Offshore Wind Power Limited

West of Orkney Windfarm Onshore EIA Report

Volume 1, Chapter 5 – Project Description

WO1-WOW-CON-EV-RP-0085: Approved by S.Kerr
Document Control 20/10/2023

ASSIGNMENT	L100632-S06
DOCUMENT	L-100632-S06-A-ESIA-005

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West of Orkney Windfarm

REVISIONS & APPROVALS

REV	DATE	DESCRIPTION	ISSUED	CHECKED	APPROVED	CLIENT
A01	12/10/2023	Issued for use	AF	NB	LS	
R05	20/07/2023	Re-Issued for Review	AF	NB	NB	
R04	13/07/2023	Re-Issued for Review	AF	NB	NB	
R03	09/06/2023	Re-Issued for Review	AF	LS	LS	
R02	23/01/2023	Re-issued for Review	LS	AF	LS	
R01	25/11/2022	Issued for Review	LS	AF	LS	

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5 PROJECT DESCRIPTION

5.1 Introduction

This chapter describes the design details of the onshore Project, comprising of all onshore components landward of Mean Low Water Springs (MLWS) (onshore export cables, onshore substation, access, and all other associated infrastructure) and all onshore Project stages from pre-construction to decommissioning. The design options and parameters of the onshore Project are described herein, alongside the activities and anticipated timing for the pre-construction, construction, operation and maintenance, and decommissioning of the onshore Project.

The contractors for the supply and installation of the components of the onshore Project have not yet been identified at the time of this Planning Permission in Principle (PPP) Application. However, the parameters and methods of construction will be within the Project Design Envelope described within this chapter.

For completeness, a high-level description of the offshore Project is provided in section 5.13 and chapter 18: Offshore EIA summary, to provide a complete overview of the Project.

5.2 Design envelope approach

The onshore Project utilised a Project Design Envelope approach to inform this Onshore Environmental Impact Assessment (EIA) Report. The Project Design Envelope approach enables a range of parameter values to be presented for each onshore Project aspect, providing the flexibility to allow for further refinement of the onshore Project design.

The Project Design Envelope approach has been adopted in accordance with the Scottish Government (2022a) guidance on using the design envelope for Applications under Section 36 of the Electricity Act 1989, however, it is considered that this guidance is also of relevance to this Application for PPP under the Town and Country Planning (Scotland) Act 1997 (as amended). The guidance outlines that, where flexibility in design parameters is required, the reason for this should be clearly explained and assessments should be undertaken on the parameters likely to result in the maximum adverse effect (i.e. the worst case scenario). In accordance with this guidance, this chapter outlines those parameters where flexibility has been maintained, and the justification for this has been provided

The first version of the Project Design Envelope was presented within the EIA Scoping Report, submitted in March 2022. The Project Design Envelope has been further refined through environmental surveys, technical and engineering studies and discussions with stakeholders and the community, as part of the EIA process. The Project Design Envelope continues to be refined as further studies and discussions with stakeholder's progress.

The Project Design Envelope contains a series of design options, including reasoned maximum and minimum parameter values, within which the final design of the onshore Project will sit. This chapter refers to the range of options for the Project Design Envelope parameters. Nonetheless, in line with the Scottish Government (2022a) guidance detailed above, the Project Design Envelope parameter values which represent the worst-case scenario for the impact assessments have been determined on a case-by-case basis, depending on the receptor and impact being considered, and these worst case scenarios are described in each topic-specific EIA chapter. Further detail on the use of the Project Design Envelope approach is provided in chapter 7: EIA methodology.

The onshore Project area presented within this PPP Application is significantly larger than the area the onshore Project will eventually occupy, i.e. the proposed 100 metre (m) working corridor that will contain the final cable route and the final substation location. The final onshore export cable route and onshore substation layout will be the result of ongoing engineering surveys and studies, including input from installation contractors, who will not be appointed until after the necessary consents and licences for the Project have been secured. The cable landfall and route may also be influenced by land access requirements. Therefore, a wide onshore Project area has been retained to accommodate multiple landfall and export cable route options.

5.3 Project overview

5.3.1 Outline description

The purpose of the onshore Project is to transmit power generated by the offshore Project to the point it is fed into the National Grid network. The key onshore components of the onshore Project include:

- Offshore export cables – up to five export cables that transmit power between the offshore Project to Transition Joint Bays (TJBs) (one TJB per cable) at the landfall site. The Onshore EIA Report only considers the offshore export cables between MLWS and the TJBs;
- Landfall – two options are proposed, one at Crosskirk and one at Greeny Geo. If either option is constrained, the TJBs may be split over the two landfalls (e.g. three TJBs at Crosskirk and two TJBs at Greeny Geo);
- Onshore export cables – up to five onshore export cable circuits1 laid in separate trenches, with each cable comprising three single core power cables and one communication cable, which transmit power as High Voltage Alternating Current (HVAC), underground between the TJBs and the onshore substation;
- Onshore substation (420 kilovolts (kV)) – required to transform the power to comply with the requirements of Scottish Hydro Electric Transmission plc (SHET-L) Spittal 2 substation and the National Grid network;
- Temporary construction compounds and working corridors for the landfall, onshore export cables and onshore substation;
- Temporary access tracks for the landfall and along the onshore export cable route; and
- Seven permanent access tracks (indicative at this stage) across the onshore Project area.

An overview schematic of the Project as a whole, including both the main components of the onshore Project and offshore Project (as further summarised in section 5.13) is shown below in Figure 5-1.

[1] *The onshore export cables will be laid in circuits (up to five circuits buried in five separate trenches) with each comprising a series of grouped cables as described. For ease of the reader, only the term 'onshore export cables' is retained throughout the topic specific assessment chapters.*

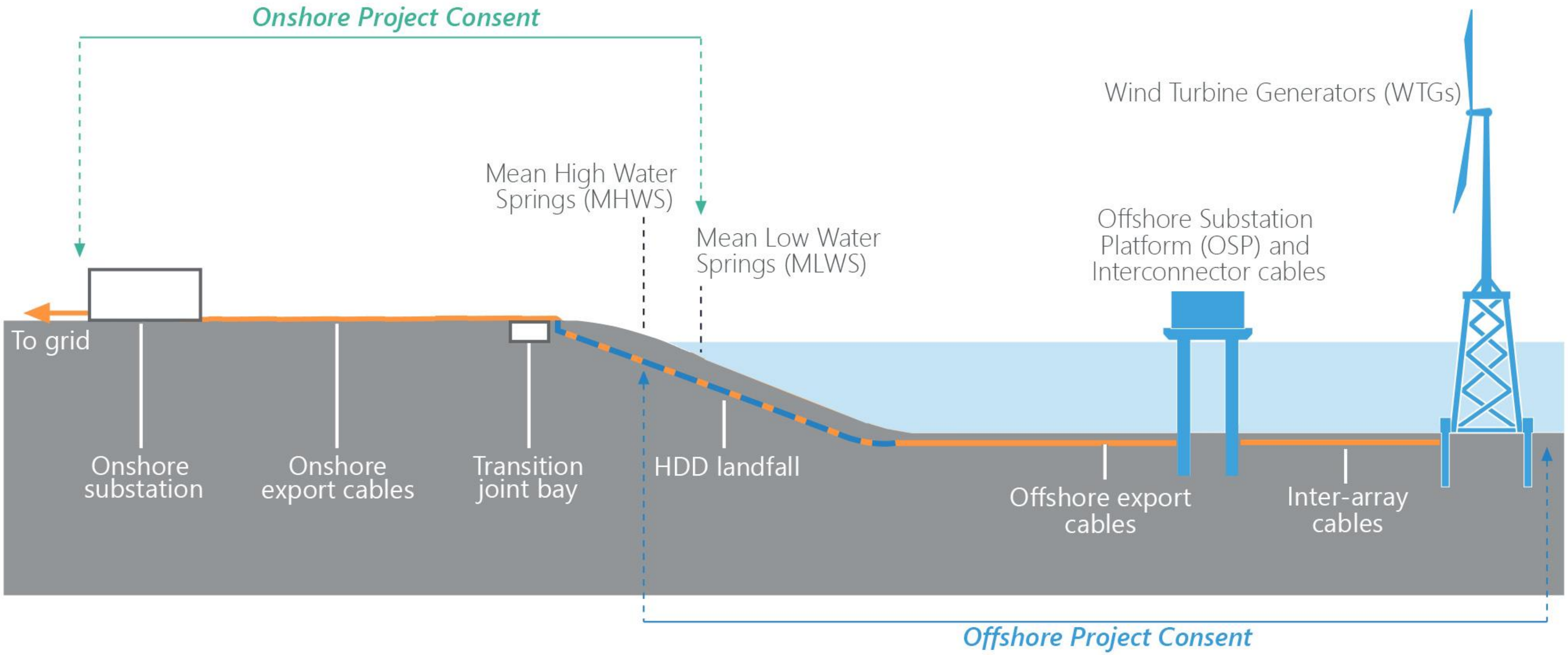

Figure 5-1 Overview of the main components of the Project

5.3.2 Construction programme

A detailed construction programme will be developed as design and procurement activities progress and full details including sequencing and installation methodologies will be confirmed in the Construction Method Statements (CMSs) which will be produced and agreed post-consent.

It is anticipated that the construction of the onshore Project will take approximately four years (subject to change) followed by a final pull through of the offshore cables. The onshore works will involve three main working areas:

- The landfall Horizontal Directional Drilling (HDD) exit pits;
- The cable route from the landfalls to the substation; and
- The substation including interconnection to the SHET-L Point of Connection.

The indicative construction programme is presented in Figure 5-2. The timing of the construction programme is indicative and depends on a number of factors, including but not limited to:

- The date that a Contract for Difference (CfD) is awarded (depends on the Project gaining necessary consents);
- Contractor availability;
- Weather conditions; and
- Other supply chain or logistical issues.

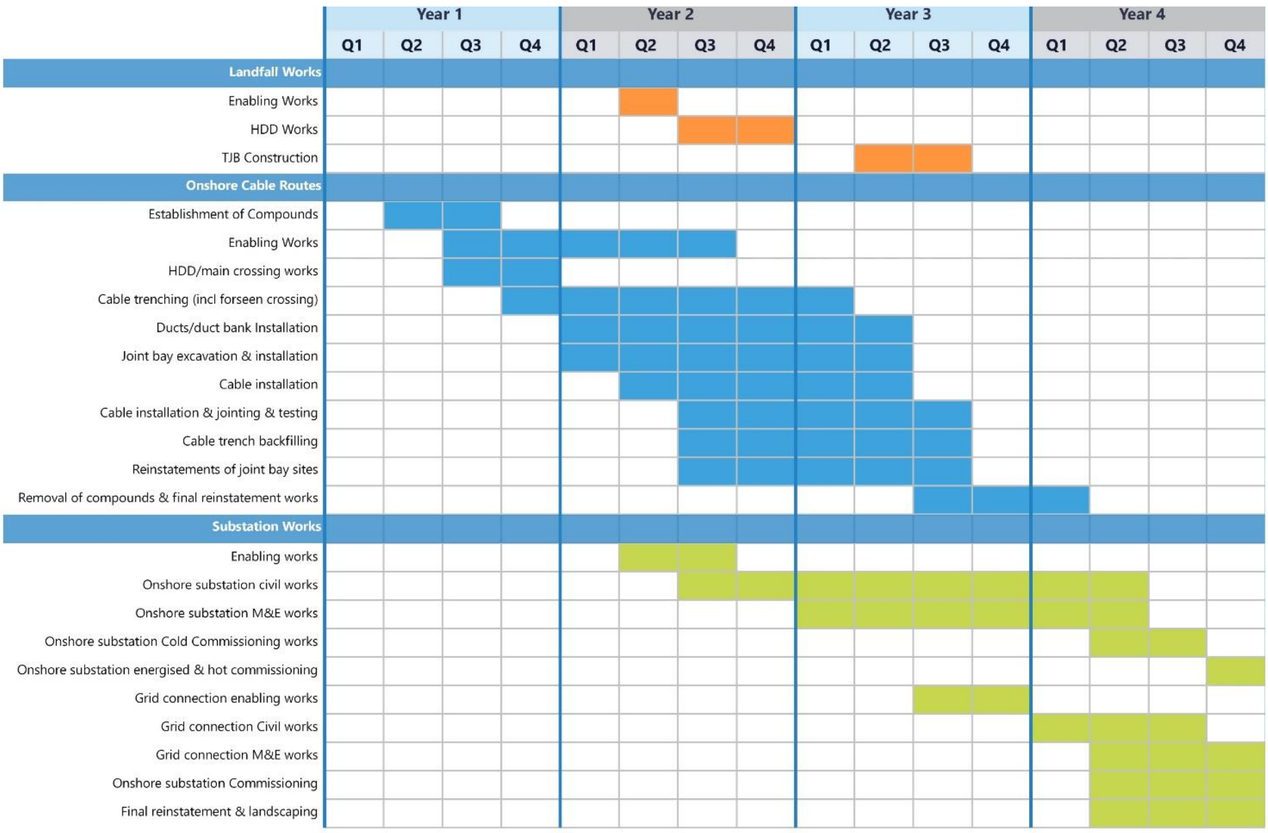

Figure 5-2 Indicative construction programme

5.3.3 Onshore project boundary

The onshore Project is within The Highland Council (THC) jurisdiction, with the landfall points located to the west of Thurso and the onshore substation to the south of Halkirk in Caithness. The onshore Project area (Figure 5-3) includes the landfalls, onshore export cable corridor options and onshore substation search area.

