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HVDC Cable Infrastructure – UK Construction Method Statement

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A	04.07.18	All	All	Initial Draft
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1. ABBREVIATIONS

CBRA	Cable Burial Risk Assessment
CPAR	Cable Protection Analysis Report
DOL	Depth of Lowering
DOB	Depth of Burial
EIAR	Environmental Impact Assessment Report
HDD	Horizontal Directional Drill
HVDC	High Voltage Direct Current
JV	Joint Venture
KP	Kilometer Point
MBES	Multi-beam Echo Sounder
MI	Mass Impregnated
MW	Mega Watt
OOS	Out of Service
OSL	Original Sea Level
ROV	Remote Operated Vehicles
SBP	Sub-bottom Profiler
SSS	Side Scan Sonar
STW	Scottish Territorial Waters
TW	Trench Width
UKEEZ	United Kingdom Exclusive Economic Zone
UXO	Unexploded Ordinance

2. PROJECT DESCRIPTION

NorthConnect is a project set up to develop, consent, build and operate an HVDC electrical interconnector between Peterhead in Scotland and Simadalen in Norway. The 665km long, 1400MW interconnector will provide an electricity transmission link allowing the two nations to exchange power and increase use of renewable energy. The intention is for the HVDC interconnector to be operational by 2023.

NorthConnect is a Joint Venture (JV) project company owned by four community and state-owned partners from Norway and Sweden: Agder Energi AS, E-CO Energi AS, Lyse Produksjon AS, and Vattenfall AB. The partnership was established on 1st February 2011.

Figure 2.1 details the main elements of the project, however this document focuses on the HVDC cabling and associated infrastructure from the UK Converter Station Building to the limits of the UK Exclusive Economic Zone (UKEEZ).

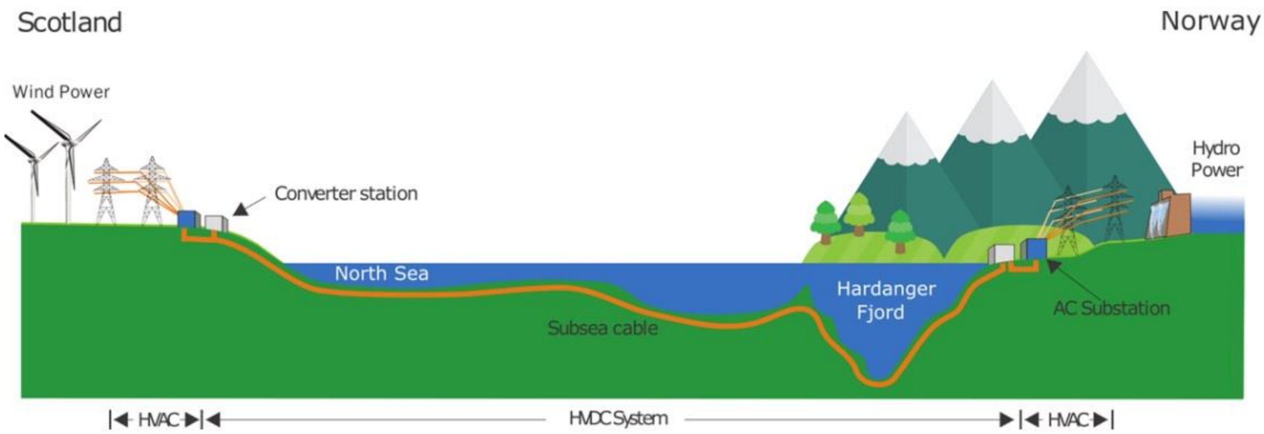


Figure 2.1: Main Project Elements

The Scottish Converter Station is located at a site called Fourfields, which is approximately 2.6km south of the outskirts of Peterhead, 4.5km south of Peterhead town centre, and 1km southwest of the village of Boddam. The Fourfields site is located to the south of Lendrum Terrace and Highfield, east of the Den of Boddam, Sandfordhill and Denhead and west of the Hill of Boddam and Stirling Hill Quarry. The cable landfall site is at Long Haven Bay, to the south of the village of Boddam and east of the village of Longhaven. The onshore cable corridor links the landfall site to the Converter Station at Fourfields.

The marine cable consenting corridor heads north-easterly for approximately 7nautical miles (NM) then in an east-north-east direction across the North Sea towards the Norwegian Coast. The corridor has been specifically selected taking account of:

- Existing infrastructure including pipelines, cables, and offshore installations;
- Bathymetry;
- Seabed geology and sediment characteristics;
- Commercial fisheries, shipping and navigation;
- Cultural heritage and marine archaeology;
- Benthic ecology and habitat types; and
- Designated sites and protected habitats.

As such the consenting corridor is not a straight route and although the majority of it is 500m wide, the width varies to avoid features such as wrecks and to provide additional options for routing in challenging areas such as areas of large sand-waves.

3. PURPOSE OF THIS DOCUMENT

This document sets out the Construction Method Statement for the installation of the HVDC and Fibre Optic Cables from the Converter Station Building to the limits of the UKEEZ. The purpose of the document is to provide a sufficient understanding of construction methods for regulators and stakeholders, to inform their consideration of the planning consent and marine license applications.

4. CABLE INFRASTUCTURE DESCRIPTION

There will be two HVDC cables connecting the Converter Stations in Fourfields and Simadalen. To provide process controls there will also be a fibre optic cable connection, which will follow the same route as the HVDC cables from Fourfields to the entrance of the Norwegian Fjord network. The fibre optic cable will not have any repeaters within the marine environment, and is landed at the Norwegian coastline, where it will connect into the wider Norwegian fibre optic network.

The landing point at Long Haven Bay is a cliff and, as such, the Horizontal Directional Drill (HDD) will be required to allow the cables to be pulled under the cliff onto shore, this is known as the Landfall HDD. Similarly, HDD will be utilised to pass the cables below the A90 and disused railway, the Road Crossing HDD.

All HVDC Cable Infrastructure within the UK EEZ will be installed within the confines of the NorthConnect Consenting Corridor, as shown in the following drawings:

- NCFFS-NCT-X-XG-0001-01;
- NCOFF-NCT-X-XG-0001-01;
- NCOFF-NCT-X-XG-0001-02;
- NCOFF-NCT-X-XG-0001-03; and
- NCOFF-NCT-X-XG-0001-04.

Further information with regard to the UK Onshore Cables and the Marine Cables is provided in this section.

4.1 HVDC Onshore Cables

There will be two HVDC cables, and one ducted fibre optic cable. The exact cable details will depend on which specialist cable manufacturer is involved, but the HVDC cables used will be Mass Impregnated (MI) in design. There are several different options for cabling, but the indicative cable parameters are shown in Table , using values assessed in similar HVDC projects and from cable manufacturers.

Table 4.1 Indicative HVDC Cable Parameters

Cable Parameter	Quantity
HVDC export system	2 x 700 MW HVDC cables
Nominal voltage (kV)	±525
HVDC onshore cable route length (km)	2
Cable linear weight (kg/m)	52 (approximately)
Cable outer diameter (mm)	130 (approximately)
Cable minimum bending radius (m)	5
Cable duct outer diameter (mm)	400
Cable maximum pulling tension (kN)	315
Fibre optic linear weight (kg/m)	1.6
Fibre optic cable outer diameter (mm)	24-30
Fibre optic minimum bending radius (m)	<1
Fibre optic duct outer diameter (mm)	90
Cable trench depth onshore (m)	1.6

Further detail on the HVDC Cable is provided in Chapter 2 of the HVDC Cable Infrastructure Environmental Impact Assessment Report (EIAR) (NorthConnect, 2018a).

The fibre optic cable is likely to be armoured with layers of steel wire and sheathed with either a polypropylene or polyethylene material for outer protection.

The onshore cable consenting corridor is wider than the actual onshore cable construction corridor required to allow for micro routing during detailed design. The actual construction corridor will include space for access along the route for excavation of cable and drainage trenches, storage of topsoil and soil from the trenches, delivery of materials and transport of personnel, excavation and cable installation plant and equipment. An overview of the onshore consenting corridor and indicative cable routes is provided in Drawing NCGEN-NCT-Z-XE-0002-01, with additional indicative detail provided in Drawings NCGEN-NCT-Z-XD-0001-01 to -04.

From Joint Pit 1 to the converter station it is assumed that the onshore HVDC cables will be laid within one trench. The width of the cable construction corridor for this section is likely to be around 20m (10m access road, 10m trench plus soil storage).

From the Landfall HDD entrance to the Joint Pit 1 it is assumed the HVDC cables will be laid in two separate trenches. For this section, the construction corridor would be 30m (10m access road and 2 x 10m trenches plus soil storage).

The onshore cables trench will be approximately 1.3m deep and 4.5m wide, with an approximate distance of 1m between the two HVDC cables if both cables are within a single trench (Drawing NCGEN-NCT-Z-XE-0003-01). For a two-trench design there will be a separation of approximately 3m between the two trenches and 7m between the two cables (Figure 4.1). The depth of the cables are such that arable farming techniques can be employed in the reinstated fields without risk of interaction with the cables.

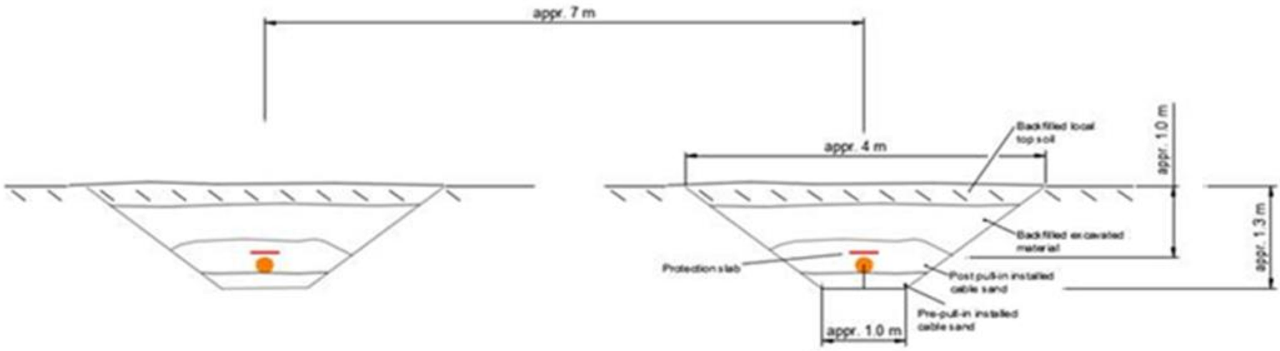


Figure 4.1: Onshore Cable Trench Cross-section a Two-Trench Design

Onshore HVDC Cables have a different armour protection composition to offshore cables, so there will be a joint pit (Jointing Pit 1) approximately 450m from the landing point to the south of the disused railway, where the transition between the two cable types will be located. Limitations on the maximum length of onshore HVDC cable that can be delivered means the maximum deliverable cable lengths are likely to be in the range of 850m – 1000m. As the proposed route is approximately 2km, a second onshore HVDC cable joint pit will be required to join the sections of onshore HVDC cables. Jointing Pit 2 will be located just to the south of Fourfields (Drawings NCGEN-NCT-Z-XD-0001-02 and NCGEN-NCT-Z-XD-0001-03).

Both jointing pits are expected to be approximately 25m long by 6m wide. Each cable will be under a precast concrete slab located at least 1 m below surface level (Drawing NCGEN-NCT-Z-XE-0003-01). The ground over a joint pit will be re-instated following the completion of the joints, such that farming activities can be resumed. In event of access to the joint be being required, the ground would be dug out to allow the concrete slab to be removed and access to the cable gained.

To avoid disruption to users of the A90 trunk road and to avoid disturbing the disused railway line, HDD will be utilised. The entry point will be on the southeast of the A90 next to Joint Pit 1 as shown in Drawing NCGEN-NCT-Z-XD-0001-02.

The HVDC cables pass under the landscape bunds around the converter station into the converter station site. The actual location will be determined by the final converter station design; however, it is likely that the cables will need to come into the site below the converter station platform. Depending on where the cables enter this may be 8 to 17m below the existing ground level, and 20m or greater below the final ground level when landscape bunds are installed. An indicative layout is provided in Drawing NCGEN-NCT-Z-XE-0004-01.

4.2 Landfall Horizontal Directional Drill (HDD)

The marine cables will be pulled ashore through ducts which will be installed into holes drilled from a point 100-120m inland from the cliffs, and under the cliffs with a marine exit point approximately 190m offshore from the cliffs. There will be 3 boreholes drilled: one for each of the HVDC cables; and one for the fibre optic cable. However, all three holes will be drilled to a diameter suitable for an HVDC cable. This is to provide redundancy such that, if there is an issue with one of the HVDC ducts preventing the cable pull, there is a backup route available. In this instance the fibre optic would be bundled with an HVDC cable for pulling. Further detail is shown in Drawing NCGEN-NCT-Z-XD-0001-01.

4.3 HVDC Offshore Cables

4.3.1 Cable Protection

The HDD marine exit point is located in water depths of approximately 26m. The fibre optic cable will be routed towards one of the marine HVDC cables and bundled with it for the remainder of the route. It is assumed that the two HVDC cables will be installed separately, there is however a potential that they could be bundled together and laid in the same trench. To protect the cable from damage the cable will be buried or protected by rock placement for the entire cable route. To identify the level of protection required, taking into account the various threats to the cable a Cable Burial Risk Assessment (CBRA) has been completed and provided as Appendix 1 to this document.

The CBRA took into account the understanding of the seabed conditions gained by the completion of the subsea survey, primary hazards including: shipping, anchorages, fishing, on-bottom stability, dredging /spoil dumping; and with particular regard to the Norwegian waters and fjords: fish farming, rockfall and submarine slopes and slide escarpments. The secondary hazard of mobile sediments was also considered. The assessment considers sections of the corridor split by sediment types based on the survey results from the centre line of the survey corridor.

The CBRA was utilised to inform the protection level required by the NorthConnect project to reduce risk of cable damage to a sufficient level. The protection levels were split into four categories A to D. Cables can be protected in four main ways:

1. They can be laid on the seabed then post-lay trenched into place, the depth the cable ends up lower than the original seabed level (OSL) is called the Depth of Lowering (DOL). The seabed material will naturally infill, the extent of which will be determined by the seabed composition, as shown in Figure 4.2.
2. The cable can be laid directly onto the seabed and rock placed on to the cable to provide protection as shown in Figure 4.3.
3. Rock can also be utilised in conjunction with trenching, where trenching has not provided a sufficient DOL as shown in Figure 4.4.
4. Pre-lay trenching can be utilised where post-lay trenching is unlikely to provide sufficient DOL to minimise the need for above OSL rock placement. However, in seabed types where this is likely to be the case, natural backfill may be slow and as such forced backfill may be required. To prevent damage to the cable from backfill ploughing, then backfill rock placement is the preferred means, to bury the cable up to OSL. The use of backfill augers or inverted plough to provide forced backfill may be considered by NorthConnect, only if the installation contractor can demonstrate relevant experience records and/or sea trials show that the cable is not jeopardised by the technique.

For the purpose of marine licencing it has been assumed that where pre-lay trenching is utilised backfill rock placement will be required to protect the cable, but that this will not be above OSL. Material removed from the trench by pre-lay trenching may form berms either side of the trench, but these will naturally disperse with time.

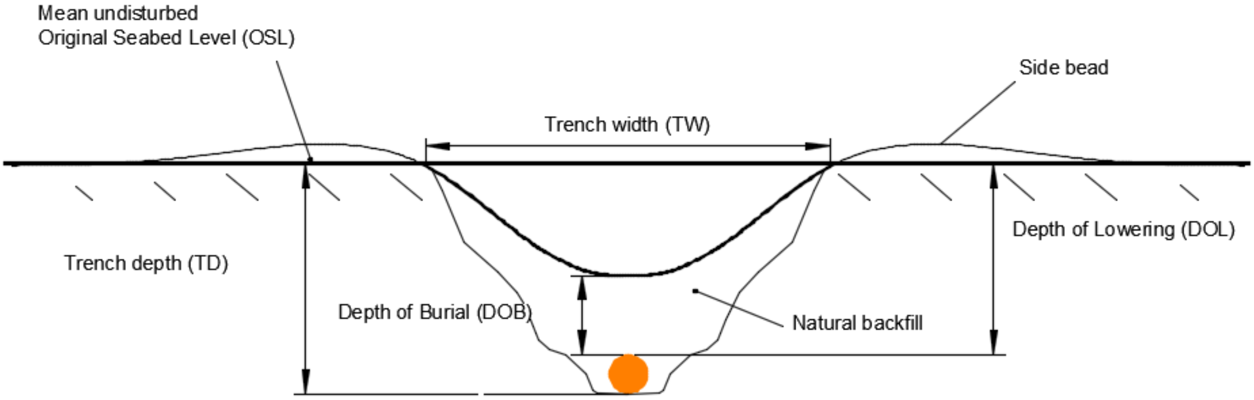


Figure 4.2: Typical Post Lay Trench Cross Profile

Where:

DOL: Depth of Lowering: Distance from the top of the cable to original seabed.

DOB: Depth of Burial: Distance from top of cable to the lowest point on any forced or natural backfill.

TW: Trench Width: Width of trench on top of trench. Top of trench is measured at mean undisturbed seabed level. Any trench side beads shall not be accounted for.

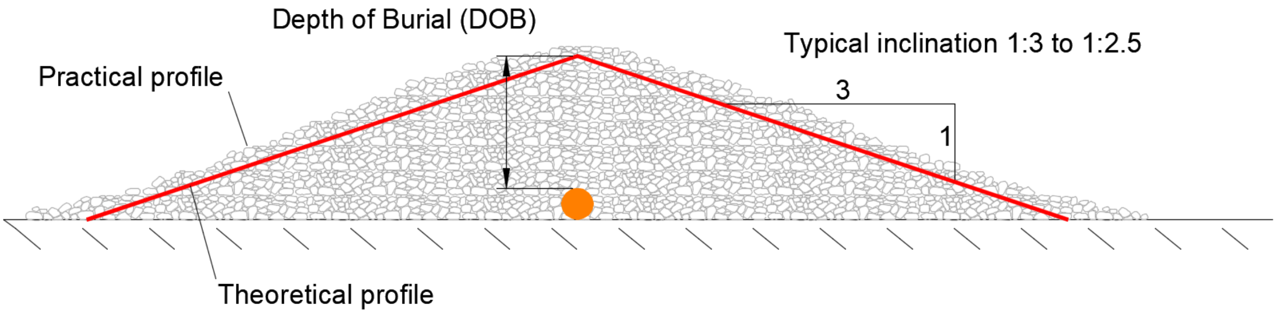


Figure 4.3: Typical Cross Profile of Protection by Rock Placement Only.

Where:

DOB: Depth of Burial: Distance from top of the berm to top of the cable.

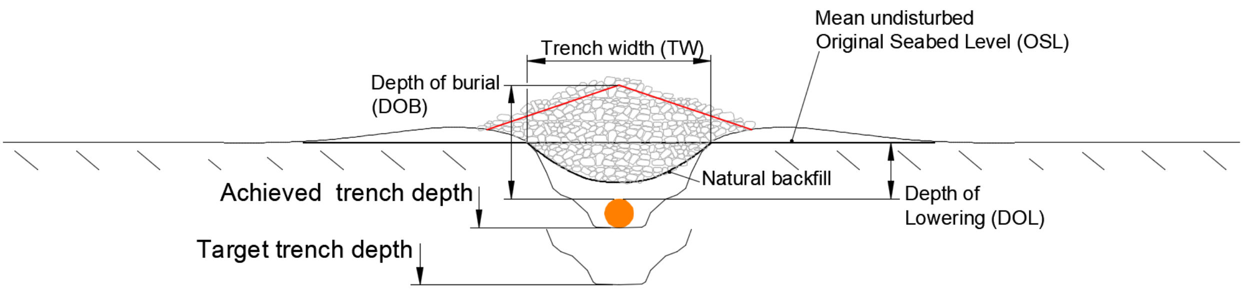


Figure 4.4: Remedial Rock Placement where Trenching is Insufficient

Where:

DOB: The sum of the backfill of seabed material and additional protection provided by rock placement.

The preference is to lower the cable as far as practicable, the minimum DOL that the cable lay contractors will be expected to achieve for each of the categories A to D identified in the CBPA is detailed in Table 4.2.

Table 4.2: Definition of Acceptance DOLs for Protection Levels A-D.

