GREEN VOLT

Chapter 7

Marine Geology, Oceanography and Physical Processes

Offshore EIA Report: Volume 1

Revision history

Revision	Date	Description	Prepared	Checked	Approved
1	25/03/2022	First draft	NC (Royal HaskoningDHV)	DB (Royal HaskoningDHV)	VC (Flotation Energy)
2	29/04/2022	Second draft	NC (Royal HaskoningDHV)	DB (Royal HaskoningDHV)	VC (Flotation Energy)
3	12/11/2022	Final for submission	CMT (Royal HaskoningDHV)	NC (Royal HaskoningDHV)	VC (Flotation Energy)

Table of Contents

Table of Tables

Table of Figures

Appendices (Volume 2)

Acronyms

Acronym	Description
BEIS	Department for Business, Energy and Industrial Strategy
BERR	Department for Business, Enterprise and Regulatory Reform, now replaced by Department for Business, Innovation and Skills (BIS)
BGS	British Geological Survey
BIS	Department for Business, Innovation and Skills
BODC	British Oceanographic Data Centre
CBRA	Cable Burial Risk Assessment
CEFAS	Centre for Ecology, Fisheries and Aquaculture Science
CFB	Coastal Flood Boundaries
CPT	Cone Penetrometer Test
CTD	Conductivity, Temperature and Depth
ECMWF	European Centre for Medium-Range Weather Forecasts
EIA	Environmental Impact Assessment
EMODnet	European Marine Observation & Data Network
EU	European Union
GB	Great Britain
GCR	Geological Conservation Review
GETM	General Estuarine Transport Model
GI	Ground Investigation
HDD	Horizontal Directional Drilling
INSPIRE	Infrastructure for Spatial Information in Europe
KP	Kilometre Point
LAT	Lowest Astronomical Tide
LCR	Local Conservation Review
MAU	Marine Analytical Unit (a unit of Marine Scotland)
MBES	Multi-Beam Echo Sounder
MEDIN	Marine Environmental Data & Information Network
MPA	Marine Protected Area
MS-LOT	Marine Scotland Licensing Operations Team
MSS	Marine Scotland Science
nm	Nautical Miles
NMP	National Marine Plan (Scotland)
NPF	National Planning Framework (Scotland)
NPS	National Policy Statement
O&M	Operation & Maintenance
ODN	Ordnance Datum Newlyn
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
PSA	Particle Size Analysis
RCP	Representative Concentration Pathways
SAC	Special Area of Conservation
SBP	Sub-Bottom Profiler
SPA	Special Protection Area
SPP	Scottish Planning Policy

SSS	Side-Scan Sonar
SSSI	Site of Special Scientific Interest
UK	United Kingdom
UKHO	United Kingdom Hydrographic Office
UXO	Unexploded Ordnance
WTG	Wind Turbine Generator

Glossary

Term	Description
Applicant	Green Volt Offshore Windfarm Ltd.
Buzzard	Buzzard Platform Complex.
Buzzard Export Cable Corridor	The area in which the export cables will be laid, from the perimeter of the Windfarm Site to Buzzard Platform Complex.
Green Volt Offshore Windfarm	Offshore windfarm including associated onshore and offshore infrastructure development (Combined On and Offshore Green Volt Projects).
Horizontal Directional Drilling	Mechanism for installation of export cable at landfall.
Inter-array cables	Cables which link the wind turbines to each other and the offshore substation platform.
Landfall Export Cable Corridor	The area in which the export cables will be laid, from the perimeter of the Windfarm Site to landfall.
Mean High Water Springs	At its highest and 'Neaps' or 'Neap tides' when the tidal range is at its lowest. The height of Mean High Water Springs (MHWS) is the average throughout the year, of two successive high waters, during a 24-hour period in each month when the range of the tide is at its greatest (Spring tides).
Moorings	Mechanism by which wind turbine generators are fixed to the seabed.
NorthConnect Parallel Export Cable Corridor Option	Landfall Export Cable Corridor between NorthConnect Parallel Landfall and point of separation from St Fergus South Export Cable Corridor Option.
NorthConnect Parallel Landfall	Southern landfall option where the offshore export cables come ashore.
Offshore Development Area	Encompasses i) Windfarm Site, including offshore substation platform ii) Offshore Export Cable Corridor to Landfall, iii) Export Cable Corridor to Buzzard Platform Complex.
Offshore export cables	The cables which would bring electricity from the offshore substation platform to the Landfall or to the Buzzard Platform Complex.
Offshore Export Cable Corridor	The proposed offshore area in which the export cables will be laid, from offshore substation to landfall or to the Buzzard Platform Complex.
Offshore infrastructure	All of the offshore infrastructure, including wind turbine generators, offshore substation platform and all inter-array and export cables.
Offshore substation platform	A fixed structure located within the Windfarm Site, containing electrical equipment to aggregate the power from the wind turbine generators and convert it into a more suitable form for export to shore.
Onshore Export Cable Corridor	The proposed onshore area in which the export cables will be laid, from landfall to the onshore substation.

Project	Green Volt Offshore Windfarm project as a whole, including associated onshore and offshore infrastructure development.
Safety zones	An area around a structure or vessel which must be avoided.
St Fergus South Export Cable Corridor Option	Landfall Export Cable Corridor between St Fergus South Landfall and point of separation from NorthConnect Parallel Export Cable Corridor Option.
St Fergus South Landfall	Northern landfall option where the offshore export cables come ashore.
Windfarm Site	The area within which the wind turbine generators, offshore substation platform and inter-array cables will be present.

CHAPTER 7: MARINE GEOLOGY, OCEANOGRAPHY AND PHYSICAL PROCESSES

7.1 Introduction

1. This chapter of the **Offshore Environmental Impact Assessment (EIA) Report** considers the marine geology, oceanography and physical processes of the Project (in this instance the Project refers to the offshore elements of the Green Volt Offshore Windfarm only, up to Mean High Water Springs (MHWS)) in relation to those aspects which have been 'scoped in' to further assessment within this stage of the EIA process (see **Section 7.7**).

2. The physical environment that has been considered within the EIA process includes the Windfarm Site (including substation), the Landfall Export Cable Corridor (considering two options for landfall, namely NorthConnect Parallel and St. Fergus South), and the Buzzard Export Cable Corridor.

3. This chapter was written by Royal HaskoningDHV marine physical processes specialists and incorporates interpretation of bathymetric survey and grab sample data collected along the Landfall Export Cable Corridor in April 2022 by Hydrofix Ltd (2022) (**Appendix 7.1** of this **Offshore EIA Report**).

7.2 Legislation, Guidance and Policy

4. The assessment considers the core objectives and relevant marine planning policies of both Scotland's National Marine Plan (NMP) (Scottish Government 2015) and the principles of Scotland's National Planning Framework 3 (NPF3) (Scottish Government, 2014a), draft NPF4, which is supported by the Scottish Planning Policy (SPP) (Scottish Government, 2014b). These are discussed further in **Chapter 3: Policy and Legislative Context**. The NMP in particular states that development proposals should not have unacceptable adverse impacts on coastal processes (Planning Policy Principle GEN 8) and that changes to coastal processes resulting from development should be minimised and mitigated.

5. Given the topics that have been scoped-in to assessment within this chapter (**Section 7.1**), the principal guidance documents that have been used are:

   - 'Guidance for geophysical surveying for Unexploded Ordnance (UXO) and boulders supporting cable installation (Carbon Trust, 2020);
   - 'Review of cable installation, protection, mitigation and habitat recoverability' (RPS Group, 2019);
   - 'Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects' (Cefas, 2011); and
   - 'Review of cabling techniques and environmental effects applicable to the offshore wind farm industry' (BERR, 2008).

7.3 Consultation

6. Consultation is a key feature of the EIA process, and continues throughout the lifecycle of the Green Volt Offshore Windfarm, from the initial stages through to consent and post-consent.

7. To date, consultation with regards to marine geology, oceanography and physical processes has been undertaken via the **Offshore Scoping Report** (**Appendix 1.2**), which was submitted to Marine Scotland Licensing Operations Team (MS-LOT) in November 2021. A 30-day consultation process on the **Offshore Scoping Report** was coordinated by MS-LOT, commencing on 3rd December 2021.

8. The Scottish Ministers' **Scoping Opinion** (MS-LOT, 2022) based on the **Offshore Scoping Report** (**Appendix 1.2**) and associated wider consultation responses that are relevant to marine geology, oceanography and physical processes represented in **Table 7.2**. It is noted that in providing the

Scottish Ministers' **Scoping Opinion** (**Appendix 1.1**) on whether the impacts identified in the **Offshore Scoping Report** are scoped in or out of the EIA, MS-LOT advises that "*the representations from consultees and advice from MSS, MAU and Transport Scotland must be considered in conjunction with the Scoping Opinion and with the expectation that recommendations and advice as directed through this Scoping Opinion are implemented*". Further detail on information scoped into the assessment is provided in **Section 7.7**.

Table 7.1. Consultation

Consultee	Date / Document	Comment	Response / where addressed in the EIA Report
Marine Scotland Licensing Operations Team (MS-LOT)	April 2022, Marine Scotland - Licensing Operations Team: Scoping Opinion for Green Volt Offshore Windfarm	**[Ref: 5.2.1] Bathymetry:** The Scottish Ministers are content with the data sources listed in Table 5.1 of the [Offshore] Scoping Report used to inform the baseline regarding bathymetric environmental data.	Noted – No further work has been undertaken to characterise the baseline bathymetry, except in relation to the Landfall Export Cable Corridor within 12 nm of the shore (see comment in response to Ref: 5.2.2 below). This is presented within **Section 7.6** of this **Offshore EIA Report.**
MS-LOT	April 2022, Marine Scotland - Licensing Operations Team: Scoping Opinion for Green Volt Offshore Windfarm	**[Ref: 5.2.2] Bathymetry:** The Scottish Ministers agree that the potential impacts on bathymetry in relation to the export cable within 12 nm during the construction, operation and maintenance phase, should be scoped in to the EIA Report for further assessment. Furthermore, the Scottish Ministers agree that all other potential impacts on bathymetry from the Proposed Development can be scoped out of the EIA Report.	The potential impacts on bathymetry in relation to the Landfall Export Cable Corridor within 12 nm during the construction, O&M phase are presented within **Section 7.7** of this **Offshore EIA Report**.
MS-LOT	April 2022, Marine Scotland - Licensing Operations Team: Scoping Opinion for Green Volt Offshore Windfarm	**[Ref: 5.3.1] Geology, Geomorphology and Offshore Sediments:** With regards to the study area, the Scottish Ministers are content with the baseline information obtained by the Developer as outlined in Table 5.3 of the Scoping Report.	Noted – No further work has been undertaken to characterise the baseline geology, geomorphology and sediments, except in relation to the Landfall Export Cable Corridor within 12 nm of the shore (including at each of the two potential landfall options). This is presented within **Section 7.6** of this **Offshore EIA Report**.
MS-LOT	April 2022, Marine Scotland - Licensing Operations Team: Scoping Opinion for Green Volt Offshore Windfarm	**[Ref: 5.3.2] Geology, Geomorphology and Offshore Sediments:** The Scottish Ministers are content that a coastal processes study will not be required for the Proposed Development due to the distance from shore which is a view supported by the NatureScot representation.	Noted – No further coastal processes study has been undertaken other than the work presented within **Section 7.6** of this **Offshore EIA Report** covering the Landfall Export Cable Corridor within 12 nm of the shore (including at each of the two potential landfall options).
MS-LOT	April 2022, Marine Scotland - Licensing Operations Team: Scoping Opinion for Green Volt Offshore Windfarm	**[Ref: 5.3.3] Geology, Geomorphology and Offshore Sediments:** In Table 5.5 of the Scoping Report the Developer summaries the potential impacts to geology, geomorphology and offshore sediments. The Developer has proposed to scope out all potential impacts identified during the different phases of the Proposed Development. The Scottish Ministers direct the Developer to Appendix A of the representation from NatureScot with regards to the physical environment and coastal processes.	Noted – The representation from NatureScot with regards to the physical environment and coastal processes is discussed in detail later within this table.

Consultee	Date / Document	Comment	Response / where addressed in the EIA Report
MS-LOT	April 2022, Marine Scotland - Licensing Operations Team: Scoping Opinion for Green Volt Offshore Windfarm	**[Ref: 5.3.4] Geology, Geomorphology and Offshore Sediments:** The Scottish Ministers do not agree with the Developer's proposal to scope out potential impacts on seabed scour during the construction, operation and maintenance and decommissioning phases and advise that this must be assessed within the EIA Report for all phases. This view is consistent with the NatureScot representation and MSS advice.	Noted – The representations from NatureScot and Marine Scotland Science (MSS) with regards to this matter are discussed in detail later within this table.
MS-LOT	April 2022, Marine Scotland - Licensing Operations Team: Scoping Opinion for Green Volt Offshore Windfarm	**[Ref: 5.3.5] Geology, Geomorphology and Offshore Sediments:** The Scottish Ministers highlight the NatureScot representation in regards to the re-exposure of cables due to accelerating sea level rise and potential demand for protective measures and advise that this must be considered in the EIA Report. Depending on the export cable route, if close to the Loch of Strathbeg Site of Special Scientific Interest ("SSSI"), NatureScot advises that it could affect the SSSI's nationally important coastal geomorphology and dependent habitats. The Scottish Ministers agree with NatureScot that the natural re-exposure of a trenched landfall should be scoped in to the EIA Report including the Loch of Strathbeg SSSI as a receptor.	It is interpreted from the detail of NatureScot's representation regarding re-exposure due to accelerating sea level rise that their concern relates predominantly to the Landfall Export Cable Corridor within 12 nm of shore. This falls under 'Changes along Landfall Export Cable (inside 12 nm)' which is scoped-in to the assessments that have been presented within **Section 7.7** of this **Offshore EIA Report.** Note that the St. Fergus South Export Cable Corridor option has been refined (narrowed) since the **Offshore Scoping Report** (**Appendix 1.2**) was produced and no longer makes landfall at St. Fergus, but along the dunes further south. Nonetheless, the consultation response remains a valid consideration at the refined landfall location for the St. Fergus South Export Cable Corridor option, although the cable at the landfall will be installed by means of Horizontal Direction Drilling (HDD) and not trenching.
MS-LOT	April 2022, Marine Scotland - Licensing Operations Team: Scoping Opinion for Green Volt Offshore Windfarm	**[Ref: 5.3.6] Geology, Geomorphology and Offshore Sediments:** The Scottish Ministers also disagree with the Developer's proposal to scope out increases in suspended sediment during all phases of the works and advise that this should be scoped in to the EIA Report for the construction and decommissioning phases. This view is in line with the MSS advice. However, the Scottish Ministers agree with the Developer that increases in suspended sediment can be scoped out of the EIA Report during the operation and maintenance phase of the Proposed Development.	Noted – The representation from MSS with regards to this matter is discussed in detail later within this table.

