APPENDIX 4-2

GRID CONNECTION
Methodology

Outline Construction Methodology

Cunlaghfadda 110kV Loop In Grid Connection

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CUNLAGHFADDA
Green Energy

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1.0 Introduction

TLI Group ("the Consultant") were engaged by Cunlaghfadda Green Energy Ltd ("the Client") to identify and analyse potential 110kV loop in options available for the Cunlaghfadda Green Energy Project, which will loop in to the existing Cloon – Castlebar 110kV line. This project will have an estimated Maximum Export Capacity (MEC) of 31.5 MW.

The 110kV grid connection will consist of constructing two end masts and a new standard EirGrid loop in substation. The Cunlaghfadda substation will be connected via two 110kV UGC circuits to the two end masts structures that will intersect with the existing Cloon – Castlebar 110kV overhead line. The OHL works will consist of the installation of two end masts and terminating the existing phase conductors on those end masts.

This document is intended to be used as an aid to understand the methodologies to be employed during construction and should be read in conjunction with all other specialist reports which accompany the planning application. Also, this document is in outline form only and will be revised and updated before the commencement of any construction activities. For the purposes of the planning application, this document should be read in conjunction with Chapter 4 of the EIAR (Description of the Proposed Project), the Construction and Environmental Management Plan (CEMP), the Appropriate Assessment Screening Report (AASR), Natura Impact Statement (NIS), and all other supporting documents and EIAR chapters as relevant. The EIAR Site boundary can be seen below in Figure 1.