The onshore export cable route is still being defined and will be dependent on the results of ongoing site investigations, engineering studies, consultation feedback and the findings of the EIA, however, will be contained within the onshore Project area as shown in Figure 5-3.

It should be noted that the onshore export cables will not utilise the whole of the onshore Project area but will have a maximum construction corridor width of 100 m and a maximum corridor length of approximately 33 kilometre (km) from the landfall to the onshore substation.

The onshore Project area is rural in nature, with a limited number of small settlements. The major land use is agriculture, including arable and grazing farmland. Other prominent features include main roads (such as the A9 and A836), minor roads and electrical overhead lines, with a mixture of wooden pole and larger lattice steel towers. The two largest rivers prominent in the onshore Project area are the River Thurso and Forss Water. Other land users include recreational features, such as core paths and the Sibster Forestry and Land Scotland Woodland. In addition, there is a single-track Network Rail Scotland railway line between Georgemas Junction and Scotscalder which overlaps the onshore Project area. There is also a second Network Rail Scotland railway line between Wick and Thurso which runs adjacent to the eastern boundary of the onshore Project area, this railway line does not cross the onshore Project area. These features are shown on Figure 5-3.

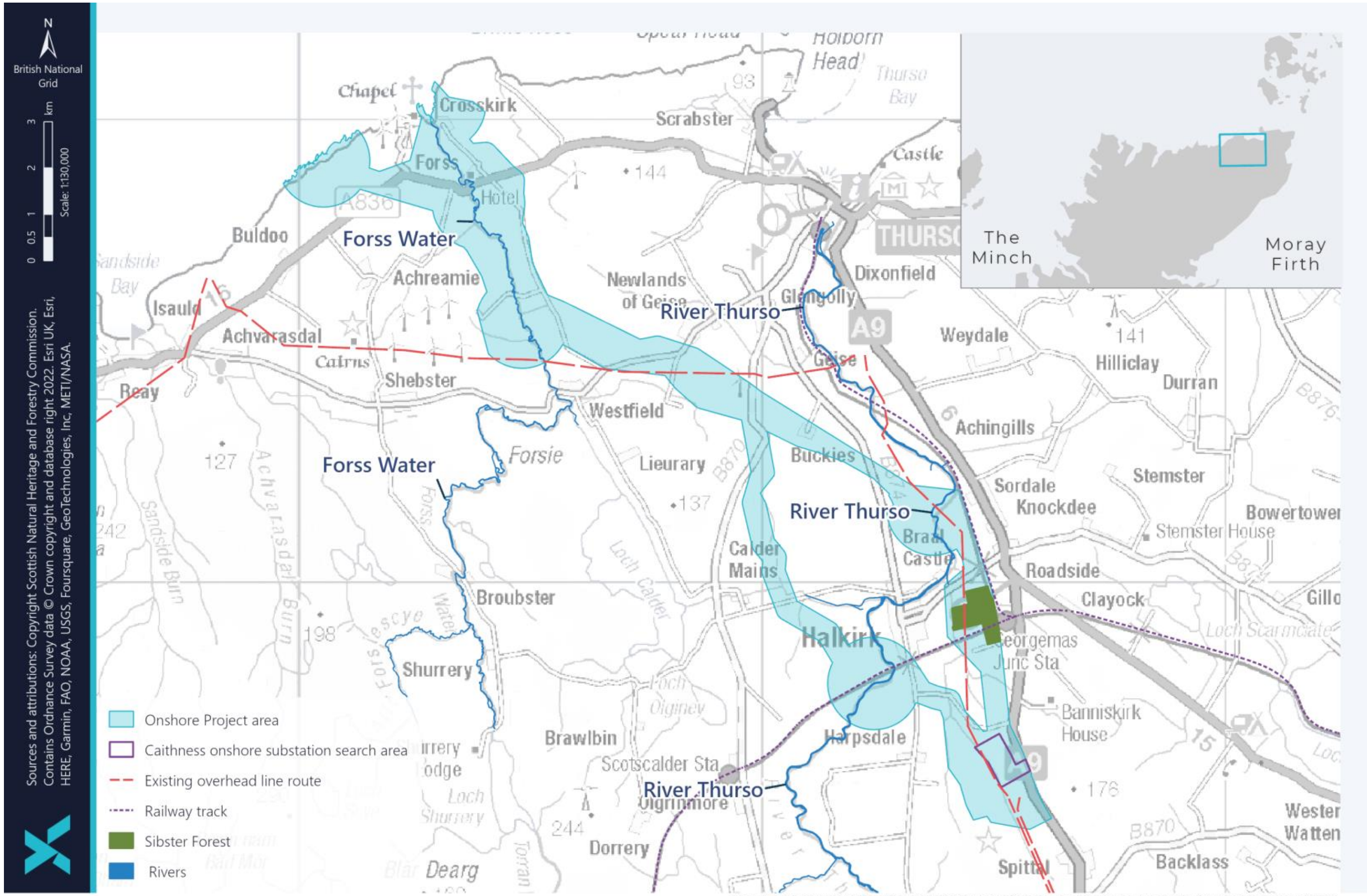

Figure 5-3 Onshore Project area

5.4 Offshore export cables and landfall

5.4.1 Design

Electricity generated by the offshore Project will be transmitted to shore by up to five offshore export cables, each consisting of three power cores and a communications cable within a single armoured cable. These cables are surrounded by a layer of insulation and armouring to protect them from external damage and to ensure they are watertight.

5.4.2 Installation

The two landfall options are located at Greeny Geo and Crosskirk, as outlined within section 5.3 and illustrated in Figure 5-3. The landfall is the interface between the offshore and onshore aspects of the Project. As such the construction work typically involves both offshore and onshore elements. Offshore components and construction methods are described in detail within the Offshore EIA Report.

The landfall installation methodology for Greeny Geo and/or Crosskirk is via HDD. HDD is a trenchless installation technique and at the landfall will involve drilling a duct from an onshore HDD compound (i.e. HDD working laydown area) out to an exit point on the seabed beyond MLWS (and as such the HDD activities from this point are considered within the Offshore EIA Report). Once the duct is drilled it is followed by the installation of a conduit pipe through which the shore end of the offshore export cable can be pulled. Five cable ducts are required, with an additional spare duct drilled as contingency.

A typical HDD operation commences with the drilling of a pilot hole using a drill bit and drill head and injection of drilling fluid. Drilling fluid usually comprises water and bentonite and lubricates the drilling rods, picking up cuttings before returning to the surface via the pilot hole. The position and progress of the drill head is monitored and controlled at the surface using electromagnetic detection equipment.

Once the drill bit exits the receiving pit, the drill head is removed, and a reamer[2] is attached to the drill string. Reaming devices are pulled back through the pilot hole until its enlarged to the required diameter. Once reaming is complete and the pilot hole is clear of all objects, the HDD duct is installed. The pull head is connected to the drill string via a swivel and is pulled back towards the receiving pit via the drill rig.

Soda Ash may also be required during drilling operations to correct the pH and if drilling fluid losses occur, Lost Circulation Material (LCM) is added in order to seal the permeable ground.

The HDD exit point is expected to be at a water depth of between 10 and 40 m below Lowest Astronomical Tide (LAT) (1,200 m length duct), which is dependent on the location with suitable sediment cover. The detailed trenchless installation design, including the specific location of entry and exit points, is dependent on geotechnical investigations as well as the final location of the offshore export cable route for the Project. There are no requirements for dredging or bunding onshore, however, there may be a requirement offshore and this will be determined by the site investigations and final detailed design. The impacts from this are considered in the Offshore EIA Report.

[2] *A reamer is a type of rotary cutting tool used to enlarge the size of a previously formed hole.*

Permanent access roads are required at the HDD landfall sites to provide both access during the construction and operations and maintenance stages of the Project. The permanent access tracks are located at Crosskirk (where a new track of approximately 770 m may be installed) and Borrowston Mains (where there will be a combination of approximately 650 m of new track installed and 690 m of existing track to be improved). Permanent access tracks for the onshore Project are shown in section 5.10, Figure 5-8.

The Project Design Envelope for the landfall infrastructure is provided in Table 5-1.

Table 5-1 Project Design Envelope of the landfall infrastructure

DESIGN PARAMETER	PROJECT DESIGN ENVELOPE
Footprint of HDD equipment	The HDD drilling rig equipment, utilities and welfare facilities requires a temporary HDD compound of up to 7,500 m^2.
Maximum number of ducts installed	Six (five plus one contingency) drilled with an Outer Diameter (OD) of up to 1.2 m (HDD bore).
Maximum HDD duct length (m per duct)	Up to 1,200 m.
Anticipated Location of HDD exit point (m, below LAT))	Between water depth of 10 m – 40 m below LAT, within the offshore export cable corridor.
Burial depth	Burial depth ranging between 21 m to 30 m.
Volume of material excavated from HDD bores	Up to 1,630 m^3 of rock cuttings removed from each HDD bore. Assuming five bores and a contingency bore, the total rock cuttings from six bores is expected to be a maximum of 9,780 m^3.

5.5 Transition Joint Bay (TJB)

At the landfall, concrete TJBs are required to house the interface joint between the offshore and onshore export cables. Up to five TJBs are required, equating to one TJB per export cable. The TJBs will either be located wholly at a single location, or if constrained split over the two landfall locations (Greeny Geo and Crosskirk). Each TJB will be set in the ground, flush with the surface, but above Mean High Water Springs (MHWS) and comprise an area ranging between 6 m long x 3 m wide x 3 m deep to 30 m long x 6 m wide x 5 m deep. The final selection of the TJB dimensions depends on ground conditions and cables, transition joints and link box sizes.

The purpose of the TJB is to allow a firm, solid base for cable jointing which can be covered to ensure the necessary environmental conditions are maintained for the jointing work. Following connection of the cables, the TJB may be backfilled to protect the joint. At each TJB, there will be a links box and communications box pit with a manhole cover to allow for operational access during the lifetime of the Project.

Installation of the TJBs generally follows the same methodology as set out for the onshore export cables as described in section 5.6 and will be constructed at a similar timeframe.

5.6 Onshore export cables

5.6.1 Design

On exiting the TJBs, the onshore export cables will be routed inland towards the onshore substation. As detailed in section 5.3.3, the underground onshore export cables will be located wholly within the onshore Project area as shown in Figure 5-3. The exact location and alignment of the onshore export cables will be established following further engineering and site investigations.

The design parameters of the onshore export cables are presented in Table 5-2. The five onshore export cables (each comprising three separate power cables and a fibre optic communications cable) are HVAC and will be buried underground in separate trenches.

Table 5-2 Project Design Envelope for the onshore export cable design

DESIGN PARAMETER	PROJECT DESIGN ENVELOPE
Voltage (kV)	Maximum voltage of up to 420 kV.
Footprint of temporary landward working area	Construction compound required of up to 150 x 150 m (22,500 m^2).
Cable specification	Up to five onshore export circuits[1] laid in separate trenches. Each export circuit comprises three single core unarmoured power cables. • Each power cable is laid in cable ducts in flat3 or trefoil formation. • Each cable has either a copper or aluminium stranded conductor with water blocking tapes or powder, Cross-Linked Polyethylene (XLPE) insulation, copper wire screen with aluminium foil laminate, and a High-Density Polythene (HDPE) outer protective layer. A separate fibre optic communications cable with polyethylene outer protective layer is laid in a separate duct. A separate bare copper earth wire may also be laid along the cable. A cover (usually recycled plastic) is placed over the export cables with marker tape to warn of their presence.
Outer cable diameter (mm) (per cable)	Landfall (seaward of the TJB) – 319 mm. Onshore (landward of the TJB) - 161 mm.

[3] *Single core cables laid flat on the ground in a plane with equal spacing between each cable.*

DESIGN PARAMETER	PROJECT DESIGN ENVELOPE
Length of a single onshore export cable (km)	Maximum length is 33 km.

