Capital Project 1021

OHL Feasibility Report

321084AJ-REP-003 | A03

April 2022

EirGrid

CP1021

Capital Project 1021

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Executive Summary

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

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

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

This technical report assess the feasibility of the two OHL options:

- Option 1 comprises a 400kV single circuit OHL from Woodland substation to Finglas substation north-west of Dublin.
- Option 2 comprises a 400kV single circuit OHL from Woodland substation to Belcamp substation east of Dublin.

The report considers the technical content, outline cost and deliverability of each option in accordance with EirGrid criteria as presented in Table 1 using the following scale to illustrate each criterion parameter:

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

Table 1. Criteria assessment

Assessment Criteria	A. Woodland to Finglas.	B. Woodland to Belcamp.
Technical Performance		
Economic Performance		
Deliverability		
Combined Performance		

The outcome of the feasibility assessment is that:

- Options 1 and 2 are technically similar (medium risk) however each faces challenges associated with designing an OHL through suburban and commercially developed areas.
- Option 1 is considered more favourable economically due to the shorter route length, however additional factors such as access and third-party protection costs will affect the cost of each option.
- From the deliverability perspective the two options are considered similar, however each is considered high risk because of constructing an OHL through suburban, commercial or environmentally sensitive areas.
- The environmental and socio-economic assessments and therefore the overall performance are reported separately in Jacobs' report 321084AJ-REP-001. The preferred option will be determined by EirGrid, however the following points are also noted in relation to the assessment:

Technical Performance

Options 1 and 2 are technically similar (medium risk) however each has challenges.

- At Woodland substation technical challenges are present due the existing OHLs connected into this site.
- Each option will introduce new sections of OHL into suburban areas around Dublin, and particularly in proximity to commercial, industrial, and recreational activity. Each of these may constrain the working clearance available for third-party activity and future maintenance of the OHL.
- Flight paths into Dublin Airport presents a challenge to both options while an OHL represent a hazard to airport operations.
- The route to Belcamp around the north of Swords will require crossing of the Broadmeadow Estuary which will be environmentally sensitive and affect local amenity. Furthermore, a site-specific support design could be required to achieve the crossing span.
- Areas of wetland in the north of the study area, along the Broadmeadow River, could impact upon the foundation and associated access requirements for structures in this area.
- The Rise of Earth Potential will need to be accounted for in areas where people or livestock congregate at the base of a proposed supports and measures may be required to mitigate this.

Economic Performance

Option 1 is considered more favourable economically, however the following factors will need to be considered in due course.

- Option 1 is considered economically advantageous due to the reduced route length, however the route to Belcamp is likely to be a slightly more efficient design than the one to Finglas to account for existing activity and infrastructure as well as planned development.
- The cost of construction in developed areas is likely to be affected by limited access, protection requirements and traffic management in these areas, whereas in rural areas, the cost of access is more likely to be orientated around ground conditions and reinstatement post construction.
- Landowner agreements are central to the installation of OHL infrastructure on third-party land and EirGrid has a compensation package available for the loss of land, however EirGrid may need to consider whether compensation claims are a risk should the OHL occupy land that could be later be developed commercially and the occupier claims loss of earnings or opportunity for development.

Deliverability

From the deliverability perspective the two options are considered similar, however each is considered high risk and will have to address certain challenges. Option 1 is considered slightly more advantageous because option 2 has the additional challenge of routing across the environmentally sensitive Broadmeadow Estuary

- Protection measures will need to be accounted for at motorways and major road crossings as well as any circuit crossings, each of which could have future operational implications for the system operator during planned maintenance.
- Access will need to be agreed with grantors and land occupiers for support positions and any associated protection measures to ensure continued operation of third-party activity.
- Both routes are likely to face public objection due the impact on third-party operations, proximity to commercial and recreational activity and particularly the operations of Dublin Airport. Objections can also be expected in relation to the environmental impact of crossing Broadmeadow Estuary.
- Traffic management measures will be required across the project; however, these could be particularly demanding in developed areas.

- As outages are difficult to obtain on the transmission network due to system and project demands, outage availability in relation to this project's related construction will need to be understood in conjunction with any other project work planned by EirGrid.

1. Introduction

1.1 What is Capital Project 1021?

Capital Project 1021 (CP1021) is a Proposed Project that would reinforce the electricity network between East Meath and North Dublin.

The four overarching solution options being considered for the Proposed Project are as follows:

- Solution Option 1: New400kV Overhead Line (OHL) between the existing Finglas and Woodland substations; or
- Solution Option 2: New 400kV Underground Cable (UGC) between the existing Finglas and Woodland substations; or;
- Solution Option 3: New 400kV OHL between the existing Belcamp and Woodland substations; or
- Solution Option 4: New 400kV UGC between the existing Belcamp and Woodland substations; or .

There are sub-options for Solution Option 2 and Solution Option 4, which comprise of the following:

- Option 2A / 4A: One 400kV circuit of standard cable type (2,500mm2 Cu XLPE installed in flat formation in a 1.7m wide trench);or
- Option 2B / 4B: One 400kV circuit alternative cable type (3,000mm2 Cu XLPE installed in flat formation in a 2.1m wide trench); or
- Option 2C / 4C: Two 400kV 2,500m^2 Al XLPE cables per phase, installed in trefoil formation in a single 1.7m wide trench..

1.2 Relationship to other technical documents

Parallel to this report, Cable Feasibility, Environmental and Social Impact studies have been prepared to investigate the impact of proposed solutions on the Study Area. Please read this report in conjunction with the following reports:

- 321084AJ-REP-001 CP1021 Proposed Project Overview Report
- 321084AJ-REP-002- CP 1021 Cable Route Feasibility Report
- 321084AJ-REP-004 - CP1021 Environmental Constraints report
- 321084AJ-REP-005 – CP 1021 Social Impact Assessment Scoping Report
- 321084AJ-REP-006 to 008 - CP1021 Substation Feasibility Reports
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1.3 The Study Area

The study has identified a relatively broad area to the north and west of Dublin, within which a 400kV OHL could conceivably be constructed between Woodland substation in the west and Belcamp substation in the east. The area extends north of Swords to allow consideration of a corridor around suburban Dublin and is bounded to the south by the R156 road (Figure 1.1).

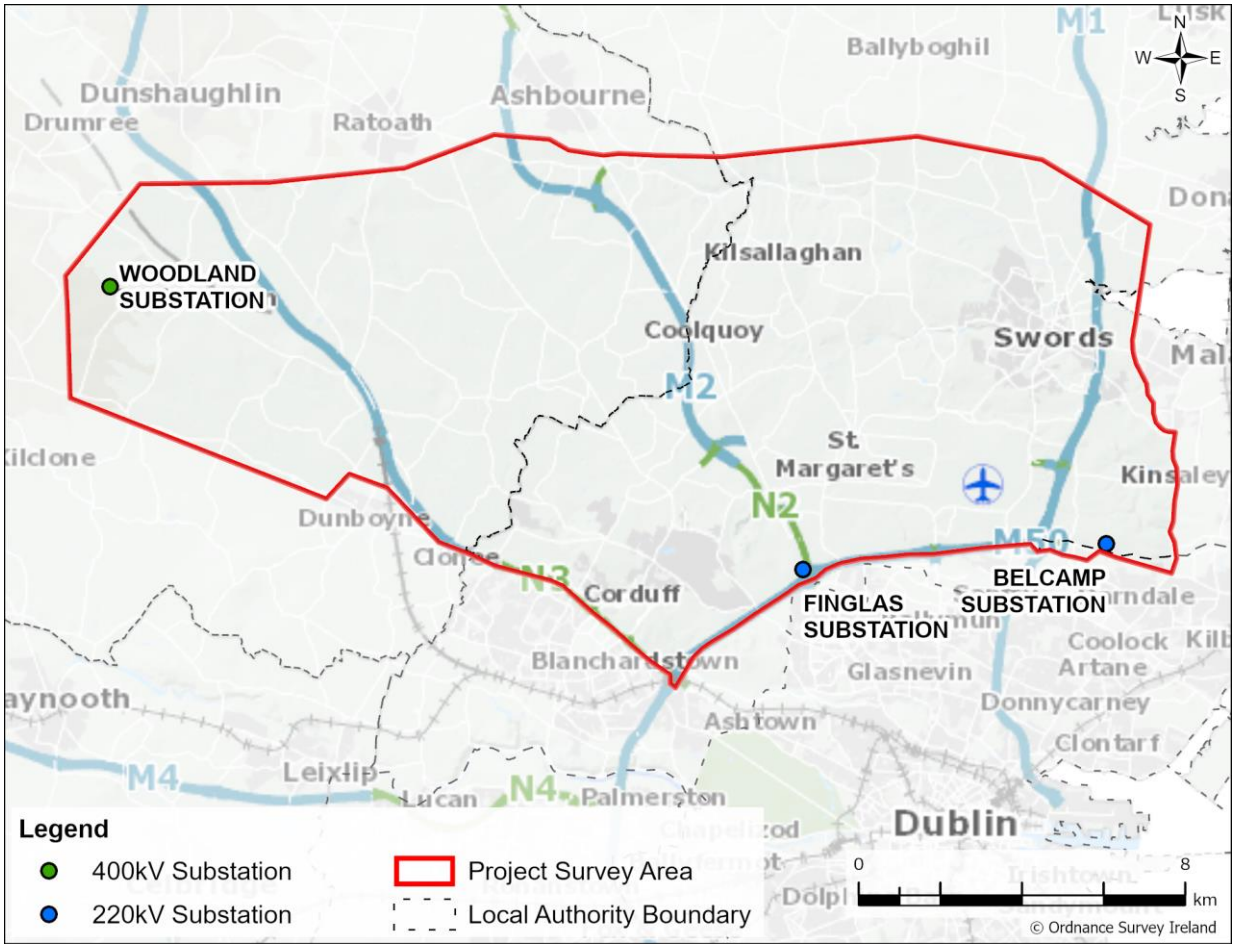

Figure 1.1 Proposed Project Study Area

Very broad, potential route corridors have been identified to both Belcamp and Finglas to assess the feasibility of installing overhead lines to each of these substations from Woodland. No corridor is completely unconstrained, however broad corridors have been considered to avoid constraints identified wherever possible and develop the most direct routes where all other factors remain equal.

1.3.1 Sub-study areas

The overall study area has been sub-divided into several smaller parcels where similar landscape or constraint characteristics are evident, and therefore identified opportunities and threats are apparent. The sub-study areas are presented as noted below and shown in Figure 1.2 The subsequent narrative is subdivided into these sub-areas to highlight issues local to these areas.

A. Study area west (Woodland)

B. Study area central (Finglas)

C. Study area north (Swords)

D. Study area north-east (Swords)

E. Study area east (Broadmeadow Estuary)

F. Study area east (south of Broadmeadow Estuary)

G. Study area south-east (Belcamp)

H. Dublin Airport (north)

I. Dublin Airport (south)

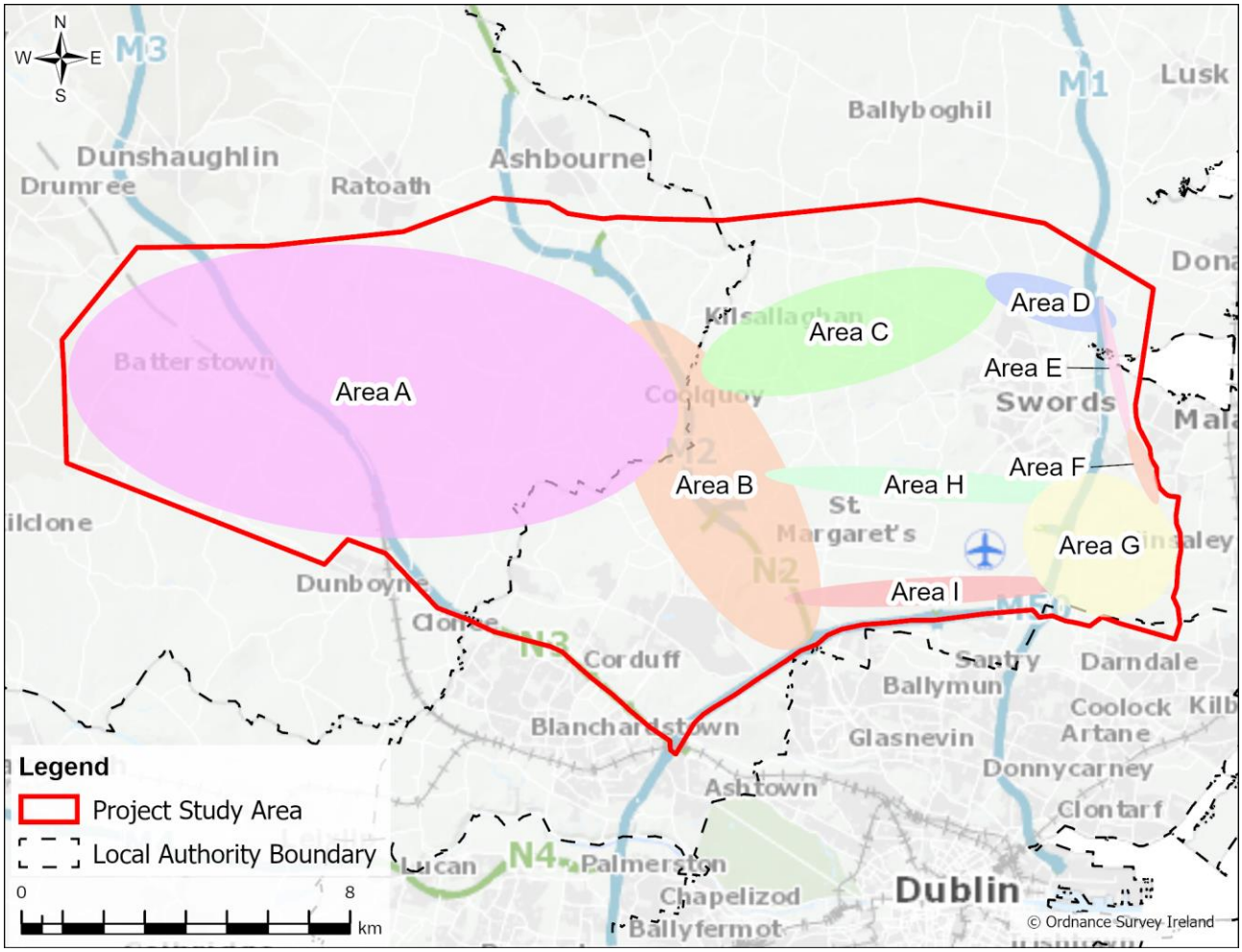

Figure 1.2 Proposed Project OHL Sub Study Areas

1.3.2 Study Area Data and Site Visit

Available data was collated in Jacobs' Project Mapper system to illustrate the various features and services in the wider Proposed Project Study Area that could potentially affect the development of an OHL. Apparent constraints and opportunities were then noted before a limited surveillance was undertaken on site. The Study Area visit was undertaken prior to the identification of potential route corridors but was limited to observation from public roads or from within affected substations. No asset records were available for the site visit.

The following observations were made from the site visit:

- The area surrounding Woodland is generally rural however the areas towards Finglas and Belcamp become increasingly suburban and commercial in use.
- In the rural areas, farm buildings and individual properties are often dispersed along the minor roads
- The general topography of the Study Area is gently undulating in the west and reasonably level further east.

- Land in the south and west of the Study Area is generally used for pasture, while land to the north of the Study Area includes arable agriculture.
- Field boundaries are generally fencing and hedgerow and there are areas of woodland scattered across the area.
- Various arterial roads are noted that radiate from Dublin including the M1, M2 and M3 motorways and various regional main roads.
- Only one railway is noted, from Dublin to Dunboyne, which terminates at junction 5 of the M3 motorway

1.3.3 Future development plans

Jacobs are aware of the following developments that have been proposed in the study area (source) which could impact on any future OHL route corridor. See Table 1.1

Table 1.1 Proposed Developments in the Study Area.

National Infrastructure Providers	Projects/Programmes already aware of
EirGrid	North South Interconnector (400kV Overhead Line) Kildare Meath Connection (400kV Underground cable)
Irish Water	Greater Dublin Drainage (Waste water Treatment Plant north west of Belcamp substation) Ballycoolin to Kingstown Trunk water Main Regional Biosolids Storage Facility (nr Huntstown Power Station, Finglas) Blanchardstown Sewerage Upgrade Scheme (Tolka Park) – under construction
Transport Infrastructure Ireland (TII)	N3 M50 to Clonee upgrade works
National Transport Authority (NTA)	BusConnects Luas Finglas
Irish Rail	DART+ West
Dublin Airport	Second runway – under construction
Fingal CC	East West Distributor Road (<100m north of Belcamp substation)

1.4 OHL Design: Assumptions and Limitations of the Study

1.4.1 Existing Arrangements

The existing overhead transmission line infrastructure within the Study Area is presented in Figure 1.3.. These will pose an obstacle where the new 400kV OHL has to cross these lines. Accordingly, potential crossings of the existing infrastructure will be kept to a minimum. It is anticipated that any such crossings will require the new 400kV OHL to be raised to a higher level local to the oversailing point to achieve the necessary clearances between new and existing OHLs.

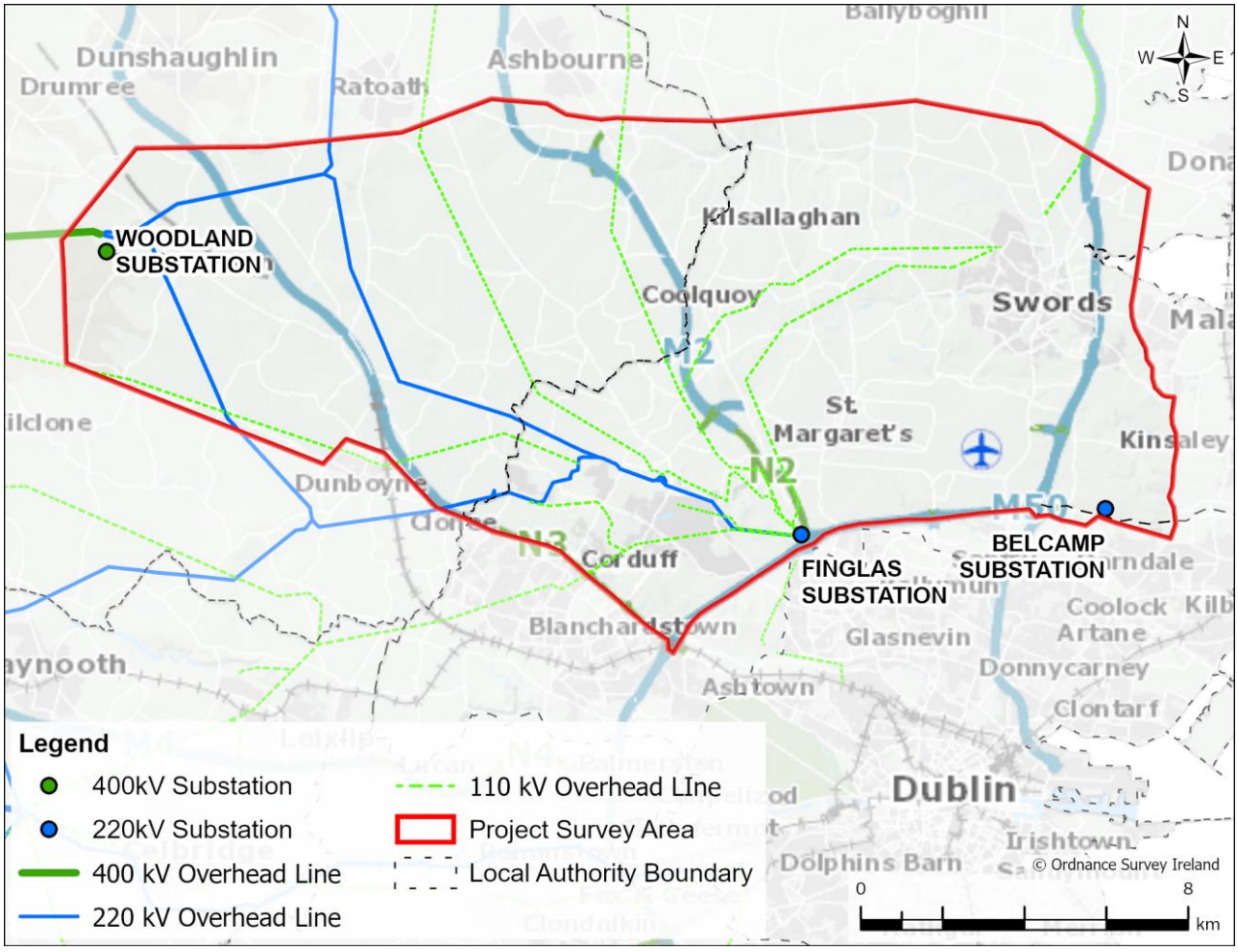

Figure 1.3 Existing 400kV, 220kV and 110kV OHL circuits within the study area

1.4.2 Required System Ratings

This study is presented on the basis that a new 400kV OHL circuit will utilise a conductor system that can be supported by the 400kV Single Circuit RL2 Tower design as defined in the EirGrid functional specification LDS-EFS-00-001-R0 i.e., 2 x 600 mm² ACSR (Curlew) or equivalent.

The RL2 tower design supports a shieldwire which could support a fibre optic service; however, this has not been confirmed by EirGrid therefore the study assumes a standard shieldwire will be used.

1.4.3 Structural Design

For each of the two OHL options identified only a limited assessment of the technical feasibility has been undertaken. At this stage there has not been an assessment of clearances to any infrastructure, features and third-party operations, and these will still need to be confirmed in due course for any proposed OHL in accordance with the EirGrid functional specification LDS-EFS-00-001-R0.

It is assumed that any proposed new towers would be standard designs in accordance with the EirGrid Functional Specification. Where non-standard or site-specific designs could be required, such as at crossings or where an enhanced clearance is required, these are noted but not confirmed.

1.4.4 Constructability and Outage Implications

Each option has been assessed on the basis that the construction interface with existing infrastructure can be constructed using a single circuit outage or series of single circuit outages.

