CALEDONIA
Offshore Wind Farm

Code: UKCAL-CWF-CON-EIA-RPT-00001-1004

Volume 1 Overview Chapters

Chapter 4 Proposed Development Description (Onshore)

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Volume 1 Chapter 4 Proposed Development Description (Onshore)

Code	UKCAL-CWF-CON-EIA-RPT-00001-1004
Revision	Issued
Date	18 October 2024

Table of Contents

List of Figures

List of Tables

Acronyms and Abbreviations

AC	Alternating Current
AIL	Abnormal Indivisible Load
AMSC	Approval of Matters Specified in Conditions
CEMP	Construction Environmental Management Plan
CTMP	Construction Traffic Management Plan
DE	Design Envelope
EHO	Environmental Health Officer
EIAR	Environmental Impact Assessment Report
ESO	Electricity System Operator
FUE	Follow Up Exercise
HDD	Horizontal Directional Drilling
HGV	Heavy Goods Vehicle
HND	Holistic Network Design
kV	kiloVolt
LGV	Light Goods Vehicle
m^2	Metre squared
m^3	Metre cubed
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
mm	Millimetre
mm^2	Millimetre squared
NETS	National Electricity Transmission System
O&M	Operation and Maintenance

OCT	Open Cut Trenching
OD	Outer Diameter
ONEC	Onshore Export Cable Corridor
OnTI	Onshore Transmission Infrastructure
OfTO	Offshore Transmission Owner
OWF	Offshore Wind Farm
PPP	Planning Permission in Principle
PRIs	Public Road Improvements
RLB	Red Line Boundary
SGT	Super Grid Transformers
SSEN-T	Scottish and Southern Electricity Networks - Transmission
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Urban Drainage System
TJB	Transition Joint Bay
WFD	Water Framework Directive

4 Proposed Development Description (Onshore)

4.1 Introduction

4.1.1 Overview

4.1.1.1 This chapter describes the onshore design parameters of the Caledonia Offshore Wind Farm (OWF) (hereby known as the 'Proposed Development (Onshore)') that have been used to inform this Environmental Impact Assessment Report (EIAR).

4.1.1.2 The Proposed Development comprises two OWF (Caledonia North and Caledonia South) which will connect to the National Electricity Transmission System (NETS) via the Onshore Transmission Infrastructure (OnTI). This EIAR supports a planning permission in principle for the OnTi for both Caledonia North and Caledonia South. The OnTI may be phased to align with the delivery of the two OWFs.

4.1.1.3 The OnTI design parameters cover all intertidal and onshore components of the Proposed Development (Onshore) located landward of Mean Low Water Springs (MLWS) and are collectively known as the OnTI.

4.1.1.4 This chapter sets out the maximum Design Envelope (DE) that will apply to the OnTI, comprising the Landfall Site, Onshore Export Cable Circuits, Onshore Substations, Onshore Grid Connection Cable Circuits and other associated infrastructure.

4.1.1.5 Temporary and permanent works/activities associated with construction, operation and maintenance (O&M) and decommissioning of the OnTI are also described in this chapter.

4.1.1.6 The information presented in this chapter has been used to inform the technical assessments completed to assess the significance of effects upon key receptors, as included within Volume 5 of this EIAR.

4.1.1.7 A description of the Proposed Development (Offshore) is provided in Volume 1, Chapter 3: Proposed Development Description (Offshore) and a detailed description of the site selection process is also provided in Volume 1 Chapter 6: Site Selection and Alternatives.

4.1.1.8 An overview schematic of the Caledonia OWF as a whole, including both the main components of the Proposed Development(Onshore) and Proposed Development (Offshore) is shown below in Figure 4-1 Although Figure 4-1 shows a jacket foundation concept, other designs are being considered for the Proposed Development (Offshore) as described in Volume 1, Chapter 3 Proposed Development Description (Offshore).

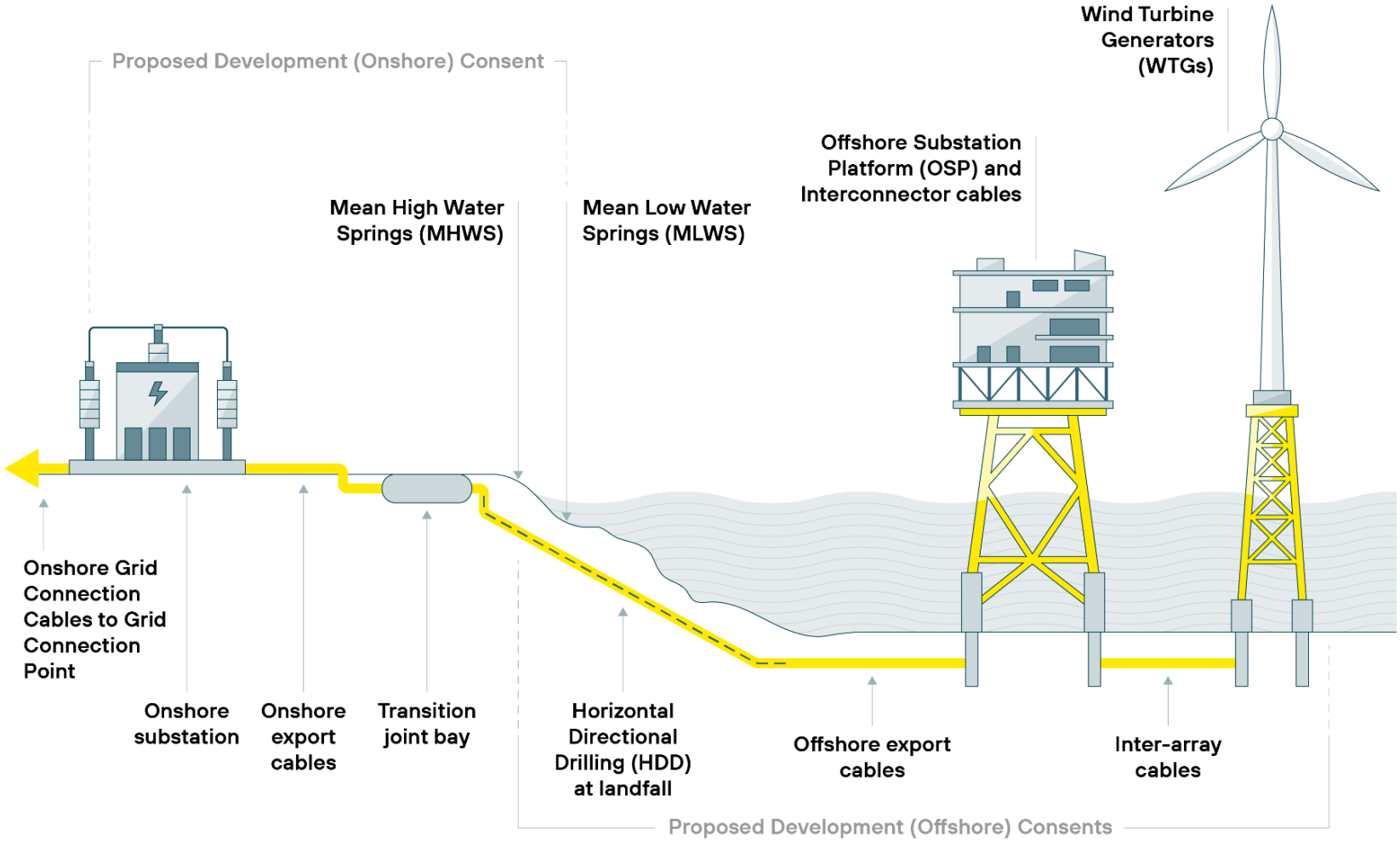


Figure 4-1: The Proposed Development indicative schematic

4.1.2 Design Envelope Approach

4.1.2.1 At this stage in the Proposed Development (Onshore) design process, information on the exact location of the OnTI and the methods that will be utilised during construction have not been confirmed. This is a result of the Proposed Development (Onshore) being in the early stages of the design development process. This detail will be brought forward during the Approval of Matters Specified in Conditions (AMSC) stage following further design refinement, allowing Aberdeenshire Council as the determining authority to consider the detailed designs for approval.