Protection Level	ACCEPTANCE CRITERIA	
	Trenching	
	Soft seabed	Hard seabed
A	DOL = 0m	DOL = 0m
B	DOL≥0.5m	DOL≥0.4m
C	DOL ≥1.0m	DOL ≥0.8m
D	DOL ≥1.5m	DOL ≥1.3m

However, it is recognised that there may be localised features of the seabed which affect the ability to lower the cable, therefore if the target DOL is not achieved, the following will apply:

- There have been three attempts to trench the cable with:
  - Correct trencher settings during all 3 attempts, and
  - All trencher functions in order.
- The maximum length of each section is no more than 20m.
- The maximum accumulated length of sections is no more than 100m/km.

Then the DOL may be reduced to those identified in Table 4.3.

Table 4.3: Relaxed Acceptance DOLs for Protection Levels A-D.

Protection Level	ACCEPTANCE CRITERIA	
	Trenching	
	Soft seabed	Soft seabed
A	n/a	n/a
B	DOL≥0.3	DOL≥0.2
C	DOL>0.5	DOL ≥0.4
D	DOL ≥1.0	DOL ≥0.8

Where the DOL detailed in Table 4.2 and 4.3 are not achieved there will be a need for above OSL rock placement as shown in Figure 4.4. Where the seabed is rock, and hence the cable cannot be lowered, then rock placement will have to be utilised as shown in Figure 4.3.

To protect the cables whether they are lowered or not they will need to be buried to provide the appropriate protection. The DOB may be achieved by: natural infill of the trench; backfill rock placement to OSL where DOL has been achieved but natural infill will not provide sufficient DOB; or where DOL has not be achieved rock placement including some above OSL. The DOB required for each of the protection levels are detailed in Table 4.3.

Table 4.3: Definition of Burial Levels

Protection Level	ACCEPTANCE CRITERIA	
	DOB	
	Normal (Note 1 & 2)	Relaxed Lowering Levels (Note 1)
A	DOB = 0m	
B	DOB ≥0.4 m	DOB ≥0.2
C	DOB ≥0.8m	DOB ≥0.4
D	DOB ≥1.3m	DOB ≥0.8

Note:

DOB = natural back fill + backfill rock /rock placement.

If DOL is as defined in Table 4.2 and the Trench Width > 1.2 x DOL, then DOB ≥ 0.5xDOL is acceptable.

Protection Level C is required for all cables within STW and UKEEZ other that than the initial 750m section from the HDD marine exit point where protection level D is required. This is not due to an increase risk to the cable, but due to a desire to increase the distance between the cable and vessels to reduce the effects of compass deviation in shallow waters to acceptable levels. As such, the lowest DOL below the seabed in STW and UKEEZ is 0.4m and this is should occur for no more an 10% of the cables length. The majority of the route ≥90% of the route will be lowered and/or buried by at least 0.8m.

The only area of bedrock within the STW/UKEEZ consenting corridor is very close to shore and the cable will be pulled under this through the HDD ducts. It is not anticipated that any sections of the cables within the UK consenting corridor; not associated with crossings; will be laid directly on the seabed and protected solely by rock placement, as per Figure 4.3.

4.3.2 Crossings

There are 20 items of infrastructure within the cable corridor which will need to be negotiated in STW/UKEEZ:

- 1 x power cable crossing;
- 10 x in-service pipeline crossings;
- 2 x in-service umbilical crossings;
- 2 x Out of Service (OOS) telecom cable crossings;
- 1 x OOS umbilical crossing; and
- 4 x OOS service pipelines.

Sections of out of service telecommunications cables will be removed, and as such there will be 18 crossings required. Figure 4.5 shows the locations of the 20 existing subsea assets that are crossed by the consenting corridor, while Drawing NCOFF-NCT-X-XG-0008-01 shows the locations of the asset crossing which will require above OSL rock protection.

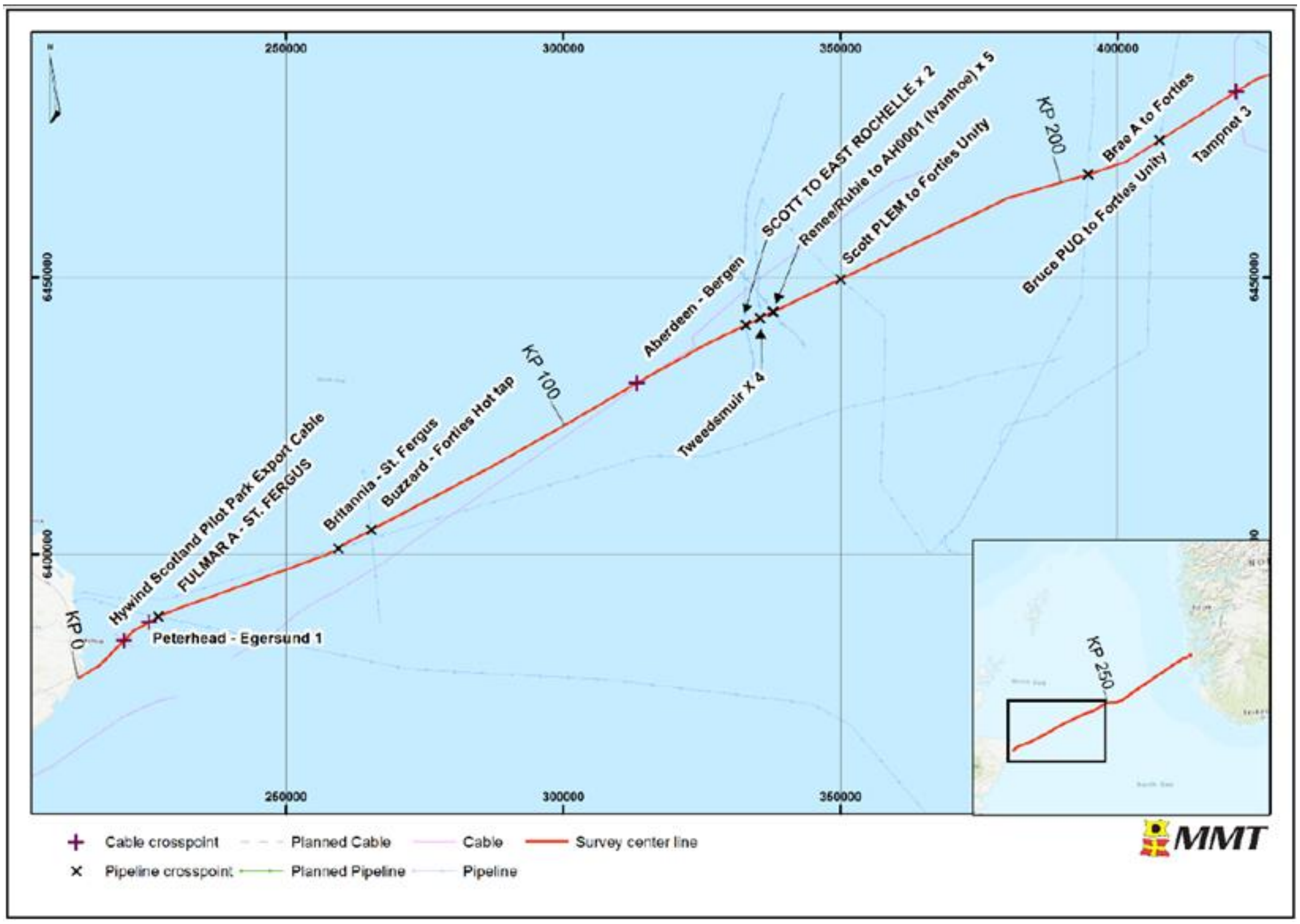


Figure 4.5: Crossing Locations

The crossing designs and methodology will be in accordance with crossing agreements with the respective crossed asset owner. The descriptions below must therefore be regarded as indicative only. The crossings shall be treated individually during detailed design considering aspects such as regional constraints, requirements from the crossed infrastructure owner, practicalities regarding trenching near the crossing, volume of rock ramps, stability, and top cover. The angle between the NorthConnect HVDC cables and the crossed utility shall be as close to 90 degrees as practicable and not be less than 45 degrees for a distance of minimum 200 m from the crossed asset.

NorthConnect has defined 4 standard types of crossings which form the basis for the planning of further work unless other designs are required by the crossed infrastructure owner.

Relevant typical crossings are illustrated in the drawings shown in Figures 4.6-4.10:

- Crossing Design A - Crossing Untrenched Pipeline
- Crossing Design B - Crossing Trenched Pipeline
- Crossing Design C - Crossing Untrenched Umbilical or Cable
- Crossing Design D - Crossing Trenched Umbilical or Cable

Some small diameter pipelines, such as glycol lines, may best be crossed according to design C or D.

At crossing of trenched or un-trenched umbilicals or cables a separation is maintained by means of adding a protection sleeve of type Uraduct, or similar onto the NorthConnect cables. The sleeve will have a length of minimum 20 m and be fitted to the NorthConnect cables during lay. Protection sleeves may be required also on pipeline crossings pending agreement with the crossed pipeline owner.

If the crossed infrastructure has such high temperature that it might result in a thermal bottle neck in the NorthConnect cables, the separation must be increased. This will be carried out either by means of additional rock placement or, alternatively, by other means such as mattresses. The rock protection on the top will be according to the general requirements to protection in the area. Trenching near the crossing will be carried out according to agreement with crossed asset owner.

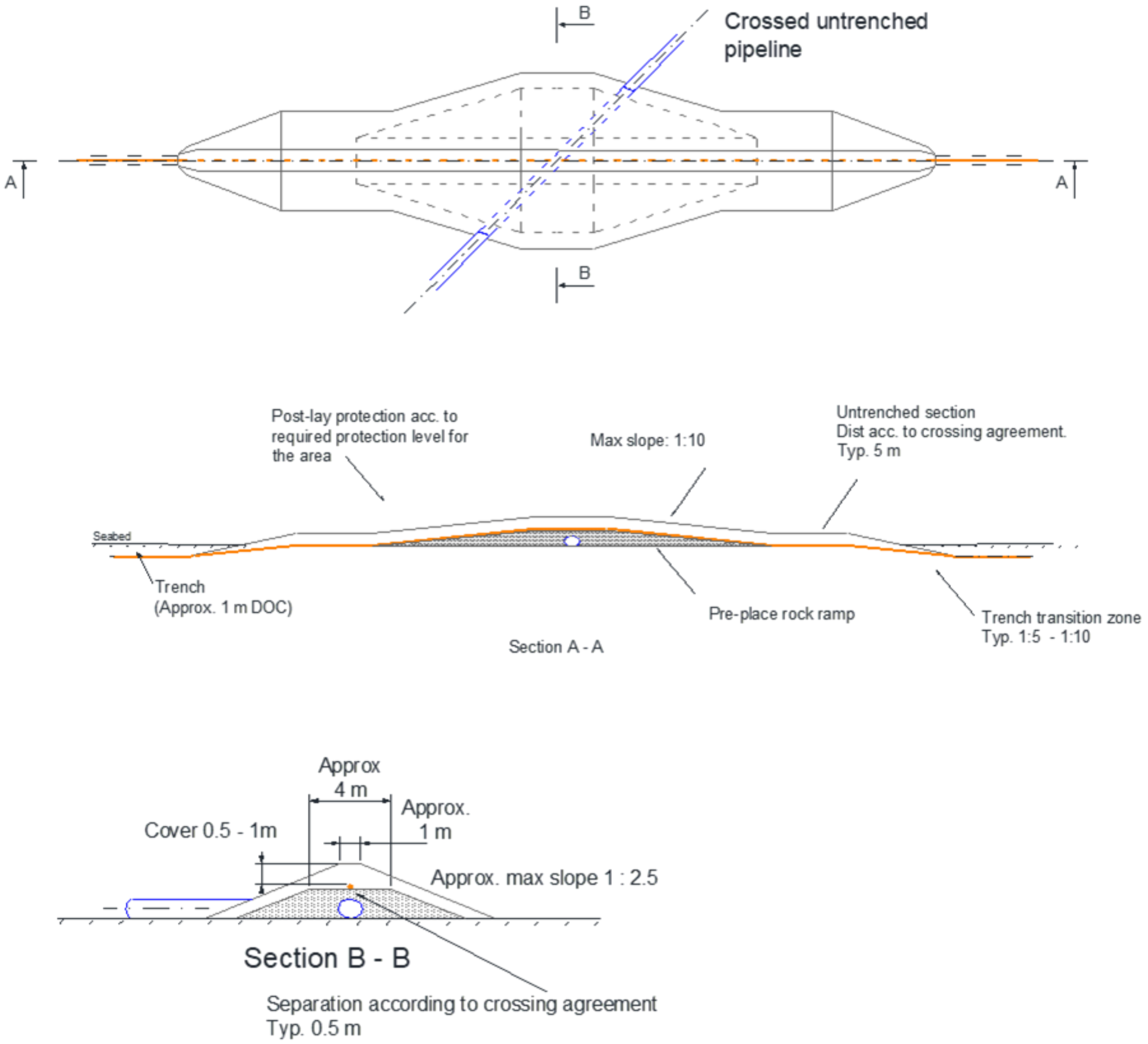


Figure 4.6: Crossings Design A - Crossing Untrenched Pipeline

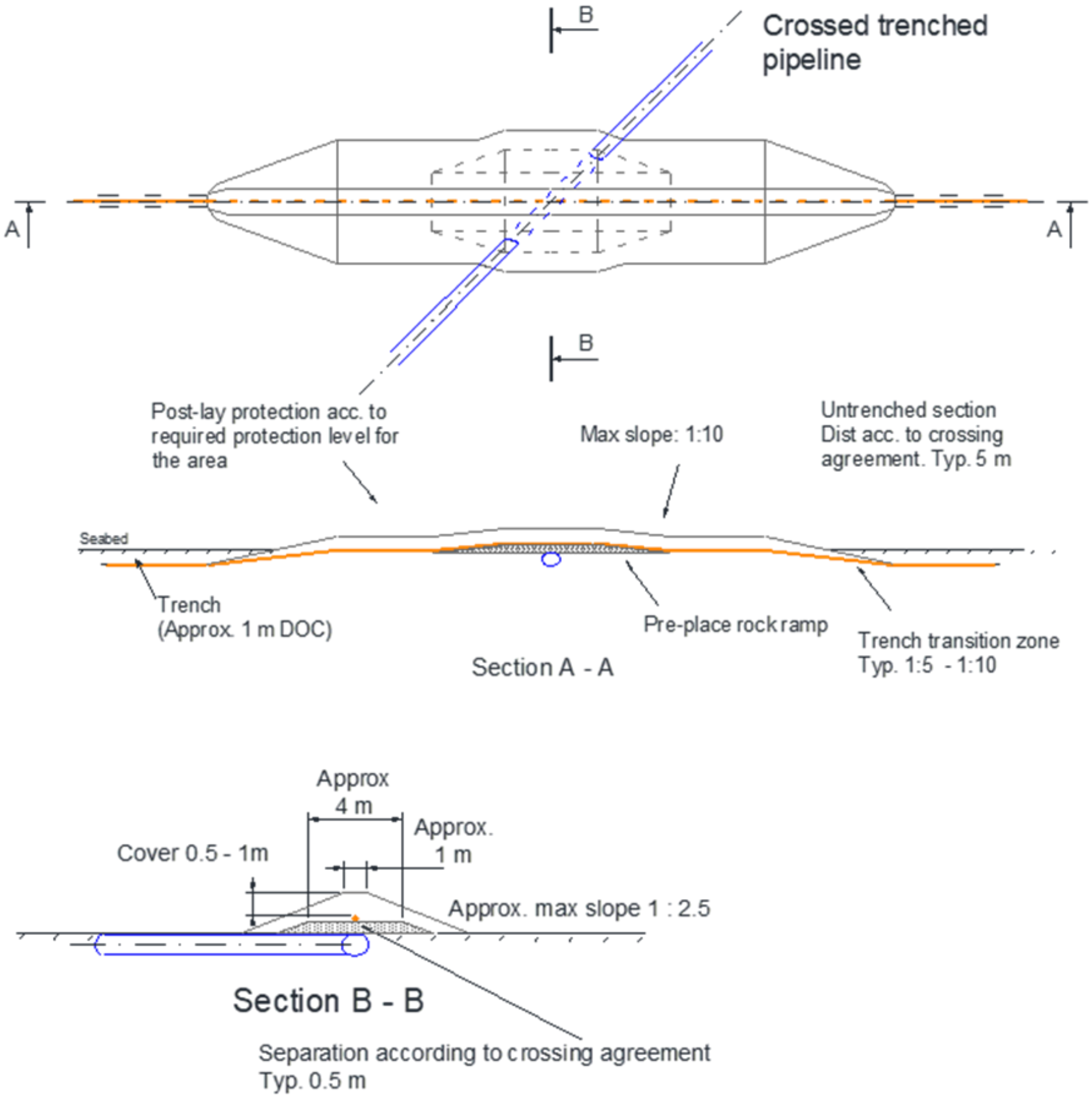


Figure 4.7: Crossings Design B - Crossing Trenched Pipeline

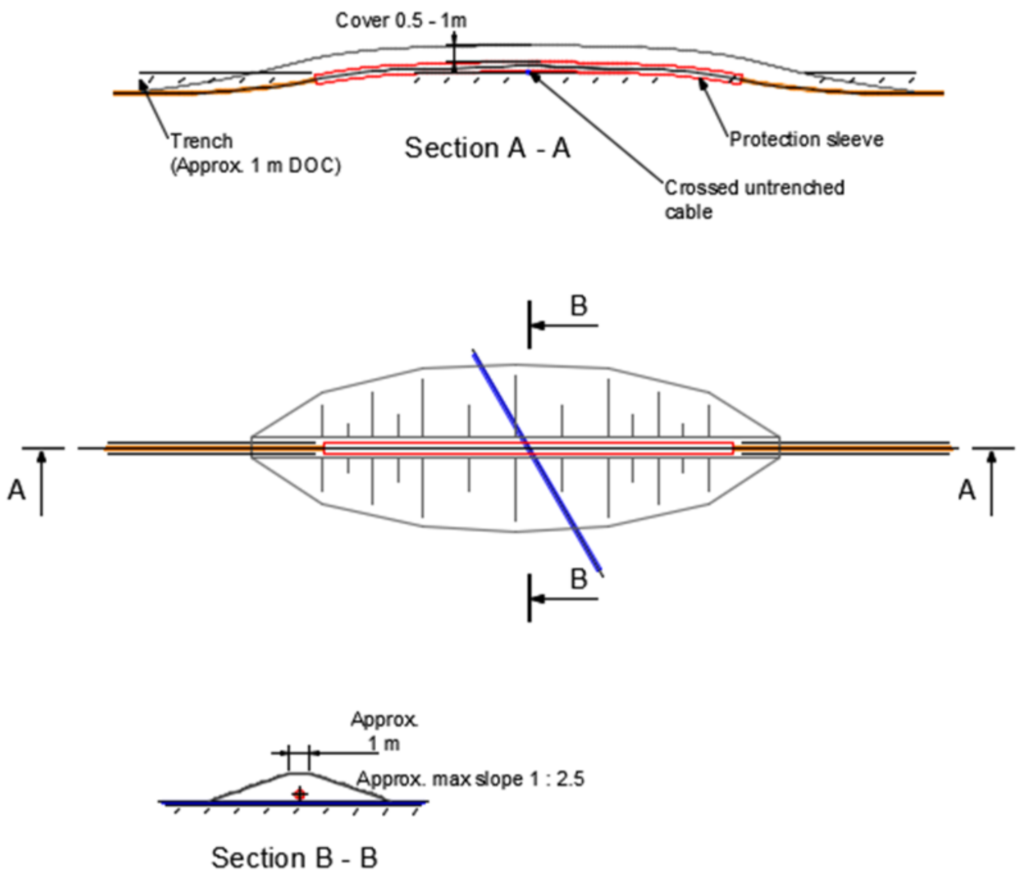


Figure 4.8: Crossing Design C1 – Crossing Untrenched Cable – Protection Sleeve for Separation

