Capital Project 1021 East Meath/North Dublin Network Reinforcement

Cable Feasibility Report

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April 2022

EirGrid

CP1021

Capital Project 1021East Meath/North Dublin Network Reinforcement

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Acronym Table

Acronym	Description
UGC	Underground cable
OHL	Overhead line
CP1021	Capital Project 1021
BoQ	Bill of Quantities
HVDC	High Voltage Direct Current
EWIC	East-West Interconnector

Executive Summary

Capital Project 1021 (CP1021) is a proposed EirGrid Project to reinforce the electricity network between East Meath and North Dublin. Further details are provided in the Proposed Project Overview Report [321084AJ-REP-001], along with more information to explain EirGrid's approach to grid development.

EirGrid is considering Overhead Line (OHL) and Underground Cable (UGC) technology options to achieve a 400kV connection between Woodland substation and either Finglas substation or Belcamp substation. This report only considers the technical feasibility of the UGC solution therefore route optioneering is not considered as part of this report.

Meetings and teleconferences have been held between the Client and Consultants to share information and to determine the scope of the study. The overall study area was jointly identified to the west of Dublin during the month of September 2021 and a team of specialists visited the study area during the month of November 2021 to survey the environment from publicly accessible areas.

The connection options being considered by EirGrid are:

- Overhead Line (OHL) options
- Underground cable options

This report only considers the technical feasibility of the UGC options. The environmental and socio-economic considerations associated with each of the options are reported separately.

To facilitate the UGC options, there are two connection options:

- Woodland 400 kV substation to Finglas 220kV substation
- Woodland 400 kV substation to Belcamp 220kV substation.

This report considers the technical content, construction sequence and the advantages of each solution and offers the outcome of the feasibility assessment in accordance with EirGrid criteria as presented in table 1 using the following scale to illustrate each criterion parameter:

More significant/difficult/risk Less significant/difficult/risk

Combined feasibility for Finglas route

The combined feasibility assessments for Finglas are provided in EX-1

Table EX-1- Finglas Cable Option Assessment Overview

Solution	Technical Feasibility	Deliverability Feasibility	Economic Feasibility	Combined Feasibility
400kV UGC (2500sqmm Cu)				
One 400kV UGC (3000sqmm Cu)				

Solution	Technical Feasibility	Deliverability Feasibility	Economic Feasibility	Combined Feasibility
400kV UGC (2x 2500sqmm Al)				

Combined feasibility for Belcamp route

The combined feasibility assessments for Belcamp are provided in Table EX-2

Table EX-2 - Belcamp Cable Option Assessment Overview

Solution	Technical Feasibility	Deliverability Feasibility	Economic Feasibility	Combined Feasibility
400kV UGC (2500sqmm Cu)				
One 400kV UGC (3000sqmm Cu)				
400kV UGC (2x 2500sqmm Al)				

Conclusion

Taking into account the combined feasibility assessments for each option and sub option, it is concluded that sub-option A, the 400kV UGC (2500sqmm Cu) cable is the least constrained and most feasible and sub option C, 400kV UGC (2 x 2500sqmm AL) is the least feasible to Finglas substation.

Similarly, for Belcamp substation, sub option A (400kV UGC (2500sqmm Cu)) is the most feasible and sub option C, the 400kV UGC (2 x 2500sqmm AL) to Belcamp is the most constrained and would be the least feasible/highest risk.

Important note about your report

- The sole purpose of the report is to support EirGrid CP1021 project
- Any information relied upon is presumed accurate in preparing the report (i.e., client and/or third party supplied information)
- Observations and findings in the report subject to the extents permitted by law
- This report shall be read in full, with no excerpts to be representative of the findings
- This report has been prepared exclusively for EirGrid Project CP1021 Step 3, no liability is accepted for any use or reliance on the report by third parties

- The stated feasibility of the cable route options is subject to the outcome of the substation reactive compensation feasibility report. This report to be read in conjunction with the "Cable integration studies" report to be issued by EirGrid

- Cable routes presented in the report are for the purpose of feasibility assessment for cable options only. This feasibility is part of EirGrid's Framework for grid development as described by Step 3. Cable route identification to take place in Step 4 if cable solution taken forward.

Key Assumptions about ratings calculations/system design

- Ratings calculations have been performed using CYME Cymcap 8 rev02
- Generic cable construction datasheets were used for the calculations above
- The number of joint bays along the route has been calculated based on the maximum deliverable length for each cable, as detailed in the supplied cable datasheets.
- The "standard" cable trench cross-section is based on drawings supplied by EirGrid
- The standard joint bay dimensions are based on drawings supplied by EirGrid
- The solutions proposed, in this report, for obstacles crossing, are to be considered provisional and based on the limited information available at this stage
- No third-party data other than that derived from Jacobs' Project Mapper system, other study reports, EirGrid official publications or from publicly available aerial imagery has been used in the study

1 . Introduction

1.1 Aim and context of this report

This report assesses the existence of possible underground cable route corridors from Woodland 400kV substation to either Belcamp 220kV substation or Finglas 220kV substation.

High-level descriptions of the available underground cable (UGC) route options between Woodland and Finglas or Belcamp will be produced, as well as assessments of possible obstacles for each route/option. This report considers the technical constraints (obstacles) that cable circuits would encounter within the study area through to the connections into the substation's bays. These constraints impact both cable ratings and installation activities. Most of these obstacles would be encountered regardless of the cable route chosen (for example streams, rivers, or motorway crossings). Some typical obstacles have been identified and are presented in the report along with indications on how these can be overcome.

It should be noted that this report will assess the feasibility of constructing a new 400 kV circuit going to either Finglas or Belcamp substation from Woodland and will not assess/compare specific cable corridors.

This report also evaluates the below cable options for each of the two options:

- One 400kV circuit standard cable type (2500sqmm Cu)
- One 400kV circuit alternative cable type (3000sqmm Cu)
- One 400kV circuit (2 conductors per phase 2500sqmm Al)

For each solution (i.e., to Finglas or Belcamp), a multi-criteria analysis (MCA) will be performed using the EirGrid coloured scale system, taking some aspects of technical performance and deliverability into account, to give an overview of each option. This will include a high-level cable rating calculation that demonstrates the achievement of the required cable rating.

Please note, that environmental and social impacts are out of the scope for this document. For more detail, see Section 1.4.

It should be noted that the above proposed cable solutions must be evaluated against:

- reactive power compensation requirements
- Harmonic filtering requirements
- Other proposed underground cable circuits entering the same substations

All of the above elements are outside the scope of this feasibility report.

1.2 Description of criteria used to assess the options

This report uses the following criteria to assess each cable solutions:

- Technical Performance

As part of technical feasibility assessment routes corridors were investigated for compliance with relevant EirGrid design standards to indicate a feasible option.

Achievable ratings have been calculated using CymCap 8 and compared against given EirGrid target ratings. These ratings as well as the proposed cable technology have been used to determine the technical feasibility. Further to this, the constraints encountered on some indicative cable route corridors have been identified and discussed highlighting issues and solutions.

- Economic Performance

An initial bill of quantities (based on logical assumptions) has been prepared for each solution.

- Deliverability

As part of deliverability assessment, existing road network, utility networks, as well as man-made and environmental constraints were considered to ensure that the solution can be safely constructed, maintained, and operated. The assessment has largely been based on availability of the road network, availability of land to construct, and the amount of excavated material.

- Environmental

Environmental assessment has not been included in this report's scope, please refer to report 321084AJ-REP-004 – Environmental Constraints Report

- Socio-economic

Socio-economic assessment has not been included in this report's scope. For social impact studies, please refer to the report 321084AJ-REP-005 – Strategic Social Impact Assessment Scoping Report.

1.3 Scale used to assess each criterion

The effect on each criteria parameter is presented along a range from "more significant"/" more difficult"/"more risk" to "less significant"/"less difficult"/"less risk". The following scale is used to illustrate each criteria parameter:

More significant/difficult/risk Less significant/difficult/risk

In the text this scale is quantified by text for example mid-level/moderate (Dark Green), low-moderate (Green),

low (Cream), high-moderate (Blue) or high (Dark Blue).

1.4 Relationship to other technical documents

For an in-depth introduction on the Capital Project 1021, please refer to report 321084AJ-REP-001 Proposed Project Overview Report.

This report is to be read in conjunction with the following reports:

- 321084AJ-REP-004 Environmental Constraints Report
- 321084AJ-REP-005 Strategic Social Impact Assessment Scoping Report

- 321084AJ-REP-006 Substation Feasibility Report
- 321084AJ-REP-003 OHL Corridor Feasibility Report

2 . The Proposed Project

2.1 Study Area

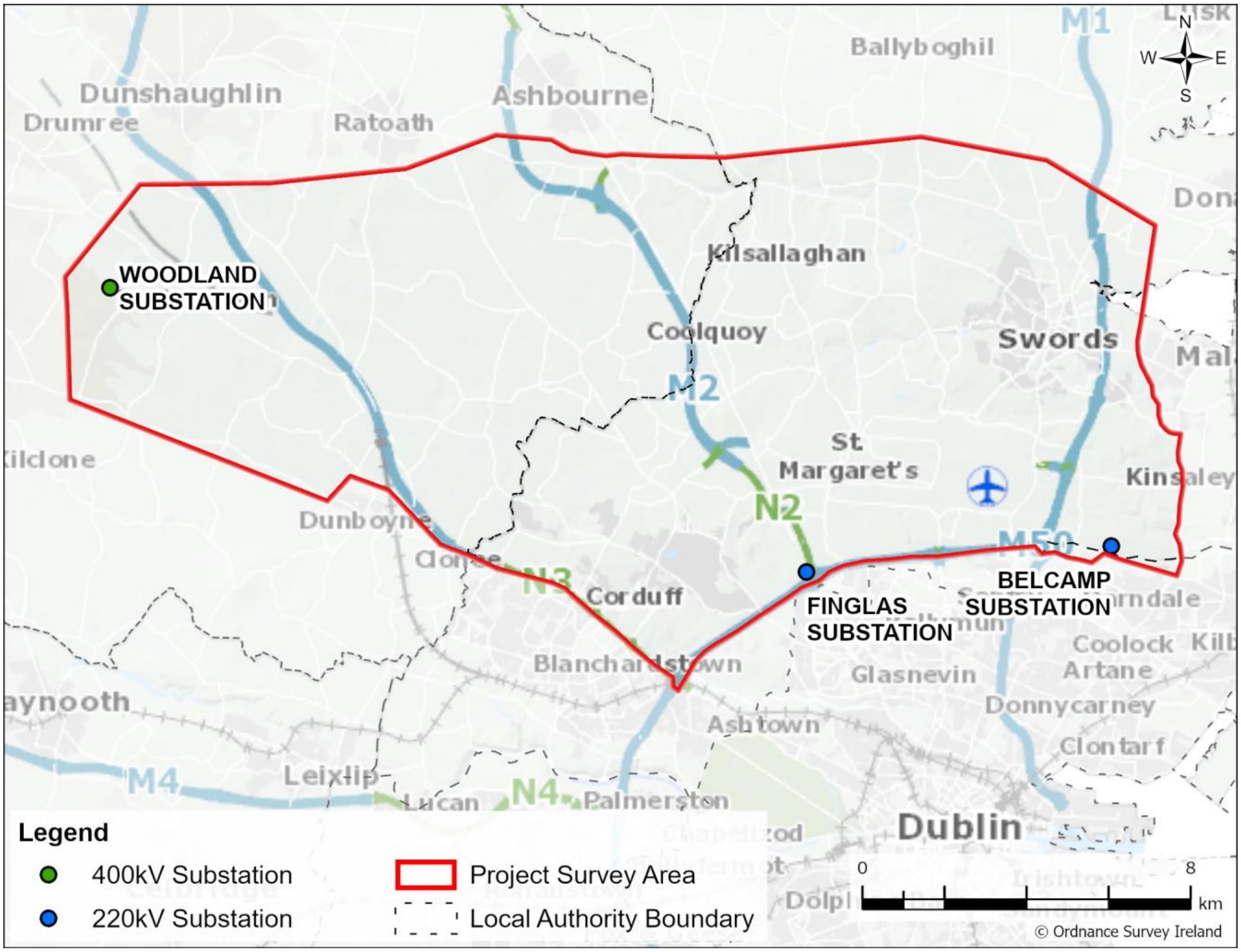

Figure 2-1 CP1021 Finalised Study Area (Project Mapper)

Figure 2-1 shows the Study Area for Step 3 of CP1021. This area has been selected to encompass all possible solutions for the proposed technology (either underground cables or overhead line) to either Finglas or Belcamp substations. The following factors were considered when creating the study area:

- Road network presence;
- Settlements including villages and towns
- Existing electrical utilities and other major services (high pressure gas networks, sewage system and water);
- Physical constraints (e.g., motorway, river, or rail crossing); and
- Environmental constraints.

By focusing on the above constraints, in particular the road network and the route length (whereby we are trying to achieve the minimum route length and using the existing road network), the Study Area was selected to give the highest likelihood of ensuring that at least one of the cable corridors to either Belcamp or Finglas would be feasible.

Following recent discussions with TII, it is assumed that motorways are to be avoided so the Study Area boundaries follow the M3/N3 to the East and the M50 to the South. South of the M50 has been removed, as this is not considered to be feasible for a variety of reasons, including the proliferation of existing utilities residential and industrial buildings and the significant disruption that would be brought to the area.. The northern border was expanded to allow for a potential route corridor north of Swords to avoid Dublin International Airport. Further dialogue will take place with TII at later stages in the Proposed Project to confirm whether this assumption remains valid.

2.1.1 Study Area Data and Site Visit

The Study Area visit was undertaken in October 2021, prior to the evaluation of options and was limited to observation from public roads or from within affected substations.

Available data was collated in Jacobs' Project Mapper system to develop a constraints plan that illustrates the various features and services in the Study Area that could affect the development of potential UGC corridors. Apparent constraints and opportunities were then noted before a limited surveillance was undertaken

The following observations were made from the site visit:

- The area surrounding Woodland is generally rural however the areas towards Finglas and Belcamp become increasingly suburban and commercial in use
- In the rural areas, farm buildings and individual properties are often situated along the narrow minor roads
- Field boundaries are generally fencing and hedgerow
- Various arterial roads are noted that radiate from Dublin including the M1, M2 and M3 motorways and various regional main roads.

2.1.2 Future Development Plans

A number of major infrastructure projects are proposed in the Study Area, which could impact on any future route corridor (see Table 2-1).

