

Illustration 5.1: Schematic depicting location and extents of landfall and intertidal areas

5.5.2 Overview of Proposed Works

- 13 The two offshore export cables will be brought from the offshore cable laying vessel, across the intertidal zone, to either a single or two adjacent transition pits located above Mean High Water Springs (MHWS). The onshore and offshore cables will be connected at the transition pit(s).
- 14 The precise cable route within the landfall area will be dependent on the results of detailed geotechnical investigations of the landfall area. In any case, this will be within the Application Boundary shown on **Figure 5.3**.
- 15 The two offshore export cables will be separated by a minimum spacing of approximately 50m, at the location where the cable laying vessel is positioned to float the cables to shore. The cable separation distance will reduce as the cables approach landfall and connection with the onshore cables. The offshore export cables will be housed in high density polyethylene ducts installed under the beach.
- 16 The exact method of installation for the intertidal works will be dependent on the ground and seabed conditions along the cable route. Two potential options are being considered for installation, namely Horizontal Directional Drilling (HDD) and Open Cut Trenching (OCT). Both methods are described below.

5.5.3 Works Description - Horizontal Directional Drilling

- 17 Horizontal Directional Drilling (HDD) is a tried and tested method of underground intertidal cable installation. The principle of HDD is to install a HDPE duct (see definition in glossary of terms) by drilling underground between two points. An electrical cable is installed within the duct and the installation is completed without the need to excavate an open trench between the two points. To achieve this, an onshore drill rig commences drilling a pilot hole at the onshore end of the works (known as the Rig Site), toward the end point of the works (known as the Pipe Site). The full process is described below. Using this methodology it estimated that the entire duration of cable installation works between the rig site and the pipe site will be approximately 4-7 months (depending on hours of working).
- 18 The rig site will be located above MHWS in an agricultural field behind the beach. A small, temporary pit will be dug in this field to launch the drill. The pipe site will be located at a point seaward of MLWS and is therefore outside the Application Boundary for the Onshore Works application. The precise location of the pipe site will be identified following the completion of a geotechnical survey.
- 19 The rig site will comprise a construction area containing equipment including a drill rig, an electrical generator, a water tanker, a mud recycling unit and a temporary site office. These items will be contained within the Application Boundary in the green hatched area, as depicted in **Figure 5.3**. Drilling mud, containing bentonite (a naturally occurring absorbent clay) and fresh water, will be used to aid the drilling process. Drilling mud will be recycled on site within a contained system throughout the drilling process to minimise fresh water usage. Upon completion of the installation process, surplus drilling mud suitable for use on other projects will be taken offsite and stored. Any drilling mud not suitable for reuse on other projects will be disposed of to landfill by a licensed contractor.

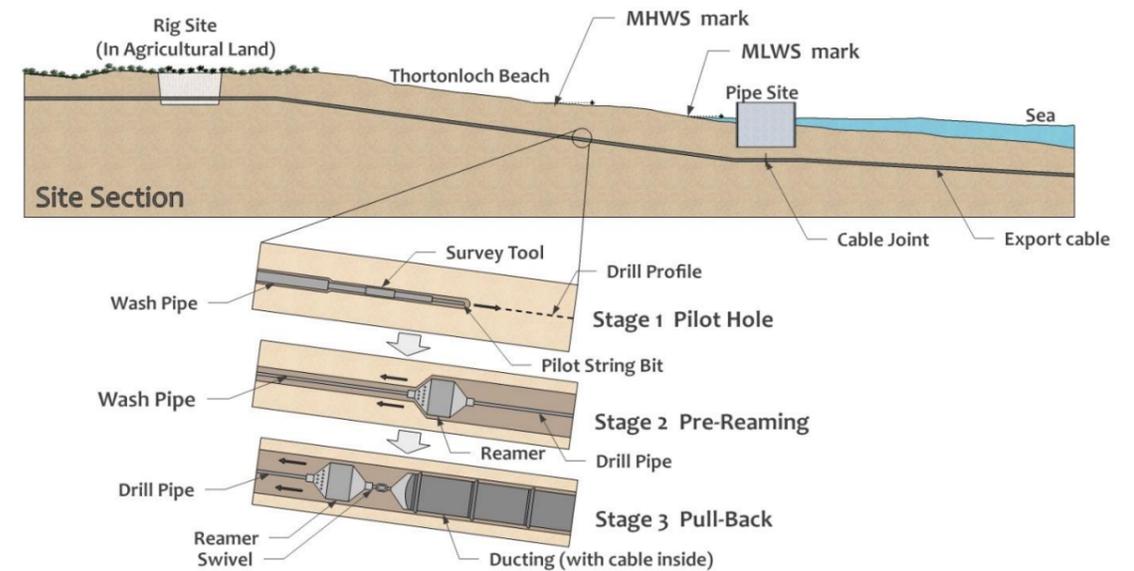


Illustration 5.2: Schematic illustration of directional drilling process

- 20 The pipe site will comprise an excavated area approximately 20m long x 20m wide with the sides retained by steel casing or steel sheets that will project above sea level and serve to keep out water. A marine jack-up platform equipped with an excavator will be used to carry out the works at this location.
- 21 **Illustration 5.2** provides a general illustration of the directional drilling process that will be followed at the landfall area (and beyond) if HDD is selected. **Illustration 5.3** depicts a HDD drilling rig in operation. In simple terms, the drilling/installation process will comprise four stages:
 - A small diameter pilot hole will be drilled from the rig site to the pipe site (Stage 1 in **Illustration 5.2** above), for the purpose of defining the path of the duct into which the cable is to be installed. Separate pilot holes will be drilled for each of the two cables.
 - A steel reamer will then be pulled back through the pilot hole from the pipe site to the rig site, enlarging the diameter of the hole as it progresses (Stage 2 in **Illustration 5.2** above). This may have to be repeated a number of times, depending on the nature of the ground/seabed through which it passes, in order to enlarge the pilot hole diameter sufficiently to accommodate the duct.
 - The ducts will then be attached to the reamer and pulled through the widened pilot hole from the pipe site to the rig site (refer to Stage 3 of **Illustration 5.2** above). This operation may be done with the cable inside the duct (as depicted in Stage 3 of **Illustration 5.2**) or alternatively after the duct is installed, the cables may then be winched through the ducts. In either case, the offshore cable will be supplied by a cable installation vessel which will remain a minimum distance from shore to ensure adequate water depth for operation. This distance is anticipated to be approximately 1 km.
 - When cable pull-through is complete, the cables will be secured in place by means of precast concrete blocks within the transition pit, for later connection to the onshore cables.
 - At the pipe site, the cable end will be connected to the rest of the offshore export cable and buried into the seabed after which the pipe site will be removed.