Figure 1: EIAR Site Boundary

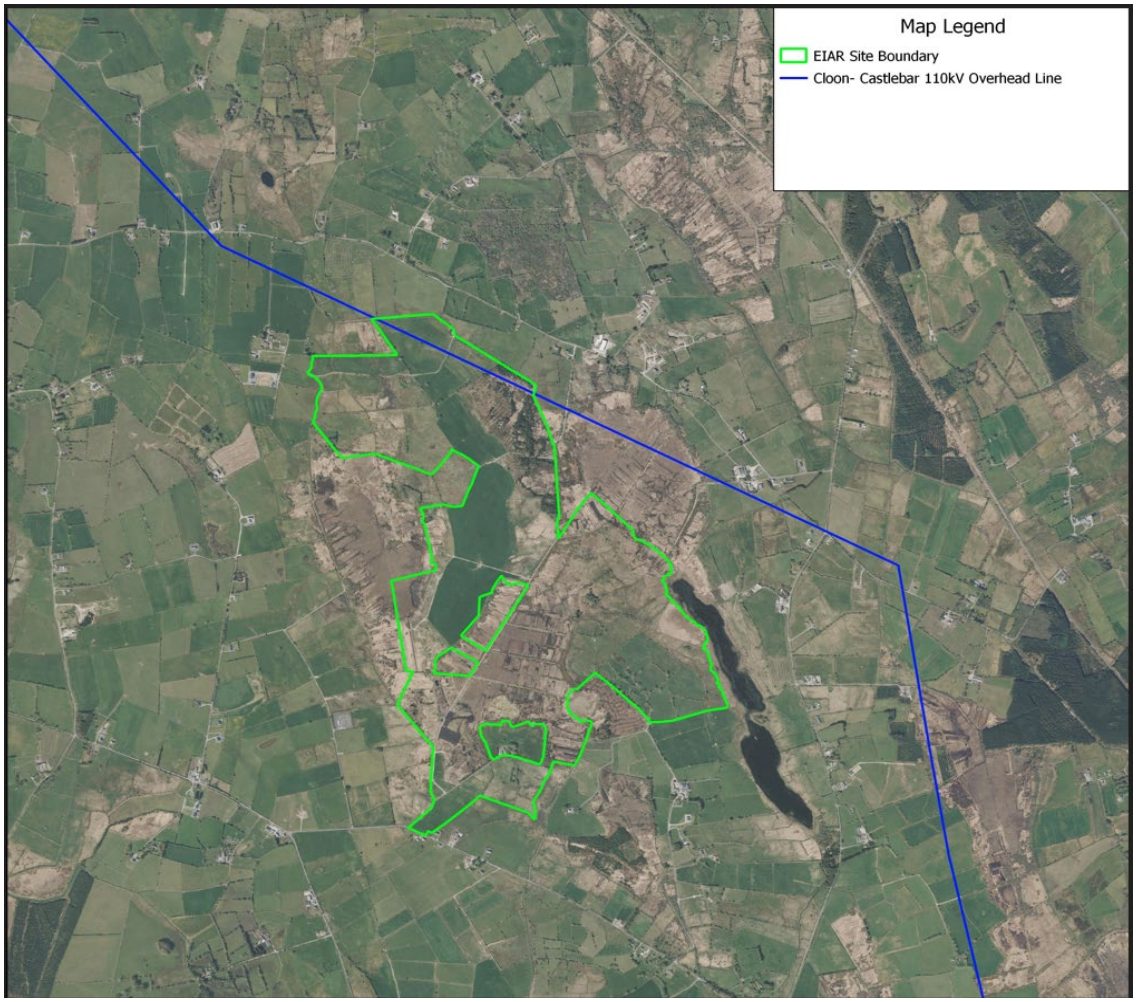

Table 1: Summary of OHL works

Table 1 - Summary of Grid Connection 110kV Design Route	
Section	**Description (all lengths are approximate and to be confirmed at detailed design stage)**
Section 1 **UGC**	Installation of 2 Steel line Cable Interface End masts Cunlaghfadda - Castlebar 110kV line UGC Circuit Length: 222.38m Cunlaghfadda - Cloon 110kV line UGC Circuit Length: 759.2m
Refer to Figure 1 and to the planning drawings submitted for location details. Note: The precise location of the proposed route within the planning application boundary is subject to change as result of existing services/utility locations, ground conditions and any environmental constraints.	

2.0 Preliminary Site Investigations

Trial pits or boreholes will be required at the location of each overhead line structure and the substation, which will be in addition to boreholes and trial pits undertaken to date.

2 boreholes or trial pits required at tower locations and along the access track to ascertain thermal resistivity of the soil.

At least 4 No. Boreholes are required at specified locations at the substation site location to ascertain ground composition and thermal/electrical resistivity of the soil.

Peat probing at the substation access track, substation compound.

Equipment:

- 4x4 vehicle
- Wheeled dumper
- Soil compactor
- 360° tracked excavator (wheeled excavator where required)
- Borehole Drill Equipment

3.0 Loop-In End masts

3.1 Existing 110kV OHL

The proposed Cunlaghfadda 110kV loop-in station will connect into the existing Cloon-Castlebar overhead transmission line. The existing line will be broken near the current Pole set structures, No. 102 and No. 105 forming the Cunlaghfadda- Cloon and Cunlaghfadda- Castlebar 110kV lines. Pole set 103, 104 and 105 are to be removed post construction.

The proposed design for the 110kV Loop-In from the existing OHL will require two new end masts, which will be constructed under the existing Cloon-Castlebar 110kV OHL. The existing OHL conductor will be terminated at these end masts connecting to the substation via underground cable.

Construction of foundations for end mast structures is anticipated to be approximately 7 days per end mast structure. It is anticipated that curing of concrete and erection of end masts will require 5 days per end mast, this being weather dependent. Stringing of conductors will be a 2-week process and final connection to the existing grid will be carried out by ESBN and at that point in time commissioning of the substation can start.

3.2 Steel End Mast Structures

The proposed end mast structure locations have been selected based on ground surveys, ground profiles, sight lines and ruling span checks.

The proposed construction scope will require the relevant personnel, machinery and materials which is as follows: -

Equipment	**Materials:**
• 5 operatives • 4x4 vehicle • Winch • Tractor and trailer • Crane • Teleporter • Chains / small tools • Tracked Excavator • Tracked Dumper	• Lattice steel end masts • Insulators • Electrical connections • Concrete (foundation) • Aggregate

The following section outlines the methodology to be followed during construction works of the new end mast structures.