The basis for construction of towers off-line, but in proximity to existing network assets, has been that while there may potentially be sufficient space available for the construction of new OHL infrastructure without the need for a proximity outage, this cannot be guaranteed at this stage and proximity outages may therefore be necessary. EirGrid has advised that outages are difficult to obtain on the transmission network due to system and project demands. Outage availability in relation to this project's related construction will therefore need to be understood and in conjunction with any other project work planned by EirGrid.

In the context of constructing 400kV OHL crossing of affected 220kV circuits, this means that routing solutions should aim to avoid impact on existing circuits where possible. However, where this is not possible, the crossing design will need to account for the related outage implications on existing circuits being limited to short durations i.e., days rather than weeks.

1.4.5 Maintenance

The basis for the maintenance assessment has been that all new OHL infrastructure will be maintainable using standard EirGrid working practices, and that any existing OHL towers that are affected by the new OHL, should still be maintainable using standard EirGrid working practices following the reconfiguration. For example, reuse of an existing tension tower could result in a change in angle of deviation on one side of that tower, but despite the entry and exit angle being different, the tower would remain maintainable after the change.

Any existing tower affected by a reconfiguration may need to be noted as 'non-standard' to recognise that an alteration has been made from the original installation and additional maintenance considerations may be required.

1.4.6 Limitations of the Study

No detailed design work is involved in Step 3 of the framework development process therefore various other assumptions are noted in relation to the feasibility assessment:

- No assets records have been provided for the existing substation arrangements or OHL routes therefore:
    - the type of foundation at existing tower sites is unknown and therefore cannot be used as a guide to the type of foundation required at new support positions.
    - existing profiles have not been confirmed or any site-specific clearance requirements noted therefore no profile drawings have been produced.
- The condition of existing assets is presently unknown therefore the study has assumed that condition will not influence any proposed reconfiguration.
- No third-party data other than that derived from Jacobs' Project Mapper system, other study reports or from publicly available aerial imagery has been used in the study,
- No structural analysis has been undertaken,
- No sequences of work have been considered in relation to identified interface with existing infrastructure.
- The presence of fibre optic services on existing infrastructure has not been confirmed or the potential implications of separate fibre outages on the options under consideration.

2. The Proposed Project Study Area

This section of the report provides an overview of characteristics/constraints apparent in each sub-study area that could potentially affect the feasibility of an OHL option. These include land use, presence of existing operations and infrastructure, apparent constraints evident from Project Mapper data and by observation. Any subsequent corridor appraisal will need to consider the relationship between these and the OHL and this is discussed in section 3 of the report.

2.1 Study Area West (Woodland - sub-study area A)

Sub-study Area A is presented in Figure 2.1

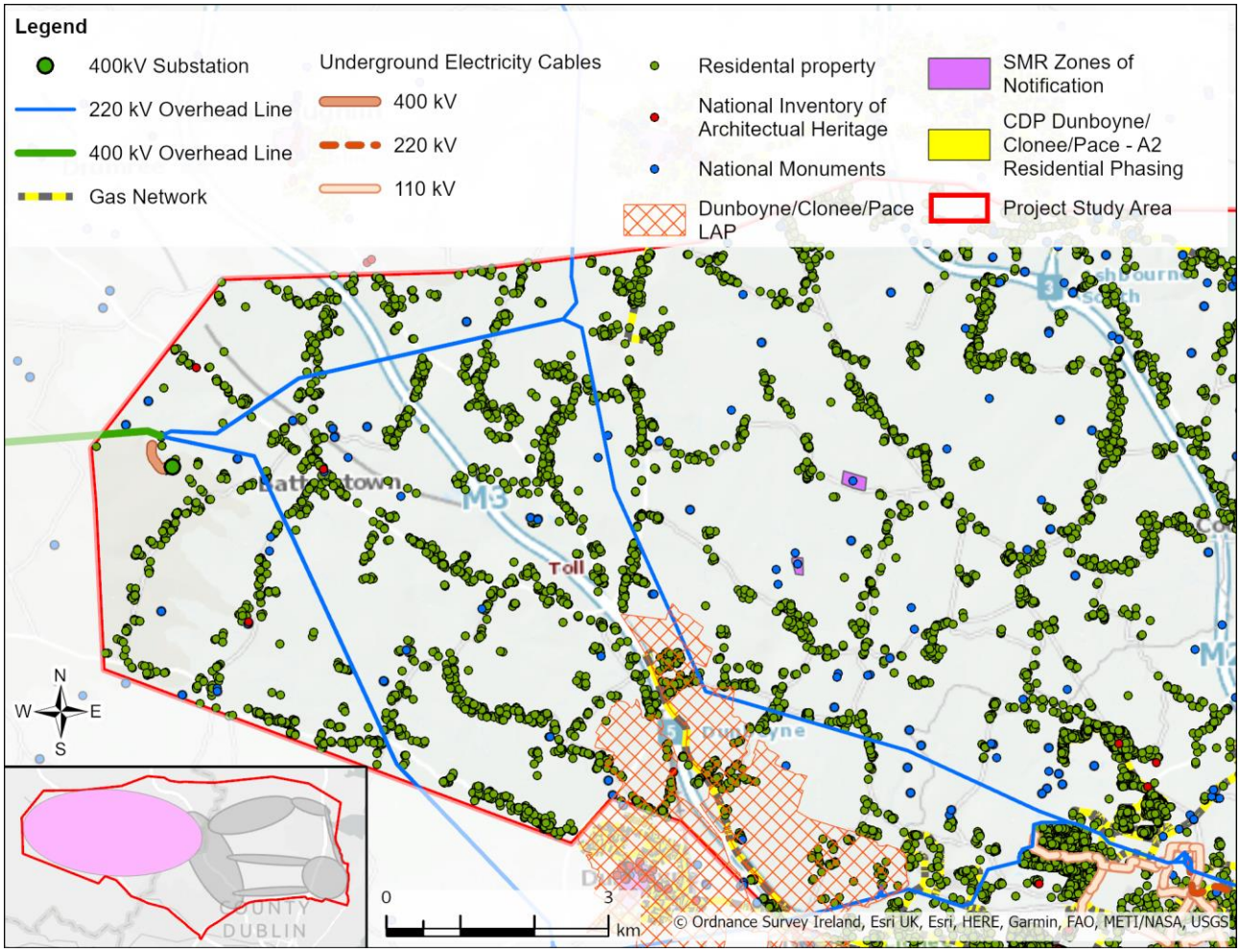

Figure 2.1Study Area West – Woodland - Sub-study Area A

2.1.1 Woodland substation

During the data collation and site visit to Woodland substation, the following observations were made that could impact on any future OHL development.

- Pasture and rough grazing land is evident on all four sides of the existing site which represents an opportunity for unimpeded OHL corridor routing.
- No construction will be permitted by EirGrid over any existing 400kV underground cables or within 6 metres (current understanding). This represents a limited constraint on positions of OHL towers.

- There are low voltage pole lines evident outside of the Southwest corner of the substation fence with teed arrangement at a higher plateau level. These may need to be relocated or undergrounded in any OHL proposal (Figure 2.2).
- Trees are evident to the west of the substation at a higher level than the substation. This may offer screening to any proposed development; however, this may be affected by any substation extension to the west.
- A small building was noted in wooded land to the west of the substation, size, condition and use unknown.
- A 'vent' or pipe was noted in the field to the south-west of the substation. Research indicates that this has been used to deliver bentonite into the 400kV EWIC cable. OHL tower positions will be affected by the cable route and the required stand-off distance required to protect the cable.
- The recently installed EWIC cables are an extremely sensitive and strategic element of EirGrid's infrastructure in this area and any OHL route corridor will need careful planning to minimise any risk of damage/impact on this cable link.
- Project CP966- Kildare Meath will have a 400kV cable connection to Woodland substation at the new bay shown in Figure 2.2
- The new North South Interconnector is due to connect to the north end of Woodland substation as shown on Figure 2.2.

Following the site visit, EirGrid confirmed that other projects are planned for the Woodland site and specific areas outlined for development. At the present time the area identified for the new East Meath 400kV connection has been proposed in the southeast corner of the existing compound, which requires an extension of the substation in that area (Figure 2.2).

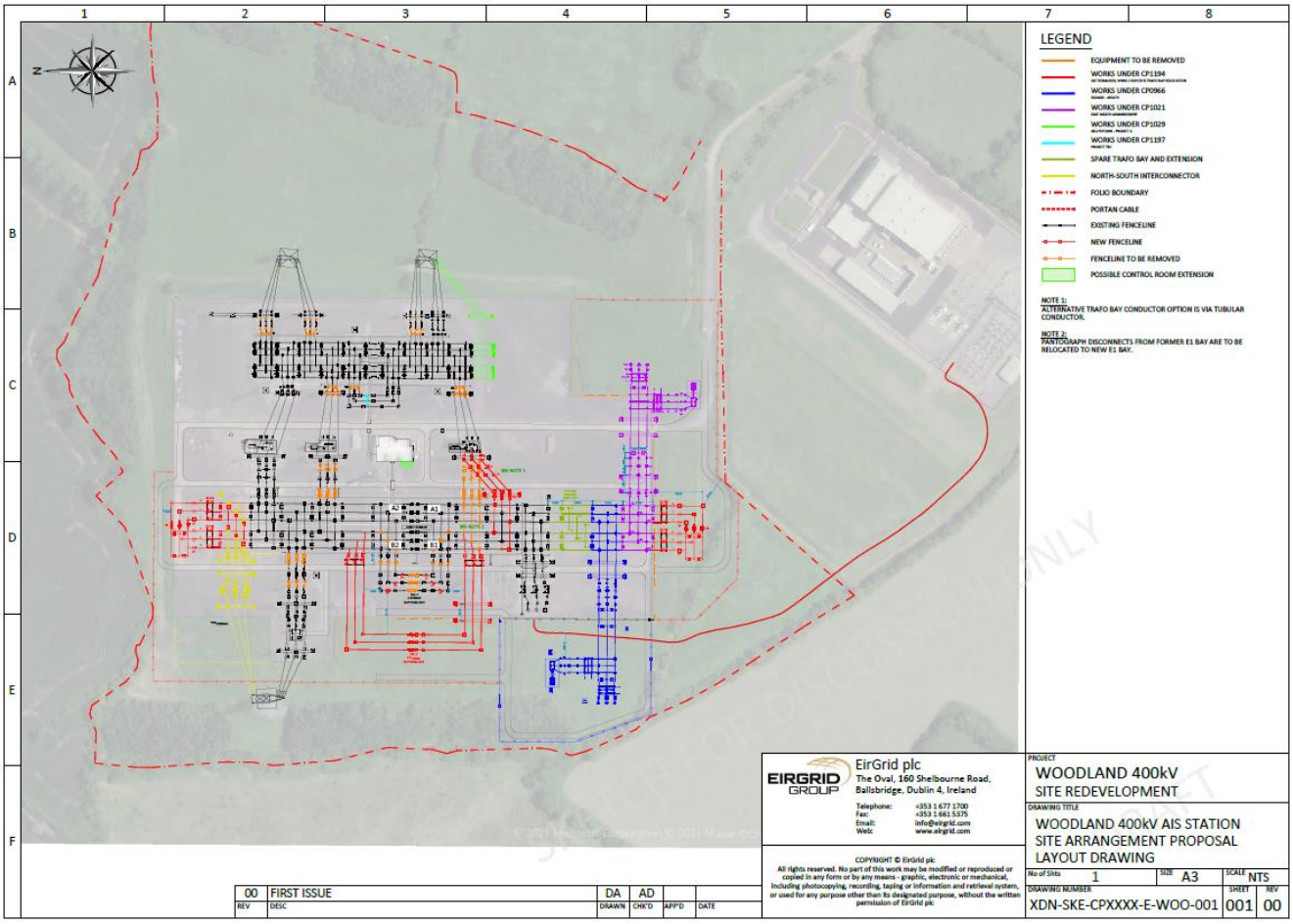

Figure 2.2 Outline of proposed arrangement at Woodland substation (reference drawing XDN-SKE-CPXXXX-E-WOO-001)

	
South-west corner (from south entrance)	South-east area (from south entrance)

	
West side (from south-west corner)	South-east substation (from south entrance)

Figure 2.3 Site visit photographs

Consequently, the study assumes an OHL will interface with the 400kV switchgear in the southeast corner of the site with a terminal tower positioned outside of the substation fence line, at a similar distance to the existing 220kV towers on the east side.

From this position, the study assumes that the OHL will head either east or south.

2.1.2 Woodland surrounding area

A limited surveillance of the area east of Woodland was also undertaken during the visit and the following observations were made that could impact on any future OHL development.

- The only existing 400kV OHL into Woodland comprises double circuit structures currently supporting one circuit. This OHL heads west (figure 2.3).
- Existing 220kV OHL are evident on the east side of Woodland substation. Two double circuit lines head east before each diverts to the north and south respectively (Figure 2.4). While these represent a potential obstacle to a new 400kV OHL, they also represent a potential screen for a new OHL when routed in parallel (Figure 2.5).
- Trees that screen the substation on the east side would be affected by a new OHL; a swathe through these trees may need to be considered.
- The Woodland converter station may offer some screening to an OHL heading south from Woodland 400kV substation.
- Existing lower voltage infrastructure in the sub-study area will be affected by a new OHL route in proximity or where crossing. For any proposed crossing arrangements suitable protection of the lower circuit will need to be incorporated into the design to ensure circuits can be maintained.
- To the north of the Study Area, equine stud farms were noted around the Fairyhouse Racetrack area, therefore others may exist in this area. The implications of managing valuable livestock in proximity to a 400kV OHL where a lightning or fault could result in the Rise of Earth Potential at a tower base will need to be considered and potential mitigation measure considered such as fencing off the tower.
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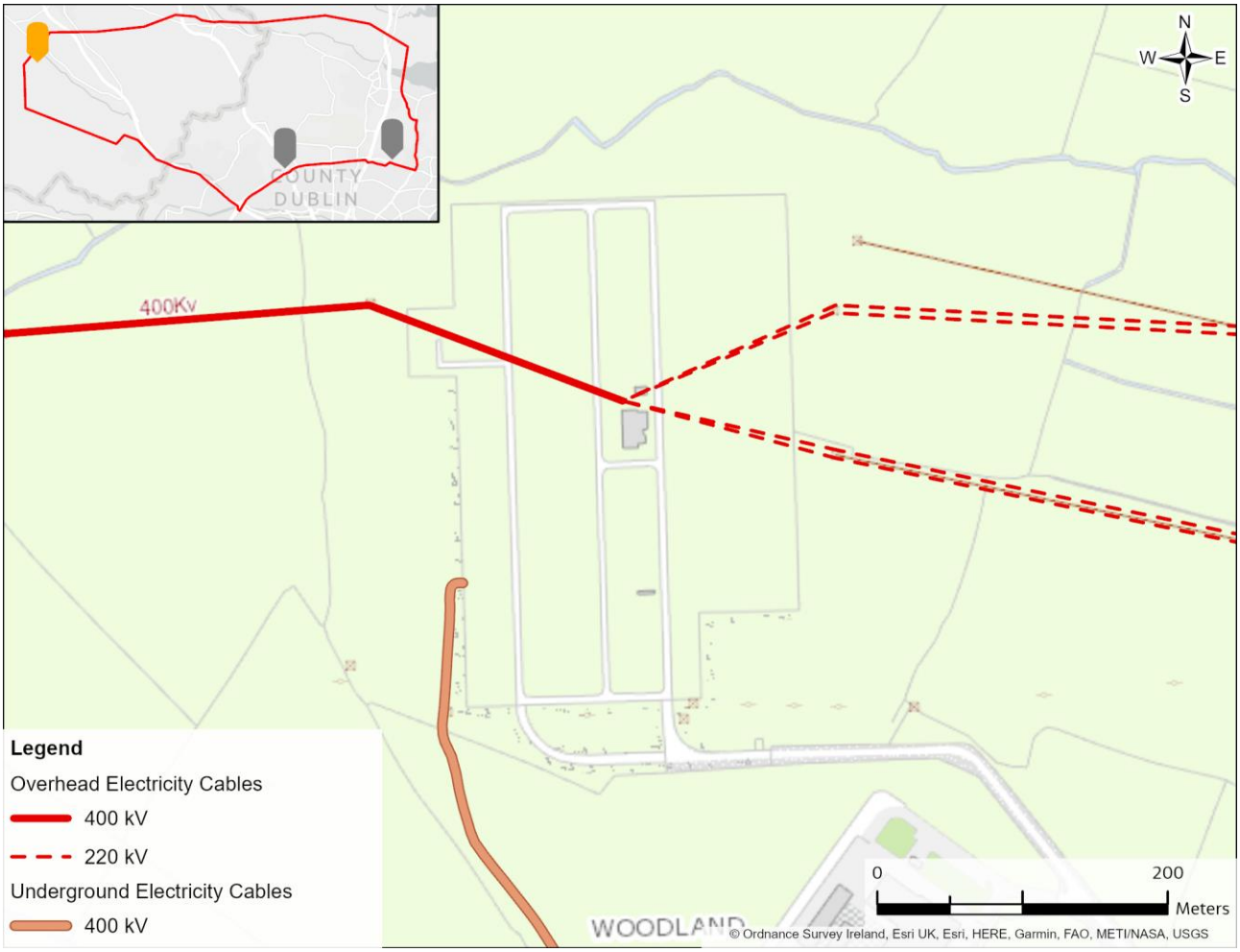

Figure 2.4 Existing OHL and cable routes into Woodland substation (Project Mapper)

	
220kV OHLs into Woodland (from west)	220kV OHL north from Woodland (from west)

Figure 2.5 Site visit photographs

The area to the south of Woodland substation is generally clear of infrastructure and development, with large swathes of open land available. Dwellings and farm buildings tend to be dispersed along existing roads and spaces

between these will need to be assessed for a suitable corridor. To the east of Woodland substation, the existing 220kV OHLs will impact on any proposed corridors and regardless of whether these corridors continue east or turn to the north of the study area, a crossing will be necessary at some point.

2.1.3 Dunboyne area

Dunboyne is in the south of the study area and presents an area of urban development extending north towards the junction 5 of the M3 motorway with the R157 road.

A limited surveillance of the areas west and north of Dunboyne was undertaken during the visit and the following observations were made that could impact on any future OHL development.

- An equine stud farm was noted south of Junction 5 of the M3; therefore, others may exist in this area.
- The railway line between Dunboyne and the M3 Parkway runs parallel to Navan Road north of Dunboyne (figure 2.5).
- There are retail development plans for the area north of Dunboyne
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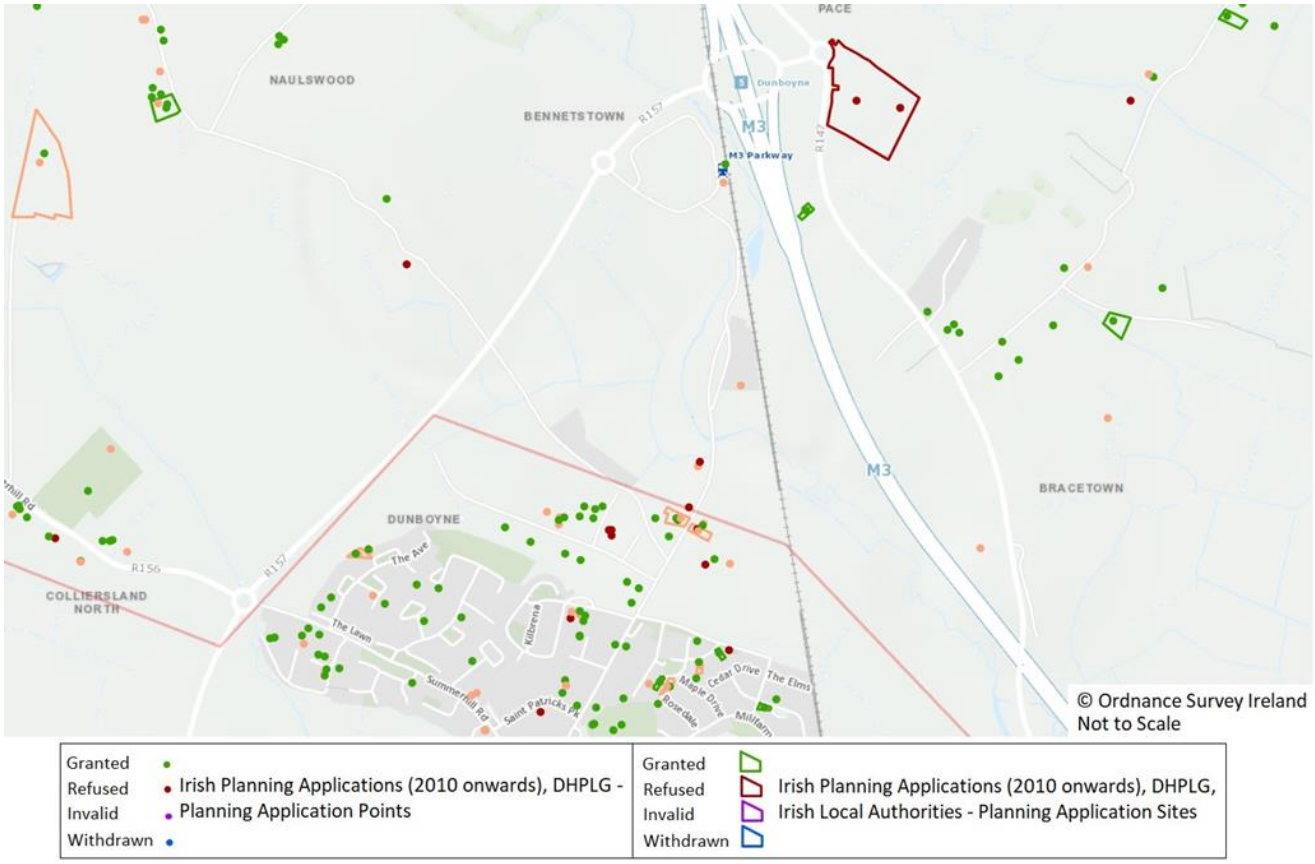


Figure 2.6 Area to the north of Dunboyne

	
Land east of Navan Road	Land west of Navan Road
	
Land west of Navan Road	Railway (M3 Parkway station nearby) west of Navan Road

Figure 2.7 Site visit photographs

The study recognises that although there is generally a rural nature to the land north of Dunboyne, there are development plans and infrastructure crossings that would need to be accommodated. As such the opportunities for routing an OHL corridor through this area will become increasingly constrained over time.