Illustration 5.3: HDD Drilling rig in operation (Courtesy of Allen Watson Limited)

5.5.4 Works Description - Open Cut Trenching

- 22 Open Cut Trenching (OCT) may be used as a method by which to install offshore cables within the landfall area. Under this arrangement, the cables will be laid in HDPE ducts with burial depths of up to 2m. A detailed geotechnical investigation and cable exposure risk assessment will be carried out before design completion. Design burial depths will be adjusted where necessary in areas of loose sand with erosion potential or in areas where shallower burial is appropriate due to outcropping rock.
- 23 Trench installation works along the intertidal zone will depend on the underlying geology. Where the sediment thickness above bedrock is sufficient, excavators will be used to dig the necessary trenches. For excavations along the beach, this will be conducted by a track mounted excavator. Excavations in water depths up to approximately 5 m below Lowest Astronomical Tide (LAT) will be achieved using an excavator mounted on a barge or jack-up platform. In the deeper water beyond this point, cable burial can be handled by cable ploughs using a Remotely Operated Vehicle (ROV). Should the sediment depth be insufficient to provide suitable cable burial, rock breakers or other mechanical cutting methods may be required to achieve the required burial depth.
- 24 When trenching is complete, cable ducts will be installed in the trenches from the transition pit(s) and a temporary winch will be located above the beach high water mark for cable pull in. Once the preparatory works are complete, the cable will be winched to shore from the offshore cable laying vessel.
- 25 For installing cable ducts (under the OCT scenario), an exclusion zone around the works could be required for up to 3 months depending on the extent of excavation or rock breaking required with an additional minor exclusion period (estimated at 1 day per cable) being required during the cable pull in. The extents of any such exclusion zone will depend on the precise route of the cable through Thorntonloch beach. This route will be determined at

detailed design stage after the completion of geotechnical survey work. The requirement or otherwise for associated exclusion zones will be determined on the basis of discussions with ELC at that stage.

5.5.5 Transition Pit(s)

- 26 The transition pit(s) will consist of underground structures that house the cable joints linking the three-core offshore export cables (2no.) with the single core onshore cables (6no.).
- 27 There will be up to 2 transition pits, located above MHWS behind any sea defences, at the location of the rig site. The rig site extent is shown on **Figure 5.3** and coordinates for the transition pits are in **Table 5.3** below.

	Easting (m)	Northing (m)
Transition Pit(s)	375274	674175

Table 5.3: Coordinates of transition pits (expressed in British National Grid OSGB 1936)

- 28 The dimensions of each transition pit are a maximum of 10 m length x 4 m width x 3 m depth. A concrete cover will be placed over the top of the pit(s) for protection and landscaping will be undertaken to reinstate the ground to its previous condition. A manhole cover will be required to enable occasional access for maintenance.
- 29 The transition pits will be excavated by a mechanical excavator after which a concrete chamber will be installed. A small temporary structure will be placed on top of the transition pit to allow a clean, secure and weatherproof working environment during cable jointing. A generator will be required to provide power supplies during jointing operations. Temporary security fencing and lighting will be constructed to enclose and secure the transition pits during construction.
- 30 A temporary access track will be required along the onshore cable route between the transition pits and the substation. The use of a temporary bridge across the Thornton Burn will be required to enable access from the A1 to the transition pits. This bridge will be a temporary structure in place only for the duration of the landfall area works and will be a maximum of 4.5 m in width. This is proposed to be a single span structure, i.e. without vertical supports placed between its start and end points.
- 31 Once the transition pit has been established, the offshore cables will be winched into place. The offshore export cables will then be joined to the onshore cables.
- 32 On completion of the joint at the transition pits, the ground surrounding and above the pits will be reinstated to the original ground level with excess material removed from site. Should this excess material be deemed suitable, it may then be used as fill material at the substation site.

5.5.6 Landfall Marker

- 33 Marking and lighting at the landfall site of the export cable route will be required at Thorntonloch. This will be achieved by Lit Cable Marker Boards positioned as near as possible to the shoreline so as to mark the points at which the cables come ashore. The Cable Marker Boards shall be diamond shaped, with dimensions 2.5 m long and 1.5 m wide, background painted yellow with the inscription 'Cables' painted horizontally in black. The marker boards shall be mounted at least 4 m above ground level, with a navigation light flashing yellow once every five seconds mounted on the upward apex of the board. The nominal range of each light will be 3 nautical miles. The navigation light will be screened landward.

5.6 Onshore Cable - Thorntonloch to Proposed Onshore Substation

- 34 The following subsections detail the works proposed for the installation of the electrical transmission cables between the transition pits and the substation.

5.7 Description of Works - Thorntonloch to Substation

- 35 The cables will run underground between the transition pits at the landfall area and the proposed substation at Crystal Rig II. Maps of the Application Boundary between Thorntonloch and the substation are provided in **Figures 5.1 and 5.2a-l**.
- 36 The majority of the corridor is 30 m wide. In some locations this widens to allow for vehicle turning or where extra space may be required, e.g. at the rig site at Thorntonloch. It is anticipated that the actual construction working

corridor will not require this entire width, with only 20 m required for the majority of the route. This will allow 10 m for micrositing to avoid any additional environmental constraints identified on site during construction.

- 37 The 20 m wide temporary working corridor will accommodate the following elements:
- A trench of approximately 2 m in width;
 - Heavy vehicle access for which a width of 5 m will be required;
 - Lay down of equipment and spoil for which a width of 5 m will be required;
 - Contingency space to avoid the trench collapsing under load for which a width of 2 m is provided from the edge of the trench;
 - Vehicle/pedestrian track for which a width of 3m will be required ; and
 - A further 3 m to establish temporary fencing and to allow space for vehicle turning and car parking.

38 This arrangement is illustrated in **Illustration 5.4** below:

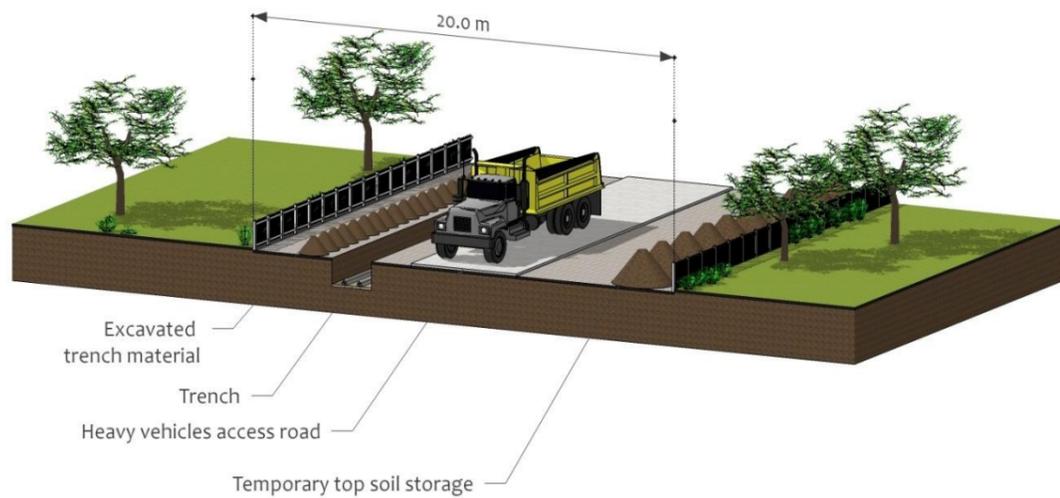


Illustration 5.4: Temporary access road and cable trench general arrangements during construction