4.1.2.2 As a result, a DE approach has been adopted. The DE identifies the main components of the Proposed Development (Onshore) and a range of design parameters. Within each topic chapter in the EIAR the combination of parameters that would result in the greatest impact (e.g., largest footprint, longest exposure, or largest dimensions) is considered and identified as the worst case assessment scenario. Any design parameter that is equal or less than those assessed will have an equal or lesser impact. By employing the design envelope approach, Caledonia Offshore Wind Farm Limited (the Applicant) seeks to retain a level of flexibility in the design of the Proposed Development (Onshore) within reasonable maximum extents and ranges. Refer to Volume 1, Chapter 7: EIA Methodology for further detail.

4.1.2.3 In line with the use of a DE approach it should be noted that when built the eventual Proposed Development (Onshore) may differ from the scenarios considered within topic assessments but will not exceed the design envelope parameters considered.

4.1.2.4 The first outline DE of the Proposed Development (Onshore) was presented within the Onshore EIA Scoping Report (Ocean Winds, 2023[1]), submitted to Aberdeenshire Council in December 2022. The Onshore Scoping Report identified an Onshore Scoping Area within which the OnTI would be located, which took the form of a corridor between potential Landfall Sites along the Aberdeenshire coast and the Onshore Substation Scoping Area in the proximity of New Deer.

4.1.2.5 Following submission of the Onshore Scoping Report, and as part of an iterative EIA process, the Applicant has refined the area within which the OnTI will be located through environmental surveys, technical and engineering studies and discussion with project stakeholders such as statutory and non-statutory consultees and through a programme of community consultation. For further details on this refer to Volume 1, Chapter 6: Site Selection and Alternatives. This refined area is identified as the OnTI Red Line Boundary (RLB).

4.1.2.6 The OnTI RLB consists four main permanent components:

- **A Landfall Site** has been identified and will comprise Horizontal Directional Drilling (HDD) activities to connect Offshore Export Cable Circuits to Onshore Export Cable Circuits at buried Transition Joint Bays (TJBs);
- **An Onshore Export Cable Corridor (ONEC)** of a minimum width of approximately 100m within which the Onshore Export Cable Circuits will be located. At this stage, an ONEC width has been defined to allow for micro siting of the Onshore Export Cable Circuits at the detailed design stage and to allow for differing cable installation activities such as HDD;
- **Two Onshore Substations** will be co-located within an Onshore Substation Site within the OnTI RLB. A concept design of the Onshore Substations within the Onshore Substation Site is provided (refer to Section 4.2.4); however, it should be noted that the layout of the Onshore Substation Site will be refined through further technical studies at the detailed design stage; and
- **An Onshore Grid Connection Export Cable Corridor** will contain the Onshore Grid Connection Cable Circuits and connect the Onshore Substations to the Grid Connection Point, for Phase 1.

4.1.2.7 The OnTI RLB also includes provision for temporary infrastructure associated with construction of the OnTI. Further details can be found in Section 4.2.3.

4.1.2.8 The OnTI RLB presented within this EIAR is larger than the area the OnTI will ultimately occupy. The parameters presented in this chapter represent the largest possible spatial extents of the Proposed Development (Onshore) as a reasonable worst-case DE.

4.1.3 Grid Connection Point

4.1.3.1 The Applicant has entered into a Bilateral Connection Agreement and Construction Agreement with National Grid Electricity System Operator (ESO) that provides the Proposed Development with a Grid Connection Point to the NETS at a proposed new substation called Greens (formerly known as New Deer 2). In the Holistic Network Design (HND) study, which sought to identify the optimum approach to connecting offshore wind farms to the NETS, National Grid ESO published that the Grid Connection Point for 1500 megawatt (MW) of the Proposed Development's capacity would connect to the NETS at the existing New Deer substation, with the balance of 500MW to be confirmed in a secondary publication, the HND Follow up Exercise (FUE). The Applicant proceeded with its development activities on this basis. In March 2024 National Grid ESO published the HND FUE, which identified that balance of 500MW of the Proposed Development's capacity would connect to the New Deer Area.

4.1.3.2 It is anticipated that the Proposed Development will connect the first phase to the existing New Deer substation, with the second phase connecting to Greens substation. This remains subject to ongoing detailed network design being conducted by National Grid ESO and Scottish and Southern Energy Networks Transmission (SSEN-T), in consultation with the Applicant. Until the detailed design is finalised, there remains the possibility that both phases of the development may connect entirely into the Greens substation.

4.1.3.3 This EIA does not consider the Onshore Grid Connection Cable Corridor for the Proposed Development's second phase, which will be required to connect the Onshore Substation to Greens. This is because the preferred location of the Greens substation was only confirmed in late January 2024[i]. Resultingly, the design of the 400 kiloVolt (kV) connection for the Proposed Development's second phase from the Onshore Substation into Greens is still under development.

4.1.3.4 For further information on how this has impacted the site selection process, please see Volume 1, Chapter 6: Site Selection and Alternatives.

4.1.4 Location, Site Information and Summary Details

4.1.4.1 The area within which the Proposed Development (Onshore) will be located is shown within Figure 4-2and is identified as the OnTI RLB. The OnTI RLB is within the Aberdeenshire Council Local Authority area.

4.1.4.2 The OnTI RLB encompasses:

- **The Landfall Site:** the area from MLWS where the Offshore Export Cable Circuits are connected to the Onshore Export Cable Circuits via HDD ducts within TJBs (buried box-like structures which house the jointing between the Offshore and Onshore Export Cable Circuits, see Section 4.2.2). The Landfall Site is located at a rocky bay named Stake Ness, 1km west of the village of Whitehills and approximately 5km west of Banff;
- **The ONEC:** where the Onshore Export Cable Circuits will be located which connects the TJBs at the Landfall Site to the Onshore Substation Site. The ONEC extends approximately 37km from Stake Ness to an area in the vicinity of the existing New Deer Substation;

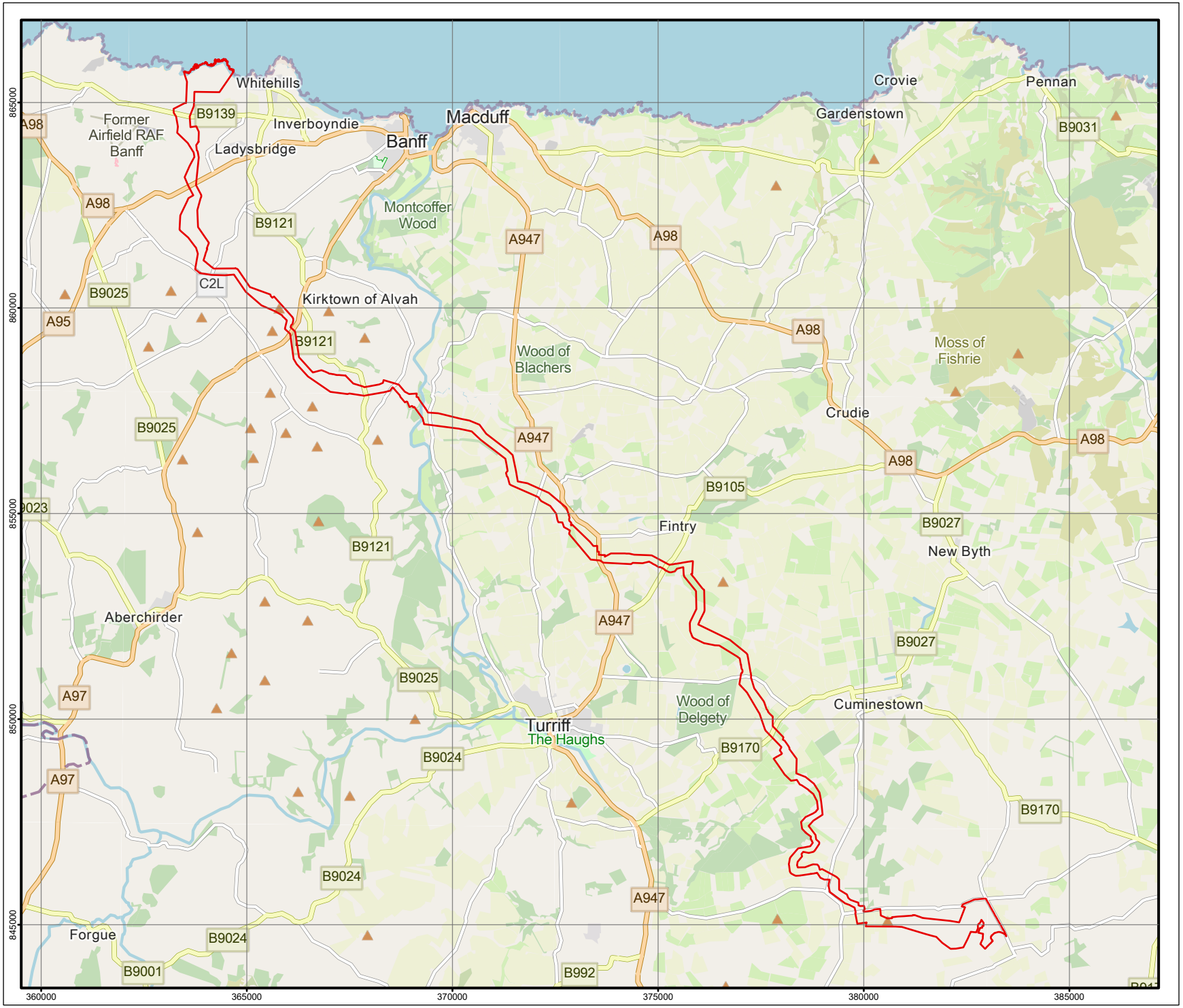
[i] See Proposal of Application Notice on the Aberdeenshire Council planning portal, ref: ENQ/2024/0139