Consultee	Date / Document	Comment	Response / where addressed in the EIA Report
MS-LOT	April 2022, Marine Scotland - Licensing Operations Team: Scoping Opinion for Green Volt Offshore Windfarm	**[Ref: 5.4.1] Metocean Conditions:** The Scottish Ministers are content with the metocean environmental data used by the Developer in the Scoping Report. The Developer summarises the metocean conditions in Section 5.3 of the Scoping Report. The Scottish Ministers note that there is no identification of potential impacts on metocean conditions and no conclusion on whether this receptor is scoped in or out of the EIA Report.	Noted – No further work has been undertaken to characterise the baseline metocean conditions, except in relation to the Landfall Export Cable Corridor within 12 nm of the shore. This is presented within **Section 7.6** of this **Offshore EIA Report**. The intended sections on 'potential impacts' and 'justification for removal from assessment' were prepared in the draft **Offshore Scoping Report** section but were unintentionally omitted from the submitted report during its final compilation. These sections should have read as follows: Potential impacts: There will be no impact during construction or decommissioning. The limited number of wind turbine generator (WTG) units is likely to have a very small impact on the wave climate and currents during the operational phase, and only within a localised area (<1 km) and therefore impacts are very limited. Justification for removal from assessment: As the Windfarm Site is located 80 km offshore from the Scottish coastline and using the previous evidence from the oil and gas subsea infrastructure installed on the seabed at this location, it has been demonstrated that there would be no or extremely limited impact on the physical environment; the potential to impact on the wave / wind / currents / tides are insignificant. Therefore, additional works on metocean conditions have been scoped out of the EIA process.
MS-LOT	April 2022, Marine Scotland - Licensing Operations Team: Scoping Opinion for Green Volt Offshore Windfarm	The Scottish Ministers direct the Developer to the MSS advice regarding baseline water column conditions and advise that changes in seasonal stratification must be scoped in to the EIA Report and that the other points raised by MSS must be fully addressed.	Noted – The representation from MSS with regards to this matter is discussed in detail later within this table.
MS-LOT	April 2022, Marine Scotland - Licensing Operations Team: Scoping Opinion for Green Volt Offshore Windfarm	Any seabed levelling or removal of substance or objects from on or under the seabed, required for installation of both the inter-array cables and export cables, will require consideration in the EIA Report and may require a marine licence.	No levelling is proposed, but pre-sweep options are discussed in Chapter 5 Project Description, and included in the worst-case scenario where appropriate. When options are confirmed, The Applicant will confirm with MS-LOT whether an additional marine licence is required.
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	In Section 5.2.3 and Table 5.5 [of the Offshore Scoping Report], seabed scour is scoped out largely on the basis that no scour has been identified around existing or previous oil and gas installations in the area where the offshore wind farm is proposed. We agree with this in regard to the offshore wind farm area; however, it is not clear that the decommissioning activities will address drill arisings and therefore we recommend further consideration is given to what if any impact	There are no cutting piles contaminated with oil based muds at Ettrick and Blackbird (Genesis, 2016). Water-based muds will have been used and discharged with drill arisings under the appropriate permit from Department for Business, Energy and Industrial Strategy - Offshore Petroleum Regulator for Environment & Decommissioning (BEIS-OPRED) following a chemical

Consultee	Date / Document	Comment	Response / where addressed in the EIA Report
		the establishment of the wind farm may have on previous drill arisings.	risk assessment to confirm that there would be no significant environmental effects either at the time or in the future. Additionally, infrastructure will be sited to avoid the wells.
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	In addition, it seems possible that scour could be an issue for parts of the export cable in or approaching the nearshore, where seabed marine energies are higher (see Fig 5.7 [of the Offshore Scoping Report] for tidal flow), and that the cable might require protection in this area by hard structures such as rock mattresses. We therefore recommend that scour (and any protection) should be scoped in for the export cable corridor.	This falls under 'Changes along Landfall Export Cable (inside 12 nm)' which is scoped-in to the assessments that have been presented within **Section 7.6** of this **Offshore EIA Report.**
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	The northern option for cable landfall, which could be trenched, appears to be at the bay of St Fergus, through a broad sandy beach and dune system. There is a history of trenched pipelines to the St Fergus terminal. We're not aware of any pipelines being re-exposed by storm erosion, but the EIA should take account of accelerating sea-level rise. It should consider the possibility of the cable landfall becoming re-exposed due to landward retreat of the beach (which is predicted for parts of the bay 3). This is part of ensuring the development is resilient to climate change effects.	This falls under 'Changes along Landfall Export Cable (inside 12 nm)' which is scoped in to the assessments that have been presented within **Section 7.6** of this **Offshore EIA Report**. Note that the St. Fergus South Export Cable Corridor option has been refined (narrowed) since the **Offshore Scoping Report** (**Appendix 1.2**) was produced and no longer makes landfall at St. Fergus, but along the dunes further south. Nonetheless, the consultation response remains a valid consideration at the refined landfall location for the St. Fergus South Export Cable Corridor option.
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	A re-exposed cable might be easily re-buried, but it might lead to demand for protective measures, which could in turn interrupt coastal sediment transport. If sufficiently close to Loch of Strathbeg SSSI, it is therefore possible that this interruption could affect the SSSI's nationally important coastal geomorphology and dependent habitats. Therefore, we recommend that natural re-exposure of a trenched landfall should be scoped in as a potential effect, with consideration given to identifying Loch of Strathbeg SSSI as a receptor.	This falls under 'Changes along Landfall Export Cable (inside 12 nm)' which is scoped-in to the assessments that have been presented within **Section 7.6** of this **Offshore EIA Report**.
NatureScot	27th January 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	Aside from the above, we are content with the scoping report - Section 5, including not undertaking coastal process studies for the offshore wind farm area.	Noted.
NatureScot	Stakeholder meeting 14/02/2022	agreed most of Geology, geomorphology and offshore sediments can be scoped out, but highlighted for the export cable. landfall, all the new issues surrounding dynamic coast and making sure its "climate change" proof. Suggested Dynamic Coasts might provide advice.	This falls under 'Changes along Landfall Export Cable (inside 12 nm)' which is scoped-in to the assessments that have been presented within **Section 7.6** of this **Offshore EIA Report.** Outputs from the Scottish Government's Dynamic Coast project has been included in **Chapter 7: Marine Geology and Physical Processes**

Consultee	Date / Document	Comment	Response / where addressed in the EIA Report
Marine Scotland Science (MSS)	4th February 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	With respect to section 5.1.3, MSS agree that changes to bathymetry with 12 nm during construction and operation (i.e. along the cable route) should be scoped in to the EIA.	Noted – This is presented within **Section 7.6** (Existing Environment) and **Section 7.7** (Assessment of Impacts) of this **Offshore EIA Report**.
MSS	4th February 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	With respect to section 5.2.3, MSS do not agree that increases in suspended sediments and seabed scour should be scoped out of the EIA. The installation of cables within the Windfarm site and along the export cable routes will entrain sediments and the ultimate fate of these sediments should be scoped into the EIA. Deposition of entrained sediments could be a potential pathway to impact on the benthic ecology. Regarding scour around the systems, MSS note that the Ettrick and Blackbird oil and gas decommissioning survey data suggest this is likely to be minimal. There is the potential for a large number of mooring lines and anchors (up to 6 per turbine, totalling up to 180), and this cumulative effect is unknown. MSS therefore advice [sic] that suspended sediment be scoped into the EIA for construction and decommissioning and seabed scour be scoped into the EIA for construction, operation, and decommissioning. It may well be the case that there is sufficient evidence from the Ettrick and Blackbird survey data to dismiss these concerns during the EIA process, but this evidence should be presented.	Noted – These matters have been addressed within **Section 7.7** of this chapter. The impacts on benthic ecology are presented in **Chapter 9: Benthic Ecology** of this **Offshore EIA Report.**
MSS	4th February 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	There is no mention of the baseline water column conditions in section 5.3, metocean conditions, including whether the region is stratified or fully mixed. The region is likely to undergo seasonal stratification (van Leeuwen et al., 2015). The baseline water column conditions should be described in the EIA. Whether the wind farm is likely to change the extent and timing of seasonal stratification should be scoped into the EIA. The wind farm could change water column mixing by the presence of the structures and/or by altering the near sea surface wind speeds.	This matter has been addressed within **Section 7.7** of this chapter. The impacts on water quality are presented **in Chapter 8: Marine Sediment and Water Quality** and the impacts on benthic ecology are presented in **Chapter 9: Benthic Ecology** of this **Offshore EIA Report.**
MSS	4th February 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	With respect to section 5.4.3, MSS agree that pollution of the water through disturbance of the existing contaminated sediments during construction and decommissioning, should be scoped into the EIA. MSS do not agree that pollution of the water through disturbance of the existing contaminated sediments during operation should be scoped out of the EIA. This is because the catenary mooring lines will lie along the seabed potentially disturbing sediments. This disturbance is likely to be extremely minimal, but MSS advise that it is scoped into the EIA given that this is a new technology and there is the potential for a large number of mooring lines.	This matter has been addressed within **Section 7.7** of this chapter. The impacts on water quality are presented in **Chapter 8: Marine Sediment and Water Quality** of this **Offshore EIA Report.**

Consultee	Date / Document	Comment	Response / where addressed in the EIA Report
MSS	4th February 2022 Representation to MS-LOT during consultation on Offshore Scoping Opinion	With respect to section 5.5.3, MSS agree that disturbance of existing contaminated sediments during construction and decommissioning should be scoped into the EIA. MSS do not agree that disturbance during operation should be scoped out of the EIA. This is because the catenary mooring lines will lie along the seabed potentially disturbing sediments. This disturbance is likely to be extremely minimal, but MSS advise that it is scoped into the EIA given that this is a new technology and there is the potential for a large number of mooring lines, and the possibility of high concentrations of contaminants (from the oil and gas operations) within the seabed. MSS also welcome the use of safety exclusion zones around plugged and abandoned well heads in order to minimise disturbance of contaminated sediments.	This matter has been addressed within **Section 7.7** of this chapter. The impacts on water quality are presented in **Chapter 8: Marine Sediment and Water Quality** of this **Offshore EIA Report**.

7.4 Assessment Methodology

7.4.1 Impact Assessment Methodology

9. In **Chapter 6: EIA Methodology**, an overarching method is presented for enabling assessments of the potential impacts arising from the Project on the receptors under consideration. Such assessments incorporate a combination of the sensitivity of the receptor, its value (if applicable) and the magnitude of the impact to determine a significance of effect. This method has been followed for the assessment of marine geology, oceanography and physical processes receptors.

10. For the impacts on marine geology, oceanography and physical processes a number of discrete receptors can potentially be identified. Generically, these might include: (i) certain morphological features with ascribed geodiversity values (e.g. earth science designations); or (ii) certain morphological features with other inherent coastal system physical functions, such as (by way of generic examples):

    - Offshore banks – these morphological features can play an important role in influencing the baseline tidal, wave and sediment transport regimes;
    - Nearshore intertidal and subtidal rock platforms – these morphological features play an important role in anchoring the coastal form; and
    - Beaches, dunes, sea cliffs and coastal slopes - these morphological features play an important natural coastal defence role.

11. In respect of the above, this chapter assesses the significance of potential effects from the Project on these receptor groups, where they are present within the Study Area (as defined in **Section 7.5.1**).

12. However, in addition to identifiable morphological receptors stated above, there are other impacts to the marine geology, oceanography and physical processes which may potentially be caused by the Project which, in and of themselves, do not result in effects to which significance can be ascribed. Rather, these impacts (such as a change in the suspended sediment concentrations in the water column) represent a physical process *effect* which may become manifest as an *impact* upon other receptors, most notably water and sediment quality, benthic ecology, fisheries or navigation (e.g. in terms of increased suspended sediment concentrations, or in terms of erosion (loss) or deposition (smothering) of habitats on the seabed).

13. Hence, the assessment presented in this chapter follows two approaches. The first assessment approach is designed for situations where potential impacts can be defined as directly affecting receptors which possess their own intrinsic geodiversity value or morphological function. In this case, the determination of significance of the effect is based on an assessment of sensitivity (**Section 7.4.1.1**) and value (**Section 7.4.1.2**) of the receptor, and magnitude of the impact (**Section 7.4.1.3**) by means of an effect significance matrix (**Section 7.4.1.4**).

14. The second assessment approach is designed for situations where effects in the baseline marine geology, oceanography or physical processes conditions may occur which could potentially manifest as impacts upon other receptors. In this case, the magnitude of impact is determined in a similar manner to the first assessment method but the sensitivity of the other receptors and the significance of effects on them is assessed within the relevant chapters of this **Offshore EIA Report** pertaining to those receptors (**Section 7.10**).

7.4.1.1 Sensitivity

15. The sensitivity and value of discrete morphological receptors and the magnitude of impact are assessed using expert judgement and described with a standard semantic scale. These expert judgements of receptor sensitivity, value and magnitude of impact are guided by the conceptual understanding of the existing environment (baseline) conditions presented in Chapter 5 of the **Offshore Scoping Report** (**Appendix 1.2**) and summarised in **Section 7.6.**

16. The sensitivity of a receptor (**Table 7.2**) is dependent upon its:

- Tolerance: the extent to which the receptor is adversely affected by an impact;
- Adaptability: the ability of the receptor to avoid adverse effects that would otherwise arise from an impact; and
- Recoverability: a measure of a receptor's ability to return to a state at, or close to, that which existed before the effect caused a change.

Table 7.2. Definitions of Sensitivity Levels for a Morphological Receptor

Sensitivity	Definition
High	Tolerance: Receptor has very limited tolerance the impact Adaptability: Receptor unable to adapt to the impact Recoverability: Receptor unable to recover resulting in permanent or long-term (greater than ten years) change
Medium	Tolerance: Receptor has limited tolerance of the impact Adaptability: Receptor has limited ability to adapt to impact Recoverability: Receptor able to recover to an acceptable status over the medium term (5-10 years)
Low	Tolerance: Receptor has some tolerance of the impact Adaptability: Receptor has some ability to adapt to the impact Recoverability: Receptor able to recover to an acceptable status over the short term (1-5 years)
Negligible	Tolerance: Receptor generally tolerant of the impact Adaptability: Receptor can completely adapt to the impact with no detectable changes Recoverability: Receptor able to recover to an acceptable status near instantaneously (less than one year)

7.4.1.2 Value

17. In addition, a value component may also be considered when assessing a receptor (**Table 7.3**). This ascribes whether the receptor is rare, protected or threatened.

18. It should be noted that high value and high sensitivity are not necessarily linked within a particular impact. A morphological receptor could be of high value (e.g. designated) but have a low or negligible physical sensitivity to an impact. In such situations care has to be taken to not inflate effect significance just because a feature is 'valued' and the narrative behind the assessment is important.

Table 7.3. Definitions of Value Levels for a Morphological Receptor

Value	Definition
High	Receptor is designated and/or of national or international importance for marine geology, oceanography or physical processes. Likely to be rare with minimal potential for substitution. May also be of significant wider-scale, functional or strategic importance
Medium	Receptor is not designated but is of local to regional importance for marine geology, oceanography or physical processes
Low	Receptor is not designated but is of local importance for marine geology, oceanography or physical processes
Negligible	Receptor is not considered to be particularly important or rare

7.4.1.3 Magnitude

19. The magnitude of an impact (**Table 7.4**) is dependent upon its:

- Scale (i.e. size, extent or intensity);
- Duration;
- Frequency of occurrence, and;
- Reversibility (i.e. the capability of the environment to return to a condition equivalent to the baseline after the impact ceases).

Table 7.4. Definitions of Magnitude Levels for a Morphological Receptor

Magnitude	Definition
High	Fundamental, permanent / irreversible changes, over the whole receptor, and / or fundamental alteration to key characteristics or features of the particular receptors character or distinctiveness.
Medium	Considerable, permanent / irreversible changes, over the majority of the receptor, and / or discernible alteration to key characteristics or features of the particular receptors character or distinctiveness.
Low	Discernible, temporary (throughout project duration) change, over a minority of the receptor, and / or limited but discernible alteration to key characteristics or features of the particular receptors character or distinctiveness.
Negligible	Discernible, temporary (for part of the project duration) change, or barely discernible change for any length of time, over a small area of the receptor, and/or slight alteration to key characteristics or features of the particular receptors character or distinctiveness.

7.4.1.4 Effect Significance

20. Following the identification of receptor value and sensitivity and magnitude of the impact, it is possible to determine the significance of the effect. A matrix is presented in **Table 7.5** as a framework to show how a judgement of the significance of an effect has been reached.

21. Through use of this matrix, an assessment of the significance of an effect can be made in accordance with the definitions in **Table 7.6**. Effects may be deemed as being either positive (beneficial) or negative (adverse).

Table 7.5. Effect Significance Matrix

		Negative Magnitude				Beneficial Magnitude			
		High	Medium	Low	Negligible	Negligible	Low	Medium	High
Sensitivity	High	Major	Major	Moderate	Minor	Minor	Moderate	Major	Major
	Medium	Major	Moderate	Minor	Minor	Minor	Minor	Moderate	Major
	Low	Moderate	Minor	Minor	Negligible	Negligible	Minor	Minor	Moderate
	Negligible	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Minor

22. For the purposes of this **Offshore EIA Report**, 'major' and 'moderate' effects are deemed to be significant (in EIA terms). In addition, whilst 'minor' effects may not be significant, it is important to distinguish these from other non-significant (negligible) effects as they may contribute to significant effects cumulatively.

23. Following initial assessment, if the impact does not require additional mitigation (or none is possible) the residual effect will remain the same. If, additional mitigation is proposed there will be an assessment of the post-mitigation residual effect.

Table 7.6. Table Significance Definitions

Effect Significance	Definition
Major	Very large or large change in receptor condition, both adverse or beneficial, which are likely to be important considerations at a regional or district level because they contribute to achieving national, regional or local objectives, or, could result in exceedance of statutory objectives and / or breaches of legislation.
Moderate	Intermediate change in receptor condition, which are likely to be important considerations at a local level.
Minor	Small change in receptor condition, which may be raised as local issues but are unlikely to be important in the decision making process.
Negligible	No discernible change in receptor condition.
No Change	No impact, therefore no change in receptor condition.

7.4.2 Cumulative Impact Assessment

24. Cumulative impacts are assessed through consideration of the extent of influence of changes or effects upon marine geology, oceanography and physical processes within the Study Area (see **Section 7.5.1**) arising from the Project alone and cumulatively with other projects.

25. A number of other projects have been identified on the east coast of Scotland, including other offshore wind farm developments, oil and gas developments, spoil disposal at licensed offshore sites, cable and pipeline projects, and other marine works such as harbour expansions, sea outfall construction and sea wall works. However, most of these can easily be screened out from cumulative impacts due to either: (i) their considerable geographical distance from the Project; and (ii) the timing of construction of other projects unlikely to overlap with timing of construction of the Project, and no significant effects arising during the operational phase.

26. Notwithstanding this, a small number of other projects cannot easily be screened out from cumulative effects and have therefore been considered within the cumulative impact assessment.

7.4.3 Transboundary Impact Assessment

27. Transboundary impacts are relevant where the extent of influence of changes or effects to baseline marine geology, oceanography and physical processes, and their potential to impact upon receptor groups, extent to areas that are located within neighbouring international waters, in this case notably nearby European Union (EU) member states.

28. Based on the findings presented in this chapter, it is concluded that transboundary impacts arising from wind farm and export cable installation, operation and decommissioning within 12 nm of the United Kingdom (UK) shore are highly unlikely to occur.

