The Grid Link Project

Lead Consultant's Stage 1 Report

Prepared for EirGrid by RPS Group

SEPTEMBER 2013

RPS

EIRGRID

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

1 INTRODUCTION

Grid25[1] is EirGrid's strategy for major investment in the transmission grid in order to meet the long term needs of the country. The strategy involves upgrading the existing high voltage system through major reinforcements using the best technological solutions available and will involve an investment of approximately €3.2 billion over the period to 2025. EirGrid implements the strategy taking account of the continuing need to balance the reliability and security objective with the costs and environmental impact of developments in a sustainable way.

The Grid Link Project represents the single largest project in the Grid25 strategy. It is required to reinforce the transmission network in the south-east of Ireland and to address a number of key drivers for the transmission network in that region, namely the integration of new renewable and conventional generation, ensuring security of supply in the south-east in order to support demand growth in the region and facilitating possible future interconnection with either Great Britain or France. The investment for Grid Link will be in the order of €500 million and EirGrid intends to develop the project over the next 8-10 years.

1.1 PROJECT DESCRIPTION

Based on a robust network development planning process (further detailed in **Chapter 2**), the option considered to meet EirGrid's statutory obligations and to best meet the need for reinforcement in the south and east of Ireland is considered to be a 400kV high voltage alternating current overhead line (HVAC OHL) linking the three node points (or transmission substations) of Dunstown, Co. Kildare and Knockraha, Co. Cork via Great Island, Co. Wexford.

As part of the development of the OHL, additional infrastructure is required at the three transmission substations identified for the Grid Link Project in order to accommodate the grid connection. In the case of Great Island and Knockraha, new 400kV substations will be required which will be located at or in the vicinity to the existing substations.

See **Chapter 2** for information on the need and justification for the project and the different technology options.

[1] *Grid25. A Strategy for the Development of Ireland's Electricity Grid for a Sustainable and Competitive Future*. (www.eirgridprojects.com).

1.2 PURPOSE OF THIS REPORT

The Grid Link Project was officially launched in April 2012 with the publication of EirGrid's *Grid Link Project Study Area Paper.* Since then, the Grid Link project team has published a number of reports, including consultation documents, and various factsheets about the work that EirGrid undertakes and the challenges in developing transmission electricity infrastructure[2]. The purpose of this *Lead Consultant's Stage 1 Report* is to draw together the work completed as part of Stage 1 of EirGrid's Project Development Road Map (see **Section 1.5** for further details) for the Grid Link Project. It culminates in the identification of feasible 1km wide corridors and substation zones which will be taken forward for consultation and ultimately further assessment with a view to identifying a least constrained corridor and indicative line route therein and associated substation sites.

The report summarises the technical considerations which have led to the identification of the proposal for a 400kV OHL linking Dunstown to Knockraha via Great Island. It also considers other issues including the identification of a study area and constraints relevant to the proposal. A detailed explanation is provided on the process used to identify feasible corridors in **Chapter 8** and these corridors are presented in **Chapter 9**.

The report also records the project team's activities up to July 2013. It is intended that the information contained within the report will enable meaningful consultation between the project team and all interested parties including members of the public, statutory consultees and key stakeholders in relation to the proposed Grid Link Project. The Terms of Reference for the next public consultation phase are outlined in **Chapter 11**.

1.3 EIRGRID

EirGrid is a state-owned commercial company tasked with the provision of transmission and market services for the benefit of electricity consumers. EirGrid plc is a leading energy company committed to delivering high quality services in Ireland and Northern Ireland. The Group includes the EirGrid Transmission System Operator (TSO) business in Ireland; System Operator Northern Ireland (SONI), the licensed TSO in Northern Ireland; the Single Electricity Market Operator (SEMO) which operates the Single Electricity Market on the island of Ireland; EirGrid Interconnector Limited, the East West Interconnector developer and EirGrid Telecoms Limited.

[2] These reports are publically available at www.eirgridprojects.com.

In its role of TSO in Ireland, EirGrid operates and ensures the maintenance of a safe, secure, reliable, economical and efficient transmission system, as well as developing key infrastructural projects which are vital for the socio-economic development of the State. As TSO, EirGrid is regulated by the Commission for Energy Regulation (CER).

See **Chapter 2** for further details of EirGrid's statutory obligations.

1.4 GRID25

Grid25 outlines a strategy for major investment in the transmission grid in order to meet the long term needs of the country and is consistent with the Government's target of 40% of electricity consumption from renewable sources by 2020. The implementation of the Grid25 strategy is essential to:

- Supporting growth in the regions and ensuring continued reliability and security of supply;
- Providing a high quality, high voltage power supply that will enable the different regions to attract new industry and boost existing industry;
- Maximising Ireland's natural renewable sources of energy (e.g. wind, wave and tidal); and
- Reducing Ireland's carbon emissions by transmitting renewable energy. A key driver is the need to provide access for renewable generation up to the levels required to meet Ireland's renewable target of 40%.

The strategy also highlights the need for extensive upgrading of the transmission grid over the next 10–15 years to meet long-term demands of the transmission network.

The Grid25 Implementation Programme (IP) 2011-2016 sets out a practical overview of the early stages of the Grid25 strategy for major investment in the transmission grid in order to meet the long term needs of the country. This IP underwent Strategic Environmental Assessment (SEA) in order to anticipate and avoid adverse impacts and to provide a clear understanding of the likely environmental consequences of decisions arising from the Grid25 IP.

1.5 EIRGRID'S PROJECT DEVELOPMENT AND CONSULTATION ROADMAP

EirGrid's approach to the planning and development of high voltage overhead power line projects follows a structured framework of project development that provides a clear and transparent process to all stakeholders. EirGrid's Project Development and Consultation Roadmap is composed of five stages as presented in **Figure 1.1**. The Grid Link Project is currently at Stage 1. Further details can be found in the EirGrid publication: *Approach to Development of Electricity Transmission Lines* (www.eirgridprojects.com).

