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Appendix 6.J – Benthic Characteristics Survey

NeuConnect Interconnector

Benthic Characterisation and Habitat Assessment Survey (UK)

Technical Report

Ref: OEL_AECNEU0818_TCR

Prepared for

AECOM

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CONTENTS

LIST OF ABBREVIATIONS

AL	Action Level
BC	Baseline Concentration
BAC	Baseline Assessment Concentration
BEIS	Department for Business, Energy and Industrial Strategy
BSH	Broad-Scale Habitats
cSAC	Candidate Special Area of Conservation
DC	Direct Current
DDC	Drop-Down Camera
DDV	Drop-Down Video
DTI	Department of Trade and Industry
DVR	Digital Video Recording
ED50	European Datum 50
EMODnet	European Marine Observation and Data Network
ESP	Environmental Sampling Plan
EU	European Union
EUNIS	European Nature Information System
FOCI	Features of Conservation Importance
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HA	Habitat Assessment
HOCI	Habitats of Conservation Interest
HVDC	High Voltage Direct Current
JNCC	Joint Nature Conservation Committee
KM	Kilometre
KP	Kilometre Point
LAT	Lowest Astronomical Tide
LED	Light-Emitting Diode
MBES	Multi-Beam Echo Sounder
MEDIN	Marine Environmental Data and Information Network
MHWS	Mean High Water Springs
MW	Megawatt
NMBAQC	NE Atlantic Marine Biological Quality Control
OEL	Ocean Ecology Limited
OSPAR	Oslo and Paris Convention for the Protection of the North East Atlantic
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PEL	Probable Effect Level
PRP	Processing Requirement Protocol

PSD	Particle Size Distribution
QMS	Quality Management System
ROV	Remote Operated Vehicle
SAC	Special Area of Conservation
SCI	Site of Community Importance
SOP	Standard Operating Protocol
SPA	Special Protection Area
SSL	Seabed Survey Licence
SSS	Side Scan Sonar
STR	Subsea Technology and Rentals
TEL	Threshold Effect Level
THC	Total Hydrocarbons
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
UKOOA	United Kingdom Offshore Operators Association
USBL	Ultra-Short Baseline
UTM	Universal Transverse Mercator
WoRMS	World Register of Marine Species

1. EXECUTIVE SUMMARY

Ocean Ecology Limited (OEL) was contracted by AECOM to conduct a benthic characterisation survey of the UK section of the proposed NeuConnect Interconnector subsea cable. Environmental sampling was undertaken from 25th September to 16th October 2018 and from 13th February to 15th February 2019. The data collected during this survey was intended to characterise the seabed sediments and benthic communities to inform the various applications and assessments that are being undertaken by AECOM on behalf of NeuConnect. This was achieved through a combination of grab sampling and acquisition of seabed imagery followed by detailed laboratory analysis and statistical analysis of the resulting biological and physico-chemical datasets.

1.1. Sediments

A wide variety of sediment types were observed along the cable route. A trend towards increased mud content was apparent at inshore stations while the offshore stations were almost entirely composed of sand, forming either ripples or megaripples. Most samples comprised of sand (S), representing EUNIS Broad Scale Habitat (BSH) A5.2 (sublittoral sand), while a number of stations were classified as mud and sandy mud (mS) or gravelly mud (gM) and gravelly muddy sand (gmS) which represent a mixture of EUNIS BSH A5.2 (sublittoral sand), A5.3 (sublittoral mud), and A5.4 (sublittoral mixed sediments). Coarser sediments were also observed intermittently along the route where stations were classified as gravelly sand (gS, EUNIS BSH A5.1 sublittoral coarse sediments).

Levels of Arsenic were particularly high at many stations where they exceeded OSPAR Baseline Concentration (BC) at 15 locations and Baseline Assessment concentration (BAC) at eight locations. The levels of most metals, and specifically Zinc, Lead, and Mercury, were higher at the intertidal and inshore stations with many exceeding mean UKOOA (2001) and even 95th % values. Nickel and Copper levels were also high in offshore areas, particularly between Kilometre Point (KP) 83 – 94. Concentrations of Copper and Zinc in offshore areas of the cable route were higher than other North Sea offshore areas but did not exceed Cefas (2003) Action Level 2 (AL2), a proxy for heavy sediment contamination, at any location.

Polycyclic aromatic hydrocarbons (PAH) were only occasionally observed at levels in excess of OSPAR BCs and BACs, Canadian sediment quality guideline Threshold Effects Levels (TELs) and Cefas (2003) Action Level 1 (AL1) guidelines. At no point were Canadian sediment quality guideline Probable Effects Levels (PELs) exceeded. Levels of organotins exceeded Cefas (2003) AL1 only at a single station (UK_ENV_001). Polychlorinated biphenyls (PCBs), and organochlorines did not exceed Cefas (2003) AL1 or Canadian sediment quality guidelines at any of the stations. Concentrations of these compounds were often below the detectable limits at many locations.

1.2. Macrobenthos

The macrobenthic assemblages identified along the NeuConnect cable route were diverse and largely dominated by annelid taxa in terms of number of taxa and overall abundance as expected in this area of the southern North Sea. Molluscs and echinoderms contributed greatest to overall biomass of the macrofaunal communities. The most common faunal group (A), dominated by polychaete worm species, was observed at 39 of the 90 stations. This faunal group was associated with sandy habitats particularly in the offshore areas of the cable route. The other dominant group (Faunal Group B) was characterised by the ross worm *S. spinulosa.* These stations corresponded with areas where notable aggregations of sand tubes constructed by this species were recorded upon review of the seabed imagery and subsequently deemed to be representative of areas of Annex I biogenic reef (as per Gubbay (2007)).

1.3. Key Habitats

The Habitat Assessment (HA) identified several principal EUNIS BSHs and a number of higher level biotopes which enabled the production of a biotope map of the UK section of the cable route combined with mapping of habitats of conservation interest (Table 1).

Table 1. Principal EUNIS biotopes and Habitats of Conservation Interest identified during the NeuConnect cable route survey. *Broad Scale Habitat (EUNIS level 3).

EUNIS Groups	BSH*	EUNIS Biotopes	Habitats of Conservation Interest
Rock	A4.2	A4.21 Echinoderms and crustose communities on circalittoral rock	Annex I Stony Reef
		A4.23 Communities on soft circalittoral rock	
Rock	A4.2	A4.23 Communities on soft circalittoral rock	Section 41 priority habitat - Peat and Clay Exposures
Biogenic Reef	A5.6	A5.611 - [*Sabellaria spinulosa*] on stable circalittoral mixed sediment	Annex I Biogenic Reef

Most seabed habitats along the cable route were characterised as either EUNIS biotope A5.25 'Circalittoral fine sand' or EUNIS biotope A5.44 'Circalittoral mixed sediment' although areas of EUNIS biotope A5.35 'Circalittoral sandy mud' were also recorded. Due to the similarity of the macrobenthos observed in shallower sections (<20 m) of the cable route to those in shallow sandbank habitats some areas of the cable corridor characterised as sublittoral sand biotopes (A5.25) were deemed to be representative of the Annex I habitat 'Sandbanks which are slightly covered by sea water all the time'. The large swaths of Sandy sediments identified along the offshore areas of the cable corridor were not however thought to be presentative of Annex I sandbanks due to the generally greater water depths (>30 m).

Annex I stony reef was identified in areas of the cable route between KP 90 and KP 115. Reefs were assessed to be of low relief only (as per Irving (2009)). Video imagery from these areas was indicative of the EUNIS Biotopes A4.21 – 'Echinoderms and crustose communities on circalittoral rock' and A4.23 – 'Communities on soft circalittoral rock'.

Areas of the Section 41 priority habitat 'Peat and Clay Exposures' were observed along the cable route. This habitat was observed in similar locations to Annex I stony reef at KPs 91, 99, and 116, through interrogation of side scan sonar (SSS) data and Drop-Down Video (DDV) imagery collected during this survey. These areas were indicative of the EUNIS Biotope A4.23 'Communities on soft circalittoral rock' and representative of Annex I bedrock reef habitat.

Representatives of Annex I biogenic reef formed by *S. spinulosa* was identified at multiple points along the cable route. These were classified as either low or medium relief reef and were concentrated around KP 60 – 78, KP 115, and KP 132. Evidence of potential *S. spinulosa* reef from the geophysical surveys and review of the SSS data identified a wider area of low relief reef within a mixed sediment biotope between KP 68 - 78 though the extent of this patch of reef is less certain. This area was indicative of the EUNIS Biotope A5.611 – '[*Sabellaria spinulosa*] on stable circalittoral mixed sediment.

2. INTRODUCTION

2.1. NeuConnect Interconnector

NeuConnect (the 'Project'), is a 1,400 megawatt (MW) interconnector between Great Britain and Germany being developed by an international consortium. The Project will create the first direct electricity link between Great Britain and German energy networks and will allow electricity to be passed in either direction. The Project will be formed by over 700 kilometres (km) of subsea and underground High Voltage Direct Current (HVDC) cables, with on-shore converter stations linking into the existing electricity grids in Great Britain and Germany.

The GB Offshore Scheme will extend from Mean High Water Springs (MHWS) on the northern coast of the Isle of Grain, through the outer Thames Estuary and the southern North Sea before crossing the median line into Dutch waters. The GB Offshore Scheme comprises a project corridor of approximately 270 km length within which subsea Direct Current (DC) cables will be installed.

2.2. Project Background

Ocean Ecology Limited (OEL) was contracted by AECOM to conduct a benthic characterisation survey of the GB Offshore Scheme section of the proposed NeuConnect cable route to include provision of survey vessels, environmental personnel, sampling equipment and sample analysis. Environmental sampling was undertaken during two survey phases from 25th September to 16th October 2018 and from 13th February to 15th February 2019. The data collected during these surveys was intended to characterise the seabed sediments and benthic communities to inform the applications and assessments that are being undertaken by AECOM on behalf of NeuConnect.

2.3. Report Scope

This report presents the results of the macrobenthic and sediment chemistry analysis combined with the results of the analysis of seabed imagery collected as part of the Habitat Assessment (HA) with the aim to characterise the biological and physio-chemical status of the seabed substrates and habitats along the route.

The grab sample data has undergone detailed statistical analysis and habitats have been mapped through interpretation of the geophysical data, which, in combination with analysis of the environmental data have been used to delineate Habitats of Conservation Interest (HOCI) (e.g. Annex I habitats) occurring along the cable corridor.

The survey area lies within the Margate and Long Sands Special Area of Conservation (SAC) and/or the Outer Thames Estuary Special Protection Area (SPA). The HA therefore includes an assessment of the habitats identified within the survey area against the relevant designated features of these protected areas.

3. NATURE CONSERVATION

3.1. Protected Sites

A number of sites that receive designation under various nature conservation legislation overlap with the survey area. Under the European Habitats Directive (92/43/EEC) that came into force in 1992 European Union (EU) Member States are required to ensure “favourable conservation status” of habitats and species listed by the Directive.

Two nature conservation designations fall within the survey area: the Margate and Long Sands SAC and the Outer Thames Estuary SPA.

3.1.1. Margate and Long Sands SAC

The Margate and Long Sands SAC starts to the north of the Thanet coast of Kent and proceeds in a north-easterly direction to the outer reaches of the Thames Estuary. It contains a number of Annex I Sandbanks slightly covered by seawater at all times, the largest of which is Long Sands itself. The sandbanks are composed of well sorted sandy sediments, with muddier and more gravelly sediments in the troughs between banks. The upper crests of some of the larger banks dry out at low tide. The banks are tidally-influenced estuary mouth sandbanks, the southern banks aligned approximately east-west in the direction of tidal currents entering the Thames Estuary from the English Channel, whereas Long Sand is aligned in a north east - south west orientation with influence from the North Sea.

Although the primary feature for designation is the Sandbank Annex I interest feature, there is a significant amount of the reef-forming ross worm (*Sabellaria spinulosa*) at this site, which when formed as a reef qualifies as an Annex I habitat (biogenic reef). However, the available data indicate that the distribution of *S. spinulosa* is patchy, or that the aggregations form crusts rather than reefs. Areas of high *S. spinulosa* density support a diverse attached epifauna of bryozoans, hydroids, sponges and tunicates, and additional fauna including polychaetes, bivalves, amphipods and crustaceans. These diverse communities are usually found on the flanks of the sandbanks and towards the troughs.

3.1.2. Outer Thames Estuary SPA

The Outer Thames Estuary SPA is classified for the protection of the largest aggregation of wintering red-throated diver (*Gavia stellata*) in the UK, an estimated population of 6,466 individuals, which is 38% of the wintering population of Great Britain. It also protects foraging areas for common tern (*Sterna hirundo*) and little tern (*Sternula albifrons*) during the breeding season.

The SPA lies along the east coast of England in the southern North Sea and extends northward from the Thames Estuary to the sea area off Great Yarmouth on the East Norfolk Coast. This SPA crosses the 12 nautical mile boundary and therefore statutory advices is provided jointly with Natural England. The foraging areas protected for little tern and common tern, enhance the protection afforded to their feeding and nesting areas in the adjacent coastal SPAs (Foulness SPA, Breydon Water SPA and Minsmere to Walberswick SPA). The Outer Thames Estuary SPA overlaps with a Special Area of Conservation/Site of Community Importance that has been identified for the protection of Harbour porpoise – the Southern North Sea SAC/SCI.

3.2. Annex I Habitats Present within the Survey Area

A number of important and sensitive habitats occur within the southern North Sea and the survey area, including Annex I habitats such as 'sandbanks slightly covered by seawater all the time', 'stony reef' and 'biogenic *S. spinulosa* reef'.

3.2.1. Sandbanks Slightly Covered by Seawater All the Time

This feature consists of sandy sediments that are permanently covered by shallow sea water, typically at depths of less than 20 m. Distinct banks, formed of elongated, round or irregular "mound" shapes arise from horizontal or sloping plains of sandy sediment. The sediment type of these habitats is the key driver of the diversity and type of associated communities, as well as physical, chemical and hydrographic factors (e.g. exposure, temperature, topography, depth, turbidity and salinity). In UK waters this feature is categorised into four sub-types: gravelly and clean sands, muddy sands, eelgrass *Zostera marina* beds and free-living maerl (Corallinacea) beds.

These habitats are typically colonised by burrowing fauna such as worms, crustaceans, bivalve molluscs and echinoderms. Mobile shrimp, gastropods, crabs and fish also inhabit these areas as well as sandeel (*Ammodytes* sp.), a key bird prey species. Where stable coarse sediments are present species of foliose algae, hydroids, bryozoans and ascidians may be present that comprise key nursery areas for various fish species. Such areas therefore often comprise key feeding grounds for numerous seabirds[1].

3.2.2. Reefs

3.2.2.1. Rocky Reef

Rocky reefs can be very variable in terms of both their structure and the communities that they support. They provide a home to many species such as corals, sponges and sea squirts as well as giving shelter to fish and crustaceans such as lobsters and crabs and can be classified as either bedrock or stony reefs.

Bedrock Reef

Similar to stony reef, Annex I bedrock reef habitat occurs where soft (e.g. clay) or hard bedrock arises from the surrounding seabed, providing a stable habitat for attachment for a diverse range of epibiota. Bedrock reefs and associated biological communities can be highly variable due to the diverse nature of these habitats in terms of topography, structural complexity and exposure to tidal streams. In the photic zone communities associated with bedrock reefs are often dominated by attached algae, and often support various invertebrate species such as corals, sponges and sea squirts. These epibiotic communities further increase structural complexity and represent key prey items that in turn attract more mobile and commercially valuable species such as fish and crustaceans.

Stony Reef

Stony reef habitats occur when stable hard substrata, namely cobbles and boulders > 64 mm in diameter arise from the surrounding habitat, creating a habitat colonised by a variety of species. Numerous SAC sites have been designated in UK waters to protect stony reef habitats and associated communities. Such communities can be highly diverse, supporting assemblages of various coral, sponges, ascidians, fish and crustaceans. These associated communities vary dramatically according to environmental variables and may incorporate species that occupy a range of trophic levels. The complexity of habitat created by stony reefs often supports a higher

[1] http://jncc.defra.gov.uk/ProtectedSites/SACselection/habitat.asp?FeatureIntCode=h1110

abundance of mobile fauna such as echinoderms and various crabs, hermit crabs, and squat lobsters, as well as fish species for which these species represent key prey items.

3.2.2.2. *Sabellaria spinulosa* Reef

Dense subtidal aggregations of tubes created by the Ross worm *S. spinulosa* may form biogenic reefs that can stabilise cobble, pebble and gravel habitats and provide a consolidated habitat for epibenthic species (Pearce et al. 2011). These reefs form solid, raised structures above the surrounding seabed, thus increasing local habitat complexity and creating a biogenic habitat onto which various other species may become established. Those *S. spinulosa* reefs of greatest conservation importance are those which occur on predominantly sediment or mixed sediment areas that allow settlement of fauna that would not otherwise occur in such areas. Biological assemblages in areas of *S. spinulosa* reefs therefore often support a rich diversity of flora and fauna compared to surrounding areas of relatively homogenous sediment habitat.

Such reefs form in areas of favourable environmental conditions, largely areas of muddy sand with coarse material for attachment and high suspended sediment concentrations for tube construction. The species is common around the British Isles, with a relatively widespread distribution throughout the North East Atlantic, the North Sea and the English Channel. Dense aggregations have been recorded in many locations, in particular the Bristol Channel, The Wash and the southern North Sea ((Jenkins et al. 2018). Due to their biological importance, *S. spinulosa* reefs have been identified as a Section 41 priority habitats and also comprise FOCI habitats.[2]

[2] http://jncc.defra.gov.uk/pdf/UKBAP_BAPHabitats-47-SabellariaSpinulosaReefs.pdf

4. SURVEY DESIGN

4.1. Survey Objectives

The overall purpose of the surveys carried out in September and October 2018 and in February 2019 was to acquire environmental data along the GB Offshore Scheme section of the proposed NeuConnect cable route to inform the project EIA being undertaken by AECOM.

The survey had the following objectives:

i. Collect video/stills footage and grab samples from pre-defined site characterisation locations positioned along the entirety of the GB Offshore Scheme section of the cable route to characterise seabed sediments and associated benthic communities.
ii. Collect additional video/stills at proposed ground-truthing stations at targeted locations along the GB Offshore Scheme section of the cable route to allow for high confidence mapping of key HOCI and for a robust assessment of any sensitive habitats identified (e.g. Annex I geogenic and/or biogenic reef habitats).

4.2. Site Characterisation Sampling

A detailed review of existing Side Scan Sonar (SSS) and Multi-Beam Echo Sounder (MBES) data and environmental data previously collected along the GB Offshore Scheme section of the proposed cable route was conducted by OEL to ensure that all strata present within the cable corridor was adequately sampled (see (Ocean Ecology Limited 2018)). This ensured that the interpretation of the SSS and MBES data was sufficiently ground-truthed facilitating subsequent biotope mapping. This resulted in the selection of 83 site characterisation sampling locations to be targeted as Drop-Down Camera (DDC) and grab sampling stations as mapped in Figures 1-3. A full rationale for the selection of each sampling station is provided as Appendix 1a.

Sample station selection was undertaken during two phases. Firstly, sampling stations were positioned at 2 km intervals along the section of the cable route that lies within the Margate and Long Sands SAC and/or the Outer Thames Estuary SPA. This resulted in positioning of 37 DDC and grab sampling stations up to Kilometre Point (KP) 84 the majority of which are predicted to be positioned on sandy sediments thought to be representative of sandbank Annex I habitat features (‘Sandbanks which are slight covered by sea water all the time) for which the Margate and Long Sands SAC is designated. The exception to this is between KP 68.9 and KP 78.3 where a substantial area of potential Annex I biogenic reef habitat formed by *S. spinulosa* was thought to occur. To avoid potential damage to this feature, Drop-Down Video (DDV) transects were proposed running along and crossing the proposed cable route (cruciform) every k in place of combined DDC and grab sampling stations.

Sampling positions along sections of the route outside the SAC and/or SPA boundaries (KP 0 to KP 2 and KP 84 to KP 270 (the UK/Netherlands median line)) were positioned either at 5 km intervals or every time that distinct changes in seabed type were predicted (e.g. rippled sand to coarse sediments) resulting in a further 44 site characterisation sampling stations.

Two additional DDC and grab sampling stations were also added at KP 81 and KP 83 to provide greater sampling coverage along the proposed route that lies approximately 1 km north of a pre-existing dredge disposal site (Area 108/3) and within the likely tidal excursion given the NE-SW tidal flow in the area.

Single grab sampling stations were proposed at 40 of the 83 sampling stations for subsequent macrobenthic and Particle Size Distribution (PSD) analysis (see Section 2.4.3) distributed along the cable route. Two grab samples were taken at the remaining 43 stations the first for subsequent macrobenthic and Particle Size Distribution (PSD) analysis and the second for chemical analysis. Additionally, a further seven stations were positioned in the intertidal area of the cable route (KP 0 – 2). A single grab was taken at all intertidal stations for macrobenthic and PSD analysis and an additional grab was taken for chemical analysis at three of the stations.

4.3. Habitat Assessment Sampling

Following the detailed review of the existing SSS and MBES data a total of 36 DDV transects were proposed to target areas where HOCI (e.g. Annex I biogenic or stony reef) were predicted to occur (Figures 1-3). Transects were positioned to intersect boundaries of key habitats to inform subsequent delineation but where possible, were aligned along or close to the proposed cable route itself to ensure data was collected within the area of potential impact during installation of the cable. Cross lines were also proposed between KP 68.9 and KP 78.3 where Annex I *S. spinulosa* reef habitat was thought to occur to form cruciform sampling at 1 km intervals. A full rationale for the selection of each sampling station is provided as Appendix 1b.