7.5 Scope

7.5.1 Study Area

29. The Study Area for matters 'scoped in' to assessment within this chapter of the **Offshore EIA Report** is principally the seabed within 12 nm of UK shore that is covered by, and adjacent to, the Landfall Export Cable Corridor. However, in addition, three specific matters pertaining to the development as a whole or specifically to the Windfarm Site itself (i.e. not just the cable corridor within 12 nm) have been considered to address specific issues raised by Scottish Ministers in the Scoping response. These issues relate to: (i) increases in suspended sediment concentration due to installation/removal of cables within the Windfarm Site; (ii) scour (due to the catenary action of mooring lines and from around anchors of the WTG within the Windfarm Site); (iii) changes in the water column structure within the Windfarm Site and along the Offshore Export Cable Corridors. The baseline description of the Windfarm Site has been fully described in the **Offshore Scoping Report** (**Appendix 1.2**) and is not repeated in this chapter.

30. For context, the Landfall Export Cable Corridor from the Windfarm Site will follow the NorthConnect HVDC Link route back towards shore and will be located adjacent to the NorthConnect route via appropriate co-location agreements. Then, at the 12 nm distance from shore (i.e. the seaward edge of this chapter's Study Area), the Landfall Export Cable Corridor route will either: (i) continue to follow the NorthConnect route to a landing point to the south of Peterhead (NorthConnect Parallel Export Cable Corridor Option); or (ii) branch off to a cable landing location to the north of Peterhead (St Fergus South Export Cable Corridor Option)).

31. The Landfall Export Cable Corridor within the Study Area passes through, or is in close proximity to, a number of sites designated as being of nature conservation or earth science heritage importance (**Figure 7.1**).

32. Both St Fergus South Export Cable Corridor Option and NorthConnect Parallel Export Cable Corridor Option pass through the southern section of the Southern Trench Marine Protected Area (MPA) and due to the potential for impacts on this MPA, both options have been considered in this chapter. Both options are sufficiently inshore of, and distant from, the Turbot Bank MPA to not cause any direct or indirect effects upon this site. There are no National Nature Reserves, National Scenic Areas, or Local Nature Reserves that could be affected by the Project within the 12 nm limit of shore under either option.

33. The NorthConnect Parallel Export Cable Corridor Option is just to the north of the Buchan Ness to Collieston Special Area of Conservation (SAC) and Buchan Ness to Collieston Coast Special Protection Area (SPA), which are respectively designated for vegetated sea cliffs and the bird species that are supported by the vegetated sea cliffs at the shore.

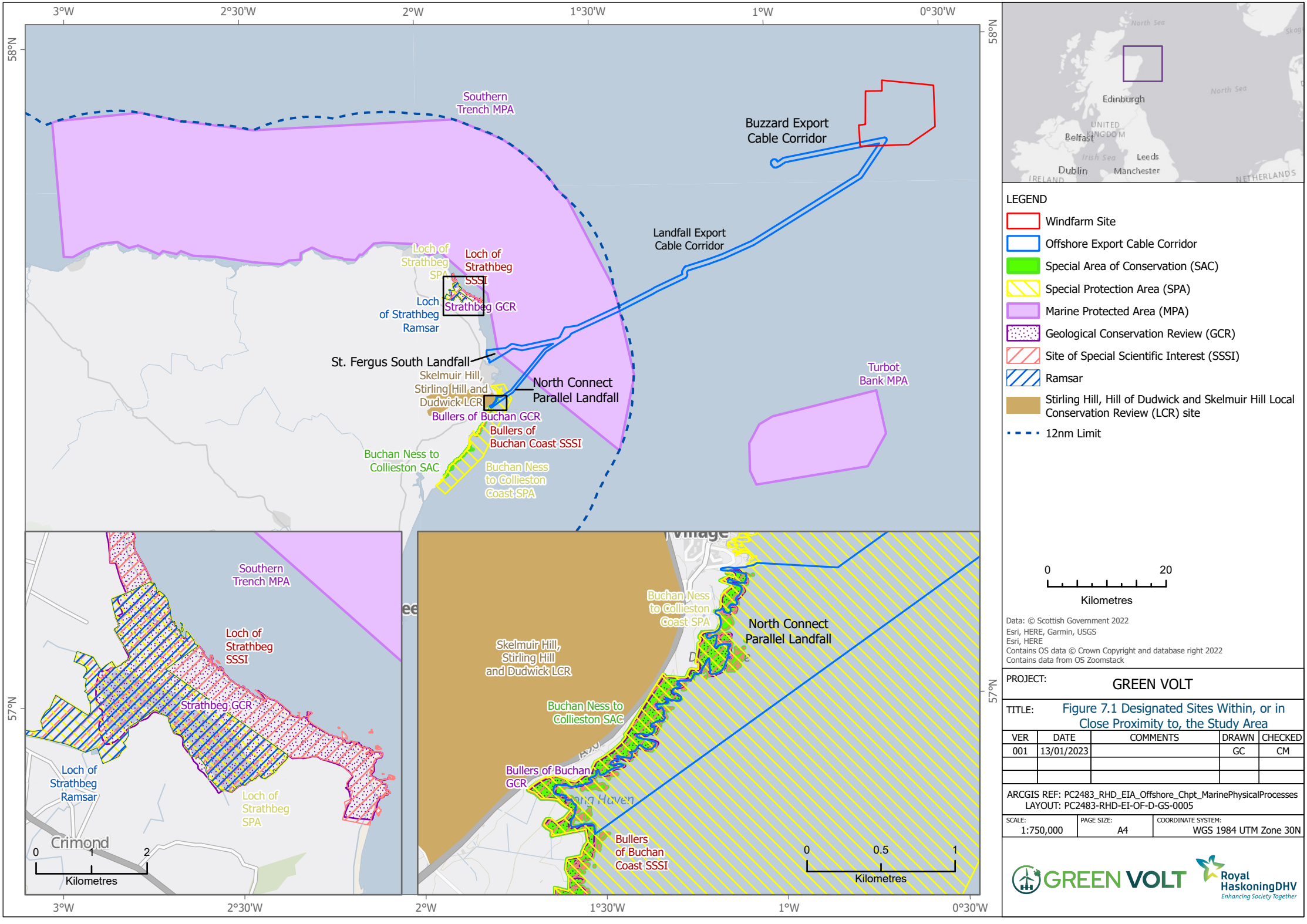
34. This landfall option is also located just to the north of the Bullers of Buchan Geological Conservation Review (GCR) site and Bullers of Buchan Site of Special Scientific Interest (SSSI), both of which are designated for their earth science importance (coastal geomorphology of Scotland and maritime cliff).

It is also in close proximity to the coastal margin of the Stirling Hill, Hill of Dudwick and Skelmuir Hill Local Conservation Review (LCR) site, which also contains important earth science features (although these are mostly on land and not affected by the export cable).

35. The St. Fergus South Landfall option for landing of the export cable route is approximately 10 km to the south of the Loch of Strathbeg. This Ramsar site and SPA comprises the largest dune slack pool in Britain, with surrounding wetland habitats (open water transition fen, fen-meadow and alder willow carr), dune and grassland communities. It provides wintering and breeding habitat for a number of important wetland bird species, particularly wildfowl.

36. The Loch of Strathbeg site is also designated as a GCR site and as a SSSI; being a key geomorphological site for its extensive and varied dune topography. Its citation states that *"it provides one of the best active examples in Scotland of progradational (accretionary) processes that produce parallel lines of dunes separated by linear depressions and contains some of the most impressive instances of erosional processes in large scale coastal dune ridges to be found anywhere in the country. The massive high dunes contain spectacular blowouts cut down to a basement of raised beach shingle and in places extensive deflation surfaces have been produced by the coalescence of major blowouts. As a relatively undisturbed area, Strathbeg presents valuable opportunities to study these and other processes of land form evolution in a comparatively natural setting. Additional interest in the site is provided by a variety of raised shoreline features. Strathbeg is therefore an outstanding site for studies in coastal geomorphology."*

37. The Windfarm Site is approximately 80 km off the coast of Peterhead in the North Sea, on the site of the decommissioned Ettrick and Blackbird oil and gas field and is anticipated to occupy an area of 116 km^2. The Project's WTGs will float above waters 100 m - 115 m deep.



Data: © Scottish Government 2022
Esri, HERE, Garmin, USGS
Esri, HERE
Contains OS data © Crown Copyright and database right 2022
Contains data from OS Zoomstack

PROJECT: GREEN VOLT

TITLE: Figure 7.1 Designated Sites Within, or in Close Proximity to, the Study Area

VER	DATE	COMMENTS	DRAWN	CHECKED
001	13/01/2023		GC	CM

ARCGIS REF: PC2483_RHD_EIA_Offshore_Chpt_MarinePhysicalProcesses
LAYOUT: PC2483-RHD-EI-OF-D-GS-0005

SCALE:	PAGE SIZE:	COORDINATE SYSTEM:
1:750,000	A4	WGS 1984 UTM Zone 30N

GREEN VOLT
Royal HaskoningDHV
Enhancing Society Together

7.5.2 Data Sources

38. During the first step of the EIA process, the **Offshore Scoping Report** (Royal HaskoningDHV, 2021) (**Appendix 1.2**), all available data from site surveys was utilised to describe: (i) bathymetry; (ii) geology, geomorphology and sediments; and (iii) metocean conditions of the physical environment described above.

39. The bathymetric data sources included surveys of the Ettrick and Blackbird oil and gas developments (covering 15 years from 2006 to 2021), Easychart and the Infrastructure for Spatial Information in Europe (INSPIRE) data from the United Kingdom Hydrographic Office (UKHO), and data from the consented NorthConnect route (which is adjacent to the entirety of the Landfall Export Cable Corridor and NorthConnect Parallel Export Cable Corridor and part of the St. Fergus South Export Cable Corridor). No data gaps were identified within the baseline information other than bathymetry of the cable corridor within 12 nautical miles (nm)[1] of the shore.

40. The geology, geomorphology and sediment data sources used included surveys of the Ettrick and Blackbird oil and gas developments (including sediment samples, drop-down camera photographs and videos), and data from the British Geological Survey (BGS), Marine Scotland, and the European Marine Observation & Data Network (EMODnet). No data gaps were identified within the baseline information other than for a section of the cable corridor within 12 nm of the shore.

41. The metocean data sources used included surveys of the Ettrick and Blackbird oil and gas developments, and data from the UKHO (Total Tide), Marine Scotland, British Oceanographic Data Centre (BODC), Marine Environmental Data & Information Network (MEDIN), the Meteorological Office, Wavenet and the European Centre for Medium-Range Weather Forecasts (ECMWF) ERA Model Output. No data gaps were identified within the baseline information.

42. Relevant chapters of the NorthConnect High Voltage Direct Current Cable Infrastructure UK EIA Report (2018) provide useful supporting information to inform this chapter. The NorthConnect HVDC Link will provide an electrical link between Scotland and Norway, allowing the two nations to exchange power and increase the use of renewable energy. The NorthConnect HVDC Link is consented to make landfall at Long Haven Bay just south of Peterhead. The NorthConnect Parallel Export Cable Corridor option follows the NorthConnect route, abutting it to its immediate north, from landfall to the 12 nm limit (and beyond). The St. Fergus South Export Cable Corridor option has a different landfall, but from around 13 km offshore then joins a common corridor to the NorthConnect Parallel Export Cable Corridor option and so also follows the NorthConnect route, abutting it to its immediate north, to the 12 nm limit (and beyond).

43. As part of the NorthConnect EIA Report, a detailed seabed survey was undertaken involving geophysical techniques (multi-beam echo sounder (MBES), side-scan sonar (SSS), sub-bottom profiler (SBP) and magnetometer) and geotechnical investigation (vibro-coring and cone penetrometer testing (CPT), with laboratory testing for physical and chemical properties). This covered the UK nearshore (landfall to 4km from shore) and the UK North Sea sections (4 km from shore to the UK Exclusive Economic Zone) of the NorthConnect route[2].

44. Furthermore, as part of the NorthConnect EIA Report (2018), detailed Ground Investigation (GI) was undertaken between November 2017 and March 2018 along the route of the HVDC cabling (and also at the Converter Station site on land) to inform the Geology and Hydrogeology chapter. This involved

[1] *12 nm is equivalent to a distance of approximately 22.22 km from shore*
[2] *It is noted that in the Seabed Quality chapter of the NorthConnect EIA Report, marine hydrology and coastal processes were not assessed for that project because the marine cable infrastructure would not be expected to result in any significant changes to these processes. In consultation with Marine Scotland, construction and decommissioning effects of cable installation were scoped out from the EIA Report, whilst during the operational phase the cables were expected to remain buried for the majority of the UK corridor. Where cable burial was not possible, such as the HDD exit point in 26m water depth, rock berm protection would be: (i) extremely localised; and (ii) not change water depth by greater than 5% of baseline values. This was deemed to be not significant in terms of effect on hydrology and coastal processes.*

trial pits, boreholes and a geophysical survey (the latter using electrical resistivity imagery, seismic reflection and surface wave ground stiffness technologies). Soil samples were laboratory tested for physical and chemical properties. Two trial pits (TP201 and TP202) and two boreholes (BH201 and BH202) were located at the landfall site, whilst part of the geophysical survey targeted the possible presence of a geological fault at the landfall.

45. Specifically for the Project, a bathymetric survey using MBES and seabed sediment grab sampling was undertaken in April 2022 by Hydrofix Ltd (Hydrofix Ltd. 2022, **Appendix 7.1** of this **Offshore EIA Report**) providing a good resolution dataset of the seabed levels and surficial sediments along both export cable corridors within 12 nm of shore.

46. Projections of future coastal change, in light of rising sea levels associated with global climate change, are provided by the Scottish Government's Dynamic Coast project. Outputs are available in the form of a report (Fitton *et al.*, 2017) and website[3].

47. Projections of future sea-level rise have been downloaded from the User Interface of the United Kingdom Climate Projections 2018 (UKCP18) for the greenhouse gas emissions scenario represented by Representative Concentration Pathway (RCP) 8.5.

48. Published BGS maps of onshore geology, onshore superficial geology and seabed sediments, along with Admiralty Charts and various literature sources provided other supplementary information.

49. A summary of the principal data sources used is provided in **Table 7.7.**

Table 7.7. Data Sources

Data	Year	Coverage	Confidence	Notes
Onshore Geology	-	UK	High	BGS onshore geology 1:625000
Onshore Superficial Geology	-	UK	High	BGS onshore superficial geology 1:625000
Sea-Bed Sediments	2018	NorthConnect High Voltage Direct Current Cable Infrastructure Corridor	High	UK Environmental Impact Assessment Report of consented project
	-	UK	High	BGS GeoIndex Offshore
	2022	Export cable corridors (two) inshore of 12 nm limit.	High	Grab samples and laboratory analysis for particle size distribution
Geology And Hydrogeology	2018	NorthConnect High Voltage Direct Current Cable Infrastructure Corridor	High	UK Environmental Impact Assessment Report of consented project
Bathymetry	2022	Export cable corridors (two) inshore of 12 nm limit.	High	Multi beam echo sounder
Coastal Change	2017	Coastline	High	Dynamic Coast project outputs
Sea-level Rise	2018	UK	High	UKCP18 User Interface projections to 2100

[3] https://www.dynamiccoast.com/webmaps

7.5.3 Assumptions and Limitations

50. The assessment presented in this chapter has been limited by the absence of SSS and SBP data of the inshore section of the export cable corridor (within 12 nm of shore). However, marine survey data from the consented NorthConnect route has been used (from available reports) to support the initial assessment within this chapter, as the export cable corridor is likely to be co-located within the same surveyed route for all (NorthConnect Parallel option) or part (St. Fergus South option) of its length from Windfarm Site to shore. Also, grab sample, drop-down video and MBES data are of good quality and resolution, and provide adequate substitution in the absence of SSS and SBP data.

51. The cable will be landed via a conduit drilled by Horizontal Directional Drilling (HDD). Due to cable lay vessel draft limitations, the HDD punch-out location will be at least -5m lowest astronomical tide (LAT), but could be as much as -10m LAT. With respect to -5m to -10m LAT, the distance will likely be between 400m and 1000m from shore for the St Fergus options, and the North Connect Parallel option south of Boddam will be between 500m and 700m from shore.

52. It is assumed that the export cable burial using HDD at the landfall will be of a sufficient depth beneath the foreshore and nearshore seabed that it will not become exposed by lowering of the foreshore associated with landward profile translocation under sea-level rise (if relevant). This will be further examined by the developer during the detailed design of the export cable landfall in the form of a Cable Burial Risk Assessment (CBRA).

53. It is assumed that the siting of the land-based infrastructure at the landfall will be of a sufficient 'set-back' distance from the cliff edge (NorthConnect Parallel Export Cable Corridor Option) or dune crest (St. Fergus South Export Cable Corridor Option) that it will not become compromised by recession of the cliff or dune associated with landward profile translocation under sea-level rise. This will be further examined by the developer during the detailed design of the export cable landfall and assessed in the **Onshore EIA Report**.