Figure 1.1: EirGrid's Project Development and Consultation Roadmap

Stage 1 Information Gathering

A draft study area was developed in March 2012 and went out to public consultation from April to June 2012. Taking into account the submissions made during the consultation period, the final study area was confirmed and constraints (physical, environmental, topographical and other relevant constraints e.g. requirements of the Habitat and Birds Directives) were then identified and mapped. The outputs of this constraints gathering and mapping went out to consultation from August to October 2012. The constraints mapping together with professional judgement has now been applied to identify feasible 1km wide corridors in which the proposed line could be accommodated while avoiding significant strategic constraints to the greatest extent possible. A key output of this stage is the publication of this Stage 1 Report for public consultation and feedback.

Stage 2 Evaluate Options

This stage includes consideration of all feedback from Stage 1. Feasible 1km corridor options and Substation Zones will be evaluated against each other based on *inter alia* technical, environmental, (including social) and cost criteria before identification of a least constrained corridor / site(s) and subsequently an indicative line within this corridor. In Stage 2 the initial process of landowner identification and engagement, and on-site survey will also commence. At the end of this stage, a Stage 2 Report will be published for public consultation and feedback.

Stage 3 Confirm Design

Stage 3 includes the statutory assessment of the preliminary design for the Grid Link Project. Specialists in a range of areas including ecology, landscape, electromagnetic field (EMF) and noise will undertake desk and field based assessments of proposals in line with current best practice and with reference to national and EU guidance on Environmental Impact Assessment (EIA). Field surveys will continue to be undertaken to assist in confirming the final alignment and landowner discussions will be on-going throughout this stage.

Stage 4 Prepare Planning Application

A planning application (including Environmental Impact Statement (EIS) will be prepared for submission to An Bord Pleanála (ABP) for determination during Stage 4. An Oral Hearing may be held (at the discretion of ABP) during this stage.

Stage 5 Wayleave and Construction

During Stage 5, construction plans will be prepared; landowners will receive wayleave notices and will be contacted to discuss construction and access.

2 TECHNICAL FOUNDATION ANALYSIS

The purpose of this chapter is to explain the rigorous process carried out by EirGrid to determine the preferred technical solution to reinforce the transmission network in the south-east of Ireland and the preferred technology for that solution. This process determined the scope and requirements for the Grid Link Project. The chapter will set out EirGrid's statutory obligations, the need and justification for the Grid Link Project and describe the different stages of the feasibility process including developing and evaluating alternative solution options.

2.1 EIRGRID'S STATUTORY AND REGULATORY FUNCTION

As set out in **Section 1.3**, EirGrid holds the licence of Transmission System Operator (TSO) in Ireland and is given certain exclusive functions through the European Communities (Internal Market in Electricity) Regulations 2000 (SI445/2000). Under this statutory function EirGrid is obliged to operate and ensure the maintenance of and, if necessary, develop a safe, secure, reliable, economical and efficient electricity transmission system having due regard for the environment.

In addition, EirGrid has a statutory obligation to offer terms and enter into agreements for connection to and use of the transmission system with all those using and seeking to use the transmission system. As part of these statutory obligations EirGrid should also explore and develop opportunities for interconnection with other systems.

EirGrid carries out its development functions in accordance with the Transmission Planning Criteria[3] (TPC) which comprise a set of technical tests and minimum standards with which the transmission system should comply. These tests and standards are in line with international best practice as defined by ENTSO-E[4].

It is in this context that EirGrid has identified a need to strengthen and reinforce the transmission system in the south-east of Ireland and is now developing what is known as the Grid Link Project.

---

[3] Available at www.eirgrid.com

[4] European Network of Transmission System Operators for Electricity (ENTSO-E)

2.2 NEED FOR THE GRID LINK PROJECT

With regard to EirGrid's statutory obligation there are three key drivers that highlight the need for further development of the electricity transmission network in the south and south-east of Ireland, namely:

1. **The integration of new generation:** significant levels of new renewable generation are to be connected to the transmission and distribution networks in the south of Ireland. This renewable generation on its own and/or together with existing conventional generation connected to the transmission network in the south of Ireland gives rise to network constraints within the single electricity market on the island of Ireland, driving the need to reinforce the transmission network.

2. **Ensuring that security of supply is maintained:** reinforcement of the transmission network is necessary in order to ensure that demand in the south-east can be securely supplied at all times, regardless of where the power is generated.

3. **The facilitation of possible future interconnections with either Great Britain or France[5]:** EirGrid has a statutory obligation to explore and develop opportunities for interconnection of its system with other systems. Given the development potential of a significant renewable energy export industry on the island and proximity of the south and east of Ireland to Great Britain and France, regional reinforcements such as the Grid Link Project must take into account requirements to ensure compliance with this statutory obligation.

In 2010 / 2011 EirGrid examined the potential impact of the above drivers on the technical performance of the transmission system. The network analysis indicated that these drivers introduce generation patterns that give rise to large regional electricity flows from the south of Ireland towards the Dublin area as illustrated in **Figure 2.1.**

[5] EirGrid is currently investigating the feasibility of a potential future Ireland-France Interconnector, and at this point in time, an initial feasibility study of the onshore element in Ireland is commencing. The Grid Link team is not considering any potential Ireland-France Interconnector in this Stage One Report. If the Ireland-France Interconnector becomes a feasible project, the Grid Link team will consider it, as appropriate in any future plans.

Figure 2.1: Map Showing the Electricity Power Flow from the South of Ireland towards the Dublin Area in a Future Planned Network

Such electricity flows would give rise to problems which need to be addressed. The problems can be categorised as insufficient network capacity and insufficient voltage support and extend to the entire south, south east and south midlands of Ireland as indicated in **Figure 2.2**.

Figure 2.2: Illustration of the Extent of the Network Capacity Problems and the Voltage Support Requirements in a Future Planned Network

The drivers that mostly influence network capacity are the integration of generation and future interconnection along the south-east coast of Ireland with either Great Britain or France. With regard to generation, there is approximately 1,600MW[6] of renewable generation expected to connect to the electricity network in the south of the country as part of the Gate 3 process. Together with existing renewable and conventional generation in the south of Ireland this will put the capacity of the existing network under pressure and create constraints. Similarly, future interconnection along the south-east coast in combination with the above mentioned existing and additional generation will also give rise to network capacity problems.