- 39 The trench will contain 6 no. single core, cross-linked polyethylene (XLPE) cables, as defined in the Glossary of Terms, rated to 245 kV and operating at 220 kV. These will be installed along the full length of the route. Two fibre optic communications cables will also be installed alongside the cables, as depicted in **Illustration 5.5**.
- 40 Open cut trenching will be used for cable installation along the majority of the route. In some sensitive areas e.g. crossing sensitive watercourses or in areas of ancient woodland, trenchless methods will be used as described earlier. The cable will be installed in discrete sections along the route. Works at each section will consist of several activities including construction of a haul road, excavation of the cable trench, cable laying, cable jointing and reinstatement. Before works begin at each section, the topsoil across the construction area will be removed using mechanical excavators and stored carefully alongside, for later replacement when works are complete. If required, aggregate (on a geotextile where soft ground is encountered) may then be laid over a section of the exposed subsoil for the haul road. Mechanical excavators will then be used to dig the cable trench. Once complete each section of cable (stored on a drum) will be lifted from the delivery truck and placed into position at the end of the trench. This will likely be achieved using a crane. The cables will then be winched through the open trench, to a

joint pit at the end of the section. Once the cables are installed, the trench will be backfilled with sand and native material, protective covers (where appropriate) and warning tapes, to avoid damage during any future excavations, then topsoil replaced. Previously excavated material will be used to backfill the cable trench wherever possible. This will minimise the amount of material to be disposed of off-site. Any stockpiling of excavated material along the cable route will be sited within the Application Boundary. A Soil Resource Management Plan will be prepared prior to construction to ensure the protection of soils and nearby habitats/watercourses. Further details on soil management are provided in **Chapter 13: Agriculture, Soils and Land Use**.

- 41 Following backfill of the cable trench, the land will be reinstated to allow a return to its former use.
- 42 The cable installation rate (covering all the activities outlined above: construction of the haul road, excavation of the trench, cable laying and jointing and reinstatement) is estimated at approximately 160 m of route per week. This figure has been estimated on the basis of works unrestricted by weather conditions. In the event of, for example, snow or severe rain, it is likely that a reduced length of route will be completed in a given week.
- 43 A cable trench cross-section is provided in **Illustration 5.5**. Please note that this image depicts the cables installed within ducts in order to provide additional protection from damage. However, ducts will only be used where necessary, in limited sections of the cable route.

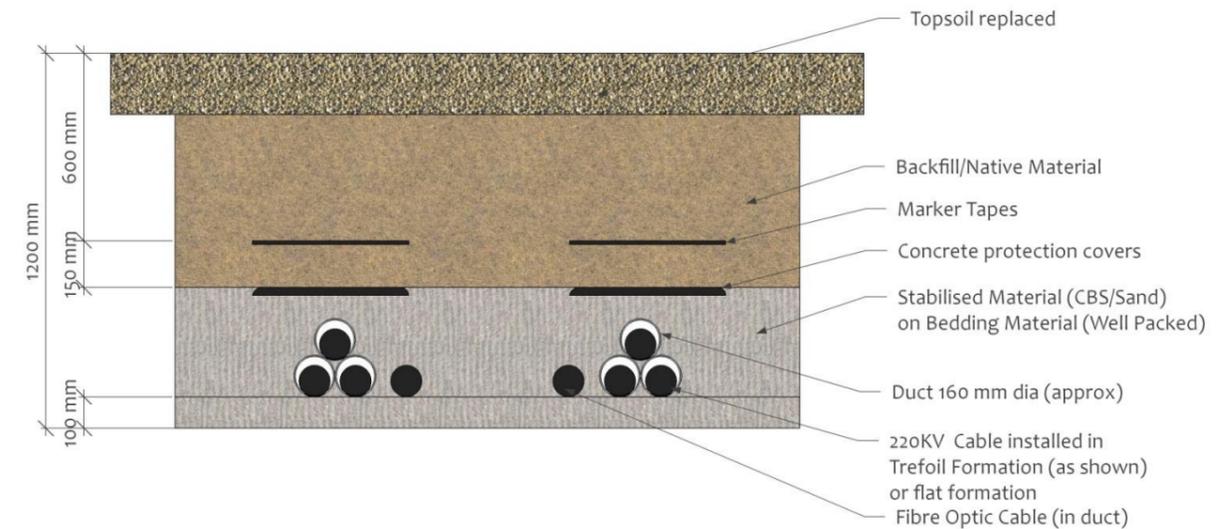


Illustration 5.5: Cable trench cross section

- 44 **Illustrations 5.6a** and **5.6b** below depict typical open trench sections and the types of plant involved in these operations.



Illustration 5.6a (Left) and 5.6b (Right) - Typical open trench section & cable drum

- 45 Some sections of the route may require trenching through the public road. The local roads which will be crossed via OCT are listed in **Table 5.4** below.
- 46 Each road is expected to be crossed in two working days and would be required to be closed for that period. Access will be maintained through temporary road diversions.
- 47 **Table 5.4** below lists the major crossings along the route, their approximate locations and the proposed crossing technique (i.e. whether open cut trench or trenchless). The locations of all the crossing points along the onshore cable route are depicted in **Figure 5.5**.

Eastings (m)	Northings (m)	Description	Crossing method
375298	674183	John Muir Way, dune & fence	Trenchless or OCT
375274	674175	Transition Pit	-
375016	674187	Thornton Burn	Trenchless
374750	674341	A1 and fence on north side	Trenchless or OCT
374689	674344	A1 and wall/fence on south side & BT overhead line	Trenchless or OCT
374601	674377	Innerwick Station Road, bus stop, fence & water mains	OCT
374329	674552	Torness 400 kV underground cable	Trenchless
374234	674595	11 kV, 33 kV & 132 kV underground cables, associated with Torness power station	Trenchless
373501	674831	East Coast Main Line railway & fence (north side)	HDD or other Trenchless
373490	674815	Fence, land drain & water main (within RLB)	Trenchless

Eastings (m)	Northings (m)	Description	Crossing method
373109	674846	Tree line, ditch/culvert & water mains	Trenchless
372287	674668	Corsick Hill Road	OCT
371991	674384	11 kV underground cable, Innerwick at Dovecote Brae Road, hedge, drain & fence	OCT
371826	674156	11 kV overhead line & 132 kV underground cable	Trenchless
371668	673932	Watercourse and hedge	OCT
371626	673870	Innerwick to Oldhamstocks Road, gates, wall & BT underground cable	OCT
371508	673617	Fence & water mains	OCT
371032	673318	Thurston Mains to Elmscleugh Road & hedge	OCT
371026	673319	33 kV underground cable	OCT
370629	673494	Tree line	Trenchless
370607	673622	Cable route construction compound	OCT
369724	673345	Tree line (Birky Bog), watercourse & small pond	Trenchless
369330	673229	Tree line (Whitley Strip) & BT underground cable	Trenchless
369238	672324	Woodhall to Elmscleugh Road, hedge & gate	OCT
367709	671572	Weatherly Burn	OCT
366971	670261	Thorter Cleugh watercourse	Special engineering solution
366643	670024	Track to Crystal Rig substation	OCT
366495	669637	Crystal Rig turbine access road	OCT

Table 5.4: Major crossing locations along cable route (expressed in British National Grid OSGB 1936)

- 48 The John Muir Way will only need to be temporarily closed if OCT is undertaken at the landfill. If trenching is undertaken, access to the John Muir Way will be maintained through the use of diversions.