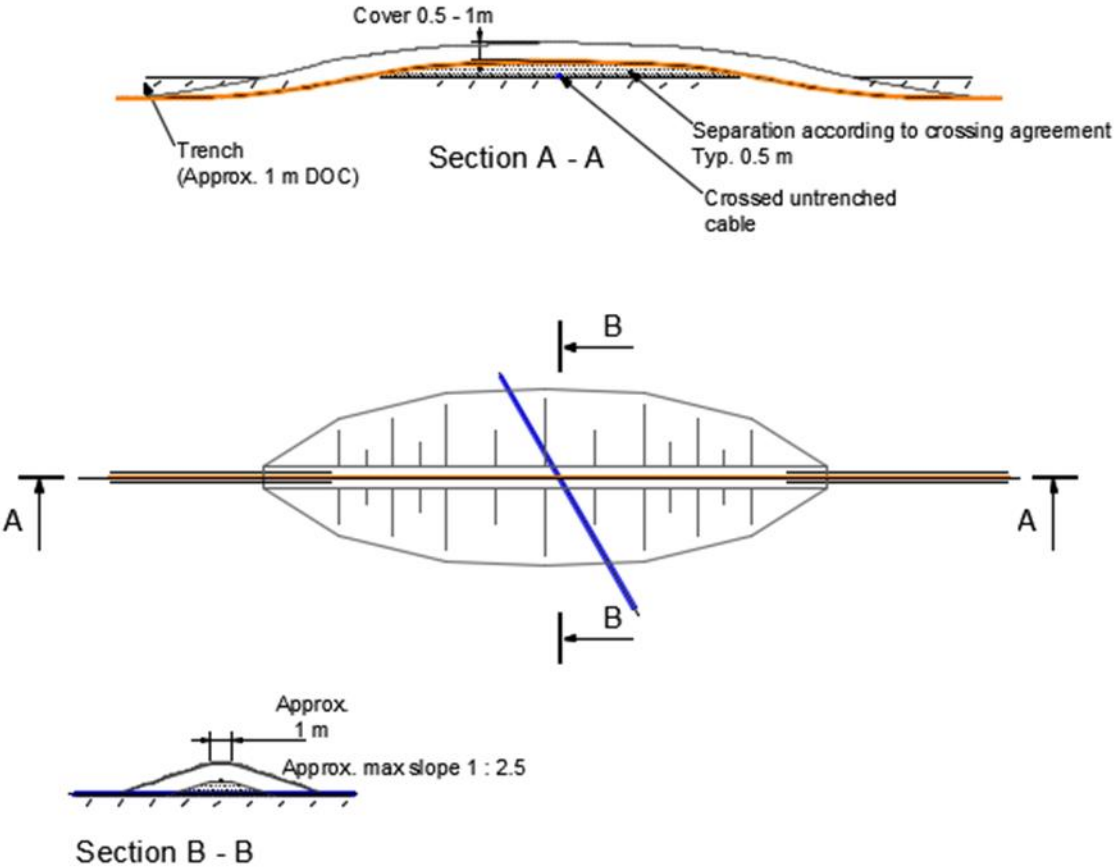


Figure 4.9: Crossing Design C2 – Crossing Untrenched Cable – Rock Ramp for Separation

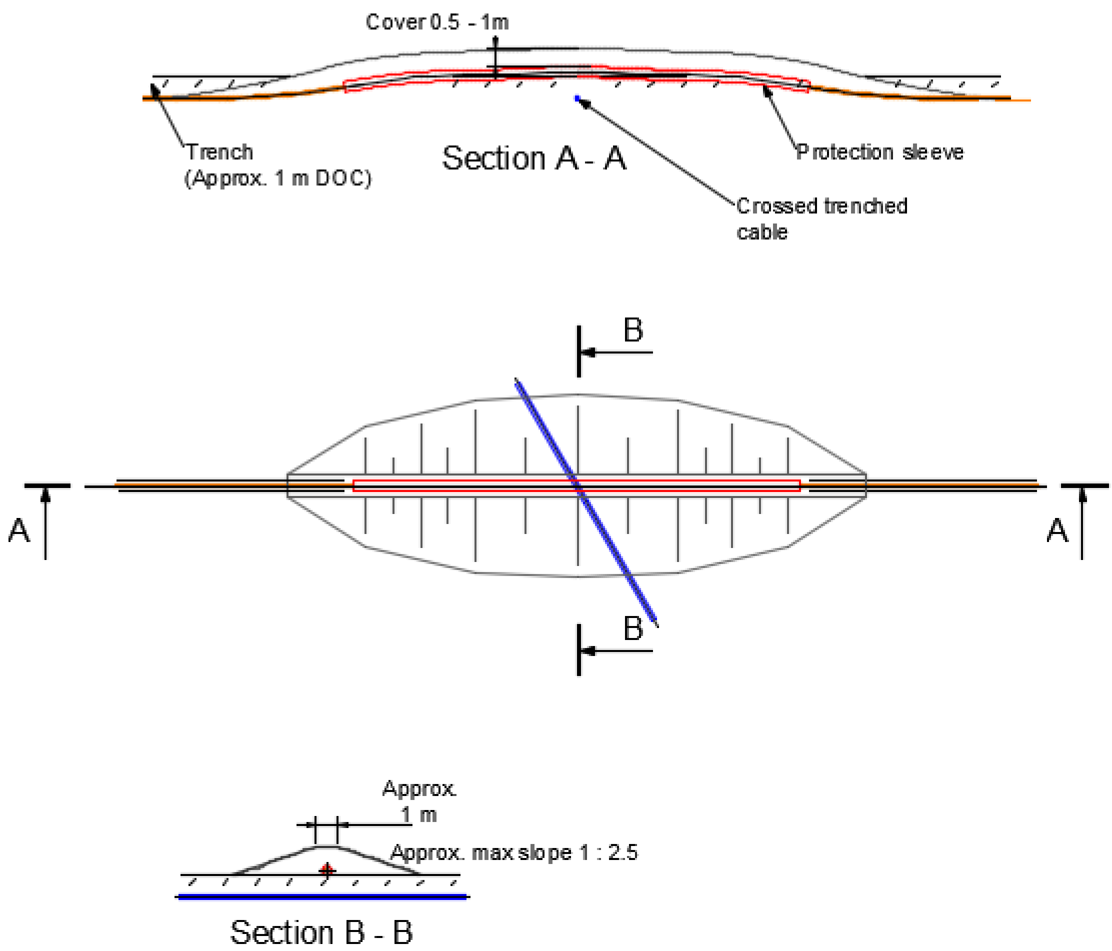


Figure 4.10: Crossing Design D – Crossing Trenched Cable – Using Protection Sleeve only

To ensure that the asset being crossed is not damaged during the HVDC Cable installation, trenching will not be carried out within the vicinity of the crossing. The distance from the asset to be crossed to the point the trenching will cease is based on the risk posed by the technique employed for:

- A trencher towed by a surface vessel: there shall be no trenching closer than 250 m from the crossing point
- Self-tracked mechanical cutting devices: there shall be no trenching closer than 50 m from the crossing location.
- A self-propelled trencher that use water jetting to excavate the trench and is designed such that there are negligible or no risk for damaging the crossed cable by interaction: there shall be no trenching closer than 15 m from the crossing location.

The distances above may vary to meet requirements of the owner of the crossed infrastructure.

4.3.3 Cable Installation Techniques

The CBRA and associated protection levels have then been utilised in the Cable Protection Analysis Report (CPAR) (Appendix 2) which considers the techniques that could be employed to provide the desired protection levels along the cable route. The five tools considered for cable installation are:

- Jet trencher
- Chain Cutter
- Combined Jet/Chain Cutting tool
- Pre-lay Plough
- Cable Burial Plough

Section 4.2 and Appendix D1.2 of the CBRA provide information about each of the installation tools. The effectiveness of each of the tools with regard to meeting the cable protection areas along the cable corridor is graded as 'A to C' in APPENDIX B. 'A' denotes that the tool should achieve the required depths across the section and 'C' denotes that the tool is inappropriate for the expected soil conditions (See Section 4.4.2 of the CPAR for full definitions). Drawings NCOFF-NCT-X-XG-0006-01, NCOFF-NCT-X-XG-0007-01, and NCOFF-NCT-X-XG-0008-01 show the grading of each of the tools within the different sections of the consenting corridor.

It is anticipated that for the majority of the cable route (~97%), jet trenching will be suitable and enable the target protection levels to be achieved. However, in areas of dense boulders (and potentially dense subsurface boulders), tills and coarse surficial sediments, pre-lay ploughing may offer a lower risk solution with greater potential for achieving the necessary target trench depths. In STW/UKEEZ the main area where jet trenching may not be suitable is between 213564E, 6378161N and 228191E and 6389279N. This is the majority of the route within STW.

NorthConnect wish to keep the range of permitted cable installation tools as wide as possible to facilitate competition from potential cable contractors, however the contractors will be required to meet the protection levels outlined in Section 4.3.1. Cable contractors will be required to carry out sea trials, to demonstrate that they can achieve the required levels of protection in the more challenging substrates, prior to their methodology being accepted by the project.

4.4 Rock Placement

Rock placement is required for crossings as discussed in Section 4.3.2. It will also be required to protect cables by increasing the DOB. The amount of rock required will be determined by the cable installation method utilised. The two options utilised to calculate the rock volumes required were:

- **Option 1: Jet Trenching** for the full route, which will potentially require remedial rock placement; and
- **Option 2: Jet Trenching in combination with Pre-lay Ploughing** for the initial section in STW until the seabed conditions makes jet trenching more acceptable. It has been assumed that pre-lay ploughing will require backfill rock placement and a small amount of remedial rock placement.

Drawings NCT-X-XG-0006-01 and NCT-X-XG-0007-01 show the location of potential rock placement for each of the options considered within STW. The two options are the same outwith STW as it is unlikely the Pre-lay Ploughing would be required beyond STW, and the rock placement locations are shown in Drawing NCT-X-XG-0008-01. The main difference between the two options is that the majority of rock utilised for Option 2 is backfill and, as such, will be below OSL, with an estimate of 5 to 10% of the cable lengths within STW requiring remedial rock placement. Whereas the majority of the rock required for Option 1 will be above OSL, with almost 100% of the route within STW requiring remedial rock placement above OSL. In the UKEEZ it is estimated that less than 1% of the route will require remedial rock placement (<2km).

The full rock estimate calculations can be found in the CPAR (Appendix F) and these are summarised in Table 4.4. Option 2 requires only 4% more rock volume (3800m^3) than Option 1. On the basis that the total rock volumes involved are similar for the two options, and that there is a preference not to change the seabed profile to minimise effects on fishing, either Option 2, or techniques that can achieve a DOL such that remedial rock is not required for the majority of the route, are preferred. Hence, the remedial rock placement above OSL is between 5 and 10% of the route in STW and 1% of the route from 12nm to the limit of the UK EEZ.

Table 4.4: Rock Volume Estimates

Assessed Length	Remedial rock placement estimate (m^3)	Backfill estimate (m^3)	Subtotal (m^3)	Crossings estimate (m^3)	Theoretical Total (m^3)	Total including 40% contingency factor (m^3)
Full Route: Option 1 - Jetting	67600	0	67600	54200	121800	170600
Full Route: Option 2 - Jetting with Pre-lay ploughing KP0.823 - 17.891	21800	48600	70400	54200	124600	174400
KP0 to 12NM limit: Option 1 - Jetting	50400	0	50400	1800	52000	72800
KP0 to 12NM limit: Option 2 - Jetting with pre-lay ploughing KP 0.823 - 17.891	4400	48600	53000	1800	54800	76600
KP0 to UK EEZ limit: Option 1 - Jetting	52400	0	52400	13800	66200	92600
KP0 to UK EEZ limit: Option 2 - Jetting with pre-lay ploughing KP0.823 - 17.891	6600	48600	55200	13800	68800	96400

The anticipated rock grading to be used is 1”-5” (CP45/125mm), with D_{10} 45mm, D_{50} 80mm, D_{90} 125mm, with an installed bulk density of 1.5 – 1.7 tons/ m^3. Hence the total rock requirement assuming Option 2 in STW/UKEEZ is 163,880 tonnes.

5. CONSTRUCTION ACTIVITIES

The following main construction activities are required to facilitate the installation of the cables:

- Onshore Enabling Works;
- Onshore Cable Installation;
- Landfall HDD;
- Offshore Preparations;
- Marine Cable Pull;
- Onshore Demobilisation and Reinstatement;
- Offshore Cable Installation; and
- Reporting.

Further details on each are discussed below. It should be noted that multiple site activities may be ongoing concurrently and that the order of tasks will not be exactly as the activities are laid out below. Details will be determined by the cable contractors' schedules and logistics but taking account of any schedule constraints.

5.1 Onshore Enabling Works

5.1.1 Fencing

To prevent livestock and members of the public accessing construction areas, security/livestock fencing will be installed around work areas. The intent is not to fence the full onshore consenting corridor for the duration of the works, but rather to fence areas prior to specific access being required. Once works have been completed in an area they will be reinstated to allow fencing to be removed and access to be restored at the earliest convenience.

5.1.2 Landfall HDD Preparations

The HDD landfall area is situated in a field to the south east of the A90, the existing access track to the fields is not of a sufficient standard to be utilised for the HDD and cable installation works. A new access road is proposed to the south of the existing access as detailed within the Transport Statement (Allen and Gordon, 2018). The road will be installed as part of enabling works, most likely through the summer months, such that the ground conditions are favourable for the works and that it is in place to allow HDD activities to be completed through the winter.

The road installation will involve the removal of topsoil and subsoil to a suitable depth, which will be retained for reinstatement purposes. The route will be levelled, with geotextile and compacted stone laid to provide appropriate stability. The initial section from the A90 will be tarmacked (at least 50m), with the later sections being finished with crushed stone placed within geogrid to enhance its load bearing capacity. Rumble strips shall be installed on the access road at least 45m before the exit onto the A90 to assist in the removal of mud from wheels.

The landfall HDD compound will also need to be prepared and a hardstanding constructed required. The topsoil and subsoil removed from the area will be utilised to form bunds to the north and south of the compound to provide some screening of the worksite in terms of noise and shelter from the winds. The east and westerly sides will need to be kept open to allow the cables to be laid inland to the west, and the HDD works out to the east.

A water supply will be required for the HDD works, so a connection will be made from the water main which runs parallel to the A90 on the seaward (south east) side. The temporary water supply will be laid adjacent to the access road.

5.1.3 Cable Duct Installation

The cables will need to be routed such that they enter the Fourfields converter site and building at appropriate locations. The earthworks will be completed prior to the cable installation, as part of the earthworks, ducts will be installed for the cables. This will involve trench excavation the required depths of which will be dependent on the location that the cables are required to enter the converter station building.

The onshore HVDC cables have to cross a core path which runs along the south side of the Fourfields site. Hence it is proposed that before the other parallel path (which bisects the Fourfields site) is closed off from public access, cable ducts will be installed under the core path. This will allow the path users to be rerouted during the duct installation via the existing path, and then the core path will be reinstated before the other is closed. The onshore HVDC cables can then be pulled after the construction of the Convertor building with minimal disturbance to the core path users. The duct installation will be a simple excavation of material to allow the ducts to be installed and reinstatement utilising the materials removed as far as practicable, and then appropriate surfacing installed.

A water supply is to be provided to the Fourfields site from the south. This pipeline will be installed in advance of the Convertor station construction and cable installation and, as far as practicable, at the same time as the cable ducts under the core path to minimise disruption.

5.2 Onshore Cable Installation

5.2.1 Trench Digging

Topsoil and subsoil will be excavated from the cable trench, these soils will be stockpiled separately within the construction corridor. If rock is incurred prior to the trench depths being achieved it will be broken out. Gaps will be left between the stockpiles so as not to impede the flow of surface water and, where practicable, the stockpiles will be located on the higher ground within the construction corridor, to minimise surface water running over them. The trench depth will be around 1.3m. The cable trench bottom will also have sand protection above the formation level and will need to be cleared of any rocks and boulders which could cause damage to the cables. Where required, the Contractor may need to use appropriate measures to prevent the trench collapsing whilst still open.

Concrete water stops will be installed approximately every 100m, to prevent water running through the cable trench. Drainage will be provided within the trench where required and this may include the digging of sumps to allow dewatering pumps to be utilised. If pumping of water is required, it will be pumped to an appropriate location to allow any sediments present to be settled out prior to discharge.

Means of escape from the trench in the form of ramps will be provided for mammals to avoid entrapment.

As detailed in Chapter 10: Onshore Water Quality of the EIAR (NorthConnect, 2018a) there will be 4 watercourse crossings along the route. The watercourses are all relatively minor. They will be dammed above and below the crossing point, to allow the crossing point to dry out. The water will be pumped from upstream of the crossing point to downstream of the crossing point, such that flows up and downstream of the crossing point are maintained throughout. The cable trench shall be dug, ducts inserted, or cables laid directly in the ground, then the stream bed reinstated, and the dams removed to allow the stream to return to its previous condition.

5.2.2 Joint Pit Formation

The joint pits will be dug as part of the trench digging works discussed in Section 5.2.1. If necessary, the excavated pit will be dewatered. Sand will be utilised to form the cable bed. The cable protection slabs will be pre-cast offsite ready for installation after the cable has been laid.

5.2.3 Road Crossing HDD

5.2.3.1 Site Set-Up

The road crossing HDD will be relatively shallow though still within rock and it may be completed by a smaller HDD Rig than the Landfall HDD, but this will be determined by the cable Contractor. The Road Crossing HDD area will be on the southeast side of the A90 within the consenting corridor. An appropriate hardstanding area will be required, and this will take the form of an engineered hardstanding or, alternatively, construction mats maybe utilised. With either method, the site will be prepared in such a way as to allow the area to be reinstated to original levels once works are complete.

5.2.3.2 Pilot Hole Drilling

Prior to drilling, an entry pit will be excavated and generally, this is several metres squared and 1.5m to 2m depth. A pump in the pit transfers any drilling fluid returns to a mud recycling unit. More information on drilling fluid is provided in Section 5.3.4. The pilot holes will be drilled, and downhole positional surveys taken at the end of each drilled rod.

5.2.3.3 Reaming

On completion of the pilot holes, the drill bit, downward motor and steering equipment are removed. The holes are then enlarged using forward reaming. The HDD may require several reaming passes with progressively larger diameter reamers until the final hole size is reached.

5.2.3.4 Duct Installation

Ducts will be pulled through the reamed holes from the north west side of the A90 towards Jointing Pit 1 on the south east side of the A90.

5.2.4 Cable Laying/Pulling

Cables can be laid directly into the open trenches. Where the cables need to cross the A90 and the disused railway line, the cables will be pulled under the A90 and disused railway to Jointing Pit 1 through the ducts installed by the HDD. Similarly, the cable will be pulled through the ducts installed under the core path and in the Fourfields site, this may be done from either end. The sequencing of the cable lay will be determined by the availability of cable and the readiness of the converter station to accept the cable connection.

As the offshore cables will be landed at different times as discussed in Section 5.7, then Joint Pit 1 may need to be accessed to allow the marine cables to be joined to the onshore cables at different times. Joint Pit 1 will be made safe in the periods between access being required. This will either be by reinstating the ground above the pit to allow access for agricultural activities, or temporary fencing installed to prevent access. The means will be determined by the programme and hence timescales between access requirements and the landowner's preferences.

5.2.5 Trench Infilling

It is likely the cable will require a stabilising material, such as sand or cement bound sand (CBS), which will be placed directly over the laid cables. Protective slabs will also be placed over the cables for added protection. The subsoil and topsoil will then be used for backfilling the cable trench, as per the indicative designs shown in Drawing NCGEN-NCT-Z-XE-003-01.

Any excess soil will be removed from site and disposed of appropriately. The corridor will be restored back to its original level and condition, and security/livestock fencing removed.

5.3 Landfall HDD

The majority of the landfall HDD drilling works will be carried out through the winter months, avoiding the bird breeding season to minimise effects associated with disturbance.

5.3.1 Site Set-Up

As discussed in Section 5.1, prior to the arrival of the HDD equipment, the vehicle access, drilling pad and working area, and the water supply to the entry site will be prepared. The equipment and welfare facilities will be delivered to the site on appropriate HGV's or low loaders in line with an agreed traffic management plan. A crane will be utilised to unload equipment from the transport vehicles and place them into position.

An indicative site layout is shown in Figure 5.1. The site layout shown has been specifically designed to place the noisiest equipment furthest away from the cliffs. Although the specific equipment utilised will be determined by the cable contractor the approach of locating equipment to minimise noise impacts will be followed.