Constraints on the transmission network primarily result from the situation where, if any of the existing 220kV circuits between Cork, the south-east and Dublin are put out of service, the power that was flowing on the circuit prior to the outage transfers to the underlying parallel 110kV network. This would result in thermal overloads primarily on the existing 110kV circuits. Even with the assumed completion of uprates of existing circuits (thereby maximising the potential of the existing network), the transmission network would not have sufficient capacity to cater for the power flow identified above. The loss of existing 220kV circuits and/or existing 110kV circuits would also result in unacceptably low voltages and potentially widespread voltage collapse in the south-east resulting from large inter-

[6] As of July 2013.

regional flows introduced by the drivers. This problem is severe and widespread which indicates that additional circuits would be required to resolve the issue.

Therefore, because of the planned connections of large amounts of renewable generation, the need to ensure that demand in the south-east is securely supplied and the potential for a new interconnector connecting to the grid in the south-east, there is a need to reinforce the transmission network between Cork, the south-east and Dublin with additional high capacity circuits.

In addition, a separate voltage support issue was identified in the south midlands area as highlighted in **Figure 2.3**.

Figure 2.3: Area of Concern for the Second Voltage Problem

This part of the transmission network is supplied by four long 110kV circuits. A sudden unplanned loss of any of the 110kV circuits supplying the area or during a planned maintenance of any of the circuits followed by a subsequent loss of any one of the remaining circuits would cause low voltages and could potentially cause a voltage collapse in the area, which would result in a total loss of supply. This is a local network problem, which is demand related. This part of the transmission network would therefore need to be reinforced.

The solution options were developed to meet both the local and the inter-regional needs identified in the south-east part of the country.

2.3 DEVELOPMENT OF SOLUTION OPTIONS

Once EirGrid identified the need for additional high capacity circuits between Cork, the south-east and Dublin, possible solution options were developed. This involved a rigorous process which covered a number of steps. **Figure 2.4** provides an overview of the process with the different steps highlighted and a high level description of what the steps entailed.

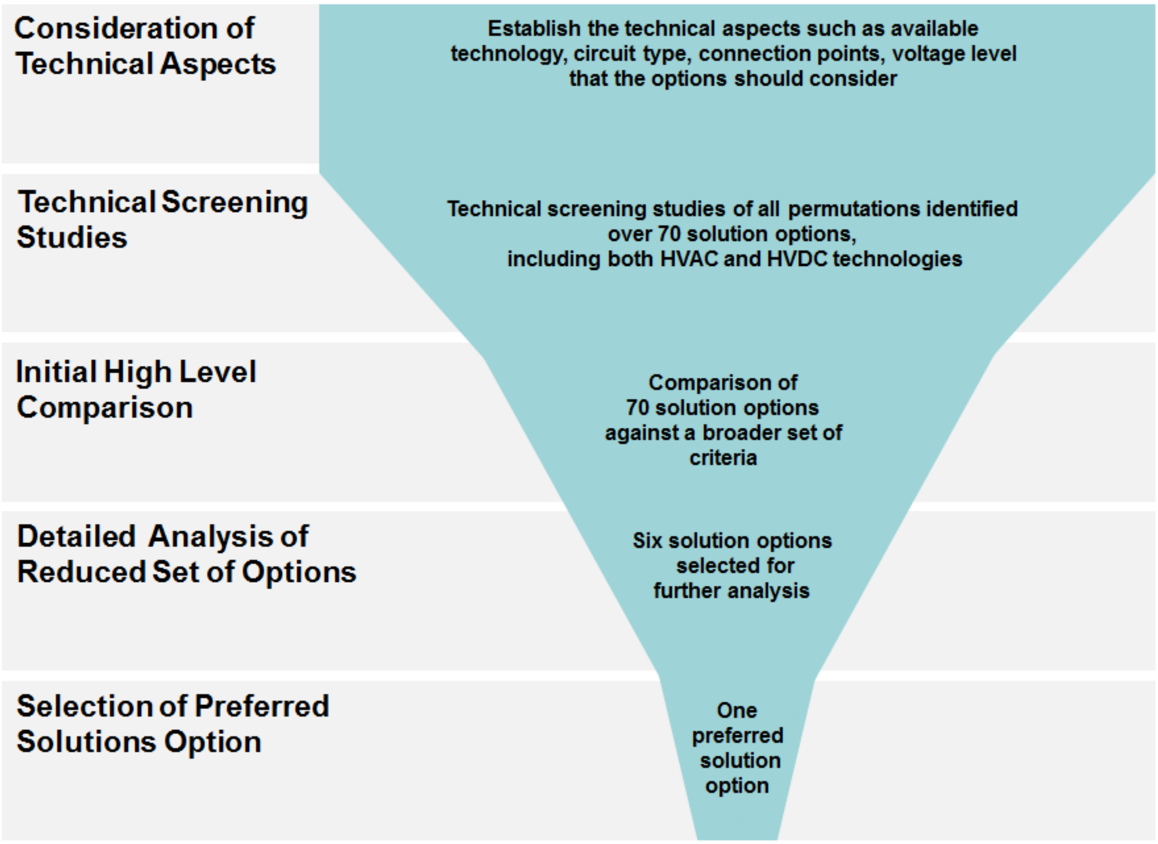


Figure 2.4: Illustration of the Process for Determining the Preferred Solution Option

The steps involved consideration of technical aspects, technical screening analysis of the identified solution options to determine if they meet the TPC, a high level comparison of the technically acceptable solutions, detailed technical analysis on a reduced set of technically acceptable solution options and a multi criteria analysis to arrive at the preferred solution option. The following sections describe these steps in more detail.

2.3.1 Technical Aspects Considered when Developing Solution Options

Before developing possible solution options there are a number of technical aspects which need to be discussed and decided upon. The technical aspects relate to identifying the appropriate candidate technologies, the appropriate technical specifications (e.g. voltage level), and the possible transmission network connection points which would be suitable to address the identified need in the south-east of Ireland.