54. There are mobile features in localised areas of the Landfall Export Cable Corridor within the 12 nm limit. Therefore, pre-sweeping of the seabed before cable installation by means of trenching, jetting, ploughing or mechanically cutting into the seabed may be required in the Study Area. whereas described in **Chapter 5: Project Description,** provisions have been made for 1 km of pre-sweeping of bedforms (of maximum height 0.7 m) within a 50 m corridor width within the 12 nm limit. This would affect a maximum area of seabed of 50,000 m^2 and yield a volume of sediment of up to 35,000 m^3 which it is assumed will be side-cast adjacent to the pre-sweeping area.

55. It is expected that generally the cable burial will achieve target depth range of 0.6 – 1.5 m below the seabed and, as such, rock deposits or concrete mattresses will not be required for the majority of the export cable route to shore from the 12 nm limit. However, a worst case assumption has been made that up to 12% of the seabed within Kilometre Point (KP)[4] KP0-5 will require protection (0.6 km) and up to 8% of the seabed between KP5-20 will require protection (1.2 km). For the KP0-5 section, no protection will be required inshore of the HDD exit point on the seabed. No other protection is expected to be required until KP35-50, which is outside the Study Area for this chapter.

56. If protection to the export cable is required within the 12 nm limit, the height of rock deposits or concrete mattresses for protection will be a maximum of 1.5 m above the seabed and at no point will this exceed 5% of the water depth to avoid impacts on navigation. This assumption is similar to the NorthConnect HVDC Link and Kincardine Offshore Windfarm approaches to laying the inshore cable, where the associated rock protection does not exceed the noted change to water depths (Royal HaskoningDHV, 2021).

57. There will be two cable crossings and three pipeline crossings within the Study Area of 12 nm from the shore.

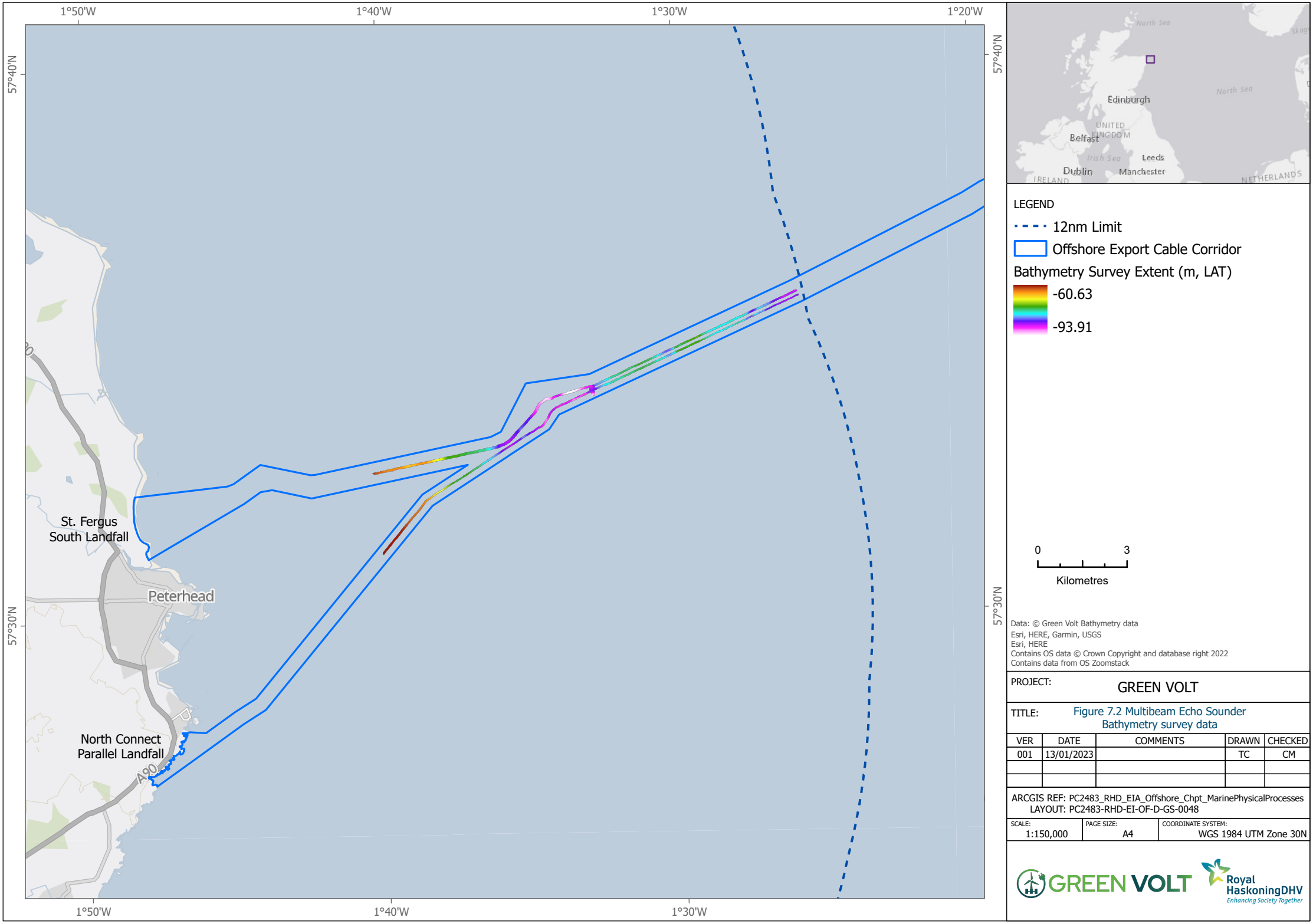
[4] *Distance, in kilometres, along the axis of the export cable corridor from landfall to its seaward extent.*

7.6 Existing Environment

7.6.1 Bathymetry, Seabed Features and Sediments

58. A MBES bathymetric survey was undertaken along the NorthConnect Parallel Export Cable Corridor and St. Fergus South Export Cable Corridor specifically for the Project (**Figure 7.2**). The survey data extends from approximately 7 km offshore to the 12 nm limit and covers a range of water depths between 60 m and 93 m. EMODnet bathymetric data is used for interpretation of the area of seabed between MHWS at the landfall to 7 km offshore.

59. Both the NorthConnect Parallel Export Cable Corridor and St. Fergus South Export Cable Corridor options run across a sharp drop in seabed level close to shore (within 1.5 km), followed by a fairly gentle drop to the 12 nm limit. The Landfall Export Cable Corridor from the 12 nm limit to the Windfarm Site is along a gently sloping seabed.



PROJECT: GREEN VOLT

TITLE: Figure 7.2 Multibeam Echo Sounder Bathymetry survey data

VER	DATE	COMMENTS	DRAWN	CHECKED
001	13/01/2023		TC	CM

ARCGIS REF: PC2483_RHD_EIA_Offshore_Chpt_MarinePhysicalProcesses
LAYOUT: PC2483-RHD-EI-OF-D-GS-0048

SCALE:	PAGE SIZE:	COORDINATE SYSTEM:
1:150,000	A4	WGS 1984 UTM Zone 30N

GREEN VOLT

Royal HaskoningDHV
Enhancing Society Together

60. For the NorthConnect Parallel Export Cable Corridor option, the water depth increases very sharply from above mean high water springs at the landfall to 10 m within 500 m of the shore, progressing to 20 m a short distance (300 m) further seaward. The 10 m and 20 m seabed contours hug the shoreline at the protruding headland at Boddam but are slightly further offshore at the geo[5] of Long Haven (although even then the 20 m contour is within only 2 km of shore). The seabed then deepens further from the 20 m contour to 50 m water depth within the first 3 km of shore and to 70 m water depth within 10 km of the shore.

61. For the St. Fergus South Export Cable Corridor option, the water depth increases from above mean high water springs at the landfall to 10 m within the first 1 km from shore. It then deepens to 25 m within the first 2 km from shore and then to 50 m within 6.5 km from shore.

62. The MBES data acquired along the NorthConnect Parallel Export Cable Corridor and St. Fergus South Export Cable Corridor show the seabed is a gentle slope between 60 m and 80 m water depth. Then, at 80 m, a break in slope marks the western edge of a bathymetric deep that is 4 km wide and reaches a maximum water depth of 93 m (this is part of the Southern Trench MPA). Water depths are shallower on the eastern margin of this bathymetric deep creating a gentle slope that dips offshore with isolated bathymetric deeps (300 m to 700 m wide) occurring locally.

63. Within the large bathymetric deep, small patches (150 m to 300 m wide) of bedforms (ripples, megaripples and sand waves) can be identified indicating sediment mobility. The distance between individual ripples is between 2 m and 5 m and their height ranges from 0.15 m to 0.30 m, although bedform heights of 0.70 m have been reported along the NorthConnect route (immediately adjacent to the NorthConnect Parallel Export Cable Corridor option). Based on the MBES data, mobile sediment features are present along 0.9 km of the St. Fergus South Export Cable Corridor and 0.95 km of the NorthConnect Parallel Export Cable Corridor. As this data does not cover the area between MHWS and 7 km of the shore, the allowance for pre-sweeping of bedforms (1 km) may need to be reconsidered.

64. A grab sampling survey was undertaken along the Offshore Export Cable Corridor in May 2022 and eight sample stations are located within 12 nm within the Offshore Export Cable Corridor (see **Figure 9.2, Chapter 9: Benthic Ecology**). Particle Size Analysis (PSA) assessment was undertaken and the results indicate the seabed at these locations comprises gravelly sand (APEM 2022).

65. The seabed geology along the NorthConnect HVDC Link route (immediately adjacent to the NorthConnect Parallel Export Cable Corridor option and therefore likely to be reasonably representative of this seabed area too) shows bedrock outcropping at the coastal cliffs, followed by fine gravelly sand and silty fine sand to 1.5 km from shore. Then, between 1.5 km and 4.0 km from shore, the seabed is coarser, dominated by sand and gravel, with gentle gradients and steep bedrock outcrops. Some large ripples, megaripples, individual boulders and boulder fields are present.

66. The only information currently available on the seabed sediments for the route of the St. Fergus South Export Cable Corridor option is viewable via the on-line BGS GeoIndex Offshore. This suggests the corridor is likely to comprise sand at the shoreline and nearshore seabed (with local areas of outcropping bedrock), with slightly gravelly sand, gravelly sand and sand further offshore to deeper water.

67. The Offshore Export Cable Corridor to shore for both options passes through the southern section of the Southern Trench MPA (**Figure 7.3**). The Southern Trench is a 58 km long, 9 km wide and 250 m deep trench that runs parallel to the north coast of Aberdeenshire. The trench is considered to be a glacial feature, carved out during the last ice age and partially infilled with glacial marine sediments.

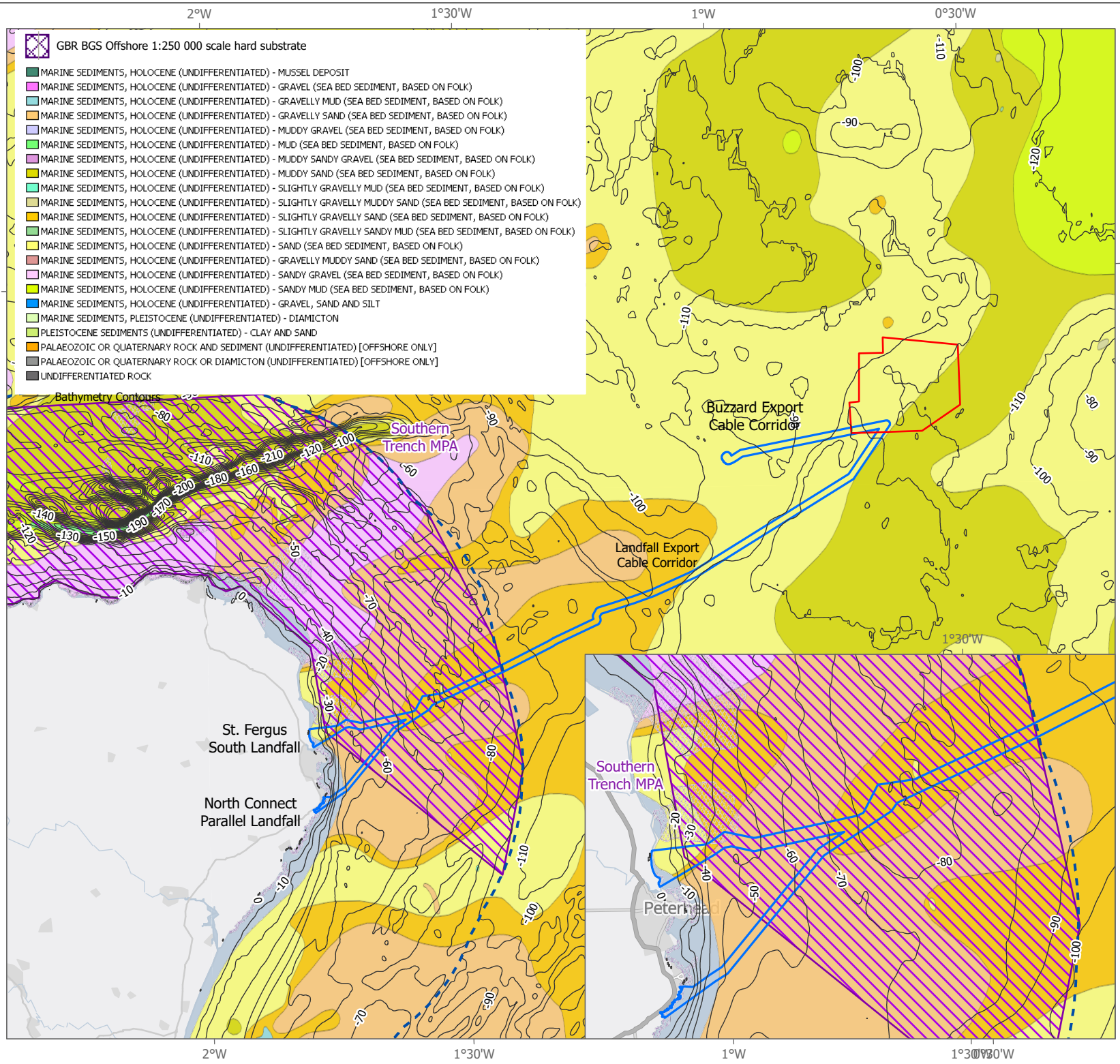
[5] *A geo is a long, narrow and deep inlet with steep rocky sides and a rock headwall, typically with little or no beach material and often with caves of enlarged fissures at their head. Long Haven provides a spectacular example of such a geo.*

68. The trench functions as a nursery ground for juvenile fish, and the thick, soft mud covering the trench floor is populated by crabs and Nephrops, sea pens and burrowing anemones. As well as biodiversity features of interest, the Southern Trench MPA has the following geodiversity interest features:

- Quaternary of Scotland (subglacial tunnel valleys and moraines); and
- Submarine mass movement.

69. The export cable corridors of both options do not pass near to the marine muds feature of the Southern Trench MPA (these are more predominant in the northern section of the MPA). Instead, the Landfall Export Cable Corridor predominantly passes through areas of gravelly sand, with some sections of slightly gravelly muddy sand (**Figure 7.3**).

70. Note that the Moray East, Moray West and Beatrice offshore Windfarm export cable routes pass through the Southern Trench MPA and another consent exists for the NorthConnect HVDC Link. Whilst the MPA was not fully designated (**Figure 7.4**) at that time those projects were consented, the site would have been treated as if it was already a designated MPA in any environmental assessments supporting each of those projects.