1. End masts sites are scanned for underground services such as cables, water pipes etc. Consultation with the landowners and utility service providers will help to identify hazards and ensure there are no unidentified services in the area.
2. For each leg of the 2 No. End masts (8 legs in total) a foundation circa. 4m x 4m x 3m deep is required. To allow for safe construction the excavation will be stepped back which requires additional area to be excavated or shutter piles used if ground material is not suitable for benching. The formation levels (depths) will be checked by the onsite engineer. The excavated material will be temporarily stored close to the excavation and excess material will be used as berms along the site access tracks.

3. To aid construction, a concrete pipe is placed into each excavation to allow operatives level the end masts at the bottom of the excavation. The frame of the reinforcing bars will be prepared and strapped to a concrete pipe with spacers as required. The reinforcing bars will be lifted into each excavated foundation using the excavator and chains/slings. The base and body section of each end masts will then be assembled next to the excavation.
4. Concrete trucks will pour concrete directly into each excavation in distinct stages.
5. A final pour for the end masts is the encasing of the end masts leg which will be finished 300mm over finished ground level. The leg of the end masts is required to be shuttered with metal panels to form the required shape.
6. Once the concrete is set after five days the shuttering is removed and if used sheet piles removed.

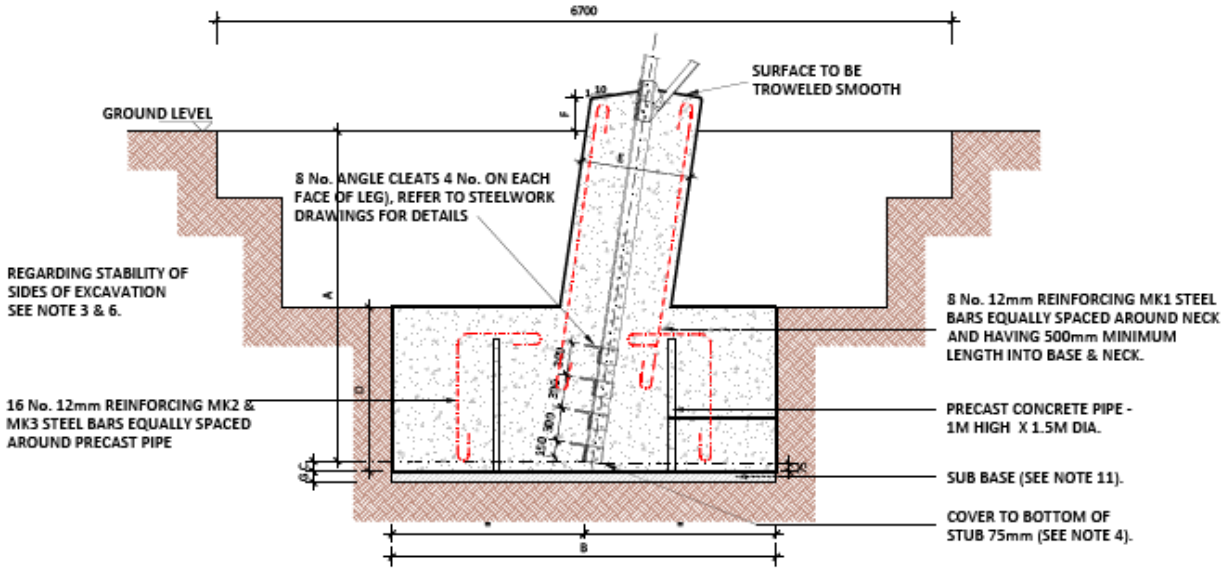

Figure 2: New End masts Foundation

Figure 3: Typical 110kV end masts foundation excavation

7. The End masts foundations will be backfilled one leg at a time with the material already excavated at the location. The backfill will be placed and compacted in layers. All dimensions will be checked following the backfilling process. All surplus excavated material will be removed from the end masts locations and stored in berms for reuse across the construction site.