- 49 BEAR Scotland has indicated that either trenchless or OCT crossings of the A1 would be acceptable and could be managed via single lane closure.
- 50 The crossing methodology for the East Coast Main Line is under development with Network Rail. The crossing will be trenchless.
- 51 The crossing of Thorter Cleugh (see **Illustration 5.7** below) is likely to consist of an open cut trench through the existing access track. However, if this is not possible, the existing culvert across Thorter Cleugh will be extended using gabion baskets and built up in a similar manner to the existing track (using aggregate or other suitably competent material). This will create a cable track adjacent to the existing access track. The cable will then be installed into a trench within the cable track and suitably protected (covered) using further aggregate. It is likely that the cables will be ducted along this short section.



Illustration 5.7: Thorter Cleugh cable crossing point

- 52 A number of overhead lines and underground cables are crossed along the length of the route. These will generally be crossed by OCT. However, certain sensitive underground cables (for example, the Torness underground cable) will need to be first identified by careful hand excavation, before being crossed using trenchless techniques. The precise methodology of this crossing will be agreed in advance with Scottish Power Transmission (SPT).
- 53 Where features such as fences, hedgerows and walls are crossed using OCT they will be fully reinstated once the works are complete (for example, fences and walls rebuilt and any gaps in the hedgerow replanted).
- 54 Where major obstacles such as sensitive watercourses or woodlands are to be avoided, directional drilling or similar trenchless methods will be used. These are discussed in detail below.
- 55 The process of HDD along the cable route will broadly follow the steps described in section 5.5.3. There will be multiple rig and pipe sites along the route, i.e. 1 no. rig site and 1 no. pipe site for each crossing point. The pipe site for the HDD operations will in many cases be carried out without the use of the steel casing described in section

5.5.3 and illustrated in **Illustration 5.2**. Unless ground conditions dictate that edge support is needed, the casing will not be required on land.

- 56 In addition to HDD, for technical reasons other trenchless methods may be required such as Auger or Thrust boring.
- 57 Auger boring is a technique used to drill/bore horizontally through soil/rock with a cutting head and auger, underneath an immovable obstruction to the cable route. This process comprises the following steps:
 - 1 A shaft of approximate plan dimensions 8 m x 3 m is excavated adjacent to the obstruction using a standard excavator to the required depth. **Illustration 5.8** below depicts a typical shaft excavated for the purpose of auger boring.
 - 2 Shuttering is installed against the walls of this shaft to ensure its stability.
 - 3 A concrete base is then cast at the bottom of the shaft onto which the auger machine will sit.
 - 4 The auger machine and cutting head are then lowered into the shaft and fixed in position.
 - 5 A cylindrical steel sleeve is lowered into the shaft, fixed to the rail(s) on the auger machine. The purpose of this sleeve is both to define the diameter of the drilled channel and to provide structural support to the channel when the drillhead is removed.
 - 6 Drilling commences within the circumference of the sleeve which follows the drillhead into the soil.
 - 7 When the entirety of the first steel sleeve has penetrated the soil, a second sleeve is lowered into the shaft and welded to the first sleeve.
 - 8 Steps 6 and 7 are then repeated until the required length of channel has been drilled.
 - 9 On the opposite side of the obstruction, a second, identical shaft is excavated into which the drillhead emerges.
 - 10 The electrical cable is then passed through the underground channel and the excavated shafts may potentially become jointing pits to connect the cable to the remainder of the onshore cable route.
 - 11 Material removed during the drilling process is initially deposited in the first shaft, before being removed and if suitable, used as fill material at the proposed substation.



Illustration 5.8: Typical auger boring shaft arrangement (Courtesy of Allen Watson Limited)

57 The second additional technique being considered for the purposes of crossing obstructions along the proposed cable route is thrust boring. In simple terms, the thrust boring process comprises a series of underground pipes being thrust through the ground, each connected to one and other in order to bore a horizontal channel through the ground.

58 The thrust boring process is very similar to that of auger boring, and follows the procedure described in steps 1-10 above. There are, however, a small number of key differences between the two processes. Firstly, in steps 4 and 5, the auger machine is replaced by the thrust boring machine. In step 6, the steel sleeve for the thrust boring process differs from that of the auger boring process in that it is fitted with a conical head. This allows the sleeve to be thrust into the soil using a hydraulic system powered by a diesel engine within the excavated shaft. The remainder of the thrust boring process is identical to that of the auger boring process.

5.7.1 Jointing Pits - Thorntonloch to Substation

59 The cable will be delivered in discrete lengths (between 500 m and 1200 m depending on cable and drum specification). Lengths are limited by the amount of cable that can be put on a single drum as well as the logistics of handling the cable drum. Each 500 m to 1200 m length of cable along the cable route will require to be jointed together, and this requires the installation of underground jointing pits along the onshore cable route.

60 Once the cables are installed within the trenches, they are then jointed to the next cable within a jointing pit. There will be a maximum of 48 joint pit locations along the onshore cable route. Jointing pits will be slightly wider than the cable trench; key dimensions are set out below:

- Pit width, 3 m.
- Pit length, 10 m.
- Pit depth, 2 m Earth link boxes, 1 m x 1 m

61 The locations of the cable jointing pits are dictated by a number of factors, including cable size/length and ongoing access requirements, and will be confirmed during detailed design. Manhole covers above jointing pits will enable access for routine maintenance.

62 Cable joint pits will be excavated by a mechanical excavator, in a similar manner to the open cut trenching for the cable runs. The sides of the pit will be strengthened using shutters and cross supports. A concrete plinth will be installed at the bottom of the pit to support the joints and provide a clean surface to work. Cable jointing requires clean and controlled conditions and will be undertaken within a temporary structure placed over the jointing pit.

63 Reinstatement of the joint pit will be similar to that outlined for open cut trenching. The cable joints will be protected from mechanical loading either by fencing to restrict vehicle access over the top or subsurface concrete covers (similar to large concrete slabs at a depth of at least 800 mm).

5.8 Construction Compound

64 To facilitate construction activity along the construction corridor, a temporary compound will be erected close to the midpoint of the route and maintained for the duration of the construction period (see **Figure 5.2f** for location). The construction compound dimensions will be up to 50 m x 110 m with an area up to 5500 m². The compound will have 24 hour security lighting for the duration of the construction programme, particularly if used for storage of cables.

65 A temporary surface of crushed stone will be added to the compound. As with the rest of the working corridor, topsoil will be stripped, temporarily stored and reinstated following the completion of works.

5.9 Proposed Onshore Substation

66 The following subsections detail the works proposed for the construction of the required electrical substation adjacent to the existing substation at Crystal Rig II.