- **The Onshore Substation Site:** comprising two co-located Onshore Substations located adjacent to the existing New Deer substation. Each substation aligns with the two project phases; and
- **The Onshore Grid Connection Cable Corridor:** connecting the Onshore Substation to the Grid Connection Point at the existing New Deer Substation (owned by SSEN-T), via two onshore cable circuits with a nominal voltage of 400kV. This connection relates to Phase 1 of the Proposed Development only. The Onshore Grid Connection Cable Corridor for Phase 2 will be subject to a separate planning application as outlined in Section 4.1.3 above.

4.1.4.3 The OnTI RLB is situated in mainly agricultural land with smaller areas of forestry, ancient woodland, residential properties, and farm steadings in the surrounding area. The proposed Landfall Site is located within the Cullen to Stake Ness Site of Special Scientific Interest (SSSI), though cables will be installed beneath the designated site and construction compounds sited outside the SSSI. Notified natural features of the SSSI include outcrops of geological interest and its habitats including fens and lowland heathland. Land surrounding the Landfall Site is predominantly agricultural land, with sparse settlements and dwellings scattered throughout, connected by small local roads and tracks.

4.1.4.4 The ONEC runs from the cable jointing at the Landfall Site over approximately 37 kilometre (km) before connecting into the Onshore Substation Site, located adjacent to the existing New Deer substation. Key crossings along the ONEC include watercourses such as the River Deveron, Class A and B roads including the A98, A97 and A947, and the Moray East OWF Onshore Export Cable Circuits.

4.1.4.5 Land uses within and surrounding the OnTI RLB are described in more detail in Volume 5, Chapter 2: Land Use.



REV	DATE	DOC STATUS	ORIGIN	REVIEW	APP
03	30/08/2024	Approved	CW	GS	GS
02	22/07/2024	For Review	CW	GS	EC
01	04/03/2024	For Review	MM	GS	EC

CALEDONIA Offshore Wind Farm

ARUP

CONTRACTOR DRAWING NO: UKCAL1_ARP_WNF_ENV_MAP_00546
CONTRACTOR REV: 03

GEODETIC PARAMETERS: OSGB36 / British National Grid (EPSG:27700)

DRAWING TITLE

Figure 4-2: Proposed Development (Onshore) Red Line Boundary

STATUS: Approved
SCALE: 1:125,000
DRAWING NUMBER: N/A
SHEET NO: 01 of 01
REV: N/A

4.1.5 Phased Approach

4.1.5.1 To make efficient use of the available grid capacity, the Applicant is seeking to retain the flexibility to deliver the OWF generation capacity across two phases. Aligned with this, the Proposed Development (Onshore) is seeking to consent the OnTI across two phases of construction works.

- Phase 1: Landfall Site, ONEC, 1 x Onshore Substation and Onshore Grid Connection Cable Corridor; and
- Phase 2: Landfall Site, ONEC, 1 x Onshore Substation and Onshore Grid Connection Cable Corridor (the Onshore Grid Connection Cable Corridor will be subject to separate planning application).

4.1.5.2 The two onshore phases will be brought forward under one of the following construction scenarios:

- **Sequential** – Construction of Phase 1 a gap of up to five years and then the build out of Phase 2. An Onshore Grid Connection Cable Corridor will be required for Phase 2 but will be subject to a separate planning application as outlined in Section 4.1.3 above; and
- **Concurrent –** Construction of both phases at the same time. This scenario may be progressed if external factors make it the most economical, timely and least impactful solution. For example, to address any potential situation where there is a delay to the NETS reinforcement works impacting the first phase of works.

4.1.5.3 The Applicant is also exploring the feasibility of undertaking targeted enabling works for Phase 2 at Phase 1. The following scenario has been included in the assessment (where it is deemed to be material) to ensure it has been assessed should it be possible to implement:

- **Enabling** – Construction of Phase 1 and enabling works for Phase 2 including HDD at the Landfall Site, trenching of ONEC, laying of ducts and construction of the platform for the Onshore Substations and Phase 1 Onshore Substation. A gap of up to five years and the remaining Phase 2 construction works of a cable pull at the Landfall Site, installation of haul road, cable pull along the ONEC and construction and electrical commissioning of the Phase 2 Onshore Substation.

4.1.5.4 Refer to Volume 1, Chapter 5: Proposed Development Phasing for further details.

4.1.6 Summary of Key Components and Design Parameters

4.1.6.1 The OnTI is comprised of the Landfall Site, the Onshore Export Cable Circuits, the Onshore Substations and Onshore Grid Connection Cable Circuits connecting to the Grid Connection Point. This chapter will provide further details on these components and their design parameters. An outline description of the Proposed Development (Onshore) design parameters is provided in Table 4-1.

Table 4-1: Outline description of the OnTI

Design Element	Design Envelope
Landfall Site	
Landfall TJB	4 x HDD works and installation of 4 x TJBs to connect Offshore Export Cable Circuits to Onshore Export Cable Circuits. Estimated permanent land take of 16.5 metre squared (m^2) per TJB, totalling 65m^2.
Onshore Export Cable	
Onshore Export Cable Circuits (Landfall Site to the Onshore Substation Site)	Up to four cable trenches, each with one 220-275kV cable circuit. **Voltage** Maximum voltage of up to 275kV **Onshore Export Cable Circuits Length** Approximate length: 37km **Onshore Export Cable Route (Corridor Working Width)** 100m wide Onshore Export Cable Route. **Burial Depth** 1m target burial depth to top of cable. **Cable Specification** Four onshore cable circuits laid in separate cable trenches. Each cable circuit comprises three single core power cables laid in trefoil formation. Each power cable has a nominal cross-sectional area of 2500 millimetre squared (mm^2).
Cable Joint Bays	The number of joint bays is dependent on the continuous length of the ONEC and the manufacturing specification of the cable supplier.

