Caithness – Moray HVDC Link - Controlled Flow Excavation / Rock Placement Marine Protected Areas Assessment

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1. Introduction

This Marine Protected Area (MPA) assessment is provided as an Appendix to an Environmental Assessment (EA) report (MarineSpace, 2019) that focuses on the potential environmental impacts that may arise from Controlled Flow Excavation (CFE) and / or rock placement works on the Caithness-Moray (C-M) HVDC cable, along with the use of a Cable Protection System (CPS) for a short inshore section of the cable and the creation and presence of a rock berm (also at an inshore location). These works are additional to those assessed in the original Environmental Impact Assessment (EIA) for the project (SHET, 2009). The exact scope of additional work relevant to this report is cable burial via CFE and / or rock placement, the use of small length of CPS and creation of a rock berm to cover and / or protect the existing cable. At the time of writing, the exact amount and location of these works is variable, on a sliding scale between 100% CFE and 100% rock placement (including the use of a CPS), plus the seabed footprint of a rock berm. The EA (and this MPA Assessment) will assess both 100% CFE and 100% rock placement (including the use of a CPS), plus the seabed footprint of a rock berm, to allow flexibility between scopes, depending on exact ground conditions, and operational constraints, along the length of the cable trench.

1.1. Status of the C-M Project

As of December 2018, much of the cable is now buried. However, areas also remain where the Depth of Cover (DoC) does not meet required specification. Therefore, additional methods for burial of currently exposed cable lengths are required. The additional methods proposed are:

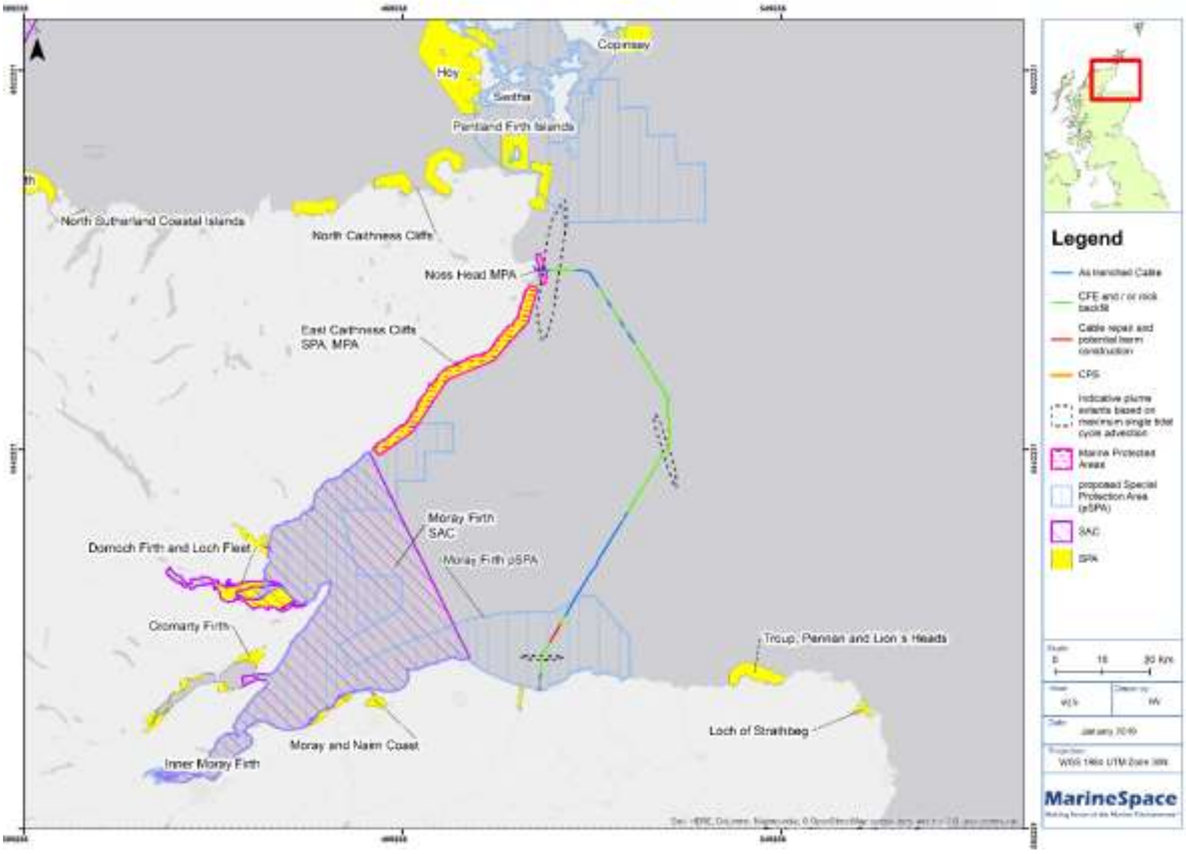
- Controlled Flow Excavation (CFE); and
- Rock placement via Fall Pipe Vessel and / or shallow water grab placement;
- Remedial rock placement associated with cable repair; and
- Cable Protection System (CPS) installed via divers and airlift.

Descriptions of these techniques, along with quantified parameters for impact assessment, are presented in Section 2 of the main EA report. Table 1.1 presents the parametrisation of the effect envelopes (footprints) associated with the proposed works and the locations are shown in Figure 1.1.

In overview, further backfilling is required to the route where the depth of cover (DoC) of the cable is less than 0.6 m. The planned primary method of backfill of the main route is to use CFE. The CFE will aim to re-mobilise existing sediment berms either side of the cable trench that were created via the initial cable installation works. Where CFE does not achieve backfill to the required DoC, rock will be placed in the cable trench, restoring the seabed to close to Mean Seabed Level (MSBL), or as close to MSBL as reasonably practicable.

In addition, along a short length of the cable between Kilometre Point (KP) 10.90 and KP 14.95, where cable repair works are planned, remedial rock placement may be undertaken. Some of this rock placement may involve the creation of a rock berm, where rock will extend above MSBL. While only sections of the cable repair corridor (between approximately KP 11 and KP 15) are likely to undergo rock placement above MSBL, in order to overestimate the potential effects associated with the operations, and thus provide a conservative assessment of the potential impacts, the assessment will be based on the entire length of the repair corridor (approximately 4.5 km) being subject to the construction of a berm with a maximum seabed footprint (i.e. width) of 6 m. The maximum potential height of the berm, above MSBL, is 1.7 m.

Figure 1.1: Location of proposed works in associated with Marine Protected Areas in the Assessment Area



Note the CPS effect footprint is assessed within (as part of) the rock placement footprint for temporary habitat disturbance and within (as part of) the use of CFE for sand advection and plume dispersal and settlement envelopes.

Further, in areas where rock placement in shallow water cannot be undertaken, a short section of the cable between KP 1.5 and KP 2.0 will require the use of a CPS such as cast-iron shells. These cast-iron shells have a diameter of 326 mm and are composed of articulated sections. The sections of CPS will be lowered into place using airlift and then locked or bolted together over the cable by divers. Some localised trenching may be required to allow the CPS to be attached to the cable.

The CPS protected cable has a smaller effect footprint, in terms of temporary seabed disturbance than for rock placement. To ensure a robust and conservative consideration of the potential impacts, this assessment includes the CPS deployment within the parameterisation of effect envelopes applied for rock placement i.e. the assessment uses the larger seabed disturbance footprint and pressure envelope associated with rock placement, rather than the smaller footprint associated with the use of the CPS at KP 1.5-2.0 alone.

In addition, any excavation associated with CPS will have a smaller effect footprint, in terms of sediment advection, than for CFE. In order, therefore, to provide a conservative assessment of this effect, the assessment will utilise the worst case sand advection envelope associated with CFE

(200 m either side of the works), and the maximum fine sediment (<63 µm) advection associated with a plume generated at the southern part of the cable (4.5 km tide-parallel of the works) i.e. the assessment uses the larger sediment advection and fine sediment plume footprints and pressure envelopes associated with CFE, rather than the smaller footprints associated with the use of the CPS at KP 1.5-2.0 alone.

1.2. Context of Marine Protected Areas Assessment

Only information directly relevant to an assessment of effects associated with CFE and / or rock placement, deployment of CPS, creation and presence of a rock berm and attendant activities, on MPAs (European marine sites (EMSs)[1] and Scottish Nature Conservation MPAs (NCMPAs)) is presented.

The following information has been used to inform the MPA assessment:

- The Moray Firth HVDC interconnector Environmental Statement (ES) (SSE, 2011);
- The Marine licences associated with the rock armouring of the cable and review of licensing issues (MarineSpace, 2017a);
- Recent work to assess the revised amount of rock placement required for the C-M project (Tideway Ltd, 2017);
- The Environmental Appraisal of the rock armour remediation works (MarineSpace, 2017b);
- The updated MPAs assessment (MarineSpace, 2017c); and
- The repair and rock placement Environmental Appraisal report and specifically the revised MPAs assessment Appendix A (MarineSpace, 2018); and
- The CFE / rock placement Environmental Appraisal to which this MPAs assessment is appended (MarineSpace, 2019).

The MPAs assessment is set within the context of the parameters presented in Table 1.1, and with pressures (effects) associated with the Scope of Works (SoW). Interactions with the Moray Firth pSPA are specifically detailed as there is a spatial overlap between the use of CFE and / or rock placement, and installation of CPS and the construction and presence of a rock berm.

Table 1.1: Effect assessment parameters (Adapted from MarineSpace, 2019)

Parameter	Maximum	Notes
A: Temporary seabed disturbance CFE		
Maximum width of (temporary) seabed disturbance	30 m	Maximum width of seabed disturbance created by CFE operation, including possible production of secondary trench

[1] Special Areas of Conservation (SAC), Special Protection Areas (SPAs) and potential SPAs (pSPAs), and Ramsar sites.

Parameter	Maximum	Notes
Maximum length of (temporary) seabed disturbance	35,000 m	Maximum length of seabed disturbance via CFE
Maximum length of (temporary) seabed disturbance within Moray Firth pSPA	8,000 m	Maximum length of seabed disturbance via CFE
A: Maximum footprint of (temporary) seabed disturbance	**1.05 km^2**	30 m width x 35,000 m length. This footprint of seabed would experience temporary disturbance via CFE operations
Maximum footprint of (temporary) seabed disturbance within Moray Firth pSPA	**0.24 km^2**	30 m width x 8,000 m length. This footprint of seabed would experience temporary disturbance via CFE operations
B: Temporary seabed disturbance rock placement (and CPS)		
Maximum width of (temporary) seabed disturbance	6 m	Maximum width of seabed disturbance created by rock placement (includes areas where rock placement cannot be undertaken, and CPS is instead deployed). CPS has a smaller effect footprint, in terms of further temporary seabed disturbance than rock placement; however, in order to provide a conservative assessment this appraisal uses the larger seabed footprint and pressure envelope associated with rock placement, rather than the smaller footprint associated with the use of the CPS alone
Maximum length of (temporary) seabed disturbance	35,000 m	Maximum length of seabed disturbance via rock placement (includes areas where rock placement cannot be undertaken and CPS is instead deployed). CPS has a smaller effect footprint, in terms of further temporary seabed disturbance than rock placement however in order to provide a conservative assessment this appraisal uses the larger seabed footprint and pressure envelope associated with rock placement, rather than the smaller footprint associated with the use of the CPS alone.
Maximum length of (temporary) seabed disturbance within Moray Firth pSPA	8,400 m	8,000 m of rock placement + 400 m of CPS. Maximum length of seabed disturbance via rock placement (includes areas where rock placement cannot be undertaken and CPS is instead deployed). CPS has a smaller effect footprint, in terms of further temporary seabed disturbance than rock placement however in order to provide a conservative assessment this appraisal uses the larger seabed footprint and pressure envelope associated with rock placement, rather than the smaller footprint associated with the use of the CPS alone.
B: Maximum footprint of (temporary) seabed disturbance	**0.21 km^2**	6 m width x 35,000 m length. This footprint of seabed would experience temporary disturbance via rock placement (includes areas where rock placement cannot be undertaken and CPS is instead deployed). CPS has a smaller effect footprint, in terms of further temporary seabed disturbance than rock placement however in order to provide a conservative assessment this appraisal uses the larger seabed footprint and pressure

Parameter	Maximum	Notes
		envelope associated with rock placement, rather than the smaller footprint associated with the use of the CPS alone
Maximum footprint of (temporary) seabed disturbance within Moray Firth pSPA	**0.05 km²**	6 m width x 8,400 m length. This footprint of seabed would experience temporary disturbance via rock placement (includes areas where rock placement cannot be undertaken and CPS is instead deployed). CPS has a smaller effect footprint, in terms of further temporary seabed disturbance than rock placement however in order to provide a conservative assessment this appraisal uses the larger seabed footprint and pressure envelope associated with rock placement, rather than the smaller footprint associated with the use of the CPS alone
C: Temporary seabed disturbance construction of rock berm		
Maximum width of (temporary) seabed disturbance	0 m	The rock for berm construction is precisely placed by Fall Pipe Vessel. There is no subsequent movement of the rock after placement, therefore there is no additional width of temporary seabed disturbance outside the berm location
Maximum length of seabed disturbance	0 m	No temporary seabed disturbance outside the berm location
C: Maximum footprint of (temporary) seabed disturbance	**N/A**	No temporary seabed disturbance outside the berm location
D: Sediment advection CFE (and CPS)		
Maximum cross-tidal[2] distance of sand plume advection	400 m	Maximum cross-tidal distance of sand plume advection (200 m either side of the cable) - settling occurs within 20 s CPS has a smaller effect footprint, in terms of sand advection than CFE, however in order to provide a conservative assessment this appraisal uses the larger sand advection footprint and pressure envelope associated with CFE, rather than the smaller footprint associated with the use of the CPS alone.
Maximum length of (temporary) seabed disturbance	35,000 m	Maximum length of seabed disturbance via CFE and CPS
Maximum length of (temporary) seabed disturbance within Moray Firth pSPA	8,400 m	8,000 m of rock placement + 400 m of CPS. Maximum length of seabed disturbance via CFE and CPS within Moray Firth pSPA
D: Maximum footprint of sand advection CFE and CPS	**14.0 km²**	400 m cross-tidal width x 35,000 m length. This footprint of seabed would experience temporary disturbance via advection of sand by CFE and CPS

[2] Cross-tidal = perpendicular to the main ebb / flood tide water flow i.e. at right angle to the tidal flow

Parameter	Maximum	Notes
Maximum footprint of sand advection CFE and CPS within Moray Firth pSPA	**3.36 km²**	400 m cross-tidal width x 8,400 m length. This footprint of seabed would experience temporary disturbance via advection of sand by CFE and CPS
Maximum tide-parallel[3] distance of fine sediment (<63 µm) advection – north cable route site (CFE)	30,000 m	Maximum tide-parallel distance of fine sediment (<63 µm) advection (tide-parallel 15 km either side of the cable). This value is only applicable in the northern part of cable route. Maximum fine sediment advection distances are lower in the central and southern parts of the cable route because of differing tidal conditions. It should also be noted that this is a highly conservative metric and would require CFE to be in operation at a single site in the north of the cable route for an entire tidal cycle. This is an extremely unrealistic scenario; however, the metric is presented as an absolute worst case. It should also be noted that CFE will not simultaneously occur everywhere along the 35 km assessed length of works
Maximum tide-parallel distance of fine sediment (<63 µm) advection – south cable route site (CPS)	9,000 m	Maximum tide-parallel distance of fine sediment (<63 µm) advection (tide-parallel 4.5 km either side of the cable). This value is only applicable in the southern part of cable route where CPS will be undertaken.
Maximum tide-parallel distance of fine sediment (<63 µm) advection – south cable route site (CPS) within Moray Firth pSPA	9,000 m	Maximum tide-parallel distance of fine sediment (<63 µm) advection (tide-parallel 4.5 km either side of the cable)
Typical thickness of deposition following settlement of fine sediment (<63 µm) plume	<1 mm	Thickness of deposited fine sediment (<63 µm) away from the immediate vicinity of the CFE and CPS operations
E: Sediment advection rock placement		
Maximum distance of sand plume advection	0 m	Rock is precisely placed using a Fall Pipe Vessel which allows placement without generating uncontrolled high flow rates at the discharge end of Fall Pipe. There is, therefore, no significant sand resuspension and advection predicted with the rock placement.
Maximum length of (temporary) seabed disturbance	35,000 m	Worst case scenario – 100% of the remaining trench to be filled via rock placement
E: Maximum footprint of sand advection	**0 m²**	There is no significant sand advection predicted with rock placement.
Maximum distance of fine sediment (<63 µm) advection	0 m	There is no significant fine sediment (<63 µm) advection predicted with rock placement

[3] Tide-parallel = in the direction of the main ebb / flood water flow

Parameter	Maximum	Notes
Typical thickness of deposition following settling of fine sediment (<63 µm) plume	N/A	There is no significant fine sediment (<63 µm) advection predicted with rock placement
F: Sediment advection construction of rock berm		
Maximum distance of sand plume advection	0 m	Rock to create the berm is precisely placed using a Fall Pipe Vessel which allows placement without generating uncontrolled high flow rates at the discharge end of Fall Pipe There is, therefore, no significant sand resuspension and advection predicted with the rock placement
Maximum length of seabed disturbance	4,500 m	Worst case scenario – rock berm will potentially be constructed between KP 10.9 and KP 14.95. In order to provide a conservative assessment of the potential impacts, this appraisal will be based on a 4.5 km length of rock berm
F: Maximum footprint of sand advection	**0 m²**	There is no significant sand advection predicted with rock placement
Maximum distance of fine sediment (<63 µm) advection	0 m	There is no significant fine sediment (<63 µm) advection predicted with rock placement (see above)
Typical thickness of deposition following settling of fine sediment (<63 µm) plume	N/A	There is no significant fine sediment (<63 µm) advection predicted with rock placement
G: Seabed sediment alteration CFE		
Maximum width of (temporary) seabed sediment alteration	30 m	CFE redistributes the majority of the current seabed material in berms back into the cable trench. There may, however, be some preferential sorting, with larger particles deposited closer to the site of operation and finer particles travelling further. This is temporary, and natural seabed sediment transport processes will continue post-operation with relatively strong tide-driven currents or wave action transporting the surface seabed layers and restoring the natural composition
Maximum length of (temporary) seabed alteration	35,000 m	Maximum length of seabed alteration via CFE operation
Maximum length of (temporary) seabed alteration within Moray Firth pSPA	8,000 m	Maximum length of seabed alteration via CFE operation within boundary of the Moray Firth pSPA
G: Maximum footprint of (temporary) seabed alteration	**1.05 km²**	30 m width by 35,000 m length. There may be some temporary preferential sorting as a result of CFE operations.
Maximum footprint of (temporary) seabed alteration within Moray Firth pSPA	**0.24 km²**	30 m width by 8,000 m length. There may be some temporary preferential sorting as a result of CFE operations.
H: Seabed sediment alteration rock placement (and CPS)		
Maximum cable trench width (at seabed surface) for rock placement	6 m	Width of trench that will be filled during rock placement (includes areas where rock placement cannot be undertaken and CPS is instead deployed). CPS has a smaller effect footprint, in terms of further seabed sediment alteration than rock placement; however.