Figure 4: Base of End masts Structure Backfilled

8. For the end masts located under the existing line, the line will be de-energised by ESB so work can commence on the construction of the end masts. Where it is offline the end masts will be built without an outage.
9. An earth mat consisting of copper or aluminium wire will be laid circa 400mm below ground around the end masts. This earth mat is a requirement for the electrical connection of the equipment on the end masts structure.
10. Once the base section of each end masts is completed and the concrete sufficiently cured, it is ready to receive the end masts body.
11. A hardstand area for the crane will be created by laying geogrid material on the ground surface and overlaying this geogrid with a suitable grade of aggregate.
12. A physical barrier (Heras Fence Site Boundary) will be put in place to restrict plant from coming too close to the OHL.
13. The end masts will be constructed lying flat on the ground beside the recently installed end masts base.
14. The conductor will be moved off centre using a stay wire and weights to anchor the stay wire to ground.
15. The end masts section will be lifted into place using the crane and guide ropes.
16. The body sections will be bolted into position.
17. The conductor will be centred over the end masts and held in place. Once the conductor is secured at both ends it is then cut and attached onto each end masts. The section of conductor in between the two end masts will be removed and utilised as connector wire for the new end masts.
18. Down dropper conductors (For Electrical Connections, Insulators, Surge arrestors), shackles and all associated accessories required for transition from line to cable will be installed on the interface end masts.
19. The circuit will be tested in both directions before the line is re-energised.

Figure 5: Cable End Mast

Figure 6: Cable End Mast

4.0 Proposed Substation Build

The Cunlaghfadda 110kV substation will be constructed to loop-in the existing Cloon-Castlebar 110kV overhead line. The Cunlaghfadda 110kV substation will be made up of a control building, transformer compound and busbar compound. The control building works will consist of foundation works, block work, roofing, low voltage electrical fit out, cladding and building finishing works. The transformer, cable chair and structural steelwork will be installed in the transformer compound. The busbar compound structural steelwork will be erected. Substation electrical equipment will be installed once the control building and compound is complete. Palisade fencing will be erected around the compound for security/protection and a concrete post and rail fence to mark the substation boundary.

5.0 Substation Construction

Equipment	**Materials:**
• Up to 10 Electrical/Civil Crews • Tracked Excavators • 360˚ tracked excavators (13 ton normally, 22 ton for rock breaker) • Tracked dumpers / tractors and trailers • Crane • Hoist • Power Tools • Generator • Scaffolding	• Stone • Geotextile • Lighting • Paving • Fencing • Steel Uprights • Concrete • Timber • Cladding • Doors

The proposed construction scope will require the relevant personnel, machinery and materials which is as follows:

1. This new substation will be in a compound of circa 125m x 100m plan area secured by a 2.6m high palisade fence.
2. The substation compound and drainage will be marked out by a qualified engineer.
3. A drainage system will be excavated and installed around the compound area.
4. Topsoil and subsoil will be removed from the footprint of the compound using an excavator. The excavated material will be temporarily stored in adjacent berms for later use during reinstatement works.
5. A layer of geotextile material will be laid over the footprint of the compound.
6. Using an excavator, a base layer of Clause 804 material will be laid followed by a 6F2 capping layer which will provide the finished surface.
7. Each layer will be compacted using a vibrating roller.
8. Earthing cable will be laid underground around the substation for connection to the various electrical components during the electrical fit out phase.
9. The construction of an 12206.8m² substation compound comprising of approx. 437.5m² single storey 110kV substation control building, a 216.4m² IPP building and associated outdoor electrical equipment, including 1 no. 110kV transformer, associated internal access track, 2.6m high station perimeter fencing and concrete post and rail property boundary fence will be built.
10. Adequate lighting will be installed around the compound on the lighting end masts.
11. Lightning protection end masts of approximate height 18m will be installed to protect the station from direct lightning strikes.
12. The electrical installation is expected to take 20 weeks and includes the following:
    - Delivery and installation of 33/110kV transformer. These are unusually large and the deliveries will be managed in accordance with regulations governing the movement of large loads.
    - Delivery and installation of all other HV equipment.
    - Wiring and cabling of HV/LV equipment, protection and control cabinets.

