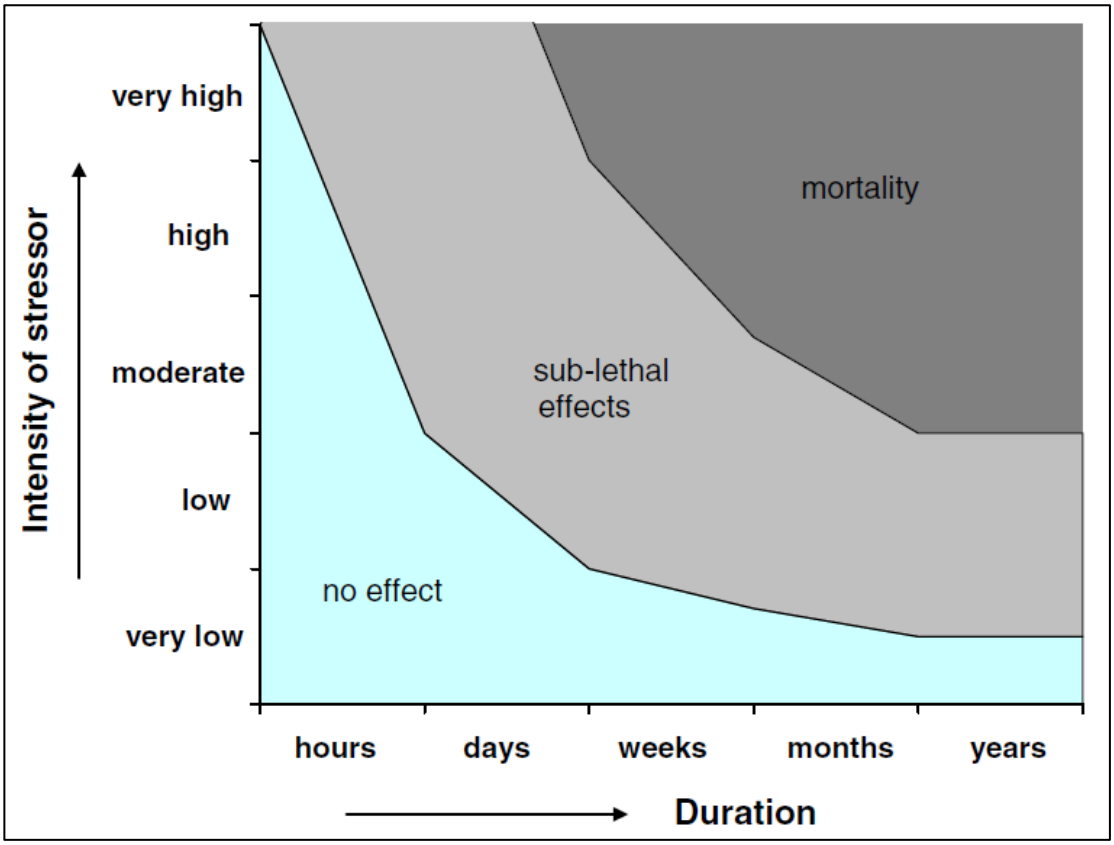
Drill Cuttings and Muds Dispersion Modelling

The discharge of drill cuttings and fluids from the MODU will result in a temporary effluent plume descending through the water column. To quantify the TSS concentrations in the water column and inform the assessment of potential environmental effects, simulations of the discharged drill cuttings and fluids from the proposed Kyla well has been completed using the three-dimensional (3D) dispersion model (MUDMAP) by RPS on behalf of Serica. MUDMAP can predict TSS plume concentrations and sediment deposition. A copy of the drill cuttings and muds dispersion modelling report is provided for reference in Appendix C. Note, impacts to the marine environment from the settlement of drill cuttings, muds and cement on the seabed are considered separately in Section 7.

To represent the combined influence of ocean drift currents and tidal currents at the Kyla location, ten years (2010 to 2019) of 3D HYCOM ocean data and HYDROMAP tidal data was generated for the study site. A grid covering a 50 km (longitude, x-direction) by 50 km (latitude, y-direction) region with varying depths was employed. For the purposes of the TSS assessment, the water column is discretised into 10 m vertical layers, allowing the model to resolve the vertical distribution and attenuation of suspended solids concentrations with depth. As the spud date can vary, a total of 100 trajectory simulations were modelled with varying start dates to assess a range of current conditions (RPS, 2025). Results from the 100 simulations were overlayed for stochastic analysis to determine maximum TSS concentrations based on acute (1-hour averaged concentration) and chronic (24-hour averaged concentration) exposure thresholds, in each grid cell.

A fundamental principle in assessing turbidity effects is the relationship between intensity (or TSS concentrations) and duration of exposure (Figure 10.1). High concentrations over a short duration may cause immediate stress or mortality, while prolonged exposures at lower concentrations can generate similar cumulative impacts.

Figure 10.1: Conceptual relationship between the intensity and duration of a stress event and the risk of sublethal and lethal effects on corals. The figure illustrates the general relationship between the magnitude of an increase in turbidity or sedimentation above background levels (vertical axis), how long it lasts (horizontal axis) and the onset of effects on corals (Erftemeijer et al., 2012) [Note 1]



Note 1: Although cold-water corals have not been recorded in vicinity of the Kyla location within the CNS, by applying thresholds based on coral responses, this assessment adopts a worst-case conservative benchmark that ensures the protection of the most sensitive ecosystem components.

The durations applied here are intentionally conservative. Acute effects in laboratory studies are typically assessed over 1–7 days and chronic effects over weeks to months (Brown et al., 2015; Stump et al., 2019). In contrast, this assessment uses exposure periods of 1 hour (acute) and 24 hours (chronic), reflecting the operational context in which TSS levels from drill cuttings can rise rapidly over minutes to days. These shorter durations ensure thresholds remain both protective and precautionary.

In offshore environments, background TSS concentrations are generally low, typically <10 mg/L, although naturally turbid nearshore systems can experience levels >100 mg/L (Erftemeijer et al., 2012). Experimental studies indicate that short-term TSS spikes of 50–100 mg/L can induce acute, sub-lethal

stress responses, including increased mucus production and reduced photosynthetic efficiency (Browne et al., 2015; Stump et al., 2019). Longer-term exposures at lower concentrations (15–50 mg/L) have been associated with chronic physiological impairment, reduced reproductive success and increased mortality (Browne et al., 2015; Erftemeijer et al., 2012). The final TSS thresholds derived for this assessment are presented in Table 10.1 (RPS, 2025).

Table 10.1: Reporting Thresholds for TTS Concentrations for the drill cuttings and unrecoverable muds discharge modelling (RPS, 2025)

Impact Level	Acute Exposure (1-hour averaged concentration) (mg/L)	Chronic Exposure (24-hour averaged concentration) (mg/L)	Notes/Comments
No Impact	<10	<5	Background or natural variability; corals tolerate well.
Low Exposure	10	5	Minor physiological stress; corals acclimate to short pulses.
Moderate Exposure	50	15	Sub-lethal effects; mucus production, reduced photosynthesis.
High Exposure	> 100	> 50	Tissue damage, mortality risk; chronic exposure particularly harmful.

The modelling of the water-column effects associated with the discharge of the Kyla cuttings and muds indicates that increases in TSS will be temporary, highly localised, and rapidly attenuated with distance from the release point (Figure 10.2 and Figure 10.3). The stochastic assessment, based on 100 simulations, shows that for acute exposure (1-hour averaged concentrations), the 10 mg/L low-exposure threshold extends no farther than 1.02 km from the MODU, with moderate exposure levels (50 mg/L) limited to 0.27 km and high-exposure concentrations (100 mg/L) confined within the same distance. The total area exceeding the acute low-exposure threshold is 1.19 km² (refer to Table 10.2). Under chronic exposure (24-hour averaged concentrations), the extent of elevated TSS is smaller still, with the 5 mg/L low-exposure threshold reaching 0.41 km, moderate concentrations (15 mg/L) extending to 0.19 km, and high-exposure levels (50 mg/L) not exceeding 0.08 km, covering a total area of 0.16 km² (refer to Table 10.2).

Deterministic modelling indicates that the higher-exposure TSS concentrations predicted by the stochastic assessment are vertically constrained within the water column (RPS, 2025). For riserless, near-seabed discharges, elevated TSS concentrations are predominantly confined to the lower 10 m of the water column, reflecting the discharge depth and the rapid settling of coarser particle fractions. Concentrations decrease rapidly with height above the seabed due to particle settling and vertical mixing, resulting in limited vertical plume extent. Conversely, for discharges released at the sea surface, the highest TSS concentrations are confined to the upper 10 m of the water column, with concentrations attenuating rapidly with depth as the plume disperses and mixes vertically. In both discharge scenarios, elevated concentrations are short-lived and restricted to the near-field plume, with rapid dilution occurring outside these zones due to the energetic hydrodynamic conditions of the CNS.

These results confirm that TSS elevations are short-lived (typically <24 hours) and rapidly diluted in the energetic CNS environment, with higher concentration thresholds occurring only in very close proximity to the discharge point. Accordingly, the likelihood of wider water-column impacts from suspended solids is considered to be low.

Table 10.2: Predicted total areas of coverage and maximum distances to acute and chronic exposure from the release location to each reporting threshold based on the results of all 100 simulations (RPS, 2025)

Reporting Threshold	Annual	
	Total Area of Coverage (km^2)	Maximum Distance (km) from the Release Location
Acute Exposure (1-hour averaged concentration)		
10	1.19	1.02
50	0.10	0.27
100	0.08	0.27
Chronic Exposure (24-hour averaged concentration)		
5	0.16	0.41
15	0.05	0.19
50	0.01	0.08

Figure 10.2: Predicted maximum 1-hour moving average of TSS concentrations, representing acute exposure, from the discharge of drill cuttings and muds. Results are based on 100 simulations and represent annual conditions (RPS, 2025)

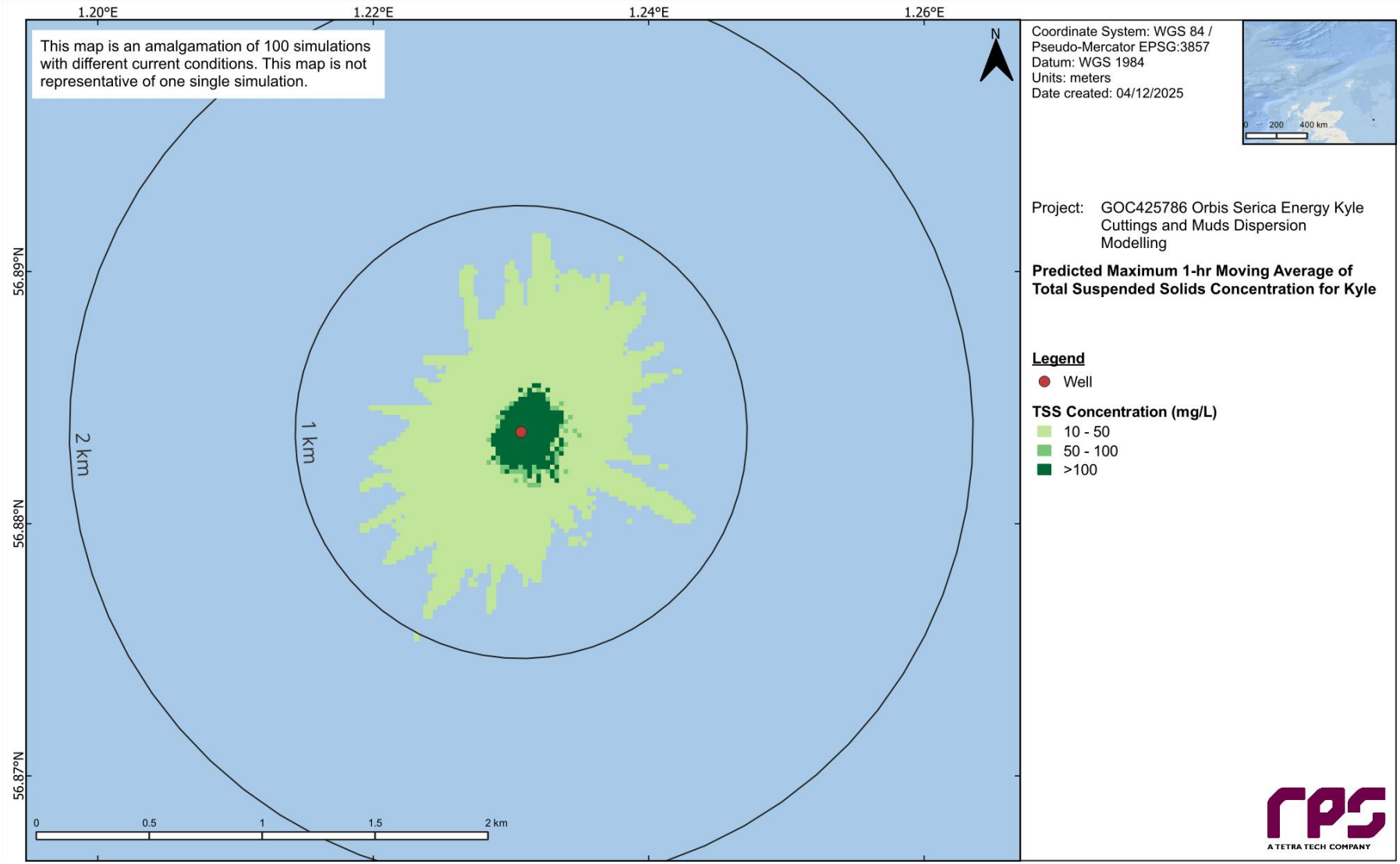
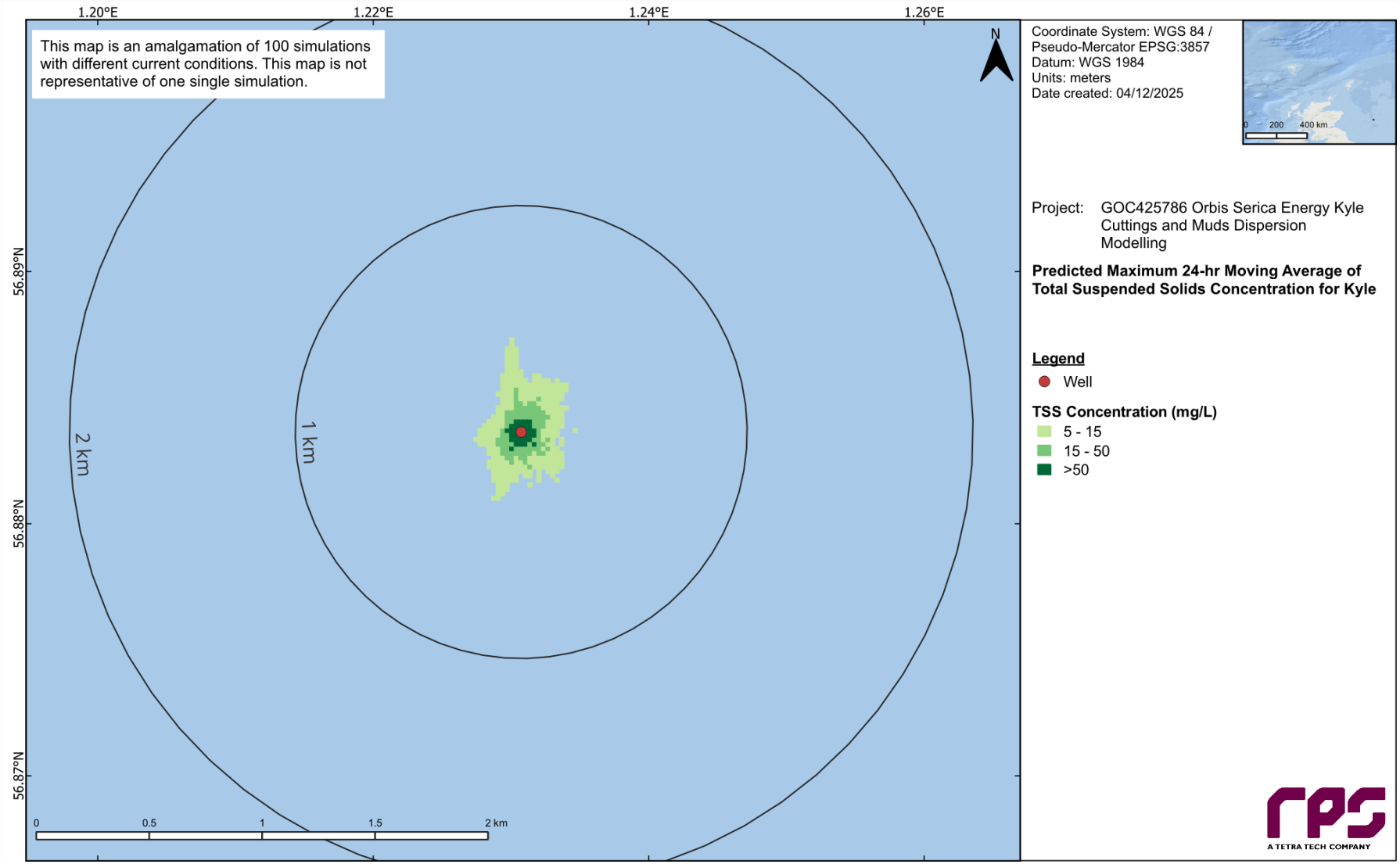


Figure 10.3: Predicted maximum 24-hour moving average of TSS concentrations, representing chronic exposure, from the discharge of drill cuttings and muds. Results are based on 100 simulations and represent annual conditions (RPS, 2025)



Water Quality

The sensitivity of the water column to contamination from the discharge of drill cuttings and muds is considered to be **Low**. The receptor has a Low value; as only the water column in relatively close proximity to the discharge point will be impacted, hence it is considered to be of local importance. The CNS 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 mud 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 muds are therefore assessed as **Minor**.

Plankton

The sensitivity of plankton to the planned discharge of drill cuttings and muds is considered to be **Low**. The receptor is of Medium value; the plankton community has a regional importance to the North Sea, providing a food source to higher trophic levels in this region. However, the temporary effluent plume resulting from the discharge of drill cuttings and muds 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 mud discharges. The magnitude of impact is considered to be **Negligible**, as the rapid dilution of the cuttings and muds 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 muds are therefore assessed as **Negligible**.

Benthic Communities

The impact to benthic communities from the discharge of drill cuttings, mud and cement at the proposed Kyla drill centre location is assessed in Section 7 (Seabed Disturbance).

Fish

The sensitivity of fish to the planned discharge of drill cuttings and muds is considered to be **Low**. The receptor has a High value; with many species listed as PMF in Scottish waters (see Section 4.3.3). However, the temporary effluent plume made from drill cuttings and muds 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 mud discharges. The magnitude of impact is considered to be **Negligible**, as the rapid dilution of the cuttings and mud 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 muds are therefore assessed as **Negligible**.

10.2.2 Discharge of Fluids Contaminated with Residual Hydrocarbons

Residual hydrocarbons may be discharged during a small number of planned activities associated with the Kyla Development, as detailed below. These relate to the management of LTOBM-contaminated drill cuttings returned to the MODU, the discharge of completion brines following well clean-up operations, and the routine discharge of produced water once Kyla is brought online via the Triton FPSO. In addition, residual hydrocarbons may be discharged in future subsea intervention programmes and during decommissioning activities.

Thermally Treated LTOBM Cuttings Water

As described in Section 3.3.4, all deeper hole sections of the Kyla well (17½", 12¼" and 9½") and contingency sidetrack options will be drilled using LTOBM and circulated back to the MODU via the marine riser. Cuttings recovered at surface will be processed through a thermal cuttings treatment system to reduce the OOC content to below the offshore discharge limit of <1% OOC. During this process, heating and mechanical separation generate a small volume of recovered water that may contain low concentrations of dispersed LTOBM.

Following treatment, the recovered water will be passed through a filtration and separation package to achieve an oil-in-water concentration of ≤30 mg/l prior to overboard discharge. This treated water stream represents a minor hydrocarbon-bearing discharge, with the majority of the LTOBM recovered and recycled back into the active mud system.

The small quantities of residual LTOBM present in the treated cuttings water will be discharged at the sea surface, where the water column is naturally energetic and characterised by strong wave action and rapid mixing. Under these conditions, any trace hydrocarbons are expected to undergo immediate dilution and dispersion, followed by further attenuation through natural microbial degradation. As a result, no measurable or persistent accumulation of hydrocarbons in the marine environment is anticipated. Representative oil in water samples will be collected at the discharge point and analysed to verify hydrocarbon concentrations in the treated water stream. Serica will obtain consent to discharge the treated cuttings water via a Drilling Chemical Permit Subsidiary Application Template (SAT) submitted on the UK Energy Portal, in accordance with the Offshore Chemicals Regulations 2002 (as amended 2011).

Well Clean-up and Completion Brines

As described in Section 3.3.5, prior to production start-up the Kyla well will undergo a series of clean-up and displacement operations to remove residual drilling fluids, solids, and debris from the wellbore and to prepare the lower and upper completion assemblies. These activities involve displacing the in-situ LTOBM with a filtered completion brine, installing the lower completion and gravel pack, and subsequently displacing the upper sections of the well with fresh brine to ensure well integrity and prevent damage to the export pipeline. In total, approximately 3,000 bbl (477 m^3) of completion brine will be discharged during the clean-up sequence. Although the brine is filtered prior to discharge, it may contain small quantities of entrained LTOBM residues mobilised during the displacement of the drilling fluid. In a worst-case scenario, the total mass of LTOBM hydrocarbons present in the discharged brine is estimated to be 14.3 kg. All fluids returned during clean-up operations will pass through a dedicated filtration and water-treatment package on the MODU and will only be discharged once the oil in water concentration has been reduced to ≤30 mg/l.

Any residual LTOBM present within the discharged completion brine will be released at the sea surface, where strong wave action and high natural mixing energy promote rapid dilution and dispersion. Under these energetic conditions, trace hydrocarbon concentrations are expected to dissipate quickly and be further reduced through natural microbial degradation, preventing any measurable or persistent accumulation in the marine environment. During well clean-up operations, representative oil in water samples will be collected at the discharge point and submitted for laboratory analysis to verify actual hydrocarbon concentrations. Serica will obtain consent to discharge these fluids through a Drilling Chemical Permit SAT on the UK Energy Portal, in accordance with the Offshore Chemicals Regulations 2002 (as amended 2011).

Produced Water Discharge from Triton FPSO

Once the Kyla well is brought online, produced fluids will be processed through the Bittern production train on the Triton FPSO. Produced water contaminated with reservoir hydrocarbons will be separated, treated and discharged overboard from Triton in accordance with the oil in water performance standard of ≤30 mg/l (monthly average), as required under the Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended 2010) and regulated through Triton's existing Oil Discharge Permit.

Kyla's incremental contribution to Triton's total produced water load is expected to remain small throughout field life, with the forecast oil in water load attributable to Kyla estimated at 14.71 tonnes between 2028 and 2035 (refer to Section 3.5.3). Upon discharge, produced water enters the high-energy waters surrounding the FPSO, where strong tidal currents, wave action, and natural turbulence promote rapid dilution and dispersion of the treated plume. Under these conditions, any dissolved or dispersed hydrocarbons are expected to attenuate quickly and remain confined to a very localised area around the discharge point, with no potential for measurable or persistent accumulation in the wider marine environment. Produced water discharges will continue to be managed and monitored under Triton's existing Oil Discharge Permit requirements to ensure ongoing compliance with regulatory limits.

Subsea Intervention and Future Decommissioning Activities

Although detailed programmes for subsea intervention and decommissioning activities will be developed at a later stage, these operations may involve the discharge of small residual volumes of hydrocarbons entrained in fluids used for well access, plugging and abandonment, or line flushing. At this pre-development stage, the timing and volumes of such discharges cannot be quantified; however, based on similar North Sea projects, any hydrocarbon-bearing discharges associated with these activities are expected to be very small in scale and short-lived when compared with those generated during drilling and routine production operations.

Assessment of Impacts

Hydrocarbons cause toxicity in aquatic organisms by a mechanism referred to as non-polar narcosis (or non-specific) toxicity. This toxicity is reversible and is observed in most organisms when exposed to sufficient levels of hydrocarbons (e.g. the effects of alcohol or solvents on humans). The partitioning of an organic substance between water and a hydrocarbon phase is described by its octanol water partition coefficient. This value is determined in the laboratory by a standardised method and reported as a logarithmic value (log P_{ow}). The higher the Log P_{ow} value the greater the amount of substance that dissolves in the organic (octanol) phase. Correlations of Log P_{ow} values with toxicity for single hydrocarbons indicate that solubility increases more rapidly with increasing Log P_{ow} than does the dissolved fraction of the hydrocarbon (i.e. the concentration that causes effects). Although this relationship varies with species it may be concluded that above a certain Log P_{ow} value a hydrocarbon will not exhibit acute toxicity. This relationship has been verified experimentally for fish and invertebrates; parafinic hydrocarbons with carbon number 10 or greater (Log P_{ow} >5) show no acute toxicity and parafinic hydrocarbons with carbon number greater than 14 (Log P_{ow}>7.3) show no chronic toxicity (CONCAWE, 2001). As such when an oil is released the lighter ends are likely to rapidly evaporate from the aquatic environment, whilst the heavier ends are not inherently toxic in aquatic systems.

Nonetheless, hydrocarbon constituents such as PAHs are of concern due to their potential mutagenic and carcinogenic properties. Despite this, many marine organisms, including fish and invertebrates possess enzymatic pathways to metabolise and detoxify PAHs at concentrations typically found in the marine environment (Stein *et al*., 2010; Tuvikene, 1995; Rust *et al*., 2004). Furthermore, the environmental fate of hydrocarbons involves a range of natural attenuation processes. Low molecular weight compounds may volatilise at the air–water interface or undergo biodegradation by native microorganisms. Others may precipitate after oxidation or become adsorbed onto suspended solids and sediments. These combined processes contribute to reducing both the concentration and bioavailability of hydrocarbon compounds in the receiving environment, thereby diminishing their overall toxicity to marine organisms (OGP, 2005).

Modelling and literature data suggest that the impacts of hydrocarbon discharges in open offshore environments are highly localised and transient. For example, a study conducted for the Norwegian petroleum sector found that while hydrocarbon effects may be observed at the level of individual organisms, no impacts were evident at the population or community level (OGUK, 2014).

Water Quality

The sensitivity of the water column to contamination from the discharge of residual hydrocarbons 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 CNS 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, receptor resistance and resilience is Very High to the discharge of residual hydrocarbons. The magnitude of impact is considered to be **Minor**, with no long-term changes in the baseline environment. Effects on water quality due to the discharge of residual hydrocarbons (from treated cuttings water, well clean-up fluid, produced water & future subsea intervention and decommissioning activity) are therefore assessed as **Minor**.

Plankton

The sensitivity of plankton to the discharge of residual reservoir hydrocarbons is considered to be **Low**. The receptor is of Medium value; the plankton community has a regional importance to the North Sea, providing a food source to higher trophic levels in this region. However, once discharged, the residual 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. 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 discharge of residual hydrocarbons (from treated cuttings water, well clean-up fluid, produced water & future subsea intervention and decommissioning activity) are therefore assessed as **Negligible**.

Fish

The sensitivity of fish to the planned discharge of residual reservoir hydrocarbon is considered to be **Low**. The receptor has a High value; with many species listed as PMF in Scottish waters (see Section 4.3.3). However, the residual 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 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 discharge of residual hydrocarbons (from treated cuttings water, well clean-up fluid, produced water & future subsea intervention and decommissioning activity) are therefore assessed as **Negligible**.

10.2.3 Discharge of Chemicals

Chemical discharges associated with the Kyla Development will occur during a defined set of activities spanning drilling, cementing, well clean-up and completion, subsea commissioning, and routine production operations. These activities are described in Section 3 and summarised below. In addition, chemicals may be used and discharged in future subsea intervention programmes and during decommissioning activities.

Discharge of Drilling, Cementing, Completion and Rig Chemicals during Drilling Operations

Drilling operations will involve several chemical discharges that are regulated under the Drilling Chemical Permit SAT, submitted via the UK Energy Portal in accordance with the Offshore Chemicals Regulations 2002 (as amended 2011) (refer to Section 3.3). During riserless drilling of the top-hole sections, seawater and bentonite sweeps will be discharged directly to the seabed. In the deeper hole sections, LTOBM will be circulated back to the MODU and treated offshore; only the treated cuttings (<1% OOC) and associated water containing permitted mud system chemicals will be discharged following separation and treatment.

Cementing activities will also generate chemical discharges, including up to 123 m^3 of cement slurry during installation of the 36" and 26" casings, with a further 123 m^3 potentially discharged in the event of a re-spud, along with small volumes of cement-wash water from post-job cleaning (refer to Section 3.3.4).

During well clean-up and completion (refer to Section 3.3.5), approximately 477 m^3 of filtered completion brine will be discharged once solids have been removed. Other specialist fluids used during clean-up—such as viscosified pills, surfactants and solvents—will be recovered to the MODU and, if contaminated, returned to shore for appropriate disposal; these fluids are not expected to be discharged offshore.

Routine MODU chemicals, including detergents, lubricants and hydraulic fluids used for equipment maintenance and BOP control, will also be used onboard. Any permitted discharges of these materials are likewise controlled under the Drilling Chemical Permit SAT. Collectively, these activities represent the principal chemical discharge streams during drilling operations.

Discharge of Subsea Commissioning Chemicals

During subsea installation and pre-commissioning, chemicals such as MEG gels, hydraulic fluids, corrosion inhibitors, oxygen scavengers and dyes will be injected into spools, jumpers and umbilical lines to preserve system integrity and to support leak detection during commissioning activities (refer to Section 3.4.5). These chemicals will remain fully contained within the subsea infrastructure and are not expected to be discharged during installation. Hydrotesting of the production system will require the use of chemically treated freshwater, with up to 400 m^3 discharged from the Triton FPSO during dewatering. The use and discharge of chemicals during pre-commissioning operations will be detailed and assessed in the Pipeline Operations MAT and associated Chemical Permit SAT, submitted via the UK Energy Portal in accordance with the Offshore Chemicals Regulations 2002 (as amended 2011).

Discharge of Production Chemicals

During routine production operations, chemicals such as corrosion and scale inhibitors, deoilers, demulsifiers, antifoam agents and methanol will be used for flow assurance and process treatment (refer to Section 3.5.6). A proportion of these chemicals will partition into the produced water stream and be discharged from the Triton FPSO as part of normal operations. These chemical discharges will be regulated under the existing Triton Production Chemical Permit SAT, submitted via the UK Energy Portal in accordance with the Offshore Chemicals Regulations 2002 (as amended 2011).

Subsea Intervention and Future Decommissioning Chemical Discharges

In addition to the operational phases described above, limited chemical discharges may occur during future subsea intervention activities and eventual decommissioning of the Kyla well and associated infrastructure. These activities may require the use of small volumes of intervention fluids, barrier testing chemicals, or line-flushing additives and cement slurries / additives associated with plug and abandonment operations. The detailed chemical inventories will be defined at the appropriate regulatory stage; however, based on comparable CNS developments, the scale of chemical discharge during intervention and decommissioning is expected to be minor relative to drilling, clean-up and routine production operations. All chemicals used during these phases will be subject to separate permitting under the Offshore Chemicals Regulations 2002 (as amended 2011).

Assessment of Impacts

The chemicals discharges associated with the Kyla Development 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 2011), Serica considers the minimisation of chemical usage a priority and recognises that substitution is an important aspect of the OSPAR Harmonised Mandatory Control Scheme (HMCS). Where practicable, chemicals with a high risk profile will be substituted out in favour of those with an improved environmental profile and, wherever possible, chemicals will be chosen which are PLONOR (Pose Little Or No Risk).

Prior to operations commencing offshore, all CHARMable (Chemical Hazard Assessment and Risk Management) chemicals to be discharged will be assessed by calculating a Risk Quotient (RQ). Where chemical use and discharge results in a RQ value >1, thus indicating a possible risk of the discharge causing harm to the marine environment, further investigation of the product will be carried out to determine if the RQ can be lowered or if an alternative product can be used which produces a lower RQ. The site-specific risk assessment of the chemicals to be used and discharged will be detailed within the appropriate Chemical Permit SAT.

It is anticipated that once discharged, the majority chemicals used will rapidly disperse given the hydrographic regime in the area and will be readily broken down through natural biodegradation

processes. Note, in the event that LTOBM is not shipped to shore for disposal, the chemical additives returned to the MODU will pass through the thermal treatment unit on the MODU and are expected to be broken down by the thermal treatment (Vik et al., 2014).

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 CNS 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 North Sea, providing a food source to higher trophic levels in this region. However, once discharged, the chemicals 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. 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; with many species listed as PMF in Scottish waters (see Section 4.3.3). 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**.

10.3 Mitigation Measures

Impacts from marine discharges during the development of the Kyla 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 2011). 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 as far as practicable;
- For assessment purposes, thermal cuttings treatment is being evaluated to treat the LTOBM contaminated cuttings to an acceptable overboard disposal limit (<1% oil on cuttings). If not selected / considered to be feasible, the LTOBM contaminated cuttings would be skipped and shipped onshore for disposal;
- During the drilling operations, any discharges of residual LTOBM hydrocarbons will be treated to meet oil in water limits of the Chemical Permit SAT. The discharge streams will also be monitored and sampled in accordance with the permit conditions;
- During the production operations, any discharges of residual reservoir hydrocarbons in the produced water stream will be treated to meet oil in water limits of the Triton Oil Discharge

Permit SAT. The discharge streams will also be monitored and sampled in accordance with the permit conditions.

10.4 Residual Effects

In summary, no significant residual effects on water quality or local flora and fauna are predicted as a result of routine marine discharges during the Kyla Development operations. The discharge of thermally treated LTOBM cuttings and associated solids during drilling is predicted to result in only short-lived and highly localised increases in water-column TSS, with modelling confirming that concentrations rapidly attenuate to background levels within a short distance of the MODU.

During the operational phase, Kyla production fluids will be processed via the existing Triton FPSO, resulting in a small incremental contribution to Triton's permitted produced water discharge. This incremental increase will be managed under Triton's existing Oil Discharge Permit and treated to meet the regulatory oil in water performance standard. Given the limited additional volumes attributable to Kyla, the high-energy receiving environment and the continued application of established treatment and monitoring controls, no discernible change to the existing produced water discharge plume or receiving water quality is anticipated.

Chemical discharges associated with drilling, completion, commissioning and routine production activities will be subject to risk assessment and permitting under the Offshore Chemicals Regulations 2002 (as amended 2011). Only chemicals with acceptable environmental profiles will be selected for use, and discharges will be controlled to ensure rapid dilution and dispersion in the receiving environment.

10.5 Transboundary Effects

The Kyla Development lies approximately 72 km to the south west of the UK / Norway median line at its closest point. It is very unlikely that marine discharges generated during the proposed Kyla Development operations would lead to transboundary impacts, as it is anticipated that discharges will be diluted rapidly, within close proximity to their release location.

10.6 Cumulative Effects

Marine discharges from the proposed Kyla Development will occur within a region of established oil and gas activity (refer to Section 4.4.3); however, the closest neighbouring assets are located at sufficient distances such that cumulative effects on the wider marine environment are not anticipated. The Kyla well will tie back to the existing Bittern subsea manifold located approximately 11–13 km to the northwest. Beyond Bittern, the nearest producing fields include the Starling subsea gas field (Shell UK), situated around 12 km to the northeast and tied back to the Shearwater platform, and the Triton FPSO (Dana), located approximately 20 km northwest of the Bittern DCB manifold and 30 km from the Kyla well. Other infrastructure in the area includes the Catcher FPSO (approximately 24 km southwest of the Bittern DCA manifold), the Gannet A platform (approximately 30 km north of the manifold), and the West Franklin WHP (approximately 36 km northeast of Kyla). The Belinda field, currently in development, lies approximately 14 km north of the Bittern DCB manifold and 24 km northwest of the proposed Kyla well and is expected to be online ahead of Kyla.

The only location where cumulative discharges may intersect is at the Triton FPSO, where Kyla's produced fluids will be processed alongside existing production streams. However, Kyla's incremental contribution to Triton's produced water and associated production chemical discharges is forecast to be small in comparison with the host facility's existing throughput (refer to Section 3.5). Although total produced water discharge volumes at Triton will increase once Kyla comes online, the combined discharges will remain within the limits authorised under Triton's existing Oil Discharge Permit and Production Chemical Permit SATs. As such, the addition of Kyla is not expected to result in a notable change in Triton's discharge footprint, and no significant cumulative effects are anticipated at the host facility.

Given the separation distances to other neighbouring assets, combined with the energetic and highly dispersive hydrodynamic conditions of the CNS, discharges from Kyla will rapidly dilute in the immediate vicinity of their release point and will not overlap with discharge plumes from adjacent

developments. Overall, the discharges associated with Kyla are small in volume, short-lived and localised, and therefore no cumulative or in-combination impacts on water quality, plankton, fish or benthic habitats are expected.

11 Accidental Releases

11.1 Introduction

This section assesses the risk of a maximum foreseeable accidental hydrocarbon release occurring from the Kyla Development well 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 Serica 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 Kyla Development well 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 Kyla field if an incident did occur will be covered in an 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 Kyla Hydrocarbon Release Scenarios

The following is a list of potential hydrocarbon release scenarios associated with the Kyla Development well:

- Uncontrolled well blowout;
- Diesel spillage from MODU or vessel;
- Pipeline rupture and subsequent release of liquid hydrocarbon inventory 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 control systems and related processes can result in an uncontrolled release of oil or natural gas (or a mixture of the two) as a result of BOP failure.

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 came 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.

Table 11.1 presents North Sea blowout frequencies for various development, production and well intervention activities which are relevant to the proposed Kyla Development. This indicates that for development drilling (for an oil well), the blowout frequency is extremely low at 3.4×10^{-5} per annum for an oil well.

In summary, given the above, the likelihood of a blowout occurring at the Kyla field is considered to be **Extremely Rare**.

An uncontrolled and unmitigated well blowout scenario is considered to result in the largest, volume of hydrocarbons released to sea from the proposed Kyla Development well (a cumulative release of 867,860.89 m^3 of 37.8°API crude oil over a period of 132 days) and has therefore been subject to oil

spill modelling and assessed in the following sections. The Kyla oil spill modelling study is presented in full in Appendix F and a summary of the modelling parameters and key results are detailed below in Section 11.3.2. Of note, the modelling has been completed in line with the OPRED Guidance Notes for Preparing OPEPs for Offshore Oil & Gas Installations and Relevant Oil Handling Facilities (Revision 7: June 2022).

Table 11.1: Blowout Frequencies (data from IOGP, 2019)

Operation	Well Category	Frequency, Average Well	Frequency, Gas Well	Frequency, Oil Well	Unit
Development Drilling	Normal	3.9×10^{-5}	4.2×10^{-5}	3.4×10^{-5}	per drilled well
Completion	-	2.1×10^{-4}	2.8×10^{-4}	1.4×10^{-4}	per operation
Workover	-	3.0×10^{-4}	4.0×10^{-4}	2.0×10^{-4}	per operation
Producing Wells Note 1	-	3.7×10^{-5}	7.2×10^{-5}	2.1×10^{-5}	per well year

Note 1: Excludes external causes such as ship collisions

Likelihood of a MODU or Vessel Collision

During the Kyla Development there is the potential for a MODU and/or vessel collision, resulting in the entire loss of diesel (fuel oil) inventory (which is typically around 3,500 m^3 for a semi-sub MODU). The risk of collision will be highest when the MODU is on location at Kyla, although shipping densities are low in the area. A vessel traffic survey (VTS) will be undertaken to inform the CtL permit application, which is required to site the MODU and subsea infrastructure at the Kyla location. A CRA may also be undertaken if considered necessary.

In addition, information on the location of the MODU, 500 m safety zone, subsea infrastructure and vessel operations will be communicated to other sea users (via the United Kingdom Hydrographic Office (UKHO)) through the standard communication channels including Kingfisher, Notice to Mariners and Radio Navigation Warnings.

The pipeline laying vessels could pose a short term obstruction to shipping and navigation. However, the vessels will be moving continually along the proposed pipeline route during the installation period so any obstruction will be of very short duration and long term exclusion from any one area will not occur. 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. In addition, in the event that pipelay operations are ongoing when the MODU is on location at the Kyla Development well, a Simultaneous Operations (SIMOPS) plan will be developed to reduce the potential for a collision incident to occur.

Given the above, the likelihood of a MODU or vessel collision is considered to be **Unlikely**. As the loss of diesel inventory is small compared to the well blow out scenario, it is not considered further in this assessment.

Likelihood of a Pipeline Rupture

Accidental releases of hydrocarbons from subsea pipelines are most likely to occur as a result of structural failures of equipment (i.e. internal corrosion for rigid pipelines and stress corrosion cracking for flexible pipelines). Releases due to impact damage are considered rare.

Table 11.2 details the number of Loss of Containment (LOC) events for hydrocarbon pipelines, risers and jumpers on the UKCS during a 20-year period from 2001 to 2020, with an estimate of LOC frequencies for operating pipelines outside of the 500 m safety zone provided in Table 11.3.

Table 11.2: Number of LOC Events (2001-2020) (PARLOC, 2024)

Pipeline Type	Number of LOC Events 2001-2020		
	Pipeline (excluding jumpers)	Risers	Jumpers
Rigid	16	6	7
Flexible	9	4	11

Table 11.3: Estimated Pipeline Loss of Containment Frequencies (PARLOC, 2024)

Pipeline LOC frequencies outside the 500 m safety zone of a production installation for different pipeline lengths					
Pipeline length (per km-year)	0 km to 3 km	3 km to 10 km	10 km to 30 km	30 km to 100 km	>100 km
Rigid Pipeline	4.3×10^{-4}	4.3×10^{-4}	7.7×10^{-5}	1.8×10^{-5}	1.1×10^{-5}
Flexible Pipeline	1.1×10^{-3}				No data

For rigid pipelines in the 10 km to 30 km length category—representative of the proposed Kyla pipeline system, the estimated LOC frequency is 7.7×10^{-5} per km-year, indicating an extremely unlikely event to occur.

The largest 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 **Extremely Rare.** Significant leakage is estimated to be a short-term event, occurring over a period of a day(s). The total volume of oil released is considerably less than the well blowout scenario which has been modelled and is therefore not considered further in the impact assessment.

It is acknowledged that the Kyla production pipeline and gas lift line also include gas, which would be released in the event of a pipeline rupture. This would result in the increased concentration of greenhouse gas (GHG) emissions in the atmosphere, further contributing to the effects of climate change, and could cause short term air quality impacts. The potential environmental effects from gaseous emissions generated from the Kyla Development are discussed in Section 9 of the ES and have not been considered further in this Section given the unlikely and one-off nature of a pipeline rupture event.

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 processes 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 ITOPF has ranked oils according to their physical characteristics (API/SG) and likely spill behaviour (Table 11.4). The hydrocarbon present in the Kyla reservoir is predominantly going to resemble an ITOPF Group 2 crude oil (based on a density of 0.8365 g/cm^3 @ 15°C and API of 37.8°) that does not form a stable emulsion (refer to Appendix F.6.3). Light crude oils such of these are more susceptible to evaporation and oxidation and consequently reduce faster over time compared to heavier oils.

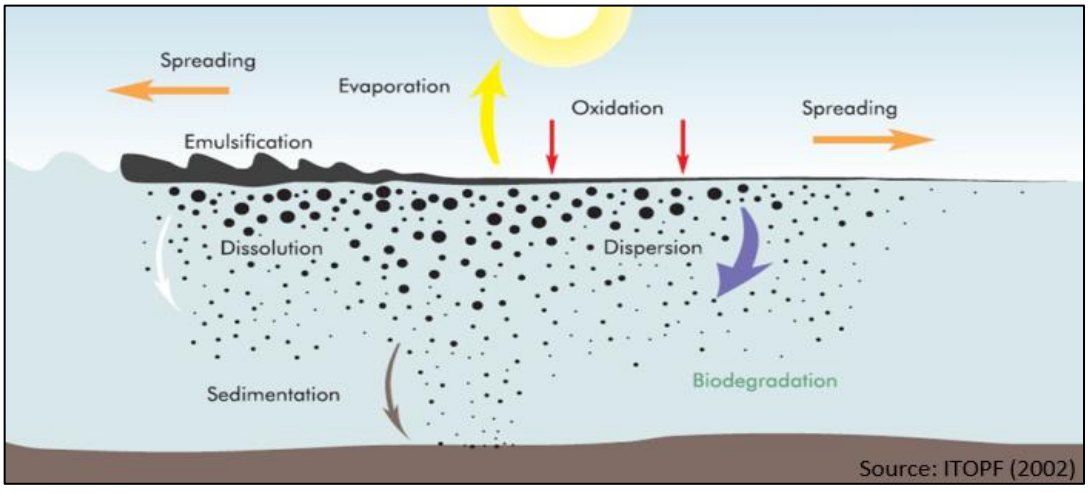
Table 11.4: ITOPF Categories and Characteristics

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, 2014b).

Over time, as a consequence of weathering, an oil spill will normally break up and begin to dissipate into the marine environment. Lighter products such as the Kyla crude oil (and diesel) under most conditions, evaporate and dissipate quickly and naturally.

Figure 11.1: Oil Weathering Process



11.3.2 Oil Spill Modelling

Although extremely rare, a well blowout event is considered to be the largest accidental release scenario that could occur at the Kyla Development. Therefore, in order to gain an understanding of the fate of the Kyla crude oil in the marine environment a subsea blowout has been modelled using the OILMAP software. Table 11.5 summarises the blowout scenario information and model setup parameters.

Table 11.5: Summary of Blowout Scenario Parameters (Kyla Development)

Parameter	Summary
Scenario Description	
Scenario type	Subsea well blowout (Kyla Development) with a declining flow rate; relief well assumed required
Volume of oil released	Cumulative release of 5,458,587.90 bbl (867,860.89 m^3) of 37.8°API crude oil, over a period of 132 days (Declining release: 49,857 bbl/day on Day 1; 32,854 bbl/day on Day 132)
Justification for largest release volume	Represents maximum credible blowout volume assuming flow can only be stopped via relief well drilling (132 days)
Hydrocarbon Properties	
Oil type	37.8°API crude oil that does not form a stable emulsion
Modelling analogue	Amended Chayvo #6 crude (ITOPF Group 2)
Key oil properties	Density 0.8365 g/cm^3 @15°C; API 37.8°; viscosity 19 cP @ 0°C / 4 cP @ 15°C; pour point 3°C; wax 7%; asphaltenes 0.15%
Release & Simulation Parameters	
Release depth	90 m (subsurface)
Release duration	132 days
Persistence after cessation	Modelled for 10 days post-release.
Simulation period	142 days
Metocean Inputs	
Sea surface temperature	7°C (winter), 14°C (summer), 9°C (spring), 10°C (autumn)
Wind data	European Centre for Medium-Range Weather Forecasts (ECMWF) - Reanalysis v5 (ERA5); date range: 2019 – 2023.
Current data	HYCOM (HYbrid Coordinate Ocean Model) general ocean circulation model and HYDROMAP hydrodynamic model; date range: 2019 – 2023.
Stochastic Setup	
Number of runs	100 runs per season
Probability grid	1 km × 1 km horizontal; 500 m vertical.
Minimum oiling thresholds	Surface: 0.0003 mm; Shoreline: 0.001 mm; Water column: 1 ppb.

Table 11.5 details the largest release scenario for the Kyla 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 scenario 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 to minimise the impact to the marine environment.

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 and subsurface 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 (OPRED, 2022) 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 shows the aggregation of results computed by running the spill scenario multiple times (i.e. 100 times per season) over different weather and metocean 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 142 days. The trajectory modelling enables fates analysis on the released oil over time.

The input parameters and modelling results are presented in full in Appendix F. A summary of the key conclusions has been provided below.

Stochastic Modelling Results

Summary of Results

Table 11.6 summarises the stochastic results for a subsea well blowout in the Kyla field across all seasons, reporting the minimum arrival time and probability of oil to reach land and the territorial waters of nearby countries.

Table 11.6: Summary of Stochastic Modelling Results

Subsea Well Blowout in the Kyla Field					
Spill Scenario / Descriptor: 5,458,587.90 bbl (867,860.89 m^3) of Crude Oil (37.8 °API) released over 132 days					
Season		Winter (December – February)	Spring (March – May)	Summer (June – August)	Autumn (September – November)
Median Crossing [Note 1]					
Median Line	**Surface Oil: Probability and Shortest Time to Reach (Minimum Thickness of 0.3 µm)**				
Netherlands	*Maximum Probability*	41 %	2 %	1 %	17 %
	Shortest Arrival Time	38 days	136 days	129 days	68 days
Germany	*Maximum Probability*	56 %	3 %	1 %	28 %
	Shortest Arrival Time	32 days	111 days	103 days	62 days
Denmark	*Maximum Probability*	83 %	20 %	17 %	83 %
	Shortest Arrival Time	16 days	32 days	37 days	28 days
Norway	*Maximum Probability*	100 %	100 %	100 %	100 %
	Shortest Arrival Time	3 days	6 days	8 days	4 days
Sweden	*Maximum Probability*	54 %	N/A	6 %	69 %
	Shortest Arrival Time	25 days	N/A	71 days	39 days
Median Line	**Subsurface Oil: Probability and Shortest Time to Reach (Minimum Water Column Concentration 1.0 ppb)**				
Netherlands	*Maximum Probability*	53 %	2 %	5 %	68 %
	Shortest Arrival Time	35 days	130 days	112 days	48 days
Germany	*Maximum Probability*	78 %	12 %	6 %	72 %
	Shortest Arrival Time	23 days	108 days	106 days	48 days
Denmark	*Maximum Probability*	91 %	58 %	79 %	100 %
	Shortest Arrival Time	15 days	31 days	36 days	29 days
Norway	*Maximum Probability*	100 %	100 %	100 %	100 %
	Shortest Arrival Time	3 days	5 days	7 days	4 days
Sweden	*Maximum Probability*	74 %	20 %	54 %	100 %
	Shortest Arrival Time	24 days	97 days	64 days	38 days

Landfall [Note 1]					
Predicted Locations	**Shoreline Oil: Probability and Shortest Time to Reach (Minimum Thickness of 1.0 µm)**				
UK					
UK (mainland)	*Maximum Probability*	34 %	39 %	7 %	9 %
	Shortest Arrival Time	53 days	27 days	23 days	30 days
Shetland	*Maximum Probability*	5 %	12 %	3 %	9 %
	Shortest Arrival Time	93 days	62 days	91 days	40 days
Orkney	*Maximum Probability*	8 %	7 %	2 %	5 %
	Shortest Arrival Time	79 days	51 days	87 days	56 days
UK Counties at Greatest Risk [Note 2]					
Aberdeenshire	*Maximum Probability*	34 %	39 %	7 %	3 %
	Shortest Arrival Time	53 days	27 days	46 days	32 days
City of Aberdeen	*Maximum Probability*	28 %	32 %	4 %	7 %
	Shortest Arrival Time	71 days	28 days	51 days	33 days
Kincardineshire	*Maximum Probability*	33 %	32 %	5 %	3 %
	Shortest Arrival Time	64 days	28 days	23 days	30 days
Angus	*Maximum Probability*	29 %	28 %	3 %	2 %
	Shortest Arrival Time	78 days	38 days	74 days	30 days
Fife	*Maximum Probability*	22 %	33 %	2 %	2 %
	Shortest Arrival Time	81 days	41 days	72 days	58 days
International					
Germany	*Maximum Probability*	3 %	N/A	N/A	2 %
	Shortest Arrival Time	56 days	N/A	N/A	83 days
Denmark	*Maximum Probability*	57 %	3 %	2 %	75 %
	Shortest Arrival Time	34 days	101 days	77 days	45 days
Norway	*Maximum Probability*	27 %	2 %	11 %	36 %
	Shortest Arrival Time	32 days	96 days	65 days	47 days
Sweden	*Maximum Probability*	22 %	N/A	2 %	40 %

	Shortest Arrival Time	27 days	N/A	139 days	44 days

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: A breakdown of the maximum probability and shortest arrival time for each UK County to be impacted by shoreline oil is displayed in Appendix F (Table F.6).

Surface Oiling

Table 11.7 reports the maximum distance that the surface oil slick may occur from the Kyla release location for each of the BAOAC 2 – 5 thresholds. This data is displayed graphically in Figure 11.2.

Table 11.7: Surface Oiling by BAOAC Thresholds

Code	Description – Appearance	Layer Thickness Interval (µm)	Litres per km^2	Max Distance from the Release Location
2	Rainbow	0.30 to 5.0	300 – 5000	909 km
3	Metallic	5.0 to 50	5000 – 50,000	872 km
4	Discontinuous True Oil Colour	50 to 200	50,000 – 200,000	93 km
5	Continuous True Oil Colour	More than 200	More than 200,000	68 km

Surface oiling is predicted to occur predominantly within UK waters, extending eastwards towards the Norwegian Trench and Skagerrak region, with lower-probability patches extending south and southeast under some seasonal conditions. The modelling results indicate a 100 % probability of surface oil, at a minimum thickness of 0.3 µm, crossing the UK / Norway median line in all seasons (Table 11.6; Figure 11.3).

A high probability (up to 83 %) of surface oiling is predicted in Danish waters, while moderate probabilities (up to 56 % and 69 %) occur in German and Swedish waters respectively (Table 11.6). The probability of surface oil entering Dutch waters remains comparatively low (≤41 %) (Table 11.6). Seasonal variability is notable, with the greatest transboundary transport predicted in winter and autumn, reflecting enhanced wind-driven spreading and deeper mixing during these periods.

The minimum transit time for surface oil exceeding 0.3 µm in thickness to leave UK waters is predicted to be 78 hours (3 days), corresponding to oil crossing the UK / Norway median line during winter conditions.

Model outputs predict that only UK waters are likely to experience BAOAC 5 (Continuous True Oil Colour) and BAOAC 4 (Discontinuous True Oil Colour) surface oiling. In contrast, BAOAC 3 (Metallic) and BAOAC 2 (Rainbow) thresholds may be reached within Dutch, German, Danish, Norwegian and Swedish waters (refer to Figure 11.2). Overall, the model predicts that surface oil is most extensive during autumn and winter.

Figure 11.2: Maximum Surface Oil Thickness (Bonn Code)

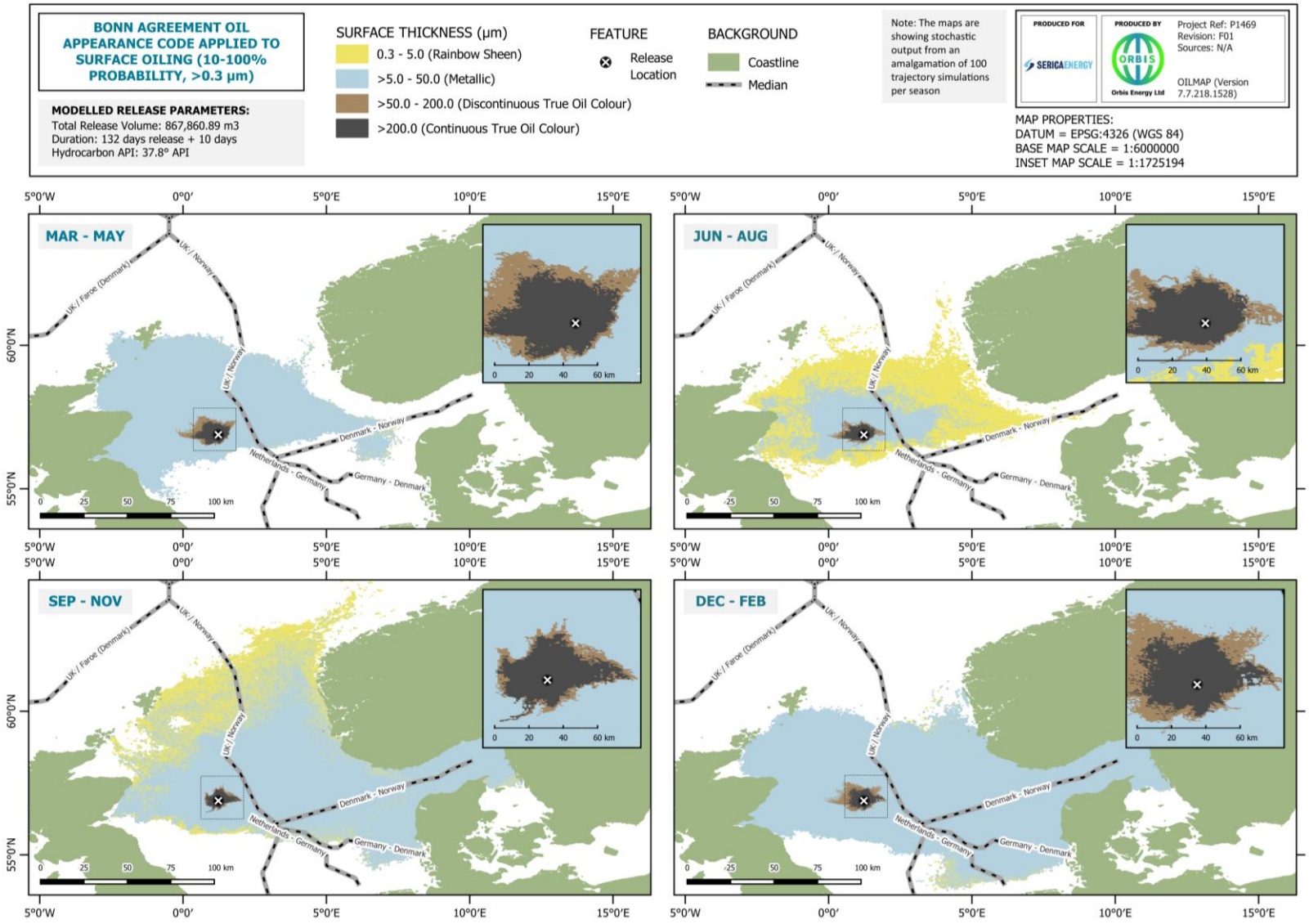
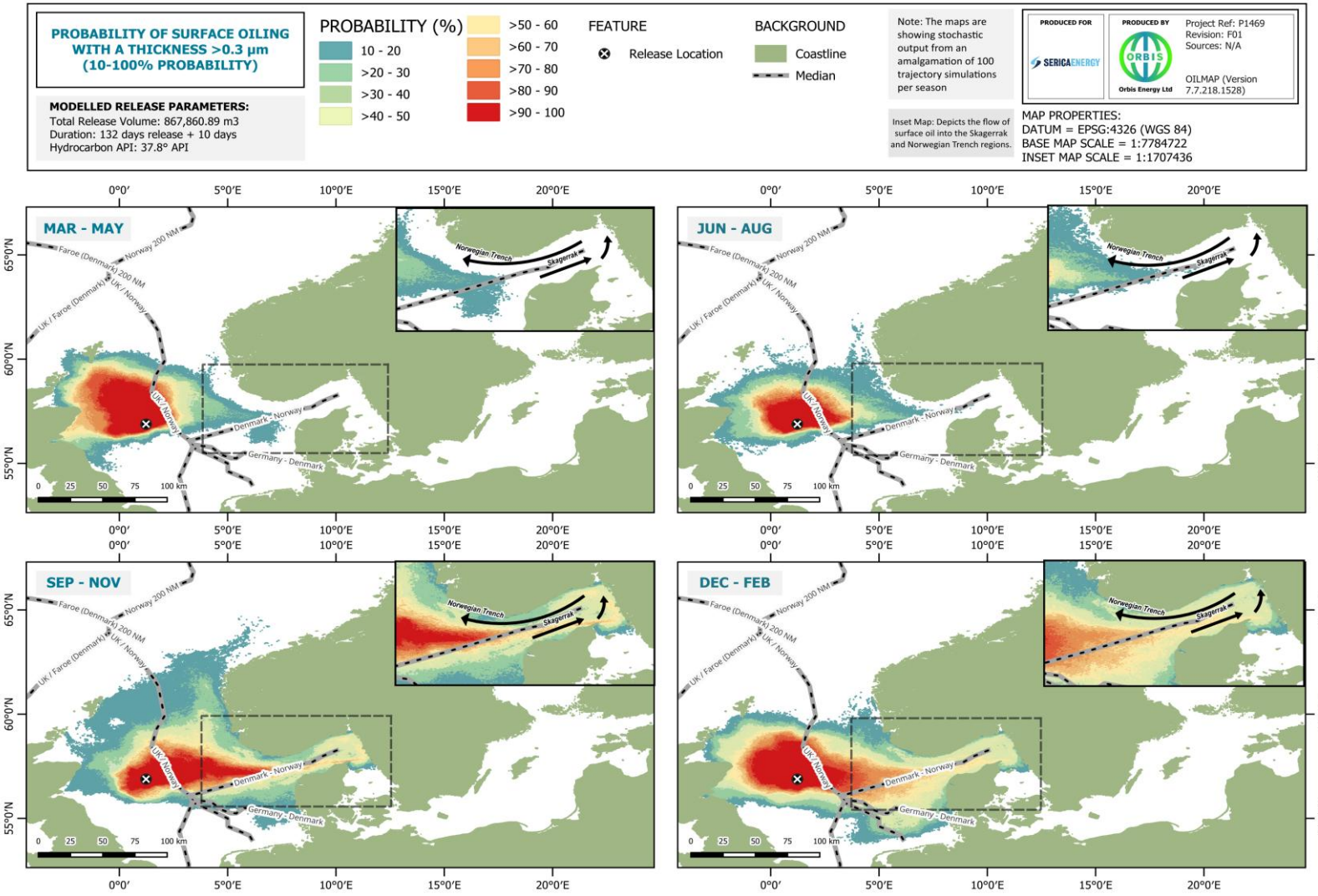


Figure 11.3: Probability of Surface Oiling



Subsurface Oiling

Table 11.8 presents the water column oil concentration thresholds that have been used in the modelling study to help determine subsurface oiling severity in the spatial context.

Table 11.8: Water Column Oil Concentration Thresholds

Threshold for Water Column Oil Concentration (ppb)	Threshold Justification (refer to Appendix F for detailed justification)
1	Screening threshold (Minimum Water Column Concentration modelled) (Trudel, 1989; French-McCay, 2002; French-McCay, 2004; French-McCay, *et al.,* 2012).
70.5	OSPAR recommended predicted no-effect concentration (PNEC) threshold for marine fauna (Smit *et al*., 2009; OSPAR, 2014)

A minimum water column concentration of 1 ppb has been used in the modelling study to determine the probability and minimum time for oiling subsea. This concentration is exceeded out to a maximum distance of 1,366 km from the release location.

Subsurface oiling concentrations are predicted to be highest (>70.5 ppb) over wide areas of the CNS, extending predominantly eastwards and south-eastwards into the Norwegian Trench and Skagerrak region. Elevated subsurface concentrations in the Skagerrak region are attributed to the bathymetric depression and persistent stratification in this area, which can trap and retain hydrocarbons within deeper water layers transported from the North Sea. These oceanographic conditions reduce vertical mixing and promote the accumulation and persistence of oil within the water column (Rodhe, 1996; Danielssen *et al*., 1997; Winther and Johannessen, 2006; OSPAR Commission, 2014; Howarth, 2001) (Figure 11.4). The maximum area at risk of oiling at these higher concentrations is 495,957.80 km^2 at the release location and the surrounding area.

Model results indicate a 100 % probability of subsurface oil, at concentrations exceeding 1 ppb, crossing the UK / Norway median line under all seasonal conditions. There is also a high probability (100 % in autumn) of subsurface oil entering Danish and Swedish waters. Probabilities within German waters range from 6–78 %, while Dutch waters exhibit lower probabilities ranging from 2–68 % (Table 11.6; Figure 11.5).

The minimum time for subsurface oil at a concentration greater than 1 ppb to leave UK waters is approximately 74 hours (3 days), corresponding to oil crossing the UK / Norway median line in winter conditions.

Figure 11.4: Maximum Total Water Column Oil Concentrations

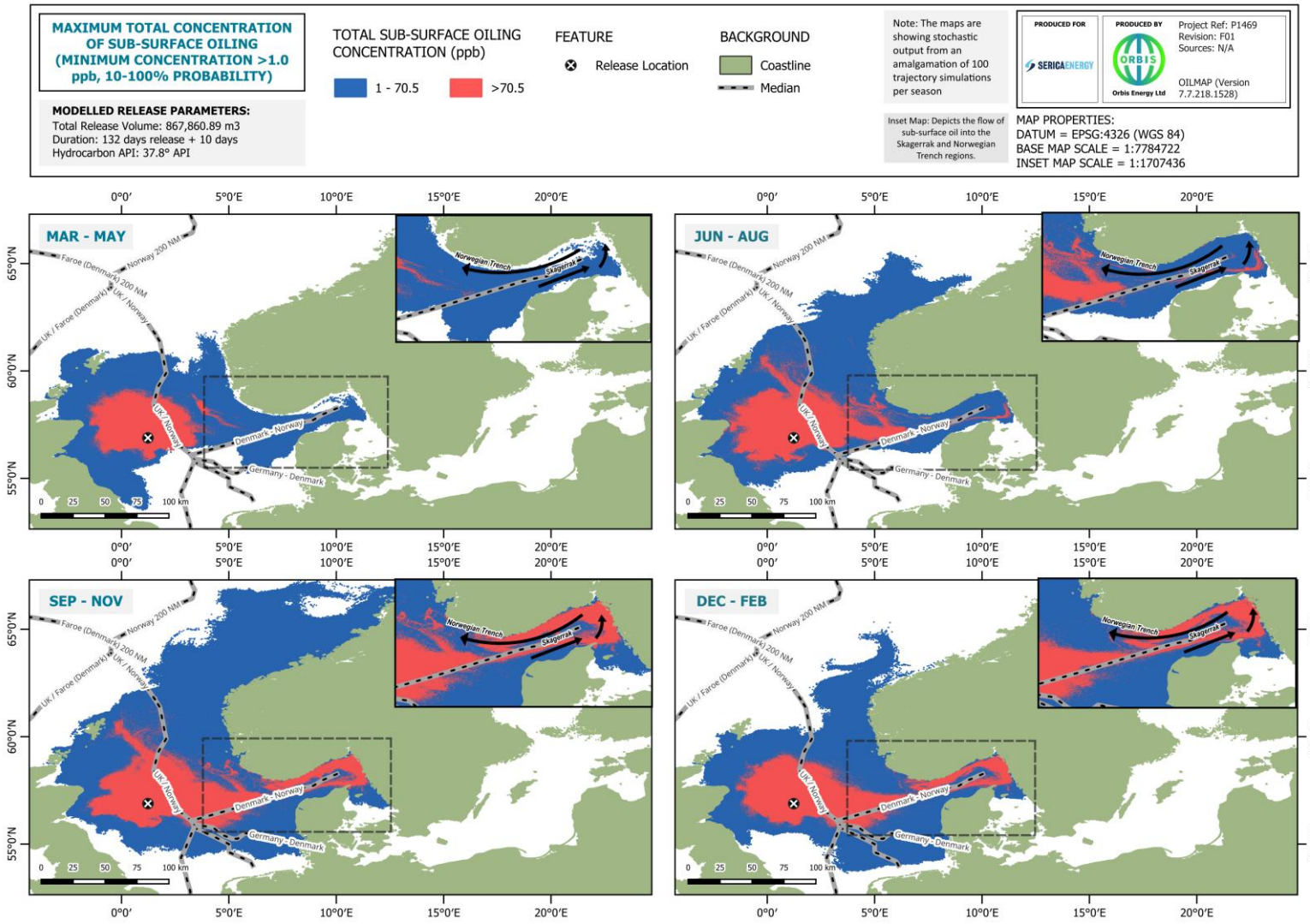
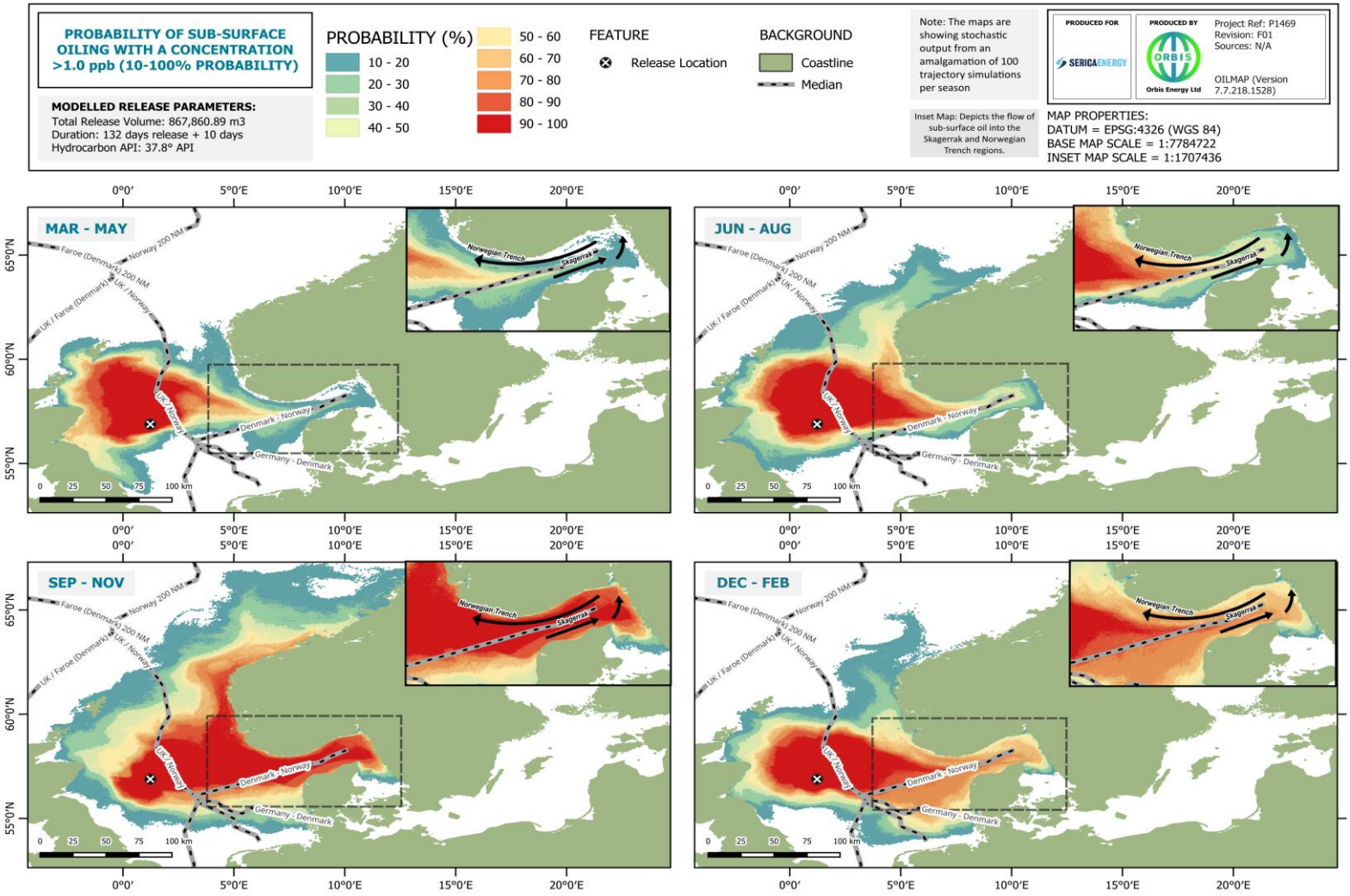


Figure 11.5: Probability of Subsurface Oiling



Shoreline Oiling

Table 11.9 presents the shoreline oiling thickness (and corresponding concentration) thresholds that have been used in the modelling study to help determine shoreline oiling severity in the spatial context.

Table 11.9: Shoreline Oil Thickness Thresholds

Shoreline Oiling Severity (ITOPF, 2014)	Thickness Threshold (mm)	Concentration
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

The stochastic modelling predicts that shoreline oiling could occur along parts of the UK coastline, primarily affecting the northeast of Scotland, with the highest probabilities along the Aberdeenshire and Kincardineshire coasts. The probability of shoreline oiling in UK waters varies seasonally, peaking during spring (up to 39 %) and winter (34 %), with minimum arrival times of 637 hours (27 days) in spring and 1,260 hours (53 days) in winter (Table 11.6). The greatest likelihood of shoreline contact occurs along the Aberdeenshire coast, where modelling indicates moderate shoreline oiling thickness thresholds are reached. Adjacent coastlines such as Angus, Fife, and the City of Aberdeen exhibit lower probabilities (typically 28–33 %) with light to moderate oiling severity. Further south, the probability of oil reaching shore decreases markedly, with only isolated moderate oiling predicted for the Firth of Tay and Firth of Forth areas in spring and winter. No moderate oiling thresholds are predicted for English coastlines (refer to Figure 11.6, Figure 11.7 and Table F.6 in Appendix F for a full breakdown of the UK counties impacted by shoreline oiling).

In northern Scotland, Shetland and Orkney show lower probabilities of shoreline oiling, with a maximum of 12 % and 8 %, respectively, and minimum arrival times of 955 hours (40 days) (Shetland) and 1,219 hours (51 days) (Orkney). These results indicate that oil reaching the northern isles would likely be weathered and patchy, corresponding to light oiling and limited moderate oiling (Table 11.6, Figure 11.6 and Figure 11.7).

Outside the UK, the stochastic modelling predicts that shoreline oiling could occur across several other countries bordering the North Sea, including the coasts of Denmark, Norway, Sweden, and, to a much lesser extent, Germany, with the probability and severity varying between seasons. The Danish coastline shows the greatest potential for transboundary shoreline contact, with maximum probabilities of 75 % in autumn and 57 % in winter, and minimum arrival times of 1,070 hours (45 days) and 818 hours (34 days), respectively (Table 11.6). Oiling along the north-west Jutland and Skagerrak coasts is generally predicted to be of light to moderate severity. Moderate shoreline oiling is most likely to occur where currents converge along the Hanstholm–Hirtshals section and in shallow embayment's of the northern Kattegat, where residual circulation may retain floating residues (Figure 11.6).

To a lesser extent, shoreline oiling is also predicted for Norway and Sweden, reflecting the north-easterly drift of surface oil through the Skagerrak region. For Norway, probabilities peak at 36 % in autumn, with the shortest arrival time of 762 hours (32 days) occurring in winter (Table 11.6). The severity of oiling along the south-west Norwegian coast, particularly between Stavanger and Fredrikstad, is expected to be light to moderate, reflecting the transport of oil through the Norwegian Trench and Skagerrak. For Sweden, shoreline oiling is predicted in autumn (40 %) and winter (22 %), with earliest arrival times of 643 hours (27 days) and 1,060 hours (44 days), respectively (Table 11.6). These results suggest a seasonal influence, with enhanced eastward transport and limited weathering during the cooler months promoting increased potential for oil to reach the Scandinavian coastlines. The shoreline oiling is predicted primarily along the west coast between Gothenburg and Strömstad, with light to moderate severity thresholds reached (Figure 11.6).

Germany shows the lowest potential for shoreline contact, with probabilities of only 2–3% during winter and autumn and arrival times exceeding 1,351 hours (56 days), indicating delayed and highly weathered oil residues which correspond to light severity oiling (Table 11.6, Figure 11.6 and Figure 11.7).

Figure 11.6: Maximum Shoreline Oiling Thickness

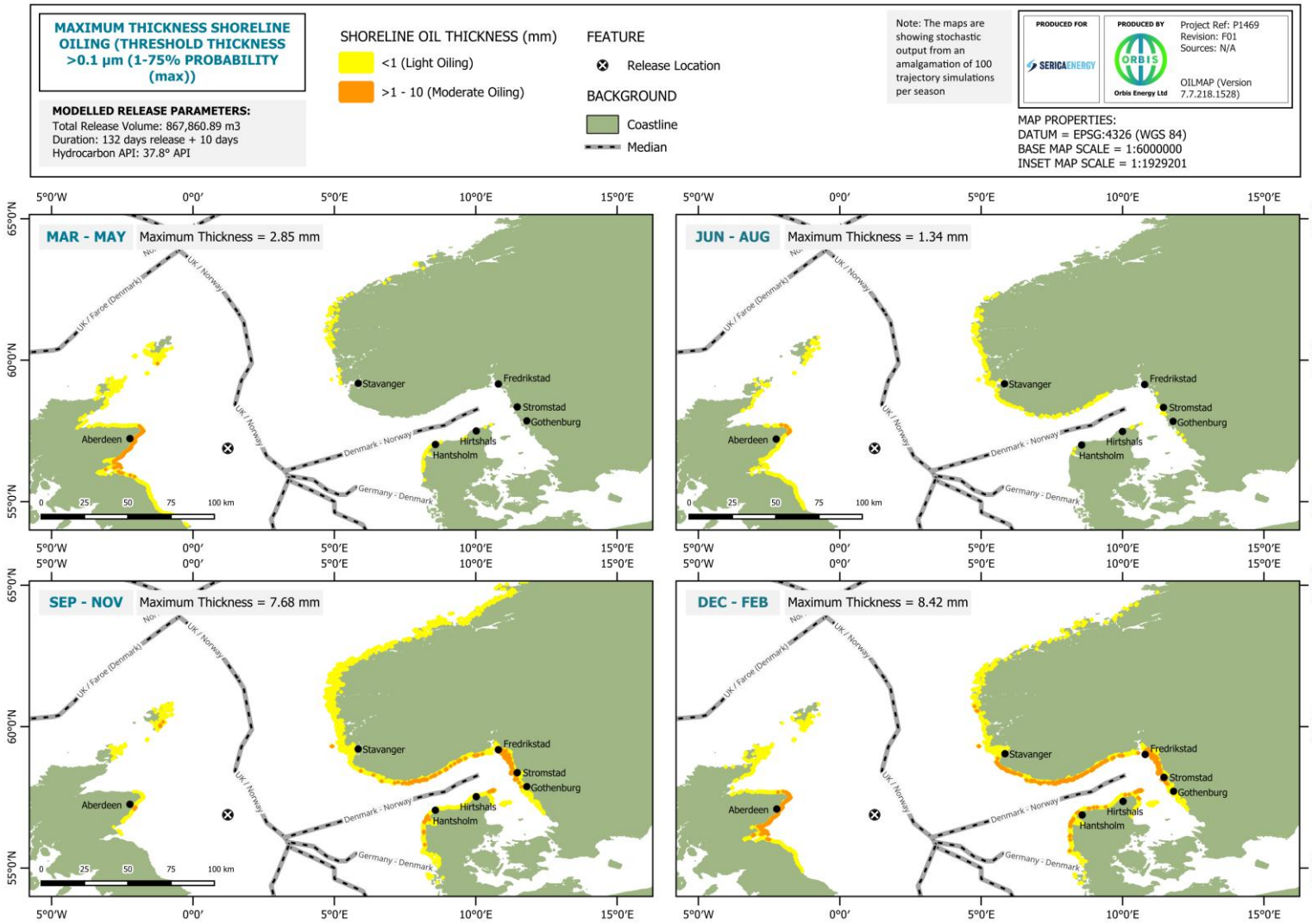
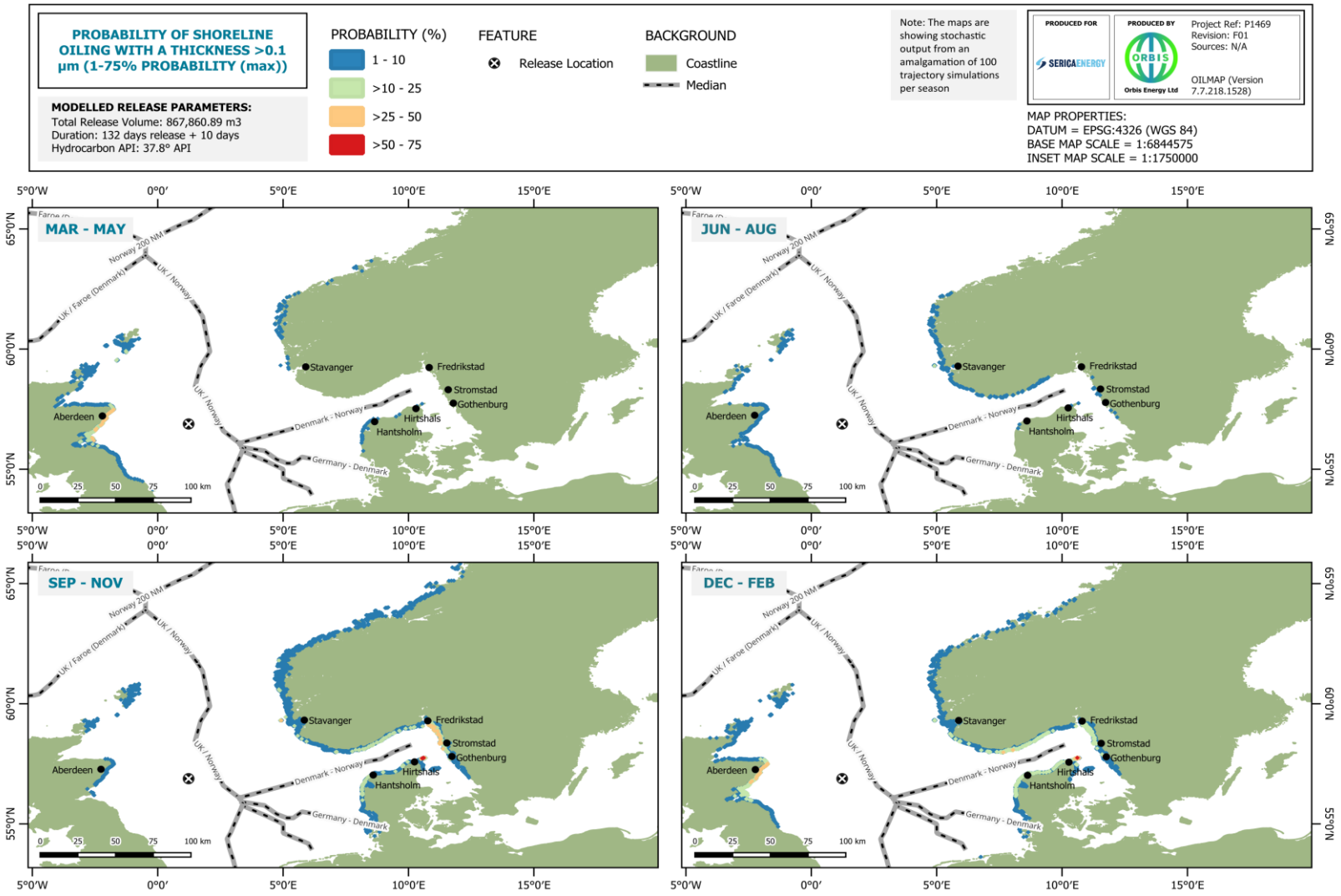


Figure 11.7: Probability of Shoreline Oiling



Worst Case Trajectory Results Summary

Worst case trajectory simulations were identified per season by the greatest mass and volume of oil beached in any one location, as detailed in Table 11.10. The worst case trajectory simulations have been displayed graphically in Appendix F showing the total swept area of surface and shoreline oiling.