5.6.2 Installation

The anticipated ground conditions along the onshore export cable route will require a variety of installation methods to be used, including rock breaking excavators to create trenches; battered-back or shored excavations in glacial tills, dewatering systems and shoring in wetter ground conditions.

The onshore export cables will be buried using Open Cut Trenching (OCT) techniques over unobstructed ground. Crossing methods for linear features, such as watercourses, roads and railways, will range from open trenching (i.e. dry OCT will be the main methodology for minor watercourses or ditch crossings) to a range of trenchless crossings (e.g. cased auger boring, thrust boring, pipe jacking or HDD). The precise installation technique will be determined based on location specific requirements; however, HDD operations will only be used at major crossings including the River Thurso, Forss Water and the single-track Network Rail Scotland railway line. These special crossings are discussed in further detail in section 5.6.4.

The method of installation considers environmental considerations, site investigations and consultations with the regulatory, statutory consultees, and other relevant parties. With a significant proportion of the route being unobstructed, OCT is the main proposed installation methodology. The final route will be developed to minimise areas of high gradient incline.

Where OCT is used, each cable trench for the five onshore export circuit installations will have an installed width (bottom of trench) of up to 2 m, allowing for both flat and trefoil installation. During construction and dependant on installation methodology there may be additional trench taper, varying as a function of burial depth (maximum top of trench width is 8 m). It is expected that tapering will be limited as the terrain in the area is generally rocky. The burial depth of the cables on agricultural land is expected to be at least 1 m, with depth required for crossing roads (0.9 to 1.2 m typically) and major crossings (may exceed 1.8 m). A cross section of a typical buried onshore export cable configuration is provided in Figure 5-4.

Although not fully defined, it is conservatively assumed that the installation of the onshore export cables will progress in sections across multiple work fronts. The process will follow trenching, installation of ducts and reinstatement and will be conducted in sections (i.e. from one Cable Joint Bay (CJB) to the next) and repeated. The total working corridor width for installation of all five onshore export cables is a maximum of 100 m, which includes an area for cable trenches, haul roads, areas of stripped soil (for the use of laydown of construction plant and other activities), cable safety zones, and an allowance of tapering of the trenches. Temporary laydown compounds (approximately 100 m x 100 m) are required approximately every 2 km along the cable route corridor.

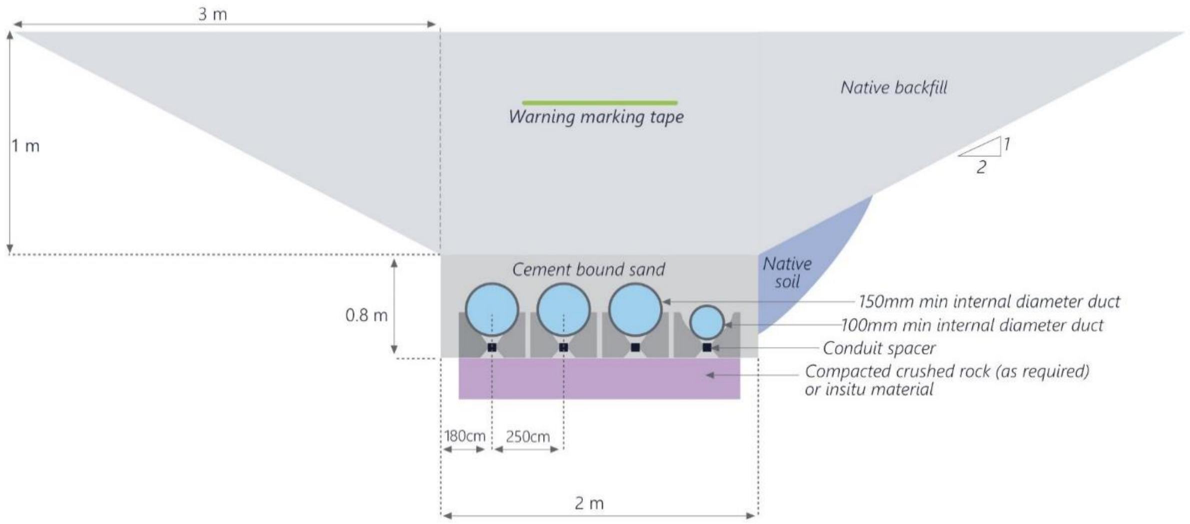

Figure 5-4 Indicative schematic of cable configuration on OCT

The final layout of the working corridor is dependent on the staged strategy, construction methodology, as well as the required trench profiles for each section. A typical plan of the working corridor width is provided in Figure 5-5.

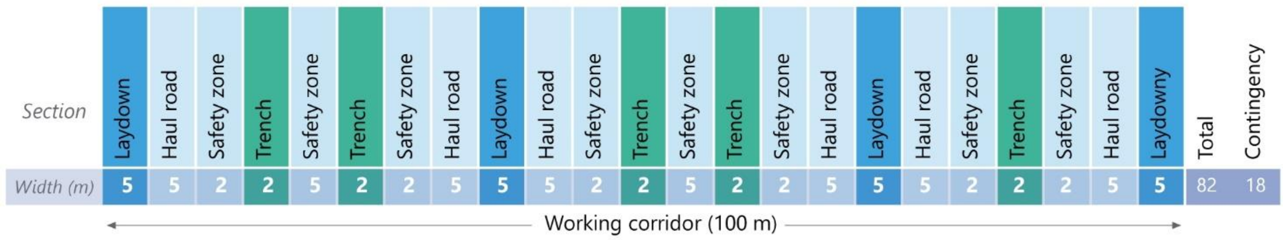

Figure 5-5 Indicative schematic of working corridor

Prior to installation, temporary fencing will be erected along the boundaries of the working corridor. There are several areas of woodland that are located within the area of the onshore Project. Local rerouting will be utilised where possible to avoid these areas, however, there are instances where woodland avoidance may not be possible (Sibster Forest and Hill of Howe woodland), and these areas are shown in Figure 5-6. All other remaining areas will be avoided.

Following vegetation clearance, topsoil will be stripped and stored. A large excavator utilising rock breaking equipment will dig the ground along the route and once reached the required depth, the ducts will be installed in the trench. Due to the length of the onshore export cable route, the cables require to be installed in a number of sections, resulting in connections at CJBs (further details provided in section 5.6.3).

Once the ducts are installed, the power cables and communication cable will be pulled through the ducts utilising intermediate pull pits as required for application of lubrication and visual inspection. Pulling pits are temporary ground excavations that are required to provide a pulling point, and once the onshore export cable installation is complete, the pulling pits will be fully reinstated back to existing ground levels.

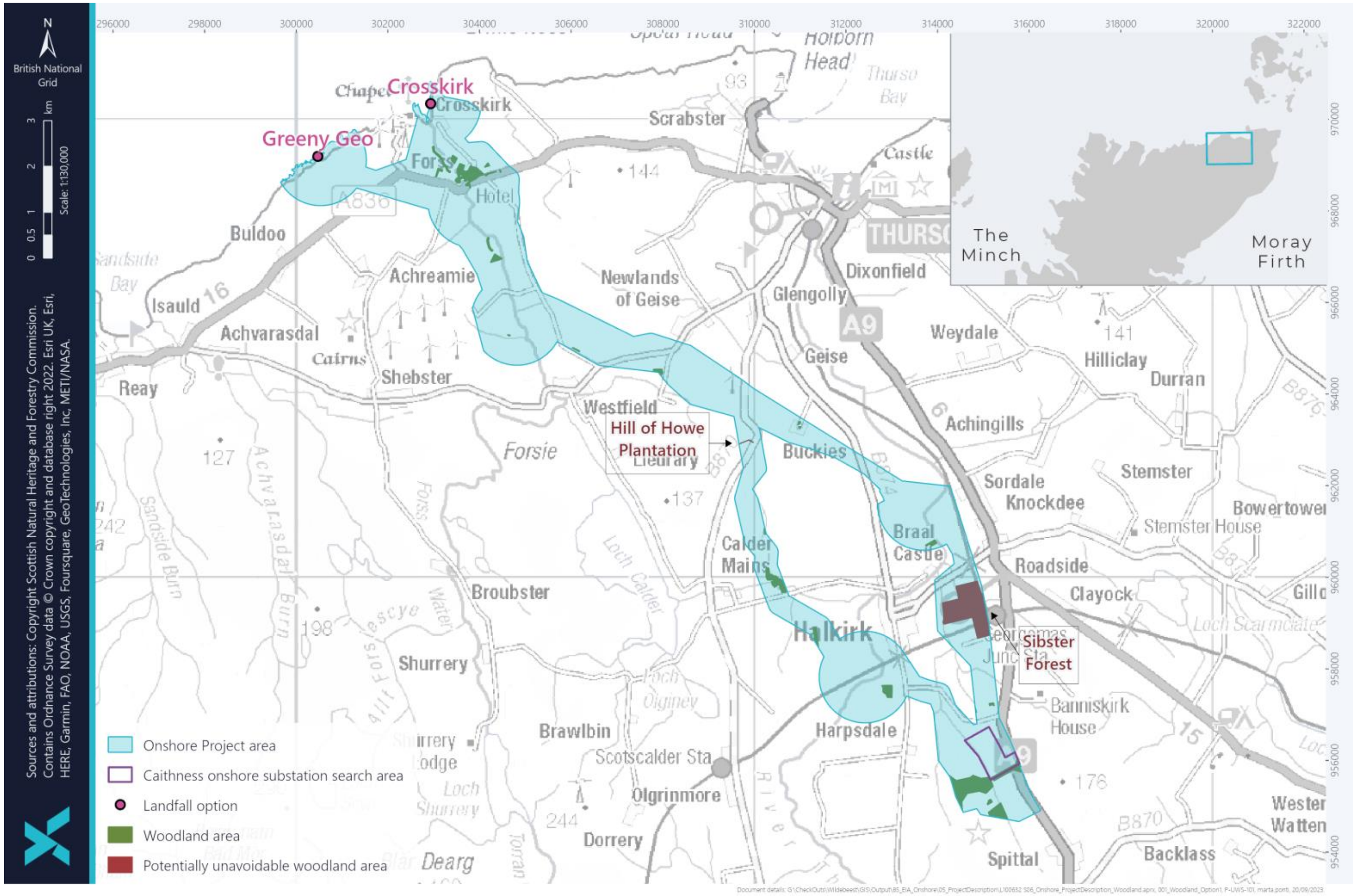

Figure 5-6 Woodland areas that may be unavoidable during onshore export cable installation

Following installation, the trench is backfilled with sand and/or stabilised material to approximately 300 millimetre (mm) above the top of the cables. This is then followed by native subsoils and finally native topsoil is placed on the trench with a typical depth of 300 mm up to the surface level.

A summary of the cable installation sequence and parameters is provided in Table 5-3.

Table 5-3 Installation parameters of onshore export cables

INSTALLATION PARAMETER	DETAILS
Typical cable installation sequence	• Construction of temporary laydown areas and access roads; • Installation of HDD ducts at landfalls and major crossings; • Marking of wayleave and installation of site fencing; • Stripping of topsoil and storage at spoil laydowns; • Preparation of haul roads, spoil storage areas and fencing; • Excavation of trench (usable material stored nearby, unusable material freighted from site and potentially used as aggregate); • Installation of bedding material; • Installation of ducts; • Pulling of cables, jointing and testing; • Backfilling with remaining imported bedding material, suitable as-dug material and native topsoil; • Reinstatement of verges, joint bays and spoil heaps; and • Reinstatement of temporary access roads and laydown areas.
Cable working corridor (m^2)	Maximum of 3,300,000 m^2 assuming 100 m width and maximum 33 km length.
Cable temporary working area (m^2)	Maximum of 215,000 m^2 includes landfall, laydowns along cable route and substation.
Excavation equipment / techniques	Ground conditions require various methods of excavations including rock breaking, battered-back or shore excavations in glacial tills, dewatering systems and shoring in wetter ground conditions. Excavation rate for open cut trenching is approximately 50-60 m per day and for HDD crossings is < 10 m per day.
Excavated trench material (m^3)	The trench will be non-uniform in nature along the route with the majority of excavated material consisting of hard rocky terrain. Maximum of 162,525 m^3 per onshore export cable, equating to a total of 975,150 m^3 for all onshore export cables.

5.6.3 Cable Joint Bays (CJBs)

The number of CJBs are dependent on the single (continuous) length of the onshore export cables and depends on the manufacturing specification of the cable supplier. It is anticipated for the onshore Project, that the minimum spacing of the CJBs will be 700 m. Therefore, there could be a requirement for up to 288 CJBs in total for all five onshore export circuits. However, the exact location, length and number of CJBs is dependent on ground conditions and route alignment and will be confirmed during detailed design.