Table 2-1 Major Infrastructure Projects in the Study Area

Name	Description
Datacentre north of Finglas	Planning permission has been granted for existing OHLs entering Finglas substation from the north to be undergrounded to facilitate the development of land to the north for a new data centre. The undergrounding work is due to be completed in Q2 2022.
Dunboyne Retail	Land has been identified and zoned for new residential and retail area north of Dunboyne in the Meath County Development Plan (November 2021).
Metrolink	A high-capacity, high-frequency rail line that will run from Swords to Charlemont, linking Dublin Airport, Irish Rail, DART, Dublin Bus and Luas services. The proposed route includes a bridge and elevated track over the M50 motorway and an underground tunnel under Dublin Airport[1].

[1] https://www.metrolink.ie/assets/downloads/Public_Consultation_Document_for_the_Preferred_Route_HR.pdf

Name	Description
Greater Dublin Drainage Project	Greater Dublin Drainage (GDD) is a project to develop a new regional wastewater treatment facility and associated infrastructure to serve north Dublin and parts of the surrounding counties of Kildare and Meath. A new regional wastewater treatment facility and sludge hub centre is proposed on a 30- hectare site at Clonshagh (Clonshaugh)[2] immediately north of Belcamp substation.
Aviation Fuel Pipe	An aviation fuel pipeline will run from Dublin Port to Dublin Airport via R139, Clonshuagh Road and Stockhole Lane[3].
Shellybank-Belcamp-Finglas UGC connection	A new 220kV UGC will connect Belcamp substation to Shellybank Substation (Capital Project0984). This includes sub-project CP0978, which is a new 220 kV cable bay in Finglas 220/110 kV station to connect the new Belcamp – Finglas 220 kV cable and the new Belcamp 220 kV station to the transmission system[4].
Kildare Meath CP966 project	CP966 is a proposed UGC project currently in Step 4 that aims to strengthen the transmission network in Kildare & Meath between Dunstown and Woodland substations. [5]
East – West Distributor Road north of Belcamp	According to Fingal County council website, there are two access roads linking Clonshagh Lane to Malahide Roadinsaley Road (Fingal East-West Distributor Road).[6]
North South Interconnector	Proposed 400kV OHL connecting Ireland to Northern Ireland. This proposed line would run through counties Monaghan, Cavan and Meath in Ireland, and Armagh and Tyrone in Northern Ireland.[7]

[2] https://www.gddapplication.ie/planning-sites/greater-dublin-drainage/docs/planning-documents/planning-reports/SID-Planning-Report.pdf
[3] https://planning.agileapplications.ie/fingal/application-details/70879
[4] EirGrid Transmission Development Plan 2020-2029
[5] http://www.eirgridgroup.com/the-grid/projects/capital-project-966/the-project/
[6] 2 Fingal County Council (2017), Fingal Development Plan 2017-2023. Available online at: https://www.fingal.ie/fingal-development-plan-2017-2023 (Accessed: November 2021)
[7] https://www.eirgridgroup.com/the-grid/projects/north-south/the-project/

2.2 UGC Design

2.2.1 Existing UGC within study area

There are existing UGC in the Study Area (see Figure 2-2).

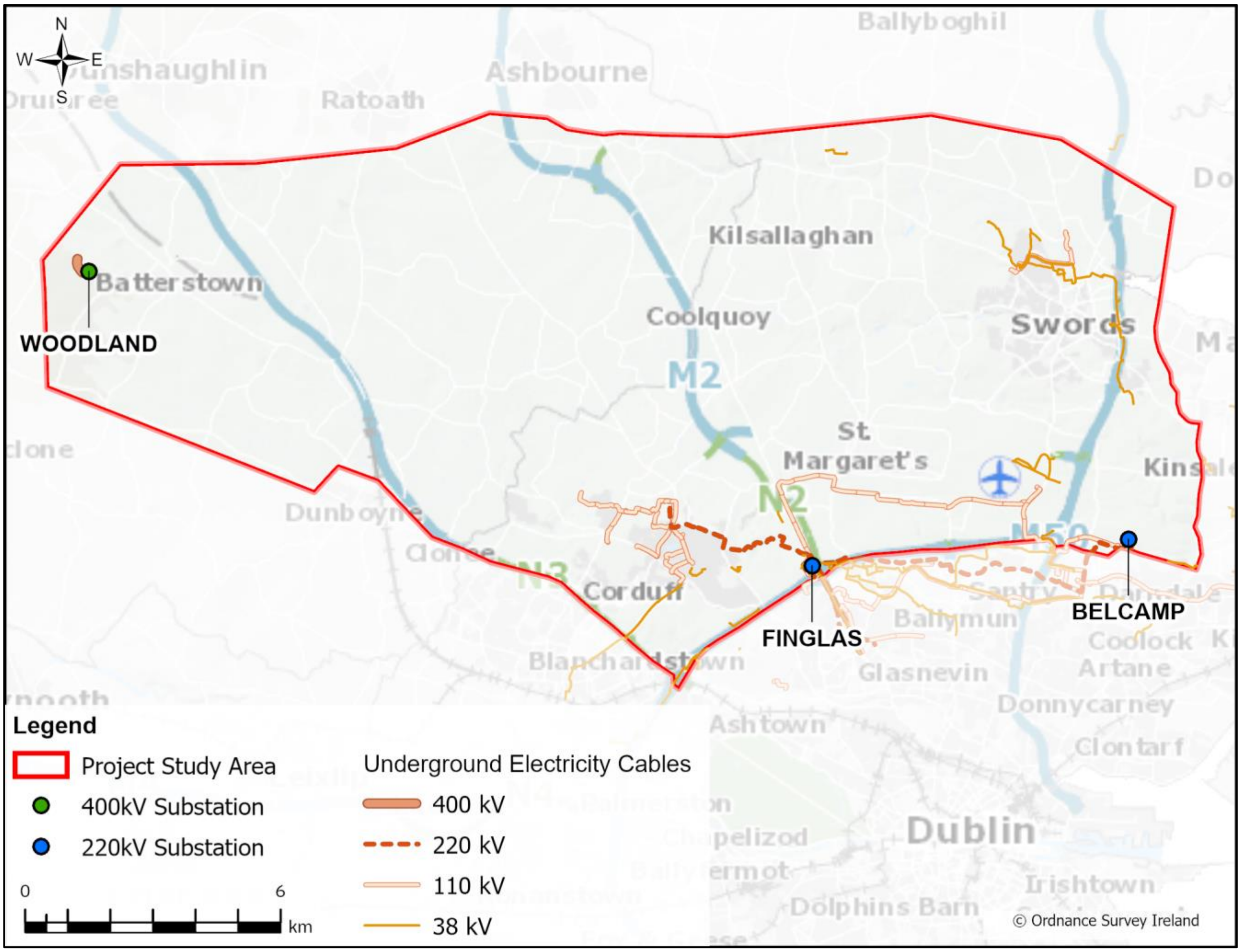

Figure 2-2 Underground Cables in the Study Area (dashed lines).

UGC connections within the Study Area are detailed in Table 2-2 and are taken from EirGrid Transmission Map (see Appendix A).

Table 2-2 UGC Connections within the Study Area

Name	Description
East West Interconnector (EWIC) AC	AC UGC connecting Woodland 400kV substation to Portan Converter Substation
EWIC DC	HVDC UGC interconnector connecting Ireland (Portan Converter Station) to Wales (Shotton) [8]

[8] http://www.eirgridgroup.com/the-grid/projects/biodiversity-project/whats-happening-now/

Name	Description
Shellybank UGC connection (Shellybank- Finglas – Belcamp)	Currently Finglas is connected to Shellybank substation as well as Belcamp substation. The order of this arrangement will be changed in the future (see Finglas – Shellybanks 220 kV Cable Diversion (CP1044).
Finglas connections	Finglas is currently connected to the following within the study area: • Dardistown 110kV substation • Corduff 110kV and 220kV substations • Macetown Maynooth 110kV substations • Ballycoolen 38kV substation • Hunstown Power 220kV substation • Belcamp 220kV substation
Belcamp connections	Belcamp is currently connected to the following within the study area: • Finglas 220kV substation • Darndale 110kV substation

2.2.2 Target System Ratings

Table 2-3 sets out the target "continuous" winter and summer current ratings, to match those of an equivalent OHL installation. The standard 400 kV OHL conductor is 2 x 600 mm^2 ACSR CURLEW at 80°C, with a winter rating of 2963 A and summer rating of 2506 A.

Table 2-3 Target System Ratings

	WINTER	SUMMER
Line ratings as specified in ITT, and equivalent to deliverable power from OHL	2963A	2506A

Any suggested underground cable solution should aim to achieve the same line ratings as an equivalent overhead line connection.

2.2.3 Assumed installation cross-sections

The following UGC and trenches have been assessed in this report:

- OPTION A: One 400kV circuit using a 2500 mm^2 Cu XLPE cable installed in flat formation in a 1700 mm wide trench – this would be the typical ESB trench formation for these voltages – see Figure 2-3

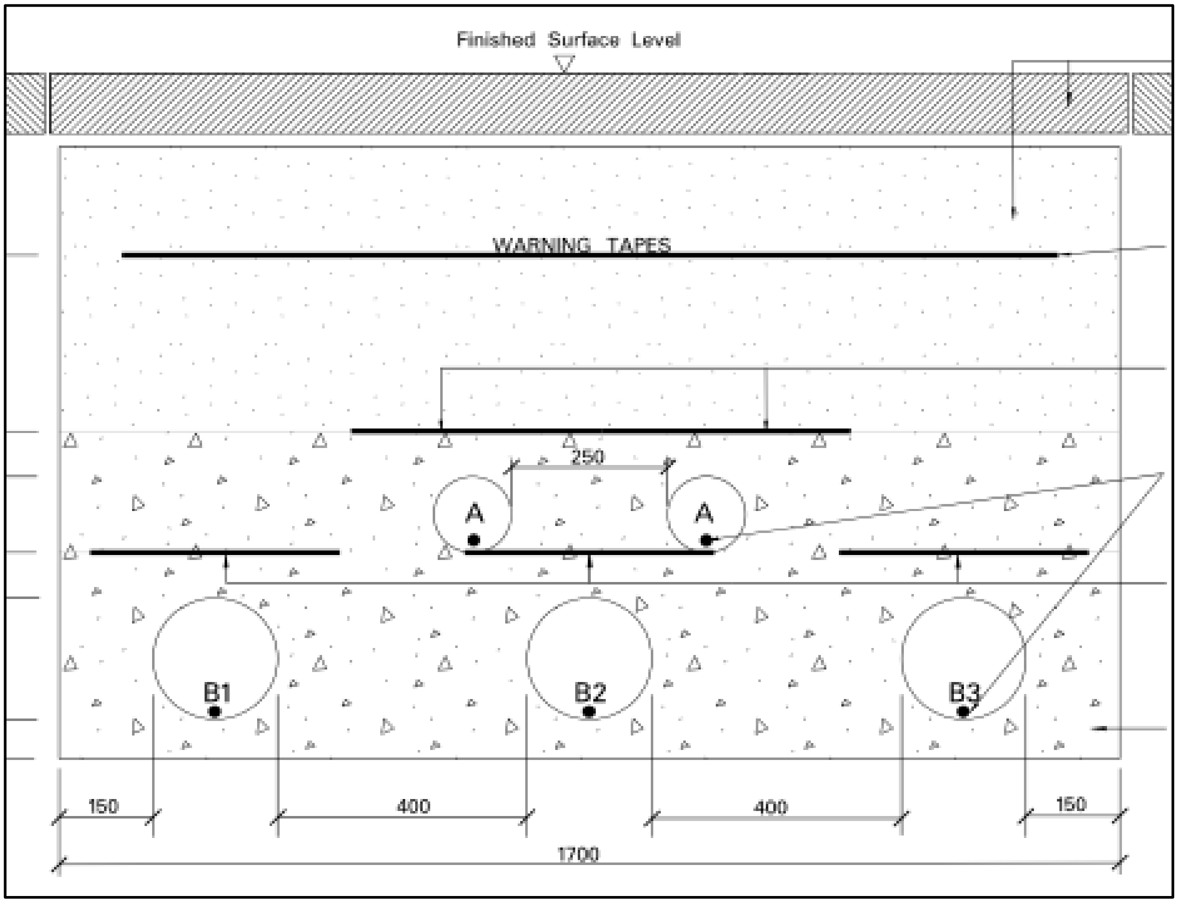

Figure 2-3 - Typical ESB trench cross-section for UGC road installation

- OPTION B: One 400kV circuit using an alternative cable type (3000 mm² Cu XLPE) installed in flat formation in a 2100 mm wide trench – See Figure 2-4.