A summary of HA transects sampled in the inshore (KP 000 to KP 084) and offshore (KP 085 to KP 270) areas of the NeuConnect cable route is provided below.

4.3.1. KP000 to KP084

A detailed review of the existing SSS data available between KP 000 and KP 084 was conducted prior to the survey mobilisation. This identified a substantial area of potential Annex I biogenic reef habitat formed by *S. spinulosa* between KP 68.9 and KP 78.3. To avoid potential damage to this feature, DDV transects were proposed running along and crossing the proposed cable route (cruciform) every kilometre in place of combined DDC and grab sampling stations. Transects were positioned to intersect boundaries of key habitats to inform subsequent delineation but where possible, were aligned along or close to the proposed cable route itself to ensure data was collected within the area of potential impact during installation of the cable. Cross lines were also completed between KP 68.9 and KP 78.3 where Annex I *S. spinulosa* reef habitat is thought to occur to form cruciform sampling at 1 km intervals. Overall, a total of 26 transects were completed between KP 000 – KP 084.

4.3.2. KP085 to KP270

Offshore areas were less targeted for HA sampling. However, irregular topography and potential Annex I *S. spinulosa* / stony reef was identified upon review of the acoustic information particularly between KP 224 – 255. Four DDV transects were therefore positioned in this area to enable higher confidence delineation of the Annex I reef habitats along this section of the cable route. A further six transects were positioned between KP085 – 190, where the same rationale was applied. This resulted in a total of 10 HA transects being surveyed between KP 085 and KP 270.

4.4. Conflicts Check

A detailed conflicts check was undertaken to ensure the proposed sampling stations/transects were positioned in safe locations and not in conflict with any seabed features or infrastructure (e.g. cables, pipelines, potential UXO etc.) that were not identified during the proximity check conducted by the Crown Estate prior to issuing the Seabed Survey Licence (SSL) for the survey.

To minimise impacts to sensitive seabed habitats and features, DDC deployments preceded grab sampling at all site characterisation sampling stations. When sensitive habitats were unexpectedly encountered during initial DDC deployments, stations were to be repositioned until an area suitable for grab sampling was identified as close to the original target location as possible. This action was not however required during the survey.

Table 2. Site Characterisation and Habitat Assessment sampling locations along GB Offshore Scheme section of the NeuConnect cable route.

KP	Station	Station Type	Sampling Method	WGS84 Latitude (DD)	WGS84 Longitude (DD)	SAC	SPA
0.0	ENV_UK_INT_001	Site Characterisation	GRB	341666.11	5704628.13	-	Thames Estuary and Marshes
1.0	ENV_UK_INT_002	Site Characterisation	GRB	341797.88	5704754.69	-	Thames Estuary and Marshes
1.0	ENV_UK_INT_003	Site Characterisation	GRB	341895.39	5704886.22	-	Thames Estuary and Marshes
1.0	ENV_UK_INT_004	Site Characterisation	GRB	341980.27	5704995.88	-	Thames Estuary and Marshes
1.0	ENV_UK_INT_005	Site Characterisation	GRB	342064.78	5705112.13	-	Thames Estuary and Marshes
2.0	ENV_UK_INT_006	Site Characterisation	GRB	342144.46	5705222.62	-	Thames Estuary and Marshes
2.0	ENV_UK_INT_007	Site Characterisation	GRB	342228.99	5705339.31	-	Thames Estuary and Marshes
2.2	ENV_UK_HAB_001	Habitat Assessment	DDV	51.47850900	0.73434200	-	-
3.0	ENV_UK_ENV_001	Site Characterisation	DDC & GRB	51.477283	0.729624	-	-
4.0	ENV_UK_ENV_002	Site Characterisation	DDC & GRB	51.479131	0.758240	-	Outer Thames Estuary
6.0	ENV_UK_ENV_003	Site Characterisation	DDC & GRB	51.480057	0.786991	-	Outer Thames Estuary
8.0	ENV_UK_ENV_004	Site Characterisation	DDC & GRB	51.482566	0.815493	-	Outer Thames Estuary
10.0	ENV_UK_ENV_005	Site Characterisation	DDC & GRB	51.484421	0.844134	-	Outer Thames Estuary
11.8	ENV_UK_HAB_002	Habitat Assessment	DDV	51.48369600	0.86893400	-	Outer Thames Estuary
12.0	ENV_UK_ENV_006	Site Characterisation	DDC & GRB	51.484822	0.872886	-	Outer Thames Estuary
12.3	ENV_UK_HAB_003	Habitat Assessment	DDV	51.48523500	0.87486400	-	Outer Thames Estuary
12.8	ENV_UK_HAB_004	Habitat Assessment	DDV	51.48290000	0.88430600	-	Outer Thames Estuary
14.0	ENV_UK_ENV_007	Site Characterisation	DDC & GRB	51.482767	0.901456	-	Outer Thames Estuary
16.0	ENV_UK_ENV_008	Site Characterisation	DDC & GRB	51.479852	0.929847	-	Outer Thames Estuary
18.0	ENV_UK_ENV_009	Site Characterisation	DDC & GRB	51.480217	0.958623	-	Outer Thames Estuary
20.0	ENV_UK_ENV_010	Site Characterisation	DDC & GRB	51.485912	0.985850	-	Outer Thames Estuary
22.0	ENV_UK_ENV_011	Site Characterisation	DDC & GRB	51.492338	1.012745	-	Outer Thames Estuary
22.9	ENV_UK_HAB_005	Habitat Assessment	DDV	51.49794200	1.02078400	-	Outer Thames Estuary
24.0	ENV_UK_ENV_012	Site Characterisation	DDC & GRB	51.501453	1.037573	-	Outer Thames Estuary
26.0	ENV_UK_ENV_013	Site Characterisation	DDC & GRB	51.511262	1.061687	Margate and Longs Sands	Outer Thames Estuary
26.4	ENV_UK_HAB_006	Habitat Assessment	DDV	51.51028200	1.06681100	Margate and Longs Sands	Outer Thames Estuary
28.0	ENV_UK_ENV_014	Site Characterisation	DDC & GRB	51.519328	1.087441	Margate and Longs Sands	Outer Thames Estuary
30.0	ENV_UK_ENV_015	Site Characterisation	DDC & GRB	51.527899	1.112769	Margate and Longs Sands	Outer Thames Estuary
30.9	ENV_UK_HAB_007	Habitat Assessment	DDV	51.53292800	1.12367800	Margate and Longs Sands	Outer Thames Estuary
32.0	ENV_UK_ENV_016	Site Characterisation	DDC & GRB	51.535821	1.138597	Margate and Longs Sands	Outer Thames Estuary
34.0	ENV_UK_ENV_017	Site Characterisation	DDC & GRB	51.545033	1.161322	Margate and Longs Sands	Outer Thames Estuary
35.5	ENV_UK_HAB_008	Habitat Assessment	DDV	51.55423400	1.17833400	Margate and Longs Sands	Outer Thames Estuary
36.0	ENV_UK_ENV_018	Site Characterisation	DDC & GRB	51.557101	1.181418	Margate and Longs Sands	Outer Thames Estuary
38.0	ENV_UK_ENV_019	Site Characterisation	DDC & GRB	51.563275	1.208173	Margate and Longs Sands	Outer Thames Estuary
40.0	ENV_UK_ENV_020	Site Characterisation	DDC & GRB	51.568197	1.235818	Margate and Longs Sands	Outer Thames Estuary
41.4	ENV_UK_HAB_009	Habitat Assessment	DDV	51.57342900	1.25712500	Margate and Longs Sands	Outer Thames Estuary
42.0	ENV_UK_ENV_021	Site Characterisation	DDC & GRB	51.574112	1.262085	Margate and Longs Sands	Outer Thames Estuary
44.0	ENV_UK_ENV_022	Site Characterisation	DDC & GRB	51.585266	1.284720	Margate and Longs Sands	Outer Thames Estuary
46.0	ENV_UK_ENV_023	Site Characterisation	DDC & GRB	51.595822	1.308079	Margate and Longs Sands	Outer Thames Estuary
48.0	ENV_UK_ENV_024	Site Characterisation	DDC & GRB	51.604705	1.332995	Margate and Longs Sands	Outer Thames Estuary

KP	Station	Station Type	Sampling Method	WGS84 Latitude (DD)	WGS84 Longitude (DD)	SAC	SPA
50.0	ENV_UK_ENV_025	Site Characterisation	DDC & GRB	51.615155	1.355819	Margate and Longs Sands	Outer Thames Estuary
52.0	ENV_UK_ENV_026	Site Characterisation	DDC & GRB	51.628045	1.375958	Margate and Longs Sands	Outer Thames Estuary
54.0	ENV_UK_ENV_027	Site Characterisation	DDC & GRB	51.640931	1.396109	Margate and Longs Sands	Outer Thames Estuary
56.0	ENV_UK_ENV_028	Site Characterisation	DDC & GRB	51.653435	1.416874	Margate and Longs Sands	Outer Thames Estuary
58.0	ENV_UK_ENV_029	Site Characterisation	DDC & GRB	51.665865	1.437764	Margate and Longs Sands	Outer Thames Estuary
60.0	ENV_UK_ENV_030	Site Characterisation	DDC & GRB	51.678578	1.458211	Margate and Longs Sands	Outer Thames Estuary
62.0	ENV_UK_ENV_031	Site Characterisation	DDC & GRB	51.691573	1.478089	Margate and Longs Sands	Outer Thames Estuary
64.0	ENV_UK_ENV_032	Site Characterisation	DDC & GRB	51.707537	1.491404	Margate and Longs Sands	Outer Thames Estuary
66.0	ENV_UK_ENV_033	Site Characterisation	DDC & GRB	51.723058	1.505869	Margate and Longs Sands	Outer Thames Estuary
68.0	ENV_UK_ENV_034	Site Characterisation	DDC & GRB	51.737524	1.523066	Margate and Longs Sands	Outer Thames Estuary
69.0	ENV_UK_HAB_010	Habitat Assessment	DDV	51.74421700	1.53102700	Margate and Longs Sands	Outer Thames Estuary
69.0	ENV_UK_HAB_011	Habitat Assessment	DDV	51.74540200	1.53063900	Margate and Longs Sands	Outer Thames Estuary
70.0	ENV_UK_HAB_012	Habitat Assessment	DDV	51.75126500	1.53941400	Margate and Longs Sands	Outer Thames Estuary
70.0	ENV_UK_HAB_013	Habitat Assessment	DDV	51.75253900	1.53913300	Margate and Longs Sands	Outer Thames Estuary
71.0	ENV_UK_HAB_014	Habitat Assessment	DDV	51.75847700	1.54806200	Margate and Longs Sands	Outer Thames Estuary
71.0	ENV_UK_HAB_015	Habitat Assessment	DDV	51.75974200	1.54778200	Margate and Longs Sands	Outer Thames Estuary
72.0	ENV_UK_HAB_016	Habitat Assessment	DDV	51.76566800	1.55675700	Margate and Longs Sands	Outer Thames Estuary
72.0	ENV_UK_HAB_017	Habitat Assessment	DDV	51.76691400	1.55645400	Margate and Longs Sands	Outer Thames Estuary
73.0	ENV_UK_HAB_018	Habitat Assessment	DDV	51.77285900	1.56545500	Margate and Longs Sands	Outer Thames Estuary
73.0	ENV_UK_HAB_019	Habitat Assessment	DDV	51.77409900	1.56514600	Margate and Longs Sands	Outer Thames Estuary
74.0	ENV_UK_HAB_020	Habitat Assessment	DDV	51.78005500	1.57414100	Margate and Longs Sands	Outer Thames Estuary
74.0	ENV_UK_HAB_021	Habitat Assessment	DDV	51.78130800	1.57386900	Margate and Longs Sands	Outer Thames Estuary
75.0	ENV_UK_HAB_022	Habitat Assessment	DDV	51.78611700	1.58476800	Margate and Longs Sands	Outer Thames Estuary
75.0	ENV_UK_HAB_023	Habitat Assessment	DDV	51.78737100	1.58492300	Margate and Longs Sands	Outer Thames Estuary
76.0	ENV_UK_ENV_035	Site Characterisation	DDC & GRB	51.792479	1.596974	Margate and Longs Sands	Outer Thames Estuary
77.5	ENV_UK_HAB_024	Habitat Assessment	DDV	51.80119700	1.61321500	Margate and Longs Sands	Outer Thames Estuary
78.0	ENV_UK_HAB_025	Habitat Assessment	DDV	51.80196400	1.61973600	Margate and Longs Sands	Outer Thames Estuary
78.0	ENV_UK_HAB_026	Habitat Assessment	DDV	51.80314500	1.62049400	Margate and Longs Sands	Outer Thames Estuary
80.0	ENV_UK_ENV_036	Site Characterisation	DDC & GRB	51.806075	1.649020	Margate and Longs Sands	Outer Thames Estuary
82.0	ENV_UK_ENV_037	Site Characterisation	DDC & GRB	51.806705	1.663487	Margate and Longs Sands	-
84.0	ENV_UK_ENV_038	Site Characterisation	DDC & GRB	51.807333	1.677955	Margate and Longs Sands	-
84.2	ENV_UK_ENV_039	Site Characterisation	DDC & GRB	51.805974	1.692194	-	-
89.0	ENV_UK_ENV_040	Site Characterisation	DDC & GRB	51.804082	1.706371	-	-
90.6	ENV_UK_HAB_027	Habitat Assessment	DDV	51.79435000	1.80046600	-	-
91.0	ENV_UK_ENV_041	Site Characterisation	DDC & GRB	51.803773	1.708685	-	-
92.0	ENV_UK_ENV_042	Site Characterisation	DDC & GRB	51.795014	1.777362	-	-
94.0	ENV_UK_ENV_043	Site Characterisation	DDC & GRB	51.792482	1.806070	-	-
99.0	ENV_UK_ENV_044	Site Characterisation	DDC & GRB	51.791214	1.820417	-	-
102.0	ENV_UK_ENV_045	Site Characterisation	DDC & GRB	51.790364	1.849134	-	-
104.0	ENV_UK_ENV_046	Site Characterisation	DDC & GRB	51.825283	1.883711	-	-
107.0	ENV_UK_ENV_047	Site Characterisation	DDC & GRB	51.851543	1.888715	-	-
110.0	ENV_UK_ENV_048	Site Characterisation	DDC & GRB	51.859062	1.914989	-	-

KP	Station	Station Type	Sampling Method	WGS84 Latitude (DD)	WGS84 Longitude (DD)	SAC	SPA
115.0	ENV_UK_ENV_049	Site Characterisation	DDC & GRB	51.870297	1.954594	-	-
116.0	ENV_UK_HAB_028	Habitat Assessment	DDV	51.89839100	2.07456900	-	-
119.4	ENV_UK_HAB_029	Habitat Assessment	DDV	51.91894800	2.10572600	-	-
120.0	ENV_UK_ENV_050	Site Characterisation	DDC & GRB	51.881519	1.994220	-	-
122.2	ENV_UK_ENV_051	Site Characterisation	DDC & GRB	51.896461	2.047085	-	-
125.0	ENV_UK_ENV_052	Site Characterisation	DDC & GRB	51.923932	2.109881	-	-
130.0	ENV_UK_ENV_053	Site Characterisation	DDC & GRB	51.941562	2.124578	-	-
132.6	ENV_UK_HAB_030	Habitat Assessment	DDV	52.01100700	2.21232000	-	-
135.0	ENV_UK_ENV_054	Site Characterisation	DDC & GRB	51.963888	2.143213	-	-
137.4	ENV_UK_HAB_031	Habitat Assessment	DDV	52.02841700	2.27755600	-	-
140.0	ENV_UK_ENV_055	Site Characterisation	DDC & GRB	52.002140	2.179170	-	-
145.0	ENV_UK_ENV_056	Site Characterisation	DDC & GRB	52.020006	2.246018	-	-
150.0	ENV_UK_ENV_057	Site Characterisation	DDC & GRB	52.037834	2.312919	-	-
155.0	ENV_UK_ENV_058	Site Characterisation	DDC & GRB	52.056826	2.378982	-	-
160.0	ENV_UK_ENV_059	Site Characterisation	DDC & GRB	52.076398	2.444645	-	-
165.0	ENV_UK_ENV_060	Site Characterisation	DDC & GRB	52.095934	2.510366	-	-
170.0	ENV_UK_ENV_061	Site Characterisation	DDC & GRB	52.120303	2.564329	-	-
175.0	ENV_UK_ENV_062	Site Characterisation	DDC & GRB	52.165182	2.568515	-	-
180.0	ENV_UK_ENV_063	Site Characterisation	DDC & GRB	52.210061	2.572708	-	-
185.0	ENV_UK_ENV_064	Site Characterisation	DDC & GRB	52.254940	2.576910	-	-
189.0	ENV_UK_HAB_032	Habitat Assessment	DDV	52.36382700	2.63727200	-	-
190.0	ENV_UK_ENV_065	Site Characterisation	DDC & GRB	52.299818	2.581120	-	-
195.0	ENV_UK_ENV_066	Site Characterisation	DDC & GRB	52.343303	2.595046	-	-
200.0	ENV_UK_ENV_067	Site Characterisation	DDC & GRB	52.365400	2.652475	-	-
205.0	ENV_UK_ENV_068	Site Characterisation	DDC & GRB	52.372866	2.724904	-	-
210.0	ENV_UK_ENV_069	Site Characterisation	DDC & GRB	52.406569	2.768830	-	-
215.0	ENV_UK_ENV_070	Site Characterisation	DDC & GRB	52.450111	2.784928	-	-
220.0	ENV_UK_ENV_071	Site Characterisation	DDC & GRB	52.491478	2.812614	-	-
224.3	ENV_UK_HAB_033	Habitat Assessment	DDV	52.60582900	2.91331800	-	-
225.0	ENV_UK_ENV_072	Site Characterisation	DDC & GRB	52.530710	2.848574	-	-
230.0	ENV_UK_ENV_073	Site Characterisation	DDC & GRB	52.570541	2.882724	-	-
235.0	ENV_UK_ENV_074	Site Characterisation	DDC & GRB	52.610628	2.916115	-	-
239.0	ENV_UK_HAB_034	Habitat Assessment	DDV	52.72259300	3.00972200	-	-
240.0	ENV_UK_ENV_075	Site Characterisation	DDC & GRB	52.650706	2.949567	-	-
241.0	ENV_UK_HAB_035	Habitat Assessment	DDV	52.73240700	3.01795600	-	-
245.0	ENV_UK_ENV_076	Site Characterisation	DDC & GRB	52.690773	2.983080	-	-
250.0	ENV_UK_ENV_077	Site Characterisation	DDC & GRB	52.730832	3.016655	-	-
255.0	ENV_UK_ENV_078	Site Characterisation	DDC & GRB	52.770880	3.050291	-	-
255.1	ENV_UK_HAB_036	Habitat Assessment	DDV	52.85311000	3.11534300	-	-
260.0	ENV_UK_ENV_079	Site Characterisation	DDC & GRB	52.810918	3.083989	-	-
265.0	ENV_UK_ENV_080	Site Characterisation	DDC & GRB	52.851727	3.114997	-	-
270.0	ENV_UK_ENV_081	Site Characterisation	DDC & GRB	52.893064	3.144170	-	-

KP	Station	Station Type	Sampling Method	WGS84		SAC	SPA
				Latitude (DD)	Longitude (DD)		
275.0	ENV_UK_ENV_082	Site Characterisation	DDC & GRB	52.921961	3.195839	-	-
280.0	ENV_UK_ENV_083	Site Characterisation	DDC & GRB	52.964058	3.216999	-	-

4.5. Geodetic Parameters

All co-ordinates were based on Word Geodetic System 1984 (WGS84) with projected grid coordinates based on Universal Transverse Mercator zone 31N (UTM Zone 31N) with a Central Meridian of 3°E. A summary of geodetic and projection parameters are provided in Table 3.

Table 3. Geodetic parameters for the NeuConnect cable corridor geophysical, geotechnical and environmental surveys.

Local Geodetic Datum Parameters	
Datum:	WGS84
Spheroid:	International 1924
Project Projection Parameters	
Grid Projection:	Universal Transverse Mercator, Northern Hemisphere
UTM Zone:	31 N
Units:	Metre
Time Datum:	All data logged including survey logbook and video overlay times shall be time stamped with UTC.