Parameter	Maximum	Notes
		in order to provide a conservative assessment this appraisal uses the larger seabed footprint and pressure envelope associated with rock placement, rather than the smaller footprint associated with the use of the CPS alone.
Maximum length of (temporary) seabed alteration	35,000 m	Worst case scenario – 100% of the remaining trench to be filled via rock placement (includes areas where rock placement cannot be undertaken and CPS is instead deployed). CPS has a smaller effect footprint, in terms of further seabed sediment alteration than rock placement; however, in order to provide a conservative assessment this appraisal uses the larger seabed footprint and pressure envelope associated with rock placement, rather than the smaller footprint associated with the use of the CPS alone.
Maximum length of (temporary) seabed alteration within Moray Firth pSPA	8,400 m	Assuming 8,000 m length of possible rock placement + 400 m length of CPS.
F: Maximum footprint of (temporary) seabed alteration	**0.21 km²**	6 m width of trench x 35,000 m trench length. This footprint of seabed would experience temporary alteration via rock placement (includes areas where rock placement cannot be undertaken and CPS is instead deployed). CPS has a smaller effect footprint, in terms of further seabed sediment alteration than rock placement; however, in order to provide a conservative assessment this appraisal uses the larger seabed footprint and pressure envelope associated with rock placement, rather than the smaller footprint associated with the use of the CPS alone.
Maximum footprint of (temporary) seabed alteration within Moray Firth pSPA	**0.05 km²**	6 m width of trench x 8,4000 m trench length. This footprint of seabed would experience temporary alteration via rock placement (includes areas where rock placement cannot be undertaken and CPS is instead deployed).
I: Permanent seabed sediment alteration construction of rock berm (occurs entirely within the Moray Firth pSPA)		
Maximum berm width (at seabed surface) after rock placement	6 m	Width of rock berm, at seabed surface, after rock has been placed
Height of rock berm after rock placement	1.7 m	Maximum height of rock berm above mean sea bed level following placement of suitable rock material
Maximum length of seabed disturbance within Moray Firth pSPA	4,500 m	Rock berm will potentially be constructed between KP 10.9 and KP 14.95. In order to provide a conservative assessment of the potential impacts, this appraisal will be based on a 4.5 km length of rock berm
I: Maximum footprint of permanent seabed alteration after berm construction within Moray Firth pSPA	**0.027 km²**	6 m width of berm x 4.5 km of berm length. This footprint of seabed would experience permanent alteration via rock placement
J: Timing of proposed works		
J: Period that proposed works will occur	**01 April-31 August 2019**	The proposed works will not occur outside of these dates

1.3. Scope of the Marine Protected Areas Assessment

Use is made of detailed evidence-based information to inform the appropriate assessment of MPAs within the area of influence of the pressures (effects) associated with the proposed CFE and / or rock placement activities (including use of a CPS) and creation and presence of a rock berm. This includes effects on:

- Annex I and domestic NCMPA designated benthic habitats;
- Annex II marine mammals and migratory fish species designated within SACs;
- Annex I bird species populations classified within SPAs and proposed SPAs (pSPAs); and
- Where appropriate, Ramsar sites.

The information identifies pressures and footprints associated with each of the activities and screens the potential exposure of these footprints with MPAs and their designated features within the study area. Where likely significant effects / risks cannot be screened out or are identified, the European site (NCMPA) is screened into appropriate assessment, a detailed assessment is presented and determinations of adverse effects / risks (or where no adverse effect / risk cannot be determined) are detailed.

Where appropriate, mitigation measures are proposed. However, note that this MPA Assessment is now compliant with the Court of Justice of the European Union ruling in respect to Article 6(3) and the *People Over Wind & Sweetman* (Case C-323/17). The ruling states that the consideration of mitigation measures should not be a part of the screening for likely significant effects and that mitigation can only be considered as part of the appropriate assessment.

2. Relevant Environmental Legislation – Habitats Regulations Assessment

2.1. The EC Habitats Directive and UK Regulations

The UK is bound by the articles of the EC Habitats Directive, the Birds Directive and the Convention on Wetlands of International Importance, also known as the Ramsar Convention. The aim of the Habitats Directive is to conserve natural habitats and wild species across Europe by establishing a network of sites known as Natura 2000 sites[4]. Sites of Community Importance (SCI), afforded protection under the 2010 Habitats Regulations (as amended) 61(2), are designated in the UK as Special Areas of Conservation (SACs) and Special Protection Areas (SPAs).

As a matter of policy, the UK Government / devolved administrations also apply the procedures described below to Ramsar sites, possible SACs, candidate SACs and potential SPAs. These sites are generally referred to as European sites or European marine sites where site boundaries exist below Highest Astronomical Tide (HAT).

Under Article 6(3) of the Habitats Directive, for any proposed plan or project, which is not directly connected or necessary to the management of the European marine site, competent authorities should make an initial consideration, in consultation with relevant Statutory Nature Conservation Bodies (SNCBs) (in this case, SNH), to establish whether the plan or project is likely to have a significant effect on the European marine site.

2.2. Overview of the Habitats Regulations Assessment Process

The Habitats Regulations Assessment (HRA) process comprises four main stages as shown in the bullet points below (extracted from Circular 06/2005 produced by the Office of the Deputy Prime Minister (ODPM)). The stages are:

- **Stage 1 Screening**: to identify the likely impacts of a project on a European site and consider whether the impacts are likely to be significant;
- **Stage 2 Appropriate Assessment (AA)**: to determine whether the integrity of the European site will be adversely affected by the project;
- **Stage 3 Assessment of Alternative Solutions**: to establish if there are any that will result in a lesser effect on the European site; and
- **Stage 4 IROPI and Compensatory Measures**: to establish whether it is necessary for the project to proceed despite the effects on the European site, and to confirm that necessary compensatory measures are in place to maintain the coherence of the Natura 2000 network.

[4] For the purpose of this advice note, and as defined under The Conservation of Habitats and Species Regulations 2010, these are referred to as European site(s), or European marine site(s) where the site exists below highest astronomical tide (HAT))

All four stages of the process are referred to collectively as the HRA, to clearly distinguish the whole process from the step within it referred to as the 'Appropriate Assessment'. Stage 3 and Stage 4 (if necessary) will result from the AA, once undertaken by the competent authority.

The approach to this HRA has followed that set out in '*Planning Circular 06/2005 on Biodiversity and Geological Conservation – Statutory obligations and their Impact within the Planning System*' produced by the ODPM. It has also taken account of a range of other guidance material including that produced by the Infrastructure Planning Commission (IPC) (2011)[5] and the European Commission (EC) (2007[6]; 2002[7], 2000[8]).

The protection given by the Habitats Directive is transposed into UK legislation through the 2010 Habitats Regulations (as amended) 61(2)[9] and Regulation 25 of the Offshore Marine Regulations (as amended)[10]. The 2010 Habitats Regulations (as amended) 61(2) (Offshore Regulation 25(2)) require the competent authority, before deciding to authorise a project which is likely to have a significant effect on a European site "*to make an Appropriate Assessment of the implications for that site in view of that site's conservation objectives*"[11].

In accordance with the 2010 Habitats Regulations (as amended) 61(2), anyone applying for consent must provide the competent authority with such information as may reasonably be required "*for the purposes of the assessment*" or "*to enable them to determine whether an Appropriate Assessment is required*"[12].

The HRA process is now compliant with the Court of Justice of the European Union ruling in respect to Article 6(3) and the *People Over Wind & Sweetman* (Case C-323/17). The ruling states that the consideration of mitigation measures should not be a part of the screening for likely significant effects (HRA Stage 1) and that mitigation can only be considered as part of the appropriate assessment (HRA Stage 2).

If a likely significant effect is determined, or no likely significant effect cannot be determined, without the use of mitigation measures, then the European site is screened into appropriate assessment.

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[5] Infrastructure Planning Commission (2011) Habitats Regulations Assessment for Nationally Significant Infrastructure Projects.

[6] European Commission (2007) Guidance Document on Article 6(4) of the Habitats Directive 92/43/EEC.

[7] European Commission (2002) *Assessment of Plans and Projects Significantly Affecting Natura 2000 Sites. Methodological Guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC*.

[8] European Commission (2000) *Managing Natura 2000 Sites - The Provisions of Article 6 of the 'Habitats' Directive 92/43/CEE*.

[9] The Conservation of Habitats and Species Regulations 2010. Statutory Instrument 2010/490.

[10] The Offshore Marine Conservation (Natural Habitats, &c.) Regulations (as amended) 2010. Statutory Instrument 2010/491.

[11] Regulation 61 of the 2010 Habitats Regulations (as amended) and Regulation 25 of the Offshore Marine Regulations.

[12] Regulation 61(2) of the 2010 Habitats Regulations, Regulation, and Regulation 25(2) of the Offshore Marine Regulations.

2.2.1. The Role and Requirements of the Competent Authority

Although the 2010 Habitats Regulations (as amended) 61(2) do not specify the methodology for carrying out an AA, they do specify the obligations of the competent authority, Marine Scotland in this respect, and the applicant. The role of the competent authority is to determine if there are likely significant effects and carry out the AA, if required, before a decision is made. The competent authority (Marine Scotland) is also required to consult with the relevant SNCB, (SNH in this case (and the public, if considered appropriate) before deciding to give consent. Where adverse effects remain, they must undertake further assessments on alternatives and prepare a justification statement for Imperative Reasons of Overriding Public Interest (IROPI).

It is the responsibility of the applicant to include ‘sufficient information’ with the ability to identify the European sites, including European marine sites, and to enable an AA to be undertaken if required. That is the rationale for the information presented in this chapter.

2.3. Domestic Nature Conservation Marine Protected Areas

The Marine and Coastal Access Act 2009 and the Marine (Scotland) Act 2010 require Marine Scotland to exercise its duties and commitments to designate an ecologically coherent network of MPAs. In designating the domestic Nature Conservation MPA (NCMPA) network, Marine Scotland has to have regard to a number of issues set out in the legislation, including the extent to which such designations would contribute to a UK network.

NCMPAs have been identified for a range of marine flora and fauna that are either considered to be rare, representative, and / or threatened and declining within Scottish territorial waters. Since 2013, 31 NCMPAs have been designated.

The rationale for the assessment process of NCMPAs in this report follows the principles of the HRA process related to the published or draft conservation objectives and designated features of any NCMPA screened for likely significant risks (effects); in relation to the pressures associated with the cable installation activities.

3. Activities to be Assessed and Associated Pressures (Effects)

The following activities associated with the CFE and / or rock placement, the use of the CPS and creation and presence of a rock berm are screened and assessed where required:

- Permanent loss (removal) of seabed habitats and change in seabed character associated with presence of a rock berm;
- Temporary disturbance (abrasion) to seabed habitats and change in seabed character via operation of the CFE and rock placement (rock placement includes the presence of the CPS);
- Creation of sediment advection plumes via operation of the CFE and installation of the CPS (increased turbidity);
- Deposition of sediment from plumes to surrounding seabed via operation of the CFE and installation of the CPS (deposition and smothering);
- Creation of secondary trenches in areas where CFE works have been focused (the existing berms either side of the main cable trench) (abrasion);
- Noise from CFE operation and rock placement (rock placement includes the use of the CPS and creation of a rock berm) (disturbance / displacement);
- Noise from vessel movements and operations;
- Visual impact of vessels; and
- Post-work surveys.

The MPAs assessment is set within the context of the scope of works parameters presented in Table 1.1, with pressures (effects) associated with the proposed works activities presented in Table 3.1.

3.1. Sources of Evidence Reviewed to Inform Assessment

The MPA assessment draws directly on other relevant material and documents being produced for the C-M HVDC cable remediation project (including referenced papers and reports presented within these). The most relevant of these are:

- MarineSpace Ltd, 2017a. *Caithness-Moray HVDC Link: Review of Marine Consenting Status and Key Issues.* Version 1.0;
- MarineSpace Ltd, 2017b. *Caithness-Moray HVDC Link: Potential Impacts on Nature Conservation Features*. Version 1.0;
- MarineSpace Ltd, 2017c. *Caithness-Moray HVDC Link: Updated Marine Protected Areas Assessment*. Version 1.1;
- MarineSpace Ltd, 2018. *Caithness-Moray HVDC Link Cable Repair & Rock Placement: Environmental Assessment Report*. Version 1.0;
- MarineSpace Ltd, 2019. *Caithness-Moray HVDC Link Cable Repair & Rock Placement: Environmental Assessment Report*. Version 2.0;
- Moray Offshore Windfarm (West) Limited, 2017. *Moray West Offshore Habitats Regulations Appraisal: HRA Screening Report*. September 2017;

- Natural Power, 2017. *EPS Risk Assessment for Work Proposed in 2018 Caithness to Moray HVDC Project*. Document No. 1156585. Issue A;
- SSE, 2011. *Moray Firth Hub & Caithness HVDC Connection Hub & Subsea Cables Volume 1: Environmental Statement*. Rev 0.0. Report produced by Aquatera Ltd;
- Tideway Ltd, 2017. *Technical Note. TW Doc. No. TW-RP-5462-09400-TR D (Rev B03)*. Issue Date: 02.10.201;
- NKT, 2018: Results from CFE trials undertaken in November 2018;
- Moray Offshore Windfarm (West) Limited, 2017. *Moray West Offshore Habitats Regulations Appraisal: HRA Screening Report*. September 2017;
- SNH (Scottish Natural Heritage), 2014. *Noss Head MPA: Assessment against the MPA selection guidelines*. Scottish MPA Project. Sept 2014 pp 11; and
- Conservation advice packages including conservation objectives and advice on operations for (where available):
    - Dornoch Firth and Morrich More SAC;
    - Moray Firth SAC;
    - Faray and Holm of Faray SAC;
    - Isle of May SAC;
    - Berriedale and Langwell Waters SAC;
    - River Oykel SAC;
    - River Moriston SAC;
    - River Spey SAC;
    - River Borgie SAC;
    - River Naver SAC;
    - River Thurso SAC;
    - River Dee SAC;
    - Dornoch Firth and Loch Fleet SPA;
    - Cromarty Firth SPA;
    - Inner Moray Firth SPA;
    - North Caithness Cliffs SPA;
    - East Caithness Cliffs SPA;
    - Moray and Nairn Coast SPA;
    - Troup, Pennan and Lion's Heads SPA;
    - Loch of Strathbeg SPA;
    - Buchan Ness to Collieston Coast SPA;
    - Pentland Firth pSPA;
    - Moray Firth pSPA;
    - East Caithness Cliffs NCMPA; and
    - Noss Head NCMPA.

Additional sources of literature reviewed included, but were not limited to:

- JNCC (Joint Nature Conservation Committee), 2017. *JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys*. August 2017;
- Nedwell J., Parvin S., Brooker A., and Lambert D., 2008. *Modelling and measurement of underwater noise associated with the proposed Port of Southampton capital dredge and*

redevelopment of berths 201/202 and assessment of the disturbance to salmon. Subacoustech Report No. 805R0444;

- Thaxter C, Lascelles B, Sugar K, Cook A, Roos S, Bolton M, Langston R, and Burton, N, 2012. Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas. *Biological Conservation*. 156.10.1016/j.biocon.2011.12.009;
- Special Committee on Seals (SCOS), 2016. *Scientific Advice on Matters Related to the Management of Seal Populations: 2016*. Pp 169; and
- ABPmer Ltd, 2017. *Race Bank Offshore Wind Farm, Cable burial by mass flow excavator*. ABPmer Report No. R.2810. A report produced by ABPmer for DONG Energy, April 2017.

3.2. Pressures Associated with Proposed CFE and / or Rock Placement Works and CPS and Emplacement and Presence of Rock Berm

Each of the proposed activities has associated pressures and the potential for exposure pathways with sensitive receptors (designated and / or classified features of MPAs). These are presented in Table 3.1.

Table 3.1: Pressures associated with proposed Controlled Flow Excavation and / or rock placement works including Cable Protection Scheme and rock berm

Effect type	Pressures and effects	Pathway
Direct effects	Permanent removal of subtidal habitat and loss of, or damage to, benthic organisms or prey species within the footprint of the rock berm at KP 11-KP 15	✓
	Temporary disturbance / abrasion of subtidal habitat and loss of or damage to benthic organisms or prey species within the footprint of the CFE works (incl. secondary trench either side of main cable trench via CFE works)	✓
	Temporary disturbance / removal of subtidal habitat and loss of, or damage to, benthic organisms or prey species within the footprint of the rock placement works (incl. CPS)	✓
	Death or permanent or temporary injury caused by risk of collision with installation vessels	✓
Indirect effects	Increased turbidity from CFE works and installation of the CPS	✓
	Sediment deposition / smothering from suspended sediment deposition from CFE works and installation of the CPS	✓
	Sediment deposition / smothering from suspended sediment deposition from rock placement	×
	Sediment deposition / smothering from suspended sediment deposition from placement of rock berm	×

Effect type	Pressures and effects	Pathway
	Re-mobilisation of contaminated sediments associated with suspended sediment which could impact on water quality from CFE works and / or rock placement (incl. CPS) and rock berm	×
	Alteration of water flow and hydrological processes from CFE works and / or rock placement (incl. CPS) and rock berm	×
	Disturbance / displacement caused by visual presence of vessels	✓
	Death or permanent or temporary injury caused by propagation of underwater sound (via CFE works / rock placement (incl. CPS) / rock berm placement) to a designated feature	✓
	Death or permanent or temporary injury caused by propagation of underwater sound (via CFE works / rock placement (incl. CPS) / rock berm placement) to prey species	✓
	Disturbance / displacement caused by propagation of underwater sound (via CFE works / rock placement (incl. CPS) / rock berm placement) to a designated feature	✓
	Disturbance / displacement caused by propagation of underwater sound (via CFE works / rock placement (incl. CPS) / rock berm placement) to prey species	✓

Table 3.1 presents all pressures associated with CFE and / or rock placement works, CPS, and the rock berm at KP 11-KP 15 on the seabed. '×' indicates those pressures which are not relevant to habitats in which the C-M activities are being conducted, or where the activity has previously been assessed in the original ES (SSE, 2011), and the most recent MPA assessment (MarineSpace, 2018), and which were considered to not be significant, and where the variation in CFE and / or rock placement works, CPS and the rock berm at KP 11-KP 15 will not result in any change to those assessments (e.g. alteration of water flow and hydrological processes).

The scale of the proposed CFE and / or rock placement works, CPS and the rock berm at KP 11-KP 15, and the associated magnitude of effects are so small in comparison with the original assessment envelope (SSE, 2011) and the additional cable protection works (MarineSpace, 2017c); and are located on recently impacted seabed, that the following pressures are screened out of further assessment:

- Re-mobilisation of contaminated sediments associated with suspended sediment which could impact on water quality; and
- Alteration of water flow and hydrological processes.

All other pressures are considered in the screening for likely significant effects / risks process.

4. Screening of Marine Protected Areas

4.1. Screening Rationale

The rationale for screening exposure to pressure pathways and assessing any Likely Significant Effects (or Risks for the NCMPAs) is presented in Table 4.1.