During the jointing operation, the bay will typically be covered by a tent or a container to ensure the correct environmental conditions for the jointing work. The working area is contained in the working corridor. The CJBs will be excavated to allow for up to 30 m in length, 3 m in width and to 2.5 m depth below ground level. The maximum excavated material expected from each CJB is 3,320 m^3, equating to a total of 956,160 m^3 for the maximum number of CJBs. CJBs are typically constructed of reinforced concrete on compacted aggregate, however alternate constructions may include reinforced concrete base raft and ceiling with blockwork walls. Following the cable jointing operation, the CJBs will be back filled with weak sand-cement mix and the ground restored as required.

Following reinstatement, a manhole cover will be the only surface level structure visible of the cable corridor and this allows access for maintenance activities.

5.6.4 Special crossings

Different methodologies will be employed along the onshore export cable route when crossing linear features (e.g. watercourses, railway lines, roads etc). The installation methodologies employed in these circumstances include those which are detailed in Table 5-4. Detailed design of crossing methodologies will be completed once the final onshore export cable route has been confirmed.

Table 5-4 Installation methodology techniques at special crossings

INSTALLATION METHODOLOGY	ANTICIPATED LOCATIONS	METHODOLOGY DESCRIPTION
Trenchless crossing (HDD)	Major roads, railway lines, main rivers (e.g. River Thurso and Forss Water), sensitive watercourses and habitats and existing utilities	HDD methodologies follow those as described in section 5.4.2. HDDs will be installed in advance of the onshore ducts and export cables. It is anticipated that up to 15 HDDs could be required if the cables are laid in flat formation and the maximum working area that is required is expected to be 100 m x 30 m. Reinstatement of all areas will be undertaken following construction. Temporary fencing of these areas will be undertaken to prevent any livestock from damaging newly reinstated areas.

INSTALLATION METHODOLOGY	ANTICIPATED LOCATIONS	METHODOLOGY DESCRIPTION
Trenchless crossings (cased auger boring, thrust boring, pipe jacking)	Existing utilities Minor roads Non-sensitive / minor watercourses	At certain asset crossings along the cable corridor route, the installation technique may be varied dependant on the design of the existing utility and ground conditions. The cased auger boring technique can be utilised for short and medium length crossings up to 120 m. Excavation pits are required on either side of the crossing to aid in the installation of the duct. A casing attaches to an auger boring drill machine with the cutting tool sitting either ahead, flush or inside the casing itself. A hydraulic jack located at the back of the machine helps to push the casing in place as the bit drills the borehole. The auger removes spoil as it transports it back through the casing to the launch pit. Other techniques may need to be applied and these include: • Thrust boring - a jacked and drilling trenchless boring method. This technique is used where excavations are less favourable, e.g. in areas with a high risk of ground instability; and • Pipe jacking - a specialist tunnelling method where hydraulic jacks are used to insert specially designed pipes behind a shield at the same time as a tunnel is excavated resulting in minimal surface disruption.
Open cut trench	Road crossings Agricultural land	Prior to road installation, a traffic light system will be employed on two-lane roads, to control traffic flows to allow for a single lane to be closed during the installation of the trench. For single-lane road installation, the road will require to be fully closed when the work is being undertaken. Signage advising of detour will be erected at the road outlets. The cable installation via OCT on the road will follow a similar process to that of agricultural land whereby the top layer (the road in this instance) will be removed first followed by the remaining earth underneath. Once the trench, duct and cables are installed, the road, verge and areas used for laydown of equipment will be reinstated.

5.7 Onshore substation

5.7.1 Design

The onshore substation includes the electrical equipment required to connect the Project to the grid. The offshore Wind Turbine Generators (WTGs) are expected to export at 132 kV with offshore substations transforming the voltage up to approximately 420 kV for transmission to the onshore substation. The onshore substation will then contain all the necessary equipment to allow connection to the grid. The preferred location of the onshore substation is within the onshore substation search area and could utilise the extent of the search area depending on final design requirements. The onshore substation search area and preferred indicative location is shown on Figure 5-7.

The grid connection point for the onshore Project will be to the new SHET-L Spittal 2 substation. The current preferred location of this substation (at the time of Application) is north of Spittal Hill at Banniskirk, to the east of the indicative onshore substation on the other side of the A9 trunk road (Scottish and Southern Electricity Networks (SSEN), 2023).

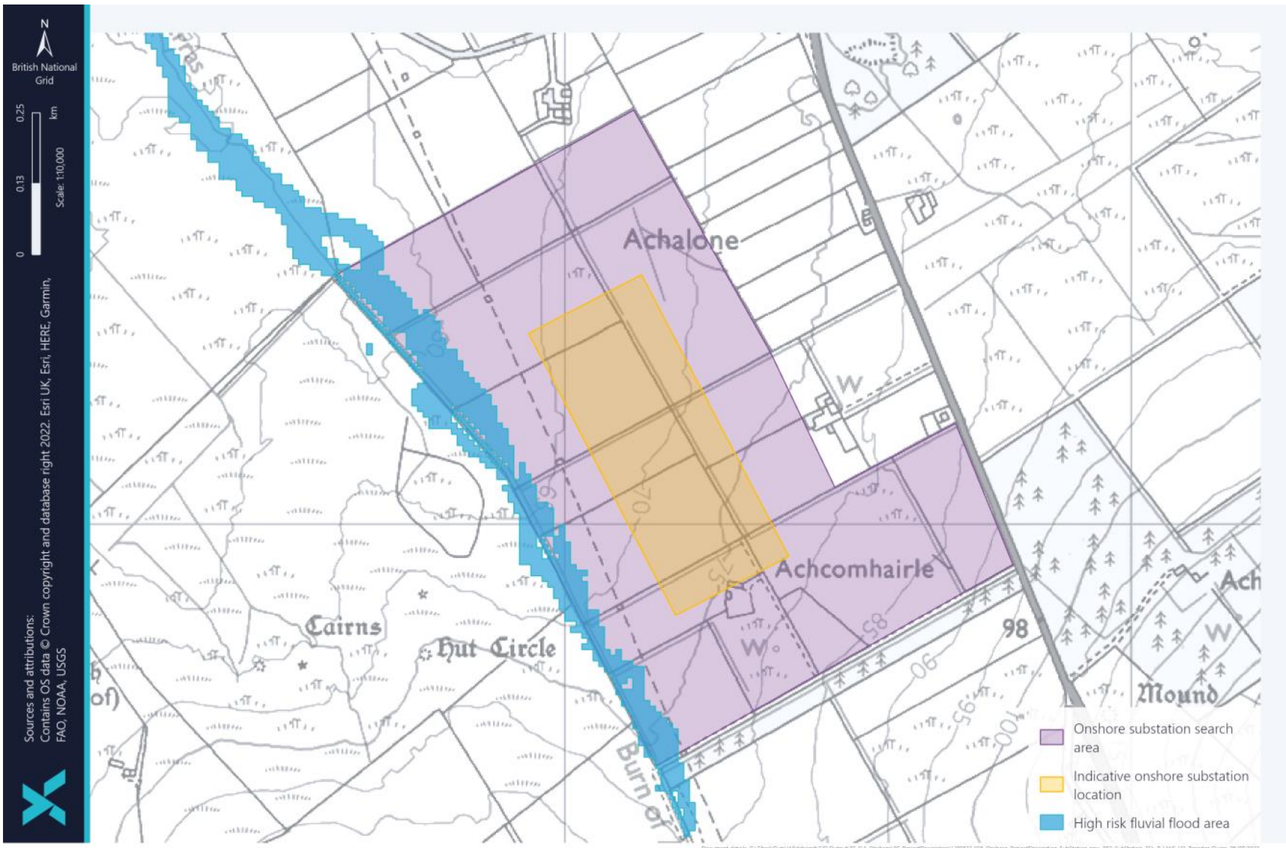

Figure 5-7 Onshore substation search area and indicative location

An onshore substation will typically include switchgear, transformers, harmonic filters, reactive compensation devices, power electronics, protection equipment, batteries and other auxiliary equipment and control systems. Some equipment may be located outdoors. The onshore substation will be above ground and secured by perimeter fencing.

An initial design process was undertaken on the positioning of the onshore substation platform in the onshore substation search area which included design of the bunding and planting strategy. Further details of this process are provided in chapter 17: Landscape and visual impact assessment. The platform level is expected to be positioned at approximately the 70 m contour in the landscape and the earth bunding is expected to be between 13-18 m in height around the onshore substation.

There are two options under consideration for the substation design including a Gas Insulated Switchgear (GIS) and Air Insulated Switchgear (AIS). The specific design parameters of the onshore substation are provided in Table 5-5.

Table 5-5 Onshore substation design parameters

DESIGN PARAMETER	DETAILS
Onshore substation size	An AIS substation platform of 520 m long x 250 m wide x 13.5 m high. If a GIS substation design is used the footprint would be approximately 35 - 40 % reduced compared to the AIS option, and the height would be approximately 14 m. The full size of development area (including substation screening and bunding) is approximately 239,200 m^2 (23.9 hectares (ha)).
Foundations	The base foundations for all electrical plant is typically constructed from concrete. The depth of the foundations is expected to be approximately 0.3 – 0.5 m.
Infrastructure	Maximum of 12 buildings which includes switchgear rooms, control buildings, storage and maintenance buildings. The control building includes relay plant, metering plant, batteries and telecommunication equipment. The AIS substation design consists of busbars and up to five Super Grid Transformers (SGTs) operating at 400 kV[4] is assumed to represent the worst-case spatial scenario from an EIA perspective. In addition to the SGTs, there is the following associated infrastructure: • Five shunt reactors used to stabilise the voltage throughout load differences in the high voltage power transmission system; • Five Static Synchronous Compensator (STATCOM5) transformers designed to be shunt-connected with the grid to compensate for reactive power; and • Five harmonic filters used to mitigate and reduce harmonics to acceptable ranges in the power transmission system. The rating of equipment is subject to detailed electrical studies. Internal access roads will be included within the footprint of the onshore substation.
Lighting	External lighting for the onshore substation will range from 2.2 lux to 150 lux in order to illuminate the building and external area. 2.5 lux will be required around the perimeter fencing. There may also be a need for up to 150 lux at areas requiring higher illumination. Passive Infrared (PIR) sensor lighting will be used or similar, however consideration will be given to permanent lighting of certain areas. All lighting will be designed to minimise light pollution with use of flat glass luminaires asymmetrical optics.
Noise	The maximum noise level at the onshore substation is 100 decibels (dB)(A) noise level 1 m from the main transformer.
Excavated materials	The maximum excavated material from the onshore substation is 1,207,000 m^3.

[4] *400 kV is the nominal operating voltage for the connection to the Grid substation.*
[5] *STATCOM continuously provides variable reactive power in response to voltage variations, supporting the stability of the grid.*

DESIGN PARAMETER	DETAILS
Security	There will be security fencing around the perimeter of the onshore substation. There will also be Closed Circuit Television (CCTV) cameras in operation around the onshore substation.

There will be a requirement for limited Abnormal Load (ABL) deliveries to support the onshore substation development. An ABL assessment has been undertaken with the results provided in the chapter 16: Access, traffic and transport and associated supporting studies.

Permanent access tracks will be required at the onshore substation site (as well as at HDD sites across the onshore Project area) to provide both access during construction and during operations. The permanent access track from the existing track to the existing Spittal substation, to the Project's onshore substation will be approximately 1,375 m^2 (5 m width and 275 m length). Permanent access tracks for the onshore Project are shown in Figure 5-8.

5.7.2 Installation

Precise construction methods for the onshore substation will vary depending on the results of the pre-construction surveys and ground investigations. The temporary construction compound footprint is a maximum of 62,500 m^2 which typically includes the following main components (in addition to the onshore substation):

- Offices / welfare facility;
- Car park;
- Control of Substances Hazardous to Health (COSHH) storage;
- Plant fuel / gas storage and refuelling area;
- Diesel generator;
- Water tanks / settlement ponds;
- General / recycling / hazardous waste skips;
- Quarantine area;
- Plant storage / laydown area; and
- Security office.