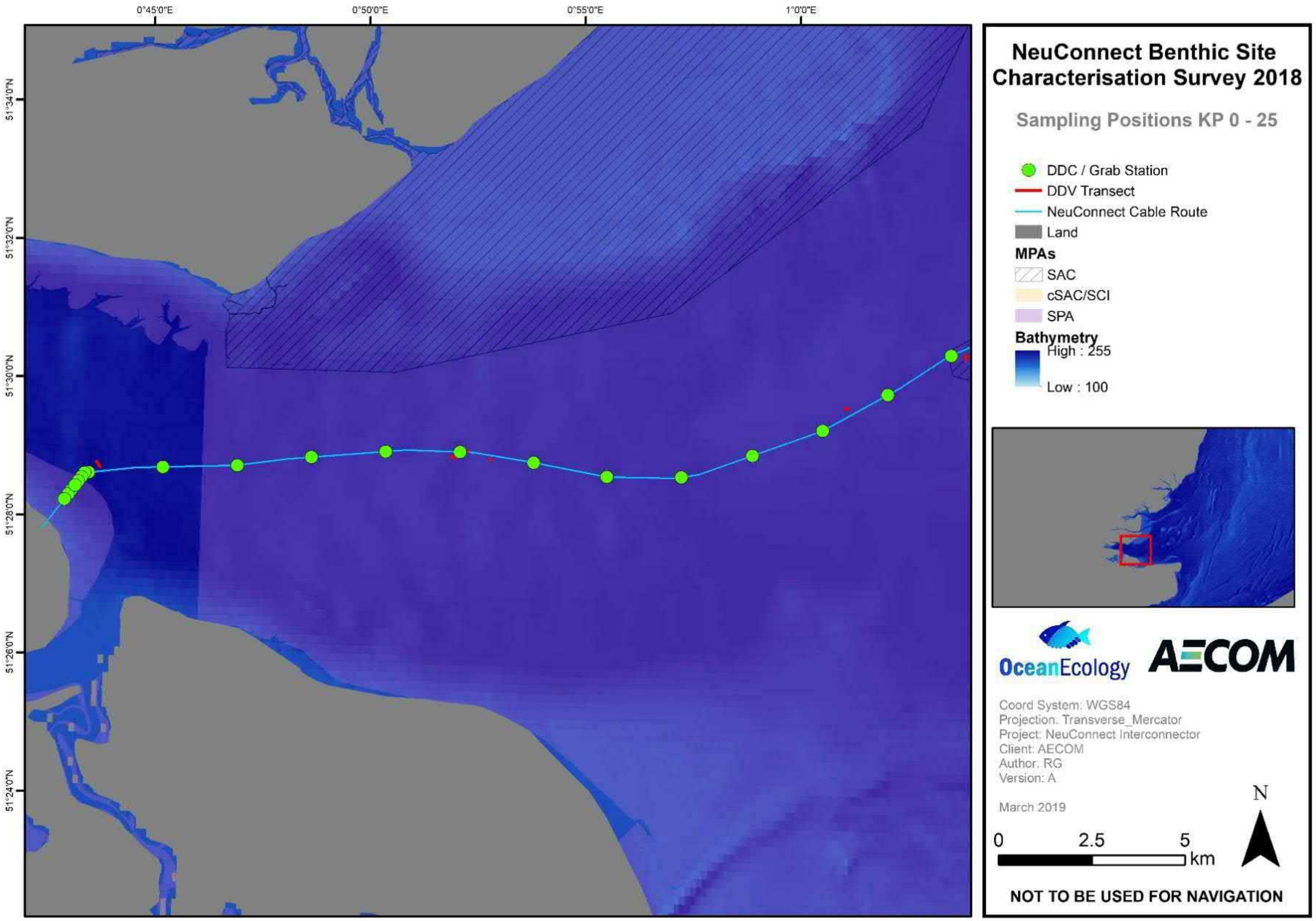

Figure 1 Overview of Site Characterisation and HA transect locations between KP 000 and KP 025 along the NeuConnect cable route[3].

[3] At the time of the writing this report the Southern North Sea Marine Protected Area had not been formally designated and therefore is referred to in all figures as a Candidate SAC (cSAC)".

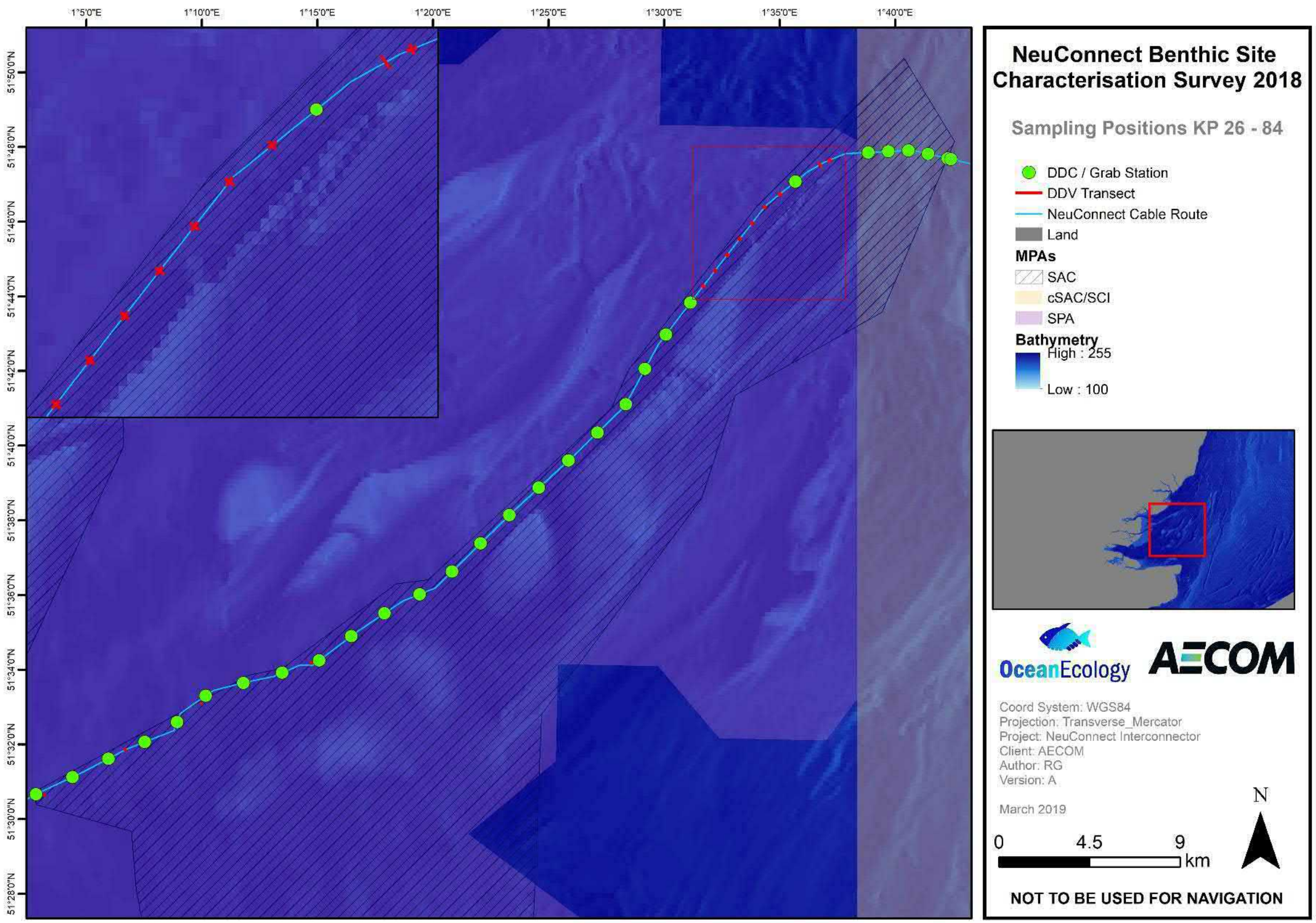

Figure 2 Overview of Site Characterisation and HA transect locations between KP 026 and KP 084 along the NeuConnect cable route and within the Margate and Long Sands Special Area of Conservation.

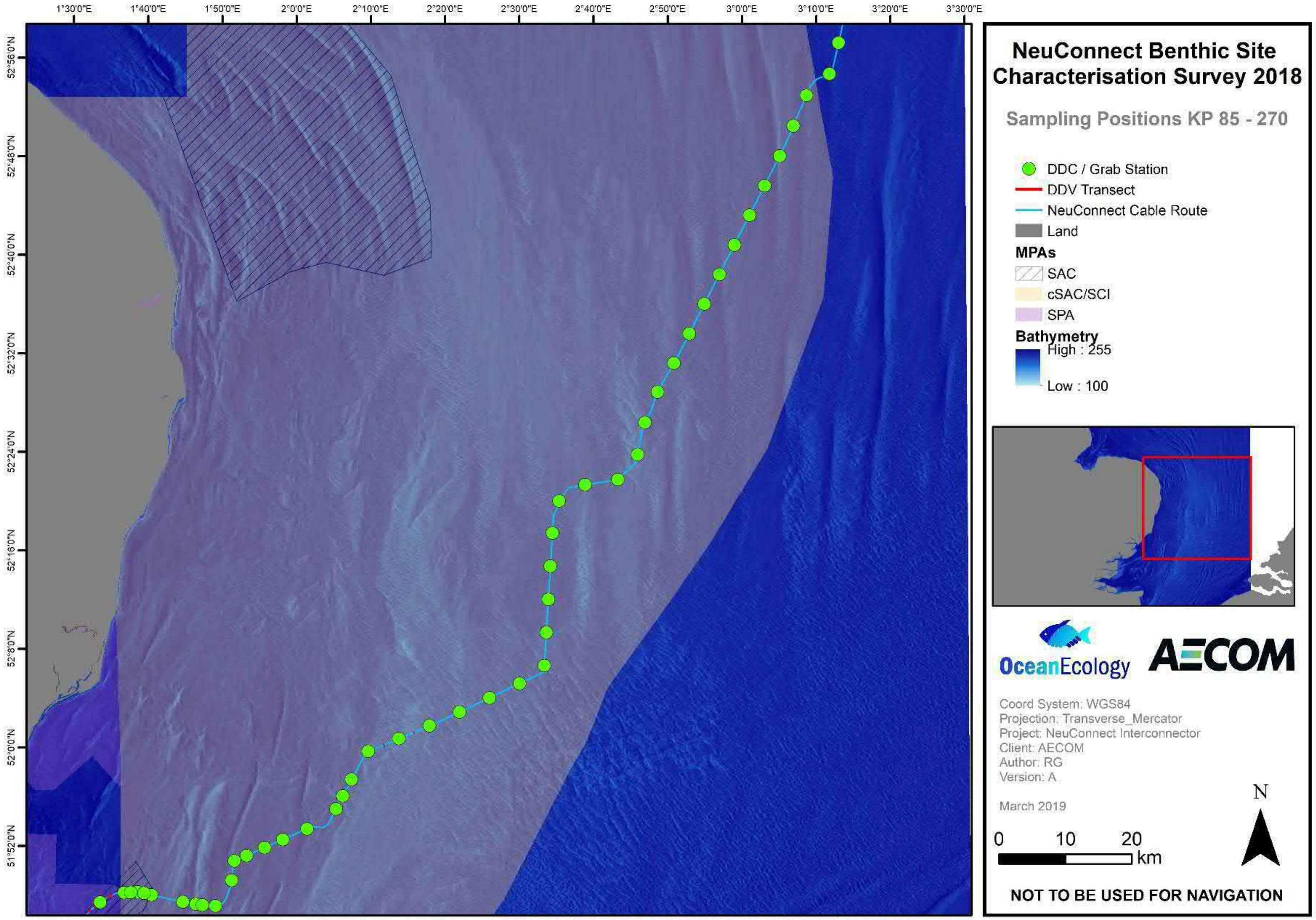

Figure 3 Overview of Site Characterisation and HA transect locations between KP085 and KP270 along the NeuConnect cable route and within the Margate and Long Sands Special Area of Conservation.

5. FIELD METHODS

5.1. Survey Vessel

Offshore survey works were undertaken aboard the vessels the Seiont A (first phase) and Isla B (second phase) operated by Barnes Offshore working out from Whitstable. Nearshore survey works and DDV transects located between KP 68.9 and KP 78.3 were undertaken aboard the survey vessel Seren Las operated by OEL working out from Shotley (Plate 1).

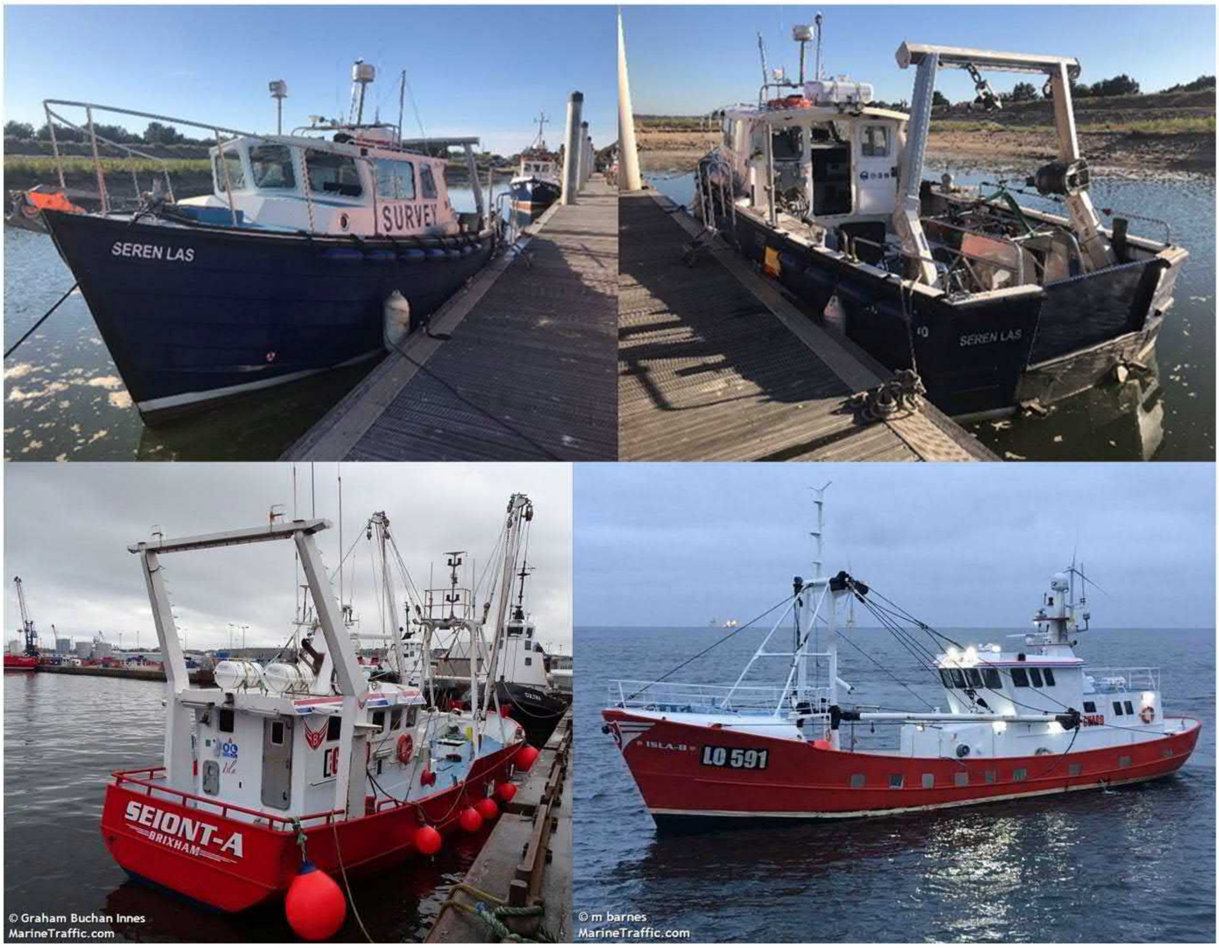

Plate 1. Survey vessels used for the NeuConnect benthic characterisation and habitat assessment survey. Top: *Seren Las*, bottom left: *Seiont-A*, bottom right: *Isla-B*

5.2. Personnel

All environmental works were carried out by a team of experienced OEL Environment Scientists. OEL field personnel all hold offshore safety training certificates and a minimum of a BSc in a Marine Environmental related discipline.

5.3. Sampling Equipment

5.3.1. Positioning

The Seiont A and Isla B were equipped with a Vector VS111™ GNSS compass systems that provided a highly accurate offset position of the sampling equipment when deployed from the stern. This provided a GPS feed to a dedicated survey navigation PC and a Digital Edge DVR system used to project the overlay on the Drop-Down Video (DDV) footage. Seren Las was equipped with a Hemisphere V104s GPS compass system that provided a highly accurate offset position of the sampling equipment when deployed from the stern. This provided a GPS feed to a dedicated survey navigation PC and a Digital Edge DVR system used to project the overlay on the DDV footage.

5.3.2. Seabed Camera System

All seabed imagery collected during the first phase of the survey (Seiont A and Seren Las) was be collected using a 208 Kongsberg camera fitted in a height adjustable freshwater housing camera system providing a variety of options for view, lighting and focal length. The use of this system maximised data quality with respect to prevailing conditions and ensured suitable imagery could be collected regardless of the water clarity at the time of sampling. The frame was also fitted with an LED lighting array.

Video was digitally overlaid using a DVR Edge topside unit giving ROV style overlay options with information including project, date, time and dGPS position (as a minimum) and recorded in a digital format on two hard drives simultaneously. A laser scaling array was also be projected into the field of view to provide a method for determining scale.

All seabed imagery collected during the second phase of the survey (Isla B) was collected using a STR SeaSpyder shallow water ultra-high-resolution camera system, equipped quad parallel lasers for scaling and four adjustable LED lamps.

5.3.3. Grab Samplers

Grab sampling was undertaken using a 0.1 m^2 Day grab. A 0.1 m^2 Hamon grab was also carried on board for sampling of coarse or compact sediments where Day grabbing was unsuccessful. Day grab sampling was prioritised where ever possible as Hamon grab samples are not generally suitable for collection of undisturbed physico-chemical samples due to the mixing of sediments when the grab is triggered.

5.4. Sampling Approach

5.4.1. Drop-Down Video Sampling

Methodologies employed for the collection of seabed imagery were based on guidance in the NMBAQC Operational Guidelines (Hitchin et al. 2015). Along each camera transect, images were taken at 5-10 m intervals and at any other feature of interest or change in habitat. All video was reviewed in situ by the on-board Environmental Scientists. A full description of DDC deployment methods employed during the survey is provided in Appendix II.

5.4.2. Grab Sampling

All grab sample collection and processing was undertaken in line with the methods described in the project Environmental Sampling Plan (ESP) (Ocean Ecology Limited 2018) aligned to relevant best practice guidance (Ware et al. 2011). Grab sampling was only conducted once suitable seabed video and stills of the seabed had been collected from each sampling station and no obstructions to inhibit the collection of grab samples had been identified. Where possible, all grab sampling was undertaken with a 0.1 m^2 Day Grab. This allowed for the collection of an undisturbed sediment surface for physico-chemical sampling (where required). Where sediments were too coarse to obtain an acceptable sample with the Day Grab, a 0.1 m^2 Hamon Grab was used. The grab was deployed to collect two replicate samples at each station. One replicate was sieved over a 1 mm mesh and preserved for macrobenthic analysis. The second replicate was subsampled for physico-chemical analysis (see Appendix II). Appendix III provides details on the sampling stations at which full physico-chemical samples were collected.

Plate 2. Top left: Deployment of freshwater housing camera system aboard *Seren Las.* Bottom left: Sieving of macrobenthic sample. Top right: Day and 0.1m^2 mini-Hamon grabs on deck. Middle right: Camera frame being deployed by Environmental Scientist. Bottom right: Deployment of 0.1m^2 Day grab using ships starboard side crane.

6. LABORATORY & ANALYTICAL METHODS

On arrival to the laboratory, all samples were logged in and entered into the project database created in OEL's web-based data management application ABACUS in line with in-house Standard Operating Procedures (SOPs) and OEL's Quality Management System (QMS).

6.1. Particle Size Distribution Analysis

PSD analysis was undertaken by in-house laboratory technicians at OEL's NE Atlantic Marine Biological Quality Control (NMBAQC) participating laboratory in line with NMBAQC protocols (Mason 2016) as described in Appendix IV.

6.2. Chemical Analysis

All organic matter, hydrocarbon and metals analysis was undertaken by SOCOTEC UK Limited. A full description of the methods used to test for each chemical determinand is provided as Appendix V.

6.3. Macrobenthic Analysis

Macrobenthic analysis was undertaken by in-house marine taxonomists at OEL's NMBAQC participating laboratory. Elutriation, extraction, identification, enumeration and biomassing was carried out in line with the NMBAQC Processing Requirement Protocol (PRP) ((Worsfold & Hall 2010)) as summarised in Appendix VI.

6.4. Seabed Imagery Analysis

6.4.1. Seabed Imagery

Following the methods described in Section 5.3.1, digital photographic stills and video footage were successfully obtained along all HA transects and site characterisation stations and subsequently analysed to aid in the identification and delineation of European Nature Information System (EUNIS) habitats and potential Annex I habitats along the cable corridor. All seabed imagery analysis was undertaken in line with the latest NMBAQC epibiota remote monitoring interpretation guidelines (Turner et al. 2016) and biotopes assigned in line with the most recent JNCC guidance on assigning benthic biotopes (Parry 2015). A full description of the analytical methods employed is provided in Appendix VII.

6.5. Geophysical Data Review

6.5.1. 2018 Geophysical Data

Geophysical data (MBES and SSS) was collected by MMT during an earlier 2018 survey programme. Data collected during the survey was further processed by OEL during interpretation for HA purposes. MBES was processed to produce a shaded relief output and a 0.25 m and 0.50 m contour map. All environmental data was then overlain to assist in the delineation of the principal habitats and biotopes present within the survey corridor.

6.6. Data Pre-Treatment

6.6.1. Macrobenthic Data

As the macrobenthic data may be used for comparison with future studies, it was imperative that the species nomenclature was recorded in a standardised manner. The macrobenthic species lists were therefore checked at the point of data recording via the live link to WoRMS within ABACUS.