Table 11.10: Worst Case Trajectory Simulations Identified from Stochastic Results

Season	Run No	Greatest Mass &Volume of Oil Beached (in any one location)			Sim Start Date	Sim Start Time	Time (hrs) to Impact
		tonnes	m^3	bbl			
Winter	33	10,225.81	12,030.36	75,662.67	03/12/2019	00:00	982
Spring	52	2,237.48	2,632.33	16,555.53	19/03/2021	15:00	1,485
Summer	81	519.96	611.72	3,847.28	05/08/2023	23:00	2,187
Autumn	34	6,096.93	7,172.86	45,112.32	08/11/2019	09:00	1,512

Table 11.11 provides summary statistics for each of the worst case trajectory simulations. It can be seen from this that the maximum surface slick area ranges between 6,772 – 21,840 km^2 across all seasons, although this is short lived due to relatively high evaporation rates.

The fate of released oil after 142 days is consistent between seasons. The released oil does not persist in the marine environment with the majority evaporated (40.15 – 44.25 %) and degraded (38.11 – 41.77 %) after 142 days. A lower proportion (16.50 – 17.63 %) of released oil remains in the water column after 142 days. The trajectory simulations predict very low percentages of oil ashore (0.05 – 0.88 %) and on the sea surface (0.02 – 0.68 %), and zero oil in the sediment after 142 days (refer to Table 11.11).

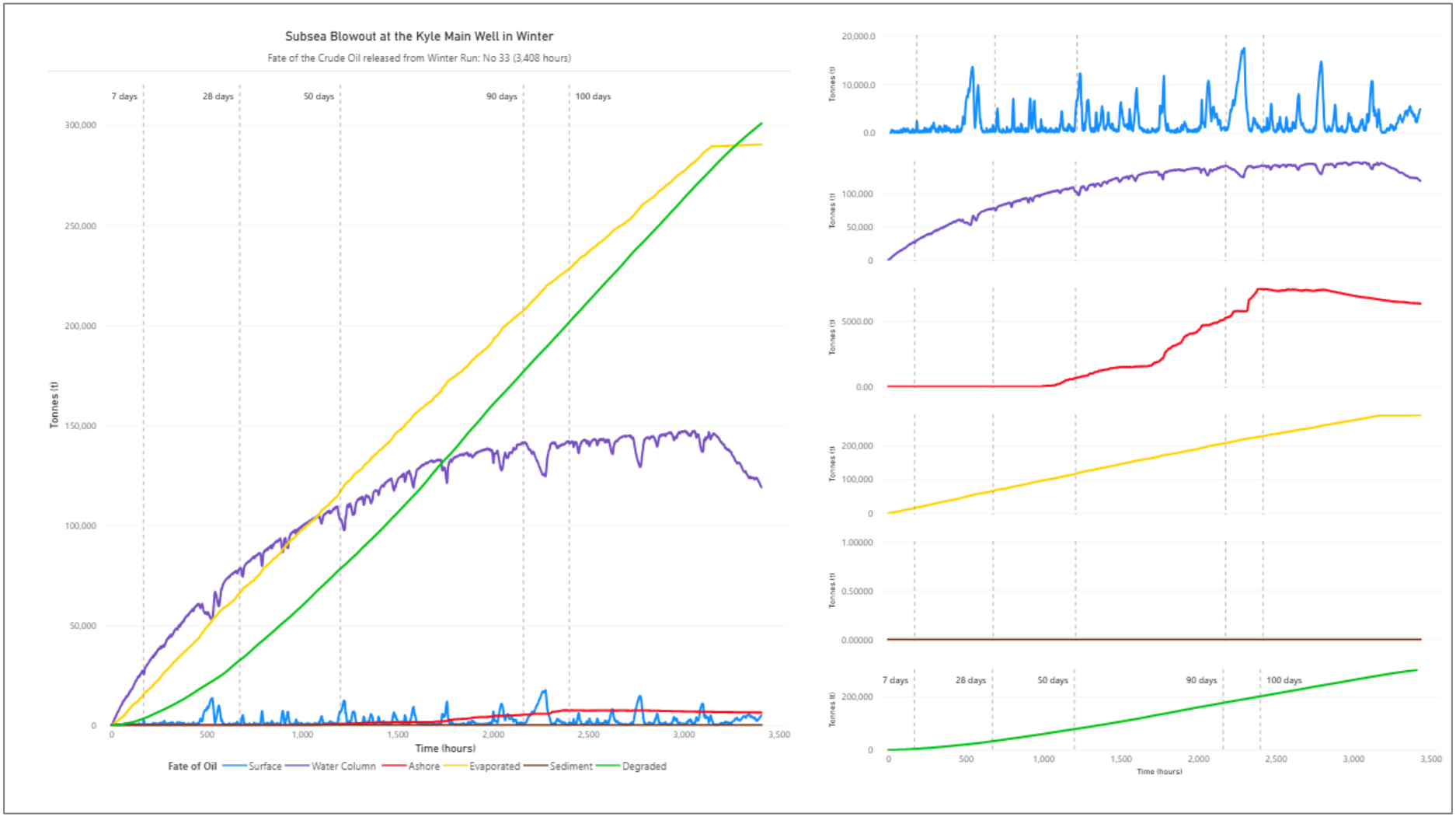
Figure 11.8 depicts the temporal fate (mass balance) of the released oil for the winter trajectory, the worst case season for shoreline oiling. At no point does surface oil exceed 17,417 tonnes, and the water column fraction remains below 147,248.2 tonnes.

The seabed sediment is subject to an undetectable amount of oiling during the spill duration.

Table 11.11: 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 142 days	Fate of Released oil after 142 days (% of total release)					
						Ashore	Surface	Water Column	Evaporated	Degraded	Sediment
Winter	33	2 hrs	21,840 km^2	643 hrs	617 km	0.88	0.68	16.50	40.25	41.70	0.00
Spring	52	2 hrs	14,035 km^2	637 hrs	206 km	0.20	0.25	17.19	44.25	38.11	0.00
Summer	81	2 hrs	6,772 km^2	561 hrs	68 km	0.05	0.11	17.63	42.15	40.06	0.00
Autumn	34	2 hrs	13,926 km^2	710 hrs	395 km	0.58	0.02	17.35	40.27	41.77	0.00

Figure 11.8: Fate of the oil released from Winter Run No. 33 (showing model duration 142 days)



Vertical Profile Modelling

Vertical profile modelling (Appendix F, Section F.5) was undertaken using the OILMAP Deep module to simulate the near-field plume behaviour and far-field water column transport of oil released during a subsea blowout in the Kyla field. It is important to note that the near-field plume represents a highly localised zone of turbulent jet mixing, typically on the metre-scale, whereas the far-field model represents the wider, kilometre-scale transport and dispersion of oil droplets under varying current and seasonal conditions.

The near-field plume represents the region immediately surrounding the blowout release where jet momentum and buoyancy control initial rise. The OILMAP Deep results show the initial near-field plume rises to a termination height of 89.55 m (reaching near the sea surface) in 33 seconds, with a maximum plume radius of ca. 6.6 m (maximum width ca. 13 m). The peak oil concentrations are predicted at the plume core on the order of ca. 41,000–44,000 ppb. Beyond this narrow near-field zone the plume transitions to the far-field model, where oil droplets fallout, ambient shear and advection dominate and lead to rapid dilution and lower oil concentrations over much wider areas.

The far-field model considers the buoyant rise of oil droplets through the water column under the influence of stratification, turbulence, and ambient currents. The results indicate that the highest oil concentrations (>10,000 ppb total hydrocarbon concentration) occur only in the immediate vicinity of the release location (within a few kilometres). These elevated concentrations are associated with larger oil droplets (>200 µm) that rapidly rise to the surface within a few hours of release. Smaller droplets (<200 µm), which account for approximately 61 % of the released oil, remain entrained within the water column for longer periods, resulting in a wider area of low-level hydrocarbon exposure. The smallest droplets (<70 µm), representing roughly 16 % of the oil, are predicted to remain in suspension and do not surface, consistent with observations of blowout behaviour (Spaulding *et al*., 2017) and with experimental modelling studies completed in the North Sea (Johansen *et al*., 2013; SINTEF, 2014).

While the vertical profile modelling provides a useful representation of near-field plume dynamics for a single deterministic trajectory, the broader stochastic modelling (refer to Figure 11.4) indicates that elevated subsurface oil concentrations (above the OSPAR PNEC threshold >70.5 ppb) may extend over a wider area of the North Sea under varying seasonal and hydrodynamic conditions. This reflects the influence of changing current regimes, stratification, and droplet size behaviour across multiple simulated release events. Nevertheless, the vertical profile (trajectory) model is useful in demonstrating that the highest oil concentrations remain predominantly within the upper water column and are most pronounced in the vicinity of the release location (refer to Appendix F, Section F.5.3). This result is consistent with findings from other blowout studies (Johansen *et al*., 2013; Spaulding *et al*., 2017; SINTEF, 2014) which show that under North Sea thermohaline and current conditions, the buoyant rise of oil droplets combined with density stratification restricts the extent of subsurface plumes, concentrating hydrocarbons in the near-surface and mid-water layers. This pattern is replicated in the Kyla oil spill modelling, with elevated oil concentrations largely limited to the top layers of the water column and declining rapidly with distance and depth due to dilution, biodegradation, and natural dispersion processes.

These results collectively indicate that while the near-field plume exhibits the highest localised concentrations, the far-field water column exposure on the regional-scale is subject to much lower oiling concentrations which are transient in nature.

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 blowout release from Kyla has been provided below based on the oil spill modelling results (refer to Section 11.3 and Appendix F) and the known environmental and socio-economic sensitivities present in the area. In this assessment, to enable a worst case assessment, it is assumed that no response or clean-up activities are implemented to mitigate the spill, noting in reality that this would not be the case.

11.4.1 Water Quality

There is the potential that a release of hydrocarbons from the Kyla field 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.

The Kyla crude is expected to be a light, ITOPF Group 2 non-emulsifying oil (37.8° API) with a pour point of +3°C. Although viscosity increases in cold waters, values are predicted to remain in the tens of centipoise (cP) (i.e. 4–20 cP between 0–15 °C) rather than hundreds or thousands. So, at typical North Sea temperatures (5–14 °C, i.e., above pour point) the oil remains fluid and is amenable to natural dispersion and entrainment, especially for a subsea release where jet turbulence promotes droplet break-up.

Once the oil reaches the sea surface (typically within 2 hours of release), it undergoes rapid weathering: evaporation removes >40 % of the released oil mass due to its light character. Despite this, modelling indicates localised areas of higher surface severity, with BAOAC 5 (Continuous True Oil Colour) and BAOAC 4 (Discontinuous True Oil Colour) predicted up to 68 km and 93 km from the release location, respectively (refer to Table 11.7 and Figure 11.2). The low asphaltene content reduces the propensity for stable emulsification, limiting persistence in the marine environment, as evidenced by the mass-balance trends in Figure 11.8. Worst case trajectory modelling predicts that 10 days after the end of the subsea blowout release, only 0.02 - 0.68 % of the oil spill total released mass (equivalent to ca. 162 - 4,877 tonnes respectively) would remain on the sea surface (Table 11.11).

Modelling results show that the water column would be impacted over a relatively wide area, with a hydrocarbon concentration of 1 ppb exceeded out to a maximum distance of 1,366 km from the release location. The 1 ppb hydrocarbon concentration was used as the minimum screening threshold in the oil spill modelling (refer to Table 11.8). However, 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 (Trudel, 1989; French-McCay, 2002; French-McCay, 2004; French-McCay, *et al*., 2012). For the assessment of potential effects to marine fauna in the water column, the OSPAR PNEC of 70.5 ppb THC is adopted. This PNEC is derived from the species sensitivity distribution (SSD) approach in Smit *et al*. (2009) and represents the HC_5 (protective for 95% of species). It is applied as a conservative threshold to identify model grid cells where transient subsurface concentrations may pose a risk of whole-organism effects. Modelling predicts that subsurface oiling at higher concentrations (>70.5 ppb) are found over wide areas of the CNS and extend eastwards and south-eastwards into the Norwegian

Trench and Skagerrak region (especially during autumn and winter) (refer to Figure 11.4). The maximum area at risk of oiling at these higher (>70.5 ppb) concentrations is 154,651.23 km^2 during autumn.

In line with expectations for a 90 m subsea blowout release, vertical profile modelling indicates that peak subsurface oiling concentrations occur within the upper water column (between the release depth and the surface), with limited downward penetration due to buoyant rise. This is consistent with North Sea blowout investigations and model intercomparisons (Johansen *et al*., 2013; Spaulding *et al*., 2017; SINTEF, 2014). On this basis, elevated oil concentrations at depth are not anticipated beyond the immediate near-field zone.

Worst case trajectory modelling predicts 10 days after the end of the subsea blowout release, approximately 16 - 18 % of the oil spill total released mass (equivalent to ca. 119,067 – 127,145 tonnes respectively) would remain in the water column (Table 11.11). Further dilution, dispersion and biodegradation would continue to reduce concentrations of oil in the water column over time.

In summary, the sensitivity of water quality to a blowout is considered to be **Medium**. The receptor has a Very High value; however, the CNS 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 ITOPF Group 2 oil pollution. The magnitude of impact is considered to be **Major**, given the area which will be subject to oiling, although the oil does not persist in the marine environment, with modelling showing rapid recovery towards baseline conditions in the 10 day duration after cessation of the blowout. Effects on water quality due to the blowout scenario are therefore assessed as **Moderate**. When combined with the likelihood of the event occurring (Extremely Rare), the risk to water quality from a well blowout is considered to be **Medium**.

11.4.2 Sediment Quality

The oil spill modelling predicts negligible seabed oiling / deposition. The modelled crude oil is light (37.8° API) and was matched as non-emulsifying with low asphaltenes (Appendix F.6.3). As a result, the released oil bulk density remains well below seawater (1.03 g cm^{-3}) and viscosity stays low–moderate at North Sea temperatures, so released droplets are positively buoyant and rise rapidly from the release depth (90 m) towards the sea surface (minimum time to surface oiling = 2 hours). Because the oil does not form stable water-in-oil emulsions, there is no modelled pathway for the density to increase towards neutrally buoyant or sinking conditions; instead, droplets ascend and are then thinned and dispersed by wind and waves. Of note, approximately 16 % of the released oil comprises very small droplets (<70 µm) that do not surface (Appendix F, Section F.5). This fraction remains entrained in the upper–mid water column, where dilution, dissolution and biodegradation reduce concentrations over time; it is transported laterally by ambient currents rather than contributing to seabed deposition or persistent surface accumulation. In summary, the Kyla trajectory simulations predict negligible seabed oiling and no persistent depositional flux to sediments over the model period.

The sensitivity of sediment quality to a blowout is considered to be **High**. The receptor has a Very High value; sediments in the region are uncontaminated and the East of Gannet and Montrose Fields NC MPA designated for the protection of seabed features (ocean quahog (*Arctica islandica*) aggregations) is within 13.4 km of the release location. Any oil interaction with the seabed sediment would be subject to high biodegradation with recoverability in the medium term. Therefore, the receptor resistance and resilience is High to oil pollution. However, the magnitude of impact is considered to be **Negligible**, as the worst case oil spill modelling revealed negligible amounts of sediment oiling throughout the blowout scenario. Effects on sediment quality due to the 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 (Ozhan *et al*., 2014).

As hydrocarbons can float on the water's surface and disperse within the ocean as it weathers, plankton may be exposed to both floating hydrocarbon slicks and to small, dissolved droplets of hydrocarbon in the water column (Cormack, 1999; Almeda *et al*., 2013). Hydrocarbon slicks can also inhibit air-sea gas exchange and reduce sunlight penetration into the water, both essential to photosynthesis and phytoplankton growth (González *et al*., 2009). 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). However, the worst case modelling predicts that surface oiling will be transient and short lived, therefore, limiting the exposure to zooplankton at the sea surface.

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).

As discussed in Sections 11.3.2 and 11.4.1 above, elevated oiling concentrations are predicted to occur over wide areas of the CNS and extend eastwards and south-eastwards into the Norwegian Trench and Skagerrak region (refer to Figure 11.4). However, the vertical profile modelling (refer to Section 11.3.2 above and Appendix F, Section F.5) shows that peak oiling concentrations (>10,000 ppb) are confined to the near-field and upper water column, declining by orders of magnitude within tens–hundreds of metres and rapidly over time as buoyant droplets rise and disperse. Beyond this zone, water column oiling concentrations are episodic, short-lived, and predominantly in the low concentration range (<100 ppb), limiting the duration and extent of exposure to plankton. On this basis, plankton exposure to harmful oiling concentrations is predicted to be localised and transient, with broader-scale exposure predominantly ≤100 ppb. Therefore population-level effects are unlikely, although short-term, localised sub-lethal effects (e.g., growth/behavioural responses) may occur.

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). The distribution of plankton across the UKCS is generally uniform and widespread such that it is likely that plankton numbers would recover after the impact of an oil spill and most studies have found that there is a rapid return to normal densities and community compositions once oil in water background levels have returned (IPIECA-IOGP, 2015). 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 blowout is considered to be **Low**. The receptor is of Medium value; the plankton community has a regional importance to the North Sea, providing a food source to higher trophic levels in this region. However, the predicted oiling is transient and does not persist; the plankton has high recoverability in the short-term with high reproduction rates. Therefore, the receptor resistance and resilience is Very High to oil pollution. The magnitude of impact is considered to be **Moderate**, as the worst case oil spill modelling predicts elevated oiling concentrations over a wide area of the CNS and into the Norwegian Trench and Skagerrak regions. However, any impacts to the plankton community are predicted to be short term and temporary. Effects on plankton due to the blowout scenario are therefore assessed as **Minor**. 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 above in Section 11.4.2, modelling predicts that seabed sediments would be subject to a negligible amount of oiling during the spill duration (refer to Figure 11.8). In addition, the vertical profile modelling indicates that peak subsurface oiling concentrations occur within the upper water column (between the release depth and the surface), with limited downward penetration due to buoyant rise. The oil is subject to rapid dispersion and biodegradation upon release, thus limiting the mass of oil reaching and persisting near the seabed. It is therefore anticipated that seabed communities will be exposed to negligible volumes of oil 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 blowout is considered to be **Medium**. The receptor has a High value, as habitats and species present at the release location are typical of this region of the CNS. The receptor resistance and resilience is High to oil pollution as the oil does not persist and the benthic community does have some tolerance to hydrocarbon contamination and is expected to recover in the medium term. The magnitude of impact is considered to be **Negligible**, as the worst case oil spill modelling revealed negligible amounts of seabed sediment oiling throughout the blowout scenario. Oil 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 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). Hydrocarbons have, however, been detected in fish bile over one year after the Deepwater Horizon oil spill (Murawski *et al*., 2014), suggesting that adult fish may accumulate hydrocarbons after a large hydrocarbon spill event.

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. Joye *et al*. (2016) reported an estimated 2–5 trillion fish larvae were killed as a consequence of the Deepwater Horizon oil spill.

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 1,329 km from the release location (refer to Figure 11.9).

The chemical components of lighter oils, such as the Kyla crude oil, have a high biological availability and toxic impacts are more likely than from a heavy crude. As previously discussed, the OSPAR PNEC (>70.5 ppb) has been applied as a conservative threshold to identify model grid cells where subsurface oiling concentrations may pose a risk of whole-organism (including fish) effects (refer to Table 11.8). It is highly unlikely that mortality to fish will occur close to the 70.5 ppb OSPAR PNEC; however, toxicological effects may be long lasting, and contamination may lead to sub-lethal effects such as impaired feeding and reproduction (ITOPF, 2014b). As previously noted, modelling predicts that

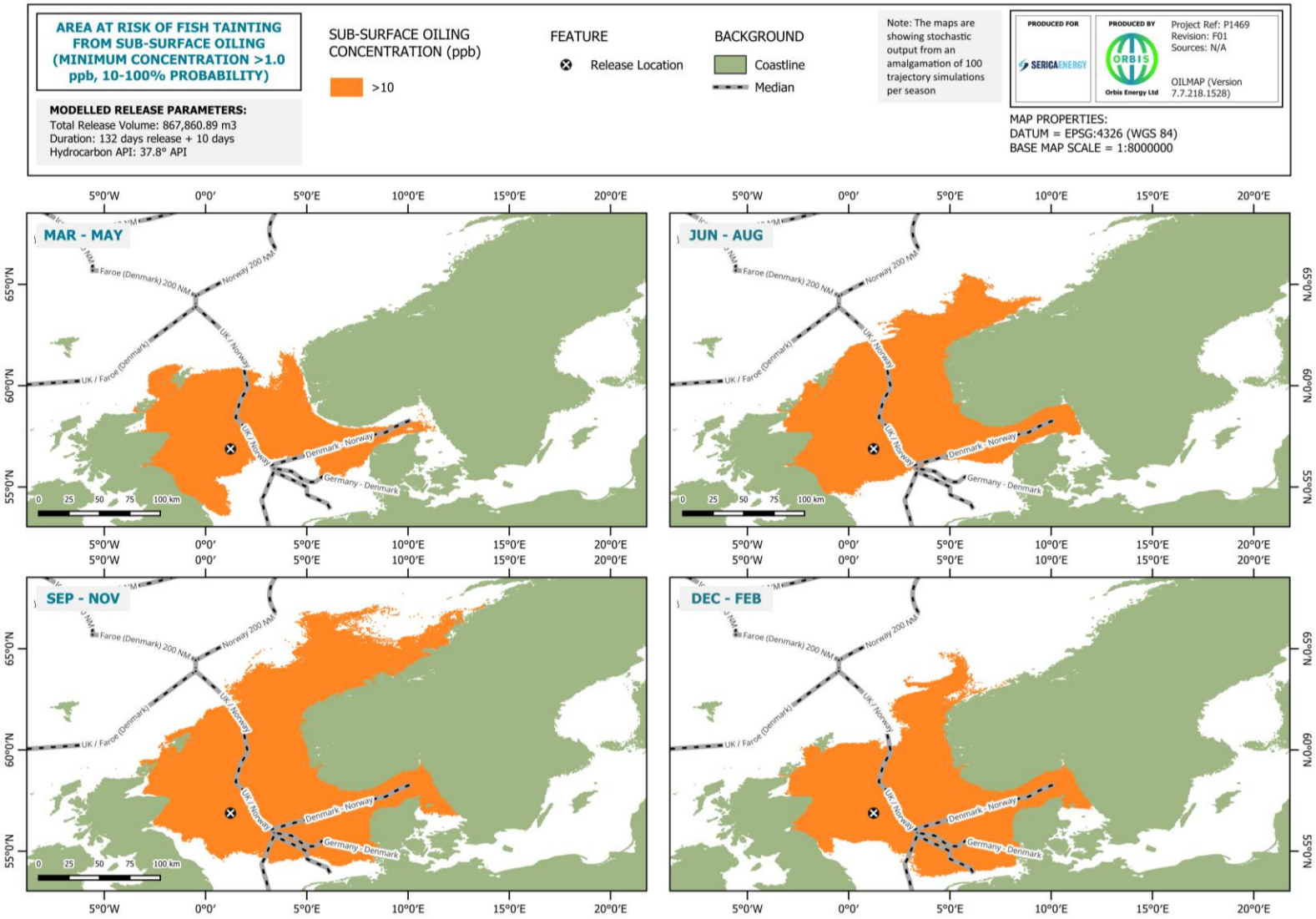
subsurface oiling at elevated concentrations (>70.5 ppb) are found over wide areas of the CNS and extend eastwards and south-eastwards into the Norwegian Trench and Skagerrak region (especially during autumn and winter) (refer to Figure 11.4). The maximum area at risk of oiling at these higher (>70.5 ppb) concentrations is 154,651.23 km^2 during autumn. Of note, the vertical profile modelling results demonstrate that peak subsurface oiling concentrations occur within the upper water column which puts pelagic fish species at greatest risk. However, the subsurface oiling exposure on the regional scale is transient in nature. 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 noted above, a large release of oil from the Kyla field could also have the potential to impact fish spawning success. The eggs and larvae of broadcast spawners, which are widely dispersed, could be exposed to oil in the water column. Fish species that are demersal spawners are less at risk, as the worst case spill modelling predicts that seabed sediments would be subject to a negligible amount of oiling during the spill duration (refer to Figure 11.8).

There are a number of fish spawning and nursery grounds which either overlap with the Kyla area or are found in the wider area (see Section 4.3.3). This includes the following species listed as PMFs in Scottish waters: anglerfish, blue whiting, cod, herring, ling, mackerel, Norway pout, sandeels, spurdog and whiting (NatureScot, 2022). However, many of 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 blowout is considered to be **Medium**. The receptor has a High value; with many species listed as PMF in Scottish waters. However, the oil 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 oil pollution. The magnitude of impact is considered to be **Major**, given the wide area which will be subject to oiling, although the oil does not persist in the marine environment, with modelling showing rapid recovery towards baseline conditions in the 10 day duration after cessation of the blowout. Effects on fish due to the blowout scenario are therefore assessed as **Moderate**. When combined with the likelihood of the event occurring (Extremely Rare), the risk to fish from a well blowout is considered to be **Medium**.

Figure 11.9: 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 Kyla Development area is located approximately 182 km from the nearest UK coastline and is therefore remote from sensitive seabird breeding areas. However, the following species may forage within the proposed development area during the breeding season: Northern fulmar and black-legged kittiwake (JNCC, 2025; Woodward *et al*., 2019; Woodward *et al*., 2024; RSPB, 2025). Following the breeding season, large numbers of moulting auks, including common guillemot, razorbill (*Alca torda*) and Atlantic puffin disperse from their coastal colonies and into the offshore waters. Kittiwake, Gannet, and Fulmar are also present in sizable numbers during the post breeding season (DESNZ, 2022). An assessment of the median SOSI scores for the UKCS Blocks making up the Kyla Development and wider area shows that the sensitivity of seabirds to oil pollution is low throughout the year (Webb *et al*., 2016) (refer to Section 4.3.4).

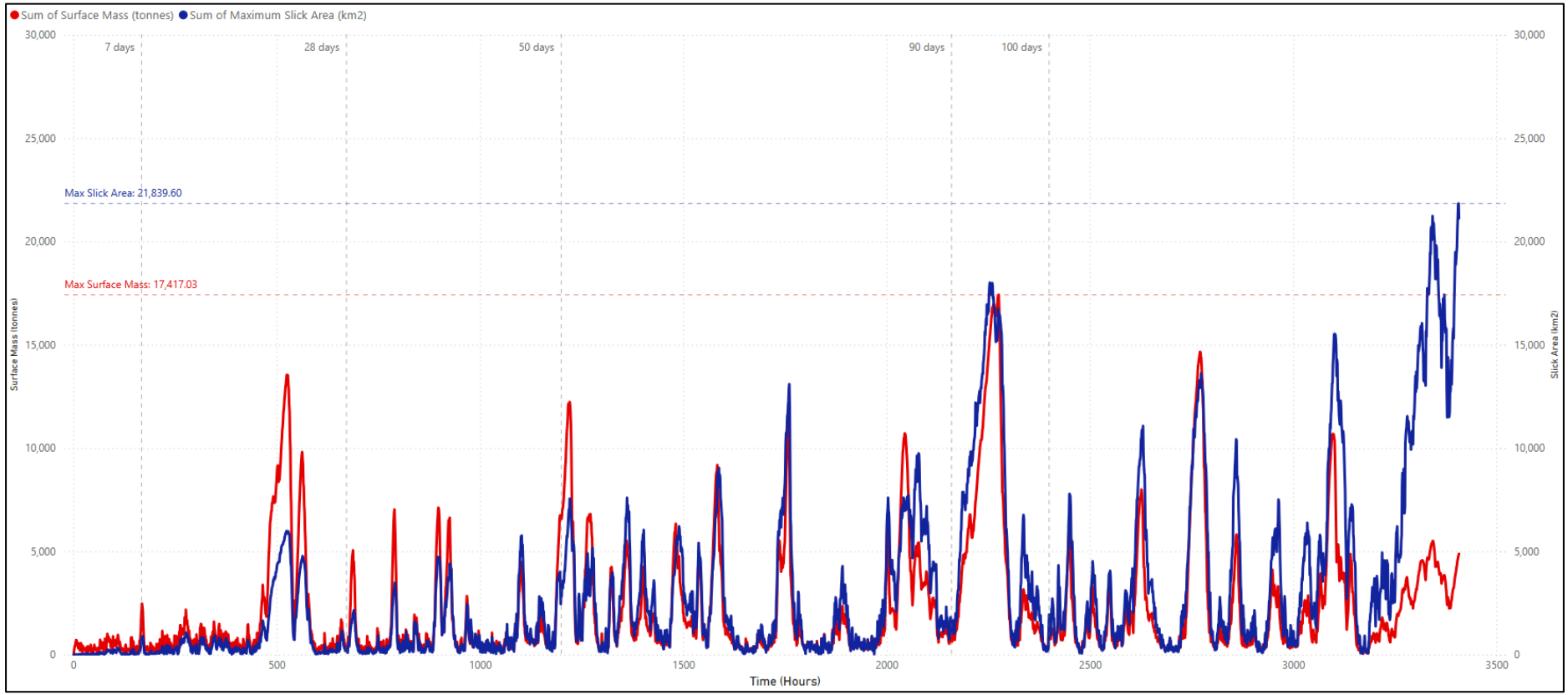
An oil sheen thickness >0.3 µm (BAOAC 2 – Rainbow) is the minimum thickness threshold modelled and has the potential to impact seabirds up to 909 km from the release location. The most severe surface oiling (BAOAC 5 - Continuous True Oil Colour) may occur within 68 km of the release location (refer to Table 11.7 and Figure 11.3). Therefore, in the event of a well blowout in the Kyla field, significant volumes of hydrocarbons may surface over a wide area, potentially affecting a large number of seabirds. Of note, despite being a considerable distance from the release location, 31 SPAs are at risk from surface oiling at BAOAC 3 (Metallic) and BAOAC 2 (Rainbow) thresholds (refer to Section 11.4.8).

Although the stochastic modelling indicates that surface oiling can occur over a wide area and, at times, at higher severity, it is not predicted to persist or accumulate. Figure 11.10 presents the time-series of surface slick area (threshold >100 kg km^{-2}) and surface oil mass for the winter trajectory, run no. 33. The maximum instantaneous slick area is 21,839.6 km^2, and the peaks / troughs reflect the episodic nature of surfacing (time for released oil to reach the sea surface) coupled with rapid evaporation once at the surface. Consequently, the slick grows and decays in pulses throughout the release, limiting the duration of peak surface exposure and the window for interaction with rafting seabirds. However, it must be recognised that even short exposures may still pose a risk to individual birds.

The stochastic modelling predicts that the Shetland Islands and the east coast of Scotland (between Aberdeenshire and Berwickshire) are at risk from 'moderate' shoreline oiling with a maximum thickness of 8.42 mm. The greatest mass of beached oil at any one location is 10,225.81 tonnes. Therefore, seabirds on the shoreline are at risk from a large scale oiling event.

In summary, the sensitivity of seabirds to a blowout is considered to be **Very High**. The receptor has a Very High value; the seabird assemblage in the adjacent coastlines to the Kyla Development area is of international importance. Seabirds that are exposed to oiling have very limited tolerance and recovery is unlikely. Therefore, the receptor resistance and resilience is Low to oil pollution. The magnitude of impact is considered to be **Major** as surface oiling has the potential to impact seabirds up to 909 km from the release location. However, the surface oil is not predicted to persist with high evaporation rates. Effects on seabirds due to the 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**.

Figure 11.10: Surface Slick Area (with a concentration >100 kg / km^2) and Surface Oil Mass over Time during Winter Run No. 33



11.4.7 Marine Mammals

As discussed in Section 4.3.5, cetacean species most likely to be present in the vicinity of the proposed Kyla Development area include: common dolphin, harbour porpoise, minke whale, white beaked dolphin and white sided dolphin. All cetaceans (whales, dolphins, and porpoises) are listed as EPS under Annex IV of the Habitats Directive. Harbour porpoise is also listed on the OSPAR List of Threatened and/or Declining Species (OSPAR, 2024) and harbour porpoise is listed under Annex II of the Habitats Directive. In addition, harbour porpoise, minke whale and white beaked dolphin are listed as PMFs (NatureScot, 2022). All species listed above are regarded as being of Least Concern in terms of their population threats (IUCN, 2025).

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). While cetaceans skin is not thought to be particularly sensitive to oil, any accidental ingestion or breathing of oily fumes could cause physiological stress (Takeshita *et al*., 2017). Notably, following the Deepwater Horizon spill in 2010, significant health issues were identified in a resident bottlenose dolphin population located in one of the most heavily oiled area, including pulmonary disease and low reproductive success (Lane *et al*., 2015; Takeshita *et al*., 2017), however, there is still some doubt these effects were directly linked to the spill. Notwithstanding the research conducted after the Deepwater Horizon, current evidence does not suggest more than a low sensitivity to oil for most cetaceans, but resident populations of some species may be both vulnerable and sensitive to large oiling events (Kirby *et al*, 2018).

Both harbour and grey seals are widespread around the adjacent east coast of Scotland (SCOS, 2024). 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 stochastic modelling predicts that the Shetland Islands and the east coast of Scotland (between Aberdeenshire and Berwickshire) are at risk from 'moderate' shoreline oiling with a maximum thickness of 8.42 mm. The greatest mass of beached oil at any one location is 10,225.81 tonnes. Therefore, seal haul-out sites on the shoreline are at risk from a large scale oiling event.

In summary, the sensitivity of marine mammals to a blowout is considered to be **High**. The receptor has a Very High value as marine mammals are of international importance. However, the oil does not persist and marine mammals have some capacity to avoid hydrocarbon pollution. Therefore, the receptor resistance and resilience is High to oil pollution. The magnitude of impact is considered to be **Major**; given the wide area which will be subject to oiling, although the oil does not persist in the marine environment, with modelling showing rapid recovery towards baseline conditions in the 10 day duration after cessation of the blowout. Effects on marine mammals due to the blowout scenario are therefore assessed as **Major**. When combined with the likelihood of the event occurring (Extremely Rare), the risk to marine mammals from a well blowout is considered to be **Medium**.

11.4.8 Marine Protected Areas

Modelling indicates that a total of 103 UK designated MPAs are at risk to oiling under the blowout scenario. Of these, 54 sites are predicted to be at risk from surface oiling, 48 sites from shoreline oiling, and 89 sites from subsurface oiling within the model domain (Table 11.12).

The greatest number of potentially affected sites are SPAs and SACs, reflecting their extensive distribution across the North Sea and along the UK's north-east coastline. Surface oiling probabilities are generally highest for offshore and nearshore SPAs and NC MPAs in the north-western CNS, with trajectories extending toward Orkney and Shetland. Higher shoreline oiling probabilities are mainly associated with SPAs and SACs around the Orkney, Shetland, and north-east Scotland coasts, with much lower probabilities for sites further south.

All MPAs potentially at risk from surface, subsurface and shoreline oiling are presented in Appendix F (Section F.3.3), where the maximum probability, minimum (shortest) arrival time, and maximum predicted severity are reported for each site. These results provide a detailed breakdown of potential exposure across SPA, SAC, NC MPA, MCZ, and Ramsar designations under the spill scenario.

Table 11.12: Summary of MPAs at risk from Oiling [Note 1]

MPA Designation Type	Total number of sites at risk from Oiling	Number of sites at risk from Surface Oil	Number of sites at risk from Shoreline Oil	Number of sites at risk from Subsurface Oil
SPA	37	31	28	32
SAC	28	8	12	22
RAMSAR	9	2	4	6
NC MPA	17	11	3	17
MCZ	12	2	1	12
Total	**103**	**54**	**48**	**89**

Note 1: Internationally designated MPAs are excluded, as they lie outside UK jurisdiction and conservation obligations, and there is no regulatory requirement to assess feature-level impacts on non-UK conservation designations. Transboundary considerations are addressed separately in Section 11.8.

A summary of the key findings is provided below and in Table 11.13. The assessment focuses on the protected features and qualifying species within designated sites that may be at risk from oiling. In determining potential significance, the assessment considers both the predicted oiling severity and the inherent vulnerability and ecological sensitivity of the designated receptors. The following sections summarise the predicted effects for MPA sites at risk from surface oil, subsurface oil, and shoreline oil exposure.

Surface Oiling

The MPAs most likely to be affected by surface oiling are those designated for the protection of seabird species and marine mammals, as these receptors spend significant time at or near the sea surface where oil accumulates. Although modelling predicts that the surface slicks will be transient and non-persistent, even short-term exposure can compromise seabird plumage and thermoregulation. Seabirds are considered to have 'Very High' sensitivity (refer to Section 11.4.6) and marine mammals 'High' sensitivity (refer to Section 11.4.7) to surface oiling.

Surface oiling with a minimum thickness of >0.3 µm (equivalent to BAOAC 2 or greater) is therefore considered sufficient to cause potential adverse effects to MPAs designated for these taxa. Table 11.13 lists MPAs where surface oiling above this threshold (>0.3 µm) is predicted under the Kyla blowout scenario, together with the qualifying features most vulnerable to surface exposure.

The MPAs designated for qualifying seabird species which are at greatest risk from surface oiling (probability >40 %) include:

- Buchan Ness to Collieston Coast SPA (68 %).
- Fair Isle SPA (48 %).

- Forth Islands SPA (49 %).
- Fowlsheugh SPA (61 %).
- Outer Firth of Forth and St Andrews Bay Complex SPA (59 %).
- Sumburgh Head SPA (41 %).
- Ythan Estuary, Sands of Forvie and Meikle Loch SPA (64 %).

The MPAs designated for qualifying marine mammal species which are at greatest risk from surface oiling (probability >40 %) include:

- Firth of Tay and Eden Estuary SAC (54 %).

Shoreline Oiling

For the purpose of this assessment, moderate shoreline oiling (1–10 litres/m²), as defined by ITOPF (2014a), has been adopted as the threshold at which potential adverse effects to the qualifying coastal or intertidal features of MPAs may occur. Below this threshold (classified as 'light oiling'), surface residues are expected to be thin, patchy and short-lived, with minimal potential for ecological harm once natural weathering and tidal dispersion processes are taken into account. Consequently, the assessment of shoreline effects focuses on sites where moderate or greater oiling severity is predicted, and where qualifying features are considered vulnerable to hydrocarbon exposure under the Kyla blowout scenario. Coastal MPAs designated for seabird colonies and for marine mammals that haul out of the water are considered most at risk from moderate shoreline oiling with 'Very High' to 'High' sensitivity.

Model predictions indicate that moderate shoreline oiling (1–10 litres/m²) could occur along discrete areas of the eastern Scottish coastline, affecting several coastal MPAs designated for seabirds, wintering waterfowl and marine mammals. The sites most at risk include the Buchan Ness to Collieston Coast SPA, Forth Islands SPA, Outer Firth of Forth and St Andrews Bay Complex SPA, Ythan Estuary, Sands of Forvie and Meikle Loch SPA, Firth of Tay and Eden Estuary SAC, and Firth of Forth Ramsar site, where shoreline oiling probabilities range from 13 - 39 %. These sites support large breeding seabird colonies and overwintering birds, extensive intertidal flats and estuarine habitats, and important haul-out areas for grey and harbour seals, all of which are sensitive to hydrocarbon contamination of shoreline substrates. Table 11.13 summarises the MPAs and their qualifying features which are predicted to experience moderate oiling severity.

Subsurface Oiling

The OSPAR PNEC of 70.5 ppb THC has been adopted as the threshold for identifying potential adverse effects to qualifying MPA features. Concentrations above this level indicate the potential for short-term toxic effects in the water column, whereas lower concentrations are not expected to cause harm to marine organisms.

Model predictions show that subsurface oiling above the OSPAR PNEC threshold (>70.5 ppb) occurs primarily in the CNS and northern North Sea, extending eastwards and south-eastwards towards the Norwegian Trench during some seasonal scenarios (particularly autumn and winter). Elevated concentrations are transient and mainly confined to the upper water column, where oil droplets remain suspended before dissipating through advection, dilution, and biodegradation (refer to Appendix F). MPAs designated for pelagic or diving seabirds, marine mammals, and fish species are considered most vulnerable to these subsurface exposures, given their time spent foraging or migrating through mid- to upper-water habitats. Their sensitivity to water column oiling ranges from 'Medium' to 'Very High' (refer to Sections 11.4.5 – 11.4.7).

Table 11.13 lists MPAs where subsurface oiling above the OSPAR PNEC threshold (>70.5 ppb) is predicted under the Kyla blowout scenario. Note, only sites with qualifying features sensitive to hydrocarbon exposure have been included. MPAs designated for seabed or benthic habitats (e.g. East of Gannet and Montrose Fields NC MPA) have been screened out of Table 11.13, as model results show negligible oiling of seabed sediments and therefore no credible risk of hydrocarbon exposure to benthic features (refer to Section 11.3.2).

The MPAs designated for qualifying seabird species which are at greatest risk from subsurface oiling (probability >40 %) include:

- Buchan Ness to Collieston Coast SPA (61 %).
- Fair Isle SPA (71 %).
- Firth of Forth SPA (51 %)
- Forth Islands SPA (67 %).
- Fowlsheugh SPA (57 %).
- Mousa SPA (50 %).
- Northumberland Marine SPA (59 %).
- Outer Firth of Forth and St Andrews Bay Complex SPA (68 %).
- Seas Off Foula SPA (70 %).
- Sumburgh Head SPA (70 %).
- Ythan Estuary, Sands of Forvie and Meikle Loch SPA (61 %).

The MPAs designated for qualifying marine mammal species which are at greatest risk from subsurface oiling (probability >40 %) include:

- Berwickshire and North Northumberland Coast SAC (58 %).
- Mousa SAC (51 %).

The MPAs designated for qualifying fish species which are at greatest risk from subsurface oiling (probability >40 %) include:

- Mousa to Boddam NC MPA (55 %).
- Turbot Bank NC MPA (97 %).

Conclusion

In summary, the protected features / qualifying species from 53 MPAs (33 x SPA; 9 x SAC; 5 x RAMSAR; 5 x NC MPA; 1 x MCZ) are at **Medium** risk from a large-scale oiling event which could adversely impact their conservation objectives. This reflects high potential consequences for sensitive receptors (i.e. 'Medium' to 'Very High' sensitivity) if exposure were to occur, tempered by the Extremely Rare likelihood of a well blowout. The majority of these MPAs are designated for the protection of seabirds, which, as previously discussed, are particularly sensitive to oil contamination.

All other designated sites at risk from oiling but not listed in Table 11.13 are considered to be at **Low** risk, either because predicted severities are low or because there is no credible exposure pathway (e.g. sites designated for benthic or seabed features).

Uncertainty has been addressed through the use of worst case spill parameters and precautionary thresholds (>0.3 µm for surface oiling; 1–10 litres/m² for shoreline oiling; 70.5 ppb THC for water-column exposure). Seasonal and hydrodynamic variability are captured within the stochastic modelling. On this basis, while localised adverse effects could occur at the most exposed MPAs designated for seabirds, marine mammals or fish under the worst case scenario, persistent or large-scale impacts across the MPA network are not expected.

Detailed site-specific probabilities, minimum arrival times, and predicted severities are presented in Appendix F (Section F.3.3) and underpin the effect evaluations provided in Table 11.13.

Table 11.13: Assessment of MPAs with Qualifying Features at Risk from Oiling

Protected Area	Surface Oil		Shoreline Oil		Subsurface Oil		Protected Features / Qualifying Species at Risk from Oiling	Impact Assessment [Note 1]		
	Probability	Maximum Severity	Probability	Maximum Severity	Probability	Maximum Severity		Sensitivity to Oiling	Magnitude of Oiling Impact	Significance Evaluation (Consequence x Likelihood)
Special Protected Areas (SPA) with Marine Components										
Auskerry SPA	14 %	BAOAC 3	N/A	N/A	24 %	Below OSPAR PNEC	**Qualifying Species:** Arctic tern (*Sterna paradisaea*), European storm-petrel (*Hydrobates pelagicus*). **Assemblage:** a diverse overall assemblage of breeding seabirds (14 species).	Very High	Major	Major x Extremely Rare = **MEDIUM**
Bluemull and Colgrave Sounds SPA	8 %	BAOAC 3	3 %	Light Oiling	18 %	Below OSPAR PNEC	**Qualifying Species:** Red-throated diver Gavia stellate (breeding).	Very High	Major	Major x Extremely Rare = **MEDIUM**
Buchan Ness to Collieston Coast SPA	68 %	BAOAC 3	39 %	Moderate Oiling	61 %	Above OSPAR PNEC	**Qualifying Species:** Black-legged kittiwake (*Rissa tridactyla*), Common guillemot (*Uria aalge*), European shag (*Phalacrocorax aristotelis*), Northern fulmar (*Fulmarus glacialis*), Herring gull (*Larus argentatus*). **Assemblage:** Seabird breeding assemblage.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Calf of Eday SPA	2 %	BAOAC 3	1 %	Light Oiling	19 %	Below OSPAR PNEC	**Qualifying Species**: (breeding) Arctic tern (*Sterna paradisaea*); Arctic skua (*Stercorarius parasiticus*); Great black-backed gull (*Larus marinus*); Herring gull (*Larus argentatus*); Common guillemot (*Uria aalge*); Razorbill (*Alca torda*). **Assemblage:** Seabird breeding assemblage — regularly supports >20,000 individual seabirds.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Copinsay SPA	33 %	BAOAC 3	6 %	Light Oiling	43 %	Below OSPAR PNEC	**Qualifying Species:** (breeding) Northern fulmar (*Fulmarus glacialis*), European shag (*Phalacrocorax aristotelis*), black-legged kittiwake (*Rissa tridactyla*), common guillemot (*Uria aalge*), razorbill (*Alca torda*). **Assemblage:** Seabird breeding assemblage — regularly supports over 90,000 individual seabirds.	Very High	Major	Major x Extremely Rare = **MEDIUM**
East Caithness Cliffs SPA	10 %	BAOAC 3	3 %	Light Oiling	10 %	Below OSPAR PNEC	**Qualifying Species:** Qualifying Species (breeding): Peregrine falcon (*Falco peregrinus*), common guillemot (*Uria aalge*), razorbill (*Alca torda*), herring gull (*Larus argentatus*), black-legged kittiwake (*Rissa tridactyla*), European shag (*Phalacrocorax aristotelis*), great black-backed gull (*Larus marinus*), northern fulmar (*Fulmarus glacialis*). **Assemblage:** Seabird breeding assemblage (>100,000 individual seabirds).	Very High	Major	Major x Extremely Rare = **MEDIUM**
East Mainland Coast Shetland SPA	12 %	BAOAC 3	8 %	Light Oiling	30 %	Above OSPAR PNEC	**Qualifying Species:** (breeding) Red-throated diver (*Gavia stellata*); Arctic tern (*Sterna paradisaea*); Black-legged kittiwake (*Rissa tridactyla*); Common guillemot (*Uria aalge*); Northern fulmar (*Fulmarus glacialis*); Atlantic puffin (*Fratercula arctica*). **Assemblage:** Breeding seabird assemblage (>50,000 individuals).	Very High	Major	Major x Extremely Rare = **MEDIUM**
East Sanday Coast SPA	5 %	BAOAC 3	2 %	Light Oiling	N/A	N/A	**Qualifying Species:** Arctic tern (*Sterna paradisaea*), breeding; Red-throated diver (*Gavia stellata*), breeding; Purple sandpiper (*Calidris maritima*), non-breeding; Turnstone (*Arenaria interpres*), non-breeding. **Assemblage:** Non-breeding wader assemblage >20,000 individuals.	Very High	Major	Major x Extremely Rare = **MEDIUM**

Protected Area	Surface Oil		Shoreline Oil		Subsurface Oil		Protected Features / Qualifying Species at Risk from Oiling	Impact Assessment [Note 1]		
	Probability	Maximum Severity	Probability	Maximum Severity	Probability	Maximum Severity		Sensitivity to Oiling	Magnitude of Oiling Impact	Significance Evaluation (Consequence x Likelihood)
Fair Isle SPA	48 %	BAOAC 3	12 %	Light Oiling	71 %	Above OSPAR PNEC	**Qualifying Species:** (breeding) Arctic tern (*Sterna paradisaea*), northern fulmar (*Fulmarus glacialis*), European shag (*Phalacrocorax aristotelis*), common guillemot (*Uria aalge*), Atlantic puffin (*Fratercula arctica*). **Assemblage:** Seabird breeding assemblage — over 170,000 individual seabirds.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Fetlar SPA	15 %	BAOAC 3	4 %	Light Oiling	N/A	N/A	**Qualifying Species:** (breeding) Arctic tern (*Sterna paradisaea*), red-throated diver (*Gavia stellata*), Arctic skua (*Stercorarius parasiticus*). **Assemblage:** Seabird breeding assemblage (>20,000 individuals) — includes fulmar, puffin, kittiwake, guillemot.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Firth of Forth SPA	27 %	BAOAC 3	10 %	Light Oiling	51 %	Above OSPAR PNEC	**Qualifying Species:** (breeding) Common tern (*Sterna hirundo*), Arctic tern (*Sterna paradisaea*), roseate tern (*Sterna dougallii*), sandwich tern (*Thalasseus sandvicensis*), cormorant (*Phalacrocorax carbo*), shag (*Phalacrocorax aristotelis*), gannet (*Morus bassanus*), kittiwake (*Rissa tridactyla*). **Assemblage:** Seabird breeding assemblage (>20,000 individuals); intertidal habitats support large non-breeding waterbird assemblage (>100,000 individuals).	Very High	Major	Major x Extremely Rare = **MEDIUM**
Forth Islands SPA	49 %	BAOAC 3	33 %	Moderate Oiling	67 %	Above OSPAR PNEC	**Qualifying Species:** (breeding) Northern gannet (*Morus bassanus*), Atlantic puffin (*Fratercula arctica*), common guillemot (*Uria aalge*), razorbill (*Alca torda*), black-legged kittiwake (*Rissa tridactyla*), sandwich tern (*Thalasseus sandvicensis*), Arctic tern (*Sterna paradisaea*). **Assemblage:** Seabird breeding assemblage (>90,000 seabirds).	Very High	Major	Major x Extremely Rare = **MEDIUM**
Fowlsheugh SPA	61 %	BAOAC 3	18 %	Moderate Oiling	57 %	Above OSPAR PNEC	**Qualifying Species:** Black-legged kittiwake (*Rissa tridactyla*), Common guillemot (*Uria aalge*), Herring gull (*Larus argentatus*), Northern fulmar (*Fulmarus glacialis*), Razorbill (*Alca torda*). **Assemblage:** Seabird breeding assemblage (>20,000 individuals).	Very High	Major	Major x Extremely Rare = **MEDIUM**
Hermaness, Saxa Vord and Valla Field SPA	3 %	BAOAC 2	1 %	Light Oiling	18 %	Below OSPAR PNEC	**Qualifying Species:** Northern gannet (*Morus bassanus*), Northern fulmar (*Fulmarus glacialis*), European shag (*Phalacrocorax aristotelis*), Black-legged kittiwake *(Rissa tridactyla*), Common guillemot (*Uria aalge*), Atlantic puffin (*Fratercula arctica*), Great skua (*Stercorarius skua*), Red-throated diver (*Gavia stellata*). **Assemblage:** During the breeding season the area regularly supports 152,000 individual seabirds.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Hoy SPA	10 %	BAOAC 3	1 %	Light Oiling	16 %	Below OSPAR PNEC	**Qualifying Species:** red-throated diver (*Gavia stellata*), breeding; peregrine falcon (*Falco peregrinus*), breeding; great skua (Stercorarius skua), breeding. **Assemblage:** Regularly supports >20,000 individual seabirds including Atlantic puffin (*Fratercula arctica*), black-legged kittiwake (*Rissa tridactyla*), Arctic skua (*Stercorarius parasitus*) and others.	Very High	Major	Major x Extremely Rare = **MEDIUM**

Protected Area	Surface Oil		Shoreline Oil		Subsurface Oil		Protected Features / Qualifying Species at Risk from Oiling	Impact Assessment [Note 1]		
	Probability	Maximum Severity	Probability	Maximum Severity	Probability	Maximum Severity		Sensitivity to Oiling	Magnitude of Oiling Impact	Significance Evaluation (Consequence x Likelihood)
Humber Estuary SPA	1 %	BAOAC 3	N/A	N/A	1 %	Below OSPAR PNEC	**Qualifying Species:** avocet (*Recurvirostra avosetta*); bar-tailed godwit (*Limosa lapponica*); bittern (*Botaurus stellaris*); black-tailed godwit (*Limosa limosa*); dunlin (*Calidris alpina*); golden plover (*Pluvialis apricaria*); hen harrier (*Circus cyaneus*); knot (*Calidris canutus*); little tern (*Sternula albifrons*); marsh harrier (*Circus aeruginosus*); redshank (*Tringa totanus*); ruff (*Philomachus pugnax*); shelduck (*Tadorna tadorna*), as well as waterbird assemblage.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Loch of Strathbeg SPA	N/A	N/A	8 %	Moderate Oiling	N/A	N/A	**Qualifying Species:** sandwich tern (*Sterna sandvicensis*), breeding; whooper swan (*Cygnus cygnus*), wintering; Svalbard barnacle goose (*Branta leucopsis*), wintering; pink-footed goose (*Anser brachyrhynchus*), wintering; greylag goose (*Anser anser*), wintering; teal (*Anas crecca*), wintering; goldeneye (*Bucephala clangula*), wintering. **Assemblage:** Winter waterbird assemblage >20,000 individuals.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Moray Firth SPA	14 %	BAOAC 3	5 %	Light Oiling	18 %	Below OSPAR PNEC	**Qualifying Species:** (non-breeding unless stated) Great northern diver (*Gavia immer*); Red-throated diver (*Gavia stellata*); Slavonian grebe (*Podiceps auritus*). Qualifying migratory waterbirds: Greater scaup (*Aythya marila*); Common eider (*Somateria mollissima*); Long-tailed duck (*Clangula hyemalis*); Common scoter (*Melanitta nigra*); Velvet scoter (*Melanitta fusca*); Goldeneye (*Bucephala clangula*); Red-breasted merganser (*Mergus serrator*); European shag (*Phalacrocorax aristotelis*).	Very High	Major	Major x Extremely Rare = **MEDIUM**
Mousa SPA	N/A	N/A	8 %	Light Oiling	50 %	Above OSPAR PNEC	**Qualifying Species:** European storm-petrel (*Hydrobates pelagicus*), breeding; Arctic tern (*Sterna paradisaea*), breeding.	Very High	Major	Major x Extremely Rare = **MEDIUM**
North Caithness Cliffs SPA	14 %	BAOAC 3	2 %	Light Oiling	17 %	Below OSPAR PNEC	**Qualifying Species:** (breeding) Peregrine falcon (*Falco peregrinus*), black-legged kittiwake (*Rissa tridactyla*), northern fulmar (*Fulmarus glacialis*), common guillemot (*Uria aalge*), razorbill (*Alca torda*), Atlantic puffin (*Fratercula arctica*). **Assemblage:** Seabird breeding assemblage (~ 130,000 seabirds).	Very High	Major	Major x Extremely Rare = **MEDIUM**
North Orkney SPA	8 %	BAOAC 3	2 %	Light Oiling	16 %	Below OSPAR PNEC	**Qualifying Species:** Great northern diver (*Gavia immer*), non-breeding; Slavonian grebe (*Podiceps auritus*), non-breeding; Velvet scoter (*Melanitta fusca*), non-breeding; Red-throated diver (*Gavia stellata*), breeding.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Northumberland Marine SPA	29 %	BAOAC 3	N/A	N/A	59 %	Above OSPAR PNEC	**Qualifying Species:** (foraging) Arctic tern (*Sterna paradisaea*), common tern (*Sterna hirundo*), roseate tern (*Sterna dougallii*), sandwich tern (*Thalasseus sandvicensis*), little tern (*Sternula albifrons*). **Assemblage:** Marine foraging area supporting >20,000 individual breeding terns from nearby colonies (Coquet Island, Farne Islands, Lindisfarne).	Very High	Major	Major x Extremely Rare = **MEDIUM**
Noss SPA	17 %	BAOAC 3	6 %	Light Oiling	32 %	Above OSPAR PNEC	**Qualifying Species:** (breeding) Northern gannet (*Morus bassanus*); Black-legged kittiwake (*Rissa tridactyla*); Common guillemot (*Uria aalge*); Northern fulmar (*Fulmarus glacialis*); Atlantic puffin (*Fratercula arctica*); Great skua (*Stercorarius skua*); European shag (*Phalacrocorax aristotelis*). **Assemblage:** Seabird breeding assemblage — regularly supports >140,000 individual seabirds.	Very High	Major	Major x Extremely Rare = **MEDIUM**

Protected Area	Surface Oil		Shoreline Oil		Subsurface Oil		Protected Features / Qualifying Species at Risk from Oiling	Impact Assessment [Note 1]		
	Probability	Maximum Severity	Probability	Maximum Severity	Probability	Maximum Severity		Sensitivity to Oiling	Magnitude of Oiling Impact	Significance Evaluation (Consequence x Likelihood)
Outer Firth of Forth and St Andrews Bay Complex SPA	59 %	BAOAC 3	33 %	Moderate Oiling	68 %	Above OSPAR PNEC	**Qualifying Species**: Sandwich tern (*Sterna sandvicensis*), Arctic tern (*Sterna paradisaea*), roseate tern (*Sterna dougallii*), common tern (*Sterna hirundo*) — breeding; Breeding seabird assemblage including kittiwake (*Rissa tridactyla*), shag (*Phalacrocorax aristotelis*), cormorant (*Phalacrocorax carbo*), Atlantic puffin (*Fratercula arctica*), common guillemot (*Uria aalge*).	Very High	Major	Major x Extremely Rare = **MEDIUM**
Papa Stour SPA	2 %	BAOAC 3	1 %	Light Oiling	N/A	N/A	**Qualifying Species:** Arctic tern (*Sterna paradisaea*), breeding; ringed plover (*Charadrius hiaticula*), breeding (migratory species).	Very High	Major	Major x Extremely Rare = **MEDIUM**
Rousay SPA	5 %	BAOAC 3	1 %	Light Oiling	N/A	N/A	**Qualifying Species:** Arctic tern (*Sterna paradisaea*), breeding. Assemblage: supports ~30,000 individual seabirds including guillemot (*Uria aalge*), kittiwake (Rissa tridactyla), Arctic skua (*Stercorarius parasitus*), fulmar (*Fulmarus glacialis*).	Very High	Major	Major x Extremely Rare = **MEDIUM**
Scapa Flow SPA	25 %	BAOAC 3	N/A	N/A	35 %	Above OSPAR PNEC	**Qualifying Species:** (non-breeding) Great northern diver (*Gavia immer*), Slavonian grebe (*Podiceps auritus*), long-tailed duck (*Clangula hyemalis*), common eider (*Somateria mollissima*), common goldeneye (*Bucephala clangula*), red-breasted merganser (*Mergus serrator*). **Assemblage:** Non-breeding waterfowl assemblage (>20,000 individuals) supported by sheltered bays and shallow inshore waters.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Seas Off Foula SPA	36 %	BAOAC 3	N/A	N/A	70 %	Above OSPAR PNEC	**Qualifying Species:** Arctic skua (*Stercorarius parasiticus*), Arctic tern (*Sterna paradisaea*), black-legged kittiwake (*Rissa tridactyla*), common guillemot (*Uria aalge*), great skua (*Stercorarius skua*). **Assemblage:** Offshore extension designated to protect foraging habitat for breeding seabird assemblages of Foula SPA.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Sumburgh Head SPA	41 %	BAOAC 3	12 %	Moderate Oiling	70 %	Above OSPAR PNEC	**Qualifying Species:** includes large breeding seabird colony counts—kittiwake, guillemot, razorbill. **Assemblage:** internationally important seabird breeding assemblage.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Teesmouth and Cleveland Coast SPA	3 %	BAOAC 3	1 %	Light Oiling	33 %	Below OSPAR PNEC	**Qualifying Species:** Little tern (*Sternula albifrons*), breeding; Sandwich tern (*Thalasseus sandvicensis*), passage; Common tern (*Sterna hirundo*), breeding; Avocet (*Recurvirostra avosetta*), breeding; Winter water-bird assemblage (>20,000 individuals) including Red knot (*Calidris canutus*), Common redshank (*Tringa totanus*).	Very High	Major	Major x Extremely Rare = **MEDIUM**
Troup, Pennan and Lion's Heads SPA	23 %	BAOAC 3	7 %	Light Oiling	19 %	Below OSPAR PNEC	**Qualifying Species:** (breeding) Common guillemot (*Uria aalge*); Razorbill (*Alca torda*); Black-legged kittiwake (*Rissa tridactyla*); Northern fulmar (*Fulmarus glacialis*); Herring gull (*Larus argentatus*). **Assemblage:** Seabird breeding assemblage (~150,000 seabirds).	Very High	Major	Major x Extremely Rare = **MEDIUM**
West Westray SPA	3 %	BAOAC 3	2 %	Light Oiling	18 %	Below OSPAR PNEC	**Qualifying Species:** Arctic tern (*Sterna paradisaea*), breeding; common guillemot (*Uria aalge*), breeding. **Assemblage:** regularly supports ~120,000 individual seabirds including razorbill (*Alca torda*), kittiwake (*Rissa tridactyla*), Arctic skua (*Stercorarius parasitus*), fulmar (*Fulmarus glacialis*).	Very High	Major	Major x Extremely Rare = **MEDIUM**

Protected Area	Surface Oil		Shoreline Oil		Subsurface Oil		Protected Features / Qualifying Species at Risk from Oiling	Impact Assessment [Note 1]		
	Probability	Maximum Severity	Probability	Maximum Severity	Probability	Maximum Severity		Sensitivity to Oiling	Magnitude of Oiling Impact	Significance Evaluation (Consequence x Likelihood)
Ythan Estuary, Sands of Forvie and Meikle Loch SPA	64 %	BAOAC 3	39 %	Moderate Oiling	61 %	Above OSPAR PNEC	**Qualifying Species:** sandwich tern (*Sterna sandvicensis*), breeding; common tern (*Sterna hirundo*), breeding; little tern (*Sternula albifrons*), breeding; pink-footed goose (*Anser brachyrhynchus*), wintering; eider (*Somateria mollissima*), wintering. **Assemblage:** Winter waterfowl assemblage >20,000 individuals.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Special Area of Conservation (SAC) with Marine Components										
Berwickshire and North Northumberland Coast SAC	30 %	BAOAC 3	10 %	Moderate Oiling	58 %	Above OSPAR PNEC	**Annex I Habitats:** Reefs; Large shallow inlets and bays; Subtidal sandbanks slightly covered by seawater all the time. **Annex II Species:** Grey seal (*Halichoerus grypus*). Notes: The site contains extensive subtidal reefs, kelp forest communities, and haul-out areas for breeding grey seals at the Farne Islands.	High	Major	Major x Extremely Rare = **MEDIUM**
Faray and Holm of Faray SAC	2 %	BAOAC 3	N/A	N/A	17 %	Below OSPAR PNEC	**Annex II Species:** Grey seal (*Halichoerus grypus*). Notes: One of the most important grey seal breeding colonies in the UK; supports ~4 % of the annual UK pup production.	High	Major	Major x Extremely Rare = **MEDIUM**
Firth of Tay and Eden Estuary SAC	54 %	BAOAC 3	17 %	Moderate Oiling	54 %	Below OSPAR PNEC	**Annex I Habitats:** Mudflats and sandflats not covered by seawater at low tide; Estuaries; Subtidal sandbanks slightly covered by seawater all the time. **Annex II Species:** Harbour seal (*Phoca vitulina*), Common (river) lamprey (*Lampetra fluviatilis*), Sea lamprey (*Petromyzon marinus*), Atlantic salmon (*Salmo salar*). Notes: Complex estuarine system supporting large populations of seals and migratory fish.	High	Major	Major x Extremely Rare = **MEDIUM**
Humber Estuary SAC	1 %	BAOAC 3	N/A	N/A	1 %	Below OSPAR PNEC	**Annex I Habitats:** Estuaries; Mudflats and sandflats not covered by seawater at low tide; Sandbanks slightly covered by seawater all the time; Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*); Salicornia and other annuals colonising mud and sand. **Annex II Species:** Sea lamprey (*Petromyzon marinus*), River lamprey (*Lampetra fluviatilis*), Grey seal (*Halichoerus grypus*)	High	Major	Major x Extremely Rare = **MEDIUM**
Mousa SAC	N/A	N/A	24 %	Moderate Oiling	51 %	Above OSPAR PNEC	**Annex I Habitats:** Reefs; Subtidal sandbanks slightly covered by seawater all the time. **Annex II Species:** Grey seal (*Halichoerus grypus*). Notes: Mousa Sound and surrounding reefs provide important pupping habitat and foraging grounds for grey seals.	High	Major	Major x Extremely Rare = **MEDIUM**
River Dee SAC	24 %	BAOAC 3	N/A	N/A	7 %	Below OSPAR PNEC	**Annex I Habitats:** None marine-specific (fluvial site). **Annex II Species:** Atlantic salmon (*Salmo salar*), Freshwater pearl mussel (*Margaritifera margaritifera*), Otter (*Lutra lutra*). Notes: Although primarily a freshwater site, the lower Dee includes a short estuarine section with transitional habitat; Atlantic salmon and otter provide marine connectivity.	High	Major	Major x Extremely Rare = **MEDIUM**
Sanday SAC	8 %	BAOAC 3	3 %	Light Oiling	19 %	Below OSPAR PNEC	**Annex I Habitats:** Sandbanks slightly covered by seawater all the time; Mudflats and sandflats not covered by seawater at low tide; Large shallow inlets and bays; Reefs; Submerged or partially submerged sea caves. **Annex II Species:** Harbour seal (*Phoca vitulina*). Notes: Extensive shallow marine and intertidal habitats supporting nationally important harbour-seal populations and diverse benthic communities.	High	Major	Major x Extremely Rare = **MEDIUM**

Protected Area	Surface Oil		Shoreline Oil		Subsurface Oil		Protected Features / Qualifying Species at Risk from Oiling	Impact Assessment [Note 1]		
	Probability	Maximum Severity	Probability	Maximum Severity	Probability	Maximum Severity		Sensitivity to Oiling	Magnitude of Oiling Impact	Significance Evaluation (Consequence x Likelihood)
Sullom Voe SAC	1 %	BAOAC 3	N/A	N/A	12 %	Below OSPAR PNEC	**Annex I Habitats:** Large shallow inlets and bays; Mudflats and sandflats not covered by seawater at low tide; Sandbanks slightly covered by seawater all the time; Reefs. **Annex II Species:** Common (harbour) seal (*Phoca vitulina*). Notes: Deep, sheltered inlet with extensive shallow-water reef and sandbank habitats; supports one of the largest Shetland harbour-seal colonies.	High	Major	Major x Extremely Rare = **MEDIUM**
Yell Sound Coast SAC	4 %	BAOAC 3	2 %	Light Oiling	19 %	Below OSPAR PNEC	**Annex I Habitats:** Reefs; Subtidal sandbanks slightly covered by seawater all the time. **Annex II Species:** Otter (*Lutra lutra*). Notes: The site's complex coastline provides ideal marine foraging and holt habitat for otters; also includes high-diversity kelp-covered reef systems.	High	Major	Major x Extremely Rare = **MEDIUM**
RAMSAR										
East Sanday Coast RAMSAR	5 %	BAOAC 3	2 %	Light Oiling	18 %	Below OSPAR PNEC	**Ramsar Criteria:** 1, 2, 5, 6. **Qualifying Features:** Extensive intertidal sand and mudflats, reefs, and dune systems supporting internationally important populations of wintering waders and wildfowl, including purple sandpiper (*Calidris maritima*) and ruddy turnstone (*Arenaria interpres*). Also supports breeding populations of Arctic tern (*Sterna paradisaea*) and red-throated diver (*Gavia stellata*). Notes: Represents one of the best examples in the UK of island coastal systems supporting rich intertidal invertebrate communities.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Firth of Forth RAMSAR	N/A	N/A	13 %	Moderate Oiling	N/A	N/A	**Ramsar Criteria:** 1, 5, 6. **Qualifying Features:** Intertidal mudflats, sandflats, and saltmarshes supporting internationally important numbers of wintering and passage waterbirds (including bar-tailed godwit *Limosa lapponica*, red knot *Calidris canutus*, and pink-footed goose *Anser brachyrhynchus*). **Assemblage:** Over 100,000 individual waterbirds regularly supported. Notes: One of the most extensive estuarine complexes on the east coast of Britain.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Firth of Tay and Eden Estuary RAMSAR	N/A	N/A	17 %	Moderate Oiling	N/A	N/A	**Ramsar Criteria:** 1, 2, 5, 6. **Qualifying Features:** Extensive estuarine complex of mudflats, sandbanks, and saltmarsh; supports important populations of wintering and passage waterbirds including shelduck (*Tadorna tadorna*), redshank (*Tringa totanus*), and eider (*Somateria mollissima*). Species of note: Harbour seal (*Phoca vitulina*), common and sea lamprey, and Atlantic salmon (*Salmo salar*). **Assemblage:** >20,000 waterbirds regularly supported.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Humber Estuary RAMSAR	1 %	BAOAC 3	N/A	N/A	1 %	Below OSPAR PNEC	**Ramsar Criteria:** 1, 2, 5, 6. **Qualifying Features:** Extensive intertidal mudflats, sandflats, and saltmarshes; breeding and wintering populations of internationally important waterbirds such as knot (*Calidris canutus*), dunlin (*Calidris alpina*), redshank (*Tringa totanus*), shelduck (*Tadorna tadorna*), and avocet (*Recurvirostra avosetta*). **Assemblage:** >140,000 waterbirds. Additional Interests: Supports significant grey and harbour seal populations and important fish nursery grounds.	Very High	Major	Major x Extremely Rare = **MEDIUM**

Protected Area	Surface Oil		Shoreline Oil		Subsurface Oil		Protected Features / Qualifying Species at Risk from Oiling	Impact Assessment [Note 1]		
	Probability	Maximum Severity	Probability	Maximum Severity	Probability	Maximum Severity		Sensitivity to Oiling	Magnitude of Oiling Impact	Significance Evaluation (Consequence x Likelihood)
Loch of Strathbeg RAMSAR	N/A	N/A	8 %	Moderate Oiling	N/A	N/A	**Ramsar Criteria:** 1, 2, 5, 6. **Qualifying Features:** Large coastal freshwater loch and associated reedbeds supporting internationally important wintering populations of whooper swan (*Cygnus cygnus*), pink-footed goose (*Anser brachyrhynchus*), and greylag goose (*Anser anser*). **Assemblage:** >20,000 individual waterbirds regularly supported. Notes: Also, of national importance for breeding and migratory terns.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Nature Conservation Marine Protected Areas (NC MPA)										
East Caithness Cliffs NC MPA	10 %	BAOAC 3	3 %	Light Oiling	10 %	Below OSPAR PNEC	**Protected Features:** Seabird aggregations (black-legged kittiwake *Rissa tridactyla*, guillemot *Uria aalge*, razorbill *Alca torda*, fulmar *Fulmarus glacialis*). **Feature Type:** Biodiversity. **Description:** Supports high-density breeding and foraging seabird populations associated with adjacent SPA cliff colonies. Offshore waters provide key feeding habitat linking several SPAs (e.g. Troup, Pennan and Lion's Heads; North Caithness Cliffs).	Very High	Major	Major x Extremely Rare = **MEDIUM**
Fetlar to Haroldswick NC MPA	15 %	BAOAC 3	4 %	Light Oiling	19 %	Above OSPAR PNEC	**Protected Features:** Black guillemot (*Cepphus grylle*); circalittoral sand and coarse sediment communities; horse mussel beds; kelp and seaweed communities on sublittoral sediments; maerl beds; shallow tide-swept coarse sands with burrowing bivalves. **Feature Type:** Biodiversity (habitats & seabird). **Description:** This high-energy marine area between Fetlar, Unst, Yell and Haroldswick supports rich biodiversity including extensive maerl beds, horse mussel beds, kelp forests and tide-swept sandy sediments, as well as a nationally important population of black guillemots. Designated to conserve these features and the seabed ecosystems which underpin seabird foraging and benthic productivity	Very High	Major	Major x Extremely Rare = **MEDIUM**
Mousa to Boddam NC MPA	24 %	BAOAC 3	N/A	N/A	55 %	Above OSPAR PNEC	**Protected Features:** Sandeels (*Ammodytes marinus*). **Feature Type:** Biodiversity (fish species). **Description:** Extensive sandy and gravelly sediments in this area support one of the most important sandeel grounds in the North Sea, feeding seabirds from the Mousa, Noss, and Hermaness SPAs. Designated to protect spawning and nursery habitat.	Medium	Major	Moderate x Extremely Rare = **MEDIUM**

Protected Area	Surface Oil		Shoreline Oil		Subsurface Oil		Protected Features / Qualifying Species at Risk from Oiling	Impact Assessment [Note 1]		
	Probability	Maximum Severity	Probability	Maximum Severity	Probability	Maximum Severity		Sensitivity to Oiling	Magnitude of Oiling Impact	Significance Evaluation (Consequence x Likelihood)
Papa Westray NC MPA	2 %	BAOAC 3	1 %	Light Oiling	16 %	Below OSPAR PNEC	**Protected Features:** Black guillemot (*Cepphus grylle*). **Feature Type:** Biodiversity (seabird). **Description:** Coastal waters surrounding Papa Westray provide vital breeding, roosting, and foraging areas for black guillemots, particularly during the post-breeding and wintering periods. The site supports one of the most significant populations of this species in Orkney.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Turbot Bank NC MPA	99 %	BAOAC 3	N/A	N/A	97 %	Above OSPAR PNEC	**Protected Features:** Sandeels (*Ammodytes marinus*). **Feature Type:** Biodiversity (fish species). **Description:** Large offshore sandbank (40–70 m depth) supporting dense sandeel populations that are key prey for seabirds, marine mammals, and demersal fish. Represents one of the few extensive offshore sand habitats of this type in the UK sector.	Medium	Major	Moderate x Extremely Rare = **MEDIUM**
Marine Conservation Zones (MCZ)										
Berwick to St Mary's MCZ	30 %	BAOAC 3	7 %	Light Oiling	55 %	Below OSPAR PNEC	**Protected Feature (Species):** Common eider (*Somateria mollissima*). **Supporting Habitats:** Intertidal coarse, mixed and mud sediments; intertidal and subtidal rock; subtidal sand and mixed sediments — providing essential foraging and loafing areas for eider. **Feature Type:** Species (sea duck). **Description:** Designated to protect the key breeding and non-breeding population of common eider along the Northumberland coast between Berwick-upon-Tweed and St Mary's Island. The MCZ encompasses extensive rocky and sedimentary shore habitats used for feeding, preening and displaying, supporting one of England's most important eider populations.	Very High	Major	Major x Extremely Rare = **MEDIUM**

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).

Commercial fishing activity within the Kyla Development area (ICES Rectangle 42F1) is low to moderate in intensity, characterised primarily by *Nephrops norvegicus* (Norway lobster) trawl fisheries. Over the 2019–2023 period, shellfish landings dominated both by weight (70 %) and by value (87 %), followed by demersal species such as haddock, whiting and monkfish, which together account for nearly one-third of the total live weight. Pelagic species (e.g. herring and mackerel) contributed less than 1 % of the overall catch. The average annual landings from ICES Rectangle 42F1 were approximately 393 tonnes, with an annual value of around £1.13 million (SG-MD, 2025). The local fishery therefore comprises a mixed *Nephrops* and whitefish trawl fishery, supported by small-scale shellfish activity. Overall, fishing effort and landings indicate that the Kyla development area supports a minor but regionally consistent component of the broader CNS fishery, with economic value largely dependent on *Nephrops* landings (refer to Section 4.4.1).

Modelling predicts that water-column oiling at concentrations exceeding 10 ppb, the level at which fish tainting may occur, could extend up to 1,329 km from the Kyla release location (refer to Figure 11.9). Elevated subsurface oiling concentrations (>OSPAR PNEC 70.5 ppb) are predicted across wide areas of the CNS, extending eastwards and south-eastwards into the Norwegian Trench and Skagerrak region, particularly during autumn and winter (refer to Figure 11.4). Although fish mortality is unlikely to occur at these concentrations, toxicological and sub-lethal effects such as impaired feeding or reproduction may arise (ITOPF, 2014b). The maximum area at risk of exposure above 70.5 ppb is approximately 154,651 km² during autumn. Vertical-profile modelling indicates that elevated concentrations remain largely within the upper water column, with limited downward penetration due to droplet buoyancy; thus, pelagic fish stocks are at greatest risk under the worst-case blowout scenario.

Throughout the spill duration, surface oiling could temporarily displace fishing vessels from the affected region. Modelling indicates that the oil slick could cover an area of 6,772 – 21,840 km² at any one time; however, the slick is short-lived, with minimal surface oil (0.02 – 0.68 % of the total release volume) remaining 10 days after cessation of the blowout.

In summary, the sensitivity of commercial fisheries to a blowout is considered to be **High**. The receptor has a Very High value as the Kyla Development area and wider CNS region are fished by both UK and international fleets. However, receptor resistance and resilience is High as the oil is not predicted to persist and fishing vessels may be able to temporarily switch to alternative fishing grounds. The magnitude of impact is considered to be **Major**, reflecting the large CNS area subject to elevated water-column concentrations (>70.5 ppb), although rapid recovery to baseline conditions is expected within 10 days after release cessation. Effects on commercial fisheries due to the blowout scenario are therefore assessed as **Moderate**. When combined with the likelihood of the event occurring (Extremely Rare), the risk to commercial fisheries from a well blowout is considered to be **Medium**.

Aquaculture

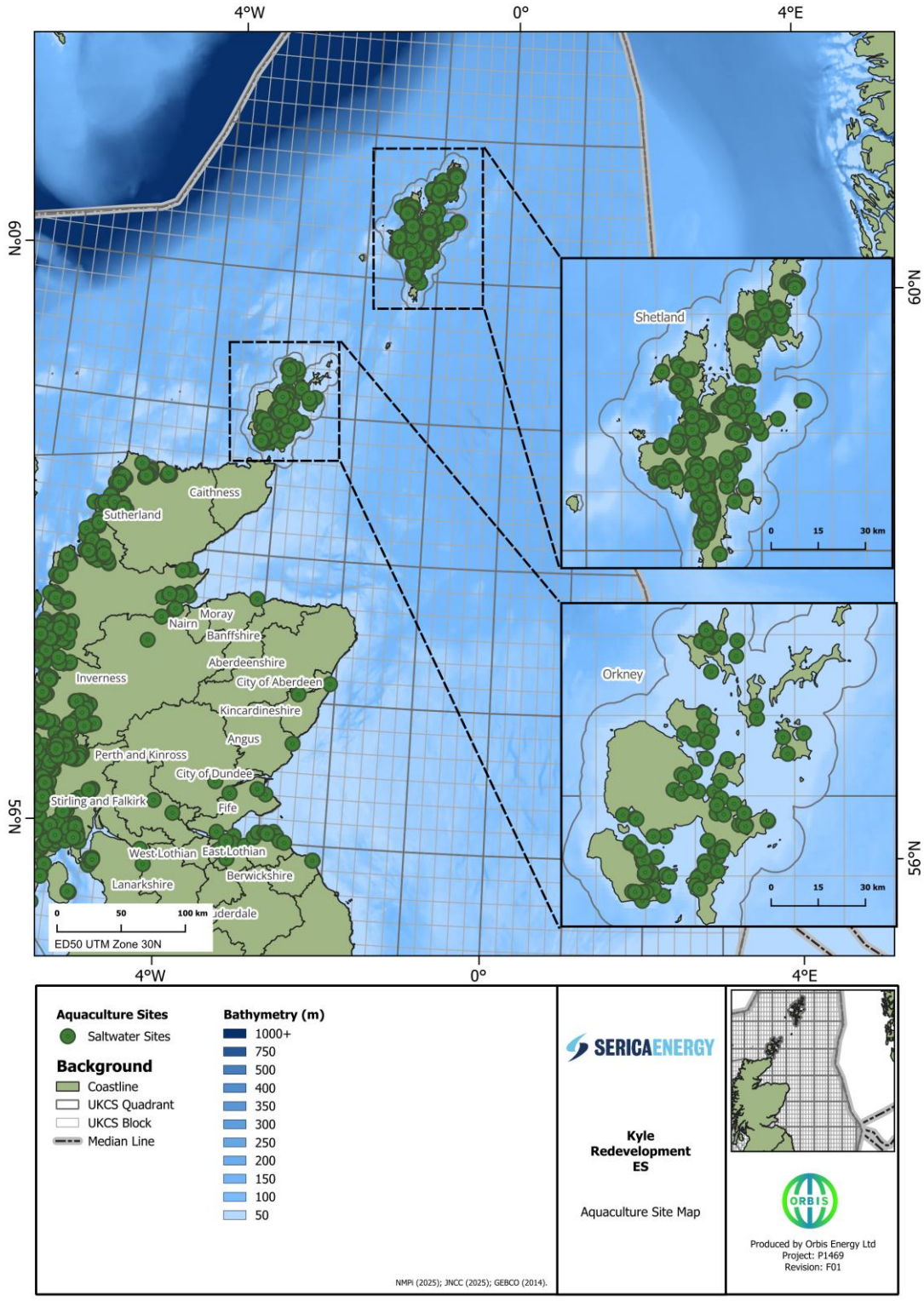
Aquaculture is a major industry in Scottish coastal waters, with the highest concentration of marine sites located around the Shetland Islands, Orkney Islands, and along the north and west coasts of mainland Scotland (refer to Figure 11.11). The sector is dominated by Atlantic salmon (*Salmo salar*) production within sea cages, with additional cultivation of mussels (*Mytilus edulis*), Pacific oysters (*Crassostrea gigas*), and other shellfish species (Marine Scotland, 2020; Scottish Government, 2023; HIE, 2017). No aquaculture sites are located in the vicinity of the Kyla Development area or elsewhere within the CNS (refer to Section 4.4.2).

