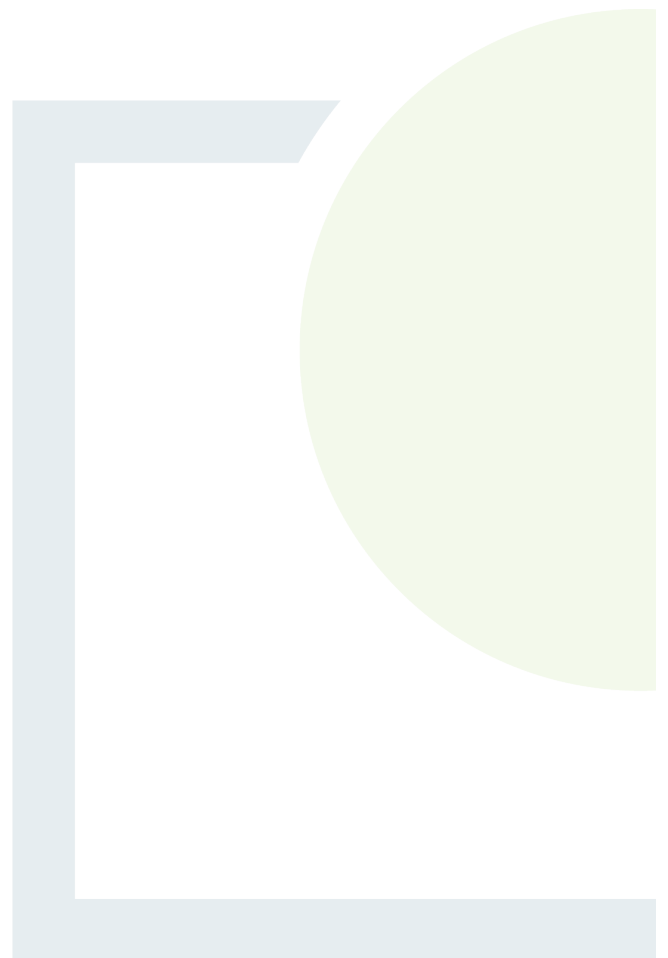




CONSULTANTS IN ENGINEERING,
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APPENDIX 3.1

110 KV Grid Connection
Feasibility Study





110KV GRID CONNECTION FEASABILITY STUDY

Coumnagappul Wind Farm

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1.0 Overview

TLI Group (the Consultant) were engaged by EM Power (the Client) to identify and analyse potential 110kV grid connection options available for the Coumna gappul Wind Farm Project, north of Dungarvan, Co. Waterford. The Client indicated that the proposed grid connection point offered by the ESB is Dungarvan 110kV Substation.

Both underground cable (UGC) and overhead line (OHL) grid connection options were to be assessed as part of this feasibility study. The scope of work for the Consultant was therefore to identify potential 110kV UGC grid connection options between Dungarvan 110kV Substation and Coumna gappul Wind Farm.

