Hynestown to Steelstown: Emerging Best Performing Technology Option Report

EirGrid PLC

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Kildare-Dublin Grid Reinforcement

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Abbreviation	
A	Amperes
AC	Alternating current
ACSR	Aluminium conductor steel reinforced
AIS	Air-insulated switchgear
ALU	Aluminium
BOCCI	Birds of Conservation Concern in Ireland
BPO	Best Performing Option
CAPEX	Capital expenditure
CENELEC	European Committee for Electrotechnical Standardisation
CU	Copper
EBPO	Emerging Best Performing Option
EMF	Electromagnetic field
ESBN	ESB Networks
EU	European Union
FRA	Flood Risk Assessment
GIS	Gas-insulated switchgear
GPR	Ground penetrating radar
GSI	Geological Survey Ireland
GZTACSR	Gap-type ZT-aluminium conductor steel reinforced
ha	Hectare
HDD	Horizontal directional drilling
HDPE	High-density polyethylene
HTLS	High temperature low sag
HV	High voltage
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEC	International Electrotechnical Commission
KCC	Kildare County Council
kV	Kilovolt
LCIM	Line cable interface mast
m	Metres
MCA	Multi-criteria analysis
MHz	Megahertz
MTTR	Mean time to repair
OHL	Overhead line

Abbreviation	
OPEX	Operating expenditure
pNHA	proposed Natural Heritage Area
PVC	Polyvinyl chloride
RFI	Radio frequency interference
RPS	Record of Protected Structures
SAC	Special Area of Conservation
SDCC	South Dublin County Council
SEM	Single electricity market
SMR	Sites and Monuments Record
SPA	Special Protection Area
TUoS	Transmission use of system
UGC	Underground cable
XLPE	Cross-linked polyethylene

Glossary of Terms	
Capital Project Number	Each project has a Capital Project Number to help coordination between EirGrid and the Transmission Asset Owner (TAO), and for reporting purposes.
Circuit	A line or cable, including associated switchgear, which carries electrical power.
Corridor	A designated study area (often 1 km wide) within which a proposed overheal line or underground cable route is evaluated.
Distribution System Operator (DSO)	In the electrical power business, a distribution system operator is the licensed entity responsible for: ▪ Operating and ensuring the maintenance and development of the distribution system in a given area (and its interconnections), if necessary and where applicable; and ▪ Ensuring the long-term ability of the system to meet reasonable demands for electrical power.
EirGrid	The independent statutory electricity Transmission System Operator in Ireland.
Flood Zone A	High probability of flooding - Where the probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 for river flooding or 0.5% or 1 in 200 for coastal flooding).
Grid	A network of high voltage lines and cables (400 kV, 275 kV, 220 kV and 110 kV) used to transmit bulk electricity supplies around Ireland. The terms grid, electricity transmission network, and transmission system are used interchangeably.
Loop-In Circuits	Loop-In Circuits are circuits used to connect a new substation by connecting or looping into an existing circuit.
Outage	Times when transmission infrastructure (i.e., lines, cables and transformers, etc.) will be out of service for maintenance or capital works.

Glossary of Terms	
Study Area	A geographic boundary defined such that it is appropriate to the scale of the proposed development, thereby facilitating the subsequent identification of the nature and extent of constraints within the proposed Study Area.
Substation Zone	A substation zone is a subset of a sub-study area and is developed to identify suitable areas for locating potential substation sites.
Substations	Contains the specialist equipment that allows the voltage of electricity to be transformed.
Transmission circuit	An overhead line, underground cable, or combination of both, used for the bulk movement of electrical energy from one node to another node within the electrical grid.
Transmission interface substation	A Transmission Interface Substation is a specific substation that serves as the critical point of connection between a Transmission System Operator (TSO) and a Distribution System Operator (DSO). This substation plays a vital role in managing the transfer of electrical power from the high-voltage transmission grid (operated by EirGrid as its role as the TSO) to the lower-voltage distribution network (operated by ESB as its role as the DSO). A Transmission Interface Substation is responsible for stepping down the voltage from transmission levels to distribution levels.
Transmission substation	A Transmission Substation is a substation within the high-voltage transmission network where electrical power is transformed, switched, and routed. It typically steps up or steps down voltage levels to facilitate efficient power transmission over long distances. Transmission substations are integral to the operation of the transmission grid, helping to control and protect the network, manage power flows, and ensure the reliable delivery of electricity across regions where it is needed.
Transmission System Operator (TSO)	In the electrical power business, a transmission system operator is the licensed entity responsible for the management of the flow of power on the electricity grid, moving high-voltage electricity around the country, from where it is produced to where it is used, supplying large energy users and the distribution network that powers homes and businesses.

1. Introduction

1.1 Who is EirGrid?

EirGrid PLC (hereafter referred to as EirGrid) operates and develops and enhances the electricity transmission system and the wholesale electricity market in Ireland and, more recently, has been mandated to operate, develop and own Ireland's offshore transmission grid. EirGrid also develops and operate interconnections with neighbouring grids and enables third-party interconnectors. EirGrid sends power from where it is generated to where it is needed.

EirGrid uses the grid to supply power to industry and businesses that use large amounts of electricity. The grid also powers the distribution network. This supplies the electricity used every day in homes, businesses, schools, hospitals, and farms.

1.2 What is the Kildare-Dublin Grid Reinforcement (Capital Project 1226)?

The current electricity network in the east of Ireland does not have the required capacity to accommodate anticipated future electrical generation and maintain compliance with the Transmission System Security and Planning Standards (TSSPS). New infrastructure is also needed to accommodate the continued growth in electricity demand in the East Kildare and South West Dublin area, which is being driven by several sectors including:

- The transfer of power in the East Kildare and South West Dublin area is encountering capacity problems on the existing 220 kV circuits during various generation and demand scenarios. This includes scenarios when the network is intact and in the case of the unplanned loss of a single circuit or piece of transmission equipment.
- The transmission system in the area needs additional capacity to facilitate the integration of renewable energy generation both from onshore and offshore, integration of new interconnectors and connection demand in counties Dublin, Meath, and Kildare. This need was identified in Shaping Our Electricity Future roadmap published in 2021.
- Additionally, new interface points or Bulk Supply Points (BSPs) that connect the Transmission System and Distribution System are needed to supply the projected demand growth in this area, including increasing demand related to new residential housing, commercial loads, as well as electrification of the heat and transport sectors with the latter as a result of the Governments Climate Action Plan 2021.

The Kildare-Dublin Grid Reinforcement (CP1226) is the Capital Project identified under the Infrastructure Agreement to address these significant additional capacity needs in East Kildare and South West Dublin while also contributing to the Government's Climate Action Plan target of 80% of electricity supplied from renewable sources. As such, it is a part of EirGrid's statutory objective to plan and develop the grid infrastructure needed to support Ireland's economy in accordance with Regulation 8(6) of SI No 445/2000 - European Communities (Internal Market in Electricity) Regulations, 2000 (SI 445/2000).

The specific new substations and circuits requirements, identified for delivery through the Kildare-Dublin Grid Reinforcement programme of works, include:

- New Hynestown 220/110 kV transmission interface substation, situated near West County Dublin;
- New Steelstown 220/110 kV transmission interface substation, situated near the South Dublin / East Kildare boundary, with new loop-in circuits from the proposed substation to the Dunstown-Carrickmines 220 kV circuit, the Dunstown-Maynooth 220 kV circuit, and the Kilteel-Maynooth 110 kV circuit;
- New transmission circuit between the proposed Hynestown Substation and the existing Maynooth 220 kV Substation;
- New transmission circuit between the proposed Hynestown Substation and the proposed Steelstown Substation;
- New transmission circuit between the proposed Hynestown Substation and either the existing Castlebagot 220 kV Substation or the existing Inchicore 220 kV Substation; and
- New transmission circuit between the proposed Steelstown Substation and the existing Carrickmines 220 kV Substation.

The Kildare-Dublin Grid Reinforcement contains several individual and autonomous projects, which can each be considered standalone projects in their own right and which can be progressed through separate planning consents (albeit together they will meet the objective of the Capital Project identified in the Transmission Development Plan).

In the interests of future-proofing, all new substations and circuits are now to be designed for 400 kV (but to be operated at 220 kV initially, where relevant).

There are four projects currently identified to deliver the new substations and circuits requirements, identified by the Kildare-Dublin Grid Reinforcement. This reflects a snapshot in time, and should be viewed as a flexible, evolving tool that will require adaptation and refinement as those projects develop and new information emerges. EirGrid has determined that this approach is correct, appropriate and the most efficient way to deliver this programme of work at this time.

1. New transmission interface substation, situated near West Dublin (‘Hynestown Substation’, abbreviated as HTN) and new transmission circuit connecting to the existing Maynooth 220 kV Substation (‘Hynestown-Maynooth Circuit’, abbreviated as HTN-MAY).
2. New transmission interface substation, situated near South Dublin / East Kildare boundary (‘Steelstown Substation’, abbreviated as SLN) with new loop-in circuits from the proposed substation to the Dunstown-Carrickmines 220 kV circuit, the Dunstown-Maynooth 220 kV circuit, and the Kilteel-Maynooth 110 kV circuit; and a new transmission circuit to the proposed Hynestown Substation (‘Hynestown-Steelstown Circuit’, abbreviated as HTN-SLN).
3. New transmission circuit between the proposed Hynestown Substation and the existing Castlebagot or Inchicore substation (‘Hynestown-Castlebagot Circuit’ or ‘Hynestown-Inchicore Circuit’, abbreviated as HTN-CBT or HTN-INC, respectively).
4. New transmission circuit between the proposed Steelstown Substation and the existing Carrickmines 220 kV Substation (‘Steelstown-Carrickmines Circuit’, abbreviated as SLN-CKM).

1.3 New Transmission Interface Substation Connecting to the Existing 220/110 kV Grid and the Proposed Hynestown Substation

The new Steelstown Substation and new transmission circuit connecting to the proposed Hynestown Substation (i.e., the Hynestown-Steelstown Circuit) is a key project under Kildare-Dublin Grid Reinforcement. It comprises a transmission interface substation which enables higher voltage levels (in this case 220 kV) to step down to 110 kV which in turn is stepped down to 38 kV (and below) at substations on the distribution system. In connecting to the existing 220 kV and 110 kV networks (via proposed loop-ins to existing OHLs), the proposed development will become a critical node on the transmission network; and a point of connection for future transmission and distribution circuits.

1.4 Purpose of this Report

This Emerging Best Performing Technology Option Report provides an update on the progress of the new Steelstown Substation and new Hynestown-Steelstown Circuit. The report documents the decision for the substation technology and identifies the emerging best performing option for the circuit technology.

Feasibility work on other individual elements / projects forming part of the Kildare-Dublin Grid Reinforcement is ongoing.

2. Project Progression Through Step 3

The objective of Step 3 is to identify a best performing technology solution and associated study area to meet the identified need from Step 2. Whilst there are similarities between the process that is followed for a substation and a circuit, they are best represented individually.

2.1 Steelstown Substation

2.1.1 Overview

Figure 2-1 outlines the process that was followed in Step 3 for the identification of the search area and emerging best performing technology for the Steelstown Substation – items no.1 through to no. 8 were carried out and documented in the previous Step 3 Report (which presented the substation technologies and zones; document ref. 0088248DG0098). A high-level summary for those items is outlined below with further detail on items no. 9 to no. 12 discussed in this section.

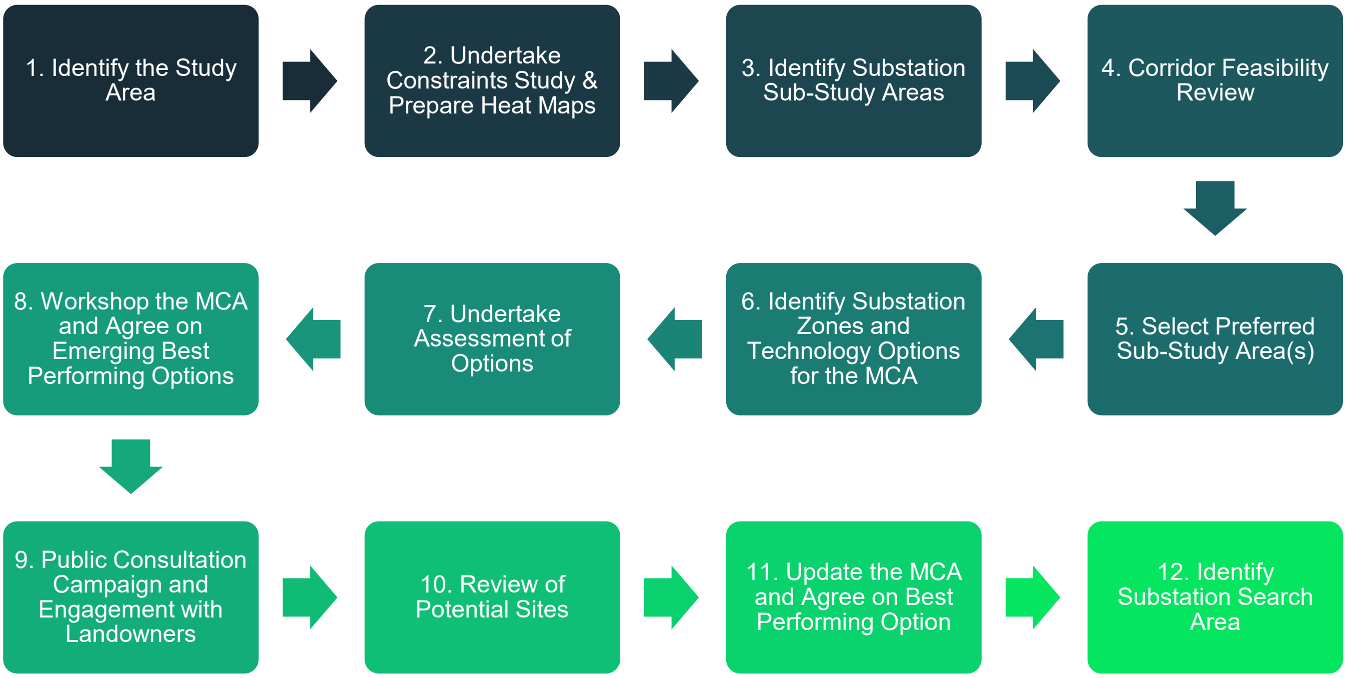

Figure 2-1 - Process Followed for Steelstown Substation in Step 3

1. **Identify the Study Area:** The Study Area was defined such that it is appropriate to the scale of the proposed development thereby facilitating the subsequent identification of the nature and extent of constraints within the proposed Study Area.
2. **Undertake Constraints Study and Prepare Heat Maps:** Once the Study Area was defined, a constraints assessment was carried out. The identified constraints were then assigned a risk, and heat maps generated to graphically represent the constraints. The heat maps were used as a 'guide' to determine locations where the proposed infrastructure could be best positioned (when considering the constraints).
3. **Identify Substation Sub-Study Areas:** Given the greenfield nature of the Study Area, a phased approach to identify feasible sub-study areas for the location for the proposed substations was considered the most applicable. A wider net was cast to identify large sub-study areas where the substations could be positioned. Key technical, economic and deliverability guiding principles, together with the environmental and socio-economic constraints

identified in the heat maps, were used to identify Three (3no.) sub-study areas for the proposed Steelstown Substation. These ranged in size from ± 615 ha to ± 1,825 ha.

4. **Corridor Feasibility Review:** A feasibility review for both OHL and UGC technologies was undertaken for the proposed Hynestown-Steelstown circuit to ensure that a route can be found between the sub-study areas for the proposed Hynestown and Steelstown substations.
5. **Select Preferred Sub-Study Area(s):** Based on the initial high-level assessment carried out, all three (3no.) sub-study areas for the proposed Steelstown Substation were selected for further assessment. The key guiding principles that informed this decision were the availability of suitable land and the connectivity to key existing electrical infrastructure.
6. **Identify Substation Zones and Technology Options for the Multi-Criteria Analysis (MCA):** Although the preferred sub-study areas had been identified, these areas were considerably larger than the actual size of land required for the proposed substation. The project team decided that substation zones (within the preferred sub-study areas) would be identified to allow a more detailed assessment to be undertaken. A total of four (4no.) substation zones were identified for the proposed Steelstown Substation, ranging in size from 145 ha to 265 ha. The range in size of the substation zones provided flexibility for the identification of multiple substation sites which are suitable to accommodate the land take required for either substation technology option under consideration (i.e., Gas-Insulated Switchgear (GIS) and Air-Insulated Switchgear (AIS)).
7. **Undertake Assessment of Options:** Using the EirGrid Multi-Criteria Analysis Guidelines and the available constraints information, an assessment of both technologies (i.e., Air Insulated Switchgear and Gas Insulated Switchgear) was undertaken for each substation zone. The sub-criteria were scored from low to high risk and the overall performance for each option determined.
8. **Workshop the Multi-Criteria Analysis (MCA) and Agree the Emerging Best Performing Option(s):** The EirGrid Cross-Functional Team and the AtkinsRéalis team conducted an MCA workshop where the options were presented and the MCA scoring of each of the options discussed. The MCA workshop concluded with a decision on the Best Performing Options to proceed with to the Step 3 Public Consultation for the Steelstown Substation.
9. **Public Consultation Campaign and Engagement with Landowners:** A public consultation campaign was carried out to seek feedback from the public. During the consultation campaign and afterwards, EirGrid engaged with landowners within the substation zones.
10. **Review of Potential Sites:** Potential sites were identified through the landowner engagement process. These were then reviewed to identify a shortlist of potential substation sites to be brought forward for more detailed assessment in Step 4.
11. **Update the MCA and Agree on Best Performing Option:** Following the review of the potential sites and review of feedback from the public consultation campaign, the MCA was updated and a Best Performing Technology Option for the substation was chosen.
12. **Identify Substation Search Area:** The search area for where the substation will likely be located was then defined based on the shortlisted sites.

2.1.2 Step 3 Substation Zones and Technology Public Consultation

In 2025, a multi-criteria analysis (MCA) was carried out on substation ‘zones’ (an area developed to identify suitable areas for locating potential substation sites). A total of four (4no.) substation zones were identified for the proposed Steelstown Substation, ranging in size from 145 ha to 265 ha. The range in size of the substation zones provided flexibility for the identification of multiple substation sites which would be suitable to accommodate the land take required for either substation technology option under consideration (i.e., gas-insulated switchgear (GIS) and air-insulated switchgear (AIS)).

The results of the MCA were documented in the Step 3 Report and across May and June 2025, EirGrid carried out a Step 3 public consultation campaign for the Kildare-Dublin Grid Reinforcement. The consultation sought feedback from the public regarding the substation zones and technologies for the proposed Steelstown Substation.

2.1.3 Review of Potential Sites

Following the Step 3 public consultation process, EirGrid's Land Management team engaged with landowners within the substation zones to identify landowners who were willing to explore the possibility of selling a portion of their land to facilitate the proposed Steelstown Substation development.

Several sites were identified and were subjected to a high-level MCA assessment, which sought to identify any significant risks to the proposed development, either on the sites themselves, or in the nearby vicinity of the sites. Upon completion of the review and site walkover surveys, sites were shortlisted to advance to Step 4. These sites will undergo further detailed assessment in Step 4 in order to identify the emerging best performing site.