Table 4.1: Screening rationale for identification of Marine Protected Areas

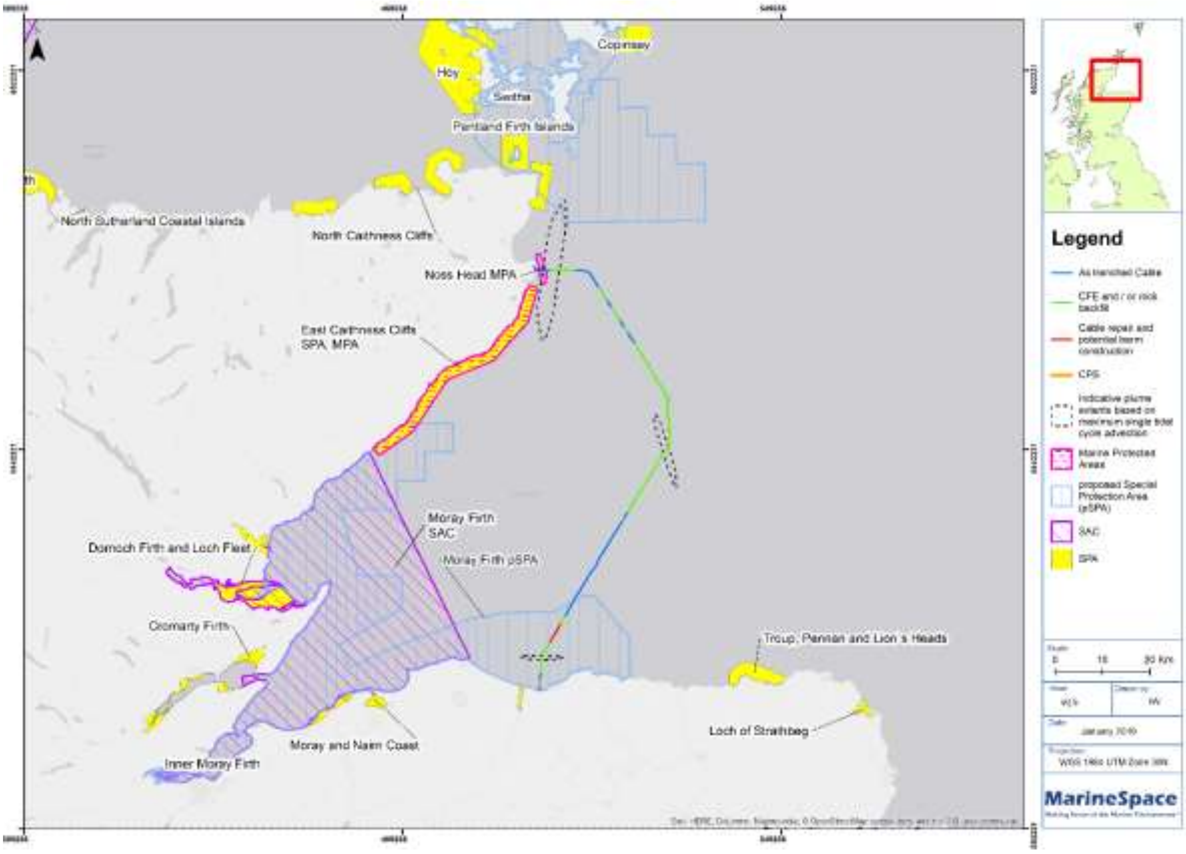
Rationale for MPA identification	Pressures	Rationale for exposure
MPA overlaps the cable route	Permanent removal of subtidal habitat and loss of, or damage to, benthic organisms or prey species within the footprint of the rock berm at KP 11-KP 15	Physical overlap between activity boundary and designated site
	Temporary disturbance / abrasion to subtidal habitat and loss of benthic organisms or prey species within the footprint of the CFE works and CPS	Physical overlap between activity boundary and designated site
	Temporary disturbance / removal of subtidal habitat and loss of benthic organisms or prey species within the footprint of the rock placement works and CPS	Physical overlap between activity boundary and designated site
	Production of a secondary trench either side of main cable trench via CFE works	Physical overlap between activity boundary and designated site
	Death, or permanent or temporary injury, to marine mammals caused by risk of collision with installation vessels	Physical overlap between activity boundary and designated site
	Disturbance / displacement (of birds) caused by visual presence of vessels	Physical overlap between activity boundary and designated site
MPA with qualifying features whose mean maximum foraging or migratory range overlaps the cable route	Increased turbidity from CFE works and CPS installation	Birds – based on Thaxter *et al.* (2012) foraging ranges Seals – based on SCOS (2016) foraging ranges from haul out

Rationale for MPA identification	Pressures	Rationale for exposure
		sites Cetaceans and migratory fish – based upon known migration routes
	Sediment deposition / smothering from suspended sediment deposition from CFE works and CPS installation	Birds – based on Thaxter *et al.* (2012) foraging ranges Seals – based on SCOS (2016) foraging ranges from haul out sites Cetaceans and migratory fish – based upon known migration routes
MPA with mobile populations of designated features (Annex II marine mammals or migratory fish) that may be exposed to auditory injury (Death or Permanent Threshold Shift (PTS) or Temporary Threshold Shift (TTS))	Death, or permanent or temporary injury, caused by propagation of underwater sound to a designated feature or prey species	Based on hearing thresholds identified in Natural Power (2017) and project-specific underwater noise modelling
MPA with mobile populations of designated features (Annex II marine mammals or migratory fish) that may display behavioural changes	Disturbance / displacement caused by propagation of underwater sound to a designated feature or prey species	Based on determinations in Natural Power (2017)
MPA with mobile populations of designated features (Annex II marine mammals) that may be at risk from collision with vessels	Death or permanent or temporary injury caused by collision with vessels	Based on determinations in Natural Power (2017)

In addition to applying the rationale presented in Table 4.1, the MPA assessment from the ES (SSE, 2011) also identifies a suite of MPAs that should be considered for screening.

The Moray West Offshore Wind Farm HRA screening report has also been referenced to develop the long-list of MPAs to be screened (Moray Offshore Windfarm (West) Ltd, 2017). The suite of MPAs to be screened for MPA assessment is presented in Figure 4.1.

Figure 4.1: The suite of European Marine Sites and Nature Conservation Marine Protected Areas within the Assessment Area



Note that relevant Ramsar Sites are mapped to the same boundaries as: Dornoch Firth and Loch Fleet SPA; Cromarty Firth SPA; and Inner Moray Firth SPA.
The CPS effect footprint is assessed within / as part of the rock placement footprint for habitat disturbance and within / as part of the CFE sediment advection and plume dispersion and settlement footprint for installation.

The full suite of MPAs screened for likely significant effects / risks are:

- Dornoch Firth and Morrich More SAC;
- Moray Firth SAC;
- Faray and Holm of Faray SAC;
- Isle of May SAC;
- Berriedale and Langwell Waters SAC;
- River Oykel SAC;
- River Moriston SAC;
- River Spey SAC;
- River Borgie SAC;
- River Naver SAC;
- River Thurso SAC;
- River Dee SAC;
- Dornoch Firth and Loch Fleet SPA;
- Cromarty Firth SPA;

- Inner Moray Firth SPA;
- North Caithness Cliffs SPA;
- East Caithness Cliffs SPA;
- Moray and Nairn Coast SPA;
- Troup, Pennan and Lion's Heads SPA;
- Loch of Strathbeg SPA;
- Buchan Ness to Collieston Coast SPA;
- Pentland Firth pSPA;
- Moray Firth pSPA;
- East Caithness Cliffs NCMPA; and
- Noss Head NCMPA.

4.2. Exposure Pathways and Connectivity

Exposure pathways to MPAs and designated / qualifying features are used to determine if there is connectivity between the features of an MPA with the pressures. Where there is no connectivity the feature / MPA is screened out of assessment i.e. no Likely Significant Effect / Risk is determined. Where there is connectivity the MPA will be screened for a determination of Likely Significant Effect / Risk. Figure 4.1, 4.2 and 4.3 show the locations of the proposed CFE and / or rock placement, the use of the CPS and creation and presence of a rock berm.

Figure 4.2: Area of proposed works at the northern part of the cable close to the Pentland Firth potential Special Protection Area and Noss Head Nature Conservation Marine Protected Area

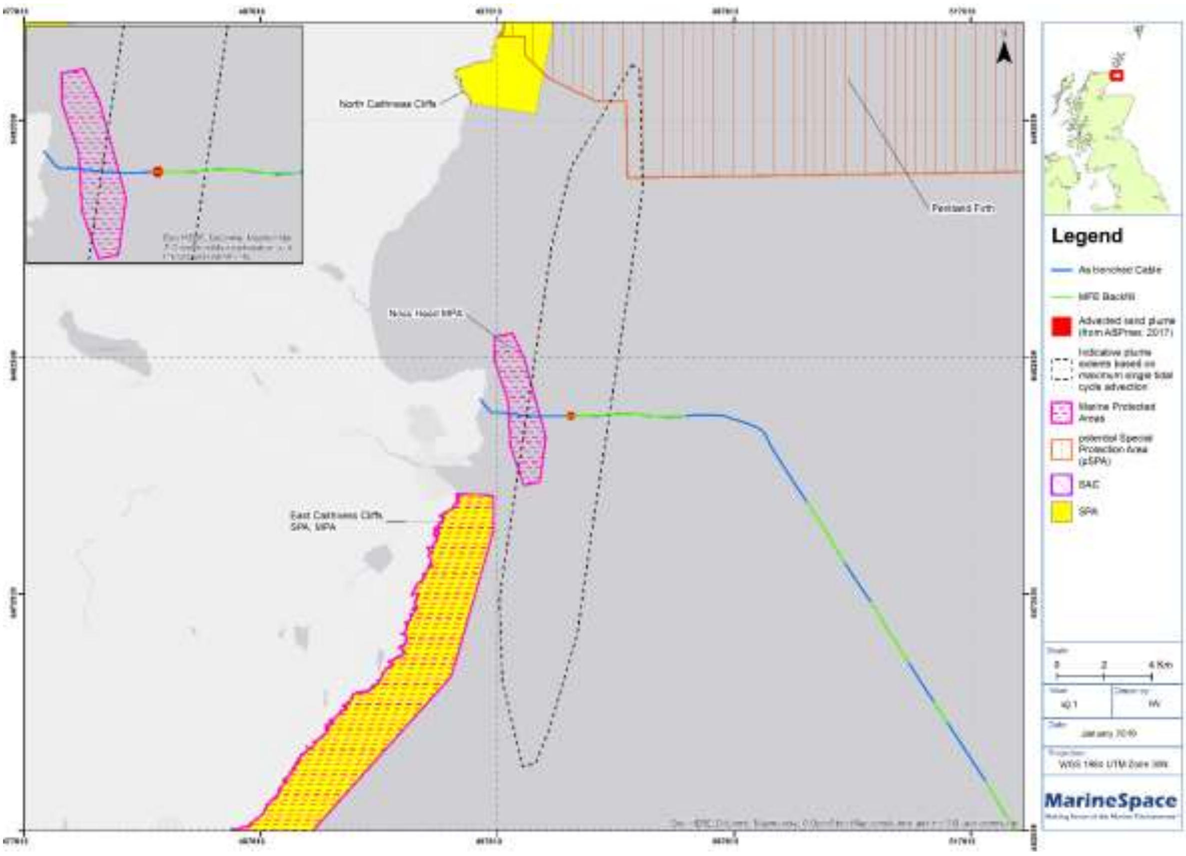
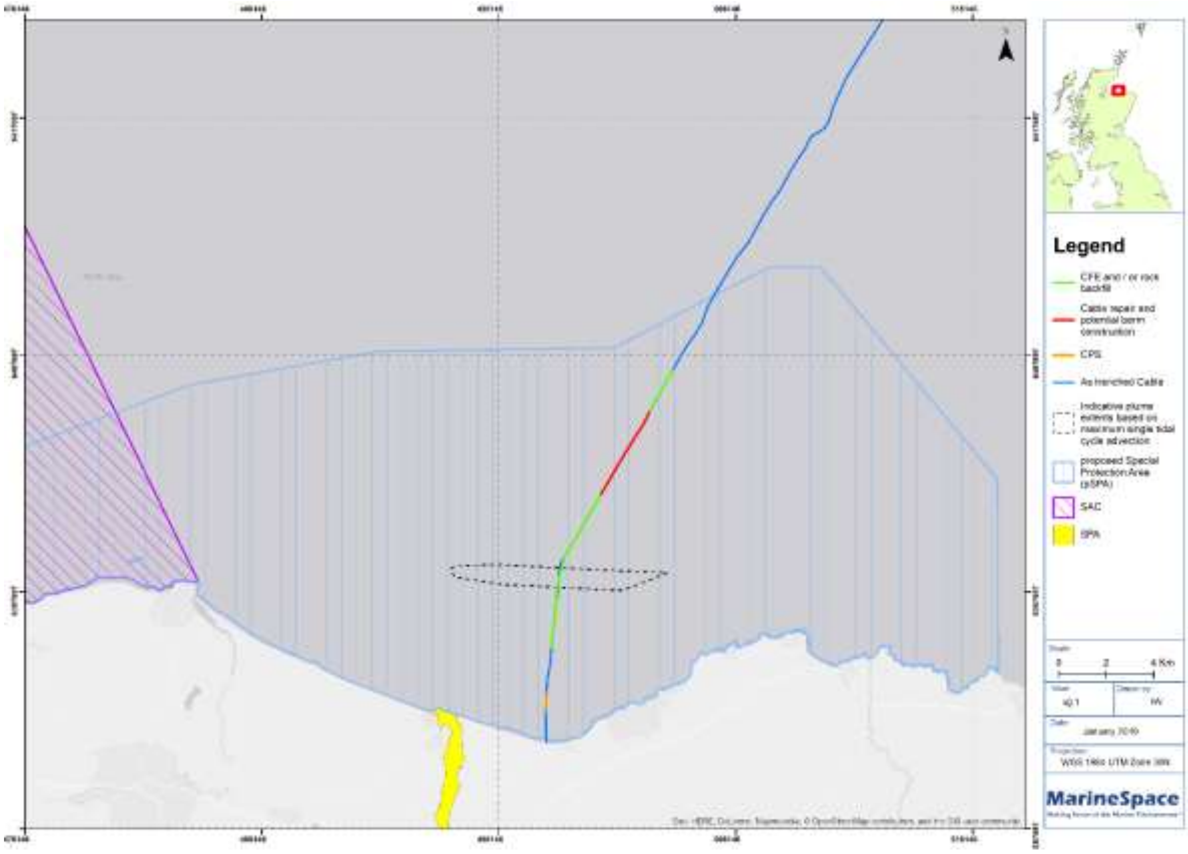


Figure 4.3: Area of proposed works at the southern part of the cable within the Moray Firth potential Special Protection Area



NB: The CPS effect footprint is assessed within (as part of) the rock placement footprint for temporary habitat disturbance and within (as part of) the use of CFE for sand advection and plume dispersal and settlement envelopes.

These figures are used to help establish the pressure pathways / envelopes to be assessed.

4.3. Sites Designated for Habitat Features

Table 3.1 and Table 4.1, 4.2 and 4.3, and Figure 4.1, Figure 4.2, and Figure 4.3 show that designated sublittoral habitat and benthic community features and prey species must be screened for direct effects where a spatial overlap occurs between the CFE works and / or rock placement, the use of the CPS and creation and presence of a rock berm and an MPA / designated feature.

These works can also generate turbidity plumes through advection of seabed sediments and deposition (smothering) footprints that need to be screened for significant (indirect) interactions with habitat features.

4.3.1. Screening of Designated Habitat Features

Designated marine Annex I habitats are present within the Moray Firth SAC and the Dornoch Firth and Morrich More SAC. A Habitat Feature of Conservation Importance is also designated in the Noss Head NCMPA. Table 4.2 shows the designated sites and their habitat features.

Table 4.2: Designated habitat features within the Marine Protected Areas screened

Marine Protected Area	Designated features
Moray Firth SAC	Sandbanks which are slightly covered by sea water all the time
Dornoch Firth and Morrich More SAC	Sandbanks which are slightly covered by sea water all the time Reefs Intertidal mudflats and sandflats Glasswort (*Salicornia* spp.) and other annuals colonising mud and sand Atlantic salt meadows Shifting dunes Shifting dunes with marram Humid dune slacks Coastal dune heathland Dune grassland Dunes with juniper thickets Lime-deficient dune heathland with crowberry
Noss Head NCMPA	Horse mussel beds

The distance between the closest part of the cable and MPAs with designated habitat features is shown in Table 4.3.

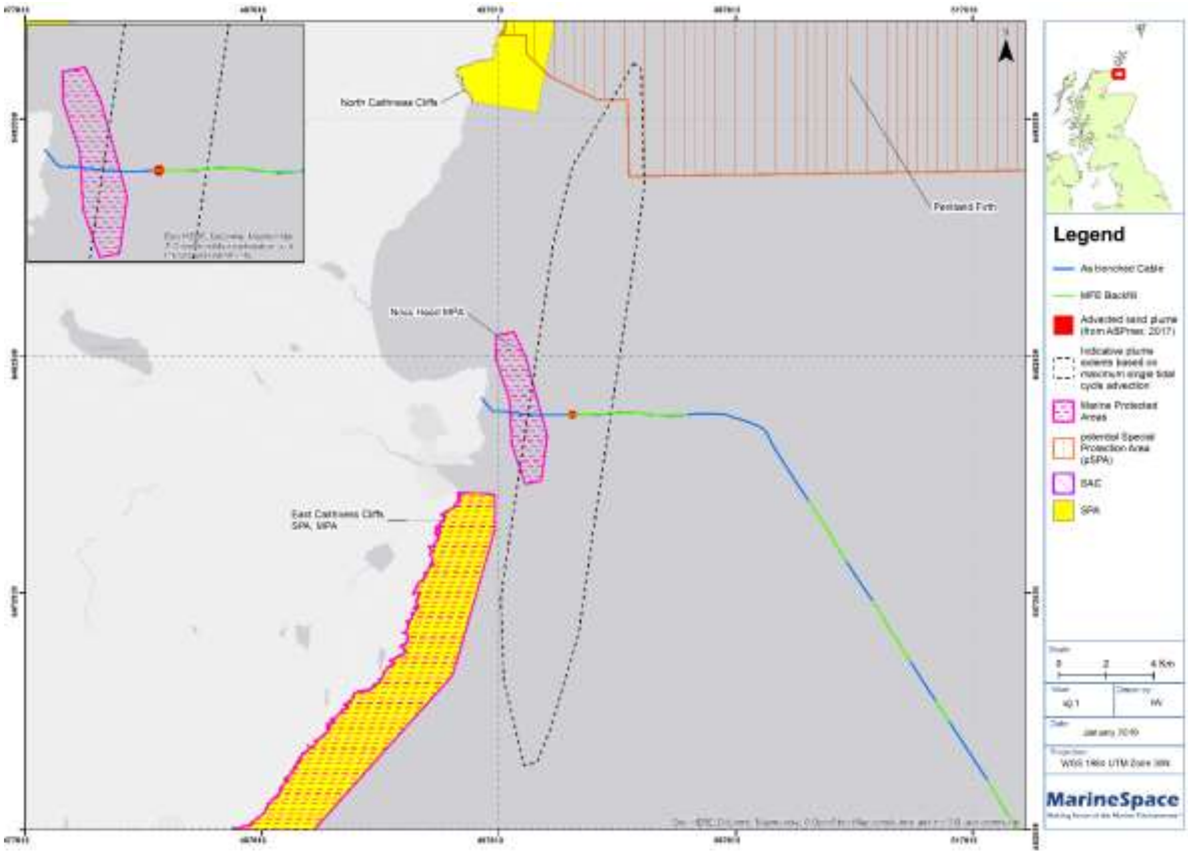
Table 4.3: Distance of Marine Protected Areas with designated habitat features to the areas of works

Marine Protected Area	Cable distance from MPA (km)		
	North	Central	South
Moray Firth SAC	56	44	16
Dornoch Firth and Morrich More SAC	88	74	55
Noss Head NCMPA	1.3	22	70

For the Moray Firth SAC, and the Dornoch Firth and Morrich More SAC, the distances between the cable and associated activities are so great that there can be no exposure to direct or indirect effects (pressures). For the Noss Head NCMPA there will be no direct effects, as the proposed use of CFE and / or rock placement will occur approximately 1.3 km outside of the site boundary (Table 4.3; Figure 4.4).