5.9.1 Proposed Onshore Substation - Definition and Location

67 For the purposes of this document, the substation is defined as the permanent compound comprising the elements of electrical infrastructure which are required to facilitate connection to the electrical grid.

68 The onshore substation serves for a number of technical purposes including the provision of reactive power compensation to the offshore wind farm, electrical switching and isolation as well as transforming of the exported power from 220 kV up to the grid voltage of 400 kV.

69 To facilitate connection to the national grid, SPT, the onshore transmission system owner, will design and build a 400 kV extension to the existing Crystal Rig II substation. This work will involve an extension to the existing 400 kV busbar of Crystal Rig substation and relocation of the existing 400 kV coupler to facilitate the installation of 2no. 400 kV circuit breakers. This 400 kV extension is not part of the application to which this EIA relates and is only included in the EIA in relation to potential cumulative effects. These works are a subject to a separate planning application from SPT to ELC. The developer is liaising closely with SPT on the earthworks design works to ensure compatibility between the neighbouring works.

5.9.2 Location

70 The Neart na Gaoithe substation will be built alongside the existing Crystal Rig II substation within the site area of Crystal Rig II wind farm. The Neart na Gaoithe substation will be located to the north of the existing substation at Crystal Rig, as shown in **Illustration 5.9** below.

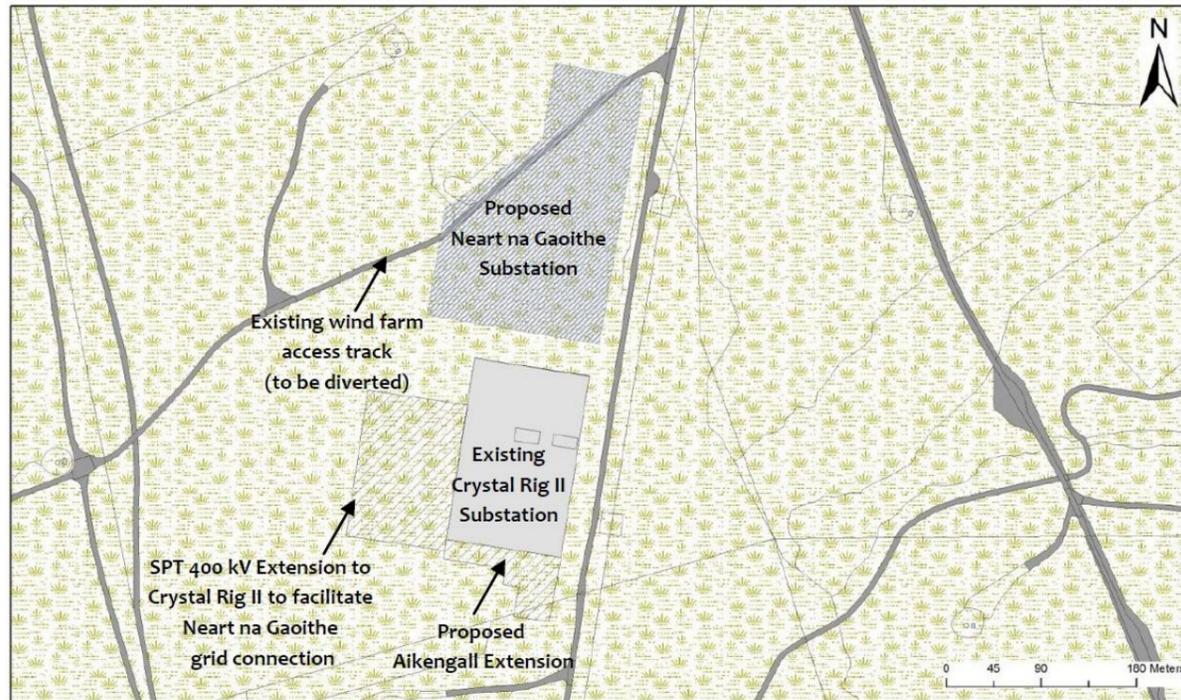


Illustration 5.9: Location and extent of onshore substation

Plant Item	Unit No.	Description
220 kV current and voltage transformers	TBC	Tall posts, to measure current and voltage on high flow systems.
220 kV busbar	1 set of 6 (for a double busbar arrangement)	Raised metallic bars, required to connect together all of the incoming cables from the project, the reactors and the power transformers. Currently, proposed as double busbar arrangement (similar to existing Crystal Rig 2 substation), but may cede to single busbar.
Cable sealing ends	2-4 sets of 3	Needed to transition from underground cable to overhead conductors.
Dynamic reactive power compensation equipment	2 sites	Required for Grid Code compliance. Largely indoor equipment. Modules can be housed in brick building or several ISO containers. Will use switchgear containing SF6.
Harmonic filters	1	Some harmonic mitigation may be required at site to comply with Grid Code requirements.
Control building	1	To house SCADA and protection control equipment. The control building will be built similar to the brick control room that is already in place at the Crystal Rig II substation. Relay plant, metering plant, batteries, and telecom equipment will be imported into the compound and installed.

Table 5.5: Design Components of the Substation

5.9.3 Description of Components

- 71 The substation will be an open air compound, similar to the existing Crystal Rig II substation, consisting of items of electrical plant as well as a control building. The footprint and layout of the substation is determined in part by the equipment, connections, safety clearances and access required for components. The permanent substation will, at its longest and widest points, have approximate dimensions of 255 m (length) and 166 m (width), with a maximum height of 15 m. The area of the substation is a maximum of 3.3ha (33,300)m².
- 72 Toilet and shower facilities within the control building will be connected to a full retention septic tank, buried and located outside the substation fence line. Due to the extremely low hydraulic loading (i.e. infrequent use by a very small number of personnel), this system will retain all effluent without discharging to a percolation area. The effluent will be emptied periodically by a licensed contractor and disposed of at a licensed off-site location. This emptying will take place at regular intervals, or as and when required. This will be confirmed prior to the commencement of works and will be based on the final specification of tank installed and personnel/activities expected at site.
- 73 The design components of the substation are set out in **Table 5.5** below.

Plant Item	Unit No.	Description
400/220 kV Power transformer	2	Needed to transform power to correct transmission voltage for grid (400 kV).
Earthing transformer	2	One located next to each power transformer.
220kV shunt reactors	2	To provide reactive power compensation. Likely that two will be required. Will look similar to the power transformers.
Circuit breakers	10 sets of 3	Used to protect against faults. Number required depends on final design, may reduce to 4 sets.
Isolators	TBC	Disconnectors needed for maintenance outages.
Surge arrestors	4-11 sets of 3	Tall posts required to protect electrical equipment from lightning strikes.