Design Element	Design Envelope
	It is assumed the Onshore Export Cable Circuits will have a total 50 joint bay locations spaced at 800 metre (m) along the ONEC. Indicative excavation dimensions: 8.8m (L) x 4.8m (W) x 2.3m (D) Estimated maximum excavated volume: 97 metre cubed (m^3) per joint bay. Burial depth: 2.3m.
Onshore Substations	**Onshore Substation Details** Two Onshore Substations will be co-located within the same Onshore Substation Site footprint. **Total Onshore Substation Site Dimensions (of both co-located Substations):** Length: 400m; Width: 250m, total area of 100,000m^2 Maximum height: 15m Total Onshore Substation Site area: 120,000m^2 (including Sustainable Drainage System (SuDS) and access roads).
Onshore Grid Connection Cable Circuits	**Voltage** Up to two cable trenches, each with one 400kV cable circuit. **Onshore Grid Connection Cable Circuits Length** 300m cable length from Onshore Substation Site to Grid Connection Point for Phase 1 at the existing New Deer Substation. **Onshore Grid Connection Cable Route (Corridor Working Width)** Maximum Onshore Grid Connection Cable Route width of 100m. **Burial Depth** 1m cable trench depth to top of cable.

4.2 Onshore Transmission Infrastructure

4.2.1.1 The following descriptions outlined in the sections below describe the OnTI in terms of total installed infrastructure for both phases of works, irrespective of construction sequencing or scenarios. This includes:

- 4 x HDD ducts and TJBs at Landfall Site;
- 4 x Onshore Export Cable Circuits;
- 2 x Onshore Substations; and
- 2 x Onshore Grid Connection Export Cable Circuits.

4.2.1.2 Cognisance should be given to the fact the OnTI may be constructed under either of the construction scenarios outlined in Section 4.1.5.

4.2.2 Landfall Site

4.2.2.1 At the Landfall Site, up to four Offshore Export Cable Circuits will come to shore and will be connected to the Onshore Export Cable Circuits via four TJB buried beneath the ground.

4.2.2.2 Each TJB will be set in the ground, covered over, and consist of an underground concrete box-like structure which houses the cable joints, connecting the Offshore Export Cable Circuits with the Onshore Export Cable Circuits.

4.2.2.3 The final selection of the TJB dimensions depends on ground conditions and TJB component sizes. At each TJB there will be a link box and communications box pit with a manhole cover to allow for maintenance access during the Proposed Development (Onshore)'s operational lifespan.

4.2.2.4 To allow for this access, there will be individual fenced areas at each TJB link box and communications box pit with indicative dimensions of 6.5m x 2.5m located above Mean high water springs (MHWS) on land currently used for agriculture at the Landfall Site.

Table 4-2: Landfall Site design envelope

Design Parameter	Design Envelope
Landfall Site construction compound area	Maximum temporary land take at Landfall Site: 100m x 200m, 20,000m^2
Offshore Export Cable Circuits and HDD Ducts	**Offshore Export Cable Circuits** Maximum of four cables installed (two for Caledonia North and two for Caledonia South) with and outer diameter (OD) of up to 330 millimetre (mm).

Design Parameter	Design Envelope
	Maximum length of cable: 180km for Caledonia North and 150km for Caledonia South. (Refer to Volume 1, Chapter 3: Proposed Development Description (Offshore)) **HDD Ducts** Maximum of four ducts installed with an OD of up to 330mm. Length of each HDD duct: 464m Maximum depth of each HDD duct: 17.2m
Maximum number of TJBs	Up to four TJBs (one TJB per export cable).
TJB Dimensions	Dimensions for each TJB: 6.5 m (L) x 2.5 m x 2.3 m (D). Permanent land take of approximately 65m^2.

4.2.3 Onshore Export Cable Circuits

4.2.3.1 Up to four Onshore Export Cable Circuits will exit the TJBs and be routed south-east inland towards the Onshore Substation Site located adjacent to the existing New Deer Substation. The ONEC which will contain the Onshore Export Cable Circuits travels across land used predominantly for agriculture (see Volume 5 Chapter 2: Land Use) and crosses the River Deveron as well as several class A roads.

4.2.3.2 The Onshore Export Cable Circuits will be located within the ONEC (as shown in Figure 4-3). The exact location and arrangement of the Onshore Export Cable Circuits within the ONEC will be determined at detailed design following further technical studies.

4.2.3.3 The design envelope for the Onshore Export Cable Circuits is summarised in Table 4-3.

Table 4-3: Onshore Export Cable Circuits design envelope

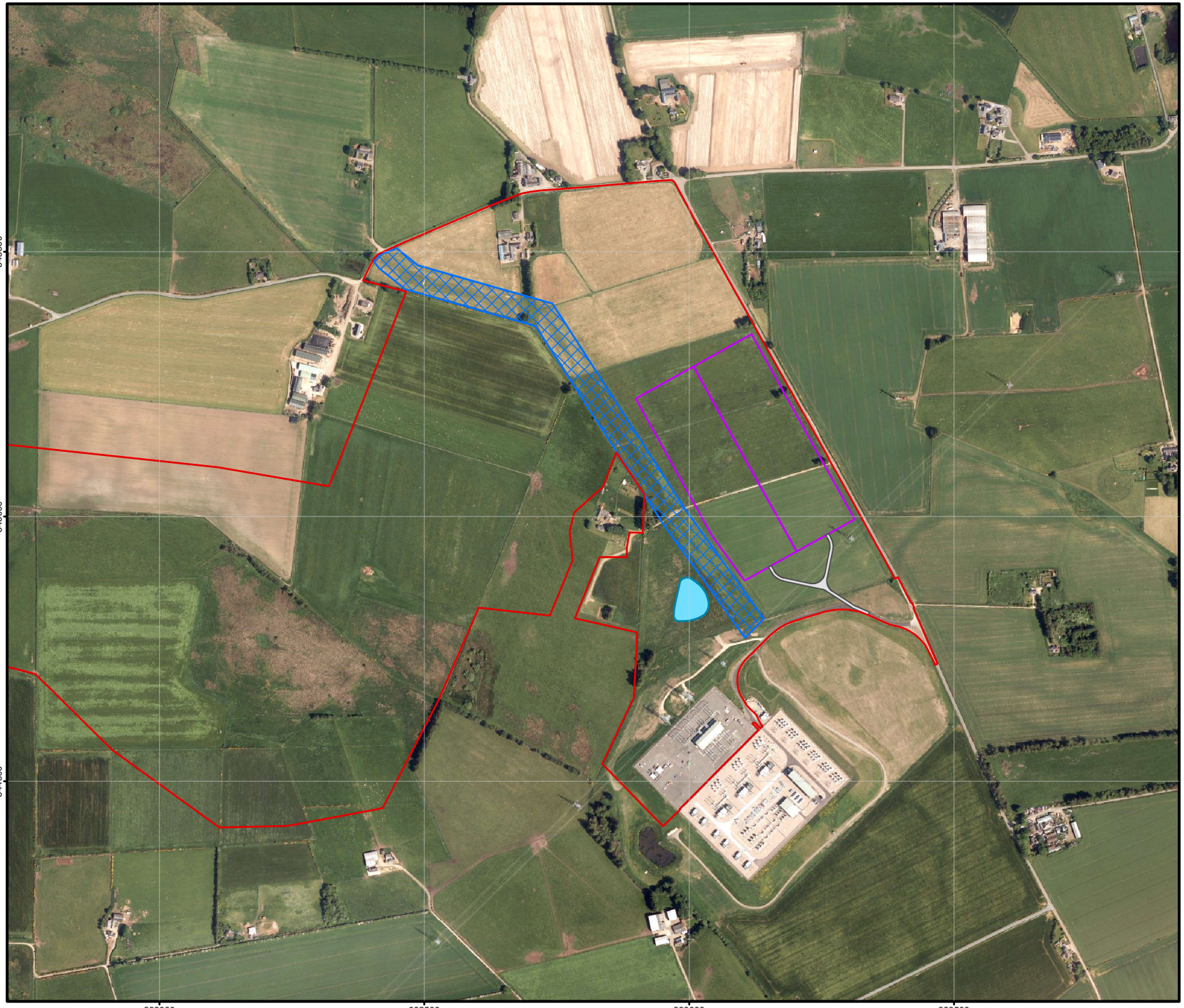
Design Parameter	Design Envelope
Voltage	220 – 275kV
Construction compounds	Primary construction compounds located approximately every 10 km, with satellite compounds every 2.5 km. Primary construction compounds: 75 m x 50 m, 3750m^2. Satellite compounds: 30 m x 15 m, 450m^2.
Cable specification	Up to four Onshore Export Cable Circuits in four cable trenches (i.e., one cable circuit per trench).
Cable route length	Approximately 37km
Onshore Export Cable Route width	100m
Cable diameter	**Onshore Export Cable Circuits (landward of Landfall Site TJB)** Maximum outer diameter of 3 cores together (one cable circuit): 298mm. Each circuit shall also include a 90mm OD comms duct which may contain a 48 core fibre optic cable. **Landfall Site (seaward of Landfall Site TJB)** Maximum outer diameter of 330mm.
Target Burial depth	1m to top of cable.
Cable Joint Bays	A total of approximately 50. Indicative dimensions of 6.5 m (L) x 2.5m (W) x 2.3m (D) Required every 800m along the Onshore Export Cable Circuit.