Sediment plumes and deposition footprints (indirect effects) will result in a short-term (hours), localised (100s and 1000s of metres from works) increase in suspended sediment concentration (SSC) of fines (<63 µm) related to the tidal excursion (tidal prism). Turbulence at the seabed may also further disturb sediment, resulting in increased suspension. Any elevations in SSC in the near-field due to fine sediment advection associated with the use of CFE will be present to distances of approximately 15 km tide-parallel on an ebb and flood tide at the northern location of proposed works and 9 km at the southern end of the cable (i.e. within the Moray Firth pSPA). Advection of sand-sized particles is likely to occur for no more than 200 m cross-tide (either side of the cable) and be short-term (no more than one single tidal excursion (SSE, 2011; MarineSpace, 2018, 2019; Figure 4.1)). The magnitude, spatial extent and duration of the proposed remediation works will be far less than that assessed for the original main cable installation activities, which were deemed to not result in no significant effects for habitat removal, abrasion, increased turbidity, smothering or alteration of processes relevant to the structure and function of the MPAs.

Figure 4.4: Location of proposed use of Controlled Flow Excavation and / rock placement and worst case modelled sand advection and fine sediment plume (from use of CFE) at the northerly works location



There is an overlap of the modelled worst case flood and ebb tide advected fine sediment plume from the northern location of proposed works, that spatially overlaps the boundary of the Noss Head NCMPA.

No Likely Significant Effects are determined for the designated habitat features of the Moray Firth SAC, the Dornoch Firth and Morrich More SAC. The designated habitat features of these sites are screened out of further assessment.

No Likely Significant Effects cannot be determined for the designated habitat features of the Noss Head NCMPA. The designated habitat features of this site are screened into further assessment.

4.4. Sites Classified or Designated for Ornithological Features

Table 4.6 and Table 4.7 show the bird features and foraging ranges / locations from the SPAs at which they are classified and the potential for exposure to direct effects (removal and abrasion of supporting subtidal habitat and loss of prey species within the footprint of the proposed works) where a spatial overlap occurs between the pressure footprints and the seabed that may support prey species.

Indirect effects can occur where sediment plumes could interfere with foraging success (increased turbidity), or where deposition (smothering from settling of suspended sediment) could affect habitat supporting prey species or the prey species themselves.

The proposed CFE and / or rock placement works onto the seabed, or the use of acoustic survey tools, can also result in secondary effects that can affect prey species (death or permanent or temporary injury caused by propagation of underwater sound to a prey species; and disturbance / displacement caused by propagation of underwater sound to a prey species).

4.4.1. Foraging Ranges

To be able to determine if there is exposure (connectivity) to coastal SPA's classified bird population's prey, the screening must assess if the pressure footprints are located within the foraging range of a species for coastal SPA populations (i.e. the pressure footprints may be outside the boundary of the SPA but fall within the area that the classified populations forage in the nearshore or offshore environment).

The information available on the distances that birds will forage depends on the species, and to some degree the season of year. Breeding birds may forage further than over-wintering individuals, as they must provide food for their chicks. Thaxter *et al.* (2012) provide data on recorded foraging ranges for a wide range of species, including the mean and maximum distances travelled. The mean-maximum range (i.e. the mean average of the maximum foraging distances recorded) has been used as a parameter for establishing whether there is likely to be connectivity, and hence risk of a likely significant effect between a coastal SPA classified population and the footprint of the activities (pressures).

For the marine SPAs (Pentland Firth pSPA and Moray Firth pSPA) which constitute an inshore / offshore site and boundary, exposure (connectivity) to the SPA's classified bird population's prey is present if there is a direct spatial overlap between the pressure footprint and the boundary of the site. This is because the boundaries of the marine SPAs include the inshore / offshore areas that support the classified populations i.e. foraging ranges are not considered, as the classified populations are found within the boundary of the site itself and are not considered to forage outside of that site boundary (e.g. the sites are themselves indicative of the foraging areas used by the classified populations for those sites).

4.4.2. Period of Works and Seasonality of Classified Populations

SPAs (or Ramsar sites) may have different populations of bird species classified at the site at various times of the year. Many sites have populations of birds at the colony / site that are present during the summer months (01 April-30 September) to nest and breed. These birds migrate away from the site following fledging of the chicks and are not present at the site during the winter period (01 October-31 March). However, other species migrate into the site to over-winter, along with some species that use the site during a wider autumnal (01 September-31 October) and spring (01 March-30 April) (bi-annual) migration cycle; using the site as a stop-over whilst travelling to and from other locations.

The period that the CFE and / or rock placement works, the use of the CPS and creation and presence of a rock berm is proposed to occur is 01 April-31 August 2019. This period sits within the summer breeding season. Therefore, only classified breeding populations of birds fall within the screening and assessment envelope (e.g. over-wintering populations of birds will have no exposure to pressures and are screened out of assessment).

4.4.3. Screening of Classified and Designated Populations of Birds

Mean-maximum foraging ranges as reported by Thaxter *et al*. (2012) have been used to determine potential connectivity with the cable works. The foraging range is set from the MPA which supports the coastal classified population out to the nearest location of the proposed works. This is a precautionary assessment envelope as it assumes that activities and pressures may occur at that nearest cable location.

Bi-annual migratory species tend to be Anaids (wildfowl - ducks, geese and swans), shoreline wader species and some raptors. These populations are classified features of the:

- Moray and Nairn Coast SPA;
- Dornoch Firth and Loch Fleet Ramsar site;
- Dornoch Firth and Loch Fleet SPA;
- Cromarty Firth Ramsar site;
- Cromarty Firth SPA;
- Inner Moray Firth Ramsar site; and
- Inner Moray Firth SPA.

These populations have no exposure to (connectivity with) any of the pressures associated with the proposed use of CFE and / or rock emplacement (as the birds use the shoreline, mud and sandflat and saltmarsh habitat) and are screened out of further assessment. **No likely significant effects are determined in relation to migratory populations of Anaid, wader species and raptors classified at the European marine sites listed above**.

Seabirds that breed in SPAs and Ramsar sites elsewhere in the UK may have a small potential to interact with the screening and assessment area during bi-annual migrations. However, the pressure pathways from CFE and / or rock emplacement are considered so small in relation to these migratory movements, only overlap with part of the spring migration period (April), and the ability to forage over vast areas of the sea whilst migrating is so great that significant effects are not expected. **No**

Likely Significant Effects are determined in relation to migratory populations of seabirds from other Marine Protected Areas outside of the screening and assessment area.

The seabirds that breed at the Pentland Firth pSPA and forage within the proposed site's boundary have the possibility of overlapping with a very small part of the modelled worst case fine sediment plume during the ebb tide.

The proposed classified populations of breeding birds at the site are present during the summer months (01 April-30 September) during the period that a sediment plume may interact with the site boundary (Figure 4.2). The species listed for classification at the pSPA are shown in Table 4.4.

Table 4.4: Qualifying features of the Pentland Firth proposed Special Protection Area

Marine Protected Area	Designated features
Pentland Firth pSPA	Common guillemot, breeding Arctic tern, breeding Arctic skua, breeding Seabird assemblage, breeding

Due to interaction of the sediment plume with the boundary of the pSPA **no Likely Significant Effects cannot be determined**. **The Pentland Firth pSPA is screened into assessment**.

4.4.4. Over-wintering Diver, Grebe, Merganser and Seaduck Species

Diver, grebe, merganser and seaduck species are present within the waters of the Moray Firth during the winter period as non-breeding populations. These species are now proposed as qualifying features of the Moray Firth pSPA (Table 4.5). They are proposed due to the offshore area that these species use for foraging and loafing during the winter period (01 October- 31 March). The only difference is for shag, that are proposed for both breeding population and use of the site during the over-wintering period.

Table 4.5: Qualifying features of the Moray Firth proposed Special Protection Area

Marine Protected Area	Designated features
Moray Firth pSPA	Shag, breeding and non-breeding Common scoter, non-breeding Eider, non-breeding Goldeneye, non-breeding Great northern diver, non-breeding Long-tailed duck, non-breeding Red-breasted merganser, non-breeding

Marine Protected Area	Designated features
	Red-throated diver, non-breeding Scaup, non-breeding Slavonian grebe, non-breeding Velvet scoter, non-breeding

There is direct spatial overlap between part of the pSPA (see Figure 4.1 and Figure 4.3) and the proposed areas of works at the south end of the cable. It is important to note that the pSPA boundary dictates the limit of any connectivity (exposure to pressure pathways[13]); it is assumed that all qualifying species forage or loaf within the boundary of the pSPA, including breeding shag. However, the proposed works will occur outside of the over-wintering period so no exposure (connectivity) of pressure footprints is possible for all species except breeding shag. In addition, in a precautionary manner, recovery of seabed habitat from temporary effects has been assumed to extend into the winter period. This means that **no Likely Significant Effects cannot be determined**. **The Moray Firth pSPA is screened into assessment**.

4.4.5. Classified Breeding Populations

There are ten species of classified breeding seabird populations that may interact (have connectivity) with the proposed areas of works and associated pressure pathways. These are:

- Atlantic fulmar *Fulmarus glacialis*;
- Common cormorant *Phalacrocorax carbo*;
- Shag *Phalacrocorax aristotelis*;
- Black-legged kittiwake *Rissa tridactyla*;
- Herring gull *Larus argentatus*;
- Great black-backed gull *Larus marinus*;
- Common tern *Sterna hirundo*[14];
- Sandwich tern *Thalasseus sandvicensis*;
- Common guillemot *Uria aalge*;
- Razorbill *Alca torda*;
- Atlantic puffin *Fratercula arctica*; and
- Arctic skua *Stercorarius parasiticus*.

[13] Removal or abrasion of subtidal habitat and loss of prey species within the footprint of the CFE and / or rock placement area, from installation of CPS and construction and presence of rock berm; Death or permanent or temporary injury caused by propagation of underwater sound to a prey species; and Disturbance / displacement caused by propagation of underwater sound to a prey species.

[14] Common tern at the Pentland Firth pSPA are screened in due to overlap of modelled sediment plume with the site.

All other classified bird populations are screened out of assessment as their mean-maximum foraging ranges do not extend to the proposed areas of works and associated pressure footprints (e.g. common tern at Cromarty Firth SPA and Inner Moray Firth SPA).

It should also be noted that the Moray East and Moray West Offshore Wind Farm ESs screened out breeding seabird populations from two SPAs in Orkney (Moray Offshore Windfarm Ltd, 2017):

"*Two SPAs in Orkney (Hoy SPA and Copinsay SPA) include breeding seabird qualifying features whose foraging ranges stretches as far as Moray West. The Moray East ES (Moray East, 2012) considered these sites and no impacts were deemed appropriate to apportion to the populations in question (due to distance and likely distribution of features foraging away from colonies). No LSE on the SPAs were therefore predicted and these sites are therefore screened out at this stage of the report and are not considered further*."

The foraging ranges of these classified populations from Hoy SPA and Copinsay SPA do not interact with the potential pressure footprints and are also screened out of assessment due to extreme distance and likely distribution of features foraging away from SPA colonies. **No Likely Significant Effects are determined for Hoy SPA and Copinsay SPA**.

Table 4.6: Classified breeding bird population features within the Marine Protected Areas screened (amber = screened in – foraging range connectivity / direct overlap of effect with site boundary; green = screened out no foraging range connectivity) [1]NB: puffin recommended to be removed from the assemblage by SNH (Moray Offshore Windfarm (West) Ltd, 2017))

Marine Protected Area	Classified features	Foraging range (km)	Distance from cable (km)		
			North	Central	South
North Caithness Cliffs SPA[1]	Fulmar	400 ± 245.8	13	34	86
	Guillemot	84.2 ± 50.1	13	34	86
	Razorbill	48.5 ± 35.0	13	34	86
	Puffin[1]	105.4 ± 46.0	13	34	86
	Kittiwake	60.0 ± 23.3	13	34	86
East Caithness Cliffs SPA	Shag	14.5 ± 3.5	4.8	24	50
	Cormorant	25.0 ± 10.0	4.8	24	50
	Fulmar	400 ± 245.8	4.8	24	50
	Guillemot	84.2 ± 50.1	4.8	24	50
	Razorbill	48.5 ± 35.0	4.8	24	50
	Great black-backed gull	60	4.8	24	50
	Herring gull	61.1 ± 44.0	4.8	24	50
	Kittiwake	60.0 ± 23.3	4.8	24	50
Troup, Pennan and Lion's Heads SPA	Fulmar	400 ± 245.8	89	39	37
	Guillemot	84.2 ± 50.1	89	39	37
	Razorbill	48.5 ± 35.0	89	39	37
	Herring gull	61.1 ± 44.0	89	39	37
	Kittiwake	60.0 ± 23.3	89	39	37
Loch of Strathbeg SPA	Sandwich tern	49.0 ± 7.1	109	63	64

Marine Protected Area	Classified features	Foraging range (km)	Distance from cable (km)		
			North	Central	South
Buchan Ness to Collieston Coast SPA	Shag	14.5 ± 3.5	127	79	77
	Fulmar	400 ± 245.8	127	79	77
	Guillemot	84.2 ± 50.1	127	79	77
	Herring gull	61.1 ± 44.0	127	79	77
	Kittiwake	60.0 ± 23.3	127	79	77
Moray Firth pSPA	Shag	Not applicable as the site boundary is used for screening	No overlap	No overlap	Overlap with cable, rock berm and sediment plume
	Common scoter		No overlap	No overlap	Overlap with rock berm habitat loss
	Eider		No overlap	No overlap	Overlap with rock berm habitat loss
	Goldeneye		No overlap	No overlap	Overlap with rock berm habitat loss
	Great northern diver		No overlap	No overlap	Overlap with rock berm habitat loss
	Long-tailed duck		No overlap	No overlap	Overlap with rock berm habitat loss
	Red-breasted merganser		No overlap	No overlap	Overlap with rock berm habitat loss
	Red-throated diver		No overlap	No overlap	Overlap with rock berm habitat loss
	Scaup		No overlap	No overlap	Overlap with rock berm habitat loss
	Slavonian grebe		No overlap	No overlap	Overlap with rock berm habitat loss
	Velvet scoter		No overlap	No overlap	Overlap with rock berm habitat loss

Marine Protected Area	Classified features	Foraging range (km)	Distance from cable (km)		
			North	Central	South
Pentland Firth pSPA	Common tern	Not applicable as all birds screened as present in the site boundary	Overlap with sediment plume	No overlap	No overlap
	Common guillemot		Overlap with sediment plume	No overlap	No overlap
	Arctic Skua		Overlap with sediment plume	No overlap	No overlap

The preceding Table 4.6 shows the designated sites and their classified breeding populations specifically screened for likely significant effects. The table shows that there is connectivity between the proposed areas of works and various classified breeding populations from several SPAs. Those features coloured amber are screened into assessment i.e. no Likely Significant Effect cannot be determined. Features coloured green can be screened out of assessment i.e. no overlap of foraging range or spatial and / or temporal overlap with that section of cable and therefore, no Likely Significant Effect can be determined.

The screening exercise shows that only the Loch of Strathbeg SPA can entirely be screened out of the assessment. There is no overlap between the foraging of Sandwich tern from the SPA and the potential pressure footprints. Therefore, **no Likely Significant Effect is determined for the Loch of Strathbeg SPA**.

Of the other SPAs:

- Shag, herring gull and kittiwake from Buchan Ness to Collieston Coast SPA are screened out of assessment.

All other breeding populations for the following SPAs are screened into assessment:

- North Caithness Cliffs SPA;
- East Caithness Cliffs SPA;
- Troup, Pennan and Lion's Heads SPA;
- Buchan Ness to Collieston Coast SPA;
- Moray Firth pSPA – for shag only (as this is the only breeding species classified at the site); and
- Pentland Firth pSPA.

In addition, the over-wintering populations at the Moray Firth pSPA (common scoter, eider, goldeneye, great northern diver, long-tailed duck, red-breasted merganser, red-throated diver, scaup, Slavonian grebe, and velvet scoter) are screened into assessment due to the probable presence of a rock berm resulting in permanent prey species-supporting habitat.

No Likely Significant Effect cannot be determined for the SPAs listed above in relation to the proposed cable remediation works.

4.4.6. Designated Habitat Within a Special Protection Area or Ramsar Site

The potential for connectivity of pressures with designated Annex I habitat supporting SPA features is only possible at Moray Firth pSPA and Pentland Firth pSPA (Figure 4.1). All other SPAs are so distant that direct and indirect effects cannot occur (Table 4.7).

Table 4.7: Distance relationship between cable sections and / or overlap with sediment plume and Special Protection Areas (and relevant Ramsar sites) (amber = screened in – overlap with site boundary; green = screened out no overlap with site boundary)

Marine Protected Area	Site boundary distance from cable (km)		
	North	Centre	South
North Caithness Cliffs SPA	13	34	86
East Caithness Cliffs SPA	4.8	24	50
Moray Firth pSPA	38	20	Overlap with cable and sediment plume
Pentland Firth pSPA	Overlap with sediment plume	25	83
Dornoch Firth and Loch Fleet SPA + Ramsar	83	73	54
Cromarty Firth SPA + Ramsar	100	81	58
Inner Moray Firth SPA + Ramsar	134	111	80
Moray and Nairn Coast SPA	96	44	5.3
Troup, Pennan and Lion's Heads SPA	89	39	37
Loch of Strathbeg SPA	109	63	64
Buchan Ness to Collieston Coast SPA	127	79	77

It cannot be determined that there is no Likely Significant Effect on designated habitat supporting qualifying features of the Moray Firth pSPA and for the Pentland Firth pSPA.

No Likely Significant Effect can be determined for the SPAs listed below in relation to designated habitats supporting classified populations in relation to all areas of proposed works and associated pressures:

- North Caithness Cliffs SPA;
- East Caithness Cliffs SPA;
- Cromarty Firth SPA + Ramsar;
- Dornoch Firth and Loch Fleet SPA + Ramsar;
- Inner Moray Firth SPA + Ramsar;
- Moray and Nairn Coast SPA;
- Troup, Pennan and Lion's Heads SPA;
- Loch of Strathbeg SPA; and
- Buchan Ness to Collieston Coast SPA.

4.5. Sites Designated for Annex II Marine Mammal Features

Table 3.1 and Table 4.1 show that marine mammal features are sensitive to direct effects (abrasion of subtidal habitat and loss of prey species within the footprint of the placement area) where a spatial overlap occurs between the placement of rock and the seabed that may support prey species. Use of CFE and / placement of rock onto the seabed or use of acoustic survey tools can also result in secondary effects that can affect prey species (Death or permanent or temporary injury caused by propagation of underwater sound to the individual or to prey species; and Disturbance / displacement caused by propagation of underwater sound to the individual or to a prey species).