2.3.1.1 Technology Used

For the purpose of identifying possible solution options at the early stages of project development, the type of technology needs to be addressed. Technology decisions relate primarily to two aspects at the early stage of studies:

- The method of power transmission; and
- Circuit type.

Chapter 6 of this report provides more detailed information on the different technologies, which supported the decisions and which are summarised here.

The method of power transmission: There are two technologies which initially could be considered when defining a reinforcement option in the study area, namely: HVAC (High Voltage Alternating Current); and HVDC (High Voltage Direct Current) technology. In the case of HVDC, there is a further decision regarding the optimum HVDC technology to use (i.e. the emerging preferred voltage-source converter, VSC, or the well established line-commutated converter, LCC).

The existing meshed network on the island of Ireland is exclusively made up of a HVAC network; any option that would consider HVAC would therefore be an extension of the existing technology. This technology was therefore considered as a viable technology to be used for development of solution options.

HVDC technology is mostly used where long distances are involved and where there is a need for the bulk transfer of power from one point to another. This type of technology is not easily accommodated into a meshed HVAC transmission network due to the differences in technologies and the complexity of the control systems that are required, but it is considered technically feasible to do. Given that one of the objectives of the south-east area study is to address the bulk power transfer between two points (i.e. Cork and Dublin) and that HVDC is suited to bulk power transfer, HVDC was therefore considered as a viable technology alternative to potential HVAC solutions. Therefore, solution options using this technology were developed.

Circuit type: There are two main technology choices for building a new circuit, whether HVAC or HVDC; namely overhead line (OHL) and underground cable (UGC).

OHL is the predominant technological choice in Ireland and across Europe because of its superior reliability and its greater cost efficiency. The average time taken to repair a fault on an OHL is far less than on an UGC, resulting in lower forced outage rates compared with cables. OHL was therefore considered a viable choice in developing the solution options.

UGCs conversely are more expensive and less reliable than OHLs and are generally considered only where OHLs are unsuitable for use, such as for crossing a large expanse of water, in areas with a congestion of OHLs, in areas of outstanding natural beauty or in urban and city environments.

As the connection points or potential routes were unknown at this early stage of developing and identifying solution options for the Grid Link Project, it was assumed that an OHL route could be achieved. Therefore, for the reasons given above, the solution options are based on preferred OHL technology.

However, it is recognised that UGCs may have to be considered to mitigate against identified environmental constraints for this project and that this would be thoroughly investigated during the project development process.

Offshore options using both HVAC and HVDC technology were also technically assessed during the initial technical screening studies undertaken by EirGrid.

2.3.1.2 Voltage Level

For each technology option, there is an appropriate voltage level that will apply. These would differ depending on the method of power transmission chosen. In the approach to developing possible solution options for the additional high capacity circuits between Cork, the south-east and Dublin the following was considered for each technology option:

- **High Voltage Alternating Current (HVAC):** The transmission system in Ireland is operated at three different voltage levels: 400kV, 220kV and 110kV. The HVAC voltage levels considered for the solution options were 220kV and 400kV. The 110kV voltage level was not considered appropriate for a regional development based on the level of power flows observed in the need analysis, but was considered for local reinforcements where it was possible to separate between local requirements and regional issues.

- **High Voltage Direct Current (HVDC):** To provide the appropriate level of capacity that is required for the regional development, a 320kV bipole VSC was considered.

2.3.1.3 Transmission Connection Points

When the transmission network is planned to be expanded the natural point to start from is existing or planned substations. A large number of potential 400kV, 220kV and 110kV connection points were considered in the development of the solution options. **Figure 2.5** shows a map with the possible connection points indicated by the red squares.

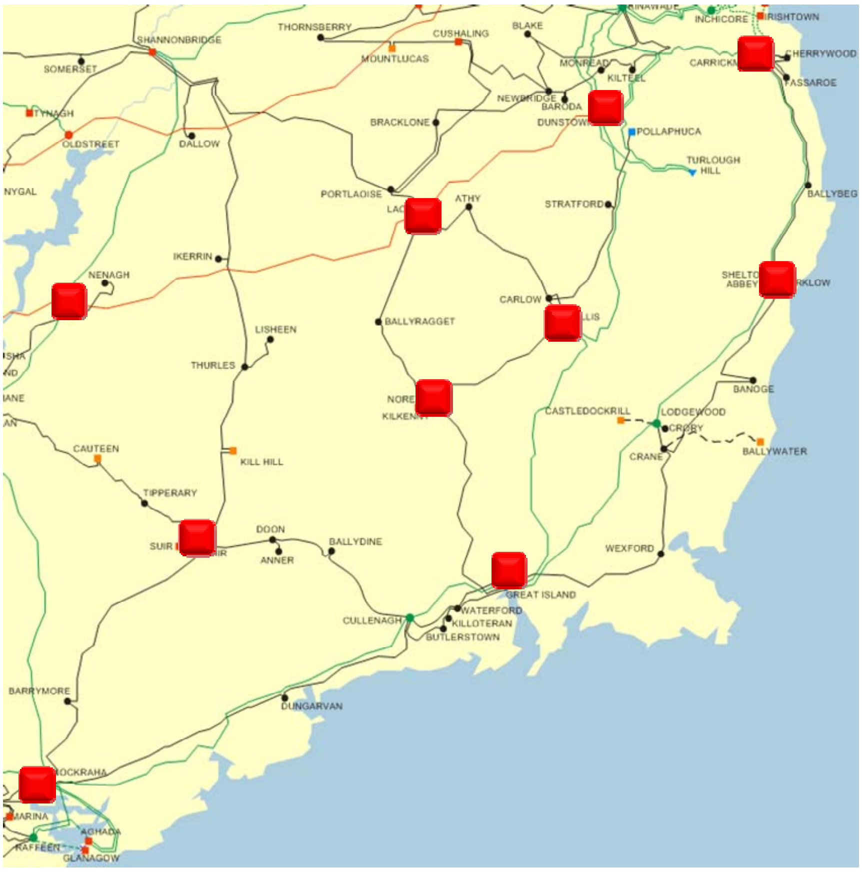


Figure 2.5: Possible Connection Points in Study Area Indicated with Red Squares

To provide some understanding of the benefits and disadvantages that the connection points present, a short description of some of the connection points is given.