Once the species nomenclature had been standardised in accordance with WoRMS accepted names, the taxon lists were examined carefully to truncate the data, excluding incidental recordings that might have skewed the data analysis or combining taxa with differing levels of identification.

In accordance with the OSPAR Commission guidelines (OSPAR 2004) records of colonial, meiofaunal, parasitic, egg and pelagic taxa (e.g. nematode, epitokes and larvae) were recorded, but were excluded when calculating diversity indices or conducting multivariate analysis of community structure. Newly settled juveniles of macrobenthic species may at times dominate the macrobenthos and can be considered an ephemeral component due to heavy post-settlement (OSPAR 2004). OSPAR (2004) states that "Should juveniles appear among the ten most dominant organisms in the data set, the statistical analysis should be conducted both with and without these in order to evaluate their importance". Analysis was conducted on the data set that excluded juveniles, as well as the data set with juveniles included. Comparison between the results of the two analyses revealed similar clustering of stations into groups, suggesting that the two datasets were revealing similar ecological patterns. Consequently, the results presented in this report are based on the data set with juveniles included as they did not dominate the macrobenthic community and enabled fewer faunal groups to be identified.

6.7. Statisical Analysis

6.7.1. Particle Size Distribution Data

Sediment PSD statistics for each sample were calculated from the raw data using Gradistat V8.0 (Blott 2010) and converted into Broad Scale Habitats (BSH) (EUNIS Level 3) using the adapted Folk trigon (Long 2006).

6.7.2. Macrobenthic Data

6.7.2.1. Diversity Indices

In order to condense the full macrobenthic community datasets into a single comparative number, univariate metrics, otherwise known as diversity indices, were calculated from the macrobenthic datasets using the DIVERSE routine in PRIMER v7.

6.7.2.2. Multivariate Analysis

The PRIMER v7 software package (Clarke & Gorley 2015) was utilised to undertake the multivariate statistical analysis on the macrobenthic dataset. In order to fully investigate the multivariate patterns in the data, a suite of analytical routines were employed as described in detail in Appendix VIII. Prior to multivariate analyses, data were displayed as a shade plot with linear grey-scale intensity proportional to macrobenthic abundance to determine the most efficient pre-treatment (transformation) method (Clarke et al. 2014).

6.8. Biotopes

6.8.1. Biotope Determination

Biotopes were identified according to the EUNIS biotope classification system in line with JNCC guidance on assigning benthic biotopes (Parry 2015) in consideration of each of the following datasets/outputs:

- Existing biotope maps (EMODnet);
- Shade plots with linear grey-scale intensity proportional macrobenthic abundance data;
- Macrobenthic faunal groups determined by SIMPROF and/or similarity slice;
- PSD analysis data converted into BSH (EUNIS Level 3) using the adapted Folk trigon (Long 2006); and
- Epibenthic data through analysis of seabed imagery.

6.8.2. Biotope Mapping

All biotope mapping was undertaken in ESRI ArcPro involving overlaying biotopes assigned to each sampling location on the mosaiced SSS and MBES data allowing for delineation of areas representative of similar acoustic signatures aligned to those at each DDC/grab station and along each DDV transect.

7. RESULTS

7.1. Particle Size Distribution Data

The composition of sediment data at each grab sampling station throughout the survey area is mapped in

Figure 4. Grab sampling logs and sample photos are provided in Appendix III and IX respectively and full PSD data has been provided in Appendix X.

7.1.1. Sediment Type

Sediment types at each grab sampling station as classified by the Folk (1954) classification are summarised in Appendix XI. Despite some variation in sediment types between stations, the majority of stations were dominated by sandy sediments with low mud content (sediments < 63 µm). Mud content was highest close to the estuary and between 80 – 100 km along the proposed cable route. Gravel content was variable along the cable route and was highest within the troughs of the Annex I sandbank features at certain locations (e.g. ENV035). The majority of samples were comprised of sand (S), representing EUNIS BSH A5.2 (sublittoral sand), while some stations were classified as muddy sand (mS) or sandy mud (sM), representing EUNIS BSH A5.3 (sublittoral mud). Others exhibited higher gravel content and were classified as gravelly mud (gM) or gravelly muddy sand (gmS), representing sublittoral mixed sediments (EUNIS BSH A5.4). Intertidal stations were classified as either EUNIS BSH A2.2 (Littoral sand and muddy sand) or A2.3 (Littoral mud).

Most of the sediments recorded were classified as poorly to extremely poorly sorted (60 % of stations) as a result of the mixed composition of different size fractions of all three principle sediment types (gravel, sand and mud). However, 20 stations (22 %) were classified as well sorted and comprised almost entirely of sand.

7.1.2. Sediment Composition

The percentage contribution of gravels (> 2 mm), sands (0.63 mm to 2 mm) and fines (< 63 μm) at each station are presented in

Figure 4. Sand was the main sediment fraction present at most stations, comprising the largest percentage contribution across the survey area (**Error! Reference source not found.**Table 3). The mean proportion of sand across all stations was 75.9 % (± 0.03), while the mean mud and gravel content across the survey area was 17.1 % (± 0.02) and 7.0 (± 0.01) respectively. Sand content was greatest at stations ENV023, ENV060, ENV061, ENV081 and ENV082 and lowest at ENV046. The mean grain size at sampling stations ranged from 15.15 μm at station ENV039 (located at the offshore edge of the Margate and Long Sands SAC) to 2455.2 μm at ENV013 (located at the inshore edge of the Margate and Long Sands SAC).

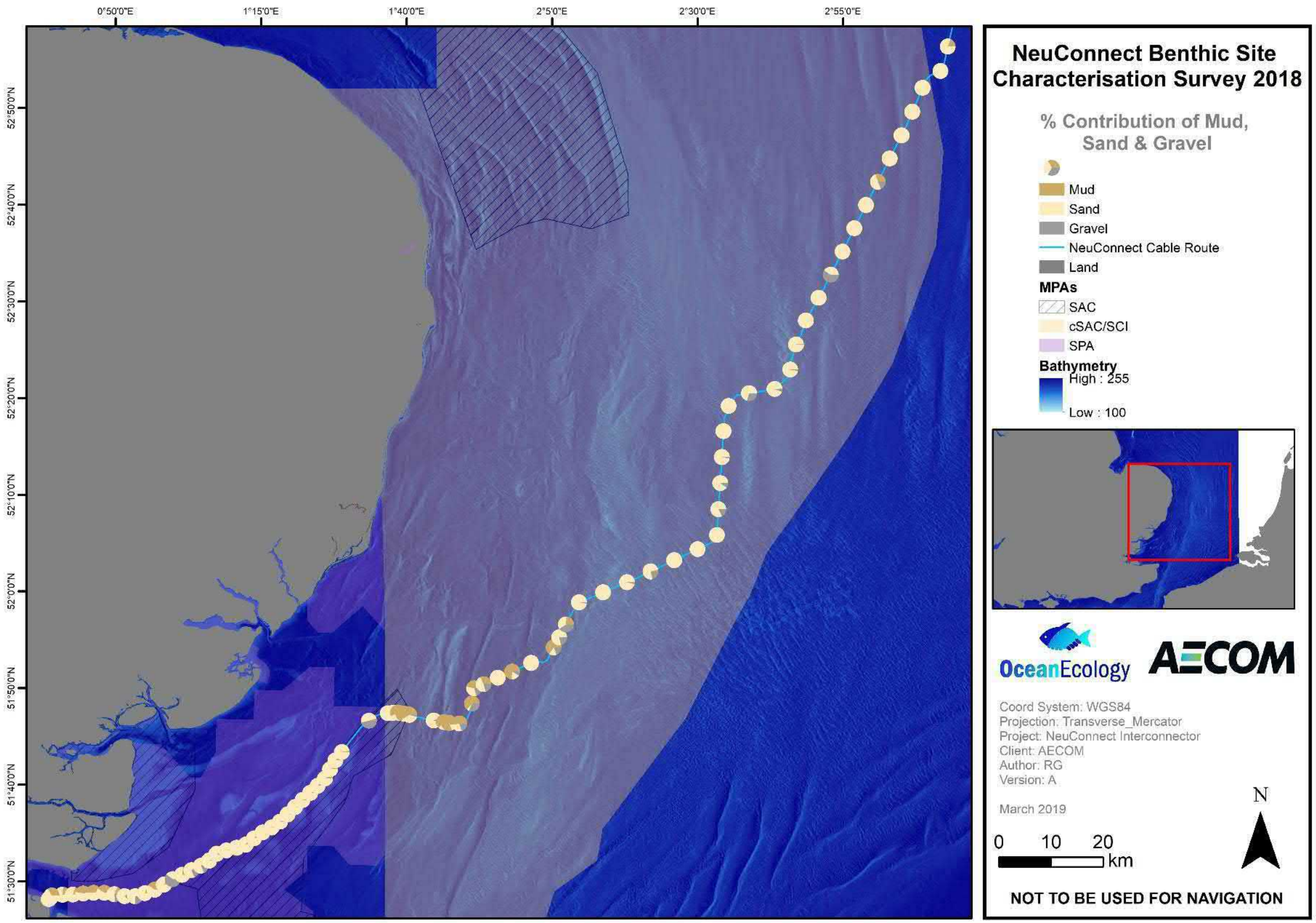

Figure 4. Percentage volume of gravel (G), sand (S) and mud (M) at each sampling station along the GB Offshore Scheme section of the proposed NeuConnect cable route

7.2. Sediment Chemistry

Sediment samples for contaminant analysis were collected from 43 stations sampled along the GB Offshore Scheme section of the proposed NeuConnect cable route. Grab samples taken for contaminant analyses were analysed for heavy and trace metals, Polycyclic Aromatic Hydrocarbon (PAH), Organotins (DBT and TBT), Polychlorinated Biphenyl (PCB), and Organochlorine concentrations.

7.2.1. Heavy and Trace Metals

A series of eight heavy and trace metals – Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), and Zinc (Zn) - were analysed from sediments taken at each of the 41 stations. The results of the sediment metal analyses are summarised in **Table 4** and Table 5, with the raw data sets reported in Appendix XII.

Where available, metal concentrations were compared to the OSPAR BC and BAC, (OSPAR 2014) as well as the UKOOA (2001) background mean and 95th percentile concentrations for the southern North Sea, Cefas (2003) ALs 1 & 2, and Canadian sediment quality guidelines TELs and PELs (See Appendix XII for definitions).

The most abundant metal was As which ranged from 5.3 $mgKg^{-1}$ at INT_002 to 78.6 $mgKg^{-1}$ at ENV_041 and was generally recorded in elevated concentrations across most stations with no obvious spatial distribution. Zn was also recorded in high concentration, ranging from 7.9 $mgKg^{-1}$ at ENV_056 to 61.4 $mgKg^{-1}$ at ENV_011, with lower values often recorded in more offshore areas. Other metals, including Cd, Cu, Ni and Pb were observed in similar concentrations and were often lower at more offshore stations with the exception of Cu. Concentrations of Cd and Cr were below UKOOA (2001) mean concentrations at all stations.

Table 5 summarises comparisons made between the eight heavy and trace metals analysed against OSPAR BC and BAC levels, UKOOA (2001), Cefas (2003) ALs, and Canadian sediment quality guidelines to identify the number of stations sampled that showed elevated concentrations. As exceeded OSPAR BC and BAC levels at the most stations (15 and 8 respectively) as well as Cefas AL1 at 11 stations suggesting high levels of As across the entire route. To a lesser extent, elevated Pb, Hg, and Ni content, in relation to OSPAR levels, were observed at a number of stations. Cu and Zn also showed elevated concentrations, where 30 and 22 stations respectively had concentrations in excess of the UKOOA (2001) mean concentrations. In total 11 sampling stations had concentrations of one or more of Cu, Hg, Ni, Pb, and Zn in excess of the UKOOA (2001) 95th percentile concentrations. This suggests very high levels against background levels for the southern North Sea were only observed at a relatively limited number of stations along the cable route.

Cefas (2003) ALs are used as part of a 'weight of evidence' approach to assessing dredged material and its suitability for disposal to sea (Cefas 2003). Contaminant levels in dredged material which fall below AL1 are of no concern and are unlikely to influence decision-making, while contaminant levels above AL2 are generally considered unsuitable for sea disposal. Contaminant levels between AL1 and AL2 require further assessment. As (11 stations) and Ni (three stations) were the only metals to have been recorded in concentrations that exceeded Cefas (2003) AL 1 with no metals recorded in excess of Cefas (2003) AL2.

Canadian sediment quality guidelines are based on field research programmes that have demonstrated associations between chemicals and biological effects by establishing cause and effect relationships in particular organisms (PLA n.d). At levels above the threshold effect levels (TELs), adverse effects may occasionally occur. At levels above the probable effect levels (PELs), adverse effects may occur frequently. Cd, Cr, Pb, Ni and Zn were all recorded at concentrations falling below the TELs. Cu and Hg were recorded above the TELs at one and two stations respectively. As was recorded above the TELs at 35 stations, and above the PELs at five stations.

A full comparison of metal concentrations with guideline levels and background levels at each sampling station is provided in Appendix XIII.

Table 4. Summary of heavy and trace metal results (mgKg-1) against UKOOA (2001) background levels for the southern North Sea

	Arsenic	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Zinc
ENV_UK_INT_002	5.3	0.09	8.8	7.4	0.06	5.3	8.1	27.4
ENV_UK_INT_004	6.8	0.1	13.3	10.3	0.1	7.8	12.9	36.5
ENV_UK_INT_006	8.6	0.12	17.3	13.1	0.14	9.9	16.8	45.6
ENV_UK_ENV_001	8.6	0.08	19.8	14.4	0.14	11.2	18.9	50.7
ENV_UK_ENV_003	5.9	0.08	10.1	8.4	0.06	5.6	9.5	26.8
ENV_UK_ENV_005	10.8	0.09	10.8	11.2	0.12	7.2	20.8	39.8
ENV_UK_ENV_007	7.5	0.08	6.9	6.9	0.09	5.7	20.5	26.8
ENV_UK_ENV_009	17.1	0.1	21.4	12.9	0.08	15.1	20.7	57.6
ENV_UK_ENV_011	51.5	0.08	11.2	5.4	0.04	7.1	26	61.4
ENV_UK_ENV_013	14.3	0.04	9.9	13.1	0.06	8.4	25.5	22
ENV_UK_ENV_015	21.6	0.09	9.3	6.8	0.02	5.3	10.5	32.5
ENV_UK_ENV_017	38.4	0.05	9.3	6.3	<0.015	5.7	8.7	29.2
ENV_UK_ENV_019	20.6	0.08	8.5	7.1	0.02	5.3	9.5	25
ENV_UK_ENV_021	12.4	0.05	8.6	6.6	<0.015	5.2	5.2	21.2
ENV_UK_ENV_023	50.1	0.07	6.8	5.5	<0.015	5.3	10.8	29
ENV_UK_ENV_025	12.2	0.06	8.7	7.7	0.02	5.7	7	20.2
ENV_UK_ENV_027	12.8	<0.04	7.6	5.9	0.02	4.4	4.6	25.4
ENV_UK_ENV_029	15.6	<0.04	7.7	6.8	<0.015	4.7	5.3	25.8
ENV_UK_ENV_031	11.5	0.05	7.3	5.9	<0.015	4.2	4.3	16.6
ENV_UK_ENV_033	9.1	0.05	7.4	6	<0.015	4.3	4.6	18.6
ENV_UK_ENV_037	10	0.05	7.5	6.7	<0.015	4.4	4.8	18
ENV_UK_ENV_039	24.6	0.25	24.5	24.9	0.06	23.8	13.1	57
ENV_UK_ENV_041	78.6	0.36	21.2	12.1	<0.015	27.5	9.7	42.4
ENV_UK_ENV_042	54.3	0.19	9.2	6.8	0.03	19.2	8.1	29.8
ENV_UK_ENV_045	50.4	0.15	22.1	13.8	<0.015	30.4	7.2	43.3
ENV_UK_ENV_051	30.3	0.12	6.2	4.9	<0.015	5.7	3.8	18
ENV_UK_ENV_056	6.3	<0.04	2.5	3.1	<0.015	2.8	1.8	7.9
ENV_UK_ENV_058	28	0.05	7.8	5.8	<0.015	8.2	3.7	15.9
ENV_UK_ENV_060	9	0.08	5	11.7	0.04	4.5	5.8	24.7
ENV_UK_ENV_062	8.6	<0.04	4.7	9.6	0.02	3.6	2.7	11.9
ENV_UK_ENV_064	8.7	<0.04	5.4	10.9	<0.015	3.9	2	14.6
ENV_UK_ENV_066	12	<0.04	5	9.1	<0.015	3.6	2.1	16.2
ENV_UK_ENV_068	15.7	<0.04	6.4	8.1	<0.015	4.1	2.6	17.1
ENV_UK_ENV_070	10.3	<0.04	5.6	10.6	<0.015	3.9	2.5	25.8
ENV_UK_ENV_072	5.8	<0.04	5.1	7.8	0.12	3.1	1.8	13.5
ENV_UK_ENV_074	11.2	<0.04	5.2	9.5	0.07	3.7	2.4	20
ENV_UK_ENV_076	10.60	<0.04	7.10	8.8	0.03	4.40	3.20	15.30
ENV_UK_ENV_078	11.60	<0.04	6.90	9.7	0.02	4.30	2.80	16.50
ENV_UK_ENV_080	15.50	<0.04	8.70	8.6	<0.015	5.40	4.60	17.80
ENV_UK_ENV_082	7.60	<0.04	7.60	7.2	<0.015	4.50	2.30	12.50
Min	5.30	0.04	2.50	3.10	0.02	2.80	1.80	7.90
Max	78.60	0.36	24.50	24.90	0.14	30.40	26.00	61.40
Mean	**18.75**	**0.10**	**9.61**	**8.94**	**0.06**	**7.61**	**8.43**	**26.91**
SD	16.69	0.07	5.33	3.76	0.04	6.53	6.86	13.44
UKOOA 95th %	**-**	**0.5**	**48.5**	**11.8**	**0.1**	**18.7**	**21.1**	**43.5**
UKOAA Mean	-	0.5	24.6	6.6	0.03	8	12.7	21.8

Table 5. Number of stations along the GB Offshore Scheme section of the proposed NeuConnect cable route exhibiting elevated heavy and trace metal levels in comparison with OSPAR, UKOOA, Cefas (2003) Action Levels 1 and 2, and Canadian sediment quality guidelines.

	UKOOA		OSPAR		CEFAS Action Level		Canadian sediment quality guidelines	
	Mean	95th %	BC	BAC	AL1	AL2	TEL	PEL
Arsenic	-	-	15	8	11	0	35	5
Cadmium	0	0	2	1	0	0	0	0
Chromium	0	0	-	-	0	0	0	0
Copper	30	7	1	0	0	0	1	0
Mercury	14	4	12	7	0	0	2	0
Nickel	9	4	1	0	3	0	0	0
Lead	9	2	2	0	0	0	0	0
Zinc	22	5	0	0	0	0	0	0

7.2.2. Polycyclic Aromatic Hydrocarbons (PAH)

A full range of PAHs were tested for all 41 samples collected, including those PAHs specified by the Department of Trade and Industry (DTI) regulations (DTI 1993) which include the 16 PAHs recommended as priority pollutants, notably the 2 to 6 ring compounds (Nyberg et al. 2013).

Samples collected for contaminant analysis were analysed for PAH. The results of the PAH analyses undertaken are summarised in Table 6, with full results reported in Appendix XIV. PAH concentrations were then compared to the OSPAR BC and BAC, Canadian sediment quality guideline TELs and PELs, and Cefas (2003) AL1 guidelines.

Table 6 summarises the OSPAR BC and BAC levels, Canadian TELs and PELs and Cefas (2003) AL1 guidelines to show the number of stations sampled that exhibited elevated concentrations. PAHs only occasionally exceeded OSPAR BCs and BACs, Canadian guideline TELs and Cefas (2003) AL1 guidelines. At no point were Canadian PELs exceeded. PAHs were only prevalent at inshore stations, with the exception of ENV_070.

A full comparison of hydrocarbon concentrations with guideline levels and background levels at each sampling station is provided in Appendix XIV.

Table 6. Overview of OSPAR, Canadian and CEFAS guideline PAH level exceedances at stations sampled along the GB Offshore Scheme section of the proposed NeuConnect cable route.

	OSPAR		Canadian sediment quality guidelines		CEFAS
	BC	BAC	TEL	PEL	AL1
Acenaphthene	-	-	3	0	0
Acenaphthylene	-	-	5	0	0
Anthracene	9	6	1	0	0
Benz[a]anthracene	12	7	1	0	1
Benzo[a]pyrene	10	6	3	0	3
Benzo[b]fluoranthene	-	-	-	-	3.0
Benzo[g,h,i]perylene	0	0	-	-	1.0
Benzo[e]pyrene	-	-	-	-	3.0
Benzo[k]fluoranthene	-	-	-	-	1.0
Naphthalene	23	20	8	0	5
Phenanthrene	10	7	2	0	2
Chrysene	12	6	2	0	2
Dibenzo[a,h]anthracene	-	-	6	0	0
Fluoranthene	11	7	4	0	4
Fluorene	-	-	2	0	0
Indeno[123,cd]pyrene	5	2	-	-	3
Perylene	-	-	-	-	1
Pyrene	12	8	0	0	1

7.2.3. Organotins

Samples collected for contaminant analysis were analysed for the organotins: Monobutyltin (MBT), Dibutyltine (DBT), and Tributyltin (TBT). A single station (UK_ENV_001) had levels of MBT greater than Cefas (2003) AL1 (0.1 mg/kg dry weight). Organotins were not detected at any other stations. A detailed summary of organotin concentrations can be found in Appendix XIV.