2.1.4 Selection of Best Performing Technology Option for the Steelstown Substation

Following the identification of the shortlisted sites, the previous MCA was updated to reflect site-specific risks that may impact on the selection of a preferred substation technology. Table 2-1 shows the overall performance of the AIS and GIS technologies for the proposed Steelstown Substation. The following lists a summary of the key outcomes from the MCA:

- **Technical:** AIS performs better than GIS (Moderate-Low vs. Moderate); AIS substations are typically easier to expand and carry a lower technology operational risk.
- **Economic:** Both technologies perform similar (Moderate-Low); although GIS substations are more expensive to construct, they do have lower project life-cycle costs (when compared to AIS substations). Land costs are generally more for AIS substations due to their larger size footprint.
- **Deliverability:** AIS performs worse than GIS (Moderate-High vs. Moderate); this is largely driven by land availability i.e., the spatial requirement for an AIS is considerably larger than for a GIS.
- **Environment:** AIS performs worse than GIS (Moderate vs. Moderate-Low); given the larger footprint of AIS (4.5 times larger than GIS), the impacts on the environment for most of the criteria would be considered worse for AIS than for GIS.
- **Socio-Economic:** AIS performs worse than GIS (Moderate vs. Moderate-Low); although for a substation the impact on traffic and transport, and recreation and tourism, may not be impacted by the technology, the same cannot be said for the impact on settlements and communities, nor amenity. As per the Step 3 Engagement and Consultation Report (M-CO, July 2025), the preference from the public is for GIS.

Based on the above MCA assessment, it was decided that the Best Performing Technology Option for the Steelstown Substation is GIS.

Table 2-1 - Steelstown Substation Step 3 Substation Technology MCA Results

Criteria	AIS	GIS
Technical		
Economic		
Deliverability		
Environment		
Socio-Economic		
OVERALL		

Table 2-2 - Criteria Scoring Scale

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

High Risk (Dark Blue)	Moderate-High (Blue)	Moderate (Dark Green)	Moderate-Low (Green)	Low (Cream)

2.1.5 Substation Search Area

The area encompassing the shortlisted sites has been used to define the Steelstown Substation search area, as shown in Figure 2-2.

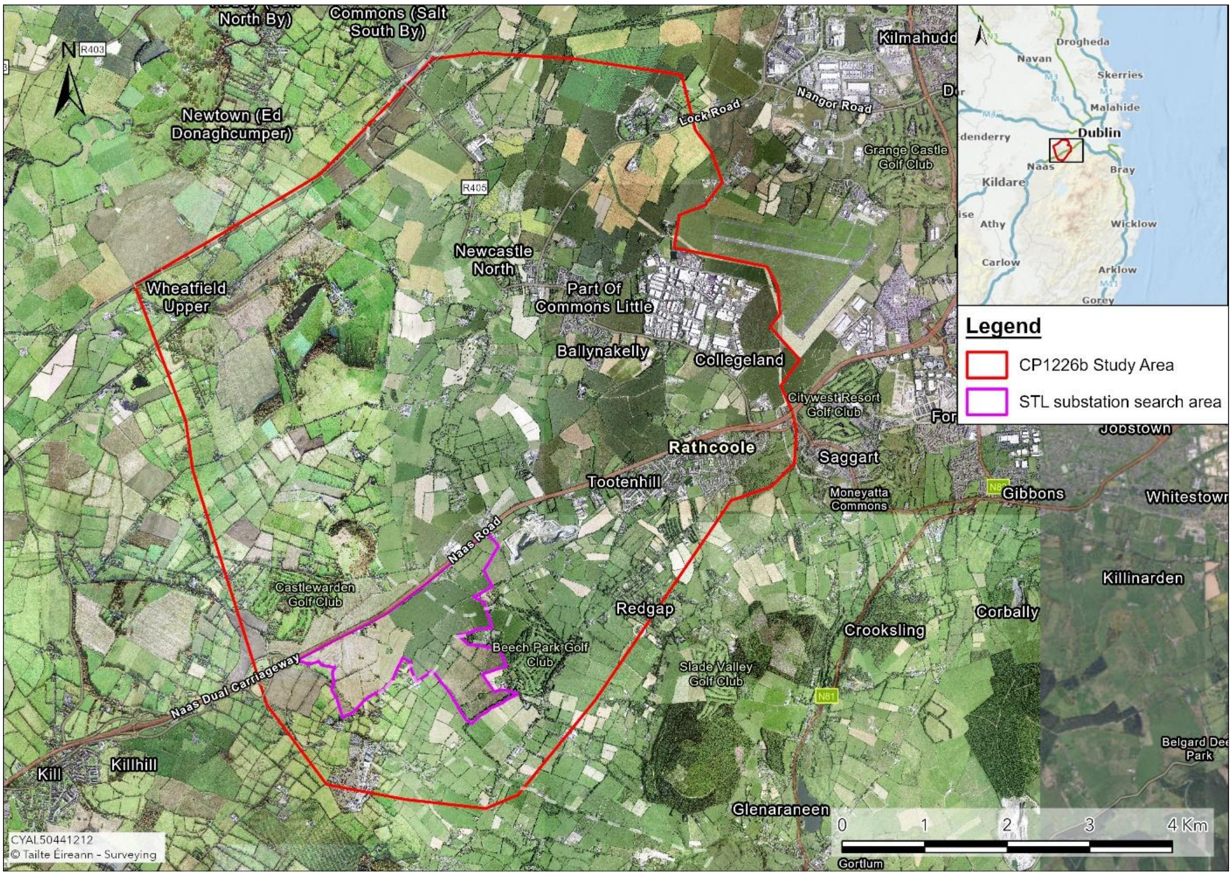

Figure 2-2 - Steelstown Substation Search Area

2.2 Hynestown-Steelstown Circuit

2.2.1 Overview

Figure 2-3 shows the process that was followed in Step 3 for the identification of the search area and emerging best performing technology for the Hynestown-Steelstown circuit. A high-level summary is outlined below with further detail discussed in this section.

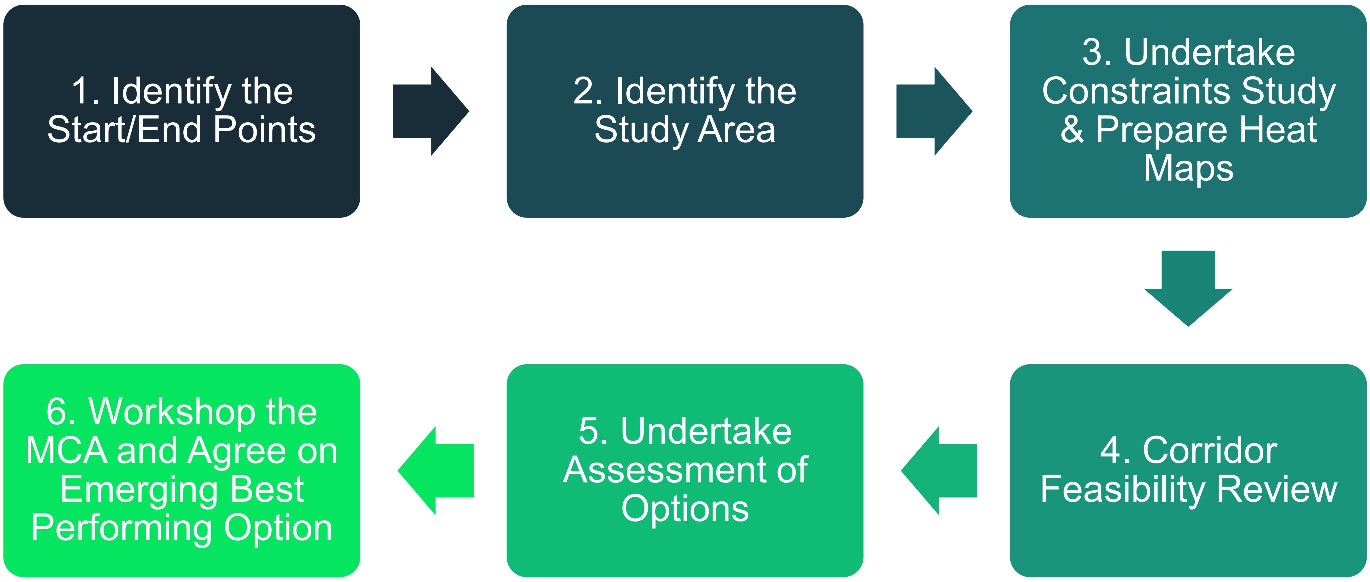

Figure 2-3 - Process Followed for Hynestown-Steelstown Circuit in Step 3

1. **Identify the Start/End Points:** The circuit will connect into substations on either end of the circuit. As both of the proposed Hynestown and Steelstown substations have yet to have a site selected, the respective substation search areas were considered as the 'start' and 'end' of the circuit.
2. **Identify the Study Area:** The Study Area was defined such that it is appropriate to the scale of the proposed development thereby facilitating the subsequent identification of the nature and extent of constraints within the proposed Study Area.
3. **Undertake Constraints Study and Prepare Heat Maps:** Once the Study Area was defined, a constraints assessment was carried out. The identified constraints were then assigned a risk, and heat maps generated to graphically represent the constraints. The heat maps were used as a 'guide' to determine locations where the proposed infrastructure could be best positioned (when considering the constraints).
4. **Corridor Feasibility Review:** A feasibility review for both OHL and UGC technologies was undertaken for the proposed Hynestown-Steelstown circuit. This feasibility review considered indicative corridors for both technologies and assessed constraints along each indicative corridor.
5. **Undertake Assessment of Options:** Using the EirGrid Multi-Criteria Analysis Guidelines and the available constraints information, an assessment of both technologies (i.e., OHL and UGC) was undertaken for the Study Area. The sub-criteria were scored from low to high risk and the overall performance for each option determined.
6. **Workshop the Multi-Criteria Analysis (MCA) and Agree the Emerging Best Performing Option(s):** The EirGrid Cross-Functional Team and the AtkinsRéalis team conducted a MCA workshop where the technology options were presented and the MCA scoring of each of the technology options discussed. The MCA workshop

concluded with a decision on the Emerging Best Performing Technology Option to proceed with for the Step 3 Public Information Campaign for the Hynestown-Steelstown circuit.

2.2.2 Study Area

The Study Area was defined such that it was appropriate to the scale of the proposed development thereby facilitating the subsequent identification of the nature and extent of constraints within the proposed Study Area. The Study Area is presented in Figure 2-4. The Study Area bisects Kildare County Council and South Dublin County Council administrative regions.

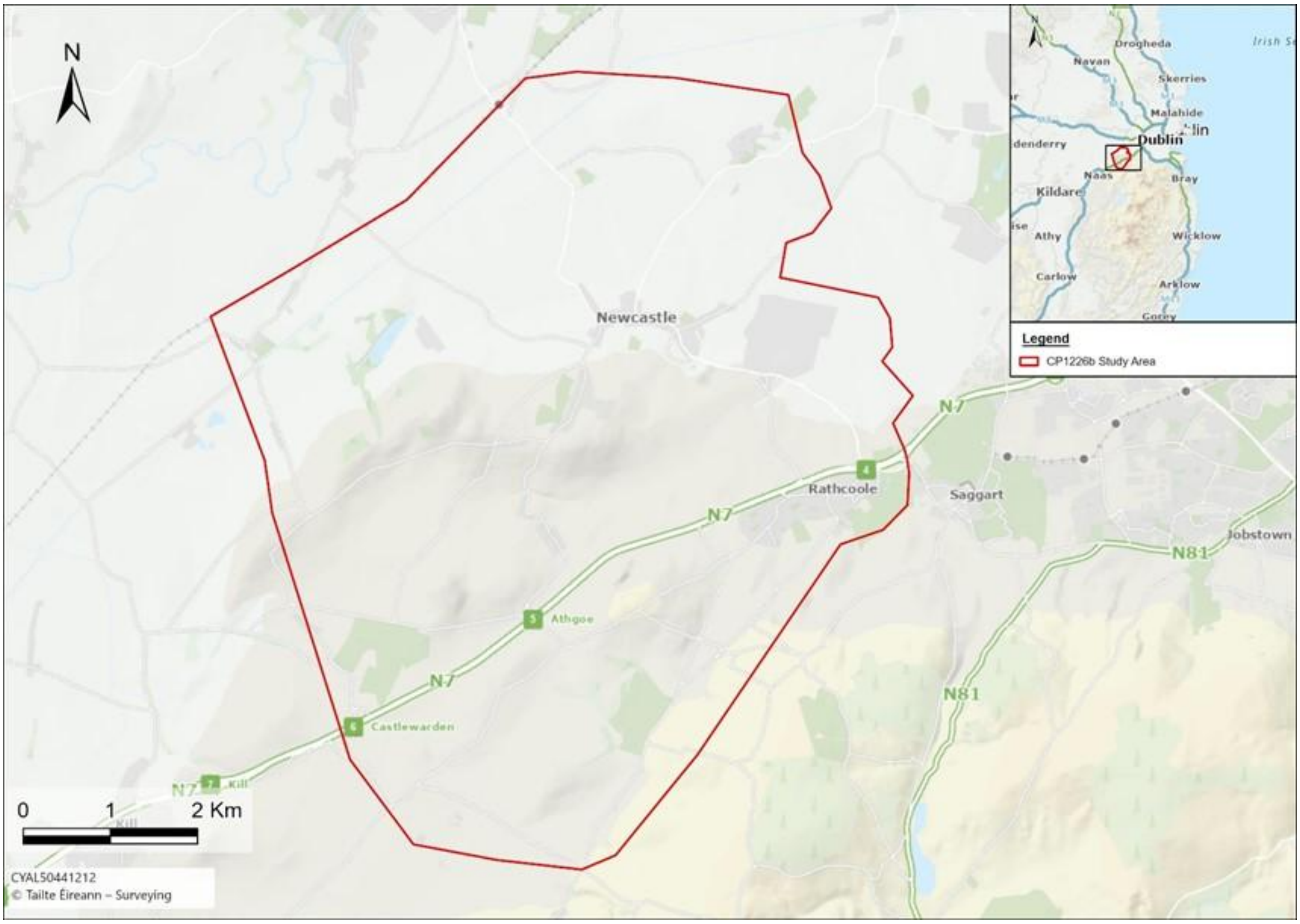

Figure 2-4 - Study Area

The identification of the Study Area was based primarily on a high-level assessment of the factors that present a significant constraint to the development of feasible solutions.

A desktop study, which was supplemented by site visits and windshield surveys, identified some key factors which influenced the identification of the Study Area from a technical development aspect:

- The potential locations for the proposed Hynestown Substation (i.e., the substation zones identified in the Step 3 Report; document ref. 0088248DG0098);
- The potential locations for the proposed Steelstown Substation (i.e., the substation zones identified in the Step 3 Report; document ref. 0088248DG0098);
- The existing 220 kV network routes for:

    - Dunstown-Carrickmines 220 kV OHL; and
    - Dunstown-Maynooth 220 kV OHL.
- The motorway network e.g., N7;
- The rail network e.g., Dublin-Cork railway line;
- Casement Aerodrome (Military), Baldonnell;
- Significant towns and settlements such as Newcastle and Rathcoole;
- Consideration of OHL route options with the shortest and straightest possible routes; and
- Consideration of UGC route options including the use of public roads and potential off-road sections.

The Study Area (Figure 2-4) is situated within the boundaries of South Dublin County Council and Kildare County Council. The northern and southern boundaries of the Study Area encompasses potential locations for the proposed Hynestown Substation and the proposed Steelstown Substation, respectively. The western boundary of the Study Area is defined by the Dublin-Cork railway line. Baldonnel Airport lies outside the eastern edge of the study area, whilst Rathcoole and Redgap fall just within the eastern boundary of the Study Area.

2.2.3 Constraints Study and Heat Mapping

Once the Study Area had been defined, a constraints assessment was carried out. The following topics were included within the constraints assessment of the Study Area:

- Biodiversity, Flora and Fauna;
- Aquatic Environment;
- Land, Soils and Geology;
- Groundwater
- Land Use and Planning Policy;
- Landscape and Visual;
- Cultural Heritage;
- Noise and Vibration;
- Climate;
- Amenity;
- Settlements and Communities;
- Recreation and Tourism; and
- Traffic and Transport.

With the constraints identified, it was necessary to present the information in a manner that would inform the assessment of the circuit technologies. This was done by developing a series of illustrative heat maps which presented the aggregated individual constraints (and their associated risks) into areas of low to high risk. Maps were created for OHL risk and UGC risk as shown in Figure 2-5 and Figure 2-6, respectively.