- In Co. Cork, Knockraha substation emerged as the preferred connection point as it is very well integrated in the existing transmission system with the majority of 220kV circuits and a total of six 110kV circuits connected into this substation. The node is therefore able to efficiently receive and transmit large amounts of power, which is one of the requirements of the Grid Link Project. This substation is also a point of common coupling between the large amounts of wind generation in the south-west and the thermal generation in the Cork City region thus allowing optimum access to the new reinforcement scheme and ensuring the ability to feed this region in low generation periods via the new reinforcement. No other connection point in

Co. Cork would provide these benefits without introducing additional transmission reinforcements in Co. Cork.

- In the Dublin area, the existing Dunstown 400kV substation in Co. Kildare was considered as the most logical connection point as it is an existing 400kV substation and would provide a strong connection to the 220kV network in Dublin. The connection point is very well integrated in the existing transmission system and this provides the ability to receive and transmit large amounts of power, which is one of the requirements of the Grid Link Project.

- In the area of Cahir, Co Tipperary, the need assessment identified a requirement to support the transmission network. To address this all solution options had to consider some form of reinforcement in this area.

- In the south-east the existing Great Island 220kV substation in Co Wexford is very well integrated in the existing transmission system with 220kV circuits and 110kV circuits connecting to this substation. This substation also has generation connected. The connection point is able to efficiently receive and transmit large amounts of power, which is one of the requirements of the Grid Link Project.

2.3.2 Technical Screening Studies

The development of the solution options resulted from analysing a vast number of technical simulations; these examined the performance of various combinations of new circuits and / or uprated circuits between all the possible connection points in the study area (as highlighted in **Section 2.3.1**). **Figure 2.6** provides an overview of the possible combinations of new high capacity (220kV or 400kV) circuits connecting existing or possible future nodes which were tested as part of the process to develop solution options. The technical screening simulations resulted in over 70 reinforcement options being identified, including both HVAC and HVDC solutions. All solution options mitigated the identified transmission system need in the south-east and were designed to comply with the TPC. In some areas additional 110kV reinforcements were also examined in an attempt to resolve localised issues.

Figure 2.6: Overview of Possible Combinations of New Circuits Examined

When analysing the results from the technical screening simulations it became apparent that some connection points performed better than others in terms of solving the identified need. For instance, some solution options considered connecting into the existing 400kV network at the future Laois 400 / 110kV substation. However, the analysis identified that connecting into this substation would involve further reinforcement of the 400kV network between this station and the existing Dunstown 400kV substation and in comparison with the other identified 70 solution options, more effective solutions were identified.

It should also be noted that the technical screening studies took account of the principle of the Grid25 strategy which is to make the best use of the existing network. Where appropriate the identified solution options considered the uprating of existing circuits by using higher capacity conductors or operating existing circuits at a higher voltage. It is also important to understand that despite this principle, additional circuits would still be required.

2.3.3 Initial High Level Comparison of Solution Options

The 70 solution options identified in the technical screening studies were taken through an initial high level comparison with the aim to reduce the number of possible solution options that would be brought forward for more detailed technical analysis.

The initial high level comparison used a number of criteria to compare the solution options against each other. The criteria, which have regard to EirGrid's statutory requirements, were:

- **Cost effectiveness:** the capital and operational costs, derived from standard costs;

- **Efficiency:** the fault level was used as an indicator of the option's relative dynamic performance. The available capacity (i.e. headroom) was used to indicate the longevity of the option;

- **Reliability:** contingency performance; and

- **Regard for the environment:** the number of new substations, extensions of existing substations and the indicative length of new circuits were used to indicate the relative impact on the environment.

The initial high level comparison resulted in six (6) solution options being identified that were then brought forward for more detailed technical analysis.

2.3.4 Options Brought Forward for Detailed Technical Analysis

After identification and evaluation of a large number of possible reinforcement solution options six were identified as best meeting the identified needs. These are listed below and illustrated in **Figure 2.7**.

- **Option 1:** Cahir-Knockraha 400kV; Cahir-Kellis 400kV; Dunstown-Kellis 400kV; and Kellis-Great Island 400kV circuits;

- **Option 2:** Cahir-Knockraha 220kV; Cahir-Kellis 220kV; Dunstown-Kellis 220kV; Kellis-Great Island 220kV and Knockraha-Great Island 220kV circuits;

- **Option 3:** Cahir-Kilkenny 110kV; Great Island-Knockraha 400kV; Dunstown-Great Island 400kV circuits, and uprate of the Cahir-Barrymore'T' 110kV line;

- **Option 4:** Cahir-Kilkenny 110kV; Great Island-Knockraha 220kV; Dunstown-Great Island 220kV circuits, and uprate of the Cahir-Barrymore'T' 110kV line;

- **Option 5:** Knockraha-Dunstown 320kV HVDC link (bipole, metallic return); and Cahir-Kellis 110kV circuit; and

- **Option 6:** Cahir-Kilkenny 110kV; Cullenagh-Great Island 220kV circuit. Construction of the Great Island-Knockraha 400kV and Dunstown-Great Island 400kV circuits at a later stage.