It is important to note that this screening exercise has been conducted concerning populations of Annex II marine mammals designated as features of SACs. A full Annex IV European Protected Species (EPS) assessment has been conducted separately for marine mammals not qualifying as designated populations (see Natural Power, 2017). The EPS assessment does make reference to designated site populations and the assessment thresholds and models presented in Natural Power (2017) form the basis of the screening and assessment here.

Natural Power (2017) in consultation with SNH and JNCC identified that the key species to address for the EPS assessment were:

- Harbour (or common) seal *Phoca vitulina*;
- Grey seal *Halichoerus grypus*;
- Bottlenose dolphin *Tursiops truncates*;
- Harbour porpoise *Phocoena phocoena*; and
- Minke whale *Balaenoptera acutorostrata*.

These species occur all year round in the Moray Firth, except for minke whale which occur in the summer. Other marine mammal species occur more occasionally, these are:

- Short-beaked common dolphin *Delphinus delphis*;
- Risso’s dolphin *Grampus griseus*;
- Atlantic white-beaked dolphin *Lagenorhynchus albirostris*;
- Killer whale *Orcinus orca*;

- Long-finned pilot whale *Globicephala melas*; and
- Humpback whale *Megaptera novaengliae*.

Natural Power (2017) also states:

"*Harbour porpoise* Phocoena phocoena *was the most commonly encountered species by Thompson et al. (2010), being seen throughout inshore and offshore waters of the Moray Firth. Harbour porpoise is considered to be in favourable condition in respect of range, population, habitat, prospects and overall status... This is one of the species of cetacean most likely to be encountered by the project during proposed cable works, along with Bottlenose dolphins. Sightings data also suggest that common and grey seals are commonplace*."

As previously stated, species which are not designated features of MPAs have been considered within the EPS report (Natural Power, 2017).

European otter *Lutra lutra* associated with SACs are not considered to have connectivity, due to no SACs for European otter overlapping with the cable or the proposed rock placement or CPS locations.

An EPS licence has been issued for the rock placement works assessed for the 2017/18 winter in MarineSpace (2017c; 2018; 2019); licence number MS EPS 01 2018 2, dated 29 March 2018. The scale and magnitude of the pressures associated with the proposed CFE and / placement of rock onto the seabed works are significantly smaller than those covered by the MS EPS 01 2018 1 EPS licence.

4.5.1. Annex II Marine Mammal Features – Foraging Ranges

4.5.1.1. Pinnipeds

To be able to determine if there is exposure (connectivity) to a designated seal population's prey, the screening has to assess if the pressure footprints are located within the foraging range of a species. The foraging range is set from the MPA / haul out which supports the designated population out to the nearest location of the works.

Harbour seals usually forage within 40-50 km of their haul out sites (SCOS, 2017; MarineSpace, 2017c; 2018), however there is evidence to suggest that they can and will forage much further than this; up to distances of between 75 and 120 km from their haul outs (Tollit *et al.*, 1998; Sharples *et al.*, 2008). Application of the precautionary principle means that the furthest distance is used to set a worst case connectivity (exposure) envelope.

For grey seal SCOS (2017) cites foraging ranges as commonly being up to 100 km from haul outs, based on satellite tracking data.

4.5.1.2. Cetaceans

To be able to determine if there is exposure (connectivity) to a designated cetacean population's prey, the screening must assess if the pressure footprints are located within the foraging range of a species. The foraging range could be set within the boundary of the SAC which supports the designated population. However, it is assumed that the cetacean species will demonstrate a high degree of mobility and will forage outside the boundary of the SAC. For bottlenose dolphin the appropriate marine management unit is used: in this case the North Sea management unit. This is a precautionary assessment envelope as it assumes that the remedial cable activities may occur within the large foraging range of the species.

4.5.2. Screening of Annex II Marine Mammal Features – Foraging Ranges

Table 4.8 shows the species of marine mammal that are designated features under Annex II and the sites at which they qualify within the assessment area. It also shows screening for the pressures of abrasion of subtidal habitat and loss of prey species within the footprint of the placement area as related by an Annex II species foraging range.

Table 4.8: Designated marine mammal population features within the Marine Protected Areas screened and screening by foraging range (amber = screened in – overlap with foraging range; green = screened out no overlap with foraging range)

Marine Protected Area	Designated features	Foraging range (km) Cetacean = Marine Management Unit Pinniped = Tollit *et al.* (1998); Sharples *et al.* (2008)	Site boundary distance from cable (km)		
			North	Centre	South
Moray Firth SAC	Bottlenose dolphin	North Sea Marine Management Unit	55	44	15
Dornoch Firth and Morrich More SAC	Harbour seal	120	87	72	54
Faray and Holm of Faray SAC	Grey seal	100	82	98	155

All other SACs with marine mammal species features are greater than 200 km distant from the cable and automatically screened out. Note: the information presented in the table can be used to determine potential connectivity with seabed supporting prey species and also physical interactions with works vessels and risk of vessel collision.

It cannot be determined that there is no Likely Significant Effect on seabed habitat with the potential to support prey species and foraging Annex II marine mammal features from: Moray Firth SAC; Dornoch Firth and Morrich More SAC; and Faray and Holm of Faray SAC. These sites are screened into assessment.

No Likely Significant Effect can be determined for the for grey seal features from Faray and Holm of Faray SAC and in relation to the south location of proposed works.

4.5.3. Screening of Annex II Marine Mammal Features – Underwater Sound Emissions

To determine if there may be any significant effects associated with emitted underwater sound waves two criteria have to be considered:

- Sensitivity of the species to the underwater sound waves produced by the source activity; and
- Potential for the species to be exposed to the underwater sound waves pathway.

4.5.3.1. Marine Mammal Hearing Sensitivities and Thresholds

Sensitivity to underwater noise is dependent upon the specific hearing abilities of the species. The potential effects are:

- Lethal effects and physical injury;
- Auditory injury (Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS)); and
- Behavioural response.

The thresholds used in this screening exercise are taken from the project-specific EPS Assessment report (Natural Power, 2017). It should be noted that although pinnipeds are not EPS and thus not directly assessed by Natural Power (2017) it is stated (in the project-specific EPS Assessment report) that the determinations of the assessment (including any proposed mitigation measures and residual risk) are also applicable for pinnipeds.

To fully inform this report and screening exercise relevant information used from Natural Power (2017) is presented in Annex A.

4.5.4. Screening of Annex II Marine Mammal Features – Damage and Disturbance

The determinations of the project-specific EPS Assessment report (Natural Power, 2017) and the updated MPAs assessments (MarineSpace, 2017c, 2018) are used here to screen for likely significant effects for foraging Annex II marine mammal features from:

- Moray Firth SAC – bottlenose dolphin; and
- Dornoch Firth and Morrich More SAC – harbour seal.

In a precautionary manner the screening assumes that connectivity / exposure (to increased underwater sound emissions from: use of CFE and placement of rock onto the seabed; or the use of acoustic survey and vessel positioning / navigation equipment; or directly from the vessels associated with the works) exists for all qualifying features listed above; and with the proposed locations of remedial works.

To screen for likely significant effects from potential vessel collision connectivity is present for both locations of works and qualifying features (see Table 4.8 for foraging range interactions).

Marine mammal species are known to be sensitive to underwater sound emissions and connectivity is possible with the sources of underwater sound emissions associated with additional rock placement.

It cannot be determined that there is no Likely Significant Effect from underwater sound emissions on foraging Annex II marine mammal features from: Moray Firth SAC; and Dornoch Firth and Morrich More SAC. These sites are screened into assessment.

No Likely Significant Effect can be determined for the Faray and Holm of Faray SAC and Isle of May SAC grey seal features in relation to the pressures assessed.

4.6. Sites Designated for Annex II Migratory Fish Features

Table 3.1 and Table 4.1 show that the use of CFE and placement of rock onto the seabed or use of acoustic survey equipment and use of vessels have the potential to result in secondary effects that can affect the species (Death or permanent or temporary injury caused by propagation of underwater sound to the individual; and Disturbance / displacement caused by propagation of underwater sound to the individual).

The installation of CPS using divers and airlift systems is not deemed to result in significant disturbance through sound emissions and is **screened out of assessment**.

Any trenching work associated with the installation of CPS is covered under the sound emission parameters used for CFE and is included in that envelope.

Diadromous fish species such as sea lamprey *Petromyzon marinus*, Atlantic salmon *Salmo salar* and European eel *Anguilla anguilla* may be present at the location of the proposed use of CFE, rock placements, the use of the CPS and / or creation and presence of a rock berm.

Atlantic salmon smolts move down rivers in April and May to reach the sea and head northwards and westwards in prolonged migrations of up to many thousands of kilometres that last for 1 or more years. Some Scottish fish travel as far as the Davis Strait between the western coast of Greenland and Baffin Island in the Canadian Arctic (Scottish Government, 2017; MarineSpace, 2018).

After 2 or 3 years at sea the salmon return to the Scottish coastline in the autumn or early winter before migrating back up their natal rivers to spawn.

Sea lamprey larvae metamorphose to adults during the summer and then migrate to sea during the late autumn and early winter, distributing to coastal and offshore waters (Maitland, 2003). After up to 6 years at sea the adults return to their natal rivers between March and June (but can start as early as September), with spawning taking place between May and June.

European eel adults appear to migrate out to sea during the summer and autumn months. The migration tends to be reliant upon increased freshwater discharge events. Juvenile elvers (glass eels) arrive at rivers during the early to late winter period and into April and May. However, there are no European eel qualifying features in any of the SACs screened for likely significant effects.

Atlantic salmon and sea lamprey qualifying species have life stages that will be moving in and through the Moray Firth during the period of the proposed works.

It should be noted that freshwater pearl mussels *Margaritifera margaritifera* are reliant on salmonids (salmon or trout). A critical part of their lifecycle involves spat settlement on the gills of salmonids, where they harmlessly live for the first year of their lives. Therefore, connectivity with

Atlantic salmon exists for successful juvenile recruitment and population sustainability. This needs to be considered in parallel with the test for likely significant effect on SACs for Atlantic salmon.

The following rivers designated as SACs feed into the Moray Firth:

- Berriedale and Langwell Waters SAC – Atlantic salmon;
- River Oykel SAC - Atlantic salmon and freshwater pearl mussel;
- River Moriston SAC - Atlantic salmon and freshwater pearl mussel; and
- River Spey SAC – Atlantic salmon, sea lamprey and freshwater pearl mussel.

In addition, there are other SACs distributed along the coastline to the north and south of the Moray Firth that may also have qualifying features that interact with the waters of the firth:

- River Borgie SAC – Atlantic salmon and freshwater pearl mussel;
- River Naver SAC - Atlantic salmon and freshwater pearl mussel;
- River Thurso SAC – Atlantic salmon; and
- River Dee SAC - Atlantic salmon and freshwater pearl mussel.

In a precautionary manner these sites and qualifying features will be screened for likely significant effects.

4.6.1. Annex II Migratory Fish Features - Damage and Disturbance

The use of CFE and the placement of rock onto the seabed or the use of acoustic survey and vessel positioning / navigation equipment associated with the rock placement have the potential to result in secondary effects that can affect migratory fish features (Death or permanent or temporary injury caused by propagation of underwater sound to the individual; and Disturbance / displacement caused by propagation of underwater sound to the individual). There may also be effects associated with an increase in underwater sound emissions from the vessels associated with the works.

To determine if there may be any significant effects associated with emitted underwater sound waves two criteria have to be considered:

- Sensitivity of the species to the underwater sound waves produced by the source activity; and
- Potential for the species to be exposed to the underwater sound waves pathway.

4.6.1.1. Migratory Fish Hearing Sensitivities and Thresholds

Sensitivity to underwater noise is dependent upon the specific hearing abilities of the species. The potential effects are:

- Lethal effects and physical injury;
- Auditory injury (Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS)); and
- Behavioural response.

Atlantic salmon can detect and respond to underwater sound emissions. They are classified as hearing generalists, unable to hear high frequencies but are able to hear low frequency sound and infrasound (SSE, 2011). Nedwell *et al.* (2008) postulate that Atlantic salmon is most sensitive to underwater sound at a frequency of 160 Hz, where the threshold Sound Pressure Level is 95 dB re 1 µPa @ 1 m. Based on these data, underwater noise might cause tissue damage to the auditory system (PTS) of the salmon following 1 hour exposure at a level of 215 dB re 1 µPa @ 1 m. Hearing impairment (TTS) might occur following exposure at a level of 195 dB re 1 µPa @ 1 m, for a period of 1 hour).

Nedwell *et al.* (2008) discuss injury and fatality from underwater transient pressure waves related to both the peak pressure, and the duration that the peak pressure acts upon the body of the fish. In terms of a peak pressure level exposure it is indicated that:

- Lethal effects occur at incident peak underwater sound levels of ≥260 dB re 1µPa @ 1 m;
- There is increasing likelihood of death or severe injury leading to death in a short time at incident peak underwater sound levels of ≥240 dB re 1µPa @ 1 m; and
- Direct physical injury to gas-containing structures and auditory organs may occur, particularly from repeat exposures at incident peak underwater sound levels of ≥220 dB re 1µPa @ 1 m.

Atlantic salmon have a dB_{ht} (*Salmo salar*) metric of 90dB_{ht} (SSE, 2011). This is postulated as the threshold for significant avoidance reaction, meaning virtually all individuals will take avoidance action when exposed to that sound level.

Rock placement was given an estimated unweighted source level of 172 dB re 1 µPa @ 1 m (Natural Power, 2017). DP vessels associated with rock placement activity produce a source noise level of 177dB re 1µPa @ 1m (SSE, 2011). This noise from the thrusters will originate at a depth of about 5-10m which is contiguous with the surface 0-5 m water depth typically used by Atlantic salmon (SSE, 2011).

Research presented in the Moray West Offshore Wind Farm HRA screening report indicates that sea lamprey responds to sound at frequencies of between 20 Hz and 100 Hz. However, they do not possess a swim bladder and are less sensitive to sound than fish that do possess a swim bladder (Moray Offshore Windfarm (West) Ltd, 2017).

Therefore, it is considered very unlikely that they are more noise sensitive than Atlantic salmon. For the purposes of this screening exercise the thresholds for Atlantic salmon are also considered relevant to sea lamprey.

It cannot be determined that there is no Likely Significant Effect from underwater sound emissions on migrating Annex II fish features from:

- **Berriedale and Langwell Waters SAC;**
- **River Oykel SAC;**
- **River Moriston SAC;**
- **River Spey SAC;**
- **River Borgie SAC;**
- **River Naver SAC;**
- **River Thurso SAC; and**
- **River Dee SAC.**

These sites are screened into assessment.

5. Assessment of Adverse Effects on Integrity of Sites

5.1. Designated Habitat Features

5.1.1. Removal or Abrasion from CFE and / or Placement of Rock

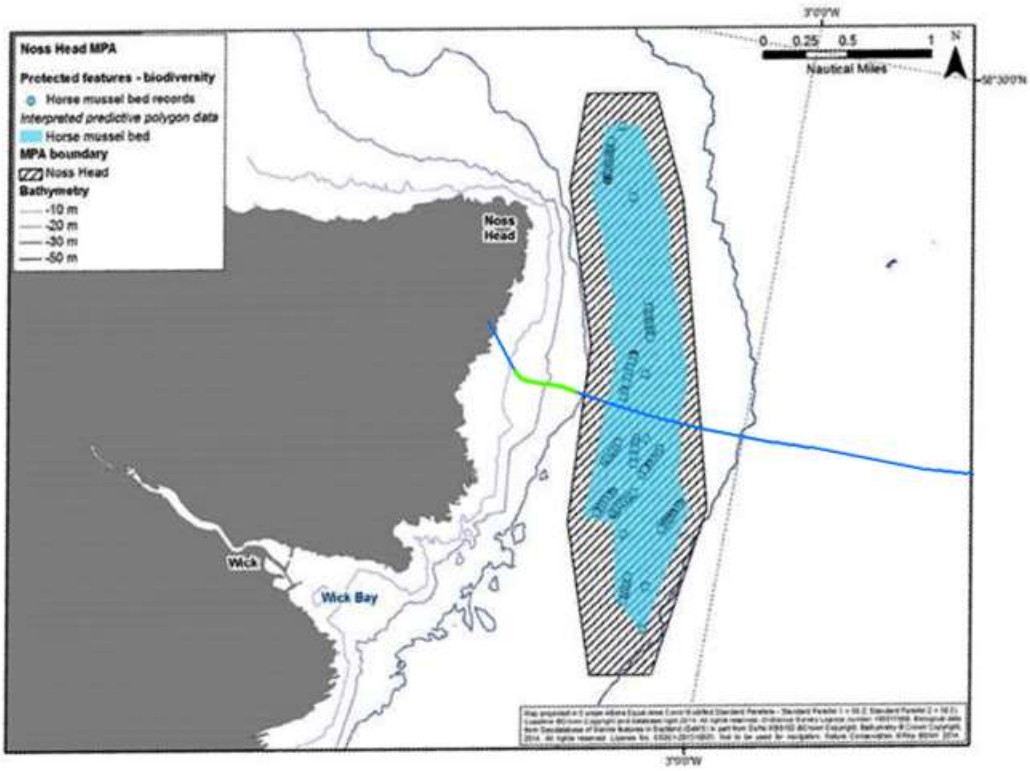
This pressure was screened out of assessment as there is no direct overlap between this pressure pathway and any Annex I designated habitats within the MPAs screened.

5.1.2. Increased Turbidity and Smothering from Deposition of Advected Sediments and Plumes from Controlled Flow Excavation and / or Placement of Rock

This pressure was screened into assessment as there is an overlap between this pressure (modelled cross-tidal extent of 'north' sediment plume) and the Noss Head NCMPA.

The Noss Head NCMPA and the extent of its designated horse mussel *Modiolus modiolus* reef is shown in Figure 5.1. The location of the horse mussel reef is located between KP110-112 (MarineSpace, 2017b, 2018). No rock armouring has occurred at this location and none is proposed as part of the works associated with the use of CFE or placement of rock in this assessment.