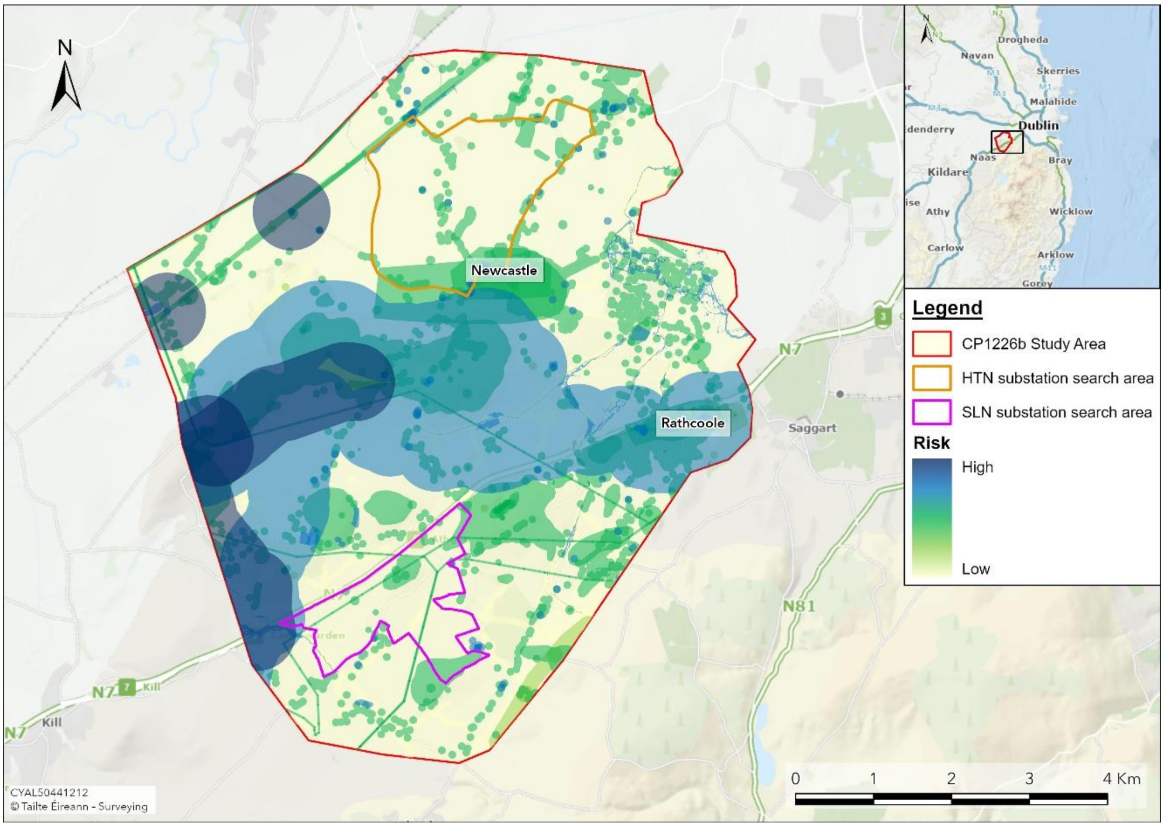

Figure 2-5 - OHL Heat Map

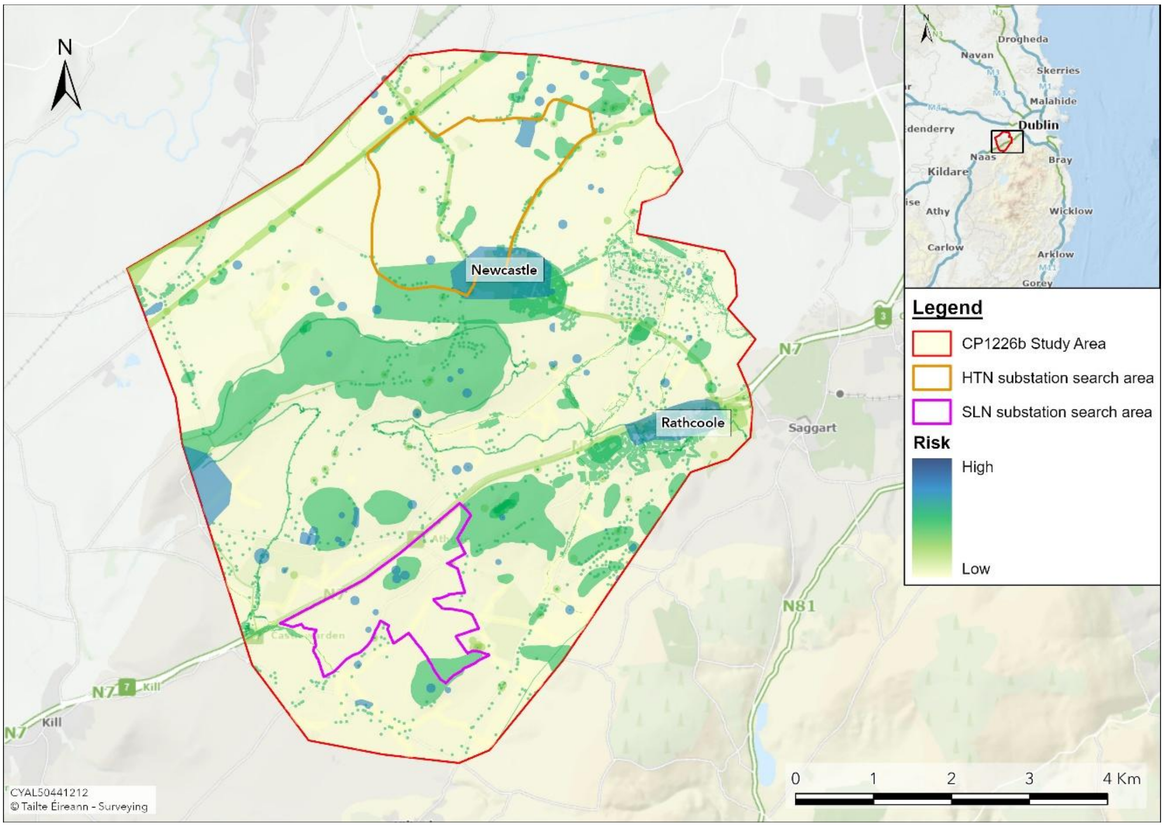

Figure 2-6 - UGC Heat Map

2.2.4 Corridor Feasibility Review

A feasibility review for both OHL and UGC technologies was undertaken for indicative circuit corridors to ensure that a route can be found between the substation search areas for the proposed Hynestown and Steelstown substations.

The review considered the heat maps produced as part of the constraints assessment and considered the viability of both OHL and UGC corridor options between the proposed and existing substations.

2.2.5 Description of Circuit Technologies

Two main technology options are available for developing the required circuit, namely overhead lines (OHL) or underground cables (UGC).

2.2.5.1 HV AC Overhead Lines (OHL) Technology

- Overhead lines strung on steel lattice towers have been used traditionally in Ireland for high voltage alternating current (HV AC) electrical transmission including 400 kV. A steel lattice tower with one or more conductors per phase, supported on insulator strings to insulate the live conductors from the earthed tower, is commonly used. Figure 2-7 shows a standard hot rolled lattice steel tower that contains bracing. For this circuit application:
  - A typical 400 kV single circuit intermediate tower is 26.3-54.3 m high and the maximum width at ground level is 14.4 m.
  - A typical 400 kV single circuit angle/strain tower is 28.0-37.0 m high and the maximum width at ground level is 12.0 m.
- When routeing OHLs, EirGrid will seek to maximise the distance of OHLs from buildings and dwellings, and for the purpose of general amenity will seek a minimum separation distance of 50 m wherever possible.
- OHLs will be routed to minimise impacts on all constraints. However, it is not possible to avoid all constraints, and in some circumstances, OHLs will need to be routed through forestry or through developed areas. In these circumstances an easement will be required. The typical easement widths (i.e., corridors) for 400 kV OHLs are:
  - Forestry:
    - 400 kV OHLs – 74 m easement corridor (i.e., 37 m either side of the line)
    - Within these corridors trees are allowed grow to a maximum height of 3 m. However, a 4 m maintenance access corridor directly under the line must be left clear at all times to allow access.
  - Buildings:
    - 400 kV Lines – 60 m easement corridor (i.e., 30 m either side of the line).
- Lattice towers can be maintained via climbing which means maintenance of access routes is not as vital because access can be achieved using 4x4 vehicles or quad bikes.

Figure 2-7 - Typical 220 kV OHL Single and Double Circuit Lattice Towers

- An alternative to lattice towers are steel monopole pylons (Figure 2-8). They offer a different aesthetic and spatial profile compared to traditional lattice towers. Steel monopoles are typically made from several steel sections either compressed or bolt flanged together. The construction can involve fabricating the monopole in sections and assembling them on site or in some cases as a single piece depending on transportation constraints. Often used in areas with limited space such as urban areas, the single pole structure requires a smaller footprint compared to lattice towers, although a large below ground foundation is needed and the easement width remains the same. To date, steel monopoles have only been used in Ireland up to 110 kV.

Figure 2-8 - Examples of HV Circuit Steel Monopole Towers (110 kV single circuit and 220 kV double circuit)

2.2.5.2 HV AC Underground Cables (UGC) Technology

- Modern HV AC cables are usually of either copper or aluminium conductor, sized for high current capacity. Cross-linked polyethylene (XLPE) insulating material is extruded around the conductor for its excellent thermal and electrical insulating properties.
- XLPE cables require little maintenance. The cables are installed (i.e., pulled) through HDPE ducting buried in trenches, with the ducts buried to a certain depth in set configurations and spacings from each other as per EirGrid specifications.
- Similar to other utility services, UGCs are typically routed along public roads for ease of construction and access for future maintenance and inspection activities. However, sometime the UGC may have to be routed off-road in order to avoid / bypass particular constraints or pinch-points, site joint bays / passing bays, etc.
- Joint bays (8-10 m x 2.5 m x 2 m) are required to join sections of cable and will be located at intervals of approximately 600-800 m along the route. This is because the cable is supplied in fixed lengths dictated by the cable drum diameter, the diameter of the cable itself, and the maximum weight that can be transported. The joint bays will be located entirely underground and will be completely backfilled/reinstated. Each joint bay has a link box chamber and C2 chamber (for communication ducts running parallel to the power ducts) which are ancillary inspection chambers adjacent to the joint bay. These chamber covers will be visible at ground level after reinstatement. Access to these chambers is required for maintenance activities and access to the joint bays is only required in the event of cables repairs / fault correction / cable replacement.

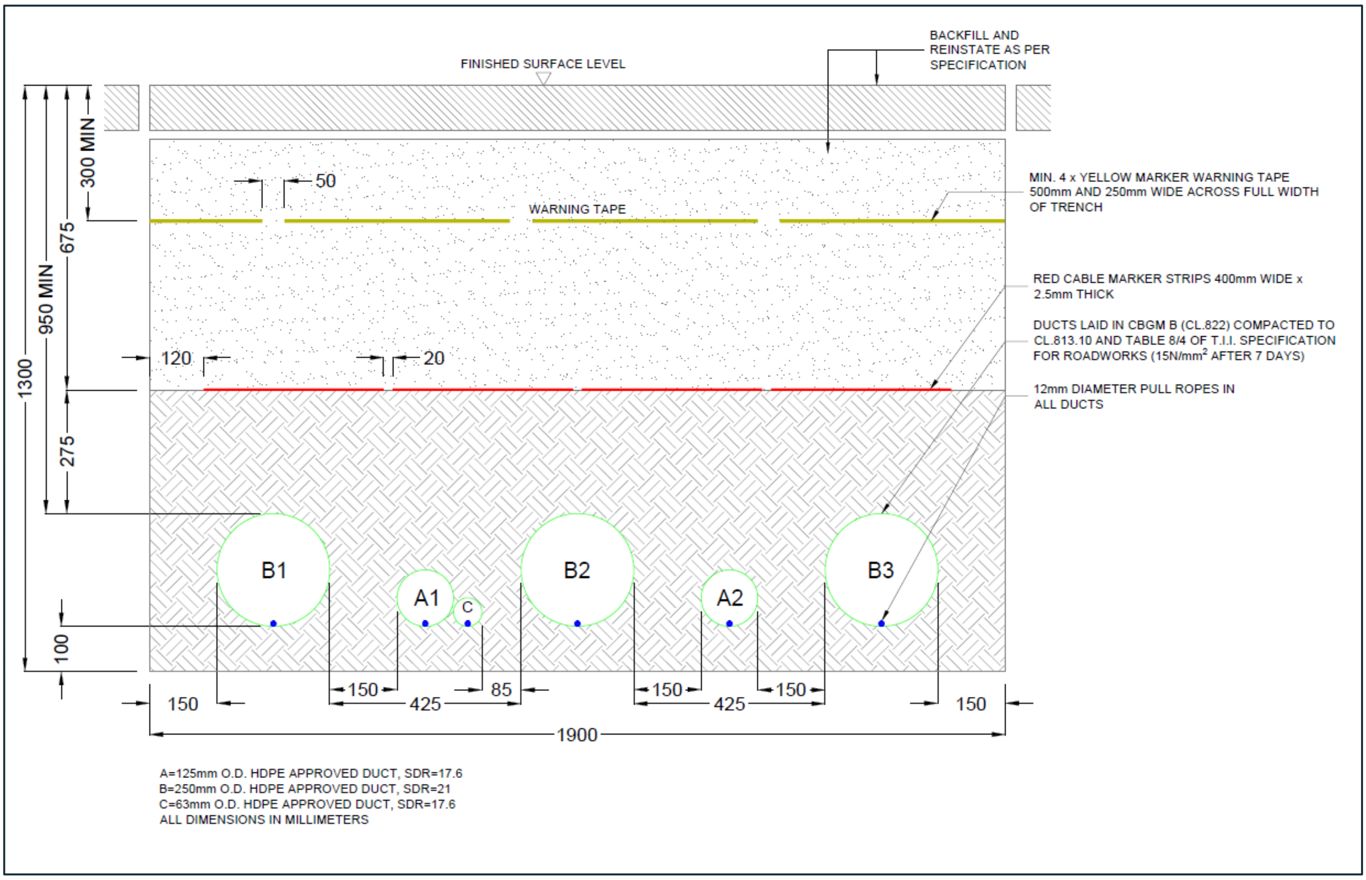

Figure 2-9 - 400 kV Standard Flat Wide Arrangement with ECC (Extract from drawing XDC-CBL-SLND-E-008)

- During construction, a temporary works area (approximately 25 m by 5 m) will be needed either side of the joint bay to allow for excavation equipment, cable pulling and cable joining works. This will be a key requirement for the selection of joint bay locations. The location of all joint bays will be required to be proven by site investigation, including ground proving.
- Where the joint bay position / construction area is significantly impeding or stopping traffic flow (i.e. on a narrow, busy country lane), a localised traffic management plan may have to be put in place and if required, a passing bay (temporary road surface) constructed to widen the existing road such than normal traffic can pass (+3.5 m).

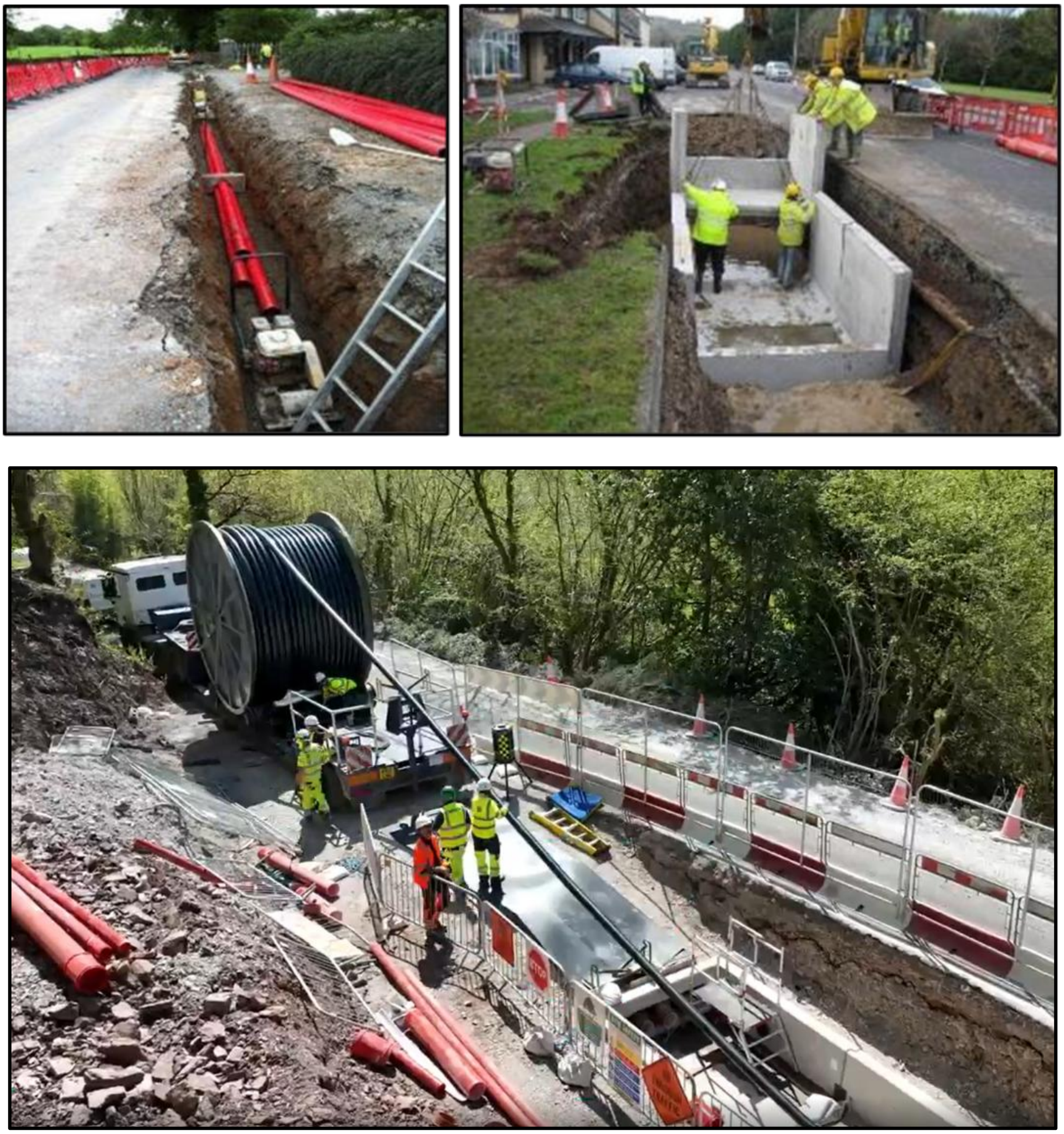

Figure 2-10 - Typical HV UGC laid in ducts / Joint Bay under construction (pre-cast) / Cable pulling (Celtic Interconnector Project)

- At highly constrained locations such as watercourse, motorway, rail crossings, etc., special installation techniques such as horizontal directional drilling (HDD) may be used to install the cable ducts at a sufficient depth to pass under the obstacle. Detailed site investigation works (i.e., boreholes) would be required at each HDD location to confirm ground conditions for detailed design stage.

Figure 2-11 - HDD rig drilling a pilot hole for HV UGCs

- Minimum wayleave widths required for 400 kV UGC is 5 m (centred on centre phase).
- UGCs would have difficulty achieving the same transmission capacity as OHL conductors as burying the cables underground will impact the capacity of a cable due to thermal affects (i.e., heating). Rating studies are carried out to determine the capacity of a circuit, as certain constraints will impact on a cable’s performance, e.g., bridge crossings, HDDs, etc.
- An alternative to UGC trenching in highly constrained urban environments, where direct bury installation would cause unacceptable disruption, is deep / micro-bore tunnelling. The method of excavation and tunnel design is largely dependent on the size of the tunnel required and the type of ground in which it is to be bored. The depth of a tunnel is typically around 25-30 m, with a tunnel diameter of 3-4 m required to provide sufficient room for up to 12no. cable cores and joint bays. Tunnel construction requires a significant amount of land at either end for constructing the large diameter (8-12 m) vertical launch shafts. In addition, tunnels of significant length require inspection and emergency access/egress points along the route to ensure escape from the tunnel within safe limits. Tunnels have not yet been used in Ireland for any HV grid connection projects but are being considered for projects in the Dublin urban area. Development costs associated with microbore tunnelling solutions can be expected to be much greater than conventional open trench methods.

Figure 2-12 - Deep Bore HV Cable Tunnel and Vertical Access Shaft

2.2.6 Circuit Technology MCA Process

To assist in identifying the best performing technology option and associated study area, a Multi-Criteria Analysis (MCA) was carried out in accordance with the EirGrid Multi-Criteria Analysis Guidelines. The five main criteria considered in the MCA are:

- Technical Performance,
- Economic Performance,
- Deliverability Aspects,
- Environmental Aspects, and
- Socio-Economic Aspects.

Each of these criteria were broken down further into sub-criteria and a multi-criteria evaluation matrix was used to identify the best performing option(s) that will be brought forward to Step 4.

2.2.6.1 Technical Performance

The following sub-criteria were scored:

- **Availability Levels:** The predicted availability level rates for the overhead line or underground cable can be calculated using, for example, recorded industry failure rates, average Mean Time To Repair (MTTR) and the length of the line or cable.
- **Circuit Ratings / Headroom:** This is an estimate of the Circuit Rating (Amps) achievable and whether it fulfils the project rating requirements (as set out in EirGrid's Cable Calculation documentation). It will consider possible circuit constraints which may limit the maximum circuit rating. Headroom is the amount of additional capacity that is available for the future without upgrades.
- **Expansion / Extendibility:** This considers the ease with which the option can be expanded.
- **Repeatability:** 'Repeatability' means whether the option can be readily repeated in the EirGrid network.
- **Technology Operational Risk:** 'Technology Operational Risk' aims to capture the risk of operating different technologies on the network.
- **Geotechnical Conditions:** Considers the impact of known ground conditions (from GSI data or other available datasets), and would include depth to bedrock, likely water table depth, known areas of poor ground / marsh etc.
- **Electromagnetic Compatibility:** Impact on wireless services such as radars, radio communications, TV, flight paths, etc.

The following sub-criteria are considered neutral (between OHL and UGC technologies) and have not been scored in the MCA process.

- **Compliance with Safety Standards:** The project should comply with relevant safety standards such as those from the European Committee for Electrotechnical Standardisation (CENELEC). Materials should comply with IEC or CENELEC standards.
- **Compliance with System Reliability, Security Standards:** The project should comply with the reliability and security standard defined in the Transmission System Security and Planning Standards and the Operation Security Standards.

2.2.6.2 Economic Assessment

The following sub-criteria were scored:

- **Project Implementation Costs:** Costs associated with the procurement, installation and commissioning of the grid development (including land cost) and therefore includes all the transmission equipment that forms part of the project's scope.
- **Project Life-Cycle Costs:** Costs incurred over the useful life of the reinforcement and include the on-going cost of ensuring that it remains viable for the evaluation period. Includes operating expenditure (OPEX), maintenance, replacement, cost of losses, decommissioning, etc.
- **Cost to SEM:** Cost to Single Energy Market from Development Unavailability (Reliability) i.e., the loss of energy due to unavailability, impact on the Grid, as well as other costs or transmission losses.