LEGEND

- Windfarm Site
- Offshore Export Cable Corridor
- Marine Protected Area (MPA)
- 12nm Limit
- Bathymetry Contours

0 20

Kilometres

Data: Contains British Geological Survey materials © UKRI 2022
Esri, HERE, Garmin
Esri, HERE
Contains OS data © Crown Copyright and database right 2022
Contains data from OS Zoomstack

PROJECT: GREEN VOLT

TITLE: Figure 7.3 The Project's Export Cable Corridor Crossing the Southern Trench MPA

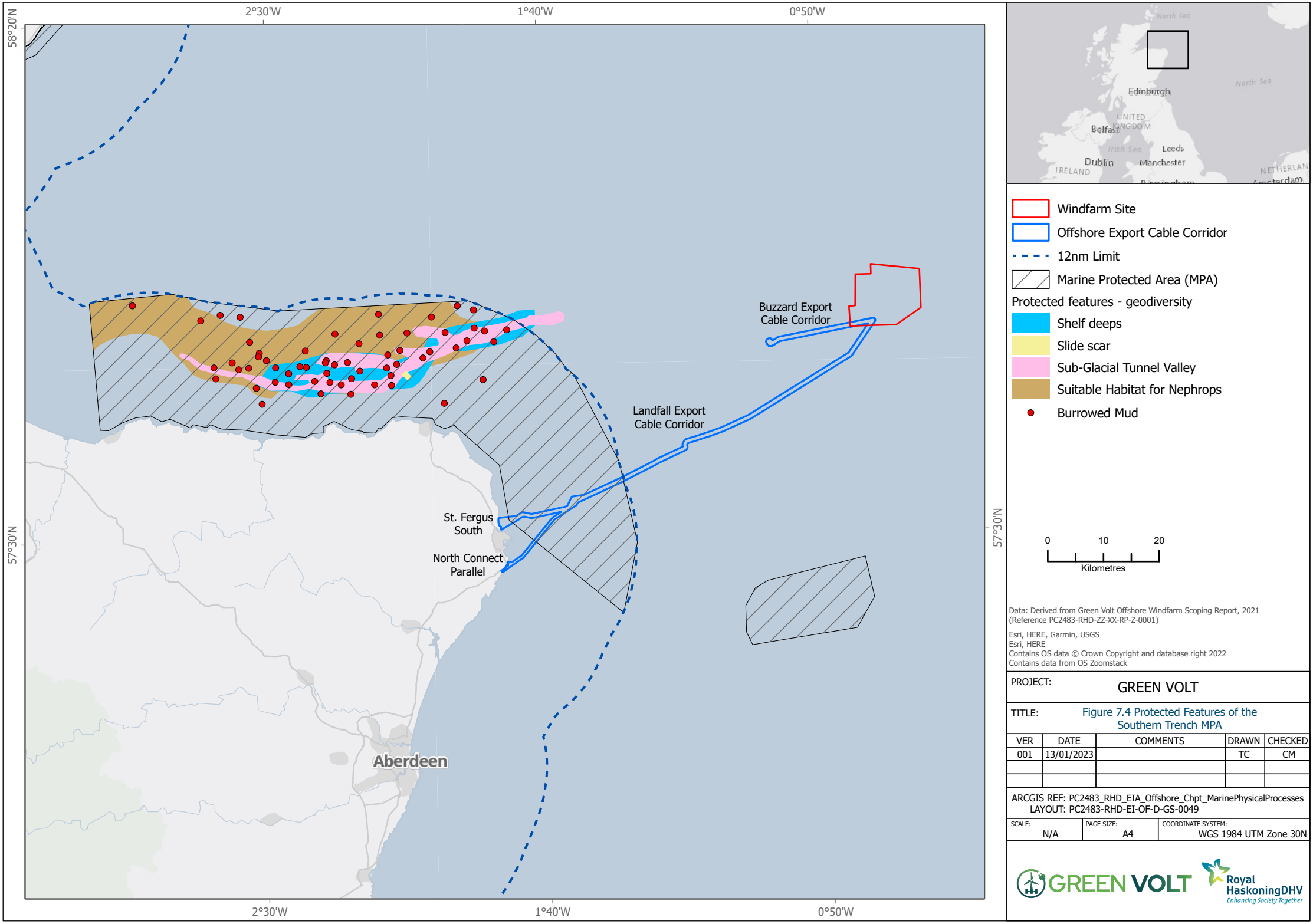
VER	DATE	COMMENTS	DRAWN	CHECKED
001	13/01/2023		GC	CM

ARCGIS REF: PC2483_RHD_EIA_Offshore_Chpt_MarinePhysicalProcesses
LAYOUT: PC2483-RHD-EI-OF-D-GS-0006

SCALE:	PAGE SIZE:	COORDINATE SYSTEM:
1:600,000	A4	WGS 1984 UTM Zone 30N

GREEN VOLT

Royal HaskoningDHV
Enhancing Society Together



Data: Derived from Green Volt Offshore Windfarm Scoping Report, 2021 (Reference PC2483-RHD-ZZ-XX-RP-Z-0001)

Esri, HERE, Garmin, USGS
Esri, HERE
Contains OS data © Crown Copyright and database right 2022
Contains data from OS Zoomstack

PROJECT: GREEN VOLT

TITLE: Figure 7.4 Protected Features of the Southern Trench MPA

VER	DATE	COMMENTS	DRAWN	CHECKED
001	13/01/2023		TC	CM

ARCGIS REF: PC2483_RHD_EIA_Offshore_Chpt_MarinePhysicalProcesses
LAYOUT: PC2483-RHD-EI-OF-D-GS-0049

SCALE:	PAGE SIZE:	COORDINATE SYSTEM:
N/A	A4	WGS 1984 UTM Zone 30N

GREEN VOLT

Royal HaskoningDHV
Enhancing Society Together

7.6.2 Geology and Geomorphology of the Landfall

71. Both landfall options are located within what is referred to as Coastal Sub-Cell 2d in Scotland. This is a stretch of coast between Girdle Ness near Aberdeen in the south and Cairnbulg Point near Fraserburgh in the north, within which non-cohesive sediment transport processes are relatively self-contained.

72. Ramsay and Brampton (2000) reported that the hard geology of the coast within this Sub-Cell, comprises metamorphic rocks, which are significantly exposed between Collieston and Peterhead and in a number of small intertidal outcrops north of Peterhead.

73. From south to north (**Figure 7.5**), the cliffed coast between Collieston and south of Cruden Bay is mainly composed of quartzites and schists which are resistant to marine erosion. Cruden Bay is a wide sandy beach backed by sand dunes. North of Cruden Bay the cliffs are 20 m to 40 m high and composed of granite (in some areas capped with bevelled till) which extend from Port Errol to Peterhead, part of which cover the Bullers of Buchan GCR site and SSSI. Within these cliffs, dolerite dykes occur which are more easily eroded by marine action than the granite, giving rise to geos, inlets, caves, arches and stacks (Hansom, 2022). North of Peterhead the coast is formed predominantly of sandy beaches with backing dunes (with occasional intertidal outcrops) as far north as Rattray Head and beyond to Back Bar, a dune system fronting the Loch of Strathbeg.

74. Evidence of former higher relative sea levels back much of the soft beach coast, with the hinterland around Rattray Head possessing a particularly wide range of relict and active geomorphological features, for which the Loch of Strathbeg is designated as a (geological/geomorphological) SSSI.

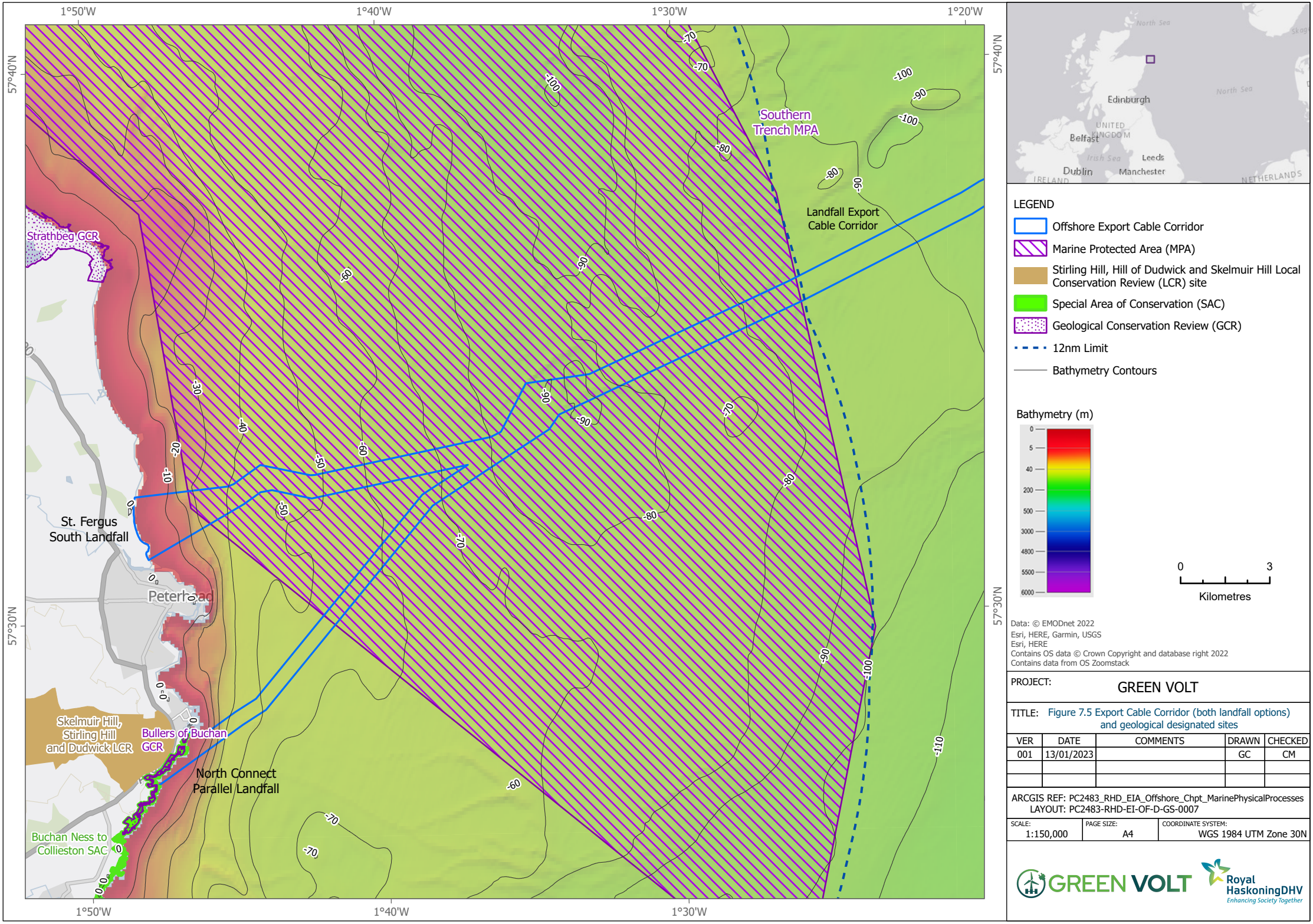
75. At a more local scale, the St. Fergus South Export Cable Corridor option makes landfall along the sandy beach and dune-dominated coast north of Peterhead (**Figure 7.6**). There are occasional rock outcrops at Craigewan and Black Stones (at Kirkton Head).

76. The Dynamic Coast website projects some erosion of the dunes between Peterhead and Rattray Head to the year 2100 under a ‘High’ greenhouse gas emissions scenario for climate change. Within the Offshore Export Cable Corridor this could be up to around 50 m in places, increasing to up to 100 m north of the Offshore Export Cable Corridor along the frontage between St. Fergus and Rattray Head.

77. Fitton *et al.* (2017) note that the dunes and beaches around St. Fergus have experienced a change from accretion (which was strongly evident from 1900 to 1971) to erosion, with in places, more than 20 m erosion occurring since the 1970s. Along this frontage the St Fergus Gas Terminal was constructed between the 1970s and 1980s, with several pipelines making landfall. However, Dynamic Coast (Rennie *et al*, 2017) suggests that the dunes were successfully reinstated following installation of pipelines, although it infers that the non-uniform pattern of erosion along this frontage in recent decades may be at least partly influenced by the instability caused by the pipelines’ installation. However, the principal factor affecting the switch from accretion to erosion is considered to be the move from past sea-level fall (due to isostatic rebound), through stasis to the onset of sea-level rise, and its exacerbation into the future due to global climate change. This is mentioned here because the original export cable corridor for the north option (since named St. Fergus South) encompassed the bay at St. Fergus, and Nature Scot provide a particular consultation response to the **Offshore Scoping Report** in relation to this area. However, since the **Offshore Scoping Report** (**Appendix 1.2**) was produced, the St. Fergus South Export Cable Corridor option has been refined (narrowed) and no longer includes the frontage at St. Fergus, but landfall will be focused along the dunes further south (just north of Peterhead).

78. The NorthConnect Parallel Export Cable Corridor option makes landfall along the granite-dominated coast just south of Peterhead (**Figure 7.7**). The shoreline is indented by bays, such as (from south to north) Heathery Haven, Long Haven, South Castle Haven or Thief's Loup). The cliffs and predominantly bedrock dominated shore (with surface gravel deposits in some bays) are resistant to erosion.

79. The Dynamic Coast website projects no significant change in shoreline position south of Peterhead to Collieston other than within the bays of Sandford Bay and Cruden Bay (both of which are outwith the landfall of the Offshore Export Cable Corridor). This substantiates the view that this granite cliff and bedrock foreshore coast is resistant to erosion.



Data: © EMODnet 2022
Esri, HERE, Garmin, USGS
Esri, HERE
Contains OS data © Crown Copyright and database right 2022
Contains data from OS Zoomstack

PROJECT: GREEN VOLT

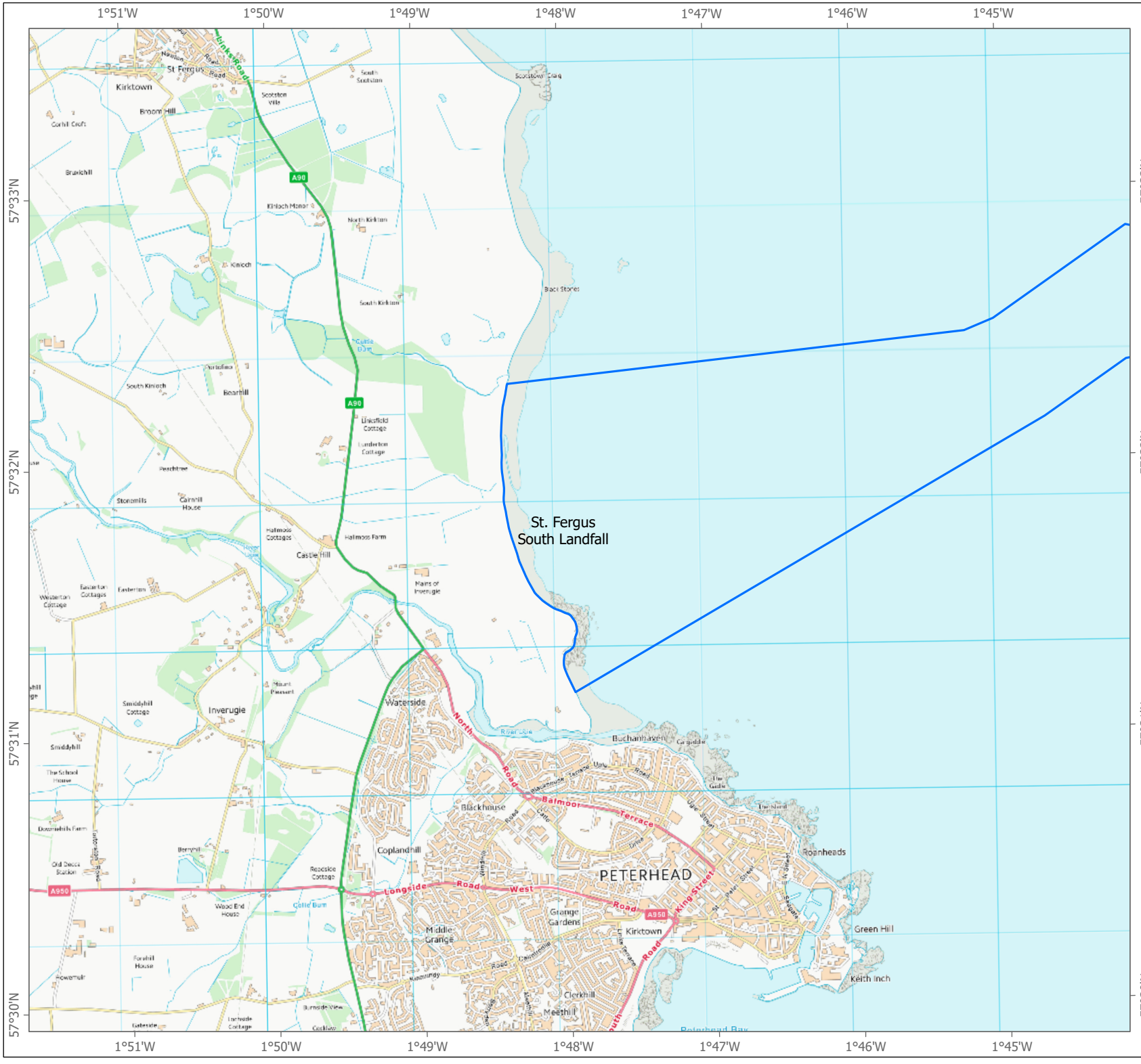
TITLE: Figure 7.5 Export Cable Corridor (both landfall options) and geological designated sites

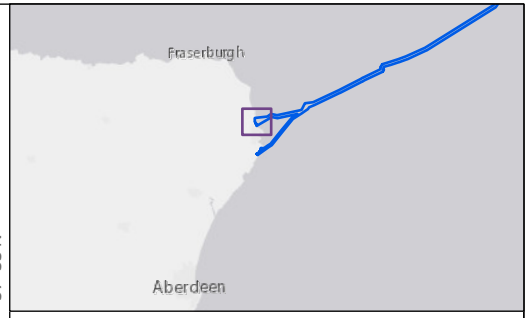
VER	DATE	COMMENTS	DRAWN	CHECKED
001	13/01/2023		GC	CM

ARCGIS REF: PC2483_RHD_EIA_Offshore_Chpt_MarinePhysicalProcesses
LAYOUT: PC2483-RHD-EI-OF-D-GS-0007

SCALE:	PAGE SIZE:	COORDINATE SYSTEM:
1:150,000	A4	WGS 1984 UTM Zone 30N

GREEN VOLT
Royal HaskoningDHV
Enhancing Society Together





LEGEND

Offshore Export Cable Corridor

0 1

Kilometres

Data:

Esri, HERE, Garmin, USGS
Esri, HERE
Contains OS data © Crown Copyright and database right 2022

PROJECT: GREEN VOLT

TITLE: Figure 7.6 St. Fergus South Export Cable Corridor Option

VER	DATE	COMMENTS	DRAWN	CHECKED
001	13/01/2023		GC	CM

ARCGIS REF: PC2483_RHD_EIA_Offshore_Chpt_MarinePhysicalProcesses
LAYOUT: PC2483-RHD-EI-OF-D-GS-0008

SCALE:	PAGE SIZE:	COORDINATE SYSTEM:
1:35,000	A4	WGS 1984 UTM Zone 30N

GREEN VOLT

Royal HaskoningDHV
Enhancing Society Together

LEGEND

Offshore Export Cable Corridor

0 1

Kilometres

Data:

Esri, HERE, Garmin, USGS
Esri, HERE
Contains OS data © Crown Copyright and database right 2022

PROJECT: GREEN VOLT

TITLE: Figure 7.7 NorthConnect Parallel Export Cable Corridor Option

VER	DATE	COMMENTS	DRAWN	CHECKED
001	13/01/2023		GC	CM

ARCGIS REF: PC2483_RHD_EIA_Offshore_Chpt_MarinePhysicalProcesses
LAYOUT: PC2483-RHD-EI-OF-D-GS-0009

SCALE:	PAGE SIZE:	COORDINATE SYSTEM:
1:35,000	A4	WGS 1984 UTM Zone 30N

GREEN VOLT

Royal HaskoningDHV
Enhancing Society Together

7.6.3 Tidal Levels and Sea-level Rise

80. The astronomical tidal range at Peterhead is around 3.30 m on spring tides and around 1.60 m on neap tides. Mean spring tides reach high water levels of 1.60 m above Ordnance Datum Newlyn (ODN) and mean neap high tides reach levels of 0.90 m above ODN.