- Commissioning of all newly installed equipment.

Figure 7: Typical 110kV Electrical Infrastructure

Figure 8: Typical 110kV Transformer Connection

6.0 UGC Construction Methodology – Private Land

The proposed UGC will consist of 2 No. trenches with a minimum of 2m separation distance between each circuit. Each trench will contain 3 No. 160mm diameter HDPE power cable ducts and 3 No. 125mm diameter HDPE communications duct to be installed in an excavated trench, typically 825mm wide by 1,315mm deep, with variations on this design to adapt to bridge crossings, service crossings and watercourse crossings, etc. The power cable ducts will accommodate 3 No. power cables. The communications duct will accommodate a fibre cable to allow communications between the Cunlaghfadda substation and the adjoining Cloon and Castlebar 110kV substations. The ducts will be installed, the trench reinstated in accordance with landowner/Mayo County Council specification, and then the electrical cabling/fibre cable is pulled through the installed ducts. Construction methodologies to be implemented and materials to be used will ensure that the UGC is installed in accordance with the requirements and specifications of EirGrid and ESB.

6.1 Trenching Methodology

The following section outlines the methodology to be followed during trenching works:

- The Contractor, and their appointed Site Manager, will prepare a targeted Method Statement concisely outlining the construction methodology and incorporating all mitigation and control measures included within the planning application and accompanying reports and as required by planning conditions where relevant.
- All existing underground services shall be identified on site prior to the commencement of construction works;
- Where the cable route intersects with culverts, the culvert will remain in place (where possible) and the ducting will be installed either above or below the culvert to provide minimum separation distances in accordance with ESB and Irish Water specifications;
- Traffic management measures will be implemented in accordance with those included in the Traffic Management Report, and a detailed Traffic Management Plan will be prepared and agreed with Mayo County Council;
- Excavated material will be temporarily stockpiled onsite for re-use during reinstatement. Stockpiles will be restricted to less than 2m in height. Stockpiles will be located a minimum of 50m from surface water features and all stockpiling locations will be subject to approval by the Site Manager and Project Ecological Clerk of Works (ECoW);
- Excavated material shall be employed to backfill the trench where appropriate and surplus material will be transferred to the spoil deposition area;
- Any earthen (sod) banks to be excavated will be carefully opened with the surface sods being stored separately and maintained for use during reinstatement;
- The excavated trench will be dewatered if required, from a sump installed within the low section of the opened trench. Where dewatering is required, dirty water will be fully and appropriately attenuated, through silt bags, before being appropriately discharged to vegetation or surface water drainage feature;
- Where required, grass will be reinstated by either seeding or by replacing with grass turves;
- No more than a 100m section of trench will be opened at any one time. The second 100m will only be excavated once the majority of reinstatement has been completed on the first;
- The excavation, installation and reinstatement process will take on average of 1 no. day to complete a 100m section;

Figure 9: Typical 110kV Underground Duct Installation on Private Land

6.2 Ducting Installation Methodology

For the trenching and ducting works the following step by step methodology will apply:

1. Grade, smooth and trim trench floor when the required 1315mm depth and 825mm width have been obtained.
2. Place bedding layer of Cement Bound Granular Mixture B (CBGM B) material in accordance with the specification and compact it so that the compacted thickness is as per the drawings.
3. Lay the bottom row of ducts in trefoil formation as detailed on the design drawings. Use spacers as appropriate to establish horizontal duct spacing. Fit a secure cap / bung to the end of each duct run to prevent the ingress of dirt or water.
4. Carefully surround and cover ducts with CBGM B in accordance with the design drawings and specifications and thoroughly compact without damaging ducts.
5. Place cable protection strips on compacted CBGM B directly over the ducts.
6. Lay the top row of ducts onto the freshly compacted CBGM B including the cable protection strips above the bottom row of ducts. Place a secure cap at the end of each duct to prevent the ingress of dirt or water.