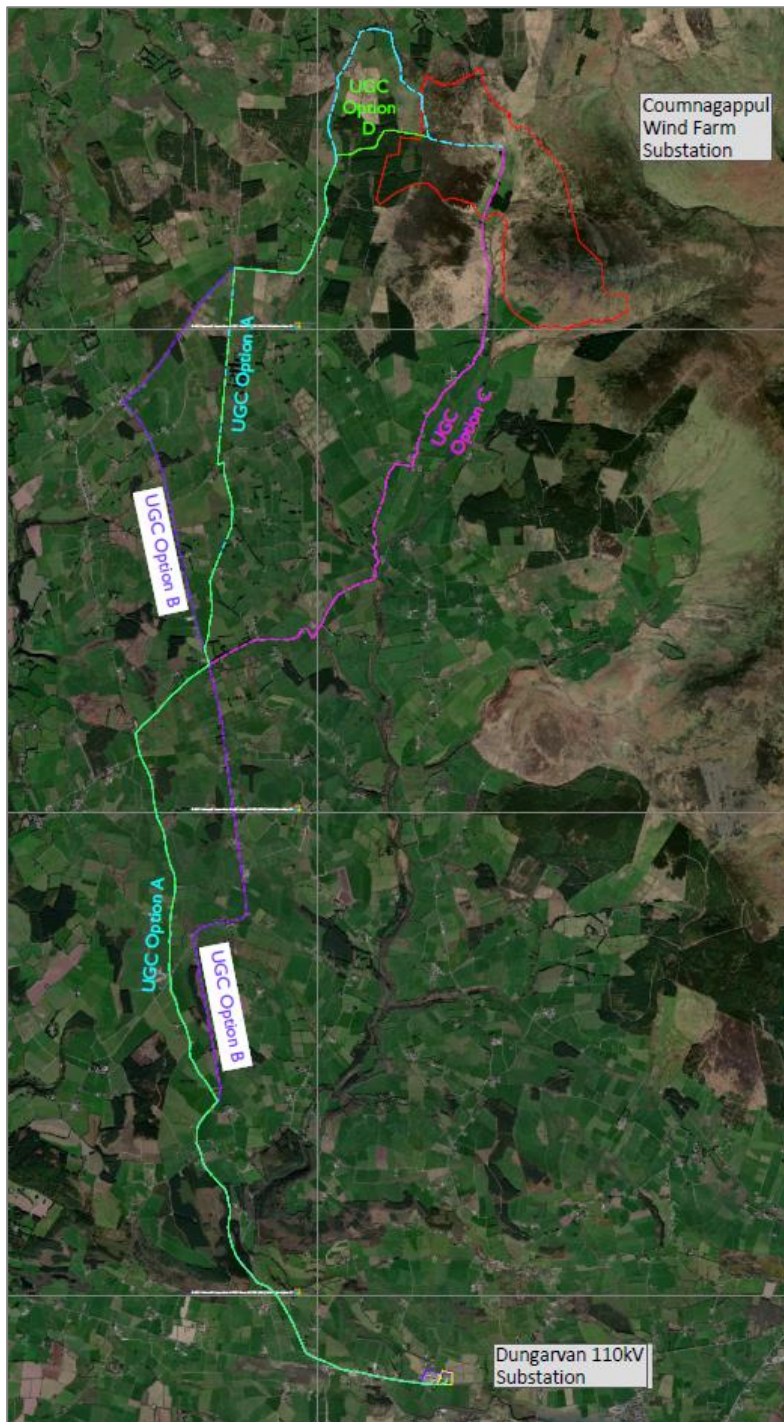


Figure 1 - Coumna gappul Wind farm Grid Connection Site Overview

2.0 Route Development Overview

In order to identify potential grid connection options between the windfarm site and Dungarvan 110kV Substation, a detailed study area constraints map was created in AutoCAD. The study area map combined data from numerous sources including available aerial imagery, protected areas, river networks, ESB network data, architectural heritage and monuments data.

Additional to the data collection exercise, the consultant (TLI Group) was also aware of considerations that EirGrid (Transmission System Operator) would solicit from indigenous connections to the grid network. Adhering to EirGrid functional requirements for the cable route selection, a key selection consideration that the consultant followed for this assessment is referenced below;

“In order to facilitate access for installation and maintenance, the cable route as standard shall follow public roadways, footpaths or green areas under the control of the relevant Local Authority”

A desktop analysis was carried out using the study area constraints map to identify potential grid routes between the windfarm site and Dungarvan Substation.