Aquaculture operations are inherently vulnerable to hydrocarbon pollution, as caged fish and shellfish are unable to avoid exposure, and bioaccumulation or tainting can occur even at relatively low concentrations of dissolved hydrocarbons. Stochastic modelling indicates that subsurface oiling at higher concentrations (>OSPAR PNEC 70.5 ppb) will remain predominantly offshore in the CNS and extend eastwards and south-eastwards into the Norwegian Trench and Skagerrak region (Figure 11.4). These elevated concentrations are transient and are mainly confined to the upper water column, where they dissipate rapidly through dilution and biodegradation following cessation of the blowout release.

However, model results also predict that fish-tainting concentrations (>10 ppb) could extend towards the northern Scottish coast (Figure 11.9), particularly around Shetland and Orkney, where aquaculture sites are concentrated Even minor contamination leading to fish tainting can have severe economic and reputational consequences for the sector, as products entering the human food chain are subject to strict quality assurance and safety standards (ITOPF, 2014d; FAO, 2018). In addition, areas of moderate shoreline oiling (1–10 litres/m²) are predicted along discrete stretches of the north-east mainland and Shetland coastline (refer to Figure 11.7), indicating potential risk of surface residue contamination to nearshore infrastructure. While these exposures are expected to be short-lived and spatially limited, localised tainting or fouling of aquaculture cages and infrastructure could occur if operations coincide with peak subsurface or surface oil concentrations.

In summary, the sensitivity of aquaculture to a blowout is considered to be **High**. The receptor has a Medium value; the aquaculture is of regional importance. Aquaculture sites are vulnerable to oiling exposure as the farmed fish / shellfish are unable to avoid or more away from oil pollution; therefore, the receptor resistance and resilience is Low to oil pollution. The magnitude of impact is considered to be **Major**, as the worst case oil spill modelling revealed that inshore areas of north east Scotland, particularly around Shetland and Orkney may be exposed to fish-tainting concentrations (>10 ppb). Effects on aquaculture due to the blowout scenario are therefore assessed as **Major**. When combined with the likelihood of the event occurring (Extremely Rare), the risk to aquaculture from a well blowout is considered to be **Medium**.

Figure 11.11: Active Aquaculture Sites around Scotland



Recreational Activity and Tourism

In coastal areas, oil spills can result in economic losses to tourism and recreation through shoreline contamination, aesthetic degradation, and access restrictions, as well as the costs associated with clean-up operations (ITOPF, 2014c). Even light surface residues or odours can deter visitors and affect public perception of environmental quality.

Within the wider model domain, tourism and recreational activity are concentrated along the Shetland and Orkney coastlines, and the north-east mainland of Scotland, where activities include wildlife watching, sea angling, sailing, kayaking, and shore-based recreation. Coastal ecotourism in Shetland and Orkney is particularly centred around seabird colonies, seals, and cetacean watching, while recreational diving occurs in sheltered areas with rocky reefs and kelp beds that support diverse marine life (VisitScotland, 2023; Marine Scotland, 2020).

Model results predict that shoreline oiling probabilities are highest along the north-east mainland coast (up to 39 %), with lower probabilities around Shetland (12 %) and Orkney (8 %) (refer to Figure 11.7 and Table 11.6). Predicted shoreline oiling is of low to moderate severity (up to 10 litres/m²) and is not expected to persist beyond the short term. Ten days after cessation of the blowout release, the majority of oil is predicted to have dispersed or degraded through natural weathering and tidal processes. Consequently, while temporary visual or odour effects could occur in isolated coastal areas, widespread or long-term disruption to tourism and recreational activity is unlikely.

In summary, the sensitivity of recreational activity and tourism to a blowout is considered to be **Medium**. The receptor has a High value; recreational activity and tourism is of importance to the local economy. However, the oil does not persist with recreational activity and tourism expected to recovery in the short to medium term; therefore, the receptor resistance and resilience is High to oil pollution. The magnitude of impact is considered to be **Moderate**, as shoreline oiling at all locations is predicted to be of low to moderate severity, with modelling showing rapid recovery towards baseline conditions in the 10 day duration after the blowout cessation. Effects on recreational activity and tourism due to the 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 Kyla Development, the major accident scenario that would result in the largest 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 F) and the assessment of environmental and socio-economic effects as detailed in Section 11.4, it is considered possible that oiling from a 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 outlined in Sections 11.4.5 to 11.4.8, the most significant threat to Annex I habitats, Annex II/IV species, and MPA features arises from the severity of surface oiling. MPAs designated for protection of seabirds are especially vulnerable due to the sensitivity of these species to oil contamination. According to Table 11.13, the protected features / qualifying species from 53 MPAs (33 x SPA; 9 x SAC; 5 x RAMSAR; 5 x NC MPA; 1 x MCZ) are at Medium risk from a large-scale oiling event which could adversely impact their conservation objectives.

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.

11.6 Mitigation Measures

Serica's commitments to ensuring protection of the environment are set out in Serica's corporate HSE policy. Serica follow the ISO 14001 standard and has an externally verified EMS.

Serica has Oil Spill Response Limited (OSRL) membership which provides access to well capping devices to contain the well. Serica has insurance provisions in place to cover well control/re-drill situations as well as legal liabilities, and the Company is a member of Offshore Pollution Liability Agreement (OPOL) which provides rapid compensation to parties directly affected by an oil spill.

It is the policy of Serica that the Kyla 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. Key mitigation measures for the Kyla Development are summarised in Table 11.14.

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 Serica in the event of a spill. All supporting vessels will also have a ship oil pollution emergency plan (SOPEP) onboard.

Table 11.14: Key Spill Prevention Measures for the Kyla 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; • 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;

Source	Spill Prevention Measures
	• 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; • 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 during bunkering operations; • 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 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 safety zone; • Notifications made to 'regular runners' and local fisheries organisations via Notices to Mariners, NAVTEX / NAVAREA warnings and fisheries notices e.g. Kingfisher Bulletin. • The drilling rig TOOPEP or CIP will be in place, and the Kyla Field OPEP will fall under both the Triton Field OPEP (pipeline rupture) and the Petrofac Field OPEP (well incident), including modelling and appropriate response planning
Well Blowout	• 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 pipelines	• Where practicable, pressure and leak testing will be undertaken onshore prior to infrastructure being installed. All pipelines will be pressure tested to above the planned operating pressure; • 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.

11.7 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 Kyla 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 Kyla Development will vary depending on the quantity and type of hydrocarbon released, the wind speed and direction and sea state and the sensitivity of receptors

depending on the time of year. A small spill of oil or diesel would be subject to rapid dilution and dispersion and any impact on receptors in the marine environment would be short term and localised.

The Kyle crude is an ITOPF Group 2 (37.8° API) oil that undergoes rapid evaporation, dispersion and biodegradation upon release. Although modelling indicates that ca. 17 % of the released mass remains within the water column at the end of the 142-day simulation (Table 11.11), concentrations decline quickly following cessation of the blowout, and the oil is not predicted to persist in the water column, at the sea surface, or on 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 Kyla field lies approximately 72 km west of the UK / Norwegian median line (which represents the nearest international boundary). As such, stochastic modelling predicts a 100 % probability of surface and subsurface oil crossing the Norwegian median line. The minimum time for surface and subsurface oil to reach the Norwegian median line is 78 hours and 74 hours, respectively (refer to Table 11.6).

In addition, there is a high probability (up to 83 %) of surface oiling is predicted in Danish waters, while moderate probabilities (up to 56 % and 69 %) occur in German and Swedish waters respectively (Table 11.6). The probability of surface oil entering Dutch waters remains comparatively low (≤41 %) (Table 11.6). Seasonal variability is notable, with the greatest transboundary transport predicted in winter and autumn, reflecting enhanced wind-driven spreading and deeper mixing during these periods.

Model outputs predict that only UK waters are likely to experience BAOAC 5 (Continuous True Oil Colour) and BAOAC 4 (Discontinuous True Oil Colour) surface oiling. In contrast, BAOAC 3 (Metallic) and BAOAC 2 (Rainbow) thresholds may be reached within Dutch, German, Danish, Norwegian and Swedish waters (refer to Figure 11.2).

It is important to note, however, 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.

Agreements are also in existence for dealing with international releases with states bordering the UK (e.g. Bonn Agreement). These agreements would operate within the framework of the National Contingency Plans (NCPs) and are oriented towards major releases. In the event of an oil spill entering Norwegian waters, the NORBRIT Agreement (the Norway-UK Joint Contingency Plan) may be activated. Responsibility for implementing joint action with neighbouring states rests with the ACA of the country on whose side of the median line a spill originated. The UK's ACA is the Counter Pollution Branch of the MCA.

Given the above, the risk of transboundary impacts 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.

11.9 Cumulative Impacts

Cumulative effects from accidental releases are not anticipated. As indicated by historical data, the likelihood of one major accidental release occurring is remote or extremely remote, limiting the cumulative impact from the Kyla Development and other existing installations.

12 Waste Management

12.1 Introduction

The management of waste produced offshore on the UKCS is regulated through a framework of international and national legislation. Waste generated on offshore installations and vessels is primarily regulated by the Merchant Shipping (Prevention of Pollution by Sewage from Ships) Regulations 2020 (as amended) and Merchant Shipping (Prevention of Pollution by Garbage from Ships) Regulations 2020 (as amended). These Regulations implement Annex IV (Prevention of pollution by sewage from ships) and Annex V (Prevention of pollution by garbage from ships) of MARPOL 73/78 (The International Convention for the Prevention of Pollution from Ships).

MARPOL Annex IV and V prohibit the discharge of all garbage (including plastics) and galley waste (except for comminuted or ground food waste to < 25 mm and treated sewage) into sea from offshore installations or vessels. Once transported onshore, waste management is regulated by the Environment Protection Act 1990 (as amended), which sets out Duty of Care requirements for the containment, transfer, handling, and recording of all onshore waste through appropriately licensed carriers holding a Waste Carrier Registration. In Scotland, the Scottish Environment Protection Agency (SEPA) is responsible for regulating waste management.

Given the subsea nature of the Kyla Development, the majority of waste associated with the Project will be generated onboard the vessels, including the MODU, contracted by Serica to undertake the development operations. Waste handling onboard the vessels, including the MODU, will therefore be the responsibility of vessel/MODU contractors. However, Serica has a Duty of Care to ensure that the collection, handling, and disposal of all waste generated by the Kyla Development is achieved, in compliance with current environmental legislation, as well as in accordance with Serica's Waste Management Procedures.

12.2 The Waste Hierarchy

Serica is committed, and has a legal duty, to take all reasonable steps to apply the waste hierarchy (as illustrated in Figure 12.1) and promote 'high quality' recycling.

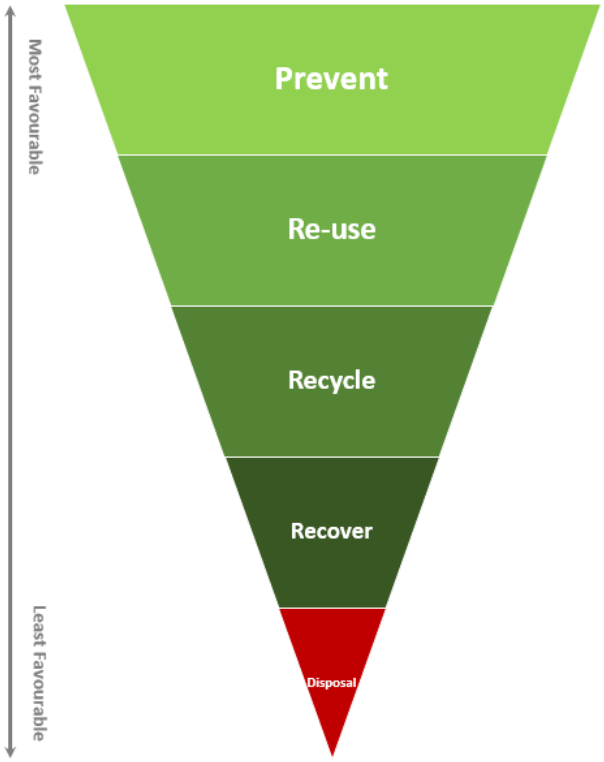


Figure 12.1: Waste Hierarchy

The waste hierarchy ranks waste management options according to the best environmental outcome, taking into consideration the lifecycle of the material. The lifecycle of a material is an environmental assessment of all the stages of a product's life from-cradle-to-grave (i.e. from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling). Waste will only be disposed of if it cannot be prevented, re-used, recycled or recovered.

In its simplest form, the waste hierarchy gives top priority to preventing waste. When waste is created, it gives priority to preparing it for reuse, then recycling, then other recovery, and last of all disposal (i.e. landfill). For example, one tonne of food waste in landfill produces 450 kg CO_2e, whereas preventing one tonne of food waste saves 3,590 kg CO_2e. The benefits of selecting options higher up the hierarchy also extend beyond carbon savings and include reduced water consumption, protection of important raw materials, creation of jobs, and other economic opportunities (Scottish Government, 2017).

12.3 Duty of Care

Anyone who produces, transports, manages and treats waste has a legal Duty of Care to ensure that waste is managed correctly. This includes proper storage, only transferring it to an appropriate person and ensuring that when it is transferred it is sufficiently well described to enable its safe recovery or disposal without harming the environment.

Serica will ensure that all waste produced from the Kyla Development operations will be minimised through appropriate procurement controls and will be properly segregated for recycling, treatment or disposal. Bulk wastes generated offshore will be segregated by type and periodically transported to shore in an auditable manner through authorised and licenced waste contractors.

Serica is responsible for ensuring that waste is transferred to waste contractors in possession of a Waste Carrier Registration. All controlled waste being transferred onshore is required to have a completed Transfer Note, whilst special waste requires a Consignment Note. These Notes provide details on the type and quantity of waste that is being transferred, the parties involved in the transfer of waste, the category of authorised person in receipt of the waste, licence numbers, and time, place and date of transfer. Once onshore, waste will be managed in accordance with the waste hierarchy and will be recovered or disposed of at appropriate licensed sites by properly licensed waste disposal contractors.

12.4 Waste Streams

The types of wastes likely to be generated during the life of the Kyla Development are summarised in Table 12.1 and include both non-hazardous waste and hazardous waste (referred to as special waste in Scotland).

Table 12.1: Types of Waste Likely to Generated from the Kyla Development

Special Waste	General Waste	Other Waste	Backloaded Cuttings [1]	NORM [2]
Oils, paints, adhesives, solvents, hazardous chemicals and brines, batteries, oily rags	Non-hazardous workover / completion / drilling fluids, brines Segregated recyclables (e.g. scrap metal, plastics, aluminium cans, paper / cardboard, glass etc.) Non-hazardous, galley waste, accommodation waste, compactor waste	Clinical materials Explosives	LTOBM cuttings Solid material (e.g. powder or stabilised products), oil and water generated by the treatment process. These will be skip and shipped back to shore for onshore processing and disposal	Naturally occurring radioactive material (NORM) from mineral scales which build up in pipework

[1] LTOBM cuttings may be backloaded for treatment onshore or processed offshore using a thermal cuttings treatment unit to an acceptable overboard disposal limit (<1% OOC) and discharged to sea (refer to Section 2.6.2).
[2] May be applicable during Kyla decommissioning operations. Where NORM readings are found, the infrastructure would be subject to specific identification, handling and waste disposal at an authorised site in accordance with legislative requirements.

Given the subsea nature of the Kyla Development, the majority of waste will be generated onboard the MODU during development drilling operations and, on cessation of production, when the Kyla infrastructure is decommissioned. See further detail below.

The quantities and disposal routes of waste arising from offshore operations associated with the Kyla Development will be reported by Serica via the OPRED EEMS, which records measured and calculated data relating to emissions and discharges from offshore installations.

12.4.1 Vessel Waste

Waste will be generated onboard all vessels associated with the proposed Kyla Development activities including the MODU and support vessels, subsea installation vessels and any vessels used during inspection and maintenance activities and decommissioning. All vessel waste will be managed in compliance with the framework of Regulations discussed above and in line with individual vessel specific Waste Management Plans (WMPs). Generally, waste will either be discharged in line with MARPOL 73/78 requirements, if appropriate, or it will be segregated and stored in suitable, labelled containers for subsequent transfer to shore, where it will be treated or disposed of in accordance with the waste hierarchy.

Offshore vessels of 100 gross tonnage and above, and every ship certified to carry 15 or more persons, must have a Garbage Management Plan and maintain a Garbage Record Book (as per MCA Marine Guidance Note 632 (M+F) Amendment 2). Solid domestic waste will normally be compacted with a garbage compactor, placed in disposal bags and returned to the mainland in waste skips. Open skips will be netted. Separate storage areas will be provided for solid and liquid waste that can be reused. Waste storage areas will be well ventilated and bunded with drainage to appropriate storage or treatment areas. Hazardous waste containers will be covered to reduce rainwater contact in the containment structure. Furthermore, segregation of recyclable materials will be implemented to avoid contamination and consequent reduction of the quality of recycled products.

12.4.2 Drilling Waste

MODUs generate various waste products during routine drilling operations (e.g. excess cement, used drilling fluids and chemicals etc.), in addition to waste generated from the everyday running of the MODU (e.g. general waste, food waste and sewage).

Wastes will be minimised by use of appropriate procurement controls, and all wastes will be segregated for recycling, disposal, and / or treatment. The appointed waste management contractor will supply monthly reports of all waste sent to shore and will complete Controlled Waste Transfer Notes as required, and records of monthly disposals will be maintained. Waste Management Duty of Care audits will also be carried out.

Oily waste will be generated on the MODU by a variety of sources, including waste engine oil and hydraulic oil. All waste oil will be held in designated storage tanks. The volumes of waste oils kept onboard the MODU will be kept to a minimum before being transferred to shore, keeping the possibility of spillages to a minimum. No sludge or waste oil will be discharged to sea. Lidded skips will be used for LTOBM contaminated drill cuttings (if required).

12.4.3 Decommissioning Waste

Onshore waste management will be in an important consideration during the decommissioning phase of the Kyla Development. A dedicated decommissioning WMP will be produced to identify all waste streams and the most appropriate removal and disposal method. All recovered waste will be brought to shore to a licenced specialist decommissioning waste facility. Where possible, materials will be sold for reuse or recycled in accordance with the waste hierarchy.

12.5 Mitigation Measures

The management of offshore waste generated on the UKCS is strictly regulated, ensuring a high level of mitigation from the outset, as described above. Serica will ensure successful implementation of the mitigation measures regarding waste management by:

- Application of the Waste Hierarchy to all produced waste;
- Compliance with Serica's WMP and use of Garbage Management Plans for the management of waste produced from vessels;
- Compliance with Serica's Waste Management Procedures for waste produced during the proposed development activities;
- Segregation, transfer onshore and disposal of waste through licensed contractors and sites.

12.6 Conclusion

Several different waste streams will be generated throughout the lifespan of the Kyla Development. Waste management will be undertaken in compliance with current environmental legislation and applicable waste procedures which includes the waste hierarchy, as described above. The management of offshore waste generated on the UKCS is strictly regulated and the UK has well-established infrastructure in place to manage this waste effectively. Therefore, no significant impacts (including cumulative or transboundary impacts) are expected as a result of the Kyla Development.

13 Environmental Management

13.1 Serica's EMS

Serica Energy Chinook Limited (Serica) is a subsidiary of Serica Energy plc and operators under the Group's policies. Serica is committed to conducting its business activities in a manner that assures the health, safety and well-being of our staff and contractor personnel whilst also safeguarding the environment within which we operate.

Serica's OMS provides the framework for systematic management of HSEQ across the Serica organisation and is designed to ensure the delivery of safe, environmentally responsible, and reliable operations in accordance with defined policies, practices, procedures and standards. Copies of Serica's HSEQ and ESG Policies are provided in Figure 13.1 and Figure 13.2, respectively.

The structure and content of the OMS recognises the principles of ISO 14001 (Environmental Management Systems) and ensures that risks to the environment are reduced to ALARP.

Serica's EMS was successfully verified against the requirements of OSPAR 2003/5 to Promote the Use and Implementation of Environmental Management Systems by the Offshore Industry in April 2025 by ERM CVS Limited. In accordance with the requirements of OSPAR 2003/5, the EMS:

- Is implemented at a strategic level and integrated into corporate plans and policies;
- Identifies the organisation's impacts on the environment and sets clear objectives and targets to improve its management of these aspects and the organisation's overall environmental performance;
- Is designed to deliver and manage compliance with environmental laws and regulations on an ongoing basis, and to quickly initiate corrective and preventative action in cases of legal non-compliance;
- Delivers good resource management;
- Incorporates assured performance metrics that demonstrate the above and can be communicated in a transparent manner;
- Delivers continual improvement.

The EMS covers aspects of environmental management, such as chemical management, pollution prevention and control, and emissions management. It is designed to achieve Serica's corporate expectation to implement best practice above and beyond the requirements of the regulations.

Key to this ambition is the Company's commitment to reduce GHG emissions from its operations in line with the global transition to a low carbon economy and the UK Government's Net Zero targets. In 2024, Serica progressed key GHG emissions reduction projects aimed at reducing the Scope 1 emissions generated from the Bruce installation and worked with our partners to progress emissions reductions on non-operated assets. Further information on Serica's GHG emissions performance is provided in Section 9.

All Serica's operations and projects, including the proposed Kyla Development, have the potential to impact on the environment and they are all subject to strict environmental regulatory controls which require Serica to prepare and submit regulatory applications to gain approval before activities commence. Serica will appoint a Well and Pipeline Operator for the Kyla Development under the Offshore Petroleum Licensing (Offshore Safety Directive) Regulations 2015, subject to approval by the NSTA.

The company constantly monitors operational activities and reports ongoing emissions, discharges and waste streams to ensure regulatory requirements are met and ensure there is no significant impact on the environment. In the event of an unplanned release/spill to sea, or a non-compliance with regulatory requirements, the relevant regulatory authorities would be notified and immediate actions taken to respond to any threat of or actual pollution. Investigations of incidents are conducted to gain any learnings or actions to prevent recurrence.

Serica is committed to continually improving environmental performance through responsible design, development and operations. For the Kyla Development, the environmental performance of contractors will be a key consideration. To this end, every effort will be made to select contractors with strong HSEQ performance and processes. Serica will also ensure that all parties engaged in the proposed Kyla Development operations understand the potential environmental impacts and commitments as outlined in this ES (refer to Section 13.2) and the importance of environmental compliance.

The company records and monitors their environmental data in line with regulatory reporting requirements. Environmental performance data for each of Serica's operated assets and associated activities is submitted to the UK environmental regulator (OPRED) via the EEMS.

Serica's Board of Directors provides support, guidance and oversight to the Company's activities in the area of ESG, in particular through the Sustainability Committee. We continue to refine our approach to climate-related risk management to ensure we are identifying and managing material risks, which is highlighted in our Taskforce on Climate-related Financial Disclosures (TCFD) Summary Report.

Figure 13.1: Serica HSEQ Policy Statement

SERICAENERGY

HEALTH, SAFETY, ENVIRONMENTAL AND QUALITY POLICY

Our Commitment

Serica is committed to conducting its business activities in a manner that assures the health, safety and well-being of our staff and contractor personnel whilst also safeguarding the environment within which we operate.

Principles

Serica's Operations Management System (OMS) provides an integrated and systematic approach to Health, Safety, Environmental and Quality (HSEQ) management and demonstrates how we:

- comply with all applicable legislation, industry standards and good practice
- promote a positive HSEQ culture through visible leadership commitment, personal accountability, communication and engagement with key stakeholders
- understand our risk profiles and apply a risk management process that reduces this risk to As Low As Reasonably Practicable (ALARP)
- ensure that HSEQ remains integral to the planning, design, construction, operation, maintenance and disposal of our assets
- promote environmental sustainability and the reduction of our carbon footprint
- provide staff with suitable information, instruction and training relevant to their duties and responsibilities
- maintain emergency response plans and the organisational capability to respond effectively to incidents and emergencies
- continually improve our HSEQ performance by defining performance objectives, monitoring and measuring results, and completing a programme of audit and assurance activities

Serica expects everyone involved in our activities to take responsibility and be accountable for compliance with this policy, our OMS, current legislation and all applicable regulatory requirements.

The Chief Executive Officer, supported by the Board of Directors, is accountable for the HSEQ performance of the company and shall ensure that sufficient resources are in place to implement this policy.

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Figure 13.2: Serica ESG Policy Statement

SERICAENERGY

ENVIRONMENTAL, SOCIAL, GOVERNANCE (ESG) POLICY

Our Commitment to Act Responsibly

We play our part in the energy transition by finding, developing and producing oil and gas in a socially and environmentally responsible manner. We aim to progressively reduce our environmental impact, promote the wellbeing of our staff, support the communities in which we operate and carry out our business in accordance with applicable laws and high standards of governance.

Our ESG Policy Highlights Our Key Principles:

Environment:

- Reduce our Scope 1, 2 and 3 emissions in line with applicable industry targets
- Pursue and implement effective, innovative and sustainable technologies through collaboration and investment
- Minimise the impact of our waste streams by careful planning, working with our suppliers and championing a circular economy
- Lower our impact on the marine environment and protect and restore biodiversity where practicable

Social:

- Prioritise the health, safety, and wellbeing of our staff and contractors in line with our HSEQ Policy
- Create an inclusive, diverse and learning culture, where people can be their true selves at work
- Train and develop our teams to help them reach their full potential
- Make a positive impact within our local communities and wider society through charitable donations, volunteering and knowledge-sharing

Governance:

- Act in accordance with applicable governance codes and practices
- Excel in transparent reporting by adopting internationally recognised frameworks and engaging with stakeholders
- Assess and mitigate sustainability-related risks associated with our operations
- Utilise ESG screening criteria when exploring new business opportunities

Our ESG Policy and ESG Strategy are contained within the Operations Management System (OMS). We expect everyone involved in our activities to take ownership of their actions and ensure that they comply with our ESG policy, our OMS, current legislation and any applicable regulatory requirements. Our CEO, with the support of our Board of Directors, owns this policy and is ultimately responsible and accountable for Serica's ESG performance.

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13.2 ES Commitments

Table 13.1 summarises the mitigation measures and commitments identified within this ES. As described above, Serica will ensure these are taken into account and implemented as the proposed Kyla Development progresses.

Table 13.1: Mitigation Measures and Commitments Register

Ref	Theme	Mitigation Measure / Commitment	ES Section
1	Physical Presence	a. If required, a guard vessel will be implemented to protect the pre-laid anchors and mooring chains from interaction with fishing vessels. b. 500 m safety zone will be designated around the MODU and a dedicated ERRV, equipped with AIS and/or ARPA will be present during the drilling operations to monitor movements of other vessels in the area and prevent them entering the safety zone. c. A Vessel Traffic Survey and, if necessary, a Collision Risk Assessment, will be prepared to support the CtL permit applications required to site the pre-laid anchors and mooring chains, MODU and subsea infrastructure at the Kyla Development location and all vessels will comply with COLREG. d. Information on the location of the MODU, MODU anchor positions, 500m safety zone, subsea infrastructure (i.e. wellhead/tree, valve skid and pipelines) and vessel operations will be communicated to other sea users via the UKHO, MCA, FishSAFE, Kingfisher Information Services, Notices to Mariners and Radio Navigation Warnings. e. Serica will continue to consult with SFF during the detailed design phase and planning process for the subsea infrastructure installation activities. A FLO will be appointed to maintain good communication with local fisheries and co-ordinate activities, particularly during installation of the pipelines and umbilical. f. Through careful planning, the number of vessels and length of time they are required on site for installation operations, will be reduced as far as practicably possible. g. Where boulders (>0.5 m) are required to be removed from the pipeline lay corridors, the as-left position of any relocated boulders will be recorded and reported via Kingfisher. h. 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. i. Pipeline working corridors will be minimised, as far as possible. j. Prior to installation, Serica will apply for a 500 m safety zone to be in place around the subsea infrastructure at the Kyla well location. The subsea infrastructure at the Kyla well location will be designed to be 'fishing friendly'. k. Following pipeline trenching and burial operations, Serica will liaise with the SFF to ameliorate any safety risks for the fishermen from mud berms being left behind. l. During the life of the field, external inspection of the pipelines and control umbilical will take place at a frequency determined by ongoing risk assessment. Any free spans recorded that present a potential hazard to fishing will be rectified by rock placement.	6

Ref	Theme	Mitigation Measure / Commitment	ES Section
2	Seabed Disturbance	a. Use the optimised number of MODU anchors and length of ground chains to maintain stability and integrity. b. MODU anchors will be set at the optimum angle for the local seabed sediments, reducing the potential drag across the seabed and helping them to become suitably embedded; c. The MODU mooring system (anchors and chains) will be placed in accordance with site survey results so as to prevent damage to sensitive seabed habitats. d. A full 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). e. If deemed feasible, thermal cuttings treatment will be used to treat the LTOBM contaminated cuttings from Kyla to an acceptable overboard disposal limit (<1% oil on cuttings) or alternatively LTOBM cuttings will be skipped and shipped for disposal onshore. f. A ROV and chemical dye will be used to monitor cement returns when cementing both the conductor and 20" casing to help ensure the volume of cement discharged to the seabed is kept at a minimum. g. Route selection and optimisation will be based on acquired Environmental, Geophysical, and Geotechnical survey data. h. The width of the working corridors during pipeline and umbilical installation operations will be minimised as far as possible. i. Any boulders removed from the pipelines and umbilical lay corridors will be placed appropriately on the seabed to avoid a snag hazard and their as-left position recorded. j. Use of DP installation vessels (where applicable) as opposed to anchored vessels. k. Rock will be deployed from a DP rock dumping vessel using a fall pipe and the rate and locations of deployment will be controlled on board the vessel and monitored using high resolution survey / sonar equipment. l. Size of subsea infrastructure will be optimised for the Kyla Development. m. Subsea infrastructure layout, trench transitions and pipeline crossing designs optimised to minimise material deposited. n. Monitoring of integrity of subsea infrastructure, including the pipelines / umbilical and stabilisation material throughout production operations and taking remedial action, if required. o. Minimise amount of deposited material whilst still achieving the required level of stabilisation / protection.	7
3	Noise	a. The piling operations will follow the JNCC protocol for minimising the risk of injury to marine mammals from piling noise (JNCC, 2010b). b. Use of properly qualified, trained and equipped MMOs or PAM operatives to detect marine mammals within a 500 m "mitigation zone" and potentially recommend a delay to piling operations. MMOs / PAM operatives 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; c. If piling is to be carried out at night or in poor visibility, PAM will be used to carry out the 30-minute pre-piling survey;	8

Ref	Theme	Mitigation Measure / Commitment	ES Section
		d. If deploying PAM, Serica will also ensure that contractors implement the JNCC guidance for the use of Passive Acoustic Monitoring in UK waters (JNCC, 2023); e. 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; and f. Repeat of the pre-piling survey and soft-start whenever there is a break in piling of more than 10 minutes.	
4	GHG Emissions	a. Drilling project management contractor (Petrofac) standard emissions reduction measures includes logistics optimisation (minimise unplanned sailings and flights). b. Selection of MODU for Kyla drilling will consider if Energy Control System is implemented on the rig to monitor the energy consumption to deliver substantial reductions in CO_2 and NOx by optimising operations. MODU operator to be ISO 140001 (Environmental Management) and ISO 50001 (Energy Management) certified by DNV. The rig will be moored during operations which has a lower fuel usage than operating on DP. c. During contracting of services, Serica/Petrofac will enforce ESG compliance and reduction information from potential suppliers. Responses to these items will be evaluated and applied as part of the service contract awards. d. Electrical powerpacks, instead of diesel powerpacks, will be used for all services on the MODU where these are compatible/available. e. The Kyla well will be planned and designed to minimise Non-Productive Time and Waiting on Weather which limit the overall emissions during well operations. f. Only Tier 1 subsea installation contractors will be shortlisted in the tendering process. g. Vessels proposed for use during the Kyla Development will be assessed against fuel consumption as part of the tender assessment process. h. Serica, as the operator of Kyla, will support the Triton FPSO operator as they continue to assess and implement reasonable decarbonisation strategies for Triton FPSO.	9
5	Marine Discharges	a. 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 2011). Where practicable, chemicals with a higher risk profile will be substituted out in favour of those with an improved environmental profile; b. Chemical use and discharge will be minimised; c. For assessment purposes, thermal cuttings treatment is being evaluated to treat the LTOBM contaminated cuttings to an acceptable overboard disposal limit (<1% oil on cuttings). If not selected / considered to be feasible, the LTOBM contaminated cuttings would be skipped and shipped onshore for disposal; d. During the drilling operations, any discharges of residual LTOBM hydrocarbons will be treated to meet oil in water limits of the Chemical Permit SAT. The discharge streams will also be monitored and sampled in accordance with the permit conditions;	10

Ref	Theme	Mitigation Measure / Commitment	ES Section
		e. During the production operations, any discharges of residual reservoir hydrocarbons in the produced water stream will be treated to meet oil in water limits of the Triton Oil Discharge Permit SAT. The discharge streams will also be monitored and sampled in accordance with the permit conditions.	
6	Accidental Discharges	a. Liquid storage areas and areas that might be contaminated with oil are segregated from other deck areas; b. Bunding or additional containment will be provided around plated areas beneath equipment with significant hydrocarbon inventories; c. Chemicals will be stored in bunded areas where any spillages can be routed to the closed drainage system; d. 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; e. Small spill kits will be on board the MODU to clean up deck spills and prevent spilt hydrocarbons and chemicals from reaching the sea; f. Non-return valves will be installed on transfer hoses and hoses to be tested and inspected as a part of a regular maintenance programme; g. 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; h. Crews will be adequately trained, supervised and regular exercises held to contain and clean-up deck spills; i. Routine equipment maintenance programme will be in place with specific emphasis on environmentally critical equipment; j. Effective management of chemicals to endeavour to reduce the volumes required and therefore the frequency of bunkering; k. Use of floating hoses during bunkering operations; l. Where feasible, bunkering operations will be undertaken in daylight and in good weather conditions. m. Consent to Locate will be in place for the MODU under Part 4A of the Energy Act 2008; n. 500m safety 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 safety zone; p. Notifications made to ‘regular runners’ and local fisheries organisations via Notices to Mariners, NAVTEX / NAVAREA warnings and fisheries notices e.g. Kingfisher Bulletin. q. The drilling rig TOOPEP or CIP will be in place, and the Kyla Field OPEP will fall under both the Triton Field OPEP (pipeline rupture) and the Petrofac Field OPEP (well incident), including modelling and appropriate response planning. 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;	11

Ref	Theme	Mitigation Measure / Commitment	ES Section
		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. Where practicable, pressure and leak testing will be undertaken onshore prior to infrastructure being installed and all pipelines will be pressure tested to above the planned operating pressure; aa. Routine monitoring of pipeline pressure and temperature will be undertaken. Automatic and manual shutdown systems in place; bb. Regular ROV inspection of all pipelines will be undertaken.	
7	Waste Management	a. Application of the Waste Hierarchy to all produced waste; b. Compliance with Serica's Waste Management Plan and use of Garbage Management Plans for the management of waste produced from vessels; c. Compliance with Serica's Waste Management Procedures for waste produced during the proposed development activities; d. Segregation, transfer onshore and disposal of waste through licensed contractors and sites.	12

14 Conclusions

Serica is proposing to develop the Kyla field via a single subsea well tied back via 12 – 13.2 km long production pipeline, gas lift pipeline and umbilical to one of the existing Bittern drill centre manifolds (either DCA or DCB). The Bittern manifolds are in turn tied back to the Triton FPSO, with both assets operated by Dana Petroleum E&P Limited (Dana). Kyla hydrocarbons will be processed on the Triton FPSO with Kyla oil exported as part of the Triton FPSO blend via shuttle tanker and sales gas routed with other Triton area gas to the St Fergus terminal onshore via the Fulmar gas pipeline.

Under The Offshore Oil and Gas Exploration, Production, Unloading and Storage (EIA) Regulations 2020, as the proposed Kyla Development will extract more than 500 tonnes of oil per day, there is a mandatory requirement for Serica to conduct an EIA to determine if the proposed Kyla Development is likely to have any significant effects on the environment, the results of which have been documented in this ES.

The key findings of the EIA undertaken for the Kyla Development are summarised below.

14.1 Physical Presence

No significant residual effects on other sea users (shipping and commercial fishing) are predicted as a result of the physical presence of the semi-submersible MODU (including pre-laid anchors and ground chains) and / or vessels during Kyla drilling, installation, inspection and maintenance and decommissioning activities or the long-term presence of the Kyla subsea infrastructure and associated protection / stabilisation material.

The Kyla Development has the potential to interact with shipping through the temporarily presence of the MODU and / or vessels resulting in the displacement of vessel traffic and increased risk of a vessel collision. The greatest impact will be before and during drilling operations, during installation of the subsea infrastructure and, following cessation of production, during decommissioning operations. However, any discernible increase in vessel presence in the area will be temporary in nature. The risk of a collision will be minimised by implementing measures, including temporarily establishing a 500 m safety zone around the MODU during the proposed drilling operations, which will be patrolled by an ERRV equipped with an AIS and/or ARPA. Notifications to other sea users will also be issued via Notices to Mariners and Kingfisher Bulletin to communicate the location of the works. A VTS will be undertaken to inform the CtL permit applications, required to moor the MODU and site the subsea infrastructure at the Kyla location. If necessary, a Collision Risk Assessment may also be undertaken. Residual effects on shipping from the physical presence of the DP MODU and vessels during drilling, installation, inspection and maintenance and decommissioning activities, are therefore **Minor** and not significant.

Fishing vessels may be temporarily displaced from the Kyla Development area during the drilling and installation phases of the Project, with an area of 0.8 km^2 at the Kyla drill centre location also lost for the life of the field development. This is a very small area in comparison to the alternative fishing grounds available in the wider CNS area, particularly as the area surrounding Kyla is subject to relatively low levels of fishing activity. In addition, the proposed Kyla Development presents a snagging risk to commercial fishing vessels. The MODU anchors and mooring lines will be pre-laid on the seabed for a number of weeks ahead of MODU arrival and will remain in place for a number of weeks following the MODU departure. To reduce the snagging risk during this period, if required a guard vessel will be used to deter vessels from the area, thereby preventing potential interaction with the mooring lines while the MODU is not on location. During subsea installation activities, the main risk of snagging will be after pipe lay, pending trenching and burial. To minimise this risk, whilst installation activities are ongoing, a guard vessel will be used to patrol the length of the lines. To further reduce the risk of snagging; the Kyla xmas tree and Kyla valve skid, as well as the potential tie-in structure at Bittern (which will be located within an existing 500 m safety zone) will be designed to be 'fishing friendly'. Where concrete mattresses are used as part of the pipeline crossings design, or in other open water locations outside the 500 m safety zones at Bittern and Kyla, rock cover will be provided to minimise risk of snagging with fishing gear. Residual effects on commercial fishing from the physical presence of the DP MODU and vessels during drilling, installation, inspection and maintenance and decommissioning activities, are therefore **Minor** and not significant.

The proposed Kyla Development is located within a region of established oil and gas activity. Other oil and gas developments in the area will utilise vessels which have the potential to act cumulatively in increasing vessel collision risk. However, given the mitigation measures which will be in place for the Kyla Development and other oil and gas operations, increased vessel presence should not act in combination with any other development to increase collision risk.

A significant cumulative increase in snagging risk with other oil and gas development in the area is also not anticipated as the Kyla subsea infrastructure will be designed to be 'fishing friendly'; the pipelines and umbilical will be trenched and buried, and the berm profile of any rock placement will be designed to be overtrawlable.

14.2 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 Kyla Development. The worst case total area of seabed that will be impacted temporarily by the Kyla Development is estimated at around 0.819 km^2, and the worst case total area of seabed that will be impacted in the long term by the Kyla Development is estimated at around 0.115 km^2. These are relatively small areas in comparison to the seabed available in the CNS region, with similar water depths, sediment types and benthic communities. Of note, the Kyla Development area is not located within or near to an MPA. The closest site, the East of Gannet and Montrose Fields NC MPA, designated for the protection of ocean quahog aggregations, is located 13.4 km north of the Kyla location.

Temporary disturbance of the seabed is attributed to the mooring of the MODU, discharge of drill cuttings, muds and cement and installation of the Kyla subsea infrastructure, including the pipelines and umbilical.

The discharge of drill cuttings, muds and cement will initially alter the seabed topography and sediment structure of a small area in close proximity to the proposed Kyla well (0.12 km^2). The accumulation of drill cuttings and mud at the Kyla drill centre 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 any 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. Field studies have shown however that recovery of benthic communities impacted with water based drilling discharges (which will be discharged directly to the seabed from the top two hole sections of the Kyla well) is likely to be very rapid (i.e. within a few months). The deeper wells sections of the Kyla well will be drilled with LTOBM. In the event that the LTOBM contaminated cuttings are discharged, thermal cuttings treatment will be used to treat the cuttings to an acceptable overboard disposal limit (<1% oil on cuttings), thereby resulting in no significant changes to the natural benthic community or re-colonisation of the seabed.

Installation of the Kyla subsea infrastructure, particularly the trenching and backfill operations during pipeline and umbilical installation, will also result in temporary disturbance to seabed from sediment suspension and re-settlement within an area of ca. 0.623 km^2. However, given the relatively fine (sandy and muddy) nature of the sediment at Kyla any sediment plumes or re-suspended sediment will tend to settle quickly and will not be prolonged or affect large areas. It is acknowledged that the Kyla survey area shows some similarity to the seapen and burrowing megafauna (burrowed mud) habitat, classified as an OSPAR threatened and/or declining habitat and Scottish PMF. However, the species that inhabit this type of benthic habitat are deemed to be highly recoverable and the area impacted will be relatively small. In addition, high rates of siltation may adversely affect ocean quahog, an OSPAR threatened and/or declining species and Scottish PMF, but any mortality caused to individual specimens as a result of the proposed operations is not considered to be significant given that impacts will be highly localised.

Exposure to increased turbidity caused by the proposed Kyla Development operations may also 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. 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 nursery areas in adjacent locations. Crucially, the Kyla survey

determined that the site was unsuitable for both herring and sandeel spawning due to the sediment composition (lack of gravel for herring and high fine content for sandeel).

It is, however, recognised that some aspects of the Kyla Development (i.e. installation of the subsea structures, pipeline and umbilical, as well as associated rock and concrete mattresses for protection / stability / trench transitions) 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 Kyla development (ca. 8 years) and beyond depending on how the infrastructure is decommissioned. The area beneath the subsea infrastructure and protection / stabilisation material will become unavailable for re-colonisation by sandy and muddy sediment inhabiting infauna and over time a new rocky substrate habitat will become established. Ultimately, it is expected that this new habitat will be colonised by the same types of mobile and encrusting epifaunal animals already present on cobbles and boulders in the wider area. As such, any long term change to the benthic environment will be localised and is not expected to cause any widespread changes to the marine life present in the wider area.

In summary, residual effects on water quality, seabed sediments, seabed communities and fish as a result of seabed disturbance during the life of the Kyla Development are predicted to be **Negligible** to **Minor** and not significant.

Effects of seabed disturbance resulting from the proposed Kyla Development will be cumulative to those of other activities in the area. The Kyla Development is located in an area containing potential cuttings piles associated with the prior Kyle field, however, these historic cuttings piles are believed to have dispersed and now lie flush with the seabed. Seabed samples taken during the pre-decommissioning survey of the Kyle field showed a chemical footprint (elevated Total Hydrocarbon Concentration levels) covering an area of 1,432 m^2; however, this elevation is not considered to be significant contamination (Fugro, 2020; CNRI, 2021). In addition, results from the 2025 Kyla survey show all stations within the vicinity of the proposed Kyla Development area have recorded THC and heavy metal concentrations that are considered consistent with background concentrations. As such, significant cumulative seabed impacts are not predicted.

14.3 Underwater Noise Emissions

Underwater noise emissions generated during the proposed Kyla Development have the potential to disturb, or cause injury to, a number of species in the marine environment, particularly fish and marine mammals. However, the only Kyla Development activity which results in underwater noise emissions with the potential to result in significant effects on marine fauna is the potential piling operations during the installation of the valve skid at the proposed Kyla well location and the tie-in structure, if required, at the Bittern manifold. It is acknowledged that the vessels associated with drilling, subsea installation, inspection and maintenance and decommissioning operations will generate underwater noise of a continuous nature, but this will only cause temporary and localised changes in distribution of marine mammals and fish in the immediate vicinity of the vessel. In addition, the noise emissions from construction activities e.g. trenching or rock placement, are usually dwarfed by the noise emissions from the vessels themselves.

To reduce the risk of injury or behavioural disturbance to marine mammals and fish from the proposed piling operations, Serica will ensure that the JNCC protocol for minimising the risk of injury to marine mammals from piling noise is followed (JNCC, 2010b). Piling operations will therefore not commence until monitoring confirms that a 500 m “mitigation zone” is clear of marine mammals and soft-starts will be incorporated into the piling schedule design.

In summary, it is possible that short term behavioural effects may be observed among marine mammals, fish and seabirds as a result of the underwater noise emissions generated from the proposed Kyla Development, but any impacts will be mitigated such that residual effects are predicted to be **Minor** to **Negligible** and not significant.

Given the mitigation measures which will be in place for the Kyla Development, significant cumulative effects are not predicted in the event that other noisy activities are occurring nearby in the marine environment at the same time as the proposed piling operations.

14.4 Greenhouse Gas Emissions

GHG emissions generated during the development of the Kyla field will arise from the combustion of hydrocarbons for power generation on the MODU, vessels, and helicopters, referred to as 'indirect, upstream scope 3 emissions'. During the production phase, hydrocarbons from the Kyla field will be processed at the Triton FPSO with processing equipment and support facilities shared with several other producing assets. This minimises the incremental energy demand caused by the development. The incremental GHG emissions associated with processing at Triton as a result of Kyla coming online, for the purposes of this assessment, are considered to be 'direct scope 1 emissions' as Kyla production is controlled by Serica. In addition, Serica has significant interest in Triton (holding a 46% equity interest in the asset) and therefore has influence over the operator of Triton (Dana). Once the hydrocarbons have been processed on Triton and sold, oil is typically tankered to Rotterdam where oil volumes are integrated into the wider European oil sales market and converted into usable fuels such as gasoline, diesel, and jet fuel. Gas is piped from Triton to the St Fergus terminal where it enters the UK's national transmission system and is delivered to end users, such as gas-fired power stations, large industrial users, or regional gas distribution networks that connect to individual homes and businesses. Further GHG emissions will therefore arise from transportation, further processing and distribution once the Kyla hydrocarbons leave Triton, as well as from the end use of the sold product (namely, the presumption that all end use Kyla hydrocarbons are eventually combusted). Collectively, these emissions are referred to as 'indirect downstream scope 3 emissions'.

It is recognised that development of the Kyla field will contribute to overall volumes of GHG emissions in the atmosphere in combination with the other projects and activities emitting GHG emissions. The total gross GHG emissions generated over the life of the Kyla Field are estimated to be ca. 7,134.45 kilotonnes of CO_2e, based on the high production case (P10 profile). It should be noted, however, that there is only a 10% probability that recovered volumes will meet or exceed the P10 case estimate.

The total gross GHG emissions generated as a result of the proposed Kyla Development are considered to be compatible with global emissions reduction pathways and targets, including those set out by The Paris Agreement. The Paris Agreement is a legally binding international treaty adopted in 2015 that commits countries to limit global warming to under 2°C above pre-industrial levels and pursue efforts to keep it below 1.5°C.

The GHG emissions associated with the Kyla Development represent a very small fraction of projected global GHG emissions under the IPCC's low (SSP1-2.6) emissions pathway consistent with limiting warming to 2°C (ca. 0.00320% of median global GHG emissions in 2030). Kyla will also contribute a very small percentage towards predicted global oil and gas production rates in international pathways consistent with limiting warming to under 2°C (ca. 0.00602% in 2030 and ca. 0.00321% in 2035 of global oil production and ca. 0.00113% in 2030 and ca. 0.00059% in 2035 of global gas production). Of note, Kyla will cease production in or before 2038, well before the global target for Net Zero emissions by 2050. Development of the Kyla field is therefore not expected to materially affect the trajectory of global temperature rise or the achievement of international climate targets in a significant way.

In a national context, the GHG emissions associated with the Kyla 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 (ca. 0.28549% of Carbon Budget 5 and ca. 0.21826% of Carbon Budget 6) and the UK's NDC commitments (ca. 0.50692% of the 2030 NDC inventory target and ca. 0.41615% of the 2035 NDC inventory target). Given these non-significant proportions, the GHG emissions generated by the Kyla Development would have no material influence on the UK's ability to meet its Carbon Budget and NDC emissions reduction targets.

Notwithstanding the above, Serica is committed to minimising the amount of GHG emission produced, with the chosen development concept for Kyla representing one of the lowest carbon intensity increase means of recovering the remaining hydrocarbons in the Kyla field. During drilling and installation operations, vessel days and fuel consumption will be reduced, as far as practicable. Responsibility for identification and implementation of emissions reduction initiatives at Triton resides with the Triton FPSO operator (Dana). However, Serica (as the operator of Kyla) will support Dana as they continue to assess and implement reasonable decarbonisation strategies for Triton FPSO. Since the use of the

produced products is not within the control of Serica, no mitigation measures that could be taken by the Kyla Development to reduce Scope 3 downstream emissions are available to implement.

The UK Net Zero Growth Plan (DESNZ, 2023b) acknowledges that fossil fuels will retain a crucial role in the energy system until there are credible clean energy alternatives that can replicate their role. The Independent Review of Net Zero (Mission Zero, 2023) also recognises that in the short term the UK will still need oil and gas to secure our energy independence and as transition fuels towards 2050. In addition, the global demand for oil, particularly for use in petrochemical feedstocks and heavy transport, is forecast to persist through the energy transition period (IPCC, 2022; IEA, 2025). Furthermore, the UK is the second largest oil producer in Europe, a market with a massive oil supply deficit, meaning the UK is critical to Europe's integrated energy system exporting crude oil and importing refined oil products largely within the Northwest European market (OEUK, 2025c).

Over the life of the Kyla field, the Triton FPSO with the input of Kyla will have an average carbon intensity of 29.9 kg CO_2/boe in the unabated scenario, decreasing to 23.3 kgCO_2/boe if all projects identified in the Triton Emissions Reduction Action Plan are implemented. In comparison, the average carbon intensity for FPSOs in the CNS in 2024 was 30.5 kg CO_2/boe. When filtering by installation age (>25 years old) this increases to 37.5 kgCO_2/boe (NSTA, 2025b). The emissions intensity for UKCS offshore fields in 2024 was 24.0 kg CO_2/boe (NSTA, 2025a).

By operating within an already-licensed area (the previously decommissioned Kyle field) and maximising use of existing North Sea oil and gas infrastructure, Kyla contributes to maintaining secure domestic supply during the UK's broader energy transition while ensuring responsible stewardship of remaining offshore reserves.

Given the above, in a Paris Aligned oil and gas production pathway, the effect of the Kyla Development's GHG emissions on the global climate is therefore considered to be **Minor** and not significant.

14.5 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 Kyla development.

The main operational discharges into the marine environment from the proposed Kyla Development will occur as a result of the discharge of drill cuttings, muds and cement during drilling, the discharge of chemicals during drilling, hook-up and commissioning of subsea infrastructure, subsea intervention activities and decommissioning operations, as well as the incremental increase in produced water discharges at the Triton FPSO (host facility) as a result of Kyla coming online.

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.

Serica 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.

For assessment purposes, thermal cuttings treatment is being evaluated to treat the LTOBM contaminated cuttings to an acceptable overboard disposal limit (<1% oil on cuttings). If not selected / considered to be feasible, the LTOBM contaminated cuttings would be skipped and shipped onshore for disposal.

During the production operations, any discharges of residual reservoir hydrocarbons in the produced water stream will be treated to meet oil in water limits of the Triton Oil Discharge Permit SAT. The discharge streams will also be monitored and sampled in accordance with the permit conditions.

Residual effects on water quality, plankton or fish from operational discharges into the marine environment from the proposed Kyla Development are therefore predicted to be **Minor** to **Negligible** are not significant.

Marine discharges from the proposed Kyla Development will occur within a region of established oil and gas activity, however, the closest neighbouring assets are located at sufficient distances such that cumulative effects on the wider marine environment are not anticipated.

14.6 Accidental Releases

All offshore activities associated with the Kyla 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, Serica'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 released, 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 Kyla Development would be an uncontrolled and unmitigated subsea blowout scenario from the Kyla well, releasing ca. 867,861 m^3 of crude oil to the marine environment over 132 days (time taken to drill a relief well). Oil spill modelling has been conducted to determine the fate of Kyla hydrocarbons released from this worst case scenario. Given the proximity to the UK/Norway median line, located approximately 72 km east of Kyla, there is a 100% potential for a surface slick of oil to cross the median line in all seasons. Other median lines which could be crossed include Denmark (83% in winter), Germany (56% in winter), Sweden (54% in winter) and the Netherlands (41% in winter). The highest probability of shoreline oiling on the UK mainland is 39% in spring, with the shortest arrival time after 23 days in summer, although the risk of shoreline oiling is highest in Denmark in the winter (57%), with beaching occurring after 34 days. However, the Kyle crude is an ITOPF Group 2 (37.8° API) oil that undergoes rapid evaporation, dispersion and biodegradation upon release, and concentrations decline quickly following cessation of the blowout, and if this event were to occur, the oil is not predicted to persist in the water column, at the sea surface, or on the shoreline.

The risk of an accidental release occurring from the Kyla 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 Kyla 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 Kyla 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.

Cumulative effects from accidental releases are not anticipated. As indicated by historical data, the likelihood of one major accidental release occurring is remote or extremely remote, limiting the cumulative impact from the Kyla Development and other existing installations.

14.7 Overall Conclusions

In summary, it is concluded that the proposed Kyla Development will not result in any significant environmental effects, including transboundary and cumulative effects.

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16 Glossary

Term	Description
Annex I habitat	A habitat type listed under the EU Habitats Directive whose conservation requires the designation of Special Areas of Conservation offshore under The Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended).
Annex II species	Animal or plant species of community interest whose conservation requires the designation of Special Areas of Conservation offshore under The Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended).
Atmospheric Emissions	A collective term for gases and particulates released to the atmosphere.
Automatic Identification System	A marine navigation safety system that uses transponders on ships and shore-based stations to automatically transmit and receive real-time data about a vessel's identity, position, course, and speed to aid collision avoidance and vessel tracking.
Barrel of Oil Equivalent	A standardised unit of energy measurement used in the oil and gas industry. It equates different types of energy product, i.e. oil, gas, etc into a single comparable unit.
Bioaccumulation	The process where a substance, such as a pesticide or heavy metal, builds up in the tissues of an individual organism over its lifetime because the rate of intake and storage (from the environment, food, and water) is faster than the rate at which the organism can break it down and excrete it.
Blowout	A blowout occurs when gas/ oil escapes in an uncontrolled manner from a well.
Blowout Preventer (BOP)	A high-pressure safety valve or series of valves installed at the wellhead that is designed to seal the wellbore to prevent uncontrolled flow of oil, gas (blowout), or drilling fluid from the well
Bottom Hole Assembly	The section of the drill string located at the very bottom of the wellbore, immediately above the drill bit, which contains specialised tools like measurement and logging devices, motors, and stabilisers to control the direction and performance of the drilling operation.
Carbon Budget	Legally binding milestone of anthropogenic CO_2 emissions proposed every 5 years to achieve Net Zero targets.
Casing	Steel pipe cemented in place during the construction process to stabilise the wellbore.
Carbon Dioxide Equivalent	A metric used to compare the climate impact of different greenhouse gases by converting the amount of each gas into the amount of carbon dioxide that would have the equivalent global warming potential.
Conductor	The casing string that is usually put into the well first to prevent the sides of the hole from caving into the wellbore.
Cumulative Weighted Sound Exposure Level	An advanced measure of the total received acoustic energy over a specified period where the sound levels are weighted according to the hearing sensitivity of the specific marine species being studied.
Cuttings	Rock chips produced by chipping and crushing action of the drill bit.
Decibel	Denoted by dB, a logarithmic unit used to express the ratio of two values of a physical quantity used to measure the intensity of sound.
Decibels relative to one micro-Pascal	Denoted by dB re 1µPa @ 1 m, a specialized unit of measurement for underwater acoustics that defines the sound pressure level by comparing the measured acoustic pressure to a standard reference pressure of one micropascal.
Degrees Latitude	The angular distance, measured in degrees North or South of the Equator, used as the primary geographical coordinate to specify the north-south position of a point on the Earth's surface

Term	Description
Degrees Longitude	The angular distance, measured in degrees East or West of the Prime Meridian (Greenwich, UK), used as the primary geographical coordinate to specify the east-west position of a point on the Earth's surface.
Demersal	Organisms (primarily fish like cod or haddock) that live on or near the seabed (the benthic zone) and often feed on benthic invertebrates, contrasting with organisms that live entirely in the open water.
Drill Bit	The cutting tool at the very end of the drill string that rotates to grind, shear, or crush rock, creating the wellbore.
Drill String	The entire length of connected steel pipe, including the drill pipe, drill collars, and bottom hole assembly, that rotates the drill bit and provides a conduit for drilling fluid from the drilling rig to the bottom of the wellbore.
Dynamic Positioning	A computer-controlled system that automatically maintains a vessel's heading and position solely by using its own thrusters and propellers, without the need for anchors.
Easting	Easting is the distance, measured in meters or kilometres, eastward from a defined north-south line or origin point in a specific coordinate system
Effects Range Low	A sediment quality guideline concentration that represents the level below which adverse biological effects are rarely observed.
Emissions Reduction Action Plan	A company's specific strategies, targets, and scheduled activities designed to measure, manage, and significantly reduce greenhouse gas emissions and other atmospheric pollutants across its operations.
Environmental Aspect	An element of an organization’s activities, products, or services that can interact with the environment.
Environmental Baseline Survey	A systematic collection and analysis of physical, chemical, and biological data in a specific area to establish the existing environmental conditions.
Environmental Effect	Consequences of environmental impacts upon receptors.
Environmental Impact	Changes to the environment as result of environmental aspects.
Environmental Impact Assessment	A systematic process of evaluating the likely environmental consequences of a proposed project or development, aiming to ensure that environmental considerations are integrated into decision-making.
Environmental Impact Identification (ENVID)	A structured, systematic review process used to identify potential environmental hazards, impacts, and risks associated with all phases of a development project or activity.
Environmental Statement	The report on the environmental impact assessment for proposed project or development.
Epifauna	Benthic organisms that live on the surface of the seabed, either sessile or free moving.
European Protected Species	Animal and plant species listed in the Habitats Directive of the European Union, afforded strict legal protection against deliberate capture, injury, killing, or disturbance, and the damage or destruction of their breeding and resting sites
Exclusive Economic Zone	The sea zone extending up to 200 nautical miles from a country's coastline, within which the coastal state has special sovereign rights for the exploration and use of marine resources.
Far-field	The region of a propagating wave distant enough from the source that the waves behave as planar, and the intensity falls off predictably (e.g., inversely with the square of the distance from the source).
Favourable Reference Population	The ideal minimum population size for a species within a given region that is needed to ensure its long-term survival and healthy status, as defined for conservation under the EU Habitats Directive.
Field	An accumulation of hydrocarbons in the subsurface. Consists of a reservoir in a shape that will trap hydrocarbons and that is covered by an impermeable, sealing rock.

Term	Description
Finch Judgment, 2024	UK's Supreme Court ruling in 2024 that a decision to grant planning permission for an onshore oil development project at a site in Surrey was unlawful, because downstream GHG emissions from the combustion of the oil produced were not assessed in the EIA as part of the planning decision.
Flare	A controlled vent system to safely and quickly burn off unwanted or excess combustible gases to the atmosphere.
Floating Production, Storage, and Offloading (FPSO)	An FPSO is a moored floating vessel used in offshore oil and gas operations to process hydrocarbons, store oil, and offload it to tankers for transport
Global Warming Potential	An index that measures how much a specific mass of a greenhouse gas will warm the Earth over a defined time period (usually 100 years) relative to the warming caused by the same mass of carbon dioxide, which is set as the baseline with a GWP of 1.
Greenhouse Gas	Any gaseous compound in the atmosphere, such as carbon dioxide, methane, or nitrous oxide, that is capable of absorbing and re-emitting infrared radiation, thereby trapping heat and contributing to the warming of the Earth's surface known as the 'Greenhouse Effect'
Habitat Assessment	A survey and evaluation process used to determine the type, quality, condition, and distribution of habitats present in a specific area.
Harmonised Mandatory Control Scheme	A regulatory framework established by the OSPAR Commission to protect the marine environment requiring all chemicals used and discharged during offshore oil and gas operations to be tested, risk-assessed, and authorised.
High Frequency	A wave or periodic event that repeats a large number of times within a specific period.
international Council for the Exploration of the Seas (ICES) Rectangle	A standard geographical unit defined by the International Council for the Exploration of the Sea used primarily for the reporting and management of fisheries, environmental monitoring, and research within the North Atlantic and adjacent seas, with each rectangle typically measuring 1˚of longitude by 0.5˚of latitude.
Intergovernmental Panel on Climate Change (IPCC)	The United Nations body that regularly assesses the scientific basis of climate change, its impacts, future risks, and options for adaptation and mitigation, providing policymakers with comprehensive and authoritative scientific reports.
IPCC Assessment Report	A comprehensive scientific evaluation of the state of knowledge on climate change, its physical science basis, impacts, adaptation, vulnerability, and options for mitigation, published every five to seven years by the IPCC.
International Union for the Conservation of Nature	A global authority and membership union composed of both governmental and civil society organisations dedicated to addressing the world's most pressing environment and development challenges.
Joint Nature Conservation Committee	UK public body that advises the UK Government and the devolved administrations on UK-wide and international nature conservation, providing scientific evidence and data on biodiversity status and trends.
Liquified Natural Gas	Natural gas that has been cooled to minus 162°c, turning it into a liquid for easier, safer, and more economical storage and transportation.
Low Frequency	A wave or periodic event that repeats a low number of times within a specific period.
Lowest Astronomical Tide	The lowest predictable water level that can occur under any combination of astronomical conditions (Sun, Moon, and Earth alignment), excluding extreme meteorological effects like storms.
Low Toxicity Oil Based Mud	An invert emulsion mud with synthetic oil as the external phase instead of oil
Marine Conservation Zone	A type of Marine Protected Area in English waters designated under the Marine and Coastal Access Act (2009) to protect nationally important species, habitats, ecological processes and features of geological/geomorphological importance.

Term	Description
Marine Drilling Riser	The large-diameter pipe that extends from a drilling vessel to the subsea wellhead, providing a conduit for the drill string, returning drilling fluid, and maintaining pressure control.
Marine Mammal Management Units	Specific geographical areas defined by UK conservation bodies to represent distinct population segments of highly mobile marine mammals (i.e. dolphins, seals and porpoises).
Marine Protected Area	A clearly defined geographical zone in the sea that receives long-term protection of its marine life, habitats, and cultural heritage.
Measured Depth	Depth of the well as measured from the rotary table on the drilling rig, therefore includes the distance between the drilling rig and the seabed.
Mobile Offshore Drilling Unit	Any vessel or structure, such as a jack-up rig or semi-submersible, capable of engaging in drilling operations for exploring or developing offshore oil and gas reserves.
Multibeam Echosounder	An advanced sonar system that transmits multiple beams of sound waves in a fan shape perpendicular to the vessel's movement, allowing it to measure and map a wide area of the seafloor simultaneously to create high-resolution, 3D bathymetric maps.
National Transmission System	The high-pressure gas pipeline network that transmits natural gas throughout Great Britain, connecting terminals and storage facilities to the regional distribution networks.
Nationally Determined Contribution	A country's self-defined national climate action plan under the Paris Agreement, outlining its specific commitments and policies to reduce greenhouse gas emissions.
Natural Gas	A naturally occurring mixture of gaseous hydrocarbons, primarily methane, often found in underground reservoirs and used as a major source of energy
Nature Conservation Marine Protected Area	A type of Marine Protected Area in Scottish waters designated under the Marine (Scotland) Act 2010 to protect nationally important marine flora, fauna, habitats, and geological or geomorphological features.
Nautical Mile	A unit used for measuring distances at sea.
Net Zero	A state where the amount of greenhouse gases emitted is balanced by the amount removed from the atmosphere.
North Sea Transition Authority	Previously known as the Oil and Gas Authority (OGA) until March 2022, it is the UK government body responsible for regulating and enabling the effective and responsible development of oil, gas, and carbon storage within the UK Continental Shelf, while driving the transition to net zero.
Northing	Northing is the distance, measured in meters or kilometres, northward from a defined east-west line or origin point in a specific coordinate system.
Octanol-water partition coefficient	A ratio used to describe how a chemical distributes itself between two immiscible phases, providing a critical indicator of a chemical's potential to bioaccumulate in organisms.
Offshore Chemical Notification Scheme	A regulatory system in the UK that manages and controls the use and discharge of all chemicals used by the offshore oil and gas industry, ensuring that they are assessed for their environmental impact before use.
Offshore Petroleum Regulator for Environment and Decommissioning	UK Government regulator responsible for regulating the environmental and decommissioning aspects of offshore oil and gas operations and carbon capture and storage in the UK.
Oil On Cuttings	The concentration of residual oil or synthetic drilling fluid that remains adsorbed or trapped on the rock fragments (cuttings) after they are brought to the surface during drilling operations.
OSPAR Commission	An intergovernmental body formed by 15 Governments and the European Union to implement the OSPAR Convention and cooperate on measures to protect the marine environment of the North-East Atlantic Ocean

Term	Description
Paris Agreement	Adopted at COP21 in 2015 and requires all major greenhouse gas emitting countries to reduce their emissions. The aim of the Paris Agreement is to restrict global temperature change to well under 2°C above pre-industrial levels and pursue efforts to keep it below 1.5°C.
Particle Size Analysis	A laboratory technique used to determine the distribution of different sized grains within a sample of sediment, which is crucial for understanding the material's properties.
Particle Size Distribution	A fundamental characteristic of any material composed of particles, such as powders, granules, or particles dispersed. It is a statistical description that defines the relative amount of particles present according to their size.
Passive Acoustic Monitoring	The technique of using underwater hydrophones or terrestrial microphones to listen to the environment and record sounds of marine species and background marine environments.
Pelagic	The zone of the water column in a sea or ocean that is neither near the shore nor close to the seabed.
Permanent Threshold Shift	An irreversible, long-term or permanent reduction in hearing sensitivity caused by exposure to sufficiently loud noise
Piling	The process of driving piles into the seabed to provide a stable foundation for structures built in water.
Pipeline Integrity Gauge (PIG)	A tool sent through a pipeline to perform various tasks such as cleaning, inspecting, ensuring the line's structural integrity and operational efficiency.
Plankton	Any aquatic organisms, including tiny plants, animals, and bacteria, that drift in the water column and cannot swim strongly enough to counteract currents, forming the base of most marine and freshwater food webs.
Polycyclic Aromatic Hydrocarbons	A group of organic chemical compounds that are naturally present in fossil fuels, a leading indicator to monitor environmental pollutants of this nature.
Priority Marine Feature	A habitat or species of particular conservation importance, identified in Scotland, to focus marine nature conservation efforts, guide planning and licensing decisions.
Representative Concentration Pathway	A greenhouse gas concentration trajectory adopted by the IPCC for climate modelling, representing a possible future level of carbon dioxide emissions and resulting climate change.
Reservoir	The underground formation where oil and gas has accumulated. It consists of a porous rock to hold the oil or gas, and a cap rock that prevents its escape.
Root Mean Square Sound Pressure Level	The time-averaged measure of the sound pressure level over a specific duration.
Scope 1 Emissions	Greenhouse gas emissions categorised as Scope 1 emissions are those that a company makes directly.
Scope 2 Emissions	Greenhouse gas emissions categorised as Scope 2 emissions are those that a company makes indirectly such as the purchase of energy for heating buildings
Scope 3 Emissions	Greenhouse gas emissions which include all other indirect emissions that occur in the upstream and downstream activities of an organisation
Scottish Fishermen's Federation	A non-profit organization representing the interests of fishermen's associations and fishing companies across Scotland.
Shellfish	Any aquatic invertebrate with a shell or shell-like exoskeleton.
Sidescan Sonar	An acoustic device towed behind a vessel that transmits sound pulses to the seafloor on both sides, creating a photographic-like, high-resolution image of the seabed surface that highlights variations in texture and features
Similarity Profile Analysis (SIMPROF)	A statistical permutation test used in ecology to objectively determine if a set of samples, which are not grouped beforehand, contain any genuine structure or statistically distinct groups.
Soft Start	Gradual, or incremental, increase in hammer blow energy/frequency.

Term	Description
Sound Exposure Level	A cumulative measure of the total acoustic energy of a sound event over a given time period.
Sound Exposure Level, single strike (SEL_{ss})	The measurement of the total acoustic energy contained within a single, distinct impulsive sound event
Sound Pressure Level peak (SPL_{peak})	The highest absolute value of the instantaneous acoustic pressure measured during a sound event.
Special Area of Conservation	Protected areas for important marine habitats and species designated under The Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) in the UK offshore area. Special Areas of Conservation, together with Special Protected Areas, form the UK's national site network.
Special Protected Area	Protected areas for wild birds designed under The Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) in the UK offshore area. Special Protected Areas, together with Special Areas of Conservation, form the UK's national site network.
Species Distribution Model	A mathematical tool that uses species occurrence data and environmental variables (i.e. temperature and elevation) to predict the geographic area where a species is most likely to be found.
Spool	Short segment of rigid pipe with a flange or other connecting fitting at either end and is commonly used to connect flowlines and / or subsea facilities together, e.g. a subsea tree to a subsea manifold.
Statutory Nature Conservation Bodies	Public sector organizations in the UK and its devolved nations that advise the government and enforce laws concerning nature and wildlife protection.
Sub-bottom Profiler	A geophysical sonar system used to map and image the geological structure of the material below the seafloor, providing detailed cross-sectional views of the shallow layers of sediment and rock.
Tie-in	A tie-in is the process of connecting a new pipeline, facility, or equipment to an existing oil and gas system.
Tie-back	A tie-back is the connection of a new well or subsea facility to an existing production system or infrastructure.
Threshold Shift	A measurable change in an species hearing sensitivity.
Total Hydrocarbon Concentration	The sum measurement of all individual hydrocarbon compounds present in a sample.
Total Organic Carbon	The amount of carbon found in an organic compound within a sample (e.g., soil or water.
Total Organic Matter	A measurement of the organic material in a soil or sediment sample, typically derived using a loss on ignition technique.
Total Suspended Solids	A measurement of the dry weight of solid particles (i.e. sediment, organic matter) that remain suspended in a water sample.
Transboundary Impacts	Potential environmental impacts on the seabed, water column and/or atmosphere, which extend beyond the boundaries of the United Kingdom Continental Shelf.
Transboundary line	The officially established line separating the Exclusive Economic Zones or Continental Shelves of two adjacent or opposing countries in a shared sea area, such as the North Sea.
True Vertical Depth Sub Sea	The vertical distance measured from a fixed reference point down to a specific point within the wellbore.
Umbilical	Connections used between the subsea equipment and/or surface installation enabling the provision of control, power, communications and chemical services.
United Kingdom Continental Shelf	The area of the continental shelf over which the United Kingdom exercises sovereign rights for the purpose of exploring it and exploiting its natural resources, primarily oil and gas.

Term	Description
United Kingdom Continental Shelf Block	Sub-division of territorial seas for the purpose of licensing to a company or group of companies for exploration and production rights. Each block has a standard size of 10 minutes of Latitude by 12 minutes of Longitude, ~200 – 250 km^2.
Venting	The discharge of un-burnt, unwanted gases or hydrocarbons.
Volatile Organic Compounds	A large group of carbon-containing chemicals that easily become vapours or gases at room temperature that largely contribute to air pollution, smog formation, and have adverse effects on human health.
Water Based Mud	A drilling fluid that uses water as the continuous phase, mixed with various clays, polymers, and chemical additives to control well pressure, cool and lubricate the drill bit, and carry rock cuttings to the surface
Wellbore	The drilled hole that extends from the surface or seabed into the earth, used to access and produce hydrocarbons from a subsurface reservoir.
Wellhead	The unit at the surface of a well which controls pressure and connects to drilling and production equipment. The wellhead is the upper part of the well, located above the casing and under the drilling floor.
Xmas Tree	A complex arrangement of valves, spools, and fittings installed at the wellhead of an oil or gas well to control the flow of fluids from the wellbore, manage pressure, and allow access for monitoring and intervention
Zooplankton	The animal components of the plankton community, consisting mostly of tiny crustaceans, protozoans, and the eggs and larvae of larger animals, which feed on phytoplankton and are themselves prey for fish and larger animals

Appendix A: Legislation and Marine Policy

A.1 Applicable Environmental Legislation

Table A.1 provides an overview of key environmental legislation pertinent to the proposed Kyla Development.

Table A.1. Key Legislation Pertinent to the Proposed Kyla Development

Legislation	Summary of Requirements	Relevance to Kyla Development
The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 and associated guidance dated July 2021	There is a mandatory requirement for an EIA and the application for consent must be supported by an ES where the Development falls within the scope of a Schedule 1 project, namely where the extraction of oil and natural gas for commercial purposes exceeds 500 tonnes per day in the case of oil and 500,000 cubic metres per day in the case of natural gas and/or where the project involves a pipeline with a diameter of more than 800 mm and a length of more than 40 km.	The Kyla production rates exceeds the 500 tonnes per day of oil threshold therefore falls within the scope of a Schedule 1 project and triggers the requirement for an Environmental Statement.
The Offshore Chemicals Regulations 2002 (as amended)	These regulations implement OSPAR Decision 2000/2 and a number of subsidiary OSPAR Recommendations and Agreements relating to the adoption of a harmonised mandatory control system for the use and discharge of offshore chemicals. All activities that involve the use and/or discharge of chemicals during the course of offshore operations require a Chemical Permit issued under the regulations	Applications for the required Chemical Permits will be made via the DESNZ UK Energy Portal in advance of the proposed Kyla Development drilling operations, pipeline operations, well intervention (if applicable) and plug and abandonment activities commencing.
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'.	Produced water from the Kyla Development shall be treated by the existing Triton produced water system where it will be discharged to sea in accordance with the Triton Oil Discharge Permit.

Legislation	Summary of Requirements	Relevance to Kyla Development
The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended)	These Regulations require consent for geological surveys related to oil and gas activities. In addition, under these Regulations. It is the responsibility of the Competent Authority (OPRED) to make an appropriate assessment of the implications of any activity that might be undertaken pursuant to a UKCS licence, consent, authorisation, or approval, on a relevant site's conservation objectives, where this is likely to have a significant effect on a relevant site, alone or in combination with any other plan or project. A relevant site is any Special Area of Conservation (SAC) or Special Protection Area (SPA).	An application for a Marine Survey Consent will be made via the DESNZ UK Energy Portal in advance of future survey operations commencing.
The Conservation of Offshore Marine Habitats and Species Regulations 2017	These Regulations implement the species protection requirements of the Habitats and Birds Directives offshore (12-200 nautical miles from the coast). The Regulations also include provisions for the designation and protection of areas that host important habitats and species in the offshore marine area (i.e. SACs and SPAs). Part 5 provides powers to OPRED to issue licences for specific activities that could result in the injury or disturbance of European Protected Species (EPS injury or disturbance licences) and the potential to issue wild birds licences (providing certain licensing tests are met).	This ES has concluded that the Kyla Development activities will not injure an EPS, or deliberately disturb EPS in such a way as to be likely to impair their ability to survive, breed, or rear or nurture their young, or significantly affect the local distribution or abundance of EPS.
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) in place, 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).	Approved OPEPs will be in place for all lifecycle phases of the Kyla Development in advance of operations commencing offshore.
Marine and Coastal Access Act 2009 (as amended) / The Marine (Scotland) Act 2010	The Marine (Scotland) Act 2010 and Marine and Coastal Access Act 2009 (known as the 'Marine Acts') 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. Marine planning matters in Scotland's inshore waters are governed by the Marine (Scotland) Act 2010, and by the Marine and Coastal Access Act 2009 for Scotland's offshore waters. The Acts also define powers to establish marine protected areas to protect natural and cultural marine features. In addition to making provisions to establish marine protected areas, they also set out how	The proposed Kyla Development, as described in this ES, has been assessed against all relevant Scottish National Marine Plan objectives and policies to confirm that the Project will not adversely impact them (refer to Section A.2 below).

Legislation	Summary of Requirements	Relevance to Kyla Development
	these are to be considered be relevant authorities at various stages, in a similar but slightly different way to HRA requirements.	
OSPAR Recommendation 2003/5 to Promote the Use and Implementation of Environmental Management Systems by the Offshore Industry	In line with the convention and reporting requirements, all operators controlling the operation of offshore installations on the UKCS should have in place an independently verified environmental management system (EMS) designed to: • Achieve the general objectives of the OSPAR Offshore Strategy; • 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 • Maintain continual improvement in environmental performance.	The Kyla field will be developed in accordance with Serica's EMS, which was successfully verified against the requirements of OSPAR 2003/5 in April 2025 by ERM CVS Limited (refer to Section 13).
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, the Kyla field will be decommissioned in accordance with the requirements of the prevailing UK and international law (refer to Section 3.6).

Legislation	Summary of Requirements	Relevance to Kyla Development
The International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)	The MARPOL Convention is the main international convention covering prevention of pollution of the marine environment by ships. It is a combination of two treaties adopted in 1973 and 1978 respectively and updated by amendments through the years. The Convention is made up of six annexes: • Annex I – sets out regulations regarding the discharge of oil into the sea and requires ships to have efficient oil separation and removal equipment onboard (transposed into UK legislation through the Merchant Shipping (Prevention of Oil Pollution) Regulations 2019 (as amended) and Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulation 2005 as amended; • Annex II – addresses the prevention of pollution by noxious liquid substances carried in bulk on ships (transposed into UK legislation through The Merchant Shipping (Dangerous or Noxious Liquid Substances in Bulk) Regulations 2018); • Annex III – addresses the prevention of pollution by harmful substances carried in packaged form (transposed into UK legislation through Merchant Shipping (Carriage of Dangerous Goods and Harmful Substances) Regulations 2024); • Annex IV – concerned with the prevention of pollution by sewage from ships (transposed into UK legislation through The Merchant Shipping (Prevention of Pollution by Sewage from Ships) Regulations 2020) (as amended); • Annex V – concerned with the prevention of pollution by garbage from ships (transposed into UK legislation through The Merchant Shipping (Prevention of Pollution by Garbage from Ships) Regulations 2020) (as amended); • Annex VI – covers prevention of air pollution from ships setting limits on sulphur oxide and nitrogen oxide emissions from ship exhausts and prohibiting deliberate emissions of ozone depleting substances (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. Further information on Serica's Waste Management strategy for the Kyla Development is provided in Section 12.

A.2 Scottish National Marine Plan

The Marine and Coastal Access Act 2009 and The Marine (Scotland) Act 2010 establish the 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 Scotland's National Marine Plan (NMP), published in March 2015. The NMP sets out strategic policies for the sustainable Development of Scotland's marine resources out to 200 nautical miles, with the aim of trying to achieve the UK's vision of having 'clean, healthy, safe, productive and diverse seas; managed to meet the long term needs of nature and people'.

When designing, planning and assessing the potential environmental impacts from the proposed Kyla Development, Serica has paid due regard to the General Policies outlined in Chapter 4 of the NMP, the Sectoral Policies for Oil and Gas detailed in Chapter 9 of the NMP, which outline how oil and gas activities are expected to develop in the longer term and the issues to be addressed to ensure they are grown sustainably, and the Strategic Objectives outlined in Annex B of the NMP.

Tables A.2 confirms that the proposed Kyla Development will not have a significant adverse impact on the General Policies of the NMP and Table A.3 confirms that the proposed Kyla Development will not have a significant adverse impact on the Sectoral Oil and Gas Policies of the NMP.