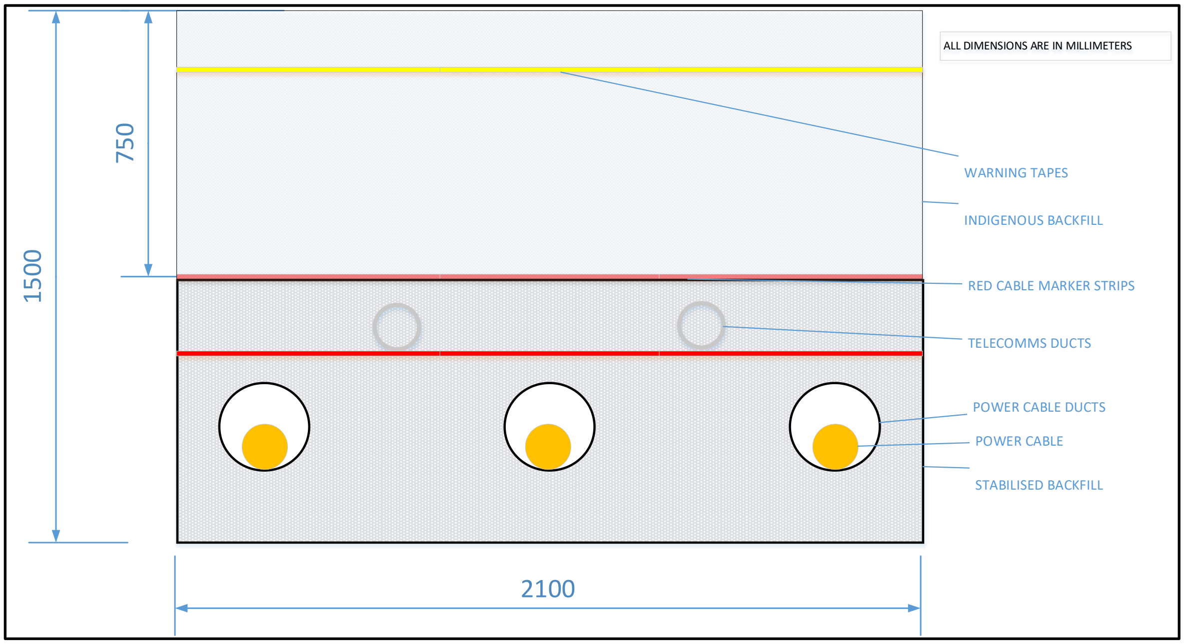

Figure 2-4 - Assumed cross-section for 2.1m wide trench

- OPTION C: One 400kV circuit using 2 conductors per phase (2500 mm^2 Al XLPE cable per phase), installed in trefoil formation in a single 1700 mm wide trench

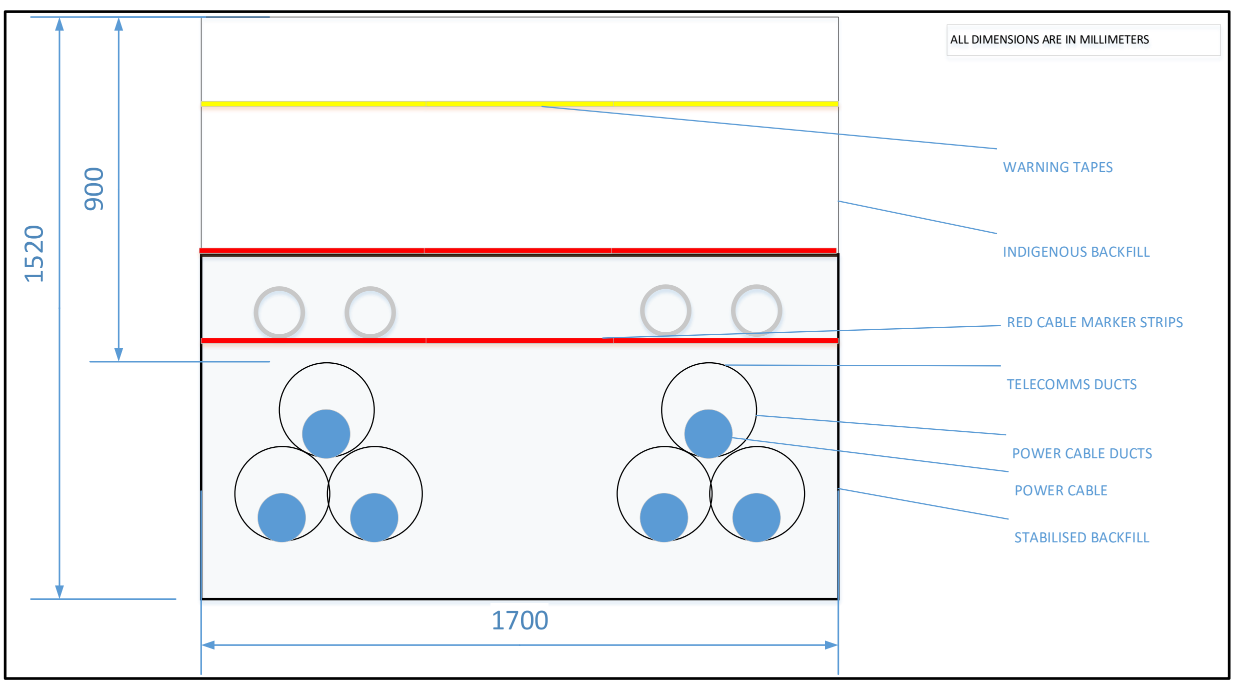

Figure 2-5 - Assumed trench cross-section for 1.7m wide trench "conductors per phase solution

All options noted above, have a stabilised CBGM bedding and surround as per EirGrid/ESB requirements.

Depth to the top of ducts is as per EirGrid/ESB requirement for cable installations in roads.

Thermal performance of indigenous and backfill materials is as per CDS-GFS-00-001-R1 - Cable Specification.

2.2.4 Options Delivered Ratings

The different options, described in Section 2.2.3 will deliver maximum continuous current ratings as per The 1700mm and 2100mm wide trench are not standard trenches. These are wider so to increase the separation between phases and improve the rating. This is the first attempt to improve the rating of these cables. If it needs to improve further additional measures will have to be taken and these are normally more expensive and less effective.

It should be noted that no effort has been undertaken to improve the capacity of the cables to carry current at this stage of the project. These efforts are best placed when the final route is developed and cable types and laying configurations for the most limiting thermal pinch points can be thoroughly examined.

Table 2-4. The 1700mm and 2100mm wide trench are not standard trenches. These are wider so to increase the separation between phases and improve the rating. This is the first attempt to improve the rating of these cables. If it needs to improve further additional measures will have to be taken and these are normally more expensive and less effective.

It should be noted that no effort has been undertaken to improve the capacity of the cables to carry current at this stage of the project. These efforts are best placed when the final route is developed and cable types and laying configurations for the most limiting thermal pinch points can be thoroughly examined.

Table 2-4 Delivered Ratings

Options	TRENCH AND CABLE SOLUTION DELIVERED RATINGS			
	WINTER	[%] REDUCTION ON TARGET RATING	SUMMER	[%] REDUCTION ON TARGET RATING
Target rating (typical OHL)	2963 [A]	0%	2506 [A]	0%
Option A	2130 [A]	28%	1878 [A]	25%
Option B	2206 [A]	26%	1950 [A]	22%
Option C	2660 [A]	10%	2290 [A]	9%

These ratings have been calculated for the cross-sections described in 2.2.3.

A number of potential crossings have been identified in the study area, such as motorways, canals, railways.

Some of these crossings may require some deep horizontal directional drill (HDD) solutions to be overcome (see Figure 2-6).

The potential further impact on the deliverable ratings of the system from these crossings has been calculated (see Table 2-5) for the following typical scenario:

- HDD crossing;

- Deepest point of the crossing located at 10m bgl. This is a conservative figure, which has been utilised on similar projects for EirGrid in Ireland;
- Average ground conditions at deepest point; and
- Assumed ground temperature of 10°C (winter and summer) at crossings.

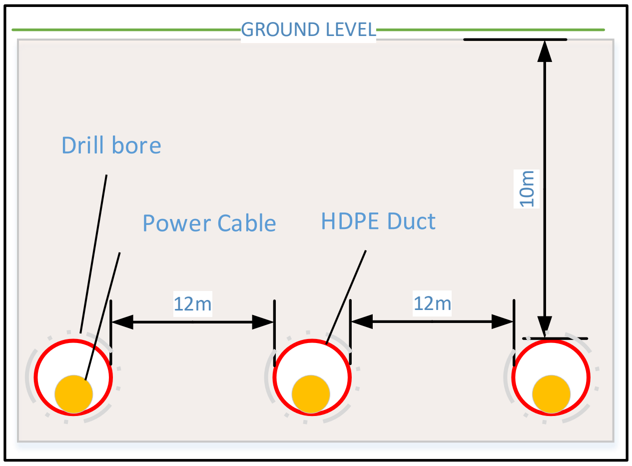

Figure 2-6 - Typical HDD cross-section for Options A and B

Table 2-5 HDD and Delivered Ratings

Options	HDD AND CABLE SOLUTION DELIVERED RATINGS				
	WINTER	[%] REDUCTION ON TARGET RATING	SUMMER	[%] REDUCTION ON TARGET RATING	Notes
ITT target rating (typical OHL)	2963 [A]	0%	2506 [A]	0%	
Option A	1884 [A]	36%	1884 [A]	25%	[1] [2]
Option B	2023 [A]	32%	2023 [A]	19%	[1] [2]
Option C	2130 [A]	28%	2290 [A]	15%	[1] [3]

[1] Bore depth of 10m

[2] 12m Phase separation

[3] 8m group separation

2.3 The Study Area

2.3.1 Study Area Constraints

There are several physical constraints which may limit the implementation of the cable routes directly such as the following:

- Vegetation
  - Figure 2-7 and Figure 2-8 show a typical country L-road found in the Study Area. Given the minimum width of the cable trench, the additional space required for the excavated backfill and the access route, it may be difficult to implement a route without damaging the existing vegetation.
  - The presence of tree/hedge roots negatively impacts the thermal resistivity of the existing ground by removing moisture from the soil. This will therefore affect the cable's rating. The tree's root systems may also get entwined around the cables resulting in physical damage to the cable and later intervention more difficult. CIGRE TB 194 recommends a minimum clearance of 2.5m between the cable and nearby trees. This requirement will need to be clarified in the next stages of the Proposed Project.
  -
- Heritage sites
  - Some locations inside the study area may be classed as heritage sites, thus imposing additional constraints on the chosen route. This is discussed within the Step 3 Environmental Constraints report, please see 321084AJ-REP-004.
  -
- Road closures
  - We foresee requiring partial/full road closures for some sections along the possible routes analysed during the site survey. This may have a substantial impact on the community due to limited access to property in the study area. Further investigations will be required at a later stage of this project.

Figure 2-7 - Example of L-Road Constraint in Study Area

Figure 2-8 - Example of L-Road Constraint in Study Area

2.3.2 Existing Infrastructure Constraints

Regardless of which route is chosen, existing infrastructure will need to be crossed and several constraints will need to be overcome. These crossing will impact the ratings and technical feasibility of all cable route options.

2.3.2.1 Bridges

There are many different bridge types within the proposed study area. These include crossings over National roads, motorways, railways and over bodies of water such as rivers and streams. Since these vary greatly in both size and construction, each solution should be investigated individually for feasibility.

The image shown in Figure 2-9 is an example of a motorway crossing. Review of the study area for Step 3 shows that for all cable solutions, we would need to cross National roads and Motorways. Use of the motorway network to route new cables has been deemed unfavourable by Transport Infrastructure Ireland.

The following options would be considered to cross a motorway or national road:

- Cable trenches installed within the bridge structure itself
- Cables attached to the underside of a bridge
- Horizontal Direct Drilling (HDD) under the motorway
- Use of alternative crossing points where use of the bridge is not possible

The use of the existing bridges to route cables would require significant additional studies. The following would need to be considered:

- Presence of other services on the bridge
- Material strength and architectural heritage
- Structural capacity
- Temporary works required to install cables into bridge including, but not limited to, erection of temporary scaffolding, temporary lane closures, and traffic management

Figure 2-9 Example of Bridge Constraint Over Motorway in Study Area (M2, County Meath)

2.3.2.2 Waterbodies

There are only small waterbody (streams and narrow canal) crossings within the proposed Study Area; no large rivers are present (see Figure 2-10). Where the use of existing road bridges to carry the new UGC across the watercourse is not possible, or when a crossing is in third party lands, e.g. agricultural land, crossing these waterbodies is assumed to be possible using either open cut trench solutions or HDD. Vegetation clearance will be required along the banks of rivers and streams, along with environmental and geotechnical studies. Potential environmental impacts relating to this are described in the Environmental Constraints Report (see 321084AJ-REP-004).

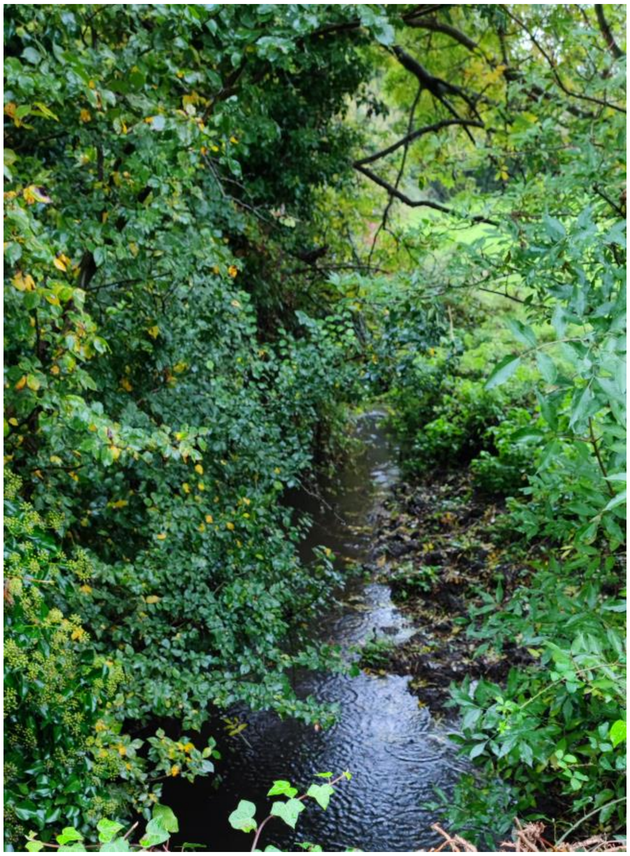

Figure 2-10 - Example of Waterbody Constraint in Study Area

2.3.2.3 Railways

There is only one railway within the Study Area, which terminates a short distance into the Study Area north of Dunboyne, at Junction 5 of the M3, close to the Tolka river (See Figure 2-11). Currently. Railways will be crossed using HDD; when using HDD to cross below railways tracks, it is important to maintain ground settlement to the minimum to avoid track deformation. This normally requires going deeper underground which in turn causes unwanted derating of the cable.

Standalone cable bridge structures can also be considered with prior agreement from the local rail authority.

Figure 2-11 - Example of Rail (left-hand side) and River Crossing (right hand side) in Study Area

2.3.2.4 Other Underground Utilities

As is to be expected, there are numerous existing underground utilities within the study area, especially in the urbanised areas including; medium/low pressure gas pipes, low voltage cables, water and sewer pipes, telecoms etc (see Figure 2-12).

Due to the size and population density within the Study Area, it is anticipated that any cable route would cross a significant number of utilities.

There are two main solutions to cross such services:

- ~~Divert the existing utility/pipe; and~~ Diverting existing services; some services , like street lighting, can be easily diverted with very short outages. Other, like medium pressure gas main, may require longer discussion with utilities and, ultimately, alternative solutions
- Install the cables underneath/ ~~over~~ above the utility

For both solutions, there is an increased cost for the civil constructions works required. In a scenario where the cable is routed underneath the utility, it is possible that the cable will be significantly de-rated and will not provide the necessary capacity as specified by EirGrid system design. To reduce the risk of having to cross major services, any cable circuit should be routed to avoid villages/towns/industrial areas where there is a high probability of several of these services within the existing roads.