2.2 Study area central (Finglas - sub-study area B)

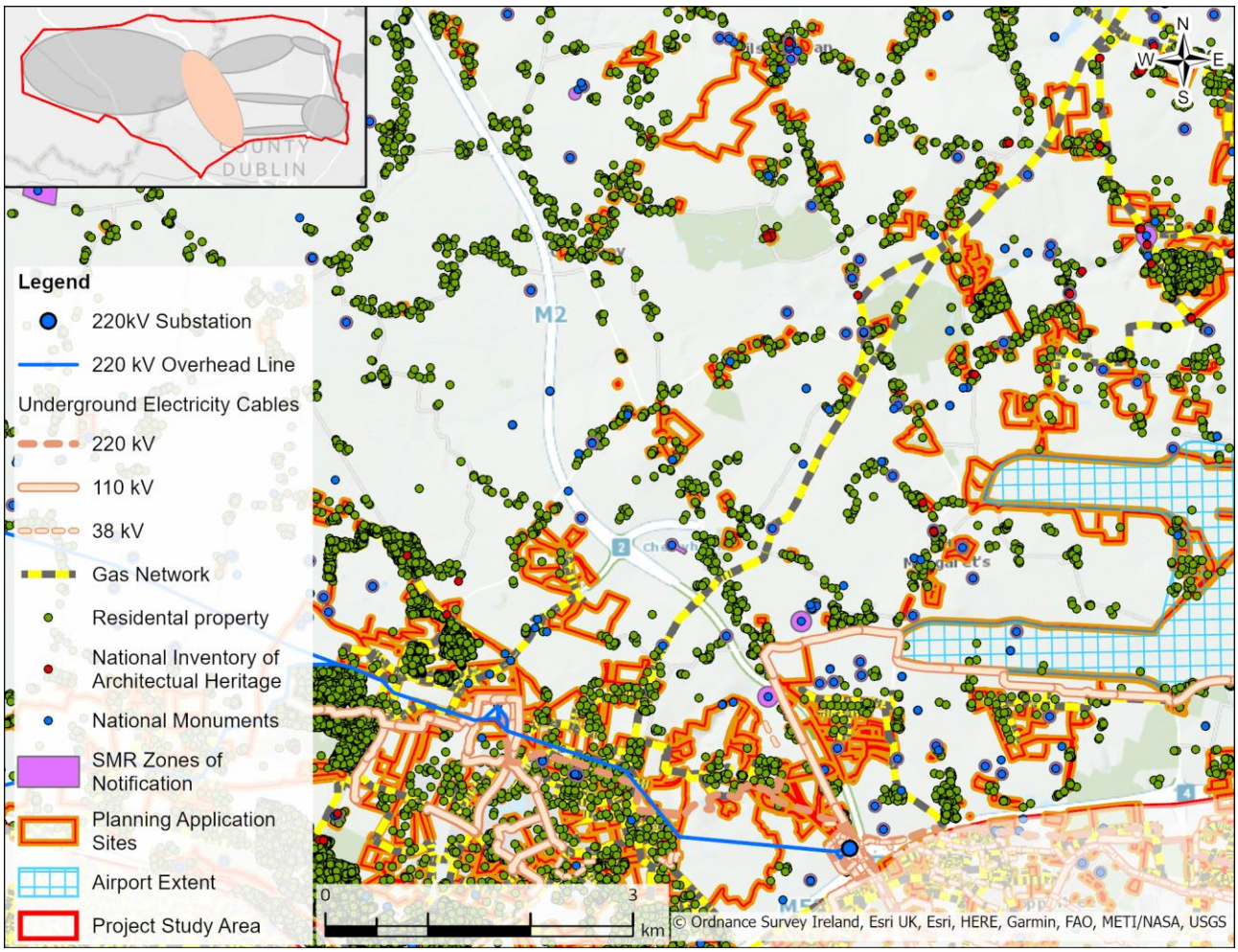


Figure 2.8 Study Area Central – Finglas – sub study area B

2.2.1 Finglas substation

During the visit to Finglas substation, the following observations were noted.

- 220kV and other lower voltage circuits enter Finglas on the west side of the site (Figure 2.9).
- The 110kV AIS substation has been decommissioned but not demolished. EirGrid advised that the redundant 110kV AIS compound site could be considered as a possible area for 400kV development (Figure 2.10).
- The 110kV circuits that approach Finglas substation are all now cabled into a GIS building on the northwest corner of the site.
- Immediately west and north of Finglas are areas of farmland.
- The N2 and M50 motorways are present immediately east and north respectively of Finglas

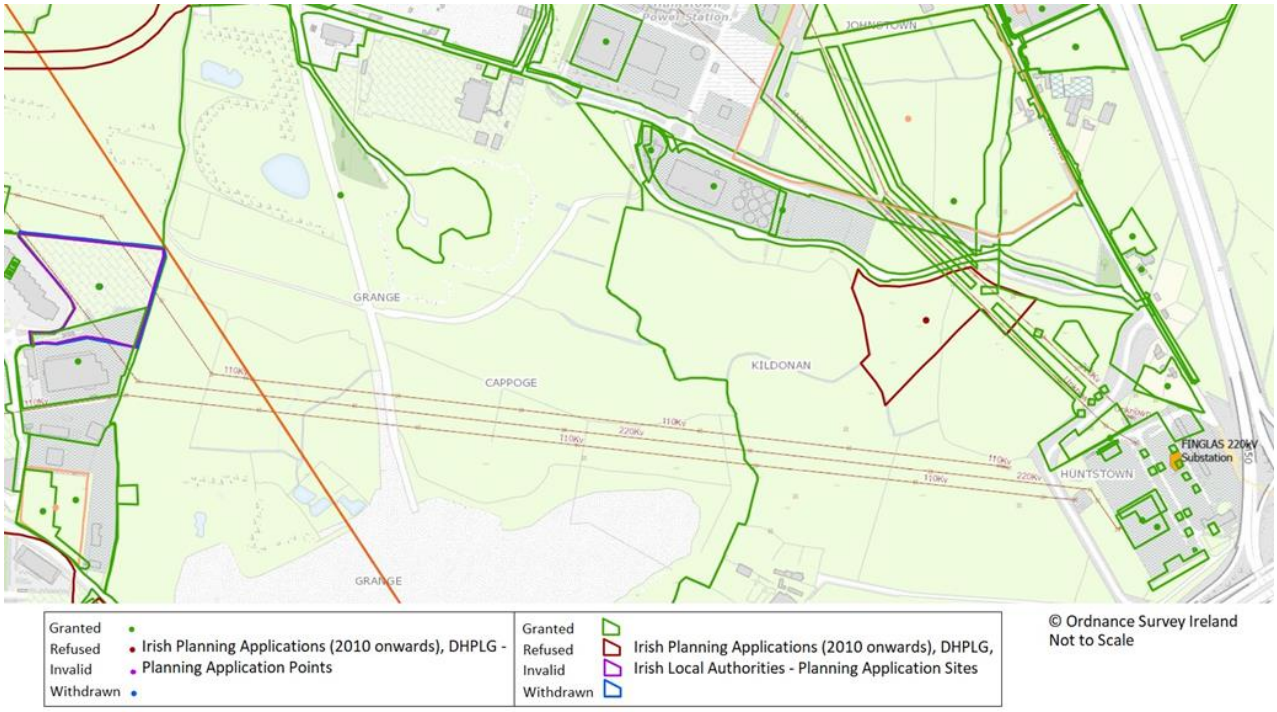


Figure 2.9 Existing OHL routes into Finglas substation

	
110kV OHL to the north	220kV OHL to the west (from substation)

	
110kV substation (decommissioned)	110kV substation (from east of substation)

Figure 2.10 Site visit photographs

The area of the Finglas site that could be used for the 400kV connection has yet to be confirmed, therefore the study has been developed on the basis that for an OHL connection, this would be achieved either into the north-east or the south-west corner of the existing substation site.

2.2.2 Finglas surrounding area

As noted above, Finglas substation is bounded on the south by the M50 motorway and to the east by the N2 motorway. Within the land to the west and north, various commercial activities are apparent. A limited surveillance of the areas west and north of Finglas substation was undertaken during the study area site visit and the following observations were made that could impact on any future OHL development.

- Existing OHL routes in a corridor to the west of Finglas substation noted to be up to 220kV (Figure 2.11).
- Existing OHL routes to the north of Finglas substation up to 110kV (Figure 2.11).
- Single circuit 110kV crossing of the M2 motorway north of Finglas.
- Jacobs understands that most of the existing 110kV OHLs to the north will be cabled into Finglas substation from further away in the future as a data centre is proposed in the area adjacent to Huntstown Power Station.
- Huntstown quarry to the north of Finglas substation remains an active operation (Figure 2.11).
- A logistics facility is located to the east of the N2 motorway with existing 110kV OHL between the facility and the N2 motorway.

	
Huntstown quarry entrance (existing 110kV OHL)	110kV OHL to the north of Finglas substation
	
OHL to the north of Finglas substation	OHL to the west of Finglas substation

Figure 2.11 Site visit photographs

The area north of Finglas is occupied with a mixture of commercial operations, agricultural operations, and numerous forms of industrial infrastructure. Further development is also planned in this area therefore the opportunities for a 400kV OHL corridor are limited.

The study has been progressed on the basis of determining areas of land that could conceivably be occupied by 400kV OHL towers and associated conductor system, or alternatively on the basis that an existing OHL could be replaced with the affected infrastructure being placed underground.

2.3 Study area north (Swords - sub-study areas C and D)

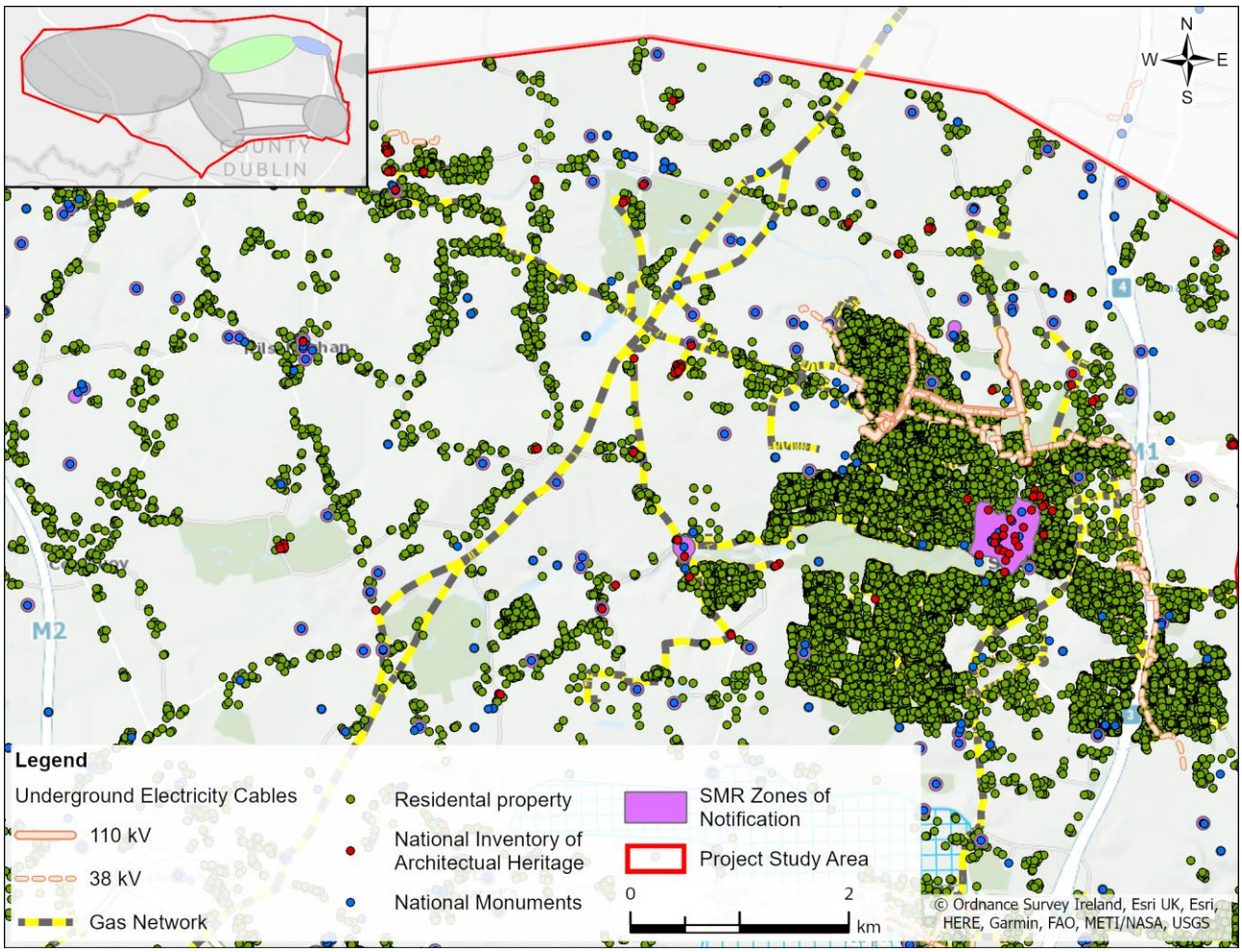


Figure 2.12 Study area north (Swords - sub-study areas C and D)

The study area north of Swords extends from the Broadmeadow Estuary around the north-east of Swords into a corridor of generally rural land to the north and northwest. The following observations were made from Project Mapper data as no surveillance was undertaken.

- Land to the west of Swords is largely mixed arable and pasture agriculture.
- Crossing of the M1 motorway north of Swords will be required.
- Broadmeadow River and tributaries are noted to the northwest of Swords towards Ashborne and various bodies of water are also evident. The river is understood not to be navigable. Figure X in the Environmental Constraints report illustrates the water bodies within the Project Study Area.
- Areas along the course of Broadmeadow River are understood to be prone to flooding, however no areas of peat are evident
- Several existing transmission lines radiate from the Swords area to the north and north-west of the sub-study area
-

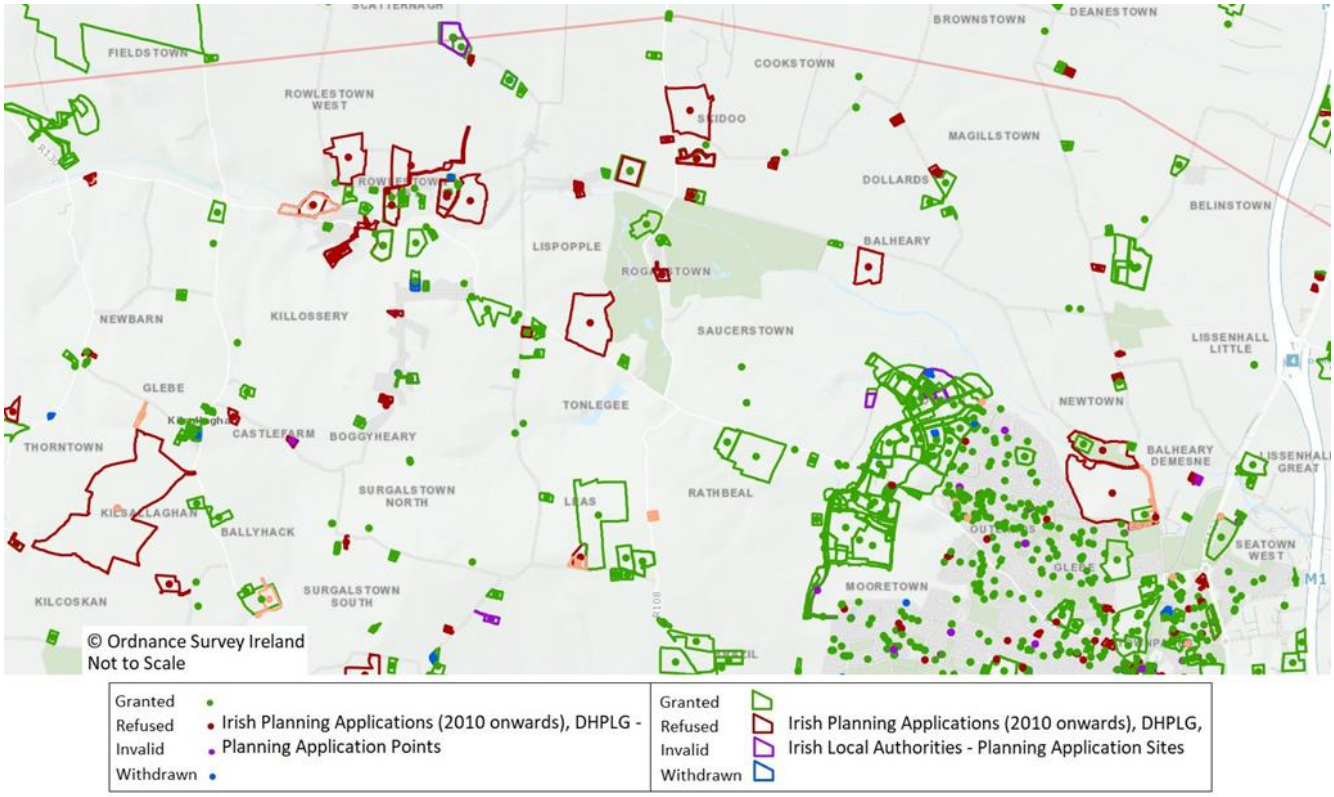


Figure 2.13. North of Swords

The study recognises that the generally rural nature of land to the west and north of Swords offers an opportunity for routing an OHL corridor, however there are various infrastructure crossings that would need to be accommodated, the most significant being the M1 motorway. Also, that the ground conditions along the river course present potential for buoyant foundations beneath towers as well as significant access works.

2.4 Study area east (Broadmeadow Estuary - sub-study areas E and F)

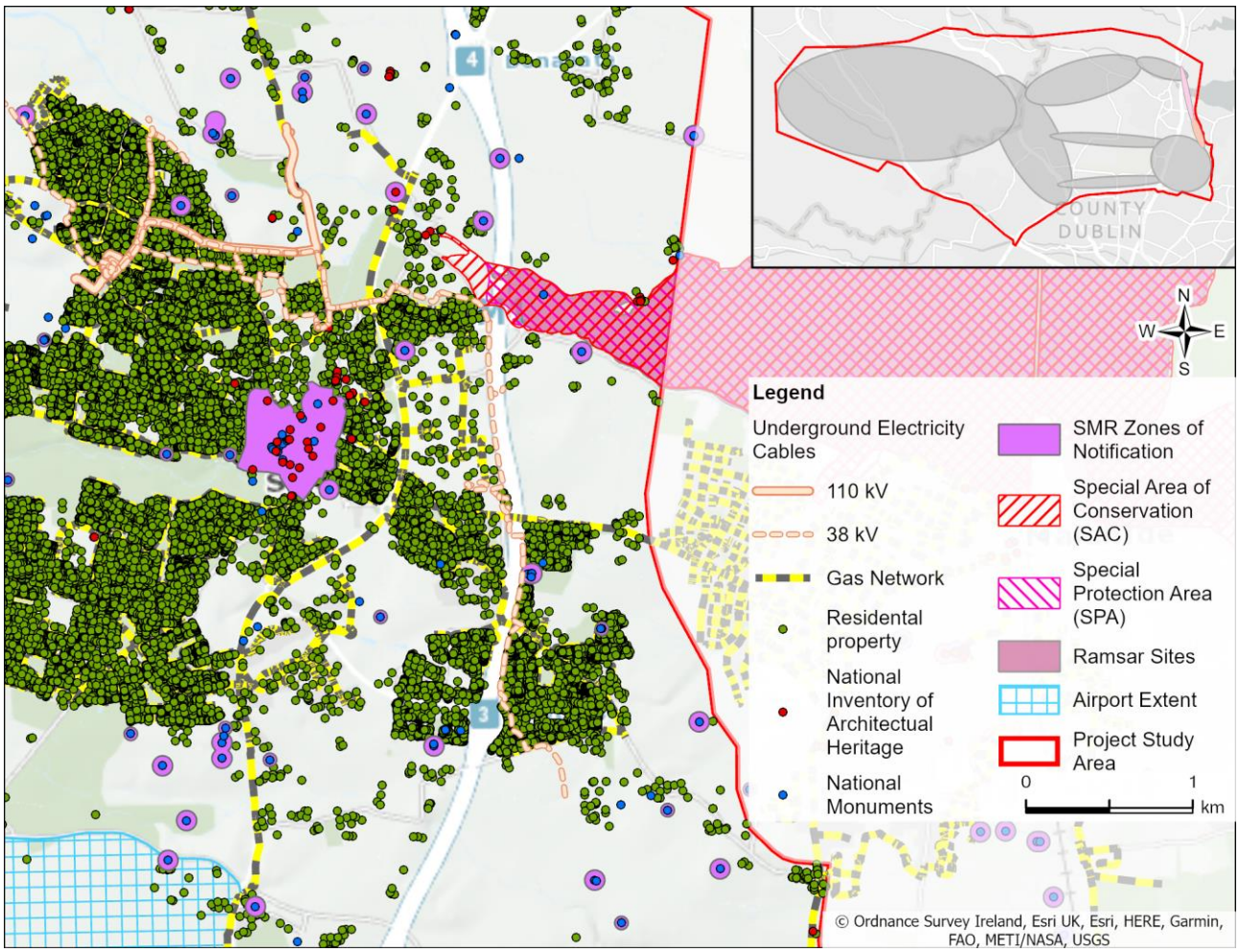


Figure 2.14 Study area east (Broadmeadow Estuary - sub-study area E and F)

A limited surveillance was undertaken of specific points in the corridor south of Broadmeadow Estuary. The following observations were made that could impact on any future OHL development.