Table A.2. General Policies Contained within Scotland's NMP that are of Relevance to the Proposed Kyla Field Development

Policy	Addressed by the Kyla 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.	Serica will ensure that the proposed Kyla Development complies with all legal requirements and does not result in a significant adverse impact on the policy goals and objectives of the NMP.
GEN 2 Economic benefit: Sustainable Development and use which provides economic benefit is encouraged when consistent with the objectives and outcomes of the Plan.	It is widely acknowledged that on the pathway to Net Zero emissions, oil and gas will continue to play an important part of the energy mix for the foreseeable future. Moreover, according to the Climate Change Committee (CCC), the UK will require 13–15 billion barrels of oil and gas equivalent in the period 2025 to 2050 but is currently only forecast to produce 4 billion (CCC, 2025; NSTA, 2025a). In a time of historically low domestic energy production with more than 40% of the UK's energy now imported, responsible development of UKCS oil and gas fields ensures that the UK meets its energy demand while retaining control over emissions. The selected Development concept for Kyla makes maximum use of existing oil and gas infrastructure and will be a contributor in the life extension of Triton FPSO. While residual operational emissions are unavoidable, the Development represents one of the lowest carbon intensity means of recovering remaining hydrocarbons in the Kyla field. Opportunities for further emissions reductions, including electrification of offshore assets and low-carbon logistics, will be assessed as part of ongoing asset stewardship and future investment planning. In addition, the Project aligns with the UK Government's strategy to maintain domestic production to preserve critical infrastructure, skills, and supply chain capacity for the energy transition.
GEN 3 Social benefit: Sustainable Development and use which provides social benefits is encouraged when consistent with the objectives of the Plan	

Policy	Addressed by the Kyla Development Project
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.	Currently, there are no planned, consented or operational offshore wind farms or carbon capture and storage sites that would be adversely impacted by the Kyla Development. In addition, there are no commercial or capital dredging activities undertaken in the area or any sites licenced for disposal of dredged material. Shipping activity in the waters CNS is relatively low and there is ample sea room for shipping to re-route or avoid the Kyla Development location (refer to Section 4.4). Two active pipelines cross with the proposed route of the pipelines and umbilical, the CATS pipeline (PL774) operated by the Wood Group and the Langeled pipeline (PL2071) operated by GASSCO AS. Crossing designs are not yet matured, but are likely to entail concrete mattresses and rock placement, as described in Section 3.4.3. Where concrete mattresses are used as part of the crossings design, or in other open water relocations outside the 500m safety zones at Bittern and Kyla, rock cover will be provided to minimise risk of snagging with fishing gear. Serica has undertaken a scoping exercise with key stakeholders to ensure that the expectations of concerned parties have been incorporated into the Project at an early stage. The feedback received and how this has been considered by the Project is detailed in Section 1.7 of this ES. Continued liaison with other users of the area will be undertaken throughout the Project to achieve a synergistic approach to the Development of the area.
GEN 5 Climate change: Marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change.	The potentially significant effects on climate from GHG emissions generated by the proposed Kyla Development are assessed in Section 9. The GHG emissions have been evaluated in the context of a global baseline scenario of GHGs, with consideration given to the impact the emissions will have on global climate change agreements, UK carbon policies and targets and associated emissions reduction pathways. The assessment has been undertaken with reference to the new DESNZ supplementary guidance for assessing the effects of downstream scope 3 emissions on climate from offshore oil and gas projects (DESNZ, 2025), published following the Finch judgment, 2024.
GEN 6 Historic Environment: Development and use of the marine environment should protect and, where appropriate, enhance heritage assets in a manner proportionate to their significance.	There are no wrecks designated as historic Marine Protected Areas (hMPAs), scheduled monuments (including wrecks) or war graves within the vicinity of the proposed Kyla Development area (NMPi, 2025), nor are there any charted wrecks (UKHO, 2024). No wrecks were observed during the 2025 survey operations (refer to Section 4.4.8).

Policy	Addressed by the Kyla Development Project
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 in Section 4 of the ES. The ES has concluded that the Kyla Development will not result in any significant environmental effects to the marine environment provided that all identified mitigation measures are implemented (refer to assessment detailed in Sections 6 – 11).
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.	The MODU and all other contracted vessels will comply with the IMO Ballast Water Management Convention throughout all stages of the Project.
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.	Serica and its contractors will adhere to the Waste Hierarchy Principles and will minimise the generation of waste as a priority (refer to Section 12). 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.
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), Marine Strategy Framework Directive or other related Directives apply.	The Marine Strategy Framework Directive aims to minimise concentrations of contaminants in biota, sediments and water. The main discharges into the marine environment from the proposed Kyla Development will occur as a result of the discharge of drill cuttings, muds, cement, completion and rig chemicals during drilling operations, chemicals during hook-up and commissioning of subsea infrastructure, including commissioning and preservation fluids and discharge of chemicals or hydrocarbons during subsea intervention activities. Once Kyla comes online, there will be an incremental increase in produced water at the Triton FPSO which will be treated by the existing Triton produced water system and discharged to sea in accordance with the Triton Oil Discharge Permit, provided the monthly average oil concentration does not exceed 30 mg/l. The effects on seabed fauna from the deposition of WBM cuttings and fine solids (from the top two well sections) are usually subtle or undetectable, although the presence of drilling material at the seabed close to the drilling location is often detectable chemically. The deeper well sections will be drilled with a LTOBM system with the LTOBM contaminated cuttings either skipped and shipped to shore for disposal or thermally treated offshore to an acceptable overboard disposal limit (<1% oil on cuttings) and discharged from the MODU. In the

Policy	Addressed by the Kyla Development Project
	event the LTOBM contaminated cuttings are discharged, significant impacts to benthic communities are not predicted as previous studies have found no evidence of significant changes to the natural benthic community or re-colonisation of the seabed when exposed to low oil on cuttings concentrations (refer to Section 7). All other discharges from the Project will be subject to rapid dilution and dispersion and are not expected to persist within the marine environment (refer to Section 10).
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, fish and seabirds) that may arise from underwater noise emissions generated by the Kyla Development are assessed in Section 8 of this ES. This has concluded that sensitive marine fauna may experience short term behavioural effects, but significant impacts are not predicted provided that in the event the piling operations are conducted, the Project adheres to the JNCC protocol for minimising the risk of injury to marine mammals from piling noise (JNCC, 2010b). Serica will also ensure that contractors implement the JNCC guidance for the use of Passive Acoustic Monitoring in UK waters (JNCC, 2023).
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.	Impacts to air quality arising from the atmospheric emissions generated during the proposed Kyla Development operations are predicted to be negligible. Emissions will disperse rapidly from source given the open and dynamic metocean environment in the CNS region.
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 the scoping exercise, as reported in Section 1.7 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 environmental baseline survey and habitat assessment undertaken at the Kyla Development location in 2025 (refer to Section 4.1).
GEN 20 Adaptive management: Adaptive management practices should take account of new data and information in decision making, informing future decisions and future iterations of policy.	As noted above, this ES has been based on robust data sources to inform the EIA process. Serica will ensure the continued use of the most up-to-date data and research when assessing the impact of the proposed Kyla Development.

Policy	Addressed by the Kyla Development Project
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 have been considered during the EIA process and are assessed in the Sections 6 to 11 of this ES. No significant cumulative impacts are predicted provided that all identified mitigation measures are implemented.

Table A.3. Sector Policies Related to Oil and Gas Developments According to Scotland's National Marine Plan

Policy	Supported Strategic Objectives	Addressed by the Kyla Development Project
OIL & GAS 1: The Scottish Government will work with OPRED, the NSTA 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 proposed Kyla Development concept has been selected and defined with consideration to the central obligation of the NSTA Strategy (refer to Section 2). The selected concept reflects the optimal Development plan for Kyla, maximising hydrocarbon recovery whilst minimising capital risk and costs, maximising use of existing North Sea oil and gas infrastructure, and significantly reduces the carbon footprint of production when compared with standalone or long-distance tie-back alternatives. Key environmental risks have been identified in the assessment sections of this ES (refer to 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	On cessation of production, the Kyla field will be decommissioned in accordance with the requirements of the prevailing UK and international law (refer to Section 3.6).
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 selected Development concept for Kyla makes maximum use of existing oil and gas infrastructure, thereby minimising the impact on the environment and other users of the sea (refer to Section 2).
OIL & GAS 5: Consenting and licensing authorities should have regard to the potential risks, both now and under future climates, to oil and gas operations in Scottish waters, and be satisfied that installations are appropriately sited and designed to take account of current and future conditions.	Social Marine Ecosystem	The Kyla field will be developed in a way that will not result in significant effects to the marine environment. With respect to future climate conditions, the Kyla field is expected to produce hydrocarbons for ca. eight years, whilst design considerations have accounted for 100-year extreme weather events. In this context, the Kyla Development is appropriately designed for the location for which it is proposed.

Policy	Supported Strategic Objectives	Addressed by the Kyla Development Project
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 Kyla 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.

Appendix B: ENVID Registers

To inform the Kyla Development EIA, an ENVironmental and socio-economic impact IDentification (ENVID) workshop was undertaken to identify those Project activities (or aspects) which should be subject to detailed assessment in the ES.

The ENVID used the Evaluation of Significance Criteria (as documented in Section 5 of the ES) to determine the likely significance of effects on the environment.

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. For the purposes of this assessment, aspects with a significance score of Minor / Moderate, Moderate, Moderate / Major or Major have been taken forward for detailed assessment in the ES.

For unplanned events, 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. For the purposes of this assessment, unplanned events with a significance score of Medium or High have been taken forward for detailed assessment in the ES.

The results of the ENVID workshop (which took place on the 22nd September 2025) are documented in the ENVID Registers provided in this Appendix, refer to Tables B.1 to B.4.

Table B.1: Drilling ENVID Matrix

Ref No.	Environmental Issue	Project Activity	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Significance	Potential Impacts	Mitigation Measures	Scoped into EIA
1.1	Physical Presence	Presence of AHVs during pre-lay, hookup and removal of MODU anchors and ground chains	Shipping	High	Medium	**Medium**	Minor	**Minor**	Vessels will present a navigational hazard and cause displacement of commercial fisheries.	Main operators of vessels passing in proximity to Kyla will be provided with advanced notice of the proposed operations; Notification to Kingfisher Bulletin.	**No**
			Commercial Fishing	High	Medium	**Medium**	Minor	**Minor**			
1.2		Presence of pre-laid MODU anchors and ground chains	Commercial Fishing	High	Medium	**Medium**	Moderate	**Minor / Moderate**	Potential snagging hazard to fishing gears towed along the seabed.	Consent to Locate will be in place; Notification to Kingfisher Bulletin. Guard vessel will be in place as required by the CtL	**Yes**
1.3		Presence of MODU (including anchors and ground chains) and supply / support vessels during drilling operations	Shipping	High	Medium	**Medium**	Moderate	**Minor / Moderate**	Vessels will present a navigational hazard and cause displacement of commercial fisheries.	A 500 m safety zone will be in place, which will be patrolled by a dedicated ERRV; Reporting of the rig move will take place in line with the requirements of Part 4a of the Energy Act and HSE Operations Notice 6 guidance; Site-specific collision risk management plan to be developed; Consent to Locate will be in place.	**Yes**
			Commercial Fishing	High	Medium	**Medium**	Moderate	**Minor / Moderate**			
			Marine Mammals	High	Very High	**High**	Negligible	**Negligible**	Potential for collision between moving vessels and marine mammals.		**No**

Ref No.	Environmental Issue	Project Activity	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Significance	Potential Impacts	Mitigation Measures	Scoped into EIA
			Seabirds	High	Very High	**High**	Negligible	**Negligible**	Potential for disturbance / displacement from foraging areas.		
1.4	Physical Presence	Artificial light emitted from the MODU and support vessels	Seabirds	High	Very High	**High**	Negligible	**Negligible**	Seabirds are easily disorientated by intense sources of artificial light.		**No**
1.5		Physical presence of wellhead and xmas tree	Commercial Fishing	High	Medium	**Medium**	Major	**Moderate**	Potential snagging hazard to fishing gears towed along the seabed.	Wellhead will be located within 500 m safety zone and will be marked as a hazard on admiralty charts and entered into the FishSafe system; Consent to Locate will be in place.	**Yes**
1.6	Seabed Disturbance	Mooring of semi-submersible MODU (anchors and ground chains)	Seabed Sediments	High	Low	**Low**	Major	**Minor**	Localised abrasion to the seabed and potential for anchor scars and mounds upon removal. Localised abrasion from lateral movement of anchor chains. Potential to disturb contaminated sediments at Kyla from prior drilling operations. Physical disturbance and smothering of benthic communities. Impacts	Anchors will be set at the optimum angle for the local seabed sediments, reducing the potential drag across the seabed and helping them to become suitably embedded; The length of ground chains used for mooring the MODU will be optimised to maintain MODU stability and integrity; Anchors and chains will be placed in accordance with site survey results so as to use best	**Yes**
			Benthic Communities	High	Very High	**High**	Major	**Moderate / Major**			
			Fish & Shellfish	High	Very High	**High**	Major	**Moderate / Major**			

Ref No.	Environmental Issue	Project Activity	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Significance	Potential Impacts	Mitigation Measures	Scoped into EIA
			Marine Protected Areas	Low	Very High	**Very High**	Negligible	**Negligible**	to foraging behaviour of fish and displacement from spawning and nursery areas.	endeavours to avoid damage to sensitive seabed habitats.	**No**
1.7		Deposit of drill cuttings and cement on the seabed.	Seabed Sediments	High	Low	**Low**	Major	**Minor**	Cuttings pile will alter the seabed topography and sediment structure. Physical disturbance and smothering of benthic communities. Impacts to foraging behaviour of fish and displacement from spawning and nursery areas.	Minimise chemical use, use less hazardous chemicals; Thermal cuttings treatment is being evaluated to treat the LTOBM contaminated cuttings to an acceptable overboard disposal limit (<1% oil on cuttings).	**Yes**
			Benthic Communities	High	Very High	**High**	Major	**Moderate / Major**			
			Fish & Shellfish	High	Very High	**High**	Major	**Moderate / Major**			
			Marine Protected Areas	Low	Very High	**Very High**	Negligible	**Negligible**			
1.8	Underwater Noise Emissions	Use of propellers / DP thrusters on vessels	Marine Mammals	High	Very High	**High**	Negligible	**Negligible**	Potential behavioural disturbance or physiological impacts to sensitive marine fauna species.	Optimise vessel movements by careful planning	**No**
			Fish & Shellfish	High	Very High	**High**	Negligible	**Negligible**			
			Seabirds	High	Very High	**High**	Negligible	**Negligible**			
1.9		Operation of equipment on MODU (e.g. rotating machinery)	Marine Mammals	High	Very High	**High**	Negligible	**Negligible**	Potential behavioural disturbance or physiological impacts to sensitive marine fauna species.	Operational and maintenance procedures will aim to optimise the efficiency of equipment.	**No**
			Fish & Shellfish	High	Very High	**High**	Negligible	**Negligible**			
			Seabirds	High	Very High	**High**	Negligible	**Negligible**			

Ref No.	Environmental Issue	Project Activity	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Significance	Potential Impacts	Mitigation Measures	Scoped into EIA
1.10	Airborne noise emissions	Use of helicopters	Seabirds	High	Very High	**High**	Negligible	**Negligible**	Potential for disturbance / displacement from foraging areas.	Optimise helicopter movements by careful planning	**No**
1.11	Atmospheric Emissions	Fuel burnt for power generation on the MODU, vessels and helicopters	Air Quality	Very High	Low	**Low**	Negligible	**Negligible**	Emissions of combustion products (particularly CO_2, CH_4, N_2O) contribute to the pool of greenhouse gases in the atmosphere resulting in global warming and potential climate change. Inputs of contaminants (particulate matter, CO, NOx, SO_2, VOCs) can contribute to the formation of local tropospheric ozone and	Supplier's environmental footprints will be factored into the tender evaluation process; Maintenance regime will ensure all equipment will operate at optimum efficiency, minimising the overall fuel consumption; The combustion plants onboard the MODU will be built to be fuel efficient and to meet all current emission standards; Use of low sulphur fuels according to IMO requirements; Optimise drilling programme including vessel movements by	**No**

Ref No.	Environmental Issue	Project Activity	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Significance	Potential Impacts	Mitigation Measures	Scoped into EIA
1.12			Climate	Medium	Very High	**Very High**	Substantial	**Major**	photochemical smog, resulting in a reduction in local air quality.	careful planning to minimise fuel use; Look to have ISO50001 in place for MODU and vessels. Consider the use of Hydrotreated Vegetable Oil (HVO) fuel in place of Marine Gas Oil (MGO). Emissions forecasting and use of 'live' emissions tracking to optimise MODU engine use etc by using Stepwise or a similar provider.	**Yes**
1.13	Marine Discharges	Discharge of cuttings at the sea surface	Water Quality	Very High	Low	**Low**	Moderate	**Minor**	Decline in water quality, including temporary increase in suspended sediment levels and turbidity in the water column, which could have toxic effects on marine biota particularly phytoplankton, zooplankton and fish.	Thermal cuttings treatment is being evaluated to treat the LTOBM contaminated cuttings to an acceptable overboard disposal limit (<1% oil on cuttings); Screening Direction and Chemical Permit will be in place.	**Yes**
			Plankton	High	Medium	**Medium**	Moderate	**Minor / Moderate**			
			Fish & Shellfish	High	Very High	**Medium**	Moderate	**Minor / Moderate**			
1.14		Discharge of drilling, cementing,	Water Quality	Very High	Low	**Low**	Moderate	**Minor**	Decline in water quality which could have toxic effects on marine biota particularly	Chemical use and discharge will be minimised to as low as practically possible;	**Yes**

Ref No.	Environmental Issue	Project Activity	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Significance	Potential Impacts	Mitigation Measures	Scoped into EIA
		completion and rig chemicals	Plankton	High	Medium	**Medium**	Moderate	**Minor / Moderate**	phytoplankton, zooplankton and fish.	Where practicable, chemicals with a higher risk profile will be substituted out in favour of those with an improved environmental profile. A Chemical Risk Assessment will be undertaken in advance of drilling ops to support the Chemical Permit as per the requirements of the Offshore Chemicals Regulations 2002 (as amended).	
			Fish & Shellfish	High	Very High	**Medium**	Moderate	**Minor / Moderate**			
1.15		MODU and support vessels - discharge of grey/blackwater	Water Quality	Very High	Low	**Low**	Negligible	**Negligible**	Increased BOD (from organic and other nutrient matter in detergents and human waste) may ultimately lead to an increase in opportunistic species.	Waste water will be disposed of in accordance with the requirements of the MARPOL convention and UK regulations	**No**
			Plankton	Very High	Medium	**Low**	Negligible	**Negligible**			
			Fish & Shellfish	Very High	Very High	**Medium**	Negligible	**Negligible**			
1.16		MODU and support vessels - release of food waste	Water Quality	Very High	Low	**Low**	Negligible	**Negligible**	Increased BOD (from organic and other nutrient matter) may ultimately lead to an increase in opportunistic species.	Food waste will be disposed of to meet the requirements of MARPOL convention and UK regulations.	**No**
			Plankton	Very High	Medium	**Low**	Negligible	**Negligible**			
			Fish & Shellfish	Very High	Very High	**Medium**	Negligible	**Negligible**			
			Seabirds	Very High	Very High	**Medium**	Negligible	**Negligible**			
1.17		Oily water discharges from	Water Quality	Very High	Low	**Low**	Negligible	**Negligible**	Decline in water quality which could have toxic effects on marine biota	Deck drainage water will be sampled prior to discharge to	**No**
			Plankton	Very High	Medium	**Low**	Negligible	**Negligible**			

Ref No.	Environmental Issue	Project Activity	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Significance	Potential Impacts	Mitigation Measures	Scoped into EIA
		deck drains on MODU	Fish & Shellfish	Very High	Very High	**Medium**	Negligible	**Negligible**	particularly phytoplankton, zooplankton and fish.	ensure the oil in water concentration is <40 mg/l; An Oil Discharge Permit will be in place.	
			Seabirds	Very High	Very High	**Medium**	Negligible	**Negligible**			
			Marine Mammals	Very High	Very High	**Medium**	Negligible	**Negligible**			
1.18		MODU and support vessels - discharge of ballast water	Water Quality	Very High	Low	**Low**	Negligible	**Negligible**	Potential to introduce alien species, which could alter the local and possibly the wider ecosystem.	Compliance with the IMO Ballast Water Management Convention	**No**
			Plankton	Very High	Medium	**Low**	Negligible	**Negligible**			
			Fish & Shellfish	Medium	Very High	**Very High**	Negligible	**Negligible**			
			Seabirds	High	Very High	**High**	Negligible	**Negligible**			
			Marine Mammals	High	Very High	**High**	Negligible	**Negligible**			
1.19	Solid Waste	General operational waste - non-hazardous & hazardous	Population & Human Health	Very High	Very High	**Medium**	Negligible	**Negligible**	Effects of onshore disposal of waste depends on the nature of waste and disposal site. Potential effects on future land use options for waste disposal sites. Potential for localised land and air contamination.	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. A project Waste Management	**No**

Ref No.	Environmental Issue	Project Activity	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Significance	Potential Impacts	Mitigation Measures	Scoped into EIA
										Plan will be put in place and followed.	
1.20	Use of Resources	Resource use during drilling operations	Population & Human Health	Medium	Very High	**Very High**	Negligible	**Negligible**	Depletion of natural resources leading to climate change, biodiversity loss and pollution, as well as socio-economic consequences for the world wide population	Minimise the use of natural resources, as far as practicable	**No**

Table B.2: Subsea Installations and Commissioning ENVID Matrix

Ref No.	Environmental Issue	Project Activity	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Significance	Potential Impacts	Mitigation Measures	Scoped into EIA
2.1	Physical Presence	Physical presence of DP installation and commissioning vessels	Shipping	High	Medium	**Medium**	Moderate	**Minor / Moderate**	Potential for the vessels to be a navigational hazard as during installation activities, vessel manoeuvrability will be restricted	Adherence to Marine law, vessel radar and AIS, Notices to Mariners, Kingfisher Bulletin.	**Yes**
			Commercial Fishing	High	Medium	**Medium**	Moderate	**Minor / Moderate**			
2.2			Marine Mammals	High	Very High	**High**	Negligible	**Negligible**	Potential for collision between moving vessels and marine mammals.		**No**
			Seabirds	High	Very High	**High**	Negligible	**Negligible**	Potential for disturbance / displacement from foraging areas.		
2.3		Presence of subsea infrastructure and associated protection material (rock, mattresses)	Commercial Fishing	High	Medium	**Medium**	Major	**Moderate**	Loss of sea area for other users (i.e. loss of access to fishing grounds) and potential snagging hazard.	Kyla safety zone and seabed infrastructure will be clearly marked on navigation charts; Subsea facilities at Kyla will be designed for fishing interaction.	**Yes**
2.4		Artificial light emitted from DP installation and commissioning vessels	Seabirds	High	Very High	**High**	Negligible	**Negligible**	Seabirds are easily disorientated by intense sources of artificial light.	Temporary disturbance, metocean conditions drive operations to target summer weather (when hours of darkness are shorter).	**No**

Ref No.	Environmental Issue	Project Activity	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Significance	Potential Impacts	Mitigation Measures	Scoped into EIA
2.5	Seabed Disturbance	Laying of production pipelines and umbilical on the seabed	Water Quality	Very High	Low	**Low**	Minor	**Minor**	Potential to disturb seabed sediments, including contaminated sediments at Kyla from prior drilling operations and affect benthic communities	Route selection and optimisation based on acquired Environmental, Geophysical, and Geotechnical survey data; Minimise working corridors, as far as possible.	**Yes**
			Seabed Sediments	High	Very High	**High**	Major	**Moderate / Major**			
			Benthic Communities	High	Very High	**High**	Major	**Moderate / Major**			
			Fish & Shellfish	High	Very High	**High**	Major	**Moderate / Major**			
			Marine Protected Areas	Low	Very High	**Very High**	Negligible	**Negligible**			**No**
2.6		Trenching and burial of pipelines and umbilical	Water Quality	Very High	Low	**Low**	Minor	**Minor**	Potential to disturb seabed sediments, including contaminated sediments at Kyla from prior drilling operations and affect benthic communities	Route selection and optimisation based on acquired Environmental, Geophysical, and Geotechnical survey data; Minimise working corridors, as far as possible.	**Yes**
			Seabed Sediments	High	Very High	**High**	Major	**Moderate / Major**			
			Benthic Communities	High	Very High	**High**	Major	**Moderate / Major**			
			Fish & Shellfish	High	Very High	**High**	Major	**Moderate / Major**			
			Marine Protected Areas	Low	Very High	**Very High**	Negligible	**Negligible**			**No**

Ref No.	Environmental Issue	Project Activity	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Significance	Potential Impacts	Mitigation Measures	Scoped into EIA
2.7	Seabed Disturbance	Installation of tie-in spools & jumpers at Kyla and Bittern	Water Quality	Very High	Low	**Low**	Minor	**Minor**	Potential to disturb seabed sediments, including contaminated sediments at Kyla from prior drilling operations and affect benthic communities	Subsea infrastructure layout optimised to minimise footprint/seabed disturbance.	**Yes**
			Seabed Sediments	High	Very High	**High**	Major	**Moderate / Major**			
			Benthic Communities	High	Very High	**High**	Major	**Moderate / Major**			
			Fish & Shellfish	High	Very High	**High**	Major	**Moderate / Major**			
			Marine Protected Areas	Low	Very High	**Very High**	Negligible	**Negligible**			**No**
2.8		Installation of 'fishing friendly' valve skid at Kyla (either a piled or gravity based structure) and tie-in structure (either a piled or gravity based structure) at Bittern	Water Quality	Very High	Low	**Low**	Minor	**Minor**	Potential to disturb seabed sediments, including contaminated sediments at Kyla from prior drilling operations and affect benthic communities	Subsea infrastructure layout optimised to minimise footprint/seabed disturbance.	**Yes**
			Seabed Sediments	High	Very High	**High**	Major	**Moderate / Major**			
			Benthic Communities	High	Very High	**High**	Major	**Moderate / Major**			
			Fish & Shellfish	High	Very High	**High**	Major	**Moderate / Major**			
			Marine Protected Areas	Low	Very High	**Very High**	Negligible	**Negligible**			**No**

Ref No.	Environmental Issue	Project Activity	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Significance	Potential Impacts	Mitigation Measures	Scoped into EIA
2.9	Seabed Disturbance	Laying of rock, concrete mattresses for protection / stability / trench transitions	Water Quality	Very High	Low	**Low**	Minor	**Minor**	Potential to disturb seabed sediments, affect benthic communities with rock / mattresses / grout bags introducing a novel hard substrata.	Minimise amount of deposited material whilst still achieving the required level of stabilisation / protection.	**Yes**
			Seabed Sediments	High	Very High	**High**	Major	**Moderate / Major**			
			Benthic Communities	High	Very High	**High**	Major	**Moderate / Major**			
			Fish & Shellfish	High	Very High	**High**	Major	**Moderate / Major**			
			Marine Protected Areas	Low	Very High	**Very High**	Negligible	**Negligible**			**No**
2.10		Construction of pipeline crossings (Langeled and CATS pipelines)	Water Quality	Very High	Low	**Low**	Minor	**Minor**	Potential to disturb seabed sediments, affect benthic communities with rock, plinths and mattresses introducing a novel hard substrata.	Crossing designs optimised to minimise material deposited.	**Yes**
			Seabed Sediments	High	Very High	**High**	Major	**Moderate / Major**			
			Benthic Communities	High	Very High	**High**	Major	**Moderate / Major**			
			Fish & Shellfish	High	Very High	**High**	Major	**Moderate / Major**			
			Marine Protected Areas	Low	Very High	**Very High**	Negligible	**Negligible**			**No**

Ref No.	Environmental Issue	Project Activity	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Significance	Potential Impacts	Mitigation Measures	Scoped into EIA
2.11	Underwater Noise Emissions	Use of propellers / DP thrusters on installation and commissioning vessels, including general noise and vibration of equipment whilst operating	Fish & Shellfish	High	Very High	**High**	Negligible	**Negligible**	Potential behavioural disturbance or physiological impacts to sensitive marine fauna species.	Optimise vessel movements by careful planning	**No**
			Marine Mammals	High	Very High	**High**	Negligible	**Negligible**			
			Seabirds	High	Very High	**High**	Negligible	**Negligible**			
2.12		Piling operations to install the valve skid and tie-in structure	Fish & Shellfish	Medium	Very High	**Very High**	Minor	**Minor / Moderate**	Potential behavioural disturbance or physiological impacts to sensitive marine fauna.	Implement statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise	**Yes**
			Marine Mammals	Medium	Very High	**Very High**	Minor	**Minor / Moderate**			
			Seabirds	Medium	Very High	**Very High**	Minor	**Minor / Moderate**			
2.13	Atmospheric Emissions	Fuel burnt for power generation on installation and commissioning vessels	Air Quality	Very High	Low	**Low**	Negligible	**Negligible**	Emissions of combustion products (particularly CO_2, CH_4, N_2O) contribute to the pool of greenhouse gases in the atmosphere resulting in global warming and potential climate change. Inputs of contaminants (particulate matter, CO, NOx, SO_2, VOCs) can contribute to the formation of local tropospheric ozone and photochemical smog, resulting in a reduction in local air quality.	Supplier's environmental footprints will be factored into the tender evaluation process; Maintenance regime will ensure all equipment will operate at optimum efficiency, minimising the overall fuel consumption; Use of low sulphur fuels according to IMO requirements; Optimise subsea installation and commissioning programme including vessel movements by careful planning to minimise fuel use.	**No**
2.14			Climate	Medium	Very High	**Very High**	Substantial	**Major**			**Yes**

Ref No.	Environmental Issue	Project Activity	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Significance	Potential Impacts	Mitigation Measures	Scoped into EIA
2.15	Marine Discharges	Use and discharge of chemicals during hook-up and commissioning of subsea infrastructure, including commissioning and preservation fluids	Water Quality	Very High	Low	**Low**	Moderate	**Minor**	Decline in water quality which could have toxic effects on marine biota particularly phytoplankton, zooplankton and fish.	Chemical use and discharge will be minimised to as low as practically possible; Where practicable, chemicals with a higher risk profile will be substituted out in favour of those with an improved environmental profile. A Chemical Risk Assessment will be undertaken in advance of pipeline installation ops to support the Chemical Permit as per the requirements of the Offshore Chemicals Regulations 2002 (as amended).	**Yes**
			Plankton	High	Medium	**Medium**	Moderate	**Minor / Moderate**			
			Fish & Shellfish	High	Very High	**Medium**	Moderate	**Minor / Moderate**			
2.16		Installation and commissioning vessels - discharge of grey/blackwater	Water Quality	Very High	Low	**Low**	Negligible	**Negligible**	Increased BOD (from organic and other nutrient matter in detergents and human waste) may ultimately lead to an increase in opportunistic species.	Waste water will be disposed of in accordance with the requirements of the MARPOL convention and UK regulations	**No**
			Plankton	Very High	Medium	**Low**	Negligible	**Negligible**			
			Fish & Shellfish	Very High	Very High	**Medium**	Negligible	**Negligible**			
2.17		Installation and support vessels - release of food waste	Water Quality	Very High	Low	**Low**	Negligible	**Negligible**	Increased BOD (from organic and other nutrient matter) may ultimately lead to an increase in opportunistic species.	Food waste will be disposed of to meet the requirements of MARPOL convention and UK regulations.	**No**
			Plankton	Very High	Medium	**Low**	Negligible	**Negligible**			
			Fish & Shellfish	Very High	Very High	**Medium**	Negligible	**Negligible**			
			Seabirds	Very High	Very High	**Medium**	Negligible	**Negligible**			

Ref No.	Environmental Issue	Project Activity	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Significance	Potential Impacts	Mitigation Measures	Scoped into EIA
2.18	Marine Discharges	Installation and commissioning vessels - discharge of ballast water	Water Quality	Very High	Low	**Low**	Negligible	**Negligible**	Potential to introduce alien species, which could alter the local and possibly the wider ecosystem.	Compliance with the IMO Ballast Water Management Convention	**No**
			Plankton	Very High	Medium	**Low**	Negligible	**Negligible**			
			Fish & Shellfish	Medium	Very High	**Very High**	Negligible	**Negligible**			
			Seabirds	High	Very High	**High**	Negligible	**Negligible**			
			Marine Mammals	High	Very High	**High**	Negligible	**Negligible**			
2.19	Solid Waste	General operational waste - non-hazardous & hazardous	Population & Human Health	Very High	Very High	**Medium**	Negligible	**Negligible**	Effects of onshore disposal of waste depends on the nature of waste and disposal site. Potential effects on future land use options for waste disposal sites. Potential for localised land and air contamination.	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. A project Waste Management Plan will be put in place and followed.	**No**
2.20	Use of Resources	Resource use during installation and commissioning operations	Population & Human Health	Medium	Very High	**Very High**	Negligible	**Negligible**	Depletion of natural resources leading to climate change, biodiversity loss and pollution, as well as socio-economic consequences for the world wide population	Minimise the use of natural resources, as far as practicable	**No**

Table B.3: Production, Inspection and Maintenance ENVID Matrix

Ref No.	Environmental Issue	Project Activity	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Significance	Potential Impacts	Mitigation Measures	Scoped into EIA
3.1	Physical Presence	Ongoing presence of subsea infrastructure and protection material (rocks and mattresses)	Commercial Fishing	High	Medium	**Medium**	Major	**Moderate**	Loss of sea area for other users (i.e. loss of access to fishing grounds) and potential snagging hazard.	Kyla safety zone and seabed infrastructure will be clearly marked on navigation charts; Subsea facilities at Kyla will be designed for minimising fishing gear interaction.	**Yes**
3.2	Seabed Disturbance	Inspection, maintenance and repair of subsea infrastructure	Water Quality	Very High	Low	**Low**	Negligible	**Negligible**	Potential to disturb seabed sediments and affect benthic communities		**No**
			Seabed Sediments	High	Very High	**High**	Negligible	**Negligible**			
			Benthic Communities	High	Very High	**High**	Negligible	**Negligible**			
			Fish & Shellfish	High	Very High	**High**	Negligible	**Negligible**			
			Marine Protected Areas	Low	Very High	**Very High**	Negligible	**Negligible**			

Ref No.	Environmental Issue	Project Activity	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Significance	Potential Impacts	Mitigation Measures	Scoped into EIA
3.3	Atmospheric Emissions	Incremental atmospheric emissions at the Triton FPSO (host facility) as a result of Kyla coming online	Air Quality	Very High	Low	**Low**	Negligible	**Negligible**	Emissions of combustion products (particularly CO_2, CH_4, N_2O) contribute to the pool of greenhouse gases in the atmosphere resulting in global warming and potential climate change. Inputs of contaminants (particulate matter, CO, NOx, SO_2, VOCs) can contribute to the formation of local tropospheric ozone and photochemical smog, resulting in a reduction in local air quality.	Triton FPSO subject to UK ETS Permit; Implementation of Triton ERAP.	**No**
3.4			Climate	Medium	Very High	**Very High**	Substantial	**Major**			**Yes**
3.5		Incremental atmospheric emissions at Triton FPSO due to additional gas cold vented from oil storage tanks as a result of Kyla production	Air Quality	Very High	Low	**Low**	Negligible	**Negligible**	Emissions of combustion products (particularly CO_2, CH_4, N_2O) contribute to the pool of greenhouse gases in the atmosphere resulting in global warming and potential climate change. Inputs of contaminants (particulate matter, CO, NOx, SO_2, VOCs) can contribute to the formation of local tropospheric ozone and photochemical smog, resulting in a reduction in local air quality.		**No**
3.6			Climate	Medium	Very High	**Very High**	Substantial	**Major**			**Yes**

Ref No.	Environmental Issue	Project Activity	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Significance	Potential Impacts	Mitigation Measures	Scoped into EIA
3.7		End use emissions from burning the extracted hydrocarbons	Air Quality	Very High	Low	**Low**	Negligible	**Negligible**	Emissions of combustion products (particularly CO_2, CH_4, N_2O) contribute to the pool of greenhouse gases in the atmosphere resulting in global warming and potential climate change. Inputs of contaminants (particulate matter, CO, NOx, SO_2, VOCs) can contribute to the formation of local tropospheric ozone and photochemical smog, resulting in a reduction in local air quality.		**No**
3.8			Climate	Medium	Very High	**Very High**	Substantial	**Major**			
3.9	Marine Discharges	Incremental increase in produced water discharges at the Triton FPSO (host facility) as a result of Kyla coming online	Water Quality	Very High	Low	**Low**	Major	**Minor**	Decline in water quality which could have toxic effects on marine biota particularly phytoplankton, zooplankton and fish.	Produced water will be separated using existing facilities on the Triton FPSO and discharged at hydrocarbon concentrations of <30 mg/l in accordance with the annual Oil Discharge Permit.	**Yes**
			Plankton	High	Medium	**Medium**	Major	**Moderate**			
			Fish & Shellfish	High	Very High	**Medium**	Major	**Moderate**			

Ref No.	Environmental Issue	Project Activity	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Significance	Potential Impacts	Mitigation Measures	Scoped into EIA
3.10		Discharge of chemicals or hydrocarbons during subsea intervention activities (IRM)	Water Quality	Very High	Low	**Low**	Moderate	**Minor**	Decline in water quality which could have toxic effects on marine biota particularly phytoplankton, zooplankton and fish.	Chemical use and discharge will be minimised to as low as practically possible; Chemicals with a higher risk profile will be substituted out in favour of those with an improved environmental profile, where possible; A Chemical Risk Assessment will be undertaken in advance of IRM ops to support the Chemical Permit; A term Oil Discharge Permit will be in place for the discharge of hydrocarbons as per the requirements of Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended).	**Yes**
			Plankton	High	Medium	**Medium**	Moderate	**Minor / Moderate**			
			Fish & Shellfish	High	Very High	**Medium**	Moderate	**Minor / Moderate**			

Table B.4: Unplanned Events ENVID Matrix

Ref No.	Unplanned Event	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Consequence	Likelihood	Risk	Potential Impacts	Mitigation Measures	Scoped into EIA
4.1	Dropped Objects	Oil & Gas	Very High	Medium	**Low**	Negligible	**Negligible**	Possible	Low	Dropped objects may pose a risk to subsea infrastructure or present a snagging risk to trawlers.	Any dropped objects to be immediately reported to the regulator (via a PON2) and procedures will be in place to recover objects, where possible; Debris will be identified during post work surveys and anything that cannot be recovered will be reported to the relevant authorities to be included on navigation charts; Subsea infrastructure to be designed for dropped objects as applicable. Installation and SIMOPS study to be carried out. Dropped objects study to be carried out before MODU arrival. Safe handling and lifting procedures to be followed.	**No**
		Commercial Fishing	High	Medium	**Medium**	Negligible	**Negligible**	Possible	Low			

Ref No.	Unplanned Event	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Consequence	Likelihood	Risk	Potential Impacts	Mitigation Measures	Scoped into EIA
4.2	Small release of hydrocarbons / chemicals to sea (e.g. from drains, bunkering operations etc.) during drilling, installation and commissioning or maintenance and well intervention activities	Water Quality	Very High	Low	**Low**	Minor	**Minor**	Possible	Low	May temporarily affect water quality and impact species within the water column.	MODU / vessels will be designed, managed and maintained to prevent spills; Crews will be adequately trained and regular exercises held; Bunkering procedures will be put in place.	**No**
		Seabed Sediments	Very High	Low	**Low**	Minor	**Minor**	Possible	Low			
		Benthic Communities	High	Very High	**High**	Minor	**Minor**	Possible	Low			
		Fish & Shellfish	High	Very High	**High**	Minor	**Minor**	Possible	Low			
		Marine Mammals	High	Very High	**High**	Minor	**Minor**	Possible	Low			
4.3	Small release of hydraulic fluid, e.g. from ROV operations / hydraulic equipment / subsea control system failure	Water Quality	Very High	Low	**Low**	Minor	**Minor**	Possible	Low	May temporarily affect water quality and impact species within the water column.	Appropriate maintenance, and pre-use checks on hydraulic equipment and ROVs PON1 reporting systems in place in the case of a release. Cefas registered hydraulic chemicals in use. Closed loop control system in place for subsea facilities.	**No**
		Plankton	Very High	Low	**Low**	Minor	**Minor**	Possible	Low			
		Fish & Shellfish	High	Very High	**High**	Minor	**Minor**	Possible	Low			
		Seabirds	High	Very High	**High**	Minor	**Minor**	Possible	Low			
		Marine Mammals	High	Very High	**High**	Minor	**Minor**	Possible	Low			

Ref No.	Unplanned Event	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Consequence	Likelihood	Risk	Potential Impacts	Mitigation Measures	Scoped into EIA
4.4	MODU or vessel collision (loss of diesel inventory) (MAH)	Water Quality	Very High	Low	**Low**	Moderate	**Minor**	Unlikely	Low	Release of fuel oil to sea may impact species within the water column, on the sea surface and in coastal habitats.	Consent to Locate will be in place for the MODU; 500m safety zone will be designated around the MODU and dedicated ERRV present; Notifications made to 'regular runners' and local fisheries organisations via Notices to Mariners, NAVTEX / NAVAREA warnings and fisheries notices; Adherence to Marine law; Vessel radar and AIS; Approved OPEP and CIP in place.	**Yes**
		Seabed Sediments	High	Very High	**High**	Moderate	**Moderate**	Unlikely	Medium			
		Plankton	Very High	Low	**Low**	Moderate	**Minor**	Unlikely	Low			
		Benthic Communities	High	Very High	**High**	Moderate	**Moderate**	Unlikely	Medium			
		Fish & Shellfish	Medium	Very High	**Very High**	Moderate	**Moderate / Major**	Unlikely	Medium			
		Seabirds	Medium	Very High	**Very High**	Moderate	**Moderate / Major**	Unlikely	Medium			
		Marine Mammals	Medium	Very High	**Very High**	Moderate	**Moderate / Major**	Unlikely	Medium			
		Marine Protected Areas	Medium	Very High	**Very High**	Moderate	**Moderate / Major**	Unlikely	Medium			
		Shipping	High	Very High	**High**	Moderate	**Moderate**	Unlikely	Medium			
		Commercial Fishing	High	Very High	**High**	Moderate	**Moderate**	Unlikely	Medium			
		Tourism & Leisure	High	Medium	**Medium**	Moderate	**Minor / Moderate**	Unlikely	Medium			
		Population & Human Health	Medium	Very High	**Very High**	Moderate	**Moderate / Major**	Unlikely	Medium			

Ref No.	Unplanned Event	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Consequence	Likelihood	Risk	Potential Impacts	Mitigation Measures	Scoped into EIA
4.5	Well blowout (releasing large quantities of hydrocarbons) in the event of a loss of well control (MAH)	Water Quality	Very High	Low	**Low**	Substantial	**Minor / Moderate**	Rare	Low	Release of hydrocarbons to sea may impact species within the water column, on the sea surface and in coastal habitats.	Well design and construction reviewed by an independent well examiner; Safety and Environmental Critical Elements will be identified, and a suitable maintenance and testing schedule applied to each; Crews will be adequately experienced, trained in well control techniques and supervised; During drilling ops, weighted drilling fluids will provide the primary barrier and the downhole pressures will be carefully controlled and monitored, with the secondary barrier, the BOP, regularly maintained and tested; Emergency drills will be held regularly; An approved OPEP, emergency response plans and equipment will be in place; OSRL Tier 2/3 support and capping device available.	**Yes**
		Seabed Sediments	High	Very High	**High**	Substantial	**Major**	Rare	Medium			
		Plankton	Very High	Low	**Low**	Substantial	**Minor / Moderate**	Rare	Low			
		Benthic Communities	High	Very High	**High**	Substantial	**Major**	Rare	Medium			
		Fish & Shellfish	Medium	Very High	**Very High**	Substantial	**Major**	Rare	Medium			
		Seabirds	Medium	Very High	**Very High**	Substantial	**Major**	Rare	Medium			
		Marine Mammals	Medium	Very High	**Very High**	Substantial	**Major**	Rare	Medium			
		Marine Protected Areas	Medium	Very High	**Very High**	Substantial	**Major**	Rare	Medium			
		Shipping	High	Very High	**High**	Substantial	**Major**	Rare	Medium			
		Commercial Fishing	High	Very High	**High**	Substantial	**Major**	Rare	Medium			
		Tourism & Leisure	High	Medium	**Medium**	Substantial	**Moderate / Major**	Rare	Medium			
		Population & Human Health	Medium	Very High	**Very High**	Substantial	**Major**	Rare	Medium			

Ref No.	Unplanned Event	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Consequence	Likelihood	Risk	Potential Impacts	Mitigation Measures	Scoped into EIA
4.6	Production pipeline rupture, releasing large quantities of hydrocarbons to sea	Water Quality	Very High	Low	**Low**	Substantial	**Minor / Moderate**	Rare	Medium	Release of hydrocarbons to sea may impact species within the water column, on the sea surface and in coastal habitats.	Facilities will be subject to stringent design specifications; Routine monitoring of pipeline pressure and temperature will be undertaken; Automatic and manual shutdown systems in place; Periodic ROV inspection of the pipeline will be undertaken; Maintaining pipeline integrity KPIs.	**Yes**
		Seabed Sediments	High	Very High	**High**	Substantial	**Major**	Rare	Medium			
		Plankton	Very High	Low	**Low**	Substantial	**Minor / Moderate**	Rare	Medium			
		Benthic Communities	High	Very High	**High**	Substantial	**Major**	Rare	Medium			
		Fish & Shellfish	Medium	Very High	**Very High**	Substantial	**Major**	Rare	Medium			
		Seabirds	Medium	Very High	**Very High**	Substantial	**Major**	Rare	Medium			
		Marine Mammals	Medium	Very High	**Very High**	Substantial	**Major**	Rare	Medium			
		Marine Protected Areas	Medium	Very High	**Very High**	Substantial	**Major**	Rare	Medium			
		Shipping	High	Very High	**High**	Substantial	**Major**	Rare	Medium			
		Commercial Fishing	High	Very High	**High**	Substantial	**Major**	Rare	Medium			
		Tourism & Leisure	High	Medium	**Medium**	Substantial	**Moderate / Major**	Rare	Medium			
		Population & Human Health	Medium	Very High	**Very High**	Substantial	**Major**	Rare	Medium			

Ref No.	Unplanned Event	Receptor	Resistance & Resilience	Value	Receptor Sensitivity	Magnitude of Impact	Consequence	Likelihood	Risk	Potential Impacts	Mitigation Measures	Scoped into EIA
4.7	Gas lift pipeline rupture, releasing large quantities of gas	Air Quality	Very High	Low	**Low**	Minor	**Minor**	Rare	Low	Atmospheric emissions due to gas release	Facilities will be subject to stringent design specifications; Routine monitoring of pipeline pressure and temperature will be undertaken; Automatic and manual shutdown systems in place; Periodic ROV inspection of the pipeline will be undertaken; Maintaining pipeline integrity KPIs.	**Yes**
		Climate	Medium	Very High	**Very High**	Substantial	**Major**	Rare	Medium			
4.8	Deposit of additional rock to rectify upheaval buckling and interaction with fishing gear	Water Quality	Very High	Low	**Low**	Minor	**Minor**	Possible	Medium	Potential to disturb seabed sediments and affect benthic communities	Minimise amount of rock deposited, as far as practicable; Periodic ROV inspection of the pipeline will be undertaken; Maintaining pipeline integrity KPIs.	**Yes**
		Seabed Sediments	High	Very High	**High**	Major	**Moderate / Major**	Possible	Medium			
		Benthic Communities	High	Very High	**High**	Major	**Moderate / Major**	Possible	Medium			
		Fish & Shellfish	High	Very High	**High**	Major	**Moderate / Major**	Possible	Medium			
		Marine Protected Areas	Low	Very High	**Very High**	Negligible	**Negligible**	Possible	Low			

APPENDIX C:
Drill Cuttings Modelling

MAKING COMPLEX EASY

A TETRA TECH COMPANY

SERICA ENERGY - KYLA WELL

Drill Cuttings and Muds Dispersion Modelling

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REPORT

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EXECUTIVE SUMMARY

Project Background

Serica Energy Chinook Ltd (Serica) is planning to develop the Kyla oil field via a single subsea well located in United Kingdom Continental Shelf (UKCS) Block 29/2c in the Central North Sea, approximately 182 kilometres (km) to the southeast of Peterhead on the Scottish coastline. Serica holds 100% equity and operatorship of the Licence. The Kyla well will be tied-back to the Bittern Valve Skid then to Triton FPSO operated by Dana Petroleum UK Limited.

To support the environmental impact assessment (ES) for the Kyla Development, Serica commissioned RPS to undertake a detailed drill cuttings and muds dispersion modelling study to quantify the distribution of deposited cuttings and muds on the seabed and the total suspended solids (TSS) concentrations in the water column resulting from the proposed drilling and discharge program.

The purpose of the modelling is to provide an understanding of a conservative 'outer envelope' of the potential area of deposited cuttings and muds on the seabed and TSS concentrations (TSS) resulting from the proposed drilling and discharge program.

Methodology

The modelling study was conducted in stages. Firstly, 10-years of three-dimensional current data (2010–2019) for the study site was generated to represent the combined influence of ocean drift currents and tidal currents. Secondly, the current data and discharge characteristics were input into a three-dimensional sediment dispersion model, MUDMAP, to predict the movement and initial settlement of cuttings and drilling muds based on the proposed discharge program, which included 895 m^3 of cuttings and 365.1 m^3 of drilling muds solids being discharged to the marine environment. Thirdly, as the spud date can vary, 100 simulations were modelled with varying start dates to assess a range of current conditions for each release location. Results from the 100 simulations were overlayed to determine deposition on the seafloor, and maximum TSS concentrations based on acute (1-hr averaged concentration) and chronic (24-hr averaged concentration) exposure thresholds, in each grid cell.

Key Results

Deposition

- The maximum predicted thickness of deposited cuttings and muds was predominantly associated with the drilling of the 36- and 26-inch bores, which were returned directly to seafloor from a discharge height of 2 m above the seafloor. A maximum thickness of 0.57 m was predicted within 50 m of the discharge location.
- Based on the assessment of 100 simulations the maximum distances from the release location to the edge of the low exposure (10 mg/cm²/day [1.0 mm]) , moderate exposure (30 mg/cm²/day [3.0 mm]) and high exposure (100 mg/cm²/day [10.2 mm]) thresholds were 0.33 km, 0.15 km and 0.06 km, respectively. The total area of coverage for the low exposure threshold, or greater, was 0.12 km^2.

Acute (1-hr averaged concentrations) Total Suspended Solids Exposure

Based on the assessment of 100 simulations, the maximum distance from the release location to the edge of the low exposure TSS concentration threshold (10 mg/L) for acute exposure (1-hr averaged concentration) was 1.02 km. Additionally, the maximum distance from the release location to the edge of the moderate exposure TSS concentration threshold (50 mg/L) for acute exposure (1-hr averaged concentration) was 0.27 km. High exposure (100 mg/L) TSS concentrations did not exceed 0.27 km from the release location. The total area of coverage for the low exposure threshold, or greater, was 1.19 km^2.

Chronic (24-hr averaged concentrations) Total Suspended Solids Exposure

- The maximum distance from the release location to the edge of the low exposure TSS concentration threshold (5 mg/L) for chronic exposure (24-hr averaged concentration) was 0.41 km. Additionally, the maximum distance from the release location to the edge of the chronic moderate exposure TSS concentration threshold (15 mg/L) was 0.19 km. Chronic high exposure (50 mg/L) TSS did not exceed 0.08 km from the release location. The total area of coverage for the low exposure threshold was 0.16 km^2.
- The discharge of cuttings and muds will lead to relatively short-lived increased TSS concentrations of typically up to 24 hours, which are expected to dilute and reduce with distance from the release location to concentrations below the reporting thresholds. Based on the temporary elevated concentrations of TSS concentrations at the low exposure threshold, and the limited occurrence of the very localised high exposure, the impact likelihood is thus considered low.

1 INTRODUCTION

Serica Energy Chinook Ltd (Serica) is planning to develop the Kyla oil field via a single subsea well located in United Kingdom Continental Shelf (UKCS) Block 29/2c in the Central North Sea, approximately 182 kilometres (km) to the southeast of Peterhead on the Scottish coastline. Serica holds 100% equity and operatorship of the Licence.

To support the environmental impact assessment (ES) for the Kyla Development, Serica commissioned RPS to undertake a detailed drill cuttings and muds dispersion modelling study to quantify the distribution of deposited cuttings and muds on the seabed and the total suspended solids (TSS) concentrations in the water column resulting from the proposed drilling and discharge program.

The coordinates for the proposed Kyla well release location is presented in Table 1.1 and illustrated in Figure 1.1.

The purpose of the modelling is to provide an understanding of a conservative 'outer envelope' of the potential area of deposited cuttings and muds on the seabed and TSS concentrations (TSS) resulting from the proposed drilling and discharge program.

Modelling was performed using an advanced three-dimensional dispersion model; MUDMAP. The MUDMAP model calculates the transport, spreading, and deposition of discharged cuttings and muds solids over time, based on the prevailing current conditions, the proposed drilling and discharge program, and physical properties of the discharged cuttings and muds solids.

As the spud date may vary, 100 simulations were modelled with varying start dates to assess a range of current conditions.

Table 1.1 Coordinates for the drill cuttings and muds discharge modelling release location.

Well name	Latitude*	Longitude*	Water depth (m)
Kyla	56° 53' 1.1" N [6,305,250 N]	1° 13' 50.7" E [575,000 E]	91

*Datum: WGS84 [ED50 / TM 0 N]

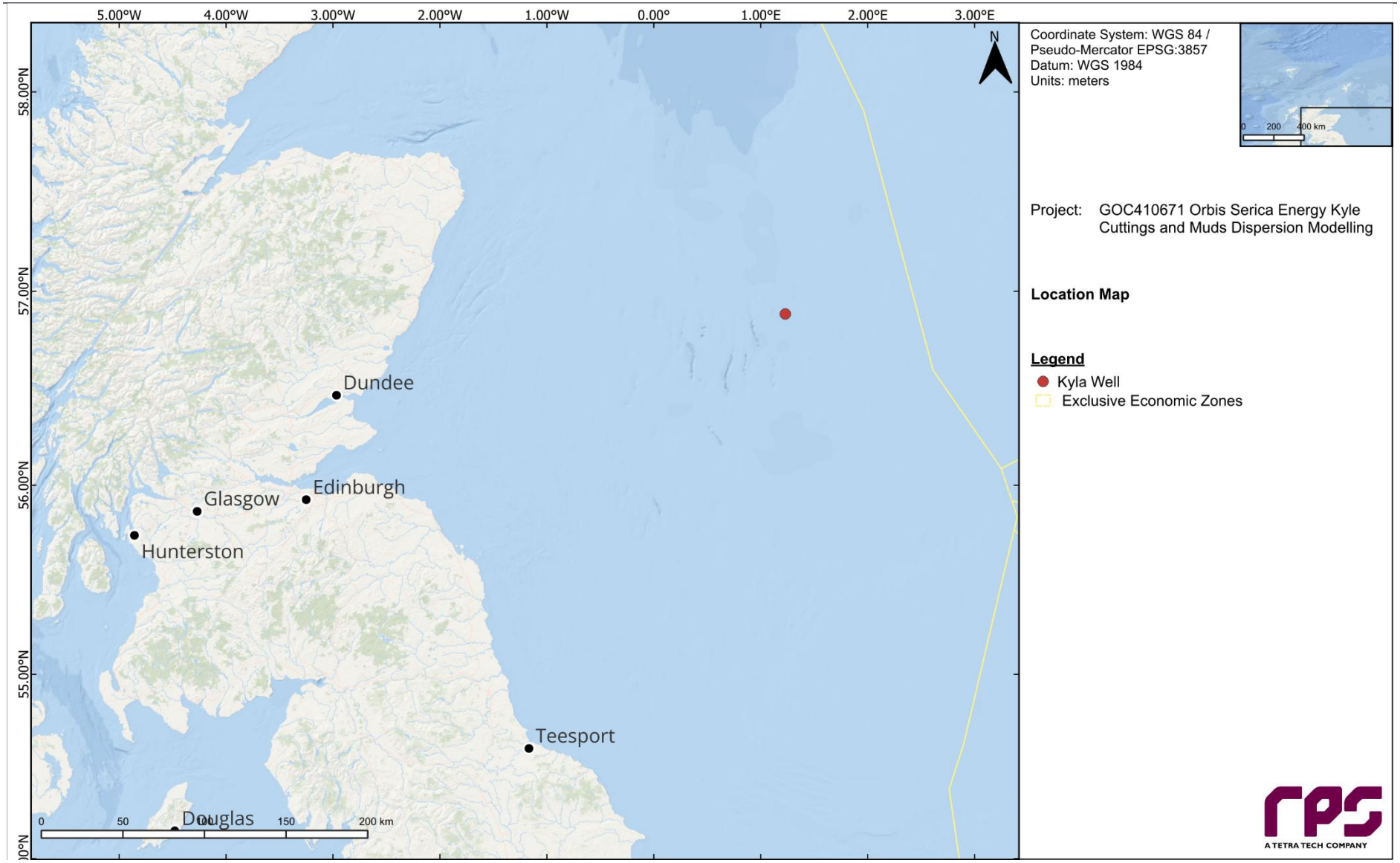

Figure 1.1 Drill cuttings and muds discharge modelling release location.

2 SCOPE OF WORK

The scope of work included the following components:

1. Ten years (2010 to 2019 (inclusive)) of current data were generated, which included the combined influence of ocean and tidal currents. The current data are suitably long enough to be indicative of interannual variability in ocean currents;

2. The current data and the defined discharge program specifics were input into the three-dimensional dispersion model (MUDMAP) with a total of 100 simulations modelled that included discharges at the seafloor and sea surface. Each simulation had different start times to ensure a range of current conditions were assessed;

3. Present example deterministic modelling results of the sea surface discharges for the drilling program; and

4. Results from the 100 simulations were overlayed to determine the maximum sediment deposition, and total TSS concentrations based on acute (1-hr averaged concentration) and chronic (24-hr averaged concentration) exposure thresholds, in each grid cell.

3 REGIONAL CURRENTS

The release location is located within the central region of the North Sea. The North Sea is a shallow sea that lies between Norway, the United Kingdom and the European Continent. Up to two thirds of the Sea is characterised by a depth shallower than 100 m. The Norwegian Trench being the one exception, with depths exceeding 700 m. This deep feature has a strong influence on the circulation within the North Sea.

The variability of the general circulation in the North Sea is determined by varying local wind conditions and their interaction with the inflow of Atlantic water masses through the northern and southern boundaries (Mathis et al., 2015). The warm and saline Atlantic waters enter the North Sea through the English Channel and northern boundary (Winther and Johannessen, 2006). Waters entering through the northern boundary can be divided into three different inflow sites; the Orkneys-Shetland section (Fair Isle Current), the Shetland shelf area and the western section of the Norwegian Trench.

General circulation patterns in the North Sea are predominantly cyclonic (Winther and Johannessen, 2006). The Atlantic water flow entering the North Sea is primarily southward and is steered by the local topography. Southern flows adjacent to the Norwegian mainland then proceed eastward through Skagerrak, the strait running between the Jutland peninsula of Denmark, the east coast of Norway and the west coast of Sweden, connecting the North Sea and the Kattegat Sea. This flow continues eastward, and when it reaches the inner part of Skagerrak, the area between Denmark, Sweden and Norway, it meets brackish water from the Baltic Sea and turns northward (Winther and Johannessen, 2006). This current follows the Norwegian coast west and then north and becomes the Norwegian Coastal Current.

Figure 3.1 presents a schematic of the regional currents in the North Sea.

Readers are referred to Lee (1980), Huthnance (1991) and Mathis et al., (2015) for detailed reviews of the physical oceanography of the North Sea.

To accurately describe the variability in currents both horizontally and vertically, data based on the combination of ocean currents and tides were included as part of this study. Below is a summary of the combined datasets.

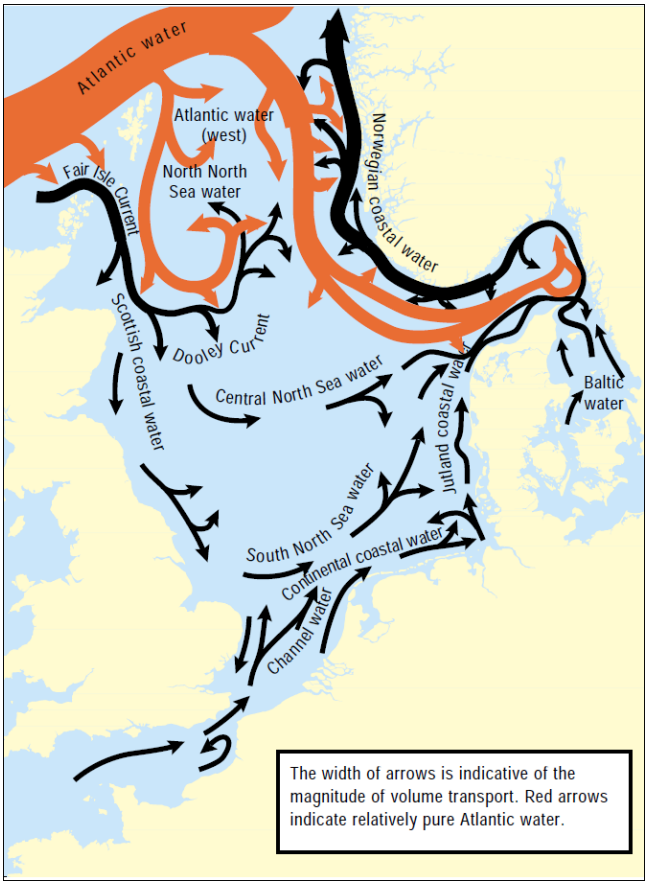

Figure 3.1 Schematic showing the oceanic current circulation in the study region (Image source: OSPAR, 2000).

3.1 Tidal currents

Tidal current data was generated using RPS's advanced ocean/coastal model, HYDROMAP. The HYDROMAP model has been thoroughly tested and verified through field measurements throughout the world for over 35 years (Isaji and Spaulding, 1984; Isaji et al., 2001; Zigic et al., 2003; Makarynskyy et al., 2010), whilst being used for a wide variety of disciplines within marine environments (e.g. Zigic et al., 2003, 2009; Talouli et al., 2009; King et al., 2010; Makarynskyy et al., 2010; 2015). HYDROMAP tidal current data has been used as input to forecast (in the future) and hindcast (in the past) pollutant spills in Australian waters and forms part of the Australian National Oil Spill Emergency Response System operated by AMSA (Australian Maritime Safety Authority).

HYDROMAP employs a sophisticated sub-gridding strategy, which supports up to six levels of spatial resolution, halving the grid cell size as each level of resolution is employed. The sub-gridding allows for higher resolution of currents within areas of greater bathymetric and coastline complexity, and/or of interest to a study.

The numerical solution methodology follows that of Davies (1977a and 1977b) with further developments for model efficiency by Owen (1980) and Gordon (1982). A more detailed presentation of the model can be found in Isaji and Spaulding (1984) and Isaji et al. (2001).

3.1.1 Grid Setup

RPS has a seamless global tidal model. The tidal domains are sub-gridded to a resolution of 500 m for shallow and coastal regions, starting from an offshore (or deep water) resolution of 8 km. The finer grid cells are allocated in a step-wise fashion to more accurately resolve flows along the coastline, around islands and over regions with more complex bathymetry. Figure 3.2 shows a zoomed in image of the North Atlantic Ocean and North Sea model regions.

A combination of datasets was used to describe the shape of the seabed within the high-resolution grid. Depths for the region were extracted from nautical charts and the SRTM30_PLUS dataset (see Becker et al., 2009), which provides a 30-arc second, or approximately 1 km, resolution.

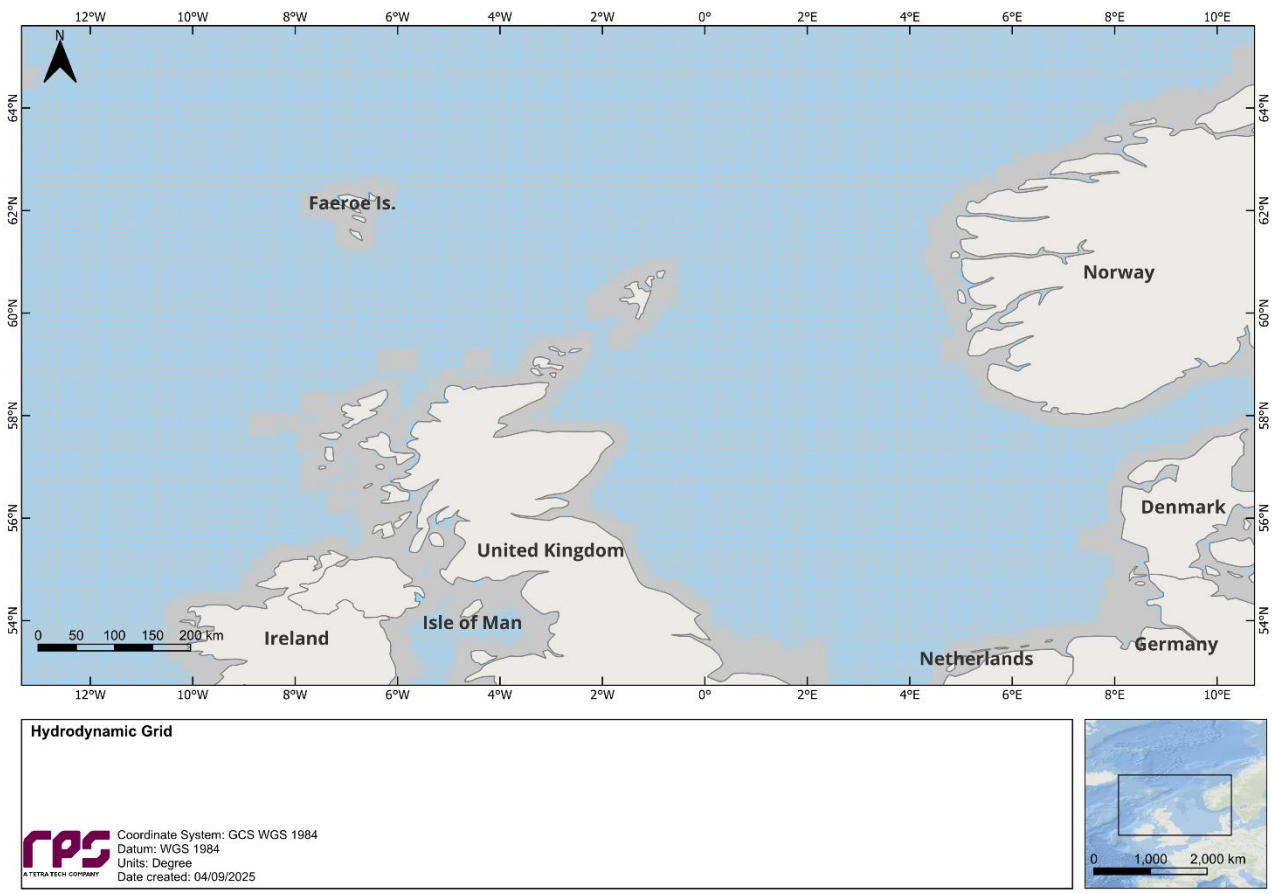

Figure 3.2 Map showing the regions of sub-gridding for the study area and example nearshore resolution.

3.1.2 Tidal Conditions

The ocean boundary data for the regional model was obtained from satellite measured altimetry data (TOPEX/Poseidon 8.0) which provided estimates of the eight dominant tidal constituents at a horizontal scale of approximately 0.25 degrees. The eight major tidal constituents used were K_2, S_2, M_2, N_2, K_1, P_1, O_1 and Q_1. Using the tidal data, time series surface heights were calculated along the open boundaries for the simulation period.

The Topex/Poseidon satellite data has a resolution of 0.25 degrees globally, with higher resolution in coastal regions, and is produced and quality controlled by NASA (National Aeronautics and Space Administration). The data capturing satellites, equipped with two altimeters capable of taking sea level measurements accurate to less than ± 5 cm, measured oceanic surface elevations (and the resultant tides) for the period 1992–2005. In total these satellites carried out 62,000 orbits of the planet. The Topex-Poseidon tidal data has been widely used amongst the oceanographic community, being referenced in more than 2,100 research publications (e.g. Andersen, 1995; Ludicone et al., 1998; Matsumoto et al., 2000; Kostianoy et al., 2003; Yaremchuk and Tangdong, 2004; Qiu and Chen 2010). The Topex/Poseidon tidal data is considered suitably accurate for this study.

3.2 Ocean Currents

Data describing the flow of ocean currents were for the years 2010 to 2019 (inclusive) obtained from HYCOM (Hybrid Coordinate Ocean Model) (Chassignet et al., 2007), which is operated by the HYCOM Consortium, sponsored by the Global Ocean Data Assimilation Experiment (GODAE). HYCOM is a data-assimilative, three-dimensional ocean model that is run as a hindcast (for a past period), assimilating time-varying observations of sea surface height, sea surface temperature and in-situ temperature and salinity measurements (Chassignet et al., 2009). The HYCOM predictions for drift currents are produced at a horizontal spatial resolution of approximately 8.25 km (1/12th of a degree) over the region, at a frequency of every 3 hours. HYCOM uses isopycnal layers in the open, stratified ocean, but uses the layered continuity equation to make a dynamically smooth transition to a terrain following coordinate in shallow coastal regions, and to z-level coordinates in the mixed layer and/or unstratified seas.

The HYCOM model has been extensively documented through many publications which are available online[1]. The HYCOM data have also been used within the North Sea region for various application (e.g., Melsom, 2005; Winther and Johannessen, 2006; Winther and Evensen, 2006; Akinbamini et al., 2022).

For this study, the HYCOM hindcast currents were obtained for the year 2010-2019. Figure 3.3 provides an example of the modelled surface ocean currents (HYCOM) for the region.

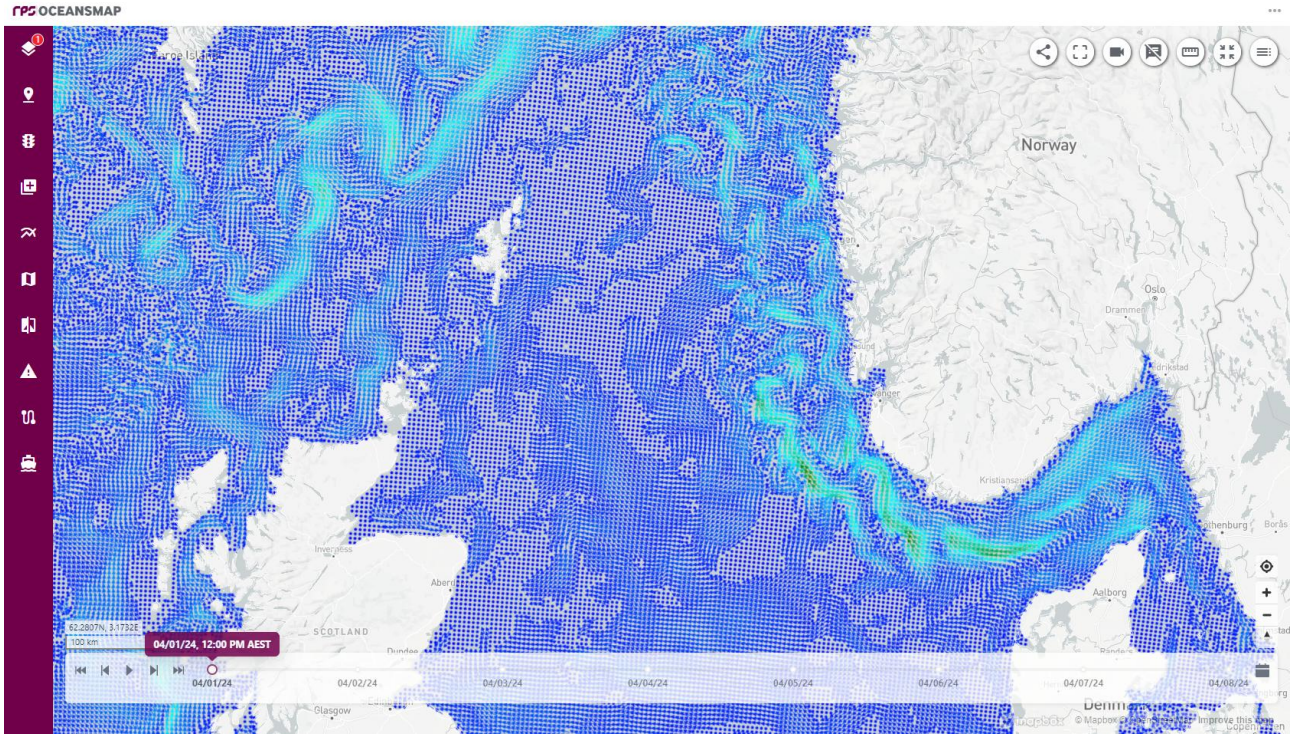

Figure 3.3 Snapshot example of the predicted HYCOM ocean surface currents in the region. Colour and size of individual arrows indicate current speed (m/s).

[1] https://hycom.org/publications

3.3 Surface and Near-Bottom Currents Nearby the Release Location

Figure 3.4 and Figure 3.5 present the monthly surface and near-bottom current roses nearby the release location, respectively. Note the convention for defining current direction is the direction the current flows towards, which is used to reference current direction throughout this report. Each branch of the rose represents the currents flowing to that direction, with north to the top of the diagram. Sixteen directions are used. The branches are divided into segments of different colour, which represent the current speed ranges for each direction. Speed intervals of 0.05 m/s and 0.1 m/s are predominantly used in these current roses. The length of each coloured segment is relative to the proportion of currents flowing within the corresponding speed and direction.

Table 3.1 and Table 3.2 present the surface and near-bottom monthly current speeds and directions nearby the release location, respectively.

The monthly average surface current speeds ranged from 0.21 m/s (June) to 0.24 m/s (January and December). Additionally, the monthly maximums reached speeds ranging between 0.63 m/s (April) and 1.01 m/s (December; Table 3.1). The surface current directions were generally consistent with currents typically flowing along the east-northeast and south-southwest axis (Figure 3.4).

In comparison, the monthly average near-bottom current speeds were relatively consistent ranging from 0.19 m/s (February, April, June and November)0.20 m/s (January, March, July to October and December), whilst near-bottom monthly maximum current speeds ranged between 0.56 m/s (May) and 0.76 m/s (August; Table 3.2). Additionally, the near-bottom current direction predominantly occurred along the east-northeast and south-southwest axis (Figure 3.5).

Table 3.1 Monthly average and maximum surface current speeds nearby the release location. The data was derived by combining the HYCOM ocean data and HYDROMAP tidal data for 2010-2019.

Month	Average current speed (m/s)	Maximum current speed (m/s)	General direction(s) (Towards)
January	0.24	0.92	East-northeast and South-southwest axis
February	0.23	0.94	
March	0.23	0.69	
April	0.22	0.63	
May	0.22	0.80	
June	0.21	0.74	
July	0.22	0.74	
August	0.22	0.82	
September	0.22	0.76	
October	0.23	0.72	
November	0.23	0.76	
December	0.24	1.01	
Minimum	**0.21**	**0.63**	-
Maximum	**0.24**	**1.01**	

Table 3.2 Monthly average and maximum near-bottom current speeds nearby the release location. The data was derived by combining the HYCOM ocean data and HYDROMAP tidal data for 2010-2019.

Month	Average current speed (m/s)	Maximum current speed (m/s)	General direction(s) (Towards)
January	0.20	0.62	East-northeast and South-southwest axis
February	0.19	0.62	
March	0.20	0.61	
April	0.19	0.61	
May	0.20	0.56	
June	0.19	0.61	
July	0.20	0.58	
August	0.20	0.76	
September	0.20	0.62	
October	0.20	0.65	
November	0.19	0.57	
December	0.20	0.71	
Minimum	**0.19**	**0.56**	-
Maximum	**0.20**	**0.76**	

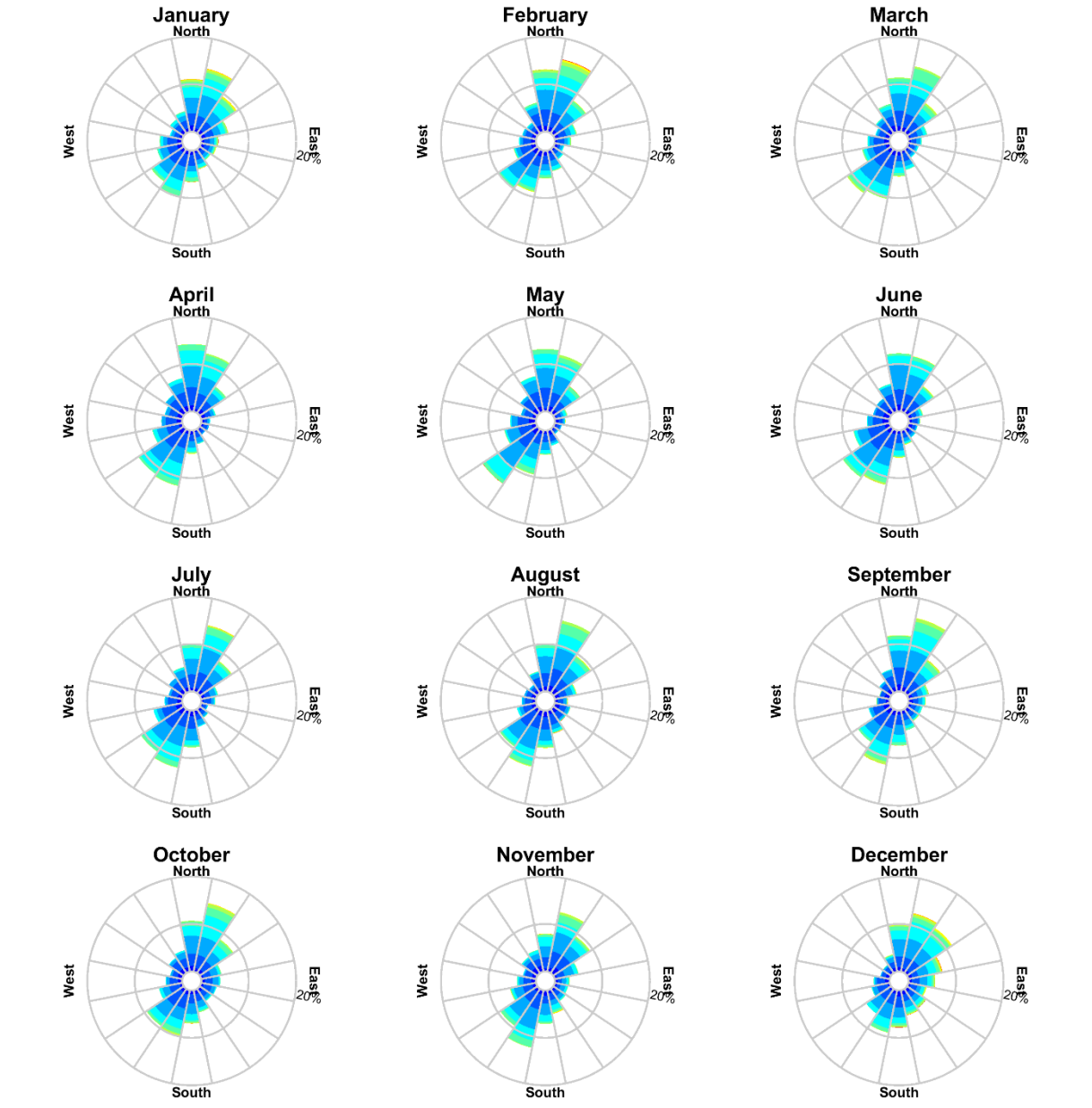

Figure 3.4 Monthly surface current rose distributions nearby the release location, derived from the 2010 to 2019 modelled dataset.

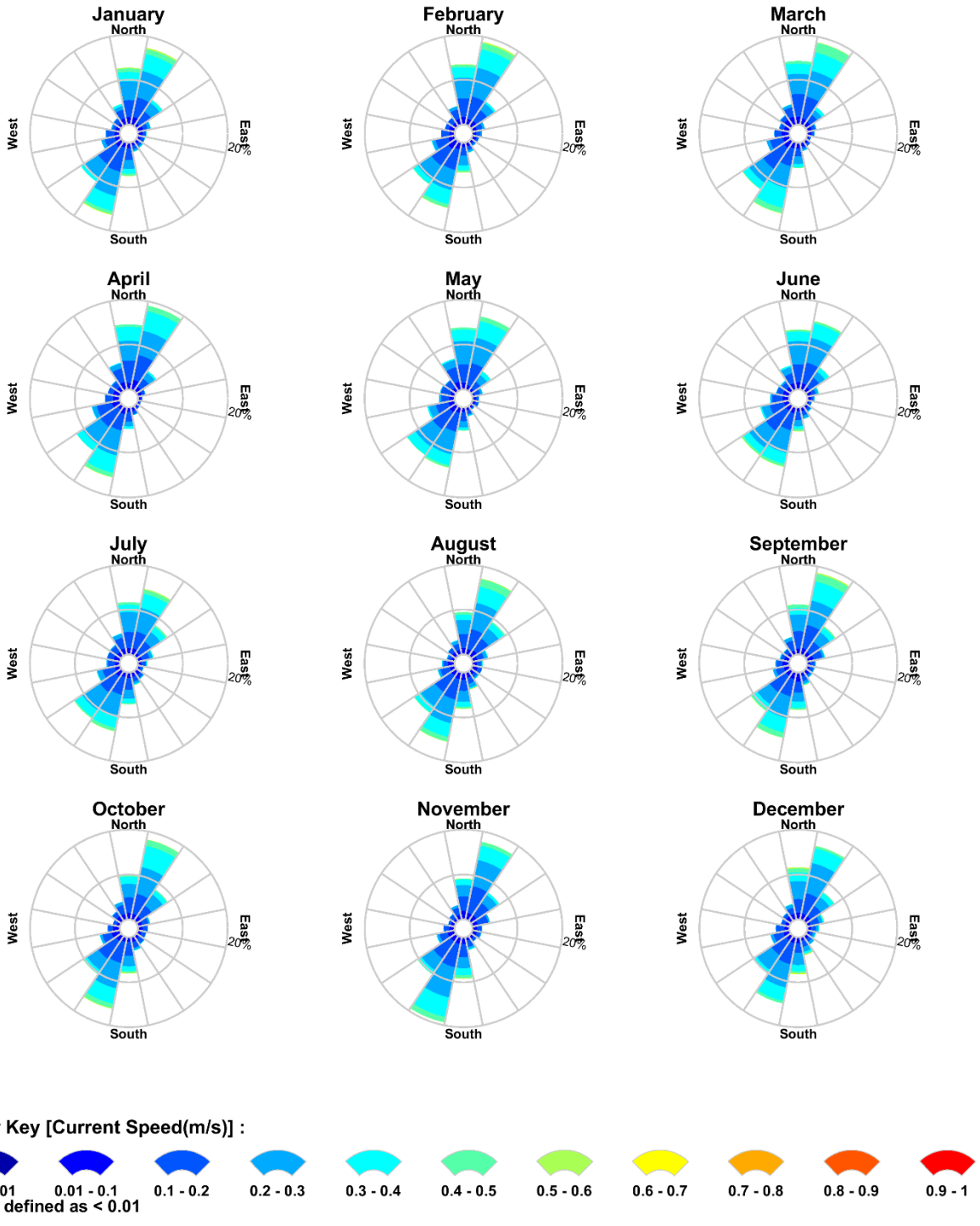

Figure 3.5 Monthly near-bottom current rose distributions nearby the release location, derived from the 2010 to 2019 modelled dataset.