Figure 2-12 - Example of a L-Road with evidence of existing services in road

Figure 2-13 - Example of Electricity Constraint in Study Area, Underground Cable Entry Point (Belcamp, County Dublin)

Figure 2-13 shows a 38kV underground cable entry point leading under a main road and provides an insight into some of the electrical utility constraints that any cable technology may encounter within the study area. Electrical interactions between Extra High Voltage (EHV) cables and High Voltage (HV) cables can lead to de-rating of both cables. Therefore, each cable crossing must be assessed for ratings compliance. This is less of an issue for Low Voltage (LV) cables – cables voltages of 1kV or below. These LV cables are typically used at distribution level for housing. The above example of a 38kV cable would require inspection.

To overcome issues linked to crossing other cables, a deeper trench must be dug underneath the existing infrastructure which will also lead to a de-rated cable. This should be avoided wherever possible.

In the North of the Study Area is the HVDC "East-West Interconnector" (±200kV DC underground cable). This is a nationally significant piece of electrical infrastructure. Any cable route within the study area would need to avoid the interconnector as crossing is not recommended.

2.3.2.5 Dublin International Airport

Figure 2-14 - Example of R-Road Near Airport Boundary in Study Area

The proposed cable corridors going towards Belcamp are likely to approach and go alongside Dublin Airport (see Figure 2-14). There are airport regulations concerning how close UGC can get to the airport boundaries. There may also be existing airport services. Initial discussions with airport authority suggests that UGC installation and operation will have minimal impact on airport activities. Potential corridors running near the airport will be investigated further at a later stage.

3 . Corridor Appraisal

Given the Study Area as per Section 2.1 above, and guidelines (provided by EirGrid), multiple indicative underground cable route corridors were identified for the feasibility assessment. The constraints (provided by EirGrid) were as follows:

- The route shall avoid motorways
- The route shall use Ireland's N, R & L roads avoiding congested city centres or industrial estates
- The use of private land shall be avoided where possible
- Minimise overall route length as reasonably practicable

3.1 Sub-study Areas

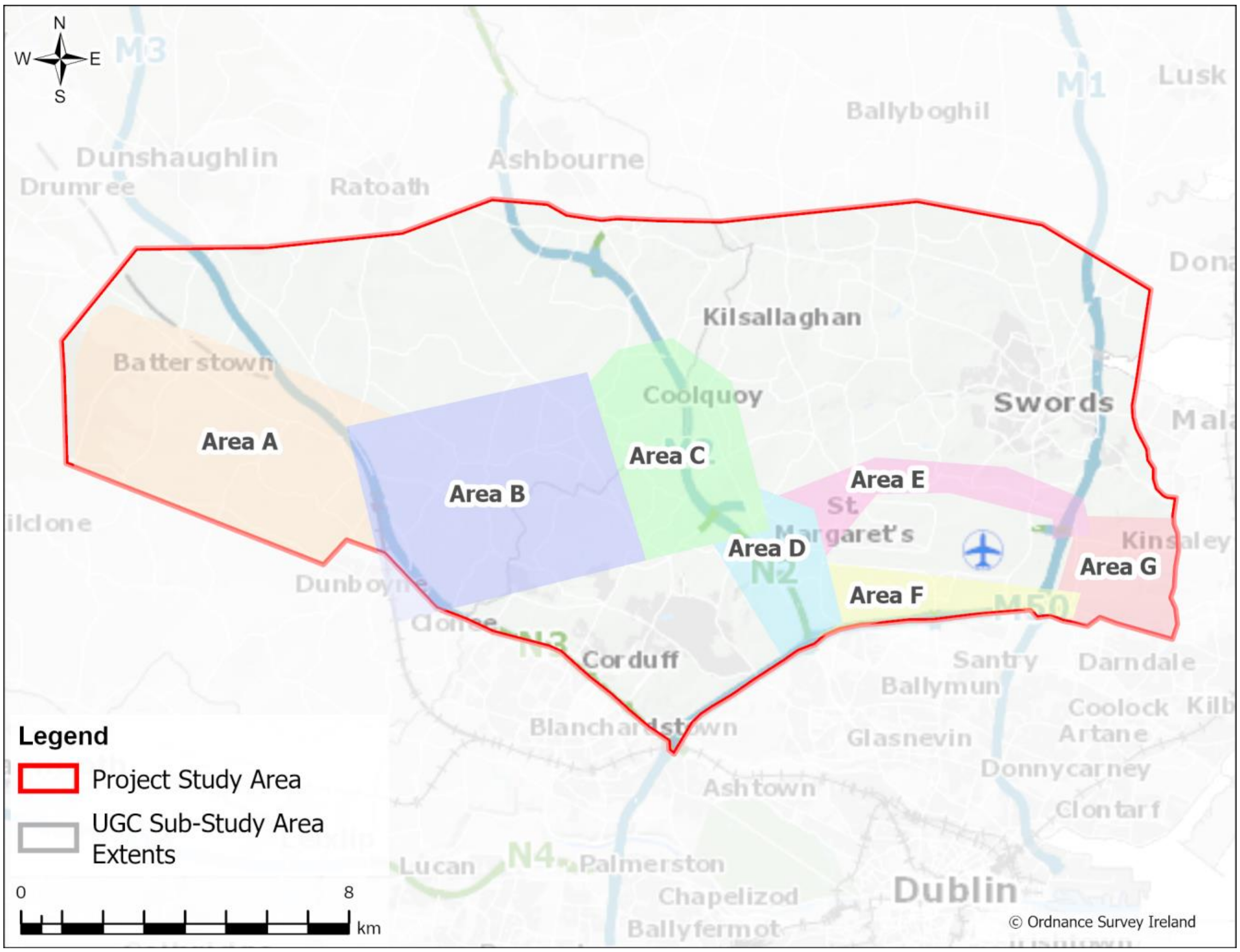

Figure 3-1 Indicative Cable Route Corridors from Woodland to Finglas and Belcamp

The Proposed Project Study Area has been sub-divided into several smaller sections where similar landscape characteristics are present and different opportunities and threats exist (see Figure 3-1). The sub-study areas are as follows:

- Sub-Area A: Woodland surrounding area
- Sub-Area B: South of Woodland
- Sub-Area C: M2 Crossing
- Sub-Area D: Finglas surrounding area
- Sub-Area E: North of Dublin Airport
- Sub-Area F: South of Dublin Airport
- Sub-Area G: Belcamp surrounding area

In consideration of the constraints outlined in Section 2, the Figure 3-1 sub-study areas provide an indication of the potential cable corridors from Woodland 400kV substation to Finglas and Belcamp 220kV substations. The very broad corridors shown are indicative and have been identified as part of this feasibility study where for the most part only existing road networks have been used.

It is anticipated, however, that any final route, due to the various constraints discussed throughout the report, will require some use of third-party land to route the cables. This is to avoid "pinch-points" due to existing constraints such as settlements within the study area or existing UGC cables near the substations.

3.1.1 Woodland Substation

The common starting/terminus point for both main options being considered is Woodland substation, in the north west of the Study Area (See Figure 3-2).

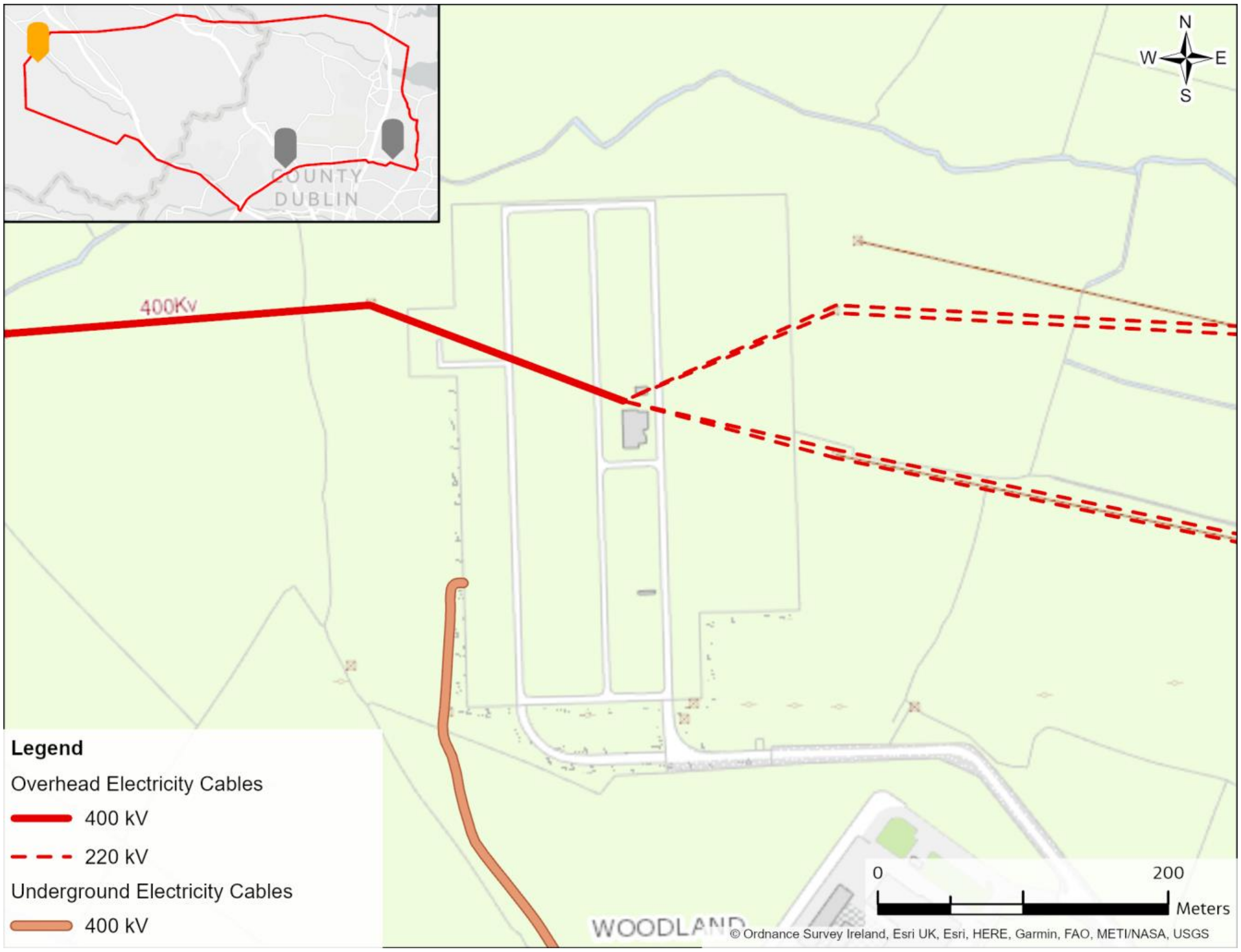

Figure 3-2 Woodland substation

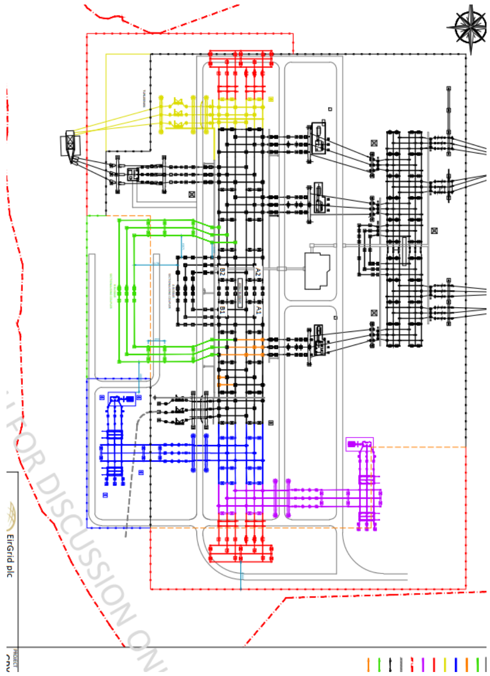

Figure 3-3 - Proposed layout for Woodland substation (CP1021 bay shown in purple)

Following the site visit, EirGrid confirmed that other projects are planned for the Woodland site and specific areas outlined for development. At the present time, the substation bay area identified for the new East Meath 400kV connection is still under discussion; the bay for this project will be in the southeast corner of Woodland substation, including an extension of the substation in that area (Figure 3-3).

There are two options of cable connections to the proposed bay (see Figure 3-4):

- Approach from the east side and follow the substation boundaries; or
- Approach from the west side and cross the East-West Interconnector cable

If the approach from the south-west is chosen, care must be taken to avoid the cable connecting Woodland substation to HVDC Portan Converter station. Figure 3-3 shows the key cable connections to Woodland that needs to be avoided. The cable for CP1021 will need to cross the cable for CP966 which may de-rate both cables. Further investigation will be required to assess the impact of this cable crossing. The cable route along the substation boundaries will also sterilise the land surrounding the substation. This will have environmental impacts and may limit future work and expansion of Woodland substation. Furthermore, this option will increase the overall length of the route which will also have cost implications.

If the approach from the south-east is chosen, crossing the East-West Interconnector (EWIC) is inevitable. The East-West interconnector is a HVDC cable that connects Ireland to Wales and is critical infrastructure. Crossing this cable, will potentially derate both the interconnector cable and the CP1021 cable.

Should this approach be chosen, cable crossing derating calculations will need to be performed. Further investigation will be required to ascertain if crossing the interconnector is feasible.