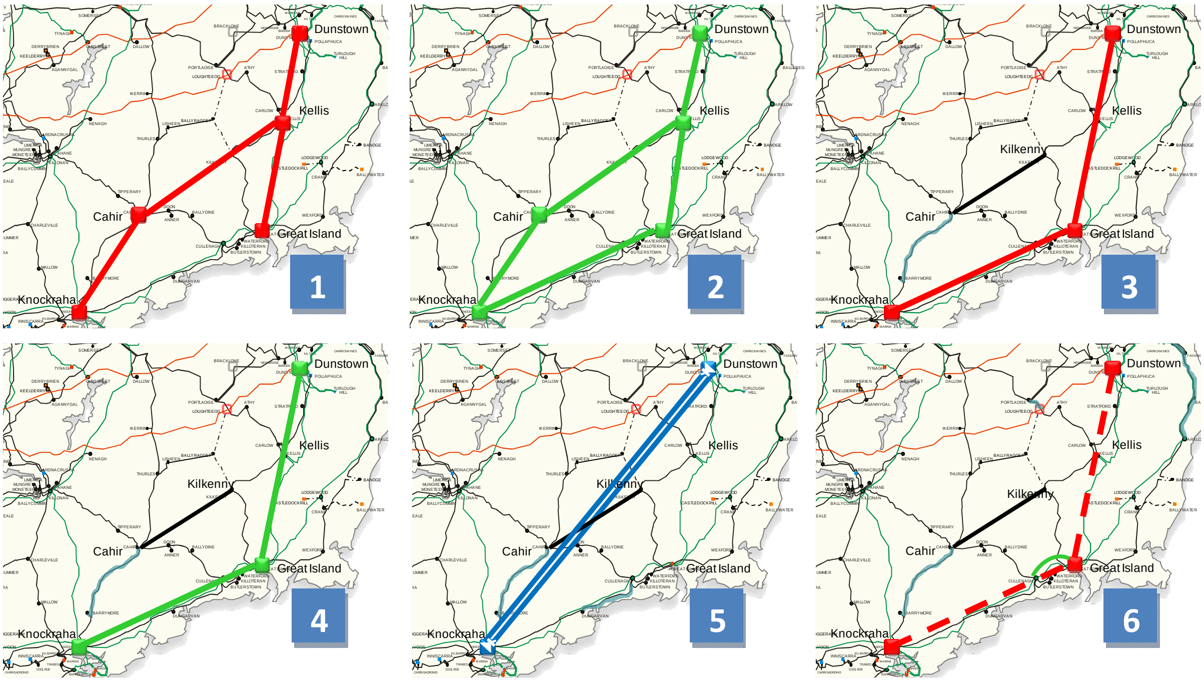


Figure 2.7: Illustration of the Six Best Solution Options that were Brought Forward for Detailed Analysis

2.4 EVALUATION OF SOLUTION OPTIONS COMPARISON

The six solution options were compared and evaluated against the following criteria:

- **Technical performance**: Should solve the technical issues (circuit overloads and voltage stability issues) that were seen in the needs assessment of the south-east and south midlands;
- **Future extensibility:** Should maximise the future extendibility of the transmission network;
- **Economic performance:** The net present value of the investment should be maximised; and
- **Strategic alignment**: The option should be in line with EirGrid's development strategy, Grid25.

The below sections discuss the different criteria and outline the different options' performance for that specific criteria.

2.4.1 Technical Performance

The relative technical performance of the individual options was based on an assessment of each option's ability to support the identified need for the south-east as set out in **Section 2.2**. The results from a load flow analysis indicated that all six solution options are technically viable in solving the network issues identified in the south-east region, while accommodating all of Gate 3 generation and potential new interconnections. However, despite the fact that the options resolve the needs identified, when the options' technical performance are compared relative to each other, some perform better than others.

The performance for each option was differentiated on the basis of quality of supply, reliability, dynamic performance, and efficiency.

The results indicated that options 1, 2, 3 and 6 exhibited comparable technical performance, while options 4 and 5 exhibited lesser levels of performance when compared to the performance of the other options, i.e. poorer voltage support in the region which may necessitate additional reactive support; larger re-dispatch of generation to mitigate trip-maintenance overloads; and a higher level of loading on the network leading to an increase in losses compared to the other options. With regard to Option 5, the option would represent one of the first applications of a HVDC network in parallel with a meshed HVAC transmission system and would therefore be a technically riskier option to pursue. The complexity of the control systems necessary to operate a HVDC circuit in parallel with an AC network would be a source of further technical risk.

2.4.2 Economic Performance

The cost of implementing a reinforcement into the transmission system is an important factor in the process of selecting a preferred solution option, and minimising the overall cost of developing the grid is recognised in EirGrid's statutory obligations. The six solution options were subjected to an economic appraisal using a discounted cash flow model in which the following components were considered:

- **Initial capital costs of the reinforcement:** the capital costs considered both the project development costs and the equipment and construction costs. For circuits, the project development costs were consistent with those submitted to and approved by Commission for Energy Regulation (CER) as part of Price Review 3 (PR3) while the equipment and construction costs were based on a set of revised standard costs from the Transmission Asset Owner (ESB Networks) received as part of the PR3 process. The transmission station costs were derived from the latest project agreements for materials with ESB Networks, relevant feasibility studies and PR3 for site acquisition costs. The costs associated with HVDC were provided by a reputable manufacturer.

- **Operational maintenance cost:** an annualised maintenance cost, applied over the lifetime of the assets, was derived for each solution option based on the 2011 transmission maintenance unit costs provided by ESB Networks.

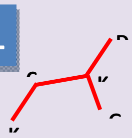
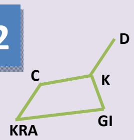
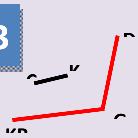
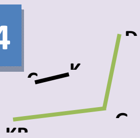
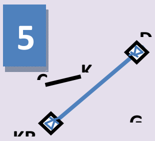
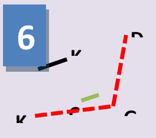
- **Production cost savings:** the production costs are determined by detailed technical simulations that seek to ensure the most economic dispatch of generation, and take a wide range of factors into account. These factors include, inter alia, fuel costs, generator availability, generation reliability, and the cost of curtailment. Comparing the production cost assuming the reinforcement is in place with the production cost in the absence of the reinforcement allows the change in production cost as a result of the reinforcement to be quantified.

The Net Present Value (NPV) was calculated for each of the six options to determine the relative economic merits of the six solution options. A Weighted Average Cost of Capital (WACC) rate of 5.95% was used in the NPV calculation which is the rate advised by the CER. **Table 2.1** displays the relative economic performance for each component (i.e. capital cost, constraint savings and maintenance cost) as well as the NPV for each solution option.

The results indicate that the economic performance of options 3, 4 and 6 are comparable. Option 5 has the worst economic performance of the options considered.

Sensitivity analyses were carried out on all options to validate the robustness of the result from the NPV calculation. The sensitivity study considered the impact of varying the input parameters (i.e. the WACC, growth in constraint savings, and capital cost) on the project NPV. The outcome of this sensitivity study did not give any reason to change the ranking of the options from an economic perspective.