The following sub-criteria are considered neutral (between OHL and UGC technologies) and have not been scored in the MCA process.

- **Project Benefits:** Avoided costs and difference in constraint costs for example due to the lack of capacity to export a forecast volume of generation.
- **Pre-Engineering Costs:** Costs associated with the design and specification, route evaluation and management of the statutory planning application, including contingencies for such activities.

2.2.6.3 Deliverability Aspects

The following sub-criteria were scored:

- **Implementation Timelines:** Relative length of time until energisation (assess significant differences).
- **Permits & Wayleaves:** Various permissions and wayleaves required to proceed to construction (e.g., number or level).
- **Land Availability:** Considers land availability for the construction of the circuit, in addition to working space during construction.
- **Ease of Construction:** Considers elements such as working time constraints, outage impact, utility congestion, etc. and how that may impact the Contractor during construction.

The following sub-criteria are considered neutral (between OHL and UGC technologies) and have not been scored in the MCA process.

- **Dependence on other Projects:** Does the project depend on the completion of other projects?
- **Risk of Untried Technologies:** Has the technology been used by EirGrid and ESBN in the past?
- **Supply Chain Constraints:** Any constraints (e.g., small number of suppliers in Ireland or internationally) that would affect the procurement of materials or services (e.g., cable laying vessels waiting list lead time) to complete the project.
- **Planning and other statutory requirements:** Considers the requirement for planning, foreshore licenses or other statutory requirements.

2.2.6.4 Environmental Aspects

The following sub-criteria were scored:

- **Biodiversity, Flora & Fauna:** Assessment of the impact on biodiversity, flora and fauna, which could include an ecological desktop study. The following topics were assessed as part of this sub-criterion:
  - Impacts on protected areas: National and European sites (e.g. SAC, SPAs, RAMSAR), National sites (e.g. NHAs) and other Natural Heritage Sites and Conservation Interest Sites e.g. refuge for fauna or flora, wildfowl reserves).
  - Impacts on sensitive bird species and/or their habitats and impacts on protected species (e.g., Annex II, IV and V of the EU Habitats Directive) and Flora Protection Order and species outside of Natura 2000 sites.
  - Impacts on Annex I Habitats outside of Natura 2000 sites (i.e., undesignated habitats).
  - Impacts on aquatic environment (including watercourses and waterbodies).
- **Soil:** Impact on soil/subsoil geology, Irish geological heritage sites, and bedrock geology, etc.
- **Water:** Impact on river crossings, lakes, and groundwater based on established methodologies.
- **Planning Policy and Land Use:** Considers whether the circuit is consistent with the local authorities Development Plans.
- **Landscape & Visual:** Assessment of landscape constraints and designations and the impact on visual amenity.
- **Cultural Heritage:** The impact of a proposed circuit on recorded cultural heritage resources.
- **Noise & Vibration:** Vibrations and operational noise impact of lines and sub-stations, taking into account sensitive receptors.

The following sub-criterion is considered neutral (between OHL and UGC technologies) and has not been scored in the MCA process.

- **Climate & Sustainability:** The potential for release of greenhouse gasses or impacts on climatic change on the asset.

2.2.6.5 Socio-Economic Aspects

The below sub-criteria were scored:

- **Amenity:** The potential impact on the overall pleasantness or attractiveness of surroundings. This includes effects on community facilities, and recreation and tourism assets (not already captured).
- **Settlements and Communities:** The expected impact of a grid development on towns, villages and rural housing, and the way of life of their communities, residents, workers and visitors (e.g., severance, settlement patterns, etc.).
- **Recreation and Tourism:** Impact on recreational activities (e.g., fishing, sports) and tourism, during and after construction, that are not included in the other sub-criteria.
- **Traffic and Transport:** This considers potential effects on traffic and transport in the study area during the construction phases of the different solutions. Of concern to communities is the potential of severance, isolation and significant delays during the construction phase.

The following sub-criterion is considered neutral (between OHL and UGC technologies) and has not been scored in the MCA process.

- **Health:** To determine potential effects on humans, this considers WHO health thresholds. Electromagnetic field (EMF) is considered as set out in EirGrid's 'Your guide to understanding electric and magnetic fields (EMFs)'.

2.2.6.6 MCA Scoring Scale

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". Table 2-3 shows the criteria performance/scoring scale used to illustrate each criteria parameter in a comparative assessment with other options.

Table 2-3 - Criteria Scoring Scale

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

High Risk (Dark Blue)	Moderate-High (Blue)	Moderate (Dark Green)	Moderate-Low (Green)	Low (Cream)

3. Multi-Criteria Analysis – Circuit Technology Selection

3.1 Emerging Best Performing Technology Option

Table 3-1 shows the overall performance of the 2no. technology options (i.e., OHL and UGC) for the Hynestown-Steelstown circuit.

From a Technical performance standpoint, OHLs can achieve higher circuit ratings and have higher availability levels (less failures). Compared to UGC circuits, OHLs are easier to expand (voltage uprate) or extend, and they carry less operational risk. In the Economic assessment, OHL solutions offer lower construction and lifecycle costs, compared to UGC technology. The improved reliability of OHLs and reduced exposure to constraints also result in lower Single Energy Market (SEM) costs over the project lifetime.

However, when considering Deliverability, UGC technology clearly performs better, as OHL construction is heavily constrained by existing and planned settlement patterns, insufficient wayleave widths, aviation constraints, and multiple high-risk crossing points. Achieving a compliant OHL corridor is significantly more challenging within the Study Area and presents greater landowner, environmental, planning and programme risk. UGC, routed mainly along existing regional roads, offers more straightforward permitting, reduced land interactions, and fewer visual and amenity concerns, enabling a more deliverable and publicly acceptable solution.

When considering Environmental and Socio-Economic aspects, UGC technology offers lower long-term impact, greater compatibility with sensitive landscape and community settings, and a lower risk profile in the context of the Study Area. Although UGC carries higher construction-phase risks, these are temporary, manageable, and confined to the construction phase. OHL, on the other hand, introduces long-term and often irreversible impacts on landscape, amenity, biodiversity, and community receptors. For a project located within a landscape featuring significant wetlands, ecological corridors, protected views, and sensitive communities, the long-term resilience and lower operational footprint of UGC make it the more appropriate option given these constraints.

Although both technologies score 'Moderate' risk overall, UGC technology is assessed as the Emerging Best Performing Technology Option due to its better performance in the Deliverability, Environmental and Socio-Economic criteria. UGC technology will provide a more robust and deliverable solution than OHL technology when considering the constraints of the Hynestown-Steelstown circuit.

Table 3-1 - MCA Scoring – Overall Score (Hynestown-Steelstown Circuit)

Assessment Criteria	OHL	UGC
Technical Performance		
Economic Assessment		
Deliverability Aspects		
Environmental Aspects		
Socio-Economic Aspects		
Overall Score		

3.2 Technical Performance

Table 3-2 shows a summary of the scores for the Technical Performance of each technology option.

Table 3-2 - MCA Scoring – Technical Performance

Sub-Criteria	OHL	UGC
Average Failure Rates		
Circuit Ratings / Headroom		
Expansion / Extendibility		
Repeatability		
Technology Operational Risk		
Geotechnical Conditions		
Electromagnetic Compatibility		
Overall Technical Score		

Circuit Availability Levels are found to be higher for OHL technology compared to UGC circuits over equivalent circuit lengths.

Compared to UGC technology, the maximum circuit rating of an OHL connection from Hynestown to Steelstown Substation will not be limited by external constraints. A UGC circuit will be constrained due to the high volume of existing services in the local road network, especially around the Newcastle, Greenogue and Rathcoole urban areas and the requirement for HDDs along the route.

OHL options are more flexible in terms of expansion and extendibility in comparison to UGCs. At 400 kV, further uprating of the line rating capacity could be achieved by replacing the ‘curlew’ conductor line with High Temperature Low Sag (HTLS) conductor (noting that this technology is not currently approved for use by ESBN at 400 kV).

There is a lower risk associated with operating HV OHL circuit compared to UGC (especially at 400 kV). OHL options are deemed to have lower geotechnical impact than UGC options due to their smaller overall footprint.

3.2.1 Average Failure Rates (Availability Levels)

Average failure rates are predicted based on the circuit length and technology. Published and internal EirGrid Asset Reliability survey data indicate that failure rate statistics for 220 kV and 400 kV OHL circuits are less compared to UGC technology.

The mean time to repair (MTTR) is much shorter for OHL circuits (matter of hours to days) as faults / failures are much easier to detect and access. For UGC circuits, significant lead time is required to locate the fault, organise access to joint bays, organise road closures, etc. Even after determining / locating the fault, more time may be required to source new cables, specialist equipment or qualified personnel, such as HV cable jointers, to make the repairs.

As such, availability levels are proven to be much for OHL circuits than equivalent UGC circuits, where:

$$Availability\ (\%) = \frac{\text{Total Time} - (\text{Failure Rate} \times \text{MTTR})}{\text{Total Time}} \times 100$$

Overall, Availability Levels are found to be higher for OHL technology compared to UGC circuits over equivalent circuit lengths.

3.2.2 Circuit Ratings / Headroom

Compared to an UGC circuit, the maximum circuit rating of an OHL connection from Hynestown to Steelstown Substation will not be limited by external constraints. At 400 kV, the target ampacity ratings for twin 'Curlew' 600mm² ACSR conductor is more than the equivalent UGC circuit rating (refer to Table 3-3). If a higher ampacity rating is required, then the conductor technology can be swapped out to HTLS (pending technology approval by ESBN).

A UGC circuit connection from Steelstown to Hynestown Substation will be constrained due to the high volume of existing services in the local road network, especially around the Rathcoole town, Newcastle town and Greenogue Business Park. Compared to OHL technology, an UGC connection between Steelstown and Hynestown substations may be constrained in meeting the specified ampacity requirements, due to the high density of existing services and major constraints along the route. HDD will likely be required for this cable corridor to cross the N7 carriageway which bisects the study area / corridor from west to east. Within the study area there are two existing road bridges (and one footbridge) over the N7, but it is expected that even if a road bridge has adequate cover to accommodate a HV UGC, it would be prohibited by TII. Any HDD crossing of the N7 would need to be approved by TII and designed in accordance with their requirements for such crossings. To achieve maximum possible ratings, the HDD bores will need to be spaced adequately apart (e.g., 3no. bores with up to 5 m separation distance for the 400 kV circuit HDDs). OHLs are ideally suited for crossing linear constraints such as rivers, railway lines, motorways, other services, etc., without directly impacting on the constraint or the circuit itself (i.e., rating). However, further liaison with TII is required to inform them of any proposed OHL crossing over the N7 dual carriageway and also with AirNav Ireland / Air Corps to confirm the proposed OHL circuit will not interfere with flight operations at Casement Aerodrome.

Table 3-3 - Circuit ratings summary

Technology	Voltage	Target Rating Sumer (A)	Target Rating Winter (A)	Standard Cable
UGC	220 kV	1,410	1,591	2500 mm^2 ALU
UGC*	400 kV	1,969	2,103	2500 mm^2 CU
OHL – "Curlew"	220 kV	1,139	1,347	600 mm^2 ACSR
OHL – Twin "Curlew"	400 kV	2,278	2,694	2x 600 mm^2 ACSR
OHL – HTLS "Traonach"	220 kV	2,081	2,161	586 mm^2 GZTACSR
OHL – Twin HTLS "Traonach"	400 kV	Not currently available	Not currently available	2x 586 mm^2 GZTACSR

** 400 kV UGC target ratings are currently under review. CP1021 target ratings included.*

3.2.3 Expansion / Extendibility

OHL options are more flexible in terms of expansion and extendibility in comparison to UGCs. Further uprating of the line rating capacity could be achieved by replacing the 'curlew' conductor line with HTLS conductor, but this technology is not currently approved / available for use in Ireland at 400 kV.

Further expansion (uprating) of a 400 kV UGC circuit will be very difficult and is constrained by current limitations on cable technology and any rating constraints (i.e., ‘pinch-points’) encountered along a route such as HDDs, circuit crossings, etc. As the circuit will be operated at 220 kV initially, certain circuit components (e.g., sheath voltage limiters, compensation equipment, etc.) will need to be changed when switching to 400 kV operation.

UGC circuits are generally more difficult to loop new circuits into compared to OHLs due to physical accessibility of the circuit, outage requirements, network issues and the cable sheath bonding arrangements.

3.2.4 Repeatability

Both OHL and UGC technology are used in the Irish transmission system however, HV OHL circuits are considered more repeatable than HV UGC circuits as there are fewer potential impact / complications to the network (e.g., need for additional power compensation equipment). The circuits length under consideration for the Hynestown-Steelstown circuit (approximately 7.0 to 8.6 km) would not be considered unsuitable for HV OHL or UGC technology.

However, the possibility of laying 400 kV UGC circuits within the local road network, if it is used, could be restrictive and limit future use of the roads for UGC circuits (but not other services such as telecoms, low pressure water pipes, etc). For a 400 kV circuit, a width of approximately 5 m on either side of the circuit will need to be kept clear of other electrical UGC circuits.

3.2.5 Technology Operational Risk

Overall, there is a lower risk associated with operating HV OHL circuits compared to UGC (especially at 400 kV).

The most significant risk factors associated with HV OHL circuits are as follows:

- Weather Vulnerability:
  - Storms and Lightning: Susceptible to faults from wind, ice, and lightning strikes.
  - Conductor Galloping: Very rare wind-induced oscillations can cause mechanical damage.
- Maintenance and Access:
  - Easier Fault Detection: Visual inspection and remote sensing are effective.
  - Faster Repairs: Typically resolved in hours to days.
  - Live Line Work: Possible with trained crews and specialised equipment.
- Environmental Impact:
  - HV corona can generate noise and RFI.
  - Electromagnetic Fields (EMFs): Elevated exposure levels as conductor are unshielded however this is mitigated by using minimum mast heights to ensure restriction level are met.
- Flexibility and Uprating:
  - Easier to Uprate: Can replace conductors with new technology (i.e., HTLS) to achieve better ratings.
  - Adaptable Routeing: Can span rivers, roads, and uneven terrain.

The most significant risk factors associated with HV UGC circuits are as follows:

- Fault Detection and Repair:
  - Slow Fault Location: Faults are harder to detect and pinpoint due to lack of visual access.
  - Long Repair Times: Repairs can take up to 2–6 weeks, requiring excavation, specialist jointers, and imported components.

- Third-Party Damage: Risk from construction, excavation, or utility interference.
- Thermal Management:
  - Heat Dissipation: Underground cables dissipate heat during operation; poor thermal conductivity of surrounding material can reduce the current-carrying capacity of the cable / prematurely age or damage the cables due to thermal stress.
- Uprating Limitations:
  - Difficult to Up-rate: Increasing capacity will require full excavation and replacement of cables and equipment.
- Limited Flexibility:
  - Cannot easily adapt to changing grid demands.

3.2.6 Geotechnical Conditions

OHL options due to their smaller overall footprint, are deemed to have lower geotechnical impact than UGC options.

The proposed OHL corridor route is via a landscape described as flat to undulating hills, gently rising in elevation as the corridor travels from north to south. From Lyons Hill to Pluckstown the corridor passes through a zone of high ground water vulnerability where it can be expected to encounter rock at very shallow depths. Shallow rock can have a negative effect on the tower footing resistivity for earthing.

There is not a major source of borehole data along the route except for the locality close to the N7 dual carriageway. Here borehole data indicates bedrock at very shallow depths north of junction no.5 (both sides of the carriageway), but south of junction no.5 bedrock should not be encountered at depths less than 5 m, except for a very localised area just south of the road. Specific site investigation works will be required for assessment and selection of final mast / foundation locations.

The OHL circuit corridor avoids passing over any major rivers or areas of flood risk.

UGC options are deemed to have higher geotechnical impact than OHL options, due to long lengths of trenching works and possible HDDs. Any UGC circuit corridor will follow along existing public roads, where geotechnical conditions can be taken as low risk. The general landscape along the route is flat / gently rising as the corridor travels from north to south, with a moderate incline encountered where the proposed UGC corridors approaches the Steelstown Substation search area west of Rathcoole.

UGC corridors do not encounter any major rivers except for a number of small tributaries of the River Liffey. Any UGC circuit will need to cross the N7 Nass Dual Carriageway using HDD. Available borehole test data along the N7 indicates a high likelihood of encountering bedrock at shallow depths (especially north and east of Steelstown). Borehole test data from Peamount south to Greenogue indicate the ground conditions consist mostly of medium to stiff brown and black gravelly silty clays (boulder clays) with bedrock encountered at very shallow depths (a few metres). Specific site investigation works will be required for assessment and selection of final UGC circuit routes, joint bay locations and HDD crossing sites.

3.2.7 Electromagnetic Compatibility

Any electrical conductor will generate a magnetic field when electrical current is passed through it. HV circuits are assessed to electromagnetic compatibility standards including IEC 61000 series and ICNIRP guideline to ensure magnetic field emissions are within allowable limits for the public / equipment, (as per EU 1999/519/EC and ICNIRP (1998) restriction levels).

Regarding OHLs, the standard 400 kV tower design heights ensure that the magnetic and electric field levels at ground height are well within ICNIRP (1998) restriction levels (note, the 1998 levels are more stringent than the more recent 2010 published levels). Likewise, any OHL circuit corridor will need to be carefully routed to ensure it can maintain a 60 m wide clearance corridor (i.e., 30 m each side of the line) from nearby buildings (residential).

The time-varying magnetic fields produced by alternating current circuits may induce voltages in nearby conductive materials therefore consideration needs to be given in the routeing of HV OHLs in proximity to metallic structures such as steel pipelines and telecoms cables (such as railway line signalling communication cables). When routeing a circuit close to such pipelines or signal cabling, care needs to be taken to avoid parallel circuits and ensuring any crossings are as close as possible to 90 degrees.

Any OHL corridor will need to be routed to avoid close proximity to existing telecommunication masts (such as at Hazelhatch train station). Final siting of the OHL masts needs to be carefully selected and assessed to ensure there is no interference with nearby airport telecommunications, radar or navigation systems at Casement Aerodrome or Weston Airport, especially on any final OHL corridor approach into Hynestown Substation (approximately 3-4 km from both airports).

Corona discharge around HV OHLs can be a source of high-frequency RFI (i.e., generate radio noise) which can affect AM radio (0.15-30 MHz) and nearby telemetry systems. In such circumstances, corona mitigation measures can be employed to reduce the effects.

Compared to OHLs, the electric fields generated by UGCs are effectively blocked by the surrounding soil/bedding material and cable sheath and are of little relevance / insignificant.

The time-varying magnetic fields produced by alternating current UGC circuits may induce voltages in nearby conductive materials therefore consideration needs to be given in the routeing of UGCs in proximity steel pipelines such as high-pressure gas and water mains including their cathodic protection systems and telecoms cables (such as rail line signalling communication cables). When approaching such pipelines or signal cabling care needs to be taken to ensure the UGC circuits do not interfere by maintaining a set separation distance and ensuring any crossings are as close as possible to 90 degree.

Additional mitigation measures include using trefoil cable arrangements which will minimise magnetic fields (but potentially reduce overall circuit ratings).

3.3 Economic Assessment

Table 3-4 shows a summary of the scores for the Economic Assessment of each technology option.