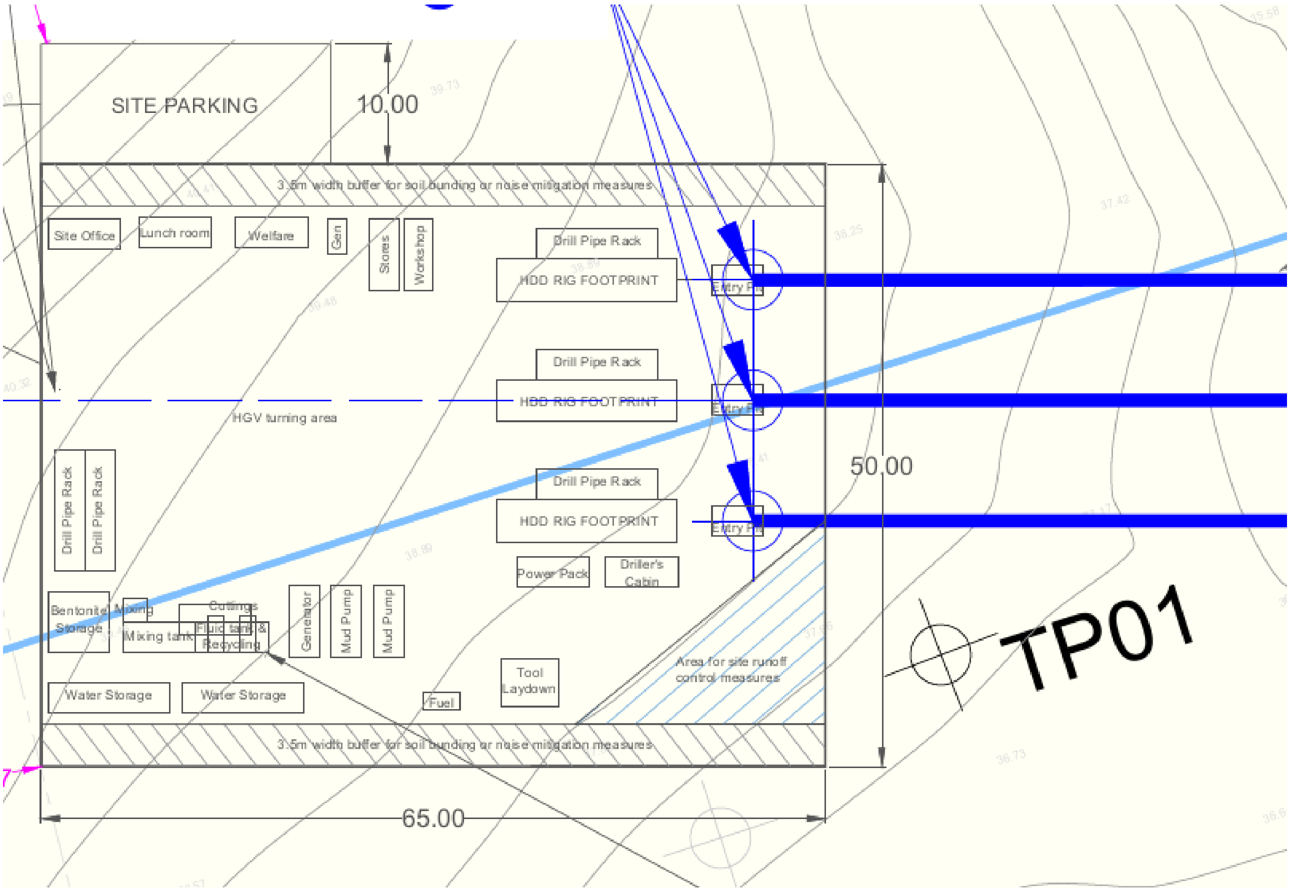


Figure 5.1: Indicative Site Set-up for the Landfall HDD

5.3.2 Pilot Hole Drilling

Prior to drilling an entry pit is excavated, generally, this is several metres squared and 1.5m to 2m depth. A pump in the pit transfers any drilling fluid returns to the mud recycling unit. The hole is drilled and downhole positional surveys taken at the end of each drilled rod.

5.3.3 Casing

Surface casing is utilised at the entry points of HDD's where the material is likely to be more weathered to prevent collapse of the hole. Surface casing may not be required at this site but, if it is, it is likely to only be 10-15m in length and will either be washed over the pilot drill or trenched in prior to pilot drilling. Ideally, the casing will be of a larger diameter than the final reamed hole size.

5.3.4 Drilling Fluid

The primary purpose is to create a thick gel to suspend soil and rock cuttings and carry them out of the hole. In addition, the fluid hydraulically excavates soil in soft ground, powers the downhole motor in hard ground, cools the drilling equipment, clears debris from the drilling bit, seals the perimeter of the borehole in porous ground and lubricates the borehole to reduce friction on the drilling equipment. The drilling fluid, once used, is pumped into a mud recycling unit, Figure 5.2, shows an example drilling fluid recycling unit with hydrocyclones and shaker screens on the upper level and active mud tank underneath. Cleaned drilling fluid is transferred to the active tank ready for circulating back into the hole.

Figure 5.2: Example Drilling Fluid Recycling Unit

5.3.5 Reaming

On completion of the pilot hole, the drill bit, downward motor and steering equipment are removed. The hole is then enlarged using forward reaming. The HDD will require several reaming passes with progressively larger diameter reamers until the final hole size is reached.

5.3.6 Pilot Hole Exit

Once all reaming is complete the pilot hole is then extended to the exit point. This is a key point to ensure minimal drilling fluid from the hydrostatic head is lost into the sea, as such excess drilling fluid will be pumped out prior to breakout to the marine environment, leaving only the volume of fluid required to complete the pilot hole exit. The remainder of the pilot hole is then opened up to the final diameter.

5.3.7 Duct Installation

A duct will be installed using a pushed installation, as this means there will be a reduction in the number of days required for the offshore works. The ducts are pushed from land to the sea and the cables can then be pulled in through the ducts. At the offshore exit point there will be temporary concrete mattressing placed over the end of the HDD until the offshore cable installation is ready to take place (Figure 5.3). The bulk of the HDD equipment will be removed from the HDD area at that point, leaving only equipment required for the cable pull activities.

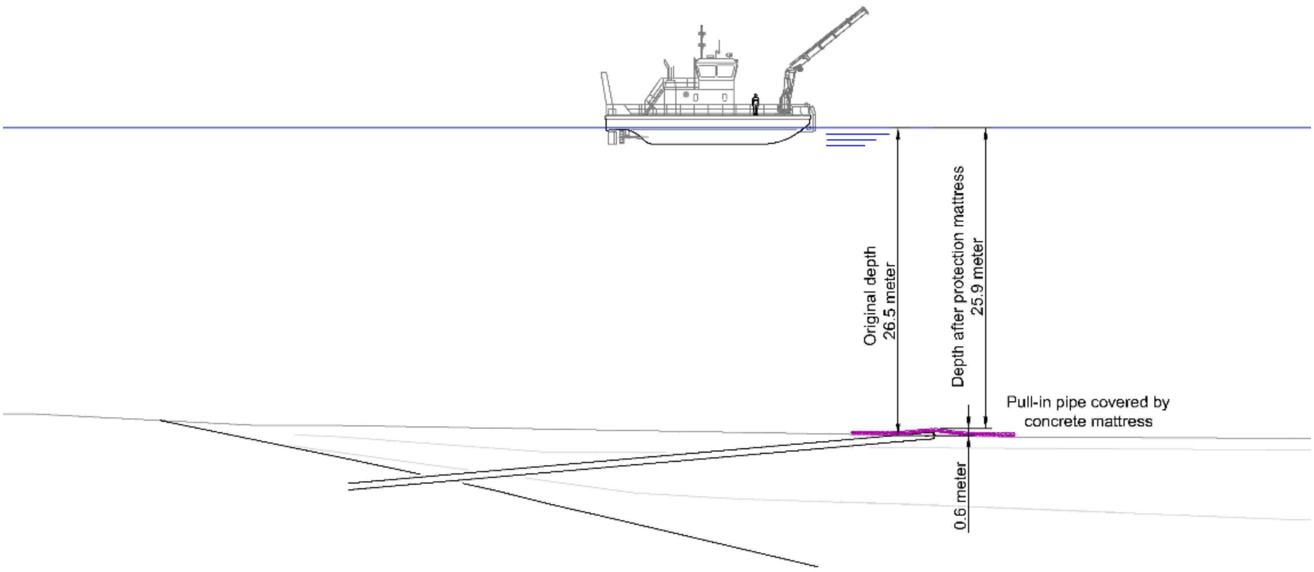


Figure 5.3: Cable Duct Protected by Concrete Mattress

5.4 Offshore Preparations

5.4.1 Pre-Lay Survey

The cable contractor shall review all existing survey data to plan their cable routing through the consenting corridor. Prior to cable installation, a survey will be completed to confirm the routing. The pre-lay survey shall be performed as close as practically possible to the start of cable installation and shall document the seabed; and relevant sub-seabed; conditions along the planned cable route(s).

The detailed survey shall be performed by a low flying ROV equipped to collect Multi-beam Echo Sounder (MBES), Side Scan Sonar (SSS) and Sub-bottom Profiler (SBP) data simultaneously. The ROV shall also be equipped with a video system for benthic habitat confirmation and possible inspection tasks on the same dive. The data shall be used for approval of the final routing with regards to obstructions, or areas where pre-lay trenching, dredging, rock placement or other forms of seabed intervention may be required. The route may be revised within the consenting corridor based on the pre-survey findings to avoid obstacles or previously unmapped sensitive habitats.

The survey will also cover the asset crossings. Crossing surveys were completed as part of the original seabed surveys, but additional surveys will be required to identify possible changes in the existing infrastructures status.

Magnetic data will be acquired for the proposed cable route, to identify potential Unexploded Ordinance (UXO). Several magnetometers shall be mounted in an array to form a gradiometer and towed behind the vessel (if water depths allow) or mounted on an ROV. The maximum distance between the survey lines to achieve full coverage to detect possible UXO will depend on the gradiometer unit, mass of the possible UXO items and the towing height of the gradiometer.

The magnetic data shall be used to map metallic objects and also evaluate the origin of the object to estimate the chance of it being an UXO. This will require full coverage of the defined cable route/corridor width in areas, which from the UXO Desk Top Study are identified as possible UXO areas. This is to ensure identification of such objects and avoid any HSE issues.

Where possible potential UXO contacts are identified during the survey, they will be avoided by an appropriate safety buffer during the final route engineering process. If avoidance is not possible, the items of UXO will be disposed of by an appropriately licenced explosives ordnance disposal contractor, or by the Royal Navy.

5.4.2 Sea Trials

The purpose of sea trials is to prove that vessels, equipment, procedures and personnel are suitable for an efficient installation of the Submarine HVDC and fibre optic Communication Cables, maintaining the cable integrity and in accordance with principles for Health Safety Environment and Quality during all phases of the Work.

Sea trials will be carried out if the cable contractor cannot:

- Provide track records of successful use of equipment under the conditions it is intended for the work;
- Demonstrate that he has successfully applied the proposed procedures on earlier comparable projects; or
- Demonstrate that the cable safety is maintained during all phases of the work.

The following typical operations would potentially require a sea trial:

- Pre-lay trenching and cable lay within the trench;
- Post-lay jet trenching in UK nearshore and other areas of competent soil conditions; and
- Post-lay mechanical trenching in UK nearshore and other areas of competent soil conditions.

The sea trials shall be carried out in the consenting corridor close to the locations where the actual Work will take place. Upon completion of the sea trials, the seabed shall be cleared of all temporary equipment deployed for the purposes of the trial. Trials may need to be completed until:

- It is evident what alterations/adjustments must be made; and
- The spread and procedures prove to function according to the requirements for the work intended.

The methods deployed are equivalent to those utilised in the actual works described below, but on a smaller scale. The trials will be over a length of 200-500m.

5.4.3 Seabed Preparation

An initial sweep of the seabed shall be carried out to remove any debris, boulders or obstacles, such as abandoned nets and wires, on the surface. This may involve a grapnel (hooked) device being dragged along the exact cable route. Alternatively, ROVs or grabs may be used to remove obstacles (Figure 5.4).

Figure 5.4: Example machinery for boulder clearance pre-cable lay.

5.4.4 Pre-Trenching

As discussed in Section 4.3, there is a potential to pre-trench parts of the cable route to help with gaining the DOL required to protect the cable. The pre-trenching plough would cut a trench in the seafloor by means of the ploughing tool being pulled along the seabed floor with great force by a vessel.

The performance of the plough and the trench depth being achieved will be closely monitored during trenching, to allow appropriate adjustments to be made and ensure that the appropriate trench depths are being achieved, as far as practicable. As discussed in Section 4.3.1, up to 3 passes will be made to reach the desired trench depth to ensure appropriate DOL can be achieved.

Pre-trenching will be conducted as soon a practically possible before cable laying, in order to minimise the risk of natural backfilling reducing the DOL before the cable is installed.

5.4.5 Crossing Rock Placement

As discussed in Section 4.3.2 there will be a need to place rocks to protect existing infrastructure prior to cables being laid over them. The rock will be placed from a specialist fall pipe vessel prior to the cable being laid.

5.5 Marine Cable Pull

5.5.1 Seabed Preparations

To allow the cables to be pulled from the offshore environment, the protective mattressing installed to protect the HDD marine exit hole will be removed. An area around the duct (pull in pipe) will be excavated and a clamp with mounting flanges installed, as shown in Figure 5.5. Preparations will be completed immediately prior to each cable being pulled. Seabed preparation works may include ROVs and Divers.

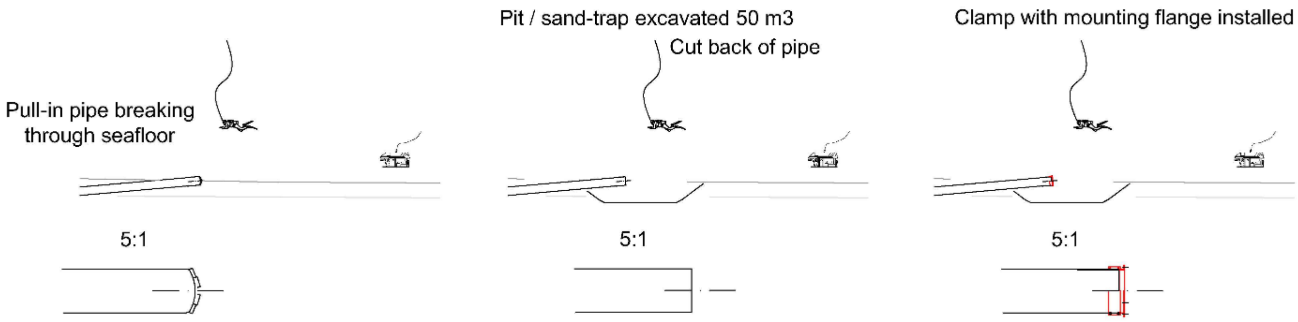


Figure 5.5: Seabed Preparations for the Marine Cable Pull.

5.5.2 Cable Pull

The marine HVDC cables will be delivered in 150 km long sections, hence assuming that the HVDC cables are laid separately, the two marine HVDC cable pulls will be carried out at different times. The fibre optic cable will be pulled during one of the HVDC cable pull campaigns, as it will be bundled with it for the remainder of the route. When the cable lay vessel arrives at site, the bell mouth will be installed to guide the cable into the duct (Figure 5.6). The cable will be pulled from land utilising a set-up similar to that shown in Figure 5.7. Once the cable is in place, a cap will be installed to isolate the duct from the sea. Bentonite will then be pumped into the duct to fix the cable in the duct (Figure 5.6). The marine cable on the seabed will then be protected by placing rock over the HDD marine exit point along the cable route (Figure: 5.6) until the cable is suitably protected by other means (see Section 5.7).

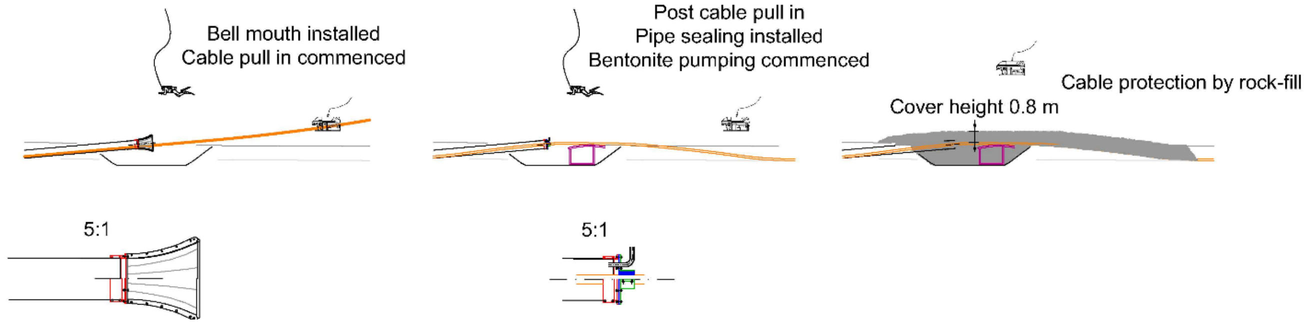


Figure 5.6: Cable Pulling Steps

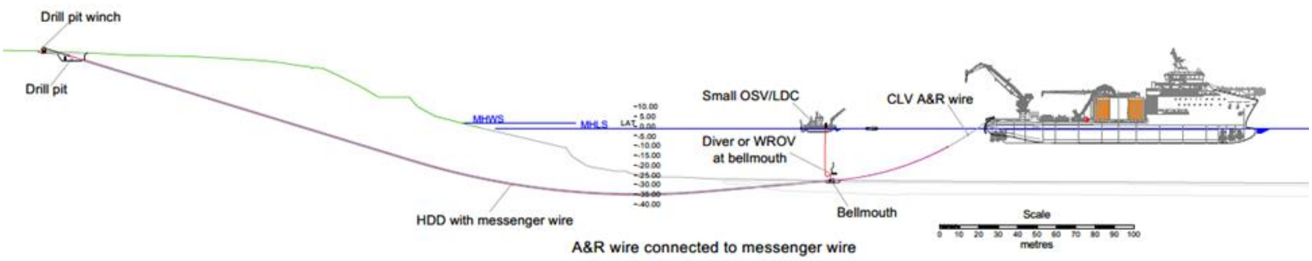


Figure 5.7: Indicative Set up for the Marine Cable Pull.

5.6 Onshore Demobilisation and Reinstatement

Once all the marine cables have been pulled onto land and jointed with the onshore cables, the onshore areas can be fully demobilised. Equipment will be removed from site, the temporary water supply removed, hardstanding materials lifted, and the field reinstated for agricultural use to its existing ground levels. The access track will be mainly removed, with only a small area of tarmac (approx. 1m wide) remaining adjacent to the A90, this is to minimise the need to control traffic on the A90 during demobilisation works. The access road route will be reinstated to original levels suitable for agricultural use.

5.7 Offshore Cable Installation

The HVDC cables will be delivered in sections approximately 150km long. Four sections of cable will be required for the STW/UKEEZ. The first cable will be pulled ashore (as discussed in Section 5.5) and installed as discussed below. The cable end will be marked with a buoy and guard vessel utilised to protect it. Information with regard to the role of guard vessels is provided in the Fisheries Liaison and Mitigation Action Plan (FLMAP) (NorthConnect, 2018c). The second cable section will either be pulled ashore and laid, or attached to the end of the first section, this will depend on the timing of the delivery in relation to the bird breeding season. The third section will be attached to the first section or pulled ashore, depending on the placement of the second section. The fourth section will be attached to the end of the second cable installed from the UK landfall.

If the HVDC cables were to be bundled, all Landfall cable pulls would be completed in one campaign, the cables would be approximately half the length (75km) and hence joins will be every 75km, with each section being joined to the end of the previous section.

In parallel, cable installation will commence at Simadalen in Norway, working eastward to join with the cables laid from the UK to the middle of the North Sea. The exact location will be determined by cable section lengths, but it is likely to be outwith the UKEEZ.

5.7.1 Cable Laying

The cable will be laid on the seabed by the cable lay vessel, along the pre-identified cable route within the consenting corridor. Where pre-trenching is utilised, the cable will be laid directly into the trench. Guard vessels will be deployed as detailed in the FLMAP (NorthConnect, 2018c) to ensure that the cable is not damaged, and prevent hazards to other legitimate users of the sea including commercial fishing vessels, while the cable is unprotected on the seabed.

5.7.2 Cable Installation Survey/ As-laid Survey

Survey operations will be carried out during the cable installation to monitor the cable and the positioning of the cable touch down point. This is likely to be carried out by an ROV, either deployed from the cable lay vessel or an additional survey vessel. Particular attention shall be given to areas of importance like obstructions (e.g. boulders), areas with limited flexibility due to exposed bedrock, possible pre-trenched sections, infrastructure crossings, etc. The survey will cover a minimum of 25m each side of the cable and utilise at least SSS and MBES.

5.7.3 Post Cable Trenching

The cable will then be trenched into the seabed utilising an appropriate trenching device as discussed in Section 4.3.3.

5.7.4 Trenching Survey

The post trenching survey is expected to consist of two phases:

- Trenching performance monitoring; and
- As trenched survey to document results of the trenching.

There is a potential that intermediate surveys may be required when multiple trench passes are executed.

The minimum survey coverage on each side of the cable shall be 25m (SSS and MBES), i.e. both “high fly survey” and “low fly survey” shall be performed to ensure MBES/SSS coverage and video coverage/cable tracking ability, respectively. SBP and cable tracking devices may also be employed to verify DOL/DOB.