4 WATER TEMPERATURE AND SALINITY

The monthly depth-varying water temperature and salinity profiles nearest to the release location were obtained from the HYCOM dataset (see Section 3.2).

The three-dimensional salinity and temperature datasets are used in the model domain to inform water density in through the water column layers.

Table 4.1 presents the monthly average sea temperature and salinity of the surface and near-bottom layers nearby the release location. Monthly average surface water temperature ranged from 6.4°C (March) to 15.4°C (August). In contrast, near-bottom waters ranged from 6.4°C (March and April) to 8.2°C (January). Salinity remained relatively consistent through the water column ranging between 34.8 psu to 35.0 psu.

Figure 4.1 presents depth profiles of water temperature and salinity nearby the release location.

Table 4.1 Monthly average sea surface temperature and salinity nearby the release location.

Month	Temperature (°C)		Salinity (psu)	
	Surface	Near-bottom	Surface	Near-bottom
January	8.2	8.2	35.0	35.0
February	7.0	7.0	35.0	35.0
March	6.4	6.4	35.0	35.0
April	7.0	6.4	35.0	35.0
May	9.5	6.5	35.0	35.0
June	12.1	6.6	35.0	35.0
July	14.5	6.9	34.9	35.0
August	15.4	6.8	34.8	35.0
September	13.6	6.9	34.8	34.9
October	11.6	7.3	34.8	35.0
November	9.0	7.7	34.9	34.9
December	7.5	7.5	35.0	35.0
Minimum	**6.4**	**6.4**	**34.8**	**34.9**
Maximum	**15.4**	**8.2**	**35.0**	**35.0**

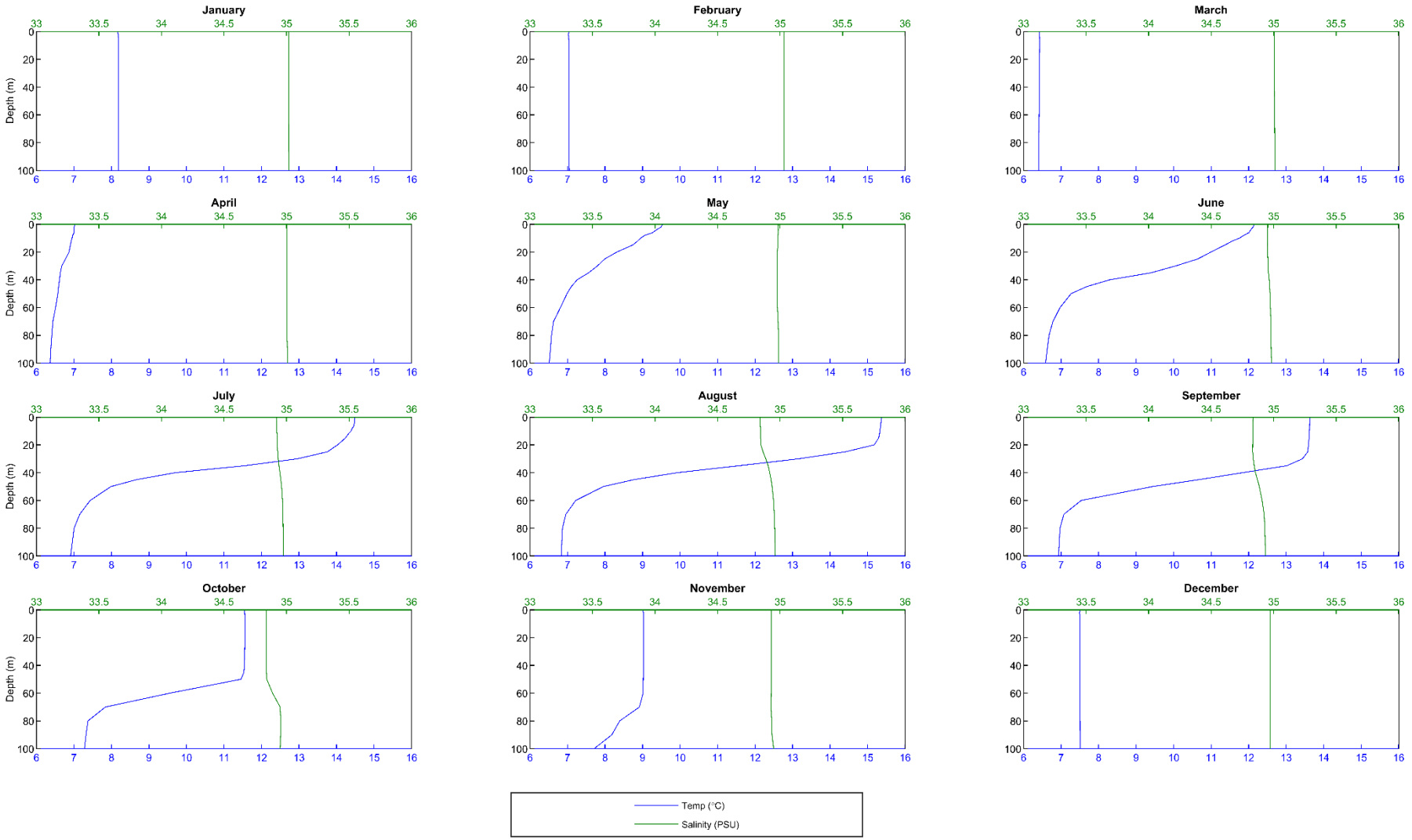

Figure 4.1 Monthly average depth profiles of water temperature and salinity nearby the release location.

5 SEDIMENT DISPERSION MODELLING

5.1 Sediment Dispersion Model Description – MUDMAP

MUDMAP is a three-dimensional plume model used by industry and regulators to aid in assessing the potential environmental effects from operational discharges such as drill cuttings, drilling fluids (muds) and produced water. The model has been applied to hundreds of assessments in over 35 countries.

The far-field calculation (passive dispersion stage) employs a particle-based, random walk procedure. The model predicts the dynamics of the discharge material and resulting seabed concentrations and bottom thicknesses over the near-field (i.e. the immediate area of the discharge) and the far-field (the wider region). Figure 5.1 shows a conceptual diagram of the dispersion and fates of drill cuttings and muds discharge to the ocean and an idealized representation of the three discharge phases.

Settling under currents is selective for particle size, with the larger particles (rock chips to sand) tending to settle quickly, forming a pile that aligns with the predominant current axis. Smaller particles (especially silts and clays) will remain suspended for longer periods and will therefore be dispersed more widely by the ambient current conditions. Dispersion of the finer discharged material will tend to be enhanced with increased current speeds and water depth and with greater variation in current direction over time and depth.

Along with the advanced analyses tools, MUDMAP can simulate six classes of material (or 36 sub-categories), each with unique density and particle-size distribution. During the dispersion stage, the model particles are transported in three-dimensions according to the current data and horizontal and vertical mixing coefficients at each time step according to the governing equations.

MUDMAP has been extensively reported, validated and applied for discharge operations (e.g. Burns et. al., 1999; King and McAllister, 1997, 1998; Spaulding, 1994; Albert and Prosser, 2023).

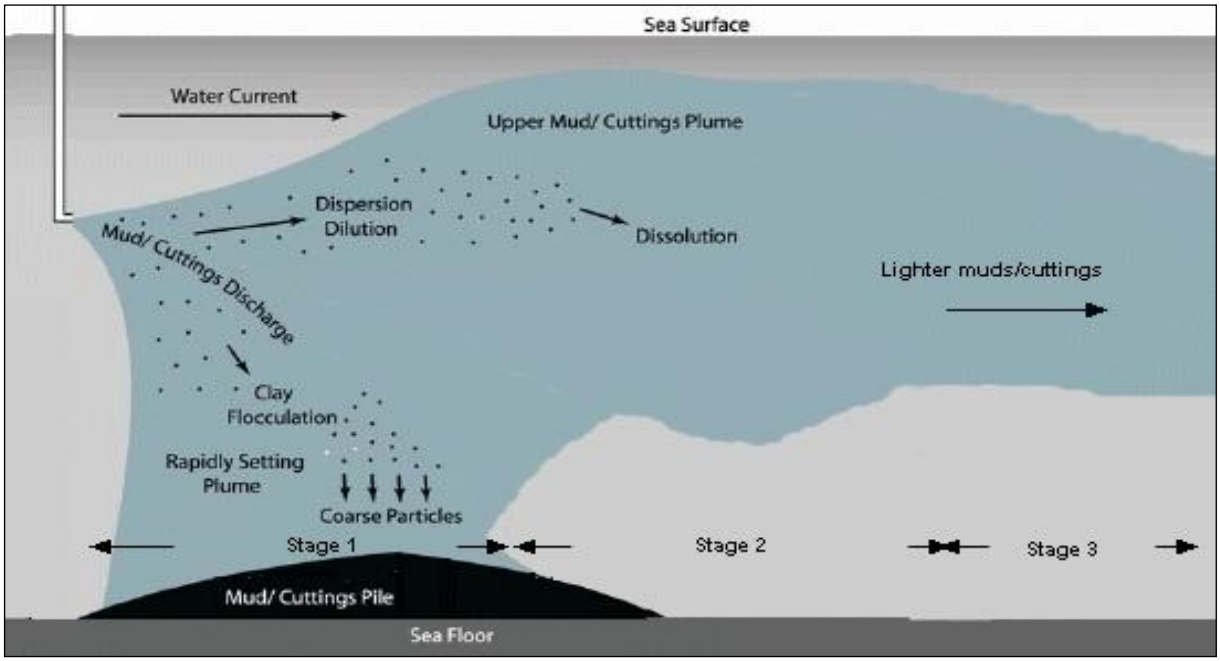

Figure 5.1 Conceptual diagram showing the general behaviour of cuttings and muds following the discharge to the ocean (Neff, 2005) and the idealised representation of the three discharge phases.

5.2 Drilling and Discharge Program

Serica has indicated that a conventional drilling design will be used for the proposed drilling program. The following is the description of the proposed drilling and discharge.

Table 5.1 presents a summary of the estimated discharge of volume of drill cuttings and unrecoverable mud solids for the proposed drilling and discharge program. To account for any unforeseen mechanical or geological issues, a re-spud scenario and contingency sidetrack have been added to the well profile to represent a worst-case scenario.

Drilling of the well will commence with a 36” bore diameter well interval followed by a 26” bore diameter well interval and may require a re-spud scenario. Both well intervals will be drilled using seawater sweeps with the cuttings being returned (discharged) directly to the seafloor (riser-less discharge) over 0.78 days and 4.88 days for the 36” and 26” bore well intervals, respectively.

Following the near-seabed discharge, 17.5”, 17.5” sidetrack, 12.25” (PH), 12.25 (Dev) and 9.5” bore diameter well intervals will be drilled using low-toxicity oil-based muds (LTOBM) which, for the purposes of this study, are assumed to be thermally processed (involving a milling process) on the mobile offshore drilling unit and returned to the sea surface. The cuttings and muds will be discharged from a vertically orientated pipe over 20.74 days (Table 5.1).

Note, the cuttings powder discharged by thermal processing have <1% oil on cuttings (OOC) which complies with Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) hydrocarbon discharge requirements (~0.06% OOC). The milled cuttings and muds solids would be dispersed in the water column and are highly unlikely to form piles on the seabed.

The anticipated total discharge duration per well is 26.4 days.

Table 5.1 Summary of the estimated discharge of volume of drill cuttings and unrecoverable mud solids for each well interval.

Bore Diameter (inches)	Discharge method	Volume of cuttings solids (m^3)	Fluid Type	Volume of muds liquid and solids (m^3)	Volume of solids in the muds (m^3)	Discharge Duration (days)
36	Returned directly to seabed	30	Seawater sweeps	125	12.5	0.39
36 (re-spud)		30		125	12.5	0.39
26		185		670	67	2.44
26 (re-spud)		185		670	67	2.44
17.5	Cuttings and drilling fluid brought to MODU and discharged to the sea surface	105	LTOBM	341	34.1	2.48
17.5 (sidetrack)		105		341	34.1	2.48
12.25 (PH)		107		449	44.9	4.73
12.25 (Dev)		100		441	44.1	5.20
9.5		48		489	48.9	5.85
Total		**895**		**3,651**	**365.1**	**26.4**

5.3 Discharge Input Data

The input data used to setup the dispersion model included:

- Volume and discharge duration of the cuttings and unrecovered muds solids;
- Particle size distributions (PSD) and associated settling velocities of discharged cuttings and unrecoverable muds solids;
- Bulk density of the discharged cuttings and unrecoverable muds solids;
- Temperature and salinity profile of the receiving waters;
- The size and orientation of the discharge pipe;
- The height/depth of the discharge point relative to mean sea level; and
- Depth-varying current data to represent local physical forcing.

Table 5.2 provides a summary of the discharge configuration and the estimated volume of cuttings and muds solids input into the discharge model. Simulations were run for an additional period after the completed discharges to allow sediments to disperse through the water column and potentially deposit on the seafloor (see Table 5.2).

Table 5.2 Input data used for the drill cuttings and muds modelling.

Parameter/description	Kyla
Total volume of cuttings discharged (m^3)	895
Total volume of muds solids discharged (m^3)	365.1
Discharge duration (days) [model duration]	26.4 [29]
Depth of surface discharge (m)	0 (sea surface)
Height of riserless discharge above seafloor (m)	2
Water depth (m)	91
Discharge pipe orientation	Vertically downwards
Number of simulations	100 (randomly selected start simulation dates and times between 2010–2019, inclusive)
Seasonal or Annual assessment	Annual

It is anticipated that well intervals will be drilled using a conventional drilling approach. Model input included particle sizes for cuttings and drilling muds returned to the seafloor varying in diameter between 0.016 mm and 6 mm (Table 5.3). The PSD is representative of data previously used for well intervals drilled using WBM (e.g. Koh & Teh, 2011; IOGP, 2016). The PSD are based on the relative contribution of cuttings and drilling muds discharge volumes. Furthermore, it is assumed that cuttings and LTOBM from the 17.5” to 9.5” well diameter intervals will undergo thermal processing that includes a milling component on the MODU based on Rotomill technology (TWMA, 2024a). Particle sizes and percentage distributions used as model input are reflective of PSD analysis data presented by TWMA (2024b) and are presented in Table 5.4.

It is important to note that grain size has a greater influence on the rate of settling than density (Neff, 2005). The fall velocities for the various size classes were derived from empirical data provided by Dyer (1986).

Table 5.3 Cuttings and muds sediment grain sizes, settling velocities and percentage distributions applicable for each release location.

Class	Grain size (mm)	Settling velocity (cm/s)	Percentage Distributions
Medium cuttings	6	53.62	8.6
	5	49.46	8.6
	2	28.55	8.6
	1	12.73	5.8
	0.5	7.5	5.8
	0.45	6.6	2.9
Light cuttings	0.4	6	2.9
	0.35	5	2.8
	0.3	4	2.8
	0.25	3.1	2.8
	0.2	2.3	2.8
	0.15	1.6	2.8
Very light cuttings	0.1	0.8	2.8
	0.05	0.22	2.8
	0.04	0.15	2.9
	0.03	0.08	2.9
	0.02	0.04	2.9
Drilling mud solids	0.063	0.34	0.4
	0.05	0.22	1.6
	0.035	0.11	3.7
	0.026	0.06	6
	0.02	0.038	7.4
	0.016	0.026	9.4

Table 5.4 Thermal processed cuttings and muds sediment grain sizes, settling velocities and percentage distributions.

Class	Grain size (mm)	Settling velocity (cm/s)	Percentage Distributions
low-toxicity oil-based mud	0.15	1.6	8
	0.063	0.34	10
	0.04	0.15	7
	0.03	0.08	10
	0.02	0.038	5
	0.016	0.026	60

5.4 Grid Configuration

A grid covering a 50 km (longitude, x-direction) by 50 km (latitude, y-direction) region with varying depths was employed. The grid consisted of cells with a horizontal resolution of 50 m to calculate the deposition of drill cuttings and muds on the seabed and a vertical resolution of 10 m to estimate the TSS concentrations.

5.5 Mixing Parameters

The horizontal and vertical dispersion coefficients are used in dispersion modelling to represent the mixing and diffusion processes caused by turbulence, which are sub-grid processes at the scale of the hydrodynamic model drivers. The dispersion coefficients are expressed in units of rate of area change (m^2/s). Increasing the horizontal dispersion coefficient will increase the horizontal spread of the discharge plume and decrease the centreline concentrations. Increasing the vertical dispersion coefficient spreads the discharge further across the vertical layers.

The horizontal turbulent diffusion of the plume is dependent on the hydrodynamic conditions (i.e. wind, wave and current) and the physical scale of the plume compared to the scales of the oceanic processes that disperse the plume. For a plume of approximately 10-100 m width, dispersion occurs primarily through small-scale horizontal swirling motions and vertical mixing, with a horizontal dispersion rate of the order of 0.1 m^2/s. As the plume grows to a scale of 1-10 km, it begins to be subject to mesoscale eddies and horizontal dispersion rate becomes of the order of a few to tens m^2/s.

A horizontal coefficient value of 0.25 m^2/s was used to account for the turbulence as the discharged solids are transported from the release location for the near-bottom discharges. Additionally for the near-bottom discharges a low vertical coefficient value was employed (0.0001 m^2/s). In comparison, sea surface discharges employed horizontal and vertical coefficients of 1.0 m^2/s and 0.001 m^2/s, respectively.

5.6 Reporting Thresholds

The MUDMAP model is capable of predicting sediment deposition and TSS concentrations at levels below ecological relevance. To ensure that model results are both meaningful and interpretable, carefully selected thresholds for reporting are applied. Among the various sensitive marine ecosystems affected by sediment and turbidity stress, corals are recognised as the most vulnerable. Although cold-water corals have not been recorded in this area of the North Sea, by applying thresholds based on coral responses, this assessment adopts a worst-case conservative benchmark that ensures the protection of the most sensitive ecosystem components.

5.6.1 Deposition

Sediment impact is usually assessed by total sedimentation rate (mass of sediment settling per unit area per day), deposition thickness, or both.

Coral species vary widely regarding their tolerance to sediment deposition, ranging from less than 10 mg/cm²/day to over 400 mg/cm²/day (Erftemeijer et al., 2012). A conservative low exposure threshold of 10 mg/cm²/day has been applied for this study (see Table 5.5). Sustained high sedimentation rates of 30 mg/cm²/day (Hodgson, 1990; Browne et al., 2015) and above 100 mg/cm²/day over several weeks can lead to coral smothering, tissue necrosis, and long-term declines in coral cover (MScience, 2011). These impacts result from multiple interacting stressors, including the physical burden of sediments, shading and light limitation, and nutrient and contaminant loads associated with suspended material (Fabricius, 2005).

Accordingly, moderate and high exposure thresholds are set at ≥30 mg/cm²/day and ≥100 mg/cm²/day, respectively, as shown in Table 5.5.

Equivalent sediment thicknesses were calculated based on the anticipated total discharge period of 26.4 days and an assumed in-situ bulk density of 2,600 kg/m³. The low exposure threshold of 10 mg/cm²/day corresponds to approximately 1.0 mm of sediment accumulation over this period. Additionally, moderate and

high exposure thickness thresholds would equate to 3.0 mm to 10.2 mm, respectively. These align with literature findings such as Gilmour (2002), who observed that older corals suffer injury from 2 mm sediment layers applied every two days, with larger polyps showing damage at 5 mm and 10 mm sediment layers. Mesocosm experiments by Trannum et al. (2010) showed that cuttings layers as thin as 3 mm cause gradual community declines over six months in soft-sediment communities.

Table 5.5 Reporting thresholds for sediment deposition for the drill cuttings and unrecoverable muds discharge modelling for the 26.4-day drilling operation.

Impact level	Sedimentation rates (mg/cm²/day)	Equivalent sediment bottom thickness thresholds (mm)^	Notes/Comments
No Impact	<10	–	No measurable effect; natural sediment fluxes tolerated
Low Exposure	10	1.0	Minor effects; some sediment accumulation but corals tolerate
Moderate Exposure	30	3.0	Sub-lethal effects; reduced larval settlement (Babcock & Davies 1991), tissue stress
High Exposure	>100	>10.2	Smothering, mortality risk; long-term coral cover decline

^ Based on anticipated total discharge duration of 26.4 days and assuming final settled in-situ bulk density of 2,600 kg/m^3

5.6.2 TSS Concentration

A fundamental principle in assessing turbidity effects is the relationship between intensity (or TSS concentrations) and duration of exposure (Figure 5.2). High concentrations over a short duration may cause immediate stress or mortality, while prolonged exposures at lower concentrations can generate similar cumulative impacts. To address this relationship, TSS thresholds are expressed using both 1-hour averages (representing acute exposure) and 24-hour averages (representing chronic exposure).

The durations used here are intentionally conservative compared to those reported in experimental studies. Typically, acute effects are measured over periods of 1 to 7 days, while chronic effects are assessed over weeks to months (Brown et al., 2015; Stump et al., 2019). By comparison, this assessment adopts durations of just 1 hour (acute) and 24 hours (chronic), which is more appropriate given the operational context of drill cuttings and mud discharges, where TSS levels can rise sharply within minutes to days, significantly exceeding background levels. By applying shorter durations, the thresholds remain protective and precautionary.

In pristine offshore environments, background TSS levels are typically less than 10 mg/L, whereas naturally turbid nearshore reefs can experience levels exceeding 100 mg/L (Erftemeijer et al., 2012). Studies have shown that short-term spikes between 50 and 100 mg/L can cause acute sub-lethal stress, such as increased mucus production and reduced photosynthesis (Browne et al., 2015; Stump et al., 2019). Chronic exposures between 15 to 50 mg/L are linked to long-term physiological impairment, reduced reproductive success and higher mortality rates (Browne et al., 2015; Erftemeijer et al., 2012). The final reporting TSS thresholds are presented in Table 5.6.

Table 5.6 Reporting thresholds for TSS concentrations for the drill cuttings and unrecoverable muds discharge modelling.

Impact level	Acute Exposure (1-hour averaged concentration) (mg/L)	Chronic Exposure (24-hour averaged concentration) (mg/L)	Notes/Comments
No Impact	<10	<5	Background or natural variability; corals tolerate well
Low Exposure	10	5	Minor physiological stress; corals acclimate to short pulses
Moderate Exposure	50	15	Sub-lethal effects; mucus production, reduced photosynthesis
High Exposure	> 100	> 50	Tissue damage, mortality risk; chronic exposure particularly harmful

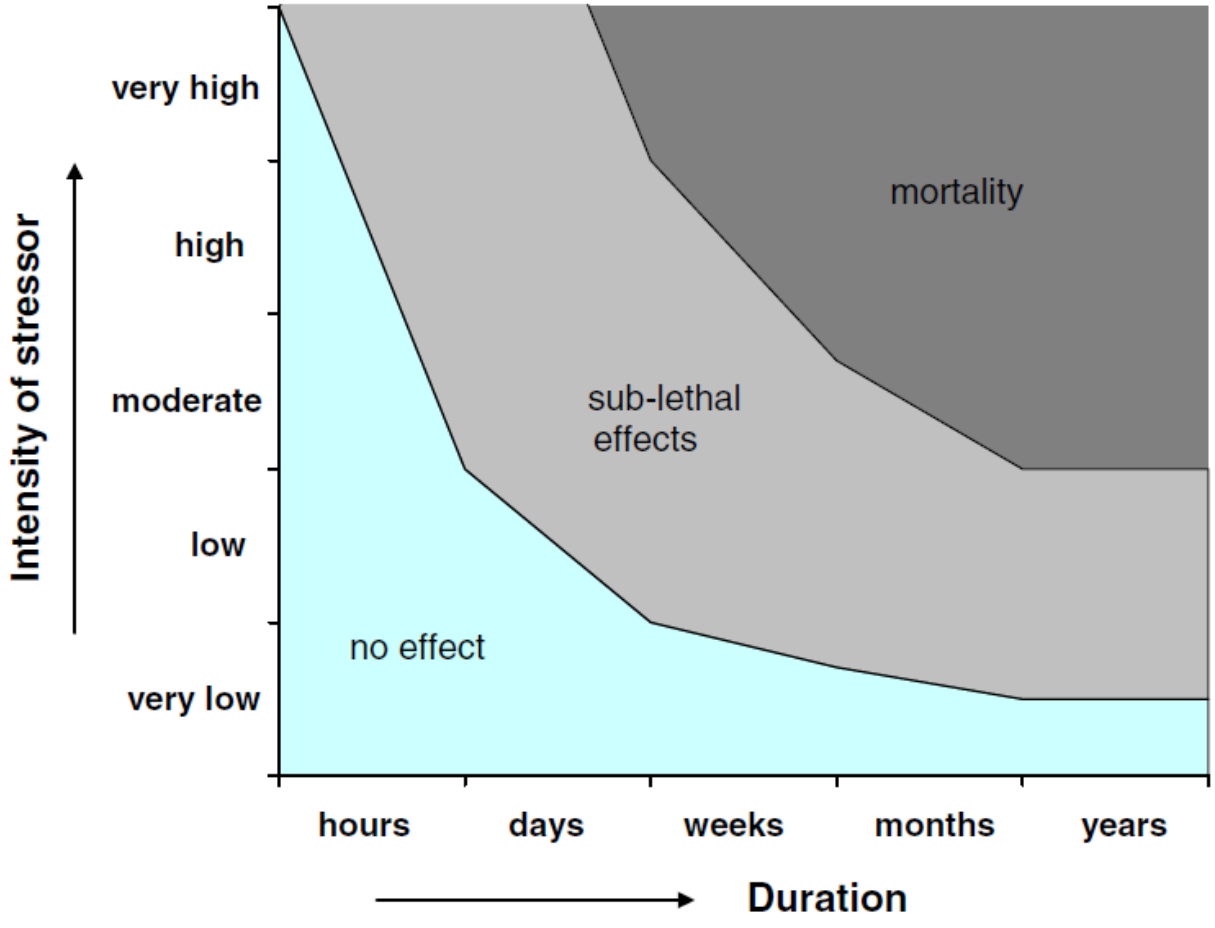

Figure 5.2 Conceptual relationship between the intensity and duration of a stress event and the risk of sublethal and lethal effects on corals. The figure illustrates the general relationship between the magnitude of an increase in turbidity or sedimentation above background levels (vertical axis), how long it lasts (horizontal axis) and the onset of effects on corals (Source: Erftemeijer et al., 2012).

5.7 Analysis of Output

During each individual simulation the MUDMAP model recorded the final mass on the seafloor in each grid cell over the entire model domain. Once all simulations were complete all model outputs were compared to determine the maximum deposition that occurred in each grid cell across all of the runs.

Additionally, during each simulation a timeseries of the TSS concentrations through the water column were recorded at 5-minute intervals within each grid cell. This time series was used to calculate the highest 1-hour moving averaged (acute exposure) and 24-hour moving averaged (chronic exposure) TSS concentrations for the simulation. Thereafter, once all the simulations were run, the moving averages from each individual simulation were compared to determine the maximum acute and chronic exposure concentrations.

It's important to note that the reported TSS concentrations are above background TTS concentrations.

6 Results

6.1 Deterministic Modelling Results

Deterministic modelling (single simulation) results of the near-seabed and near-sea surface discharges for the drilling and discharge program are presented below.

6.1.1 Deposition

Figure 6.1 and Figure 6.2 present model screenshots of the sedimentation rate during the modelled drilling and discharge operation during the near-seabed discharges from a single simulation. The sedimentation rate during the near-surface discharges for the single simulations did not exceed the low exposure threshold of 10 mg/cm²/day, as such no figures are presented.

The model screenshots illustrate the evolution of the deposition. These images have been included to provide an example "snapshot" of the predicted orientation and size of depositional footprint influenced by the time-varying current directions and speeds.

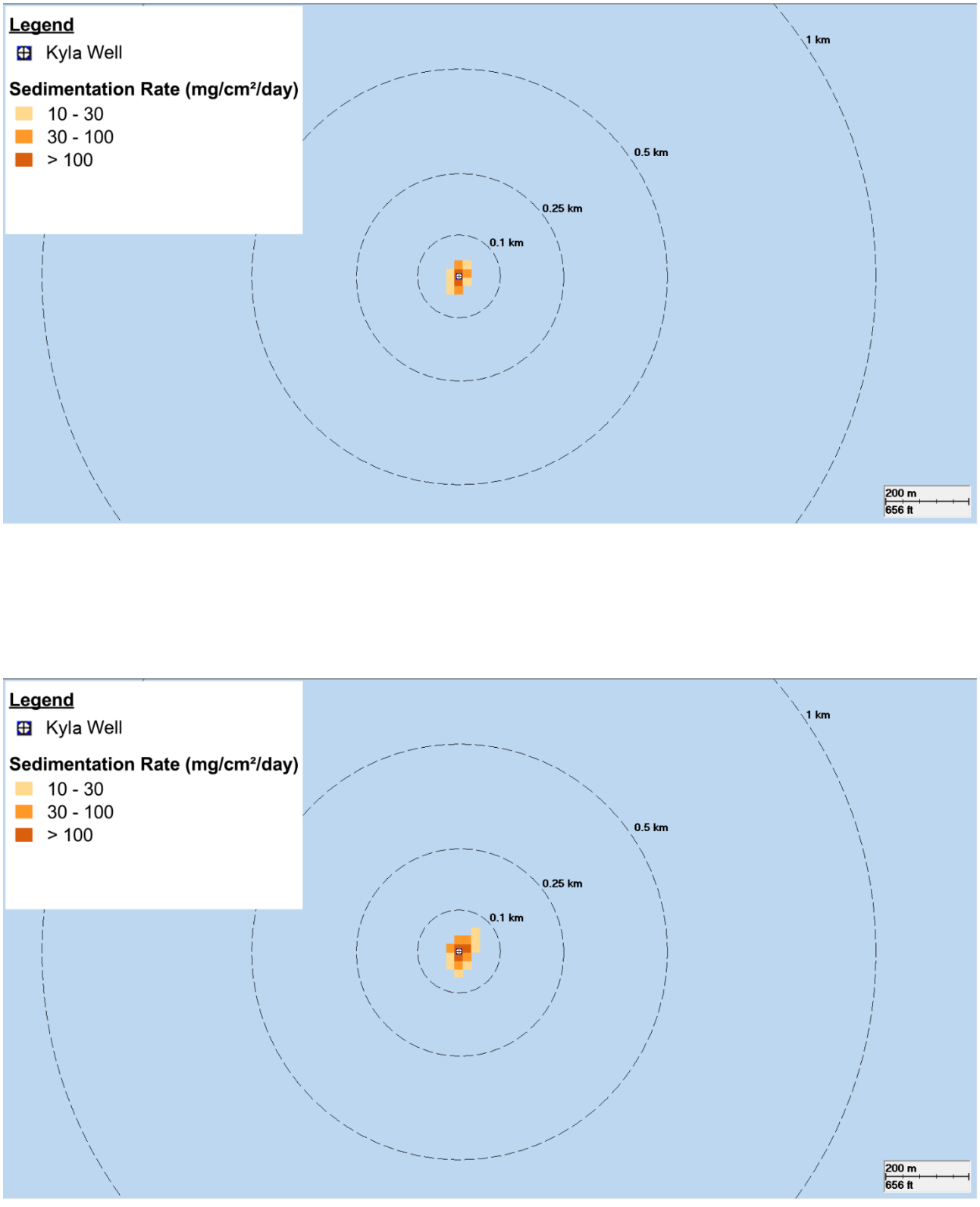

Figure 6.1 **Example plan-view screenshots of the predicted sedimentation rate (in each grid cell) 24 hours (top image) and 48 hours (bottom image) after the commencement of the near-seabed discharges of drilling cuttings and muds. Screenshot results are from 1 simulation of the 100 modelled as part of the study.**

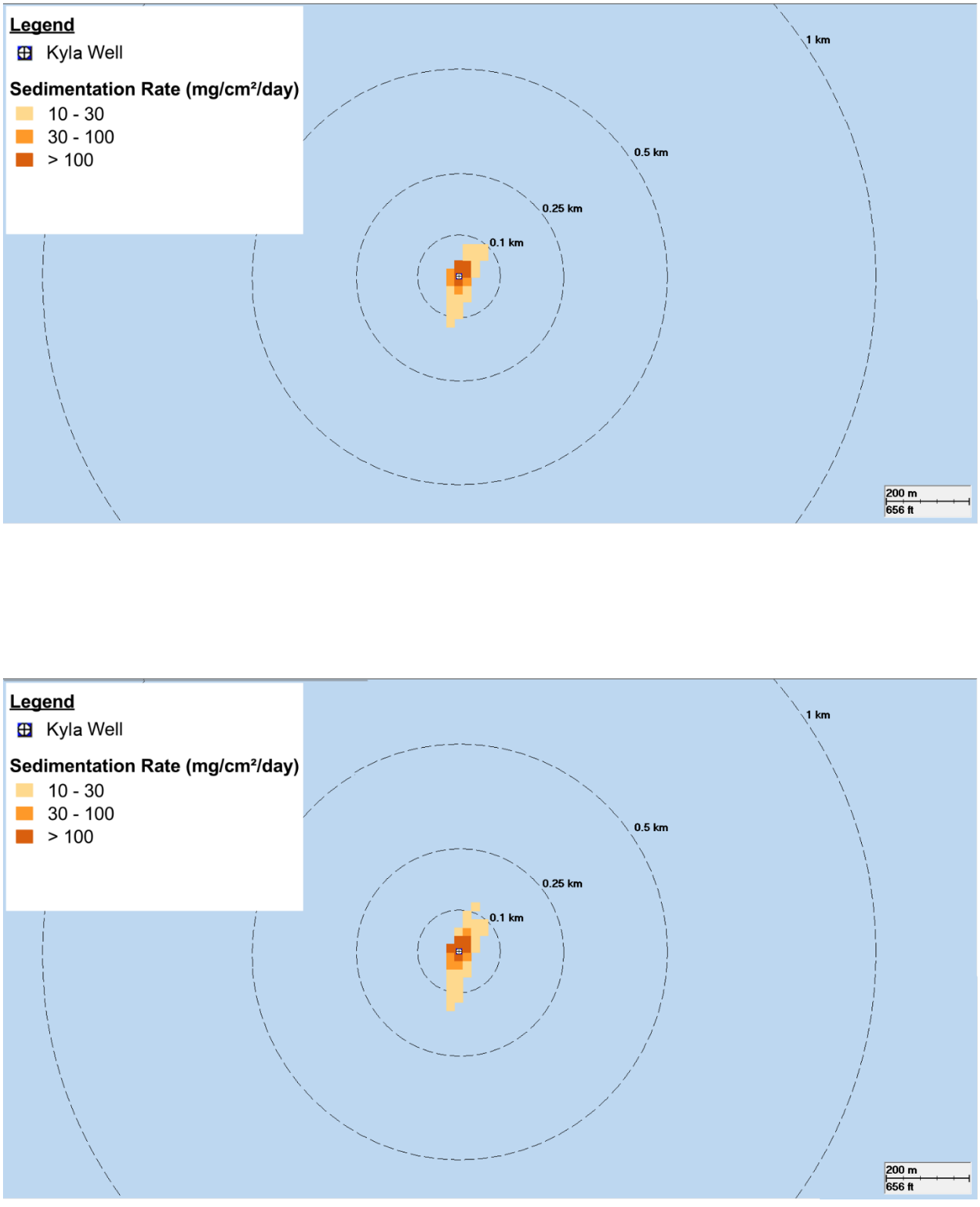

Figure 6.2 **Example plan-view screenshots of the predicted sedimentation rate (in each grid cell) 72 hours (top image) and 96 hours (bottom image) after the commencement of the near-seabed discharges of drilling cuttings and muds. Screenshot results are from 1 simulation of the 100 modelled as part of the study.**

6.1.2 Total Suspended Solids

Figure 6.3 and Figure 6.4 present model screenshots of the TSS concentrations during the modelled drilling and discharge operation during the near-seabed discharges from a single simulation. Additionally, Figure 6.5 and Figure 6.6 present the associated TSS concentration during the near-surface discharges also during a single simulation.

The model screenshots illustrate the dynamic nature of the TSS plume and provide both an aerial (plan) view illustrating the predicted TSS concentrations within the water column (cross section) along a given transect.

These images have been included to provide an example “snapshot” of the predicted orientation and size of the TSS plume influenced by the time-varying current directions and speeds.

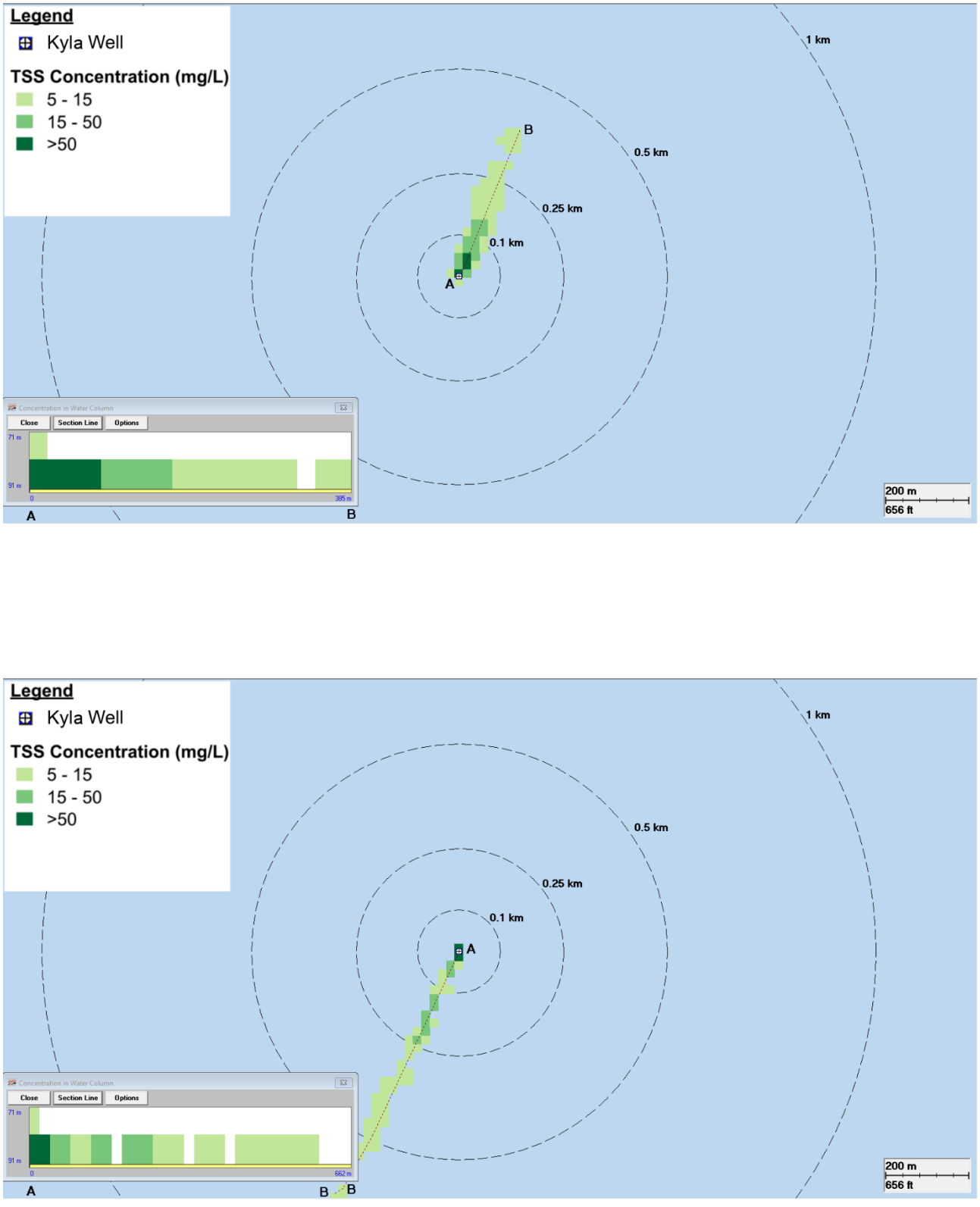

Figure 6.3 Example plan-view and water column (cross section) screenshots of the predicted TSS concentrations (in each grid cell) 3 hours (top image) and 6 hours (bottom image) after the commencement of the near-seabed discharges of drilling cuttings and muds. Screenshot results are from 1 simulation of the 100 modelled as part of the study.

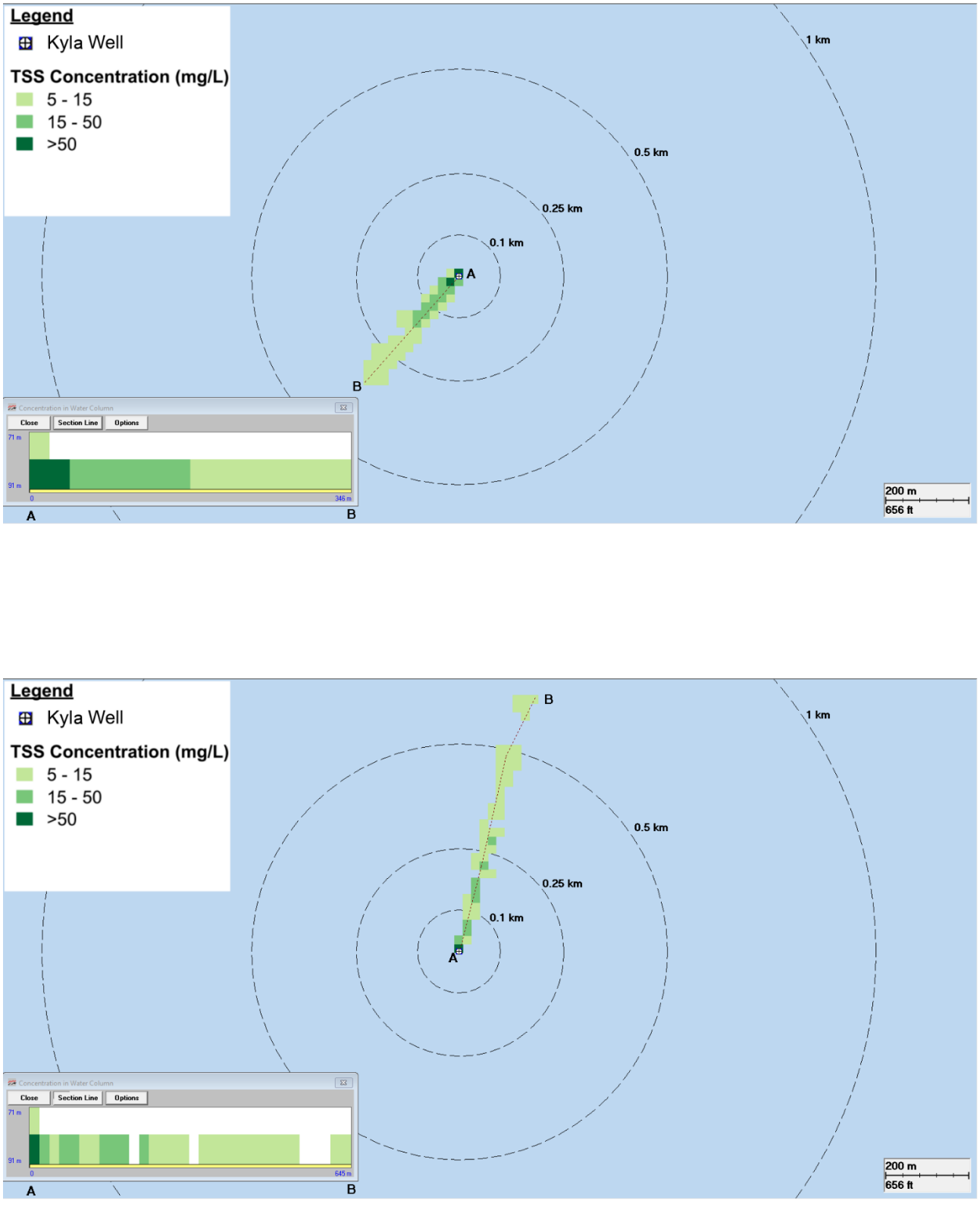

Figure 6.4 Example plan-view and water column (cross section) screenshots of the predicted TSS concentrations (in each grid cell) 9 hours (top image) and 12 hours (bottom image) after the commencement of the near-seabed discharges of drilling cuttings and muds. Screenshot results are from 1 simulation of the 100 modelled as part of the study.

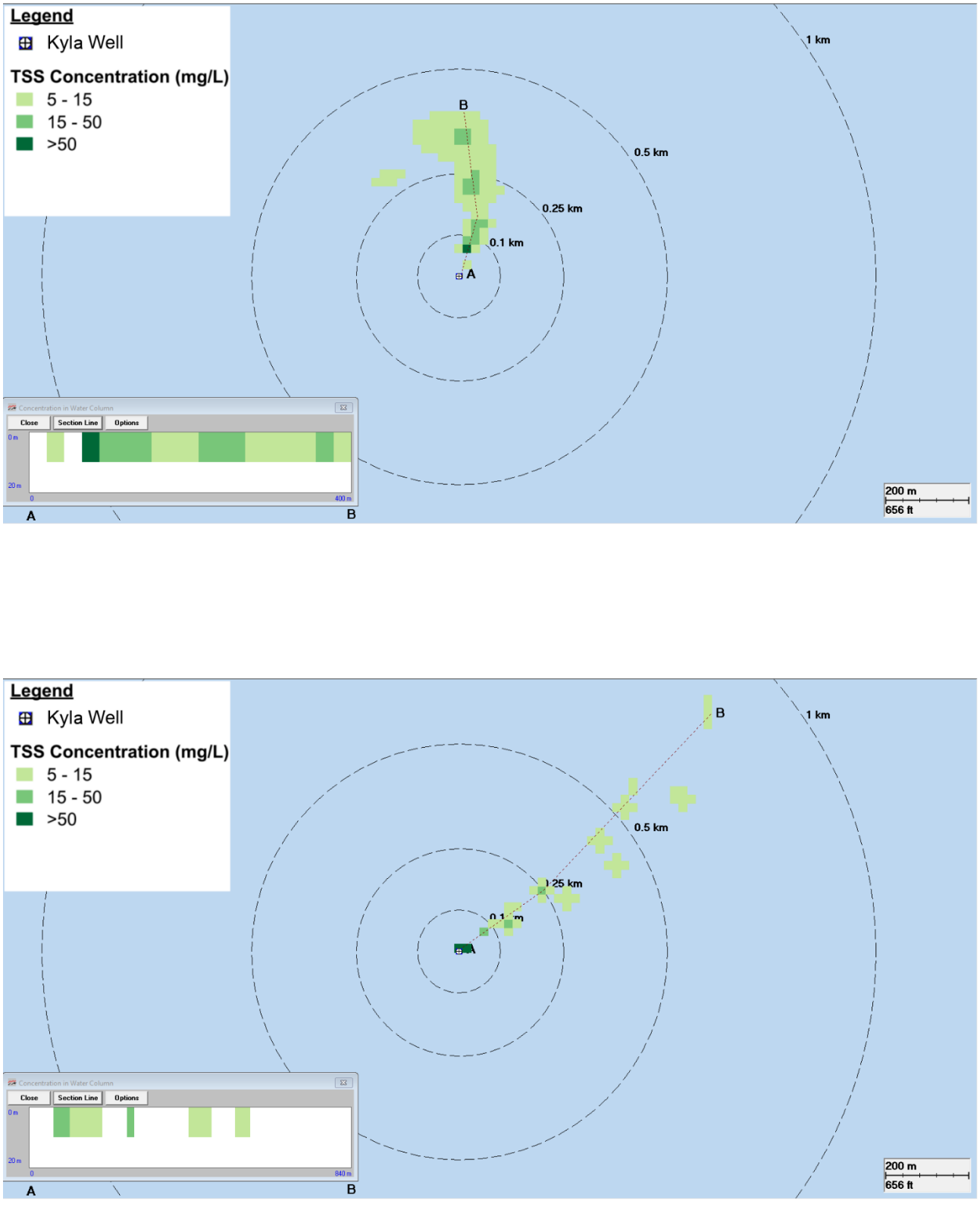

Figure 6.5 Example plan-view and water column (cross section) screenshots of the predicted TSS concentrations (in each grid cell) 3 hours (top image) and 6 hours (bottom image) after the commencement of the surface discharges of drilling cuttings and muds. Screenshot results are from 1 simulation of the 100 modelled as part of the study.

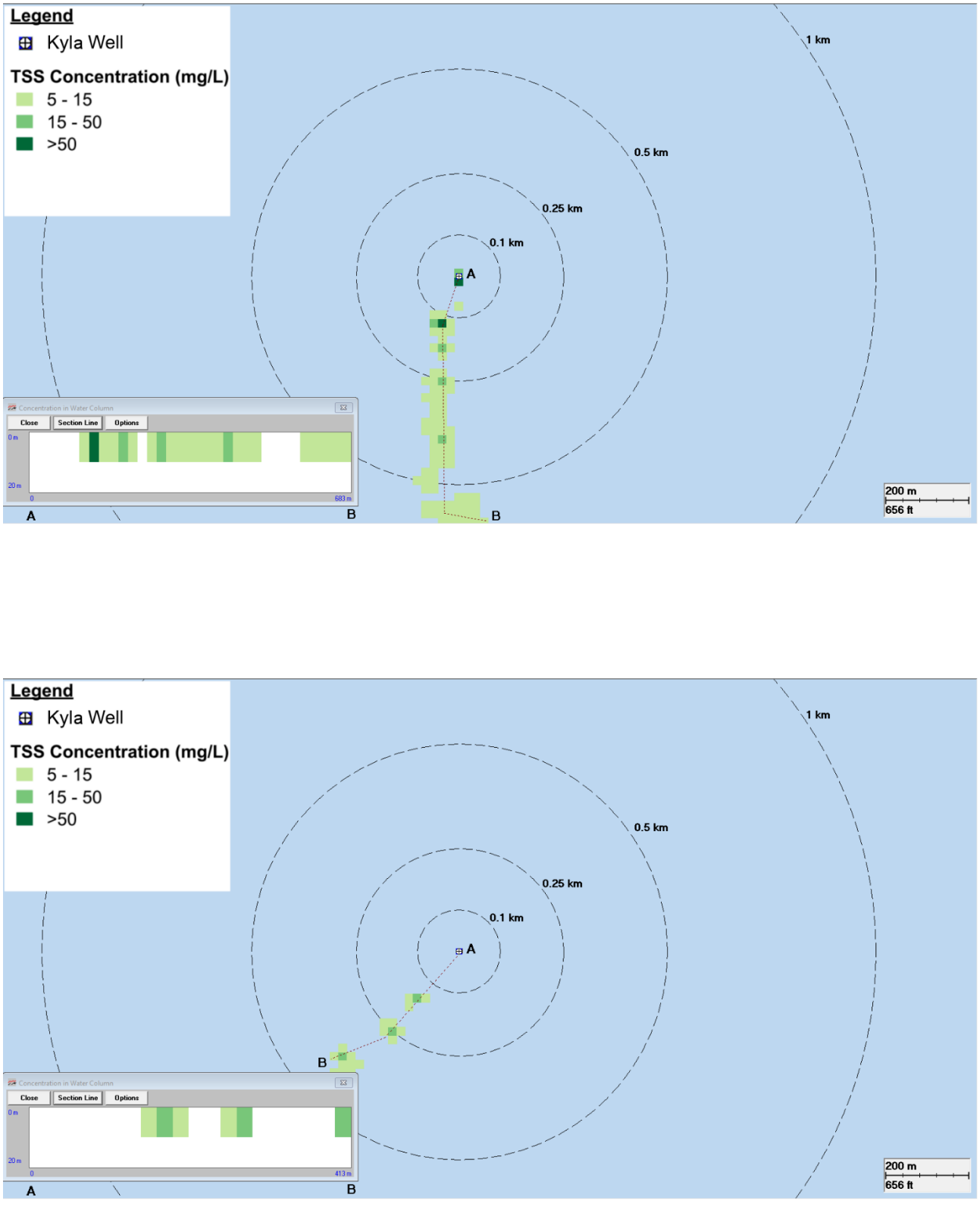

Figure 6.6 Example plan-view and water column (cross section) screenshots of the predicted TSS concentrations (in each grid cell) 9 hours (top image) and 12 hours (bottom image) after the commencement of the surface discharges of drilling cuttings and muds. Screenshot results are from 1 simulation of the 100 modelled as part of the study.

6.2 Stochastic Modelling Results

6.2.1 Deposition

Figure 6.7 presents the maximum sedimentation rates and equivalent total bottom thickness in each grid cell from all simulations (100 per release location) to define the potential exposure from the discharge of cuttings and muds for the proposed drilling program, to define the potential exposure from the discharge of cuttings and muds for the modelled discharge program.

The maximum predicted thickness of deposited cuttings and muds was predominantly associated with the drilling of the 36- and 26-inch bores, which were returned directly to seafloor from a discharge height of 2 m above the seafloor. A maximum thickness of 0.57 m was predicted within 50 m of the discharge location.

Table 6.1 summarise the total area of coverage and the maximum distances from the release location for each sedimentation rate (and equivalent total bottom thickness) of 10 mg/cm²/day (1.0 mm), 30 mg/cm²/day (3.0 mm) and 100 mg/cm²/day (10.2 mm; Table 6.1) for the modelled 26.4-day discharge program.

Based on the assessment of 100 simulations the maximum distances from the release location to the edge of the low exposure (10 mg/cm²/day [1.0 mm]) , moderate exposure (30 mg/cm²/day [3.0 mm]) and high exposure (100 mg/cm²/day [10.2 mm]) thresholds were 0.33 km, 0.15 km and 0.06 km, respectively.

The total area of coverage for the low exposure threshold, or greater, was 0.12 km^2 (Table 6.1).

Table 6.1 Predicted areas of coverage and maximum distances from the release location for each reporting threshold based on the results of all 100 simulations.

Annual assessment			
Sedimentation rate (mg/m^2/day)	**Equivalent total sediment bottom thickness* (mm)^**	**Total area of coverage (km^2)**	**Maximum distance (km) from the release location**
10	1.0	0.12	0.33
30	3.0	0.02	0.15
100	10.2	0.01	0.06

* Based on anticipated total discharge duration and assuming final settled in-situ bulk density of 2,600 kg/m^3

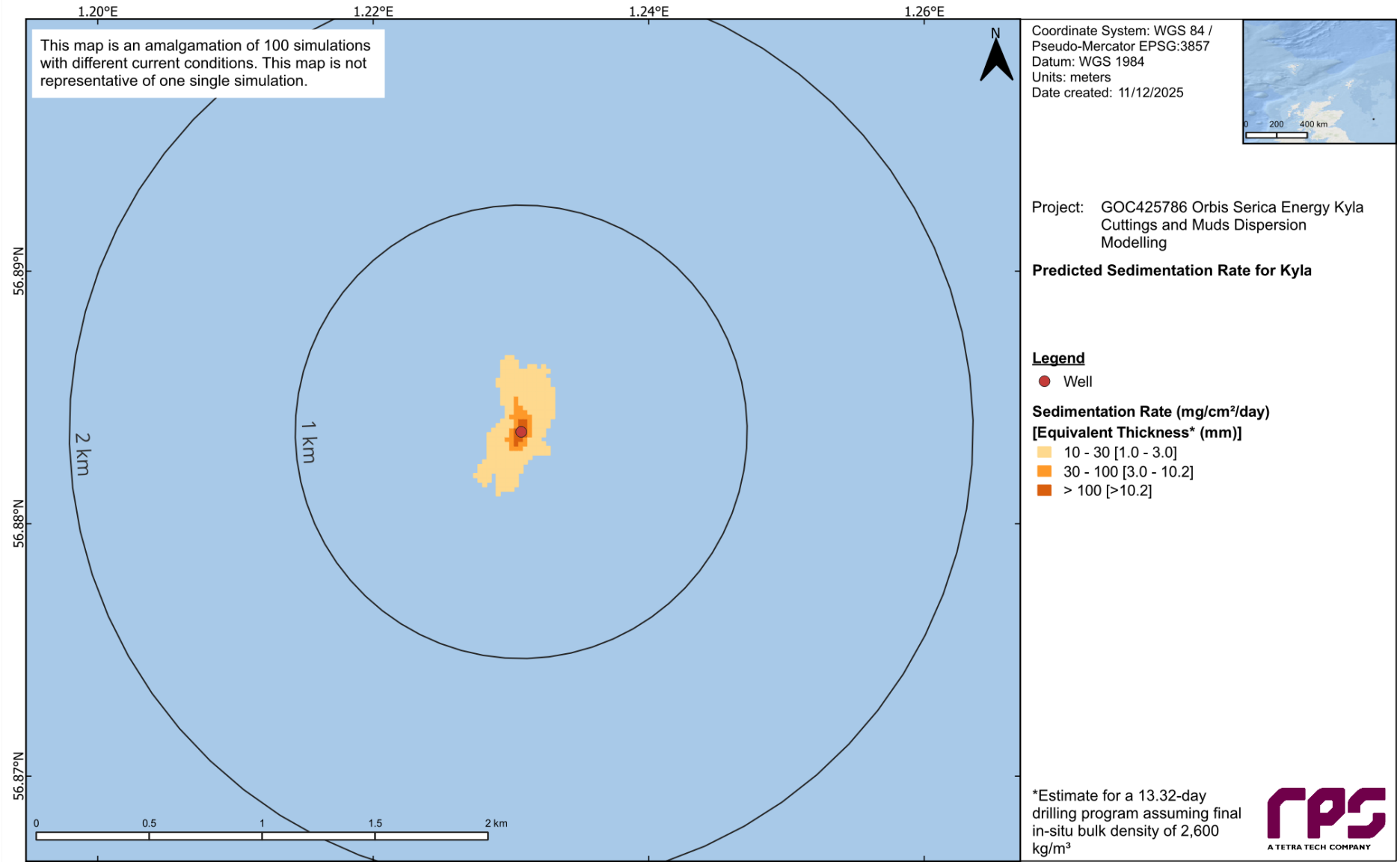

Figure 6.7 Predicted maximum sedimentation rate and equivalent thickness from the discharge of drill cuttings and muds. Results are based on 100 simulations and represent annual conditions.

6.2.2 Total Suspended Solids

Figure 6.8 and Figure 6.9 illustrate the maximum moving average concentrations computed over 1-hr and 24-hr in each grid cell from all 100 simulations, representing acute and chronic exposures respectively, to define the potential exposure from the discharge of cuttings and muds.

Table 6.2 summarises the total area of coverage and maximum distances from the release location for each TSS concentration threshold based on acute and chronic exposures.

Based on the assessment of 100 simulations, the maximum distance from the release location to the edge of the low exposure TSS concentration threshold (10 mg/L) for acute exposure (1-hr averaged concentration) was 1.02 km. Additionally, the maximum distance from the release location to the edge of the moderate exposure TSS concentration threshold (50 mg/L) for acute exposure (1-hr averaged concentration) was 0.27 km. High exposure (100 mg/L) TSS concentrations did not exceed 0.27 km from the release location. The total area of coverage for the low exposure threshold, or greater, was 1.19 km^2 (Table 6.2).

The maximum distance from the release location to the edge of the low exposure TSS concentration threshold (5 mg/L) for chronic exposure (24-hr averaged concentration) was 0.41 km. Additionally, the maximum distance from the release location to the edge of the chronic moderate exposure TSS concentration threshold (15 mg/L) was 0.19 km. Chronic high exposure (50 mg/L) TSS did not exceed 0.08 km from the release location. The total area of coverage for the low exposure threshold was 0.16 km^2 (Table 6.2).

The discharge of cuttings and muds will lead to relatively short-lived increased TSS concentrations of typically up to 24 hours, which are expected to dilute and reduce with distance from the release location to concentrations below the reporting thresholds. Based on the temporary elevated concentrations of TSS concentrations at the low exposure threshold, and the limited occurrence of the very localised high exposure, the impact likelihood is thus considered low.

Table 6.2 Predicted total areas of coverage and maximum distances to acute and chronic exposure from the release location to each reporting threshold based on the results of all 100 simulations.

	Annual	
Reporting threshold (mg/L)	**Total area of coverage (km^2)**	**Maximum distance (km) from the release location**
	Acute Exposure (1-hr averaged concentration)	
10	1.19	1.02
50	0.10	0.27
100	0.08	0.27
	Chronic Exposure (24-hr averaged concentration)	
5	0.16	0.41
15	0.05	0.19
50	0.01	0.08

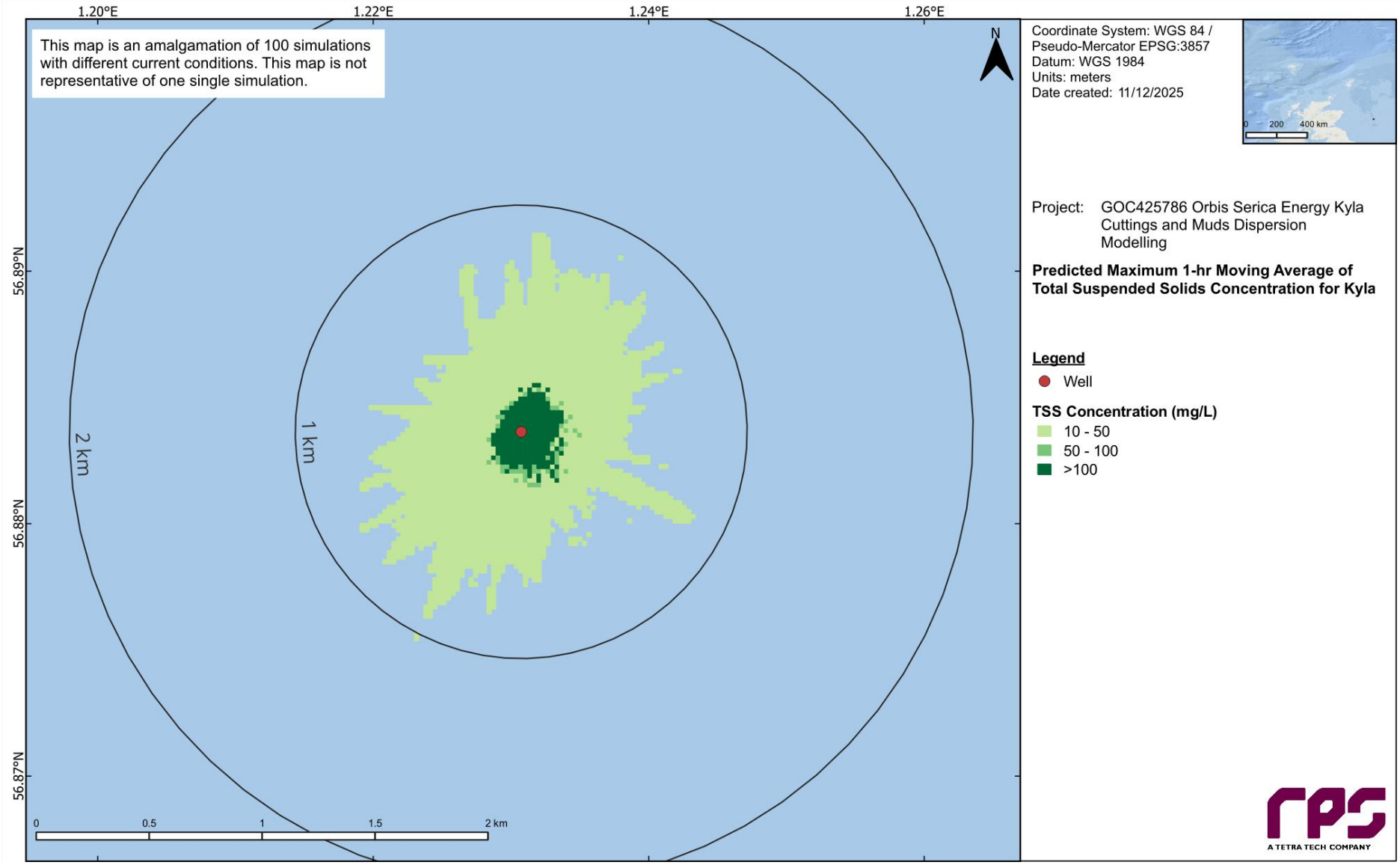

Figure 6.8 Predicted maximum 1-hr moving average of TSS concentrations, representing acute exposure, from the discharge of drill cuttings and muds. Results are based on 100 simulations and represent annual conditions.

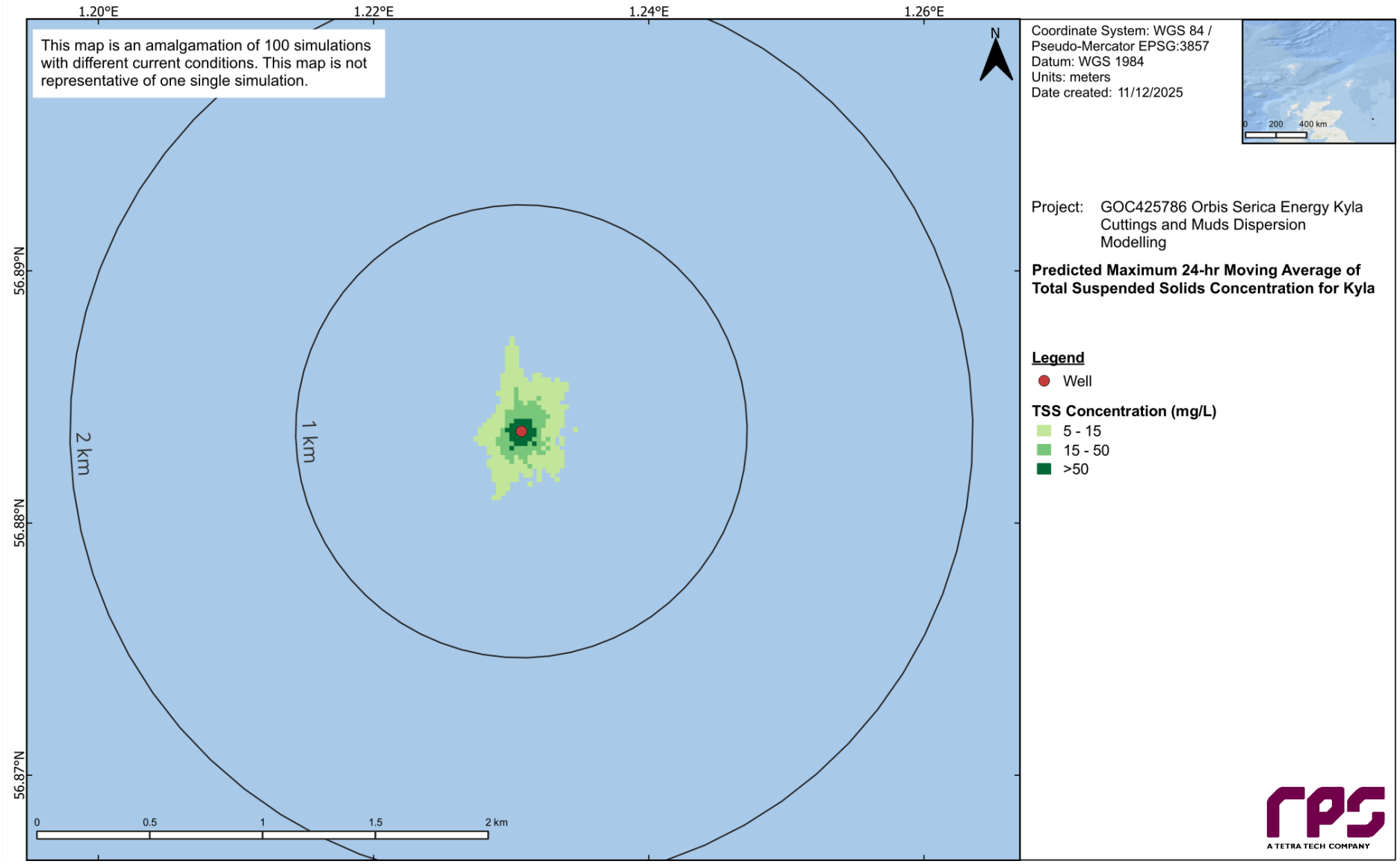

Figure 6.9 Predicted maximum 24-hr moving average of TSS concentrations, representing chronic exposure, from the discharge of drill cuttings and muds. Results are based on 100 simulations and represent annual conditions.

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APPENDIX D:
Underwater Noise Modelling

Subsea Piling in the Kyle Oil Field (UKCS Block 29/2c): Underwater Noise Modelling Assessment

[redacted]

31st October 2025

Subacoustech Environmental Report No.
P435R0101

[redacted]

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This report is a controlled document. The report documentation page lists the version number, record of changes, referencing information, abstract and other documentation details.

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Executive Summary

An assessment of the likely effect of underwater noise on marine mammals and fish from planned offshore piling at the Kyle Oil Field (UKCS Block 29/2c) in the North Sea has been undertaken by Subacoustech Environmental Ltd. The assessment covers the noise generated from impact piling of a valve skid structure. Detailed numerical modelling of the works was used to generate noise contours, which were then used to predict the likely ranges to the relevant noise exposure criteria for marine mammals and fish.

The results have been interpreted using the guidelines provided in Southall *et al.* (2019) for marine mammals and Popper *et al.* (2014) for fish. These interpretations are based on worst-case parameters with no implemented mitigation measures.

It is predicted that marine mammals such as harbour porpoise would need to be 20 m from the impact piling operation during piling at maximum energy to exceed the permanent auditory injury criteria, with smaller ranges for other species of marine mammal. For fish, it is unlikely that noise from impact piling will cause injury at ranges greater than 10 m when considering a fleeing receptor. However, fish with swim bladders involved in their hearing (e.g., cod, sprat and shad) are at risk of mortality if they remain within 180 m of the piling for the full 8-hour installation period.

Note that the modelling calculations and predicted impact ranges will produce results that should be considered indicative of the onset of effects on receptors during the works and should not be considered as absolute ranges.

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Terminology

Cumulative Sound Exposure Level (SEL_{cum} or $L_{E,p,t}$)	Single value for the collected, combined total of sound exposure over a specified time or multiple instances of a noise source.
Decibel (dB)	A customary scale commonly used (in various ways) for reporting levels of sound. The dB represents a ratio/comparison of a sound measurement (e.g., sound pressure) over a fixed reference level. The dB symbol is followed by a reference value (e.g., re 1 µPa).
Level of the Peak Sound Pressure (SPL_{peak} or $L_{p,pk}$)	The highest (zero-peak) positive or negative sound pressure, in decibels.
Peak pressure	The highest pressure above or below ambient that is associated with a sound wave.
Peak-to-peak pressure	The sum of the highest positive and negative pressures that are associated with a sound wave.
Permanent Threshold Shift (PTS)	Noise threshold that represents the onset level of a permanent impairment hearing caused by acoustic trauma. PTS results in irreversible damage to the sensory hair cells of the ear, and thus a permanent reduction of hearing acuity.
Root Mean Square (RMS)	The square root of the arithmetic average of a set of squared instantaneous values. Used for presentation of an average sound pressure level.
Sound Exposure Level (SEL or $L_{E,p,t}$)	The constant sound level acting for one second, which has the same amount of acoustic energy, as indicated by the square of the sound pressure, as the original sound. It is the time-integrated, sound-pressure-squared level, and is typically used to compare transient sound events having different time durations, pressure levels, and temporal characteristics.
Single Pulse Sound Exposure Level, (SEL_{sp} or $L_{E,p,sp}$)	Calculation of the sound exposure level representative of a single noise impulse, typically a pile strike.
Sound Pressure Level (SPL or L_p)	The sound pressure level is an expression of sound pressure using the decibel (dB) scale; the standard frequency pressures of which are 1 µPa for water and 20 µPa for air.
Temporary Threshold Shift (TTS)	Onset threshold level for a temporary reduction of hearing acuity caused by exposure to sound over time.
Unweighted sound level	Sound levels which are “raw” or have not been adjusted in any way, for example to account for the hearing ability of a species.
Weighted sound level	A sound level which has been adjusted with respect to a “auditory weighting function” or “weighting envelope” in the frequency domain, typically to make an unweighted level relevant to a particular species.

Units

dB	Decibel (sound pressure)
Hz	Hertz (frequency)
kg	Kilogram (mass)
kgm^{-3}	Kilogram per metre squared (density)
kJ	Kilojoule (energy)
kHz	Kilohertz (frequency)
km	Kilometre (distance)
km^2	Square kilometres (area)
m	Metre (distance)
mms^{-1}	Millimetres per second (particle velocity)
ms^{-1}	Metres per second (speed)
Pa	Pascal (pressure)
Pa^2s	Pascal squared seconds (acoustic energy)
µPa	Micropascal (pressure)

Acronyms

BGS	British Geological Survey
EIA	Environmental Impact Assessment
EMODnet	European Marine Observation and Data Network
GIS	Geographic Information System
HF	High-Frequency Cetaceans
LF	Low-Frequency Cetaceans
NMPi	National Marine Plan Interactive
NPL	National Physical Laboratory
PCW	Phocid Carnivores in Water
PPV	Peak Particle Velocity
PTS	Permanent Threshold Shift
RMS	Root Mean Square
SE	Sound Exposure
SEL ($L_{E,p}$)	Sound Exposure Level
SEL_{cum} ($L_{E,p,t}$)	Cumulative Sound Exposure Level
SEL_{ss} ($L_{E,p,ss}$)	Single Strike Sound Exposure Level
SPL (L_p)	Sound Pressure Level
SPL_{peak} ($L_{p,pk}$)	Peak Sound Pressure Level
$SPL_{peak\text{-}to\text{-}peak}$ ($L_{p,pk\text{-}pk}$)	Peak-to-peak Sound Pressure Level
SPL_{RMS} ($L_{p,RMS}$)	Root Mean Square Sound Pressure Level
TTS	Temporary Threshold Shift
VHF	Very High-Frequency Cetaceans

1 Introduction

1.1 Project Overview

On behalf of Serica Energy Chinook Ltd (Serica), Orbis Energy Ltd have requested underwater noise modelling covering the noise related to offshore piling works at the Kyle Oil Field, located in UKCS Block 29/2c in the central North Sea.

Kyle is a ceased-production oil field located approximately 182 km to the southeast of Peterhead on the Scottish coastline. As part of the re-development project, Serica plan to install a piled valve skid structure at the proposed Kyle drill centre. A total of two valve skid structures are proposed to be installed, each with four piles per structure, installed via subsea impact piling. The potential noise and impacts on relevant marine fauna in the region from these works has been assessed using underwater noise modelling.

This report provides the results and findings of the detailed modelling assessment of the impact piling activities. The modelling has been used to predict the sound generated during these activities, and to assess the impact of these levels on sensitive marine species in the region, with particular focus on marine mammals and fish.

1.2 Study Area

The location of one of the skid structures, where the piling will take place, is marked in Figure 1-1, which has been used for this modelling. The modelling extent covers a 100 km × 100 km area around this location. Within the modelling extent, the bathymetry shows similar water depths throughout, with several strips of very deep water found to the west and southwest, reaching depths of up to 174 m.

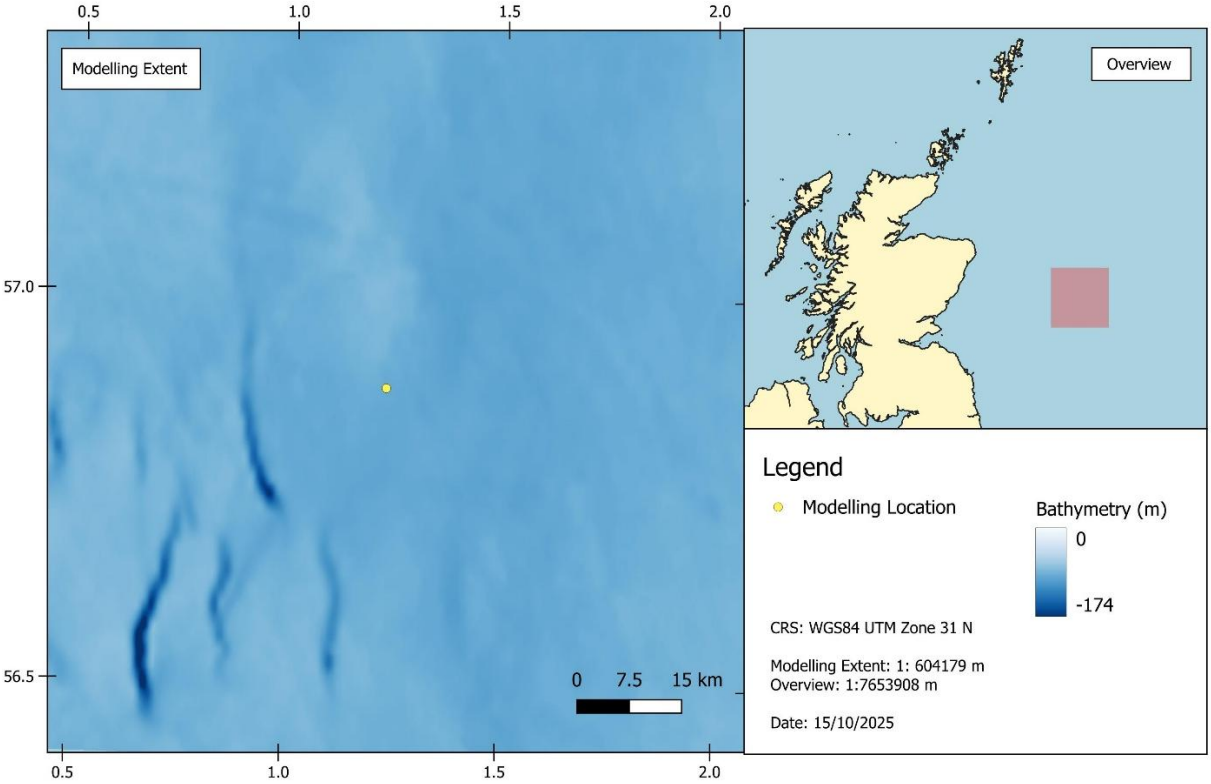

Figure 1-1: Overview of the modelling extent, including the location of the works which generates the noise source (modelling location) in the North Sea.

1.3 Noise Sources

A total of eight subsea piles are proposed to be installed across two skid structures (four subsea piles per structure). Each pile is estimated to take two hours to install, with a total of eight hours piling per day across a two-day period. A soft start is also included. The following details have been provided:

- Pile size: 0.61 m (24-inch) diameter x 24 m length, installed to a depth of 20 m.
- Maximum hammer blow energy: 90 kJ.
- Maximum blow rate: 50 blows per minute.
- Soft start with a ramp up from 30% energy to full energy over 5 minutes, with a reduced blow rate of 6 strikes per minute.

Impact piling has been identified as the only noise generating activity associated with the works. Details of the input parameters used for modelling this noise source in this assessment are presented in Section 3.1.5.

1.4 Document Overview

This report presents a detailed assessment of the potential underwater noise from the impact piling activities in the central North Sea, and covers the following:

- Section 2: Review of background information on measuring and assessing underwater noise.
- Section 3: Discussion of the modelling approach, input parameters and assumptions for the noise modelling undertaken.
- Section 4: Presentation of detailed subsea noise modelling and interpretation of the results using suitable noise metrics and criteria.
- Section 5: Summary and conclusions.

2 Underwater Noise Concepts

Sound travels much faster in water (approximately 1,500 ms^{-1}) than in air (343 ms^{-1}) as water is relatively incompressible and has a higher density than air. This affects the way in which sound measurements are expressed between the two mediums, which means that underwater sound levels are not directly comparable to airborne sound levels. This is noted for context; this report does not contain or include any reference to airborne sound levels.

2.1 Units of Measurement

Sound measurements are usually expressed using the decibel (dB) scale, which is a logarithmic measure of sound. The dB scale represents a ratio, and therefore, it is used with a reference unit, which is the base from which the ratio is expressed. The fundamental definition of the dB scale is given in Equation 1:

(1)

$$Sound\ pressure\ level\ (L_p) = 20 \log_{10}\left(\frac{P}{P_{ref}}\right)$$

where P is pressure, measured in Pascals (Pa), and P_{ref} is the reference pressure, given as 1 µPa (1x10^{-6} Pa) as defined in ISO 18405:2017 for underwater noise. Noise can be quantified using various metrics depending on the nature of the sound, as discussed below.

2.1.1 Sound Pressure Level

Sound Pressure Level (SPL or L_p) is a measure of the pressure variation caused by sound waves, expressed in decibels (dB), as seen in Equation 1. Variations of L_p are used depending on the noise source being measured. Unless otherwise defined, all L_p noise levels in this report are referenced to 1 µPa.

2.1.1.1 Level of the Mean Squared Sound Pressure

For continuous, non-impulsive noise sources such as drilling or vibropiling, an unweighted sound pressure level, averaged over a measurement period, known as a root mean squared (RMS) sound pressure level (SPL_{RMS} or $L_{p,RMS}$), can be used to represent the noise levels. The RMS period must be specified (e.g. $L_{p,RMS(125ms)}$), as the mean level can vary significantly depending on the measurement duration.