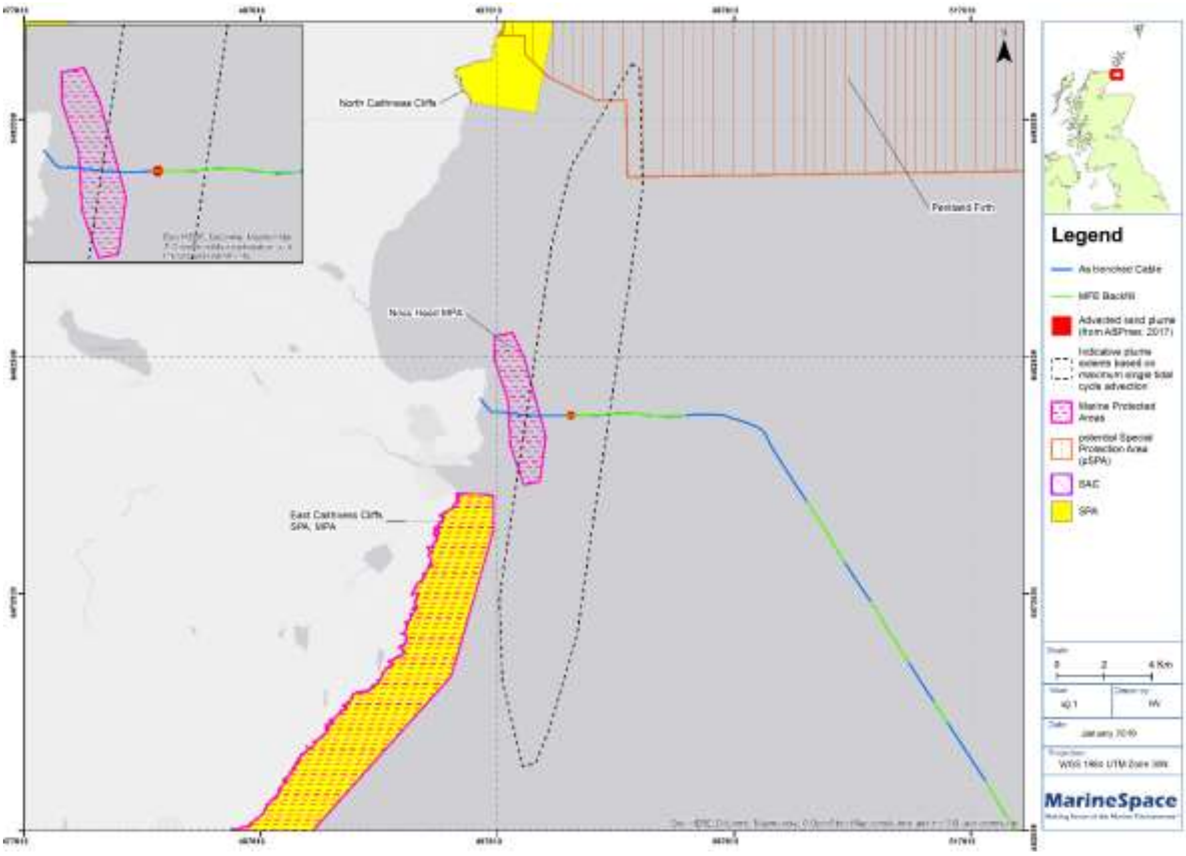
Figure 5.1: Location of horse mussel reef feature in the Noss Head Nature Conservation Marine Protected Area and location of cable (indicated in blue) and 2018 rock emplacement (indicated in green)



The distance between the Noss Head NCMPA and the nearest cable location where remedial works (use of CFE and / or rock placement) are required is 1.3 km. This distance is measured from the western-most edge of the 400 m diameter sand advection footprint (represented by the red dot in Figure 4.4 (re-presented below)). This means that any elevated levels of suspended sediment concentrations associated with sand advection have no pathway for exposure (spatial overlap) with the designated reefs within the NCMPA.

Figure 4.4 shows that there is a spatial overlap between the western-most part of the potential sediment plume, associated with the use of the CFE, and the boundary of the NCMPA. This cross-tidal plume footprint represents the <63 µm fines component of the seabed sediments that may be mobilised by the CFE.

Figure 4.4. (re-presented): Location of proposed use of Controlled Flow Excavation and / or rock placement and worst case modelled sand advection and fine sediment plume (from use of CFE) at the north location



The overlap of the modelled worst case sediment plume overlaps with 2.87 km^2 of the Noss Head NCMPA. This equates to 38% of the site area (Noss Head MPA covers a total area 7.53 km^2).

As discussed in Section 3.2.2.1 of the main EA report (MarineSpace, 2019), the sediment along the majority of the cable route is sandy gravel, gravelly sand and sand. Data from an assessment for Race Bank (ABPmer, 2017) suggest that sand would be expected to be re-suspended no more than 10 m above the seabed. Sand-sized particles will also settle out of suspension relatively rapidly following disturbance with ABPmer (2017) suggesting re-settlement within 20 s of initial suspension.

These effects may result in a short-term impact in the localised area but as presented in Figure 4.4, and discussed above, this area of effect is located outside of the NCMPA.

For fine sediment (<63 µm) advection, the spatial extent of plumes will be greatest along the northern section of the cable route in the vicinity of the Noss Head NCMPA, with a maximum potential advection of 15 km along the tidal prism either side of the location of the cable where CFE works take place (effectively in a north-northeast-south-southwest orientation). However, apart from the immediate area around the CFE works, where very elevated suspended sediment levels will occur, the level of suspended sediments in the fine plumes will be barely recordable above background levels within a few hundred metres of the CFE works (ABPmer, 2017). This is especially the case cross-tidal i.e. moving westwards (and eastwards) across the predominant ebb and flood tide flow.

Sediment plumes and deposition footprints (indirect effects) will, therefore, result in a short-term (hours), and generally localised (10s and 100s of metres from works) increase in SSC related to the tidal excursion. Turbulence at the seabed may also further disturb sediment resulting in increased suspension.

5.1.3. Determination of Impacts from Increased Turbidity and Smothering from Deposition of Advected Sediments and Plumes from Controlled Flow Excavation and / or Placement of Rock

Horse mussel is a biogenic filter-feeding bivalve species. It is the evolution of biogenic reefs that makes the species a notable nature conservation feature of interest (Holt *et al.*, 1998). The reef has been cabled through during initial installation but has not been exposed to subsequent direct impacts or secondary effects associated with cable remediation works to since that time.

MarLIN indicates that horse mussel has a low intolerance (is relatively tolerant) to increased SSC, with an immediate recovery from this pressure (Tyler-Walters, 2007). It is insensitive to increases in SSC.

Holt *et al.* (1998) state that:

"*Effects of offshore disposal of dredge spoil* [on horse mussel] *and other solid wastes are little known. In a bed off the Humber long-term changes in contaminant loads associated with spoil disposal were detectable in the shells of these very long-lived animals. While this indicates survival of the mussels within a dispersal zone around a disposal ground, information on loss of condition, as occurs when Mytilus are subjected to excessive sediment loads, is not available…From such spoil mounds the material usually disperses, but there are no case histories to indicate rates of sediment accretion that Modiolus clumps can keep up with. Exploratory benthos sampling off North Wales in the 1960s showed that there were Modiolus beds in or near the ground for which FEPA licences are presently issued for disposals from Holyhead…*"

Tyler-Walters (2007) states that for smothering (deposition) pressure horse mussel shows a high sensitivity. It has an intermediate intolerance and a low recovering rate to this pressure. However, the assessment of sensitivity is based upon a benchmark of the bivalve being smothered by up to 5 cm of sediment for a period or 1 month.

As described in this assessment, the area of potential worst case cross-tidal sediment deposition expected from the use of CFE is no more than 1 mm of fines (<63 µm particles), that are expected to be re-mobilised and winnowed into natural background nearbed transport within a tidal cycle or two. The pressure resulting from deposition of fines associated with the use of CFE and / or rock placement does not trigger the benchmark and will be effectively undetectable at the location of the reefs in the Noss Head NCMPA.

In addition, it is possible that a positive effect may result from the promulgation of the sediment plume as it may result in a localised increase in biogenic matter and food particles that the reef may beneficially filter-feed from. This possible positive effect is not considered in a material manner in this assessment.

Considering the temporary temporal nature of the CFE and / or rock installation activity, the extremely small detectable increases in SSC and relatively undetectable deposition of fines, and the fact that horse mussel is either insensitive to the pressure (increased turbidity) or not exposed to the benchmark threshold that triggers sensitivity to smothering seabed footprint, it is determined that **no adverse effects on (risks to) site integrity will result for the Noss Head NCMPA**.

5.2. Ornithological Qualifying Features

5.2.1. Increased Turbidity from CFE and / or Placement of Rock

The proposed cable repair works will result in temporary disturbance to seabed sediments along the 35 km length of cable that will require exposing. This activity, to be undertaken by CFE, will result in a short-term (hours), localised (100s and 1000s of metres from works) increase in SSC in the area of the works. Turbulence at the seabed may also further disturb sediment resulting in increased suspension. Any elevations in SSC in the near-field will be localised and short-term. The magnitude, spatial extent and duration of the planned repair will be less than that assessed for the original main cable installation activities, which were deemed to not result in significant impacts via this effect.

The potential rock placement works that may be required will also lead to increased SSC, but any such increases will be even shorter in duration and more localised than those that will arise via the cable de-burial and re-burial works.

The magnitude, spatial extent and duration of the proposed remediation works will be far less than that assessed for the original main cable installation activities, which were deemed to not result in significant effects for habitat removal, abrasion, increased turbidity, smothering or alteration of processes relevant to the structure and function of the MPAs.

Sediment along the majority of the cable route is coarse in nature, mostly consisting sandy gravel, gravelly sand and sand (MarineSpace, 2018, 2019). Resuspension of coarse sediments is spatially and temporally limited. Modelling results for Race Bank (ABPmer, 2017) indicate that coarser sediments (sand and gravel) will settle relatively rapidly to the seabed. Modelled results from a 100% sand seabed indicated values in the region of 200 m for the distance resuspended sand would be advected by a current, and with a duration of influence on local suspended sediment concentrations of approximately 20 s. Seabed sediment types and current speeds along the C-M cable route are similar to those modelled at Race Bank so this scale and duration would appear to be applicable.

In operation, the CFE will leave a secondary trench as a result of the flow and induced erosion of the seabed sediment. Any potential secondary trench created by the project will, on average, be managed so that the depth of any secondary trench will be less than 0.3 m deep below the mean seabed level.

CFE will redistribute the majority of the current seabed material in berms back into the cable trench. There may, however, be some preferential sorting, with larger particles deposited closer to the site of operation of the tool and finer particles travelling further. This is temporary, and natural seabed sediment transport processes will continue post-operation with the relatively strong tide-driven currents or wave action transporting the surface seabed layers and restoring the natural composition.

In addition, the proposed areas of works are occurring on areas of seabed that have previously been impacted and any additional works on areas of cables will only result in a slight delay (up to 12 months) of the recovery of the seabed previously assessed, and determined, to not result in any adverse effects on the integrity of the site (MarineSpace 2017c, 2018).

5.2.2. Determination of Impacts of Increased Turbidity and Deposition

Considering the temporary temporal nature of the CFE and / or rock installation activity, the use of the CPS and creation and presence of a rock berm, the extremely small seabed footprint in the context of the all bird foraging ranges assessed, and the small magnitude of habitat alteration from sand advection and plume settlement it is determined that **no adverse effects on site integrity will result for the SPAs and Ramsar sites** screened into assessment:

- Pentland Firth pSPA;
- Moray Firth pSPA;
- North Caithness Cliffs SPA;
- East Caithness Cliffs SPA;
- Troup, Pennan and Lion's Heads SPA; and
- Buchan Ness to Collieston Coast SPA.

5.2.3. Prey Species Habitat Loss and Loss of Foraging Habitat

It may be necessary to construct rock berms to cover cables between KP 11 and KP 15 within the Moray Firth pSPA. These are anticipated to be up to 1.7 m above MSBL with a width at seabed surface of 6 m. At the time of assessment, the total length of this protection is not known. Whilst likely that the entire 4 km length will not require the construction of rock berms the assessment assumes, in a precautionary manner, that this may be the case. The assessment envelope is extra-precautionary as it assumes 4,500 m of rock berm construction resulting in permanent habitat loss / alteration (Table 1.1).

Table 1.1 shows that the worst case seabed footprint for rock berm construction equates to an area of 0.027 km^2 (4,500 m length x 6 m width). This area is assumed to fall entirely within the Moray Firth pSPA and could result in the permanent loss of benthic habitat that is important for prey species for the classified populations of the pSPA.

The rock berm presents a pressure pathway to the over-wintering classified populations as it represents a permanent loss of habitat potentially supporting prey species.

CFE works and installation of the CPS have the potential to temporarily affect the local seabed sediments as a result of the redeposition of sediments suspended as a result of the CFE operation. Sediment along the majority of the cable route is coarse in nature, mostly consisting sandy gravel, gravelly sand and sand. Resuspension of coarse sediments is spatially and temporally limited. Modelling results for Race Bank (ABPmer, 2017) indicate that coarser sediments (sand and gravel) will settle relatively rapidly to the seabed. Modelled results from a 100% sand seabed indicated values in the region of 200 m for the distance resuspended sand would be advected by a current, and with a duration of influence on local suspended sediment concentrations of approximately 20 s. Seabed sediment types and current speeds along the C-M cable route are similar to those modelled at Race Bank so this scale and duration would appear to be applicable.

In operation, the CFE will leave a secondary trench as a result of the flow and induced erosion of the seabed sediment. Any potential secondary trench created by the project will, on average, be managed so that the depth of any secondary trench will be less than 0.3 m deep below the mean seabed level.

CFE will redistribute the majority of the current seabed material in berms back into the cable trench. There may, however, be some preferential sorting, with larger particles deposited closer to the site of operation of the tool and finer particles travelling further. This is temporary, and natural seabed sediment transport processes will continue post-operation with the relatively strong tide-driven currents or wave action transporting the surface seabed layers and restoring the natural composition.

The seabed itself is assessed as having no sensitivity to redistribution of seabed sediments (N.B.: the sensitivity of biological receptors will be assessed within the appropriate biological environment sections).

The magnitude of pressure is low and redistribution of natural sediments means any changes will be barely distinguishable and approach the natural pre-works condition after the action of local and regional sediment transport processes.

It is anticipated that some temporary modification of seabed character will take place as a result of rock placement and the installation of the CPS along the cable route. The preferred option for cable burial will be to use CFE, however in areas where CFE is ineffective, rock placement within the existing trench and to relative seabed level only will occur. The exact length of rock placement required is currently unknown, however a worst case (if unrealistic) scenario would be for rock placement to occur along the whole length of currently exposed cable (i.e. along the entire 35 km of the proposed works).

Placement of rock will, however, temporarily alter the current seabed sediments from predominantly gravelly sand and sandy gravels, to a gravel sediment within the backfilled trench. It should be noted, however, that the level of this placed gravel will remain below MSBL surrounding the trench, and that natural seabed sediment transport will, over time, deposit local sands into and over the emplaced gravel. The ES (SSE, 2011) suggests that:

"the seabed will gradually be reworked by currents, wave action and seabed animals until within a few months or years the tracks of the cables are not expected to be visually distinguishable at the seabed."

5.2.4. Determination of Impacts on Prey Species and Loss of Foraging Habitat

The rock berm will result in a **permanent** loss of seabed habitat supporting prey species in the Moray Firth pSPA only.

Table 1.1 shows that the worst case seabed footprint for rock berm construction equates to 4,500 m length x 6 m width = an area of 0.027 km^2. This area is assumed to fall entirely within the Moray Firth pSPA. The pSPA comprises in total an area of 1,762.36 km^2. The area of permanent habitat loss associated with the worst case footprint of rock berm equals 0.000015% of the pSPA total habitat provision for breeding and over-wintering shag and the over-wintering divers, shag, mergansers and seaducks. This area of seabed is so small, that even it represented prime foraging habitat and habitat supporting prey species, it's effect would be entirely undetectable at the population-scale within the pSPA.

The extremely small seabed footprint in the context of the pSPA assessed, and the small magnitude of impact it is determined that **no adverse effects on site integrity will result for the Moray Firth pSPA in relation to permanent loss of habitat supporting prey species and provision of prey species**.

Assuming a worst case scenario that the entire 35,000 m length of remediated trench is filled with emplaced rock, and the trench width is 6 m, then the overall footprint of effect across the firth is calculated as 0.21 km^2. The works are also short in duration but will interact with breeding birds.

However, the area of actual effect on prey species habitat and the availability of prey species occurs only within the Moray Firth pSPA. Approximately 8 km of cable may require rock placement within the pSPA and this equates to 6 m width x 8,000 m length = 48,000 m^2 (0.048 km^2) (several orders or magnitude less that the recent MPAs assessment in MarineSpace (2017c) and half the area assessed in MarineSpace (2018)): 0.1 km^2 for the additional deposition of rock projection in the 2017 assessment compared to a maximum of 0.048 km^2 for the proposed works within the pSPA.

The additional rock placement will account for a loss of 0.048 km^2 of seabed within the site. The Moray Firth pSPA comprises in total an area of 1,762.36 km^2. The additional rock accounts for a loss of 0.003% of the area of the pSPA. This makes no account for suitability of that habitat space to support prey species. However, considering the extremely small extent of footprint the effects are expected to be negligible and undetectable at population scale, either for fish and other prey species, but also at the classified bird population level.

The installation of CPS may involve some limited trenching to assist application of the metal shells onto the cable. As indicated in Table 1.1 the pressures associated with this are assumed worst case to be similar to the parameters for rock placement e.g. 6 m width (which is very precautionary for the CPS) x length of cable protected). For installation of CPS within the Moray Firth pSPA this equals an area of 0.0024 km^2 of seabed (6 m width x 400 m length) or 0.00014% of the area of the pSPA. This makes no account for suitability of that habitat space to support prey species. However, considering the extremely small extent of footprint the effects are expected to be negligible and undetectable at population scale, either for fish and other prey species, but also at the classified bird population level.

The overall residual effects on fish, including prey species, from disturbance of the seabed are considered to be negligible; a total combined footprint of 0.0774 km^2 resulting in 0.004% of the pSPA being exposed to permanent and temporary habitat loss and alteration. The works do not extend across either a full winter or summer period and sufficient foraging area remains available to all bird species. This is especially the case when considering the fact that only discrete areas of cable will be worked at any single time within the window of operations.

The significance of effects on prey species and foraging habitat availability are not of a magnitude sufficient to result in any adverse effects on qualifying species and their classified populations.

Considering the **temporary** temporal nature of the CFE and / or rock installation activity, installation of the CPS and construction and presence of rock berm(s), the extremely small seabed footprint in the context of the all bird foraging ranges assessed, and the small magnitude of habitat alteration it is determined that **no adverse effects on site integrity will result for the SPAs and Ramsar sites** screened into assessment:

- Moray Firth pSPA;
- Pentland Firth pSPA;
- North Caithness Cliffs SPA;
- East Caithness Cliffs SPA;
- Troup, Pennan and Lion's Heads SPA; and
- Buchan Ness to Collieston Coast SPA.

5.2.5. Underwater Sound Emissions on Prey Species

The effects of underwater noise on bird prey species were assessed in the 2011 ES (SSE, 2011) and associated HRA. The determinations were that no adverse effects on site integrity (for all sites and qualifying species assessed) would result.

The increase in underwater sound emissions associated with the use of CFE and placement of additional rock will extend the period of exposure to bird prey species. However, the overall area of seabed affected by extended periods of underwater sound emissions will not substantially affect areas of sea that are suitable for seabird foraging (for any species). SSE (2011) demonstrated that the area of effect is localised to within approximately 5 m of the area of rock placement whilst rock deposition is occurring. This potential area of effect is very small compared with nearby areas where seabirds are known to feed. Furthermore, the source of noise associated with, and effects of, the proposed activities will be temporary and localised, and fish populations are not determined to be adversely affect.

It is also important to note that the noise associated with the proposed works, including vessels doing the works, is much less than that associated with piling operations. The piling operations assessed for platform installation were determined to have no adverse effects on fish species (SSE, 2011).

Migratory fish species which are qualifying features of SACs or Ramsar sites are assessed separately below. No adverse effects on those populations were determined.