7. Carefully surround and cover ducts with CBGM B material in accordance with the drawings and thoroughly compact without damaging ducts.
8. Place red cable protection strip on top of compacted CBGM B over each set of ducts as shown on the drawings.
9. Place and thoroughly compact CBGM B material or Clause 804 backfill or soil backfill as specified and place warning tape at the depth shown on the drawings.
10. For unsurfaced/grass sections, backfill with suitable excavated material to ground level leaving at least 100 mm topsoil or match existing level at the top to allow for seeding or replace turves as per the specification of the local authority or landowner.
11. Clean and test the ducts in accordance with the specification by pulling through a brush and mandrel. Install 12 mm polypropylene draw rope in each duct and seal all ducts using robust duct end seals fitted with rope attachment eyes in preparation for cable installation later. All the works should be witnessed by ESBN Clerk of Works (CoW) as required.

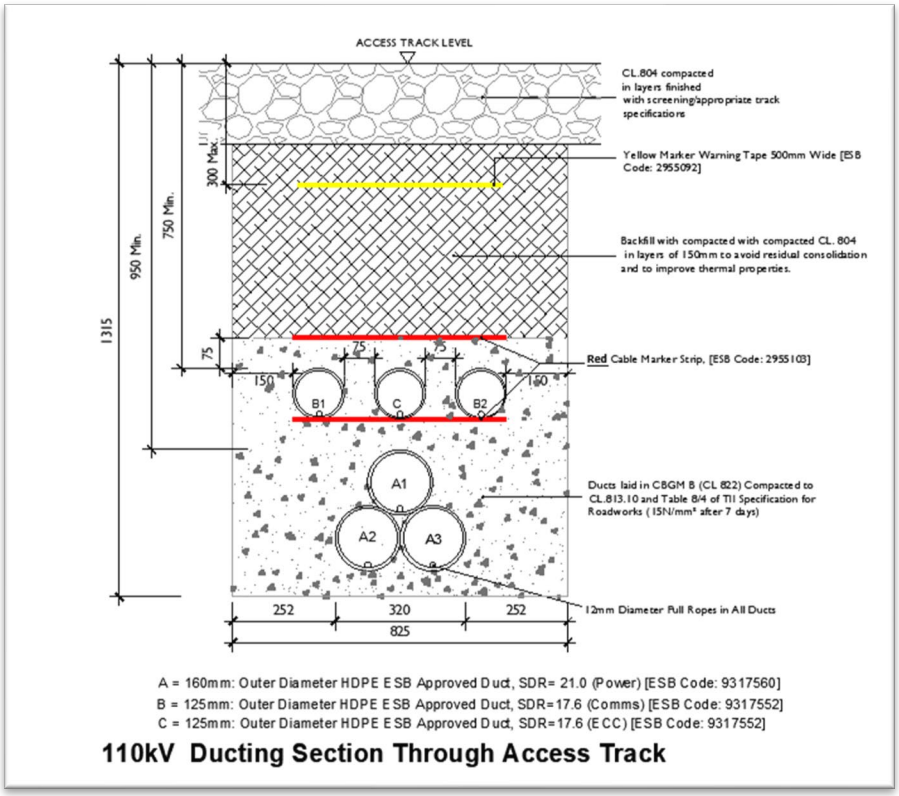

Figure 10: Typical Single Trench in Access Track

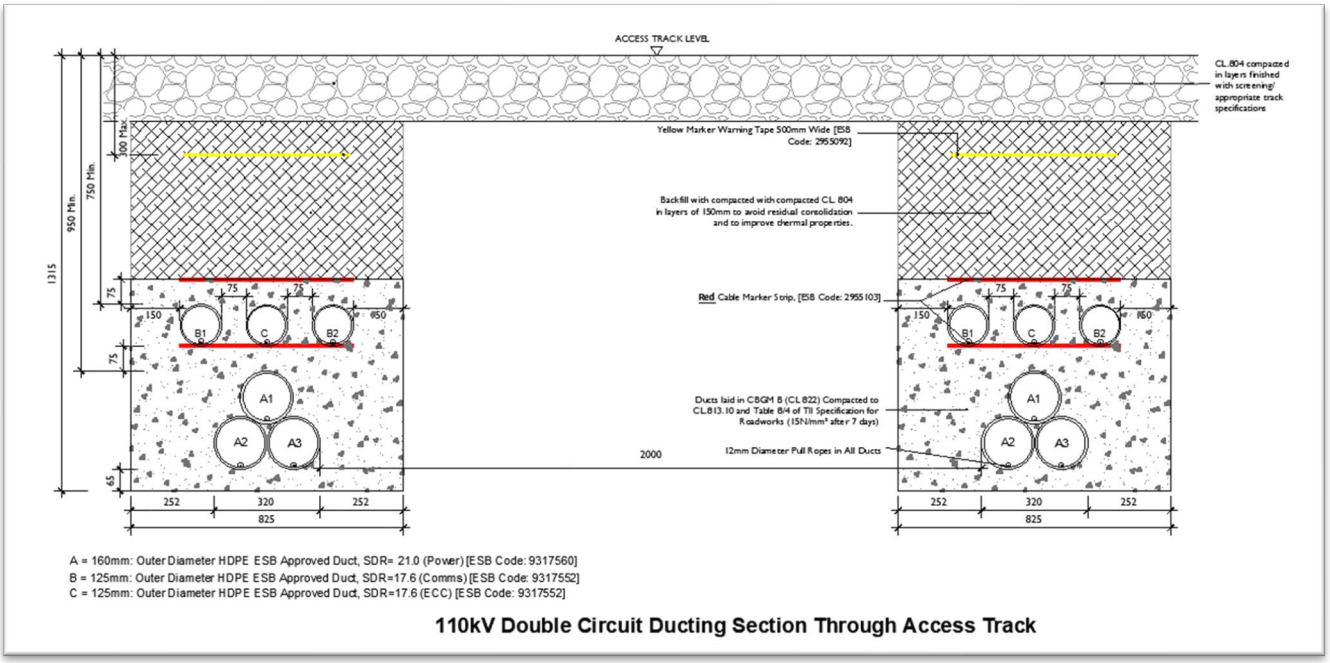

Figure 11: Typical Double Trench in Access Track

Equipment:

- 1 no. tracked excavator (only rubber tracked machines will be allowed on public roads);
- 1 no. dumper or tractor and trailer.

Materials:

- Sand for pipe bedding;
- Ready-mix Concrete where necessary (delivered to site);
- Trench backfilling material (excavated material and aggregates) to relevant specifications;
- 160mm diameter HDPE ducting;
- 125mm diameter HDPE ducting;
- Temporary Surface Reinstatement Materials

6.3 Surface Cable Markers & Marker posts

Surface cable markers will be placed along the route where cable depth is unavoidably shallow, due to constraints such as existing services, to indicate the precise location of the UGC. These markers will be metallic plates in accordance with ESB standards.

Marker posts will be used on non-roadway routes to delineate the cable route. Corrosion proof aluminium triangular danger sign, with 700mm base, and with centred lightning symbol, on engineering grade fluorescent yellow background shall be installed in adequately sized concrete foundations. Marker posts shall also be placed if burial depth is not to standard. Siting of marker posts to be dictated by ESBN as part of the detailed design process. Figure 12