5.9.4 Description of Works – Proposed Onshore Substation

- 74 An area close to the substation site will be used to accommodate the substation contractor temporary works site and will include offices, stores, delivery and off-loading areas, welfare facilities, parking areas and security accommodation. The proposed construction compound location would be located within the Application Boundary and is identified in **Figure 5.21**. Similar to the substation site, this area will be prepared by removing the top ground surface layer and introducing a layer of stone capping. The area of the proposed construction compound was previously used as the construction compound for the Crystal Rig substation. The construction compound area is 6,827 m² (0.68 ha).
- 75 Once the substation site and external access track are established, initial ground works will be progressed including levelling the ground, establishing a copper earthing mat and equipment foundations, compacting, surfacing and establishing drainage systems. The final level of the substation will be 298 m Above Ordnance Datum (AOD). As the site of the substation is on gently sloping ground, to achieve this finished level will require some cutting on the west side and filling on the east side. There will be a requirement to excavate approximately 62,000 m³ of material, much of which may not be suitable for use as fill and therefore will need to be taken off site. However, some excavated material (approximately 13,000 m³) will be used to create a screening berm around the substation. The berm will be up to 3 m in height above the existing ground level and 33 m across at its widest point. This will leave a requirement for approximately 49,000 m³ of excavated material to be taken off site. There is estimated to be a requirement for approximately 16,240m³ of imported fill.
- 76 An earthworks layout and sections at the substation are provided in **Figure 5.6**, **Figure 5.7** and **Figure 5.8**. The footprint of the permanent substation, including earthworks will be a maximum of 75,178 m² (or 7.5 ha). The maximum area of temporary works around the substation will be 132,540 m² (or approximately 13 ha).
- 77 Cable routes and internal access road works will then be established, followed by the construction of the necessary control buildings then installation of external components, internal components and finally cable installation. After testing and commissioning, reinstatement works will be carried out.
- 78 A palisade security fence of up to 3 m height will be erected around the perimeter of the substation site and warning signs posted. The fence will be in keeping with the design at the existing Crystal Rig II substation. Twenty-four hour security lighting will be in place for the duration of the construction period.

- 79 Most substation equipment will be delivered directly into the substation compound area to its intended installation location. Fabrication work will take place off-site or within the substation compound area.
- 80 Once the foundations are in place and the oil containment scheme complete, delivery and installation of the transformers and reactors will be undertaken. Each transformer (and possibly each reactor) delivery will be classed as an Abnormal Indivisible Load, and will be transported using specialist transportation equipment. Delivery and installation will include the use of cranes and jacks to lift the equipment into position, typically via skidways or rails to manoeuvre the transformers and reactors into place. For a limited period, 24-hour working will be required to fill the transformers and reactors with oil and undertake oil processing to remove traces of moisture. The provision of a local electricity supply will also be required.
- 81 An oil containment system will be incorporated to prevent pollution from any spillage or leak from the transformers and reactors. The transformers will be located in oil containment bunds, which drain to a Class 1 oil interceptor system to capture any oil spillage. Roads and skidways required for the delivery and off-loading of the transformers and their associated oil delivery/processing equipment and car parking areas will be separately contained and drained into the oil interceptor system.
- 82 The final surfacing of internal roads and placement of chippings to the site areas will complete the site.

5.10 Construction Access, Traffic and Transport

5.10.1 Access to Landfall Area & Cable Route Works

- 83 Temporary haulage routes will be constructed within the Application Boundary to provide access to the transition pit within the landfall area and along the length of the cable trench for construction vehicles requiring access to each specific section of the route.
- 84 Construction access/turning points have been provided at a number of points along the route, as depicted in in **Figure 5.4**. The haul road will be formed of crushed stone/hard standing or tracked and will be maintained for the duration of the construction period, as required. Following construction, the temporary surface will be removed and the area reinstated to the previous land use.

5.10.2 Access to Crystal Rig

- 85 Construction traffic to/from the proposed substation site at Crystal Rig will use existing public roads and the existing wind farm access track to gain access/egress.
- 86 The access points and minor roads to be used for construction access are depicted on **Figure 5.4**.

5.10.3 Traffic and Transport

- 87 Traffic figures have been generated for each aspect of construction, i.e. the intertidal works (separate figures have been provided for the HDD and OCT options), the onshore cable route works and the substation works. Refer to **Chapter 14: Access, Traffic & Transport** for further information.
- 88 Traffic estimates have been underpinned by a number of assumptions and these are listed below, for the landfall area, onshore cable works and substation works:

5.10.3.1.1 Landfall Area Works (HDD installation)

- The drilling will be performed by a drill rig, approximately 200t.
- Fresh water supplies for mixing drilling muds will be brought to site via tankers.
- All material bored from the drilling process will be extracted as slurry onshore and will be taken off site as a result of drilling activity.
- Duct delivery is based on a 1,000 m installation run.

5.10.3.1.2 Landfall Area Works (OCT installation)

- Works will be informed by tracked excavators that will also be used for the onshore cable trenching works (rock breaker attachments may be required if the geotechnical investigation identifies shallow bedrock in the intertidal area).

- For both OCT & HDD scenarios, it is estimated that on average approximately 6-10 workers would be on site.

5.10.3.1.3 Onshore Cable Route Works

- Estimates for haul road construction have been made assuming that 0.5 m depth of aggregate material will be used for all sections of the route.
- The cables will be jointed every 500 m.
- Three cable drums will be delivered per articulated lorry based on 500 m lengths.
- A vehicle movement will be associated with delivery of the cable drums to the construction compound, with a separate movement for delivery from the compound to the installation site.
- For all HDD crossings, fresh water supplies will be brought to site via tankers.
- HDD crossings will be performed by approximately 20t drill rigs.
- Two cable jointing gangs will work simultaneously (one for each circuit) at each jointing location.
- All concrete required for construction will be brought to site in ready-mix trucks.
- All construction plant and welfare facilities will be brought to site once and left for the duration of the works
- For civil works, cable installation and cable jointing it is anticipated that 23 workers will be on site on average, with an anticipated maximum of 32.

5.10.3.1.4 Proposed Substation

- Excavations/earthworks will be as described as above.
- All concrete required for construction will be brought to site in ready-mix trucks.
- Only the two 400/220 kV transformers and two large 220 kV reactors will represent abnormal loads.
- All construction plant and welfare facilities will be brought to site once and left for the duration of the works, being marshalled from within and from the site construction compound.
- It is estimated that on average approximately 20 workers would be on site regularly for the duration of construction.

- 89 An assessment of the impacts of construction and operational traffic is provided in **Chapter 14: Access, Traffic and Transport, Chapter 15: Air Quality, Chapter 16: Noise and Vibration**. Refer to these chapters for further details.

5.11 Construction Working Hours

- 90 Standard working hours are assumed to be 8am – 6pm Monday to Friday, 8am to 1pm on Saturdays with Sunday/Bank Holiday working only by prior arrangement with ELC. However, 24 hour working, 7 days per week has been assumed at the landfall area in the scenario where HDD is employed. In addition, 24 hour/7 day working may also be required where the cable crosses both the A1 and East Coast Main Line, although for much shorter periods. The duration of A1 crossing works is anticipated to be 48 hours, with crossing works at the East Coast Main Line lasting up to 3 weeks. The exact working hours at these and all locations will be determined in consultation with Network Rail, Transport Scotland, BEAR and ELC. Local residents with the potential to be disturbed by noise will also be consulted with regard to any proposed 24 hour working.