Specific details of the construction stages for the onshore Project will be confirmed at detailed design phase, however details of a typical construction sequence for an onshore substation are as follows:

- Construction of temporary access roads from the existing road network to the onshore substation (see also section 5.3.1). The access road will be suitable for use by heavy construction vehicles and for moving the substation equipment (e.g. transformers and prefabricated building units);
- Site clearance, including removal of any buildings and underground obstructions, followed by site preparation including retention of any walls, fencing off the construction area, provision of services to the site and creation of a construction compound with office and welfare facilities;

- Civil works to prepare the site for the heavy-duty equipment required for the installation of the foundations for the transformers and associated oil containment facilities and other building structures. This comprises of temporary drainage systems and earthworks to remove vegetation and strip soils before creating a firm and level platform across the site with crushed stone to provide stability for construction operations;
- Security fencing is erected around the site boundary for the duration of the construction period;
- Most substation equipment will be delivered directly into the site to its intended installation location. Any fabrication work will take place off-site or within the substation compound area;
- Airborne pollution from site preparation and construction operations will be minimised by the use of damping sprays during periods of dry weather. At site entry / exit points a wheel wash facility will be installed minimise earth being transferred onto the public highway;
- Appropriate measures will also be employed to intercept run-off from the work site, for example using silt fences, check dams and settlement ponds to reduce the suspended sediment load of the water prior to any potential discharge into watercourses. Guidance on methods to be employed will be taken from Scottish Environment Protection Agency (SEPA) WAT-SG-75 Water Runoff from Construction Sites;
- Foundation works are undertaken for the transformers, oil containment facilities and buildings (e.g. switchgear and control building). It is expected the foundations of substation infrastructure are concrete, although depending on ground conditions, piling may be required. Once the foundations are in place and the oil containment system is complete, delivery and installation of the plant takes place;
- Delivery and installation of the plant is undertaken utilising cranes and jacks to lift the equipment into position (typically via skidways or rails to manoeuvre the transformers into place). Once fixed into place, the plant is connected and configured;
- Provision of the main utilities to service the site including electrics, water and telecommunications;
- Construction of the main buildings housing the switchgear and controls;
- Landscaping and bunding works including earthworks and vegetation planting; and
- Commissioning activities.

It is anticipated that concrete batching is undertaken onsite, although there may be a requirement to import this from an off-site supplier. If undertaken onsite, then a suitable water source will be determined.

5.8 Pre-construction and construction

5.8.1 Pre-construction surveys and site investigation

Several activities are required ahead of construction, including pre-construction surveys, site investigations and site preparation. These surveys may include intrusive archaeological investigations, pre-construction ecology surveys, hydrology surveys, geotechnical and ground stability surveys. The requirement for these surveys will be determined following the engineering design phase and enforced through post-consent conditions.

5.8.2 Construction Environmental Management Plan (CEMP)

An outline CEMP has been prepared and submitted as part of this PPP Application to THC (Outline Management Plan (OMP) 1: Outline CEMP). The CEMP will be finalised and submitted to THC prior to the construction of the onshore Project, once detailed design and procurement are complete.

The CEMP will detail the procedures which will be adhered to in order to ensure all activities with potential to adversely affect the environment are appropriately managed. The CEMP will incorporate Environmental Management Plans, CMSs and working procedures relating to mitigation as agreed with Offshore Wind Power Limited (OWPL) and statutory consultees as part of the planning conditions. The CEMP will be included as part of the overall site management and operational procedures and all staff will receive appropriate training on its contents. The CEMP will be a live document and if necessary, will be periodically revised to take account of emerging best practice and standard procedures. The contractor's compliance with environmental procedures including measures for pollution prevention and control and monitoring of performance will be implemented by the contractor and monitored by OWPL.

5.8.3 Construction working hours

Core working hours for the construction of the onshore elements of the Project will be typical working hours which are taken to be 8 am to 7 pm Monday to Friday and 8 am to 1 pm on Saturdays. This will also apply to Heavy Goods Vehicle (HGV) movements. In certain circumstances, specific works may have to be undertaken outside the normal working hours (such as HDD operations). In these instances, working hours will be agreed in advance with THC's Environmental Health Department.

Chapter 15: Noise and vibration presents an assessment on construction noise to provide THC with the required information to assess the need for any additional requirements on the onshore Project under Section 60 of the Control of Pollution Act 1974.

5.8.4 Construction access

There is a requirement for several temporary access roads and laydown areas and construction compounds during construction operations. Temporary access roads are required to provide access for the landfall works, onshore export cable works, HDD crossings and onshore substation. Laydowns are required at intervals of approximately every 2 km along the onshore export cable corridor. Local road improvements are also required including widening, stabilisation and construction of laybys.

Temporary bridges / spanning structure will be considered for appropriate locations for haul roads. Numerous and robust silt control measures will be required at these crossings and where construction nears a watercourse. There will also be a requirement for the cutting, storage and reinstatement of turfs.

In addition to these construction access requirements, permanent access roads are required throughout the onshore Project area to facilitate operation and maintenance activities, these requirements are detailed in section 5.10.

The final requirement for these and their locations will be determined by the contractor prior to construction operations in agreement with the landowners and THC as part of the detailed design. Where possible, local infrastructure including road networks, farmer tracks and utility access roads are to be utilised to minimise the construction of new temporary access roads. An indication of the temporary access road, laydown area and construction compound dimensions and volume of excavated material is provided in Table 5-6. The volume of the excavated material is dependent on final access locations, topography and ground conditions.

Table 5-6 Indicative temporary access road, laydown area and construction compound area parameters

DESIGN PARAMETER	DETAILS
Temporary access roads	
Dimensions	Width of up to 5 m Landfall(s) and HDD site(s) access: up to 2,300 m length Substation: up to 1,000 m length
Footprint	Landfall(s) and HDD site access: up to 11,500 m^2 Substation: up to 5,000 m^2
Excavated material	Landfall(s) and HDD site access: up to 4,600 m^3 Substation: up to 2,000 m^3
Laydown areas	
Dimensions	Laydown compounds along the onshore export cable corridor 100 m × 100 m
Footprint	10,000 m^2 every 2 km with 130,000 m^2 total for the onshore export cable corridor
Temporary construction compound areas	
Dimensions	Construction compound at landfall(s) of 150 m × 150 m Construction compound at onshore substation of 150 m × 150 m Site office and car park at onshore substation 200 m x 200 m
Footprint	Onshore export cables construction compound at the landfall(s) up to 22,500 m^2 Onshore substation up to 22,500 m^2 Site office and car park up to 40,000 m^2

The access roads and laydown areas will be prepared by removing vegetation and stripping the soils before introducing a capping layer of crushed stones, likely to be on top of a geotextile material, and further layers to formation levels. There may be an opportunity to utilise existing crushed rock material which is removed from the trench, however this will only be determined during detailed design.

In addition to temporary access roads and laydown areas, there is a requirement for haul roads along the cable corridor. The haul roads are located within the working corridor as detailed in section 5.6. The location of these will be defined at detailed design.

The temporary access roads and laydown areas will be fenced off for the duration of construction.

5.8.5 Construction traffic

Construction of the onshore Project will generate traffic on the local road network. This is likely to include HGVs delivering plant and equipment, as well as Light Good Vehicles (LGVs) and cars associated with construction staff movements. The construction plant likely to be used for the onshore export cable route includes tracked or wheeled hydraulic excavators and tracked trencher and for the substation includes excavators, piling rigs (if required) and cranes. Indicative traffic numbers and plant requirements are discussed within chapter 16: Access, traffic and transport.

An Outline Construction Traffic Management Plan (CTMP) has been prepared and submitted as part of this PPP Application to THC (OMP2: Outline CTMP). The CTMP will include details of access routes, delivery timings, car parking arrangements, temporary signage, amongst others. The CTMP will be finalised and submitted to THC prior to the construction of the onshore Project, once detailed design and procurement are complete.

As discussed in section 5.7.1, an Abnormal Load Assessment (ALA) is provided in the Onshore EIA Report, Supporting Study (SS) 15: Abnormal Load Assessment (ALA), which takes into consideration the roads that may be used to deliver any abnormal or special loads and any works necessary to accommodate them.

5.8.6 Construction waste

The Principal Contractor will make arrangements for the safe and legal disposal of waste during the construction, installation, operation and maintenance, and decommissioning of the onshore Project.

Temporary site office and welfare areas will be provided with closed skips for the segregation and disposal of paper, cardboard and mixed municipal waste. All waste containers will be stored away from drainage runs and kept clean and closed to prevent odour, wind-blown litter and to avoid attracting vermin. Effluent from portable toilets will be collected by the toilet hire company with disposal to a sewage treatment works.

Waste wood, metals and ceramics (cement) are to be segregated into skips for off-site recycling. Mixed construction and demolition waste will be collected for offsite disposal by a licenced waste contractor. Facilities for the disposal of hazardous solid waste will be provided for items such as oil filters, batteries, paint tins, resins sealants and adhesives. Liquid hazardous wastes such as hydraulic oils will be stored in a suitable tank or drum within a bunded area. Fly tipping will be prevented by effective security measures.

HDD is unlikely to give rise to significant amounts of waste as drilling mud is typically captured and reused during the process, however, any excess waste, such as drill cuttings, will be transported by lorry and disposed of by a licenced waste operator at a licenced facility. It is anticipated that six tipper loads of spoil will be removed per week for HDD at the cable landfall(s).

Wastewater will be disposed of via main facilities where available with temporary facilities utilised where necessary. The final strategy will be agreed upon with statutory consultees and detailed within the CEMP.

5.9 Drainage strategy

A review of SEPA Flood Maps (SEPA, 2021) indicates that the majority of the onshore substation search area is not at risk from fluvial flooding. Nonetheless, the Burn of Achanarras is located immediately adjacent to the western edge of the onshore substation search area and this is shown to have a high likelihood of fluvial flooding based on SEPA Flood Maps (i.e. each year this area has a 10% chance of flooding). However, the indicative location for the onshore substation (see Figure 5-7) is out with this high-risk area.

Sustainable Drainage Systems (SuDs) will be required for the onshore substation for all surface water drainage. The surface water drainage network for the onshore substation will be designed taking into account THC's Supplementary Guidance: Flood Risk and Drainage Impact Assessment (THC, 2013), SuDS Working Party (SUDSWP) Water Assessment and Drainage Assessment Guide (SUDSWP, 2016) and Construction Industry Research and Information Association (CIRIA) Publication C753 – the SuDS Manual (CIRIA, 2015).

Proposed SuDS to be incorporated in the drainage strategy for the onshore Project include use of settlement ponds, swales, filter strips, check dams / berms, sumps and silt fences / straw bales at different stages of the onshore substation and onshore export cable installation. Different types and levels of treatment will be required for the various onshore Project components during construction, operation and maintenance and decommissioning: These features considered for the onshore Project are outlined in detail within an Outline Drainage Strategy submitted alongside the Application for PPP. The Outline Drainage Strategy is presented within the Onshore EIA Report SS3: Flood Risk and Drainage Assessment.

Any areas within the onshore substation where potentially polluting materials will be stored or used are likely to require additional treatment to ensure that spills and leaks do not gain direct access into the groundwater or surface water environments. Such additional treatment is likely to include oil separators, or provision of a self-contained drainage network which is entirely separate from the surface water drainage system. Treatment and discharge of surface water to the water environment is regulated under the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended). This forms an additional requirement to planning conditions. Any formal authorisations under the Controlled Activities Regulations (CAR) that are needed for the drainage strategy will be put in place prior to construction works.

The drainage strategy is indicative at this stage, and the final detailed drainage design will be consulted upon with THC and other key stakeholders, as required, and will be completed at a future date following approval of the PPP and contractor appointment. It is intended that the final Drainage Strategy and Flood Risk Plan will be appended to the final CEMP.

5.10 Operations and maintenance

Following final commissioning, it is anticipated that the onshore substation will be unmanned and operate continuously (24 hours a day, 7 days a week) except during planned shutdowns for maintenance. The onshore export cables are also anticipated to be in operation continuously.

Over the lifespan of the onshore Project, it is anticipated that there will be 50% planned shutdown rate for the onshore export cables in years 5, 10, 15, 20 and 25. At the substation, STATCOM scheduled refurbishments are scheduled in 9-year cycles with planned shutdowns in Year 9 and 18.

In addition, there will be routine maintenance activities at both the onshore substation and the onshore export cables which will include the following:

- Onshore substation - periodic planned inspections of all switchgear, buildings and ancillary equipment. This includes visual inspections, minor and major maintenance. In addition, monthly and annual BS 5266 Emergency Lighting Test and Emergency Warning and Intercommunication System (EWIS) and Automatic Fire Detection System Test will be carried out; and
- Onshore export cables– periodic visual inspection of the link boxes / TJBs and CJBs (typically bi-annually) including checking for faults, water penetration / ingress, corrosion of joints and cables and structural conditions.

Regular preventative visual checks will be carried out at the onshore substation, in addition to the periodic maintenance activities. Where possible, remote restart / reset of systems is to be utilised. There will be limited amounts of traffic to and from the onshore substation for general operation and maintenance purposes. The estimated traffic volume is around one vehicle per week. The duration of visits is dependent on manufacturer recommendations for the installed equipment and the final maintenance regime. Beside this, there will be no day-to-day personnel on site during normal operation.