In order to achieve optimised trenching performance, the trencher operators shall actively use data from the survey to optimise trencher setup, such as sword depth, trenching speed, buoyancy, water pressure, nozzle configuration, etc.
The as-trenched survey is partly the measurements used to control/monitor the trenching operations and partly necessary to check/document survey results where the quality of the trenching for some reason is doubtful. In challenging areas, the as-trenched surveys are normally performed in limited trenching sections and, if appropriate, performed in several passes to document the results of additional trenching passes.

5.7.5 Cable Joints

To join cable sections, the installed cable will be lifted from the seabed to the cable lay vessel, where the joint will be made prior to relaying the cable on the seabed and installation of the cables being completed (trenched/rock placed).

5.7.6 Rock Placement

Rock will be placed in the following circumstances:

- To provide cable protection at crossings;
- To backfill trenches which have not naturally infilled sufficiently, or where natural infilling is not expected to achieve the required DOB; or
- Remedial rock placement to provide the appropriate protection levels where DOL has not been achieved.

Rock will be placed from a specialist fall pipe vessel at the required locations, to provide the appropriate protection levels. The rock will be appropriately sloped at gradients between approximately 1:3 to 1:2.5 to ensure stability, and to allow for demersal trawl fishing to be carried out safely over the rock berms.

5.7.7 Rock Placement Survey

A rock placement survey shall be performed immediately after rock placement or, if necessary, at an intermediate stage during rock placement by the rock placement vessel with the fall-pipe ROV.

The rock placement survey shall cover 25m on each side of the cable (SSS and MBES), i.e. both "high fly survey" and "low fly survey" shall be performed to ensure MBES/SSS coverage and video coverage/cable tracking ability, respectively. SBP and cable tracking devices may also be employed to verify DOL/DOB. The rock placement survey shall be conducted either to monitor the performance of an on-going rock placement operation, or in order to form the basis for the as-built documentation/as-installed survey planning.

Remedial works will be conducted where: rock berms do not provide an adequate level of protection as defined in Section 4.3.1, do not meet the specifications detailed in Section 5.7.6, or where a snagging rick is identified,

5.7.8 Post Installation Survey/As-Built Survey

An as-built survey shall document the final conditions of the cable and the nearby corridor after the cable has been completely installed, including protection and possible sediment settlement. This survey shall cover a minimum corridor width of 50m centred over each cable and the results shall form the reference for future inspection surveys. The as-built survey shall be performed as a low-fly survey using the basic ROV spread, including MBES, SSS, SBP, video cameras, and an appropriate cable tracker, along all installed cables.

The main objectives of the as-built survey shall be to:

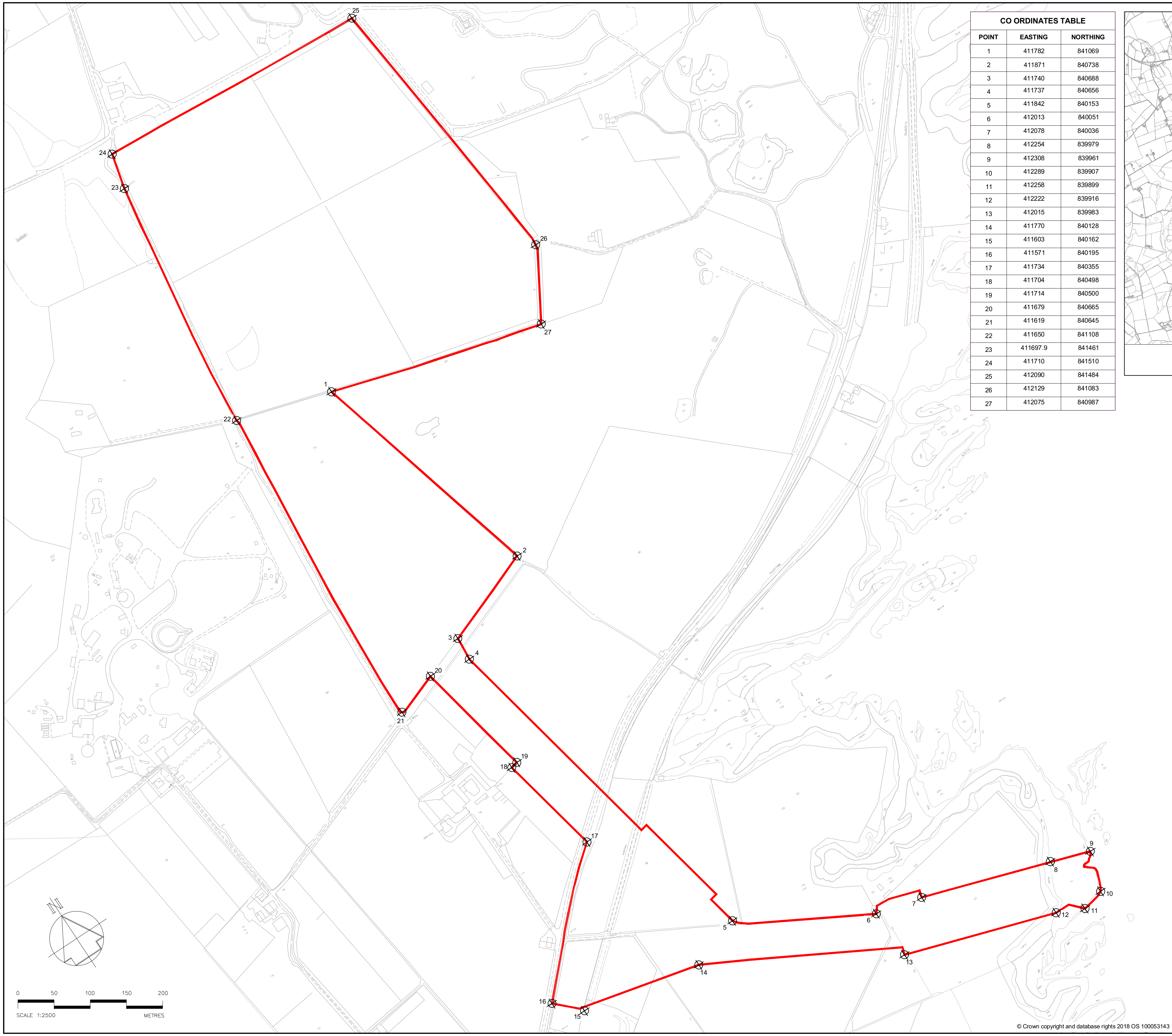
- Map the horizontal and vertical curvature of the cable;
- Identify cable separation;
- Identify any free spans and rectified if found (none are expected in STW/UKEEZ);
- Map the protection depth (top of cable) in trench/rock berm and compare with depth specification;
- Map the detailed topography of the trench and corridor to investigate, e.g.:
  - Width of trench;
  - Depth of trench (and thus depth of cover);
  - Cross profiles of rock berms;
  - Potential debris/obstructions within the corridor; and
  - Moving sediments

5.8 Reporting

The as-built survey results will provide the exact routes the cables have taken. This information will be shared with the appropriate bodies as detailed in the Communications Strategy (NorthConnect, 2018b).

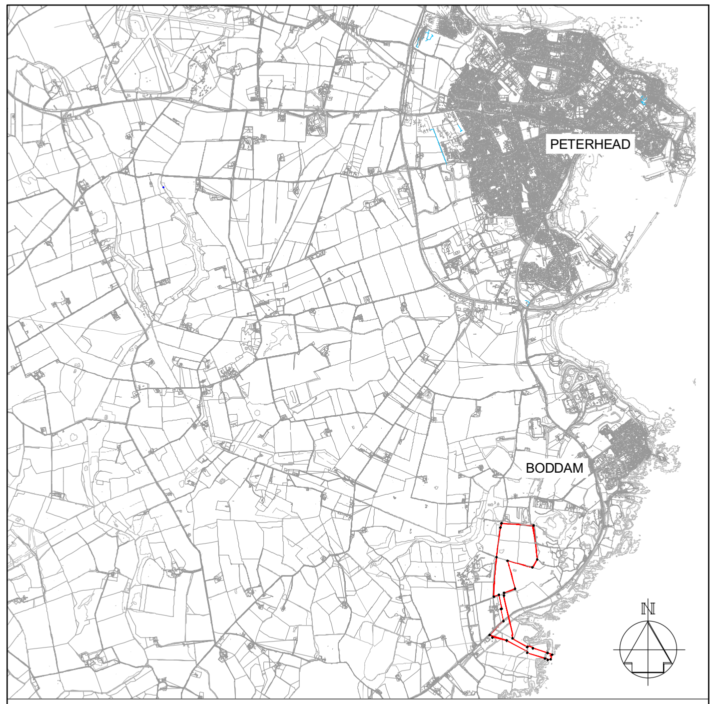
6. REFERENCES

Allen and Gordon. (2018). HVDC Cable Infrastructure - Transport Statement.
NorthConnect. (2018a). HVDC Cable Infrastructure - UK Environmental Impact Assessment Report. *2 - Main Report*(NCGEN-NCT-X-RA-0004).
NorthConnect. (2018b). HVDC Cable Infrastructure - Communication Strategy.
NorthConnect. (2018c). HVDC Cable Infrastructure - Fisheries Liaison Mitigation Action Plan.



CO ORDINATES TABLE

POINT	EASTING	NORTHING
1	411782	841069
2	411871	840738
3	411740	840688
4	411737	840656
5	411842	840153
6	412013	840051
7	412078	840036
8	412254	839979
9	412308	839961
10	412289	839907
11	412258	839899
12	412222	839916
13	412015	839983
14	411770	840128
15	411603	840162
16	411571	840195
17	411734	840355
18	411704	840498
19	411714	840500
20	411679	840665
21	411619	840645
22	411650	841108
23	411697.9	841461
24	411710	841510
25	412090	841484
26	412129	841083
27	412075	840987



LOCATION PLAN

NOTES

LEGEND

RED LINE BOUNDARY

REV NO	ISSUE REASON	DATE	PREPARED	CHECKED	APPROVED
0	IFU - ISSUED FOR USE	24/07/18	JAM	JOA	STM

PROJECT

NORTHCONNECT

DRAWING TITLE

UK HVDC RED LINE BOUNDARY (ONSHORE) PLAN

Co-financed by the European Union
Connecting Europe Facility

DRAWING NO

NCFFS-NCT-X-XG-0001-01

SHEET	REVISION	FORMAT	SCALE	GEODETIC REFERENCE SYSTEM
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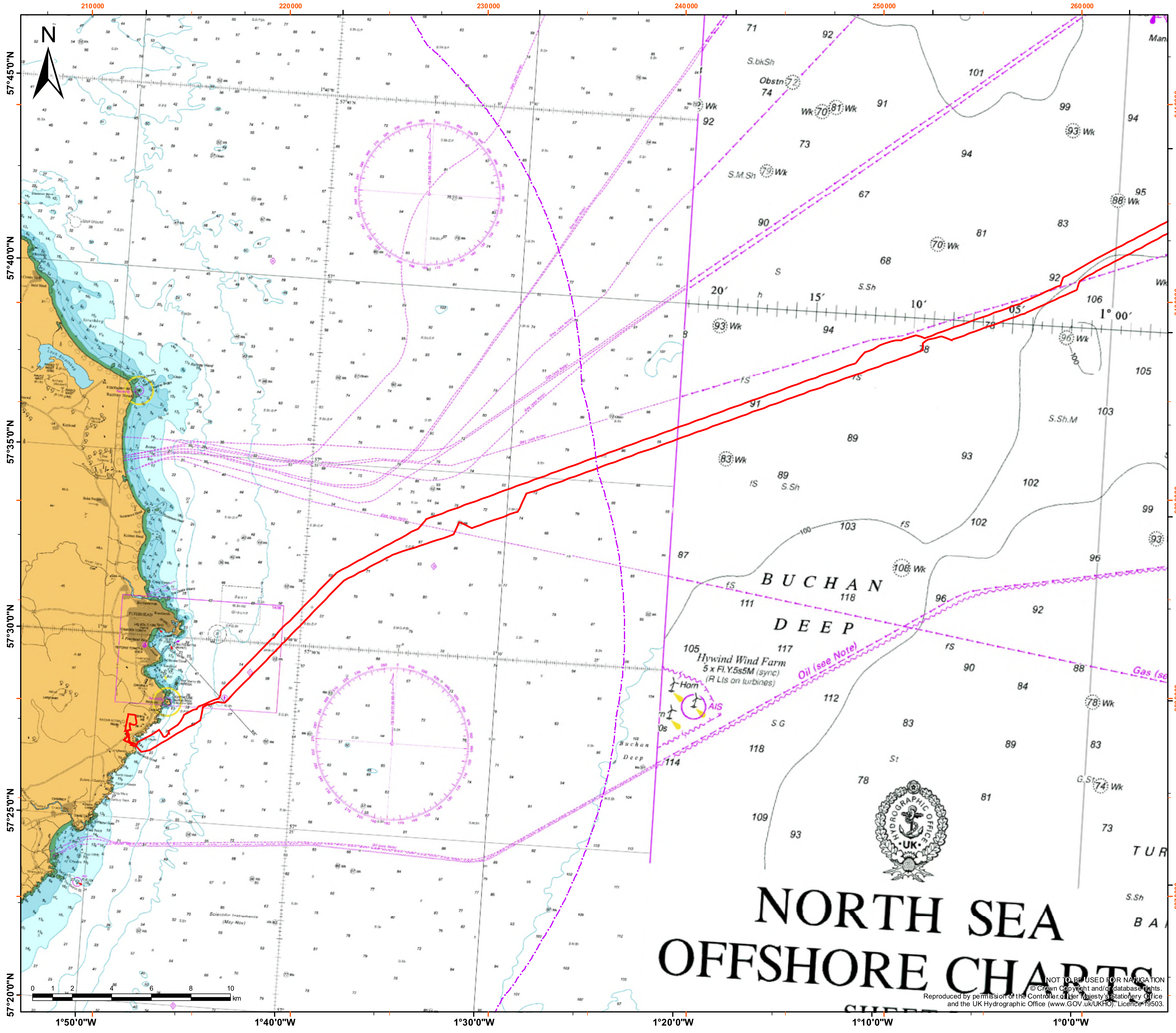

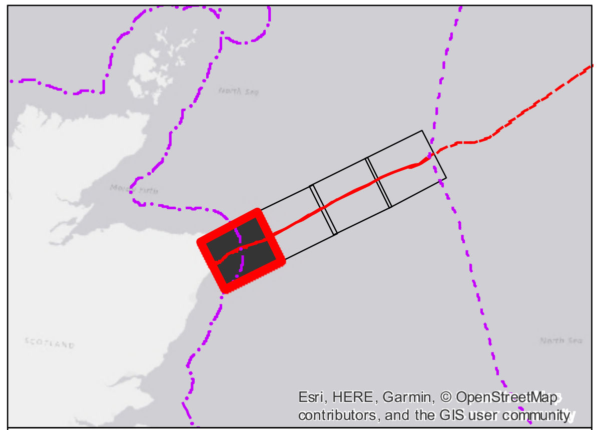

Legend

- UK Red Line Boundary
- Norwegian Consenting Corridor
- UK Exclusive Economic Zone
- UK 12NM Territorial Waters

REV NO	ISSUE REASON	DATE	PREPARED	CHECKED	APPROVED
0	Issued for use	24/07/2018	DAM	JOA,ECB	PEJ
A	Review	29/03/2018	BPH	JOA,ECB	PEJ

PROJECT

NORTHCONNECT

NORTHCONNECT CONNECTING RENEWABLES

DRAWING TITLE

UK HVDC Red Line Boundary (Marine) Plan 1

Co-financed by the European Union
Connecting Europe Facility

DRAWING PRODUCER LOGO

exprodat

DRAWING NO.

NCOFF-NCT-X-XG-0001-01

SHEET	REVISION	FORMAT	SCALE	GEODETIC REF. SYSTEM
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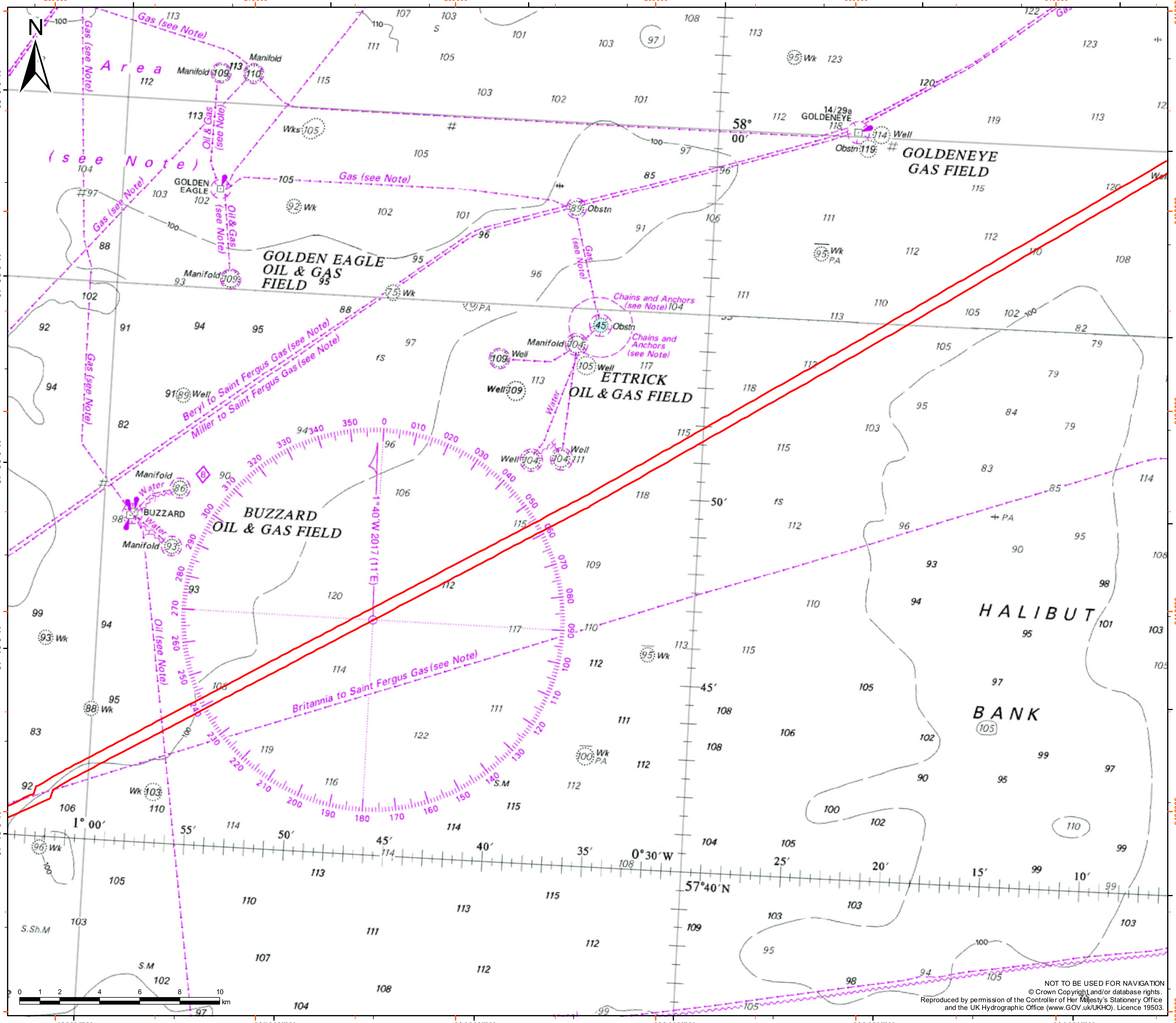
DRAWING PRODUCER DOC. REV.: 0



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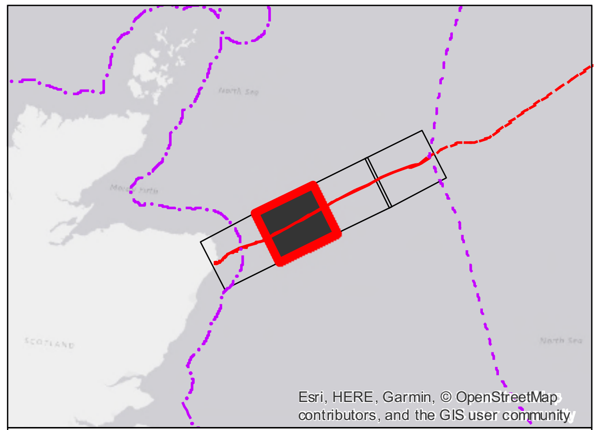