2.1.1.2 Level of the Peak Sound Pressure

Transient, impulsive pressure waves, such as generated from impact piling, are usually expressed using level of the peak sound pressure (SPL_{peak} or $L_{p,pk}$). This is calculated using the maximum pressure variation from positive to zero, representing the peak change in pressure as the transient wave propagates. A further variation of this is the peak-to-peak sound pressure level ($SPL_{peak\text{-}peak}$ or $L_{p,pk\text{-}pk}$) which considers the maximum pressure variation from positive to negative. For a symmetrically distributed wave, the peak-to-peak pressure is twice the peak level, or 6 dB higher.

2.1.2 Sound Exposure Level

Sound Exposure Level (SEL or $L_{E,p}$) is a measures Sound Exposure (SE), which represent the total acoustic energy of a sound event in dB, accounting for both the sound's intensity and duration. $L_{E,p}$ provides a way to quantify the total energy in a sound, making it useful for assessing the impact of both continuous and transient sounds. Variations of $L_{E,p}$ are used depending on the noise source being measured. For context, $L_{E,p}$ can be compared $L_{p,\mathrm{RMS}}$ using Equation 2:

(2)

$$L_{E,p} = L_{p,RMS} + 10 \times \log_{10} T$$

where the $L_{p,RMS}$ is a measure of the average level of broadband noise and the $L_{E,p}$ sums the cumulative broadband noise energy. For continuous sounds shorter than one second, the $L_{E,p}$ is lower than the $L_{p,RMS}$. For durations longer than one second, the $L_{E,p}$ exceeds the $L_{p,RMS}$ (e.g., a 10-second sound results in a 10 dB higher SEL and a 100-second sound gives a 20 dB higher SEL). Unless otherwise defined, all $L_{E,p}$ noise levels in this report are referenced to 1 µPa^{2}s.

2.1.2.1 Single Strike Sound Exposure Level

Single strike Sound Exposure Level ($\mathrm{SEL_{ss}}$ or $L_{E,p,ss}$) refers to the total acoustic energy from a single, loud, short duration noise event (such as a blast or impact) measured over a specified duration. This can be expressed using Equation 3:

(3)

$$L_{E,p,ss} = 10 \times \log_{10} \left(\frac{\int_0^T p^2(t)dt}{{p^2}_{ref} T_{ref}} \right)$$

where p is the acoustic pressure in Pascals, T is the total duration of sound in seconds, and t is time in seconds.

2.1.2.2 Cumulative Sound Exposure Level

A cumulative Sound Exposure Level ($\mathrm{SEL_{cum}}$ or $L_{E,p,t}$) accounts for the exposure from multiple impulses or pile strikes over time, where the number of impulses replaces the T in the Equation 3, leading to Equation 4:

(4)

$$L_{E,cum} = L_{E,p,ss} + 10 \times \log_{10} X$$

Where X is the total number of impulses or strikes within a specific timeframe.

2.2 Properties of Sound

2.2.1 Impulsive vs Non-impulsive

Sound can be categorised loosely into two types: impulsive and non-impulsive. These can be defined as:

- Non-impulsive: a steady-state sound. It does not necessarily have to have a long duration.
    - Examples: vibropiling, drilling
- Impulsive: a sound with a high peak sound pressure, short duration, fast rise-time and broad frequency content at the source.
    - Examples: impact piling, seismic airguns, explosives

These differences are crucial for assessing auditory injury, as impulsive sound is typically more harmful than non-impulsive sound. Different metrics are needed to describe these distinct sound sources:

- Impulsive: Use $L_{p,\mathrm{pk}}$, $L_{E,p,\mathrm{ss}}$ or $L_{E,p,t}$
- Non-impulsive: Use $L_{p,\mathrm{RMS}}$ or $L_{E,p,t}$

Categorising sound as impulsive or non-impulsive can be challenging, especially over long distances. As impulsive sounds travel, their energy dissipates, making them less impulsive and therefore potentially less injurious. Ongoing research, such as Martin *et al.* (2020), aims to define these categories. Hastie *et al.* (2019) found that impulsive sound can be considered non-impulsive 3.5 km from the source, while Southall (2021) suggests noise should be non-impulsive if energy above 10 kHz is absent. Research is ongoing to refine pulse characteristics, like kurtosis, for better categorisation.

2.2.2 Particle Motion

Particle motion, a key component of sound, describes the back-and-forth movement of particles in a medium (such as water) caused by sound waves. Unlike sound pressure, particle motion contains directional information (Hawkins and Popper, 2017). It is typically quantified by peak particle velocity (PPV), though acceleration or displacement can also be used. Research shows many fish species and marine invertebrates are sensitive to particle motion (e.g., Popper and Hawkins, 2019; Nedelec *et al.,* 2016, Radford *et al.,* 2012, Sole *et al.,* 2023), but sound pressure metrics are still more commonly used due to limited data (Popper and Hawkins, 2018). Calls for further research on particle motion levels and effects continue.

2.3 Analysis of Environmental Effects: Assessment Criteria

Over the past 20 years, it has become clear that human-generated underwater noise impacts marine species. The severity of these effects depends on factors like sound level, frequency, exposure duration, and repetition rate (Hastings and Popper, 2005). As a result, research on aquatic species' hearing abilities has grown, with studies focused on high-level noise sources such as seismic airguns, impact piling, and blasting, which have the most immediate environmental effects, though interest in chronic noise exposure is rising.

The impacts of underwater sound on marine species can be broadly summarised as follows:

- Physical traumatic injury and fatality.
- Auditory injury (either permanent or temporary).
- Behavioural responses

The following sections outline the underwater noise criteria used in this study for marine mammals and fish in the North Sea.

2.3.1 Marine Mammals

2.3.1.1 Southall *et al.* (2019): Auditory Injury (PTS and TTS) criteria

Southall *et al*. (2019) is one of the most recognised references for marine mammal hearing thresholds and aligns with the thresholds provided in the National Marine Fisheries Service (NMFS, 2018) guidance. At the time of undertaking the assessment, although NMFS (2024) had been published as an updated weighting criteria and impact threshold, no UK regulators had provided guidance that the updated thresholds were acceptable and should be used in modelling assessments. Therefore, we continued with Southall *et al.* (2019) as the most trusted criteria at the time.

The Southall *et al.* (2019) guidance categorises marine mammals into groups based on similar species and applies filters to the unweighted noise levels to approximate their hearing sensitivities. These groups are summarised in Table 2-1, with auditory weighting functions in Figure 2-1. Additional groups for sirenians and other marine carnivores are provided but not included in this study, as these species are not common in the North Sea. It should be noted that the inclusion of "wtd" in $L_{E,p,t,\mathrm{wtd}}$ notation refers to a $L_{E,p,t}$ with an appropriate Southall *et al.* (2019) marine mammal weighting function applied.

Table 2-1: Marine mammal hearing groups (from Southall et al., 2019).

Hearing group	Auditory Weighting Function	Generalised hearing range	Species group	Example species
Low-frequency Cetaceans	LF	7 Hz to 35 kHz	Baleen whales	Sei Whale, Fin Whale, Minke Whale, Humpback Whale
High-frequency Cetaceans	HF	150 Hz to 160 kHz	Toothed whales, including dolphins and beaked whales	Bottlenose Dolphin, White-beaked Dolphin, Risso's Dolphin, Common Dolphin, Orca, Sperm Whale, Pilot Whale, Northern Bottlenose Whale
Very high-frequency Cetaceans	VHF	275 Hz to 160 kHz	True porpoise	Harbour porpoise
Phocid carnivores in water	PCW	50 Hz to 86 kHz	True seals	Harbour seal, Grey Seal

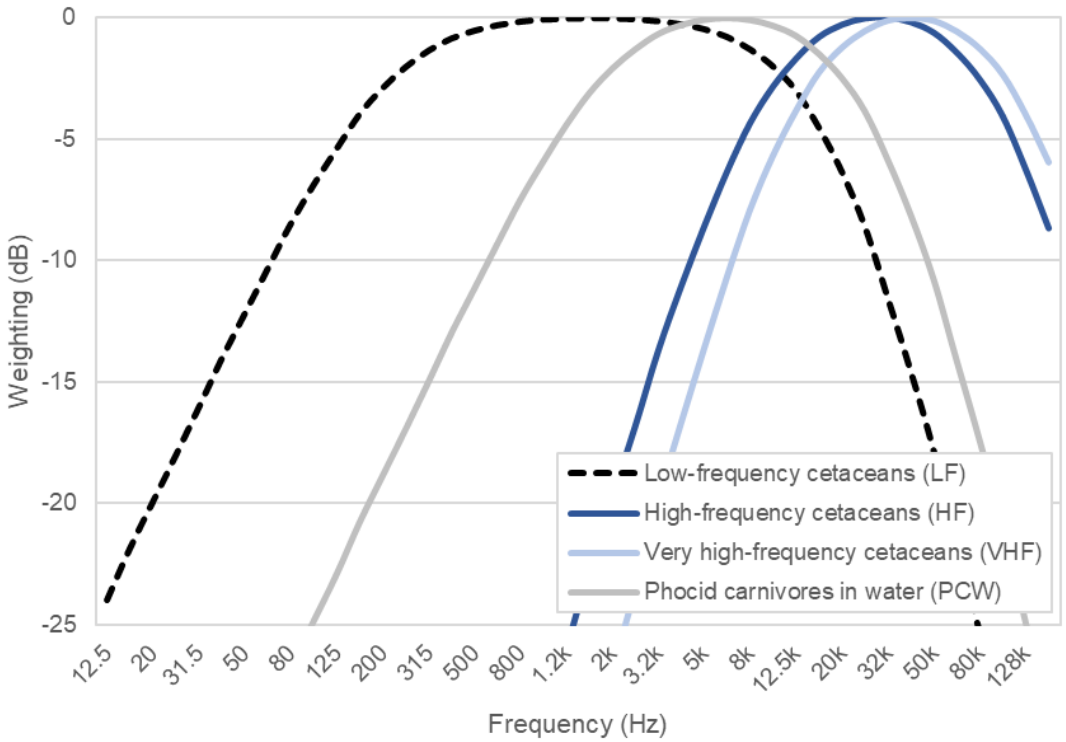

Figure 2-1: Auditory weighting functions for low-frequency cetaceans (LF), high-frequency cetaceans (HF), very high-frequency cetaceans (VHF), and phocid carnivores in water (PCW) (from Southall et al., 2019)

Southall *et al.* (2019) presents noise impact thresholds for marine mammal groups based on:

- The sound type (impulsive vs non-impulsive)
- The type of auditory injury of concern

Impact ranges based on impulsive criteria are recommended for most sources, except clearly non-impulsive ones. However, if the predicted range exceeds 3.5 km (see Section 2.2.1), the true impact range is likely to lie between the impulsive and non-impulsive ranges. Thus, both criteria are considered unless the sound source is explicitly non-impulsive.

For $L_{E,p,t}$ thresholds in marine mammals, a fleeing animal model is used, assuming the animal swims away from the sound source. These are worst-case assumptions, as marine mammals can swim faster under stress (Kastelein *et al.*, 2018), particularly at the start of a noisy event when they are closest to the source. The following flee speeds are applied for each marine mammal group:

- 2.1 ms^{-1} for LF cetaceans (Scottish Natural Heritage; SNH, 2016)
- 1.52 ms^{-1} for HF cetaceans (Bailey and Thompson, 2006)
- 1.4 ms^{-1} for VHF cetaceans (SNH, 2016)
- 1.8 ms^{-1} for PCW pinnipeds (SNH, 2016)

Southall *et al.* (2019) presents specific impact thresholds for impulsive and non-impulsive sound criteria, based on different of auditory injury associated with the characteristics of these sounds. Auditory injury is categorised into two types:

- PTS (permanent threshold shift): the greatest severity, which is unrecoverable (but incremental) reduction in hearing sensitivity.
- TTS (temporary threshold shift): the least severity, which is a short-term reduction in hearing sensitivity.

TTS represents the potential auditory impact with the most extensive range, but PTS represents the most significant and permanent impairment, making it the key impact threshold.

Since impact piling is an impulsive noise source that is likely to propagate more than 3.5 km from the source, this study considered the impulsive and non-impulsive sound criteria for marine mammal PTS and TTS thresholds from Southall *et al.* (2019), which is summarised in Table 2-2 and Table 2-3.

Table 2-2: Peak SPL ($L_{p,pk}$) criteria for PTS and TTS in marine mammals (Southall et al., 2019)

Southall *et al.* (2019)	$L_{p,pk}$ (dB re 1 µPa)	
	Impulsive	
	PTS	TTS
Low-frequency cetaceans (LF)	219	213
High-frequency cetaceans (HF)	230	224
Very high-frequency cetaceans (VHF)	202	196
Phocid carnivores in water (PCW)	218	212

Table 2-3: Cumulative SEL ($L_{E,p,wtd}$) criteria for PTS and TTS in marine mammals (Southall et al., 2019)

Southall *et al.* (2019)	$L_{E,p,wtd}$ (dB re 1 µPa^{2}s)			
	Impulsive		Non-impulsive	
	PTS	TTS	PTS	TTS
Low-frequency cetaceans (LF)	183	168	199	179
High-frequency cetaceans (HF)	185	170	198	178
Very high-frequency cetaceans (VHF)	155	140	173	153
Phocid carnivores in water (PCW)	185	170	201	181

2.3.2 Fish

2.3.2.1 Popper *et al.* (2014): Mortality, injury and behavioural effects

Popper *et al.* (2014) offers guidelines on underwater noise impacts to marine fauna (excluding marine mammals). Unlike earlier studies, it categorises fish based on physiological morphology, particularly swim bladder function, that affect hearing sensitivity and provides criteria for key anthropogenic sound sources. Marine faunae are grouped into sea turtles, eggs and larvae, and three fish hearing categories:

- Fish: no swim bladder
- Fish: swim bladder not involved in hearing
- Fish: Swim bladder involved in hearing.

Popper *et al.* (2014) then provides impact thresholds for each marine faunae category related to sound exposure, including:

- Mortality and potential mortal injury: immediate or delayed death.
- Impairment, such as:
    - Recoverable injury: injuries unlikely to result in mortality.
    - Temporary Threshold Shift (TTS): short or long-term changes in hearing sensitivity that may or may not reduce fitness.
    - Masking: Reduction in sound detectability due to the simultaneous presence of another sound.
- Behavioural effects: substantial change in behaviour for the animals exposed to a sound (long or short term).

Despite emerging evidence of fish sensitivity to particle motion (see Section 2.2.2), the Popper *et al.* (2014) criteria provide a quantitative criterion as thresholds for impact onsets in terms of sound pressure related functions (e.g., $L_{p,pk}$, $L_{p,RMS}$, $L_{E,p,t}$). For fish, both stationary and fleeing animal models are used for $L_{E,p,t}$ thresholds to account for species diversity and varying responses to noise. Most species in Popper *et al.* (2014) are likely to flee from harmful sounds (Dahl *et al.,* 2015), and these flee speeds are likely to vary widely across species. Therefore, a conservative fleeing speed of 1.5 ms^{-1} (Hirata, 1999) is used in fleeing animal models. However, some species in Popper *et al.* (2014) have lower sensitivity not sound, such as benthic or swim bladderless species, remain stationary even when exposed to high intensity sounds (e.g., Goertner *et al.,* 1994, 1978; Stephenson *et al.,* 2010; Halvorsen *et al.,* 2012). Therefore, to avoid overestimating risk, a combined approach, which presents both fleeing and stationary models, is used in this report.

When the available data is insufficient to provide a quantitative criterion, Popper *et al.* (2014) provides a relative assessment of risk, qualified as either high, moderate, or low, based on the receptor. These risks are assessed for three approximate distances relative to the sound source: the near-field (tens of meters), intermediate-field (hundreds of meters) or far-field (thousands of meters). This study uses the criteria from Popper *et al.* (2014) for pile driving, summarised in Table 2-4.

Table 2-4: Recommended guidelines for pile driving according to Popper et al. (2014) for fish, sea turtles and eggs and larvae (N = Near-field; I = Intermediate-field; F = Far-field).

Popper *et al.* (2014) criteria for Pile Driving					
Type of fish	**Mortality and potential mortal injury**	**Impairment**			**Behaviour**
		Recoverable injury	**TTS**	**Masking**	
Fish: no swim bladder	**>219 $L_{E,p}$** **>213 $L_{p,pk}$**	**>216 $L_{E,p}$** **>213 $L_{p,pk}$**	**>>186 $L_{E,p}$**	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder not involved in hearing	**210 $L_{E,p}$** **>207 $L_{p,pk}$**	**203 $L_{E,p}$** **>207 $L_{p,pk}$**	**>186 $L_{E,p}$**	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder involved in hearing	**207 $L_{E,p}$** **>207 $L_{p,pk}$**	**203 $L_{E,p}$** **>207 $L_{p,pk}$**	**186 $L_{E,p}$**	(N) High (I) High (F) Moderate	(N) High (I) High (F) Moderate
Sea Turtles	**210 $L_{E,p}$** **>207 $L_{p,pk}$**	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) High (I) Moderate (F) Low
Eggs and Larvae	**>210 $L_{E,p}$** **>207 $L_{p,pk}$**	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low

3 Underwater Noise Modelling: Methodology

Modelling of underwater noise is complex and can be approached in several different ways. To estimate the noise levels generated by the impact piling activities, Subacoustech have chosen to utilise dBSea (software version 2.4.28), a commercially available software developed by Marshall Day Acoustics designed to predict underwater noise which uses various numerical solvers to calculate underwater noise. For this project, two different solvers were used:

- A parabolic equation (PE) method for lower frequencies (12.5 Hz to 250 Hz)
    - Widely used within the underwater acoustics community but has computational limitations at high frequencies.
- A ray tracing method for higher frequencies (315 Hz to 100 kHz).
    - More computationally efficient at higher frequencies but is not suited to low frequencies (Etter, 1991).

The model incorporates bathymetry data and noise sources, with user-defined seabed and water properties (e.g. sound speed, temperature, salinity, current). Using selected numerical solvers, the software calculates 1/3rd octave band noise levels between 12.5 Hz – 100 kHz at set distances across the defined area, considering inputted environmental parameters and source characteristics.

3.1 Input Parameter

3.1.1 Modelling Location

One skid structure was provided by the client as a representative modelling location. To stay within the modelling software's capabilities, the 24 m subsea pile was represented as a point source at its midpoint, 12 m above the seabed at 79 m depth. Details of the noise source location used are presented in Table 3-1.

Table 3-1: Details of the modelling locations. Latitude/Longitude are in ED50.

Modelling location	Latitude	Longitude	Source depth below surface (m)	Depth at source location (m)
Skid Structure	56°53'0.43"N	1°13'49.04"E	79	91

3.1.2 Bathymetry

The bathymetry data used in the modelling was obtained from The European Marine Observation and Data Network (EMODnet, 2018). This data has a resolution of 1/16th arcminutes (approximately 115 × 115 m). The bathymetry used for modelling covers an area of 100 km × 100 km surrounding the modelling location.

3.1.3 Seabed Properties

Characteristics of the seabed were based on local data supplied by the Marine Scotland National Marine Plan Interactive (NMPi) tool. The seabed in the area is assumed to be comprised of a 50 m sediment layer of sand, which is above a bedrock layer of sandstone. Geo-acoustic properties for the seabed were based on available data from Jensen *et al*. (1994, 2011), which are provided in Table 3-2.

Table 3-2: Seabed geo-acoustic properties of the area.

Material	Compressive sound speed profile in substrate (ms^{-1})	Density profile in substrate (kgm^{-3})	Attenuation profile in substrate (dB/wavelength)
Sand	1,650	1,900	0.8
Sandstone	3,000	2,500	0.1

3.1.4 Sound Speed Profile

The speed of sound in the water has been calculated for the average annual temperature and salinity using the Mackenzie (1981) equation, with data from the Marine Scotland for the modelling location. The resulting profile is shown in Figure 3-1.

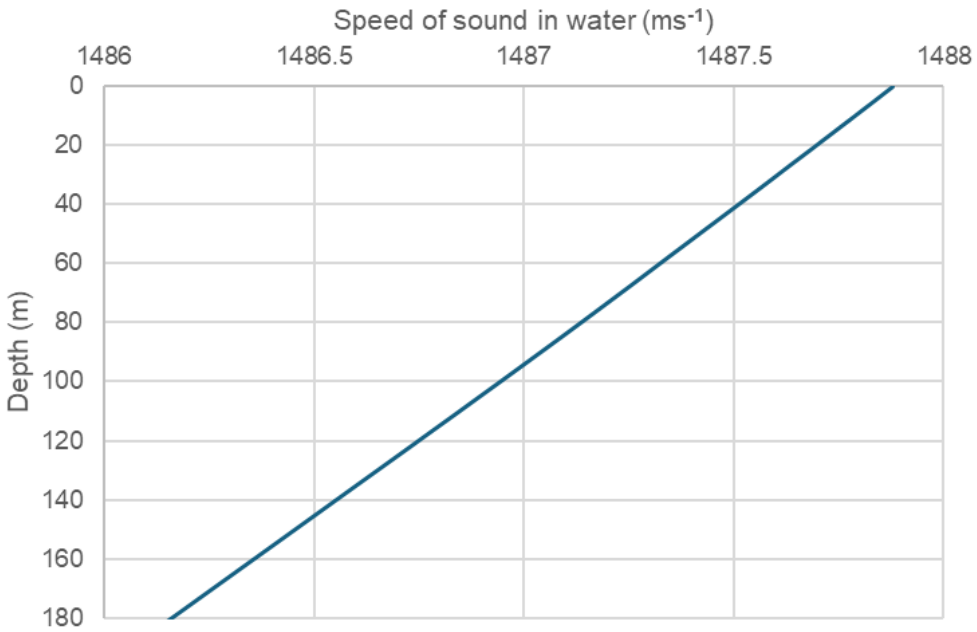

Figure 3-1: Sound speed profile used for detailed modelling of the area.

3.1.5 Noise Source

To carry out detailed noise modelling, a source spectrum and estimated source levels for $L_{p,pk}$ and $L_{E,p,ss}$ (single strike) from the noise source must be used. To calculate source levels, piling specifications are required, which were provided by the client:

- Pile type:
  - Diameter: 0.61 m (24-inch) diameter x 24 m length, installed to a depth of 20 m.
  - Maximum hammer blow energy: 90 kJ
- Total duration:
  - Piling will take place for a maximum of 8 hours per day:
    - It will take 2 hours of piling to install one pile.
    - 4 piles are proposed to be installed per 24-hour period.

- Piling schedule, including soft start:
    - 15 blows at 30% energy (27 kJ), delivered at a strike rate of 6 strikes per minute, over a period of 2.5 minutes
    - 15 blows at 60% energy (54 kJ), delivered at a strike rate of 6 strikes per minute, over a period of 2.5 minutes
    - 5,750 blows at 100% energy (90 kJ), delivered at a strike rate 50 strikes per minute, over a period of 1 hour and 55 minutes.

Within a 24-hour period, this schedule is repeated 4 times (once for each pile), giving a total maximum piling duration of 8 hours. It should be noted that because this project is not yet at the detailed design stage, specific soft start parameters are not currently known, and therefore, the modelled parameters are based on those used for similar projects. These details are summarised in Table 3-3 below.

Table 3-3: Summary of the piling procedure used for the modelling

Blow energy	30% (27 kJ)	60% (54 kJ)	100% (90 kJ)
No. of strikes	15	15	5,750
Duration (mins)	2.5	2.5	115
Strike rate (str/min)	6	6	50
5,780 strikes over 2 hours per pile 23,120 strikes over 8 hours for four sequentially installed piles			

Source levels were extrapolated from direct measurements of impact piling using, taken by Subacoustech Environmental (Midforth and East, 2019), which used similar pile sizes and blow energies. The apparent source levels used in modelling are presented in Table 3-4.

Table 3-4: Summary of the $L_{p,pk}$ and $L_{E,p,ss}$ source levels for different impact piling energies used in the piling sequence.

Blow energy	Apparent source level @ 1 m	
	$L_{p,pk}$ (dB re 1 µPa)	$L_{E,p,ss}$ (dB re 1 µPa^{2}s)
30% (27 kJ)	204.2	189.6
60% (54 kJ)	211.9	192.7
100% (90 kJ)	216.7	194.8

To carry out detailed noise modelling, a source spectrum for each noise source was used from relevant measured data taken by Subacoustech of piling at Portsmouth Harbour using similar pile sizes and blow energies (Midforth and East, 2019). From this measured data, the 1/3rd octave levels were then adjusted to achieve the required source levels and peak frequencies for each noise source (values stated in Table 3-4). An example of the 1/3rd octave source spectrum for the impact piling at 100% energy is shown in Figure 3-2, which was adjusted for each impact piling energy according to the associated approximate source level stated in Table 3-4.

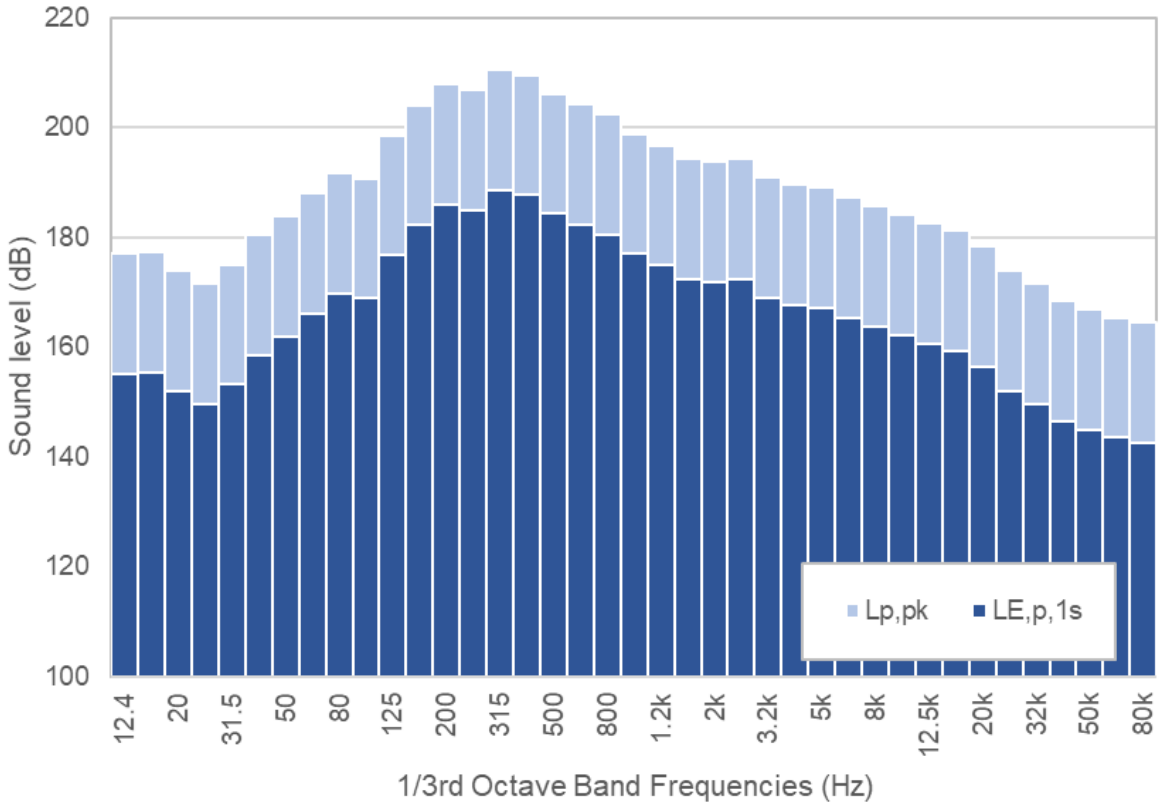

Figure 3-2: An example of the source spectrum containing 1/3rd octave band levels used to model impact piling at 100% energy.

To calculate $L_{E,p,24h}$ from $L_{E,p,ss}$, the total number of strikes at each energy per 24-hour period, presented in Table 3-3, was accounted for, as per Equation 4 (Section 2.1.2.2).

4 Underwater Noise Modelling: Results

The distribution of noise from impact piling noise are presented as noise contour plots in the following section. These noise contours are then interpreted into impact ranges using the relevant criteria from Southall *et al.* (2019) for marine mammals, and Popper *et al.* (2014) for fish.

4.1 Model Validation

A common practice in underwater noise studies of impact piling is to report noise levels at 750 m. This standard distance enables consistent comparison with other models and measurement data, as it lies beyond nearfield effects and mitigation zones where propagation patterns are stable and measurements are more reliable than levels measured at the source (for example, von Pein *et al*., 2022). A summary of the modelled unweighted levels at a range of 750 m are given in Table 4-1 considering the transect with the greatest noise transmission.

Table 4-1: Summary of the predicted maximum $L_{p,pk}$ and $L_{E,p,ss}$ across all modelled transects at 750 m range for different impact piling energies used in the piling sequence.

Blow energy	Predicted Maxium Level @ 750 m	
	$L_{p,pk}$ (dB re 1 µPa)	$L_{E,p,ss}$ (dB re 1 µPa^{2}s)
30% (27 kJ)	163.6	148.7
60% (54 kJ)	171.3	151.8
100% (90 kJ)	176.1	153.9

4.2 Predicted Noise Levels

The distribution of noise from the impact piling activities is presented as noise contour plots in Figure 4-1 to Figure 4-4 representing $L_{p,pk}$ and $L_{E,p,ss}$. These plots show the maximum predicted noise level in the water column projected to the surface.

Figure 4-1 represents the $L_{p,pk}$ noise levels generated by the first strike in the impact piling sequence at 30% energy, and Figure 4-2 represents the noise levels at 100% energy, as the highest, and therefore worst-case energy. Figure 4-3 and Figure 4-4 represent the same but for the $L_{E,p,ss}$ metric. Noise levels generated from the total strikes across all three energies were used to calculate the $L_{E,p,24hr}$ for each piling sequence.

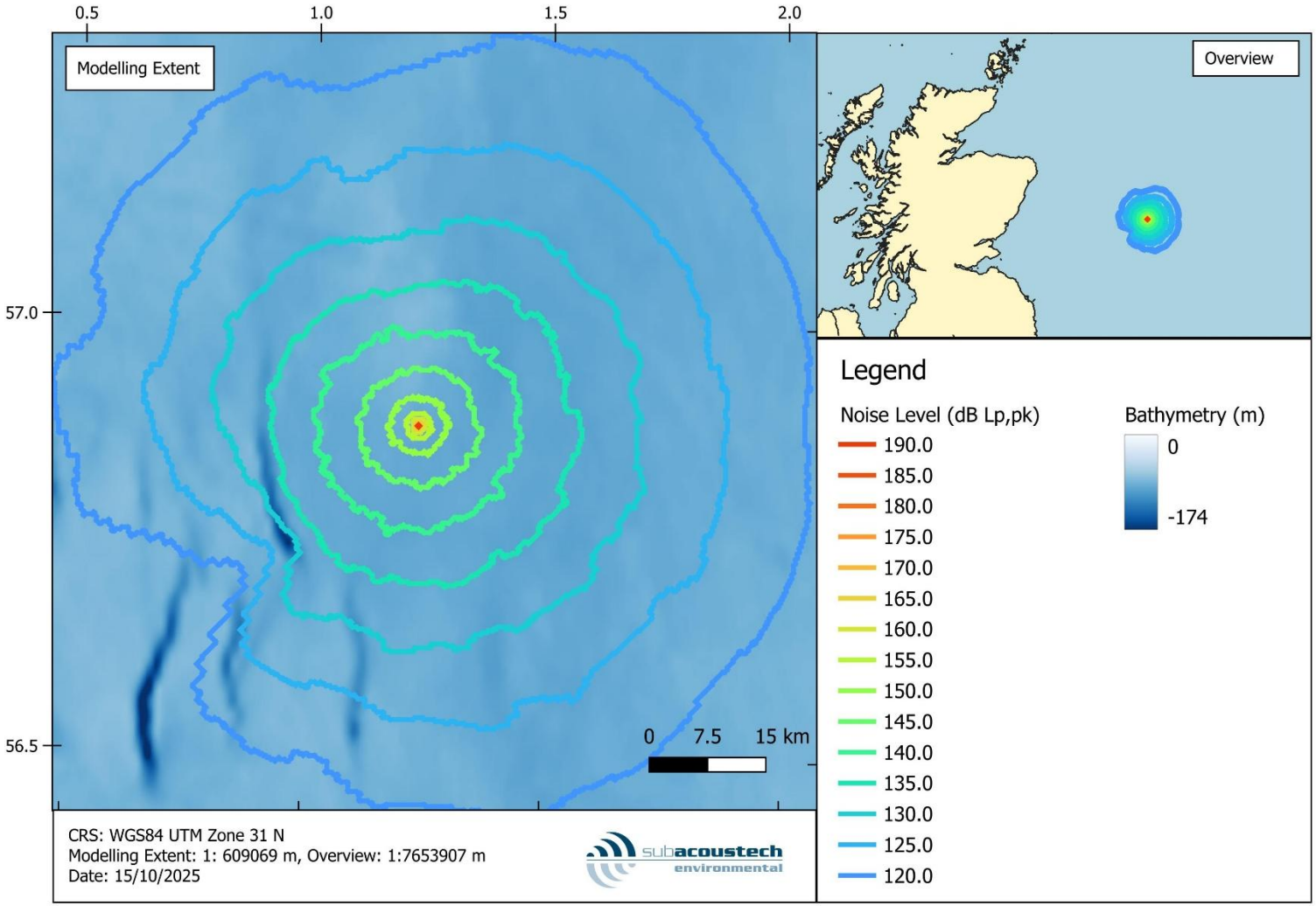

Figure 4-1: $L_{p,pk}$ contours predicted for impact piling at 30% energy (27 kJ).

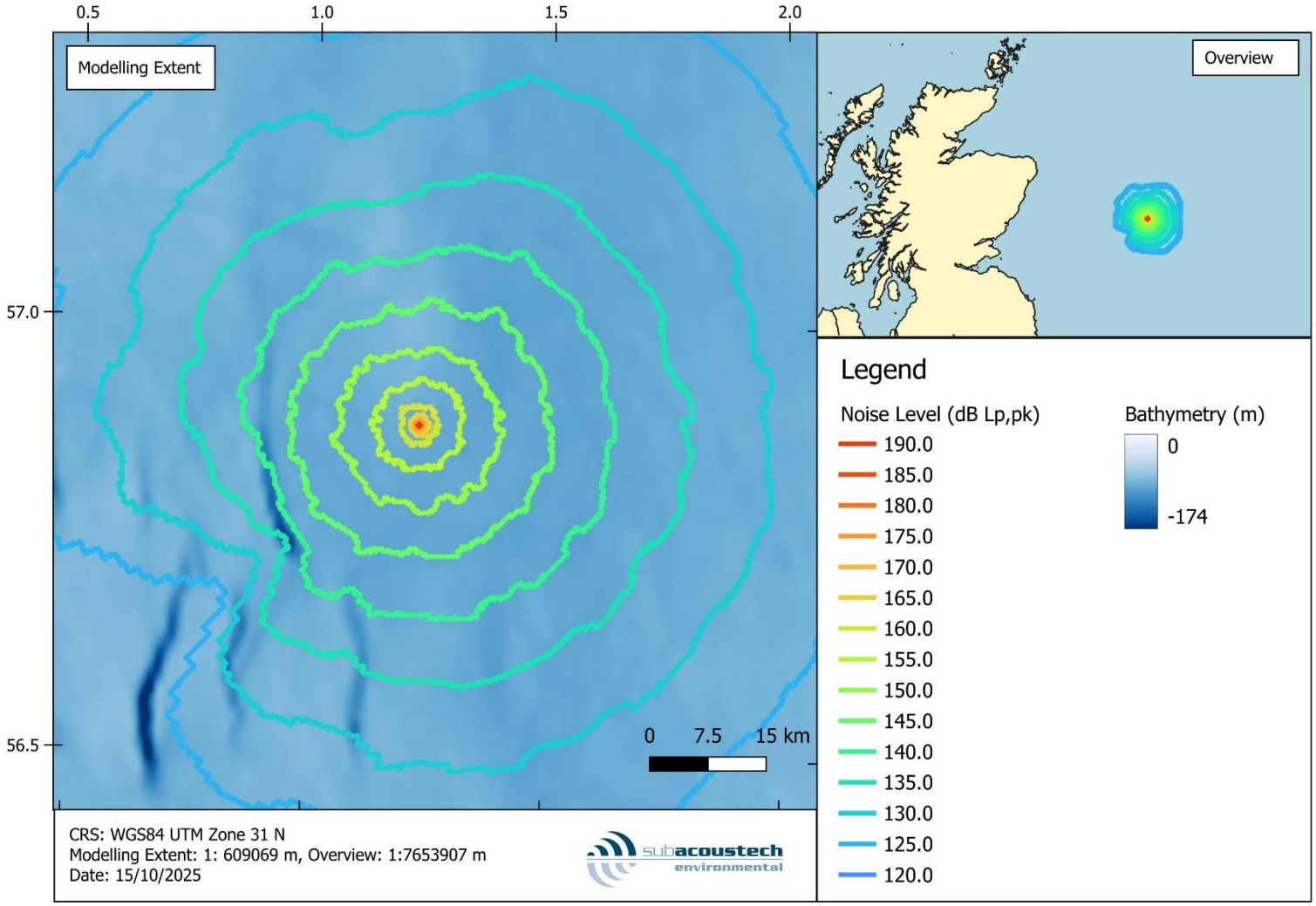

Figure 4-2: $L_{p,pk}$ contours predicted for impact piling at 100% energy (90 kJ)

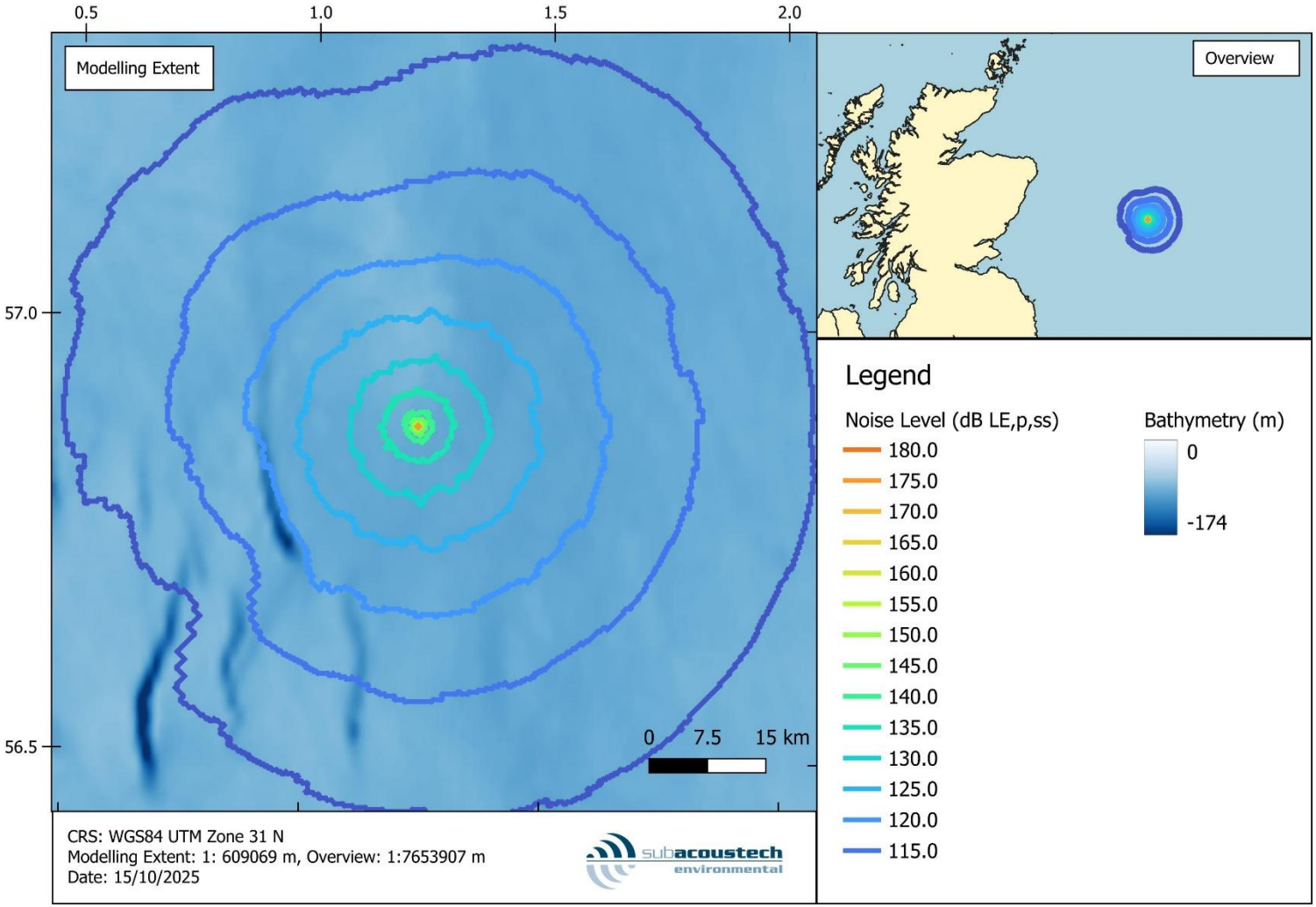

Figure 4-3: $L_{E,p,ss}$ (single strike) contours predicted for impact piling at 30% energy (27 kJ).

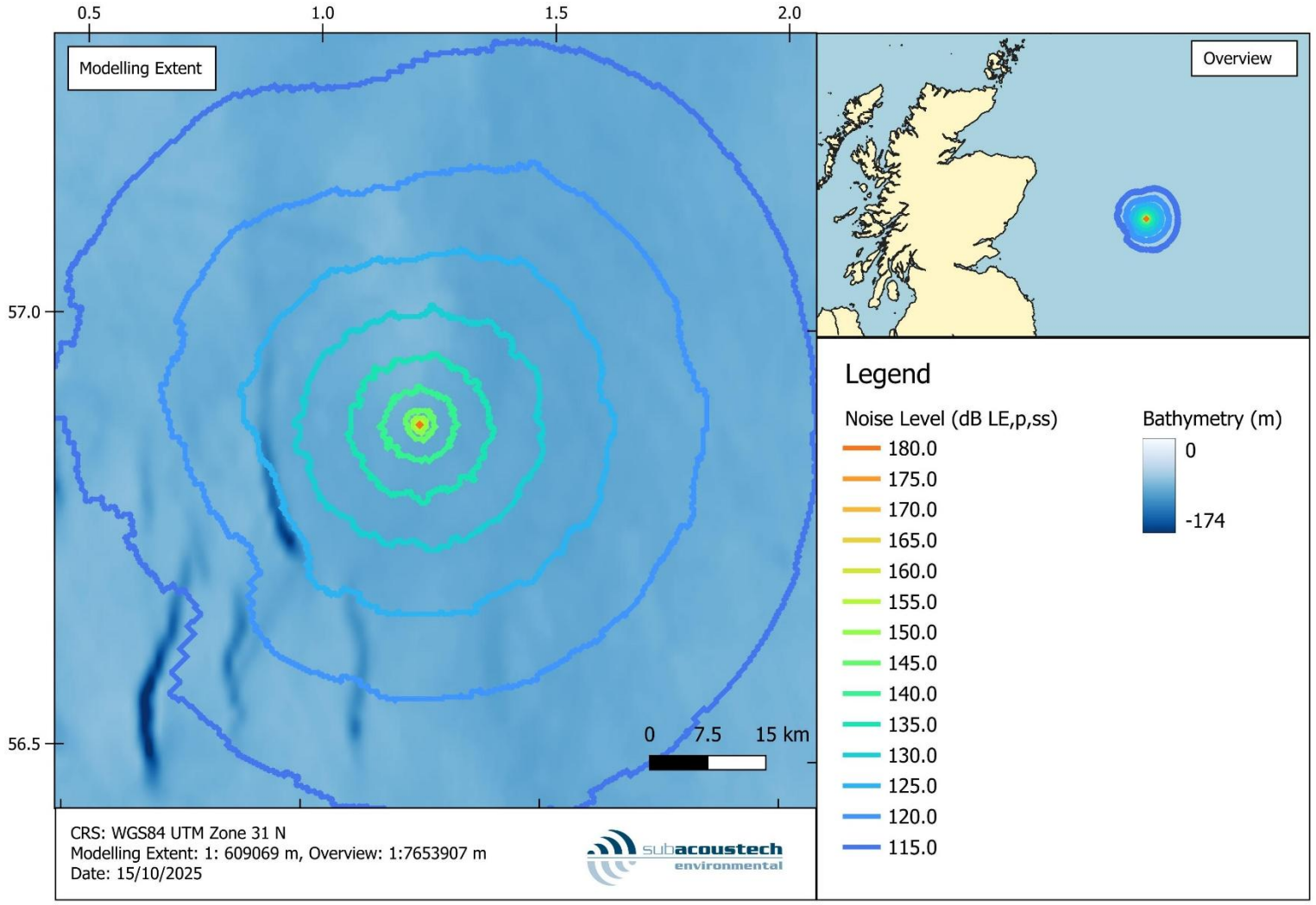

Figure 4-4: $L_{E,p,ss}$ (single strike) contours predicted for impact piling at 100% energy (90 kJ).

4.3 Interpretation

Due to the complexity in noise conditions at close range to the source, estimated impact ranges are limited to a resolution of 10 m from the source, as such, ranges smaller than this have been presented as "< 10 m". Any impact range noted as NE indicates that no exceedance is expected for the given criteria based on the results of the modelling.

4.3.1 Assessment: Marine Mammals

The noise level results from Section 4.2 were weighted and assessed against the Southall *et al.* (2019) guidelines to predict the likely range at which the thresholds for impulsive and non-impulsive sounds would be exceeded by marine mammals.

4.3.1.1 $L_{p,pk}$ criteria

Using the predicted $L_{p,pk}$ noise contours (Figure 4-1 and Figure 4-2) to calculate the $L_{p,pk}$ impacts using the Southall *et al*. (2019) criteria, it is unlikely that animals will exceed the PTS threshold at any range from the impact piling activities at the first strike of the soft start at 30% energy. At maximum energy, the PTS ranges are predicted out to 20 m for VHF cetaceans. These details, along with TTS impact ranges predicted across all groups, are presented in Table 4-2 and Table 4-3.

Table 4-2: Estimated impact ranges for impact piling activities at 30% energy using the Southall et al. (2019) $L_{p,pk}$ marine mammal criteria for impulsive noise sources.

Southall *et al*. (2019) criteria $L_{p,pk}$ (Impulsive)			Estimated Impact Range (m)		
			Maximum	Mean	Minimum
LF Cetaceans	PTS	219 dB	NE	NE	NE
	TTS	213 dB	NE	NE	NE
HF Cetaceans	PTS	230 dB	NE	NE	NE
	TTS	224 dB	NE	NE	NE
VHF Cetaceans	PTS	202 dB	< 10	< 10	< 10
	TTS	196 dB	< 10	< 10	< 10
PCW Pinnipeds	PTS	218 dB	NE	NE	NE
	TTS	212 dB	NE	NE	NE

NE = No predicted exceedance

Table 4-3: Estimated impact ranges for impact piling activities at 100% energy using the Southall et al. (2019) $L_{p,pk}$ marine mammal criteria for impulsive noise sources.

Southall *et al*. (2019) criteria $L_{p,pk}$ (Impulsive)			Estimated Impact Range (m)		
			Maximum	Mean	Minimum
LF Cetaceans	PTS	219 dB	NE	NE	NE
	TTS	213 dB	< 10	< 10	< 10
HF Cetaceans	PTS	230 dB	NE	NE	NE
	TTS	224 dB	NE	NE	NE
VHF Cetaceans	PTS	202 dB	20	20	20
	TTS	196 dB	40	40	40
PCW Pinnipeds	PTS	218 dB	NE	NE	NE
	TTS	212 dB	< 10	< 10	< 10

NE = No predicted exceedance

4.3.1.2 $L_{E,p,t}$ criteria

The predicted $L_{E,p,ss}$ (single strike) levels (Figure 4-3 and Figure 4-4) were combined using the piling sequency detailed in Table 3-3, species weightings and fleeing animal assumptions to calculate PTS and TTS ranges in terms of $L_{E,p,24hr,wtd}$. Based on the impulsive noise $L_{E,p,wtd}$ criteria from Southall *et al.* (2019), animals would need to be within 10 m of piling activities to exceed the PTS thresholds. These details, along with TTS impact ranges and non-impulsive criteria ranges, are presented in Table 4-4 and Table 4-5.

Table 4-4: Estimated impact ranges for the impact piling activities using the Southall et al. (2019) $L_{E,p,wtd}$ marine mammal criteria for impulsive noise sources assuming a fleeing animal.

Southall *et al*. (2019) criteria $L_{E,p,wtd}$ (Impulsive)			Estimated Impact Range (m)		
			Maximum	Mean	Minimum
LF Cetaceans	PTS	183 dB	10	10	10
	TTS	168 dB	8,800	8,000	6,800
HF Cetaceans	PTS	185 dB	< 10	< 10	< 10
	TTS	170 dB	< 10	< 10	< 10
VHF Cetaceans	PTS	155 dB	10	10	10
	TTS	140 dB	3,400	3,200	2,900
PCW Pinnipeds	PTS	185 dB	10	10	10
	TTS	170 dB	70	40	20

Table 4-5: Estimated impact ranges for the impact piling activities using the Southall et al. (2019) $L_{E,p,wtd}$ marine mammal criteria for non-impulsive noise sources assuming a fleeing animal.

Southall *et al*. (2019) criteria $L_{E,p,wtd}$ (Non-Impulsive)			Estimated Impact Range (m)		
			Maximum	Mean	Minimum
LF Cetaceans	PTS	199 dB	< 10	< 10	< 10
	TTS	179 dB	80	50	30
HF Cetaceans	PTS	198 dB	< 10	< 10	< 10
	TTS	178 dB	< 10	< 10	< 10
VHF Cetaceans	PTS	173 dB	< 10	< 10	< 10
	TTS	153 dB	30	20	10
PCW Pinnipeds	PTS	201 dB	< 10	< 10	< 10
	TTS	181 dB	< 10	< 10	< 10

4.3.2 Assessment: Fish

The noise level results from Section 4.2 were assessed against the Popper *et al.* (2014) guidelines to predict the likely range at which the thresholds for impact piling would be exceeded by fish.

4.3.2.1 $L_{p,pk}$ criteria

Table 4-6 and Table 4-7 show that using the $L_{p,pk}$ criteria, it is unlikely that animals will exceed the any of the thresholds for fish at any distance from the impact piling activities.

Table 4-6: Estimated impact ranges for the impact piling activities the Popper et al. (2014) $L_{p,pk}$ fish criteria for pile driving at 30% energy.

Popper *et al*. (2014) criteria $L_{p,pk}$ (Pile Driving)			Estimated Impact Range (m)		
			Maximum	Mean	Minimum
Fish: no swim bladder	Mortal and potential mortal injury	213 dB	< 10	< 10	< 10
	Recoverable injury		< 10	< 10	< 10
Fish: swim bladder not involved in hearing	Mortal and potential mortal injury	207 dB	< 10	< 10	< 10
	Recoverable injury		< 10	< 10	< 10
Fish: swim bladder involved in hearing	Mortal and potential mortal injury	207 dB	< 10	< 10	< 10
	Recoverable injury		< 10	< 10	< 10

Table 4-7: Estimated impact ranges for the impact piling activities the Popper et al. (2014) $L_{p,pk}$ fish criteria for pile driving at 100% energy.

Popper *et al*. (2014) criteria $L_{p,pk}$ (Pile Driving)			Estimated Impact Range (m)		
			Maximum	Mean	Minimum
Fish: no swim bladder	Mortal and potential mortal injury	213 dB	< 10	< 10	< 10
	Recoverable injury		< 10	< 10	< 10
Fish: swim bladder not involved in hearing	Mortal and potential mortal injury	207 dB	< 10	< 10	< 10
	Recoverable injury		< 10	< 10	< 10
Fish: swim bladder involved in hearing	Mortal and potential mortal injury	207 dB	< 10	< 10	< 10
	Recoverable injury		< 10	< 10	< 10

4.3.2.2 $L_{E,p,t}$ criteria

The predicted unweighted $L_{E,p,ss}$ for each blow energy were combined to calculate the total $L_{E,p,24hr}$. Using the $L_{E,p,t}$ criteria for pile driving from Popper *et al*. (2014), animals are unlikely to exceed injury thresholds if they flee at a constant speed for over the 8 hours of piling.

However, if the receptors are assumed to remain stationary for the entire 8-hour piling sequence, mortality and potential mortal injury ranges are expected to 180 m for fish with swim bladders involved in hearing. These details, along with the other calculated impact ranges predicted across all groups, are presented in Table 4-8 for fleeing animals, and Table 4-9 for stationary animals.

Table 4-8: Estimated impact ranges for the impact piling activities the Popper et al. (2014) $L_{E,p,24h}$ fish criteria for pile driving assuming a fleeing animal.

Popper *et al*. (2014) criteria $L_{E,p,24h}$ (Pile Driving)			Estimated Impact Range (m)		
			Maximum	Mean	Minimum
Fish: no swim bladder	Mortal and potential mortal injury	219 dB	< 10	< 10	< 10
	Recoverable injury	216 dB	< 10	< 10	< 10
	TTS	186 dB	10	10	10
Fish: swim bladder not involved in hearing	Mortal and potential mortal injury	210 dB	< 10	< 10	< 10
	Recoverable injury	203 dB	< 10	< 10	< 10
	TTS	186 dB	10	10	10
Fish: swim bladder involved in hearing	Mortal and potential mortal injury	207 dB	< 10	< 10	< 10
	Recoverable injury	203 dB	< 10	< 10	< 10
	TTS	186 dB	10	10	10

Table 4-9: Estimated impact ranges for the impact piling activities the Popper et al. (2014) $L_{E,p,24h}$ fish criteria for pile driving assuming a stationary animal.

Popper *et al*. (2014) criteria $L_{E,p,24h}$ (Pile Driving)			Estimated Impact Range (m)		
			Maximum	Mean	Minimum
Fish: no swim bladder	**Mortal and potential mortal injury**	219 dB	30	30	30
	Recoverable injury	216 dB	40	40	40
	TTS	186 dB	3,900	3,600	3,300
Fish: swim bladder not involved in hearing	**Mortal and potential mortal injury**	210 dB	110	110	100
	Recoverable injury	203 dB	310	310	300
	TTS	186 dB	3,900	3,600	3,300
Fish: swim bladder involved in hearing	**Mortal and potential mortal injury**	207 dB	180	180	170
	Recoverable injury	203 dB	310	310	300
	TTS	186 dB	3,900	3,600	3,300

5 Summary and Conclusions

Subacoustech Environmental, on behalf of Orbis Energy Ltd and their client Serica Energy Chinook Ltd, has undertaken an underwater noise modelling assessment in anticipation of offshore piling works taking place at the Kyle Oil Field, located in UKCS Block 29/2c in the central North Sea, UK. The works involve two valve skid structures, each comprising of four piles to be installed via impact piling. Piling activities will likely take place for a maximum of 8 hours per day. A soft start was also anticipated as part of the piling schedule.

The level of underwater noise generated by the survey was estimated in the dBSea software using a combined parabolic equation and ray tracing modelling approach. The modelling considers a wide array of input parameters including the equipment source level, sound frequency content, seabed properties and the sound speed profile in the water column. Full account is also taken of the bathymetry in the areas surrounding the piling area.

The modelled noise levels for all sources were then interpreted in accordance with the guidelines outlined in Southall *et al.* (2019) for marine mammals in relation to impulsive and non-impulsive noise sources and the Popper *et al.* (2014) guidelines for fish in relation to pile driving.

For marine mammals, any animals within 20 m of the piling when it is at 100% energy will exceed the VHF cetacean $L_{p,pk}$ PTS criteria. When total noise output is considered using the $L_{E,p,24hr}$ metric, including the soft start, the PTS threshold is unlikely to be exceeded by any animal. For fish, the greatest predicted distance for mortality or injury risk from total noise output is predicted at 180 m from the piling activities for fish with a swim bladder involve in hearing. The $L_{p,\text{pk}}$ threshold across all fish morphologies are unlikely to be exceeded at any range, for any hammer blow energy.

By its nature, mathematical modelling will produce results that indicate a precise range at which a criterion will be reached, but this does not reflect the inherent uncertainty in the physical processes, including many that change constantly under real world conditions. While the results present specific ranges at which each impact threshold is met based on the modelling results, the ranges should be taken as indicative in determining where environmental effects may occur in receptors during the proposed operations.

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Appendix E: Quantification of GHG Emissions

E.1 Introduction

This appendix sets out the methodology used to calculate the quantity of GHG emissions estimated to be generated from the proposed Kyla Development over the life of the field and supports the assessment documented in Section 9 (GHG Emissions) of the ES.

E.2 Direct GHG Emissions

E.2.1 Scope 1 Emissions (Processing of Kyla Hydrocarbons)

Once Kyla is online, Kyla production fluids will be processed offshore at the Triton FPSO. Incremental GHG emissions will be generated at the Triton FPSO, arising from the power generation requirements to treat the Kyla hydrocarbons (fuel gas is used to power the compressors and turbines) and from venting.

Calculation Methodology

The following equations have been used to calculate the incremental GHG emissions generated at the Triton FPSO as a result of Kyla coming online:

1. $GHG\ Emissions_{FUEL} = Fuel\ Gas\ used\ to\ power\ GTG \times GHG\ Conversion\ Factor$
2. $GHG\ Emissions_{VENT} = Volume\ of\ Gas\ Vented\ \times GHG\ Conversion\ Factor$

Therefore,

$$Total\ GHG\ Emissions = GHG\ Emissions_{FUEL} + GHG\ Emissions_{VENT}$$

Table E.1 lists the GHG conversion factors which have been used to calculate GHG emissions generated from fuel gas used to power the Gas Turbine Generators (GTG) and from venting (non-routine, with the primary source of venting on Triton from crude oil tanks) at the Triton FPSO.

Table E.1: GHG Conversion Factors for Fuel Use and Flaring at the Triton FPSO (EEMS, 2008)

Emission Factor Source	Triton FPSO Activity	GHG Conversion Factors (tonnes)			
		CO_2	N_2O	CH_4	CO_2e
'Gas Consumption Plant' (EEMS, 2008)	Fuel Gas (GTG)	2.86	0.00022	0.00092	Note [1]
'Gas Venting' (EEMS, 2008)	Venting from Crude Oil Tanks	0	0	0.9	Note [1]

[1] The GWPs used in the calculation of CO_2e are based on the IPCC Fifth Assessment Report (AR5).

Quantification of Scope 1 Emissions

Table E.2 details the incremental GHG emissions generated at the Triton FPSO as a result of Kyla coming online, assuming the Triton FPSO continues to operate as normal (i.e. powered by 2 x 42 MW GTG). GHG emissions have been calculated for all Kyla hydrocarbon profiles, namely high (P10), mid (P50) and low (P90) production cases.

Table E.2: Kyla Incremental Emissions at Triton FPSO

Year	Vent (kt/yr)	Fuel Gas (kt/yr)	Total Emissions (kt) [1]			
			CO_2	N_2O	CH_4	CO_2e
High Case (P10)						
2028	0.05	0.17	0.48	0.00	0.04	1.64
2029	0.30	1.10	3.16	0.00	0.27	10.85
2030	0.26	0.92	2.64	0.00	0.23	9.23
2031	0.21	0.73	2.09	0.00	0.19	7.36
2032	0.18	0.62	1.77	0.00	0.16	6.26
2033	0.15	0.54	1.54	0.00	0.14	5.46
2034	0.14	0.49	1.40	0.00	0.13	4.97
2035	0.13	0.45	1.29	0.00	0.12	4.61
Total	**1.41**	**5.03**	**14.37**	**0.00**	**1.27**	**50.36**
Year	**Vent (kt/yr)**	**Fuel Gas (kt/yr)**	**Total Emissions (kt) [1]**			
			CO_2	**N_2O**	**CH_4**	**CO_2e**
Mid Case (P50)						
2028	0.04	0.15	0.44	0.00	0.04	1.50
2029	0.23	0.84	2.41	0.00	0.21	8.39
2030	0.20	0.69	1.98	0.00	0.18	6.98
2031	0.15	0.52	1.48	0.00	0.13	5.29
2032	0.12	0.41	1.17	0.00	0.11	4.18
2033	0.10	0.34	0.96	0.00	0.09	3.46
2034	0.09	0.30	0.85	0.00	0.08	3.07
2035	0.08	0.28	0.79	0.00	0.07	2.85
Total	**1.01**	**3.53**	**10.09**	**0.00**	**0.91**	**35.72**
Year	**Vent (kt/yr)**	**Fuel Gas (kt/yr)**	**Total Emissions (kt) [1]**			
			CO_2	**N_2O**	**CH_4**	**CO_2e**
Low Case (P90)						
2028	0.01	0.05	0.15	0.00	0.01	0.50
2029	0.09	0.32	0.93	0.00	0.08	3.12
2030	0.08	0.30	0.87	0.00	0.07	2.93
2031	0.08	0.29	0.83	0.00	0.07	2.81
2032	0.08	0.29	0.83	0.00	0.07	2.79
2033	0.07	0.28	0.80	0.00	0.07	2.71
2034	0.07	0.28	0.80	0.00	0.07	2.71
2035	0.08	0.28	0.81	0.00	0.07	2.74
Total	**0.56**	**2.10**	**6.02**	**0.00**	**0.51**	**20.31**

[1] Refer to GHG conversion factors in Table E.1.

E.3 Indirect GHG Emissions

E.3.1 Upstream Scope 3 Emissions (Offshore Operations)

Upstream scope 3 emissions are the indirect emissions which will be generated by Serica's contractors offshore when extracting, producing and exporting Kyla hydrocarbons to the Triton FPSO, as well as during decommissioning operations upon cessation of production.

Calculation Methodology

The following equation has been used to calculate the total quantity of upstream scope 3 emissions generated from the Kyla development offshore operations:

$$GHG\ Emissions = Activity\ (Fuel\ Consumption) \times GHG\ Conversion\ Factor$$

Table E.3 lists the GHG conversion factors which have been used to calculate GHG emissions generated from offshore transport related activity (i.e. vessel and helicopter movements).

Table E.3: GHG Conversion Factors for Fuel used in Transport Activities (DESNZ, 2025e)

Fuel	Kyla Activity	GHG Conversion Factors (kg CO_2e of GHG per unit)			
		CO_2	N_2O	CH_4	CO_2e [1]
'Marine Gas Oil'	Vessels	3205.99000	38.40721	0.90720	3245.30441
'Aviation Turbine Fuel'	Helicopters	3149.67000	26.50000	2.19520	3178.3652

[1] The GWPs used in the calculation of CO_2e are based on the IPCC Fifth Assessment Report (AR5).

Quantification of Total Upstream Scope 3 Emissions

Table E.4: Kyla Total Upstream Scope 3 Emissions (Offshore Operations)

Kyla Activity	Total Fuel Use (tonnes) [1]	GHG Emissions (tonnes) [2]			
		CO_2	N_2O	CH_4	CO_2e
Drilling Operations	7,539.00	24,164.72	213.09	6.77	24,384.58
Installation Operations	4,504.00	14,439.78	111.53	4.09	14,555.40
Inspection and Maintenance Operations	1,000.00	3,205.99	38.41	0.91	3,245.30
Decommissioning Operations	3,401.00	10,902.33	99.35	3.07	11,004.75
Total:		**52,712.82**	**462.38**	**14.83**	**53,190.04**

[1] Total fuel use based on vessel and helicopter requirements for drilling operations (Table 3.1), installation operations (Table 3.11), inspection and maintenance operations (Table 3.17), and decommissioning operations (Table 3.18), as detailed in Section 3.
[2] Refer to GHG conversion factors in Table E.3.

E.3.2 Downstream Scope 3 Emissions (Further Refinement, Transportation and Distribution and End Use of Sold Products)

Downstream scope 3 emissions are the indirect emissions which will be generated once the Kyla hydrocarbons have been processed to export specification at Triton and sold, including from transportation and distribution, as well as from the end use of the sold product (namely, the presumption that all end use Kyla hydrocarbons are eventually combusted). Of note, oil from Triton is typically tankered to Rotterdam where oil volumes are integrated into the wider European oil sales market. Gas from Triton is piped to the St Fergus terminal where it enters the UK's national distribution system.

Further Refinement, Transportation and Distribution

Calculation Methodology

Well-to-Tank (WTT) emissions represent the GHG emissions generated during the extraction, refinement, transport and distribution of fuels prior to their end-use. In a downstream context, this includes all emissions associated with the handling and logistical operations required to deliver refined hydrocarbons to market, but excludes combustion or end-use emissions, which are quantified separately below.

The following equation has been used to calculate the total quantity of GHG emissions generated from the further refinement, transportation and distribution of Kyla hydrocarbons:

$$GHG\ Emissions = Production\ (Oil\ or\ Gas) \times GHG\ Conversion\ Factor$$

Table E.5 details the GHG conversion factors used to calculate the WTT emissions. 'Natural gas (100% mineral blend)' has been assumed as the downstream proxy fuel for Kyla gas, and 'fuel oil' has been assumed as the downstream proxy fuel for Kyla oil.

Table E.5: Well-to-Tank GHG Conversion Factors (DESNZ, 2025e)

Kyla Hydrocarbon	Downstream Proxy Fuel	GHG Conversion Factor (kg CO_2e of GHG per unit)
Oil	'Fuel Oil' WTT Fuels [1]	714.86545
Gas	'Natural gas (100% mineral blend)' WTT Fuels	423.16368

[1] 'Fuel Oil' has been used as a proxy as it is considered to most closely match oil for the purposes of this assessment.

As the WTT GHG conversion factors encompass the emissions associated with the extraction, refining and transportation of hydrocarbons prior to their end use, these already account for the incremental emissions that would be generated at Triton FPSO as a result of Kyla coming online (as presented in Section H.2). Therefore, to prevent double-counting, the Kyla Scope 1 baseline emissions have been deducted from the total calculated WTT emissions. This adjustment ensures that only the downstream GHG emissions associated with the further refinement, transport and distribution of hydrocarbons beyond the Triton FPSO are represented within the WTT total.

However, given the nature of the Kyla hydrocarbons and the known stages of refinement prior to transport and distribution to market, particularly as gas exported from the St Fergus Gas Terminal feeds directly into the NTS, the quantity of CO_2e emissions calculated for the Further Refinement, Transportation and Distribution phase is likely to be a conservative estimate.

Quantification of GHG Emissions

Table E.6: Kyla Development WTT Scope 3 Emissions

Kyla Hydrocarbon	Total Quantity of Produced Hydrocarbons (kt) [1]	CO_2e Emissions (kt) [2]
High Case (P10)		
Kyla Oil	1,586.43	1,134.09
Kyla Gas	255.88	108.28
High Case (P10) Total:	**1,842.31**	**1,242.36**
Mid Case (P50)		
Kyla Oil	1,130.06	807.84
Kyla Gas	179.60	76.00
Mid Case (P50) Total:	**1,309.66**	**883.84**
Low Case (P90)		
Kyla Oil	629.69	450.14
Kyla Gas	107.15	45.34
Low Case (P90) Total:	**736.83**	**495.48**

[1] Refer to Appendix G for Kyla production profiles. Gas converted from m^3 to tonnes using a density of 1.066 kg/m^3.

[2] Refer to GHG conversion factors in Table E.5.

Table E.7: Kyla Further Refinement, Transportation and Distribution Emissions

Kyla Production Case	Field Life WTT CO_2e Emissions (kt) [1]	Field Life Scope 1 CO_2e Emissions (kt) [2]	Net Further Refinement, Transportation & Distribution CO_2e Emissions (kt)
High Case (P10)	1,242.36	50.36	**1,192.00**
Mid Case (P50)	883.84	35.72	**848.12**
Low Case (P90)	495.48	20.31	**475.17**

[1] Refer to totals in Table E.6

[2] Refer to totals in Table E.2

End Use of Sold Products

Calculation Methodology

The following equation has been used to calculate the total quantity of scope 3 emissions generated from the end use of sold products (namely, the presumption that all end use Kyla hydrocarbons are eventually combusted):

$$End\ Use\ GHG\ Emissions = Production\ (Oil\ or\ Gas) \times GHG\ Conversion\ Factor$$

Table E.8 lists the GHG conversion factors which have been used to calculate End Use GHG emissions.

Table E.8: End Use GHG Conversion Factors (DESNZ, 2025a)

Kyla Hydrocarbon	Proxy Fuel	GHG Conversion Factors (kg CO_2e of GHG per unit)			
		CO_2	N_2O	CH_4	CO_2e [1]
Oil	'Fuel Oil' (DESNZ, 2025a)	3216.38	5.38720	7.12200	3228.88920
Gas	'Natural Gas (100% mineral blend)' (DESNZ, 2025a)	2,598.26	3.8528	1.19161	2,603.30441

[1] The GWPs used in the calculation of CO_2e are based on the IPCC Fifth Assessment Report (AR5).

Quantification of GHG Emissions

Kyla High Case (P10)

Table E.9: GHG Emissions from Combustion of Kyla Gas and Oil (High Case, P10)

Year	Volume of Gas Produced [1]		Emissions (kt) [2]			
	Mm^3/yr	kt/yr	CO_2	N_2O	CH_4	CO_2e
Combustion of Kyla Gas (Kyla High Case, P10)						
2028	8.12	8.63	22.43	0.03	0.01	22.47
2029	52.86	56.19	145.99	0.22	0.07	146.28
2030	44.17	46.96	122.00	0.18	0.06	122.24
2031	34.96	37.16	96.55	0.14	0.04	96.73
2032	29.68	31.55	81.98	0.12	0.04	82.14
2033	25.82	27.44	71.31	0.11	0.03	71.44
2034	23.45	24.92	64.76	0.10	0.03	64.88
2035	21.65	23.02	59.81	0.09	0.03	59.93
Totals:	**240.71**	**255.88**	**664.83**	**0.99**	**0.30**	**666.12**
Year	**Volume of Oil Produced (kt/yr) [3]**		**GHG Emissions (kt) [2]**			
			CO_2	N_2O	CH_4	CO_2e
Combustion of Kyla Oil (Kyla High Case, P10)						
2028	50.70		163.08	0.27	0.36	163.72
2029	339.03		1,090.43	1.83	2.41	1,094.67
2030	290.56		934.54	1.57	2.07	938.17
2031	232.26		747.04	1.25	1.65	749.95
2032	197.67		635.79	1.06	1.41	638.27
2033	172.58		555.08	0.93	1.23	557.24
2034	157.42		506.33	0.85	1.12	508.30
2035	146.21		470.27	0.79	1.04	472.09
Totals:	**1,586.43**		**5,102.57**	**8.55**	**11.30**	**5,122.42**
	High Case (P10) Totals:		**5,767.40**	**9.53**	**11.60**	**5,788.54**

[1] Gas volumes based on Kyla high case (P10) production profile (refer to Appendix G), with production commencing in September 2028 and cessation of production in December 2035. Gas converted from m^3 to tonnes using a density of 1.066 kg/m^3.

[2] Refer to GHG Conversion Factors in in Table E.8.

[3] Oil volumes based on Kyla high case (P10) production profile (refer to Appendix G), with production commencing in September 2028 and cessation of production in December 2035.

Kyla Mid Case (P50)

Table E.10: GHG Emissions from Combustion of Kyla Gas and Oil (Mid Case, P50)

Year	Volume of Gas Produced [1]		Emissions (kt) [2]			
	Mm^3/yr	kt/yr	CO_2	N_2O	CH_4	CO_2e
Combustion of Kyla Gas (Kyla Mid Case, P50)						
2028	7.33	7.79	20.25	0.03	0.01	20.29
2029	40.35	42.89	111.44	0.17	0.05	111.66
2030	33.15	35.24	91.57	0.14	0.04	91.75
2031	24.83	26.39	68.58	0.10	0.03	68.71
2032	19.56	20.80	54.04	0.08	0.02	54.14
2033	16.14	17.16	44.58	0.07	0.02	44.67
2034	14.31	15.21	39.52	0.06	0.02	39.60
2035	13.28	14.12	36.68	0.05	0.02	36.75
Totals:	**168.96**	**179.60**	**466.66**	**0.69**	**0.21**	**467.56**
Year	**Volume of Oil Produced (kt/yr) [3]**		**Emissions (kt) [2]**			
			CO_2	N_2O	CH_4	CO_2e
Combustion of Kyla Oil (Kyla Mid Case, P50)						
2028	46.69		150.17	0.25	0.33	150.75
2029	263.64		847.96	1.42	1.88	851.26
2030	220.65		709.69	1.19	1.57	712.45
2031	167.72		539.46	0.90	1.19	541.56
2032	132.91		427.50	0.72	0.95	429.17
2033	109.94		353.61	0.59	0.78	354.98
2034	97.63		314.02	0.53	0.70	315.24
2035	90.87		292.29	0.49	0.65	293.42
Totals:	**1,130.06**		**3,634.69**	**6.09**	**8.05**	**3,648.83**
	Mid Case (P50) Totals:		**4,101.35**	**6.78**	**8.26**	**4,116.39**

[1] Gas volumes based on Kyla mid case (P50) production profile (refer to Appendix G), with production commencing in September 2028 and cessation of production in December 2035. Gas converted from m^3 to tonnes using a density of 1.066 kg/m^3.

[2] Refer to GHG Conversion Factors in in Table E.8.

[3] Oil volumes based on Kyla mid case (P50) production profile (refer to Appendix G), with production commencing in September 2028 and cessation of production in December 2035.

Kyla Low Case (P90)

Table E.11: GHG Emissions from Combustion of Kyla Gas and Oil (Low Case, P90)

Year	Volume of Gas Produced [1]		Emissions (kt) [2]			
	Mm^3/yr	kt/yr	CO_2	N_2O	CH_4	CO_2e
Combustion of Kyla Gas (Kyla Low Case, P90)						
2028	2.52	2.67	6.95	0.01	0.00	6.96
2029	15.51	16.49	42.84	0.06	0.02	42.92
2030	14.55	15.47	40.19	0.06	0.02	40.27
2031	13.96	14.84	38.56	0.06	0.02	38.64
2032	13.85	14.72	38.26	0.06	0.02	38.33
2033	13.42	14.27	37.06	0.05	0.02	37.14
2034	13.40	14.24	37.00	0.05	0.02	37.07
2035	13.59	14.44	37.53	0.06	0.02	37.60
Totals:	**100.80**	**107.15**	**278.40**	**0.41**	**0.13**	**278.94**
Year	**Volume of Oil Produced (kt/yr) [3]**		**Emissions (kt) [2]**			
			CO_2	N_2O	CH_4	CO_2e
Combustion of Kyla Oil (Kyla Low Case, P90)						
2028	15.59		50.15	0.08	0.11	50.34
2029	96.50		310.38	0.52	0.69	311.58
2030	90.73		291.82	0.49	0.65	292.95
2031	87.15		280.30	0.47	0.62	281.39
2032	86.60		278.54	0.47	0.62	279.62
2033	84.01		270.20	0.45	0.60	271.25
2034	83.97		270.08	0.45	0.60	271.13
2035	85.14		273.84	0.46	0.61	274.91
Totals:	**629.69**		**2,025.31**	**3.39**	**4.48**	**2,033.19**
	Low Case (P90) Totals:		**2,303.71**	**3.81**	**4.61**	**2,312.13**

[1] Gas volumes based on Kyla low case (P90) production profile (refer to Appendix G), with production commencing in September 2028 and cessation of production in December 2035. Gas converted from m^3 to tonnes using a density of 1.066 kg/m^3.

[2] Refer to GHG Conversion Factors in in Table E.8.

[3] Oil volumes based on Kyla low case (P90) production profile (refer to Appendix G), with production commencing in September 2028 and cessation of production in December 2035.

Total Downstream Scope 3 Emissions

Table E.12 details the total downstream scope 3 emissions which will be generated from the proposed Kyla Development assuming the Triton FPSO continues to operate as normal (i.e. powered by GTGs).

Table E.12: Kyla Development Total Downstream Scope 3 Emissions

Downstream Activities	Total GHG CO_2e Emissions (kt)
Kyla High Case (P10)	
Further Refinement, Transportation and Distribution Emissions	1,242.36
End Use of Sold Products	5,788.54
Total High Case (P10):	**7,030.90**
Kyla Mid Case (P50)	
Further Refinement, Transportation and Distribution Emissions	883.84
End Use of Sold Products	4,116.39
Total Mid Case (P50):	**5,000.23**
Kyla Low Case (P90)	
Further Refinement, Transportation and Distribution Emissions	495.48
End Use of Sold Products	2,312.13
Total Low Case (P90):	**2,807.61**

E.4 Summary of Total GHG Emissions

Table E.13 details the total GHG emissions estimated to be generated as a result of the proposed Kyla Development, based on the highest production case, assuming the Triton FPSO continues to operate as normal (i.e. powered by GTGs).

Table E.13: Kyla Development Total GHG Emissions

Emissions Category	Total GHG CO_2e Emissions (kt)		
	P10 (High)	P50 (Mid)	P90 (Low)
Total Direct GHG Emissions (Scope 1) [1]	50.36	35.72	20.31
Total Indirect Upstream GHG Emissions (Scope 3) [2]	53.19	53.19	53.19
Total Indirect Downstream GHG Emissions (Scope 3) [3]	7,030.90	5,000.23	2,807.61
Grand Total	**7,134.45**	**5,089.14**	**2,881.11**

[1] Refer to Section H.2.1

[2] The total indirect upstream GHG emissions generated are the same for all Kyla production profiles (refer to Section H.3.1).

[3] The total indirect downstream GHG emissions generated depend on the Kyla production profiles as the methodology applies GHG conversion factors to production volumes (refer to Sections H.3.2).

In summary, the P10 case total gross GHG emissions generated over the life of the Kyla Field are estimated to be ca. 7,134.45 kilotonnes of CO_2e, based on the high production case (P10 profile) which represents a highest production emissions profile. It should be noted, however, that there is only a 10% probability that recovered volumes will meet or exceed the P10 case estimate.

For context, the P50 (mid case) scenario, generates total GHG emissions approximately 29% lower than the P10 (high case) estimate, and the P90 (low case) scenario, representing a conservative, lower production outcome, is approximately 60% lower than the P10 (high case) estimate.

In contrast, a 'do-nothing' scenario (e.g. a scenario where the Kyla Development does not proceed) would result in the generation of zero GHG emissions.

Appendix F: Oil Spill Modelling Study

This appendix presents the results of the oil spill modelling study undertaken to support the Kyla 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 a subsea well blowout. 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 7: June 2022).

F.1 OILMAP Spill Modelling Package

This oil spill modelling study has been carried out in RPS ASA's OILMAP (Version 7.7.218.1528) modelling system, which predicts the surface trajectory of spilled oil and includes algorithms for oil spreading, evaporation, emulsification, entrainment, and oil shoreline interaction. The distribution and mass balance of oil with respect to time are predicted for the specific oil spilled. Additional modules are utilised in OILMAP to execute more in-depth modelling processes such as simulating subsurface oil releases and computing probability.

The following modules have been utilised in OILMAP for the Kyla Development oil spill modelling study:

- **OILMAP Deep:** This module is a near-field model used to simulate subsurface releases of oil and gas. OILMAP Deep predicts the near-field plume characteristics and oil droplet size distributions for a specified release.
- **Trajectory and Fates Model:** The trajectory and fates module is a far-field model, for surface and subsurface releases, that predicts the 3D trajectory and fate of oil for instantaneous or continuous release spills.
- **Stochastic Model (RunStoch):** The stochastic module is used for risk assessment and contingency planning. It helps determine the most likely spill paths and the minimum time for oil to reach specific points on monthly, seasonal, or annual basis.

F.1.1 OILMAP Deep

The OILMAP Deep module was developed as an enhanced version of the OILMAP modelling system and is based on published work on plume formation and behaviour as well as droplet formation. The OILMAP Deep model contains two major sub-models, the droplet size distribution model and the plume model.

The droplet size distribution model employs a character diameter calculation (d_{95} hereby referred to as maximum droplet size) and the Rosin Rammler distribution (Yapa et al., 2001) based on the oil properties (primarily the interfacial tension between oil and seawater) and the energy of the release through calculation of the dimensionless Weber number associated with the release. The Weber number is based on the volumetric release rate, the pipe diameter and receiving water density in the numerator, and the oil interfacial tension (IFT) in the denominator. The maximum droplet diameter for a release is related to the Weber number, i.e. a larger Weber number results in larger droplet size. Therefore, lowering the IFT or increasing exit velocity results in a distribution of relatively smaller droplets.

The plume model solves equations for the conservation of water mass, momentum, buoyancy, and gas mass using integral plume theory, following work outlined in McDougall (1978), Spaulding (1982), and Fanneløp and Sjøen (1980). A simplified integral jet theory is employed for the vertical and horizontal motions of the gas-oil plume. The necessary model parameters defining the rates of entrainment and spreading of the jet are obtained from laboratory studies. The plume model calculates the evolution of the blowout plume as it rises and entrains water until it eventually either surfaces or comes into equilibrium with the receiving water. The receiving water is characterized by a site-specific, depth-variable temperature and density profile. These water column properties influence the plume properties since the state of gas is a function of the temperature and pressure. Similarly, temperature and pressure are used to adjust plume bulk density, based on the volume of entrained seawater, to determine the depth at which the plume bulk density approaches the receiving water density. At the point the plume bulk density is equal to that of the receiving water, plume ascension ceases, and the

plume becomes trapped at what is referred to as the termination (plume trap) height. The plume dynamics account for oil and gas buoyancy, gas compression and expansion as a function of depth, hydrate formation, dynamic gas bubble size distribution formulation, gas dissolution, and seawater entrainment and plume spreading processes.

F.1.2 Trajectory and Fates Model

Following OILMAP Deep, the Trajectory and Fates model simulates the droplet rise phase and surfaced oil. The 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.

F.1.3 Stochastic Model (RunStoch)

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 F.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 F.2 demonstrates how to interpret probability and features of interest (e.g. marine protected areas).