Table 3-4 - MCA Scoring – Economic Assessment

Sub-Criteria	OHL	UGC
Project Implementation Costs		
Project Life-Cycle Costs		
Cost to SEM		
Overall Economic Score		

The cost of implementing a new circuit connection depends mainly on the circuit length, chosen technology (OHL vs UGC), and any specialised equipment needed at the substations to facilitate the circuit / connection. In general, OHL circuits are cheaper to construct and operate than UGC circuits of equivalent length.

Life-cycle costs are lower for OHL circuits because they have longer asset lifespans, lower failure rates, cheaper and faster fault repairs, and less frequent maintenance. UGC circuits age faster due to thermal and electrical stresses and require more expensive and time-consuming fault rectification.

In terms of impact on the Single Electricity Market (SEM), OHLs are more economical. UGCs have higher capital and operational costs, leading to increased Transmission Use of System (TUoS) charges. Their lower availability and longer repair times increase constraint and imperfection charges. OHLs, while having higher electrical losses, still offer better overall market efficiency due to flexibility in upgrades, easier integration of renewables, and support for meshed network operation, which reduces redispatch costs.

3.3.1 Project Implementation Costs

Assuming no additional land procurement is required at either substation, the circuit implementation costs will be driven predominantly by the length / technology of the required circuit connection and any bespoke equipment required at the connecting substation (i.e., for OHLs; LCIMS or conductor gantries).

HV OHL circuit development costs are approximately half those of equivalent UGC circuits. Considering the relatively short length of OHL circuit expected there is no need for any additional circuit/network compensation equipment. Considering the use of UGC technology, additional circuit and network compensation equipment (e.g., shunt reactors) may also be required, particularly if the length of UGC circuit involved are considerably long.

OHLs by their nature will be able to span over the major constraints along the route such as the N7 Nass dual carriageway.

Future-proofing the OHL circuit for 400 kV will require higher specification equipment and masts sizes, increasing procurement and construction costs. Future-proofing the UGC circuit for 400 kV will require higher specification equipment and trench sizes, increasing procurement and construction costs. Rather complex and large crossing designs / land takes will be required to cross under the N7 Nass dual carriageway.

3.3.2 Project Life-Cycle Costs

Life cycle costs are less for HV OHL circuits compared to UGC circuits. This is due to:

- Lower equipment failure rates and replacement costs.
- Longer expected lifespan of the OHLs (40-60 years) compared to UGC (30-40 years). Even though OHL equipment is exposed to the environment / weather, it is not impacted as much as UGC technology which has shorter life spans due to thermal stress / electrical aging effects.
- Fault correction costs are lower for OHL as it is easier to determine fault locations and typically requires less time to gain access to rectify (hours compared to days).
- Longer inspection / maintenance intervals required for OHL due to the longer lifespans of the equipment.

3.3.3 Cost to SEM

The cost to the Single Energy Market is generally less for OHL circuits compared to equivalent UGC circuits. This is for a number of factors:

- Capital and Operational Costs:
  - UGCs are more expensive to construct than OHLs.
  - Higher capital and operational costs translate into higher TUoS charges.
- Reliability and Outage Costs:
  - Availability Levels are found to be much lower for UGC technology compared to equivalent OHL circuits. This is due to higher failure rates for UGC technology (at 220 kV and 400 kV), coupled with UGCs having longer fault repair times (MTTR) on the order of days to weeks for UGC compared to hours to days for OHL.
  - This increases constraint costs and imperfections charges in the SEM.
- Transmission Losses:
  - OHLs generally have higher electrical losses, which can increase wholesale energy costs. However, this disadvantage is often outweighed by the lower capital and maintenance costs.
- Flexibility and Grid Integration:
  - OHLs are easier to upgrade or reroute, supporting dynamic grid needs and renewable integration (e.g., loop-ins).
  - UGCs are less flexible, which can lead to higher curtailment costs for renewables and reduced market efficiency.
- Impact on Market Dispatch:
  - OHLs support more robust meshed networks, reducing the need for costly redispatch.

3.4 Deliverability Aspects

Table 3-5 shows a summary of the scores for the Deliverability aspects of each technology option.

Table 3-5 - MCA Scoring – Deliverability Aspects

Sub-Criteria	OHL	UGC
Implementation Timelines		
Permits & Wayleaves		
Land Availability		
Ease of Construction		
Overall Deliverability Score		

The study area has a relatively high density of dwellings (but lower in the west part of the study area) which will limit the number of possible OHL circuit routes through the Study Area. Compared to UGC, construction of the proposed HV OHL circuit (masts and conductor stringing) is considered to be more straight forward unless any sections of the circuit must be undergrounded. The only major constraint encountered is where the circuit must cross over the existing DUN-MAY 220 kV OHL circuit in close proximity to the N7 dual carriageway.

Any UGC circuit will deliberately make use of wide road corridors (i.e., regional roads), routed predominantly through mostly countryside in the west or built-up urban / commercial areas in the east of the Study Area. The eastern roads have a high density of existing services within the road network, including water, sewage, medium pressure gas, low voltage power cables, and telecoms. Compared to the western roads, construction along the eastern roads will be onerous due to the difficultly in determining a viable trench corridor, the high number of service crossings involved, and expected traffic management / work time restrictions in the urban areas / town centres.

Construction of an UGC circuit along the road network will likely cause local disruption and impact on traffic around the Newcastle / Greenogue / Rathcoole areas. Within the study area there are only two existing road bridges crossing over the N7 Naas dual carriageway. These bridges are deemed unlikely to be suitable (or allowed by TII) for a HV UGC to be installed in the bridge deck. As such, crossing under the dual carriageway will likely need to be facilitated via HDD.

A number of off-road sections are likely to be required for an UGC circuit to facilitate getting around unavoidable pinch-point or constraints and to locate joint bays / passing bays, HDD crossing launch / receiving pits, etc. Any off-road sections will require an easement from the relevant landowners / statutory authority. Obtaining public acceptance and the necessary landowner wayleaves for any off-road UGC sections is considered to be less difficult than compared to OHL technology and pose less risk to the overall development programme.

Future-proofing an UGC circuit to 400 kV specifications will require marginally larger trench, joint bay and HDD designs which could cause further disruption. Future-proofing an OHL circuit to 400 kV specifications will require larger/taller tower masts and foundations to be constructed but this would be considered more straight forward to implement.

3.4.1 Implementation Timelines

Construction of an UGC circuit between Hynestown and Steelstown is expected to be longer than an OHL option, on account that an UGC will need to route via suitable roads within the road network, whereas an OHL circuit can be more direct going off-road / cross country. Construction of an OHL circuit is estimated to take approximately 6-9no. months (compared to approximately 12no. months for an UGC circuit) depending on the number of construction crews deployed and the number / specification of masts to be constructed.

All materials and components are considered standard and should not represent any risk or delays to the usual procurement timelines, including 400 kV cables (approximately 9+ months).

For both technologies, no major circuit outages will be required except possibly for a partial busbar outage when connecting into either of the new Hynestown or Steelstown substations (if the substation is built and energised prior to this circuit).

Regarding the overall development timeframe, obtaining public acceptance and the necessary landowner wayleaves for any off-road UGC sections is considered to be less difficult than compared to OHL technology and pose less risk to the overall development programme.

3.4.2 Permits & Wayleaves

An OHL circuit will predominately route via private, agricultural based land which will require easements (68-74 m wide) to be negotiated and agreed with the relevant landowners. Consultation and approval will be required from TII for the OHL to cross the N7 Dual carriageway. If the OHL masts on the final approach into Hynestown Substation are assessed to encroach / impede on the AirNav height restrictions around Casement Aerodrome then further agreements will be required from the relevant Aviation authorities / Air Corps. For the construction phase, further liaison and possibly a Special Aeronautical Study may need to be carried out to determine any potential restrictions on allowable crane heights so as not to impact on flight operations at Casement Aerodrome.

Compared to UGC technology, it is considered that it will be more difficult to obtain public acceptance and the necessary landowner wayleaves for an OHL circuit within the Study Area and as such is scored at higher risk.

Any UGC circuit will predominately route along public roads. A number of off-road sections will be required to facilitate getting around unavoidable pinch-point or constraints and to locate joint bays / passing bays, HDD crossing launch / receiving pits, etc. Any off-road sections will require a wayleave from the relevant landowners / statutory authority. Off-road wayleaves required for 400 kV UGC circuits will need to be minimum 5 m wide, with the additional requirements for a 3.5 m access track along the off-road routes to ensure subsequent access for maintenance activities, etc. Wayleaves will be required from TII for the UGC circuit to cross under (HDD) the N7 Nass dual carriageway.

The UGC routes will likely encounter medium pressure underground gas pipelines, especially in the vicinity of Newcastle, Greenogue and Rathcoole, but no high-pressure gas pipelines are known to traverse the Study Area. During the construction phase, a road opening licence will be required from the local road authority (KCC and SDCC) to construct the UGC circuit trenches and joint bays along any sections of public road. Engagement with the local authorities' road engineers is required to confirm trench designs, reinstatement details and exact joint bay locations. Principal inspection reports and technical assessment reports may also be required for any existing or proposed structures affected by the UGC, for example bridges, culverts or project joint bays.

3.4.3 Land Availability

The study area has a relatively high density of dwellings (but lower in the west part of the study area) which will limit the number of possible OHL circuit routes through the Study Area.

Any OHL circuit corridor will require easements (68-74 m wide) to be negotiated and agreed with the relevant landowners, including a permanent 4 m access corridor directly under the line which needs to be kept clear at all times. Obtaining the necessary land easements from private landowners will likely be more onerous compared to UGC circuit technology options.

Very often with OHL circuits, the final connection into a substation is facilitated using an UGC rather than OHL. This is due to constraints at the substation location prohibiting the construction of OHL masts / gantries in close proximity to the substation. If an UGC is to be used for the final section of circuit to connect either Steelstown or Hynestown substations, then a terminal overhead line tower and OHL to UGC interface compound (approximately 35 m x 45 m) including an access road may be required to facilitate the changeover from OHL to UGC technology.

Routeing a 400 kV UGC circuit from Steelstown to Hynestown will be constrained by Newcastle and Rathcoole towns located within the study area. The proposed circuit route will predominately route along public roads and within any built-up urban areas the circuit will encounter roads containing a high density of existing services including medium pressure gas pipelines. Several off-road sections may be required to facilitate getting around unavoidable pinch-points or constraints and to locate joint bays / passing bays, HDD crossing launch / receiving pits, etc.

Any off-road sections of the UGC circuit including joint bays, passing bays, HDDs, etc. will require a wayleave from the relevant landowners. Off-road wayleaves of 5 m are required for 400 kV UGC circuits.

3.4.4 Ease of Construction

An OHL circuit will predominately route via private, agriculturally based land which should have good access and ground conditions for siting and constructing the overhead masts and foundations (>20no. masts required in total).

Construction of the proposed HV OHL circuit (masts and conductor stringing) is considered to be straight forward. The only major constraint encountered is where the circuit must cross over the existing DUN-MAY 220 kV OHL circuit in close proximity to the N7 dual carriageway. As this 220 kV OHL circuit is also to be looped-in to the Steelstown Substation it offers an opportunity to potentially combine the two circuits into one double circuit OHL arrangement into the substation.

Additional protection measures may need to be put in place when stringing the circuit conductors over major roadways such as the N7 dual carriageway. Some limitations of construction crane heights may be imposed in the vicinity of Casement Aerodrome.

Any UGC circuit will deliberately make use of wide road corridors (i.e., regional roads), routed predominantly through countryside in the west or built up urban / commercial areas in the east of the Study Area. The roads in the east of the Study Area have a high density of existing services within the road network, including water, sewage, medium pressure gas, low voltage power cables, and telecoms. Compared to the roads in the west of the Study Area, construction of an UGC circuit along the road network will be onerous due to the difficultly in determining a viable trench corridor, the high number of service crossings involved, and expected traffic management / work time restrictions in the urban areas / town centres.

Within the study area there are only two existing road bridges crossing over the N7 Naas dual carriageway. These bridges are deemed unlikely to be suitable (or allowed by TII) for a HV UGC to be installed in the bridge deck. As such, crossing under the dual carriageway will likely need to be facilitated via HDD.

3.5 Environmental Aspects

Table 3-6 shows a summary of the scores for the Environmental aspects of each technology option[1].

Table 3-6 - MCA Scoring – Environmental Aspects

Sub-Criteria	**OHL**	**UGC**
Biodiversity, Flora & Fauna		
Soil		
Water		
Planning Policy and Land Use		
Landscape & Visual		
Cultural Heritage		
Noise & Vibration		
Overall Environmental Score		

Both UGC and OHL technologies present different risks within the Study Area and the overall risk profile differs between these technologies.

OHL development generally results in less ground disturbance, but presents a higher overall level of risk in the Study Area context due to long-term landscape and visual impacts and the limited opportunities for alternative routeing within the Study Area. While micro-siting can help avoid sensitive cultural and ecological features, OHL infrastructure introduces additional considerations such as avian collision risk and operational noise. The presence of designated sites such as the Grand Canal proposed Natural Heritage Area (pNHA) also constrains viable tower locations, increasing sensitivity.

UGC development involves extensive excavation, which increases the potential for disturbance to wetlands, watercourses and hydrological systems, particularly in areas of soft soils, groundwater vulnerability and flood risk. These construction-phase impacts require robust mitigation, however UGC offers greater certainty in avoiding direct impacts on above-ground cultural heritage features and allows routeing within existing road corridors. While UGC introduces a higher level of construction-phase disturbance (principally through trenching, excavation, and horizontal directional drilling) these impacts are temporary, predictable, and can be effectively managed through established mitigation measures and careful construction planning. The most pronounced environmental sensitivities in the Study Area relate to wetlands, watercourses, and hydrologically connected habitats such as the Grand Canal pNHA and Grand Canal (Kildare) – Grand Canal pNHA wetland; although UGC interacts more intensively with these receptors during installation, the resulting risks are short-term and can be reduced through avoidance of high-value features during routeing.

[1] Note: Planning, Policy and Land use scored equal for both technologies and this sub-criterion did not contribute to differentiating between these technologies. Information on this sub-criterion is given in Appendix A.

3.5.1 Biodiversity, Flora & Fauna

3.5.1.1 National and European Sites

There are no Special Areas of Conservation (SAC) or Special Protection Areas (SPA) within the Study Area, and there is no hydrological connectivity to any European Site within 15 km of the Study Area. One proposed Natural Heritage Area (pNHA), the Grand Canal pNHA, bisects the Study Area at the northern boundary and represents a key ecological constraint due to its extent and ecological value (Figure 3-1). A wetland of national importance (Grand Canal [Kildare]) occurs within this pNHA and contributes to its ecological value. This habitat is highly sensitive to hydrological changes and physical disturbance and conflicts between grid infrastructure and high-value habitats typically occur in wetland areas[2].

For OHL technology, potential impacts include bird collision risk for Annex I species and Birds of Conservation Concern in Ireland (BOCCI) that use local wetlands for foraging or roosting. Risks to watercourses and water-dependent habitats arise mainly during OHL tower foundation construction, but these can generally be mitigated through careful tower placement and standard construction measures. UGC technology removes collision risk entirely but may cause temporary disturbance to birds during construction activities. More importantly, UGC presents a greater potential for disturbance to water-dependent habitats due to the need for trenching, excavation, and longer construction periods, which can increase the risk of sedimentation or hydrological disruption.

Overall, both OHL and UGC technologies present comparable ecological risks within the Study Area, though the risk pathways differ. OHL carries a low risk of water-quality impacts, and collision risks can be mitigated if required. UGC presents a low risk of bird disturbance but a higher potential for impacts on water-dependent habitats during excavation.

[2] cms.eirgrid.ie/sites/default/files/publications/EirGrid-Evidence-Based-Environmental-Study-4-Habitats.pdf

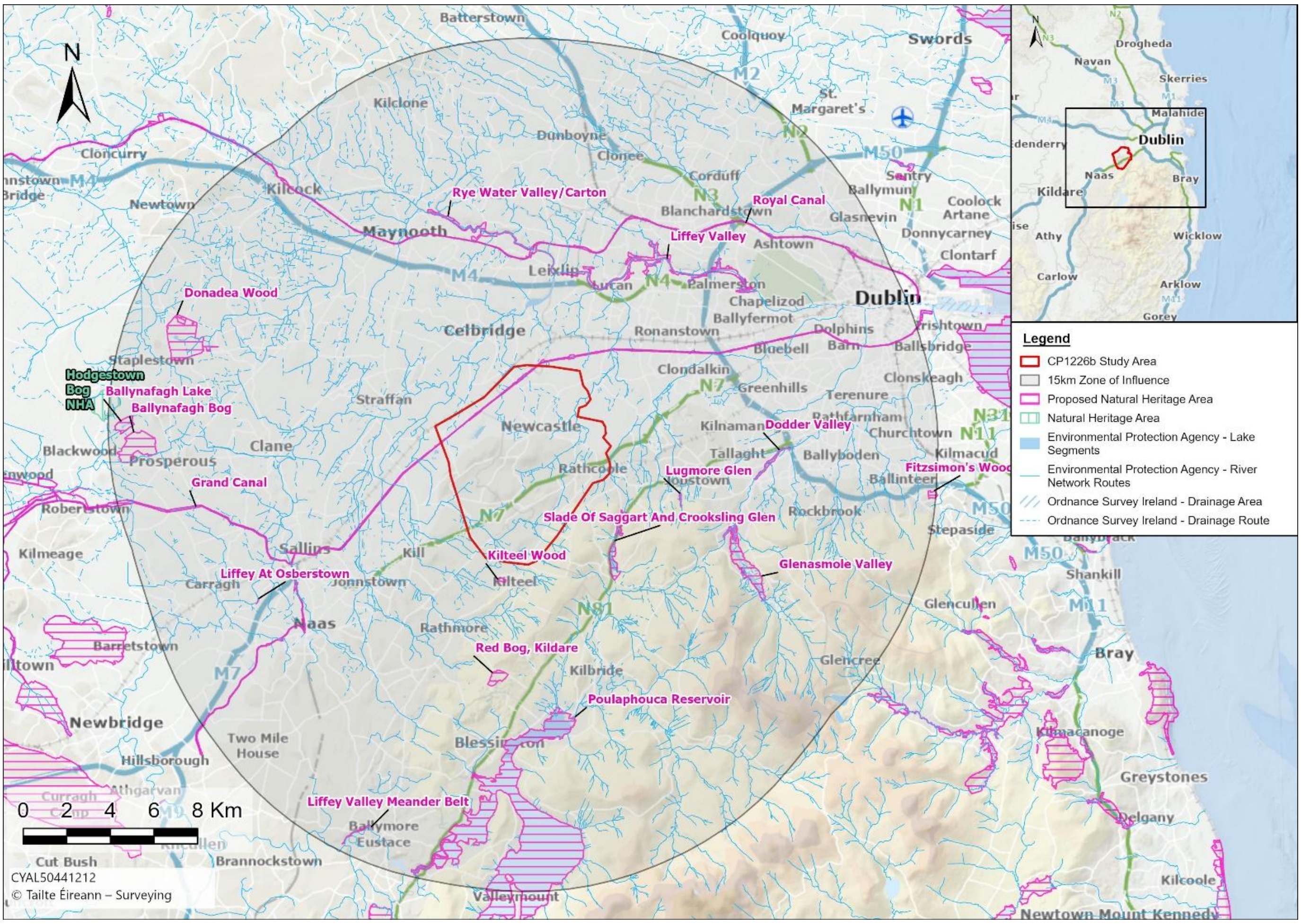

Figure 3-1 - Proposed Natural Heritage Areas within the Study Area and 15 km Zone of Influence

3.5.1.2 Protected Species and Habitats

OHL presents a higher risk to sensitive bird species and habitats within the Study Area compared to UGC, primarily due to potential collision risk for Annex I species (e.g., Red Kite) and BOCCI-listed species that may use local wetlands, Irish Wetland Bird Survey (I-WeBS) sites (2no. located within 4 km of the Study Area) or nearby SPAs outside of the Study Area (Poulaphouca Reservoir SPA located 6.8 km south). While mitigation measures such as tower siting and bird flight diverters can reduce residual risk, it cannot be fully eliminated. UGC removes collision risk but may cause temporary disturbance to birds during construction.