- Broadmeadow Estuary represents an area of environmental sensitivity and public amenity that would be significantly affected by a new 400kV OHL.
- Wintering birds are also noted to forage on land to the east of Swords. More details on these are provided in CP1021 Environmental Constraints Report (Doc ref. 321084AJ-REP-004)
- A 38kV OHL on wood poles is evident through this sub-study area. This could offer a potential corridor for a 400kV OHL route assuming the 38kV route can be placed underground, however the magnitude of the upgrade would significantly impact on the existing route corridor (Figure 2.15).
- Residential property in the sub-study area is noted to be close to the 38kV OHL alignment in certain areas e.g., Malahide Road, and would be visually impacted by an OHL upgrade to 400kV.
- Use of the allotment area on Malahide Road would be affected by an OHL upgrade to 400kV as workable land would be lost and the Rise of Earth Potential (ROEP) would also need to be considered (Figure 2.16).
- Malahide rugby club ground is noted on the north side of Estuary Road which could require consideration of specific recreational clearance requirements.
-

	
Land south of Estuary Road	Broadmeadow Estuary north of Estuary Road
	
38kV OHL over Malahide allotments	Land opposite Malahide allotments
	
Land north of Feltrim Road	Land south of Feltrim Road

Figure 2.15 Site visit photographs

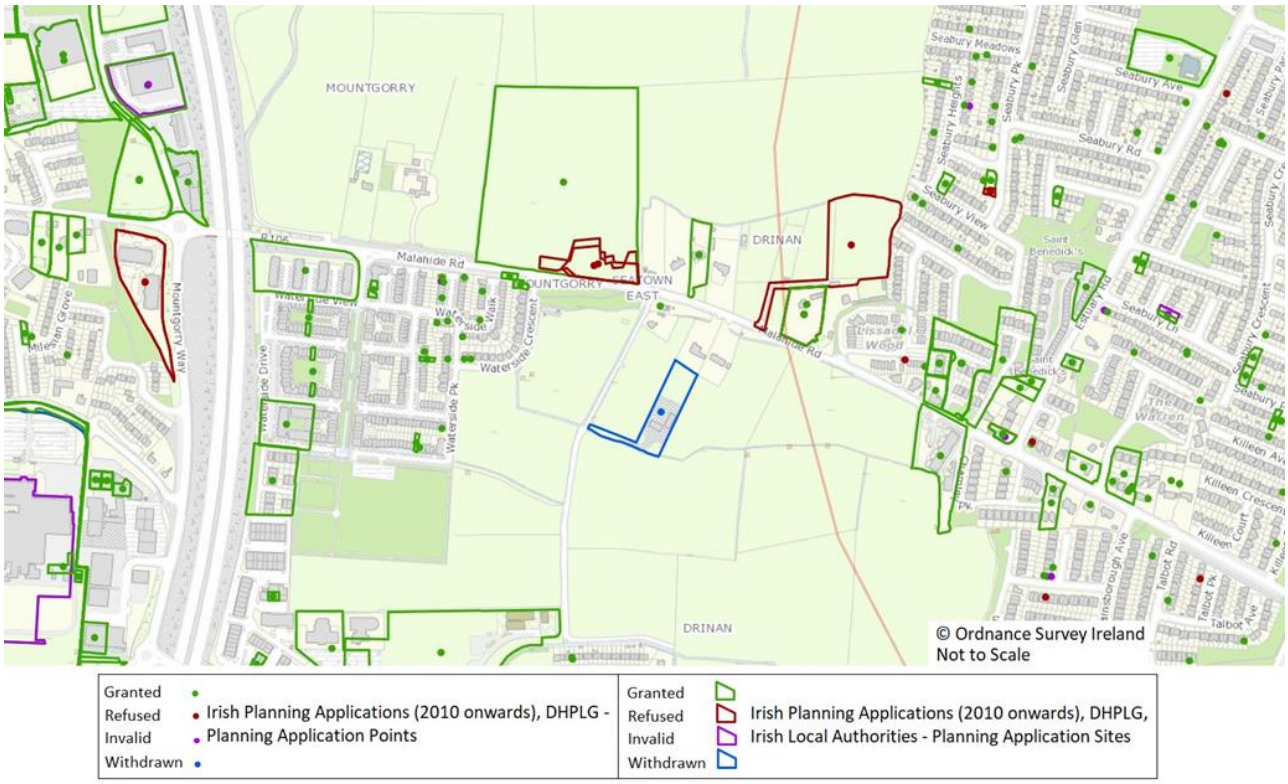


Figure 2.16 Malahide Road, north of Belcamp substation

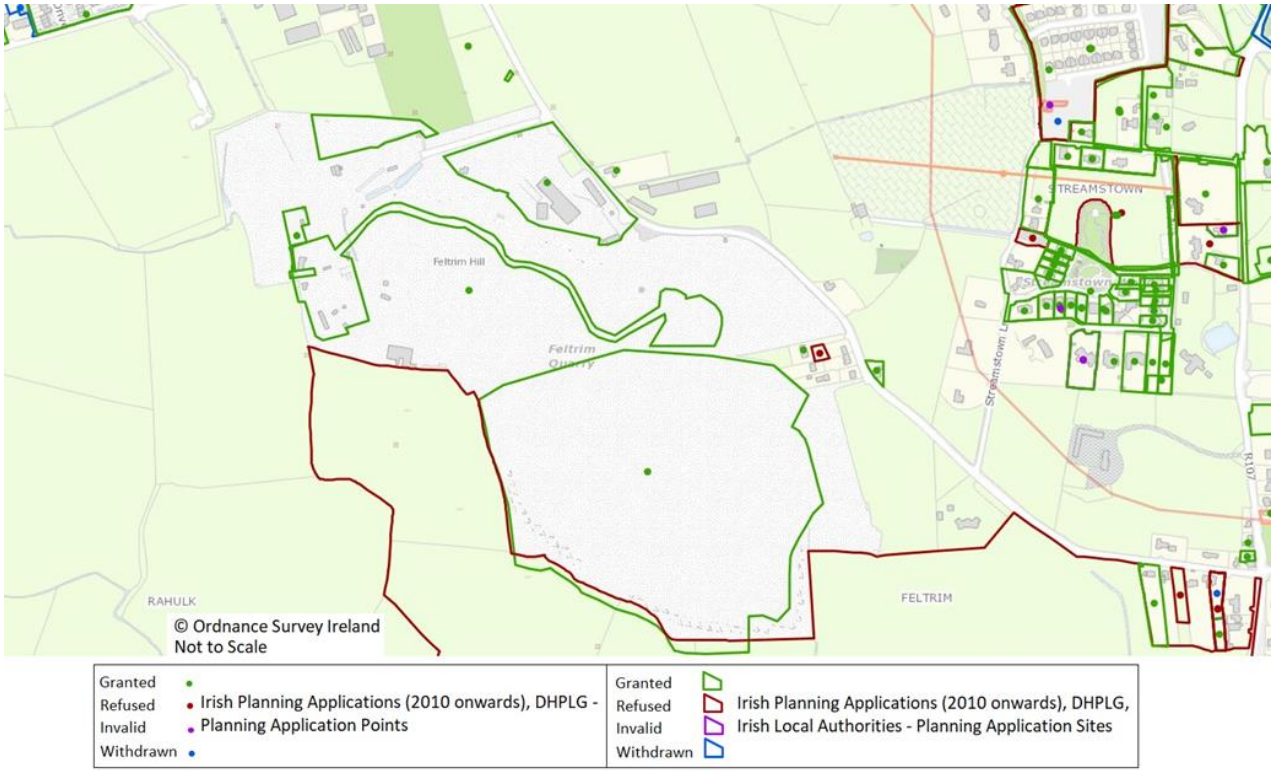


Figure 2.17 Feltrim, north of Belcamp substation

Consequently, there are only a limited number of areas available for accommodating a 400kV OHL which are not in close proximity to existing residence, amenity, and commercial activity.

2.5 Study area south-east (Belcamp - sub-study area G)

A limited surveillance was undertaken of specific points in the corridor north of Belcamp substation towards Broadmeadow Estuary. The following observations were made that could impact on any future OHL development.

Immediately north of Belcamp, land is rural however towards Broadmeadow Estuary land becomes more developed and suburban in nature.

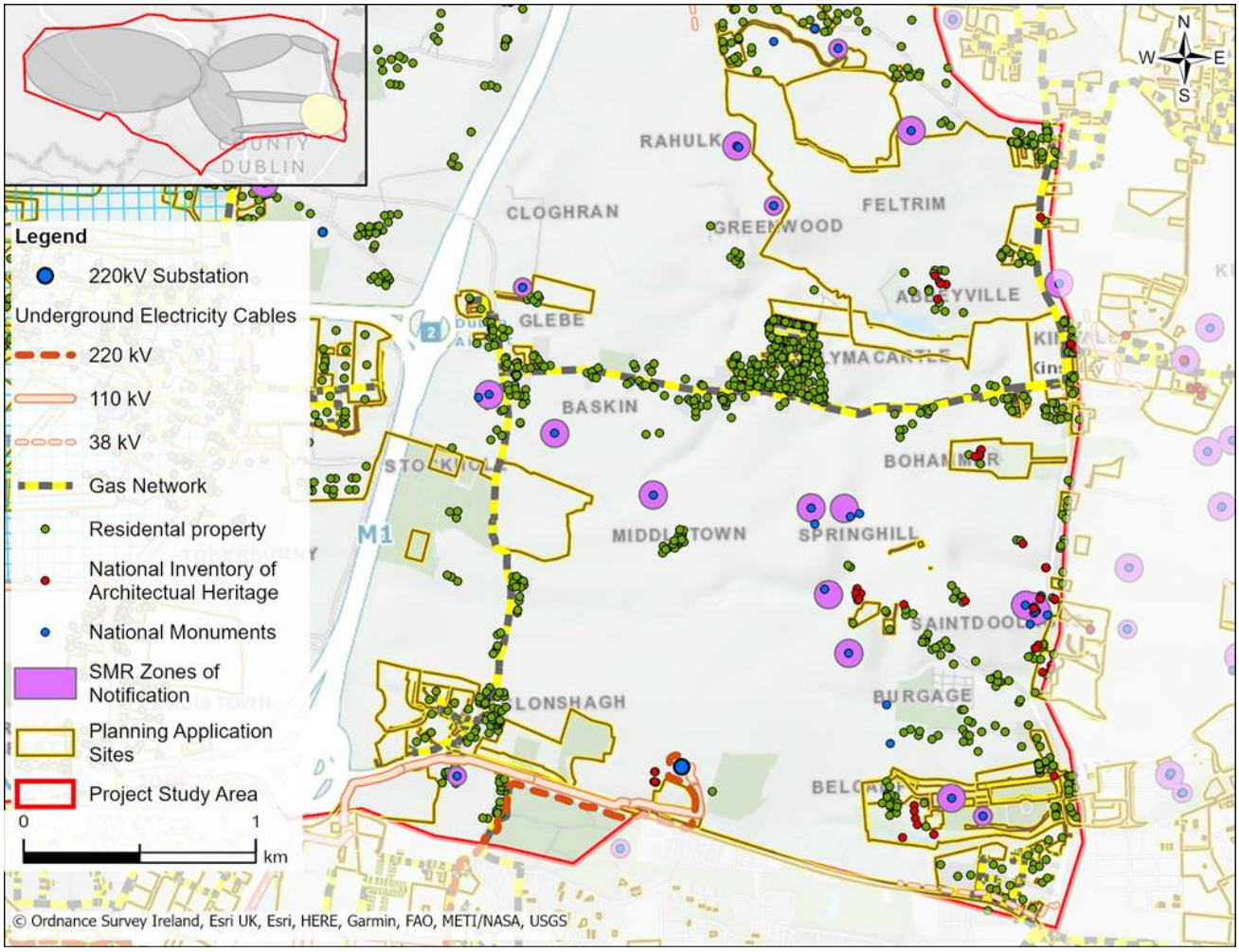


Figure 2.18 Study area south-east (Belcamp - sub-study area G)

Currently, there are no OHLs into Belcamp substation as all existing connections are cabled (Figure 2.19). During the visit to Belcamp substation, the following observations were noted.

- The R139 dual carriageway borders the site to the south with rough grazing and pasture on all other sides and a sports field further to the east.
- The property has two fence lines, the outer being the overall property, and the inner being a substation fence.
- The settling pond to the south of site is understood to capture water drained from the substation site for treatment before discharge (Figure 2.20).
- EirGrid advised that contaminated land is apparent to the west side of the entrance gate. Tipping was also noted to the west side of the entrance gate.
- There is a drain crossing noted inside of the entrance gate.

- EirGrid also advised that there is a stream to the north of site that would need to be relocated should the site extend into this area.
- Berms are evident on three sides of the site (not to the south) that provide screening. The north side berm would need to be relocated should the site extend into this area.
- A Waste Water Treatment Plant is planned north of site (as part of Irish water's Greater Dublin Drainage Project) and that other developments are being considered in this area (Figure 2.19).
- An East – West Distributor Road is also planned north of Belcamp substation and parallel to the R139 road (Finglas County Development Plan)
- There is an historic wall extending west from the substation.
- The overall site is presently at split level with the substation area set at the level of natural ground in south-east corner.

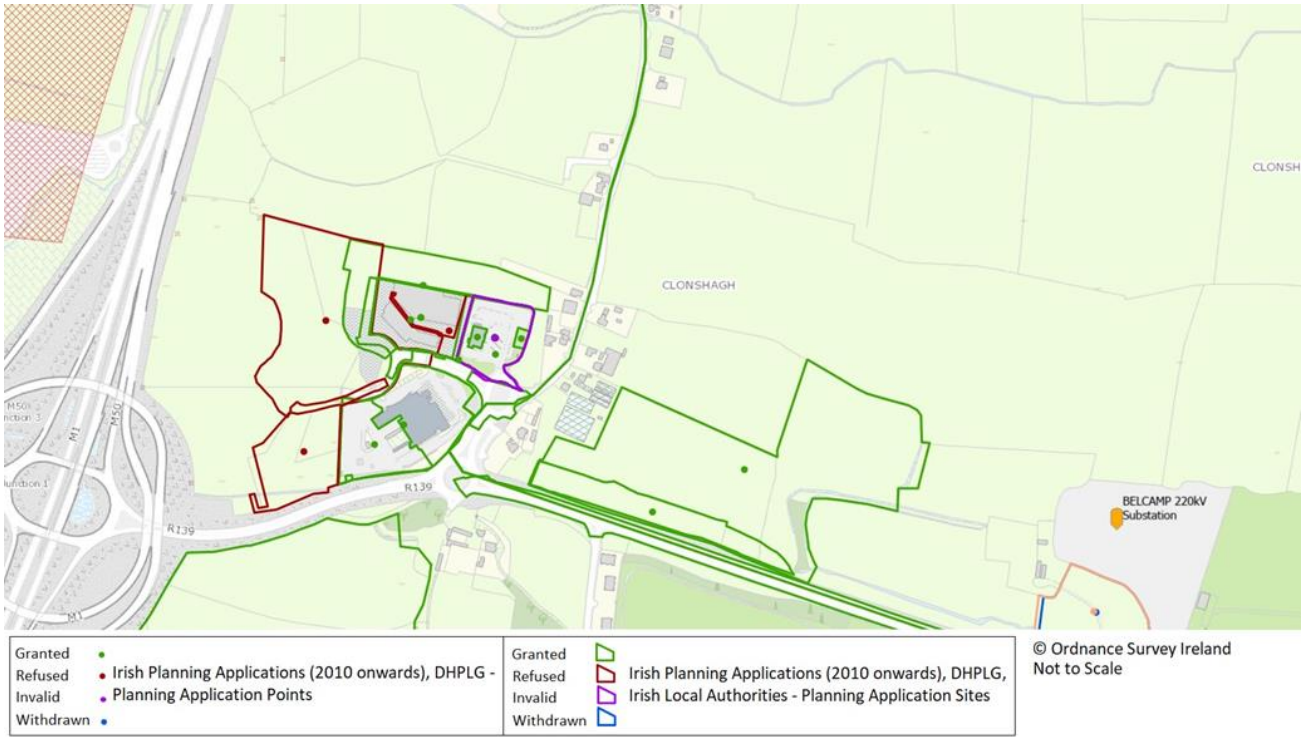


Figure 2.19 Existing cable routes into Belcamp substation

	
North side (from east)	Settling pond to the south
	
North of the substation (from south)	West of the substation (from east)

Figure 2.20 Site visit photographs

The study therefore assumes that a OHL will approach the extended Belcamp substation from either the north or west, however each of these could affected by planned developments.

2.6 Dublin Airport (sub-study areas H and I)

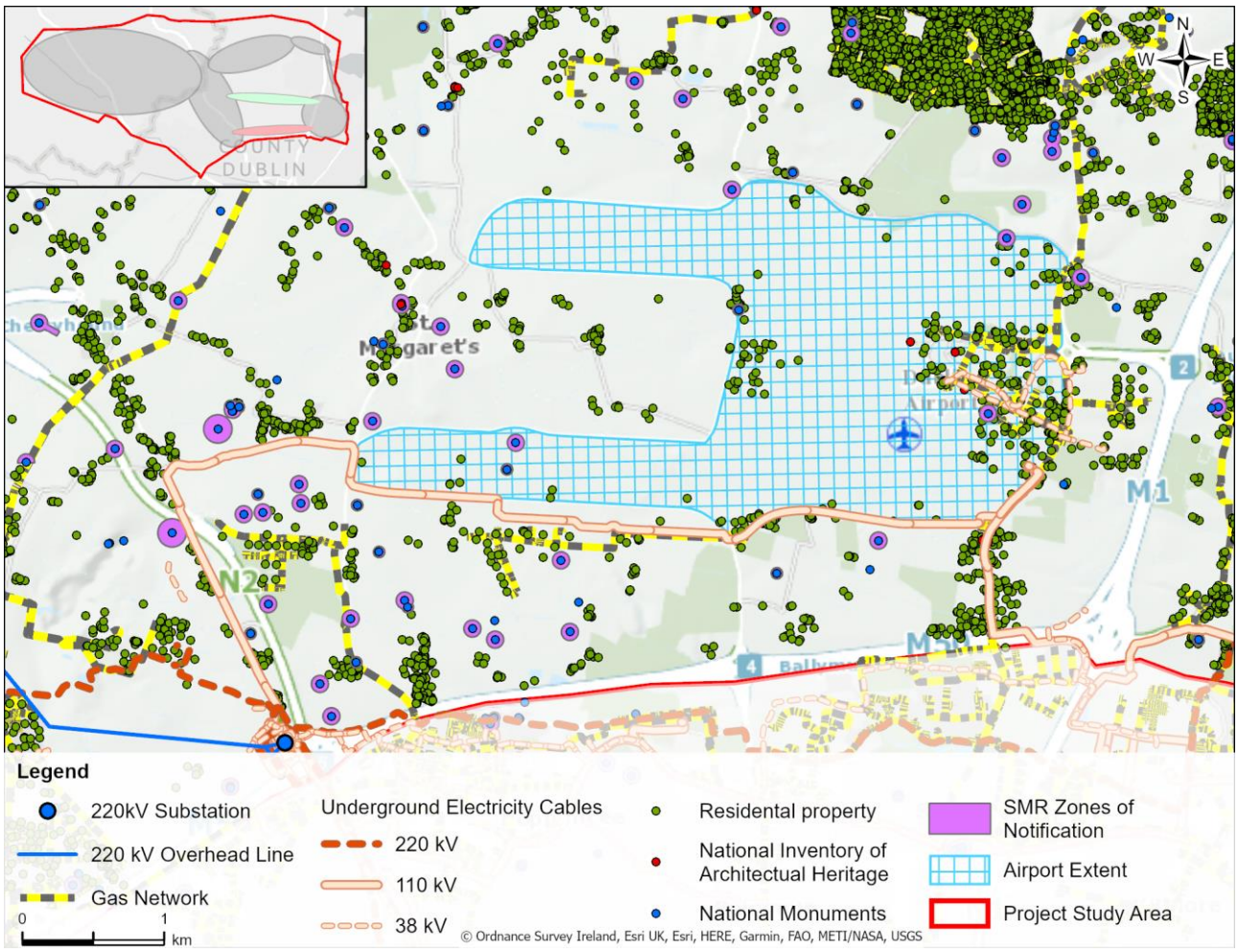
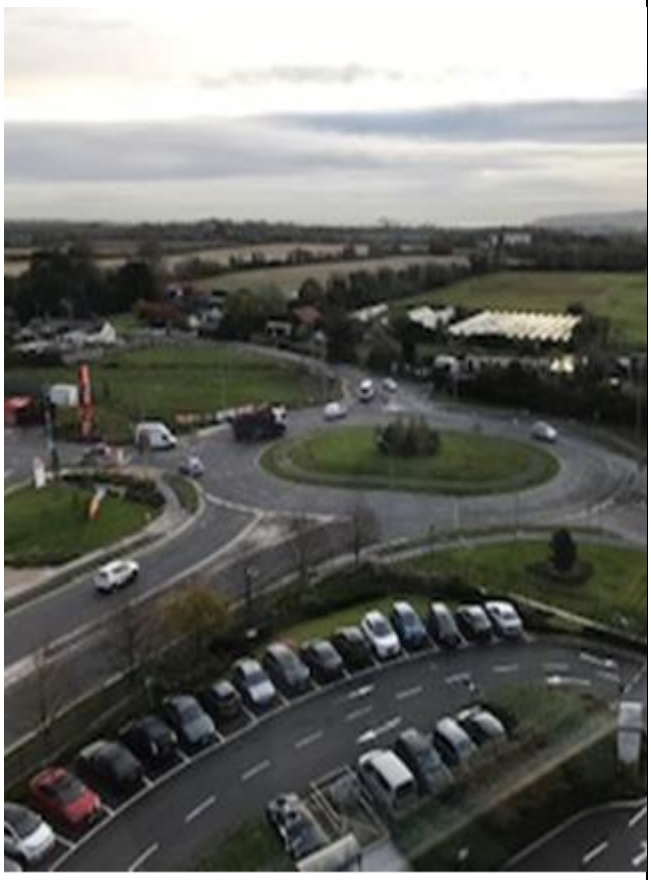


Figure 2.21 Dublin Airport (sub-study areas H and I)

Presently there are two operational runways at Dublin Airport, however a third runway is under construction and is due to be operational in 2022 (https://www.dublinairport.com/). The current runways allow for operation during different wind conditions; the main runway being orientated east - west and the shorter crosswind runway being orientated north-west south-east. The third runway will be parallel to the main runway.