5.2.6. Determination of Impacts from Underwater Sound Emissions on Prey Species

Considering the temporary temporal nature of the rock installation activity, the small seabed footprint in the context of the all bird foraging ranges assessed, and the small magnitude of habitat alteration it is determined that **no adverse effects on site integrity will result for the SPAs and Ramsar sites** screened into assessment:

- Pentland Firth pSPA;
- Moray Firth pSPA;
- North Caithness Cliffs SPA;
- East Caithness Cliffs SPA;
- Troup, Pennan and Lion's Heads SPA; and
- Buchan Ness to Collieston Coast SPA.

5.3. Annex II Marine Mammal Features

5.3.1. Prey Species Habitat Loss, Loss of Foraging Habitat Space and Impacts from Underwater Sound Emissions and Foraging Success

The determinations made in Section 5.2 are also directly applicable to marine mammal prey species. All qualifying marine mammal features have sufficient range and foraging habitat space to make the determinations comparable.

5.3.2. Determination of Impacts on Prey Species Habitat Loss, Foraging Area and from Underwater Sound Emissions on Prey Species

Considering the temporary temporal nature of the activities assessed, the small seabed footprint in the context of the all marine mammal foraging ranges assessed, and the extremely small magnitude of habitat alteration it is determined that **no adverse effects on site integrity will result for the SACs and Ramsar sites** screened into assessment:

- Moray Firth SAC – bottlenose dolphin; and
- Dornoch Firth and Morrich More SAC – harbour seal.

5.3.3. Impacts from Damage and Disturbance

The use of CFE and the placement of rock onto the seabed or the use of acoustic survey and vessel positioning / navigation equipment associated with the rock placement have the potential to result in secondary effects that can affect marine mammal features and / or their prey species (Death or permanent or temporary injury caused by propagation of underwater sound to the individual or to prey species; and Disturbance / displacement caused by propagation of underwater sound to the individual or to a prey species). There may also be effects associated with an increase in underwater sound emissions from the vessels associated with the works. Finally, the risk of collision with vessels must be considered.

To determine if there may be any adverse effects associated with emitted underwater sound waves two criteria have to be considered:

- Sensitivity of the species to the underwater sound waves produced by the source activity; and
- Potential for the species to be exposed to the underwater sound waves pathway.

5.3.3.1. Marine Mammal Hearing Sensitivities and Thresholds

Sensitivity to underwater noise is dependent upon the specific hearing abilities of the species. The potential effects are:

- Lethal effects and physical injury;
- Auditory injury (Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS)); and
- Behavioural response.

The thresholds used in this screening exercise are taken from the EPS Assessment report (Natural Power, 2017). It should be noted that although pinnipeds are not EPS and thus not directly assessed by Natural Power (2017) it is stated (in the EPS Assessment report) that the determinations of the assessment (including any proposed mitigation measures and residual risk) are also applicable for pinnipeds.

To fully inform this report and screening exercise relevant information used from Natural Power (2017) is presented in Annex A.

The following sites were screened into assessment:

- Moray Firth SAC – bottlenose dolphin; and
- Dornoch Firth and Morrich More SAC – harbour seal;

In a precautionary manner the screening assumes that connectivity / exposure (to increased underwater sound emissions from: cable de-burial; cable laying; placement of rock onto the seabed; or the use of acoustic survey and vessel positioning / navigation equipment; or directly from the vessels associated with the works) exists for the proposed areas of works and qualifying features listed above.

Potential vessel collision connectivity is present at the proposed work areas and qualifying features listed above (see Table 4.8 for foraging range interactions).

5.3.3.2. Lethal Effects and Physical Injury

Use of Controlled Flow Excavation

Natural Power (2017) notes that no predictions exist for CFE, however suction dredging is considered a suitable proxy and the Barham *et al*. (2014) underwater noise assessment for the Caithness to Moray project noted that this activity was less impacting than cable laying (when modelled for bottlenose dolphins). There is no potential for lethal effects or physical injury (for which the thresholds are 240 dB re 1 µPa and 220 dB re 1 µPa respectively) from the placement of rock (see Annex A).

Rock Placement

Rock placement was given an estimated unweighted source level of 172 dB re 1 µPa @ 1 m (Natural Power, 2017). There is no potential for lethal effects or physical injury (for which the thresholds are 240 dB re 1 µPa and 220 dB re 1 µPa respectively) from the placement of rock (see Annex A).

Acoustic Survey Equipment

There is no potential for lethal effects resulting from increased anthropogenic noise from acoustic survey equipment (Natural Power, 2017).

Increased Vessel Noise

The estimated unweighted source level for noise from a large vessel is 168 dB re 1 µPa @ 1 m (Natural Power, 2017). There is therefore no potential for lethal effects or physical injury, for which the thresholds are 240 dB re 1 µPa and 220 dB re 1 µPa respectively.

Determination

No adverse effects on site integrity are predicted for:

- Moray Firth SAC – bottlenose dolphin; and
- Dornoch Firth and Morrich More SAC – harbour seal.

5.3.3.3. Auditory Injury

Controlled Flow Excavation and Rock Placement (including Rock Berm)

It is assumed that marine mammals will flee from the noise source, rather than remain stationary. Therefore, exposure to a level of noise at which auditory injury is expected to occur from the use of CFE and / or rock placement work is extremely unlikely to occur. This is because the M-weighted SEL ranges out to which auditory injury is predicted show that auditory injury is only likely to occur at ranges of less than 1 metre (Natural Power, 2017).

Acoustic Survey Equipment

Natural Power (2017) states:

"*Sound emitted by the USBL system has the potential to cause physical injury at very close range and induce the onset of auditory injury in low and high frequency cetaceans. However, with implementation of the mitigation measures outlined in section 7.1* [see following]*, there is negligible potential for physical or auditory injury as a consequence of increased anthropogenic noise from geophysical equipment which emits sound*."

Mitigation measures for the operation of USBL systems will consist of pre-work searches prior to the use of USBL systems and beacons. See Section 7 for a detailed description of the proposed mitigation measures.

Increased Vessel Noise

The M-weighted SEL ranges out to which auditory injury is expected to occur for noise from large vessels is predicted to be less than 1 metre (Natural Power, 2017).

Determination

No adverse effects on site integrity are predicted (so long as mitigation measures are implemented) for:

- Moray Firth SAC – bottlenose dolphin; and
- Dornoch Firth and Morrich More SAC – harbour seal.

5.3.3.4. Behavioural Response – Disturbance

Controlled Flow Excavation and Rock Placement (including Rock Berm)

Natural Power (2017) predicted that the potential for a behavioural response due to increased anthropogenic noise from rock placement was 31 m for bottlenose dolphin (and 99 m for harbour porpoise) based on predicted 90 dBht (species) impact ranges. These ranges (<1 km) do not interact with any of the SACs with Annex II marine mammal features. Therefore, only foraging individuals have the potential to interact with the effect footprint. It is expected that sound emissions associated with cable de-burial will not exceed those associated with rock placement.

Natural Power (2017) estimated the areas of potential impact from each activity using the 90 dBht (species) impact ranges as the radius in the formula πr2. The data used in the EPS Assessment report indicate that estimated number of individuals which have the potential to be affected is less than one for all species.

Acoustic Survey Equipment

Natural Power (2017) states:

"*The positioning equipment (USBL systems and beacons) may be detected by cetacean EPS and therefore have the potential to cause animals to exhibit a behavioural response. However, the most likely response will be temporary avoidance of the area (there is evidence that short-term disturbance caused by a commercial two-dimensional seismic survey does not lead to long-term displacement of harbour porpoises… The resulting impact is considered not significant in terms of EPS legislation (i.e. it will not be detrimental to the maintenance of the population of the species concerned at a FCS in their natural range).*"

This determination is also applicable at a site level (SAC) as sufficient extensive foraging habitat remains for all qualifying species, and the use of such equipment was previously licensed for the initial cable installation scope of works. In addition, mitigation measures will be implemented (see Section 7).

Except for the USBL systems and beacons, the sound emitted by the acoustic survey equipment will not be audible to marine mammals. This is because the frequencies over which the equipment operates are higher than the higher frequency hearing cut-offs for each of the functional hearing groups (Natural Power, 2017; Annex A).

Increased Vessel Noise

The number of individuals which have the potential to be affected by increased vessel noise was not estimated by Natural Power (2017) because the ranges of potential impact were determined to be so small. It is considered that sound from vessel activity associated with the proposed rock placement work will not significantly add to the background noise levels from vessels already present in the Moray Firth when considering the high number of vessel movements already existing within the Moray Firth (SSE, 2011; Natural Power, 2017).

Determination

No adverse effects on site integrity are predicted for:

- Moray Firth SAC – bottlenose dolphin; and
- Dornoch Firth and Morrich More SAC – harbour seal.

5.3.3.5. Vessel Collision

Vessel collisions are known to cause mortality in marine mammals. These events are usually associated with large cetaceans and tend to be lethal (Natural Power, 2017).

Non-lethal collisions are documented with injuries represented by blunt trauma (collision with the bow) or lacerations (collision with propellers). Injured cetaceans may have an increased susceptibility to predation or succumbing to secondary infections (Natural Power, 2017).

Collisions between larger vessels and small odontocete cetaceans are considered much more of a risk with dolphins often seeking positive interactions such as bow-riding. These small odontocetes do demonstrate avoidance behaviour from small manoeuvrable vessels such as speedboats and jet-skis (Natural Power, 2017).

The use of CFE and / or rock placement works will be undertaken by large vessels following the cable route (a pre-defined linear route) when working. Nearshore works conducted by small to medium-sized vessels will either be stationary or travelling at low working speeds. Considering these factors, it will be easy for marine mammals to predict vessel movements and to demonstrate avoidance. The potential for collision with the vessels undertaking the rock placement work is therefore considered to be negligible.

As mentioned in Natural Power (2017), the risk of collision during transit to and from the area of works will be mitigated using a dedicated competent observer and the Master of the Vessel implementing the Scottish Marine Wildlife Watching Code (see Section 7.1.3).

Determination

No adverse effects on site integrity are predicted for:

- Moray Firth SAC – bottlenose dolphin; and

- Dornoch Firth and Morrich More SAC – harbour seal.

5.3.3.6. Overall Determination of Adverse Effects

No adverse effects on site integrity can be determined for pressures associated with underwater sound emissions, use of acoustic survey equipment, vessel noise and vessel collision risk for the qualifying Annex II marine mammal features of: Moray Firth SAC; and Dornoch Firth and Morrich More SAC.

5.4. Annex II Migratory Fish Features

5.4.1. Damage and Disturbance

The following SACs were screened into assessment:

- Berriedale and Langwell Waters SAC – Atlantic salmon;
- River Oykel SAC - Atlantic salmon and freshwater pearl mussel;
- River Moriston SAC - Atlantic salmon and freshwater pearl mussel;
- River Spey SAC – Atlantic salmon, sea lamprey and freshwater pearl mussel;
- River Borgie SAC – Atlantic salmon and freshwater pearl mussel;
- River Naver SAC - Atlantic salmon and freshwater pearl mussel;
- River Thurso SAC – Atlantic salmon; and
- River Dee SAC - Atlantic salmon and freshwater pearl mussel.

The use of CFE and / or placement of rock onto the seabed or the use of acoustic survey and vessel positioning / navigation equipment associated with the CFE and / or rock placement have the potential to result in secondary effects that can affect migratory fish features (Death or permanent or temporary injury caused by propagation of underwater sound to the individual; and Disturbance / displacement caused by propagation of underwater sound to the individual). There may also be effects associated with an increase in underwater sound emissions from the vessels associated with the works.

To determine if there may be any adverse effects associated with emitted underwater sound waves two criteria have to be considered:

- Sensitivity of the species to the underwater sound waves produced by the source activity; and
- Potential for the species to be exposed to the underwater sound waves pathway.

5.4.1.1. Migratory Fish Hearing Sensitivities and Thresholds

Sensitivity to underwater noise is dependent upon the specific hearing abilities of the species. The potential effects are:

- Lethal effects and physical injury;
- Auditory injury (Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS)); and
- Behavioural response.

Atlantic salmon can detect and respond to underwater sound emissions. They are classified as hearing generalists, unable to hear high frequencies but able to hear low frequency sound and infrasound (SSE, 2011). Nedwell *et al.* (2008) postulate that Atlantic salmon is most sensitive to underwater sound at a frequency of 160 Hz, where the threshold Sound Pressure Level is 95 dB re 1 µPa @ 1 m. Based on these data, underwater noise might cause tissue damage to the auditory system (PTS) of the salmon following 1 hour exposure at a level of 215 dB re 1 µPa @ 1 m. Hearing impairment (TTS) might occur following exposure at a level of 195 dB re 1 µPa @ 1 m, for a period of 1 hour.

Nedwell *et al.* (2008) discuss injury and fatality from underwater transient pressure waves related to both the peak pressure, and the duration that the peak pressure acts upon the body of the fish. In terms of a peak pressure level exposure it is indicated that:

- Lethal effects occur at incident peak underwater sound levels of ≥260 dB re 1µPa @ 1 m;
- There is increasing likelihood of death or severe injury leading to death in a short time at incident peak underwater sound levels of ≥240 dB re 1µPa @ 1 m; and
- Direct physical injury to gas-containing structures and auditory organs may occur, particularly from repeat exposures at incident peak underwater sound levels of ≥220 dB re 1µPa @ 1 m.

Atlantic salmon have a dB_{ht} (*Salmo salar*) metric of $90dB_{ht}$ (SSE, 2011). This is postulated as the threshold for significant avoidance reaction, meaning virtually all individuals will take avoidance action when exposed to that sound level.

Research presented in the Moray West Offshore Windfarm HRA screening report indicates that sea lamprey responds to sound at frequencies of between 20 Hz and 100 Hz. However, they do not possess a swim bladder and are less sensitive to sound than fish that do possess a swim bladder (Moray Offshore Windfarm (West) Ltd, 2017). Therefore, it is considered very unlikely that they are more noise sensitive than Atlantic salmon. For the purposes of this screening exercise the thresholds for Atlantic salmon are also considered relevant to sea lamprey.

5.4.1.2. Lethal Effects and Physical Injury

Controlled Flow Excavation and Rock Placement (including Rock Berm)

Rock placement was given an estimated unweighted source level of 172 dB re 1 µPa @ 1 m (Natural Power, 2017). There is no potential for lethal effects or physical injury (for which the thresholds are ≥240 dB re 1 µPa and ≥220 dB re 1 µPa respectively) from the placement of rock. It is determined that the use of CFE (analogous to dredging activity from the dredge head) will be no noisier than rock placement (Natural Power, 2017).

Acoustic Survey Equipment

There is no potential for lethal effects resulting from increased anthropogenic noise from acoustic survey equipment as the typical source pressure level from an USBL system is <220 dB re 1 µPa (Natural Power, 2017). All other acoustic survey equipment types emit typical source pressure levels <220 220 dB re 1 µPa, except multi beam echo sounders (MBES), which may operate output at 221 dB re 1 µPa (Natural Power, 2017). Therefore, it is possible that physical injury may occur to any

Atlantic salmon or sea lamprey that is within range of MBES equipment. However, MBES operate at a 200-455 kHz frequency range which is beyond the sensitivity range of Atlantic salmon (160 Hz) and sea lamprey (20-100 Hz).

Increased Vessel Noise

The estimated unweighted source level for noise from a large DP vessel is in the range of 168-177 dB re 1 µPa @ 1 m (SSE, 2011; Natural Power, 2017). There is therefore no potential for lethal effects or physical injury, for which the thresholds are ≥240 dB re 1 µPa and ≥220 dB re 1 µPa respectively.

Determination

No adverse effects on site integrity are predicted for:

- Berriedale and Langwell Waters SAC – Atlantic salmon;
- River Oykel SAC - Atlantic salmon;
- River Moriston SAC - Atlantic salmon;
- River Spey SAC – Atlantic salmon and sea lamprey;
- River Borgie SAC – Atlantic salmon;
- River Naver SAC - Atlantic salmon;
- River Thurso SAC – Atlantic salmon; and
- River Dee SAC - Atlantic salmon.

5.4.1.3. Auditory Injury

Controlled Flow Excavation and Rock Placement (including Rock Berm)

It is assumed that fish species will flee from the noise source, rather than remain stationary. Therefore, exposure to a level of noise at which auditory injury is expected to occur from the rock placement work is extremely unlikely to occur. This is because the M-weighted SEL ranges out to which auditory injury is predicted show that auditory injury is only likely to occur at ranges of less than one metre (Natural Power, 2017). It is determined that the use of CFE (analogous to dredging activity from the dredge head) will be no noisier than rock placement (Natural Power, 2017).

Acoustic Survey Equipment

The typical source pressure level from an USBL system is <220 dB re 1 µPa (Natural Power, 2017). All other acoustic survey equipment types emit typical source pressure levels <220 220 dB re 1 µPa, except multi beam echo sounders (MBES), which may operate output at 221 dB re 1 µPa (Natural Power, 2017). Therefore, it is possible that auditory injury may occur to any Atlantic salmon or sea lamprey that is within range of MBES equipment (direct physical injury to auditory organs may occur, particularly from repeat exposures at incident peak underwater sound levels of ≥220 dB re 1µPa @ 1 m). However, MBES operate at a 200-455 kHz frequency range which is beyond the sensitivity range of Atlantic salmon (160 Hz) and sea lamprey (20-100 Hz).

Increased Vessel Noise

The M-weighted SEL ranges out to which auditory injury is expected to occur for noise from large vessels is predicted to be less than 1 metre (Natural Power, 2017).

DP vessels associated with rock placement activity produce a source noise level of 177dB re 1µPa @ 1m (SSE, 2011). This noise from the thrusters will originate at a depth of about 5-10 m which is contiguous with the surface 0-5 m water depth typically used by Atlantic salmon (SSE, 2011). Atlantic salmon and sea lamprey are likely to demonstrate avoidance behaviour within 5 m of a vessel and auditory injury is unlikely to occur considering the threshold of repeat exposures at incident peak underwater sound levels of ≥220 dB re 1µPa @ 1 m.

Determination

No adverse effects on site integrity are predicted for:

- Berriedale and Langwell Waters SAC – Atlantic salmon;
- River Oykel SAC - Atlantic salmon;
- River Moriston SAC - Atlantic salmon;
- River Spey SAC – Atlantic salmon and sea lamprey;
- River Borgie SAC – Atlantic salmon;
- River Naver SAC - Atlantic salmon;
- River Thurso SAC – Atlantic salmon; and
- River Dee SAC - Atlantic salmon.

5.4.1.4. Behavioural Response – Disturbance

Controlled Flow Excavation and Rock Placement (including Rock Berm)

SSE (2011) predicted that the potential for a behavioural response due to increased anthropogenic noise from rock placement for Atlantic salmon was well below that expected to elicit avoidance behaviour. Atlantic salmon have a dB_{ht} metric of $90dB_{ht}$ (*Salmo salar*) (SSE, 2011). This is postulated as the threshold for significant avoidance reaction, meaning virtually all individuals will take avoidance action when exposed to that sound level. It is determined that the use of CFE (analogous to dredging activity from the dredge head) will be no noisier than rock placement (Natural Power, 2017).

Rock placement was given an estimated unweighted source level of 172 dB re 1 µPa @ 1 m (Natural Power, 2017). This translates to an approximate value < 42 dB_{ht}(*Salmo salar*), which is well below the threshold for that species.