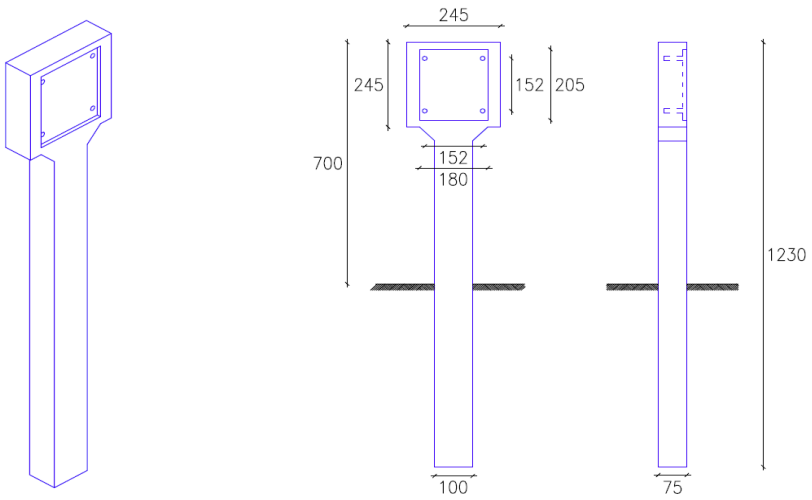

Figure 12: Typical ESB Marker Posts Example

6.4 Managing Excess Material from Trench

All excavated material will be temporarily stored adjacent to the trench prior to re-use in the trench reinstatement (where applicable). Stockpiles will be restricted to less than 2m in height. Where excess material exists, it will be disposed of to the spoil deposition area.

6.5 Storage of Plant and Machinery

All plant, machinery and equipment will be stored on site within the works area or within the temporary construction compound to be located within the Cunlaghfadda Wind Farm. Oils and fuels will not be stored on site and will be stored in an appropriately bunded area within the temporary construction compound.

1. The cable is supplied in pre-ordered lengths on large cable drums (Figure 13). Installing “one section” of cable normally involves pulling three individual conductors into three separate ducts. The cable pulling winch must be set at a predetermined cut off pulling tension as specified by the designer. The cable will be connected to the winch rope using approved suitably sized and rated cable pulling stocking and swivel or the pulling head fitted by the cable manufacturer**.** A sponge may also be secured to the winch rope to disperse lubricant through the duct. Lubrication is also applied to the cable before it enters the duct.

Figure 13: HV cable pulling procedure (Typical drum set-up)

Equipment:

- 1 Excavator Operator
- 360˚ tracked excavator (13 ton normally, 22 ton for rock breaker)
- 1 no. tracked dumper or tractor and trailer

Materials:

- Sand for pipe bedding
- Blinding Concrete where necessary
- Clause 804 Material
- 160mm diameter HDPE ducting;
- 125mm diameter HDPE ducting;
- Precast Chamber Units / Relevant construction materials for chambers
- Link Box

7.0 Access Routes to Work Area, Crane Pads and Temporary Laydowns

Access tracks, laydown areas and crane pads on the consented land (if required due to ground conditions and/or landowner requirements) will consist of crushed rock on a geotextile. Upon completion of the works, all access tracks will remain in place for future access to the substation and wind farm grounds. Access routes will be carefully selected to avoid any damage to land. Local consultation will be carried out with the relevant landowners to ensure that any potential disturbance will be minimised. Prior to the commencement of construction, the contractor will assess all access routes and determine specific requirements for each area.

Any such requirements will be incorporated into the relevant method statement. A combined laydown and crane pad area (40x82m) will be utilised for tower installation and erection.

Figure 14: Access Track

Figure 15: Access Track Build-up with Geotextile

Figure 16: Crane pad and laydown areas

8.0 Programme

Estimates for the duration of the construction works are included in the table below. Please note that some of the elements are likely to happen concurrently, therefore the overall start-to-finish duration is estimated to be fourteen months.

Table 3: Estimated Construction Duration (Activities Run Concurrently)	
Development Element	**Estimated Construction Duration**
Construct 110kV Substation	14 months
Overhead Line Structures	3 months
Underground Cable	3 months
Connection to Existing OHL and Commissioning	6 weeks
Total	14 Months