Figure F.1: Diagram to show how stochastic probability maps are made

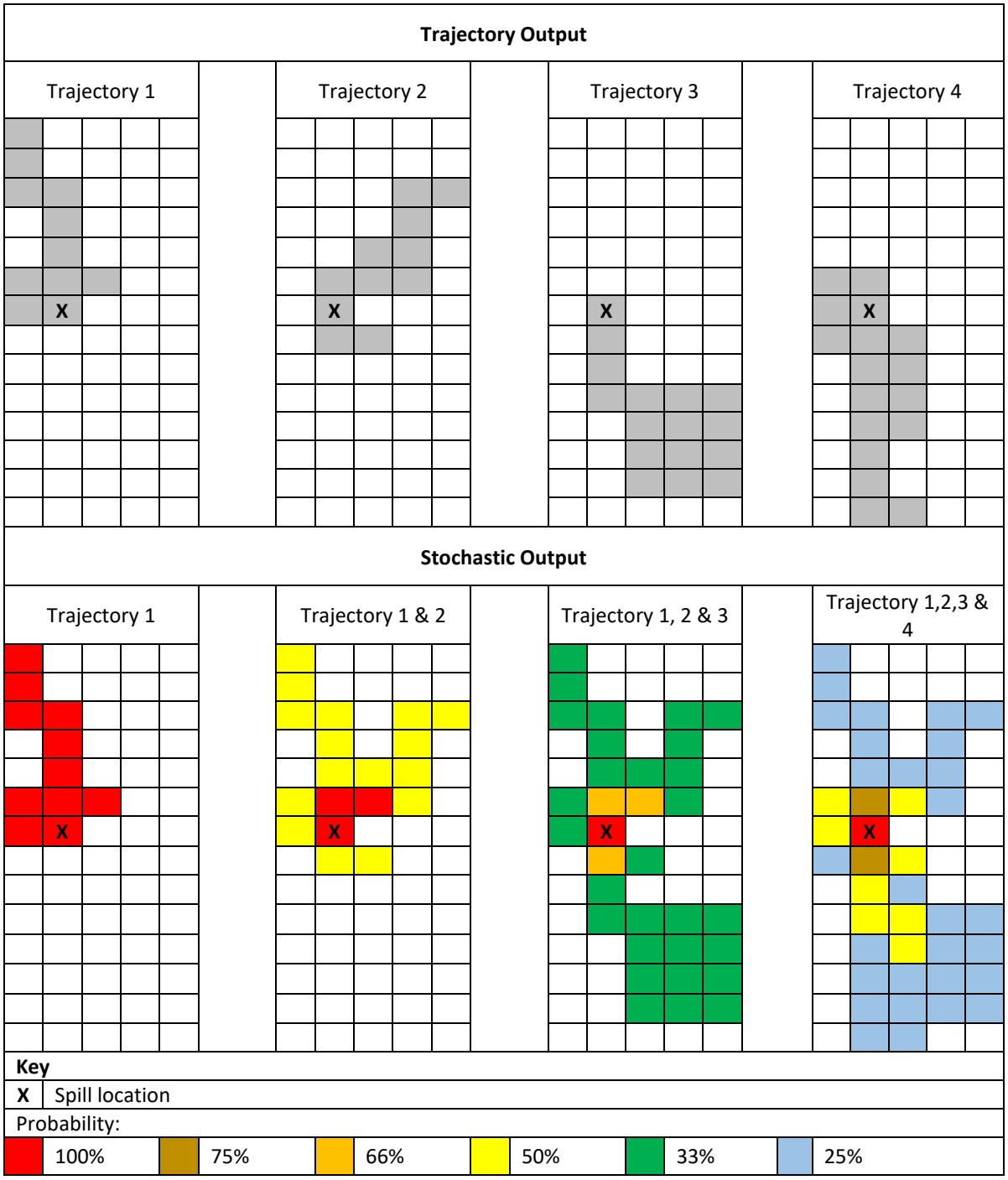
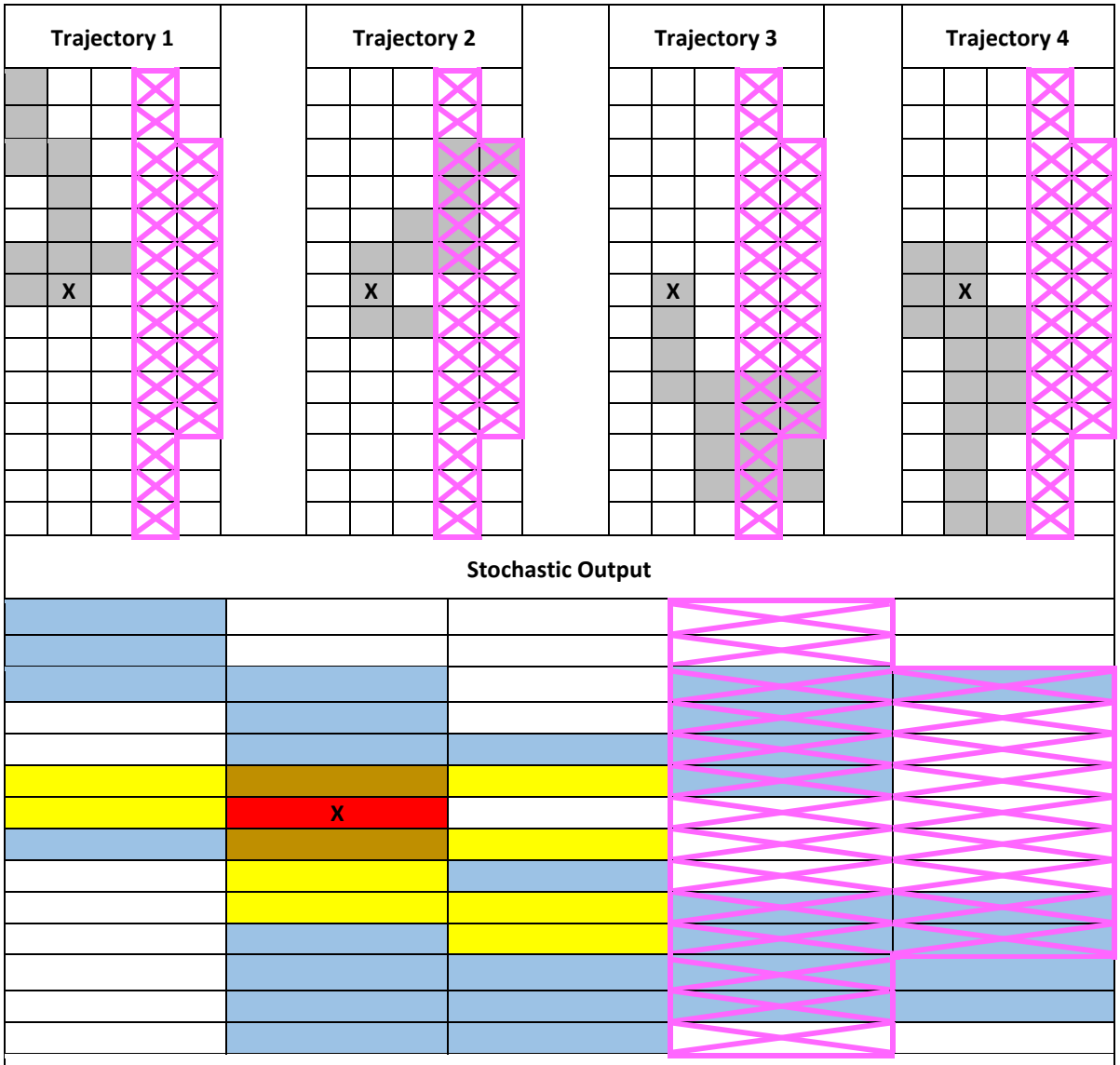


Figure F.2: Interpretation of Probability Mapping (Probability Grid vs Context Driven)



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 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.

F.2 Modelled Scenario

F.2.1 Worst Case Spill Scenario

The following worst case spill scenario has been modelled for the Kyla Development:

- Subsurface blowout release from the Kyla Development well with a cumulative release of 5,458,587.90 barrels (bbl) (867,860.89 cubic metre (m^3)) of 37.8°API crude, released over a period of 132 days.

F.2.2 Summary of Model Input Parameters

The model input parameters for the Kyla Development subsea blowout scenario are detailed in Table F.1.

Table F.1: Model Input Parameters for a Subsurface Blowout in the Kyla Development

Scenario 1: Well Loss Parameters								
Loss from Well / FPSO / Rig (please specify)	Kyla Development Subsea Well Blowout			**Instantaneous Loss?**	No			
Worst case volume	5,458,587.90 bbl (867,860.89 m^3)			**Will the well self-kill? If yes, when**	No, it is assumed a relief well would be required.			
Flow rate	Declining flow rate - starting at 49,856.60 bbl (7,927.20 m^3) / day on day 1, declining to 32,853.50 bbl (5,223.71 m^3) / day on day 132 (refer to Section F.6.4)							
Justification for predicted worst case volume	This represents the anticipated worst case blowout scenario for the Kyla Development in terms of both the volume of crude 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 132 days to drill).							
Location								
Spill Source point Latitude (N/S)	56° 52’ 58.7283” N;			**Spill source point Longitude (E/W)**	01° 13’ 45.1198” E			
Installation / Facility Name	Proposed Kyla Development Well			**Quad / Block**	29/02			
Hydrocarbon Properties								
Hydrocarbon name	Crude							
Assay available	No			**Was an analogue used for spill modelling?**	Yes –the Chayvo #6 Crude assay was amended to match the expected Kyla Crude properties.			
Analogue	**Name**	**ITOPF Category**	**Density**	**API**	**Viscosity at temp**	**Pour Point (°C)**	**Wax Content (%)**	**Asphaltene Content (%)**
	Amended Chayvo #6 Crude Analogue (refer to Section F.6.3)	Group 2	0.8365 g/cm^3 @ 15°C	37.8°	19cP @ 0°C; 4cP @ 15°C	3	7	0.15

Metocean Parameters				
Sea surface temperature	Winter (Dec – Feb)	7°C	Summer (June – Aug)	14°C
	Spring (Mar – May)	9°C	Autumn (Sep – Nov)	10°C
Wind data	Data period	2019 – 2023		
	Data reference	European Centre for Medium-Range Weather Forecasts (ECMWF) - Reanalysis v5 (ERA5)		
Current data	Data period	2019 – 2023		
	Data reference	HYCOM (HYbrid Coordinate Ocean Model) general ocean circulation model and HYDROMAP hydrodynamic model		

Modelled Release Parameters			
Surface or Subsurface	Subsurface	**Depth**	90 m
Release duration	132 Days	**Instantaneous?**	No
Persistence duration	10 Days	**Release rate**	Declining flow rate - starting at 49,856.60 bbl (7,927.20 m^3) / day on day 1, declining to 32,853.50 bbl (5,223.71 m^3) / day on day 132 (refer to Section F.6.4)
Total simulation time	142 Days	**Total cumulative release**	5,458,587.90 bbl (867,860.89 m^3)

Subsea Release Parameters (OILMAP Deep Blowout Model)	Gas to Oil Ratio (GOR)	128.2 m^3/m^3
	Salinity and Temperature Profile	Refer to Section F.6.1.
	Gas Viscosity	0.0190 Centipoise (cP)
	Gas Diffusivity	0.0000000011 m^2/s
	Diameter of Release Hole	0.2204974 m
	Oil Temperature	83.90 °C
	Particle Size / Velocity Distribution Method	Model calculated with 6 droplet size bins
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 metres (m) Cell Size (Z axis) = 500 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 millimetres (mm)
	Shoreline Thickness:	0.001 mm
	Water Column Concentration:	1.0 parts per billion (ppb)

Oil Spill Modelling Software			
Name of software	OILMAP	**Version**	7.7.218.1528

F.2.3 Reporting Thresholds

Probability and Minimum Time

Table F.2 outlines the minimum oiling thresholds used for this study to determine the probability and minimum time for oiling.

Table F.2: Minimum Oiling Thresholds used for Probability and Minimum Time Reporting

Category	Threshold	Justification
Surface	Minimum Thickness of 0.3 micrometres (µm)	The OPRED Guidance Notes for Preparing OPEPs for Offshore Oil & Gas Installations and Relevant Oil Handling Facilities (Revision 7: June 2022) 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).
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 F.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 F.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 Note 1	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	

Note 1: The Oilmap outputs are modelled to a minimum of 0.30 µm as per the OPRED Guidance Notes for Preparing OPEPs for Offshore Oil & Gas Installations and Relevant Oil Handling Facilities (Revision 7: June 2022).

Water Column Oiling Severity

Table F.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 F.4: Water Column Oil Concentration Thresholds

Minimum 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).	
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, polychaetes, echinoderms and molluscs). The 70.5 ppb figure is the OSPAR recommended predicted no-effect concentration (OSPAR, 2014).	

Shoreline Oiling Severity

Table F.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 International Tanker Owners Pollution Federation Limited (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 F.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	

F.3 Stochastic Modelling Results

F.3.1 Summary of Results

Table F.6 summarises the stochastic results for a worst case subsea well blowout associated with the Kyla Development well across all seasons. The results in Table F.6 report the minimum arrival time and probability of oil to reach land and the territorial waters of nearby countries.

Table F.6: Summary of Stochastic Modelling Results

Scenario 1: Kyla Development Subsea Well Blowout					
Spill Scenario / Descriptor: 5,458,587.90 bbl (867,860.89 m^3) of Crude (37.8 °API) released over 132 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)**				
Netherlands	*Maximum Probability*	41 %	2 %	1 %	17 %
	Shortest Arrival Time	915 hrs	3,262 hrs	3,087 hrs	1,639 hrs
Germany	*Maximum Probability*	56 %	3 %	1 %	28 %
	Shortest Arrival Time	773 hrs	2,660 hrs	2,460 hrs	1,490 hrs
Denmark	*Maximum Probability*	83 %	20 %	17 %	83 %
	Shortest Arrival Time	379 hrs	761 hrs	890 hrs	683 hrs
Norway	*Maximum Probability*	100 %	100 %	100 %	100 %
	Shortest Arrival Time	78 hrs	134 hrs	190 hrs	103 hrs
Sweden	*Maximum Probability*	54 %	N/A	6 %	69 %
	Shortest Arrival Time	588 hrs	N/A	1,715 hrs	947 hrs
Identified Median Line	**Subsurface Oil: Probability and Shortest Time to Reach (Minimum Water Column Concentration 1.0 ppb)**				
Netherlands	*Maximum Probability*	53 %	2 %	5 %	68 %

	Shortest Arrival Time	835 hrs	3,121 hrs	2,698 hrs	1,144 hrs
Germany	*Maximum Probability*	78 %	12 %	6 %	72 %
	Shortest Arrival Time	540 hrs	2,580 hrs	2,547 hrs	1,147 hrs
Denmark	*Maximum Probability*	91 %	58 %	79 %	100 %
	Shortest Arrival Time	363 hrs	754 hrs	871 hrs	688 hrs
Norway	*Maximum Probability*	100 %	100 %	100 %	100 %
	Shortest Arrival Time	74 hrs	124 hrs	179 hrs	93 hrs
Sweden	*Maximum Probability*	74 %	20 %	54 %	100 %
	Shortest Arrival Time	582 hrs	2,326 hrs	1,545 hrs	907 hrs
Landfall [Note 1]					
Predicted Locations	**Shoreline Oil: Probability and Shortest Time to Reach (Minimum Thickness of 1.0 µm)**				
Germany	*Maximum Probability*	3 %	N/A	N/A	2 %
	Shortest Arrival Time	1,351 hrs	N/A	N/A	2,000 hrs
Denmark	*Maximum Probability*	57 %	3 %	2 %	75 %
	Shortest Arrival Time	818 hrs	2,423 hrs	1,848 hrs	1,070 hrs
Norway	*Maximum Probability*	27 %	2 %	11 %	36 %
	Shortest Arrival Time	762 hrs	2,311 hrs	1,550 hrs	1,136 hrs
Sweden	*Maximum Probability*	22 %	N/A	2 %	40 %
	Shortest Arrival Time	643 hrs	N/A	3,344 hrs	1,060 hrs
UK Counties					
Shetland Isles	*Maximum Probability*	5 %	12 %	3 %	9 %

	Shortest Arrival Time	2,224 hrs	1,484 hrs	2,176 hrs	955 hrs
Orkney	*Maximum Probability*	8 %	7 %	2 %	5 %
	Shortest Arrival Time	1,904 hrs	1,219 hrs	2,083 hrs	1,348 hrs
Caithness	*Maximum Probability*	3 %	2 %	3 %	N/A
	Shortest Arrival Time	1,844 hrs	1,617 hrs	2,147 hrs	N/A
Sutherland	*Maximum Probability*	1 %	2 %	N/A	N/A
	Shortest Arrival Time	2,529 hrs	1,981 hrs	N/A	N/A
Ross & Cromarty	*Maximum Probability*	1 %	2%	N/A	N/A
	Shortest Arrival Time	2,671 hrs	2,676 hrs	N/A	N/A
Nairn	*Maximum Probability*	1 %	N/A	N/A	N/A
	Shortest Arrival Time	2,522 hrs	N/A	N/A	N/A
Moray	*Maximum Probability*	3 %	5 %	2 %	N/A
	Shortest Arrival Time	1,957 hrs	1,674 hrs	2,904 hrs	N/A
Banffshire	*Maximum Probability*	5 %	3 %	4 %	N/A
	Shortest Arrival Time	2,013 hrs	1,284 hrs	1,998 hrs	N/A
Aberdeenshire	*Maximum Probability*	34 %	39 %	7 %	3 %
	Shortest Arrival Time	1,260 hrs	637 hrs	1,095 hrs	764 hrs
City of Aberdeen	*Maximum Probability*	28 %	32 %	4 %	7 %
	Shortest Arrival Time	1,713 hrs	659 hrs	1,221 hrs	796 hrs
Kincardineshire	*Maximum Probability*	33 %	32 %	5 %	3 %
	Shortest Arrival Time	1,539 hrs	666 hrs	561 hrs	710 hrs

Angus	*Maximum Probability*	29 %	28 %	3 %	2 %
	Shortest Arrival Time	1,864 hrs	920 hrs	1,764 hrs	711 hrs
City of Dundee	*Maximum Probability*	12 %	12 %	2 %	N/A
	Shortest Arrival Time	2,178 hrs	963 hrs	2,175 hrs	N/A
Perth and Kinross	*Maximum Probability*	1 %	3 %	N/A	N/A
	Shortest Arrival Time	3,046 hrs	1,962 hrs	N/A	N/A
Fife	*Maximum Probability*	22 %	33 %	2 %	2 %
	Shortest Arrival Time	1,948 hrs	985 hrs	1,734 hrs	1,392 hrs
City of Edinburgh	*Maximum Probability*	1 %	2 %	1 %	N/A
	Shortest Arrival Time	3,198 hrs	1,767 hrs	2,808 hrs	N/A
East Lothian	*Maximum Probability*	13 %	12 %	2 %	N/A
	Shortest Arrival Time	2,015 hrs	950 hrs	2,713 hrs	N/A
Berwickshire	*Maximum Probability*	10 %	10 %	5 %	N/A
	Shortest Arrival Time	1,997 hrs	1,281 hrs	2,703 hrs	N/A
Northumberland	*Maximum Probability*	6 %	7 %	3 %	N/A
	Shortest Arrival Time	2,320 hrs	1,520 hrs	2,715 hrs	N/A
Tyne & Wear	*Maximum Probability*	2 %	3 %	2 %	N/A
	Shortest Arrival Time	2,989 hrs	1,932 hrs	2,733 hrs	N/A
Durham	*Maximum Probability*	N/A	2 %	1 %	N/A
	Shortest Arrival Time	N/A	2,048 hrs	2,824 hrs	N/A
North Yorkshire	*Maximum Probability*	N/A	2 %	N/A	N/A

	Shortest Arrival Time	N/A	2,048 hrs	N/A	N/A
East Riding of Yorks	*Maximum Probability*	N/A	1 %	N/A	N/A
	Shortest Arrival Time	N/A	2,890 hrs	N/A	N/A
Worst Case Trajectory Simulations Identified from Stochastic Results					
Greatest Volume of Oil Beached (in any one location)	*Trajectory Run No. (out of 100)*	33	52	81	34
	m^3	12,030.36	2,632.33	611.72	7,172.86
	bbl	75,662.67	16,555.53	3,847.28	45,112.32
	Tonnes	10,225.81	2,237.48	519.96	6,096.93
	Sim Start Date	03/12/2019	19/03/2021	05/08/2023	08/11/2019
	Sim Start Time	00:00	15:00	23:00	09:00

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.

F.3.2 Stochastic Maps

The stochastic results for the Kyla Development worst case subsea well blowout scenario were calculated from a total of 400 trajectory runs (100 simulations per season). The well blowout scenario involves the release of 5,458,587.90 bbl (867,860.89 m^3) of Crude (37.8 °API) over a 132-day period. The model is simulated for an additional 10 days following cessation of the blowout.

The stochastic model analysis used a 1 kilometres (km) x 1 km grid cell size. Therefore, the mapped stochastic output is shown at a 1 square kilometre (km^2) resolution. The following maps are presented using the WGS84 coordinate system:

Sea Surface

- **Figure F.3** - Probability of oil reaching surface cells.
- **Figure F.4** - Minimum arrival time of oil to surface cells.
- **Figure F.5** - Maximum surface oil thickness.

Water Column

- **Figure F.6** - Probability that a water column cell could be impacted.
- **Figure F.7** - Minimum arrival time of oil to water column cells.
- **Figure F.8** - Maximum total water column oil concentration.

Shoreline

- **Figure F.9** - Probability that a shoreline cell could be impacted.
- **Figure F.10** - Minimum arrival time of oil to shoreline cells.
- **Figure F.11** - Maximum shoreline oil thickness.

In accordance with the OPRED Guidance Notes for Preparing OPEPs for Offshore Oil & Gas Installations and Relevant Oil Handling Facilities (Revision 7: June 2022), the stochastic map outputs have not displayed surface and subsurface oiling probabilities <10 %.

Figure F.3: Probability of Oil Reaching Surface Cells

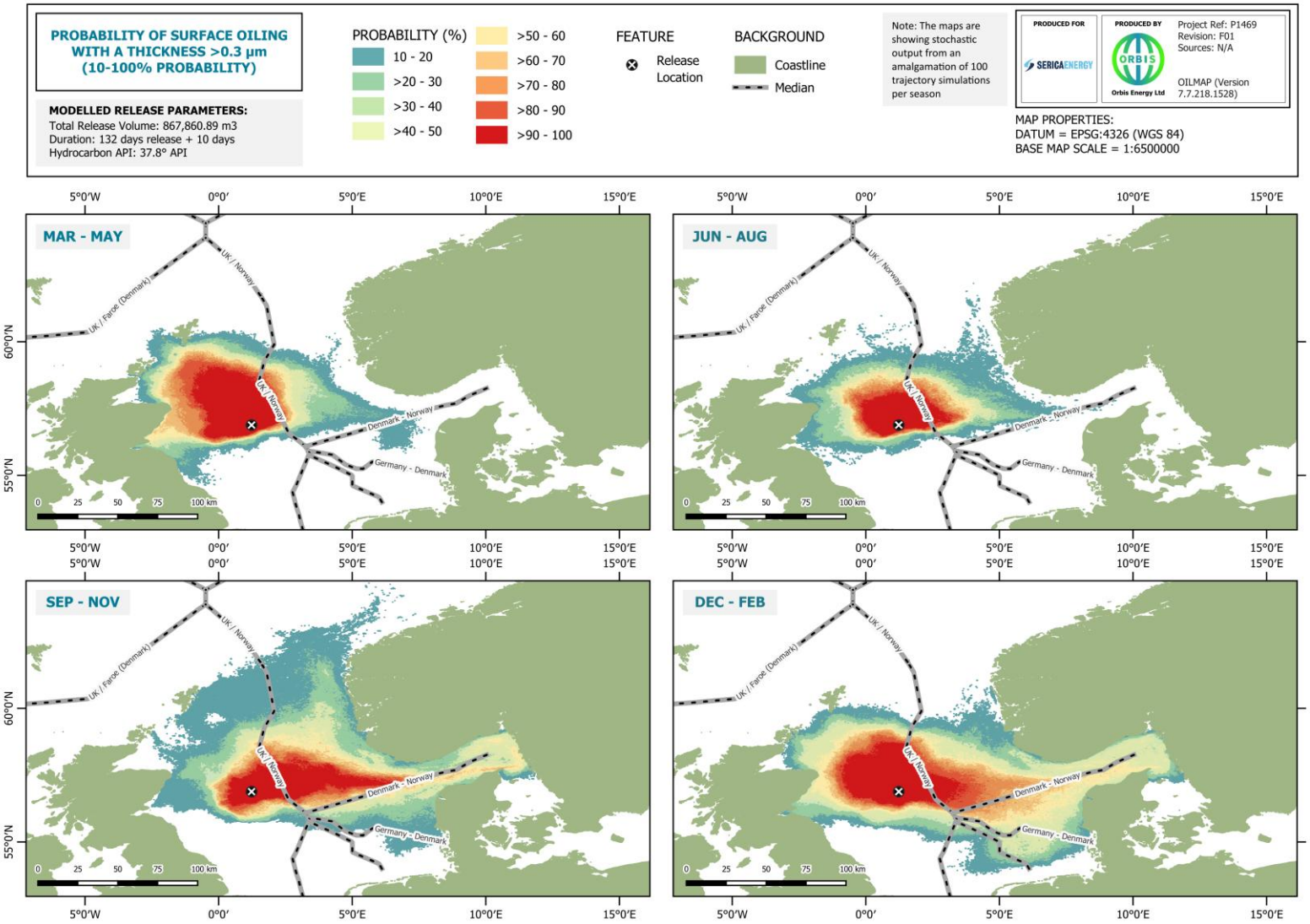


Figure F.4: Minimum Arrival Time of Oil to Surface Cells

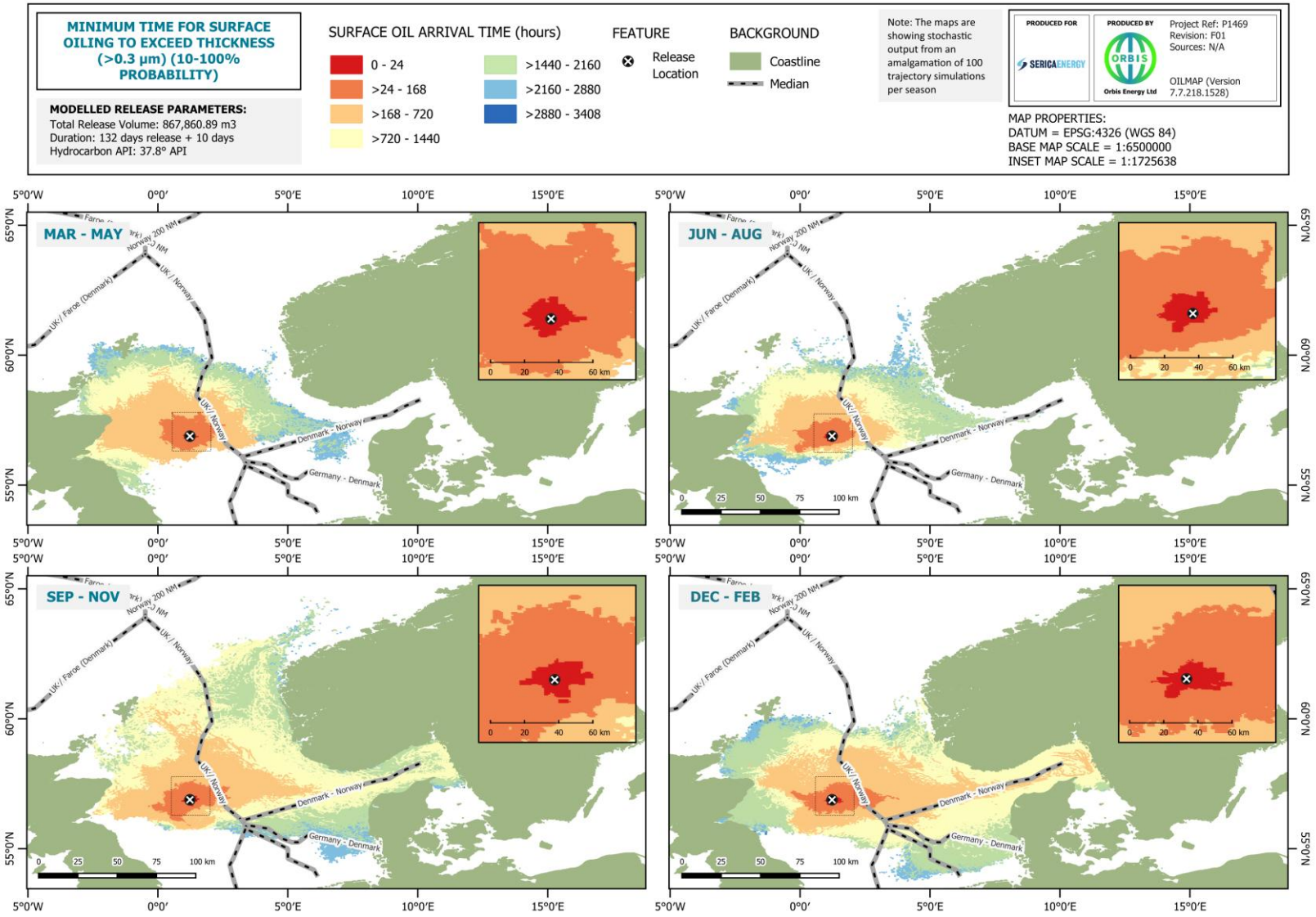


Figure F.5: Maximum Surface Oil Thickness (Bonn Code)

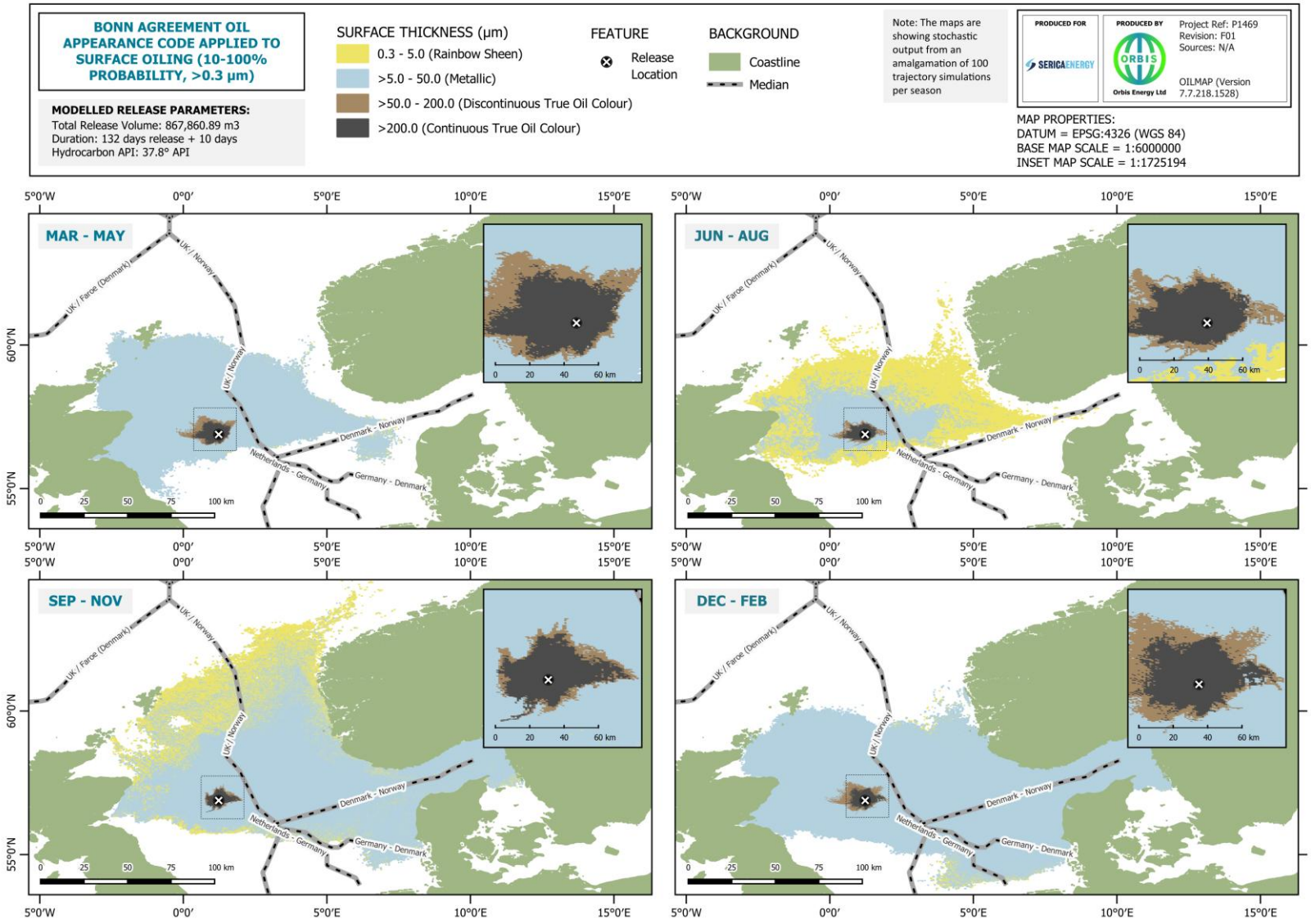


Figure F.6: Probability of Water Column Cells Impacted

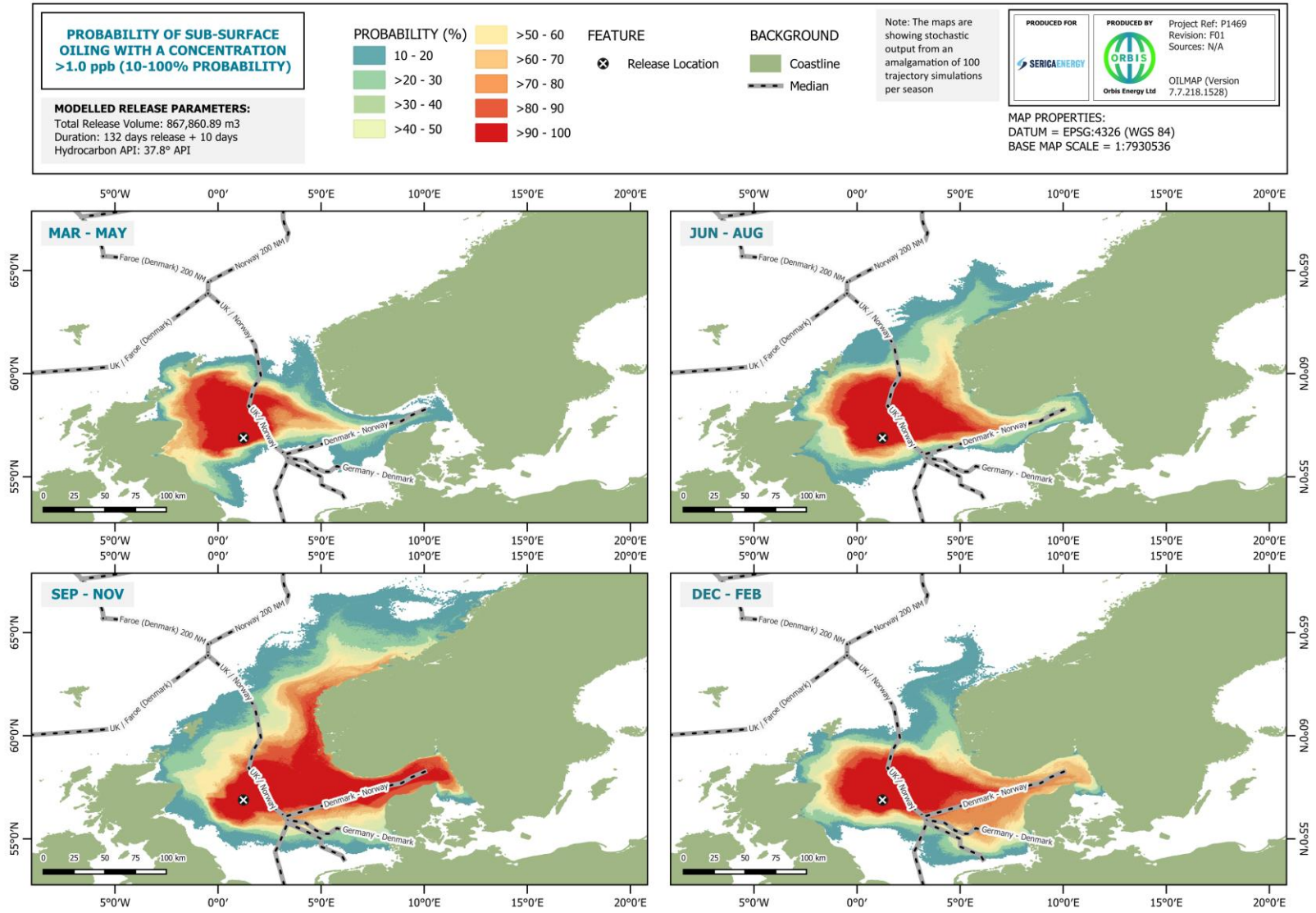


Figure F.7: Minimum Arrival Time of Oil to Water Column Cells

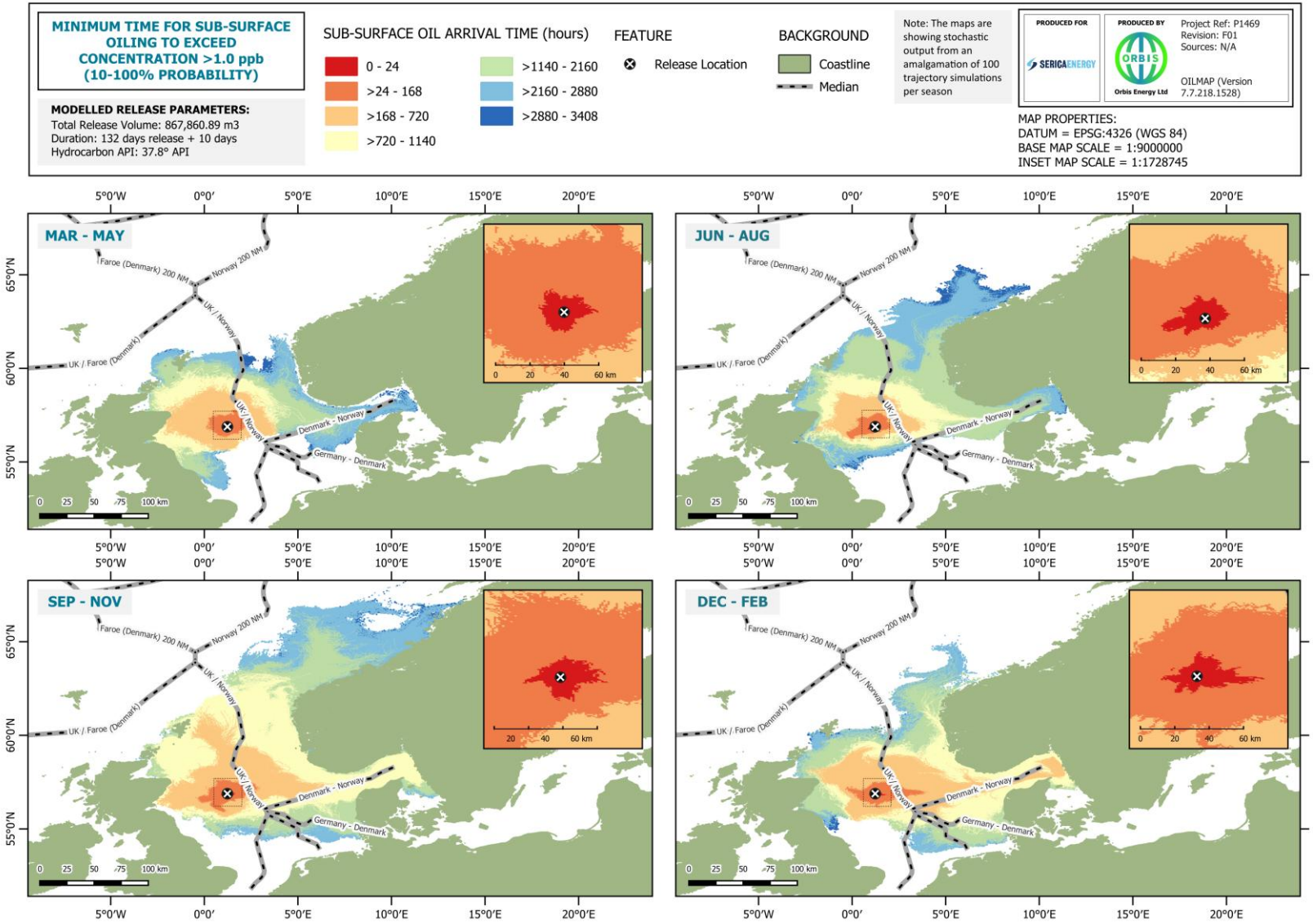


Figure F.8: Maximum Total Water Column Oil Concentrations

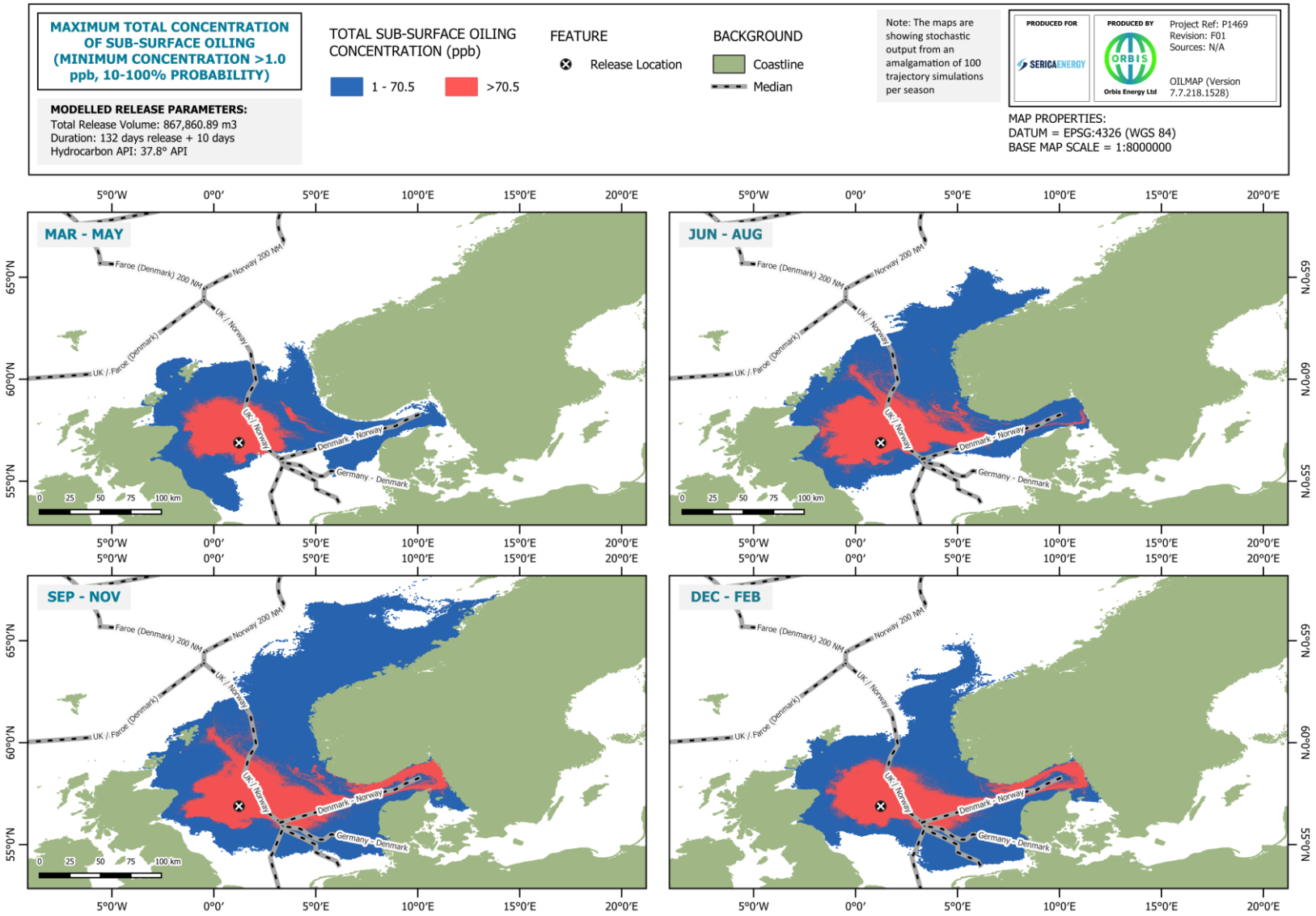


Figure F.9: Probability of Shoreline Oiling

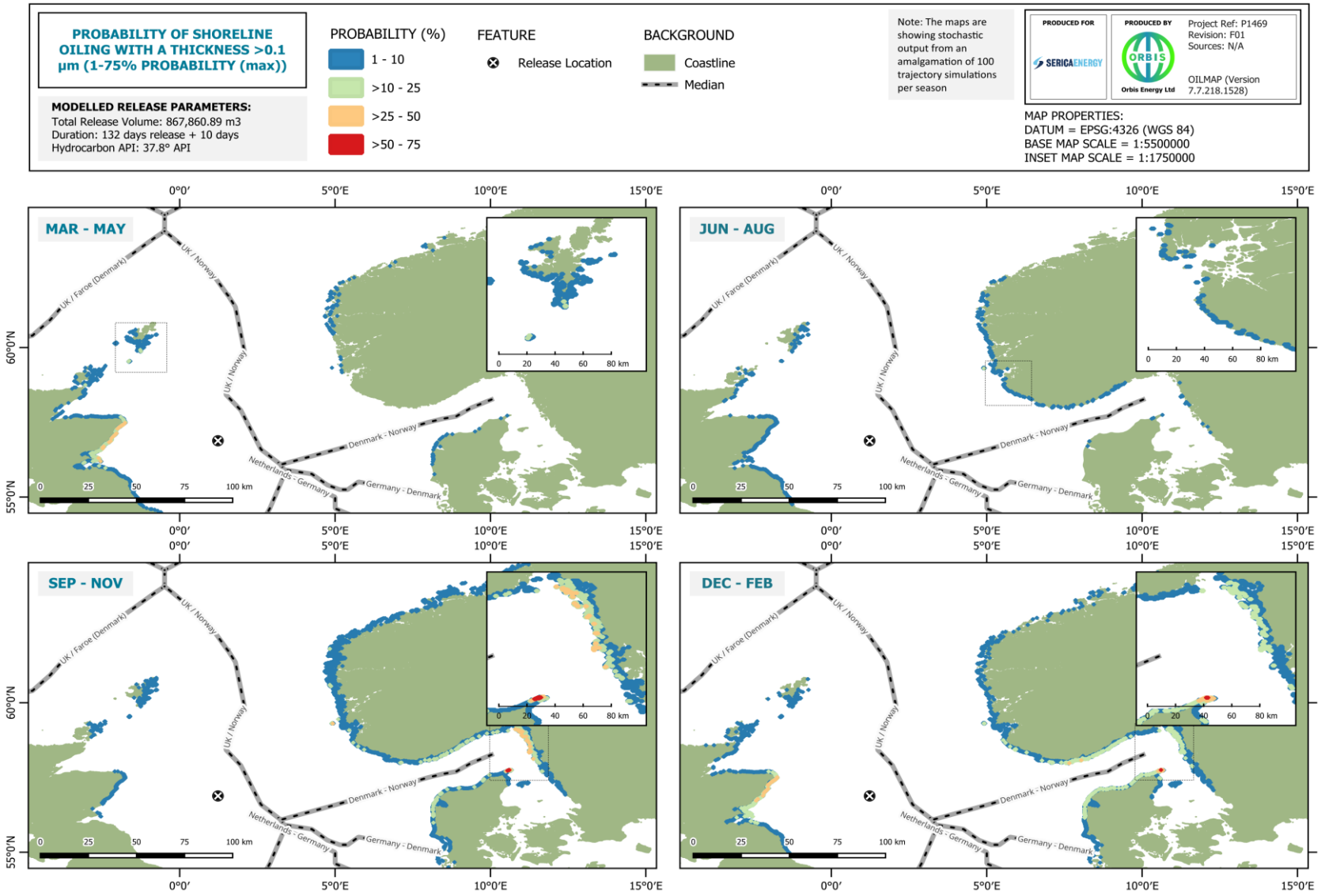


Figure F.10: Minimum Arrival Time of Oil to Shoreline Cells

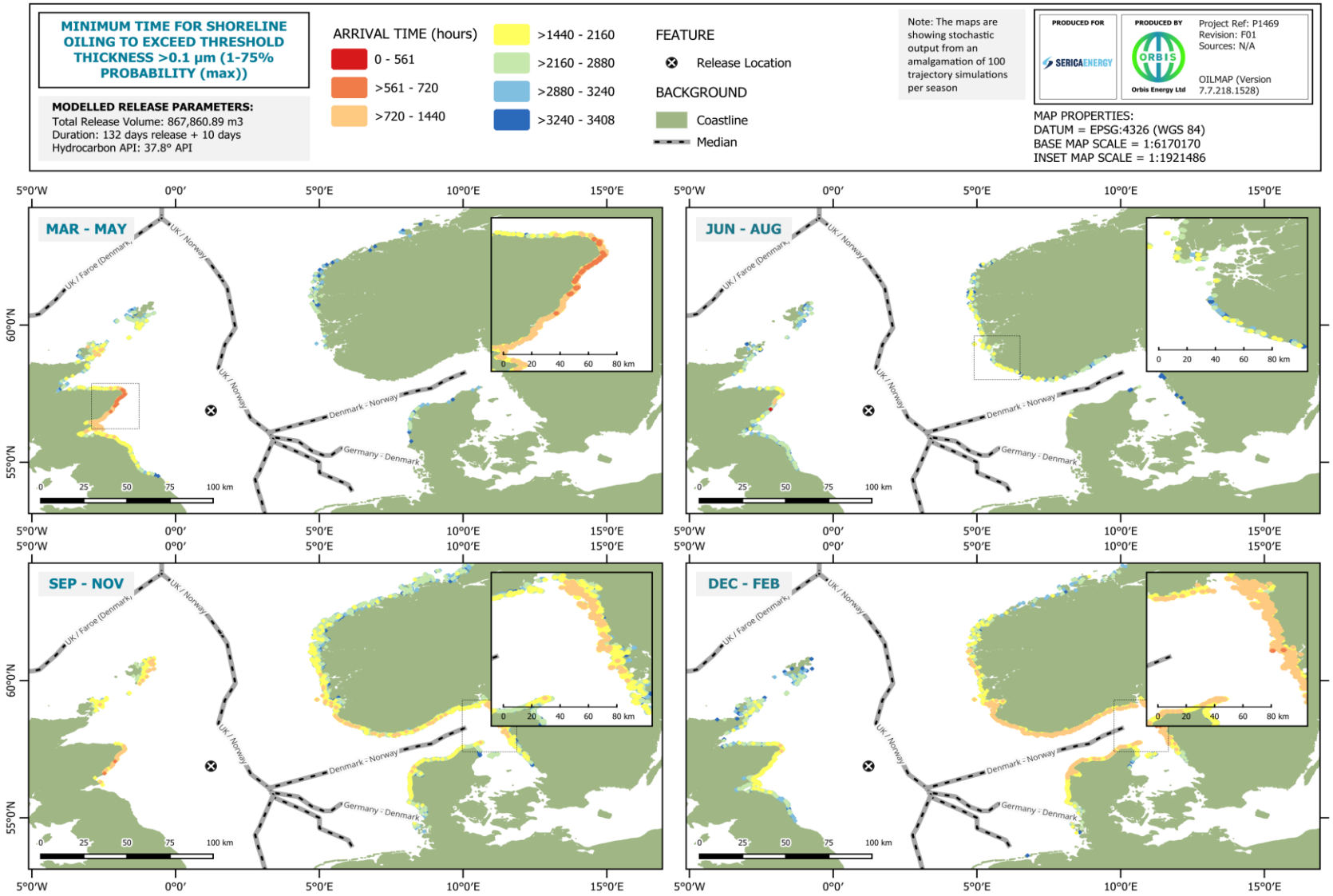
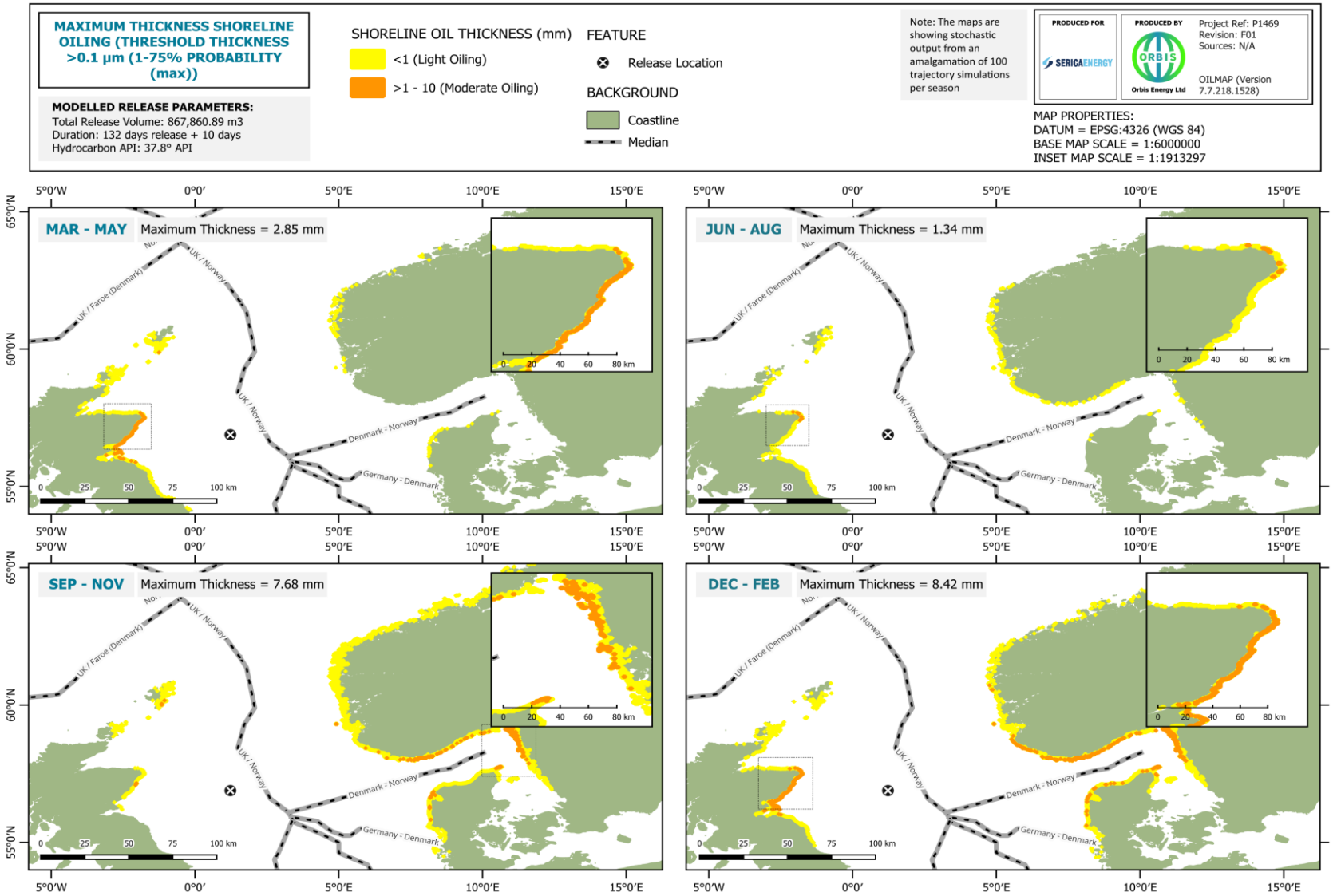


Figure F.11: Maximum Shoreline Oiling Thickness



F.3.3 Protected Areas at Risk

Stochastic Analysis for Protected Areas at Risk

Table F.7 lists the protected areas at risk from oiling. The worst-case probability, minimum time and severity of oiling is reported for surface, shoreline and subsurface oil across all seasons.

Table F.7: Protected Areas at Risk from Surface, Shoreline and Subsurface Oiling [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 F.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table F.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table F.4)
Special Protected Areas (SPA) with Marine Components									
Auskerry SPA	14 %	1,349 hrs	Bonn Code: 3 Metallic	N/A	N/A	N/A	24 %	1,353 hrs	Below OSPAR PNEC (<70.5 ppb)
Bluemull and Colgrave Sounds SPA	8 %	1,377 hrs	Bonn Code: 3 Metallic	3 %	1,398 hrs	Light Oiling (0.001 – 1 litres / m^2)	18 %	1,228 hrs	Below OSPAR PNEC (<70.5 ppb)
Buchan Ness to Collieston Coast SPA	68 %	634 hrs	Bonn Code: 3 Metallic	39 %	647 hrs	Moderate Oiling (1 – 10 litres / m^2)	61 %	653 hrs	Above OSPAR PNEC (>70.5 ppb)
Calf of Eday SPA	2 %	1,868 hrs	Bonn Code: 3 Metallic	1 %	1,963 hrs	Light Oiling (0.001 – 1 litres / m^2)	19 %	1,326 hrs	Below OSPAR PNEC (<70.5 ppb)
Copinsay SPA	33 %	1,234 hrs	Bonn Code: 3 Metallic	6 %	1,393 hrs	Light Oiling (0.001 – 1 litres / m^2)	43 %	1,247 hrs	Below OSPAR PNEC (<70.5 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 F.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table F.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table F.4)
East Caithness Cliffs SPA	10 %	1,719 hrs	Bonn Code: 3 Metallic	3 %	1,844 hrs	Light Oiling (0.001 – 1 litres / m^2)	10 %	1,726 hrs	Below OSPAR PNEC (<70.5 ppb)
East Mainland Coast Shetland SPA	12 %	712 hrs	Bonn Code: 3 Metallic	8 %	955 hrs	Light Oiling (0.001 – 1 litres / m^2)	30 %	801 hrs	Above OSPAR PNEC (>70.5 ppb)
East Sanday Coast SPA	5 %	1,551 hrs	Bonn Code: 3 Metallic	2 %	1,510 hrs	Light Oiling (0.001 – 1 litres / m^2)	N/A	N/A	N/A
Fair Isle SPA	48 %	1,052 hrs	Bonn Code: 3 Metallic	12 %	1,572 hrs	Light Oiling (0.001 – 1 litres / m^2)	71 %	1,041 hrs	Above OSPAR PNEC (>70.5 ppb)
Fetlar SPA	15 %	747 hrs	Bonn Code: 3 Metallic	4 %	1,104 hrs	Light Oiling (0.001 – 1 litres / m^2)	N/A	N/A	N/A
Firth of Forth SPA	27 %	1,459 hrs	Bonn Code: 3 Metallic	10 %	1,465 hrs	Light Oiling (0.001 – 1 litres / m^2)	51 %	1,420 hrs	Above OSPAR PNEC (>70.5 ppb)
Flamborough and Filey Coast SPA	N/A	N/A	N/A	N/A	N/A	N/A	18 %	2,350 hrs	Below OSPAR PNEC (<70.5 ppb)
Forth Islands SPA	49 %	804 hrs	Bonn Code: 3 Metallic	33 %	1,233 hrs	Moderate Oiling (1 – 10 litres / m^2)	67 %	828 hrs	Above OSPAR PNEC (>70.5 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 F.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table F.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table F.4)
Fowlsheugh SPA	61 %	554 hrs	Bonn Code: 3 Metallic	18 %	816 hrs	Moderate Oiling (1 – 10 litres / m^2)	57 %	668 hrs	Above OSPAR PNEC (>70.5 ppb)
Greater Wash SPA	N/A	N/A	N/A	N/A	N/A	N/A	13 %	2607 hrs	Below OSPAR PNEC (<70.5 ppb)
Hermaness, Saxa Vord and Valla Field SPA	3 %	1,213 hrs	Bonn Code: 2 Rainbow	1 %	2,059 hrs	Light Oiling (0.001 – 1 litres / m^2)	18 %	1,183 hrs	Below OSPAR PNEC (<70.5 ppb)
Hoy SPA	10 %	1,511 hrs	Bonn Code: 3 Metallic	1 %	3,028 hrs	Light Oiling (0.001 – 1 litres / m^2)	16 %	2,043 hrs	Below OSPAR PNEC (<70.5 ppb)
Humber Estuary SPA	1 %	3,271 hrs	Bonn Code: 3 Metallic	N/A	N/A	N/A	1 %	3,355 hrs	Below OSPAR PNEC (<70.5 ppb)
Loch of Strathbeg SPA	N/A	N/A	N/A	8 %	661 hrs	Moderate Oiling (1 – 10 litres / m^2)	N/A	N/A	N/A
Marwick Head SPA	N/A	N/A	N/A	N/A	N/A	N/A	10 %	2,361 hrs	Below OSPAR PNEC (<70.5 ppb)
Moray Firth SPA	14 %	1,607 hrs	Bonn Code: 3 Metallic	5 %	1,659 hrs	Light Oiling (0.001 – 1 litres / m^2)	18 %	1,504 hrs	Below OSPAR PNEC (<70.5 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 F.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table F.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table F.4)
Mousa SPA	N/A	N/A	N/A	8 %	1,209 hrs	Light Oiling (0.001 – 1 litres / m^2)	50 %	982 hrs	Above OSPAR PNEC (>70.5 ppb)
North Caithness Cliffs SPA	14 %	1,612 hrs	Bonn Code: 3 Metallic	2 %	1,617 hrs	Light Oiling (0.001 – 1 litres / m^2)	17 %	1,832 hrs	Below OSPAR PNEC (<70.5 ppb)
North Orkney SPA	8 %	1,373 hrs	Bonn Code: 3 Metallic	2 %	1,391 hrs	Light Oiling (0.001 – 1 litres / m^2)	16 %	1,429 hrs	Below OSPAR PNEC (<70.5 ppb)
Northumberland Marine SPA	29 %	1,298 hrs	Bonn Code: 3 Metallic	N/A	N/A	N/A	59 %	1,210 hrs	Above OSPAR PNEC (>70.5 ppb)
Noss SPA	17 %	1,325 hrs	Bonn Code: 3 Metallic	6 %	1,366 hrs	Light Oiling (0.001 – 1 litres / m^2)	32 %	896 hrs	Above OSPAR PNEC (>70.5 ppb)
Outer Firth of Forth and St Andrews Bay Complex SPA	59 %	424 hrs	Bonn Code: 3 Metallic	33 %	953 hrs	Moderate Oiling (1 – 10 litres / m^2)	68 %	398 hrs	Above OSPAR PNEC (>70.5 ppb)
Outer Thames Estuary SPA	N/A	N/A	N/A	N/A	N/A	N/A	1 %	3,008 hrs	Below OSPAR PNEC (<70.5 ppb)
Papa Stour SPA	2 %	2,904 hrs	Bonn Code: 3 Metallic	1 %	2,908 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 F.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table F.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table F.4)
Rousay SPA	5 %	1,212 hrs	Bonn Code: 3 Metallic	1 %	1,219 hrs	Light Oiling (0.001 – 1 litres / m^2)	N/A	N/A	N/A
Scapa Flow SPA	25 %	1,334 hrs	Bonn Code: 3 Metallic	N/A	N/A	N/A	35 %	1,321 hrs	Above OSPAR PNEC (>70.5 ppb)
Seas Off Foula SPA	36 %	1,123 hrs	Bonn Code: 3 Metallic	N/A	N/A	N/A	70 %	1,033 hrs	Above OSPAR PNEC (>70.5 ppb)
Sumburgh Head SPA	41 %	1,093 hrs	Bonn Code: 3 Metallic	12 %	1,420 hrs	Moderate Oiling (1 – 10 litres / m^2)	70 %	991 hrs	Above OSPAR PNEC (>70.5 ppb)
Teesmouth and Cleveland Coast SPA	3 %	2,111 hrs	Bonn Code: 3 Metallic	1 %	2,201 hrs	Light Oiling (0.001 – 1 litres / m^2)	33 %	2,093 hrs	Below OSPAR PNEC (<70.5 ppb)
Troup, Pennan and Lion's Heads SPA	23 %	1,219 hrs	Bonn Code: 3 Metallic	7 %	1,284 hrs	Light Oiling (0.001 – 1 litres / m^2)	19 %	826 hrs	Below OSPAR PNEC (<70.5 ppb)
West Westray SPA	3 %	1,208 hrs	Bonn Code: 3 Metallic	2 %	2,630 hrs	Light Oiling (0.001 – 1 litres / m^2)	18 %	1,420 hrs	Below OSPAR PNEC (<70.5 ppb)
Ythan Estuary, Sands of Forvie and Meikle Loch SPA	64 %	620 hrs	Bonn Code: 3 Metallic	39 %	637 hrs	Moderate Oiling (1 – 10 litres / m^2)	61 %	679 hrs	Above OSPAR PNEC (>70.5 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 F.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table F.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table F.4)
Special Area of Conservation (SAC) with Marine Components									
Berwickshire and North Northumberland Coast SAC	30 %	905 hrs	Bonn Code: 3 Metallic	10 %	1,281 hrs	Moderate Oiling (1 – 10 litres / m^2)	58 %	979 hrs	Above OSPAR PNEC (>70.5 ppb)
Braemar Pockmarks SAC	N/A	N/A	N/A	N/A	N/A	N/A	100 %	422 hrs	Above OSPAR PNEC (>70.5 ppb)
Dogger Bank SAC	N/A	N/A	N/A	N/A	N/A	N/A	56 %	941 hrs	Below OSPAR PNEC (<70.5 ppb)
East Caithness Cliffs SAC	N/A	N/A	N/A	2 %	2,970 hrs	Light Oiling (0.001 – 1 litres / m^2)	N/A	N/A	N/A
Fair Isle SAC	N/A	N/A	N/A	11 %	1,984 hrs	Light Oiling (0.001 – 1 litres / m^2)	N/A	N/A	N/A
Faray and Holm of Faray SAC	2 %	1,858 hrs	Bonn Code: 3 Metallic	N/A	N/A	N/A	17 %	1,416 hrs	Below OSPAR PNEC (<70.5 ppb)
Firth of Tay and Eden Estuary SAC	54 %	924 hrs	Bonn Code: 3 Metallic	17 %	953 hrs	Moderate Oiling (1 – 10 litres / m^2)	54 %	792 hrs	Below OSPAR PNEC (<70.5 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 F.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table F.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table F.4)
Flamborough Head SAC	N/A	N/A	N/A	N/A	N/A	N/A	14 %	2,513 hrs	Below OSPAR PNEC (<70.5 ppb)
Hoy SAC	N/A	N/A	N/A	1 %	3,334 hrs	Light Oiling (0.001 – 1 litres / m^2)	N/A	N/A	N/A
Humber Estuary SAC	1 %	3,271 hrs	Bonn Code: 3 Metallic	N/A	N/A	N/A	1 %	3,345 hrs	Below OSPAR PNEC (<70.5 ppb)
Inner Dowsing Race Bank and North Ridge SAC	N/A	N/A	N/A	N/A	N/A	N/A	7 %	2,817 hrs	Below OSPAR PNEC (<70.5 ppb)
Isle of May SAC	N/A	N/A	N/A	N/A	N/A	N/A	62 %	831 hrs	Below OSPAR PNEC (<70.5 ppb)
Lower River Spey – Spey Bay SAC	N/A	N/A	N/A	3 %	2,429 hrs	Light Oiling (0.001 – 1 litres / m^2)	N/A	N/A	N/A
Moray Firth SAC	N/A	N/A	N/A	N/A	N/A	N/A	10 %	1,627 hrs	Below OSPAR PNEC (<70.5 ppb)
Mousa SAC	N/A	N/A	N/A	24 %	1,270 hrs	Moderate Oiling (1 – 10 litres / m^2)	51 %	981 hrs	Above OSPAR PNEC (>70.5 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 F.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table F.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table F.4)
North Fetlar SAC	N/A	N/A	N/A	2 %	1,707 hrs	Light Oiling (0.001 – 1 litres / m^2)	N/A	N/A	N/A
North Norfolk Sandbanks and Saturn Reef SAC	N/A	N/A	N/A	N/A	N/A	N/A	6 %	2,584 hrs	Below OSPAR PNEC (<70.5 ppb)
Papa Stour SAC	N/A	N/A	N/A	2 %	2,908 hrs	Light Oiling (0.001 – 1 litres / m^2)	32 %	1,621 hrs	Below OSPAR PNEC (<70.5 ppb)
Pobie Bank Reef SAC	N/A	N/A	N/A	N/A	N/A	N/A	40 %	587 hrs	Above OSPAR PNEC (>70.5 ppb)
River Dee SAC	24 %	2,042 hrs	Bonn Code: 3 Metallic	N/A	N/A	N/A	7 %	1,981 hrs	Below OSPAR PNEC (<70.5 ppb)
Sanday SAC	8 %	1,208 hrs	Bonn Code: 3 Metallic	3 %	1,510 hrs	Light Oiling (0.001 – 1 litres / m^2)	19 %	1,201 hrs	Below OSPAR PNEC (<70.5 ppb)
Sands of Forvie SAC	N/A	N/A	N/A	4 %	2,627 hrs	Moderate Oiling (1 – 10 litres / m^2)	N/A	N/A	N/A
Scanner Pockmark SAC	N/A	N/A	N/A	N/A	N/A	N/A	100 %	306 hrs	Above OSPAR PNEC (>70.5 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 F.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table F.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table F.4)
Solan Bank Reef SAC	N/A	N/A	N/A	N/A	N/A	N/A	1 %	3,363 hrs	Below OSPAR PNEC (<70.5 ppb)
Southern North Sea SAC	N/A	N/A	N/A	N/A	N/A	N/A	35 %	924 hrs	Below OSPAR PNEC (<70.5 ppb)
Sullom Voe SAC	1 %	2,425 hrs	Bonn Code: 3 Metallic	N/A	N/A	N/A	12 %	2,025 hrs	Below OSPAR PNEC (<70.5 ppb)
The Wash and North Norfolk Coast SAC	N/A	N/A	N/A	N/A	N/A	N/A	2 %	3,150 hrs	Below OSPAR PNEC (<70.5 ppb))
Yell Sound Coast SAC	4 %	1,805 hrs	Bonn Code: 3 Metallic	2 %	1,815 hrs	Light Oiling (0.001 – 1 litres / m^2)	19 %	1,159 hrs	Below OSPAR PNEC (<70.5 ppb))
RAMSAR									
Cromarty Firth RAMSAR	N/A	N/A	N/A	N/A	N/A	N/A	1 %	3,182 hrs	Below OSPAR PNEC (<70.5 ppb)
Dornoch Firth and Loch Fleet RAMSAR	N/A	N/A	N/A	N/A	N/A	N/A	2 %	2,924 hrs	Below OSPAR PNEC (<70.5 ppb)
East Sanday Coast RAMSAR	5 %	1,551 hrs	Bonn Code: 3 Metallic	2 %	1,510 hrs	Light Oiling (0.001 – 1 litres / m^2)	18 %	1,315 hrs	Below OSPAR PNEC (<70.5 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 F.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table F.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table F.4)
Firth of Forth RAMSAR	N/A	N/A	N/A	13 %	1,465 hrs	Moderate Oiling (1 – 10 litres / m^2)	N/A	N/A	N/A
Firth of Tay and Eden Estuary RAMSAR	N/A	N/A	N/A	17 %	953 hrs	Moderate Oiling (1 – 10 litres / m^2)	N/A	N/A	N/A
Humber Estuary RAMSAR	1 %	3,271 hrs	Bonn Code: 3 Metallic	N/A	N/A	N/A	1 %	3,355 hrs	Below OSPAR PNEC (<70.5 ppb)
Loch of Strathbeg RAMSAR	N/A	N/A	N/A	8 %	661 hrs	Moderate Oiling (1 – 10 litres / m^2)	N/A	N/A	N/A
Moray and Nairn Coast RAMSAR	N/A	N/A	N/A	N/A	N/A	N/A	2 %	2,082 hrs	Below OSPAR PNEC (<70.5 ppb)
Ronas Hill – North Roe and Tingon RAMSAR	N/A	N/A	N/A	N/A	N/A	N/A	10 %	1,593 hrs	Below OSPAR PNEC (<70.5 ppb)
Nature Conservation Marine Protected Areas (NC MPA)									
Central Fladen NC MPA	N/A	N/A	N/A	N/A	N/A	N/A	100 %	511 hrs	Above OSPAR PNEC (>70.5 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 F.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table F.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table F.4)
East Caithness Cliffs NC MPA	10 %	1,719 hrs	Bonn Code: 3 Metallic	3 %	1,844 hrs	Light Oiling (0.001 – 1 litres / m^2)	10 %	1,726 hrs	Below OSPAR PNEC (<70.5 ppb)
East of Gannet and Montrose Fields NC MPA	100 %	13 hrs	Bonn Code: 5 (Continuous True Oil Colour)	N/A	N/A	N/A	100 %	13 hrs	Above OSPAR PNEC (>70.5 ppb)
Faroe- Shetland Sponge Belt NC MPA	N/A	N/A	N/A	N/A	N/A	N/A	3 %	2,344 hrs	Below OSPAR PNEC (<70.5 ppb)
Fetlar to Haroldswick NC MPA	15 %	747 hrs	Bonn Code: 3 Metallic	4 %	1,104 hrs	Light Oiling (0.001 – 1 litres / m^2)	19 %	737 hrs	Above OSPAR PNEC (>70.5 ppb)
Firth of Forth Banks Complex NC MPA	71 %	265 hrs	Bonn Code: 3 Metallic	N/A	N/A	N/A	77 %	309 hrs	Above OSPAR PNEC (>70.5 ppb)
Mousa to Boddam NC MPA	24 %	1,021 hrs	Bonn Code: 3 Metallic	N/A	N/A	N/A	55 %	982 hrs	Above OSPAR PNEC (>70.5 ppb)
North- east Faroe-Shetland Channel NC MPA	N/A	N/A	N/A	N/A	N/A	N/A	8 %	943 hrs	Below OSPAR PNEC (<70.5 ppb)
North West Orkney NC MPA	22 %	1,384 hrs	Bonn Code: 3 Metallic	N/A	N/A	N/A	48 %	1,081 hrs	Below OSPAR PNEC (<70.5 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 F.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table F.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table F.4)
Norwegian Boundary Sediment Plain NC MPA	N/A	N/A	N/A	N/A	N/A	N/A	100 %	227 hrs	Above OSPAR PNEC (>70.5 ppb)
Noss Head NC MPA	12 %	1,645 hrs	Bonn Code: 3 Metallic	N/A	N/A	N/A	7 %	1,809 hrs	Below OSPAR PNEC (<70.5 ppb)
Papa Westray NC MPA	2 %	1,880 hrs	Bonn Code: 3 Metallic	1 %	3,158 hrs	Light Oiling (0.001 – 1 litres / m^2)	16 %	1,291 hrs	Below OSPAR PNEC (<70.5 ppb)
Solan Bank Reef NC MPA	N/A	N/A	N/A	N/A	N/A	N/A	1 %	3,363 hrs	Below OSPAR PNEC (<70.5 ppb)
Southern Trench NC MPA	76 %	493 hrs	Bonn Code: 3 Metallic	N/A	N/A	N/A	78 %	446 hrs	Above OSPAR PNEC (>70.5 ppb)
Turbot Bank NC MPA	99 %	348 hrs	Bonn Code: 3 Metallic	N/A	N/A	N/A	97 %	368 hrs	Above OSPAR PNEC (>70.5 ppb)
West Shetland Shelf NC MPA	N/A	N/A	N/A	N/A	N/A	N/A	1 %	3,086 hrs	Below OSPAR PNEC (<70.5 ppb)
Wyre and Rousay Sounds NC MPA	4 %	1,215 hrs	Bonn Code: 3 Metallic	N/A	N/A	N/A	3 %	1,918 hrs	Below OSPAR PNEC (<70.5 ppb)
Marine Conservation Zones (MCZ)									

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 F.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table F.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table F.4)
Berwick to St Mary's MCZ	30 %	1,281 hrs	Bonn Code: 3 Metallic	7 %	1,558 hrs	Light Oiling (0.001 – 1 litres / m^2)	55 %	1,122 hrs	Below OSPAR PNEC (<70.5 ppb)
Cromer Shoal Chalk Beds MCZ	N/A	N/A	N/A	N/A	N/A	N/A	2 %	3,127 hrs	Below OSPAR PNEC (<70.5 ppb))
Farnes East MCZ	N/A	N/A	N/A	N/A	N/A	N/A	62 %	1,035 hrs	Below OSPAR PNEC (<70.5 ppb)
Fulmar MCZ	N/A	N/A	N/A	N/A	N/A	N/A	100 %	72 hrs	Above OSPAR PNEC (>70.5 ppb)
Holderness Inshore MCZ	N/A	N/A	N/A	N/A	N/A	N/A	8 %	2,790 hrs	Below OSPAR PNEC (<70.5 ppb)
Holderness Offshore MCZ	N/A	N/A	N/A	N/A	N/A	N/A	20 %	2,110 hrs	Below OSPAR PNEC (<70.5 ppb)
Kentish Knock East MCZ	N/A	N/A	N/A	N/A	N/A	N/A	1 %	3,046 hrs	Below OSPAR PNEC (<70.5 ppb)
Markham's Triangle MCZ	N/A	N/A	N/A	N/A	N/A	N/A	9 %	2,626 hrs	Below OSPAR PNEC (<70.5 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 F.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table F.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table F.4)
North East of Farnes Deep MCZ	21 %	750 hrs	Bonn Code: 3 Metallic	N/A	N/A	N/A	49 %	914 hrs	Below OSPAR PNEC (<70.5 ppb)
Orford Inshore MCZ	N/A	N/A	N/A	N/A	N/A	N/A	1 %	3,024 hrs	Below OSPAR PNEC (<70.5 ppb)
Runswick Bay MCZ	N/A	N/A	N/A	N/A	N/A	N/A	30 %	1,582 hrs	Below OSPAR PNEC (<70.5 ppb)
Swallow Land MCZ	N/A	N/A	N/A	N/A	N/A	N/A	96 %	149 hrs	Above OSPAR PNEC (>70.5 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.

F.4 Trajectory Modelling Results

The stochastic modelling results detailed above in Section F.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 142 days model duration).

The worst-case trajectory simulations have been identified by the 'greatest mass of beached oil at any one location'. The following trajectory simulations have been extracted and analysed:

- **Winter (Dec-Feb):** Run No. 33 (Start Date: 03/12/2019; Start Time: 00:00), 10,225.81 tonnes (75,662.67 bbl or 12,030.36 m^3) of oil beached.
- **Spring (Mar-May):** Run No. 52 (Start Date: 19/03/2021; Start Time: 15:00), 2,237.48 tonnes (16,555.53 bbl or 2,632.33 m^3) of oil beached.
- **Summer (Jun-Aug):** Run No. 81 (Start Date: 05/08/2023; Start Time: 23:00), 519.96 tonnes (3,847.28 bbl or 611.72 m^3) of oil beached.
- **Autumn (Sep-Nov):** Run No. 34 (Start Date: 08/11/2019; Start Time: 09:00), 6,096.93 tonnes (45,112.32 bbl or 7,172.86 m^3) of oil beached.

Figure F.12 displays the trajectory simulations spatially, with total swept area of surface and shoreline oiling at 24-hour time steps after 142 days.

Table F.8 provides summary statistics for the trajectory simulations. The fate of the released oil is consistent between seasons with the majority evaporated and degraded after 142 days. The winter and autumn simulations produce the greatest impact on the shoreline.

Table F.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 142 days	Fate of Released oil after 142 days (% of total release) Note 1					
						Ashore	Surface	Water Column	Evaporated	Degraded	Sediment
Winter	33	2 hrs	21,839.60 km^2	643 hrs	617.16 km	0.88	0.68	16.50	40.25	41.70	0.00
Spring	52	2 hrs	14,034.64 km^2	637 hrs	205.64 km	0.20	0.25	17.19	44.25	38.11	0.00
Summer	81	2 hrs	6,771.71 km^2	561 hrs	67.72 km	0.05	0.11	17.63	42.15	40.06	0.00
Autumn	34	2 hrs	13,925.62 km^2	710 hrs	395.34 km	0.58	0.02	17.35	40.27	41.77	0.00

Note 1: Refer to fates analysis graphs (**Winter**: Figure F.13; **Spring**: Figure F.14; **Summer**: Figure F.15; **Autumn**: Figure F.16) showing spill progression over the total simulation time of 142 days (3,408 hours).