Design Parameter	Design Envelope
	One or two exposed maintenance access covers per Cable Joint Bay (no permanent above-ground structures). Fencing may be required in some locations (subject to individual land agreements).

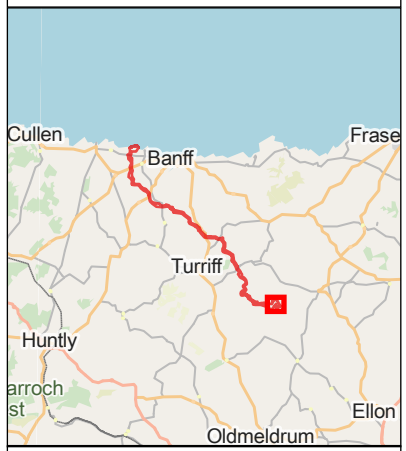
4.2.4 Onshore Substations

4.2.4.1 Two Alternating Current (AC) Onshore Substations will be co-located within the same Onshore Substation Site which will be able to accommodate a total combined capacity of around 2GW. The Onshore Substations will house the electrical equipment required to connect the Proposed Development (Onshore) to the Grid Connection Point and each will have dedicated associated Onshore Grid Connection Cable Circuits.

4.2.4.2 The Onshore Substation Site is adjacent to the existing New Deer Substation. Figure 4-3 outlines the Onshore Substation Site Location and provides an indicative concept design of the Onshore Substation Site layout.



- Onshore Transmission Infrastructure Red Line Boundary
- Indicative Onshore Substations
- Indicative Permanent Onshore Substations Access
- Sustainable Drainage System Area
- Moray East Onshore Cable Route



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03	30/08/2024	Approved	CW	GS	EC
02	02/08/2024	For Review	CW	GS	EC
01	04/05/2024	For Review	CE	GS	EC

CALEDONIA Offshore Wind Farm

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CONTRACTOR DRAWING NO: UKCAL1_ARP_WNF_ENV_MAP_00252	CONTRACTOR REV: 03
GEODETIC PARAMETERS: OSGB36 / British National Grid (EPSG:27700)	

DRAWING TITLE

Figure 4-3: Onshore Substation Site

STATUS: Approved	SCALE: 1:10,000	
DRAWING NUMBER: N/A	SHEET NO: 01 of 01	REV: N/A

4.2.4.3 The Onshore Substations could comprise of Air Insulated Switchgear (AIS) or Gas Insulated Switchgear (GIS). The worst-case parameters are different for these technologies and each topic has identified the appropriate worst-case design parameters for their assessment. An overview of the design envelope for the Onshore Substations is provided in Table 4-4.

Table 4-4: Onshore Substations design envelope

Design Parameter	Design Envelope
Permanent land take (m^2)	120,000m^2
Onshore Substation Dimensions	2 x Onshore Substations co located within same Onshore Substation Site. Maximum height of 15m. Length: 400m; Width: 250m, total area of 100,000m^2.
Construction compounds	Maximum construction compound area of 250 x 120, 30000m^2.
Foundations	Foundations for structures and equipment will be raft/slab or pad concrete foundations, founded on the in situ cut subgrade or on the recompacted fill. Approximate depth 750mm (Equipment slabs will be sized according to equipment sizes).
Equipment	The Onshore Substations could consist of: ▪ 4 x up to 275 kV XLPE Cu/Al conductor underground export cables without armour; ▪ 8 x up to 275kV insulating fluid filled shunt reactors with cooling radiators. Maximum height of acoustic enclosures: 8m; ▪ Up to 275kV switchgear Circuit Breakers and busbars. Maximum height of 15m; ▪ 4 x up to 275kV harmonic filters (one per export cable circuit); ▪ 4 x 400/up to 275/33/13.8 kV insulating fluid filled power transformers (Super Grid Transformers, SGTs) with cooling radiators; ▪ 4 x 33/13.8kV transformer tertiary connected Static VAR Compensator (SVC) or STATCOM equipment; ▪ 400kV Double Bus GIS switchgear Circuit Breakers and busbars; and ▪ Up to 4 x 400kV harmonic filters.

Design Parameter	Design Envelope
Buildings	The following buildings may be required: ▪ 4 x switchgear buildings. ▪ A control building. ▪ Steel framed and acoustically/weatherproof clad enclosures shunt reactors and SGTs. ▪ A building to house control equipment for the SVC/STATCOM together with internal Thyristor/IGBT equipment.
Lighting	Inward facing lighting will be installed on the site perimeter and will only be used during maintenance visits. Security lighting may also be required.
Excavated Materials	A balanced cut and fill approach has been assumed. Maximum level of excavated material:75,000m^3.
Security fencing	Security fencing will be provided around the perimeter of the Onshore Substations with a maximum height of 3m.

4.2.5 Grid Connection Point

4.2.5.1 The Grid Connection Point for the Proposed Development (Onshore) is anticipated to be at the existing New Deer Substation for the first phase.

4.2.5.2 From the Onshore Substation for the first phase, there will be up to two Onshore Grid Connection Export Cable Circuits. Each cable circuit will likely comprise three single phase 400 kV cables in flat formation. Each cable circuit will be installed in a separate trench.

4.3 Onshore Construction

4.3.1 Construction methodology

Landfall Site

4.3.1.1 The landfall installation methodology will be HDD, requiring an estimated construction compound of approximately 20,000m^2. Installation will involve drilling and installing four ducts (one for each Offshore Export Cable Circuit) from the drilling pit within the construction compound out to the

seabed beyond MLWS. Subject to further ground study and detailed engineering, each duct will have an indicative length of 464m and maximum depth of 17.2m and the ducts are expected to be spaced approximately 30m apart.

4.3.1.2 The HDD process uses a drilling head controlled from the rig to drill a pilot hole along a pre-determined profile to the HDD exit point. The pilot hole is then widened using sequentially larger drilling heads until the hole is wide enough to accommodate the cable ducts. Drilling mud, typically including a lubricant such as bentonite (a non-toxic, inert natural clay material), is pumped to the drilling head to stabilise the borehole, recover drill cuttings and ensure the borehole does not collapse. Once the drilling operation has taken place, the ducts are pulled through the drilled holes. Once the Offshore Export Cable Circuits have been pulled through the ducts, the HDD exit pits will either be backfilled using side-cast material or left to naturally backfill. Figure 4-4 provides a representation of the typical HDD process.