Only a limited surveillance of the area south of Dublin Airport was possible during the site visit. At present the areas immediately east and west of the airport runways contain limited development.



Land to the east of Dublin Airport (Stockhole Lane)

Figure 2.22 Site visit photographs

- The land immediately south of the Airport presently contains a mixture of commercial, recreational and residential activity
- There is limited use of the land immediately north of the Airport, however the Forrest Little Golf Club occupies land between the Naul Road and the urban area of Swords
- Floodlight and telecoms masts are apparent along the boundary of the Ballymun Kickhams GAA sports ground (figure 2.19).
- The Silloge Park Golf Club course is noted to be a public course (figure 2.19).
- There are commercial and industrial works either side of the Swords Road and Old Airport Road junction

	
Floodlight and masts at GAA sports ground	Silloge Park Golf course

Figure 2.23 Site visit photographs

Overall, the areas available for the development of an OHL are constrained by existing and future planned Airport operations as well as the presence of commercial activity. The study also recognises that Dublin Airport represents a commercial hub which will continue to attract development.

3. Corridor Appraisal

The corridor appraisal considers the design related issues/constraints apparent in each sub-study area and comment on how these might be accommodated, including any assumptions, to assess the feasibility of each OHL option i.e. between Woodland and Finglas and Woodland and Belcamp. These are generally limited to crossings of motorways, railways and other OHL infrastructure, plus proximity to features such as dwellings or third-party, operations. Each sub-study area is presented in the same order as Section 2 of this report.

Any subsequent design studies will need to account for the above in determining a suitable corridor width with consideration of the conductor system both in still air and under blown conditions with appropriate safety clearances accounted for in both cases.

3.1 Study Area West (Woodland - sub-study area A)

3.1.1 Approach to Woodlands substation

EirGrid has indicated the East Meath 400kV OHL could connect in the south-east corner of the site, however as this has not been confirmed, the study considers connection options east and west.

On the basis that the CP1021 bay is situated on the west side of the substation then the terminal tower will be located on land to the west and from that point will initially need to head either the north or south and then pass (broadly) around the substation before heading east (Figure x).

- To the north there is an existing 400kV OHL to cross and there will also be a need to cross existing 220kV OHL on the east side at some point (either instead of or perhaps as well as the 400kV).
- To the south, only existing 220kV circuits could be affected. Crossings can be managed provided clearance is available but as oversailing circuits, they do represent a hazard.
- These corridors could also potentially affect any future OHL connections into the west side of the site.

However, if the CP1021 bay is constructed on the east side of the substation as presented on drawing XDN-SKE-CPXXXX-E-WOO-001 (figure 2), the bay will be facing the general direction of the OHL although there will still be a need to cross 220kV circuits at some point. (see Figure 3.1)

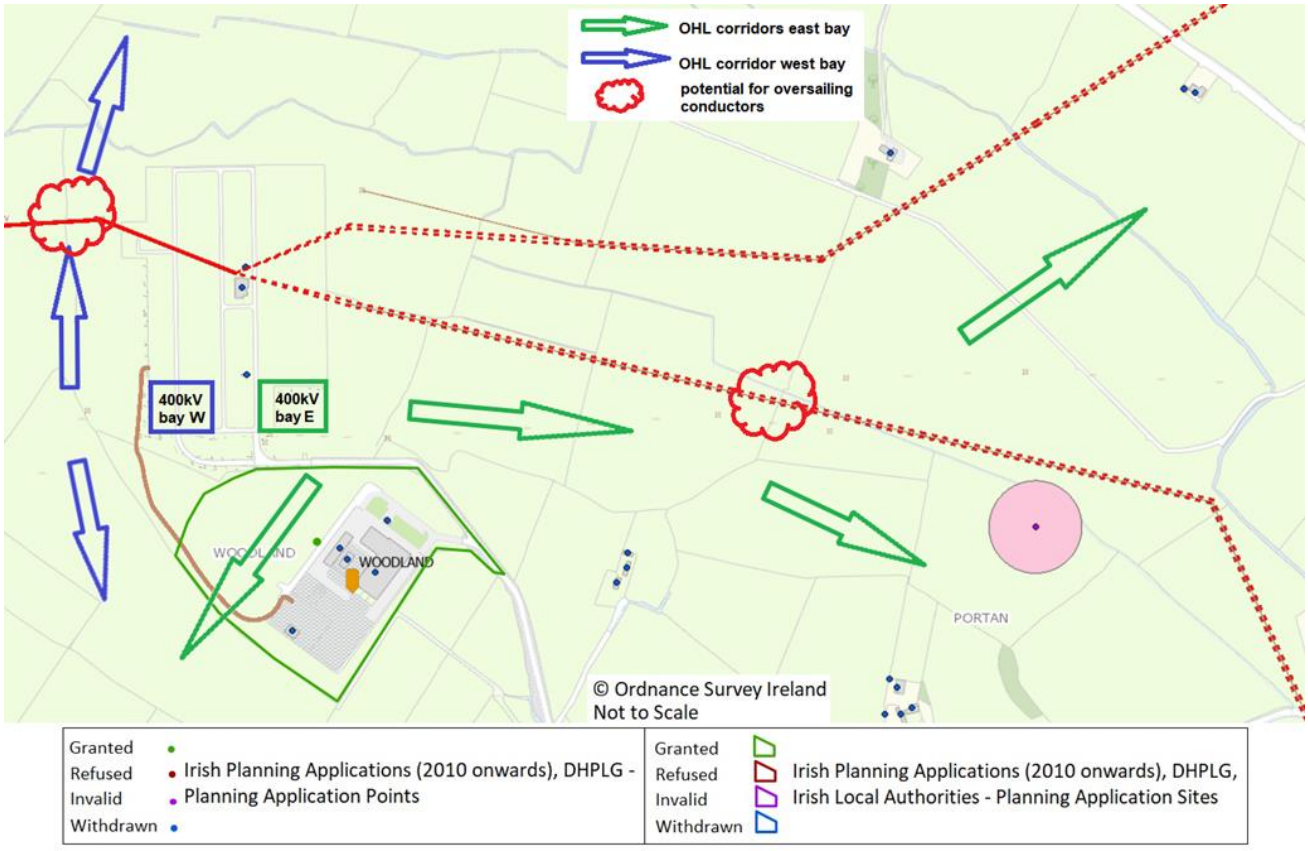


Figure 3.1 Woodland Schematic

For OHL crossings, the low voltage circuit is normally brought beneath the higher voltage circuit as the clearance requirements to ground are less onerous. In this instance however as the 220kV OHL is double circuit the crossing may be easier to engineer by bringing the single circuit 400kV beneath the 220kV circuits. This requires consideration of not only ground clearance, but circuit separation requirements and the protection of the lower circuit if the upper circuit is being maintained or replaced during outage. Each crossing would have to be assessed to determine the outage implications to EirGrid; construction beneath an existing OHL will be constrained by the height of the conductors but will however offer the opportunity for non-outage related construction.

Similarly, if a new OHL is taken north from the West side of the substation then there is a need to pass beneath the existing 400kV double circuit OHL; this is a similar issue as above albeit at the same voltage.

The protection of a lower OHL circuit is often accounted for by use of netted scaffold; essentially two scaffold towers supporting a span of netting to prevent items from work above falling onto the circuit below during construction works, including the conductor being worked on, which should be supported by the scaffold towers in the event of a failure. Space is therefore required at each crossing for this type of arrangement, which increases in size with the voltage and related geometry of the affected OHLs.

3.1.2 East of Woodlands substation

As the 400kV OHL progresses east (see Figure 3.2), crossings of the 220kV double circuit OHLs will be necessary although these could be single circuit crossings with distance away from Woodland. As noted above, the low voltage circuit is normally positioned below the higher voltage circuit, but each crossing will need to be engineered on a site-specific basis.

On the basis that outages are severely constrained (as noted earlier in this report) the next stage of study should identify the specific points in a route corridor where crossings would be required, then determine the options available and the associated outage implications with constructing a crossing solution.

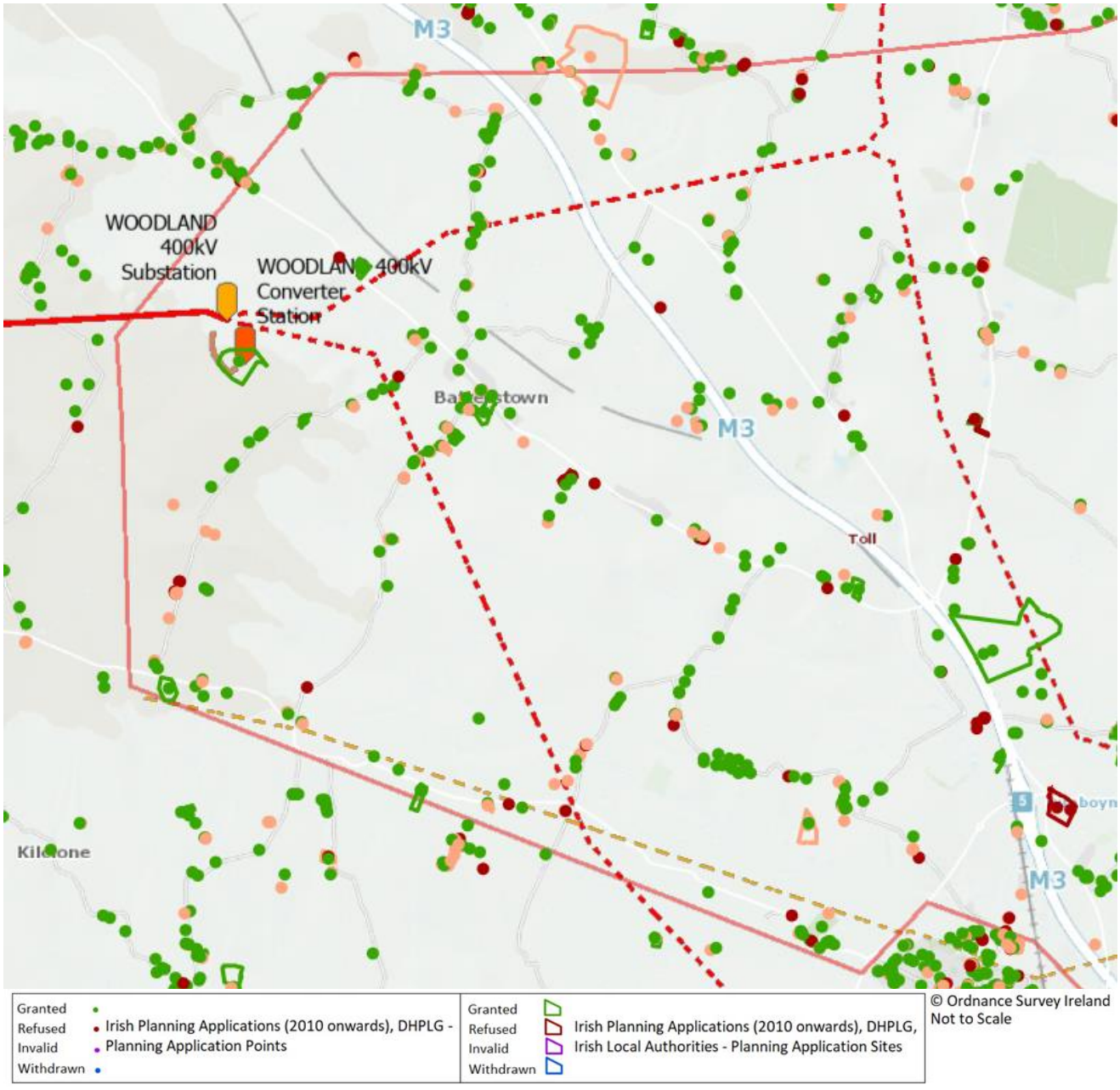


Figure 3.2 East of Woodland

EirGrid Functional Specification LDS-EFS-00-001-R0, section 6.4.4 details that high voltage transmission lines (110, 220 & 400 kV) shall have a minimum lateral clearance of 10 metres from the nearest outer phase of the

transmission line to support structures of lower voltage (distribution) lines, and support structures shall be located at a minimum of 15 metres from lower voltage distribution lines.

Furthermore, lower voltage crossings must not cross a 220 kV or a 400 kV line at an angle of less than 37° (inclusive angle).

Where any 400kV OHL is proposed in parallel to existing infrastructure, the study assumes that offset should be allowed to ensure sufficient area for construction of a 400kV OHL in proximity to a live circuit. At this stage, a nominal allowance of 50 metres has been assumed between circuits for 400kV proximity working, however this could be established on a site-specific basis and reduced in relation to the voltage if required.

EirGrid Functional Specification LDS-EFS-00-001-R0, section 6.4.7 notes guideline minimum distances of overhead transmission lines (conductor spans etc.) to habitable dwellings as 50m at 400kV and that the design should ensure that dwellings should not be at risk from capacitive, resistive, or inductive coupling, eliminating risk to the public of transferred potential during faults. The specification notes that risks can be caused by the presence of metal or wire fences near earthed parts of overhead lines.

The surveillance noted several equine stud farms in the area and Fairyhouse racecourse. The OHL design will need to consider the risk of Rise of Earth Potential (REOP) to horses or other livestock present around any proposed 400kV tower.

The M3 motorway traverses this sub-study area and will need to be crossed by the OHL at some point. EirGrid Functional Specification LDS-EFS-00-001-R0 does not distinguish roads from motorways therefore clearance requirements are defined as roads, however the protection necessary over a motorway to facilitate construction and any future maintenance can become complex. The means of protection is often a netted scaffold arrangement similar to that noted in section 3.1.1. Crossing angles for any proposed OHL should be as square (perpendicular) to the motorway as possible to minimise the extent of protection required, and consideration should be given to the areas available either side of the motorway for constriction of protection support systems, such as scaffold towers which may require external guys for stability.

No specific industrial or commercial activities have been noted in this sub-study area.

3.1.3 North of Dunboyne

The area north of Dunboyne towards the M3 motorway junction is presently rural, however is noted to contain the railway from Dunboyne out to the M3 Parkway facility (Figure 3.3).

EirGrid Functional Specification LDS-EFS-00-001-R0, section 6.4.11 notes that where overhead line support structures are proposed in the vicinity of a railway line, the structures shall maintain a minimum clearance of the falling height plus 2 metres. More significantly, the clause also notes that the location of OHL and their supporting structures in the vicinity of railway lines shall be avoided where economically viable.

Jacobs are also aware of plans for a proposed development of retail facilities north of Dunboyne. This could affect the opportunities for an OHL corridor through this area, and so without details of the development, the study assumes that an OHL may need to be located further north of this area and perhaps north of the M3 motorway junction 5.

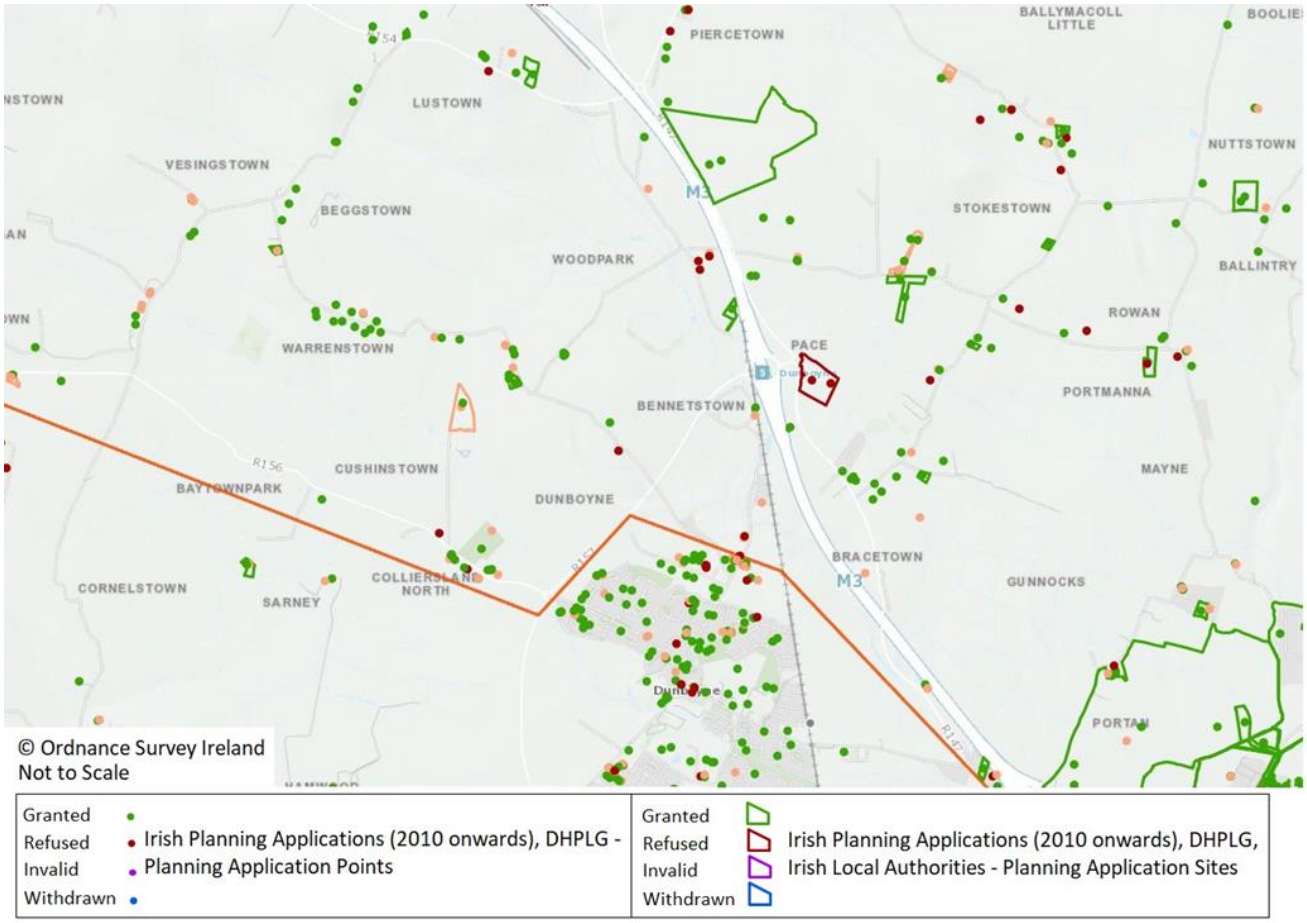
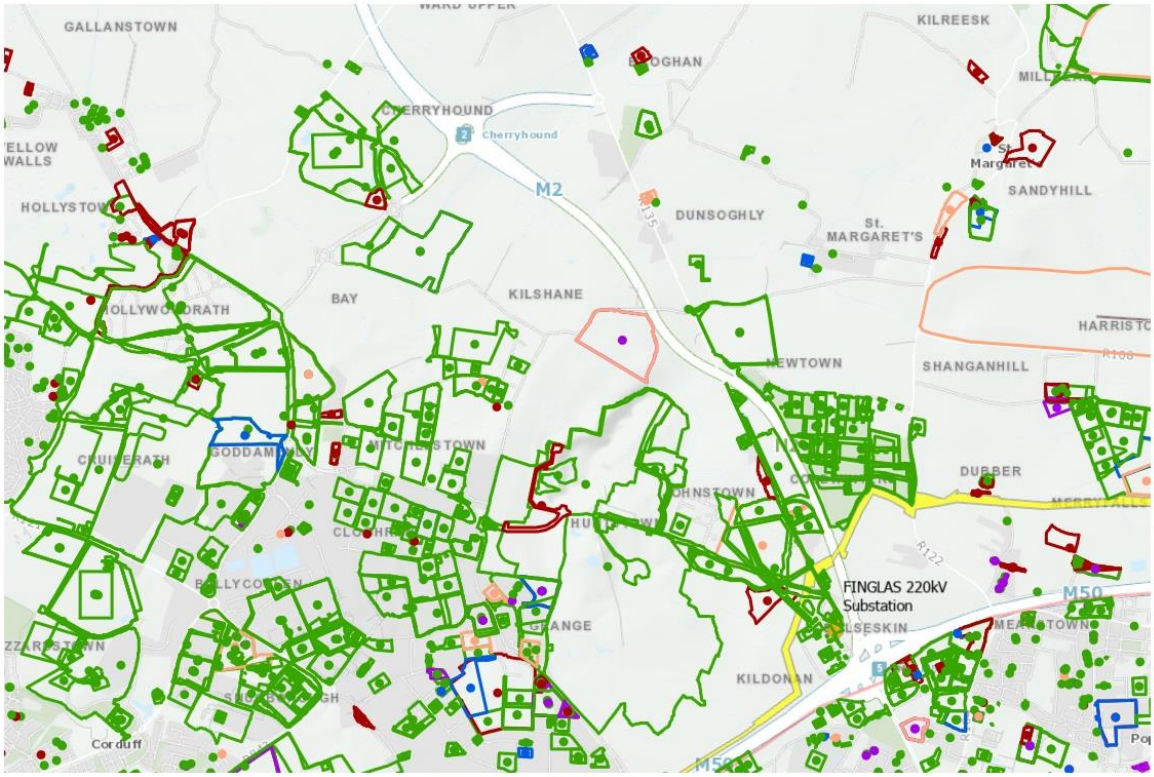


Figure 3.3 Areas north of Dunboyne

3.2 Study area central (Finglas - sub-study area B)

3.2.1 Approach to Finglas substation

Presently there are two corridors used to connect existing OHL into Finglas substation: to the north and to the west. The OHL routes out to the north are generally 110kV and below and EirGrid advise that most of these will be undergrounded shortly to accommodate a proposed data centre at Huntstown (Figure 3.4), while the corridor to the west contains OHL including double circuit 220kV lines.



© Ordnance Survey Ireland
Not to Scale

Greater Dublin Drainage Project - Study Area

Granted Refused Invalid Withdrawn	Irish Planning Applications (2010 onwards), DHPLG - Planning Application Points
Granted Refused Invalid Withdrawn	Irish Planning Applications (2010 onwards), DHPLG, Irish Local Authorities - Planning Application Sites

Figure 3.4 Areas north and west of Finglas substation

Irrespective of the route taken to bring a 400kV OHL around the Huntstown site, the route corridors converge in an area north of Finglas, referred to on the plans as Kilshane. The only apparent alternative to this would be to route further to the east initially, however this would take the OHL closer to the Airport runways (refer to section 3.7).