OHL results in lower physical disturbance to ground and aquatic habitats, reducing impacts on Annex II and IV species such as white-clawed crayfish, common frog, pine marten and bats. In contrast, UGC introduces greater potential for disturbance to water-dependent habitats and Annex II/IV species due to trenching, soil excavation, and sedimentation, which can affect aquatic species and disrupt riparian corridors used by bats.

3.5.1.3 Aquatic Environment

OHL involves minimal ground disturbance, reducing direct interaction with watercourses, wetlands (Figure 3-2), and riparian habitats. Tower foundations and access tracks can be sited to avoid sensitive aquatic features, limiting sedimentation and hydrological alteration risks. The main residual risk is sediment runoff during foundation works, which is typically low and manageable with standard mitigation. In contrast, UGC requires extensive trenching and soil excavation, significantly increasing the potential for sediment runoff, hydrological disruption, and contamination of watercourses and wetlands, which could degrade habitats for species such as white-clawed crayfish and amphibians and impact riparian corridors used by bats. Flood-prone areas located along tributaries of the River Liffey can generally be avoided with OHL, whereas UGC works within these areas elevate the risk of pollutant mobilisation and downstream impacts (Figure 3-3).

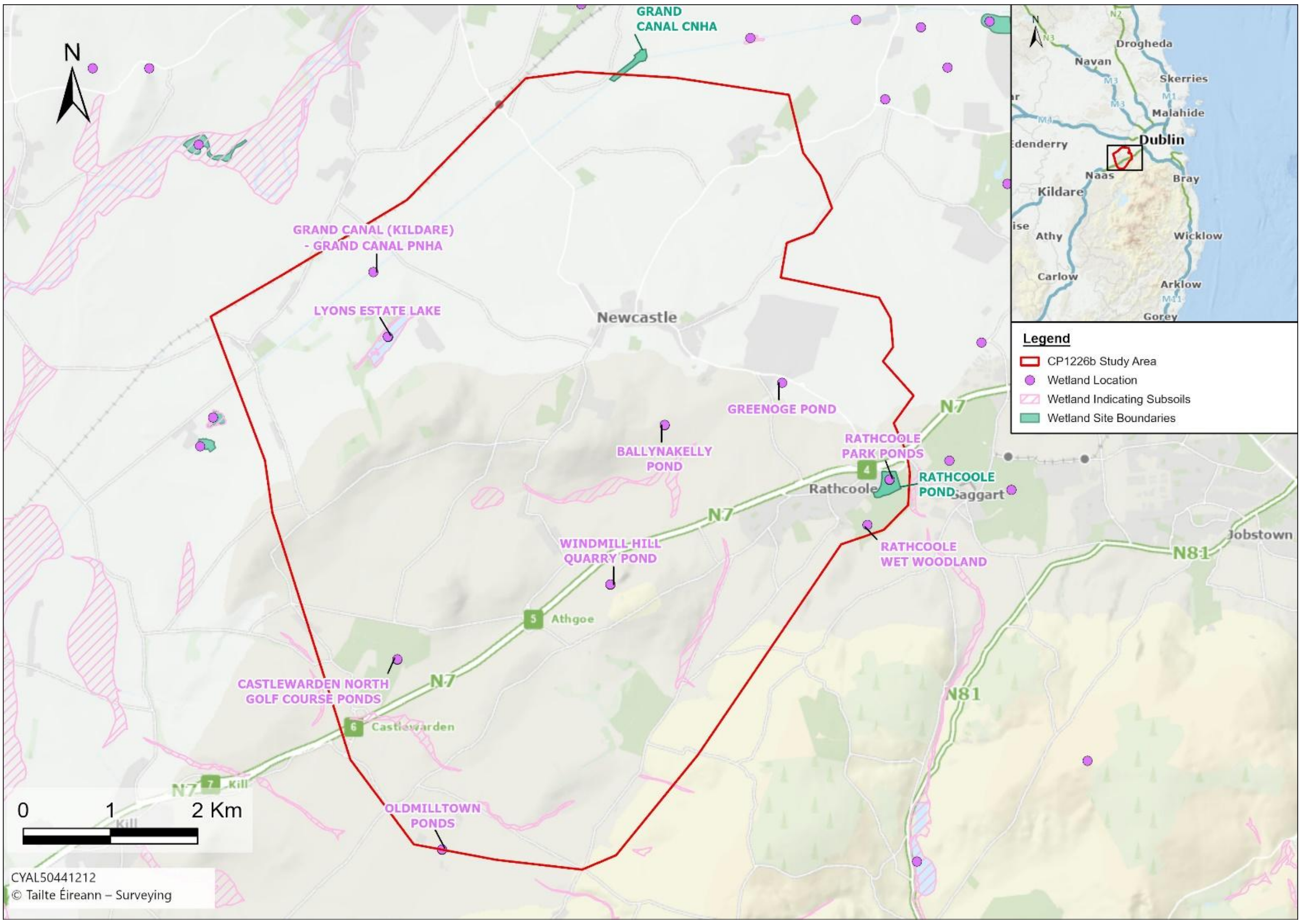

Figure 3-2 - Wetlands within the Study Area

3.5.2 Soil

The Study Area contains one Geological Heritage Site: Newcastle Buried Channel. This is a nationally and/or county-significant feature and considered a sensitive receptor. This site should be avoided during route selection and may influence alignment of access tracks, tower locations, or cable routes. Landslide susceptibility is generally low, though isolated areas of moderate to high susceptibility occur on steeper slopes or weaker soils. Where construction involves significant earthworks, slope stability assessments may be required.

For OHL technology, these areas present a higher risk due to tower foundations and associated access works. UGC installation may also require geotechnical assessments, particularly where trenching intersects susceptible slopes.

Made Ground is present in the urbanised areas of Newcastle and Ratcoole and may contain construction debris, variable soil types, and contaminants. This introduces risks of differential settlement and soft spots, complicating foundation design and trench stability. Detailed site-specific investigations, including contamination assessments and geotechnical testing, will be necessary. While OHL routes are unlikely to traverse major urban areas, UGC routes often follow road networks and may encounter Made Ground, increasing the need for mitigation measures.

3.5.3 Water

The Griffeen River flows through the Study Area and includes areas of Flood Zone A, indicating a high probability of flooding. Past flood events have occurred near the Griffeen River and other low-lying areas, meaning infrastructure such as cable routes and access tracks in these zones may require Flood Risk Assessment (FRA) and climate resilience measures. Tower foundations for OHL in flood-prone areas near the River Liffey tributaries will need careful consideration, as access and construction could be complicated by flood risk (Figure 3-3).

The Study Area also contains zones of moderate to high groundwater vulnerability, with pockets of extreme vulnerability and shallow bedrock. These areas have limited attenuation capacity, increasing contamination risk during trenching or HDD works associated with UGC. Soft alluvial soils and flood-prone areas near watercourses will require detailed geotechnical investigation to ensure trench stability and HDD feasibility. While these factors could typically result in a moderate-high score, mitigation measures can reduce this to moderate.

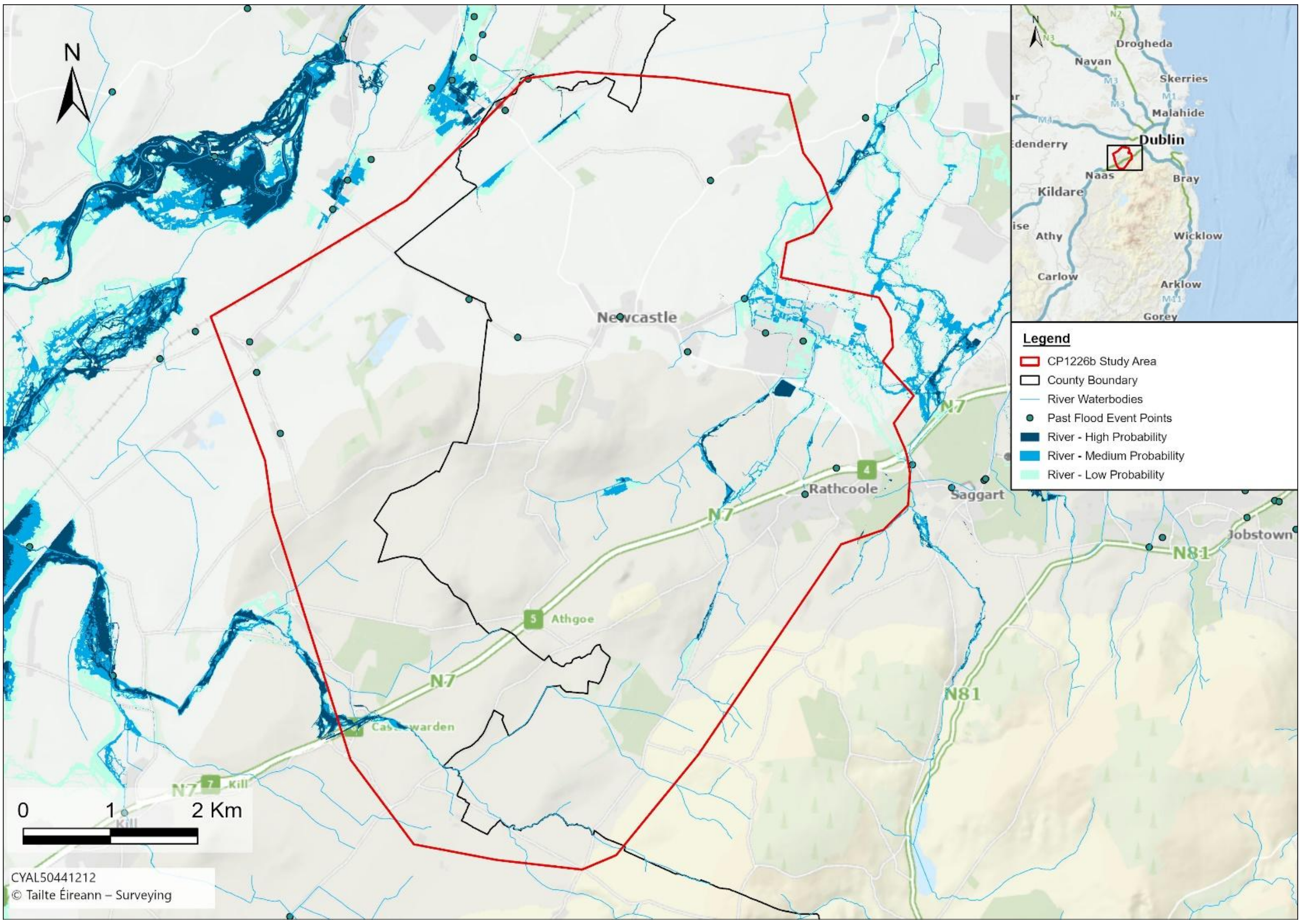

Figure 3-3 - Flood risk within the Study Area

3.5.4 Planning Policy and Land Use

The Study Area contains a variety of zoned lands that influence how transmission infrastructure can be routed, particularly in the areas around Rathcoole, Newcastle, and the Grand Canal. Among these, lands zoned as Open Space, designated to preserve and provide for recreational amenities represent an important constraint. These areas form part of the wider green infrastructure network and support recreational and community uses, meaning that any infrastructure passing through or near them must be planned sensitively to avoid undermining their intended function.

The presence of multiple zoning types across the Study Area requires careful alignment to ensure that route options minimise encroachment on lands with amenity or recreational value and remain compatible with established land-use objectives.

Local planning policy is set out in the South Dublin County Development Plan 2022–2028 and Kildare County Development Plan 2023-2029, which includes several key objectives relevant to the provision of transmission infrastructure:

South Dublin County Development Plan 2022-2028

- IE5 Objective 2 promotes the undergrounding of utilities where appropriate, particularly in areas of high visual or heritage sensitivity.
- Policy IE6 recognises the importance of developing and reinforcing electricity infrastructure to support security of supply.
- IE6 Objective 2 provides specific support for the delivery and enhancement of the electricity transmission and distribution network, subject to compliance with environmental, landscape and community considerations.

Kildare County Development Plan 2023-2029

- Objectives ECO67 and ECO74 notes that overhead cables shall minimise visual impact by avoiding areas of high landscape sensitivity, sites and areas important for biodiversity and/or archaeological, cultural or heritage interest, and that undergrounding of cables is promoted in sensitives areas, in particular within Heritage Towns and Areas of Architectural Conservations.
- Objectives ECO64 and ECO65 supports safeguarding of reliable electricity supply, and reinforcement and strengthening of the electricity transmission and distribution network

Together, these policies establish a planning framework that encourages necessary grid development while ensuring that it is delivered in a way that respects local character, protects sensitive land uses, and aligns with broader strategic planning aims.

3.5.5 Landscape & Visual

The Study Area contains a diverse range of Landscape Character Areas (LCAs) with varying levels of landscape sensitivity and is subject to a number of recognised visual constraints identified in local development plans. These include designated scenic routes, protected views, and a series of hilltop viewpoints and river valley vistas that contribute to the overall landscape value and visual amenity of the wider area. These features form important components of the local landscape framework and must be considered during the siting and alignment of transmission infrastructure.

Development located within 500 m of scenic routes or areas classified as Class 4 or Class 5 landscape sensitivity, the latter situated less than 500 m north of the Study Area, triggers the requirement for a Landscape and Visual Impact Assessment (LVIA). The presence of these highly sensitive receptors means that any new infrastructure must be carefully planned to avoid adverse effects on significant views, landscape character, and publicly accessible viewpoints. In contrast, areas of lower landscape sensitivity within the Study Area may offer greater flexibility for routing infrastructure, although detailed assessment remains essential.

Landscape sensitivity is particularly moderate to high along the western extent of the Study Area, where protected views have been designated in local policy. These locations are highly sensitive to vertical structures, and any development will require careful alignment, micro-siting, and the application of appropriate mitigation measures to reduce potential visual intrusion. For OHL, this may include avoiding elevated ridgelines, maintaining distance from key viewpoints, and respecting the visual context of open rural landscapes. To the east, the Study Area intersects with the Grand Canal proposed Natural Heritage Area (pNHA), where both landscape and ecological sensitivities are elevated. While development in this area would benefit from construction methodology which does not involve ground disturbance through trenching, the introduction of tall structures has the potential to affect the setting of the canal corridor, its associated habitats, and the wider recreational amenity of the Grand Canal Way. Routeing in these locations therefore requires heightened sensitivity to the visual and experiential qualities of the canal landscape.

Although underground infrastructure has minimal long-term visual presence, temporary construction compounds, excavation works, and access arrangements may give rise to short-term landscape and visual impacts. Such works also have the potential to interact with the setting of nearby heritage assets, particularly in areas with protected views, designated landscapes, or clusters of cultural heritage features. Mitigation in these cases may include screening, careful location of temporary works, and appropriate timing to minimise visibility from sensitive receptors.

Overall, the mixture of LCAs, designated visual amenities, and landscape sensitivities across the Study Area means that landscape and visual considerations will play a significant role in informing the refinement of route options in subsequent project stages. Continued coordination with landscape policy objectives, alongside detailed LVIA where required, will ensure that emerging design options remain consistent with the protection of valued landscape features and visual amenity.

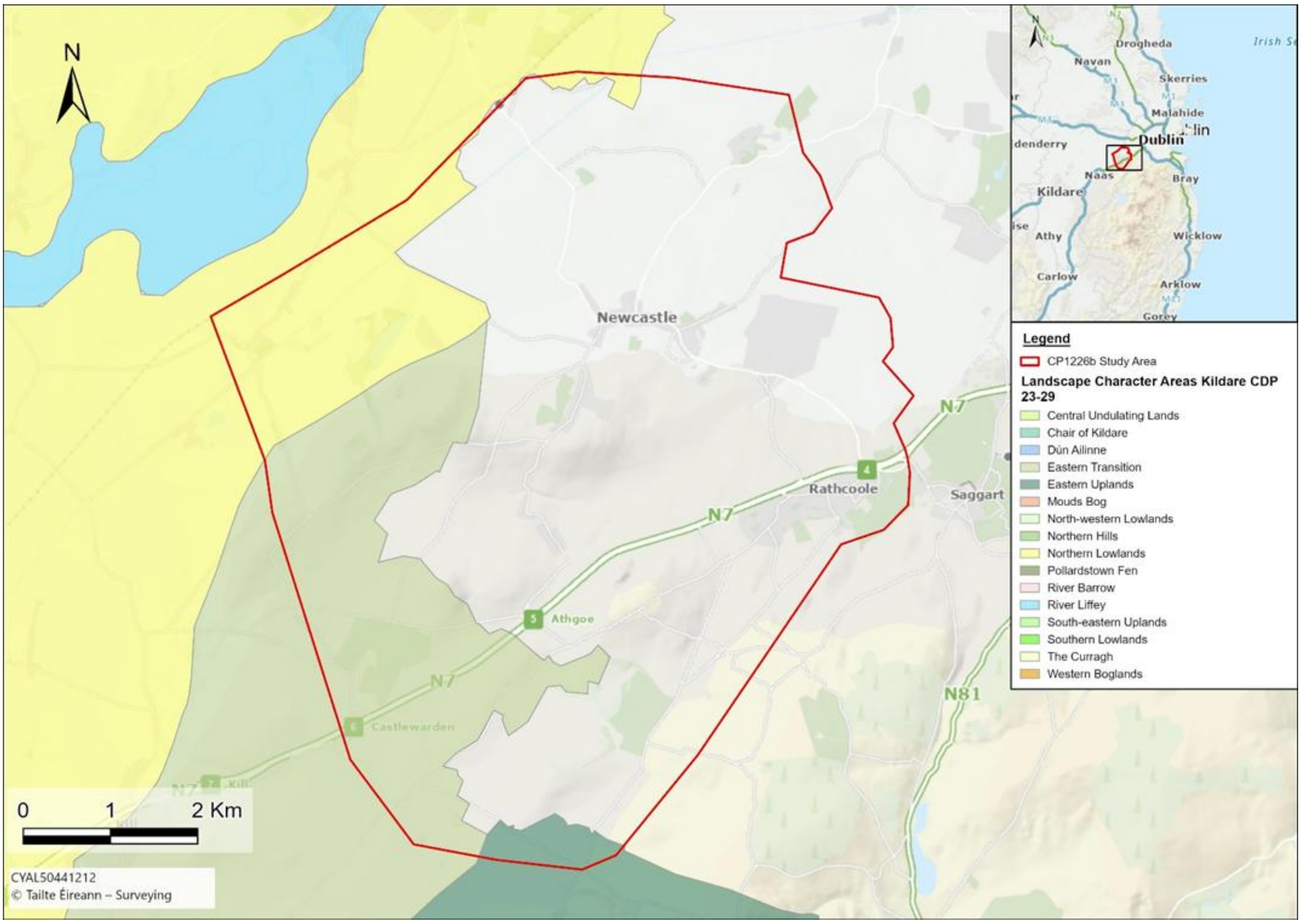

Figure 3-4 - Landscape Character Areas for the Study Area

Note: GIS data was not available for South County Dublin.