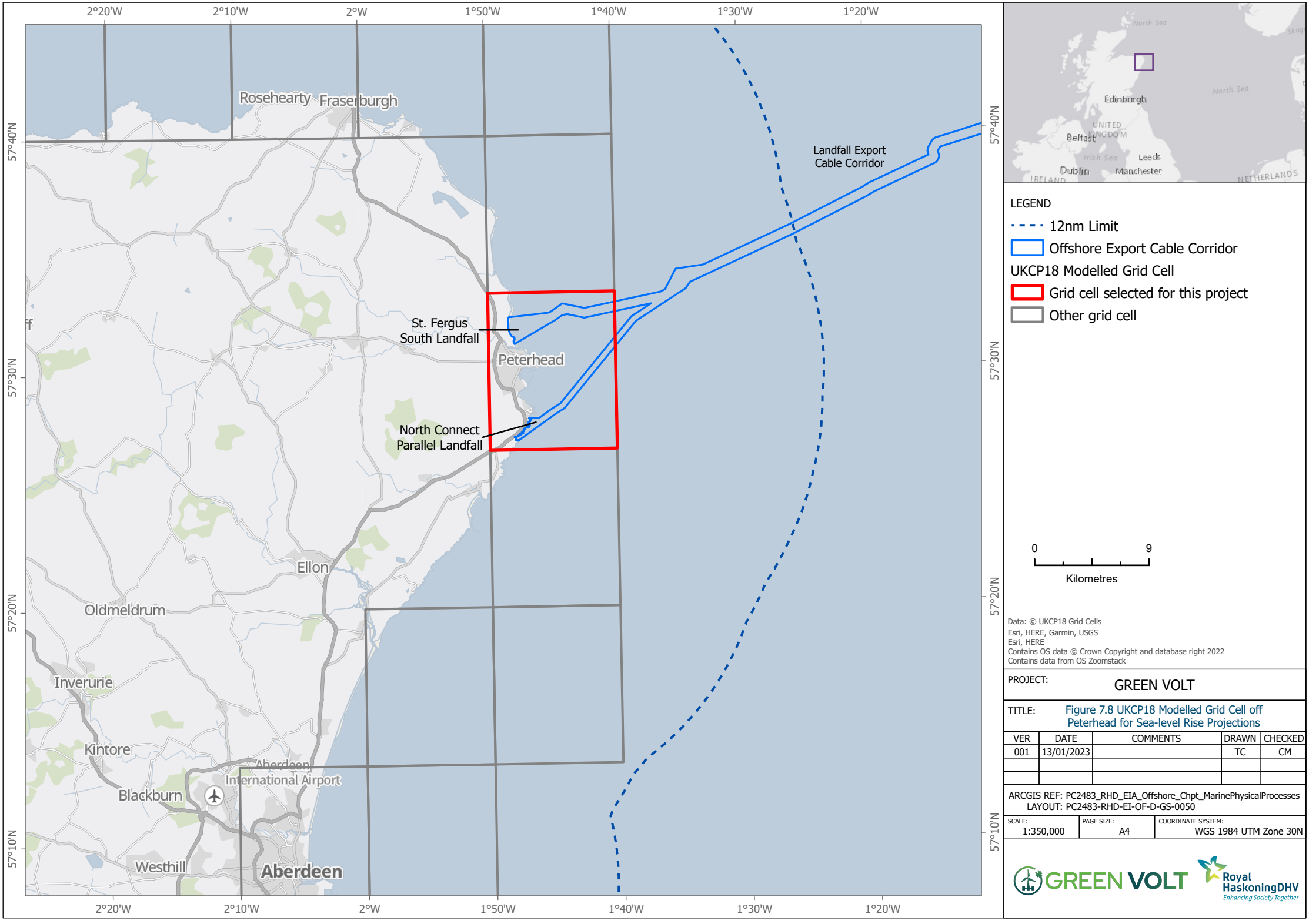
81. These regular, predictable astronomical tides can be influenced by meteorological effects such as surge or wind set-up, causing extreme water levels. Latest available research from the UK Coastal Flood Boundaries (CFB) Project indicates extreme water levels off Peterhead during 1 in 1 year return period events of 2.37 m above ODN and during 1 in 200-year return period events of 2.89 m above ODN. These values related to a base date of 2017.

82. Over recent geological time (last 10,000 years), the coastline around Peterhead has experienced relative sea-level fall, leading to the formation of many of the important geomorphological features along the shore and hinterland including raised beaches, especially observable around Rattray Head and the Loch of Strathbeg. This was due to isostatic rebound of the Great Britain (GB) landmass since the last Ice Age (rising in the north and sinking in the south) outpacing global eustatic sea-level rise in the north. However, in more recent decades, the rate of isostatic rebound has reduced whilst the rate of eustatic sea-level rise has increased, leading to initial sea level stasis through to the onset of relative sea-level rise. The rate of relative sea-level rise is further projected to increase into the future due to ongoing global climate change.

83. The UKCP18 outputs provide projections over three future greenhouse gas emissions scenarios, named RCPs. For this study, RCP 8.5 has been used, representing the highest of the three modelled RCPs. Projected sea-level rise has been downloaded from the UKCP18 on-line User Interface for a modelled grid cell immediately offshore from Peterhead, covering both landfall options (**Figure 7.8**)**.** Outputs using the 70th percentile value are provided in **Table 7.8**, showing changes in mean sea level relative to a base date of 2017 (this date was selected to tie-in with the base date of the extreme water levels stated earlier, which were derived from the UK CFB Project).

Table 7.8. UKCP18 Modelled Projections of Sea-level Rise off Peterhead

Year	Representative Concentration Pathway	Percentile Value	Sea-level Rise (m) Relative to 2017 Base Date
2025	RCP 8.5	70th	0.034
2050	RCP 8.5	70th	0.178
2075	RCP 8.5	70th	0.382
2100	RCP 8.5	70th	0.627



PROJECT: GREEN VOLT

TITLE: Figure 7.8 UKCP18 Modelled Grid Cell off Peterhead for Sea-level Rise Projections

VER	DATE	COMMENTS	DRAWN	CHECKED
001	13/01/2023		TC	CM

ARCGIS REF: PC2483_RHD_EIA_Offshore_Chpt_MarinePhysicalProcesses
LAYOUT: PC2483-RHD-EI-OF-D-GS-0050

SCALE:	PAGE SIZE:	COORDINATE SYSTEM:
1:350,000	A4	WGS 1984 UTM Zone 30N

GREEN VOLT

Royal HaskoningDHV
Enhancing Society Together

7.6.4 Tidal Currents

84. Tidal currents generally run parallel to the coastline, with the flooding tide running to the south and the ebbing tide to the north. Approximately 8 km offshore, peak spring tidal currents can reach 1.0 m/s with peak neap currents around 0.6 m/s. These currents reduce closer to shore, except locally around headlands; for example, Admiralty tidal diamonds show currents up to 0.85 m/s off Peterhead.

7.6.5 Waves

85. Waves offshore from Aberdeen, which will have a similar wave climate to Peterhead, approach from all direction sectors between 0°N and 200°N, with a slight bias from between 0°N and 60°N due to the dominance of swell conditions generated in the Norwegian Sea. At the coast, the dominant wave direction is between 30°N and 150°N south of Peterhead, but north of Peterhead waves from 0°N to 90°N are more prevalent, with the coast being sheltered from more southerly waves by the headland.

7.6.6 Water Column Structure

86. Marine Scotland Science's (MSS) representation requested that the baseline water column conditions should be described in the EIA, including whether the region is stratified or fully mixed. Reference was made to a publication by van Leeuwen *et al.* (2015) which suggests that the region is likely to undergo seasonal stratification.

87. Despite the apparent existence of a large number of past Conductivity, Temperature and Depth (CTD) measurements in the vicinity of the Windfarm Site and export cable corridors[6], there is no known readily available systematic understanding of the baseline water column conditions, including stratification, other than that published by van Leeuwen *et al.* (2015), so that paper forms the basis of the understanding of the existing environment.

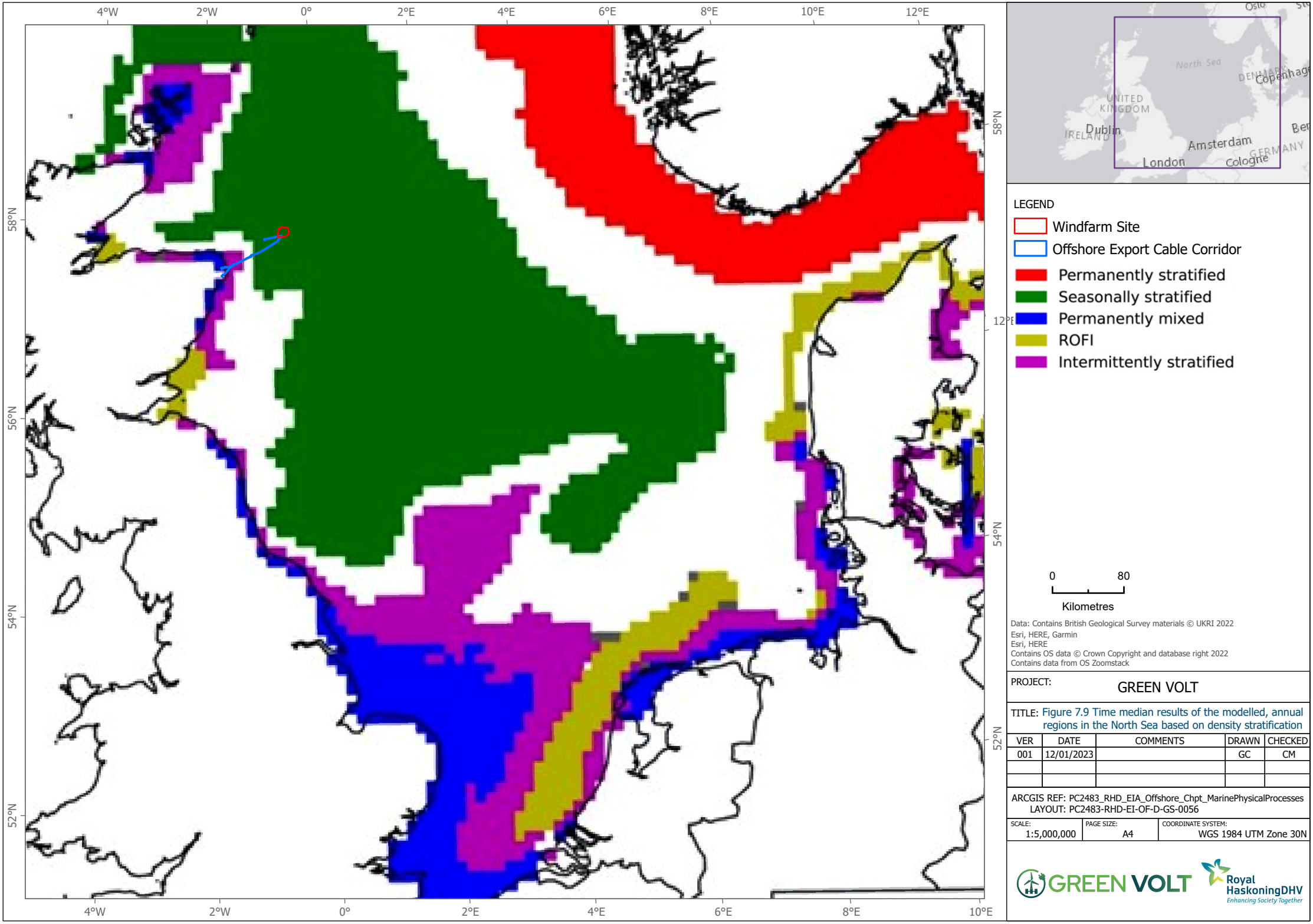
88. Based upon results from a 51-year simulation period using an applied ecosystem General Estuarine Transport Model (GETM) (specifically the coupled hydro-bio-geo-chemical model (GETM-ERSEM-BFM), the paper delineated the North Sea into five distinct regimes, based on multi-decadal stratification characteristics. The five identified regimes are:

    1. Permanently stratified
    2. Seasonally stratified
    3. Intermittently stratified
    4. Permanently mixed
    5. Region of freshwater influence

89. Whilst each region shows some interannual variation in geographic coverage (meaning that 29% of North Sea waters fail to classify as any one particular defined stratification regime), they are overall remarkably stable features within the North Sea.

90. The paper was focused on defining the physical condition of the water column as an underlying basis for marine biological classification to support the aims of the European Union's Marine Strategy Framework Directive. In particular, much discussion covered the relationship between vertical mixing and plankton. However, it is the paper's presentation of the underlying physical conditions of the water column that are relevant in responding to MSS' representation in respect of the proposed Project.

[6] http://ocean.ices.dk/



PROJECT: GREEN VOLT

TITLE: Figure 7.9 Time median results of the modelled, annual regions in the North Sea based on density stratification

VER	DATE	COMMENTS	DRAWN	CHECKED
001	12/01/2023		GC	CM

ARCGIS REF: PC2483_RHD_EIA_Offshore_Chpt_MarinePhysicalProcesses
LAYOUT: PC2483-RHD-EI-OF-D-GS-0056

SCALE:	PAGE SIZE:	COORDINATE SYSTEM:
1:5,000,000	A4	WGS 1984 UTM Zone 30N

GREEN VOLT

Royal HaskoningDHV
Enhancing Society Together

91. The time median results of the modelled annual regions in the North Sea, based on density stratification, are reproduced in **Figure 7.9**. This shows that the Windfarm Site (which is the part of the development area that is pertinent to MSS' representation) is within a region of the North Sea classified as being seasonally stratified. This region extends widely across the northern and central North Sea (representing, on average over the 51-year period, 27% of North Sea waters) and is stated to thermally stratify in spring when air temperatures increase and stay stratified until autumn processes remix the water column. Winter is characterised by continuous mixed conditions. These results are unsurprising because the water depths at the Windfarm Site are typically in the order of 100 m – 115 m and there would be an expected measurable temperature difference between the water surface and the near-bed layers of the water column during spring and especially summer months, and possibly extending into early autumn.

7.6.7 Littoral Sediment Transport

92. Extensive fluvio-glacial and post-glacial deposits along this coast have been re-worked as sea levels have fluctuated to form the features evident today. Sea levels are presently relatively stable and with much of the coast dominated by erosion-resistant cliffs, there is little fresh input of sediment to the littoral system.

93. Littoral sediment transport is driven by wave action, although tidal currents may be sufficiently strong at times to transport sediment. Most research into this subject has been in the vicinity of Aberdeen Bay to inform major harbour and coastal defence schemes, and not at Peterhead. However, a minor northerly longshore sediment transport is postulated north of Peterhead towards Rattray Head and onwards to the Back Bar dune system fronting the Loch of Strathbeg.

94. Major bays, such as Cruden Bay, appear to be dominated by onshore-offshore movement of sediment during storms (and post-storm recovery) rather than strong net longshore transport. Other beaches also show relative stability with very little net longshore sediment transport.

7.6.8 Coastal Defences

95. Other than around Peterhead, there are relatively few coastal defences between Collieston and Rattray Head, and those few structures that are present are local.

7.7 Potential Impacts

96. Having presented a baseline understanding of the bathymetry, geology, geomorphology, sediments, and metocean conditions for the Project, the **Offshore Scoping Report** (**Appendix 1.2**) then presented a scoping assessment of the potential impacts upon the physical environment arising from the three different phases of the Project (construction, operation and maintenance (O&M), and decommissioning), as presented in **Table 7.1**.