Non-routine maintenance activities may be required due to events leading to unplanned defects or failures. These unexpected faults may lead to increasing traffic volumes depending on the type of fault.

To allow for these operation and maintenance activities, permanent access tracks and improvements to existing roads are required at the HDD sites (at the landfalls and for major crossings along the onshore export cable corridor) and at the onshore substation site (as detailed in section 5.7.1). It is anticipated that up to six permanent access tracks will be required for HDD sites and one permanent access track will be required at the onshore substation, subject to final design of the onshore Project and discussions with THC and landowners. This consists of 5.08 km in length of permanent access tracks. 24% (1.2 km) are existing tracks, 44% (2.21 km) are existing tracks that require improvements and 32% (1.67 km) will be newly installed tracks. The proposed permanent access tracks are shown in Figure 5-8.

Relevant management plans for the operation and maintenance activities of the onshore Project will be developed post-consent to detail how operation and maintenance activities will be managed. These plans will be adhered to for the lifespan of the onshore Project.

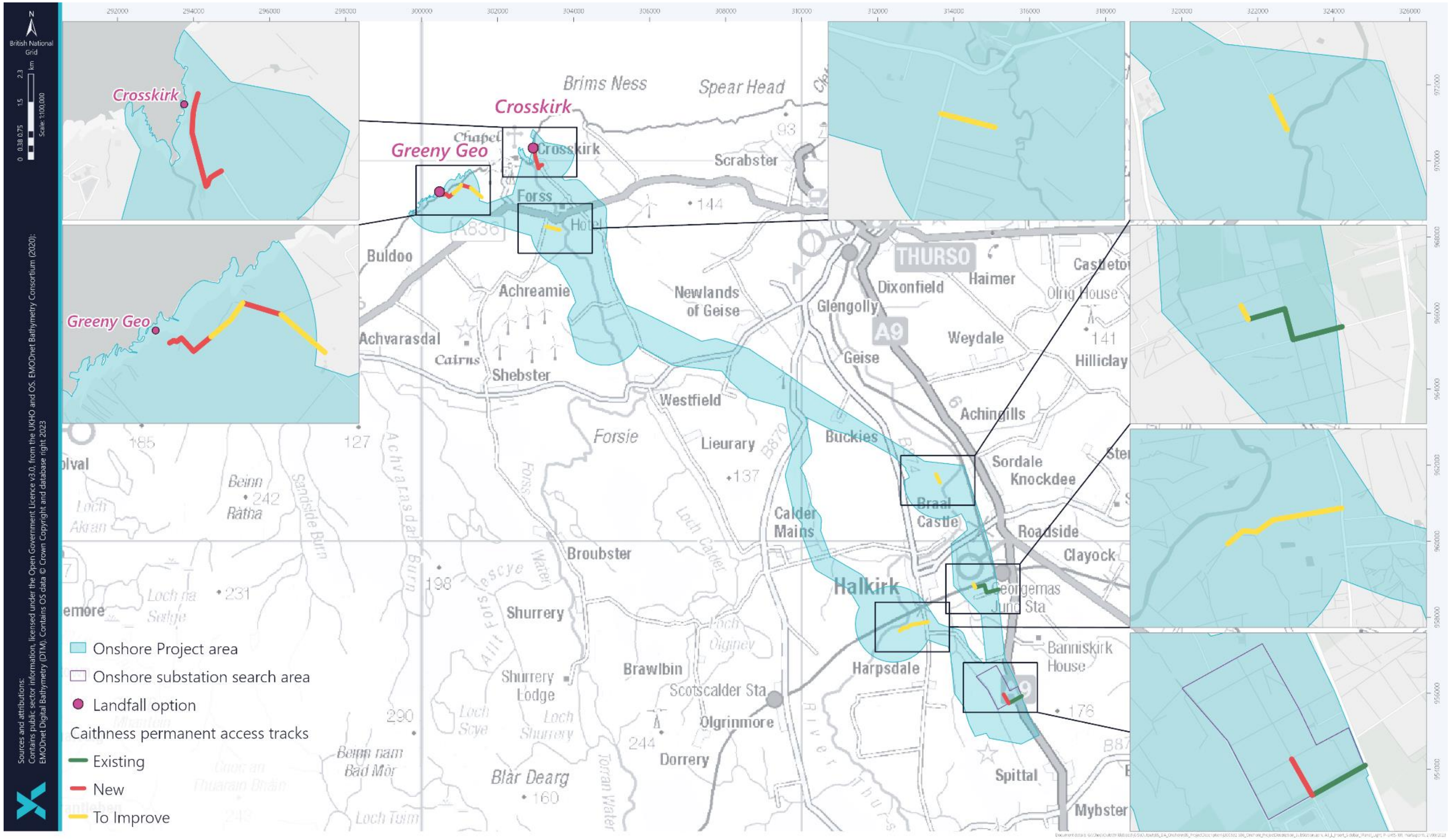

Figure 5-8 Indicative permanent access tracks required for the onshore Project

5.11 Repowering

If the decision is made to extend the onshore Project design life beyond what has been assessed within this Onshore EIA Report, this would be subject to a separate planning process. Therefore, the repowering of the onshore Project is outwith the scope of this Onshore EIA Report.

5.12 Decommissioning

The preferred decommissioning option is for as close to full removal as possible, whilst recognising that this is subject to assessments and consultation closer to the time of decommissioning. This preference has been integral to the selection of design options and will continue to be through the detailed design phase.

A Decommissioning, Restoration and Aftercare Plan is required as a planning condition to be approved by THC, prior to the onshore decommissioning works. Decommissioning best practice and legislation will be applied at that time. It is expected that decommissioning follows a reverse order of the installation activities with some infrastructure potentially left *in situ*.

A high-level summary of the decommissioning strategy for components of the onshore Project is provided in Table 5-7.

Table 5-7 Decommissioning strategy

ONSHORE INFRASTRUCTURE	DECOMMISSIONING APPROACH
Onshore substation	All electrical equipment, plant, access tracks and fencing are dismantled and/or removed and transported to a facility for re-use, recycling or disposal in accordance with waste management and Decommissioning Plans. Potential hazards and pollutants to the environment are identified and a plan put in place to ensure removal is carried out with minimal risk of damage to the surrounding environment. The amenity value of any SUD facilities are assessed and may be retained if preferable. It will be agreed with THC and appropriate stakeholders (e.g. Scottish Forestry and NatureScot) the most appropriate strategy for the bunding and plantation following decommissioning.
Onshore export cables	Cables are removed from the ducts utilising the joint bays and disposed of / recycled. The appropriateness of removing the cable ducts will be assessed with the relevant authorities closer to the time of decommissioning. It is considered that these may be left *in situ* due to potential significant disturbance along the cable routes. An inert fill may be used to provide lateral strength and prevent access to the ducts.

ONSHORE INFRASTRUCTURE	DECOMMISSIONING APPROACH
Concrete Structures	Concrete structures such as the foundations, TJBs or CJBs are excavated and materials such as steel re-bar are recovered, and concrete will be broken up and recycled. The pits are then backfilled and reinstated in keeping with the local environment.
HDD crossings	Cables at HDD locations are removed from the ducts and disposed of / recycled. It is anticipated that the ducts are capped and grouted and remain *in situ*.

5.13 Offshore infrastructure

5.13.1 Overview

OWPL are seeking Section 36 Consent for the offshore Project, as required under the Electricity Act 1989, and Marine Licences, as required under the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009. The Section 36 Consent and Marine Licence Applications were submitted in September 2023. Information on the offshore Project is included here to ensure a complete understanding of the whole Project.

The offshore Project area (Figure 5-9) includes the array area and the offshore export cable corridor. The array area reflects the Option Agreement Area (OAA) awarded to OWPL through the ScotWind Leasing Round and is approximately 28 km from the west coast of Hoy, Orkney and 23 km from the north coast of Scotland. The offshore Project comprises of the following:

- Up to 125 WTGs with fixed-bottom foundations (monopile, piled jacket or suction bucket jacket);
- Up to five HVAC Offshore Substation Platforms (OSPs);
- Up to 500 km of inter-array cables;
- Up to 150 km of interconnector cables; and
- Up to five offshore export cables to landfalls at Greeny Geo and/or Crosskirk in Caithness, with a total combined length of up to 320 km (average of 64 km per offshore export cable).

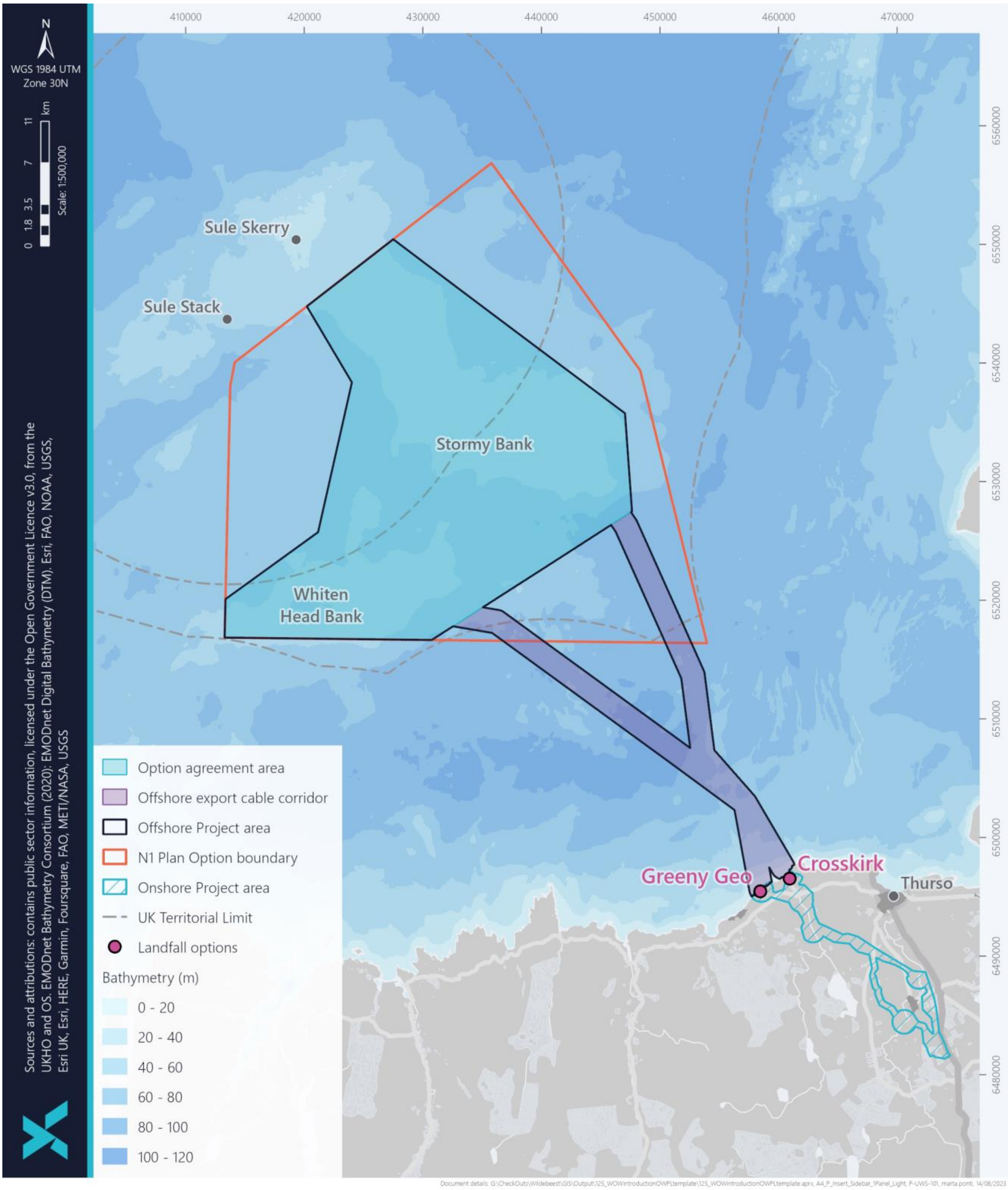

Figure 5-9 Offshore Project boundary

5.13.2 Construction

It is anticipated that the construction of the offshore Project will take four years, ahead of which there will be the need for pre-construction activities. Construction works would preferably occur during the months April to September (inclusive) and typically be undertaken 24 hours a day, seven days a week offshore, dependent upon weather conditions. The general series of activities is outlined in Table 5-8.