3.2.2 Corridor to the north of Finglas substation

To the north of Finglas, one of the existing 110kV OHL routes appears unaffected by the proposed data centre works as the route turns east to cross the M2 motorway. This existing route corridor offers an opportunity for either an additional 400kV OHL alongside of the existing infrastructure, or potentially through replacement of this OHL route with the 110kV circuit placed underground in the same corridor (Figure 3.5) however, this corridor will be affected by the proposed Greater Dublin Drainage (GDD) Project, and the implications of motorway crossings, as noted above in section 2.2, and would also apply in this instance.

Having crossed the motorway, the existing 110kV OHL turns north and heads between a logistics facility and the motorway. Opportunities exist to bring a 400kV OHL back across the M2 motorway before heading north-west towards Kilshane. This would require two motorway crossings at 400kV in a short space.

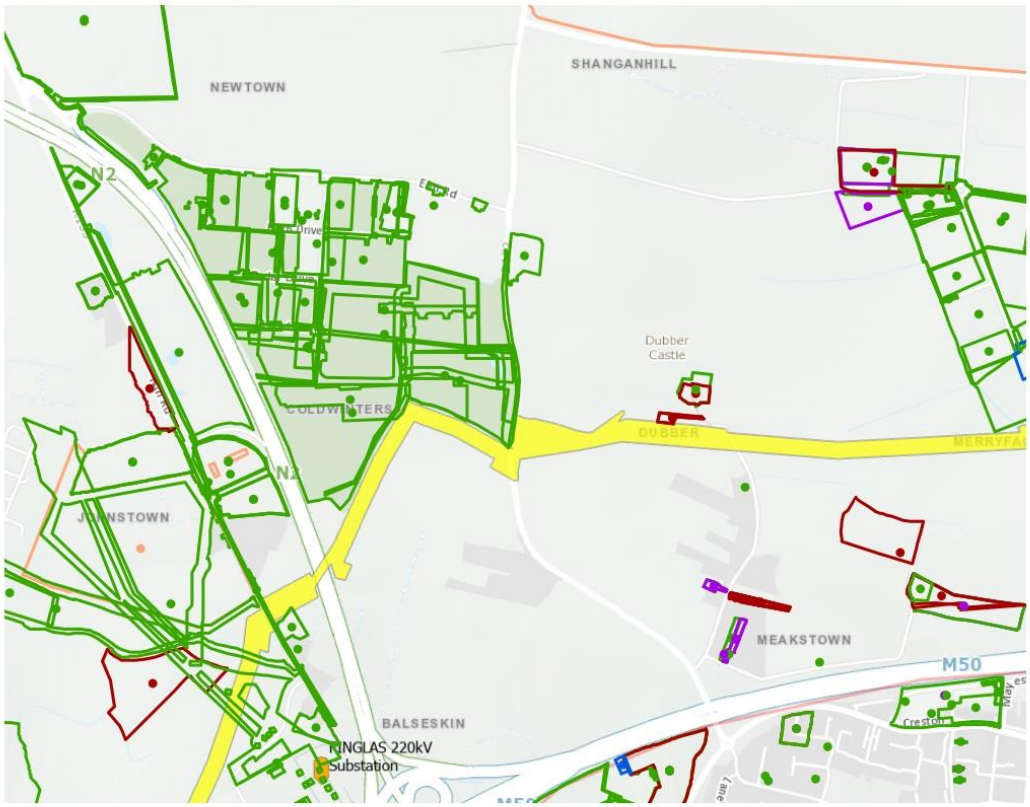


Figure 3.5 Areas east of Finglas substation

3.2.3 Corridor to the west of Finglas substation

As the arrangements for developing Finglas substation have still to be confirmed, any proposed OHL to the west of Finglas will probably need to account for crossing existing circuits at some point. The existing circuits generally head east, however a 400kV connected to the south side of Finglas substation and heading north, will undoubtably need to cross these circuits (Figure 3.6).

The existing OHL corridor is also in proximity to quarry operations, therefore any additional OHL development would need to consider the potential hazard of work beneath a new 400kV OHL. Economically EirGrid may also need to consider whether compensations claims are a risk should the OHL occupy land that could be later be quarried.

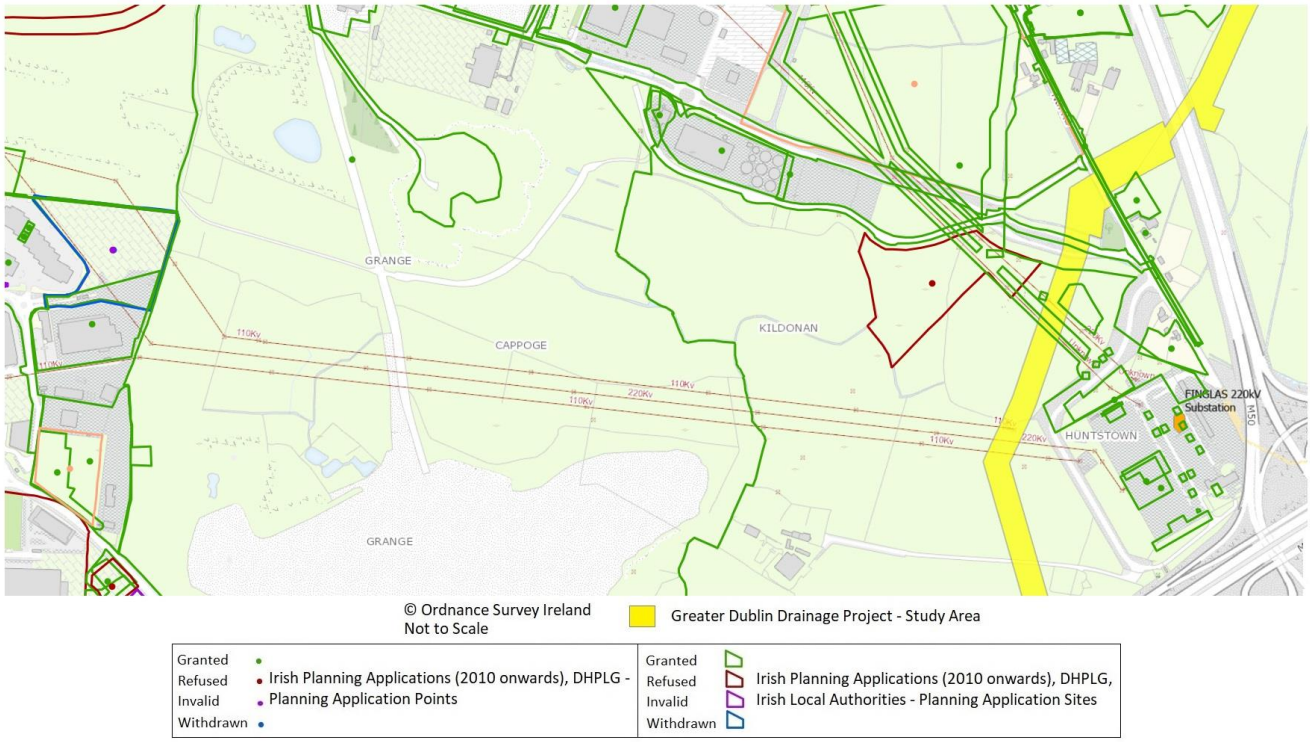


Figure 3.6 Areas west of Finglas substation

3.3 Study area north (Swords - sub-study areas C and D

The area north of Swords is generally rural (See Figure 3.7), however, there are infrastructure crossings that would be encountered, such as the M1 motorway, R132 road and several lower voltage OHLs. Protection measures necessary for interfacing with each of these are as noted in previous sections.

Commercial activity in this area appears to be generally agricultural. Broad Meadow River is noted to meander through this area and several water bodies are also noted. The study is not aware that this river is navigable, and the nature of the area could be an indication of a floodplain , which could impact on tower foundation designs.

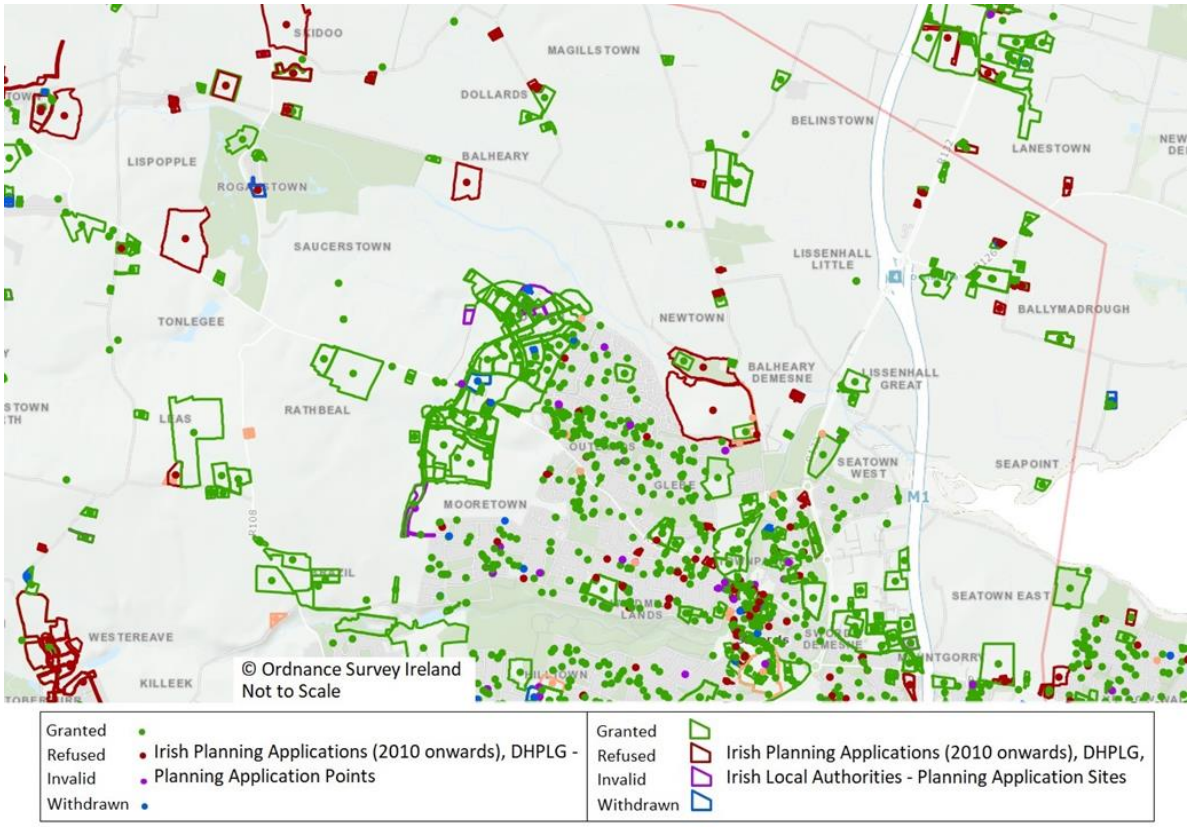


Figure 3.7 Areas north of Swords

3.4 Study area east (Broadmeadow Estuary - sub-study areas E and F)

The area further north from Belcamp is largely open which may reflect historic restrictions imposed by airport operations on development in this area, however development is now planned for this area and within a few kilometres north, suburban development becomes more apparent around Feltrim and the availability of corridors more limited (see Figure 3.8).

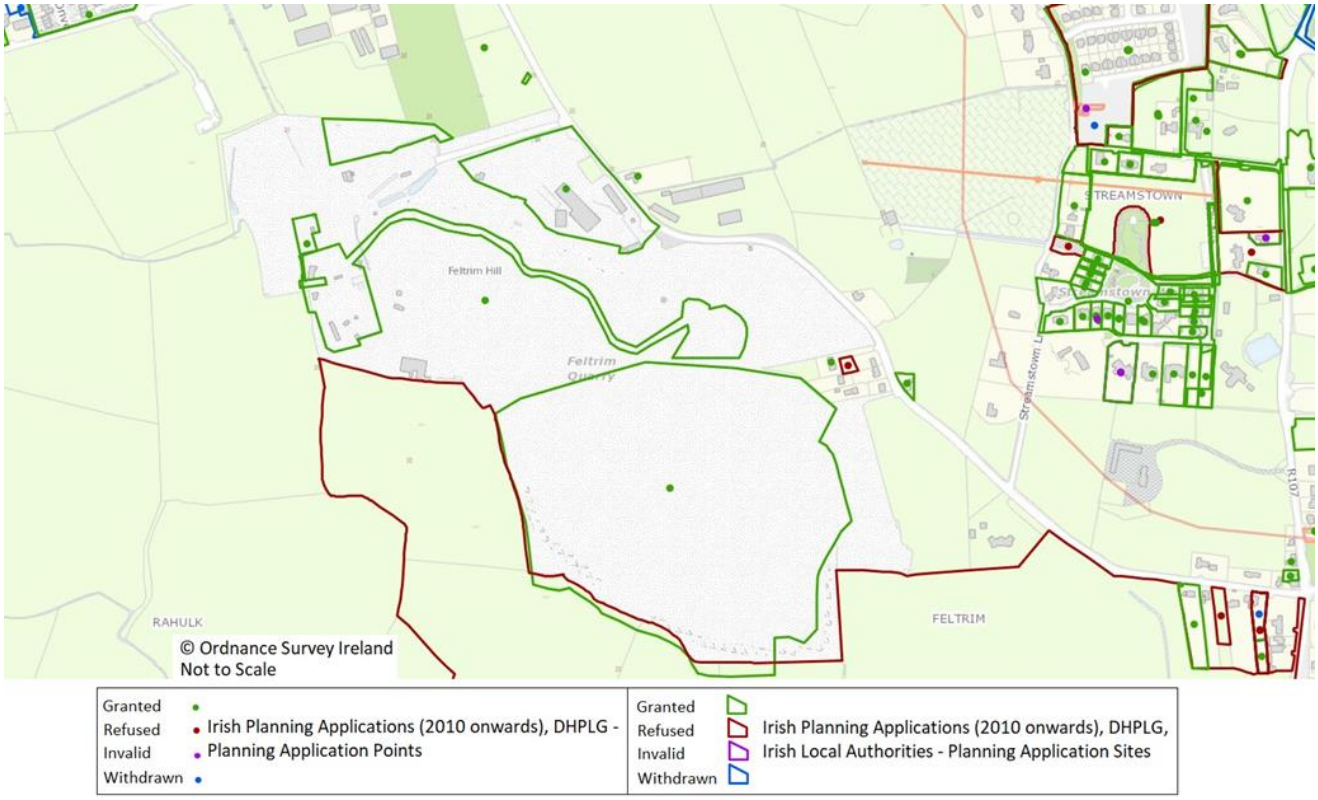


Figure 3.8 Feltrim area, east of Dublin Airport

Within the overall corridor between Belcamp and Broadmeadow Estuary several specific features and activities have been noted.

A low voltage OHL already crosses the allotments on Malahide Road (see Figure 3.9). This is presently of wood pole construction therefore a replacement or additional 400kV OHL with steel towers would impact on the land available for allotment use. Furthermore, the OHL design will also need to consider the risk of Rise of Earth Potential (REOP) to people tending allotments around any proposed 400kV towers, although protection measures could be considered at affected support structure such as additional earthing or insulated steelwork.

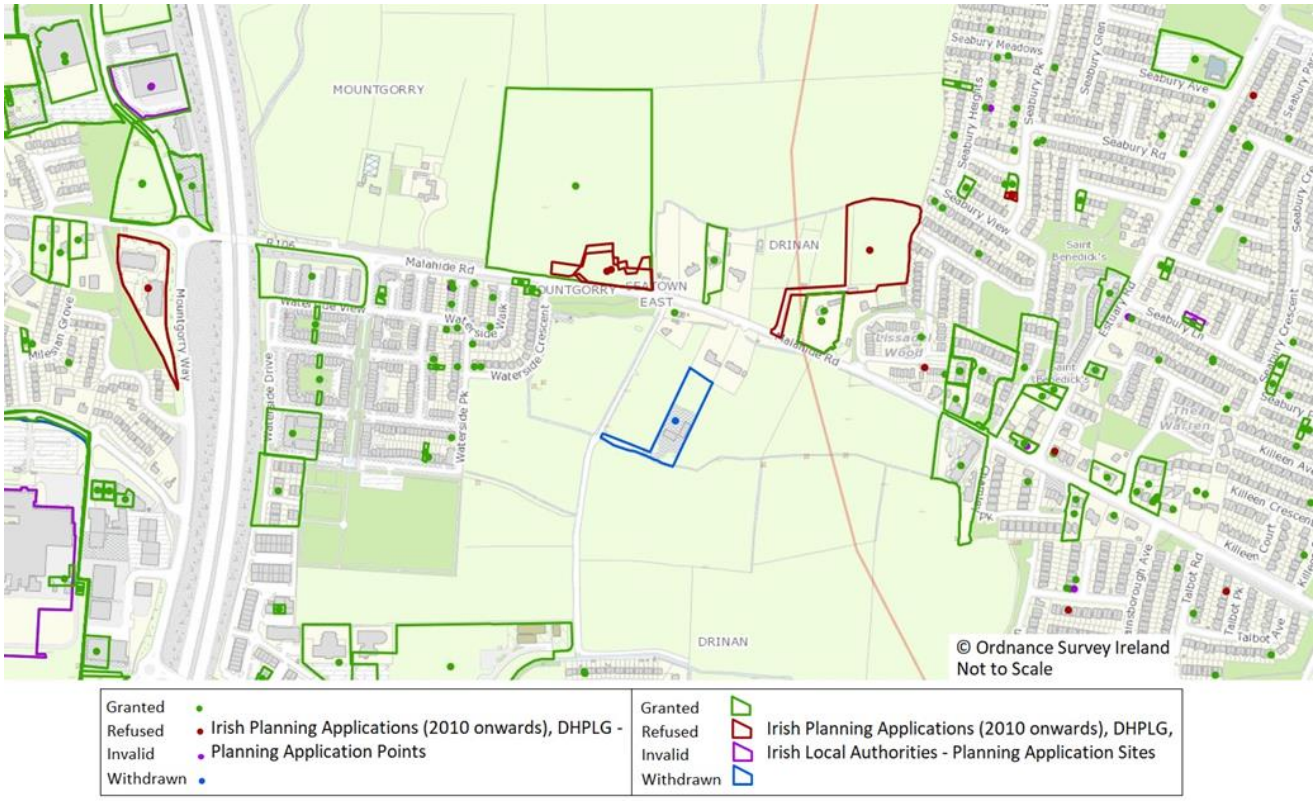


Figure 3.9 Malahide Road east of M1 motorway

Recreational facilities are apparent in this sub-study area. Clearances from an OHL to any affected areas will need to account for the particular activity and specific clearance requirement that could result in the extended height of towers.

3.4.1 Broadmeadow Estuary

This report acknowledges that the environmental consideration associated with routing an OHL across the Broadmeadow Estuary would be the primary determinants of whether that is feasible, and reference should therefore be made to report 321084AJ-REP-004. Consequently, this section only considers the design and technical elements of routing an OHL in this area. Consideration of the environmental constraints is presented in the Environmental Constraints Report (Document Ref. 321084AJ-REP-004).

From a technical perspective a crossing span of the Broadmeadow Estuary would be required in accordance with EirGrid Functional Specification LDS-EFS-00-001-R0 where the maximum span for a 400kV Single Circuit RL2 Tower is limited to 500m. The study assumes that the estuary is not navigable and therefore clearance requirements can be considered as 'normal ground', however should the crossing require a longer span or enhanced clearance, then a site-specific support design becomes more likely including the need for taller support structures (see Figure 3.10) Bird flight diverters could be considered as a means of mitigating the effect of the OHL on migrating birds, however these may only be available for certain species.

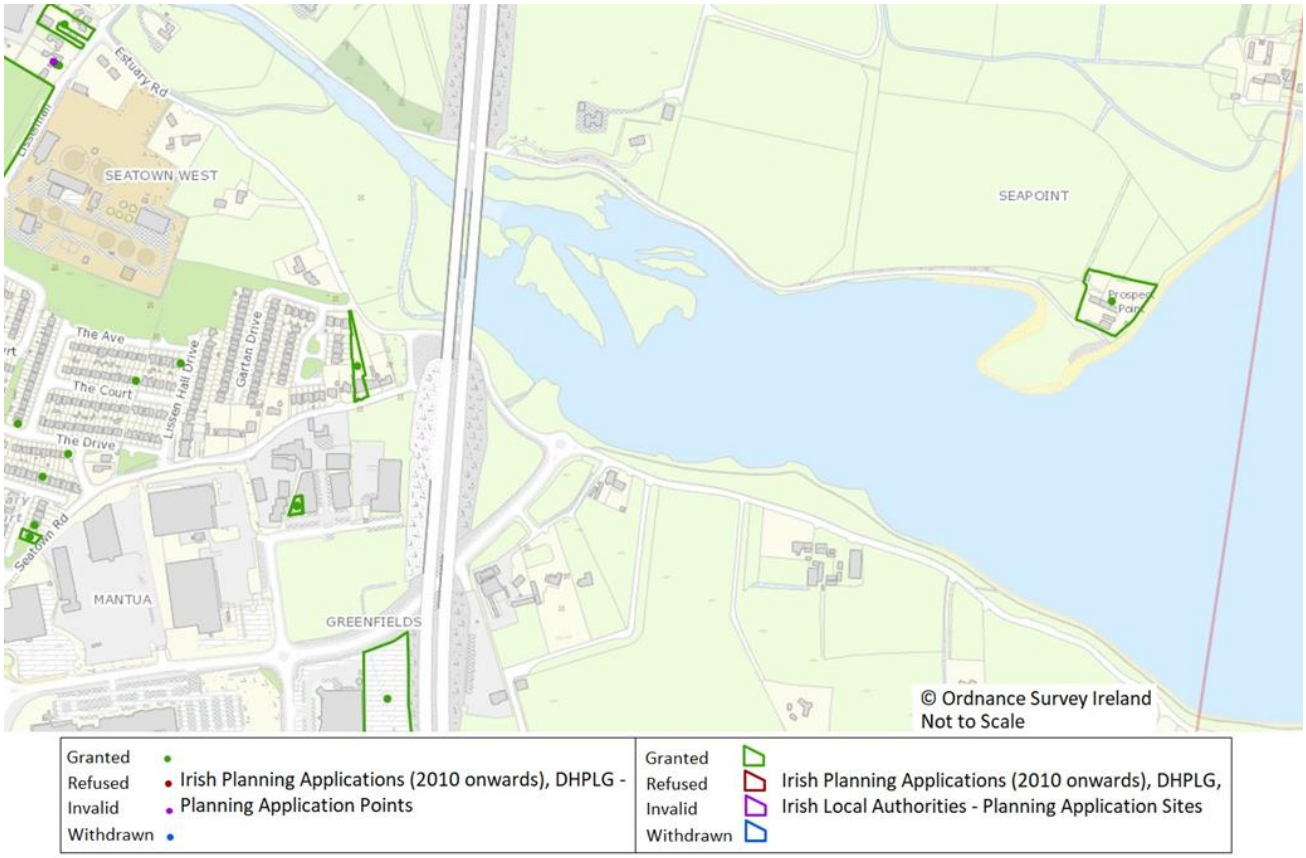


Figure 3.10 Broadmeadow Estuary east of Swords

3.5 Study area south-east (Belcamp - sub-study area G)

Immediately to the north of Belcamp substation, the OHL direction could be either directly west towards Dublin airport, or north towards Swords and the Broadmeadow Estuary, however this alignment will be directly affected by the developments planned in this area, particularly the proposed Greater Dublin Drainage (GDD) Project (figure 3.11) and associated Waste Water Treatment Plant where oversailing conductors could present a hazard to the works operation.