97. In its **Scoping Opinion** dated April 2022, Marine Scotland Licensing Operations Team (MS-LOT) stated that the Scottish Ministers disagreed with the Developer's proposal to scope out those items in **Table 7.1** marked with an asterix, and advised that these should be scoped in to the **Offshore EIA Report** for the identified project phases, taking due note of the representations from NatureScot and MSS in doing so.

Table 7.9. Potential Impacts Scoped In To / Out From Assessment in the EIA Report

Topic	Description	Construction	O&M	Decommissioning
Bathymetry	Changes at Windfarm Site	x	x	x
	Changes along export cable (outside 12 nm)	x	x	x
	Changes along export cable (inside 12 nm)	✓	✓	x
	Changes along Buzzard Export Cable Corridor	x	x	x
Geology, geomorphology and offshore sediments	Increases on suspended sediment	x * Advised to be **Scoped IN** by Scottish Ministers ✓	x	x * Advised to be **Scoped IN** by Scottish Ministers ✓
	Seabed scour	x * Advised to be **Scoped IN** by Scottish Ministers ✓	x * Advised to be **Scoped IN** by Scottish Ministers ✓	x * Advised to be **Scoped IN** by Scottish Minsters ✓
Metocean conditions	Changes to wave climate	x	x	x
	Changes to tidal currents	x	x	x

98. This chapter provides a baseline description of the marine geology, oceanography and physical processes along the Offshore Export Cable Corridor within 12 nm of shore, followed by an assessment of the magnitude of impact and significance of the effects upon these baseline conditions resulting from the construction, operation and decommissioning of the Offshore Export Cable Corridor (inshore of 12 nm), using realistic worst case scenarios for the Project. In addition, impacts inshore of 12 nm resulting from cumulative interactions with other existing or planned projects are considered.

99. In addition, those potential impacts within the Windfarm Site and Offshore Export Cable Corridor beyond 12 nm from shore that were initially scoped out of assessment by the **Offshore Scoping Report** (**Appendix 1.2**) but have since been advised by Scottish Ministers to be scoped into the EIA Report have been assessed.

100. The potential impacts to marine geology, oceanography and physical processes within the Landfall Export Cable Corridor (within 12 nm of shore) during the construction phase, may arise due to direct physical disturbance of the seabed during installation of the cable (or placement of any required rock deposits or concrete mattresses to installed cables or at cable/pipeline crossings). This could be manifest as damage to the seabed structure and form (geological or geomorphological impact) or increase in suspended sediment concentration in the water column due to trenching/backfilling or placing rock deposits or concrete mattresses onto the seabed. Installation of cables within the

Windfarm Site during the construction phase could disturb seabed sediments that may become entrained within the water column and potentially transported in suspension and ultimately deposited onto the seabed.

101. During the O&M phase, the Offshore Export Cables will be mostly buried and therefore the only interaction with marine geology, oceanography and physical processes will be in areas where rock deposits or concrete mattresses protect the cable, or at cable/pipeline crossings, both standing proud of the seabed. This will cause a footprint effect on the seabed and, depending on its length and height above the seabed, could potentially affect the seabed, waves, tidal currents and sediment transport. There are also potential effects on the baseline water column structure, in particular related to the extent and timing of seasonal stratification, that could arise during the O&M phase.

102. During the decommissioning phase, the potential impacts to marine geology, oceanography and physical processes will be similar to those during the construction phase, but caused by removal of the cable and any rock deposits or concrete mattresses that has been placed.

103. A summary of the potential impacts assessed is provided in **Table 7.10.**

Table 7.10. Potential impact pathways on marine geology and physical processes receptors

Green Volt Project Phase	Potential Impact Pathways	Receptor
Construction	Damage to seabed structure and form	Seabed (seaward of HDD option exit point to 12 nm limit)
	Increase in suspended sediment concentration and deposition	Seabed (seaward of HDD option exit point to 12 nm limit)
	Disturbance of seabed sediments during cable installation	Seabed
O&M	Rock deposit or concrete mattress footprint on seabed	Seabed (seaward of HDD option exit point to 12 nm limit)
	Effect of rock deposits or concrete mattresses on wave, tidal and sediment regime	Seabed (seaward of HDD option exit point to 12 nm limit)
	Disturbance of seabed sediments due to catenary action of mooring lines in Windfarm Site	Seabed (Windfarm Site)
	Disturbance of seabed sediments due to scour around the foundations of the mooring anchors in Windfarm Site	Seabed (Windfarm Site)
	Changes to water column mixing by the presence of structures and/or alterations to the near-surface wind speeds in Windfarm Site	Water column
Decommissioning	Damage to seabed structure and form	Seabed (seaward of HDD option exit point to 12 nm limit)
	Increase in suspended sediment concentration and deposition	Seabed (seaward of HDD option exit point to 12 nm limit)
	Disturbance of seabed sediments during cable removal	Seabed

7.7.1 Embedded Mitigation

104. HDD will be used to connect the Landfall Export Cable to shore to avoid disturbance to the cliffs (NorthConnect Parallel option) or dunes (St. Fergus South option), intertidal shore and nearshore seabed that would otherwise be caused by trenching (or similar intrusive installation).

105. The Offshore Export Cable Corridors have been refined during the EIA process so that the envelope of each corridor option has been narrowed as far as practicable towards each landfall. In particular, the St. Fergus South Landfall option no longer covers the bay of St. Fergus, but is narrowed to an area further south (just north of Peterhead).

7.7.2 Worst Case Scenario

106. The worst case scenarios with regard to marine geology, oceanography and physical processes within the Study Area (i.e. landfall to 12 nm limit) are presented by impact in **Table 7.11**.

Table 7.11. Worst Case Assumptions

Impact	Parameter	Notes
Construction		
Impact C1: Damage to seabed structure and form	**Area of sediment disturbed = 3.11 km²** • Total area of disturbance from ploughing/jetting of export cables = 3.00 km² • Total area of rock protection for non-buried export cables = 0.800 km² • Total area of rock protection for crossings export cables = 0.0330 km² **Volume of sediment to be disturbed = = 4,535 km³** • Total length of cable = 300 km • Maximum depth of burial = 1.5 m • Maximum width of disturbance = 10 m (jetting/ploughing) • Total maximum volume of sediment disturbed = 4,500,000 m³ • Max pre-sweep volume = 35,000 m³ • Total maximum volume of sediment disturbed = 4,535,000 m³	Study Area confined to Offshore Cable Corridor within 12 nm of shore is 27 km for the NorthConnect Parallel Landfall Export Cable Corridor option which is greater than the St Fergus South Landfall Export Cable Corridor option at 24 km. Jetting/ploughing has greater width of disturbance (10 m) compared to trenching / cutting (3 m)
Impact C2: Increase in suspended sediment concentration	**Area of sediment disturbed = 3.11 km²** • Total area of disturbance from ploughing/jetting of export cables = 3.00 km² • Total area of rock protection for non-buried export cables = 0.800 km² • Total area of rock protection for crossings export cables = 0.0330 km² **Volume of sediment to be disturbed = = 4,535 km³** • Total length of cable = 300 km • Maximum depth of burial = 1.5 m • Maximum width of disturbance = 10 m (jetting/ploughing) • Total maximum volume of sediment disturbed = 4,500,000 m³ • Max pre-sweep volume = 35,000 m³	Method involves HDD to exit point (1,300 m from shore in approx. 20 m water depth) followed by trenching, jetting, ploughing or mechanical cutting to 12 nm

Impact	Parameter	Notes
	• Total maximum volume of sediment disturbed = 4,535,000 m^3	
Impact C3: Disturbance of seabed sediments during cable installation	**Area of sediment disturbed = 4.55 km^2** • Total substructure moorings = 0.06825 km^2 (based on worst case for catenary system) • Total area of disturbance from ploughing/jetting inter-array cables = 1.34 km^2 • Total area of rock protection for crossings of inter-array cables = 0.0189 km^2 • Total area of disturbance for OSP foundations = 0.00724 km^2 (based on worst case for suction bucket foundation including scour protection) • Total area of disturbance from ploughing/jetting of export cables = 3.00 km^2 • Total area of rock protection for non-buried export cables = 0.800 km^2 • Total area of rock protection for crossings export cables = 0.0330 km^2 **Volume of sediment to be disturbed = = 6,545 km^3** • Total length of cable = 300 km • Maximum depth of burial = 1.5 m • Maximum width of disturbance = 10 m (jetting/ploughing) • Total maximum volume of sediment disturbed = 4,500,000 m^3 • Max pre-sweep volume = 35,000 m^3 Total maximum volume of sediment disturbed = 4,535,000 m^3 • Total length of cable = 134 km • Maximum depth of burial = 1.5 m • Maximum width of seabed disturbance = 10 m (jetting/ploughing) • Total maximum volume of sediment disturbed = 2,010,000 m^3	Within the Windfarm Site and along the Landfall Export Cable Corridor. In most places, burial will be less than the 1.5 m maximum and could be as low as 0.6 m minimum depth. The width of disturbance could also be as low as 3 m depending on the installation technique used.
Operation		
Impact O1: Rock deposits or concrete mattresses footprint on seabed	Cable protection: • KP0-5: 12% of cable protected (0.6 km) • KP5-20: 8% of cable protected (1.2 km) • KP20-35: 0% of cable protected (0.0 km) • Max seabed length affected = 3.0 km • Max. width on seabed = 10 m • Max area of footprint = 60,000 m^2 • Max volume of material = 18,450 m^3 Cable & pipeline crossings: • 2 no. cable crossings and 3 no. pipeline crossings • Length of crossings = 300 m • Width of crossings = 10 m	Study Area confined to Offshore Cable Corridor within 12 nm of shore is 27 km for the NorthConnect Parallel Landfall Export Cable Corridor option which is greater than the St Fergus South Landfall Export Cable Corridor option at 24 km.

Impact	Parameter	Notes
	• Max seabed length affected = 1,500 m • Max. seabed area of material per cable crossing = 3,000 m^2 • Max. seabed area of material per pipeline crossing = 3,000 m^2 • Max area of footprint for all crossings = 1,5,000 m^2	
Impact O2: Effect of rock deposits or concrete mattresses on tide, wave and sediment regime	Cable protection: • Max. height above seabed = 1.5 m • Change in water depth no greater than 5% of baseline values • Max. volume of material = 18,450 m^3 Cable & pipeline crossings: • 2 no. cable crossings and 3 no. pipeline crossings • Max. height above seabed = 1.5 m • Change in water depth no greater than 5% of baseline values • Max. volume of material per cable crossing = 2,475 m^3 • Max. volume of material per pipeline crossing = 4,500 m^3 • Max. volume of material for all crossings = 18,450 m^3	
Impact O3: Disturbance of seabed sediments due to catenary action of mooring lines in Windfarm Site	Catenary drag footprint = 1.134 m^2 per WTG at low water when mooring line radius is at a maximum	Within Windfarm Site
Impact O4: Disturbance of seabed sediments due to scour around the foundations of the mooring anchors in Windfarm Site	• Maximum number of WTGs = 35 (12MW) • Maximum number of anchors = six per WTG (210 total) Anchor types will be drag embedment, torpedo, gravity based or suction piles (no driven or drilled piles) with a maximum seabed footprint of 10 m x 10 m per anchor (up to 600m^2 total per WTG)	Within Windfarm site
Impact O5: Changes to water column mixing by the presence of structures and/or alterations to the near-surface wind speeds in Windfarm Site	• Wind farm capacity = 560MW • Maximum number of WTGs = 35 (12MW)	Within Windfarm Site
Decommissioning		
Impact D1: Damage to seabed structure and form	As for construction impact C1	-
Impact D2: Increase in suspended sediment concentration	As for construction impact C2	-
Impact D3: Disturbance of seabed sediments (suspension and deposition) during cable removal	As for construction impact C3.	Within the Windfarm Site and along the Landfall Export Cable Corridor

7.7.3 Potential Impacts during Construction

7.7.5.1 Impact C1: Damage to seabed structure and form

107. The geology and geomorphology of the seabed between the shoreline and the exit point of the HDD will not be affected by installation of the cable since within this section HDD techniques will be used for installation. Therefore, in this section there will be no impact.

108. Further offshore from the exit point of the HDD to the 12 nm limit, the options considered for the Landfall Export Cable Corridor do not pass near to the marine muds feature of the Southern Trench MPA (these are more predominant in the northern section of the MPA). Instead, the Landfall Export Cable Corridor predominantly passes through areas of gravelly sand, with some sections of slightly gravelly muddy sand. This area of the seabed is of negligible sensitivity and whilst it is within the Southern Trench MPA (and therefore part of an area of seabed deemed as being of high value), the main interest features of the MPA that are of relevance to this chapter are not affected.

109. Whilst the seabed along the cable footprint will be directly impacted by jetting/ploughing (worst case) or trenching/cutting for cable installation (including pre-sweeping if necessary) or by placement of rock deposits / concrete mattresses where required for installed cable or at cable/pipeline crossings, the impact will be short term, highly localised (to the footprint of the affected area) and recoverable over time (due to both backfilling, if undertaken, and natural processes). The magnitude of impact is considered negligible and the overall significance of effect is therefore deemed **negligible**.

110. There is medium confidence in the assessment. There is demonstrable evidence from around UK waters of similar cable installation approaches causing negligible impact on the baseline marine geology, oceanography and physical processes in similar types of seabed environment, but there is also an absence of SSS and SBP survey data along the inshore section of the cable route to precisely define the existing seabed and sub-surface features.

7.7.3.2 Impact C2: Increase in suspended sediment concentration and deposition

111. The suspended sediment concentrations between the shoreline and the exit point of the HDD will not be affected by installation of the cable since within this section HDD techniques will be used for installation. Therefore, in this section there will be no impact.

112. Further offshore from the exit point of the HDD to the 12 nm limit, the jetting/ploughing (worst case) or trenching/cutting for cable installation (including pre-sweeping if necessary) or the placement of rock deposits / concrete mattresses (where required for installed cable or at cable/pipeline crossings) will cause temporary increases in suspended sediment concentrations. However, these will be short in duration (the maximum installation programme is 38 days) and, over time, the suspended sediment will disperse, either through settling of coarser sediments rapidly to the seabed close to the point of disturbance or, for finer sediments, as they become entrained within a plume within the water column and widely dispersed by tidal and wave action. The increase in suspended sediment concentrations is not likely to be high in magnitude for prolonged periods of time and is most likely to be within the range of natural variability in the system (e.g. during storms, suspended sediment concentrations will naturally be higher than during calm periods). Furthermore, with the construction impacting different sections of the cable route progressively over time (rather than being instantaneous across the whole route at a single point in time) the impact is localised, although this will be most concentrated in areas where pre-sweeping is undertaken (if required).

113. The Southern Trench MPA is not particularly sensitive to deposition of such sediments as the main interest features are muddy sediments. The sensitivity of the geodiversity interest of the MPA is therefore negligible, whilst the magnitude of impact is considered negligible. The overall significance of effect is therefore deemed **negligible**.

114. There is medium confidence in the assessment. There is demonstrable evidence from around UK waters of similar cable installation approaches causing negligible impact on the baseline marine geology, oceanography and physical processes in similar types of seabed environment, but there is an absence of SSS and SBP survey data along the inshore section of cable route to precisely define the existing sub-surface sediments. These data will be collected prior to design of cable installation.

7.7.3.3 Impact C3: Disturbance of seabed sediments during cable installation

115. The jetting/ploughing (worst case) or trenching/cutting for cable installation (including pre-sweeping if necessary) will cause temporary increases in suspended sediment concentrations at the point of seabed disturbance. However, these will be short in duration (the maximum installation programme is 38 days) and, over time, the suspended sediment will disperse, either through settling of coarser sediments rapidly to the seabed close to the point of disturbance or, for finer sediments, as they become entrained within a plume within the water column and widely dispersed by tidal currents and waves. The increase in suspended sediment concentrations is not likely to be high in magnitude for prolonged periods of time, especially as the water is deep across the Windfarm Site and seaward lengths of the Landfall and Buzzard Export Cable Corridors (beyond 12 nm limit) (reaching up to 110 m in places within the Windfarm Site). Such increases in suspended sediment concentrations are likely to be within the range of natural variability in the system (e.g. during storms, suspended sediment concentrations will naturally be higher than during calm periods). Furthermore, the impact is localised because the installation will impact different sections of the Windfarm Site and Offshore Export Cable Corridors progressively over time, rather than being instantaneous across the whole route at a single point in time. The impact will be most concentrated in areas where pre-sweeping is undertaken (if required).

116. The Southern Trench MPA is not sensitive to deposition of such sediments because the main interest features are similar muddy sediments. Hence, the sensitivity of the geodiversity interest of the MPA is negligible. The magnitude of impact is also considered negligible, and so the overall significance of effect on the geodiversity interest of the MPA is therefore deemed **negligible**.

117. There is medium confidence in the assessment. There is demonstrable evidence from around UK waters of similar cable installation approaches involving similar (or greater) quantities of sediment disturbance causing negligible impact on the baseline marine geology, oceanography and physical processes in similar types of seabed environment.