Figure 3-4 Cable Connection on the southeast side of Woodland

3.1.2 Sub-Area A Woodland Surrounding Area

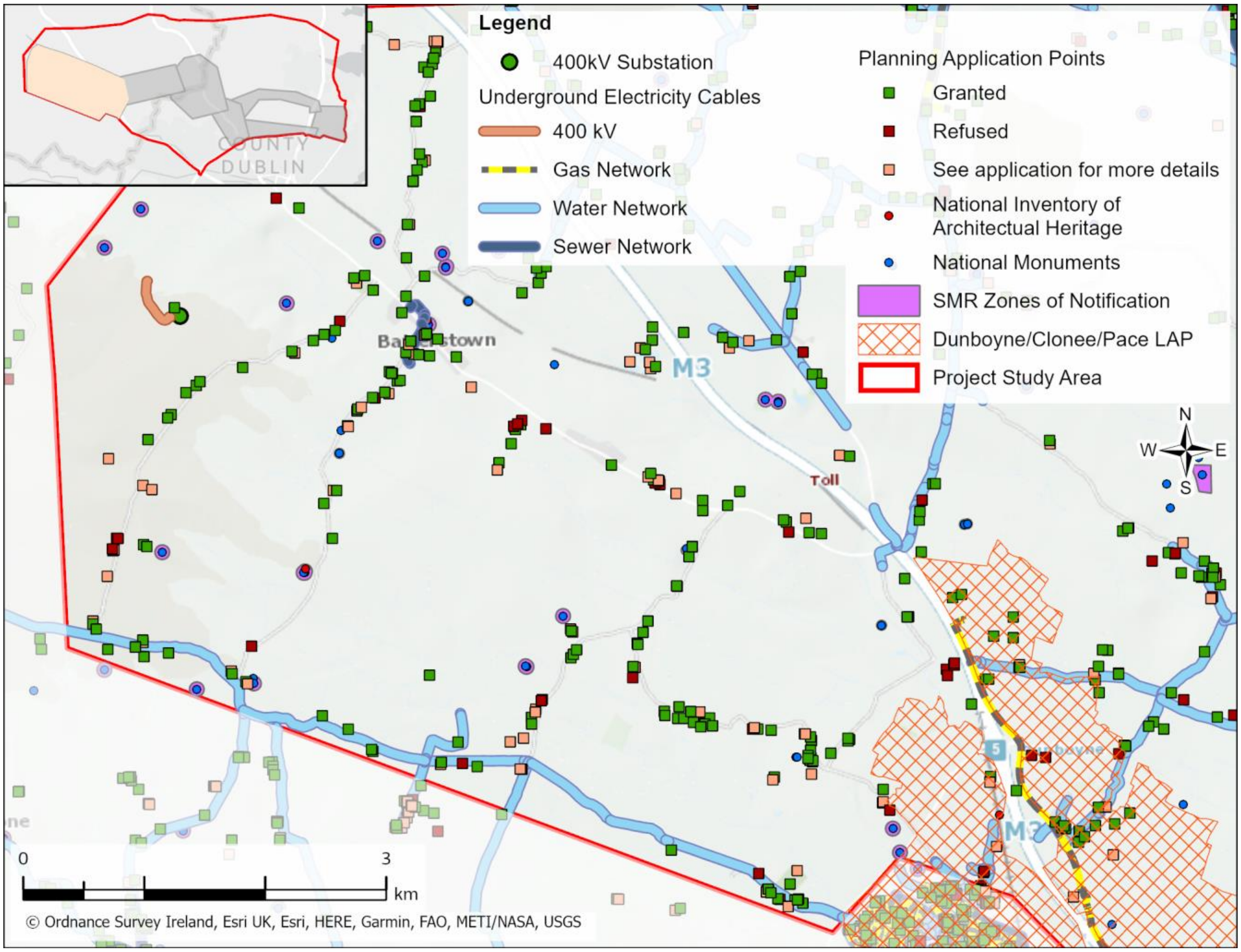

Figure 3-5 – Sub-area A Woodland Surrounding Area

There are multiple potential routes out of Woodland substation depending on which bay connection into Woodland substation is chosen. To avoid high voltage cables already present near Woodland, for instance the East West Interconnector and the proposed CP966 cable, it is likely the route out of Woodland substation will have off-road sections.

3.1.3 Sub-Area B South of Woodland

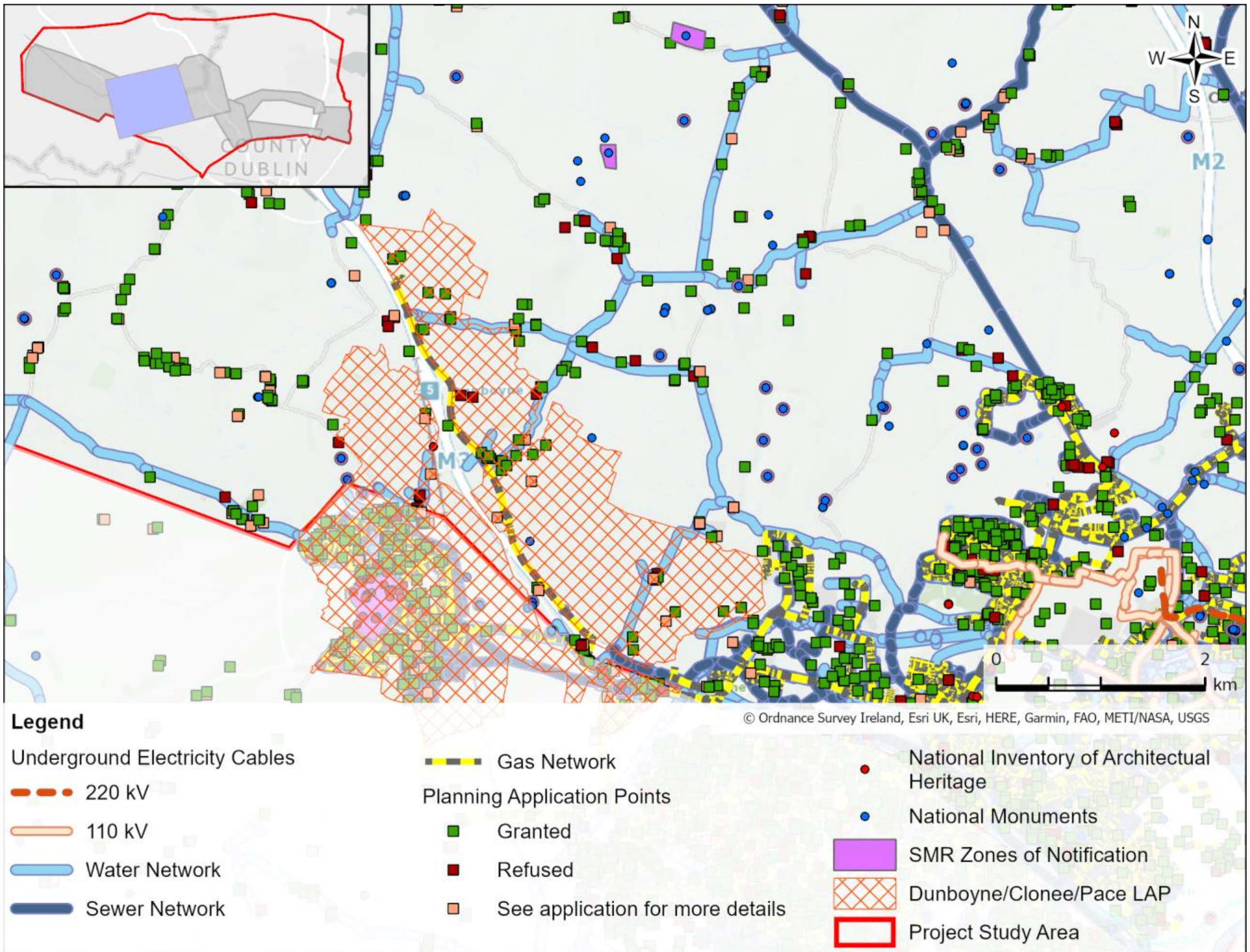

Figure 3-6 – Sub-area B South of Woodland

Once the cable is suitably far away from Woodland, it could either go East or West and then East to reach the larger regional R roads to the East of this sub-area. Either approach will require interactions with residential areas, cross several waterbodies, to then cross the M3 motorway.

It appears from publicly available records that there are no existing services within the R-roads within this sub-area. If the cable route passes Batterstown, it will pass residential areas, cultural heritage sites and cross a sewage gravity main.

If the cable route goes southwest past Dunboyne, it will run parallel to waterbodies next to the road, cross a main river and finally cross the M3 and M3 Parkway railway station. There is also planning application for a new shopping area near Dunboyne.

East of the M3, there is a limited number of roads going across towards Finglas and Belcamp, with the majority of them being local roads. During the site survey, it was observed that most of these roads are narrow with waterbodies along the side of the road and some sections with waterbodies on both sides of the road.

This sub-area was chosen to avoid the built-up areas south of the boundary where existing services within the roads are more likely.

3.1.4 Sub- Area C M2 Crossing Sub-Area

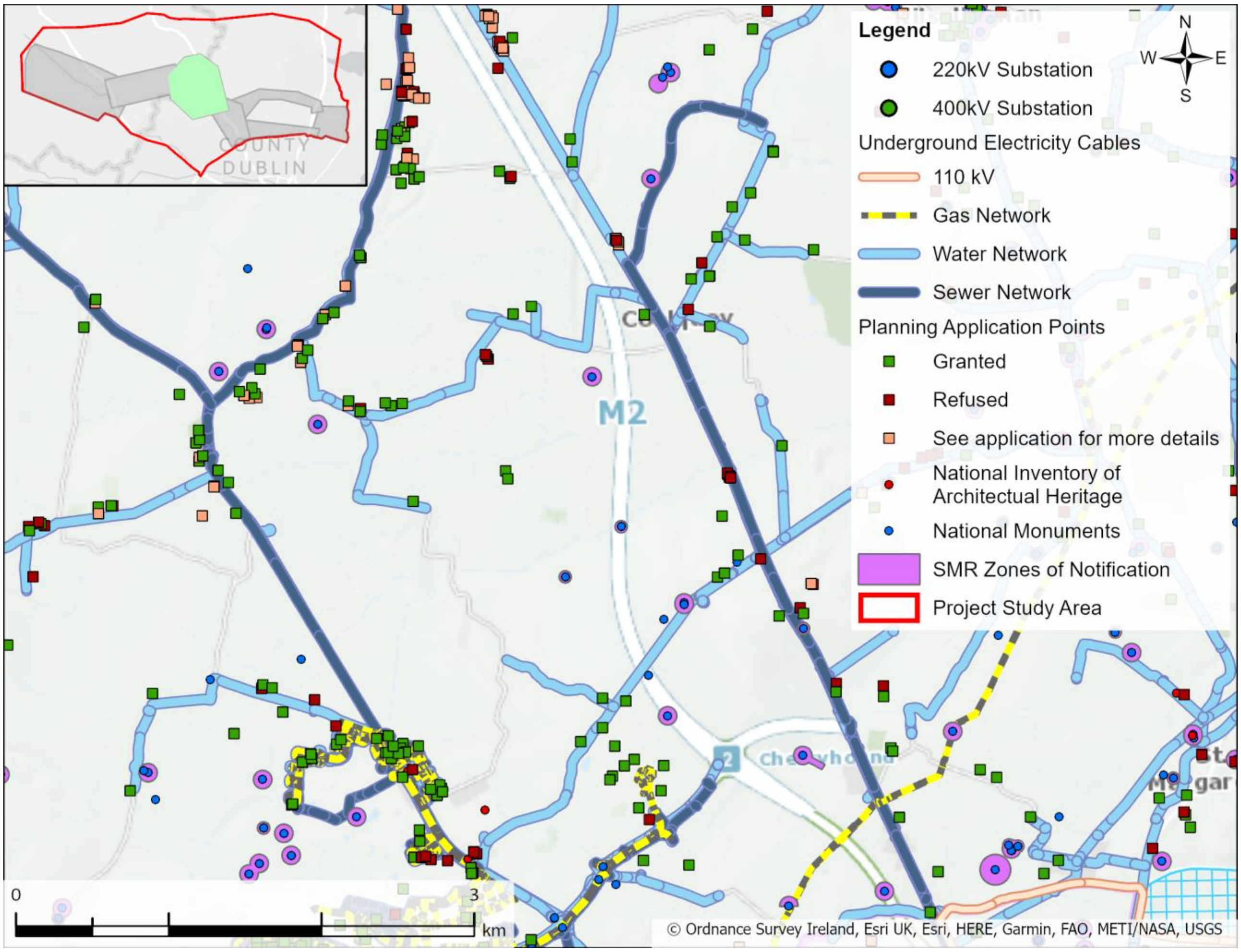

Figure 3-7 – Sub-Area Crossing M2

Within this sub-area (Figure 3-7), there are medium gas networks present along main road going north and waterbodies along most roads crossing the motorway. There are also some residential areas and cultural heritage sites present.

This sub-area shows that there are multiple possible crossings of the M2. The site survey suggested that there are many possible areas for HDD to cross the M2.

3.1.5 Sub-Area D Finglas Surrounding Area

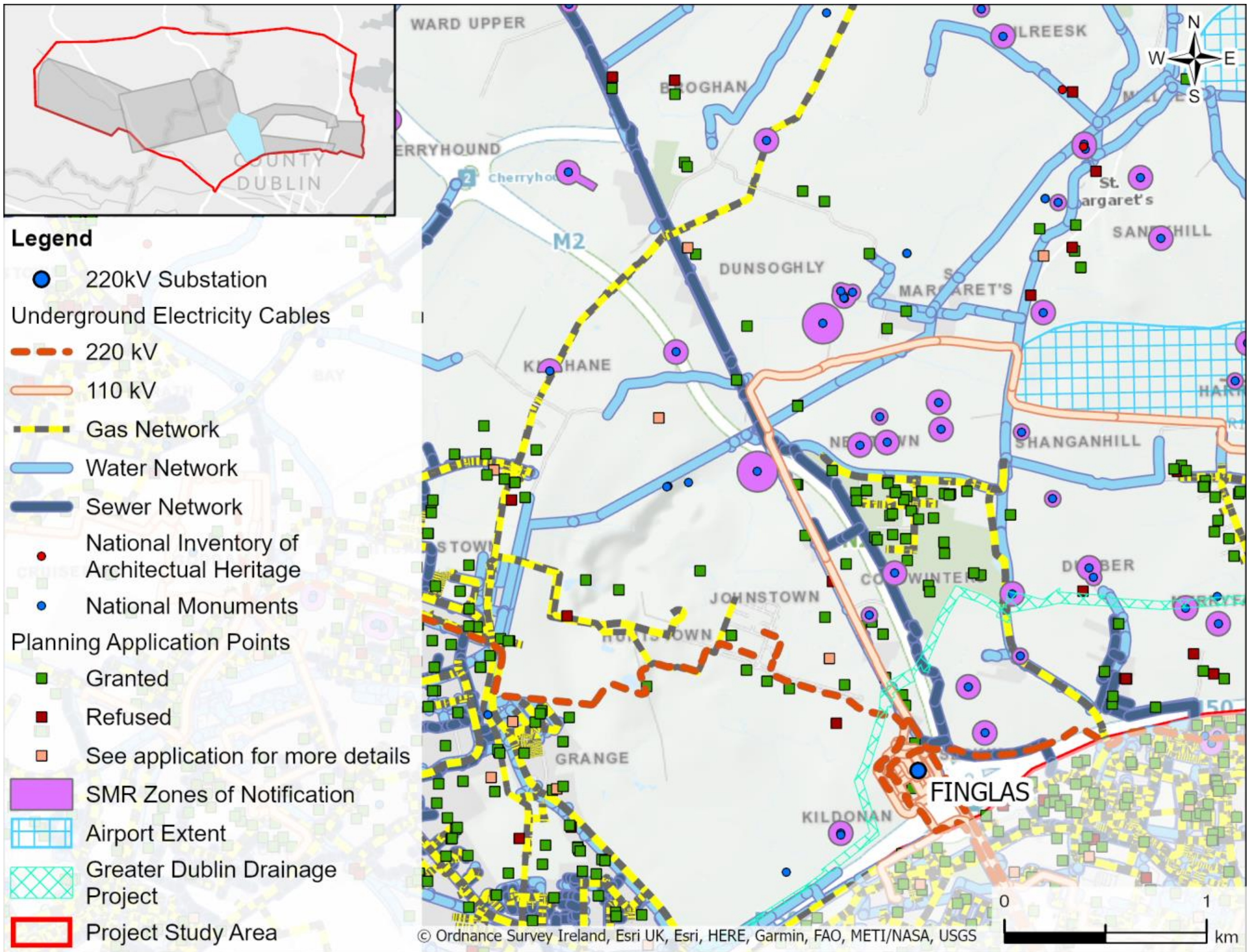

Figure 3-8 - Finglas Surrounding Area (Project Mapper)