5.12 Construction Environmental Management Plan

- 91 The following sections set out proposed procedures to be adopted in terms of construction, waste and environmental management. Further details are provided within the topic specific chapters.
- 92 The developer will produce a Construction Environmental Management Plan (CEMP) which will identify those responsible for overseeing the construction works and outline a series of established good practice working methods intended to minimise environmental disturbance. The CEMP will represent a commitment to delivering the environmental recommendations, mitigation measures and consent conditions formulated in the design and development process, during construction of the Onshore Works.

93 The appointed contractors will also be required to produce and implement an Environmental Management System (EMS) that meets the requirements of ISO 1400 and which reflects the content of the EMP. Compliance with the requirements of the EMS and the EMP will be a contractual requirement for the appointed contractor and will be audited at regular intervals by the developer's environmental representative on site.

94 The appointed contractors will also be required to produce Construction Method Statements (CMSs) to detail the methodology and control of any operations for works identified in the CEMP as potentially environmentally sensitive. For example, a CMS may include measures to avoid disturbance to protected species such as bats and otter, as well as sensitive areas of trees and woodland. Where necessary, these CMSs will be drawn up in consultation with statutory consultees such as the Scottish Environment Protection Agency (SEPA) and Scottish Natural Heritage (SNH).

95 An Ecological Clerk of Works will be employed to oversee those aspects of construction that have potential to impact on habitats or protected species. Representatives will also be required to oversee mitigation associated with the Landscape and Visual, Agricultural, Land Use and Soils and Cultural Heritage and Archaeology Chapters. Further details are provided in the respective topic chapters.

5.12.1 Hydrology, Flood Risk, Water Resources and Surface Water Quality

96 The following water resource protection measures will be detailed in the CEMP:

- spill plans (including actions to be taken in the case of oil spillage);
- sediment control measures.

97 A strategy to monitor the water quality of watercourses potentially affected by construction activities will be agreed with SEPA before works commence. Monitoring will be undertaken by an Ecological Clerk of Works (or equivalent) to ensure that Construction Environmental Management Plans are implemented.

5.12.2 Soils Agriculture and Land Use

98 A Soil Resource Management Plan (SRMP) and Peat Management Plan (PMP) which will form part of the overall CEMP will be developed in detail prior to construction. The SRMP will ensure that soil resources are managed in accordance with best practice and soil mitigation measures are fully implemented on a specific basis within each section of the route corridor. The principles that the SRMP will follow are:

- a Soil Resource Survey will be completed prior to any earthworks operations to inform the plan and map, delineate, quantify and characterise the topsoils and subsoils within the route corridor;
- stripping, stockpiling or placing of soil will be done so in the driest conditions possible using tracked equipment where possible to reduce compaction;
- traffic movement will be confined to designated routes;
- soil storage periods will be kept as short as possible;
- stockpiles of different soil materials will be clearly defined;
- methods will be employed at all times to limit the risk of spread of pests and soil borne diseases.

99 Suitable engineering will be employed to ensure the stability of peat is maintained. The PMP will be in accordance with the document 'Developments on Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste.' Reuse options for surplus peat will include:

- blending for use as a reinstatement material;
- landscaping (e.g. through creation of berms around the substation);
- use in the substation base;
- cable backfilling;
- peatland restoration such as ditch blocking and;
- dewatering for use as a horticultural product.

100 Further details on the measures which will be included in the SRMP and PMP are included in **Chapter 13: Soils, Agriculture and Land Use.**

5.12.3 Air Quality

101 The following air quality protection measures will be detailed in the CEMP:

5.12.3.1 Site Planning

- no bonfires will be permitted;
- machinery and dust causing activities will be located away from sensitive receptors;
- tips and stockpiles will be located away and down-wind from neighbours where possible;
- all personnel will be fully trained;
- a trained and responsible manager will be on site during working times to maintain logbook and carry out site inspections;
- hard surface/compact site haul routes will be utilised, where practical.

5.12.3.2 Construction Traffic

- all vehicles will switch off engines when not required with no idling vehicles;
- effective vehicle cleaning and specific fixed wheel washing will be used on leaving site and haul routes dampened down;
- a surfaced track will be provided between washing facilities and the site exit;
- all loads entering and leaving site will be covered;
- site runoff of water or mud will be prevented;
- haul roads and other dusty surfaces will be swept;
- on-road vehicles will comply with set emission standards;
- all non-road mobile machinery (NRMM) will use ultra low sulphur tax-exempt diesel (ULSD) where available and be fitted with appropriate exhaust after-treatment from the approved list;
- low speed limits will be observed on site;
- the movement of construction traffic around site will be minimised;
- haul routes will be hard surfaced where possible and effectively cleaned.

5.12.3.3 Site Activities

- dust generating activities will be minimised;
- a dust removal system for plant will be provided;
- the drop height of falling material will be limited;
- water will be used as a dust suppressant where applicable;
- stockpiles will be covered, seeded or fenced to prevent wind whipping;
- activities will be temporarily suspended if the creation of dust cannot be avoided.

5.12.4 Ecology and Ornithology

102 The following ecological protection measures will be detailed in the CEMP:

- the site induction process for construction personnel which will include a site briefing provided by the Ecological Clerk of Works (ECoW) regarding otter, badger, breeding birds and reptiles, and the identification of shelters of

these species. The briefing will also emphasise the importance of protection of watercourses and key habitats such as wetland areas;

- general good practice measures for working in and near to watercourses as described in **Chapter 12: Hydrology, Flood Risk, Water Resources and Surface Water Quality**;
- standard sediment and pollution management measures in compliance with SEPA's Pollution Prevention Guidelines;
- the use of suitable capping material for the access tracks to minimise the potential for run-off of fine material;
- that new roadside drains will not directly discharge into streams (or drainage channels leading directly to streams), and that specifically designed silt traps will be used where necessary to act as filters;
- the storage of fuels and other chemicals securely in line with The Water Environment (Oil Storage) (Scotland) Regulations 2006;
- the use of appropriate wash-out facilities for vehicles and machinery used for concrete pouring;
- that trenches and excavations will include ramps, and stored pipes will be capped, to prevent entrapment of animals;
- that construction fencing will retain a sufficient gap to allow mammals such as badgers to pass underneath;
- where it is not possible to undertake construction works outside the bird nesting season, the prevention of disturbance of the active nests and dependent young of breeding raptors, waders (lapwing and curlew) and any species listed on Schedule 1 of WCA by setting up an exclusion zone of 300 m radius around the location until the breeding attempt ends, or young move away.
- the agreement of locations for storage of excavated arisings in advance with the ECoW to minimise the risk of protected species using stockpiled soil as a shelter;
- if construction work is carried out during the hours of darkness, that machinery and floodlights will be directed away from watercourses and woodlands to avoid potential disturbance, albeit unlikely, to otter and bat commuting and foraging features. These measures will be subject to advice from the ECoW on the location of sensitive ecological features. Where no features have been identified in close proximity to works, such restrictions may not be required;
- application of a site speed limit of 15 mph for all construction traffic (excluding public highways) during the hours of darkness to protect badger and otter;
- requirements for re-seeding where necessary. Following completion of construction works, temporary construction works areas will be re-seeded with a suitable seed mix in consultation with SNH and East Lothian Council.