7.7.4 Potential Impacts during Operation and Maintenance

7.7.4.1 Impact O1: Rock deposit or concrete mattress footprint on seabed

118. The installation of the cable between the shoreline and the exit point of the HDD will be undertaken using HDD techniques and therefore will require no rock deposits or concrete mattresses. Therefore, in this section there will be no impact.

119. Between the HDD exit point and the 12 nm limit, there will be potential for some short sections of the export cable corridor to require rock deposits or concrete mattresses (including at cable/pipeline crossings). This will be a permanent footprint on the seabed until the cable is decommissioned. The cable route avoids the main interest features of the Southern Trench MPA and as it covers mainly gravelly sand or some sections of slightly gravelly muddy sand, the seabed is of low sensitivity. The impact is confined to the footprint of the cable along distinct sections (including at cable/pipeline crossings) and upon removal, the affected seabed is fully recoverable. The magnitude of impact is therefore deemed low and the overall significance of effect is **negligible**.

120. There is medium confidence in the assessment because whilst there is demonstrable evidence from around UK waters of recoverability from local-scale footprint impacts, there is also an absence of SSS and SBP survey data along the inshore section of cable route to precisely define the existing seabed and sub-surface features.

7.7.4.2 Impact O2: Effect of rock deposits or concrete mattresses on the wave, tidal and sediment regimes

121. The installation of the Landfall Export Cable between the shoreline and the exit point of the HDD will be undertaken by HDD techniques and therefore will require no rock deposits or concrete mattresses. Therefore, in this section of the Landfall Export Cable there will be no impact.

122. Between the exit point of the HDD and the 12 nm limit, there will be potential for some short sections of the Landfall Export Cable to require rock deposits or concrete mattresses (including at cable/pipeline crossings).

123. For the HDD, this is considered to be such a small length (even for the worst case scenario) and be located sufficiently far from shore (1000-1300 m) (behind the exit point of the HDD) that it will not have a measurable impact on the baseline wave, tide and sediment regime, other than local to each section of rock deposits where there will be local turbulence, sediment scour or deposition. This local change will be negligible compared to the baseline high energy environment, and the broader wave, tide and sediment regimes would be of negligible sensitivity to such local impacts.

124. NatureScot provided a consultation response to the **Offshore Scoping Report** (**Appendix 1.2**) that expressed the view that interruption of longshore sediment transport from cable protection at the landfall could affect the Loch of Strathbeg SSSI's nationally important coastal geomorphology and dependent habitats. This consultee response was based on the potential for a 'short' HDD option that would exit the seabed at 200 m. However, due to changes to the Project design, the 'short' HDD option is no longer being considered and the HDD will exit much further offshore between 1,000 m and 1,300 m. Therefore, any measurable impact on the baseline wave, tide and sediment regime will be negligible. As such, there are no expected adverse effects upon baseline littoral sediment transport processes along the shore from the HDD landfall installation.

125. This is due to the negligible sensitivity of the shoreline to the south of Peterhead at the NorthConnect Parallel Export Cable Corridor and, for the St. Fergus South Landfall option, with HDD installation being a sufficient distance offshore to not influence the littoral sediment transport regime.

126. The magnitude of impact is negligible due to relatively low baseline activity in terms of littoral sediment transport beyond the exit of the HDD for either cable corridor option.

127. Due to the considerations, no expected change in erosion or deposition is likely at locations adjacent to or nearby designated geodiversity or nature conservation sites. Therefore, the overall significance of the effect under these options is **negligible**.

7.7.4.3 Impact O3: Disturbance of seabed sediments due to catenary action of mooring lines in the Windfarm Site

128. The seabed in the vicinity of the WTGs may be affected by the catenary action of the mooring lines for each WTG. However, this action is expected to be restricted to within 1-2 degrees of the mooring lines and will likely only occur during large storm events. The worst case area of seabed affected per WTG is 1134 m^2. If there is sediment present on the seabed (rather than exposed bedrock) then this will be entrained into suspension in the water column by the effect of the catenary action. However, the sediment is likely to be sand or muddy sand and so much of this will fall to the seabed shortly after disturbance. Only the finest fractions will reside in the water column and in these cases for short durations and in the lower water layers. The total volume of sediment that could be disturbed is relatively low. Even the fullest swept area of 2,100m^2 per WTG, impacting only a thin layer of surface sediment, equates to a few tens or at most a few hundreds of cubic metres of sediment per WTG, although this could be a frequent disturbance through the O&M phase. Overall, the impact will be localised and small in magnitude, and although it will persist throughout the O&M phase it is deemed to be of **negligible** effect significance.

7.7.4.4 Impact O4: Disturbance of seabed sediments due to scour around the foundations of the mooring anchors in the Windfarm Site

129. Considering a worst case anchor footprint of 10m x 10m per anchor (which is relatively small in size), the physical separation between anchors at each WTG location, and with the WTGs being located in water depths of between 100m and 115m, there is unlikely to be sufficient wave-generated current or tidal current velocities acting on the seabed to generate significant quantities of scour (if any) around each of the mooring anchors in the Windfarm Site. With up to 35 WTGs, each with a maximum of six anchors, there will be a maximum of 150 anchors on the seabed (lower than the 180 anchors assumed at the time of the **Offshore Scoping Report** (**Appendix 1.2**). As acknowledged by MSS, evidence from the Ettrick and Blackbird oil and gas decommissioning survey data confirms that seabed scour is likely to be minimal in these deeper waters. Based upon these considerations, the effect is deemed to be **negligible** throughout the O&M phase.

7.7.4.5 Impact O5: Changes to water column mixing by the presence of structures and/or alterations to the near-surface wind speeds in the Windfarm Site.

130. The extent of project infrastructure that is located below the waterline within the Windfarm Site is so limited for each WTG that there will be no measurable impact upon landscape-scale water circulation that could significantly alter how the water column mixes. Furthermore, the number of WTGs is small (35) when compared with other offshore wind farms being developed in North East Scotland (Moray West = 85 WTG; Moray East = 100 WTGs; Beatrice = 84 WTG). The Project will cause no change to the water temperature. Given these findings, the presence of the project infrastructure below the water line will have **no effect** on the regional-scale patterns of seasonal stratification.

131. The effect of wind energy extraction by the WTGs on wind-sea states (generated by near-surface wind speeds) will not be measurable within the Windfarm Site. The principal factor causing seasonal stratification is water temperature rather than metocean processes (including wind-generated waves) and the Project will cause no change to the water temperature. Given these findings, the wind energy extraction by the WTGs will have **no effect** on the regional-scale sea patterns of seasonal stratification.

132. Based on the above findings, there will be **no effects** on the water column, including regional-scale seasonal stratification processes, during the O&M phase.

7.7.5 Potential Impacts during Decommissioning

7.7.5.1 Impact D1: Damage to seabed structure and form

133. Decommissioning impacts on the seabed structure and form will be similar to those experienced during the construction phase. This means there will be **negligible effect**. Upon completion of decommissioning, there will be no notable effect remaining from the Project.

7.7.5.2 Impact D2: Increase in suspended sediment concentration and deposition

134. Decommissioning impacts upon suspended sediment concentrations will be similar to those experienced during the construction phase. This means there will be **negligible effect**. Upon completion of decommissioning, there will be no notable effect remaining from the Project.

7.7.5.3 Impact D3: Disturbance of seabed sediments (suspension and deposition) during cable removal

135. Decommissioning impacts upon suspended sediment concentrations will be similar to those experienced during the construction phase. This means there will be **negligible effect** on the geodiversity interest of the MPA. Upon completion of decommissioning, there will be no notable effect remaining from the Project.

7.8 Cumulative Impacts

136. The impacts from the Project alone (within the 12 nm inshore Study Area, unless otherwise stated) are listed in **Table 7.12** and assessed for their potential to act cumulatively with other projects. No impacts have the potential to cause cumulative effects in association with other projects.

Table 7.12. Potential Cumulative Impacts

Impact	Potential for cumulative impact	Data confidence	Rationale
C1: Damage to seabed structure and form	No	High	Negligible impacts arising from the Project alone, so no potential for significant cumulative effects with other projects.
C2: Increase in suspended sediment concentrations and deposition	No	High	
C3: Disturbance of seabed sediments during cable installation	No	High	
O1: Rock deposit or concrete mattress footprint on seabed	No	High	
O2: Effect of rock deposits or concrete mattresses on wave, tidal and sediment regime	No	High	Negligible impacts arising from the Project alone, so no potential for significant cumulative effects with other projects.
O3: Disturbance of seabed sediments due to catenary action of mooring lines in Windfarm Site	No	High	
O4: Disturbance of seabed sediments due to scour around the foundations of the mooring anchors in Windfarm Site	No	High	
O5: Changes to water column mixing by the presence of structures and/or alterations to the near-surface wind speeds in Windfarm Site	No	High	
D1: Damage to seabed structure and form	No	High	Negligible impacts arising from the Project alone, so no potential for significant cumulative effects with other projects.
D2: Increase in suspended sediment concentration and deposition	No	High	
D3: Disturbance of seabed sediments (suspension and deposition) during cable removal	No	High	

7.9 Transboundary Impacts

137. No transboundary impacts have been identified in relation to marine geology, oceanography and physical processes.

7.10 Inter-relationships

138. Some of the impacts assessed within this chapter have the potential to manifest as effects not only on morphological receptors (assessed within this chapter) but on other receptors assessed in other chapters. **Table 7.13** presents a cross-referencing to related chapters where potential for such effects arise.

Table 7.13. Chapter Topic Inter-Relationships

Topic and description	Related Chapter	Where addressed in this Chapter
Damage to seabed structure and form during construction	**Chapter 9: Benthic Ecology**	**Section 7.7.3.1**
Increase in suspended sediment concentration during construction	**Chapter 8: Marine Sediment and Water Quality**	**Section 7.7.3.2**
	Chapter 14: Shipping and Navigation	
Rock deposits or concrete mattresses footprint on seabed during operation	**Chapter 9: Benthic Ecology**	**Section 7.7.4.1**
Effect of rock deposits or concrete mattresses on tide, wave and sediment regime	**Chapter 9: Benthic Ecology**	**Section 7.7.4.2**
Damage to seabed structure and form during decommissioning	**Chapter 9: Benthic Ecology**	**Section 7.7.5.1**
Increase in suspended sediment concentration during decommissioning	**Chapter 8: Marine Sediment and Water Quality**	**Section 7.7.5.2**
	Chapter 14: Shipping and Navigation	
Disturbance of seabed sediments (suspension and deposition) due to cable installation or removal during construction and decommissioning phases.	**Chapter 9: Benthic Ecology**	**Sections 7.7.3.3 and 7.7.4.3**
	Chapter 8: Marine Sediment and Water Quality	**Sections 7.7.3.3 and 7.7.4.3**
Scour effects due to foundation anchors and mooring lines	**Chapter 8: Marine Sediment and Water Quality**	**Section 7.7.4.4**
	Chapter 9: Benthic Ecology	**Section 7.7.4.4**
Change to water column mixing by the presence of structures and/or alterations to the near-surface wind speeds.	**Chapter 8: Marine Sediment and Water Quality**	**Section 7.7.4.5**
	Chapter 9: Benthic Ecology	**Section 7.7.4.5**
	Chapter 11: Marine Mammal Ecology	**Section 7.7.4.5**

7.11 Summary

139. Following recommendations of the **Scoping Opinion** (**Appendix 1.1**), and in line with the representations received from statutory and non-statutory consultees, an assessment of the significance of the effects arising from the Project upon baseline marine geology, oceanography and physical processes has been completed along the Offshore Export Cable Corridor within 12 nm of shore.

140. This assessment (summarised in **Table 7.14**) concludes mostly no impacts which will result in negligible effect upon identified morphological receptors.

141. The CIA concludes that there are no cumulative impacts in relation to marine geology, oceanography and physical processes between the Project and other activities. Nor have any transboundary impacts been identified in relation to marine geology, oceanography and physical processes.

Table 7.14. Potential Impacts Identified for Marine Geology, Oceanography and Physical Processes

Potential Impact	Receptor	Value/ Sensitivity	Magnitude of Impact	Significance of Effect	Mitigation	Residual Effect
Construction						
C1: Damage to seabed structure and form	Seabed (seaward of HDD option exit point to 12 nm limit)	Negligible	Negligible	Negligible adverse	None required	Negligible adverse – not significant
C2: Increase in suspended sediment concentration and deposition	Seabed (seaward of HDD option exit point to 12 nm limit)	Negligible	Negligible	Negligible adverse	None required	Negligible adverse – not significant
C3 - Disturbance of seabed sediments during cable installation	Seabed	Negligible	Negligible	Negligible adverse	None required	Negligible adverse – not significant
Operation & Maintenance						
O1: Rock deposit or concrete mattress footprint on seabed	Seabed (seaward HDD exit point to 12 nm limit)	Negligible	Low	Negligible adverse	None required	Negligible adverse – not significant
O2: Effect of rock deposits or concrete mattresses on wave, tidal and sediment regime	Seabed (seaward of HDD option exit point to 12 nm limit)	Negligible	Negligible	Negligible adverse	None required	Negligible adverse – not significant
O3 - Disturbance of seabed sediments due to catenary action of mooring lines in Windfarm Site	Seabed (Windfarm Site)	Negligible	Negligible	Negligible adverse	None required	Negligible – not significant
O4 - Disturbance of seabed sediments due to scour around the foundations of the mooring anchors in Windfarm Site	Seabed (Windfarm Site)	Negligible	Negligible	Negligible adverse	None required	Negligible adverse – not significant
O5 - Changes to water column mixing by the presence of structures and/or alterations to the near-surface wind speeds in Windfarm Site	Water column	No impact				

Potential Impact	Receptor	Value/ Sensitivity	Magnitude of Impact	Significance of Effect	Mitigation	Residual Effect
Decommissioning						
D1: Damage to seabed structure and form	Seabed (seaward of HDD option exit point to 12 nm limit)	Negligible	Negligible	Negligible adverse	None required	Negligible adverse – not significant
D2: Increase in suspended sediment concentration and deposition	Seabed (seaward of HDD option exit point to 12 nm limit)	Negligible	Negligible	Negligible adverse	None required	Negligible adverse – not significant
D3 - Disturbance of seabed sediments (suspension and deposition) during cable removal	Seabed	Negligible	Negligible	Negligible adverse	None required	Negligible adverse – not significant
Cumulative						
None identified						
Transboundary						
None identified						

References

APEM (2022). Green Volt Benthic Analyses. APEM Scientific Report P000008889. Floatation Energy Plc, 17 June 2022, v1.0 Draft, 19 pp.

Carbon Trust (2020) *Guidance for geophysical surveying for* Unexploded Ordnance (*UXO) and boulders supporting cable installation.* Offshore Wind Accelerator Report, April 2020.

Cefas (2011). *Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects*. Cefas contract report: ME5403 – Module 15.

BERR (2008) *Review of cabling techniques and environmental effects applicable to the offshore wind farm industry*. Technical Report, January 2008.

Fitton, J.M., Rennie, A.F. and Hansom, J.D. (2017) *Dynamic Coast - National Coastal Change Assessment: Cell 2 - Fife Ness to Cairnbulg Point*, CRW2014/2.

Genesis (2016) Ettrick and Blackbird Decommissioning EIA Completion of ESIA for Blackbird and Ettrick Decommissioning Programme. J73319B-Y-RT-24006/D3 Genesis 2016

Hansom, J.D. (2022) *Bullers of Buchan*.

Hydrofix Ltd (2022) *Green Volt Export Route EIA Data Acquisition Survey Report*. Doc no H22023-REP-001. April 2022

NorthConnect KS (2018) *NorthConnect HVDC Cable Infrastructure Environmental Impact Assessment Report. Volume 2: Main Assessment*. July 2018.

Ramsay, D. L. and Brampton, A. H. (2000) *Coastal Cells of Scotland: Cell 2 – Fife Ness to Cairnbulg Point*. Research, Surveying & Monitoring Report to Scottish Natural Heritage.

Royal HaskoningDHV (2021) *Green Volt Offshore Windfarm - Offshore Environmental Impact Assessment: Offshore Scoping Report*. Report to Flotation Energy, November 2021.

RPS Group (2019) *Review of cable installation, protection, mitigation and habitat recoverability*. Report to The Crown Estate, November 2019.

Scottish Government (2014a). *Scotland's Third National Planning Framework*. Available at: 1. Our spatial strategy - National Planning Framework 3 - gov.scot (www.gov.scot). Accessed November 2022.

Scottish Government (2014b). *Scottish Planning Policy*. Available at: Scottish Planning Policy (SPP) - Scottish planning policy - gov.scot (www.gov.scot) Accessed November 2022

Scottish Government (2015) *Scotland's National Marine Plan*. Available at: https://www.gov.scot/publications/scotlands-national-marine-plan/. Accessed March 2022.

van Leeuwen, S., Tett, P., Mills, D., & van der Molen, J. (2015). Stratified and non-stratified areas in the North Sea: Long-term variability and biological and policy implications. *Journal of Geophysical Research-Oceans*, *120*(7), 4670-4686. https://doi.org/10.1002/2014JC010485. Accessed November 2022.

This page is intentionally blank