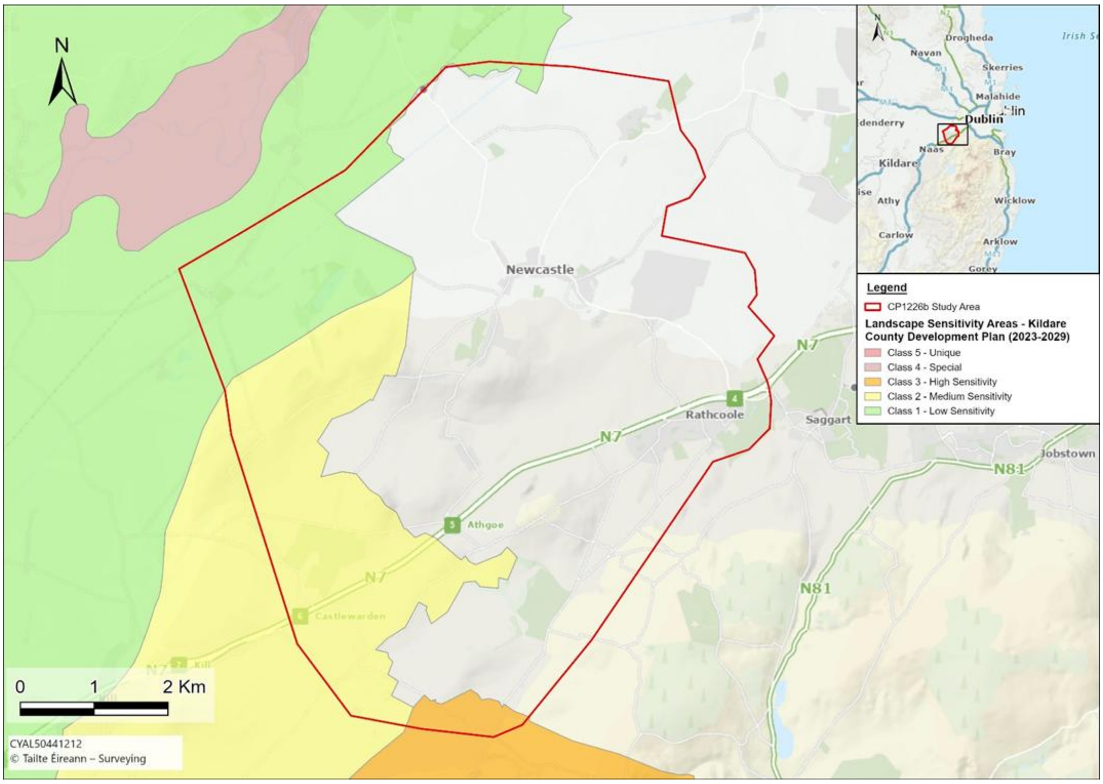

Figure 3-5 - Landscape Sensitivity Areas for the Study Area

Note: GIS data was not available for South County Dublin.

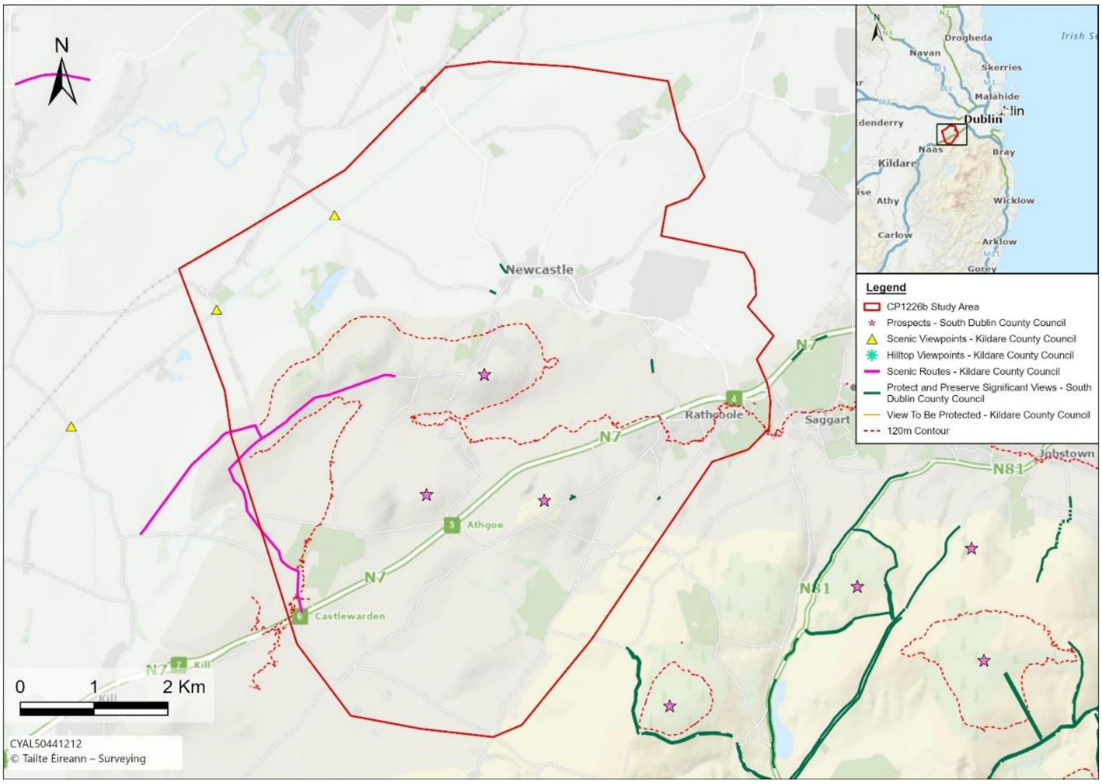

Figure 3-6 - Visual Constraints identified in Kildare and South County Dublin Development Plans for the Study Area

3.5.6 Cultural Heritage

The Study Area contains a dispersed cultural heritage resource made up of isolated archaeological sites, such as ringforts, enclosures and historic field systems distributed mainly across open countryside. This pattern allows for flexibility in routing, as infrastructure can be micro-sited or aligned to avoid direct physical impacts on recorded remains. For OHL development, this flexibility extends to the siting of towers, enabling avoidance of the majority of identified features where needed. Newcastle and Rathcoole, however, present higher architectural sensitivity due to protected structures and historic townscape elements located along existing road corridors. Where underground cable installation follows these roads, the likelihood of encountering subsurface archaeological remains increases, and careful placement of works compounds is required to prevent curtilage impacts on protected structures.

The Grand Canal forms one of the most significant cultural heritage features within the Study Area, characterised by historic canal infrastructure, locks, bridges and canal-side structures listed in the NIAH. Any infrastructure routed in proximity to the canal must avoid direct effects on these features and protect the integrity of the canal's historic setting. While overhead infrastructure would require careful positioning to avoid imposing on the canal landscape, underground cable works near the canal introduce additional constraints. Trenching near canal-side structures or along road networks close to the canal would require detailed planning to manage archaeological risk and protect heritage value.

Across the wider Study Area, cultural heritage constraints primarily relate to the need for sensitive alignment in areas of architectural interest, appropriate micro-siting around archaeological features, and the careful management of excavation or construction activities near the Grand Canal. Through continued assessment, early avoidance, and informed route planning, both above-ground and below-ground infrastructure can be developed in a manner that safeguards archaeological sites, architectural heritage, and the historic integrity of the canal corridor.

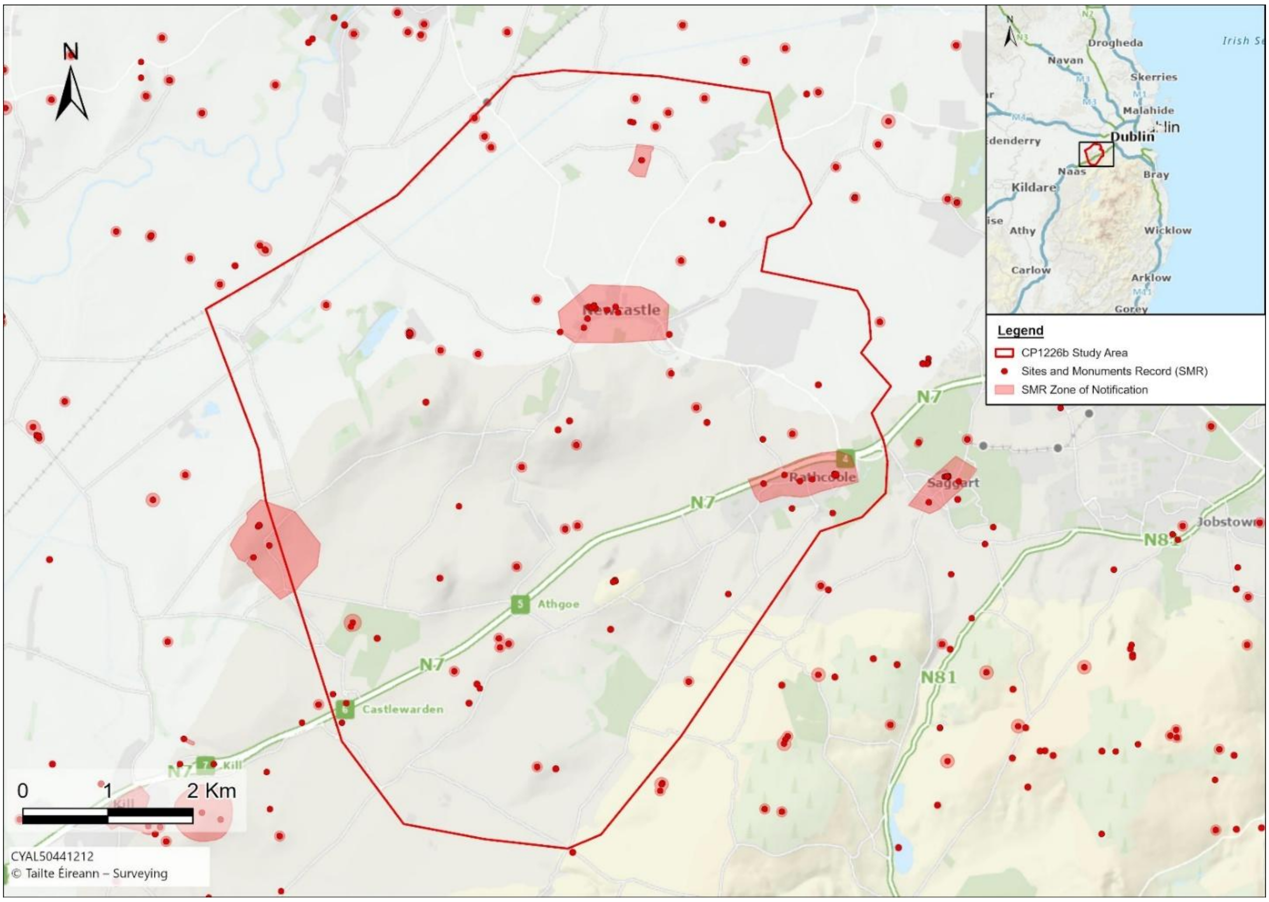

Figure 3-7 - Sites and Monuments (SMR) listed features within Study Area (NMS, 2025)

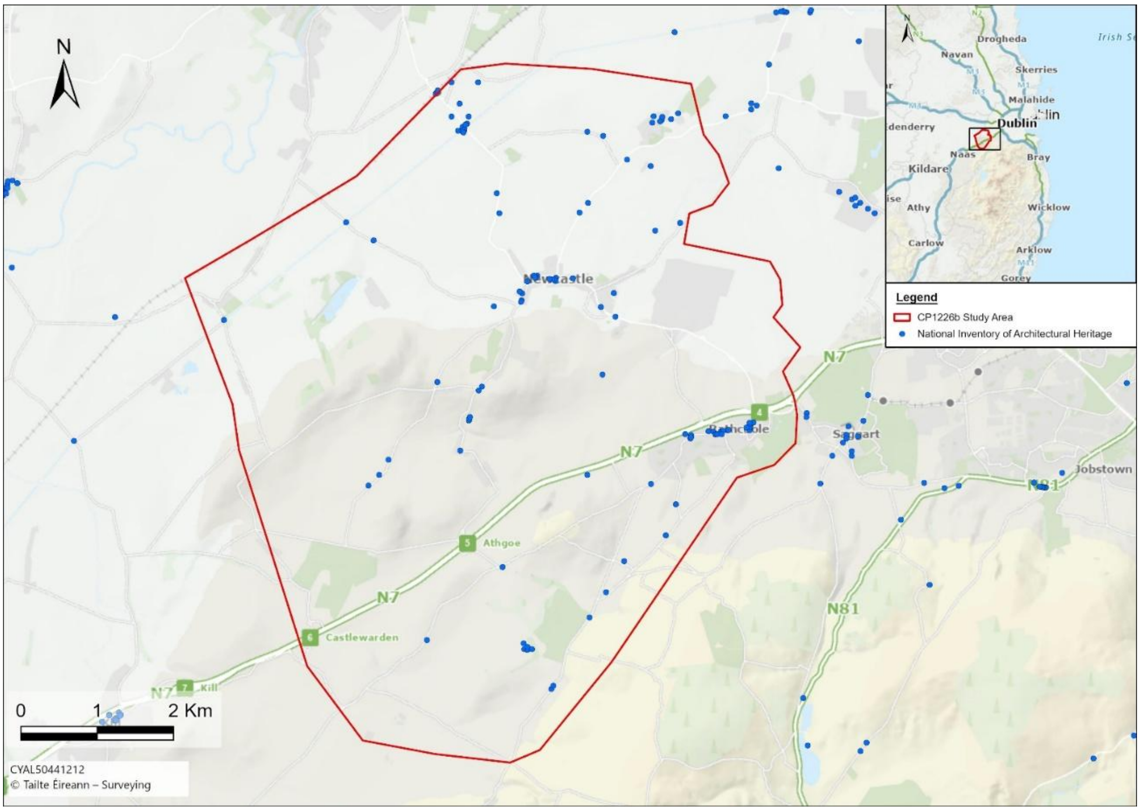

Figure 3-8 - National Inventory of Architectural Heritage (NIAH) listed structures within the Study Area (NMS, 2025)

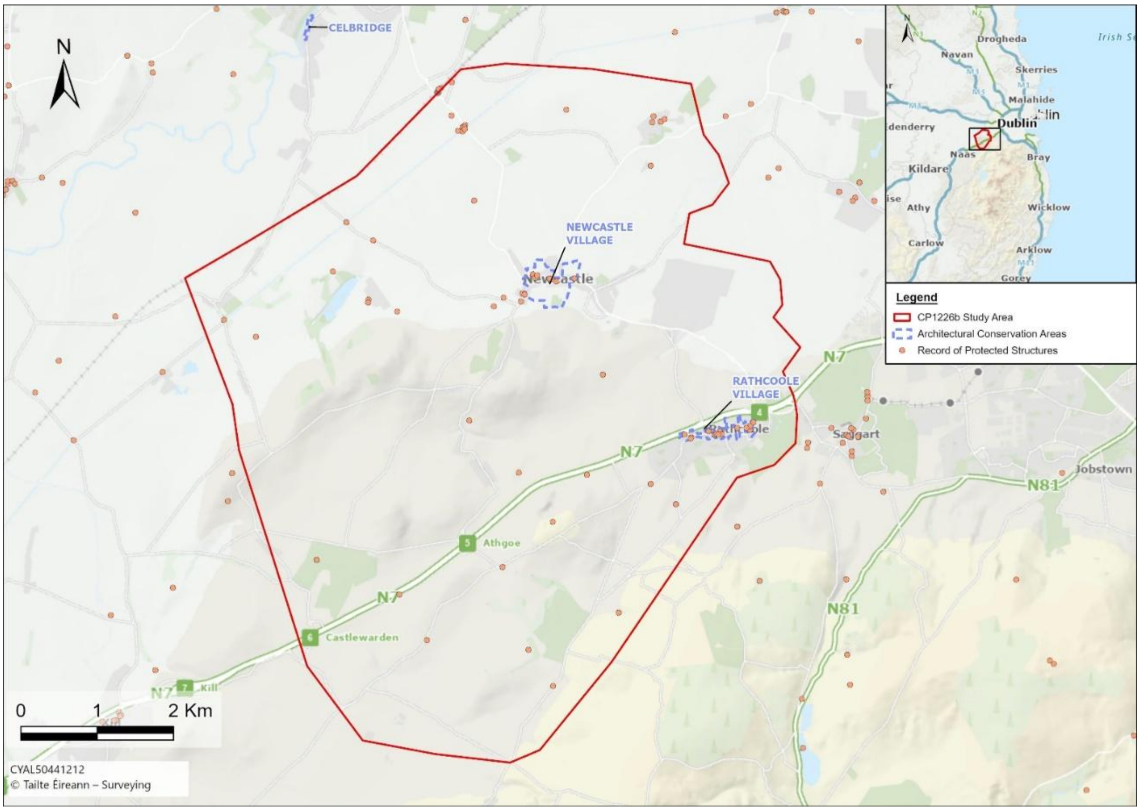

Figure 3-9 - Architectural Conservation Areas in the Study Area

3.5.7 Noise & Vibration

Noise and vibration considerations within the Study Area relate primarily to construction activities, the operational characteristics of overhead transmission infrastructure, and the proximity of sensitive receptors such as rural dwellings, proposed residential developments, and ecological habitats.

Construction of overhead line infrastructure may give rise to temporary noise impacts, particularly for isolated rural residences located near tower foundation works or conductor-stringing activities. In operation, overhead lines can generate corona discharge noise, which becomes more pronounced at higher voltage levels (understood to be significant for 350-500 kV and above)[3]. The limited availability of routing options within parts of the Study Area means that careful consideration of proximity to noise-sensitive receptors is important. Existing baseline noise levels from regional roads and rail infrastructure may also influence the assessment of cumulative operational noise effects in certain locations.

Underground cable installation, in contrast, involves construction-related noise and vibration concentrated along road corridors or localised off-road sections. These impacts are short-term but can coincide with areas experiencing ongoing or planned residential and infrastructure development, which may heighten cumulative effects for communities. Trenching, joint bay excavation, and horizontal directional drilling have the potential to create temporary disturbance, particularly where works occur near housing, schools, healthcare facilities, or sensitive ecological habitats. While no operational noise is expected from underground cable systems once installed, alignment and construction planning should still avoid densely populated areas and sensitive habitats wherever feasible to minimise construction-phase impacts.

Overall, noise and vibration effects across the Study Area are expected to be temporary and manageable with appropriate mitigation, but alignment decisions must take account of existing and proposed development, baseline noise conditions, and the presence of sensitive receptors to ensure impacts remain as low as reasonably practicable.