7.2.4. Polychlorinated Biphenyls (PCB)

Samples collected for contaminant analysis were analysed for PCBs. None of the sampled stations had values greater than Cefas (2003) AL1 or Canadian guideline TELs and PELs. A detailed summary of PCB concentrations can be found in Appendix XIV.

7.2.5. Organochlorines

Samples collected for contaminant analysis were analysed for the organochlorines Dieldrin and Dichlorodiphenyltrichloroethane (DDT). None of the sampled stations had values greater than Cefas (2003) AL1 (0.005 and 0.001 mg/kg dry weight respectively). A detailed summary of organochlorine concentrations can be found in Appendix XIV.

7.3. Macrobenthos

7.3.1. Diversity

The macrobenthic assemblage identified along the GB Offshore Scheme section of the proposed NeuConnect cable route was relatively diverse with a total of 356 taxa recorded with a mean (± SE) of 15.1 ± 2.0 taxa per sample. Mean (± SE) abundance per sample was 62.7 ± 11.6 individuals per sample. These values exclude records of eggs, epitoke, megalopa, juvenile, parasitic and zoea taxa as summarised in Table 7. The full abundance and biomass matrix is provided in Appendix XIV in line with Marine Environmental Data and Information Network (MEDIN) data standards presenting the abundance of each taxon and biomass per major group (Annelida, Crustacea, Mollusca, Echinodermata and Others) in all samples collected across the survey area.

Table 7. Summary of macrobenthic abundance and diversity along the GB Offshore Scheme section of the proposed NeuConnect cable route.

Taxa	Abundance (N)	Number of Taxa (S)
Colonial	-	62
Eggs	1	1
Epitoke	1	1
Juvenile	384	29
Megalopa	2	1
Parasite	1	1
Zoea	6	1
Others	5,033	260
TOTAL	**5,428**	**356**

Figure 5 illustrates the relative contributions to total abundance (N), diversity (S) and biomass (gAFDM) of the major taxonomic groups of the macrobenthic communities sampled within and outside the Margate and Long Sands SAC and combined. Annelid taxa dominated the assemblages in terms of N accounting for 39 % of all individuals recorded (across all areas) with higher % contribution recorded within the SAC (59.7 %). Annelid taxa also dominated S accounting for 36.8 % of the taxa identified across all areas although echinoderms dominated the overall biomass (48.2 %). Molluscs were the second greatest contributors to overall abundance (32.3 %) and biomass (38.3 %), particularly in areas outside of the SAC. The greatest abundance and diversity of macrobenthic taxa were sampled in areas along the cable route characterised as EUNIS biotope A5.611 '*Sabellaria spinulosa* on stable circalittoral mixed sediment' and A5.44 circalittoral mixed sediment

Figure 7 and

Figure 8.

The mollusc, *Peringia ulvae*, contributed most to total abundance, had the highest maximum abundance in a single sample, and the highest mean density per sample (Figure 6). The Ross worm, *S. spinulosa*, was also abundant across the survey area. *S. spinulosa* accounted for 6.5 % of all individuals recorded and was recorded in 21.1 % of samples (Figure 6). *Nephtys cirrosa* and *Nephtys* juveniles were the most frequently observed taxa and were recorded in 44.4 % and 37.8 % of samples respectively (Figure 6B).

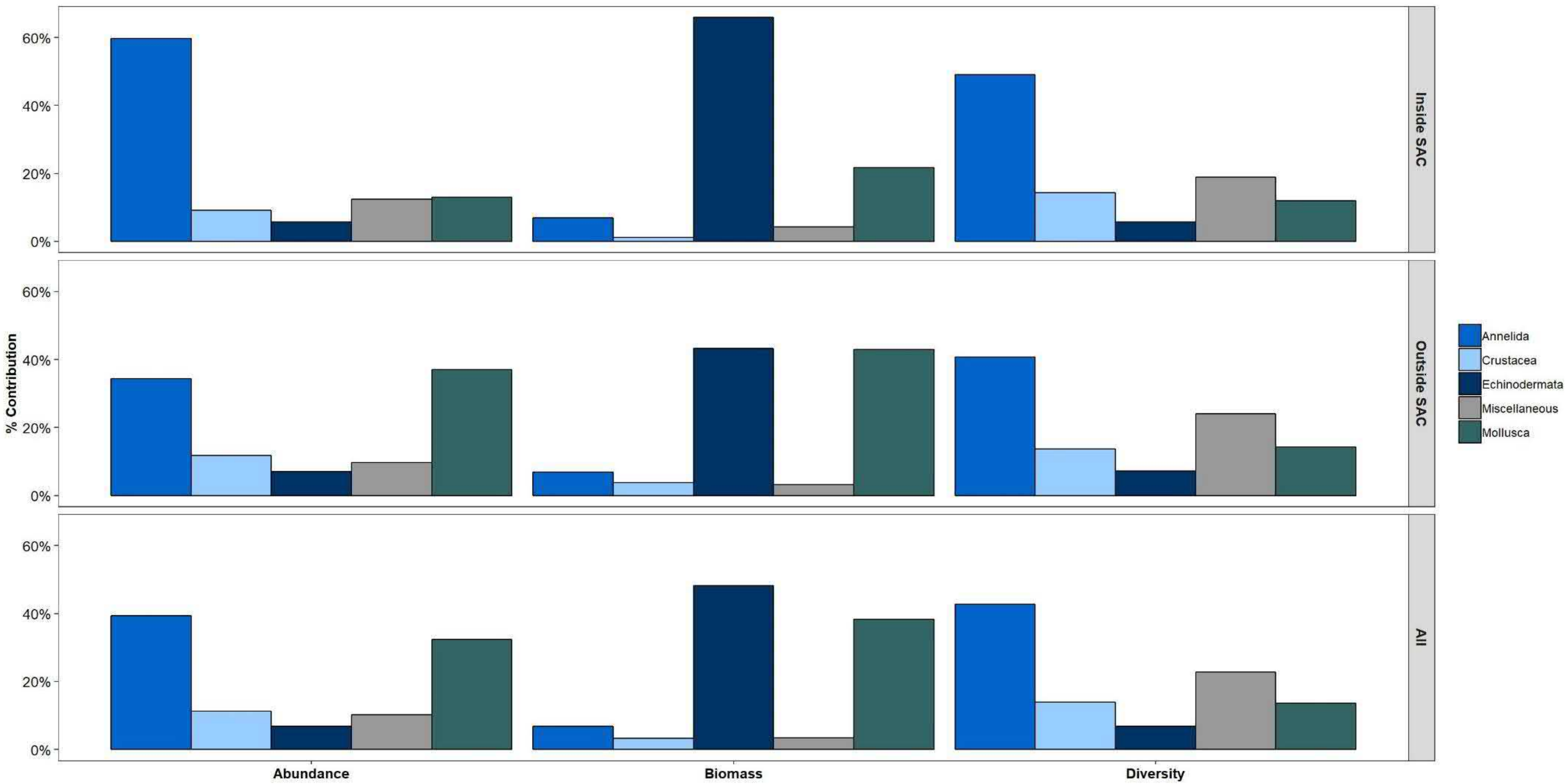

Figure 5. Relative contribution of the major taxonomic groups to the total abundance (N), biomass (gAFDW), and diversity (S), of the macrobenthic communities sampled along the GB Offshore Scheme section of the proposed NeuConnect cable route. Data reported for both inside and outside the Margate and Long Sands Special Area of Conservation (SAC) as well as for both areas combined.

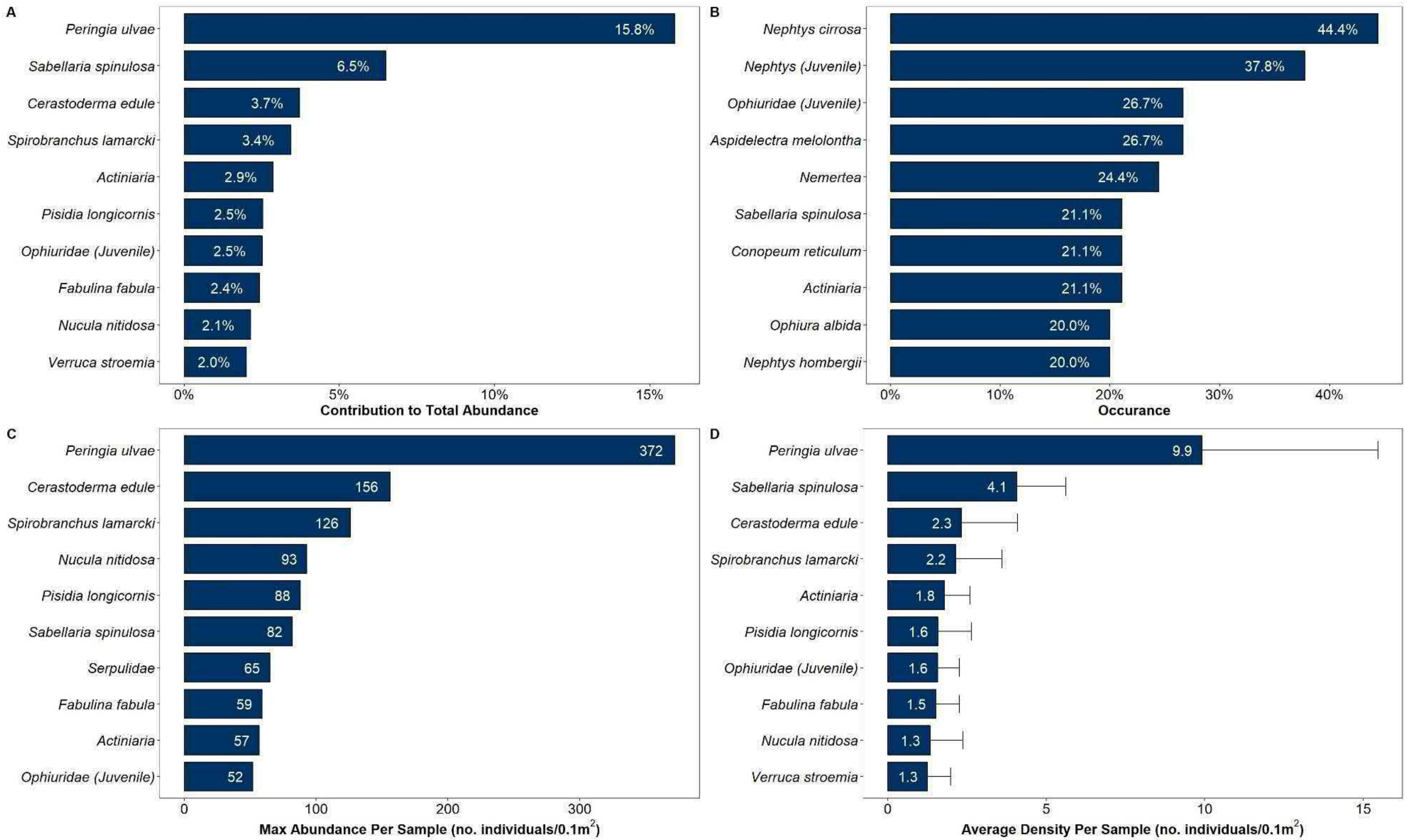

Figure 6. Percentage contributions of the top 10 taxa to total abundance (A) and occurrence (B) from samples collected during the NeuConnect cable survey. Also shown are the maximum densities of the top 10 taxa per sample (C) and average densities of the top 10 taxa per sample (D).

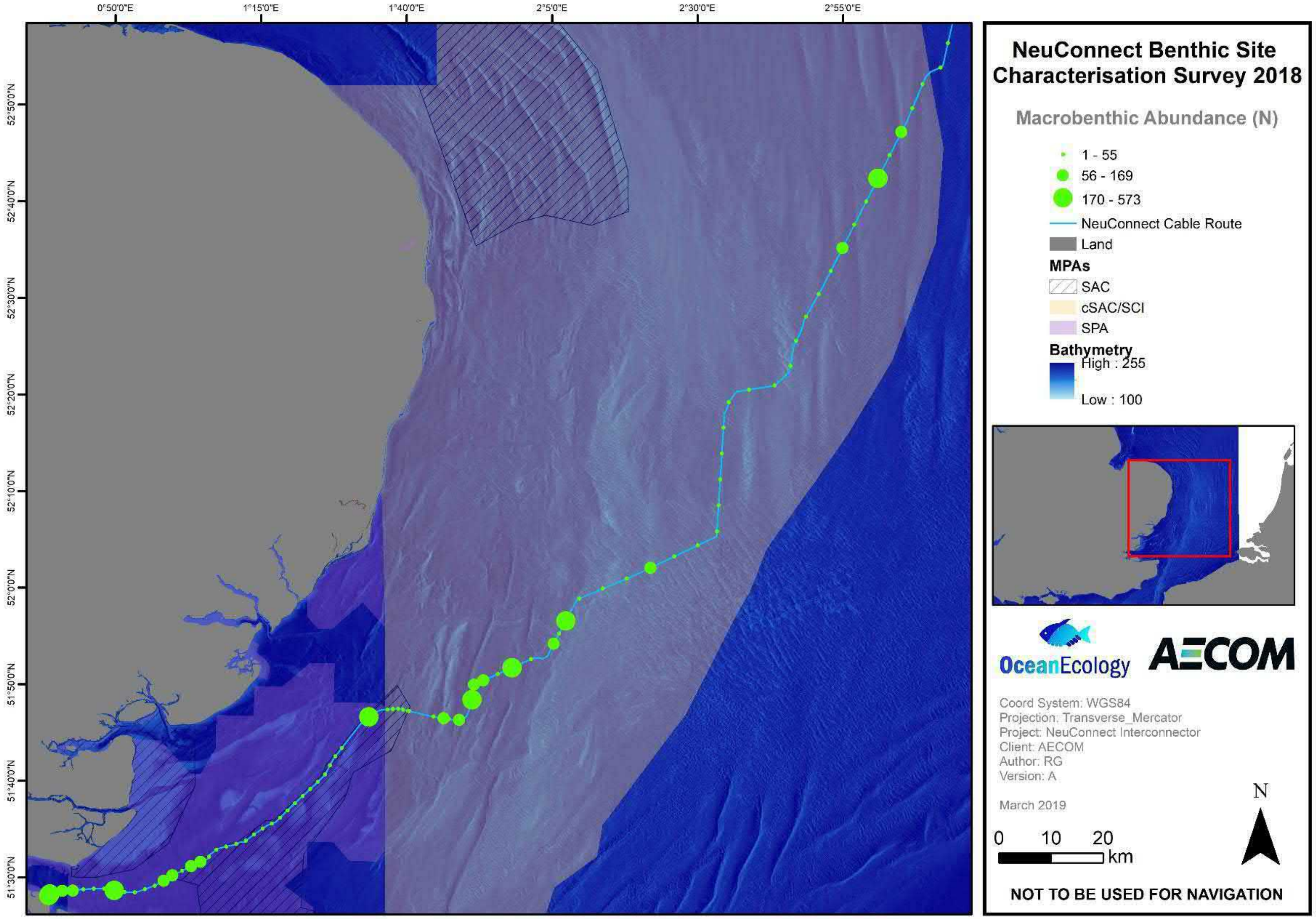

Figure 7 Map to show mean macrobenthic abundance along the GB Offshore Scheme section of the proposed NeuConnect cable route overlain on EUNIS biotope mapping determined as part of the HA for the project.

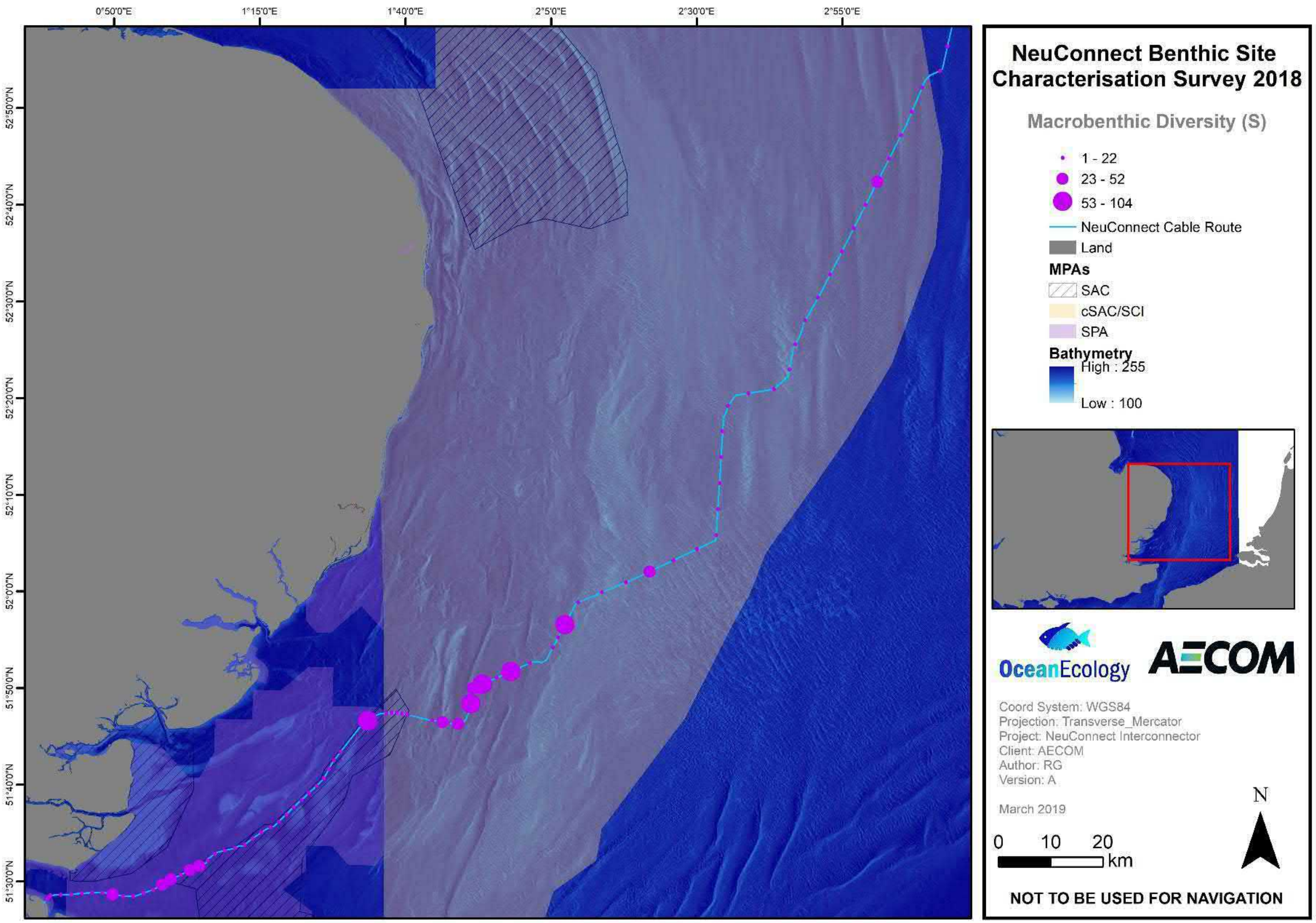

Figure 8 Map to show mean macrobenthic diversity along the GB Offshore Scheme section of the proposed NeuConnect cable route overlain on EUNIS biotope mapping determined as part of the HA for the project.