Within Sub-area D (See Figure 3-8) towards Finglas, the following utilities can be found:

- High-pressure gas network;
- Mainline of a water network;
- Telecommunications cables;
- 110kV UGC within road ; and
- Potential for further UGC crossings due to datacentre planning application (see Section 2.1.2) connection to Finglas substation

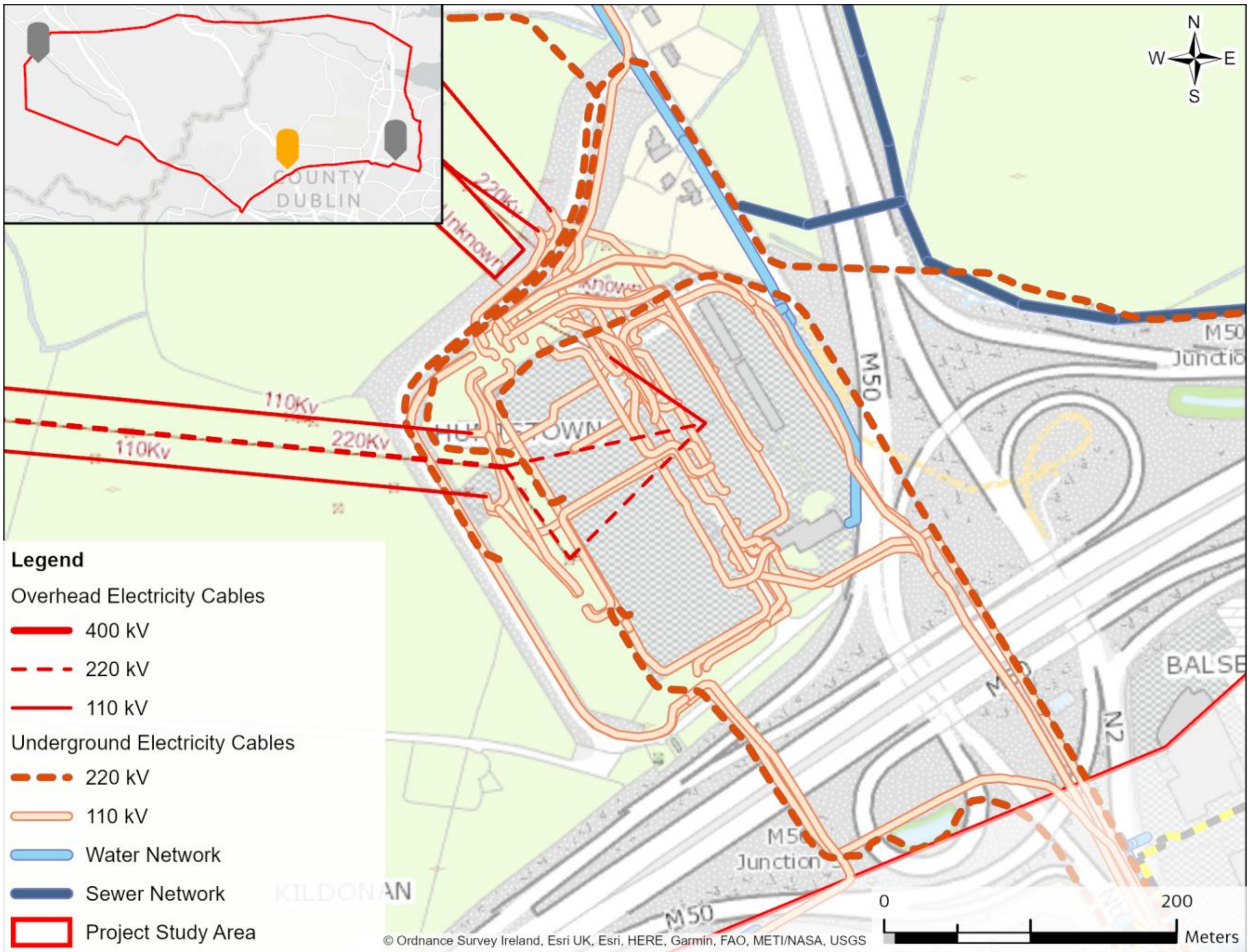

Figure 3-9 - Finglas Substation (Project Mapper)

Figure 3-9 shows the extent of existing underground cables around Finglas substation which will impact the feasibility of this 400kV connection. Further studies will be required to assess the impact of a new UGC on the existing cables within the area. The substation boundary is constrained by the proximity of the motorway to the east and south. There are also several cable joint bays present in the land surrounded by the motorway which limit entry from the east.

As stated in Section 2.1.2, there is a planned datacentre a short distance north of Finglas substation that requires existing overhead line connections into the north of the substation to be undergrounded. This will add to the number of UGC in the area.

The 110kV substation on the northeast side of Finglas has been decommissioned but not demolished. EirGrid advised that the redundant 110kV compound site could be considered as a possible area for 400kV development. There is also a disused part of the site on the southwest side which could also be used for the 400kV connection.

The area of the Finglas site that could be used for the 400kV connection has yet to be confirmed, therefore the study has been developed under the assumption that the UGC connection would be either in the northeast or the southwest corner of the existing substation site.

3.1.6 Sub- Areas E and F Dublin Airport

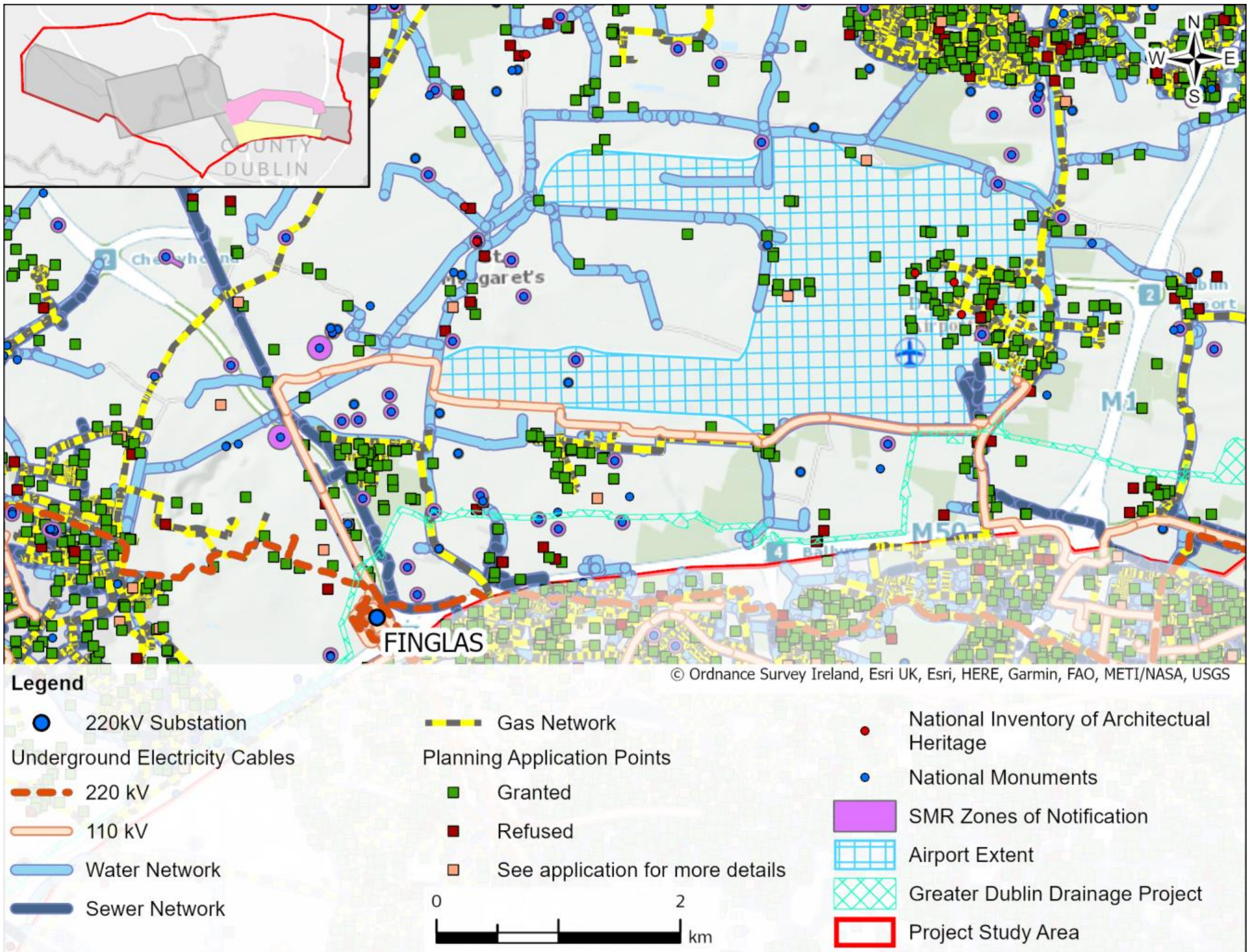

Figure 3-10 – Sub-Area E North of Dublin Airport (Project mapper)

There are two potential broad corridors allowing for an UGC connection to Belcamp from the M2/N2 road corridor; one to the north between the airport and Swords and one to the south between the airport and the M50.

The northern sub-area is constrained by the airport boundary and the area of Swords. It is further constrained by Forrest Little and St. Margaret's golf course.

The northern sub-area has potential crossings with a high-pressure gas network, waterbodies along roads and cultural heritage sites. It was noted during the site survey that many of the local roads within this sub-area are narrow and have trees/hedges on either side of the road.

There is also a consented planning application for Dublin airport extension which may extend over potential corridors within R-roads in the area.

The proposed Metrolink will also cross this sub-area via an underground tunnel under Dublin Airport. Any crossing of this railway is considered to be feasible since it is assumed that the underground tunnel will be much deeper than the cable trenches required for this Proposed Project.

The M1 motorway will also need to be crossed to reach Belcamp substation. Information from the site survey indicate that this crossing is feasible via HDD by the motorway.

The southern sub-area is constrained by the airport boundary and N2, M50 and M1 motorways. It is further constrained by Sillogue golf course and land owned by the airport. A study of utilities maps of the area show that there is already telecommunications cable and UGC present in one of the key R-roads in this sub-area.

Other possibilities within this sub-area include land next to the M50 motorway boundary, although this would be constrained by a large number of UGC present at the junction of the N2 and M50 next to Finglas (see Figure 3-9), the need to access some third-party land and the Sillogue golf course. There is also a proposed raised surface Metrolink crossing over the M50 which continues along the surface towards the airport. A crossing of the Metrolink railway in this location is likely to be feasible but requires further investigation.

The M1 motorway will also need to be crossed to reach Belcamp substation. Information from the site survey indicate that this crossing is feasible via HDD by the motorway.

3.1.7 Sub-Area G Belcamp Surrounding Area

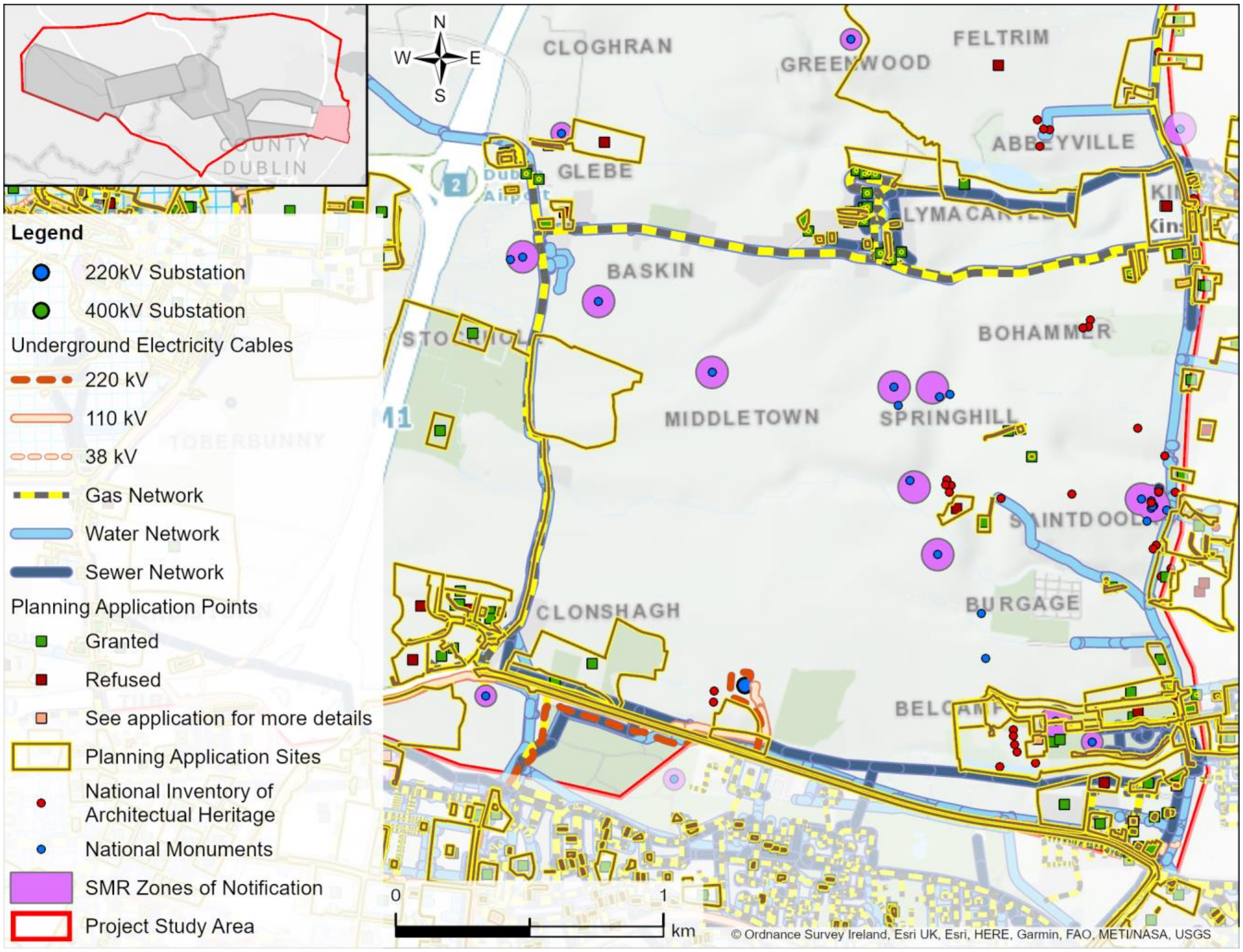

Figure 3-11 - Belcamp Surrounding Area (Project Mapper)

There are multiple feasible routes into Belcamp substation, depending on which route around the airport is chosen. Along the northern border of this sub-area, the route is constrained by a medium gas network present on both sides of the road as well as trees lining the road.