Legend

- UK Red Line Boundary
- Norwegian Consenting Corridor
- UK Exclusive Economic Zone
- UK 12NM Territorial Waters

REV NO	ISSUE REASON	DATE	PREPARED	CHECKED	APPROVED
0	Issued for use	24/07/2018	DAM	JOA,ECB	PEJ
A	Review	29/03/2018	BPH	JOA,ECB	PEJ

PROJECT
NORTHCONNECT

NORTHCONNECT CONNECTING RENEWABLES

DRAWING TITLE
UK HVDC Red Line Boundary (Marine) Plan 2

Co-financed by the European Union Connecting Europe Facility

DRAWING NO.
NCOFF-NCT-X-XG-0001-02

exprodat

SHEET	REVISION	FORMAT	SCALE	GEODETIC REF. SYSTEM
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TK1330-02
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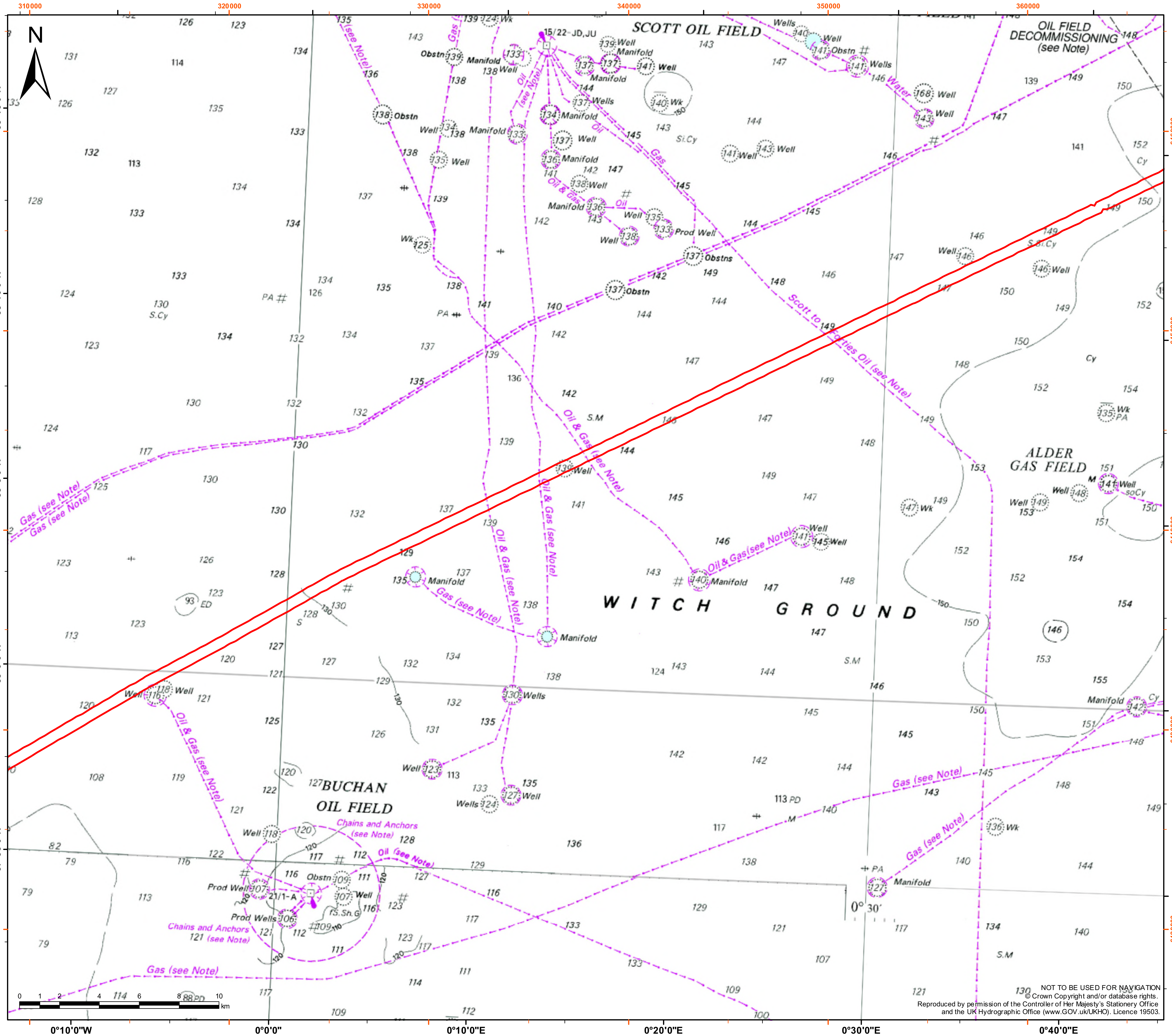

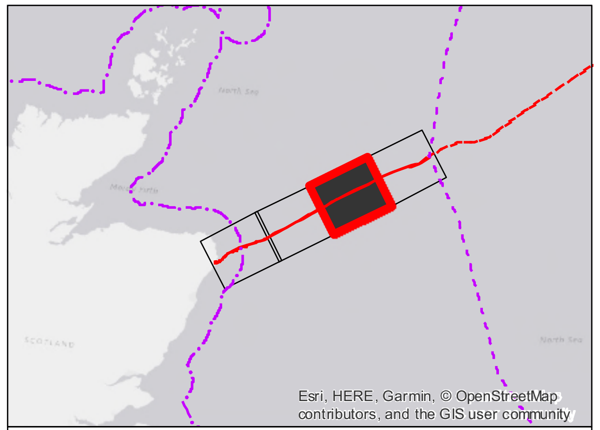

Legend

- UK Red Line Boundary
- Norwegian Consenting Corridor
- UK Exclusive Economic Zone
- UK 12NM Territorial Waters

REV NO	ISSUE REASON	DATE	PREPARED	CHECKED	APPROVED
0	Issued for use	24/07/2018	DAM	JOA,ECB	PEJ
A	Review	29/03/2018	BPH	JOA,ECB	PEJ

PROJECT

NORTHCONNECT

NORTHCONNECT CONNECTING RENEWABLES

Co-financed by the European Union
Connecting Europe Facility

DRAWING TITLE

UK HVDC Red Line Boundary (Marine) Plan 3

DRAWING PRODUCER LOGO

exprodat

DRAWING NO.

NCOFF-NCT-X-XG-0001-03

SHEET	REVISION	FORMAT	SCALE	GEODETIC REF. SYSTEM
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DRAWING PRODUCER DOC. NO.
TK1330-03

DRAWING PRODUCER DOC. REV.
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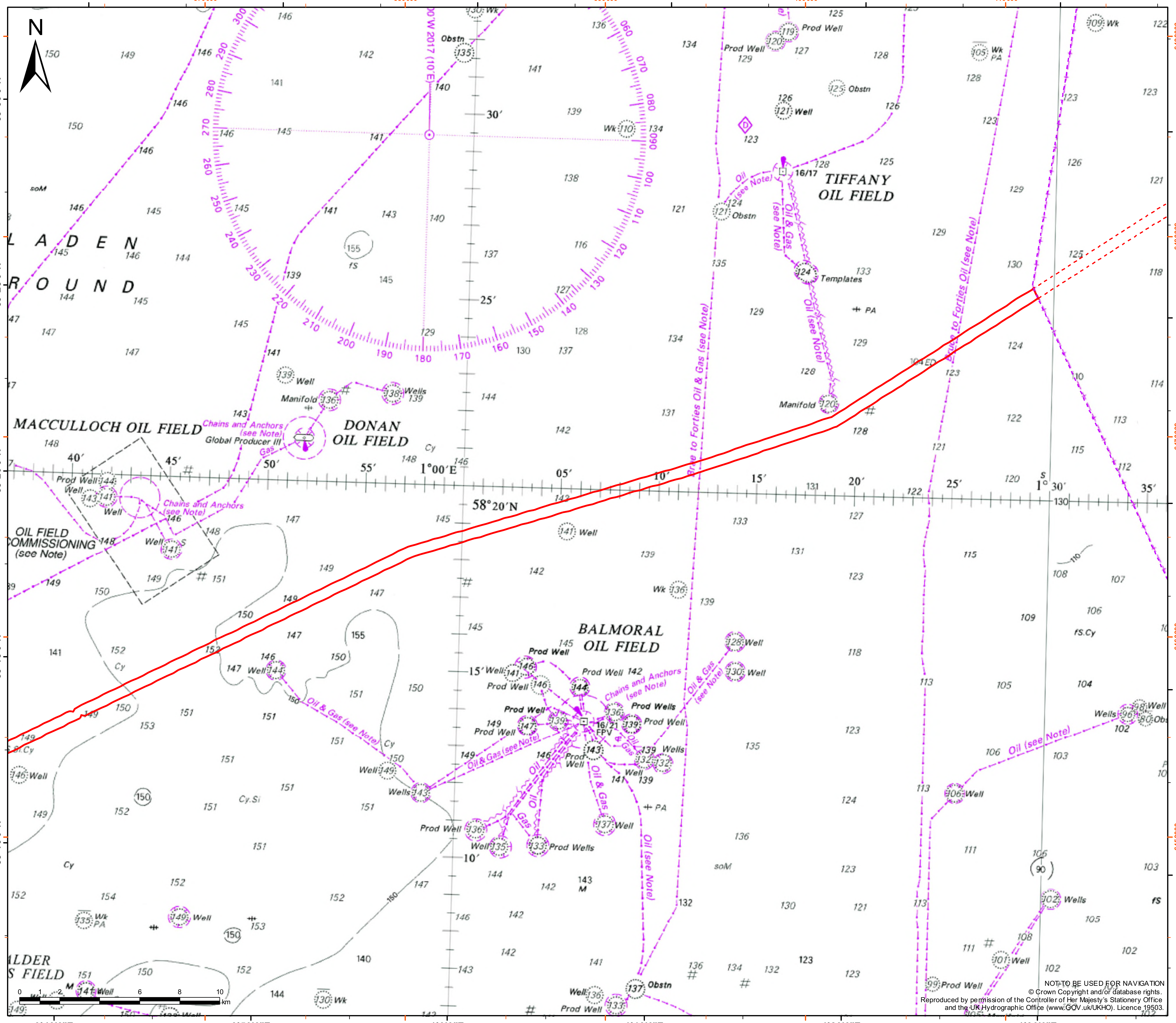

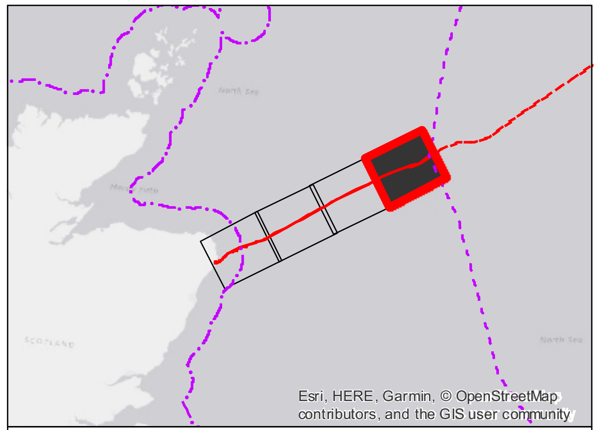

Legend

- UK Red Line Boundary
- Norwegian Consenting Corridor
- UK Exclusive Economic Zone
- UK 12NM Territorial Waters

REV NO	ISSUE REASON	DATE	PREPARED	CHECKED	APPROVED
0	Issued for use	24/07/2018	DAM	JOA,ECB	PEJ
A	Review	29/03/2018	BPH	JOA,ECB	PEJ

PROJECT

NORTHCONNECT

DRAWING TITLE

UK HVDC Red Line Boundary (Marine) Plan 4

Co-financed by the European Union
Connecting Europe Facility

DRAWING NO.

NCOFF-NCT-X-XG-0001-04

exprodat

SHEET	REVISION	FORMAT	SCALE	GEODETIC REF SYSTEM
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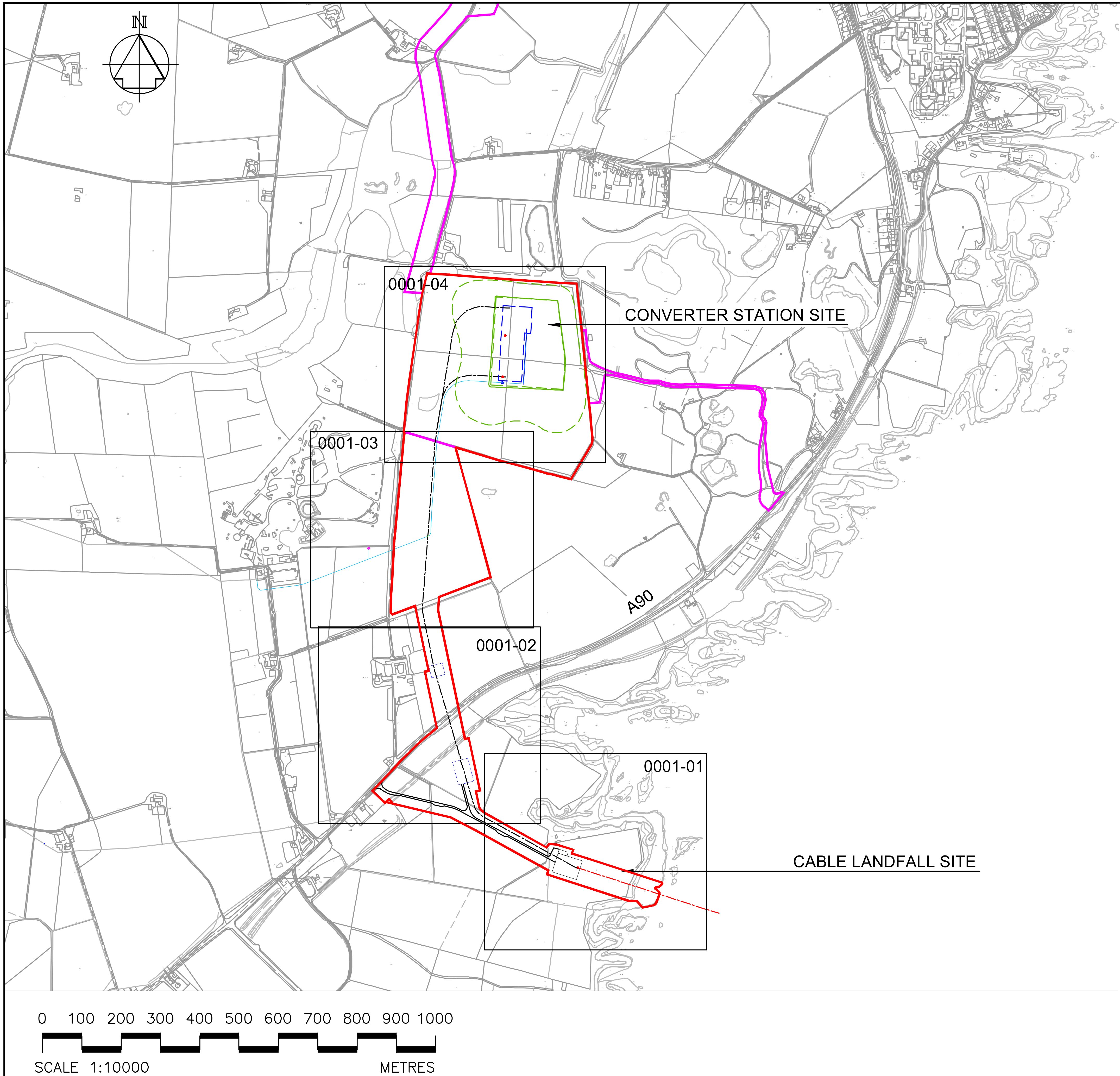

LEGEND

- PROPOSED WATER MAIN
- INDICATIVE HVDC CABLE ROUTE(S)
- REDLINE BOUNDARY
- PREVIOUSLY CONSENTED RED LINE BOUNDARY (REF: APP/2015/1121)
- OUTLINE OF PROPOSED CONVERTER BUILDING
- EXTENT OF LANDSCAPING BUNDS

NOTES

TO BE READ IN CONJUNCTION WITH DRAWING Nos. 0001-01, 0001-02, 0001-03 & 0001-04

REV NO	ISSUE REASON	DATE	PREPARED	CHECKED	APPROVED
1	IFU - ISSUED FOR USE	23/07/2018	JAM	STM	GMC
0	IFU - ISSUED FOR USE	10/07/2018	EH	GJD	GJD

PROJECT

NORTH CONNECT

Co-financed by the European Union
Connecting Europe Facility

DRAWING TITLE

HVDC ONSHORE CABLE ROUTE MASTERPLAN

DRAWING NO

NCGEN-NCT-Z-XE-0002-01

SHEET	REVISION	FORMAT	SCALE	GEODETIC REFERENCE SYSTEM
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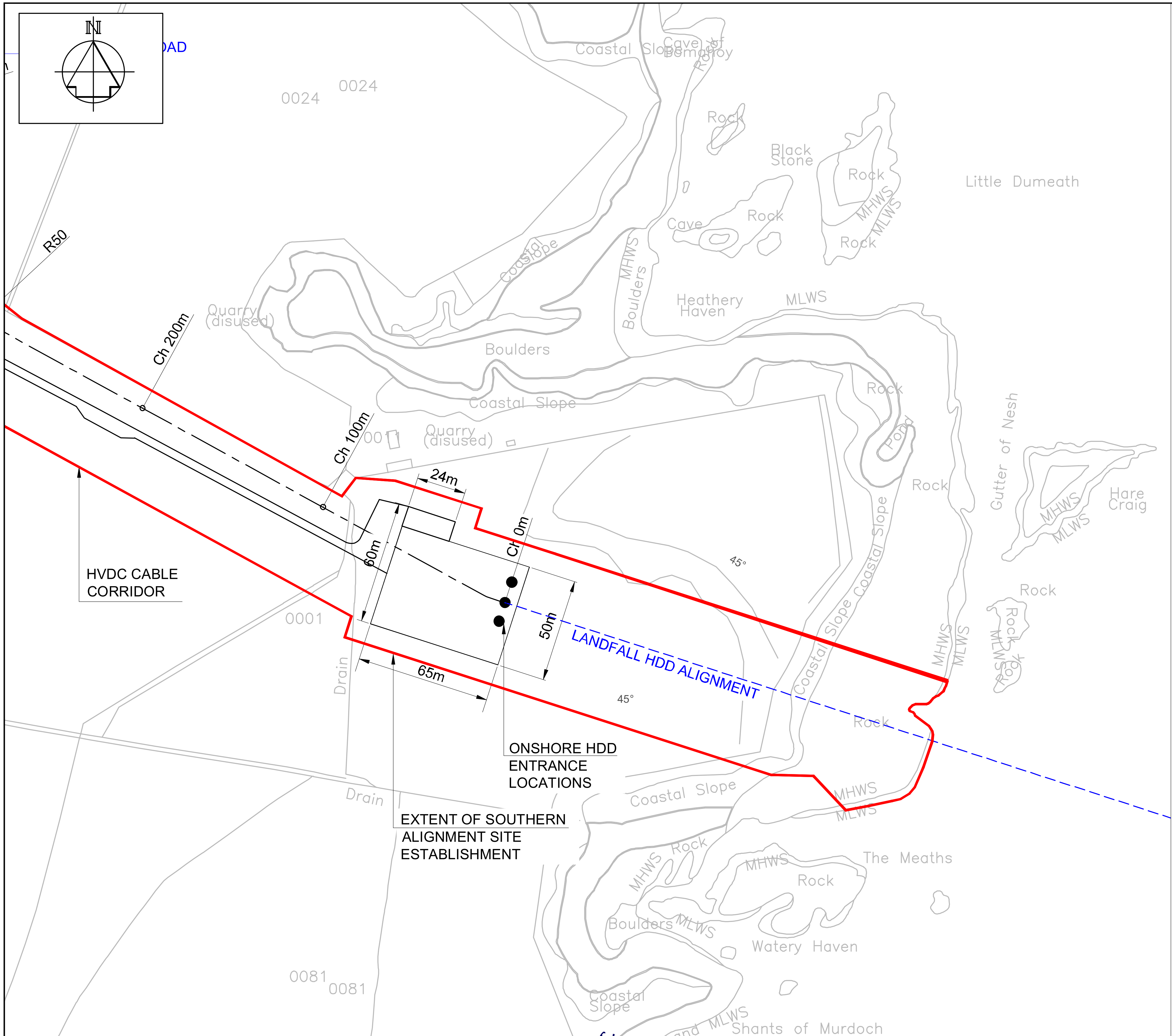