Initially the following preliminary grid connection options were identified from the desktop analysis:

- UGC Option A - UGC from Dungarvan Substation to Coumnagappul Wind farm utilizing sections of UGC in public road, primarily local roads, and private lands into the wind farm. [22.51km]
- UGC Option B - UGC from Dungarvan Substation to Coumnagappul Wind farm utilizing sections of UGC in public road, primarily the R672, and private lands into the wind farm. [23.05km]
- UGC Option C - UGC from Dungarvan Substation to Coumnagappul Wind farm utilizing sections of UGC in public road and agricultural track into the wind farm. [19.17km]
- UGC Option D - UGC from Dungarvan Substation to Coumnagappul Wind farm utilizing sections of UGC in public road, primarily local roads, Collite forestry track and private lands into the wind farm. [20.47km]
- UGC Option E - OHL Option E - OHL from Dungarvan Substation to Coumnagappul Wind farm utilizing private lands into the wind farm.

Surveys of the preliminary routes identified were carried out onsite in order to examine the feasibility of each route and identify any additional constraints which were not visible during the desktop analysis (i.e. ground conditions, additional infrastructure, land use, etc.) The proposed routes were analysed and altered based on the site conditions in order to select the most feasible route corridors available.

3.0 UGC Grid Connection Options

The following potential 110kV grid connection options have been identified for Coumnaappul Wind Farm at this stage of the process based on desktop analysis and initial site surveys.

Coumnaappul Wind farm - 110kV Grid Connection												
Route Summary												
Rev 1 (26.09.23)												
Route Option	Length of UGC (km)	Length of UGC in National	Length of UGC in Primary roads (km)	Length of UGC in Secondary/Tertiary road (km)	Access to WF Substation	Off road/Private (km)	Watercourses	No. of Bridges	No. of Culverts	No. of Service Crossings	No. of HDDs	Comments
UGC Route Option A - CYAN	22.5	1.225	3.81	14.69	2.32	0.50	3	3	5	>20	1	A1 requires HDD
UGC Route Option B - PURPLE	23.0	0.975	13.03	6.24	2.32	0.47	5	8	6	>10	3	B1 Requires HDD, Pipe Culverts: B2. Possible HDD: B6
UGC Route Option C - MAGENTA	19.2	1.225	9.683	8.34	N/A	N/A	3	6	8	>10	2	C1 Requires HDD, Pipe Culverts: C4
UGC Route Option D - GREEN	21.0	1.225	4.17	12.77	2.32	0.50	3	3	4	>20	1	D1 Requires HDD, D4 not surveyed

Table 1 - UGC Route Summaries

3.1 UGC Option A [Cyan]

UGC Option A - UGC from Dungarvan Substation to Coumnaappul Wind farm utilizing sections of UGC in public road, primarily local roads, and private lands into the wind farm. [22.5km]

Route option A utilises UGC with a route length of approx. 22.56km in total. The Radley Engineering factory, located on the west side of Dungarvan 110kV Substation, is prone to high volumes of traffic. It is also worth noting that Sunrise Energy Supply Limited have submitted a 10km UG grid connection for planning to connect a solar farm in Cappoquin, Co. Waterford to the Dungarvan 110kV Substation (Planning Ref. 16/126), the proposed UGC route follows a similar section of the N72 as chosen for this grid route. The UGC will exit the Dungarvan Substation Compound to the south, passing a number of UGCs in the vicinity of the substation gate, and joins onto the national road (N72). Following the N72 in a west direction for approx. 588m before meeting the first bridge on this route. Bridge A1 (Figures 3 & 4 below) is a precast concrete bridge of approx. 80m length.



Figure 2 – Side elevation of Bridge Crossing A1 (WD-N72-007.00)

This bridge is TII owned bridge, labelled 'WD-N72-007.00'. As this bridge is precast concrete, 500mm concrete slab, with the road surface sitting 100mm below the top of the concrete slab. There is a 500mm concrete base to support the bridge. This would indicate insufficient cover available to allow the ducts to be installed in the bridge deck, it is therefore recommended to utilise Horizontal Directional Drilling (HDD) to pass under the bridge and riverbed, within the road corridor. It should also be noted that TII have objected to the installation of HV cables in any TII bridge infrastructure in recent times. There are existing footpaths on both sides of the road, however due to this being a TII owned bridge it is highly unlikely that permission to use the footpaths or road within the bridge for the cable would be granted.