The route along the western side also has a medium gas pipe, as well as water mains currently in the road. There is also planning permission for an aviation fuel pipe to the south of this sub- area (see Section 2.1.2), which travels in an east west direction along the R139 and Stockhole Lane before heading north to the airport.

Towards the east there are waterbodies along the road, as well as several cultural heritage sites including a church and cemetery. This option also will pass through residential areas which may have several existing services already present. There is also a 38KV UGC crossing from the corner of the R107 to the R139.

3.1.8 Connection to Belcamp substation

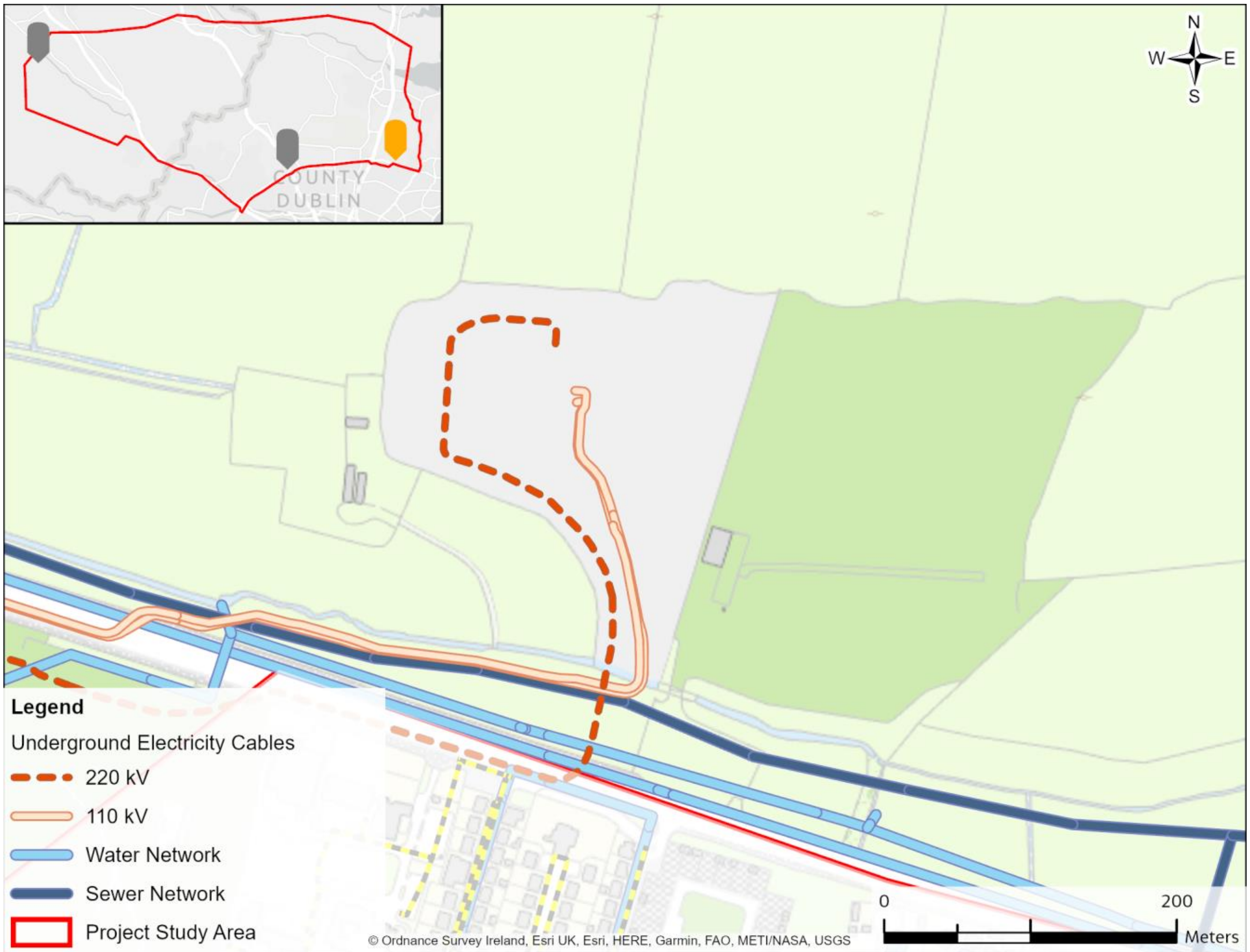

Figure 3-12 - Belcamp Substation (Project Mapper)

There are already several UGC connections to Belcamp substation that will affect the 400kV connection assessed in this feasibility study. Recent studies, including the feasibility report for the substations for this Proposed Project (document ref 321084AJ-REP-006) indicate that the substation will require to be extended into the field to the North to accommodate works required at the substation. Consequently, the connections for the Proposed Project are likely to be on the north-westerly side of the substation extension (see Figure 3-13). The cables will then go either go north-west or south-west to connect to the nearest roads, limiting the off-road length of the route, taking into account existing services; for example, the R135 already has existing services as stated in the previous section, therefore a cable corridor traveling south west would be constrained by this to the R135 boundary.

Figure 3-13 - Potential Cable Corridors Belcamp Substation

4 . Cable options appraisal

4.1.1 Cable ratings in trenches

There are three key UGC solutions being investigated between Woodland and Finglas or Belcamp substations:

- 400kV UGC standard cable type (1 conductor/phase);
- 400kV UGC alternative cable type (1 conductor/phase); and
- 400kV UGC (2 conductors/phase).

Cable ratings define how much power can be transmitted via the cable. The higher the rating, the higher its capacity, hence more power can be transmitted. The cable ratings are limited by the cable's ability to dissipate heat and this relates strongly to its surroundings i.e. materials its buried in (backfill), surrounding soil and depth of buried cables.

Section 2.2 has provided information of the amount of power that can be transferred by each solution under specific trench arrangements.

When reviewing the entire route from a ratings prospective, it will be the worst performing "pinch point" which has the potential to derate the entire system. There are a number of solutions to limit the impacts of each pinch point, and these shall be discussed in the next stages of the project.

4.1.2 Crossing with cable bridges

Natural or man-made obstacles can also be crossed utilising cable bridges. This solution does not reduce the ampacity of the circuit but comes with some drawbacks such as the visual impact and the increased risk of damage to the cable systems.

Figure 4-1 below shows an example of an existing bridge out from Finglas substation which could be re-purposed as both a pedestrian crossing and cable bridge.

Figure 4-1 - Example of Pedestrian Bridge Constraint Over National Road (Bridge over N2 at Finglas)

4.1.3 Joint Bays

It is not feasible to supply one continuous length of cable to site for the entire route. This is due to the maximum length of cable per drum that can physically be moved to site. Long cable routes (typically above 1 km) require various smaller separate lengths of cable to be delivered and jointed on site to make up the full length of the route. A joint bay is where any separate lengths of cables are physically joined together. A typical joint bay design utilised by EirGrid is detailed below.

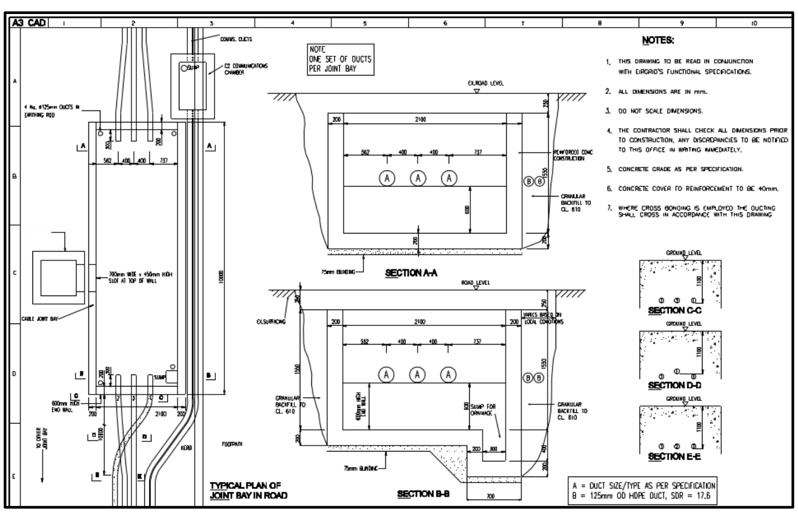

Figure 4-2 - Typical 400kV joint bay

Joint bays will be located at regular intervals along the route. The distance between two consecutive joint bays and their exact location is dictated by the following factors:

- Average length of cable per drum: assumed 500m for a 2500mm^2 400kV cable;
- Land constraints along the route: space, accessibility, maintainability etc.;
- Other electrical design constraints (i.e. maximum allowed sheath standing voltages); and
- Other installation constraints (i.e. cable pulling forces).

The size of the joint bays may vary based on the following:

- Local ground conditions; and
- Need for additional equipment inside the joint bay (cable monitoring, telecoms etc...).

4.1.4 Connections into substations

The cable circuits will be terminated in Woodland and Finglas or Belcamp substations where new Switchgear bays will be constructed to accommodate the incoming cable connections.

Details of the options considered for new connections at each substation is the subject of a separate report (see 321084AJ-REP-006).

4.1.5 Third Party Land

For any cable solution, some third party land use is likely to be necessary. Whether this is for storing of materials and equipment, or for the routing of the cable itself. Where land use is necessary for temporary works, the necessary permissions, payments, and wayleaves will need to be obtained from the landowner. Vegetation clearance will be required where the land is undeveloped.

There are some advantages to cables being routed through third party land. These are:

- Lower likelihood of encountering other utilities
- Construction impact on existing road network, and travel disruption caused by works is lowered

Some disadvantages of routing cables through third party land include:

- Access to the land for construction and operation
- Temporary access roads or permanent track requirements
- Private fields are not controlled in the same manner as a public road would be. In public roads an opening licence is required, and as built records checked before any construction activity is allowed to take place.
- To counter this potential issue, there will be some restrictions placed on the landowner in terms of what can and cannot be planted and any additional activities which may be proposed, including future development of the land.
- There are environmental impacts associated with routeing a cable through farming land, in particular, a loss of hedgerow and mature trees which may form boundaries to the fields. During construction there is also

some increase in risks to ditches and larger water bodies which would need to be crossed without the benefit of an existing road bridge.

The Study Area crosses counties Meath and Fingal and borders on Dublin City Council area in what is considered a commuter region for the city of Dublin. As such, there are several ongoing housing developments in the area. Any routing of the cable through third party land near settlements could sterilize further land development.

Moreover, if any new scheme is deemed more important than the cable, it could result in EirGrid being required to divert the cable at a later stage. Cost and risks associated of diversion would be high and may not be feasible due to EirGrid's responsibility for security of supply.

5 . Evaluations of the Options

5.1 Option Review

5.1.1 Technical Feasibility

Technical Feasibility is based on the evaluation of the points below against the proposed technological solutions.

- Delivered cable ratings;
- Safety Standard Compliance;
- Ease for Expansion/Extendibility;
- Repeatability;
- Technical Operational Risk; and
- Risk of untried technologies

The considerations developed in Section 2.2 has led us to rate the solutions as per Tables 5.1 to 5.4. Although cable ratings play an important part in scoring the technical ability, the technical operational risk and untried technologies contribute significantly to the scoring assessment below. Doubling the number of joints significantly increases the risk of failures. The Technical Feasibility is the same for both Finglas and Belcamp options.

More significant/difficult/risk Less significant/difficult/risk

Table 5-1 Technical Feasibility for 400kV UGC (2500sqmm Cu)

Solution	Technical Feasibility
Delivered Cable Ratings	
Safety Standard Compliance	
Ease for Expansion/Extendibility	
Repeatability	
Technical Operational Risk	
Risk of Untried Technologies	

Table 5-2 Technical Feasibility for 400kV UGC (3000sqmm Cu)

Solution	Technical Feasibility
Delivered Cable Ratings	
Safety Standard Compliance	
Ease for Expansion/Extendibility	
Repeatability	
Technical Operational Risk	
Risk of Untried Technologies	

Table 5-3 Technical Feasibility for 400kV UGC (2x2500sqmm)

Solution	Technical Feasibility
Delivered Cable Ratings	
Safety Standard Compliance	
Ease for Expansion/Extendibility	
Repeatability	
Technical Operational Risk	
Risk of Untried Technologies	

Table 5-4 Combined Technical Feasibility Options Assessment

Solution	Technical Feasibility
400kV UGC (2500sqmm Cu)	
One 400kV UGC (3000sqmm Cu)	
400kV UGC (2x 2500sqmm Al)	

5.1.2 Economic Feasibility (High-Level)

5.1.2.1 Key Assumptions

Calculated materials quantities are based on the following assumptions:

- Standardised preliminary route lengths have been assumed for all calculations and to determine the Bill of Quantities (BoQ) for each technology options. This is the average value, rounded up to the nearest km, of the tentative route corridors. The average length of feasible route corridors from Woodland to Finglas is 28km and the average length Woodland to Belcamp is 37km.
- The conductor cross-section and material are assumed constant along the entire route; there are no conductor cross-section changes required for special crossings etc.
- The number of joint bays has been calculated using the maximum delivery lengths as per in the standard cable datasheets. At this stage, no allowance has been allowed for unbalanced minor sections along the route
- Average length of cable between joint bays: assumed 500m for a 2500mm^2 and 3000mm^2 400kV cable

5.1.2.2 Approximate Materials Quantities

Based on the assumptions of 5.1.2.1, EirGrid Technical specifications and Jacobs experience on similar projects, we have determined the quantities as set out in Table 5-5 and Table 5-6.