Table 5-8 Outline of offshore construction activities

ACTIVITY	DESCRIPTION
Pre-construction surveys and site investigations	Pre-construction surveys and site investigations will be undertaken, including geophysical surveys which may include Multi-Beam Echo Sounder (MBES), Side-Scan Sonar (SSS) and magnetometer. The requirement for these surveys and other site investigations will be determined following the engineering design phase and post-consent conditions.
Site and seabed preparation	Site preparation activities may be required including Unexploded Ordnance (UXO) clearance, boulder clearance, pre-lay grapnel runs, bedform clearance[6] and dredging.
WTG foundation installation	The WTGs will be supported by fixed-bottom foundations. The specific technology and makeup of the WTG foundations has not yet been selected, and the final technology selection will be driven by a series of environmental, technical and commercial variables, as technologies and methodologies continue to evolve. The following design options being considered for the offshore Project include monopiles and jacket foundations (piled or suction buckets).
OSP installation	A maximum of five OSPs are required for the offshore Project. They will collect, transform and export the power generated by the WTGs. OSP foundations are pre-installed ahead of the topside structure. OSP topsides will be supported by pin-piled jacket foundations (16 pin-piles per jacket foundation) or suction bucket jacket foundations with up to eight legs. The topsides will be manufactured onshore and equipped with all electrical and mechanical equipment prior to being transported offshore to be installed atop of the OSP foundations. The topsides will be welded, grouted or bolted to the foundation. The OSP topsides will be installed by a semi-submersible crane vessel.
Inter-array and interconnector cable installation	Inter-array cables carry the electrical current produced by the WTGs and connect them to the OSPs. The primary method of installation is to bury the cable under the seabed to a target depth of 1 - 3 m, and this is also the primary approach to protecting the cable itself. External protection options include concrete mattresses, rock placement, rock bags, grout bags, cement bags, sandbags, articulated pipes, cast iron shells, bend restrictors and vortex-induced suppression strakes, and this will only be used where adequate burial is not achievable or additional protection is required.

[6] *Bedforms include sandwave bedforms, bedform fields comprising of sand and gravel, megaripples and rippled scour depressions which are present in different areas across the offshore Project area.*

ACTIVITY	DESCRIPTION
Offshore export cables installation	The offshore export cables, each correspond to an HVAC submarine power cable system consisting of three core armoured submarine power cable with one (or more) fibre optic cable(s) embedded in the main submarine cable. The offshore export cables export energy from the OSPs to the onshore export cables via the offshore / onshore interface at the landfalls. Up to five offshore export cable systems will be required across the offshore Project to the landfall(s) at Caithness. Each will be located in a separate trench within the offshore export cable corridor. At approximately 13 km from the landfall(s) at Caithness, the offshore export cable corridor diverges into two cable route options, to the east and west of the OAA. One or both of the landfall options may be utilised. The primary method of installation is to bury the cable under the seabed, and this is also the primary approach to protecting the cable itself. External protection options include concrete mattresses, rock placement, rock bags, grout bags, cement bags, sandbags, articulated pipes, cast iron shells, bend restrictors and vortex-induced suppression strakes. These will only be used where adequate burial is not achievable and/or additional protection is required.
WTG installation / commissioning	The WTGs convert wind energy to electricity and consist of rotor blades, towers, gearboxes, transformers, power electronics and control equipment. The WTGs will be installed following the installation of the foundations. The WTGs will be transported via a vessel from the construction base to the OAA for installation, either by a self-propelled installation vessel or transport barge. The assembly and construction base(s) has not yet been identified, as this is dependent on the Project-specific requirements based on the final design, the availability of ports at the time of construction and practical considerations, such as local facilities and ease of access. The exact approach for the installation of the WTGs depends on the final WTG design option and the installation contractor. This will be determined post-consent. Following installation of the WTG and connection to the inter-array cabling and wider infrastructure, a process of testing and commissioning will be undertaken.

5.13.3 Operation and maintenance

An Operator will be appointed by the Project who is responsible for the co-ordination and execution of the operation and maintenance activities, including Health and Safety and Environment (HSE) management. The Operator will employ remote monitoring of the offshore Project, either from onshore Operations and Maintenance (O&M) base or another location. Options for the onshore O&M base are currently being considered and work has already been undertaken to assess Scottish port capabilities to understand the viability of options available to meet the Project requirements. It is anticipated that the Project will be managed from a local onshore facility for the lifecycle of the Project.

During the operation and maintenance stages, the following classifications of maintenance may be required:

- Routine maintenance: activities that are carried out on a regular basis based on the Original Equipment Manufacturer (OEM) recommendations and good industry practice, for example inspections, testing and investigation of minor faults;
- Unscheduled maintenance: activities that may be required to carry out repairs or remedial works to return the asset to serviceable condition;
- Major component replacement / repair: Faults that could trigger emergency repairs requiring large component replacements and extensive remedial works; and
- All offshore infrastructure, including WTGs, foundations, cables and offshore substation platforms is included in monitoring and maintenance programmes.

It is anticipated that routine maintenance is serviced through Service Operated Vessel (SOVs), Crew Transfer Vessels (CTVs), daughter craft, Remote Operated Vehicle Support Vessels (ROVSVs) and helicopters. Any major exchanges may require the use of jack-up barges or semi-submersible crane vessels.

5.13.4 Decommissioning

The Energy Act 2004, as amended by the Scotland Act 2016 contain statutory requirements in relation to the decommissioning of Offshore Renewable Energy Installations (OREI) and require the offshore Project to provide a Decommissioning Programme, supported by appropriate financial security, prior to Commencement of Construction. The Decommissioning Programme will follow the guidance found in the Scottish Government's 'Decommissioning of Offshore Renewable Energy Installations in Scottish Waters or in the Scottish part of the Renewable Energy Zone under the Energy Act 2004:' Guidance notes for industry (in Scotland) (Scottish Government, 2022b) and Decommissioning of Offshore Renewable Energy Installations under the Energy Act 2004' Guidance Notes for Industry (England and Wales) from the United Kingdom (UK) Department for Business Energy and Industrial Strategy (BEIS) (Department for Business Energy and Industrial Strategy, 2019). Decommissioning activities will comply with all relevant legislation and best practice at the time of decommissioning.

Throughout the offshore Project lifespan, the Decommissioning Programme will be reviewed and updated every five years. Consultee bodies listed in the S105 Notices[7], and any additional consultees identified by Marine Directorate – Licensing Operations Team (MD-LOT) or OWPL will be provided with the opportunity to comment on the Decommissioning Programme prior to it being finalised. It is anticipated that the final revision process will commence two years prior to the commencement of decommissioning activities. Best practice will be followed when developing a Decommissioning Programme.

5.14 Consideration of hazards, accidents and risks

Major accidents and disasters have been considered within the onshore EIA Report, specifically those in relation to the health and safety of human receptors and those which pose a risk to the onshore Project. Accidents and disasters such as coastal, fluvial and surface water flood risk, traffic and transport accidents and severe weather events have been considered where relevant when compiling the topic-specific assessments and supporting studies.

[7] *Section 105 notices, are issued under the Energy Act 2004 (as amended), following consent of a Marine Licence after which the Applicant must submit a Decommissioning Programme including details on the costs and financial securities for decommissioning.*

It is considered that there is no potential for major accidents and/or disasters to arise from the onshore Project and the onshore Project is not vulnerable to these considered accidents and disasters due to careful design and by adhering to best construction practices such as, but not limited to, the Construction (Design and Management) Regulations 2015 and Health and Safety regulations (e.g., Health and Safety at Work etc. Act 1974, The Management of Health and Safety at Work Regulations 1999, The Planning (Hazardous Substances) Regulations 2015 and Control of Major Accident Hazards Regulation 2015).

All Project risks are considered to be As Low as Reasonably Practicable (ALARP) with the implementation of embedded mitigation measures and no additional mitigation has been identified to reduce risk further at this time. Risk reduction will continue to be refined during detailed engineering design, to ensure that a hierarchy of controls are in place through the various management plans and method statements produced post-consent once the final design of the onshore Project is known.

5.15 Embedded mitigation and management plans

Embedded mitigation measures are measures that reduce the potential for impacts to the environment. Embedded mitigation can take different forms, but primary mitigation measures are measures that are identified and adopted as part of the evolution of the design for the onshore Project. As described in chapter 7: EIA methodology, primary mitigation refers to measures built into the design of the onshore Project.

Management plans that are considered embedded mitigation will form conditions to the PPP being sought by the onshore Project. The management plans, and the embedded mitigation measures within them, will be expanded upon at the post-consent stage of the onshore Project.

Additional mitigation measures, including secondary and tertiary mitigation, do not form part of the fundamental design and implementation of the onshore Project. These are detailed within each topic-specific EIA chapter. A full list of the mitigation measures identified for each EIA topic is provided within chapter 19: Summary of mitigation and monitoring.

A summary of the primary embedded mitigation measures for the onshore Project is provided in Table 5-9.

Table 5-9 Embedded primary mitigation measures adopted as part of the onshore Project

EMBEDDED MITIGATION	DESCRIPTION
Construction working hours	Core working hours for the construction of the onshore Project will be typical working hours which are 8 am to 7 pm Monday to Friday and 8 am to 1 pm on Saturdays, as stated by THC. This will also apply to HGV movements. In certain circumstances, specific works may have to be undertaken outside the normal working hours e.g. HDD works. In these instances, working hours will be agreed in advance with THC's Environmental Health Department Section 61 of the Control of Pollution Act 1974. Activities carried out during mobilisation and maintenance, which will not generate significant noise or vibration levels, may continue outside the core working hours. Requirements of working hours during construction are detailed within OMP1: Outline CEMP and OMP2: Outline CTMP. These plans are submitted alongside the Application for PPP.
Use of HDD as the landfall installation technique	HDD is the proposed landfall installation technique, and this minimises the disturbance to the coastline (e.g. effects on coastal morphology) when compared with other installation techniques such as OCT and rock pinning, which have subsequently been removed from the design envelope. No de-vegetation or ground-breaking works are to occur within 50 m of the cliff edge. This will ensure that sensitive coastal habitats and species are not adversely affected by the construction, operation or decommissioning works for the onshore Project.
Underground onshore export cables	All onshore export cables to be buried in trenches with no overhead power cables. Cables to be drilled at sufficient depth to shield electrosensitive species from the potential impacts of Electromagnetic Field (EMF) and to prevent channel alteration, or exposure, during a channel-forming event, e.g., storm event.
Onshore construction compounds	Construction compounds and set down areas will be sited to respond to sensitive receptors. Suitable temporary routes will be provided during construction stage and the duration of any diversions for core paths will be minimised.
Minimisation of onshore Project footprint	The land take for the onshore Project will be kept to the minimum necessary for safe construction and operation for the works. The onshore Project area has been established based on identifying the shortest and most economical route from landfall to the grid location.

EMBEDDED MITIGATION	DESCRIPTION
Avoidance of sensitive areas	The boundary of the onshore Project has been developed to avoid sensitive areas wherever possible, including: identified cultural heritage assets, designated cultural heritage assets, peatland, Groundwater Dependent Terrestrial Ecosystems (GWDTEs), designated areas such as protected sites, woodland and high value forestry, high value agricultural land, watercourse crossings, third party assets, residential and commercial properties, utilities, roads, areas of contaminated land and private water supplies. These sensitive features will also be considered as part of the constraints mapping exercise to inform final cable routes and associated construction infrastructure. Where impacts to these areas cannot be avoided, these will be minimised. All designated sites including Special Areas of Conservation (SAC), Special Protected Areas (SPAs), Sites of Special Scientific Interest (SSSIs) and Geological Conservation Review (GCR) sites (with the exception of the River Thurso SAC) have been avoided.
Proximity to GWDTEs and watercourses	Where possible, the following buffers between GWDTEs and excavations will be implemented: 250 m buffer for the onshore export cable corridor and any other excavations greater than 1 m in depth; and 100 m buffer for excavations less than 1 m in depth. If the onshore export cable corridor is located within 250 m of any GWDTEs, clay stoppers will be included in the onshore export cable corridor trench to prevent them from acting as preferential pathways for drainage. Additionally, where possible, crossings with watercourses will be minimised and the onshore Project will avoid, routing the onshore export cables close to (within 100 m) and parallel to watercourses for distances greater than 500 m.
Habitat/ land reinstatement	Once an area is no longer required for construction, it will be re-instated to ensure it can return to its original use for the remainder of the construction period and operational period. Terrain and ground cover will be reinstated to avoid any impacts on the setting of heritage assets and on visual and landscape amenity. Where the riverbed or riverbank has been subject to construction, full reinstatement will be delivered. For general habitat reinstatement, turfs will be removed to a suitable storage point where they will be maintained during works. Topsoil and subsoil, where applicable, will also be stored separately, and excavations backfilled with these materials to maintain the original stratification as well as is practical. Turfs will then be replaced as close to their original location as possible. Due to the temporary and short-term nature of most construction activities, this method will allow the reinstatement of habitat immediately after works are completed in a given area. For high sensitivity habitats (e.g., Annex I habitats, GWDTEs and Scottish Biodiversity List (SBL) habitats), particular care will be taken when removing, storing and reinstating the turfs. In addition to ensuring that the turfs are replaced as close to their original location as possible, and as quickly as possible following works in a given area, the turf will be reinstated in their original orientations. Additionally, targeted specific National Vegetation Classification (NVC) surveys as agreed with NatureScot post-consent will be carried out within a 250 m buffer ahead of construction works to allow for the micrositing of the route to avoid particularly sensitive habitats in the Project area.