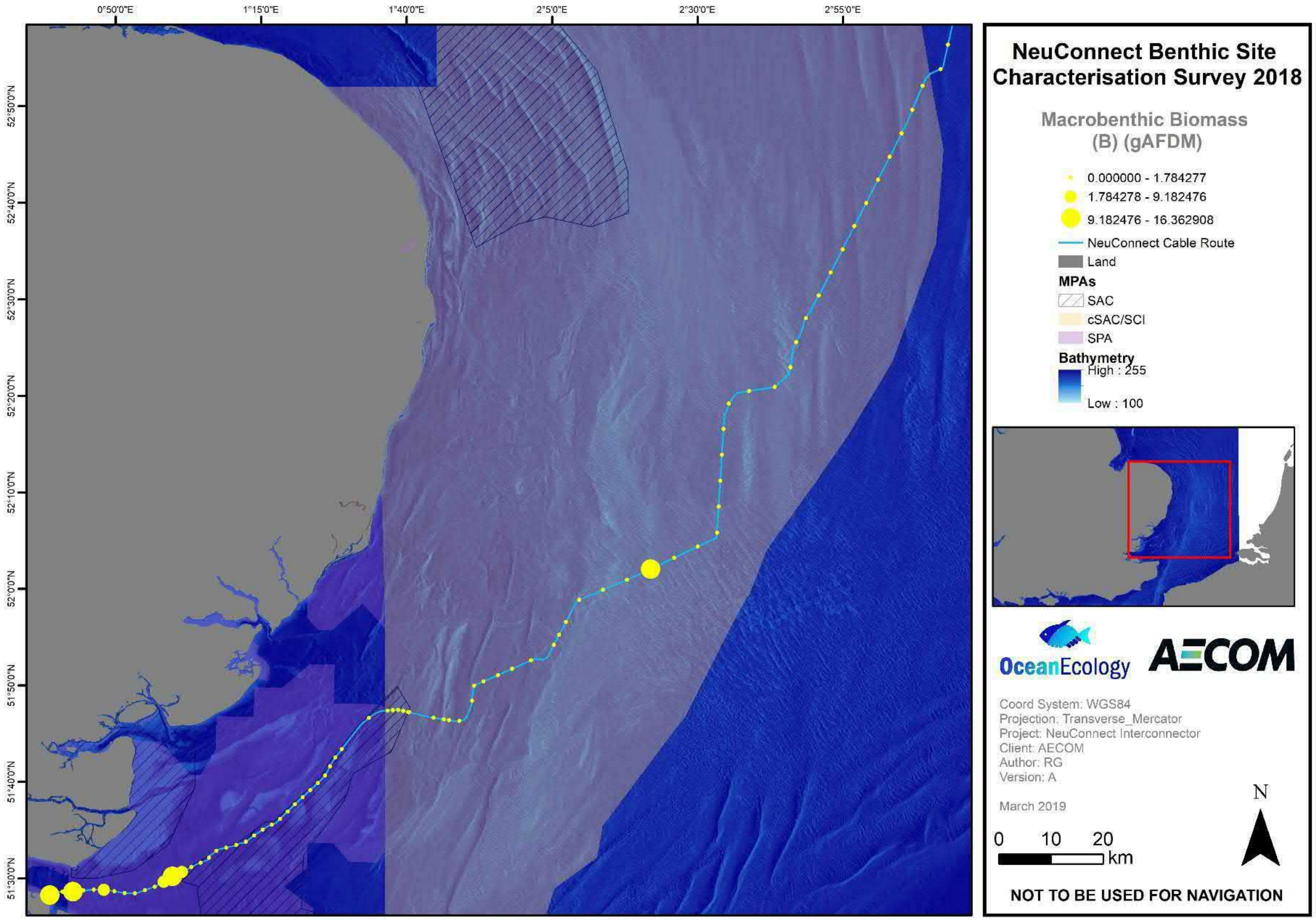

Figure 9 Map to show mean macrobenthic biomass (gAFDM) along the GB Offshore Scheme section of the proposed NeuConnect cable route overlain on EUNIS biotope mapping determined as part of the HA for the project.

Plate 3. Example micrographs of the key macrobenthic taxa sampled along the GB Offshore Scheme section of the proposed NeuConnect cable route.

7.4. Macrobenthic Faunal Groupings

Two techniques were used to elucidate similarities and differences in the macrobenthic data; cluster analysis, which outputs a dendrogram displaying the relationship between data based on the Bray Curtis similarity measure, and non-metric multi-dimensional scaling (nMDS) in which station data are ordinated in a 2-dimensional plot. All data underwent a square-root transformation as a means of reducing the influence of highly abundant taxa which would otherwise have a disproportionate influence on the dataset, whilst allowing the underlying community structure to be assessed. Details of the multivariate statistical analyses routines undertaken are presented in Appendix VIII.

7.4.1. Determination of Macrobenthic Faunal Groups

The dendrogram and SIMPROF test identified 17 statistically significant faunal groups and six outliers derived based on the similarity of the community composition. Similarity between stations was relatively low, however, SIMPROF groups were condensed (to 15 % similarity) to form a more manageable number of groups. Given the size of the area sampled, which covered a wide variety of habitats from the intertidal to offshore, low similarity between stations is to be expected. Lack of replicates can also lead to increased variability in the dataset as well as low numbers and diversity of taxa in samples.

The similarity slice (15 %) was overlain on the dendrogram to identify fewer faunal groupings and therefore demonstrate broader scale changes in community composition. The slice grouped the stations into 11 significant groups (A-C) and two outliers. Faunal group A contained the greatest number of stations within the survey area (39 out of 90). The corresponding nMDS ordination plot

Figure 10, displayed in two-dimensions, graphically displays the similarity of the communities based on the distance between the sample points. The degree of clustering of intra-group sample points demonstrates the level of within group similarity (i.e. points within Faunal Groups A and B show distinct clustering), whilst the degree of overlap of inter-group sample points is indicative of the level of similarity of the different faunal groups. One outlier, station ENV_030, is not shown in Figure 10 as it was highly dissimilar from all other samples.

The stress value of the nMDS ordination (0.18) indicates that the two-dimensional plot provides a relatively poor representation of the similarity between the samples given the variability between them as to be expected when considering single replicates across an expansive survey area. The characteristic taxa within each of the faunal groups were determined by the results of the SIMPER routine which provide a level of percentage contribution (%Contrib) to the group similarity which is discussed for each faunal group below. Results of the SIMPER routine are provided in Appendix XV. The distribution of the faunal groups along the pipeline route are shown in Figure 11.

7.4.2. Composition of Macrobenthic Faunal Groups

Faunal Group A occurred at 39 of the 90 sampling stations and was dominated by a number of polychaete worm species including *Nephtys cirrosa, Nephtys* sp. (Juveniles), and *Magelona johnstoni* which contributed 57.0 %, 9.1 % and 6.4 % of the within-group similarity respectively. Stations belonging to this faunal group were located within areas of high sand content characterised as EUNIS biotope A5.25 ‘Circalittoral fine sand’ and was observed within the SAC and in offshore areas (Figure 11).

Faunal Group B occurred at 15 sampling stations and was characterised by the ross worm *S. spinulosa, Actinaria* sp., *Lumrineris cingulata, and Notomastus* sp. which all contributed between 6.9 and 6.3 % to within-group similarity. Stations belonging to this faunal group were located within areas with high mud and gravel content thought to be generally representative of the EUNIS biotopes A5.511 '*Sabellaria spinulosa* on stable circalittoral mixed sediment' and A5.44 'Circalittoral mixed sediment' (Figure 11).

Faunal Group C occurred at nine sampling stations and was dominated by the polychaete *Nephtys hombergii* (57.0 % similarity) and also contained the bivalves *Nucula nitidosa* and *N. nucleus* which contributed to 11.0 %, and 8.4 % of the within-group similarity respectively. Stations belonging to this faunal group were located within areas of high sand content characterised as EUNIS biotope A5.25 'Circalittoral fine sand' and was mainly observed in inshore areas (Figure 11). This group contained the two outermost intertidal stations (INT_006 and INT_007).

Faunal Group D was representative of six sampling stations and was characterised by *Peringia ulvae, Cerastoderma edule,* and *Nephyts* sp. (Juveniles) which contributed to 38.6 %, 21.1 %, and 13.9 % of the within-group similarity respectively. This faunal group was characteristic of the sandy intertidal communities. This included five of the seven intertidal stations: INT_001 – INT_005.

Faunal Group E occurred at five sampling stations and was characterised by *Spiophanes bombyx, Conopeum reticulum,* and *Mytilidae* sp. (Juveniles) which contributed to 16.4 %, 13.1 %, and 8.5 % of the within-group similarity respectively. Stations belonging to this faunal group were located within patches of coarse and mixed sediments characterised as EUNIS biotope A5.14 'Circalittoral coarse sediment' and A5.44 'Circalittoral mixed sediment' (Figure 11).

Faunal Group F was representative of four sampling stations and was dominated by the bryozoans *Aspidelectra melolontha* and *Electra monostachys* which contributed to 57.0 % and 22.8 % of the within-group similarity respectively. This faunal group was observed in sandy/coarse sediments.

Faunal Group G occurred at two sampling stations and had very low within group similarity (17.9 %) which was characterised by the presence of *Ophiuridae* sp. (100 %) in each sample.

Faunal Group H occurred at two sampling stations and was characterised by *Actiniaria* spp. and *Nemertea* spp. which both contributed to 36.9 % within-group similarity.

Faunal Group I occurred at two sampling stations and had very low within group similarity (16.6 %) which was characterised by the presence of *Urothoe brevicornis* (100 %) in each sample.

Faunal Group J occurred at two sampling stations and had low within group similarity (25.0 %) which was characterised by the presence of *Ophiura albida* (100 %) in each sample.

Faunal Group K occurred at two sampling stations and while it higher within group similarity (36.9 %) than other groups it was characterised by the presence of *Gastrosaccus spinifer* (100 %) in each sample.

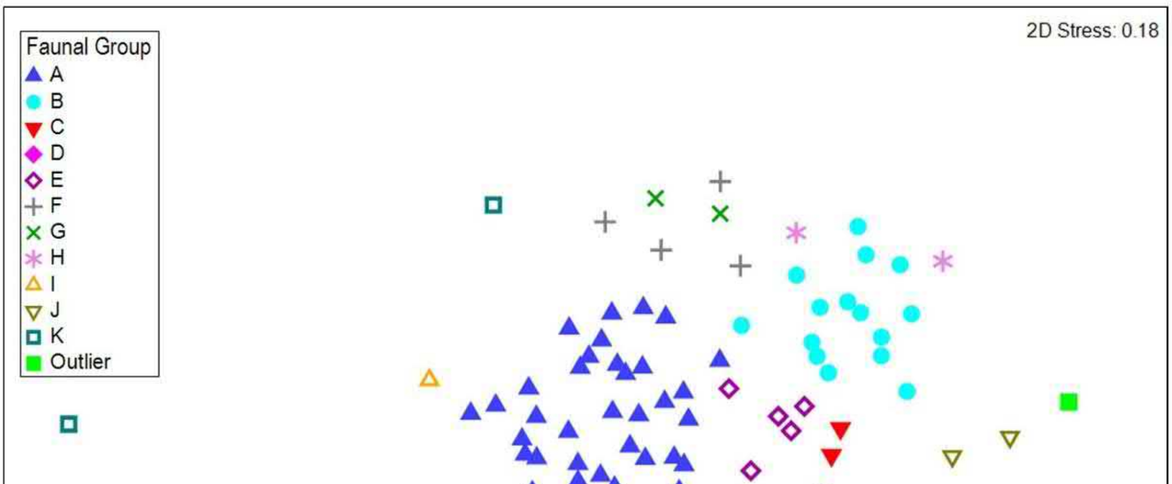

Figure 10. nMDS ordination plot of square-root transformed Bray-Curtis similarity macrobenthic abundance data. Faunal groups were grouped based upon 15 % similarity.

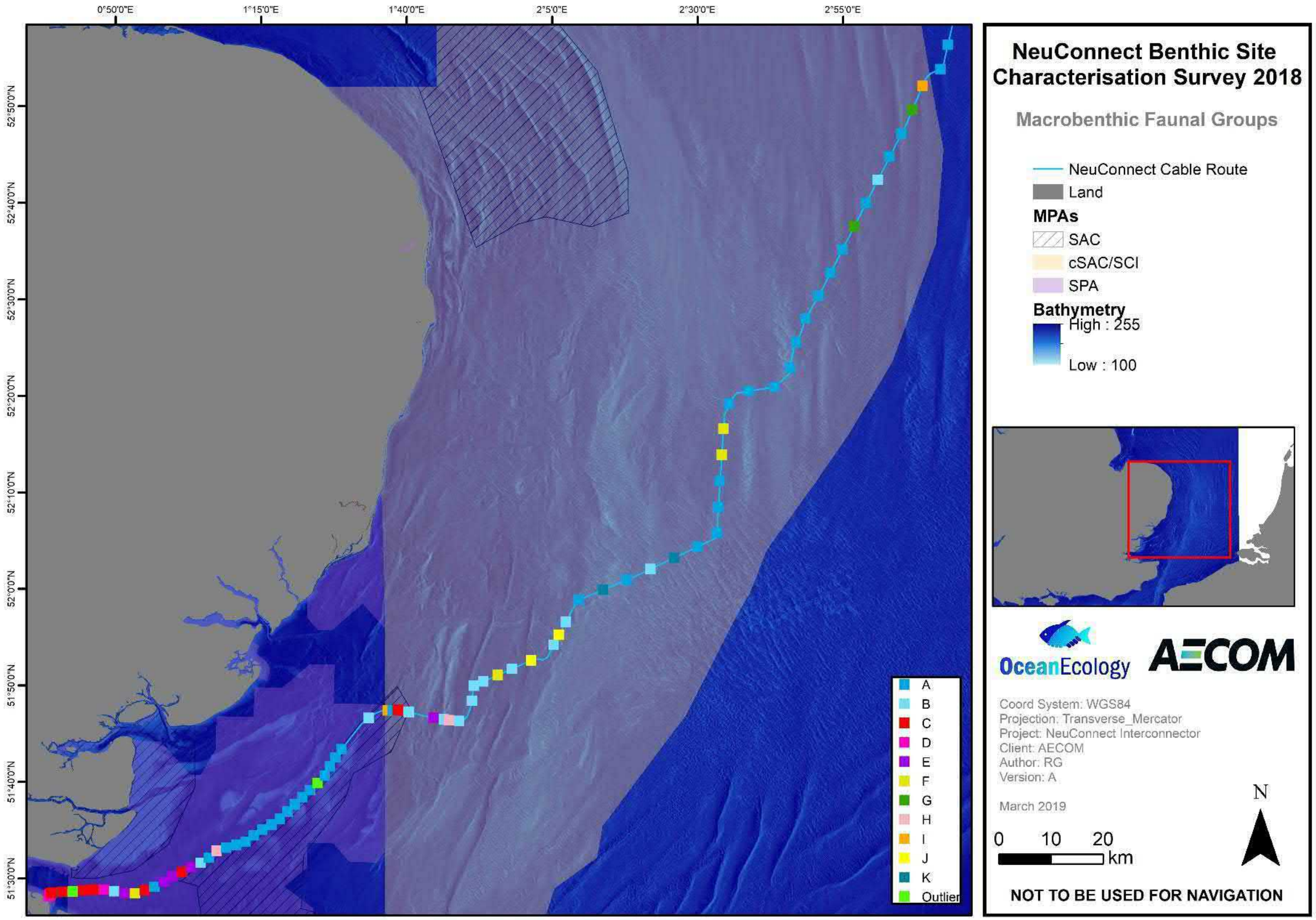

Figure 11 Distribution of macrobenthic faunal groups along the GB Offshore Scheme section of the proposed NeuConnect cable route.

7.5. Seabed Imagery

Generally, seabed imagery correlated well with SSS however the ability to delineate between coarser sediments in the central area of the route and those sandier sediments furthest offshore using SSS was limited therefore DDV transects and PSD data were fundamental in determining the sediment / substrate type. The main assessment was conducted using the still images captured during the DDC deployments / DDV transects due to high turbidity levels, which reduces the resolution of analysis from the video imagery. The main habitats identified based on the seabed imagery are presented in Plate 4.

Example imagery from each DDC station is presented in Appendix XVII, along with a description of the substratum type, species present and the EUNIS habitat description. The dive logs for all seabed imagery collected during HA and site characterisation transects are presented in Appendix XVIII and XX respectively. Example imagery from site characterisation transects can be found in Appendix XIX.

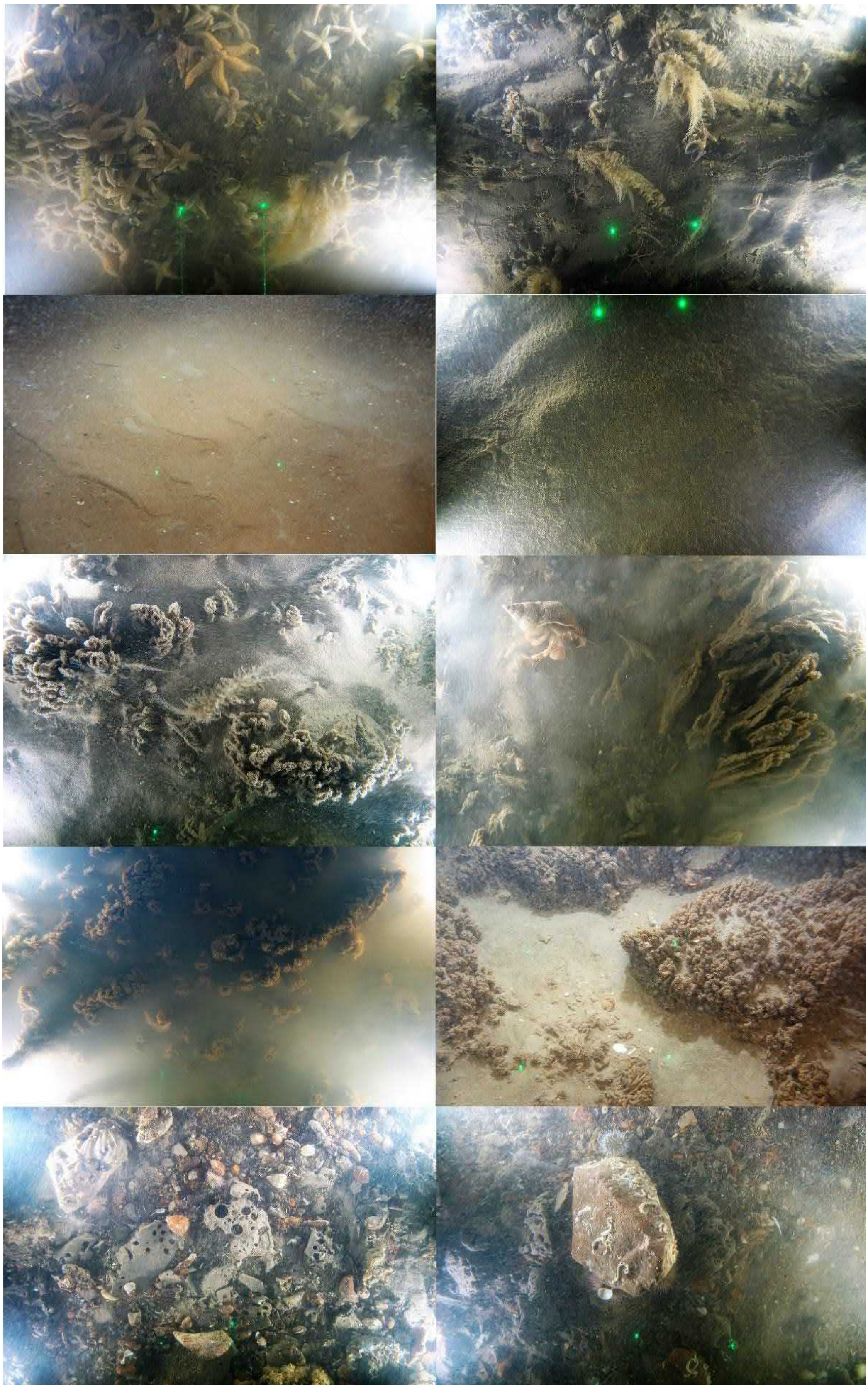

Plate 4. Example seabed imagery collected along the GB Offshore Scheme section of the proposed NeuConnect cable route. Top row: EUNIS biotope A5.44 Circalittoral mixed sediments. Second row (left): EUNIS biotope A5.25 Circalittoral fine sand. Second row (right): EUNIS biotope A5.35 Circalittoral sandy mud. Third and fourth rows: Annex I *Sabellaria spinulosa* reef. Bottom row (left): Section 41 priority habitat Peat and Clay Exposures. Bottom row (right): EUNIS biotope A4.21 Echinoderms and crustose communities on circalittoral rock.

7.6. Biotope Mapping

To map the principal biotopes along the extent of the NeuConnect cable route, a full interrogation of available geophysical data in combination with review of DDV imagery collected at dedicated HA transect locations and site characterisation DDV locations was undertaken. PSD data was also used to support this data and better understand the sediment type within the wider habitat types. The main habitats identified along the route at which seabed imagery or grab samples were obtained comprised primarily of rippled or megarippled sand characterised as EUNIS biotope A5.25 'Circalittoral fine sand' in offshore areas, A5.44 'Circalittoral mixed sediment' in central areas. The inshore areas where comprised of a mixture of sediment types in the inshore areas ranging from A5.14 'Circalittoral coarse sediment' to A5.35 'Circalittoral sandy mud'.

Annex I stony reef formations were present in inshore/central areas which also corresponded with the presence of the Section 41 priority habitat 'Peat and Clay Exposures'. Areas of mixed sediment with *S. spinulosa* tube aggregations, sometimes present as low-medium reef (Annex I) formations, were observed intermittently along the route. The distribution and extent of the habitats identified across the survey area based on all the available data have been mapped in

Figure 12 to

Figure 14. Descriptions of each of these habitat types, for which shapefiles have been created for biotope mapping purposes, are presented in

Table 8, along with the corresponding EUNIS biotopes associated with each habitat.

Three main biotopes were identified in the intertidal areas. The inner-most sites, INT_001 – INT_004, were best characterised by the EUNIS biotope A2.242 '*Cerastoderma edule* and polychaetes in littoral muddy sand', though high numbers of *Peringia ulvae* were also present. Station INT_005 had a greater proportion of sand with a limited macrofaunal community and represented EUNIS biotope A2.231 'Polychaetes in littoral fine sand'. The outer intertidal stations INT_006 and INT_007 were best represented by the EUNIS biotope A2.321 '*Nephtys hombergii* and *Streblospio shrubsolii* in littoral mud'.

Table 8. Summary of EUNIS Biotopes, Broad Scale Habitats (BSHs) and Habitat Sensitivities to inform biotope mapping shown in

Figure 12 to

Figure 14.