Table 2.1: Relative Economic Performance of Each Option Considered

Present Value (€'m)	1 	2 	3 	4 	5 	6 
Capital Cost	Poor	Moderate	Moderate	Good	Poor	Moderate
Constraints Savings	Good	Good	Good	Moderate	Moderate	Poor
Maintenance Cost	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Net Present Value	Moderate	Moderate	Good	Good	Poor	Good

LEGEND:	Good performance	Moderate Performance	Poor Performance

2.4.3 Strategic Alignment and Future Extendibility

EirGrid's Grid Development Strategy, Grid25, published in October 2008 outlines how EirGrid will deliver an efficient transmission network for Ireland's social and economic development. In the context of optimising the capacity and efficiency of power corridors, building at 400kV rather than 220kV would be considered to be more efficient and provide greater power carrying capability. On this basis, the preference would be that new transmission lines be built at 400kV.

The above possibility was recognised when the preferred solution option was selected and out of the six options this is best achieved by a 400kV development.

2.4.4 Comparison of Solution Options

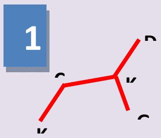
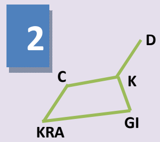
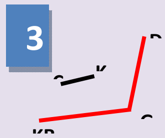
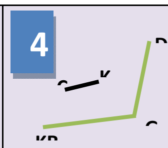
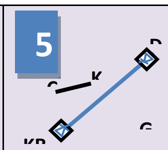
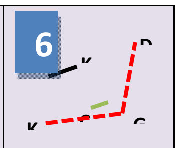
The overall performance of the six reinforcement options was evaluated using multi-criteria analysis. The selection criteria that were used to evaluate and rank the solution options were:

- Meet technical requirements;
- Maximise future extendibility;
- Maximise economic benefit; and

- Grid25 strategic alignment.

Table 2.2 provides a summary comparison of the six solution options against the above mentioned criteria. Darker shade of colour indicates that the option performs better against the criterion, whereas lighter shading indicates poorer performance.

Table 2.2: Comparison of Solution Options Against Selection Criteria

Criteria						
Meets technical need						
Maximise future extendibility						
Maximise economic benefit						
Grid25 strategic alignment						

LEGEND:	Good performance	Moderate Performance	Poor Performance

The result of the multi-criteria analysis indicates that the reinforcement option that best satisfies the identified evaluation criteria is Option 3, i.e. Cahir-Kilkenny 110kV; Great Island-Knockraha 400kV; Dunstown-Great Island 400kV circuits, and uprate of the Cahir-Barrymore'T' 110kV line. Thereafter, Options 1 and 6 are the next best solution options.

2.5 PREFERRED SOLUTION AND JUSTIFICATION

Based on the balance of a number of considerations which include technical performance, extendibility, economic value and strategic alignment, and with the information available at the time, Option 3 represented the preferred solution to address the identified need to reinforce the transmission system in the south-east of Ireland.

This option involves the construction of two 400kV circuits, namely:

- A 400kV single circuit between a new Knockraha 400kV Substation and a new Great Island 400kV Substation; and

- A 400kV single circuit between the new Great Island 400kV Substation and the existing Dunstown 400kV Substation.

This solution option also includes the need for the construction of a Cahir-Kilkenny 110kV line at some time beyond 2025 and will be subject to a separate future application for approval when the need presents itself.

Selection of the preferred solution option provided the terms of reference for the Grid Link Project to proceed into the project development process which includes preliminary design, environmental impact assessment and preparation of planning application.

3 STRATEGIC PLANNING CONTEXT

3.1 LEGISLATIVE CONTEXT

The Planning and Development (Strategic Infrastructure) Act 2006 (SIA) introduced a streamlined planning approval regime for major infrastructure projects, including electricity transmission infrastructure. Section 4 of the SIA amends Part XI of the Planning and Development Act, 2000 (PDA) by inserting new sections (sections 182A – 182E inclusive) which outline the planning approval procedures for the 'Provision of Strategic Electricity Transmission and Gas Infrastructure'.

Under Section 182A of the PDA where a person intends to carry out a "*development comprising or for the purposes of electricity transmission"* an application for approval, with appropriate documentation e.g. an Environmental Impact Statement (EIS), shall be submitted to An Bord Pleanála (ABP). Section 182A(9) explains the meaning of 'transmission' in this context:

> *"'transmission' in relation to electricity, shall be construed in accordance with section 2(1) of the Electricity Regulation Act 1999 but, for the purposes of this section, the foregoing expression, in relation to electricity, shall also be construed as meaning the transport of electricity by means of – (a) a high voltage line where the voltage would be 110 kilovolts or more, or (b) an interconnector, whether ownership of the interconnector will be vested in the undertaker or not".*

The Grid Link Project falls within the scope of Section 182A of the PDA as amended being as it is, primarily for the purposes of the transmission of electricity by means of a 400kV circuit. Accordingly, it is considered at this stage of project development that an application for approval will be submitted directly to ABP. However, this must be confirmed formally by ABP, following formal pre-application consultation in respect of the proposed development.

3.2 POLICY CONTEXT

The application for statutory approval for the Grid Link Project will be considered by ABP in the context of European, national, regional and local planning policy. This chapter focuses on how the principle of the Grid Link Project sits within this policy context.

3.3 NATIONAL POLICY CONTEXT

The strategic context for energy infrastructure in Ireland is set out in a number of national development plans and policy documents. These perform an important function in establishing energy policy and initiatives and in guiding the physical implementation of infrastructure. Those of particular relevance to the Grid Link Project are outlined in the following sections.

3.3.1 National Spatial Strategy for Ireland 2002-2020

The National Spatial Strategy (NSS) 2002-2020 is a 20 year strategic vision for the spatial planning and development of the country. It outlines how a strengthened network of cities, towns and rural communities and their resources will be mobilised and complemented by social and physical infrastructure, to create balanced national development. This was to be facilitated by designation of gateways and hubs through which employment and investment could be directed.