0 50 100 200

SCALE 1:2000 METRES

LEGEND

PROPOSED LANDFALL HDD ALIGNMENT

INDICATIVE CABLE ROUTE

RED LINE BOUNDARY

NOTES

1. EARTHING REQUIREMENTS ALONG CABLE ROUTE TO BE CONFIRMED

TO BE READ IN CONJUNCTION WITH DRAWING Nos. 0002-01, 0001-02, 0001-03 & 0001-04

REV NO	ISSUE REASON	DATE	PREPARED	CHECKED	APPROVED
1	IFU - ISSUED FOR USE	23/07/2018	JAM	STM	GMC
0	IFU - ISSUED FOR USE	10/07/2018	EH	GJD	GJD

PROJECT: NORTH CONNECT

NORTHCONNECT

Co-financed by the European Union Connecting Europe Facility

DRAWING TITLE: HVDC ONSHORE CABLE GENERAL ARRANGEMENT SHEET 1 OF 4

DRAWING NO: NCGEN-NCT-Z-XD-0001-01

Allen Gordon

SHEET	REVISION	FORMAT	SCALE	GEODETIC REFERENCE SYSTEM	DRAWING PRODUCER DOC. NO./REV
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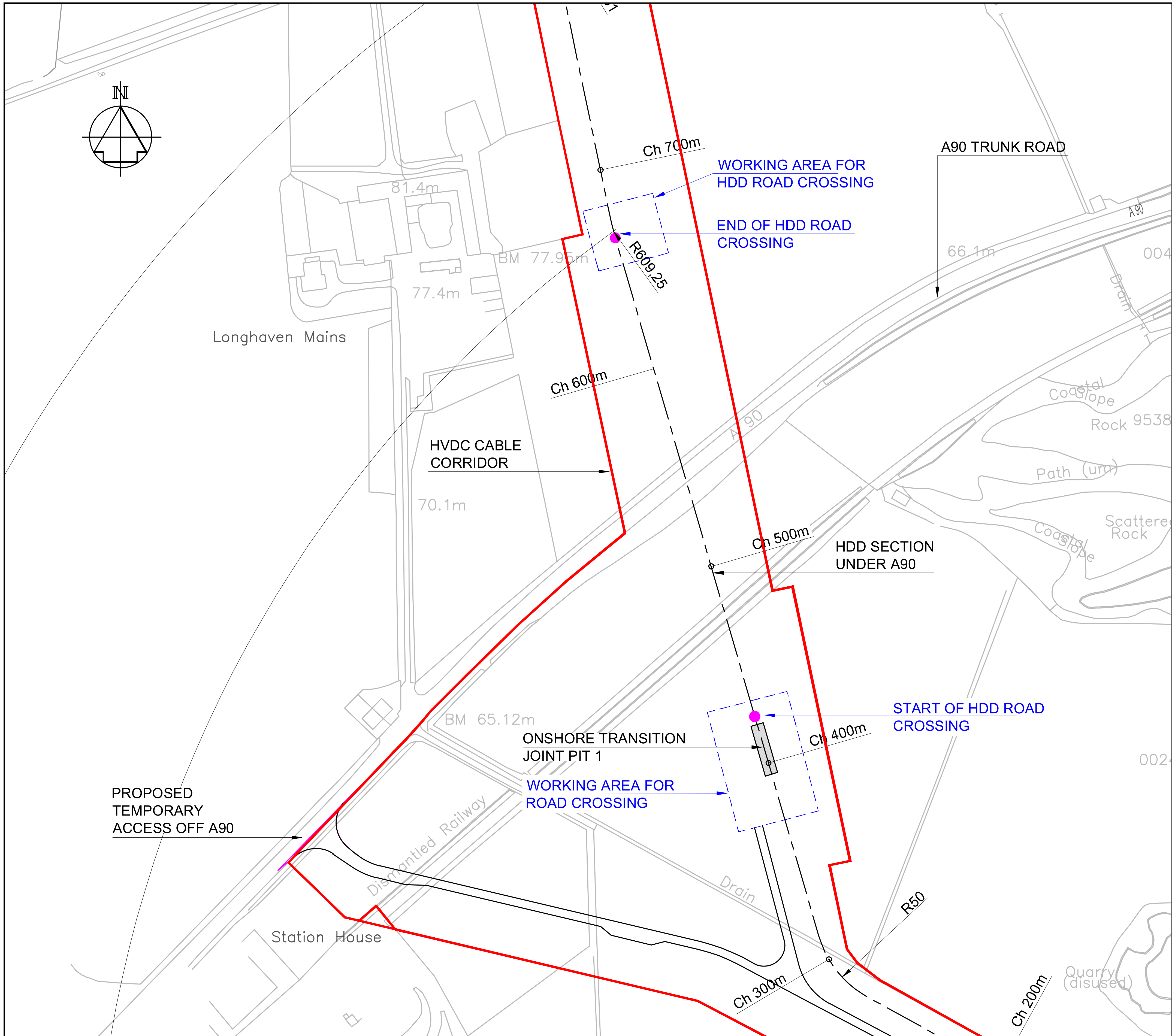

0 50 100 200

SCALE 1:2000 METRES

LEGEND

INDICATIVE CABLE ROUTE	—— - —— - ——
RED LINE BOUNDARY	————
WORKING AREA HDD ROAD CROSSING	— — — — —

NOTES

1. EARTHING REQUIREMENTS ALONG CABLE ROUTE TO BE CONFIRMED

TO BE READ IN CONJUNCTION WITH DRAWING Nos. 0002-01, 0001-01, 0001-03 & 0001-04

REV NO	ISSUE REASON	DATE	PREPARED	CHECKED	APPROVED
1	IFU - ISSUED FOR USE	23/07/2018	JAM	STM	GMC
0	IFU - ISSUED FOR USE	10/07/2018	EH	GJD	GJD

PROJECT: NORTH CONNECT

NORTHCONNECT

Co-financed by the European Union
Connecting Europe Facility

DRAWING TITLE: HVDC ONSHORE CABLE ROUTE GENERAL ARRANGEMENT SHEET 2

DRAWING NO: NCGEN-NCT-Z-XD-0001-02

Allen Gordon

SHEET	REVISION	FORMAT	SCALE	GEODETIC REFERENCE SYSTEM
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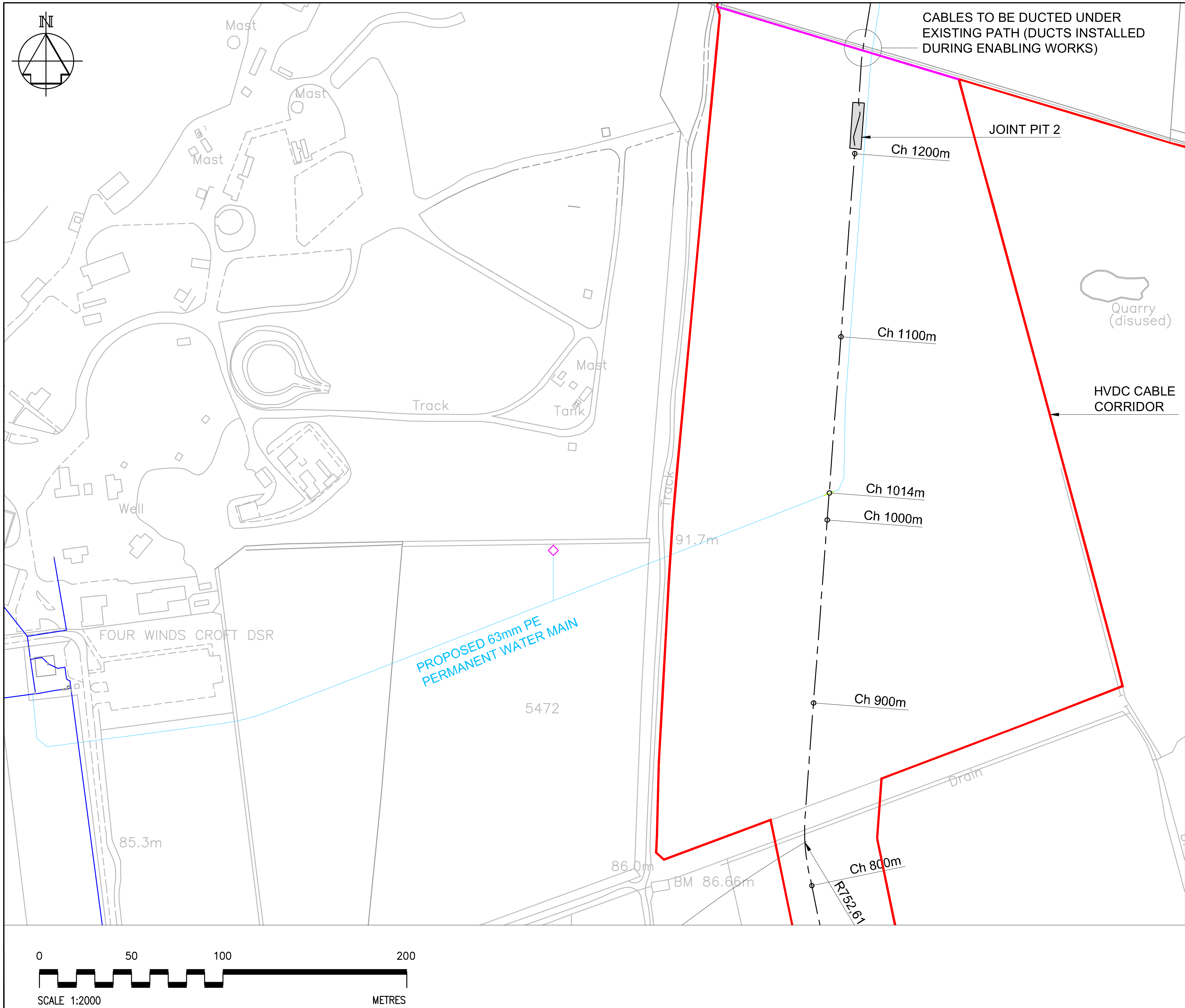
DRAWING PRODUCER DOC. NO./REV

DRAWING PRODUCER DOC. TAG NO.



LEGEND

PROPOSED WATER MAIN	(light blue line)
INDICATIVE CABLE ROUTE	(dash-dot line)
RED LINE BOUNDARY	(red line)
EXISTING WATER MAIN	(blue line)
PREVIOUSLY CONSENTED RED LINE BOUNDARY (REF: APP/2015/1121)	(magenta line)

NOTES

1. EARTHING REQUIREMENTS ALONG CABLE ROUTE TO BE CONFIRMED

TO BE READ IN CONJUNCTION WITH DRAWING Nos. 0002-01, 0001-01, 0001-02 & 0001-04

REV NO	ISSUE REASON	DATE	PREPARED	CHECKED	APPROVED
1	IFU - ISSUED FOR USE	23/07/2018	JAM	STM	GMC
0	IFU - ISSUED FOR USE	10/07/2018	EH	GJD	GJD

PROJECT
NORTH CONNECT

DRAWING TITLE
HVDC ONSHORE CABLE ROUTE
GENERAL ARRANGEMENT
SHEET 3

Co-financed by the European Union
Connecting Europe Facility

DRAWING NO
NCGEN-NCT-Z-XD-0001-03

SHEET	REVISION	FORMAT	SCALE	GEODETIC REFERENCE SYSTEM
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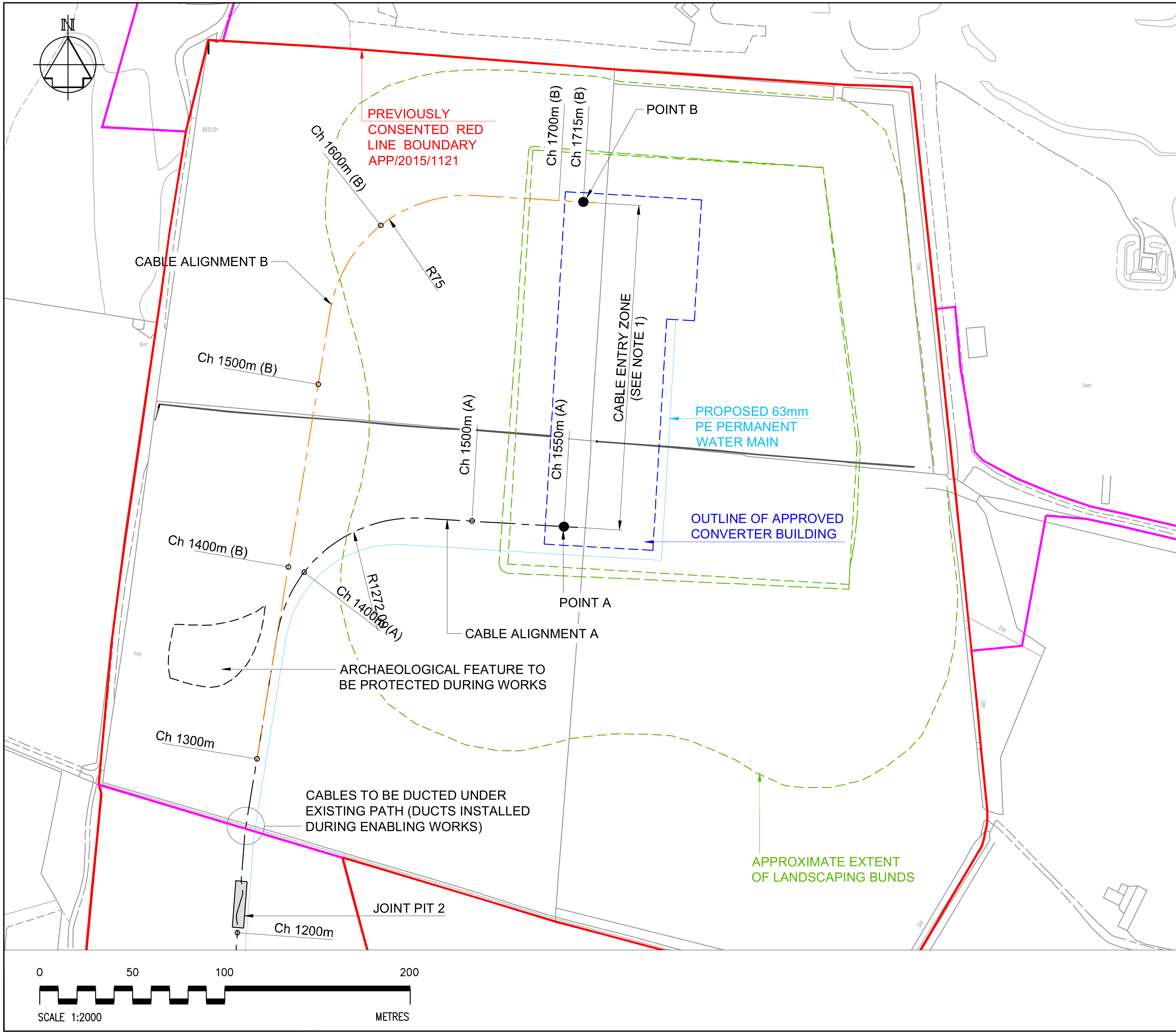

LEGEND

- PROPOSED PERMANENT WATER MAIN
- INDICATIVE CABLE ROUTE A
- INDICATIVE CABLE ROUTE B
- REDLINE BOUNDARY
- OUTLINE OF PROPOSED CONVERTER BUILDING
- PREVIOUSLY CONSENTED RED LINE BOUNDARY (REF: APP/2015/1121)
- EXTENT OF LANDSCAPING BUNDS

NOTES

1. THE HVDC CABLE WILL BE ROUTED INTO AN APPROPRIATE LOCATION IN THE CONVERTER STATION, LINES SHOWN HERE ARE INDICATIVE ONLY.
2. SEE DRG NO. *NCGEN-NCT-Z-XE-0004-01* FOR DETAILS OF CABLE DUCTS UNDER LANDSCAPING BUNDS.
3. EARTHING REQUIREMENTS ALONG CABLE ROUTE TO BE CONFIRMED.

TO BE READ IN CONJUNCTION WITH DRAWING Nos. 0002-01, 0001-01, 0001-02 & 0001-03

REV NO	ISSUE REASON	DATE	PREPARED	CHECKED	APPROVED
1	IFU - ISSUED FOR USE	23/07/2018	JAM	STM	GMC
0	IFU - ISSUED FOR USE	10/07/2018	EH	GJD	GJD

PROJECT: NORTH CONNECT

DRAWING TITLE: HVDC ONSHORE CABLE ROUTE GENERAL ARRANGEMENT SHEET 4

Co-financed by the European Union Connecting Europe Facility

DRAWING NO: NCGEN-NCT-Z-XD-0001-04

SHEET	REVISION	FORMAT	SCALE	GEODETIC REFERENCE SYSTEM
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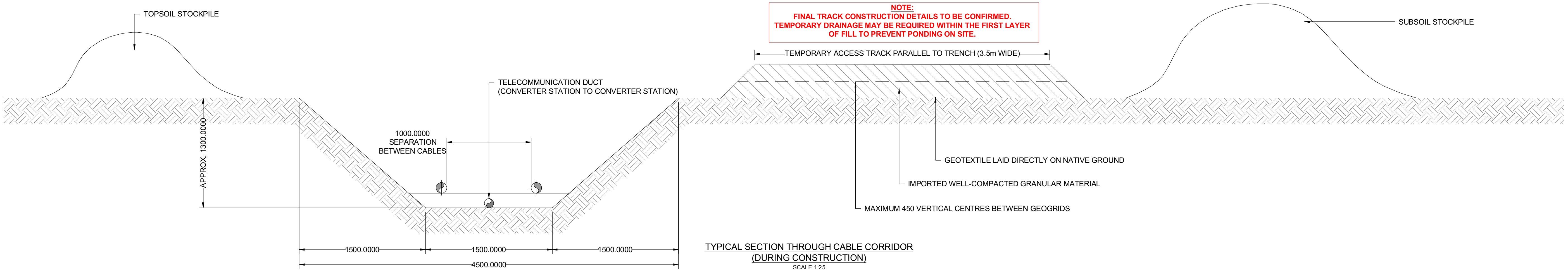
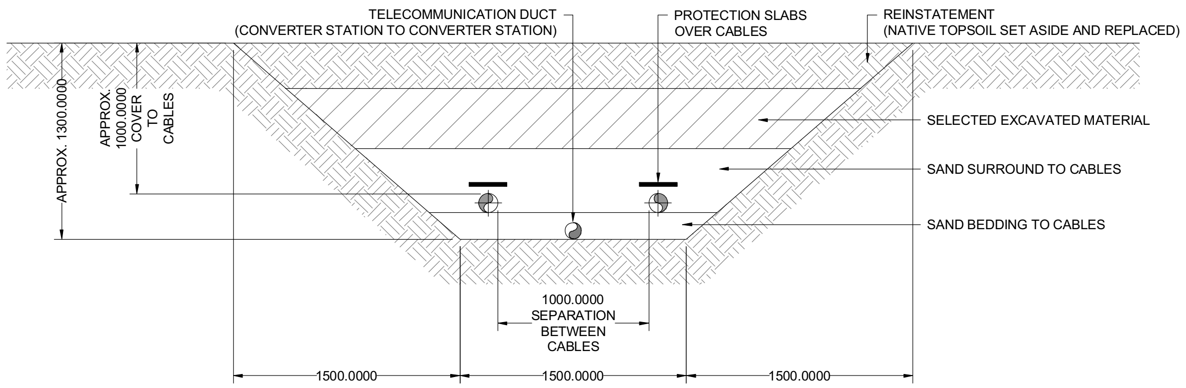
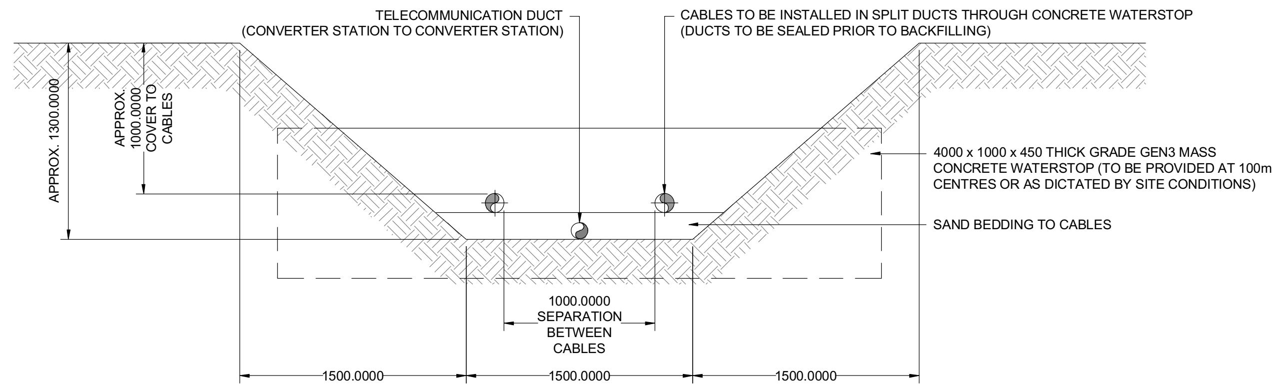