	Description	Habitat Sensitivity	EUNIS Groups	BSH	EUNIS Biotope

Annex I Habitats					
Stony Reef	Stable cobbles and boulders with a dense faunal turf and epifaunal community.	Annex I Stony Reef	Rock	A4.2	A4.21 Echinoderms and crustose communities on circalittoral rock
					A4.23 Communities on soft circalittoral rock
Sabellaria Reef	Agglomerations of *Sabellaria spinulosa* on circalittoral gravelly muddy sands.	Annex I Biogenic Reef	Mixed sediment	A5.6	A5.611 - [Sabellaria spinulosa] on stable circalittoral mixed sediment
				A5.4	A5.44 - Circalittoral mixed sediment
Peat and Clay Exposures	Mosaic of coarse gravels, pebble and cobble with clay exposures and sparse epifauna.	Section 41 priority habitat	Rock	A4.2	A4.23 Communities on soft circalittoral rock
Seabed Habitats					
Coarse Sediment	Very coarse pebble and cobble with diverse epifaunal community.	n/a	Coarse Sediment	A5.1	A5.14 - Circalittoral coarse sediment
Sand (Rippled)	Rippled fine sand.	Annex I Sandbanks*	Sand and Muddy Sand	A5.2	A5.25 - Circalittoral fine sand
Sand (Megarippled)	Fine sand with megaripples.	Annex I Sandbanks*	Sand and Muddy Sand	A5.2	A5.25 - Circalittoral fine sand
Sandy Mud	High proportion of finer (muddy) sediments with sand.	n/a	Mud and Sandy Mud	A5.3	A5.35 - Circalittoral sandy mud
Mixed Sediment	Mosaic of sand, gravel, mud, pebbles, and occasional boulders with occasional epifauna.	n/a	Mixed Sediment	A5.4	A5.44 - Circalittoral mixed sediment
Intertidal Habitats					
Littoral Sand and Muddy Sand	Mixture of mud and sand particles with polychaetes.	n/a	Littoral Sand and Muddy Sand	A2.2	A2.231 - Polychaetes in littoral fine sand
					A2.242 - *Cerastoderma edule* and polychaetes in littoral muddy sand
Littoral Mud	High proportion of finer (muddy) sediments with polychaetes	n/a	Littoral Mud	A2.3	A2.321 - *Nephtys hombergii* and *Streblospio shrubsolii* in littoral mud

* Sandbanks which are slightly covered by sea water all the time' in areas where water depth <20 m.

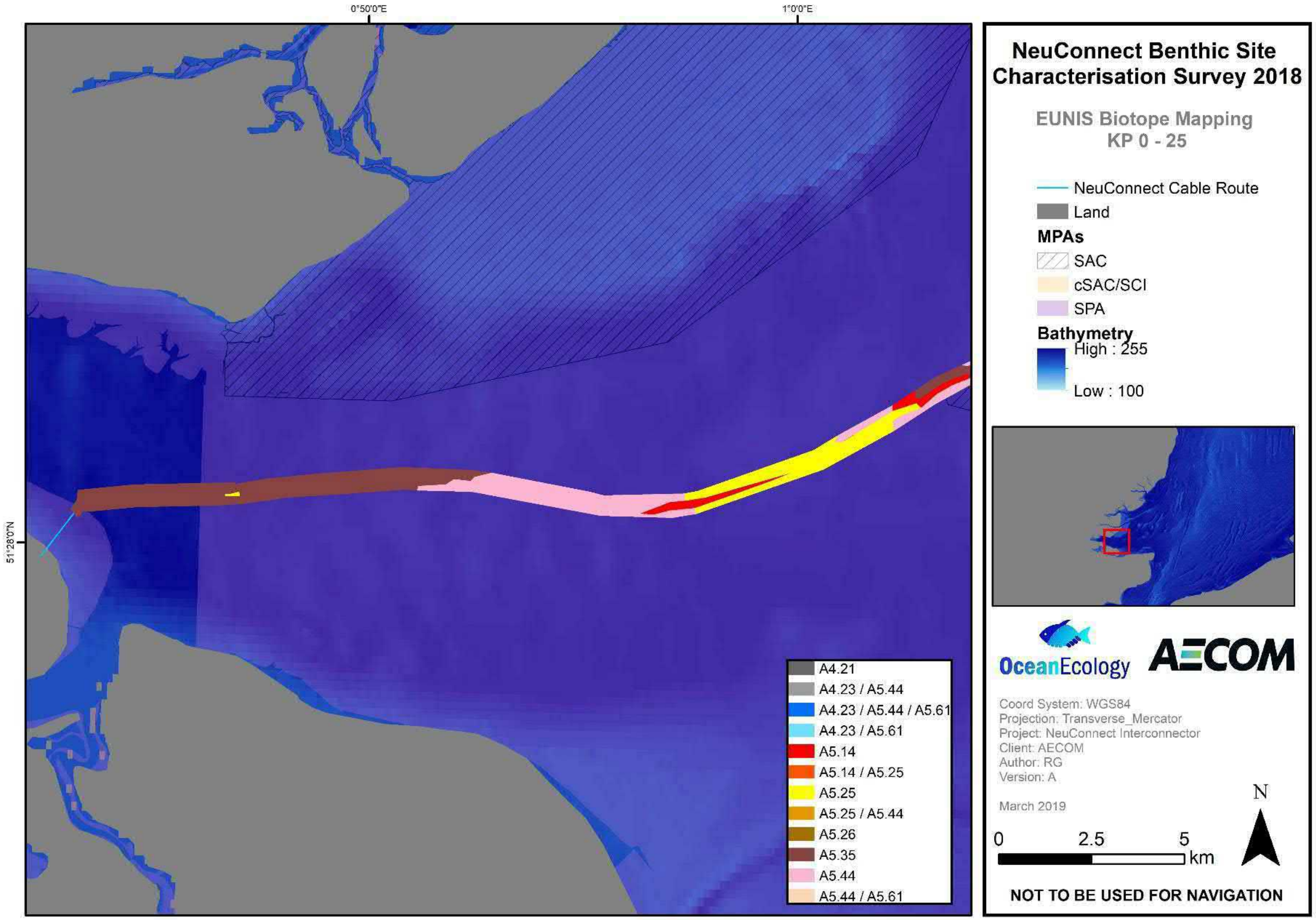

Figure 12 Map to show EUNIS biotopes between between KP 000 and KP 25 of the GB Offshore Scheme section of the proposed NeuConnect cable route.

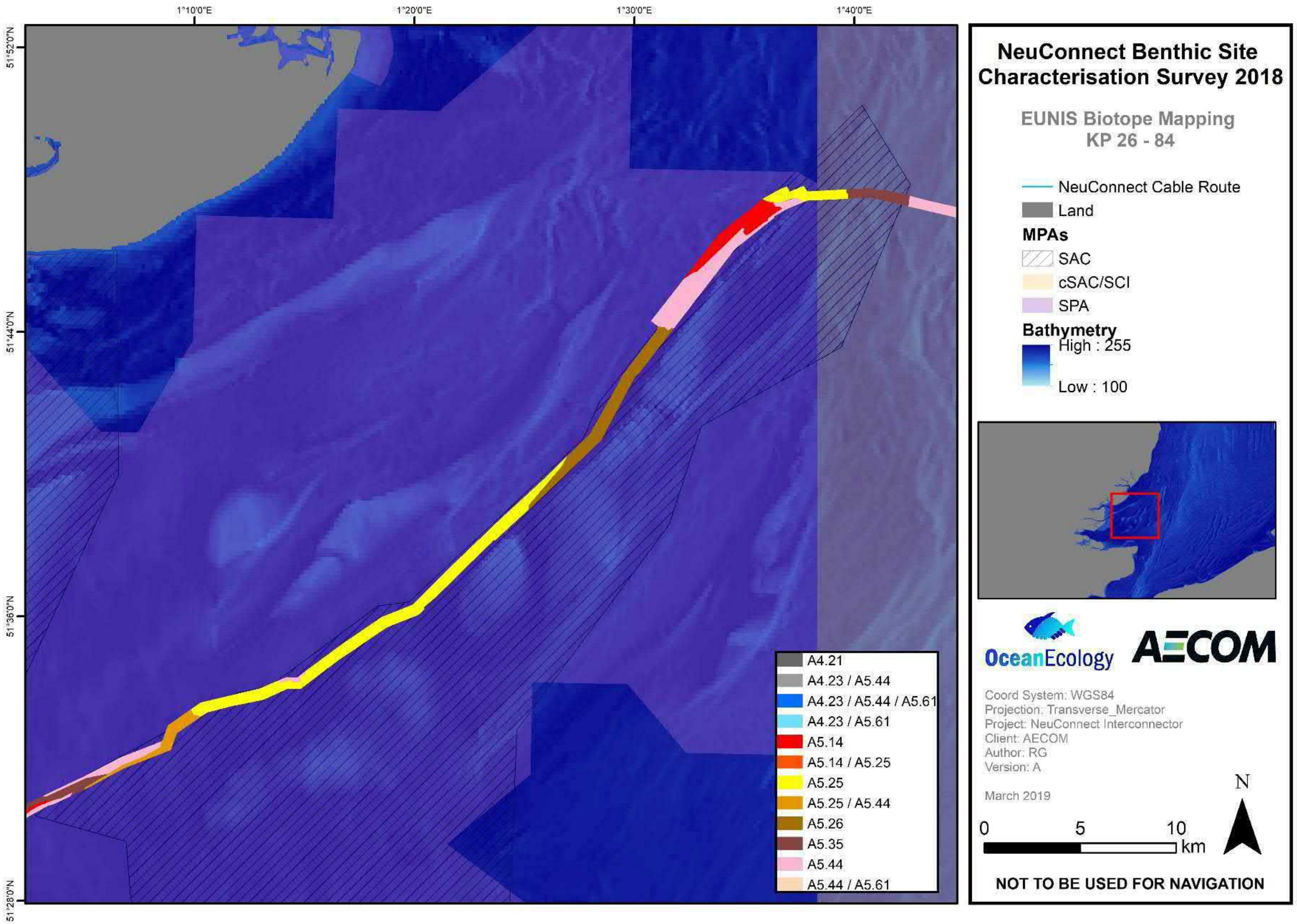

Figure 13 Map to show EUNIS biotopes between KP 26 and KP 84 of the GB Offshore Scheme section of the proposed NeuConnect cable route.

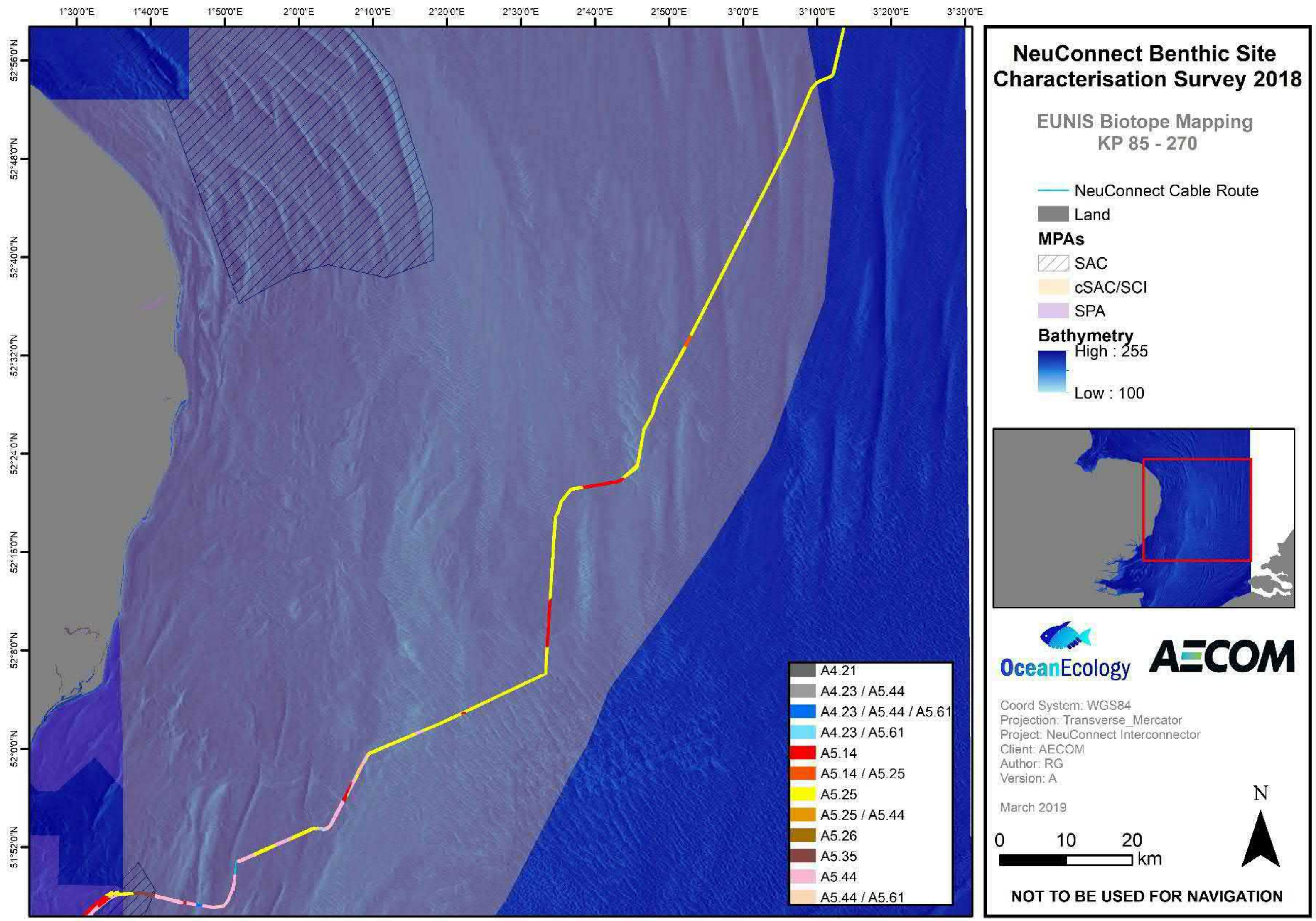

Figure 14 Map to show EUNIS biotopes between KP 85 to KP 270 of the GB Offshore Scheme section of the proposed NeuConnect cable route

7.7. Habitats of Conservation Value

7.7.1. Annex I Stony Reef

Small areas of Annex I stony reef were present along the NeuConnect cable survey corridor however these areas were restricted to between KP 91 and KP 116 (Figure 15). In total, four video transects showed evidence of low resemblance stony reef (Table 9). Coverage of this habitat type was most extensive at HAB_028, ENV_048, ENV_046, and ENV_50, however, reefs were only classified as low resemblance. In order to qualify as reef, the composition must be 10 - 40 % cobbles and with elevation greater than “flat” but less than 64 mm. According to Irving (2009) the minimum size of a cobble reef is considered to be >25 m^2, which must consist of >10 % cobbles or boulders. From this assessment there were several areas identified as stony reef. Example imagery, including classification procedures based on the Irving (2009) criteria is presented in Plate 5 and Appendix XIX.

Table 9. Summary of Annex I stony reef quality assessments to show predominant reef quality classification per transect.

Station	Annex I Stony Reef (Image Classification)	
	Not a Reef	Low
ENV_UK_ENV_011	2	0
ENV_UK_ENV_043	0	6
ENV_UK_ENV_046	0	8
ENV_UK_ENV_047	0	8
ENV_UK_ENV_048	3	3
ENV_UK_ENV_050	5	0
ENV_UK_HAB_028	4	9

Plate 5. Example imagery of stony reef habitat quality assessments based on percentage cover and elevation.

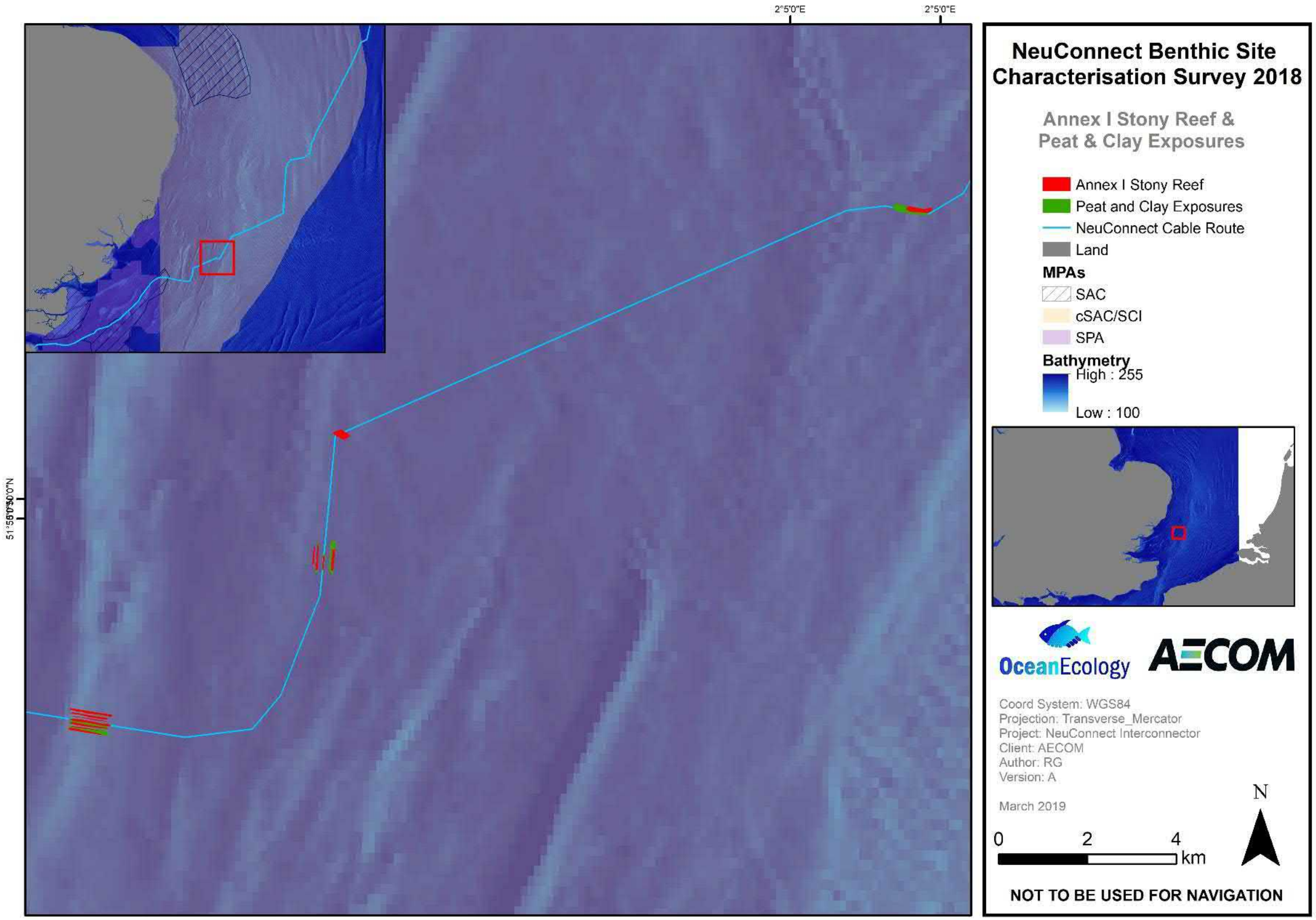

Figure 15. Map to show distribution of Annex I stony reef and Section 41 priority habitat 'Peat and Clay Exposures' between KP 91 and KP 116 of the GB Offshore Scheme section of the proposed NeuConnect cable route.

7.7.2. Peat and Clay Exposures

The Section 41 priority habitat 'Peat and Clay Exposures'[4] was recorded at the stations HAB_028, ENV_043 and ENV_046 within the NeuConnect cable survey area. These stations coincided with areas that stony reef was observed between KP91 and KP116 in offshore areas of the cable route. Exposures were surrounded by a matrix of cobbles and coarse sediments with incidental patches of mixed sediments ranging from mud to coarse gravels and pebble and occasional patches of low relief Annex I stony reef.

Associated epifauna was often sparse restricted to *Flustra foliacea, Alcyonium digitatum,* and *Tubularia* sp. on stable substrate and occasional starfish, *Asterias rubens,* present at the interface between hard substrate and coarse sediments. Evidence of boring piddocks (Pholadidae) was also noted in the majority of still images where exposed clay was observed. This habitat was indicative of the EUNIS biotope A4.23 – 'Communities on soft circalittoral rock' which was also representative of Annex I reef. Example imagery is presented below in Plate 6 and the extent of this habitat is mapped in

Figure 15.

Plate 6. Example imagery showing exposed clay as part of the Section 41 priority habitat – Peat and Clay Exposures.

[4] It should be noted that as soft rock substrates, clay exposures qualify as Annex I bedrock.

7.7.3. Annex I *Sabellaria spinulosa* Reef

Generally, the presence of *S. spinulosa* was restricted to small clusters of tube aggregations amongst mixed sediments. Denser aggregations or condensed reef formations were observed in the mid-offshore stations HAB_030, HAB_033, and HAB_035 (KP 132, KP 224, and KP 241).

Plate 7 presents example imagery of *S. spinulosa* reef quality assessments based on percentage cover and reef elevation criteria as outlined in Gubbay (2007). In general, where *S. spinulosa* was present, it was predominately patchy agglomerations of tubes with low elevation <5 cm and with very little to no concretion of sediment. Where there were clumps of taller tubes (>5 cm in height), they often did not cover an area large enough to be consistently classified as reefs. In order to qualify as low quality reef as per Gubbay (2007), elevation must be over 2 cm height with more than 10 % substratum coverage of an area of at least 5 x 5 m (25 m^2). Therefore, a high number of images analysed from the transects were classified as "not a reef" or "low". There were only 17 images classified as medium reef under the Gubbay (2007) assessment criteria. This classification is however based on the assumption that still images collected at 5 m intervals were representative of the surrounding 25 m^2 area[5].