EMBEDDED MITIGATION	DESCRIPTION
Compensatory planting	All felled woodland will be compensated for by an appropriately designed new compensatory planting scheme, produced post-consent. Planting undertaken in a specified timeline and as agreed in consultation with Scottish Forestry and Forestry and Land Scotland (FLS) (if appropriate). Areas of compensatory planting will be undertaken within suitable area(s), at a time which takes account of the needs of the landowner, the progress of the works and the suitability of the time for establishing new planting.
Ecological Clerk of Work(s) (ECoW(s)	Appropriately qualified ECoW(s) will be present at sensitive locations and/or sensitive periods where appropriate.
Species and Habitat Protection Plan (SHPP)	The SHPP will ensure all trenches and excavations will be fenced or covered over at night to prevent any animals from falling in and becoming trapped. If this is not possible, an adequate means of escape must be provided (i.e. a gently graded side wall or provision of gently sloped wooden plank or equivalent). Pre-construction surveys for protected mammal and reptile species will be undertaken to identify any species making use of the onshore Project area ahead of works. Should any protected species be identified, specific mitigation would be developed in consultation with NatureScot. Pre-construction surveys will identify features with the potential to be used by reptiles as hibernation sites. Wherever possible works will avoid impacts on these features by micrositing. Where this is not possible, potential hibernation features will be dismantled under the supervision of a suitably qualified and experienced ECoW(s), outwith the hibernation season (September to March inclusive) (Cathrine, 2018). For protection of bats and bat roosts, no works are to take place within 30 m of any buildings. If works cannot be avoided within the recommended buffer area, and significant direct or indirect impact is still anticipated, detailed bat roost potential survey and bat activity surveys are to be undertaken prior to construction. In the event that a bat roost is identified within the 30 m buffer, it may be necessary to secure a bat Derogation Licence prior to works commencing.
Freshwater ecology protection measures	The following measures will be implemented to help prevent harm to freshwater ecology receptors: • Protect salmonid river entry by avoiding works within tidal river reaches from April to November; • Protect salmonid spawning and incubation through no in-channel working between October to May where appropriate; • Sustain passage of fish through site during works at crossing locations where appropriate; • No post-construction channel barriers; • Prevent fish mortality with rescues at all working areas within channels where appropriate; and • The use of temporary bridges/spanning structures rather than pipework will be used in watercourses where appropriate for the haul roads to reduce potential impacts to migrating fish.

EMBEDDED MITIGATION	DESCRIPTION
Geese and swan protection measures	Construction and maintenance activities will not take place within 500 m of feeding locations identified by Project specific surveys and potentially important feeding areas based on NatureScot dataset (Jonathan Swale, pers. comm. (2023) between September and mid-May (Goodship & Furness, 2022). Where this is not possible, monitoring will be undertaken by a suitably experienced and qualified ECoW searching for Greenland white-fronted geese, greylag geese, or whooper swans within 500 m of active construction activities. If these species are found, they will be observed for signs of disturbance. If birds are observed to be disturbed (i.e. multiple short flights within a small area, or small groups of birds leaving the main skein), all works will stop within 500 m, and will not recommence until the ECoW has confirmed it is safe to do so after these species are no longer within the buffer area. In addition, foraging habitat within important feeding areas will be prioritised for reinstatement so as to ensure any disruption to Greenland white-fronted geese, greylag geese, and whooper swans is as temporary as possible. No construction activities will take place within 500 m of a Greenland white-fronted goose, greylag goose, or whooper swan roost within one hour before and after sunrise, and one hour before and after sunset. This is to avoid impacts on roosting birds. Any foraging Barnacle geese identified will be afforded a 50 m buffer to avoid disturbance.
Onshore substation site location and design	The site selection and iterative design of the onshore substation location and layout has been a key process which has considered the potential impacts to landscape and visual receptors and also reduce noise and vibration impacts. The location of the onshore substation will be immediately west of the preferred SHET-L Spittal 2 substation where this area has a strong influence of this type of infrastructure. Additionally, a linear arrangement of the onshore substation is proposed to enable the onshore substation to be set back from the A9 and to respond to the existing terrain. The colour of the onshore substation and structures will be a recessive colour such as dark brown or dark grey to further reduce visual impacts. The onshore substation design incorporates landscape screening which will include bunding with appropriate planting to reduce its visual impact in views from sensitive receptors and designated heritage assets (see chapter 17: Landscape and visual for details). The detailed design will take place post-consent.
Noise and vibration management	For the onshore substation equipment, specification of low noise plant, engineering acoustic measures and specialist noise enclosures, such that the following criteria are achieved at surrounding noise-sensitive properties: • Noise from the onshore substation in the 100 Hertz (Hz) one-third octave frequency band does not exceed 30 dB Equivalent Continuous Sound Pressure Level (LAeq), 5min; and • The Rating Level of noise would not exceed 25dB LAeq.

EMBEDDED MITIGATION	DESCRIPTION
	The final specification of the acoustic measures required would be determined through further studies when the final onshore substation design and equipment specifications are known and will be designed to meet the thresholds as part of the detailed design process. These specifications will be detailed within the Noise and Vibration Management Plan (NVMP) and developed post-consent.
Traffic management	The following measures will be implemented to reduce impacts from traffic associated with the onshore Project: • All HGVs delivering materials to the site will be roadworthy, adequately maintained and sheeted as required; • Adequate traffic management and banksmen[8] will be deployed for the movement of HGVs; and Full HGV loads will be maximised to ensure that part-load deliveries are minimised.
Dust management	Appropriate site layouts will be developed so that machinery and dust causing activities are located away from receptors, as far as possible. Equipment will be readily available on site to clean any dry spillages and ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out. Materials that have a potential to produce dust will be removed from site as soon as possible. Adequate water supplies will be present on site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.
Livestock water supplies	Water supplies for livestock will be protected at all times and alternative supplies will be provided where access could be compromised by any works.

[8] *A worker who supervises the use of vehicles and heavy machinery.*

5.16 Variances from the Project Design Envelope presented in the EIA Scoping Report

The design details of the onshore Project are being refined throughout the development stage. The Project description described above has some variances in dimensions and measurements from those provided in the EIA Scoping Report, which was prepared based on the best design information available at that time. Where the worst case scenario dimensions and measurements differ from those that were presented in the EIA Scoping Report, they are set out in Table 5-10 including explanatory notes as to the reason for the variance.

Consideration has been given as to whether in the case of any variance, the scoping advice from consenting authorities and stakeholders would have differed had the updated dimensions or measurements been available at the time of scoping. This is not considered to be likely.

Table 5-10 Variation in design parameter since EIA Scoping

DESIGN PARAMETER	DETAILS PRESENTED IN SCOPING REPORT	PROJECT DETAILS AT TIME OF EIA	REASON FOR DIFFERENCE IN PARAMETERS
Landfall infrastructure	5 HDD ducts	6 HDD ducts	No more than 5 export cables will be installed, and 5 HDD ducts utilised, however following engagement with an HDD specialist, the Project has allowed for the drilling of a 6th contingency duct. The EIA has therefore assessed impacts from the drilling of up to 6 ducts.
	1 TJB	5 TJBs	Clarification of terminology used in the Scoping Report with regards to the TJBs. There will be a TJB for each of the 5 (maximum) offshore export cables. For the EIA 180 m^2 (plus a small amount of contingency) is allowed for each of the 5 TJB, which is within the 200 m^2 allowance in the Scoping report for each offshore export cable.
	1,250 m^2 HDD compound	7,500 m^2 HDD compound & landfall onshore working area	The area presented in the EIA allows for both the HDD compound and temporary working area required at the landfall end of the onshore cable corridor for cable installation. This difference in areas from what was presented in the Scoping Report is due to engineering refinement that has taken place since scoping and information that has been made available from engagement with an HDD specialist with regards to the HDD compound.
Onshore export cables	175 km (total length for all 5 cable circuits)	198 km (total length for all 5 cable circuits)	The potential maximum total length of the onshore cables presented in the EIA includes a 20% contingency. Discounting this contingency, the length of the onshore cables would be less than that presented in the Scoping Report. It should be noted that the actual cable length isn't a material consideration for the EIA.
	1,250 m^2 temporary working areas at HDD crossings	3,000 m^2 temporary working areas at HDD crossings	The difference in the area from what was presented in the Scoping Report is due to engineering refinement that has taken place since scoping and information that has been made available from engagement with an HDD specialist.

DESIGN PARAMETER	DETAILS PRESENTED IN SCOPING REPORT	PROJECT DETAILS AT TIME OF EIA	REASON FOR DIFFERENCE IN PARAMETERS
Onshore substation	20 ha footprint of substation	23.9 ha footprint of substation, including screening	The difference in the area from what was presented in the Scoping Report is due to engineering refinement that has taken place since scoping. The additional 3.92 ha includes screening (bunding and planting areas); however the area of the actual substation does not exceed the 20 ha detailed in the Scoping Report. It should be noted that engineering refinement since scoping has reduced the area required for the temporary construction compound at the substation from 15 ha to 6.25 ha. Therefore, the overall area required for the substation, screening and temporary construction compound is within that presented in the Scoping Report.

5.17 References

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5.18 Abbreviations

ACRONYM	DEFINITION
ABL	Abnormal Load
AIS	Air Insulated Switchgear
ALA	Abnormal Load Assessment
ALARP	As Low As Reasonably Practicable
BEIS	Department for Business, Energy & Industrial Strategy
CAR	Controlled Activities Regulations
CCTV	Closed Circuit Television
CEMP	Construction Environmental Management Plan
CfD	Contract for Difference
CIRIA	Construction Industry Research and Information Association
CJB	Cable Joint Bay
CMS	Construction Method Statement
COSHH	Control of Substances Hazardous to Health
CTMP	Construction Traffic Management Plan
CTV	Crew Transfer Vessel
dB	Decibels
dB(A)	Decibels A scale
ECoW	Ecological Clerk of Work
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EWIS	Emergency Warning and Intercommunication System
FLS	Forestry and Land Scotland
GCR	Geological Conservation Review
GIS	Gas Insulated Substation
GWDTE	Groundwater Dependent Terrestrial Ecosystems

ACRONYM	DEFINITION
Ha	Hectares
HDD	Horizontal Directional Drilling
HDPE	High-Density Polythene
HGV	Heavy Goods Vehicle
HSE	Health and Safety and Environment
HVAC	High Voltage Alternating Current
Hz	Hertz
km	Kilometre
kV	Kilovolts
LAeq	Equivalent Continuous Sound Pressure Level
LAT	Lowest Astronomical Tide
LCM	Lost Circulation Material
LGV	Light Good Vehicle
m	Metre
m^2	Metres squared
m^3	Metres cubed
MBES	Multi-Beam Echo Sounder
MD-LOT	Marine Directorate – Licensing Operations Team
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
mm	Millimetre
NVC	National Vegetation Classification
NVMP	Noise and Vibration Management Plan
OAA	Option Agreement Area
OCT	Open Cut Trenching
OD	Outer Diameter
O&M	Operations and Maintenance

ACRONYM	DEFINITION
OEM	Original Equipment Manufacturer
OREI	Offshore Renewable Energy Installation
OSP	Offshore Substation Platforms
OWPL	Offshore Wind Power Limited
PIR	Passive Infrared
PPP	Planning Permission in Principle
ROVSV	Remote Operated Vehicle Support Vessels
SAC	Special Area of Conservation
SBL	Scottish Biodiversity List
SEPA	Scottish Environment Protection Agency
SGT	Super Grid Transformer
SHET-L	Scottish Hydro Electric Transmission plc
SHPP	Species and Habitat Protection Plan
SOV	Service Operated Vessel
SPA	Special Protected Area
SSEN	Scottish and Southern Electricity Networks
SSS	Side-Scan Sonar
SSSI	Sites of Special Scientific Interest
STATCOM	Static Synchronous Compensator
SuDS	Sustainable Drainage Systems
SUDSWP	Sustainable Drainage Systems Working Party
THC	The Highland Council
TJBs	Transition Joint Bays
UK	United Kingdom
UXO	Unexploded Ordnance
WTG	Wind Turbine Generator
XLPE	Cross-Linked Polyethylene