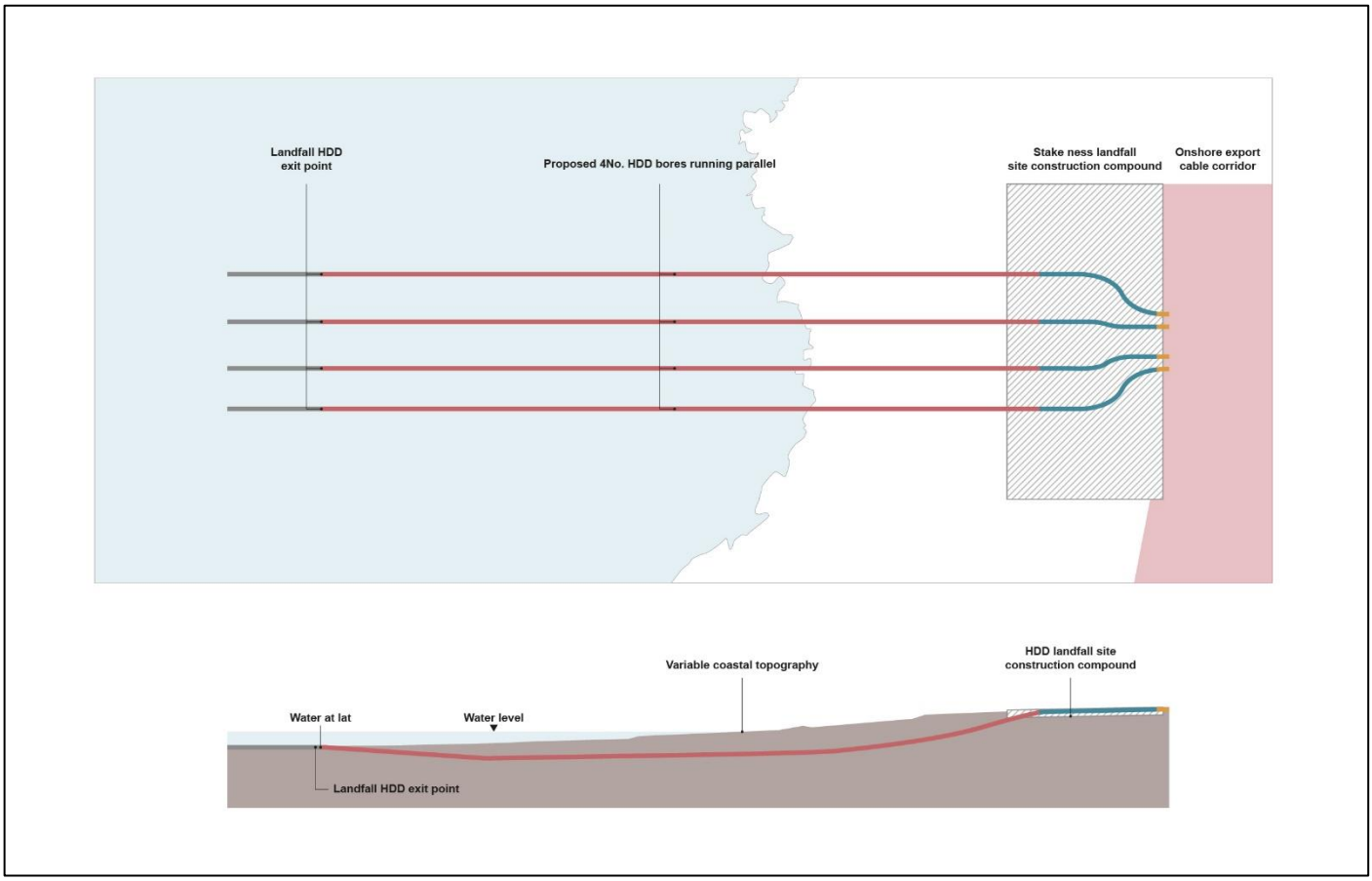

Figure 4-4: Indicative HDD Process

Onshore Export Cable Circuits

4.3.1.3 The Onshore Export Cable Circuits will be installed using predominantly Open Cut Trenching (OCT) techniques to bury the cable circuits in trenches. Varying ground conditions will require differing installation methods to excavate the trenches.

4.3.1.4 For linear features along the cable route such as watercourses, roads and existing cables, crossing methods will range from OCT to trenchless crossing techniques such as HDD. Minor watercourses, ditch crossings and Class B roads are anticipated to be crossed via OCT with trenchless methodologies to be used at the following crossing types:

- existing onshore export cable circuit crossings;
- class A roads and adjacent drains;
- protected woodlands;
- major watercourses (including the River Deveron);
- Water Framework Directive (WFD) waterbodies; and
- salmonoid watercourses.

4.3.1.5 The precise order and timescales in which the Onshore Export Cable Circuits are installed will be determined at a later stage depending on the construction programme and phasing scenario adopted, as described in Volume 1, Chapter 5: Proposed Development Phasing. It is presumed that the installation of the Onshore Export Cable Circuits will progress in sections, with connections from one section to the next made via Cable Jointing Bays. Broadly, the process will follow cable trenching, duct installation, cable pull through and reinstatement.

4.3.1.6 Works to install all four Onshore Export Cable Circuits will be contained within an Onshore Export Cable Route with activities progressing across multiple work locations. Included within the working corridor are areas for cable trenching, haul roads and laydown areas for construction plant.

4.3.1.7 It is estimated that primary construction compounds will be required approximately every 10km along the ONEC, with smaller satellite compounds required approximately every 2.5km. These numbers and sequencing represent a worst case which has been identified as part of the initial design exercise. The final number will be determined during detailed design and specified in subsequent AMSC applications.

4.3.1.8 Establishing construction compounds alongside site access (including Public Road Improvements (PRIs) where required) will be followed by erecting temporary fencing along the margins of the working corridor and preparing the work sites, including haul road construction. Vegetation will be cleared, and topsoil stripped and stored before the cable trenches and jointing pits for the Cable Joint Bays are excavated and ducts installed along the cable corridor. Following installation of the ducts and jointing pits, the export cables will be pulled through the ducts.

4.3.1.9 Construction activities for all phases may include:

- 1) Establish primary construction compounds and site access points, which may include PRIs where required;
- 2) Site preparation including fencing and haul road construction;
- 3) Establish satellite construction compounds;
- 4) Excavate trenches, install ducts and reinstate. Excavate jointing pits;
- 5) Carry out any HDD works;
- 6) Pull Cables, joint cables and reinstate jointing pits;
- 7) Testing and Commissioning;
- 8) Remove the haul road and reinstate previous ground conditions;
- 9) Demobilisation of satellite compounds; and
- 10) Demobilisation of construction compounds.

4.3.1.10 If feasible, some enabling works for Phase 2 may take place at Phase 1, including HDD works. Please refer to Volume 1, Chapter 5: Proposed Development Phasing.

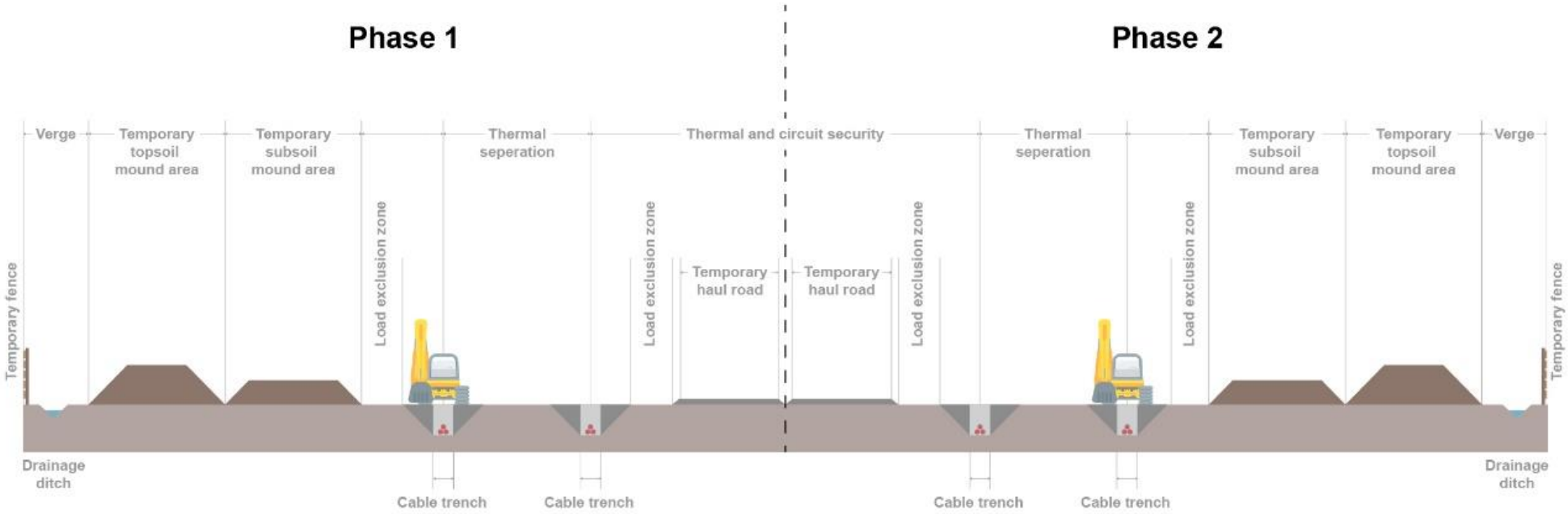

Figure 4-5: Indicative Cross Section of the Onshore Export Cable Corridor

Onshore Substations

4.3.1.11 The precise order and timescale in which the Onshore Substations will be constructed will be determined at a later stage depending on the construction programme and phasing scenario adopted, as described in Volume 1, Chapter 5: Proposed Development Phasing.