Figure F.12: Worst Case Trajectory Simulations Showing Swept Area for Surface and Shoreline Oiling at 24-hour intervals

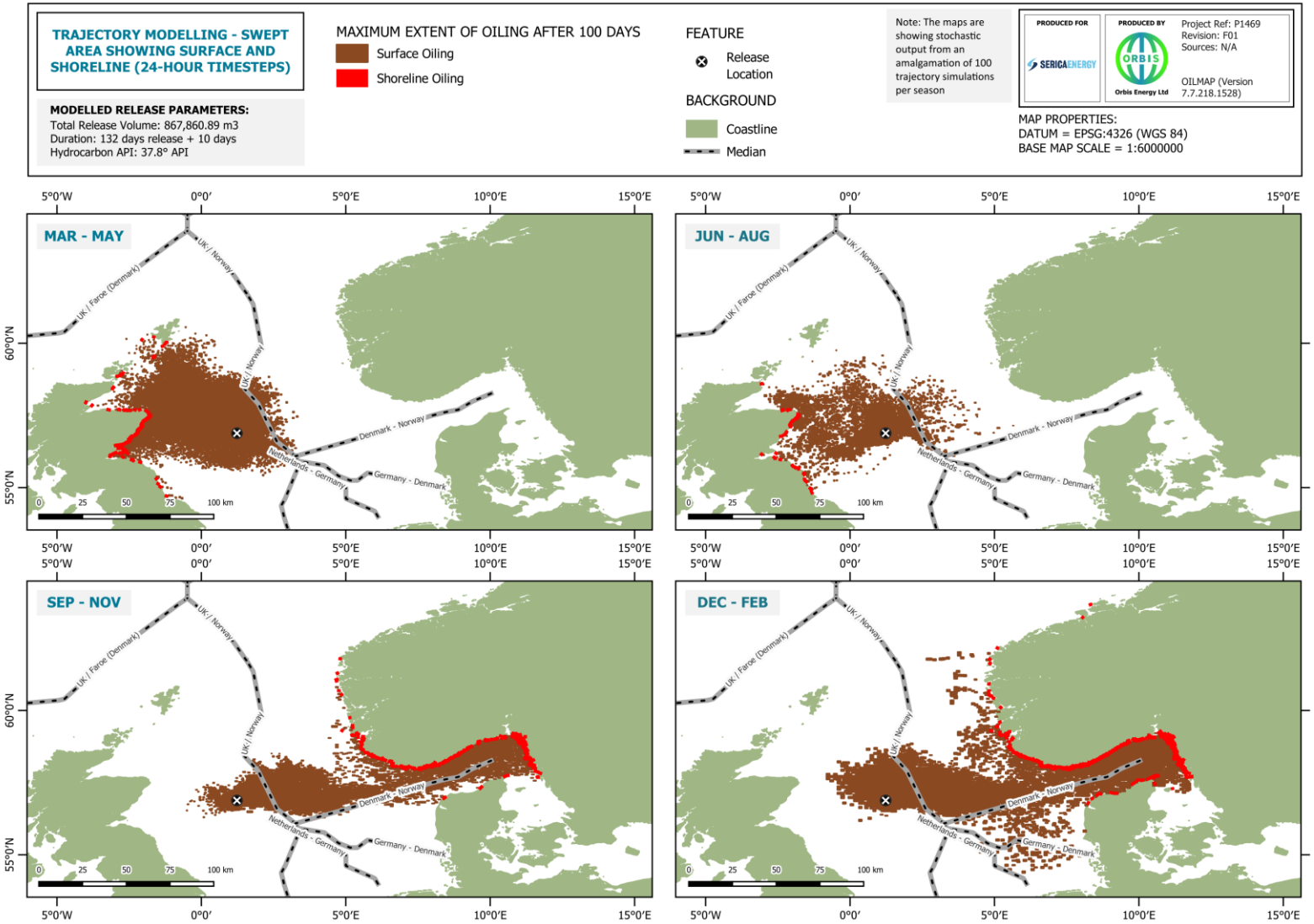


Figure F.13: Fate of the oil released from Winter Run No. 33 (showing model duration 142 days)

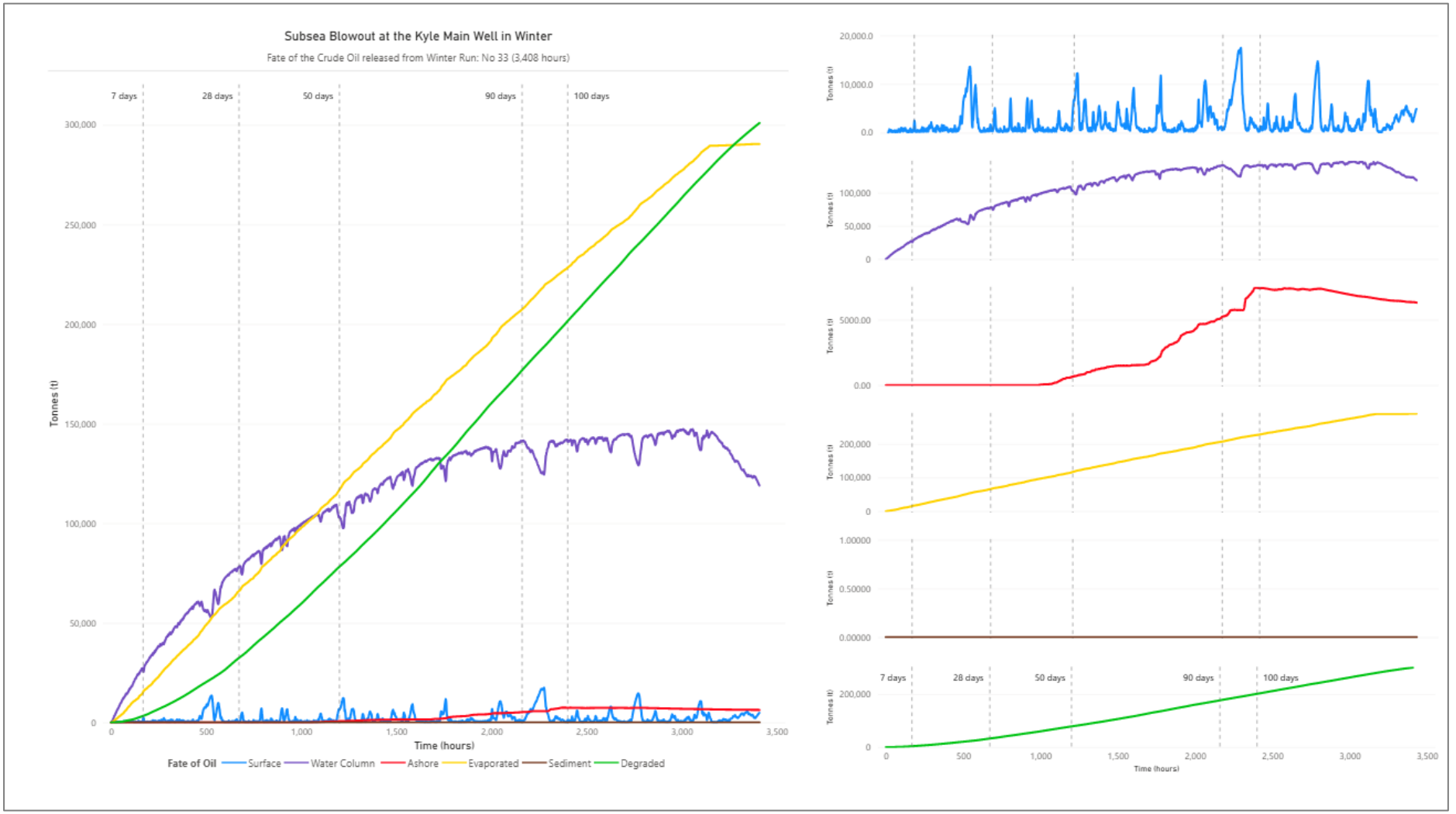


Figure F.14: Fate of the oil released from Spring Run No. 52 (showing model duration 142 days)

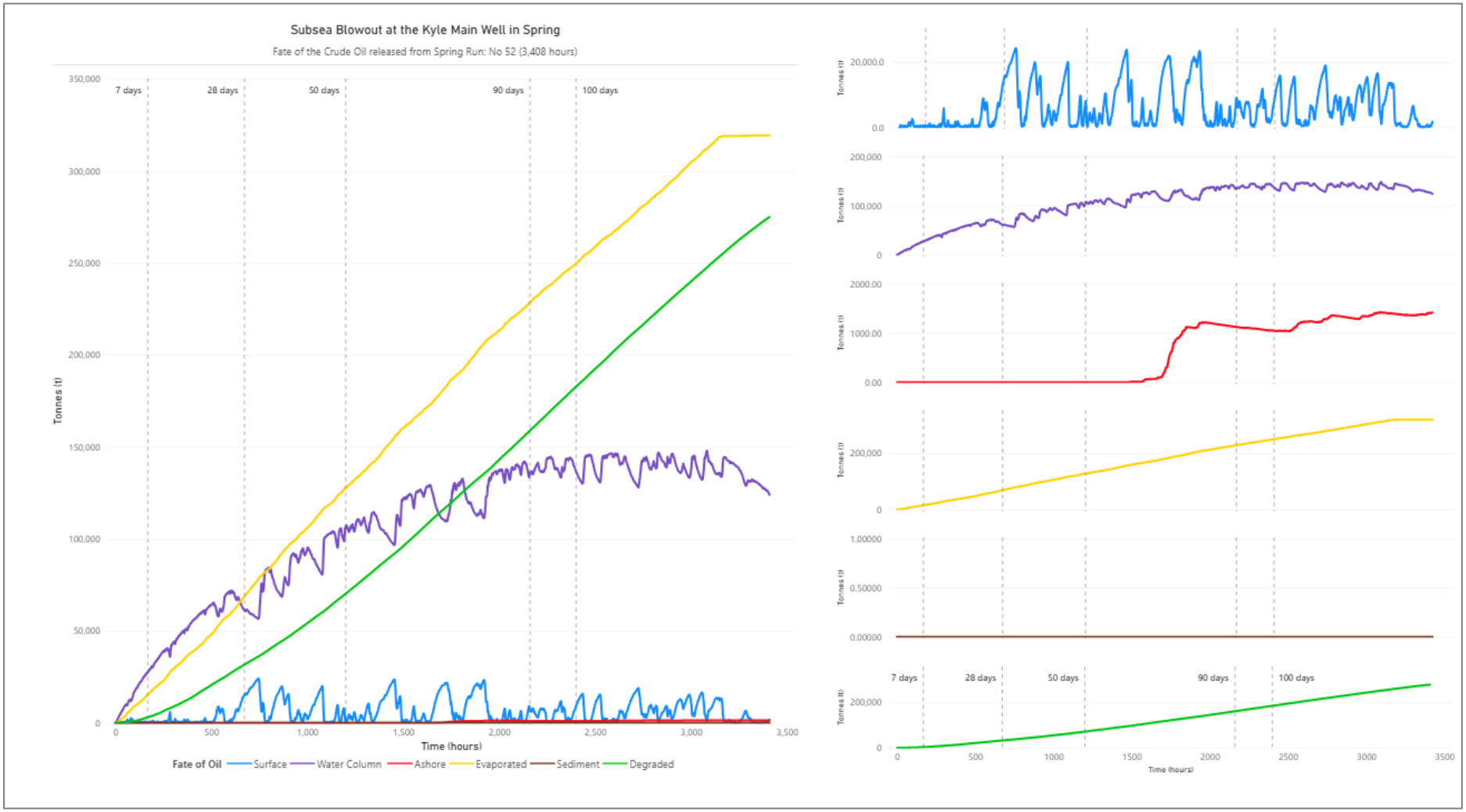


Figure F.15: Fate of the oil released from Summer Run No. 81 (showing model duration 142 days)

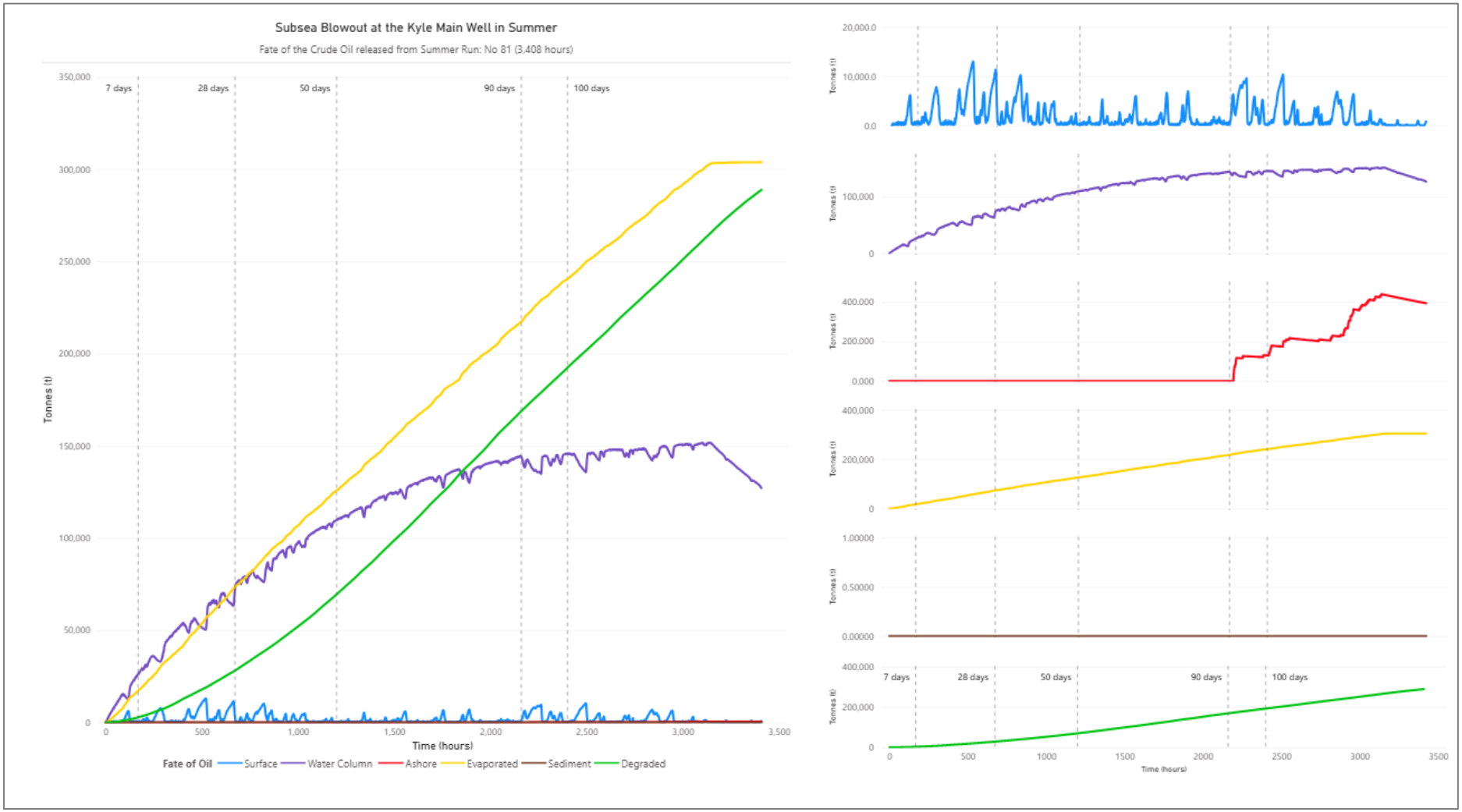
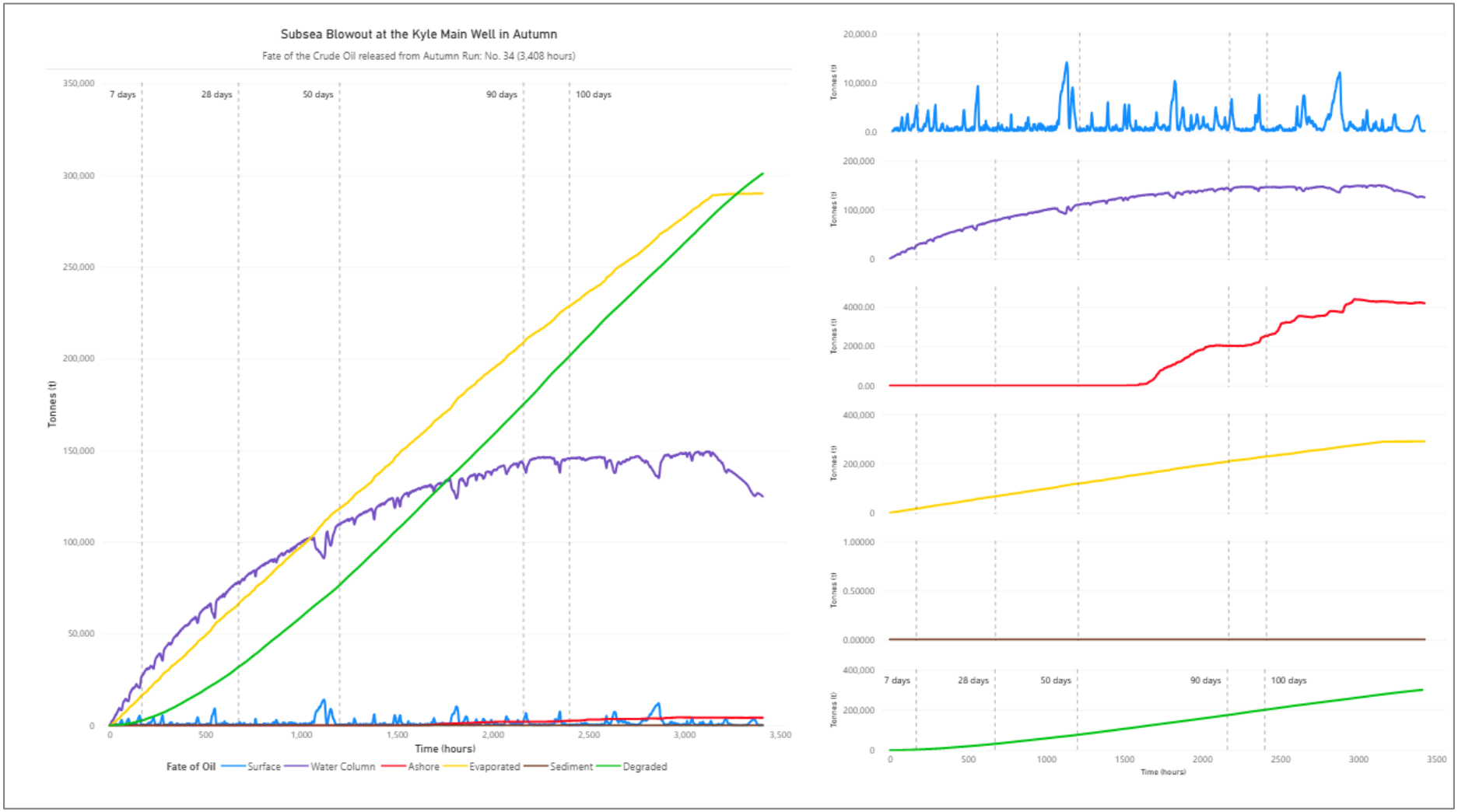


Figure F.16: Fate of the oil released from Autumn Run No. 34 (showing model duration 142 days)

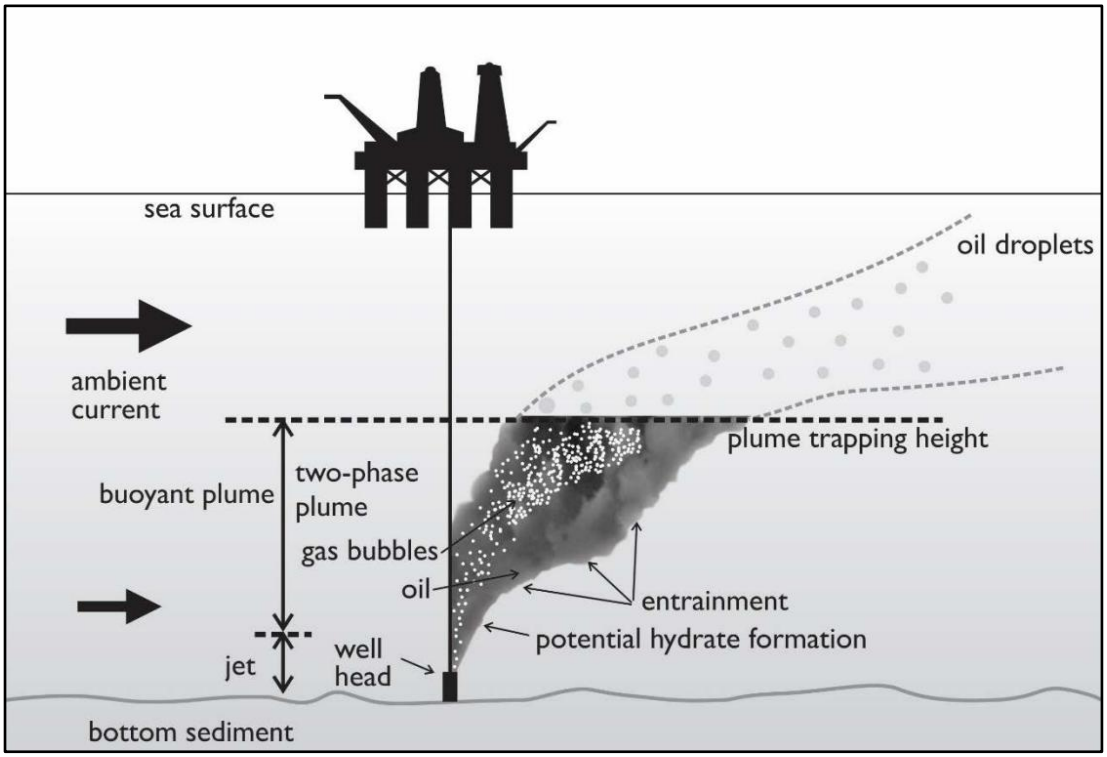


F.5 Vertical Profile Modelling

F.5.1 Background

The OILMAP Deep plume model evaluates the jet and buoyant plume of the oil and gas release near the well release point. Figure F.17 presents a schematic of the various stages of a subsurface release in the water column. The OILMAP Deep blowout model estimates the radius and location of a buoyant oil and gas plume in response to the release parameters and environmental characteristics, tracking the development of the plume until the point where the integrated density of the plume matches the ambient density, through entrainment of surrounding seawater in the stratified ocean. At this depth, the plume buoyancy has decreased to an extent that the oil and gas mixture no longer rises. At this stage the blowout model outputs the locations, volumes, and droplet sizes of the released oil droplets, which then become input to the oil trajectory and fate model.

Figure F.17: Stages of a deep-water blowout plume



Blowout Description

In a subsurface well blowout, discharged materials consisting of a mixture of gaseous and liquid hydrocarbons go through three phases, namely (1) momentum jet, (2) buoyant plume, and (3) oil droplets free-rise and advection-diffusion (Zheng et al., 2003), (as illustrated schematically in Figure F.17):

- **Phase 1 momentum jet:** The difference between the pressure immediately inside the well and that of the ambient water drives the discharge in a momentum jet exiting the blowout orifice. The momentum of the jet dissipates relatively quickly as it entrains surrounding water, and hence the jet zone is always confined to the immediate vicinity of the wellhead, or blowout site (typically on the order of metres, depending on the release hole size). At the blowout opening, the oil in the release is exposed to significant turbulent energy, resulting in the break-up of oil into small droplets. These droplets (typically micrometres to millimetres in diameter) are transported upward with the rising plume.
- **Phase 2 buoyant density plume:** As the discharge moves upward, the density difference between the gas bubbles (and to a lesser extent, oil droplets) in the plume and the ambient waters results in a buoyant force which drives the plume. As the plume rises, it continues to

entrain sea water, increasing the plume's density and radius, and reducing the velocity and buoyancy. The plume gas is in the form of bubbles which are subject to dissolution based on Zheng and Yapa (2002) which serves to reduce the buoyancy. If the ambient currents are strong enough the plume may bend as shown in Figure F.17. Gas bubbles may also separate from the plume if their rise speeds exceed the plume's rise rate. The oil droplets continue to be transported upwards with the plume, but their individual rise velocities contribute little to their upward motion.

- **Phase 3: oil droplets free-rise and advection-diffusion:** When the plume reaches the sea surface or its termination or trap height (all plume buoyancy is lost), it can be deflected in a radial pattern, within a horizontal flow zone, without appreciable loss of momentum. This radial flow carries the oil particles rapidly away from the centre of the plume, while the velocity and oil concentrations in this flow zone decrease with distance from the plume centreline of the release. Subsequently, oil particles ascend to the surface solely driven by their own buoyancy. Rise velocities of oil droplets are much slower than the velocity of a buoyant gas-liquid plume, resulting in particle transport that may take considerably longer to reach the surface and moving further (horizontally) from the release site because of ambient currents.

Of the three phases described above, the OILMAP Deep plume model simulates only Phase 2, the buoyancy driven portion. The assumption is that Phase 1, the momentum jet, is very limited in distance from the release (a few times the diameter of the discharge hole) and hence relatively insignificant in the prediction of the overall plume development and the trap height. Phase 3, the passive oil droplet transport and fate, is simulated using the OILMAP Trajectory and Fates model (far-field oil particle transport and fates).

F.5.2 Blowout Plume (Near-field Modelling Results)

The key inputs for the OILMAP Deep near-field model include the well release rate, GOR, diameter of release hole, and a vertical profile of water temperature and density.

For the Kyla Development blowout scenario, the GOR was 128.2 m^3/m^3 and the diameter of release hole was 0.2204974 m. The water temperature and density profile used in the model for the Kyla Development location is displayed in Figure F.23.

The near-field modelling results provide a description of the plume characteristics, including the plume location (namely plume trap height), plume geometry (plume radius), and the release droplet size distribution. The results of the near-field model are then used to provide the initial conditions for the stochastic and deterministic far-field modelling in OILMAP Trajectory and Fates model, including:

- Termination height (trap height) of the plume;
- Diameter of the plume; and
- Oil droplet size distribution.

Table F.9 presents a summary of the OILMAP Deep plume modelling results from the Kyla Development well blowout scenario by season. There is very little variation in plume formation and behaviour as well as oil droplet formation between seasons.

Table F.9: Predicted blowout plume characteristics for the Kyla Development well blowout scenario by season

Season	Maximum Height of Plume (height above the wellhead)	Time to reach Maximum Height of Plume	Maximum Plume Radius	Maximum Oil Plume Concentration Note 2	Maximum Dissolved Methane Concentration Note 3	Oil Droplet Size (µm) Note 1 (free-rise and advection-diffusion)		
						Minimum	Maximum	Median
Winter	89.55 m	33 seconds	6.58 m	44.091 ppm	0.006 mol/m^3	36.97	356.65	150.28
Spring	89.55 m	33 seconds	6.59 m	44.433 ppm	0.006 mol/m^3	37.10	357.83	150.78
Summer	89.55 m	33 seconds	6.62 m	43.242 ppm	0.006 mol/m^3	36.69	353.90	149.12
Autumn	89.55 m	33 seconds	6.58 m	41.768 ppm	0.005 mol/m^3	36.22	349.35	147.20

Note 1: The oil droplet size distribution is as a histogram in Figure F.19.
Note 2: ppm = parts per million.
Note 3: mol = moles.

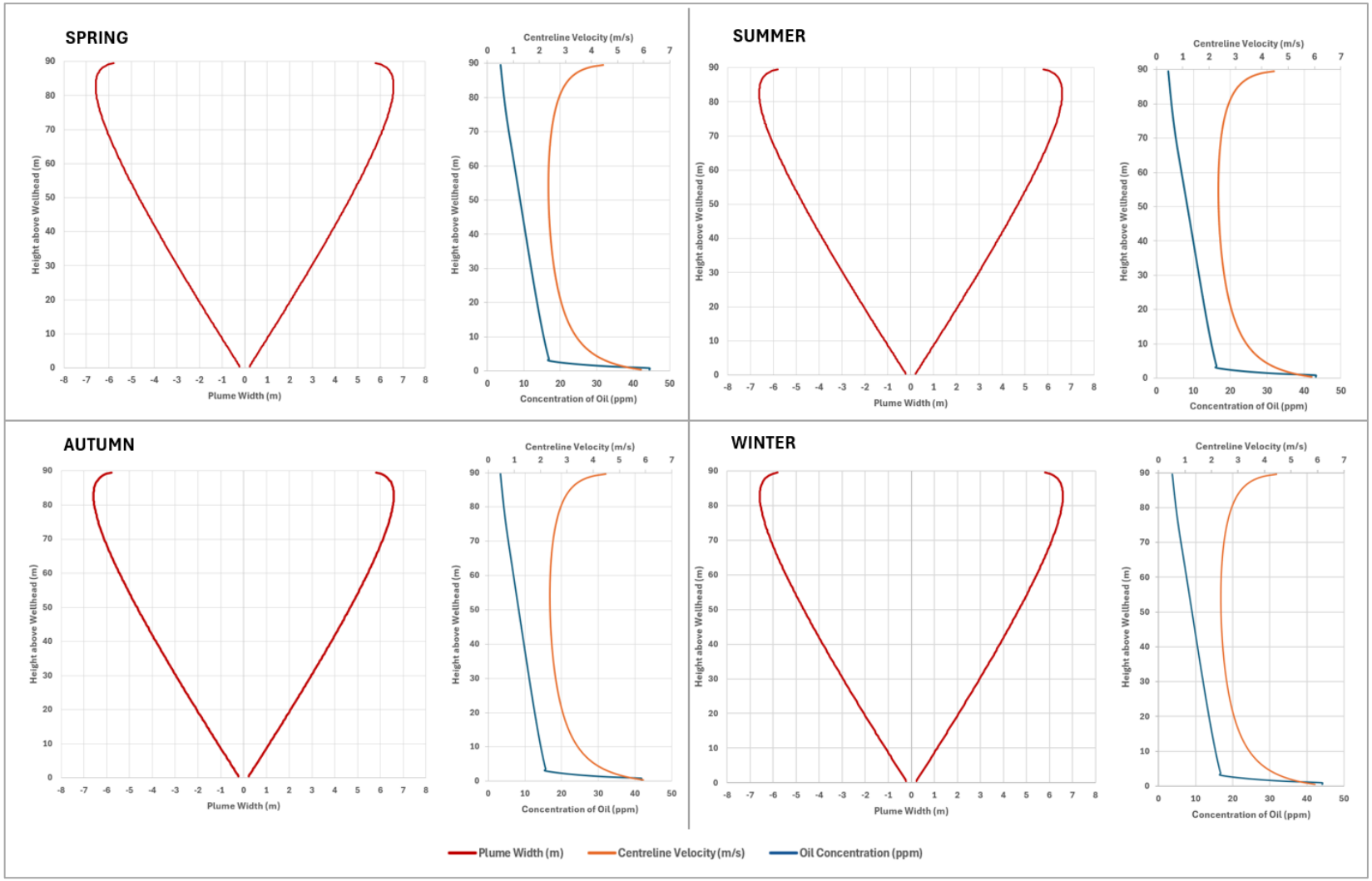
Figure F.18 shows the modelled plume width (positive and negative radius) as a function of the height above the seabed. Across all seasons, the plume exhibits a symmetrical widening from the release point, reaching a maximum width of approximately 13 m. The plume reaches a termination point just below the sea surface (89.55 m above the seabed release location).

The plume centreline velocity defines the vertical movement of the mixture of gas, oil, and water along the centre of the plume. The model shows that the centreline velocity of the plume remains relatively consistent, with peak rise values ca. 6 m/s at depth before a gradual reduction with elevation, where plume momentum is dissipated through entrainment and mixing. A slight increase in the plume centreline velocity is evident close to the sea surface, caused by the interaction with background current shear rather than a true physical acceleration of the plume (Figure F.18). The plume reaches its maximum termination height (89.55 m) after 33 second for all seasons (Table F.9).

Oil concentrations along the plume centreline are highest immediately above the release point (ca.40 ppm) and decline rapidly with height, approaching negligible values before the upper extent of the model domain (Figure F.18).

Seasonal variability in plume width, velocity, and concentration is minimal, indicating that near-field plume behaviour is largely unaffected by seasonal changes in oceanographic conditions. The near-field modelling results indicate that seasonal stratification is not a dominant control on plume behaviour or trap height. The plume rise appears to be controlled primarily by the release momentum and buoyancy flux and by turbulent entrainment, while background tidal and wind-driven mixing in the central North Sea is sufficient to prevent persistent trapping or strong deflection of the plume by seasonal density layers. As a result, the near-field plume geometry and predicted centreline oil concentrations are similar across seasons and potential environmental effects in the immediate vicinity of the release point are expected to be broadly consistent year-round.

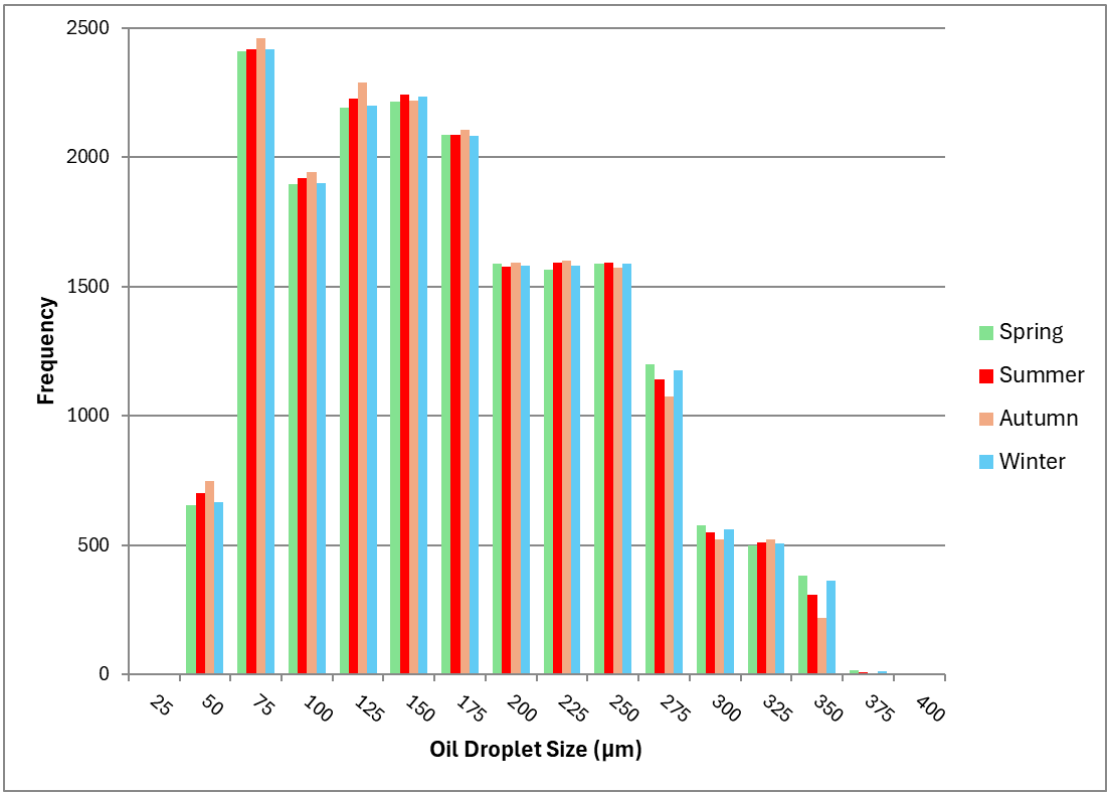
Figure F.18: Predicted blowout plume centreline velocity, oil concentration and plume radius after 132 days versus elevation above the release point for the Kyla Development well blowout scenario by season



The OILMAP Deep near-field modelling also calculates the oil droplet size distribution generated by the blowout. The oil droplets fall out of the plume at termination height and are used in the far-field oil trajectory and fate model (refer to Section F.5.1 and Figure F.17). This oil droplet size distribution has a profound effect on how oil is transported after the initial plume, as the droplet size dictates how long the oil droplet will remain suspended in the water column. Larger droplets are more buoyant and rise relatively quickly to the sea surface, while smaller droplets remain entrained in the water column for longer periods and ascend more slowly. Figure F.19 shows the model-estimated droplet size distribution. The minimum, maximum and median oil droplet sizes are presented in Table F.9. Oil droplet sizes <200 µm account for 61.4% of the spill volume, these droplet sizes are associated with high turbulence and rise very slowly to the sea surface resulting in prolonged water column entrainment. Oil droplets <70 µm (accounting for ca. 16 % of the spill volume) do not rise to the surface and remain within the water column. Oil droplet sizes >200 µm and <1,000 µm account for 38.6 % of the spill volume, these droplet sizes are associated with an intermediate turbulent energy and will rise at a quicker rate (Delvigne and Sweeny, 1988).

The maximum oil droplet size across all seasons modelled was 357.83 µm; a droplet this size was found to surface within 2-hours of dropping out of the plume.

Figure F.19: Oil Droplet Size Distribution



F.5.3 Oil in the Water Column (Far-field Modelling Results)

Of the trajectory modelling detailed in Section F.4, the Spring Trajectory Run No. 52 was identified as having the greatest surface and subsurface oiling within UK waters (refer to Table F.8). Therefore, the Spring Trajectory Run No. 52 has been selected to show the oil concentration and transport in the vertical water column.

Figure F.20, Figure F.21 and Figure F.22 show the oil concentration in the vertical water column at the 1, 25-, 50-, 75-, 100- and 142-day model time stamps. The cross-section line (282 km in length) intersects with the release location to the nearest point on land. The vertical profile model demonstrates that the highest oiling concentrations (>10,000 ppb) are found in the upper water column and only occur near the release location. The vertical profile model for Spring Trajectory Run No. 6 was representative for all seasons.

Figure F.20: Section view and subsurface oiling during spring (Trajectory Run No. 52) after day 1 & day 25

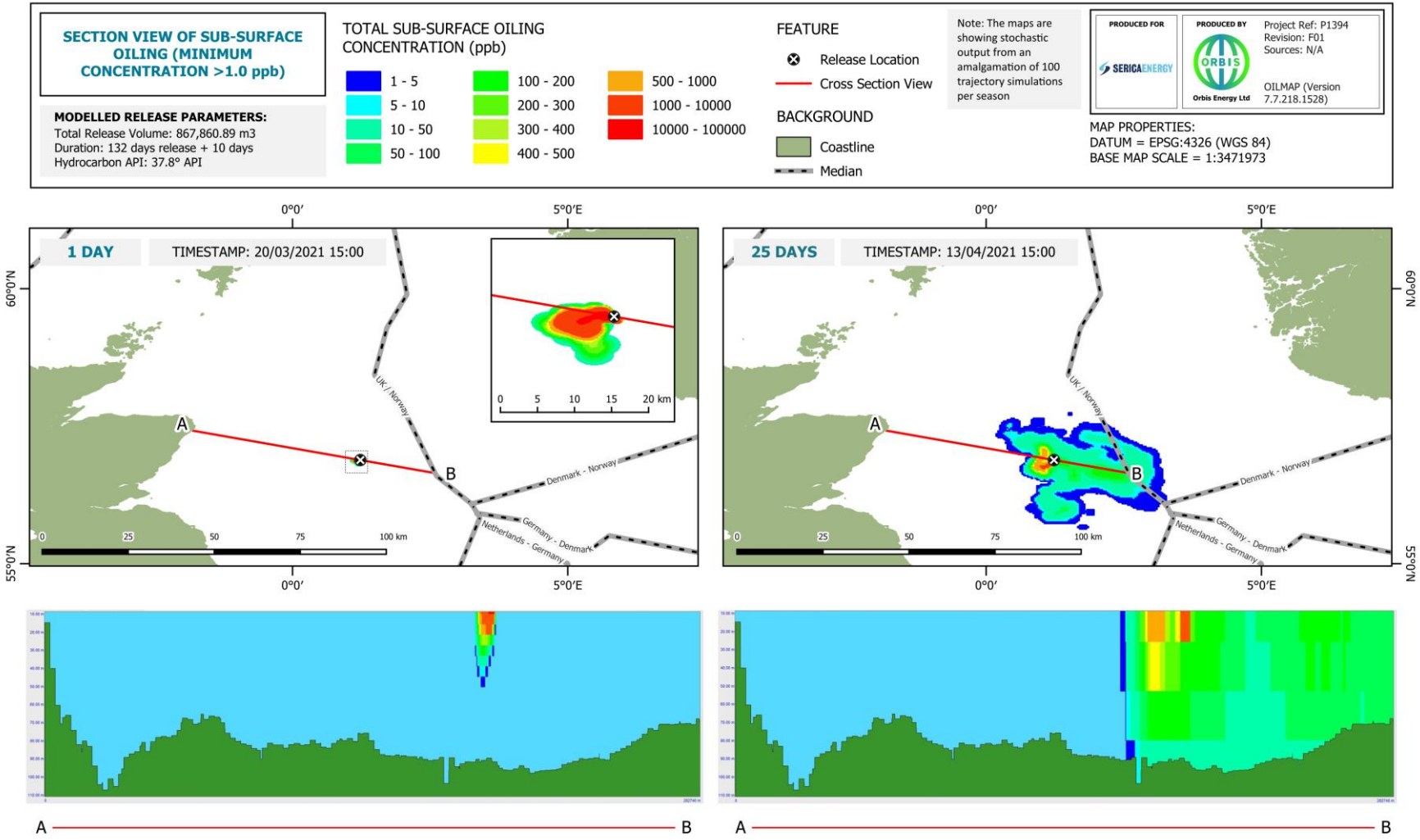


Figure F.21: Section view and subsurface oiling during spring (Trajectory Run No. 52) after day 50 & day 75

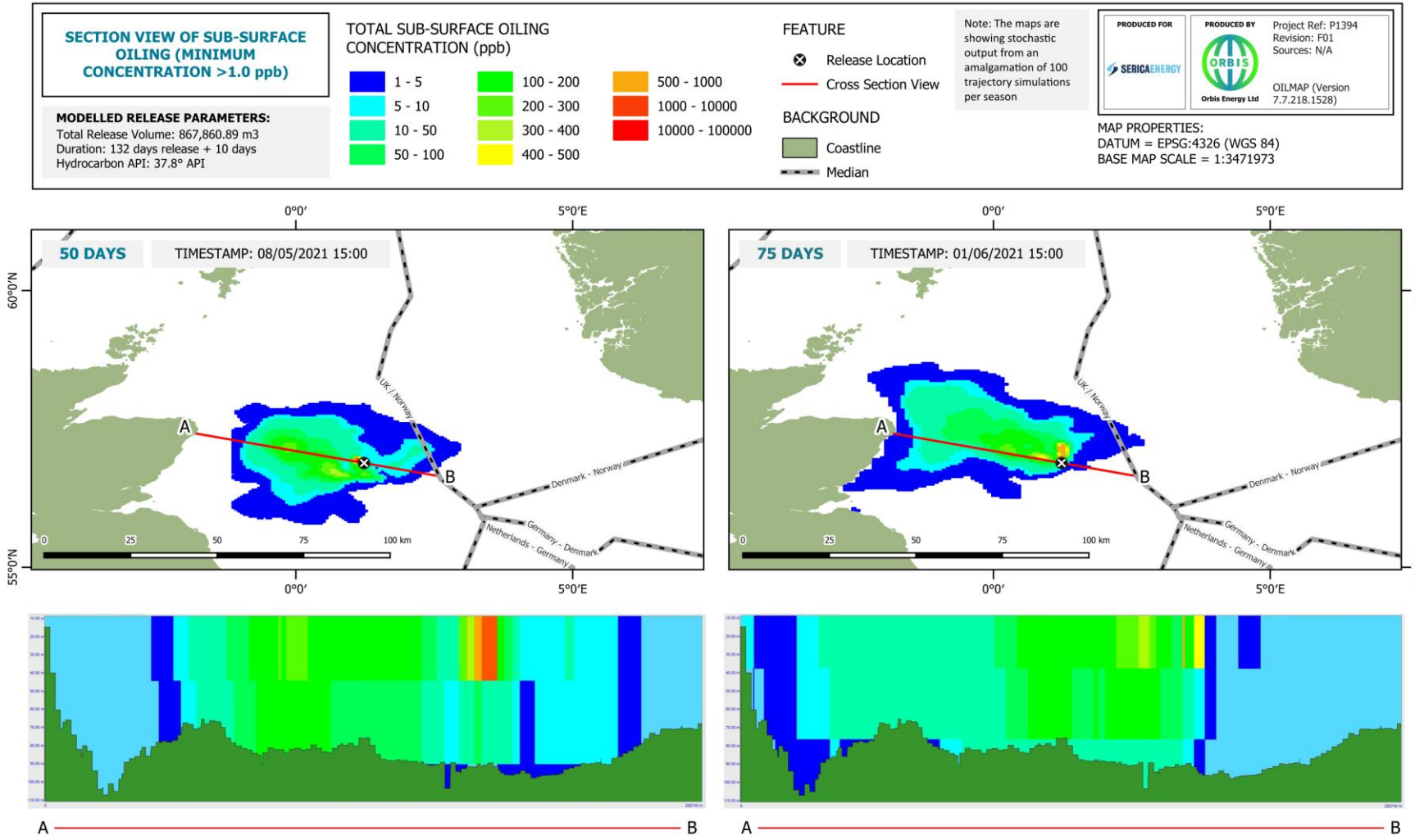
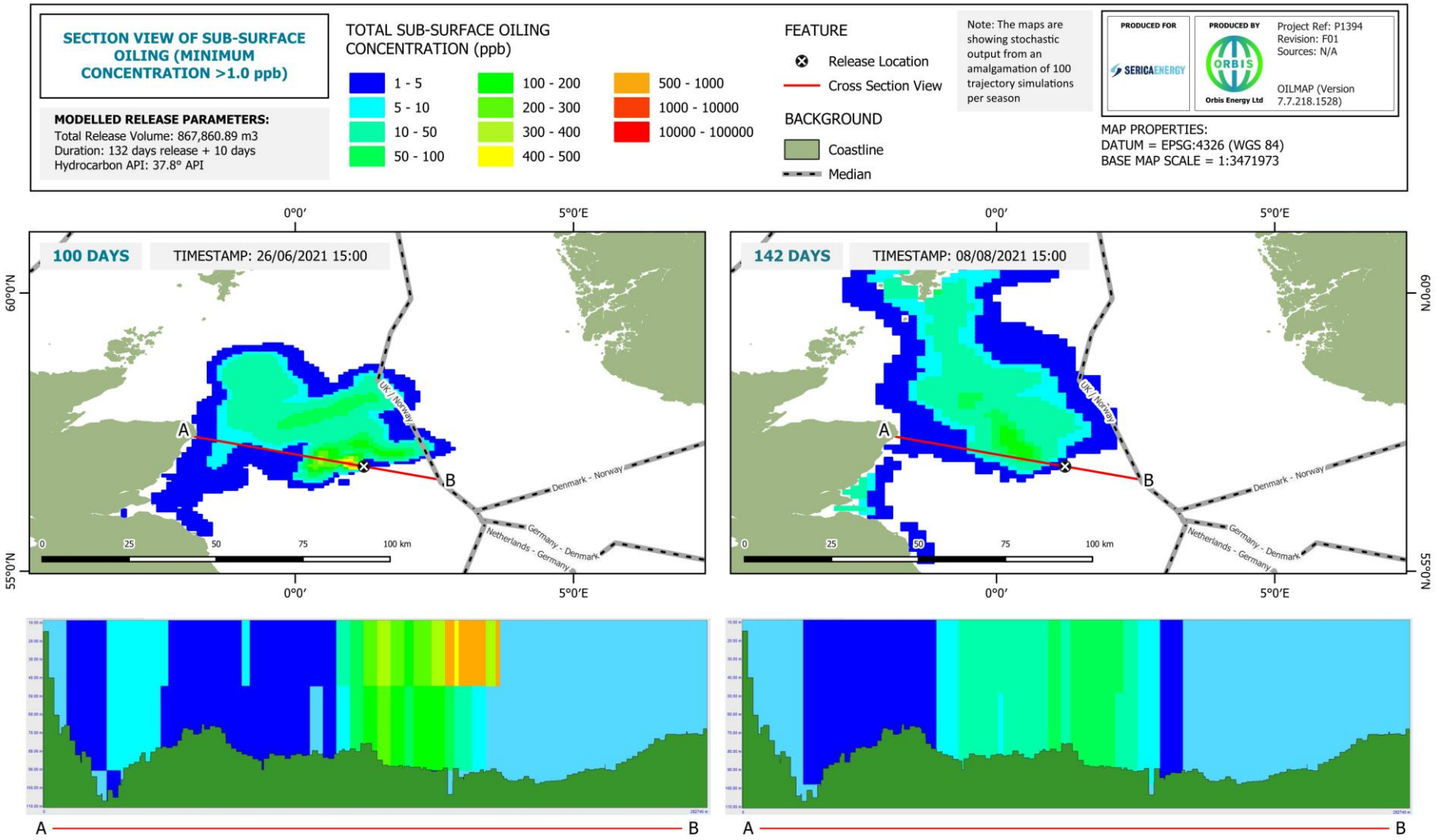


Figure F.22: Section view and subsurface oiling during spring (Trajectory Run No. 52) after day 100 & day 142



F.6 Model Input Data

F.6.1 Metocean Data

Current and Tidal Data

To capture the complex nature of the regional and coastal circulation for the areas near to the UK, two different current datasets are provided which can be combined to simulate an oil spill (refer to Table F.10):

- A regional dataset (HYDROMAP) that captures the general mesoscale circulation (HYCOM);
- A higher resolution dataset developed by RPS to capture the tidal circulation important in the coastal areas.

Table F.10: Current dataset details used for the modelling

Parameter	Global	Regional tidal
Name of Dataset	HYCOM (GLBy0.08/expt_93.0)	HYDROMAP
Owner/Provider	Naval Research Laboratory (USA)	RPS
Bathymetry	GEBCO	GEBCO
Wind Forcing	NAVGEM (USA)	No
Tides	No	Yes
Horizontal Grid Size	0.08° x 0.04°	~300m to 9km
Hindcast Period	2019 - 2023	Periodic tidal constituents' phase and amplitude
Output Frequency	Daily	30-minute processing

Global Current dataset – HYCOM analysis

Current data was obtained from the HYCOM + Navy Coupled Ocean Data Assimilation (NCODA) Global 1/12° analysis (Table F.10) which captures the oceanic large-scale tidal residual circulation. Details of the data assimilation procedure are described in Cummings and Smedstad (2013) and Cummings (2005). Forcing data for the model comes from the NAVy Global Environmental Model (NAVGEM). The analysis is composed of 3-D temperature, salinity, sea surface height, zonal velocity and meridional velocity fields. Ocean dynamics including geostrophic, and wind driven currents are reproduced by the model. The most recent version of the model is 'GLBu0.08/expt_19.1' which includes data from January 2019 to December 2023. However, as this version of HYCOM does not include tidal information, a separate model (HYDROMAP Tidal Model) was used to supplement HYCOM and generate tidal currents.

Tidal Currents – HYDROMAP Tidal Model

HYDROMAP, a hydrodynamic model (Table F.10) developed by RPS, was used to reproduce the local circulation due to tides around UK. It is a globally re-locatable hydrodynamic model (Isaji, et al., 2001a, 2001b) capable of simulating complex circulation patterns due to tidal forcing, wind stress, and freshwater flows. The framework used by HYDROMAP, employs a novel step-wise-continuous-variable-rectangular gridding strategy with up to six levels of resolution. The term "step-wise continuous" implies that the boundaries between successively smaller and larger grids are managed in a consistent integer step. This model has been applied in numerous sediment dispersion and transport studies in the U.S. and worldwide.

HYDROMAP can be used to make constant cyclical current fields for each component of the circulation separately. These cyclical current fields in the form of tidal ellipses are saved in CIR file. Once generated,

the CIR file can be combined with the HYCOM circulation to present a complete hydrodynamic dataset for the oil spill simulation.

Wind Data

Wind model output were obtained from the ECMWF Reanalysis Product for a 5-year period (2019 to 2023), as described in Table F.11. The ECMWF provides the ERA5 reanalysis product that includes wind hindcast data on a global scale. The data are generated using an atmospheric model with data assimilation and distributed on a grid with 0.25° horizontal resolution. ERA5 covers the period of January 1st, 1979, to present time. Gridded data products include a large variety of surface parameters, describing atmospheric as well as ocean-wave and land-surface conditions (Dee et al., 2011).

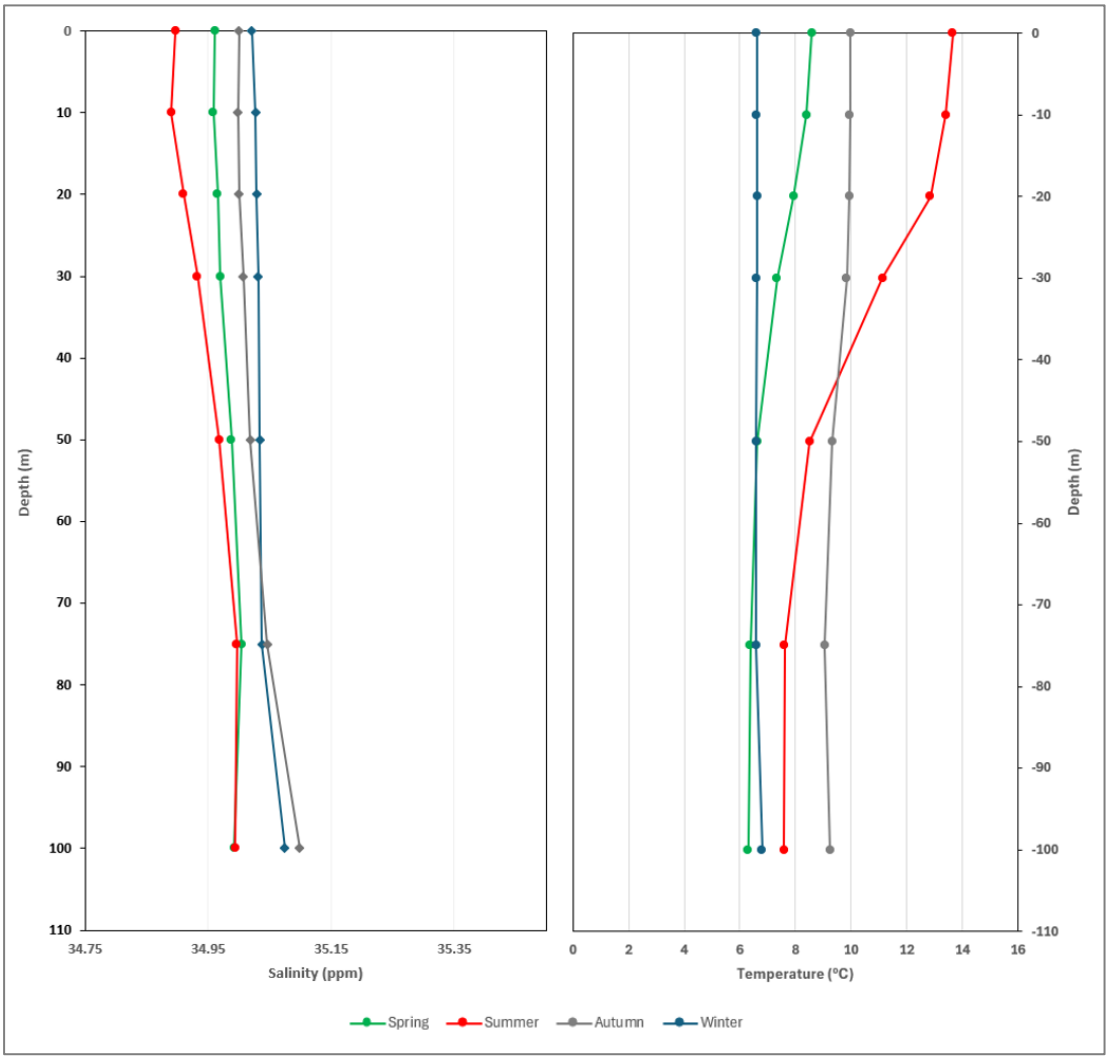
Table F.11: Wind dataset details used for the modelling

Name of Dataset	ERA5
Coverage	-20°E to 30°E and 40°N to 72°N
Owner/Provider	ECMWF
Horizontal Grid Size	0.25°x0.25°
Hindcast Period	2019 - 2023
Time Step	6-hour

Temperature and Salinity Data

Figure F.23 presents a salinity and temperature plot against depth for the modelled location per season.

Figure F.23: Salinity and Temperature plot against depth for each modelled season at the Kyla Development release location



F.6.2 Model Domain Setup

Bathymetry

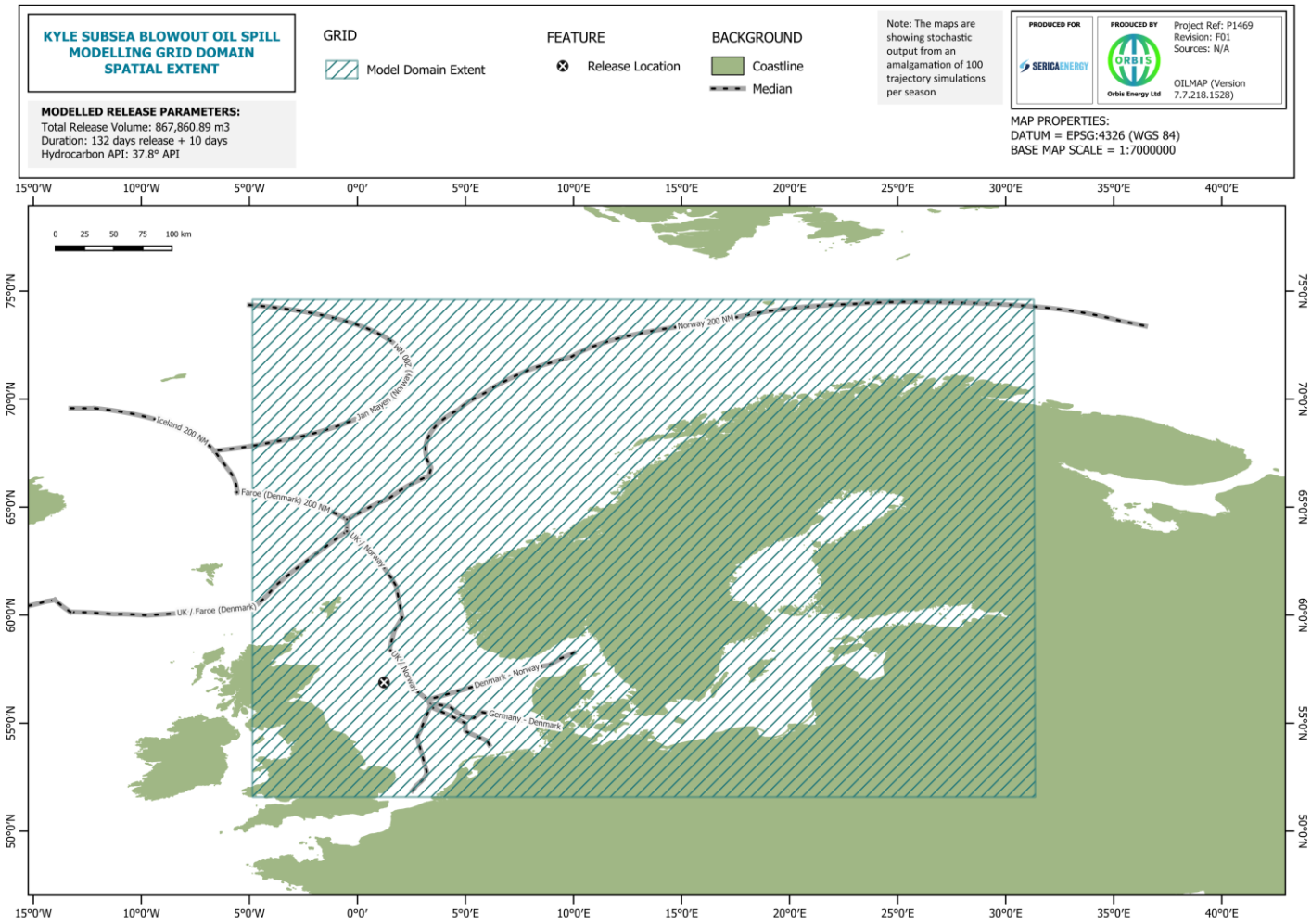
General Bathymetric Chart of the Oceans (GEBCO) ESRI ASCII files (GEBCO_2024 Grid) were retrieved from https://download.gebco.net and inputted into the OILMAP Land-Water domain grid.

The GEBCO_2024 Grid was released in July 2024. It provides global coverage of elevation data, in meters, on a 15 arc-second interval geographic grid and consists of 43200 rows x 86400 columns, giving 3,732,480,000 data points. The data values are pixel-centre registered i.e. they refer to elevations, in meters, at the centre of grid cells. The grid uses as a 'base' Version 2.6 of the SRTM15+ data set (Harper & Sandwell, 2024; Tozer et al., 2019) largely between latitudes of 50° South and 60° North. This data set is a fusion of land topography with measured and estimated seafloor topography. The SRTM15+ base grid has been augmented with the gridded bathymetric data sets developed by the four Seabed 2030 Regional Centres to produce the GEBCO_2024 Grid. The Regional Centres have compiled gridded bathymetric data sets, largely based on multibeam data, for their areas of responsibility. These regional grids were then provided to the Global Centre.

Model Domain Extent

The model domain extent area (including bathymetry, current and tidal, and wind data coverage) is shown in Figure F.24.

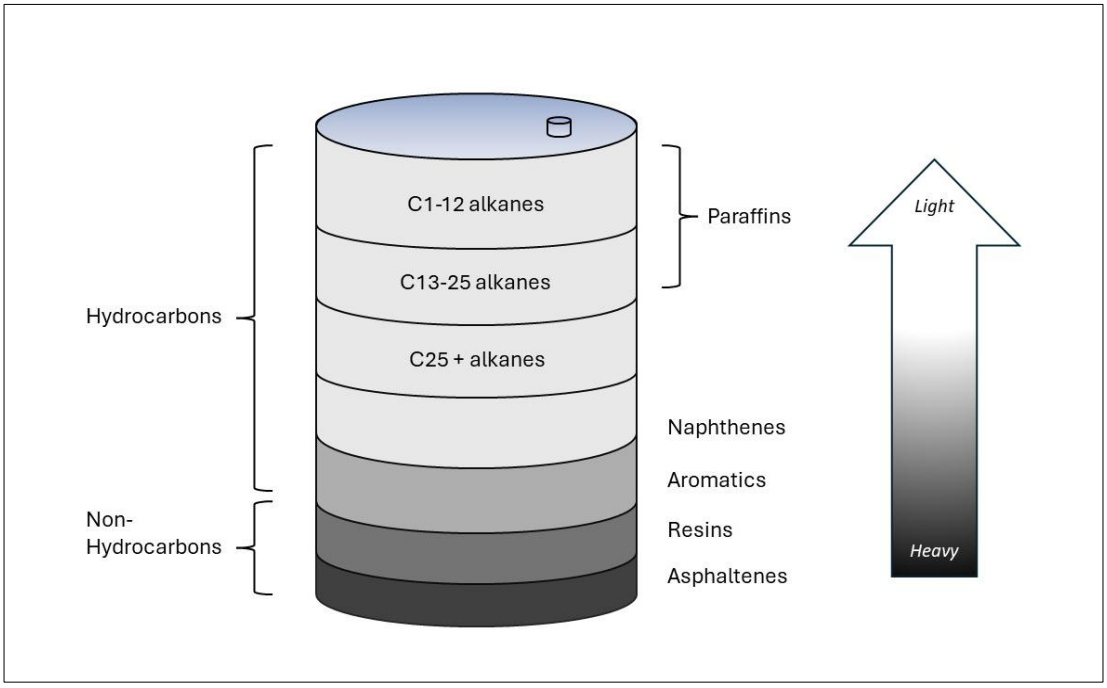
Figure F.24: Model Domain Extent



F.6.3 Hydrocarbon Characteristics

The components found in crude oil are classified into two main groups: hydrocarbons and non-hydrocarbons (refer to Figure F.25). If oil is rich in C1-12 alkanes, it is particularly light, as these are lighter components than the C25+ alkanes. Conversely, if oil contains high quantities of C25+ alkanes, resins and asphaltenes, it is heavy.

Figure F.25: The chemical composition of oil



The chemical composition of oil is important when predicting how it will break down or weather. For example, oil containing mostly light components is likely to lose a greater volume to evaporation than heavy oil. Oils with carbon chains exceeding 15 (C15+) cannot evaporate. Long chains (for example, C25+ alkanes) take a long time to degrade in the water column. Asphaltenes can increase the stability of oil, allowing it to take up water but preventing the oil and water emulsion from breaking down.

Ultimately, the fate of oil depends on its physico-chemical properties, which are accounted for in the in the modelling input data. OILMAP (Version 7.7) includes the most up-to-date oil database from RPS. This Master Database includes all the necessary oil property information to run the new oil spill model. The parameters stored in the oil database control the oil's spreading, evaporation, degradation and mousse formation during spill simulations. Any of the parameters can be changed and new oils can be added to the data base.

Oil Matching and Creation

The parameters described in Table F.12 represent the minimum data required to model a specific oil using OILMAP. Note that these properties are for dead oils and condensates (i.e., without gas). OILMAP does not evaluate dissolution, and so aromatic composition data are not needed for OILMAP.

The API gravity is the most important parameter for oil creation and matching. API Gravity, like specific gravity, is a ratio between the densities of oil and water. Unlike specific gravity, API gravity is only used to describe oil, which it characterises as follows:

- Light oil: API >31.1°
- Medium oil: API between 22.3° and 31.1°
- Heavy oil: API <22.3°
- Extra heavy oil: API <10°

API Gravity is converted to Specific Gravity using the following formula:

- API Gravity = (141.5 / Specific Gravity) – 131.5

An API of 10° is equivalent to water, so oils with an API above 10° will float on water while oils with an API below 10° will sink.

The reliability of oil behaviour can be improved by additional data described in Table F.13. When this additional data is available its inclusion can bolster model predictive power. Asphaltene, wax and resin content are used to predict if the oil will emulsify. If the oil is known to emulsify, these data are not necessary (assumptions may be made). Although proxies can be used when data are unavailable, reliance on such proxies will necessarily introduce additional assumptions and model reliability may decrease depending on the omitted data. The properties described in Table F.13 will augment the simulation of weathering and emulsion formation.

Table F.12: Minimum data required to run oil spill models in OILMAP

Property of Oil	Units	Common Range	Prediction for the Kyla Development (client supplied data)
API or Density at specified temperature	Grams per cubic centimetre (g/cm^3) or API	0.7-1.1 g/cm^3	Density from K14 Production Well Test. Crude Oil Sample: ACL 2005 0092b (3.04). • SG = 0.8365 @ 15°C • API = 37.8°
Dynamic viscosity at specified temperature	Centipoise (cP)	1 – 30,000 cP	Viscosity from K14 Production Well Test. Crude Oil Sample: ACL 2005 0092b (3.04). • 11.053 cP @ 20°C
Boiling Curve (True Boiling Point Distribution)	Fraction by mass or volume @ °C or °F	0 – 0.99	Unknown
Does the oil emulsify?	Yes or No	Yes or No	No

Table F.13: Other useful data to run oil spill models in OILMAP (to improve reliability, not mandatory)

Property of Oil	Units	Common Range	Prediction for the Kyla Development (client supplied data)
A second Density at a second specified temperature	g/cm^3 or API	0.7-1.1 g/cm^3	Unknown
A second Viscosity at a second specified temperature	Centipoise (cP)	1 – 30,000 cP	Unknown
Maximum Water Content of emulsions	Percentage	0 – 80%	Oil not expected to form emulsions.
Interfacial Tension (IFT): oil-brine and/or oil-fresh water	Dynes (mN/m)	0 – 50	Unknown
Pour Point	°C	-63 – >5 °C (semi-solid)	Pour point from K14 Production Well Test. Crude Oil Sample: ACL 2005 0092b (3.04).

Property of Oil	Units	Common Range	Prediction for the Kyla Development (client supplied data)
			• +3°C
Asphaltene content	Concentration percentage	0 – 25 %	Asphaltene content C7 (% wt) from 29/2c-8z Exploration Well Test. Crude Oil Sample: ACL 971294. • 0.15 %
Resin Content	Concentration percentage	0 – 25 %	Unknown
Wax Content	Concentration percentage	0 – 12 %	Wax content (% wt) from 29/2c-8z Exploration Well Test. Crude Oil Sample: ACL 971294. • 7 %

The main physical properties that affect the behaviour and the persistence of an oil spilled at sea are specific gravity / API, distillation characteristics, vapour pressure, viscosity and pour point. All are dependent on chemical composition, such as the proportion of volatile components and the content of asphaltenes, resins and waxes. Of note, oil emulsification will generally only take place if the asphaltene content is greater than 0.5 %. Importantly, the formation of water-in-oil emulsions reduces the rate of weathering processes and is the main reason for the persistence of light and medium oils on the sea surface and shoreline.

The hydrocarbon properties expected from the proposed Kyla Development are anticipated to resemble a ITOPF Group 2 crude oil that does not form a stable emulsion.

The 'Chayvo #6 Crude' analogue has been selected as a suitable proxy oil for the proposed Kyla Development because it is compositionally a non-emulsifying crude oil (refer to Table F.14 for the key properties). For the purposes of the Kyla Development oil spill modelling study, the analogue has been amended where data is available (refer to Table F.12 and Table F.13) to fine tune the API gravity / density, pour point and wax content parameters. The amended analogue is shown in Table F.14.

Table F.14: Key properties for the 'Chayvo #6 Crude' proxy oil analogue

Oil Name (Analogue)	API Gravity	Density	Oil-Seawater Interfacial Tension	Viscosity 1	Viscosity 2	Pour Point	Percent water when fully emulsified as mousse	Oil Stability Class (emulsion)	Distillation Data (fraction)				Saturate, Aromatic, Resin and Asphaltene (SARA)				Wax Content
									Boiling Points: < 180°C	Boiling Points: 180°C – 264°C	Boiling Points: 265°C - 380°C	Distillation Sum	Saturate Content	Aromatics Content	Asphaltene Content	Resin Content	
Chayvo #6 Crude (ITOPF Group 2)	38.1	0.8345 g/cm³ @ 25°C	15.8 dyne / cm	19 cP @ 0°C	4 cP @ 15°C	-4	0.2 %	Un-Stable	Total Hydrocarbon = 0.230000	Total Hydrocarbon = 0.261880	Total Hydrocarbon = 0.188520	0.680400	87.86	8.59	0.15	3.4	5%
Amended 'Chayvo #6 Crude' Analogue for the Kyla Development Well (ITOPF Group 2)	37.8	0.8365 g/cm³ @ 15°C	15.8 dyne / cm	19 cP @ 0°C	4 cP @ 15°C	3	0.2 %	Un-Stable	Total Hydrocarbon = 0.230000	Total Hydrocarbon = 0.261880	Total Hydrocarbon = 0.188520	0.680400	87.86	8.59	0.15	3.4	7%

Note 1: Amended oil analogue properties in red.

F.6.4 Declining Flow Rate

Figure F.26 shows the high case open hole flow rate from the Kyla K14 well for 132 days. The worst-case oil flow rate starts at 7926.70 m^3/day (49,856.60 bbl/day) on day 1 of the spill scenario and declines to 5223.38 m^3/day (32,853.50 bbl/day) after 132 days. The total cumulative release of oil after 132 days is 867,860.89 m^3 (5,458,587.90 bbl).

Figure F.26: Declining flow rate for the Kyla K14 Well (Reservoir Case = High) (132 days)

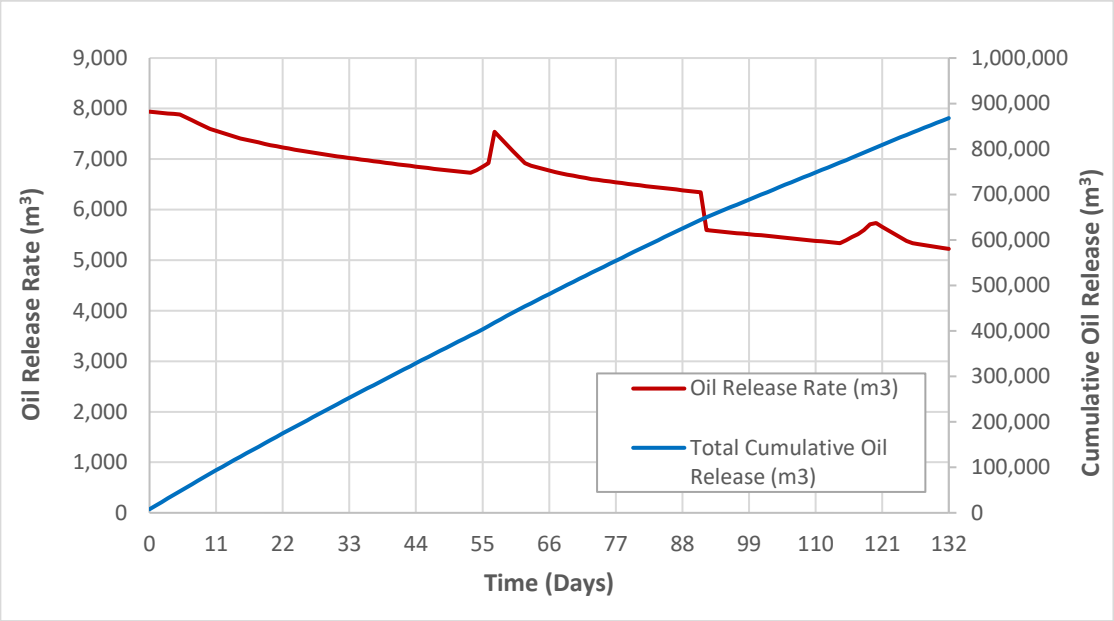


Table F.15 displays the declining flow rate data at 24-hour intervals which was input into the OILMAP modelling software.

Table F.15: Variable Flow Rate (VFL file) Model Input Data

Time (Hours)	Declining flow rate for the K14 well (Reservoir Case = High) (132 days) (bbl)
24.00	49856.60
48.00	49784.50
72.00	49712.30
96.00	49640.00
120.00	49567.60
144.00	49211.30
168.00	48846.60
192.00	48484.20
216.00	48124.20
240.00	47774.30
264.00	47537.20
288.00	47301.20
312.00	47066.30
336.00	46832.40
360.00	46599.70
384.00	46431.40

Time (Hours)	Declining flow rate for the K14 well (Reservoir Case = High) (132 days) (bbl)
408.00	46264.20
432.00	46097.60
456.00	45931.50
480.00	45766.00
504.00	45622.10
528.00	45483.80
552.00	45346.00
576.00	45208.50
600.00	45071.40
624.00	44940.80
648.00	44824.90
672.00	44709.20
696.00	44593.80
720.00	44478.70
744.00	44363.90
768.00	44263.20
792.00	44163.80
816.00	44064.60
840.00	43965.50
864.00	43866.70
888.00	43767.60
912.00	43668.40
936.00	43569.50
960.00	43470.80
984.00	43372.30
1008.00	43275.40
1032.00	43183.80
1056.00	43092.30
1080.00	43001.10
1104.00	42910.10
1128.00	42819.20
1152.00	42735.00
1176.00	42654.30
1200.00	42573.80
1224.00	42493.50
1248.00	42413.30
1272.00	42333.30
1296.00	42650.50
1320.00	43081.40
1344.00	43516.20

Time (Hours)	Declining flow rate for the K14 well (Reservoir Case = High) (132 days) (bbl)
1368.00	47442.00
1392.00	46629.30
1416.00	45830.30
1440.00	45044.00
1464.00	44271.80
1488.00	43512.80
1512.00	43203.80
1536.00	43001.40
1560.00	42800.00
1584.00	42599.80
1608.00	42400.60
1632.00	42229.00
1656.00	42090.60
1680.00	41952.70
1704.00	41815.40
1728.00	41678.60
1752.00	41542.40
1776.00	41433.50
1800.00	41334.80
1824.00	41236.50
1848.00	41138.40
1872.00	41040.60
1896.00	40943.90
1920.00	40851.50
1944.00	40759.40
1968.00	40667.50
1992.00	40575.90
2016.00	40484.60
2040.00	40398.30
2064.00	40316.50
2088.00	40235.00
2112.00	40153.70
2136.00	40072.70
2160.00	39991.90
2184.00	39897.70
2208.00	35176.20
2232.00	35100.30
2256.00	35024.70
2280.00	34949.20
2304.00	34876.90

Time (Hours)	Declining flow rate for the K14 well (Reservoir Case = High) (132 days) (bbl)
2328.00	34809.90
2352.00	34743.10
2376.00	34676.50
2400.00	34610.10
2424.00	34543.80
2448.00	34477.60
2472.00	34397.90
2496.00	34318.60
2520.00	34239.50
2544.00	34160.60
2568.00	34082.00
2592.00	34004.10
2616.00	33929.10
2640.00	33854.30
2664.00	33779.70
2688.00	33705.40
2712.00	33631.20
2736.00	33557.30
2760.00	33921.50
2784.00	34302.70
2808.00	34687.90
2832.00	35212.00
2856.00	35907.10
2880.00	36070.80
2904.00	35608.30
2928.00	35153.20
2952.00	34705.20
2976.00	34264.30
3000.00	33830.30
3024.00	33550.60
3048.00	33432.20
3072.00	33314.40
3096.00	33197.20
3120.00	33080.70
3144.00	32964.70
3168.00	32853.50
Cumulative Oil Release	**5,458,587.90**

Appendix G: Kyla Production Profiles

This appendix presents the range of potential reserve volumes for Kyla (oil, gas and water production figures) as follows:

- Table G.1 – P10, High case (based on a one well development scenario)
- Table G.2 – P50, Mid case (based on a one well development scenario)
- Table G.3 – P90, Low case (based on a one well development scenario)

As a comparison, Table G.4 presents the Kyla oil and gas production figures as presented in the Field Development Plan (FDP). Where the FDP data has been converted for use in this ES, the following conversion factors have been used:

- 1 m^3 = 6.2898 bbl
- 1 m^3 = 0.83432 tonnes
- 1 m^3 = 3.53147 * 10-5 mmscf

Table G.1: Kyla Oil, Gas and Water Production Volumes, High case [1,2]

Year	Oil (tonnes/d)	Oil (m^3/d)	Oil (bbl/d)	Gas (m^3/d)	Gas (MMscf/d)	Water (m^3/day)	Water (bbl/d)
2028	416	498	3,133	66,564	2.4	2	14
2029	928	1,112	6,997	144,720	5.1	11	69
2030	795	953	5,997	120,940	4.3	64	403
2031	636	762	4,794	95,705	3.4	155	972
2032	541	649	4,080	81,265	2.9	224	1409
2033	472	566	3,562	70,684	2.5	261	1644
2034	431	517	3,249	64,194	2.3	296	1862
2035	400	480	3,018	59,288	2.1	333	2097

[1] P10 (High case) is defined as the highest estimate of recoverable and/or potentially recoverable volumes from the Kyla Development based on a one well development scenario. There is a 10% probability that recovered volumes will meet or exceed the high case estimate.
[2] Production values presented in this table have been rounded up to the nearest integer. All calculations in Appendix E were undertaken using the original unrounded data. Reproduction of calculations using the rounded figures in the above table may therefore result in minor discrepancies.

Table G.2: Kyla Oil, Gas and Water Production Volumes, Mid case [1,2]

Year	Oil (tonnes/d)	Oil (m^3/d)	Oil (bbl/d)	Gas (m^3/d)	Gas (MMscf/d)	Water (m^3/day)	Water (bbl/d)
2028	383	459	2,885	60,092	2.1	2	14
2029	722	865	5,442	110,471	3.9	13	83
2030	604	724	4,555	90,770	3.2	41	259
2031	459	550	3,462	67,981	2.4	111	695
2032	364	436	2,743	53,565	1.9	176	1,105
2033	301	361	2,269	44,195	1.6	212	1,332
2034	267	320	2,015	39,176	1.4	242	1,522
2035	249	298	1,875	36,355	1.3	271	1,704

[1] P50 (Mid case) is defined as the best estimate of recoverable and/or potentially recoverable volumes from the Kyla Development based on a one well development scenario. There is a 50% probability that recovered volumes will meet or exceed the mid case estimate.
[2] Production values presented in this table have been rounded up to the nearest integer. All calculations in Appendix E were undertaken using the original unrounded data. Reproduction of calculations using the rounded figures in the above table may therefore result in minor discrepancies.

Table G.3: Kyla Oil, Gas and Water Production Volumes, Low case [1,2]

Year	Oil (tonnes/d)	Oil (m^3/d)	Oil (bbl/d)	Gas (m^3/d)	Gas (MMscf/d)	Water (m^3/day)	Water (bbl/d)
2028	128	153	963	20,626	0.7	3	19
2029	264	317	1,992	42,467	1.5	7	43
2030	248	298	1,873	39,841	1.4	7	44
2031	239	286	1,799	38,228	1.4	7	46
2032	237	284	1,787	37,923	1.3	8	50
2033	230	276	1,734	36,741	1.3	9	55
2034	230	276	1,733	36,680	1.3	10	65
2035	233	279	1,758	37,201	1.3	13	82

[1] P90 (Low case) is defined as the lowest estimate of recoverable and/or potentially recoverable volumes from the Kyla Development. There is a 90% probability that recovered volumes will meet or exceed the low case estimate.
[2] Production values presented in this table have been rounded up to the nearest integer. All calculations in Appendix E were undertaken using the original unrounded data. Reproduction of calculations using the rounded figures in the above table may therefore result in minor discrepancies.

Table G.4: Kyla Oil and Gas Production Volumes (Low, Mid and High case) as reported in the FDP

Kyla	Low case				Mid case				High case			
1 Well	Oil		Gas		Oil		Gas		Oil		Gas	
Year	*Kte*	*mmstb*	*ksm³*	*bscf*	*kte*	*mmstb*	*ksm³*	*bscf*	*kte*	*mmstb*	*ksm³*	*bscf*
2028	47	0.35	7,549	0.27	140	1.06	21,994	0.78	152	1.15	24,362	0.86
2029	96	0.73	15,500	0.55	263	1.99	40,322	1.42	339	2.55	52,823	1.87
2030	91	0.68	14,542	0.51	221	1.66	33,131	1.17	290	2.19	44,143	1.56
2031	87	0.66	13,953	0.49	168	1.26	24,813	0.88	232	1.75	34,932	1.23
2032	87	0.65	13,880	0.49	133	1.00	19,605	0.69	198	1.49	29,743	1.05
2033	84	0.63	13,410	0.47	110	0.83	16,131	0.57	172	1.30	25,799	0.91
2034	84	0.63	13,388	0.47	98	0.74	14,299	0.50	157	1.19	23,431	0.83
2035	85	0.64	13,578	0.48	91	0.68	13,270	0.47	146	1.10	21,640	0.76
Total	661	4.98	105,801	3.74	1223	9.22	183,565	6.48	1687	12.72	256,874	9.07