Figure 3 – Proposed direction of HDD

From here the UGC route follows the N72 for approx. 1,110m before heading north west to follow the regional road R672. The UGC route follows the R672 for 3,600m. The R672 has several drainage crossings under the road, the majority of which are 350mm pipes. The UGC would run parallel to existing Irish Water infrastructure along this section of the route. The UGC transitions north onto local road (L5068). The UGC passes a large busy transport facility (Dungarvan Transport) along this section of the UGC route. The UGC follows the L5068 for approx. 4,626m before turning east onto the L1041 for a further 623m before encountering the second watercourse crossing of the UGC route. This culvert (A2) was inaccessible on the day of the survey and no accurate measurement could be taken. It is estimated that a 500mm diameter PVC pipe was used to direct the watercourse/stream under the road. There was no evident water on the day of the survey to indicate the requirement for a bridge. As a result, it could not be determined if there is the adequate cover required to cross at this point. There are a number of existing Overhead Line (OHL) crossings along these sections of the route, however, there should be minimal impact to the UGC.

The UGC continues in the L1041 for a further 581m before re-entering the R672 for approx. 200m. The UGC then follows the local road (L5111), single lane road, north east for 2,242m, before following another un-named local road to the west. The previous sections would share part of the road with existing Irish Water Infrastructure. The UGC follows this un-named road through a series of bends (it may be more feasible to utilise private lands to remove the bends in the cable) for approx. 85m before heading north for 2,370m along an unidentified local road before reaching a staggered crossroads. At this point the UGC will veer east and have to cross the third bridge (A3) of this UGC option. Preliminary measurements taken show a cover of approx. 400mm which is less than the required 640mm cover between the road and the top of the bridge key

stone required. This bridge would require a HDD to pass under. As this bridge is located on the bend the HDD would be required to cross privately owned land, Folio WD5902.

It may be possible to install a footpath and cross the bridge using a footpath flat formation detail, however in recent times the ESB's approach has been this is only applicable when there is an existing footpath in place. There is approx. 1m of grass verge on both sides of the bridge to cater for a footpath.



Figure 4 - Bride A3/B10 View from West of Bridge

The UGC follows this local road as shown in Figure 4 above, for 4,188m northeast, encountering an OHL crossing and gradient changes in the road network, before entering private lands. The UGC passes through 605m of Folio WD9204 following the folio boundary to the east and a river. The UGC then adjusts its course through Folio WD12912 for approx. 156m following the southern boundary before entering a second land parcel on Folio WD12912 for a further 125m. From here the UGC enters the wind farm boundary and continues to the wind farm substation. An access track would be required, over the cable route, for the off-road sections of the UGC.

Some Site Investigation works would likely need to be carried out on the proposed route as part of the design process in order to identify all services and select a final corridor for the new trench.

Route Option A Constraints:

- Existing ESB UGCs installed at the entrance of Dungarvan Substation.
- Road opening Licences required.
- A general high amount of traffic using the route (N72 & R672).
- 1 No. Bridge crossings with HDD required.
- 3 No. Bridge crossings total
- Several drain crossings along all roads along the route, in particular along the R672.

3.2 UGC Option B [Purple]

UGC Option B - UGC from Dunqarvan SS to Coumnaqappul Wind farm utilizing sections of UGC in public road, primarily the R672, and private lands into the wind farm. [23.0km]

Route option B utilises UGC with a route length of approx. 23.05km in total. This option follows the same route as outlined in Option A for the first 5,369m. Option B Utilises the regional road [R672] for a further 9,106m. The UGC encounters 8 No. bridge crossings and several drainage crossings along the R672. These bridge/drain crossings could pose a risk to the route as due to access the preliminary measurements could not be taken to show a deck cover of great than 640mm to the road surface for all bridge structures.