4.3.1.12 Broadly, construction of the Onshore Substations will involve the following:

- Pre-construction surveys: Surveys may include pre-construction archaeological surveys, ecology surveys, hydrology surveys, geotechnical and ground stability surveys. The requirement for specific surveys will be established at detailed design and secured through planning conditions;
- Site establishment: Activities will include establishing the contractors' compound area (cabins, welfare facilities, stores, fuel facilities, etc), securing the site boundary, and topsoil stripping and formation of bunds. Temporary access roads will be constructed from the existing road network into the Onshore Substation Site. The access roads will be suitable for use by heavy construction vehicles and for transporting the substation equipment;
- Civil enabling works: Works will be undertaken to prepare the site for the heavy equipment required for the construction of the foundations for the transformers and other buildings. This will include subsoil excavation to formation level to form a level platform across the site, creation of temporary drainage systems such as attenuation ponds and bunds and breaking out of rock if found to impact on platform level;
- Civil construction works: Foundation works will be undertaken for the transformers and buildings. Foundations are anticipated to be concrete, although piling may be required depending on ground conditions;
- Onshore Substation construction works: Construction and installation of drainage systems, infrastructure trenches, roads and hard standing areas and building superstructures;
- Installation and commissioning. Substation equipment will be delivered and installed using cranes and jacks to lift the equipment into place. Once in place the substation equipment is connected, tested and commissioned; and
- Landscaping. Remediation works and landscape planting for visual mitigation and ecological enhancement Table 4-1.

4.3.2 Construction compounds, material storage and laydown areas

4.3.2.1 There is a requirement for construction compounds, laydown areas and material storage areas to construct the Proposed Development (Onshore).

4.3.2.2 Indicative dimensions for construction compounds for the Landfall Site, ONEC and Onshore Substations are described in sections 4.2.2, 4.2.3 and 4.2.4 respectively. These are also summarised in Table 4-5 below.

Table 4-5: Indicative Construction Compound Dimensions

OnTI	Indicative Dimensions
Landfall Site	Maximum dimensions: 100m x 200m, 20,000m^2.
ONEC	Main Compounds: 75m x 50m, 3,750m^2 located every 10km on average. Satellite Compounds: 30m x 15m located every 2.5km on average.
Onshore Substations	Maximum dimensions: 250 x 120, 30000m^2.

4.3.2.3 Temporary laydown will also be required in addition to the construction compounds. These would be used to receive, potentially assemble and temporarily store construction equipment. As part of the Onshore Export Cable Circuits installation, temporary laydown areas will be contained in the Onshore Export Cable Route within the ONEC.

4.3.2.4 It is expected that any excavated materials will also be stored within the OnTI RLB and as a result material storage areas will be required. Precise locations for materials storage will be determined at detailed design.

4.3.2.5 Temporary laydown and materials storage areas will be prepared in a similar manner to temporary access roads, by removing vegetation and stripping and storing the topsoil and subsoil material. Soil and vegetation will be reinstated following completion of construction works.

4.3.3 Construction traffic

4.3.3.1 Construction of the Proposed Development (Onshore) will generate traffic on the local road network. This will include Heavy Goods Vehicles (HGVs) and Light Goods Vehicles (LGVs). Indicative construction traffic movements and potential resulting effects based on a worst-case construction scenario are discussed in Volume 5, Chapter 9: Traffic and Transport of this EIAR.

4.3.3.2 An Outline Construction Traffic Management Plan (CTMP) has also been prepared and submitted as part of the Planning Permission in Principle (PPP) application, see Volume 7E, Appendix 9-2: Outline Construction Traffic Management Plan. The CTMP will be finalised as designs are progressed and submitted to Aberdeenshire Council in advance of construction of the Proposed Development (Onshore). The CTMP will include details of delivery timings for plant and equipment, vehicle access routes, restrictions to timing of vehicle movements, construction signage and car parking arrangements as well as any other key requirements.

4.3.4 Working hours

4.3.4.1 Core working hours for construction of the OnTI will be typical working hours of 7am to 7pm Monday to Friday and 7am to 12pm Saturday. Certain works such as HDD may have to be undertaken outside of normal working hours with the potential for 24 hours working required. Any instances of works being undertaken outside of normal working hours will be agreed with Aberdeenshire Council's Environmental Health Officer (EHO).

4.3.5 Construction access

4.3.5.1 There is a requirement for several temporary access roads to facilitate delivery of key plant and equipment to install the OnTI. The location of these access roads will be determined at detailed design.

4.3.5.2 For all access roads, local pre-existing infrastructure such as road networks, farmer tracks and utility access roads have been considered as first priority and will continue to be utilised through detailed design to minimise the construction of new roads. Some of these assets will need to be upgraded to accommodate the OnTI construction activities.

4.3.5.3 Access roads will be prepared by removing vegetation and stripping the soils before capping with crushed rocks. PRIs may also be required where necessary to allow for abnormal indivisible load (AIL) vehicles such as substation equipment deliveries, and cable drum deliveries.

4.3.5.4 In addition to temporary access roads, two haul roads, to accommodate works across each potential phase, within the Onshore Export Cable Route will be required to facilitate cable laying. Temporary access roads and haul roads along the length of the Onshore Export Cable Route will be designed to have an indicative width of 5m. This indicative width comprises a standard width of a single track road to permit one way HGV movements as well as passing bays to allow vehicles meeting along the haul road to pass safely.

4.3.6 Outline Construction Environmental Management Plan (CEMP)

4.3.6.1 An outline CEMP which sets out the framework to be applied for construction environmental and waste management procedures has been prepared and submitted as part of this PPP Application (see Volume 7, Appendix 10: Outline Construction Environment Management Plan). Topic specific mitigation, management and monitoring measures during construction are also provided within each respective chapter of Volume 5: Proposed Development (Onshore). A detailed CEMP will be submitted to Aberdeenshire Council for approval prior to the Proposed Development (Onshore) construction commencing.

4.3.6.2 The detailed CEMP shall set out the procedures which will be adhered to, as to ensure appropriate management of all activities with the potential to adversely affect the environment. This will cover, but not necessarily be limited to, the following environmental issues during construction of the Proposed Development (Onshore):

- Noise and vibration;
- Dust and air pollution;
- Surface and ground water;
- Ecology and ornithology (including protection of habitats and species);
- Agriculture and land use (including protection of livestock and land);
- Cultural heritage;
- Waste;
- Pollution prevention and response (for both land and water); and
- Site operations (including maintenance of the construction compound, working hours and safety of the public).

4.3.6.3 The CEMP will incorporate Environmental Management Plans (e.g., Site Waste Management Plan, Materials Management Plan) and the working procedures which correspond to the environmental mitigation described within this EIAR and how the Applicant will implement and monitor this mitigation.

4.3.7 Indicative Construction Programme

4.3.7.1 As per Section 4.1.5, the Proposed Development (Onshore) is being brought forward across two phases of works to accommodate different grid connection dates as a result reinforcement of the NETS. These phases will be delivered under one of three possible construction scenarios (Sequential, Enabling and Concurrent) as introduced in Section 4.1.5. The total indicative construction durations for each scenario are:

- Sequential: 7 years;
- Concurrent: 5 years; and
- Enabling: 6 years.

4.3.7.2 Volume 1, Chapter 5: Proposed Development Phasing provides a more detailed justification for delivering the Proposed Development in a phased manner and a description of the possible OnTI construction scenarios.