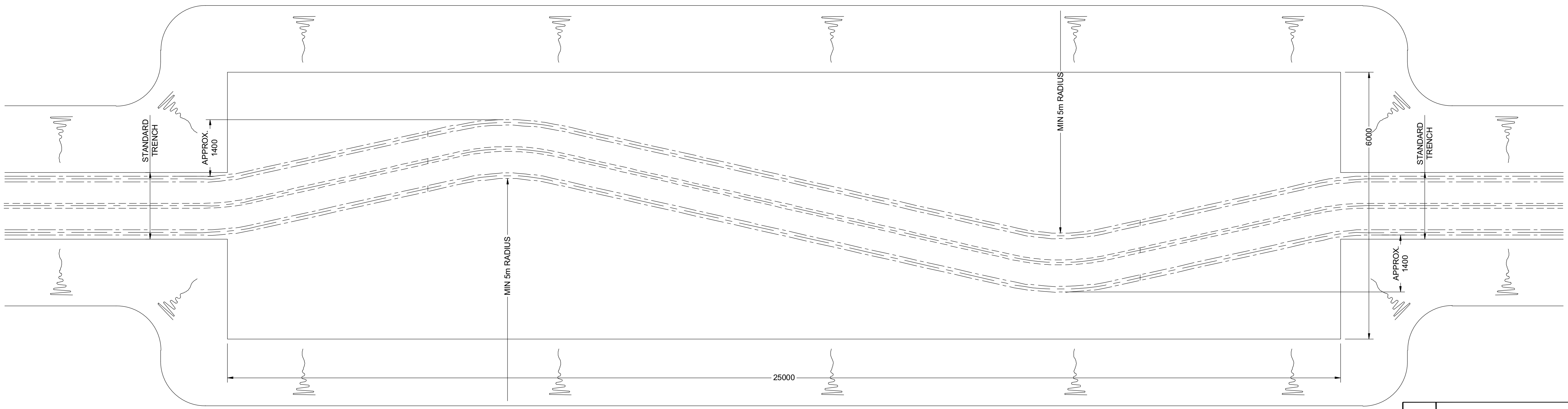
TYPICAL SECTION THROUGH CABLE CORRIDOR
(DURING CONSTRUCTION)
SCALE 1:25



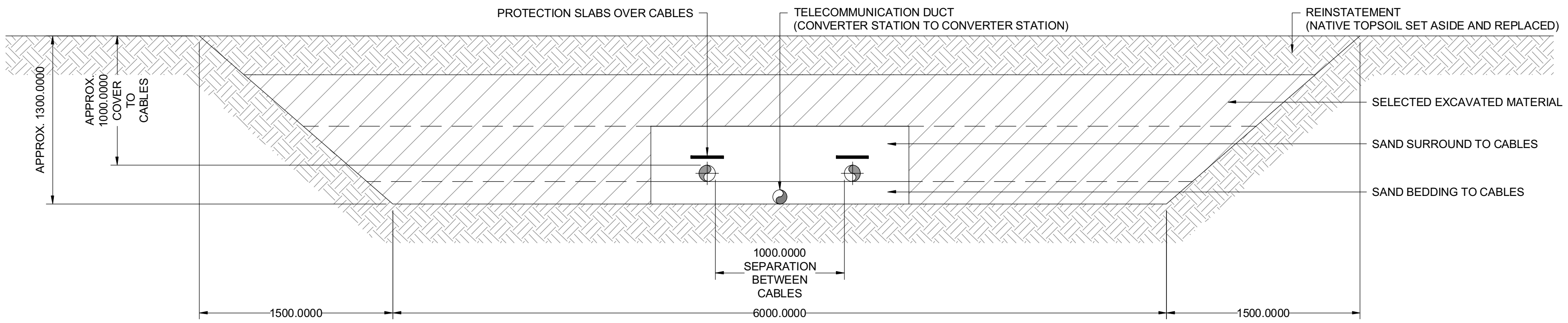
TYPICAL SECTION THROUGH CABLE TRENCH
(POST - CONSTRUCTION)
SCALE 1:25



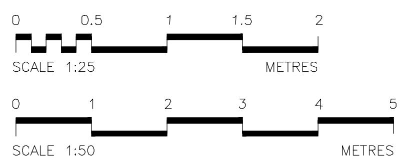
SUGGESTED WATERSTOP DETAIL
SCALE 1:25



JOINTING PIT PLAN
SCALE 1:50



JOINTING PIT - SECTION THROUGH CABLE TRENCH (POST - CONSTRUCTION)
SCALE 1:25



REV NO	ISSUE REASON	DATE	PREPARED	CHECKED	APPROVED
2	RFU - INDICATIVE ONLY NOTE REMOVED	24/08/2018	JM	STM	STM
1	RFU - TELECOMMUNICATIONS DUCT ADDED TO CABLE TRENCH & NOTE ADDED (INDICATIVE ONLY)	25/07/2018	JM		
0	IFU - ISSUED FOR USE	10/07/2018	EH	GJD	GJD

PROJECT
NORTH CONNECT

DRAWING TITLE
HVDC ONSHORE CABLE ROUTE DETAILS

Co-financed by the European Union
Connecting Europe Facility

DRAWING NO
NCGEN-NCT-Z-XE-0003-01

SHEET	REVISION	FORMAT	SCALE	GEODETIC REFERENCE SYSTEM
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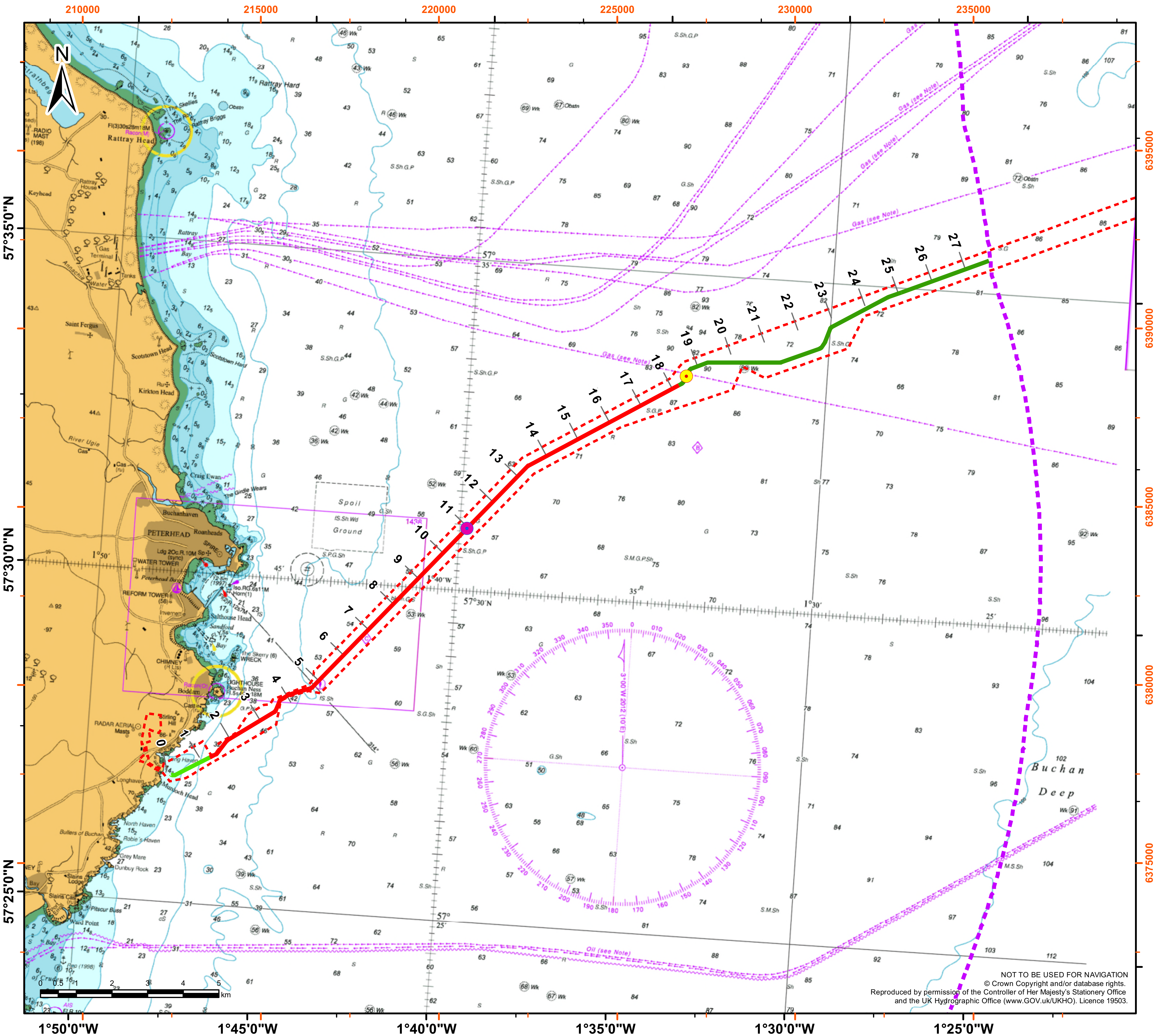

Legend

- Kilometer Post
- Territorial Waters
- Redline Boundary

Crossings Rock Placement

- Cable
- Pipeline

Estimated Remedial Rock Placement Requirements

Percentage of Section Length

- 0%
- 0 - 2%
- 2 - 8%
- 8 - 12%
- 100%

REV NO	ISSUE REASON	DATE	PREPARED	CHECKED	APPROVED
0	Issued for Use	09/07/2018	DAM	JOA, ECB	PEJ
A	Issued for Review	05/07/2018	DAM	JOA, ECB	PEJ

PROJECT

NORTHCONNECT

DRAWING TITLE

Predicted Remedial Rock Placement: Jetting Only – UKTW

DRAWING NO.

NCOFF-NCT-X-XG-0006-01

SHEET	REVISION	FORMAT	SCALE	GEODETIC REF. SYSTEM
000	0	A3	100,000	ETRS 1989 UTM Zone 31N

Co-financed by the European Union Connecting Europe Facility

DRAWING PRODUCER LOGO

exprodat

DRAWING PRODUCER DOC. NO.

TK1323-01

DRAWING PRODUCER DOC. REV.

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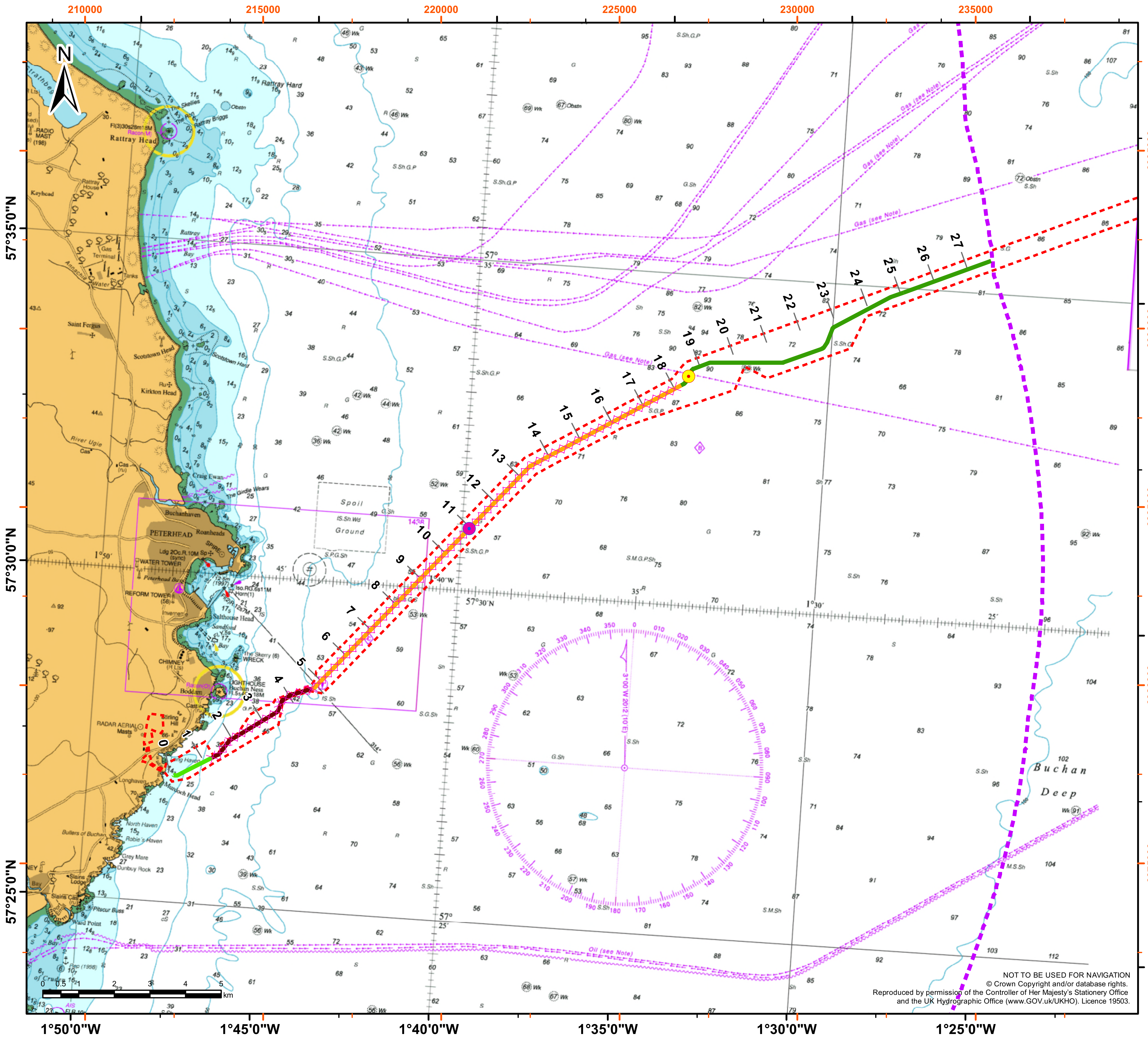

Legend

- Kilometer Post
- Territorial Waters
- Redline Boundary

Crossings Rock Placement

- Cable
- Pipeline

Estimated Remedial Rock Placement Requirements

Percentage of Section Length

- 0%
- 0 - 2%
- 2 - 8%
- 8 - 12%
- 100%
- Prelay Plough Backfill Rock Placement

REV NO	ISSUE REASON	DATE	PREPARED	CHECKED	APPROVED
0	Issued for Use	09/07/2018	DAM	JOA, ECB	PEJ
A	Issued for Review	05/07/2018	DAM	JOA, ECB	PEJ

PROJECT

NORTHCONNECT

DRAWING TITLE

Predicted Remedial and Backfill Rock Placement: Jetting + Prelay Plough – UKTW

DRAWING NO.

NCOFF-NCT-X-XG-0007-01

SHEET	REVISION	FORMAT	SCALE	GEODETIC REF. SYSTEM
000	0	A3	100,000	ETRS 1989 UTM Zone 31N

NORTHCONNECT CONNECTING RENEWABLES

Co-financed by the European Union Connecting Europe Facility

DRAWING PRODUCER LOGO

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DRAWING PRODUCER DOC. NO.
TK1323-01
DRAWING PRODUCER DOC. REV.
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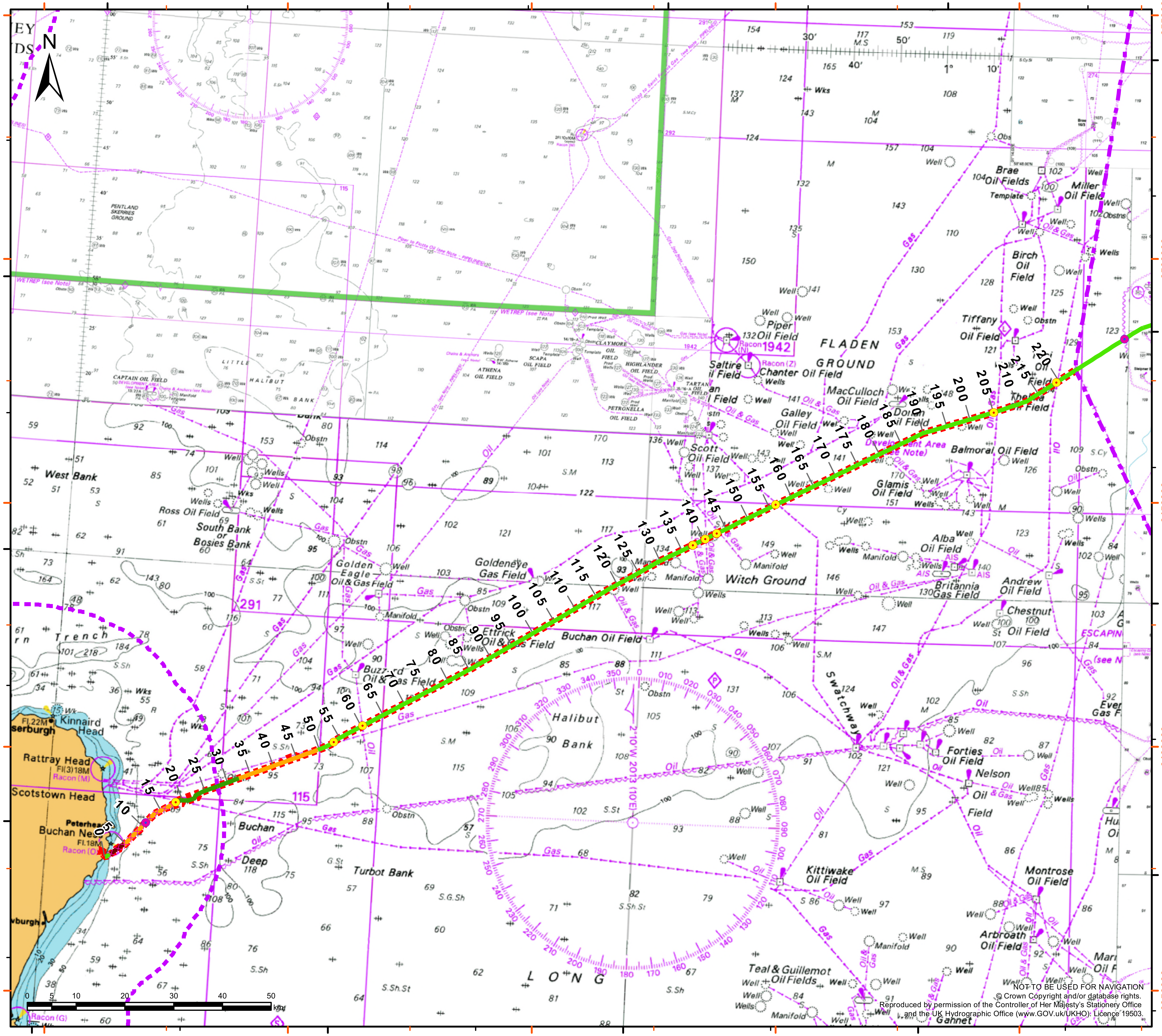

Legend

- Kilometer Post
- Exclusive Economic Zone
- Territorial Waters
- Redline Boundary

Crossings Rock Placement

- Cable
- Pipeline

Estimated Remedial Rock Placement Requirements

Percentage of Section Length

- 0%
- 0 - 2%
- 2 - 8%
- 8 - 12%
- 100%
- Prelay Plough Backfill Rock Placement

REV NO	ISSUE REASON	DATE	PREPARED	CHECKED	APPROVED
0	Issued for Use	09/07/2018	DAM	JOA, ECB	PEJ
A	Issued for Review	05/07/2018	DAM	JOA, ECB	PEJ

PROJECT: **NORTHCONNECT**

NORTHCONNECT CONNECTING RENEWABLES

Co-financed by the European Union Connecting Europe Facility

DRAWING TITLE: **Predicted Remedial and Backfill Rock Placement: Jetting + Prelay Plough – UKEEZ**

DRAWING PRODUCER LOGO: exprodat

DRAWING NO.: **NCOFF-NCT-X-XG-0008-01**

SHEET	REVISION	FORMAT	SCALE	GEODETIC REF. SYSTEM
000	0	A3	750,000	ETRS 1989 UTM Zone 31N

DRAWING PRODUCER DOC. NO.: TK1323-01

DRAWING PRODUCER DOC. REV.: 0