The option B UGC route encounters a watercourse crossing (B2) approx. 2,062m after diverting from Option A. This watercourse was a PVC pipe of approx. 500mm diameter with approx. 900mm cover from road level to the top of the pipe. This would indicate the UGC could cross within the road using a flat formation.

Continuing along the R672 for 1,549m the route encounters B3 (Figure 5 below), preliminary measurements indicate approx. 1100mm of cover between the road and the key stone which would allow for the cable to pass within the road using a flat formation.



Figure 5 - Bridge B3/C3 towards Dungarvan Substation [WD-R672-003.00]

The UGC encounters two further bridges (B5 & B6) in the next section of the route. Preliminary measurements taken show greater than the required minimum of 640mm cover which would allow both bridges to be crossed within the road network in flat formation.

The route continues in the R672, encountering OHL crossings, drainage crossings and Irish Water infrastructure. At the crossroads between the R672 and the L5114 there is a culvert/drain that runs on the left hand side of the road just off the road that appears to cross from one side of the junction to the other that would need to be crossed under/over.

After passing through this junction, the UGC route encounters the B6 watercourse crossing. No measurements could be taken safely on the day due to the heavy traffic on the day, however at this stage it is estimated that this bridge crossing would not provide the adequate cover to crossing within the road network and therefore would require either a HDD within the road corridor or to divert into private lands. Following on 243m the route encounters watercourse crossing B7. Measurements taken indicate a cover of approx. 1000mm which would allow for a flat formation crossing of this bridge. The UGC follows the R672 for a further 245m parallel to existing Irish water infrastructure, before crossing under/over and into the L5119.

The UGC turns northeast onto the L5119, the routes follow's the L5119 for approx. 2,090m. This section of the UGC must share a short section of the road with existing Irish Water infrastructure. The UGC then must cross Bridge B10, see Figure 4 above. This is the same bridge/crossing method as seen in A3 in Option A. Following on from Bridge A3/B10 the UGC follows the same route and constraints as Option A for the remaining 6,485m to the wind farm.

Route Option 2 Constraints:

- Existing ESB UGCs installed at the entrance of Dungarvan Substation.
- Road opening Licences required.
- A general high amount of traffic using the route (N72 & R672).
- At least 3 No. Bridge crossings with HDD required.
- 8 No. Watercourse crossings total
- Several drain crossings along all roads along the route, in particular along the R672.

3.3 UGC Option C [Magenta]

UGC Option C - UGC from Dungarvan SS to Coumnaqappul Wind farm utilizing sections of UGC in public road and agricultural track into the wind farm. [19.17km]

For the purpose of this review, it should be noted that UGC Option C follows the same route as UGC Option B for the first 10,981m. Option C is the shortest of the three routes examined. Option C encounters the same constraints as outlined previously for Option B, which includes 3 Bridge/Culvert crossings.



Figure 6 – Beary’s Cross Junction

After the 10,981m, the UGC diverts northeast at Beary’s Cross onto the L1041 local road. The UGC follows the L1041 for approx. 2,707m, until it meets the Colligan River. Over the course of this section the UGC encounters one large drain and 1 No Bridge crossing & passing 2 No. OHL crossings. The drain would require an undercrossing. There is a series of sharp bends with a large gradient difference on this section that could pose a risk at the cable pulling stage. The Bridge crossing is a double bridge where the River Colligan and the Skeheens Stream meet. The cable route is only required to cross the bridge over the Skeheens stream, however on the day of the survey there was a substantial volume of water flowing in this stream, which would indicate this water body could be more of a river than a stream. Figure 7 below, shows Bridge C5 overlooking the Colligan River, with the Skeheens stream running parallel, from right to left, on the opposite side of the local and the green field in the background. Preliminary measurements would indicate that there is sufficient cover, of greater than 640mm, with approx. 1000mm available to allow the cable to be located within in the road in flat formation.