5.12.5 Waste Management

- 103 Waste will be generated and will require management at a number of construction stages.
- 104 All wastes will be identified, classified, quantified and, where practicable, appropriately segregated. Any materials that cannot be reused, will be disposed of according to relevant waste management legislation which will serve to address a number of possible environmental effects. This includes:
- The Duty of Care imposed by Section 34 of the Environmental Protection Act 1990; and
 - The Waste Management Licensing (Scotland) Regulations 2011, particularly provisions relating to registered exemptions from waste management licensing.
- 105 All waste materials removed from site will be handled in accordance with relevant waste and environmental legislation. Waste will be transferred using a registered waste carrier to a licensed waste disposal site or recycling centre.

- 106 On completion of the construction works, stone used for the temporary access tracks will be removed and reused where possible. Any excess stone will be removed from site to a licensed waste facility. The underlying geotextile and geofabric will also be removed and transported to a licensed waste facility.

5.12.6 Resource and Energy Use

- 107 It is good practice to consider energy usage during the construction of a proposed development, including associated emissions of greenhouse gases. Whilst the project as a whole is driven by national policy in relation to renewable energy, it is recognised that energy will be used during the construction phase, including the fuel for construction plant and the energy required for the transportation of personnel. The materials used to construct the cable connections and substation works will also incorporate embodied energy, i.e. energy required to manufacture construction materials, including the energy used in the transport of the material from its source to the site, via processing plant where applicable.
- 108 The current scope to reduce the consumption of energy and associated carbon dioxide (CO₂) emissions by selecting energy efficient equipment, and fuels and materials with low embodied energy, is considered to be limited. For example, biodiesel fuel could not be used for all construction vehicle trips as it is not commercially available to large scale users at the present time. However, work to progress the practical application of emerging technologies is ongoing and the matter will be given further consideration prior to construction.
- 109 The procurement process will seek to incorporate principles of sustainability within the construction of the Onshore Works. Environmental performance, including energy use, will form part of the scoring for contractors bidding to undertake these works.

5.12.7 Health and Safety

- 110 The following sections are intended to provide an indication of the procedures to be adopted throughout the project. This list is by no means intended to be exhaustive and will be continually reviewed for adequacy in meeting the developer's health and safety objectives as the project progresses
- 111 Health and safety is of primary importance. In designing the Onshore Works, the developer will take account of the health and safety of the general public and all those involved in the construction, commissioning and operation and maintenance of the plant and equipment.
- 112 All construction activities will be managed within the requirements of the Construction (Design and Management) Regulations 2007 and will not conflict with the Health and Safety at Work etc Act 1974. To further reduce possible health and safety risks, a Health and Safety Plan for the project will also be drawn up. All staff and contractors working on the project will be required to comply with the safety procedures and work instructions outlined in the plan at all times. Consideration of health and safety will form a key part of the procurement process and contractors will be scored on their health and safety record as well as their proposed health and safety management measures.
- 113 Current industry standards will be followed to manage the risks posed by heavy equipment, falls from heights and rough and dangerous terrain. Information will be made available to the public with respect to any possible safety hazards and open excavations will be fenced off and sign posted.

5.12.8 Community Liaison

- 114 In partnership with the developer, the appointed contractors will be required to maintain close liaison with local community representatives, landowners and statutory consultees throughout the construction period. This is likely to include circulation of information about ongoing activities, particularly those that could potentially cause disturbance. A telephone number will be provided and persons with appropriate authority to respond to calls and resolve any problems made available.
- 115 The developer and the appointed contractors will liaise with ELC and communities to identify any major events in the area and to programme road closures and associated diversions to ensure that these do not disrupt the local road network on those days.

5.13 Operation and Maintenance

- 116 The onshore components are expected to require limited maintenance.

5.13.1 Onshore Underground Cables Operations and Maintenance

- 117 Annual checks, on foot, will be required along the route during operation. Access would normally be along the agreed cable route wayleave. In the unlikely event that there is any failure of cables, a fault finder with test gear would locate the fault along the cable section. Once located, the area around the fault would be excavated and the fault repaired. If the cable cannot be repaired, a new length of cable would be inserted and jointed to replace the failed section. Underground cables are marked on services maps provided to other utilities and are installed with marker tape to warn of their presence below the ground in the case of excavation taking place above the cables, see **Illustration 5.5**. Underground cables will also be way-marked at points where the cables cross watercourses, roadways, pipelines and railways.
- 118 For sensitive tree line crossings, it is anticipated that the cables will be installed in ducts using trenchless installation techniques. By far the most common failure mode in cables is due to external mechanical damage (e.g. diggers and spades) which can be avoided by marking the cables on services maps as described above. The likelihood of a breakdown in XLPE insulation due to other problems is very low, particularly for cables installed in ducts. In the unlikely situation where the cable may fault at a location near/beneath these sensitive areas such as woodlands, it is anticipated that the faulted cable section would be cut at either end of the duct, removed and replaced.
- 119 Building over cables, earth mounding and excavation on the cable easement strip is limited. Planting trees and other deep rooted vegetation over the cables or within 3 m of the cable trench is also restricted, to prevent encroachment by vegetation. If hedgerow reinstatement is required over the cable route, a specific cable protection strategy will need to be implemented (e.g. cables will be laid in ducts).

5.13.2 Onshore Substation Operation and Maintenance

- 120 The substation will not be permanently manned but will be visited approximately two to four times per month to inspect the equipment on site including the switchgear, protection equipment and relay testing, transformer and other equipment as necessary. Each visit will require at least two personnel (in a van or car). For scheduled maintenance, it is anticipated that two visits would be required per year, requiring up to 10 personnel. Additional visits would be required for faults.

5.13.3 Operational Traffic Movements

- 121 Operational traffic movements are expected to be low. The effects of operational traffic movements are considered in **Chapters 14: Access, Traffic & Transport; Chapter 15: Air Quality** and **Chapter 16: Noise and Vibration**.

5.14 Decommissioning

- 122 Before construction of the offshore project can commence, a decommissioning plan for the Offshore Works must be agreed with the Department for Energy and Climate Change. After the lifetime of the Near na Gaoithe offshore wind farm (assumed to be up to 50 years from the start of offshore operation¹), the Onshore Works are likely to remain in situ as part of the functioning transmission network. However, following consultation with East Lothian Council (ELC) it was agreed that the likely effects of decommissioning the Onshore Works would be considered in this ES.
- 123 At the substation, decommissioning would involve the removal of above ground infrastructure and hardstanding, followed by disposal off-site. Where possible, materials would be reused or recycled, with the remainder of materials being disposed of to a licensed waste disposal site. The substation site would be re-profiled using appropriate materials (including peat) to the level existing prior to construction.
- 124 If the cable is removed, the area disturbed should be no more than the area disturbed at construction. Where ducts are in place, the cables would be pulled through rather than disturbing the ground above. Where ducts are not in place, the ground would be opened to remove the cables.

¹ A licence for the sea bed will be provided for 50 years.