The area immediately to the west of Belcamp is largely open towards the M1 motorway whereupon a crossing will be required (as section 3.1.2 above). West of the motorway an area of open land is apparent towards Dublin Airport (see Figure 3.11).

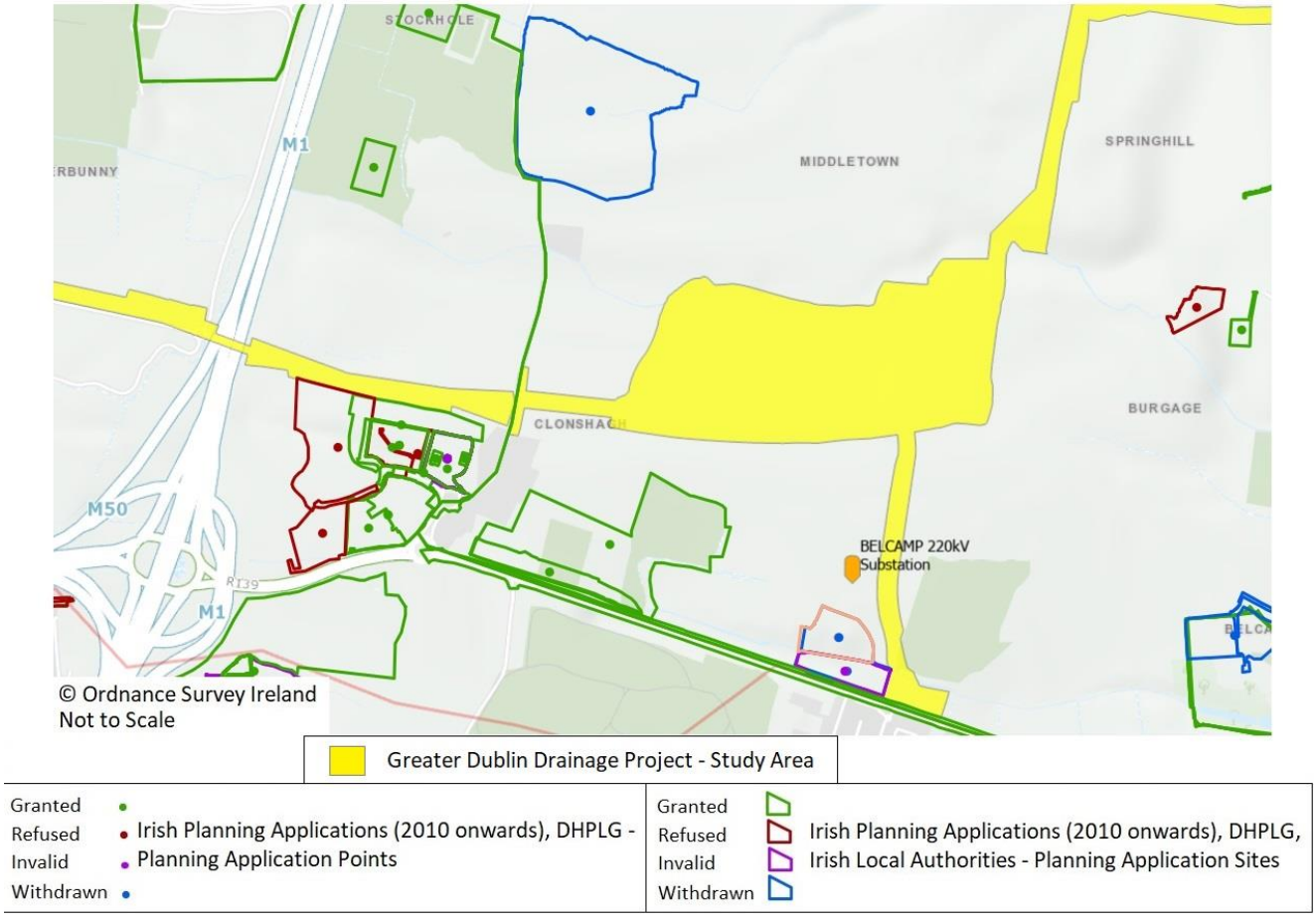


Figure 3.11 Approach to Belcamp

The study assumes that an OHL terminal tower at Belcamp will be directly aligned with the new 400kV bay, and that this tower will be positioned on a green field site with open ground between tower and the proposed 400kV substation

The interface between OHL alignment and substation will be affected by the proposed developments north of Belcamp, specifically the proposed East West Distributor Road and the GDD Waste Water Treatment Plant which would both be located in the land approximately 100m north of Belcamp substation.

The study notes that any proposed level change between tower position and substation could affect downlead design e.g., vertical angle of downleads could impact on clearances at the substation structure

3.6 Dublin Airport (sub-study areas H and I)

Dublin Airport and the development of a second runway has a significant impact on the possibilities for developing an OHL into Belcamp and Finglas.

With reference to European Union Aviation Safety Agency (EASA) operational and design documentation noted as CS-ADR-DSN, Issue 5, Certification Specifications and Guidance Material for Aerodrome Design and Regulation (EU) No 139/2014, Easy Access Rules for Aerodromes, there is a need to maintain an exclusion zone at the end of each runway, in both plan and elevation, to ensure that a clear flight path in maintained.

- The Airport has an exclusion zone at the end of each runway, in plan and elevation, to ensure that a clear flight path in maintained. In plan this equates to 15% (which converts to 8.53°) and in elevation 1.2% slope (which converts to 0.69°), and which extends 10km from the airport. See Figure 3.12
- The flight path assessment must also account for emergency situations, therefore a 400kV OHL beyond 10km could still be considered an obstacle as far as the Airport is concerned.
- Electromagnetic compatibility is understood to be a limitation only where OHL infrastructure is proposed within approximately 200m of air traffic control related operations.
- Jacobs understands that in the longer term, the airport intends to extend the main runways.
-

3.6.1 Flight path to the east and west of Dublin Airport

A preliminary assessment of the flight paths to the west of Dublin Airport has been undertaken to determine the potential impact on a new 400kV OHL across the study area and in proximity to Belcamp and Finglas substations respectively. When the exclusion zone criteria noted above are applied, OHL towers at either end of the airport and within 2500 metres would effectively be limited to approximately 30m in height to keep within slope limits (Figure 3.13), which will affect the OHL profile at 400kV. To mitigate this, EirGrid could consider alternative technologies such as Insulated Crossarms to reduce the overall height of the support structure.

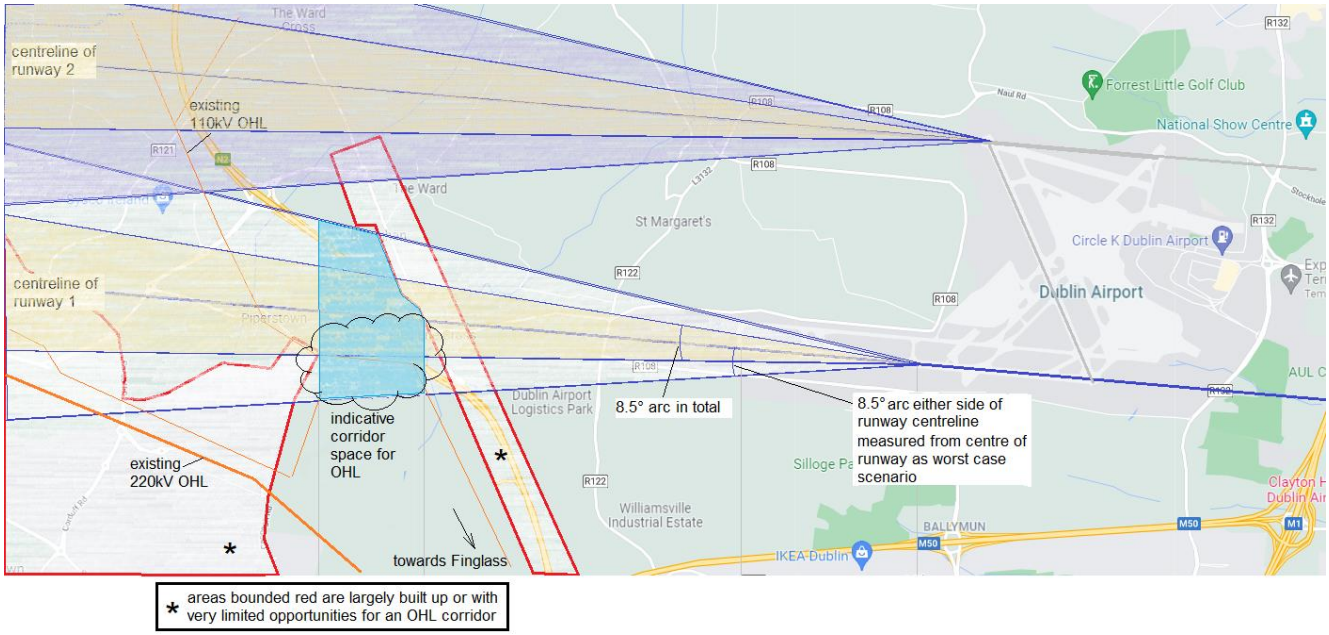


Figure 3.12 Safety Exclusion Zones Dublin Airport

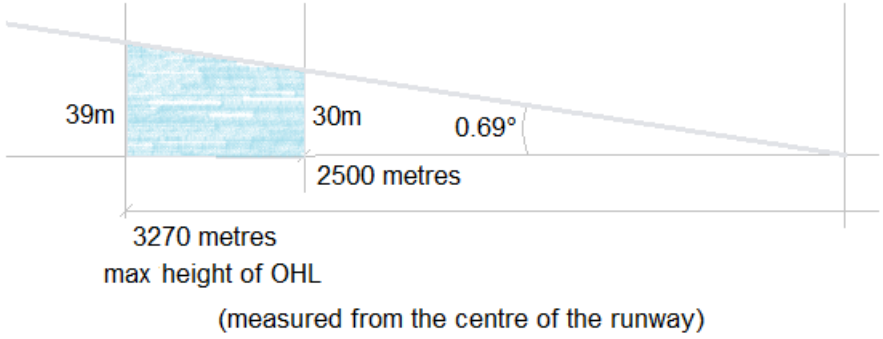


Figure 3.13 Flight path assessment (west)

3.6.2 North-west south-east aligned runway

A preliminary assessment of the flight paths for the north-west south-east aligned runway has been undertaken and when the exclusion zone criteria noted above are applied, OHL towers to the north and south side of the airport and within 1500 metres, would effectively be limited to approximately 18m in height to keep within slope limits (Figure 3.14). This is likely to limit the OHL profile at 400kV to short spans given the need to maintain clearances to ground for features and operations beneath the OHL.

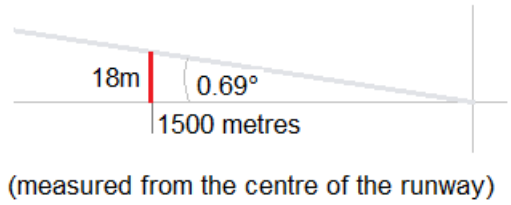


Figure 3.14 Flight path assessment (north-west south-east)

3.6.3 Local issues

At a more local level, road crossings would be required in areas that are generally developed or where opportunities for constructing protection measures are limited. As an example, at the junction of Old Airport Road and Swords Road south-east of the Airport, an OHL corridor would impact upon commercial activity adjacent to the corridor as well as requiring a complex protection of the junction for conductor installation and future maintenance (Figure 3.15).

Figure 3.15 junction of Old Airport Road and Swords Road (Google Earth)

An OHL would impact on the two golf courses, Sillogue to the south-west of the airport (Figure 3.16) and Forrest Little to the north (Figure 3.16). While these areas represent an opportunity to screen an OHL, towers and oversailing conductor systems would directly affect the course design and require management of the environmental implications.

Either side of this area, open land is available however an OHL in proximity to the GAA sports ground would need to consider future maintenance of both floodlights and telecoms mast.

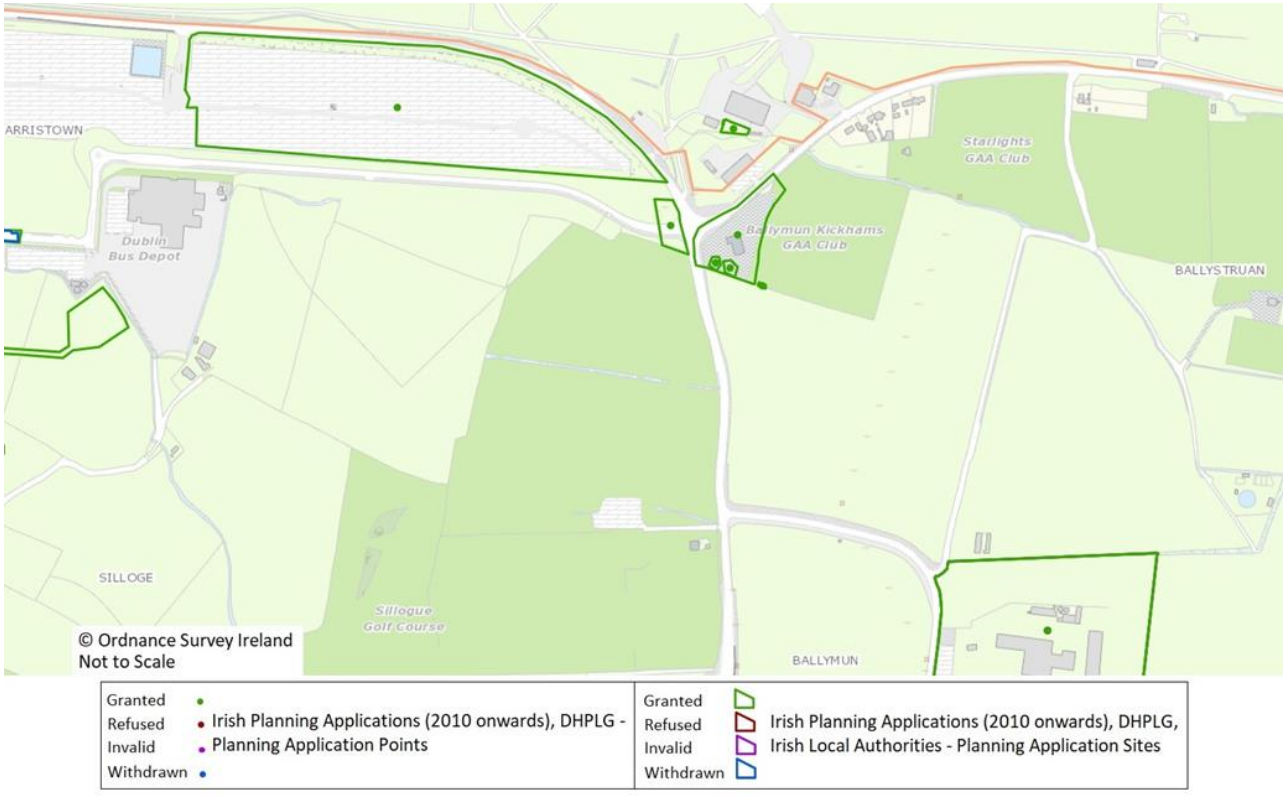


Figure 3.16 Sillogue golf course and GAA sports ground

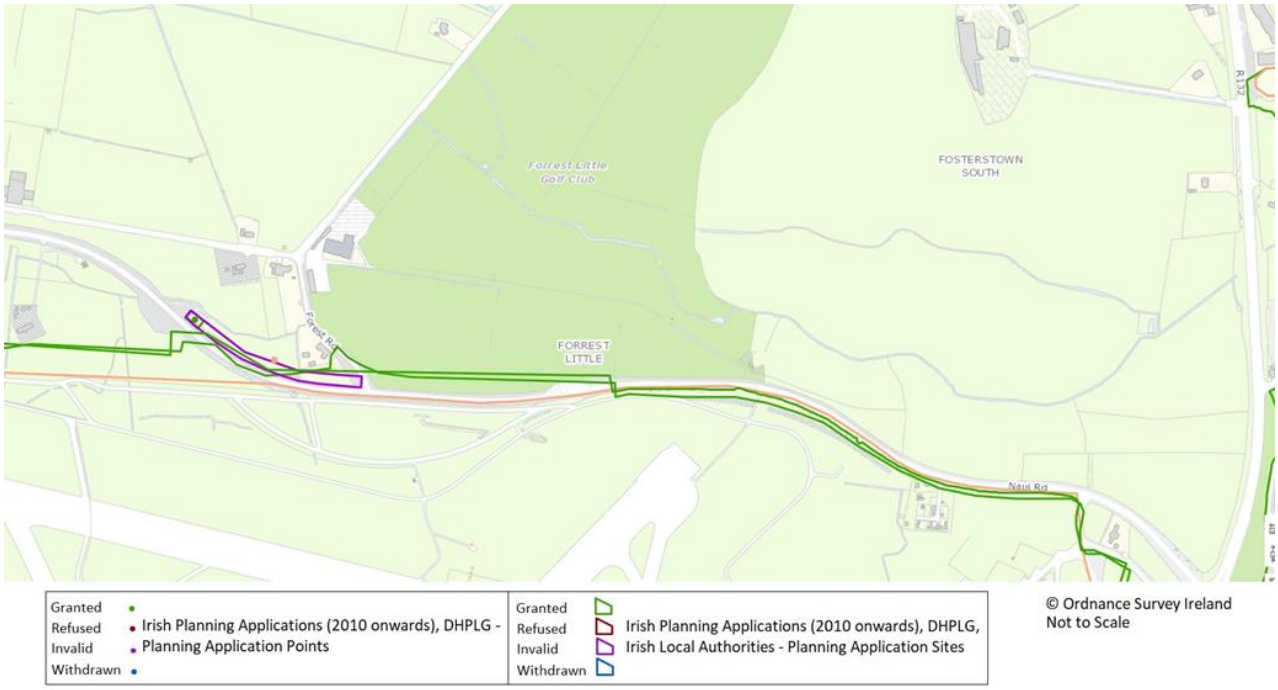


Figure 3.17 Forrest Little golf course

4. Evaluation of the Options

4.1 Option Review

EirGrid requires an overall evaluation of options with reference to specific criteria:

- Technical Performance
- Deliverability
- Economic Performance
- Environmental
- Socio-economic

This section of the report considers the technical performance, deliverability, and economic performance. The environmental and socio-economic factors are accounted for elsewhere in the reference reports noted previously.

4.2 Technical Performance

EirGrid considers favourable options to be those which extend technical performance beyond minimum acceptable levels, provide operational switching flexibility and which minimise risks to operation during maintenance. The extent to which future reinforcement or modification to the transmission network can be facilitated should also be considered.

An assessment of the two options has been made in relation to technical performance with reference to the following criteria:

- safety standard compliance.
    - The study has considered whether there are any complex or site-specific design requirements in the option corridor, for example, a motorway crossing where the maintenance of clearance and the site-specific protection measures will be necessary for future maintenance or operation of the motorway.
- expansion or extendibility.
    - The application of standard OHL design in accordance with EirGrid's functional specification has been assumed for each option unless stated otherwise and therefore is extendable or adaptable to allow future development such as diversion or connection to other parts of the network.
- repeatability.
    - The use of a standard design as proposed will allow EirGrid to develop similar projects to the same specification elsewhere on the network if required
- technical operational risk.
    - Operational risk has been considered where OHL circuits are noted to be crossing or are in proximity, and thereby represent a hazard i.e., OHL crossings will require site-specific protection measures to enable safe system operations and therefore will have outage implications for the system operator.

4.2.1 Option 1 - Woodland substation to Finglas substation

This option includes the following sub-study areas as noted and presented in figure 4.1 below. Additional comments are then provided in relation to the technical performance of a 400kV OHL in this area.