Figure 7 - Bridge C6 towards Dungarvan Substation

After crossing Bridge C5, the UGC route diverges north to follow an unnamed local road for approx. 3,212m. This section of the route has numerous OHL crossings, 2 No. drain crossings C6 & C7 and must share the road with Irish Water infrastructure. This road has numerous residential and agricultural properties that would appear to be opposed to wind farms in the area, see Figure 8 below. Similar posters could be seen at entrances to several properties along this section of the route. As there is a visual presence of objectors to wind farms in the area, this could also pose a risk to a cable route in this area.



Figure 8 - Local Objectors to Wind Farms

It is proposed the UGC would then pass through a private agricultural access track which leads to the windfarm. The UGC would pass through Folios WD9242, WD5865 & an unregistered folio for approx. 2,270m



Figure 9 - Agricultural Access track which leads to the wind farm

UGC Option C Constraints:

- Existing ESB UGCs installed at the entrance of Dungarvan Substation.
- Road opening Licences required.
- A general high amount of traffic using the route (N72 & R672).
- At least 2 No. Bridge crossings with HDD required.
- 6 No. Watercourse crossings total
- High volume of drain crossings along all roads along the route.
- Engagement with Landowners required for final section to Wind farm
- Evident local objections to wind farms in the area.

3.4 UGC Option D [Green]

UGC Option D - UGC from Dungarvan SS to Coumnaappul Wind farm utilizing sections of UGC in public road, primarily local roads, Coillte forestry track and private lands into the wind farm. [21.0km]

For the purpose of this review, it should be noted that UGC Option D follows the same route as UGC Option A for the first 18,217m, until it reaches the Coillte forestry track to the west of the Coumnaappul Wind Farm. Option D provides an alternative entry to the wind farm utilising existing Coillte forestry track. The diversion through Coillte forestry track would reduce the cable route by approx. 2,038m and as there is an existing track, it would remove the requirement to construct a new track in a large portion of the off-road (private land) section. There would still be a requirement for a new track for approx. 1,274m from the end of the Coillte track to the Wind farm substation.

The diversion outlined in Option D would encounter one watercourse crossing. This crossing was not surveyed so the clearance could not be determined.

The diversion follows the Coillte track east through the privately owner folio WD9241 for approx. 162m. The UGC continues in the Coillte track for another 720m through a Coillte owned folio, WD5582. The route then enters another Coillte owner folio WD11403, which is where the forestry track ends, the cable then goes off-road for approx. 260m before entering the wind farm and continuing along the same route as option A into the wind farm substation. The 260m off-road section through Folio WD11403 would require a new track over the cable route, this track would then follow the remainder of the cable route to the wind farm substation.

UGC Option D Constraints:

- Existing ESB UGCs installed at the entrance of Dungarvan Substation.
- Road opening Licences required.
- A general high amount of traffic using the route (N72 & R672).
- At least 1 No. Bridge crossings with HDD required.
- 3 No. Bridge crossings total
- High volume of drain crossings along all roads along the route.
- Engagement with Landowners required for final section to Wind farm
- Engagement with Coillte required for permission to use existing track.

3.5 UGC Option E

OHL Option E - OHL from Dungarvan Substation to Coumnagappul Wind farm utilizing private lands into the develop site [14.00km]

For the purpose of this review, it should be noted that UGC Option E was a very high-level exercise to examine the potential for an OHL route to the wind farm. The aim to explore a potential OHL corridor, however, with the distance involved between the proposed wind farm site and the Dungarvan 110kV substation posed an immediate constraint. The elevation changes between the Dungarvan Substation and Coumnagappul Wind farm presented a major constraint to an OHL option. There are a number of deep valleys identified between the proposed wind farm and the ESB substation. An OHL Option would face substantial objections from local residents, which would prove getting landowner consent to be very labour intensive and costly. Additionally, there are forestry areas that would need to be traversed resulting in the requirement for tree felling. When crossing forestry a corridor of twice the height of the maximum height of tree grown in the area plus the width of the line shall be cleared of forestry. No trees or hedges within a 5m lateral line of the outer phase of the OHL can exceed 3m in height.