Acoustic Survey Equipment

Considering that MBES system's typical source pressure levels operate outside the sensitivity bands of Atlantic salmon and sea lamprey hearing it is unlikely that avoidance behaviour will occur.

Increased Vessel Noise

It is considered that sound from vessel activity associated with the proposed rock placement work will not significantly add to the background noise levels from vessels already present in the Moray Firth when considering the high number of vessel movements already existing within the Moray Firth (SSE, 2011; Natural Power, 2017).

Determination

No adverse effects on site integrity are predicted for:

- Berriedale and Langwell Waters SAC – Atlantic salmon;
- River Oykel SAC - Atlantic salmon;
- River Moriston SAC - Atlantic salmon;
- River Spey SAC – Atlantic salmon and sea lamprey;
- River Borgie SAC – Atlantic salmon;
- River Naver SAC - Atlantic salmon;
- River Thurso SAC – Atlantic salmon; and
- River Dee SAC - Atlantic salmon.

5.4.1.5. Overall Determination of Adverse Effects

No adverse effects on site integrity can be determined for pressures associated with underwater sound emissions, use of acoustic survey equipment, and vessel noise for the qualifying Annex II migratory fish features of: Berriedale and Langwell Waters SAC; River Oykel SAC; River Moriston SAC; River Spey SAC; River Borgie SAC; River Naver SAC; River Thurso SAC; and River Dee SAC.

As no adverse effects are predicted for Atlantic salmon then **no adverse effects on site integrity for freshwater mussel feature are also determined** for: **River Oykel SAC; River Moriston SAC; River Spey SAC; River Borgie SAC; River Naver SAC; and River Dee SAC.**

6. In-combination Assessment

Other reasonably foreseeable plans or projects that have been considered as part of this MPAs assessment include:

- Beatrice Offshore Wind Farm;
- Moray East Offshore Wind Farm;
- Moray West Offshore Wind Farm; and
- Previous C-M HVDC Link additional rock placement.

In addition, relevant information from consented projects has also been reviewed:

- Telford Offshore Wind Farm;
- MacColl Offshore Wind Farm;
- Stevenson Offshore Wind Farm; and
- Kincardine Offshore Wind Farm.

No significant in-combination effects were identified in any of the appropriate assessments associated with the projects listed above.

The most relevant assessment was presented in the C-M HVDC Link additional rock placement MPAs assessment report (MarineSpace, 2018). That in-combination assessment considered all of the reasonably foreseeable plans and projects listed here and was conducted in November 2017. That in-combination assessment, which is part of this assessment, determined no adverse effects on the integrity of all MPAs considered.

It should be noted that the Beatrice OWF ES identified that due to the conservation importance of the bottlenose dolphin and harbour seal (and their associated SACs within the Moray Firth), the in-combination effects during the piling period were considered to be significant for both these species.

The population modelling showed that harbour seal would recover in the long-term and therefore no significant effects were predicted for this species or for the Dornoch Firth and Morrich More SAC. Bottlenose dolphin was also likely to recover in the long-term, but subject to the uncertainties in this assessment (e.g. limited scientific understanding of the population-level effect of displacement), the effect on bottlenose dolphin and the Moray Firth SAC was predicted as significant. For all other species there were no significant effects predicted from cumulative piledriving noise.

The Beatrice OWF HRA determined that no in-combination effects were likely to materialise regarding bottlenose dolphin and harbour seal qualifying features.

No detailed information is currently available regarding the Moray East Offshore Wind Farm – alternate design or the Moray West Offshore Wind Farm. However, the pressures (effects) associated with the additional rock placement on the relevant MPAs and their qualifying features are unlikely to have a temporal overlap with activities likely to combine effects from construction of the wind farm. This is specifically the case for indirect effects associated with prey species, foraging activity or underwater sound emissions.

Habitat loss or alteration for prey species associated with the use of CFE or the placement of additional rock at MSBL are determined to be so small within the context of functional habitat provision for qualifying feature's prey species that they are not significant.

The only MPA where there is a combined effect from known deposition of rock with the proposed works assessed in this report is the Moray Firth pSPA. In 2018 additional rock emplacement accounted for a loss of 0.044 km^2 of seabed within the site. The Moray Firth pSPA comprises in total an area of 1,762.36 km^2. The 2018 rock placement accounts for a loss of 0.003% of the area of the pSPA. The proposed placement of rock accounts for an additional 0.048 km^2 of seabed within the site plus an area of 0.0024 km^2 of seabed associated with the CPS installation. Therefore, the total combined temporary habitat loss within the pSPA equals:

$$0.044\ km^2 + 0.048\ km^2 + 0.0024\ km^2 = 0.094\ km^2 \text{ of seabed.}$$

This equates to a combined footprint of 0.005% of the area of the pSPA.

In addition, the worst case footprint of permanent habitat loss from construction and presence of a rock berm in the pSPA is an area of 0.027 km^2.

Assuming an overlap in the period of recovery of the seabed from the 2018 works already completed, combined with the impact and recovery from the proposed works and factoring the footprint of permanent habitat loss, then for the 2-5 years the Moray Firth pSPA may have a combined 'loss' of 0.094 km^2 + 0.027 km^2 = 0.117 km^2 of seabed (prey species habitat) or **0.007% of the entire habitat provision with the whole pSPA.**

This increase is also only temporary given the use of CFE and a predicted return to natural seabed conditions or use of rock placement up to MSBL. The only permanent loss is associated with rock berm presence. The area affected in the short-term is so small as to be undetectable at the population level of the prey species and the designated and classified populations of fish, birds and marine mammals that forage within the Moray Firth.

It is determined that there will be NO ADVERSE EFFECTS ON THE INTEGRITY OF ANY SITE SCREENED INTO THIS ASSESSMENT IN-COMBINATION, OR ALONE.

7. Mitigation Measures Proposed for the use of USBL Systems and Beacons

The following text is taken directly from the EPS Assessment report (Natural Power, 2017) and proposes methods to mitigate significant or adverse effects on marine mammals within the area of influence of the rock placement works. This mitigation is also applicable for foraging Annex II marine mammal features from:

- Moray Firth SAC – bottlenose dolphin; and
- Dornoch Firth and Morrich More SAC – harbour seal.

7.1. Mitigation

Operation of the USBL systems and beacons during the cable pull in, CFE, backfill and rock placement work has the potential to cause (1) physical injury at very close range and (2) induce the onset of auditory injury in (low and high frequency) cetacean EPS. Therefore, mitigation in the form of pre-work searches will be undertaken prior to use of the USBL systems and beacons during all cable pull in, controlled flow excavation, backfill and rock placement work in order to reduce the potential for physical and auditory injury to negligible levels.

7.1.1. Pre-Work Searches

The methodology for the pre-work searches (which will be undertaken in order to reduce the potential for marine mammals to occur in close proximity to the USBL systems and beacons prior to their initiation) is based on the recommendations outlined in the JNCC guidelines (2017).

Clear channels of communication between the MMO / PAM operator and relevant crew will be established prior to commencement of any operations. The crew will inform the MMO / PAM operator (or nominated lead) sufficiently in advance of any proposed work so that a full pre-work search can be completed prior to work commencing.

At least one dedicated MMO / PAM operator will be available to undertake pre-work searches of 30 minutes in length. Visual searches of a 500 m radius mitigation zone will be conducted when weather conditions, daylight and sea state allow. During the hours of darkness, or when visual observation is not possible due to weather conditions or sea state, a proven PAM system (and operator) will be used.

If marine mammals are detected within the mitigation zone during a pre-work search (either visually or acoustically), work will be delayed until their passage, or the transit of the vessel, results in them being outside the mitigation zone. There will be a minimum of 20 minutes from the time of the last detection within the mitigation zone to the commencement of the work.

As per the 2017 JNCC guidelines, unplanned breaks refer to instances where the USBL system / beacons cease pinging unexpectedly during operations. In these instances:

- Work will resume without a pre-work search after unplanned breaks of 10 minutes or less, provided that no animals are detected in the mitigation zone during the breakdown period; and
- A full pre-work search will be conducted before work resumes after unplanned breaks of longer than 10 minutes. Any time the MMO / PAM operator has spent observing prior to the breakdown period will contribute to the pre-work search time.

7.1.2. Soft Starts

It is understood that it is not possible to soft start the USBL system or beacons therefore no soft starts will be employed. Where it is possible to do so, soft starts (gradual increase in the sound pressure over a duration of 20-40 minutes) will be employed on other pieces of geophysical equipment.

7.1.3. Transit Watches

A nominated competent observer on the bridge of all vessels will keep watch for marine mammals during transit between port and the location of works for the HVDC cable route. Any sightings will be communicated to the Master of the Vessel as soon as is practicable and the following actions, as per the Scottish Marine Wildlife Watching Code, implemented:

- The Master of the Vessel will ensure that marine mammals are avoided to a safe distance (100 m or more) in all possible circumstances; and
- The Master of the Vessel will minimise high powered manoeuvres where this does not impair safety.

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9. Annex A

Excerpts from the Draft European Protected Species Risk Assessment Report

Natural Power, 2017. *EPS Risk Assessment for Work Proposed in 2018 Caithness to Moray HVDC Project*. Document No. 1156585. Issue A.

Anthropogenic Noise Related Impact Assessments

Lethal Effects and Physical Injury

Lethal effects may occur where peak to peak levels exceed 240 dB re 1 µPa, Physical injury may occur where peak to peak levels exceed 220 dB re 1 µPa (Parvin et al., 2007).

Auditory Injury

Underwater sound can cause injury to the auditory system either following a brief exposure to extremely high sound levels, or following more prolonged exposure to lower levels of continuous sound (Richardson et al., 1995).

Nedwell et al. (2007) suggest the use of a 130 dBht (species) level as suitable criteria for predicting the onset of traumatic hearing loss in marine mammals. This is similar to that used for human exposure in air.

Southall et al. (2007) provide indicative thresholds for Sound Exposure Levels (SELs) that have the potential to cause auditory injury (Permanent Threshold Shift – PTS and Temporary Threshold Shift – TTS) in marine mammals. These thresholds are based on unweighted, instantaneous peak sound pressure levels (SPLs) and M-weighted SELs, where:

- *SEL: expression of total energy of a sound wave which incorporates both the sound pressure level and duration; and*
- *M-weighted function: frequency weighting applied to the SEL allowing functional hearing bandwidths of different marine mammal groups (e.g. harbour porpoise vs. bottlenose dolphin) taking a relevant or derived species audiogram into account.*

Thresholds of 198 dB re 1 µPa2-s are defined by Southall et al. (2007) for all cetacean groups exposed to pulsed noise and 215 dB re 1 µPa2-s for non-pulsed noise for predicting thresholds for the onset of PTS.

More recent work (King, 2013) undertaken on behalf of the Department for Energy and Climate Change (DECC) reviewed the Southall et al. (2007) report in light of updated studies and found that the thresholds required updating. The study found that certain species (e.g. harbour porpoise) are more susceptible to TTS as a result of noise exposure, whilst other odontocetes such as bottlenose dolphins are likely to have higher thresholds. As such, King (2013) recommends the use of species dependent ranges of 162–183 dB re 1µPa2-s for TTS onset and 177-198 dB re 1µPa2-s for PTS onset to indicate significant impacts for pulsed noise.

The US National Marine Fisheries Service (NMFS) issued guidance for assessing the effects of anthropogenic sound on marine mammal hearing in 2016 (NOAA, 2016). These thresholds are different to Southall et al.'s (the frequency weighting bands for each hearing group have been refined, and subsequently narrowed), and are presented below in Table 5.1 and Table 5.2 for comparison.

This assessment considers both the well-established Southall et al. (2007) thresholds, as well as the more precautionary (and recently published) NOAA (2016) thresholds.

Table 5.1: Comparison of PTS (and TTS in brackets) onset thresholds – SPLs (dB re 1 µPa) – in response to a single pulse exposure (assesses the potential for injury to occur instantaneously)

Functional hearing group	Non-pulsed sound	Pulsed sound	
	Southall *et al.* (2007)	Southall *et al.* (2007)	NOAA (2016)
Low frequency cetacean e.g. minke whale	230	230 (224)	219 (213)
Mid frequency cetacean e.g. bottlenose dolphin	230	230 (224)	230 (224)
High frequency cetacean e.g. harbour porpoise	230	230 (224)	202 (196)

Table 5.2: Comparison of PTS (and TTS in brackets) onset thresholds – SELs (dB re 1 µPa^2-s) – in response to a single pulse exposure within a 24 h period (allows assessment of whether the total energy that an animal receives as it flees the area will cumulatively lead to an effect over the period of time assessed)

Functional hearing group	Non-pulsed sound		Pulsed sound		
	Southall *et al.* (2007)	NOAA (2016)	Southall *et al.* (2007)	NOAA (2016)	King (2013)
Low frequency cetacean e.g. minke whale	215	199	198 (183)	183 (179)	-
Mid frequency cetacean e.g. bottlenose dolphin	215	198	198 (183)	185 (178)	198 (183)
High frequency cetacean e.g. harbour porpoise	215	173	198 (183)	155 (153)	~177 (162-171)

Behavioural Response

Table 5.3 presents information on species sensitivity, and therefore likelihood of response, to underwater noise.

Table 5.3: Estimated auditory bandwidth for cetaceans (Southall *et al.*, 2007; NOAA, 2016)

Functional hearing group	Relevant species	Estimated auditory bandwidth (kHz)
Low frequency cetaceans	Minke whale	0.007 - 35
Mid frequency cetaceans	Bottlenose dolphin	0.15 – 160
High frequency cetaceans	Harbour porpoise	0.2 – 180

The dB_{ht} (species) metric (Nedwell *et al.*, 2007) has been developed as a means of quantifying the potential for a behavioural effect on a species in the underwater environment. Sound is perceived differently by different species (since they have differing hearing abilities) and therefore the species name must be appended e.g. dB_{ht} (harbour porpoise). Table 5.4 summarises the dB_{ht} assessment criteria for a behavioural response.

Table 5.4: Assessment criteria to estimate the potential responses by EPS to underwater noise (Nedwell *et al.*, 2007)

Level in dB_{ht} (species)	Reaction
0	None
0 to 50	Mild reaction in minority of individuals, probably not sustained
50 to 90	Stronger reaction by majority of individuals, but habituation may limit effect
90 and above	Strong avoidance reaction by virtually all individuals.
Above 110	Tolerance limit of sound; unbearably loud.
Above 130	Possibility of traumatic hearing damage from single event.

Increased Anthropogenic Noise from Geophysical Equipment Which Emits Sound

Overview of Potential Impact

The use of geophysical equipment which emits sound has the potential to increase levels of anthropogenic noise in the marine environment (and therefore the potential to affect marine mammals). All geophysical, positioning, monitoring and navigational equipment carried by the vessels, ROVs and other remote systems (SCAR plough, controlled flow excavation system) have been examined and those which emit sound assessed.

Prediction of Potential Impact

A summary of the types of geophysical equipment (on the vessels, ROVs and other remote systems e.g. SCAR plough, controlled flow excavation system) which emit sound and are likely to be used during work proposed in 2018 is given in Table 5.8 below, along with the typical source pressure levels and frequency ranges of each type of equipment. An assessment of whether each type of equipment is likely to have the potential to induce the onset of auditory injury or a behavioural response has been made, with justification provided in the sections below.

Table 5.8: Details of the proposed types of geophysical equipment which emit sound

Equipment Type	Typical Source Pressure Level (dB re 1 µPa @ 1 m)	Potential for auditory injury?	Typical Frequency Range (kHz)	Potential for a behavioural response?
USBL System	< 220	Potential risk	18-36	Y
USBL Beacons	< 206	Potential risk	19-36	Y
Multi Beam Echo Sounder (MBES)	< 221	Negligible risk	200-455	N
Obstacle Avoidance Sonar (OAS)/Multi Beam Imaging Sonar	< 207	Negligible risk	200-1100	N
Dual Head Scanning Sonar (DHSS)	< 210	Negligible risk	200-2250	N
Doppler Velocity Log (DVL)	< 217	Negligible risk	600 or 1200	N

Lethal Effects and Physical Injury

The source pressure levels of the proposed geophysical equipment which emits sound are lower than the lethal effects criteria (240 dB re 1 µPa). Therefore there is no potential for lethal effects as a consequence of increased anthropogenic noise from geophysical equipment which emits sound.

Sound emitted by the USBL system and MBES has the potential to cause physical injury at very close range (their source pressure levels are equal to or slightly greater than the 220 dB re 1 µPa threshold at 1 m).

Auditory Injury

If the Southall et al. (2007) threshold for auditory injury (230 dB re 1 µPa; see Table 5.1) is used, the sound produced by the proposed geophysical equipment would not be considered to have the potential to induce the onset of auditory injury in any functional hearing group.

Using the NOAA (2016) thresholds (Table 5.1), none of the proposed geophysical equipment which emits sound has the potential to induce the onset of auditory injury in mid frequency cetaceans. However, high frequency cetaceans may be susceptible to the onset of auditory injury as a result of the sound produced by much of the geophysical equipment (the PTS onset threshold for high frequency cetaceans is an SPL of 202 dB re 1 µPa). This is also the case for low frequency cetaceans for the USBL and MBES (the PTS onset threshold for low frequency cetaceans is an SPL of 219 dB re 1 µPa).

It should be noted that, in shallow (< 200 m) water, the risk of causing injury to marine mammals from multi beam surveys is considered to be negligible (JNCC, 2017). This is because the (high frequency) sounds produced during multi beam surveys are likely to attenuate quickly. This is also assumed to be the case for the high frequency sound produced by the other pieces of geophysical equipment listed in Table 5.8. The exception to this is USBL systems and beacons, which produce relatively low frequency sounds.

Behavioural Response

With the exception of the positioning equipment (USBL systems and beacons), the sound emitted by the geophysical equipment will not be audible to marine mammals because the frequencies over which the equipment operates (Table 5.8) are higher than the higher frequency hearing cut-offs for each of the functional hearing groups (Table 5.3).

It is possible that the USBL systems and beacons may be detected by cetacean EPS and therefore their use may have the potential to cause disturbance. The most likely response will be temporary behavioural avoidance (there is evidence that short-term disturbance caused by a commercial two-dimensional seismic survey does not lead to long-term displacement of harbour porpoises; Thompson et al., 2013). Using information from this study, where harbour porpoise avoidance from geophysical (seismic) survey vessels in the Moray Firth was observed out to 10 km, the number of individuals which have the potential to be affected has been estimated (Table 5.9). This is considered to result in highly conservative estimates because the noise levels produced by the oil and gas exploration geophysical surveys will be well in excess of those produced during use of the positioning equipment (USBL systems and beacons) described here. Notwithstanding this, the percentage of the reference population estimated to have the potential to be affected was less than 1 % for the three main cetacean species which occur in the Moray Firth.

Table 5.9: The number of individuals estimated to have the potential to be disturbed by the positioning equipment (USBL systems and beacons)

Species	Range of potential impact (km)	Area of potential impact (km^2)	Number of individuals within the area of potential impact	Percentage of reference population which has the potential to be affected
Minke whale	10	314	3	0.013 %
Bottlenose dolphin	10	314	1	0.644 %
Harbour porpoise	10	314	48	0.021 %

Source: SCANS III density estimates used in calculations from Hammond et al. (2017) and reference population abundance estimates used in calculations from IAMMWG (2015)

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