A. Study area west (Woodland)

B. Study area central (Finglas)

H. Dublin Airport (north)

I. Dublin Airport (south)

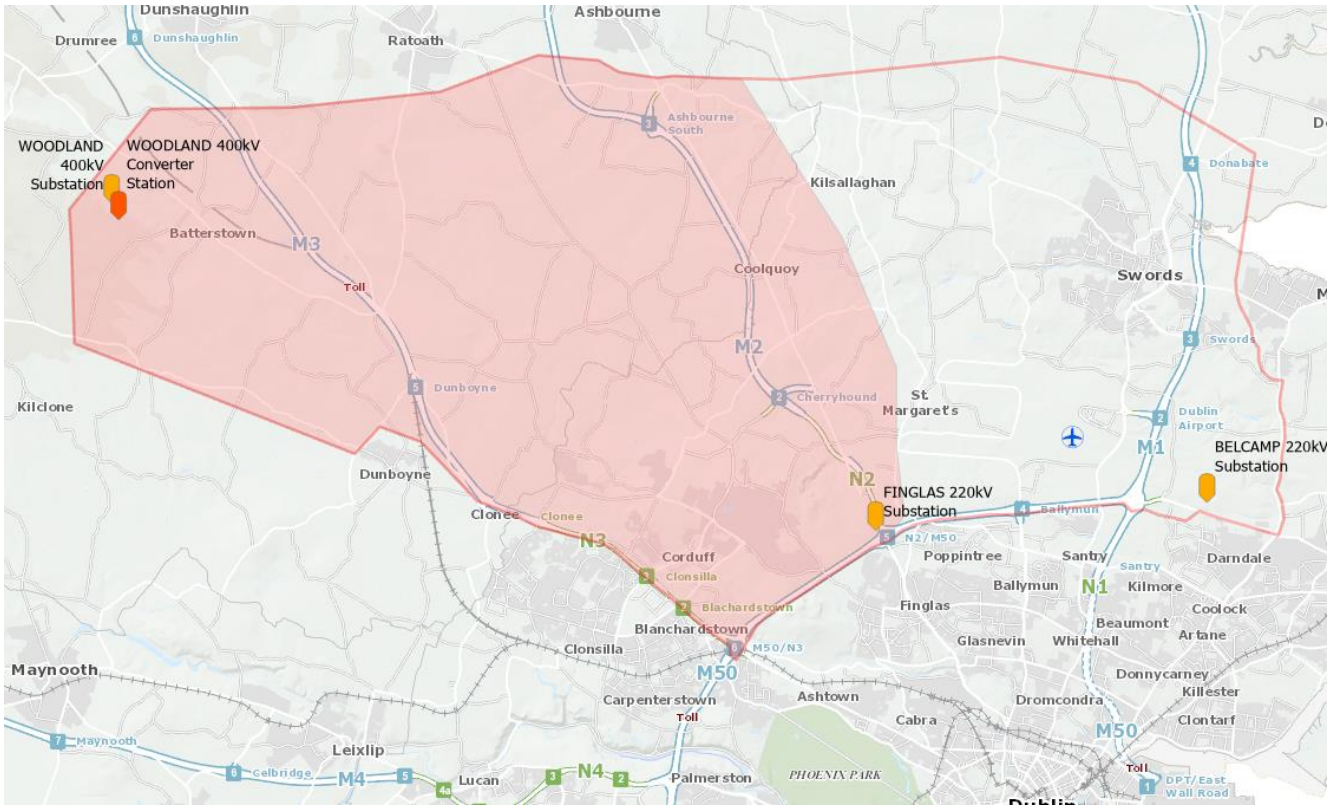


Figure 4.1. Finglas Study area

Within the sub-study areas of this option, open land is evident to the north, south and east of the study area that provides wide swathes for an OHL corridor to be developed, however there are several complex or site-specific design requirements, particularly in the central study area towards Finglas and Dublin Airport where potential corridors are constrained, and options are therefore limited as the OHL would need to interface with various third-party operations and infrastructure.

Within severely constrained corridors, the extent of protection measures necessary will need to be accounted for during the project development, at motorway and major road crossings as well as any circuit crossings, as each of these could have future operational implications for the system operator during planned maintenance of any affected OHL. Given the outage constraints on the EirGrid transmission system, as noted above, maintenance outages will need to be planned in advance of the works. Third parties would also need to understand the operational and electrical implications of the OHL on their infrastructure.

Commercial and industrial operations as well as recreational facilities are likely to be affected by an OHL and therefore the interface will need to be managed during the route development, in particular operations at Dublin Airport where there is limited vertical clearance available for the OHL to satisfy the Airport regulations.

There are potential opportunities in this study area, such as reusing existing OHL route corridors, however this is likely to require sections of existing circuits to be placed underground. There are areas of land available for OHL

routing in the area around Finglas and west of Dublin Airport, however these are generally limited either in proximity to or directly impacting on commercial and recreational activities.

4.2.2 Option 2 - Woodland substation to Belcamp substation.

This option includes all of the sub-study areas as presented in figure 4.2 below

A. Study area west (Woodland)

B. Study area central (Finglas)

C. Study area north (Swords)

D. Study area north-east (Swords)

E. Study area east (Broadmeadow Estuary)

F. Study area east (south of Broadmeadow Estuary)

G. Study area south-east (Belcamp)

H. Dublin Airport (north)

I. Dublin Airport (south)

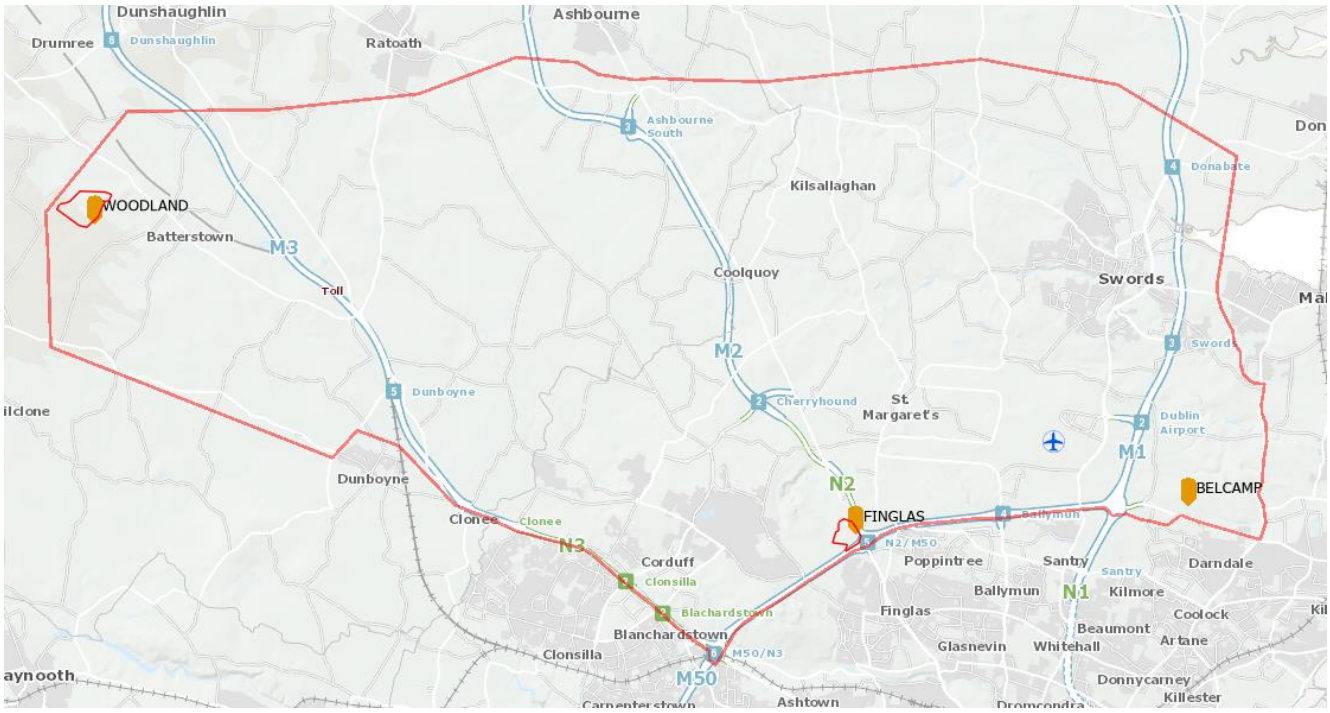


Figure 4.2. Belcamp Study area

The OHL for option 2 could follow a similar route to option 1 from Woodland into the area north of Finglas and in proximity to Dublin Airport, therefore the technical performance is as noted above. However, in the east of the overall study area, an alternative route may be considered that extends to the north of Swords and which limits the direct impact of airport operations to the area immediately north of Belcamp substation, and east of the airport.

Therefore, in addition to the factors identified for option 1, an OHL development further east and into Belcamp substation may also need to consider the following additional factors.

Open land is evident to the north and north-west of Swords that provides wide swathes for an OHL corridor to be developed, however there is a motorway to cross as well as several existing OHLs. There is also the potential need to route the OHL across wetlands along the Broadmeadow River corridor, which could require piled or special foundations beneath OHL supports.

The Broadmeadow estuary area is environmentally sensitive to the physical and visual impact of an OHL and particularly if the estuary crossing span requires an enhanced or site-specific design.

There is limited land available for OHL routing in suburban areas surrounding Swords and south towards Belcamp, generally being restricted to narrow corridors of land between existing developments or in proximity to certain areas such as allotments and recreational areas where the Rise of Earth Potential (ROEP) could affect around human activity or congregation.

The interface with proposed development north of Belcamp will also need to be accounted for in the design to ensure any resulting hazards are understood.

4.2.3 Deliverability

An assessment of the two options has been made in relation to deliverability with reference to the following criteria:

- implementation timelines.
    - The study has considered whether there are any programme implications evident in the works, otherwise assumes that the project can be delivered against a foreseeable programme.
- project plan flexibility.
    - Both options require OHL design and construction in areas of existing commercial and industrial activity, therefore there will be the need to liaise with third parties throughout the project. This will impact on the project plan and programme, and therefore the flexibility available to EirGrid.
- dependence on other projects.
    - The study recognises that there are other projects planned by EirGrid that impact upon Woodland substation, such as CP966 Kildare Meath. Available details for these have been incorporated into the overall report, however dependencies have not been confirmed at this stage.
    - The report notes that, as outages are difficult to obtain on the transmission network due to system and project demands, outage availability in relation to this project's related construction will need to be understood in conjunction with any other project work planned by EirGrid.
- risk of untried construction technology.
    - The report has considered whether there are any specific engineering issues identified in the works on the basis that standard methodologies will be applied to the construction of towers and the installation of associated conductor systems. Any third-party protection measures, such as netted scaffolds, are assumed to be temporary arrangements similar to those used by EirGrid elsewhere on their system, notwithstanding that each site may require a bespoke design for which a presently undefined area of land will be required.
- supply chain constraints; permits & wayleaves.
    - The report has considered whether there are any elements of the work that could result in objections and that consequently could lead to a delay in obtaining agreements with grantors or permits from authorities.

- Regarding the supply chain for OHL materials and equipment, the report notes that these shall be in accordance with EirGrid functional specifications, therefore are noted to be subject to the usual fluctuations in natural resource availability, cost, and manufacture.

- water impact during construction.
  - The report notes the wetlands along the Broadmeadow River corridor could impact upon the access works in this area as more environmentally sensitive measures may be required to protect these areas.
- air quality impact during construction; and traffic & noise impact during construction.
  - The study assumes that local tracks will be used to access to new tower sites where possible and that additional access tracks may be required in certain areas to reduce the volume of construction traffic on local roads.

4.2.4 Option 1 - Woodland substation to Finglas substation

For the sub-study areas presented above in section 1.2.1:

There will be outage implications associated with work when the new 400kV circuit crosses existing circuits and possibly when in proximity. This will be to allow the safe construction of protection measures over a lower circuit such that the upper circuit can then be safely worked on without affecting operation of the lower circuit. As such these outage durations need to be accounted for in the construction phase programme but should also be recognised in relation to future maintenance of the OHL.

The OHL will need to cross a motorway at some point in the study area, where similar protection measures will be required to an OHL crossing i.e., protection of the traffic lanes to ensure safe working on the circuit. Access to motorways for this type of work can be constrained given the effect of a road closure on traffic while protections are installed, therefore night-time working for example may be necessary to minimise the impact. Long term planning is likely to be required for this type of activity or works planned in proximity to motorway operations.

The complexity of oversailing circuits at OHL infrastructure crossings may result in the need for specialist construction methods or untried technology, however this should only be by exception, but is made more likely by the impact or constraints of surrounding commercial or industrial activity around Finglas and Dublin Airport.

The study area review noted that there is a potential risk from the Rise of Earth Potential (ROEP) in areas of regular human activity or congregation and equine activity, resulting from a new OHL. If people or livestock are allowed to congregate at the base of a tower, then there is a risk of electrocution in the event of a system fault or lightning strike. Measures can be taken to mitigate this such as insulated steelwork, additional earthing or the risk can be eliminated by fencing to prevent access; however, the latter solution will require additional land.

The overall project will need to recognise the planning and consent risks associated with constructing a 400kV OHL in proximity to the various features and activity evident in the study are, such as dwellings, industrial and commercial activity, airport operations, recreation, and amenity. As all of these are present in the study area, with many concentrated around Finglas substation and Dublin Airport, objection to the proposed OHL can reasonably be expected.

4.2.5 Option 2 - Woodland substation to Belcamp substation.

As noted for the technical performance review, the OHL for option 2 could extend to the north of Swords and therefore, additional factors have been identified in relation to the deliverability of an OHL development further east and into Belcamp substation.

The programme will need to consider the timescales required for assessing the environmental impact of the OHL on the Broadmeadow Estuary, including surveys to determine any necessary remedial measures, many of which will have seasonal implications. This is also likely to impact upon the design and construction of an estuary crossing

span where the installation of conductor will be required across open water and could subsequently affect wildlife such as birds in flight. Measures can be taken to mitigate this such as the installation of bird flight diverters.

The study also notes that there is the potential for buoyant or piled foundations, particularly along the Broadmeadow River. Designs for such foundations are generally standard practice, however the construction often requires substantial items of plant, for example piling rigs, which can require extensive ground works to allow safe access and working areas on wet or boggy ground. This work will also need to account for the environmental sensitivity of access and construction on wetland.

4.2.6 Economic

A provisional table of quantities has been produced for each option such that an economic comparison can be made by EirGrid and is presented in Table 4.1. As each option has only been developed as a concept, the details of each for quantity are based on the stated assumptions.

In the absence of cost data for individual OHL elements this aspect of the study has been limited to estimated quantities of route length.

400kV Single Circuit RL2 Towers with Shieldwire (EirGrid specification LDS-EFS-00-001-R0) represents 400kV single circuit towers supporting 2 x 600 mm^2 ACSR conductor system and an earthwire.

Route lengths are estimated for comparison and are not based on any assessment of tower positions.

Table 4.1 Table of quantities

Option	Specification and cost reference	OHL length	Cost per km	Cost
Woodland - Finglas	RL2 (L400-2)	22km	€1,200,000	€26,400,000
Woodland - Belcamp	RL2 (L400-2)	34km	€1,200,000	€40,800,000

The longer-term implications of maintenance activities have not been accounted for in the above costs. There may be a cost implication associated with maintaining non-standard or site-specific arrangements.

4.3 Multi Criteria Assessment

The feasibility assessment for these options, in accordance with EirGrid criteria, is presented in Table 4.2.

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

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

Table 4.2 Criteria assessment

Assessment Criteria	A. Woodland to Finglas.	B. Woodland to Belcamp.
Technical Performance		

Economic Performance		
Deliverability		

Technically there are challenges in relation to constructing either option as an OHL. Both options will have to interface with Woodland substation and the OHLs already connected to that site, however there is open land to the north, south and east of Woodland that provides wide swathes for an OHL corridor to be developed and both options could use the same corridor from Woodland. A corridor to the north of the study area would probably be more economic for routing north of Swords to Belcamp as once the corridor reaches the area north of Finglas, the challenges become more complex.

There is extensive industrial and commercial activity north of Finglas (existing and planned) as well as infrastructure crossings and the airport that will have an impact on routing an OHL through this area. Construction of an OHL in the area around Finglas and north of Belcamp will need to be integrated with the various industrial, commercial and infrastructure operators in these areas, with the crossing of Broadmeadow estuary adding to this complexity in the connection to Belcamp. While each OHL route can expect objections from stakeholders during the planning stage, the environmental implications of constructing across the Broadmeadow estuary would appear to be especially challenging.

Dublin Airport presents a challenge to both options, as towards Finglas the flight path to the west will be impacted by the OHL and represent a hazard to airport operations, while towards Belcamp the flight path to the east likewise. There are limited areas available either north or south of the Airport for developing an OHL corridor, directly impacting upon commercial and recreational activity and the proximity of the north-west to south-east runway will significantly constrain the height of any OHL.

Economically, an OHL will be more favourable to construct than an underground cable. Routing through areas of industrial and commercial activity is likely to require a greater number of route turning points and therefore represents a less economically efficient design, while the cost of construction in these areas is likely to be affected by limited access, protection requirements and traffic management in these areas. Access will need to be agreed with grantors and land occupiers for support positions and any associated protection measures to ensure continued operation of third-party activity. In the more rural areas, the access considerations are more likely to be orientated around the implications of ground conditions and reinstatement post construction.

The length of an OHL to Belcamp will be greater than one into Finglas and therefore is more expensive, although sections of the route to Belcamp could be more efficient in design with longer sections between turning points.

EirGrid may wish to consider whether an OHL route from Woodland to Belcamp could be extended in the future towards Finglas should this be required. As the present requirement is for a single circuit connection, any future extension into Finglas could require a double circuit OHL to create Woodland – Finglas and Finglas – Belcamp circuits, unless the single circuit can be teed. Developing a double circuit OHL through the corridor into Finglas would be even more challenging than a single circuit as the increased height of a double circuit OHL would have a greater impact on airport operations.

5. Conclusions

Two options have been considered in relation to achieving a connection from Woodland substation.

- Option 1 requires a new section of 400kV single circuit OHL from Woodland substation to Finglas substation north-west of Dublin.
- Option 2 requires a new section of 400kV single circuit OHL from Woodland substation to Belcamp substation east of Dublin.

Various assumptions have been made in the study, each of which should be examined further to determine the relevance and impact upon the outcome. As no records of existing infrastructure assets have been provided for the study, the direct impact of a new 400kV OHL on these has only been assessed in general terms, for example, profiles at suggested crossing points are required to confirm the feasibility of constructing a new OHL across an existing OHL.

Use of standard tower designs is proposed for each option. Any subsequent design studies will need to consider corridor width in relation to the proposed conductor system both in still air and under blown conditions with appropriate safety clearances accounted for in both cases.

The study has estimated quantities of OHL route for each option to determine the outline cost. An OHL based option will generally cost less to construct than the cabled equivalent. Furthermore, experience indicates that the OHL options will subsequently cost less to maintain than the cable option. Also, locating and repairing faults is more easily undertaken on overhead lines as compared to cables.

An assessment of the options has been made using the EirGrid colour coding system which ranges from high risk (dark blue) to low risk (cream). The outcomes from this are noted as follows:

5.1 Technical Performance

Options 1 and 2 are technically similar (medium risk) however each has challenges.

- At Woodland substation the same technical challenges are present due the presence of existing OHLs into this site.
- While land use across west and north of the study area appears to be largely rural and agricultural, each option will introduce new sections of OHL into suburban areas around Dublin, and particularly in proximity to commercial, industrial, and recreational activity. Each of these may constrain the working clearance available for third-party activity and maintenance of the OHL, therefore design and construction of an OHL in these areas would need to be integrated with the various industrial, commercial and infrastructure operators. Clearances will need to be confirmed in accordance with EirGrid functional specifications as well as third-party guidance such as the regulations for airport operations which include exclusion zones at the end of each runway.
- Flight paths into Dublin Airport presents a challenge to both options while an OHL represent a hazard to airport operations. The route to Belcamp from the area north of Finglas is further constrained by the limited areas available either north or south of the Airport for developing an OHL corridor.
- The route to Belcamp around the north of Swords will require crossing of the Broadmeadow Estuary which will be environmentally sensitive and affect local amenity. Furthermore, should the crossing require a longer span or enhanced clearance, then taller site-specific support structure designs could be required.
- Areas of wetland in the north of the study area, along the Broadmeadow River, could impact upon the foundation requirements for structures in this area. The type of tower foundations required in the study area cannot be confirmed but could reasonably be estimated from records of existing OHL support foundations in the study area. Where substantial items of plant are required for construction, the extent of ground works to allow safe access and working areas will need to be confirmed as well as the environmental sensitivity of this activity.

- If people or livestock are allowed to congregate at the base of a proposed supports, then the risk resulting from the Rise of Earth Potential in the event of a system fault or lightning strike will need to be accounted for and measures taken to mitigate this.

5.2 Economic Performance

Option 1 is considered more favourable economically, however the following factors will need to be considered in due course.

- Option 1 is considered economically advantageous due to the reduced route length, however the route to Belcamp is likely to be a slightly more efficient design than the one to Finglas where more deviation positions will be required to account for existing activity and infrastructure as well as planned development.
- The cost of construction in developed areas is likely to be affected by limited access, protection requirements and traffic management in these areas.
- In the more rural areas, the cost of access is more likely to be orientated around the implications of ground conditions and reinstatement post construction.
- Landowner agreements are central to the installation of OHL infrastructure on third-party land and EirGrid has a compensation package available for the loss of land occupied by new assets, however EirGrid may need to consider whether compensations claims are a risk should the OHL occupy land that could be later be developed commercially, and the occupier claims loss of earnings or opportunity for development resulting from the presence of the OHL.

5.3 Deliverability

From the deliverability perspective the two options are considered similar, however each is considered high risk and will have to address certain challenges.

- Option 1 is considered slightly more advantageous because option 2 has the additional challenge of routing across the environmentally sensitive Broadmeadow Estuary.
- Protection measures will need to be accounted for at motorways and major road crossings as well as any circuit crossings, each of which could have future operational implications for the system operator during planned maintenance. Outage durations will need to be accounted for in the construction phase programme but should also be recognised in relation to future maintenance of the OHL.
- As outages are difficult to obtain on the transmission network due to system and project demands, outage availability in relation to this project's related construction will need to be understood in conjunction with any other project work planned by EirGrid.
- Access will need to be agreed with grantors and land occupiers for support positions and any associated protection measures to ensure continued operation of third-party activity.
- Both routes are likely to face public objection due the impact on third-party operations, proximity to commercial and recreational activity and particularly the operations of Dublin Airport. Objections can also be expected in relation to the environmental impact of crossing Broadmeadow Estuary in option 2.
- The study area contains a road network which should make delivery of construction materials and plant reasonably straightforward for each of the options, however greater amounts of temporary roads will probably be required to each construction site in rural areas. While traffic management measures will be required across the project, these could be particularly demanding in developed areas.
- The construction programme will need to consider the timescales required for assessing the environmental impact of each option, including surveys to determine any necessary remedial measures, many of which will have seasonal implications.