4.3.7.3 An indicative construction programme for one phase of construction activities under the sequential scenario summarising typical construction activities and their durations is outlined is outlined below in Figure 4-6. This construction programme is a representation of works required to deliver the Proposed Development (Onshore) and is presented irrespective of anticipated grid connection dates.

4.3.7.4 Several permutations to the below programme and how the two phases of development are constructed may arise depending on the outcome of grid reinforcement activities and the resultant construction scenario adopted by the Applicant. For example, under the sequential scenario the below programme would occur once over 3.5 years, with a potential gap of up to five years followed by the same activities and durations in a subsequent phase. Under the Enabling scenario, the below activities would also include enabling works in the first phase over 3.5 years, thereby reducing the overall construction durations of the second phase to 2.5 years. Under the concurrent scenario, all of the OnTI below would be built out in one single phase of construction, resulting in a slightly longer single phase of 5 years, but an overall shorter construction programme.

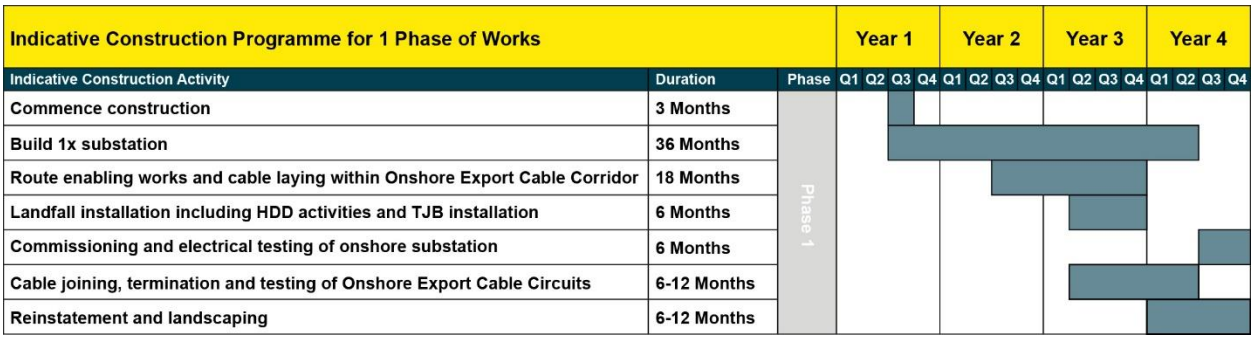

Figure 4-6: Indicative Construction Scenario for One Phase of Construction Works

4.4 Operation and Maintenance

4.4.1 Onshore Substations

4.4.1.1 The Applicant is required to divest the OnTI under the Electricity (Competitive Tender for Offshore Transmission Licences) Regulations 2015 (United Kingdom (UK) Parliament, 2015[2]) which is a competitive tender process managed by OFGEM. As a result, at operation stage the OnTI will be transferred to an Offshore Transmission Owner (OFTO) who will become responsible for its enduring operation. As a result of the potential need for the project to be delivered in two phases (see Section 4.1.5) and the need to divest the OnTI, two separate OFTOs may be responsible for Operation and Maintenance of each Phase of the OnTi.

4.4.1.2 It is anticipated that the Onshore Substations will be unmanned and operate 24 hours a day, 7 days a week. Typical operational activities for the normally unmanned substation will include:

- Annual inspection and maintenance:
  - System health check (Supervisory Control and Data Acquisition, control and protection);
  - Partial discharge/thermographic surveys; and
  - Statutory inspection and maintenance (fire systems, transformer water mist system, lifting equipment, Heating, Ventilation and Air Conditioning systems).
- Primary equipment inspection and maintenance:
  - SGTs, acoustic enclosures and auxiliary transformers;
  - Shunt reactors, acoustic enclosures;
  - Harmonic filters; and
  - GIS (partial discharge, gas checks etc).
- Miscellaneous checks:
  - Inspection of direct current battery/chargers;
  - Closed Circuit Television, telephone, security maintenance;
  - Lighting and small power;
  - Switchboards;
  - Metering;
  - Building management system;
  - Gates;
  - SuDS and drainage maintenance; and

- Landscape management (fences, gates, weed killing, drainage, roads and surfaces.).

4.4.1.3 As indicated within Figure 4-3, permanent access to the Onshore Substation Site will likely be from the south, sharing an access from the main road with the existing New Deer substation. The exact location of this road will be determined through consultation with landowners and Aberdeenshire Council at detailed design and will be subject to subsequent consents under AMSC applications.

4.4.1.4 In addition the reinstatement of the permanent access for a residential property immediately to the west of the Onshore Substation Site will be required. The location of this access will be subject to discussions with the landowner and agreement with Aberdeenshire Council. The access route will maintain the existing crossing of the Burn of Asleid.

4.4.1.5 It is anticipated that there would be weekly operational vehicles movements under normal operation, with more frequent movements during planned maintenance or repair works.

4.4.1.6 Although minor items of equipment will be replaced as and when required, no major refurbishment works at the Onshore Substations are currently envisaged during the design life. If a major equipment failure occurs it may be necessary to replace the faulty major equipment.

4.4.1.7 The anticipated operational lifespan of the Onshore Substations is 35 years.

4.4.2 Landfall Site, Onshore Export Cable Circuits and Grid Connection Cable Circuits

4.4.2.1 It is anticipated that the Onshore Export Cable Circuits will be in continuous operation. TJBs at the landfall and Cable Joint Bays will be backfilled, and land reinstated to existing ground level with the only visible permanent works being the ground level access to link box and communications box pit. It is not anticipated that any permanent access roads for routine maintenance will be required following construction reinstatement. Similarly, no permanent access is anticipated along the ONEC following reinstatement. Access regimes are likely to be in the form of landowner agreements to drive over land and use existing tracks should maintenance be required.

4.4.2.2 There will be routine maintenance activities at the Onshore Export Cable Circuits and Onshore Grid Connection Export Cable Circuits including periodic visual inspection of the link boxes, TJBs and Cable Joint Bays (typically bi-annually) including checking for faults, water penetration, corrosion of joints and cables and structural conditions. No major refurbishment works at the Landfall Site and Onshore Export Cable Circuits are currently envisaged during the design life. If a cable failure occurs it may be necessary to replace the section of faulty cable.

4.5 Decommissioning

4.5.1.1 The decommissioning phases will commence when the operational lifetime of the Proposed Development (Onshore) ends.

4.5.1.2 At the time of decommissioning, it is likely that all underground equipment and the Onshore Substations foundations will remain in-situ. Above ground equipment at the Onshore Substation Site will be cleared and the site reinstated. It is considered that the environmental effects of this approach to decommissioning will be less than those arising from the breakup and removal of all infrastructure. A decommissioning plan will be submitted and agreed with the relevant authorities close to the OnTI's end of life. Any applicable new legislation or guidelines published prior to decommissioning will be considered in relation to any design of mitigation prior to decommissioning taking place. The operational lifespan of each phase may differ depending on when they are constructed, therefore the decommissioning of the OnTI could happen independently for each phase. This information will be included in the decommissioning plan when submitted to the relevant authorities.

4.6 Life Extension and Repowering

4.6.1.1 The DE includes an anticipated operational lifespan of the Proposed Development (Offshore) of up to 35 years. At the end of the Proposed Development's lifespan, there will be an assessment of the viability for life extension or repowering versus decommissioning. If life extension or repowering was deemed feasible, an assessment process would be completed at a later stage seeking relevant consents (not included as part of the current EIA/application process), this would include consideration of extending the operational lifespan of the Proposed Development (Onshore) or partial decommissioning and repowering.

4.7 References

[1] Ocean Winds (2023) 'Caledonia Offshore Wind Farm Onshore Scoping Report'. Available at: https://www.caledoniaoffshorewind.com/wp-content/uploads/2022/12/22-12-Caledonia-OWF-Onshore-Scoping-Report-Issue-051222.pdf (Accessed 01/10/2024).

[2] UK Parliament (2015) 'The Electricity (Competitive Tenders for Offshore Transmission Licences) Regulations 2015'. Available at: https://www.legislation.gov.uk/uksi/2015/1555/contents/made (Accessed 01/10/2024).

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