[3] https://cms.eirgrid.ie/sites/default/files/publications/EirGrid-Evidence-Based-Environmental-Study-8-Noise.pdf

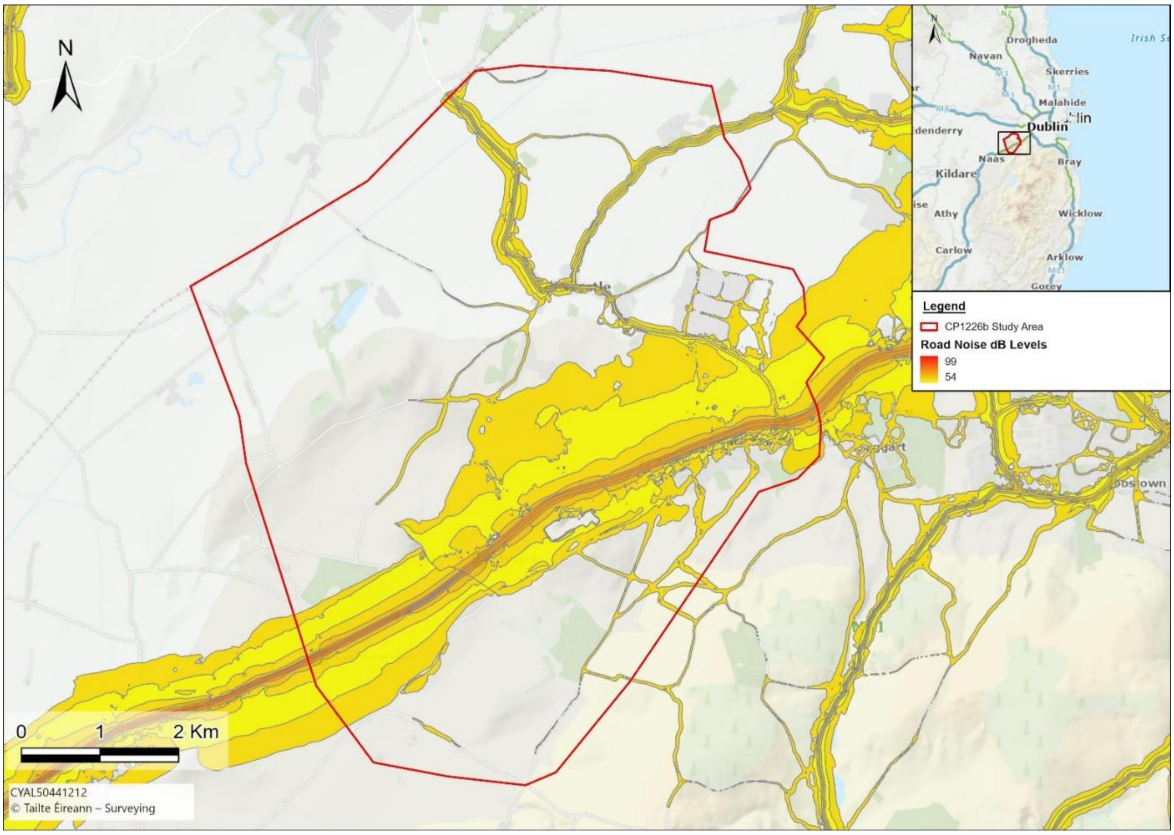

Figure 3-10 - Noise levels from the road network in the Study Area (EPA, 2025)

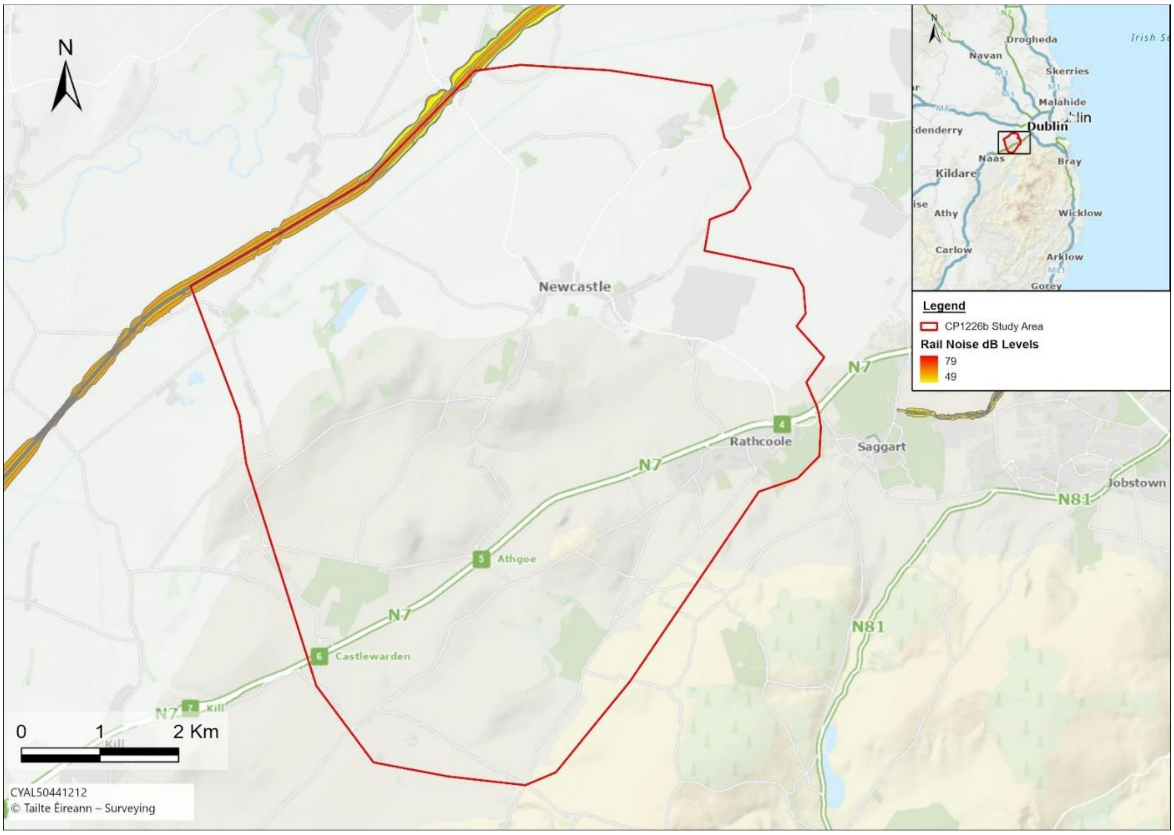

Figure 3-11 - Noise levels from the rail network in the Study Area (EPA, 2025)

3.6 Socio-Economic Aspects

Table 3-7 summarises scores for the Socio-Economic aspects of each technology option.

Table 3-7 - MCA Scoring – Socio-Economic Aspects

Sub-Criteria	OHL	UGC
Amenity		
Settlements and Communities		
Recreation and Tourism		
Traffic and Transport		
Overall Socio-Economic Score		

Both OHL and UGC technologies present community and socio-economic risks within the Study Area, but their overall risk profiles differ.

OHL presents a greater and more persistent socio-economic risk including permanent changes to visual amenity, restrictions on land management and agricultural practices due to wayleaves, potential community concerns regarding landscape character and perceived safety. These long-term effects outweigh the relatively modest construction impacts associated with OHL installation. There will be additional need for landowner engagement around visual and safety concerns, and the potential for operational impacts such as visual intrusion and community perception. Although traffic impacts for OHL are limited, temporary access tracks may still require local traffic management.

UGC leads to short-term construction disruption, including temporary traffic impacts, restricted access along recreational routes such as the Grand Canal Way, and localised disturbance in rural and peri-urban areas. However, these effects diminish once construction is complete. In the long term, UGC has minimal socio-economic footprint, generating no operational noise, no visual intrusion, and no ongoing constraints on land use or agricultural activities. UGC impacts are largely short-term and construction-related, including temporary traffic disruption at regional road crossings, restricted access along the Grand Canal Way, and potential effects on nearby heritage and tourism receptors. These impacts are generally manageable through phased works and traffic management.

3.6.1 Amenity

Amenity considerations within the Study Area relate to the presence of community facilities, open spaces, and established recreational routes that contribute to the overall character and enjoyment of the local environment.

Overhead line infrastructure has the potential to introduce long-term changes where routes pass through areas zoned as open space or across rural landscapes with moderate sensitivity. In these locations, the presence of tall structures could alter the visual quality of the surroundings and affect the perceived amenity of nearby recreational or community assets. As a result, careful tower siting, micro-siting, and the use of existing vegetation or screening will be required to limit visual intrusion and maintain the amenity value of these areas.

Underground cable development generally avoids long-term amenity impacts, as once installed it leaves no above-ground presence. However, construction activities particularly trenching, joint bay installation, or horizontal directional drilling can temporarily disrupt local amenities. This is most relevant along the Grand Canal Way, a recreational route zoned for walking and cycling, where temporary access restrictions or localised disturbance could diminish user experience during the construction phase. Similar temporary impacts may occur near other community facilities or open spaces where construction works coincide with public use.

3.6.2 Settlements and Communities

Settlement patterns within the Study Area consist of a mixture of scattered rural dwellings, agricultural holdings, and pockets of denser residential development, all of which influence the feasibility of routeing transmission infrastructure.

For overhead line development, the presence of dispersed housing and active farmland creates constraints that cannot be fully avoided, as potential corridors are limited and often intersect with rural properties or lie in proximity to established community areas. Careful alignment, engagement with landowners, and micro-siting will therefore be required to minimise potential impacts on residences, working farms, and local community functions. Given the extent of development around the Study Area and the constrained nature of potential corridors, some interaction with settlement receptors is anticipated and will need to be managed sensitively.

Underground cable infrastructure interacts differently with settlements, as its primary impacts arise during construction. When routed through predominantly agricultural land with relatively sparse rural settlement, the short-term effects on communities are expected to be limited. However, where construction passes near sensitive receptors, such as schools, retirement homes, healthcare facilities, or areas undergoing new residential or commercial development, temporary noise, access disruption, and health and safety risks must be carefully considered. Business estates within the Study Area also require attention during planning, as construction traffic, temporary lane restrictions, or access limitations could affect daily operations. While underground cables do not generate operational noise or visual impacts, construction-phase activities necessitate avoidance of densely populated areas wherever possible, alongside detailed traffic and construction management planning to maintain safe and convenient access for local communities.

Across both technologies, settlement-related considerations emphasise the need for early engagement, sensitive alignment, and construction planning that accounts for rural dwellings, community facilities, and ongoing development activity within the Study Area. Thoughtful mitigation and clear communication will be essential to minimise disruption and maintain the well-being of local residents throughout the development process.

3.6.3 Recreation and Tourism

The Study Area contains a number of valued recreational and tourism assets that contribute significantly to local amenity and visitor experience. These include the Grand Canal Way, a well-used walking and cycling route, and prominent heritage attractions such as Lyons Estate and Demesne.

Overhead line infrastructure has the potential to influence the character of these areas, particularly where routes pass through open space or landscapes appreciated for their scenic or historic qualities. Such changes could affect how visitors experience these locations and may place constraints on the development of future recreational or tourism facilities within affected areas.

Underground cable installation does not introduce long-term visual changes, but the construction phase can temporarily disrupt access and diminish the quality of recreational experience, especially along the Grand Canal Way where trenching or horizontal directional drilling could necessitate temporary closures or diversions. Similar short-term impacts may occur near other tourism receptors, including Lyons Estate and Demesne, where visitor access or tranquillity could be affected during periods of construction activity.

3.6.4 Traffic and Transport

Traffic and transport considerations within the Study Area relate primarily to road crossings, access requirements during construction, and the presence of sensitive receptors such as residential estates, schools, healthcare facilities, and business parks.

For overhead line development, traffic impacts are generally limited, as crossings of regional and local roads; including the R405, L6001, Peamount Road, Lyons Road and Athgoe Road, can typically be managed without major disruption. However, the creation of temporary access tracks and the use of construction plant for tower installation may still require localised traffic management and coordination with the relevant authorities. These activities must also account for ongoing and proposed housing and infrastructure developments within the Study Area, which increase the potential for cumulative congestion effects. Close liaison with local authorities and developers will be essential to manage these overlapping constraints and maintain safe access for local communities.

Underground cable development presents a more complex set of traffic management challenges, particularly where routing occurs within built-up areas such as Newcastle, Rathcoole, or nearby business estates. These areas contain higher concentrations of sensitive receptors, including schools and healthcare facilities, making them highly susceptible to construction-phase impacts such as restricted access, lane reductions or temporary diversions. Trenching along regional roads can disrupt traffic flow, while the installation of joint bays requires additional working space that must be carefully sited to minimise interference with road users. Similarly, road crossings throughout the Study Area will generate short-term impacts that must be addressed through appropriate traffic mitigation measures.

4. Conclusion

The objective of Step 3 is to identify a best performing technology solution and associated study area to meet the identified need from Step 2. This report provides an update on the technology selection for the Steelstown Substation following the public consultation carried out in May and June 2025. This report also summarises the MCA completed in Step 3 on the two (2no.) options for the Hynestown-Steelstown circuit technology (i.e., underground cable and overhead line).

4.1 Steelstown Substation

Following the work carried out previously, the public consultation campaign (held in 2025), and additional engagement with landowners and assessment of potential sites, the substation technology MCA was updated. Table 4-1 shows the overall performance of the AIS and GIS technologies for the proposed Steelstown Substation. The following lists a summary of the key outcomes from the MCA:

- **Technical:** AIS performs better than GIS (Moderate-Low vs. Moderate); AIS substations are typically easier to expand and carry a lower technology operational risk.
- **Economic:** Both technologies perform similar (Moderate-Low); although GIS substations are more expensive to construct, they do have lower project life-cycle costs (when compared to AIS substations). Land costs are generally more for AIS substations due to their larger size footprint.
- **Deliverability:** AIS performs worse than GIS (Moderate-High vs. Moderate); this is largely driven by land availability i.e., the spatial requirement for an AIS is considerably larger than for a GIS.
- **Environment:** AIS performs worse than GIS (Moderate vs. Moderate-Low); given the larger footprint of AIS (4.5 times larger than GIS), the impacts on the environment for most of the criteria would be considered worse for AIS than for GIS.
- **Socio-Economic:** AIS performs worse than GIS (Moderate vs. Moderate-Low); although for a substation the impact on traffic and transport, and recreation and tourism, may not be impacted by the technology, the same cannot be said for the impact on settlements and communities, nor amenity. As per the Step 3 Engagement and Consultation Report (M-CO, July 2025), the preference from the public is for GIS.

Based on the above MCA assessment, it was decided that the Best Performing Technology Option for the Steelstown Substation is GIS.

Table 4-1 - Steelstown Substation Step 3 Substation Technology MCA Results

Criteria	AIS	GIS
Technical		
Economic		
Deliverability		
Environment		
Socio-Economic		
OVERALL		

4.2 Hynestown-Steelstown Circuit

To assist in identifying the best performing circuit technology, a Multi-Criteria Analysis (MCA) was carried out in accordance with the EirGrid Multi-Criteria Analysis Guidelines. The five main criteria considered in the MCA are:

- Technical;
- Economic;
- Deliverability;
- Environmental; and
- Socio-Economic.

Each of these criteria were broken down further into sub-criteria and a multi-criteria evaluation matrix was used to identify the best performing technology option. Table 4-2 shows the overall performance for the 2no. technology options.

Table 4-2 - MCA Scoring – Overall Score (Hynestown-Steelstown Circuit)

Assessment Criteria	OHL	UGC
Technical Performance		
Economic Assessment		
Deliverability Aspects		
Environmental Aspects		
Socio-Economic Aspects		
Overall Score		

Although both technologies score ‘Moderate’ risk overall, UGC technology is assessed as the Emerging Best Performing Technology Option due to its better performance in the Deliverability, Environmental and Socio-Economic criteria. UGC technology will provide a more robust and deliverable solution than OHL technology when considering the constraints of the Hynestown-Steelstown circuit.

Technical: OHLs can achieve higher circuit ratings and have higher availability levels (less failures). Compared to UGC circuits, OHLs are easier to expand (voltage uprate) or extend, and they carry less operational risk.

Economic: OHL solutions offer lower construction and lifecycle costs, compared to UGC technology. The improved reliability of OHLs and reduced exposure to constraints also result in lower SEM costs over the project lifetime.

Deliverability: UGC technology performs better, as OHL construction is heavily constrained by existing and planned settlement patterns, insufficient wayleave widths, aviation constraints, and a potential high-risk crossing over the N7 dual carriageway. Achieving a compliant OHL corridor is significantly more challenging within the Study Area and presents greater landowner, environmental, planning and programme risk. UGC, routed mainly along existing regional roads, offers more straightforward permitting, reduced land interactions, and fewer visual and amenity concerns, enabling a more deliverable and publicly acceptable solution.

Environmental and Socio-Economic: In the context of the Study Area, UGC technology offers lower long-term impact, greater compatibility with sensitive landscape and community settings, and a lower risk. Although UGC carries higher construction-phase risks, these are temporary, manageable, and confined to the development phase. On the other hand, in the context of the Study Area, OHL introduces long-term and often irreversible impacts on landscape, amenity, biodiversity, and community receptors. For a project located within a landscape featuring significant wetlands, ecological corridors, protected views, and sensitive communities, the long-term resilience and lower operational footprint of UGC make it the more appropriate option given these constraints.

5. Next Steps

This report, the Emerging Best Performing Technology Options Report, will be published and presented to the public through an information campaign, led by EirGrid. Should feedback be given in response to this public information campaign it will be documented by EirGrid and considered by the project team in the future steps of the project.

EirGrid has commenced engagement with key stakeholders (e.g., public bodies, local authorities, utility providers, etc.) and this process will continue in parallel with the public information campaign, and into future steps of the project.

EirGrid will continue to engage with landowners regarding the shortlisted substation sites. Once potential circuit corridors are identified in Step 4, landowner engagement for any off-road sections of these potential corridors (if required) will also be carried out.

The substation site and circuit corridor options will then undergo a detailed MCA assessment in Step 4 to identify an Emerging Best Performing Option (EBPO), which will be subject to further public consultation in Step 4.

The assessments in future steps will be aided by site visits, site walkover surveys, and if applicable, site investigations. EirGrid will continue to engage with communities and landowners about relevant surveys and provide updates before they start. These may include, but are not limited to, the following:

- Topographical surveys;
- Ground investigations, including test pits and boreholes;
- Ground penetrating radar (GPR) surveys;
- Slit trench surveys;
- Ground resistivity measurements;
- Soil contamination testing; and
- Ecological and environmental site investigations e.g., geophysical surveys.

For the next steps i.e. Step 4 and Step 5 , the following reports will be prepared:

- Social Impact Assessment;
- Planning and Consent Strategy;
- Screening for Appropriate Assessment and Screening for Environmental Impact Assessment;
- Step 4 Report; and
- All environmental, technical and planning documents associated with the Step 5 planning application submission.

APPENDICES

Appendix A. Additional Information

A.1 Planning, Policy and Land Use

The Study Area includes multiple zoned areas that may constrain infrastructure development. These include lands zoned as Open Space (to preserve and provide for recreation), Rural and Agricultural (to protect and improve rural amenity and improve agricultural uses), and High Amenity Dublin Mountains (protect and enhance the outstanding natural character of the Dublin Mountains). These zones will influence route selection for both technologies. Based on a review of the Kildare County Development Plan (2023–2029)[4] the part of the Study Area within County Kildare lies outside any specific land-use zones.

Relevant planning policies from the Kildare County Development Plan (2023–2029) and South Dublin County Development Plan (2022–2028) support the delivery of electricity infrastructure while requiring compliance with environmental, visual, and heritage considerations. Key objectives include:

- Safeguarding reliable electricity supply and facilitating integration of renewable energy projects.
- Minimizing visual impact of overhead lines by avoiding areas of high landscape sensitivity and sites of biodiversity or cultural importance.
- Ensuring compliance with international standards for proximity to sensitive receptors such as dwellings, schools, and healthcare facilities.
- Supporting strategic corridors for grid infrastructure and safeguarding them from encroachment.
- Facilitating grid reinforcements and trans-boundary connections subject to Appropriate Assessment screening.
- Undergrounding utilities in town centres and heritage areas to protect visual amenity.

For OHL implementation, alignment must consider policies requiring avoidance of high-sensitivity landscapes and heritage areas. Micro-siting and visual mitigation measures will be necessary in zones designated for open space or amenity. For UGC technology, undergrounding aligns with policy objectives for town centres and heritage areas but requires careful planning to manage construction impacts in sensitive zones such as recreational routes and green infrastructure corridors.

[4] https://www.myplan.ie/zoning-map-viewer/

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