The option of a Loop in station connecting into an existing HV OHL was considered, however, the closest OHL is approximately 550m from the Dungarvan Substation and therefore deems unsuitable.

OHL Option E Constraints:

- *High volume of landholdings to be crossed would require landowner consent.*
- *OHL option would face major objections from local residence.*
- *Tree felling required in forestry areas.*
- *Difficult terrain between the Dungarvan Substation and the proposed Coumnagappul Wind Farm.*

4.0 Conclusions and Recommendations

The distance between Dungarvan 110kV Substation and the Coumragappul Wind Farm Substation is approx. 15km point to point. There are a number of grid connection options available as detailed in Section 3. Within the constraints mapping carried out on AutoCAD and from initial site surveys it must be stated at this stage that there are significant constraints associated with all three grid route options and that it may be required to pursue more than one option at this stage. Within the constraints mapping carried out on AutoCAD and from initial site surveys there are HV cables entering Dungarvan Substation from the south (N72). Although the position of the UGC's is detailed in the ESB network map data, these positions are indicative only. Site surveys and consultation with ESB would need to be completed as part of the design process in determining the actual position of these UGCs which would in turn determine the position of the proposed route for the new grid connection.

Dungarvan Substation is located in an urban area, however with the close proximity to the industrial development of the Radley Engineering factory the area is prone to high volumes of traffic. It is also worth noting that Sunrise Energy Supply Limited have submitted a 10km UG grid connection for planning linking a solar farm in Cappoquin, Co. Waterford to the Dungarvan 110kV Substation (Planning Ref. 16/126) following a similar section of the N72 as chosen for this grid route. Discussions with Waterford County Council on the proposed route will be key in ensuring that any proposed routes are feasible.

An OHL route was unfeasible due to the volume of tree cutting required (60m corridor) to bring the OHL through a number of forestry areas and the high volume of landowners situated between the proposed wind farm and the ESB Networks substation.

There are a number of bridge crossings to be negotiated in all options. Bridge 1 would require a HDD in order to cross. Bridge B6 potentially would require a HDD. There are number of drainage crossings to note along the R672. Additional survey works will need to be completed on the preferred route selected to confirm the proposed crossing methods.

The UGC routes have been selected based on desktop analysis and initial site surveys and are indicative only. In order to design a final corridor for a potential UGC route, a detailed GPS survey would need to be carried out on the terrain. The UGC trench details will need to be designed to ensure that sufficient clearance distance is maintained between all hazards (existing UGCs, landowner boundaries, vegetation, etc.).

Recommendation

At this stage of the process the Consultant recommends two options that the Client should look to progress.

The first option is to progress *UGC Option D – [Green]* as the preferred grid connection option for the project. UGC Option D utilises an minimal amount of Primary roadway and as a result will incur the lowest costs. However, the success of this grid connection option is dependent on landowner consent for the off-road UGC sections of the route entering the wind farm. Landowners should therefore be engaged at an early outset given the potential resistance to a new UGC outlined above. Option D has the minimal number of bridges along the route that would be required to be crossed. Aforementioned, Option D also utilises the least amount of primary carriageway, the R672 which has a substantial amount of traffic and this option would therefore cause the least amount of traffic disruption during construction.

The second option is to progress UGC Option C [Magenta] as the preferred grid connection option for the project. UGC Option C is the shortest of the three routes options. Option C is required to cross 6 bridges along the route. However, the success of this grid connection option is highly dependent on landowner consent for the off-road UGC sections of the route. Landowners should therefore be engaged at an early outset given the potential resistance to a new UGC outlined above. This route has obvious objectors to the wind farm and there could be a potential risk for a cable route.

At this stage Route Option B [Purple] would be the least desirable route option due to the high number of Bridges encountered along the route. The construction of the cable within the R672 would require a stop and go traffic management system. Option B has the highest volume of constraints along the route as it is the longest of the cable routes and has the highest number of required bridge crossings.



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