The review of digital imagery did not identify Annex I *S. spinulosa* reef between KP 68 – 78, however, following review of the SSS data as well as analysis of data from geophysical surveys (completed by MMT) an area of low relief reef was identified in this area. A lower confidence score has been assigned to this specific area due to low sampling coverage and lack of *S. spinulosa* in corresponding imagery.

Table 10. Summary of Annex I *S. spinulosa* reef quality assessments from DDV still imagery per transect.

Station	Annex I *S. spinulosa* Reef (Image Classification)			
	No. *S.spinulosa* present in grab sample	Not a Reef	Low	Medium
ENV_UK_ENV_006	1	-	-	-
ENV_UK_ENV_007	82	-	-	-
ENV_UK_ENV_012	1	-	-	-
ENV_UK_ENV_013	1	-	-	-
ENV_UK_ENV_014	17	-	-	-
ENV_UK_ENV_016	3	-	-	-
ENV_UK_ENV_039	1	-	-	-
ENV_UK_ENV_040	3	-	-	-
ENV_UK_ENV_041	1	-	-	-
ENV_UK_ENV_043	0	1	-	-
ENV_UK_ENV_045	3	5	-	-
ENV_UK_ENV_046	57	-	-	-
ENV_UK_ENV_047	15	-	-	-
ENV_UK_ENV_050	69	-	-	-
ENV_UK_ENV_054	8	-	-	-
ENV_UK_ENV_058	4	-	-	-
ENV_UK_ENV_063	0	1	-	-
ENV_UK_ENV_068	1	-	-	-
ENV_UK_ENV_069	1	-	-	-
ENV_UK_ENV_074	58	-	-	-
ENV_UK_ENV_077	41	-	-	-
ENV_UK_HAB_028	N/A	-	1	1
ENV_UK_HAB_030	N/A	3	-	7
ENV_UK_HAB_033	N/A	6	-	4
ENV_UK_HAB_034	N/A	8	2	
ENV_UK_HAB_035	N/A	3	6	5

[5] The distinction between *S. spinulosa* aggregations and surrounding substrates is usually evident in SSS data however in this instance the low-lying nature of the tubes aggregations meant it was not possible to confidently make this distinction.

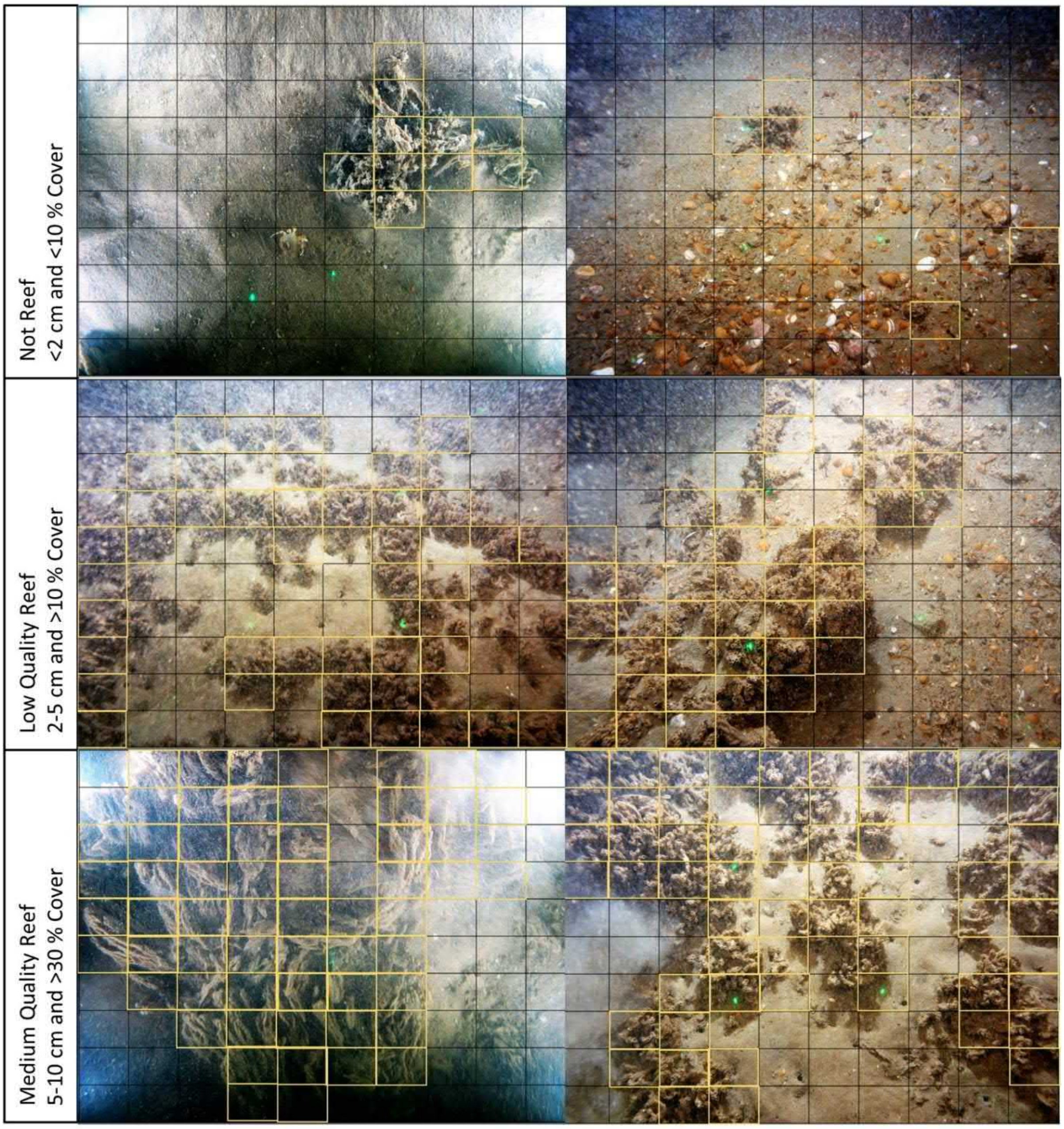

Plate 7. Example imagery of *S. spinulosa* habitat quality assessments based on percentage cover and elevation, including habitat not classified as reef, low quality and medium quality reef.

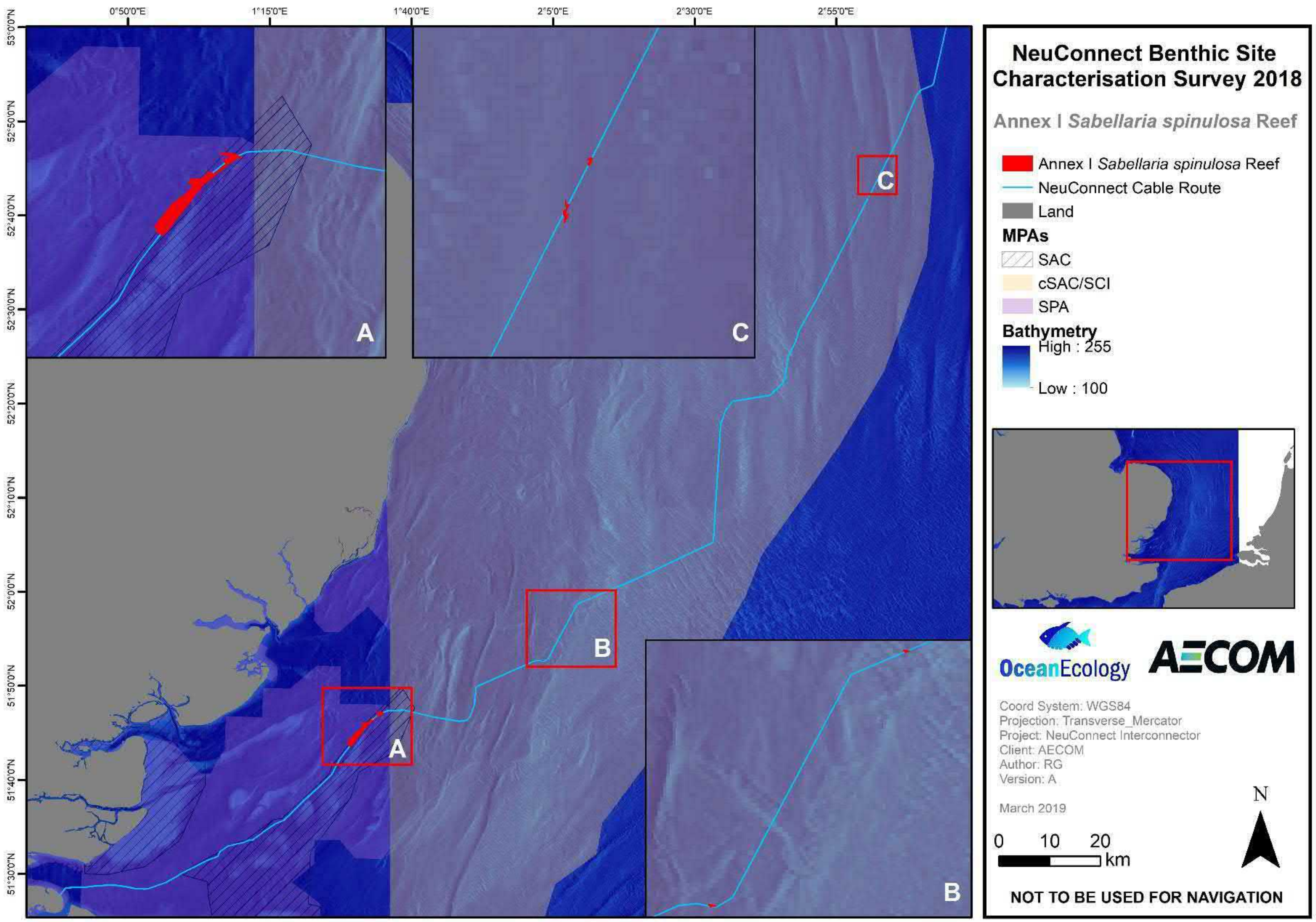

Figure 16 Map to show observed areas of Annex I *S. spinulosa* reef within a wider EUNIS biotope of A5.611 – '[*Sabellaria spinulosa*] on stable circalittoral mixed sediment' along the GB Offshore Scheme section of the proposed NeuConnect cable route.

7.7.4. Other Habitats

Most seabed habitats along the GB Offshore Scheme section of the proposed NeuConnect cable route were characterised as either EUNIS biotope A5.25 'Circalittoral fine sand' or EUNIS biotope A5.44 'Circalittoral mixed sediment' although areas of EUNIS biotope A5.35 'Circalittoral sandy mud' were also recorded.

7.7.5. A5.25 Circalittoral sand

Areas of the cable route were characterised by this biotope at both inshore and offshore sections of the survey area. Areas of sand were often characterised by the presence of either ripples or megaripples, with megaripples more common in offshore areas. Both the macrobenthos and epifauna were relatively impoverished in these sandy habitats. Where present in less than 20 m water depth in the inshore parts of the cable corridor these areas were deemed to be representative of Annex I 'Sandbanks which are slightly covered by sea water all the time' due to the relatively shallow water depths in these areas. Areas characterised by this biotope are mapped in Figure 12 to Figure 14 and example imagery is presented in Appendices XVII and XIX.

7.7.6. A5.44 Circalittoral mixed sediment

Seabed habitats in the central portion of the cable route were best characterised as EUNIS biotope A5.44 'Circalittoral mixed sediment'. These areas exhibited greater mud content, along with sands, gravels, and some coarser sediments, including stable pebbles, cobbles and occasional boulders. Areas characterised by these habitats supported relatively diverse epifaunal communities including dense hydroid/bryozoan turf including *Flustra foliacea* and *Hydrallmania falcata*, Ophiuridae and more diverse and abundant infaunal communities.

7.7.7. A5.35 Circalittoral sandy mud

Inshore sediments were primarily characterised as EUNIS biotope A5.35 'Circalittoral sandy mud'. These areas exhibited elevated levels of mud content and finer particles in comparison to the rest of the cable route. Areas characterised by these habitats supported relatively sparse macrobenthic communities, with low numbers of individuals and diversity recorded.

7.7.8. Species of Conservation Importance and Non-natives

Two individuals of the non-native species *Austrominius modestus* were found at a single intertidal station (INT_003). *A. modestus* occurs naturally in Australasia and was first reported in Britain in 1946, by which time it was already widespread in the southeast of England. By 1972 it was common in parts of the west coast of Scotland and in 1978 it was reported in Shetland (Hiscock et al. 1978). *A. modestus* not only competes with endemic British species, particularly *Balanus balanoides*, but has colonized some sheltered and estuarine habitats not previously inhabited by them (Bassindale 1964).

Thia scutellate was observed at four stations (ENV_058, 064, 068, and 071). This species is listed under the Great Britain Rare and Scarce Species list, classified as occurring in nine to 55 grid squares within the three mile territorial limit.

8. DISCUSSION

8.1. Sediments

A wide variety of sediment types were observed along the cable route. A trend towards increased mud content was apparent at inshore stations while the offshore stations were almost entirely composed of sand, forming either ripples or megaripples. Most samples comprised of sand (S), representing EUNIS BSH A5.2 (sublittoral sand), while a number of stations were classified as mud and sandy mud (mS) or gravelly mud (gM) and gravelly muddy sand (gmS) which represent a mixture of EUNIS BSH A5.2 (sublittoral sand), A5.3 (sublittoral mud), and A5.4 (sublittoral mixed sediments). Coarser sediments were also observed intermittently along the route where stations were classified as gravelly sand (gS, EUNIS BSH A5.1 Sublittoral coarse sediments).

Arsenic was observed in the highest concentrations along the cable route. Levels of Arsenic were particularly high at a number of stations where they exceeded OSPAR BC and BAC values at 15 and eight stations respectively, and Canadian sediment quality guideline TELs and PELs at 35 and five stations respectively. Additionally, Cefas (2003) AL1 was exceeded at 11 stations, which suggests contamination. Although background levels were exceeded along the route, at this level of investigation, there were no macrobenthic anomalies identified at this location to suggest any adverse effects were present. Elevated metal sediment concentrations do not necessarily imply toxicity to benthic communities (Rees et al. 2007) as the bioavailability of these metals is more important than simply concentration levels.

The levels of most metals, and specifically Zinc, Lead, and Mercury, were higher at the intertidal and inshore stations with many exceeding mean UKOOA (2001) and even 95th % values. Nickel and Copper levels were also high in offshore areas, particularly between KP 83 – 94. Levels of some metals (including Lead and Copper) are known to be higher in the southern North Sea compared to the northern North Sea UKOOA (2001) and in particular higher than usual concentrations of pollutants in the sediments around the Dogger Bank, in proximity to the survey area (Portman 1987). Conversely, Aluminium, was recorded in very low concentrations and Mercury was recorded at or below detection limits at all stations.

Comparison of five commonly reported metals (Ni, Cu, Zn, Cd and Hg) showed that the concentrations of these metals along the cable route were generally lower than concentrations recorded in the wider North Sea (northern and central areas) and in proximity to oil & gas installations

Table 11. Concentrations of Copper and Zinc in offshore areas of the cable route were higher than other North Sea offshore areas but did not exceed Cefas (2003) AL2, a proxy for heavy sediment contamination, at any location.

Table 11. Comparison of mean concentrations (mgKg^{-1}) of five key metals sampled along the NeuConnect cable route with previous records.

Area	Nickel	Copper	Zinc	Cadmium	Mercury
Oil & Gas Installations in the North Sea[1]	17.79	17.45	129.74	0.85	0.36
Offshore areas of the North Sea[1]	9.5	3.96	20.87	0.43	0.16
Central and Northern North Sea[2]	23	14	155	-	-
Neuconnect Cable Route (Offshore >12nm)	7.50	8.61	22.14	0.12	0.04
Neuconnect Cable Route (Coastal <12nm)	7.86	9.68	38.03	0.08	0.08
Guidelines Values (OSPAR ERL - ERM)[3]	20.9 - 51.6	34 - 270	150 - 410	1.2 - 9.6	0.15 - 0.71

1 Cefas (2001). Contaminant Status of the North Sea. Technical report produced for SEA2. TR_004. Pp. 101.
2 Breuer et al., (1999) A review of contaminant leaching from drill cuttings piles.
3 Long, E.R., MacDonald, D.D., Smith, S.L. and Calder, F.D., (1995). Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management, 19:81-97.

PAHs only occasionally exceeded OSPAR BCs and BACs, Canadian guideline TELs and Cefas (2003) AL1 guidelines. At no point were Canadian PELs exceeded. It is considered that concentrations that are above OSPAR BCs, Canadian guideline TELs and Cefas (2003) AL1 rarely cause adverse effects in marine organisms; however, concentrations above OSPAR BACs and Canadian guideline PELs can often cause adverse effects in some marine species (OSPAR 2009, PLA n.d).

Levels of organotins exceeded Cefas (2003) AL1 at a single station (UK_ENV_001). Organotins were not detected at any other stations. Levels of polychlorinated biphenyls (PCBs) and organochlorines did not exceed Cefas (2003) AL1 at any of the stations. Concentrations of these compounds were often below the detectable limits at many locations and so are not likely to cause concern.

8.2. Macrobenthos

The macrobenthic assemblages identified along the NeuConnect cable route were diverse and largely dominated by annelid taxa in terms of number of taxa and overall abundance as expected in this area of the southern North Sea. Molluscs were highly abundant at stations that were outside of the Margate and Long Sands SAC. Furthermore, molluscs, as well as echinoderms, contributed greatest to overall macrobenthic biomass.

Sediment habitats can be highly heterogenous as they are heavily influenced by ambient environmental conditions such as sediment composition (Cooper et al. 2011), hydrodynamic forces and physical disturbance (Hall 1994), depth (Ellingsen, 2002) and salinity (Thorson 1966). Sediment composition is a key factor in determining macrobenthic community structure (Hall 1994, Cooper et al. 2011), itself defined by ambient conditions. This is clearly a strong driver of variability within the macrobenthic communities along the cable route. There was a high degree of variability in the macrobenthic communities, as demonstrated by the numbers of statistically significant faunal groupings. This may be due to a number of reasons. Firstly, the cable route covers a large distance and intersects a variety of sediment habitats and environmental gradients (from the intertidal to offshore). Secondly, the lack of replicates at each station is likely to have led to increased variability within the dataset. Grabs sample a small area and so a single replicate is less likely to be entirely representative of the broader area (Downing & Downing), only a portion of the macrobenthic community is likely to be present in a single sample which can lead to statistically significant faunal groups. Finally, relatively few numbers of individuals and taxa in a number of samples can lead to increased numbers of statistically significant groups as indicated by the relatively loose clustering of the faunal groups (Warwick 1988). The most common faunal group (A), dominated by polychaete worm species, was observed at 39 of the 90 stations. This faunal group was associated with sandy habitats particularly in the offshore areas of the cable route. The other dominant group (Faunal Group B) was characterised by the presence of the ross worm *S. spinulosa.* These stations corresponded with areas where notable aggregations of sand tubes constructed by this species were recorded upon review of the seabed imagery and subsequently deemed to be representative of areas of Annex I biogenic reef (as per Gubbay (2007).

8.3. Key Habitats

Most seabed habitats along the cable route were characterised as either EUNIS biotope A5.25 'Circalittoral fine sand' or EUNIS biotope A5.44 'Circalittoral mixed sediment' although areas of EUNIS biotope A5.35 'Circalittoral sandy mud' were also recorded. Due to the similarity of the macrobenthos observed in shallower sections (<20 m) of the cable route to those in shallow sandbank habitats some areas of the cable corridor characterised as sublittoral sand biotopes (A5.25) were deemed to be representative of the Annex I habitat 'Sandbanks which are slightly covered by sea water all the time'. The large swaths of Sandy sediments identified along the offshore areas of the cable corridor were not however thought to be presentative of Annex I sandbanks due to the generally greater water depths (>30 m).

Annex I stony reef was identified in areas of the cable route, focused between KP 90 and KP 115. Reefs were assessed to be of low resemblance only (as per Irving (2009)). Video imagery was indicative of the EUNIS biotopes A4.21 – 'Echinoderms and crustose communities on circalittoral rock' and A4.23 – 'Communities on soft circalittoral rock'. These areas often coincided with the presence of the Section 41 priority habitat 'Peat and Clay Exposures'. This habitat was observed between at KP 91, 99, and 116, through interrogation of SSS data and DDV imagery collected during this survey. These areas were indicative of the EUNIS Biotope A4.23 'Communities on soft circalittoral rock' and representative of Annex I bedrock reef habitat.

Sabellaria spinulosa Annex I biogenic reef was identified at multiple points along the cable route. These were classified as either low or medium reef 'status' (as per Gubbay (2007)) and was concentrated around KP 60 – 78, KP 115, and KP 224. Evidence of potential *S. spinulosa* reef from the geophysical surveys and review of the SSS data identified a wider area of low 'status' reef within a wider mixed sediment biotope between KP 68 - 78 though the extent of this patch of reef is less certain. Lower confidence in the extent of the reef in this area is due to a lack of sampling coverage over this area (grabs or imagery) and the lack of *S. spinulosa* in corresponding video stations. As *S. spinulosa* can be ephemeral it may not always be present across the entire area. This area was indicative of the EUNIS Biotope A5.611 – '[*Sabellaria spinulosa*] on stable circalittoral mixed sediment.

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