Table 5-5 Bill of Quantities Woodland to Finglas Connection

BoQ for Woodland to Finglas connection		
One 400kV circuit (2500sqmm Cu)		
Route Lengths	28	Km
Joints	165	Units
Terminations	6	Units
Cross bonding/ direct earthing link boxes	57	Units
One 400kV circuit (3000sqmm Cu)		
Route Lengths	28	Km
Joints	165	Units
Terminations	6	Units
Cross bonding/ direct earthing link boxes	57	Units
One 400kV circuit (2 x 2500sqmm Al)		
Route Lengths	28	Km
Joints	330	Units
Terminations	12	Units
Cross bonding/ direct earthing link boxes	114	Units

Table 5-6 Bill of Quantities Woodland to Belcamp Connection

BoQ for Woodland to Belcamp connection		
One 400kV circuit (2500sqmm Cu)		
Route Lengths	37	Km
Joints	222	Units
Terminations	6	Units
Cross bonding/ direct earthing link boxes	75	Units
One 400kV circuit (3000sqmm Cu)		
Route Lengths	37	Km
Joints	222	Units
Terminations	6	Units
Cross bonding/ direct earthing link boxes	75	Units
One 400kV circuit (2 x 2500sqmm Al)		
Route Lengths	37	Km

BoQ for Woodland to Belcamp connection		
Joints	444	Units
Terminations	12	Units
Cross bonding/ direct earthing link boxes	150	Units

5.1.2.3 Economic feasibility assessment

Taking into account the BQ outlined above, the economic feasibility (cost) is determined and presented in Table 5-7. The Bill of Quantities is the same for options which require one cable per phase; however for the 3000m2 option, costs will be higher because the cable is 20% larger.

More significant/difficult/risk Less significant/difficult/risk

Table 5-7 Economic Feasibility

Solution	Woodland to Finglas	Woodland to Belcamp
400kV UGC (2500sqmm Cu)		
One 400kV UGC (3000sqmm Cu)		
400kV UGC (2x 2500sqmm Al)		

5.1.3 Deliverability

This section deals with the deliverability of the cable solutions and looks to provide a brief overview of the works required to install any of the cable technologies. As such it focusses on how any of the solutions will be constructed and the key constraints to constructing any cable scheme.

Overall, all the solutions can be delivered with proven methodologies, the complexity dependent on the number of conductors to be placed in the ground.

5.1.3.1 Construction Methodology

There are a few different construction methodologies for laying EHV underground routes, each divided in several subcategories.

5.1.3.1.1 Trenched

- Ducted cables

With this method High Density Polyethylene (HDPE) pipes are laid in the trench at the excavation stage and cables are pulled through at a later stage. This allows the de-coupling between civils works and cable installation. This allows for faster construction, reduced time on roadway and the time needed for temporary traffic measures including road closures.

For the deliverability assessment, it is assumed that the entire route will be fully ducted, since this is the only acceptable methodology employed on cable installations in Ireland.

This is in line with the typical cable trench detail provided by EirGrid

Delivery of cable drums can be timed to arrive after trench works reducing the amount of land required during construction as well as project traffic on local network at any given time for the duration of the project.

A typical EHV cable construction employing this method would normally divide the entire route in several smaller construction sites each in correspondence with a "major section" of the cable system.

Each construction site would remain open only for the duration necessary for the ducts installation and the joint bay preparation. A smaller site would be set up during cable pulling and cable joint activities.

- Direct buried cables

A direct buried solution is when the cables are buried directly in the soil. Diggers will excavate a specified trench to the required width and depth. The cables are then pulled into place. A selected thermal backfill is poured over the cables. This helps the cables to dissipate heat during operation, improving the achievable rating. Specially selected backfill is then compacted back to ground surface level. This solution requires synchronization of civils works with cable installation.

This is a non-standard and not acceptable installation method in Ireland.

- Cables in troughs

Typically used within a substation environment only, normally from the fence boundary to the cable sealing end compound.

This is a non-standard and not acceptable installation method in Ireland.

5.1.3.1.2 Trenchless

- Cables in Horizontal Direct Drill (HDD)

HDD and deep tunnel boring are expensive methodologies, requiring the use of specialist equipment, and are typically used in special circumstances only. HDD may be used to cross specific obstacles within the study area, such as rivers, for short lengths of the cable route.

This is the only acceptable and standard methodology employed in Ireland.

- Cables in deep bore tunnel may be used for short sections when traditional horizontal directional drilling techniques would de-rate the cable circuits excessively.

This is a non-standard solution in Ireland

- Cables in Pipe Jacked solutions / Micro tunnels.
- This is a non-standard solution in Ireland

Other

- Bespoke cable bridges, often serving a dual purpose for both pedestrians and services, can be used to divert cable routes around constraints where other solutions are not suitable.

5.1.3.2 Temporary Working Strip

A temporary working strip is defined as the area of land required, a cable corridor, for the installation of EHV underground cable transmission lines. There will be various ongoing construction activities within the temporary working strip:

- Storage of equipment, and material
- Storage of the excavated topsoil and subsoil
- Delivery of cable drums to site
- Excavation of the cable trench
- Cable drums and accessories deliveries
- Excavation equipment deliveries
- Jointing equipment and wellbeing facilities deliveries and removal
- Specialized backfills deliveries
- Waste removal
- Staff ingress/egress from site

Figure 5-1 - Indicative Working Strip for trench preparation

Figure 5-2 - Indicative Working Strip for cable Installation at joint bay

Figure 5-1and Figure 5-2show an indicative temporary working strip which could be put in place for the installation of the three cable solutions.

Pictures above show road widths occupied when using space efficient installation techniques utilising machines excavating and pouring the concrete for the ducts online (i.e. machines working along the “lane close” shown in Figure 5-1[9]). Additional machinery can be used to remove the spoil at the same time. This reduces the land required for the temporary working strip and keeps disruption for local residents to a minimum.

For the purposes of the Step 3 study, it is estimated that a traditional land swathe could be as wide as 12m.

The working strip will vary throughout the study area depending on local constraints to the installation of the cable. In some stretches it will not be possible to accommodate a 12m width. In these instances, a more space efficient installation technique can be used such as the described technique in the previous paragraph.

Within the study area we will most likely be burying cables under the Local (L roads); Regional (R roads); and National (N roads).

For narrow roads, farmland within the study area could be used for the cable routes. However, the larger the working strip the higher the cost of the project. The necessary easements and wayleaves would be required before works could be started.

5.1.3.3 Easement and Wayleaves

It is expected that large amounts of third-party land are required for the installation of the cable options. The easement is defined as “the use of someone else’s property or land for a stated reason”. A wayleave is defined as “access to property granted by a landowner in return of payment”. The need for these is common for any utility being installed and maintained.

The use of third-party land would require wayleaves to be agreed with the landowner.

5.1.3.4 Excavated materials

Whilst the cost of third-party land use will have a significant impact on the cable solutions choice, there are other economic and technical issues to be considered.

Most notably, the construction materials required, and their storage and disposal. Of these, the excavated soil will likely pose the highest cost as its storage has a significant footprint on the working strip

Some of the excavated soil could be repurposed, however most of the excavated soil will have to go to spoil. This will be achieved by using HGVs to truck the soil from site to predetermined disposal sites. The more soil excavated, the more soil to be disposed, the more HGVs you need and the higher the construction cost.

Furthermore, this will add to the construction traffic on the existing road network causing congestion around sites. The storing and disposal of excavated material will be a significant factor in the cost of the project.

5.1.3.5 Fill

All excavations will have to be backfilled to road level after cable duct installation. In ducted construction, two materials are used for the fill: Cement Bound Granular Mixtures (GBGM); and engineered fill. After the ducts are installed the CBGM is poured to surround the ducts to a calculated level. This level depends on the thermal dissipation required to meet the ratings. CBGM has a lower thermal resistivity than native soil and so conducts heat away from the cables more efficiently. However, the pouring CBGM to ground level is not cost effective. Instead

[9] https://www.youtube.com/watch?v=P8iSJGEAsUQ Installation of Underground Cables - EirGrid

trenches are designed with enough CBGM to achieve ratings and then use engineered fill to ground level. In some scenarios, specialised thermal backfill will be used instead of CBGM to give a lower thermal resistivity, improving the rating performance of the cables.

For the purpose of this assessment a simplified calculation has been adopted to estimate the volume of fill. Table 5-8 presents the estimated fill for each trench size considered in Section 2.2.3:

Table 5-8 Estimated fill requirements for each option

Trench Size	CBGM (m3/km)	Backfill (m3/km)	Total Fill (m3) Woodland to Finglas (28km)	Total Fill (m3) Woodland to Belcamp (37km)
OPTION A	859	1148	56174	74230
OPTION B	1392	1575	83087	109794
OPTION C	1425	1250	74894	98967

The fill will need to be delivered to site having additional impacts to the cost of the project as well as the amount of construction traffic on the road network. In the assumed methodology, the fill would be delivered to site in a truck and poured directly into the trench. Alternatively, if the trench is not complete before delivery, the fill will need to be stored in a temporary storage area. The delivery of fill, requirement for temporary storage and construction methodology are project specific. Details to be confirmed at a later stage in the project if a cable option is progressed.

5.1.3.6 Impacts on existing road network

The cable technologies are to be primarily routed via the existing road network within the study area. This will have a significant impact on the delivery of the project.

The study area has a relatively dense road network that makes some of its more remote areas more accessible, as well as the larger N and M roads making it easier to deliver materials to site. Construction deliveries will have to be planned to reduce the amount of construction traffic present on road networks as much as reasonably possible.

For the smaller R and L roads it is possible that abnormal load assessments will be required for the delivery routes to ensure the heavier construction materials, such as the cable drums, can be delivered to site without damaging existing roads and structures.

Traffic management will also play a key part in project deliverability as the cables are likely to be buried for large sections under the existing road network hence, requiring road closures to facilitate the work.

It is assumed that many of the R roads are wide enough to allow a single trench under one of the lanes. This would result in a lane closure for the installation. This has significant Health and Safety implications for construction workers. Workers will be working next to live traffic. Whilst this is not unusual in the construction industry it does raise the risk profile of any cable technology being installed within the study area.

The L roads within the study area are small and a full road closure will likely be required where the cables are routed under these roads.

These challenges are typically faced by any cable project and do not impact overall feasibility.

5.1.3.7 Impacts during construction

The study area contains only small waterbodies such as streams and narrow canals so there will be little impact on waterbodies during construction.

Most of the roads within the study area are L and R roads. The size of these roads means that much of the route may have to be installed using more space efficient techniques as shown in Figure 5-1 and Figure 5-2. Alternatively, additional lane closure or temporary use of third-party land may be required. Furthermore, any lane closures will require traffic management as well as additional H&S planning to mitigate the hazards posed by working next to live traffic such as reduced air quality and noise during construction. This does not necessarily differ greatly from any typical cable scheme involving roadways.

Furthermore, the movement of spoil from site will generate a significant amount of construction traffic. This can be mitigated somewhat through phased construction of the cable trench. This could lead to local congestion to the works.

5.1.3.8 Overall Deliverability

The three cable solutions proposed will have similar implications for deliverability as all involve the installation of a single trench along one route. The impact on deliverability, is the availability and size of the existing roads and the number of obstacles encountered (canals, motorways, utilities), that will require additional civil works to overcome such as HDD, utilising existing structures, or specialised cable bridges.

Also, the study area contains towns and residential areas that will be supported by an active network of utilities including water, gas, and electricity. These networks will be primarily routed via the existing road network. Diversions or crossings are therefore anticipated for all cable solutions where the more utilities in the area, the increase in construction required to deliver the project.

Taking the above into account, with the current constraints present within the study area, it is considered that the installation of 28km of cables for Finglas and 37km for Belcamp using the existing road network is feasible (see Table 5-9). The route to Belcamp scores less favourably because it is longer and so there is a higher risk associated with its deliverability. To a large extent, deliverability will be the same per km whether the cable is routed to Finglas or Belcamp; however the longer route does present additional constraints for the Belcamp option, which are considered in the analysis.

Table 5-9 Overall Deliverability

Solution	Woodland to Finglas	Woodland to Belcamp
400kV UGC (2500sqmm Cu)		
One 400kV UGC (3000sqmm Cu)		
400kV UGC (2x 2500sqmm Al)		

5.2 Criteria Assessment

5.2.1 Combined feasibility for Finglas route

The combined feasibility assessments for Finglas are provided in Table 5-10

Table 5-10- Finglas Cable Option Assessment Overview

Solution	Technical Feasibility	Deliverability Feasibility	Economic Feasibility	Combined Feasibility
400kV UGC (2500sqmm Cu)				
One 400kV UGC (3000sqmm Cu)				
400kV UGC (2x 2500sqmm Al)				

5.2.2 Combined feasibility for Belcamp route

The combined feasibility assessments for Belcamp are provided in Table 5-11.

Table 5-11 - Belcamp Cable Option Assessment Overview

Solution	Technical Feasibility	Deliverability Feasibility	Economic Feasibility	Combined Feasibility
400kV UGC (2500sqmm Cu)				
One 400kV UGC (3000sqmm Cu)				
400kV UGC (2x 2500sqmm Al)				

6 . Conclusion

Taking into account the combined feasibility assessments for each option and sub option, it is concluded that sub-option A, the 400kV UGC (2500sqmm Cu) cable to Finglas is the least constrained and most feasible. Sub option C, the 400kV UGC (2 x 2500sqmm AL) to Belcamp is the most constrained and would be the least feasible.

Appendix A. EirGrid Transmission Network Map