The issue of 'enhanced accessibility' in the NSS is of particular relevance to the Grid Link Project. In this regard, according to the strategy 'enhanced accessibility' can be achieved *"for urban and rural areas, through an interconnected mesh of efficient and integrated road or rail transport systems, energy and communications grids – all designed to converge at nationally strategic locations".*

The NSS also identifies that *"a feature of the most mature and successful economies is that they possess highly developed, well integrated infrastructure that supports movement, i.e. public and private transport, and energy and communications networks."*

The effectiveness of the NSS strategy is currently being debated, and other models to address balanced regional development are being explored putting the long-term fate of the strategy into question. However, whatever the model chosen, there remains a need for a high quality energy supply in order to achieve a wider and stronger economic base, greater economic competitiveness and associated social progress at a regional level.

3.3.2 The Government White Paper – the Energy Policy Framework 2007-2020: Delivering a Sustainable Energy Future for Ireland 2007[7]

This policy framework sets out current Government Energy Policy, taking full account of global and EU developments. The policy seeks to ensure security of energy supply, promote the sustainability of energy supply and use, and enhance competitiveness in energy supply. Ireland's opportunities in the

[7] The Government is currently in the process of drafting its new White Paper on Energy with an anticipated publication date later this year (2013).

areas of renewables (and bio-energy) are noted and the potential role in job creation is specifically acknowledged. Challenges identified include our small energy market, peripherality and limited indigenous fuel resources.

Strategic Goal 3 (to 'Ensure Security of Energy Supply'), commits to delivering significant growth in renewable energy as a contribution to fuel diversity in power generation with a target of 33%[8] of electricity consumption to come from renewable resources by 2020. Wind energy will provide the pivotal contribution to achieving this target.

Section 3.1 of the policy framework states the need for quality energy infrastructure of sufficient capacity. It states that we *"need robust … electricity networks and electricity generating capacity to ensure consistent supply".*

Section 3.5.2 sets out the commitment to investing in electricity transmission infrastructure: "*We will ensure through EirGrid's Grid Development Strategy 2007–2025 and in light of the All-island Grid Study the necessary action to ensure that electricity transmission and distribution networks can accommodate, in an optimally economic and technical way, our targets for renewable generation for the island to 2020 and beyond"*.

3.3.3 National Renewable Energy Action Plan 2010

The National Renewable Energy Action Plan Directive (2009/28/EC) requires each Member State of the EU to adopt national renewable energy action plans setting out that Member State's target for energy from renewable sources by 2020, and how it will be achieved. Ireland submitted its National Renewable Energy Action Plan (NREAP) to the European Commission in July 2010. It set out measures which the Government considers necessary to achieve Ireland's 16% target of total final energy consumption to come from renewable sources in 2020. The target will be made up of the following contributions: 12% from renewable energy in heat and cooling; 10% from renewable energy in transport; and 42.5% from renewable energy in electricity.

The NREAP notes the 2007 White Paper referred to above, in particular its strategic goal of *"delivering electricity and gas over efficient, reliable and secure networks*". It also refers to the subsequent commitments of Grid25 (see **Section 3.3.7** below), the Government approved strategy for the development of the necessary transmission infrastructure to support national targets and a more sustainable long term electricity supply:

---

[8] This target has subsequently been increased to 40%.

> *"Grid25 provides the framework to build a more cost effective and efficient system to cater for the shift towards the integration of increasing amounts of renewable generation over time. The transmission capacity assumptions informing this grid development strategy are based on the high level principles of ensuring network safety, security of supply and economic transmission development, while delivering on the renewable target in the years ahead. It provides a foundation for more detailed work on specific reinforcements in coming years and will lead to plans for particular projects which will be delivered in consultation with the public and in line with planning legislation."*

3.3.4 Strategy for Renewable Energy 2012-2020

This strategy sets out goals with regard to, *inter alia*, building robust and efficient networks and expanding wind power. Strategic Goal No. 5 of the Strategy is to: "*Develop an intelligent, robust and cost efficient energy networks system*". This includes the modernisation and expansion of the electricity grid and the cost effective delivery by EirGrid of their investment programmes in electricity transmission.

3.3.5 The National Development Plan 2007-2013: Transforming Ireland – A Better Quality of Life for All and Infrastructure and Capital Investment 2012 – 2020 (Medium Term Exchequer Framework)

The National Development Plan (NDP) has four basic strategic objectives:

- To continue sustainable national economic and employment growth;
- To strengthen and improve Ireland's international competitiveness;
- To foster balanced regional development; and
- To promote social inclusion.

The strategic objective of the NDP energy programme, set out in Chapter 7 of that document, is to ensure security of supply nationally and regionally, to be competitively priced and meet a high level of environmental standards. It identifies that Ireland must develop a more competitive contribution from indigenous, and in particular, renewable energy sources, along with major improvements in efficiency in transport, energy supply systems, buildings and industry. The NDP outlines the direction of investment for EirGrid over the life of the Plan: "*During the period 2007–2013, the main focus of investment by EirGrid will entail improvement of the transmission network for electricity to accommodate increased usage and enhance security of supply, to allow increased connection of* *sustainable and* renewable *energy sources to the network and to support greater interconnection with Northern Ireland and Great Britain….."*

On 10th November 2011 the Department of Public Expenditure and Reform launched a document entitled *Infrastructure and Capital Investment 2012-2016: Medium Term Exchequer Framework*. The document acknowledges that over the medium-term, there will be a lower level of recourses available for capital investment. The Department of Public Expenditure and Reform also stated that the document replaces the NDP for 2007-2013.

The Framework identifies four main investment strategy components including "*Economic infrastructure – encompassing transport networks, energy provision and telecommunications capacity*". In particular, energy is identified as a *"key input to economic activity and the economy must have a secure and reliable source of energy:*

- *to ensure a fully sustainable, secure and competitive energy market underpinned by diverse energy sources, energy efficiency and robust infrastructure; and*

- *to help address climate change by meeting our binding obligations in the reduction of energy related greenhouse gas emissions".*

In terms of investment in energy infrastructure the framework advises *"The cost effective maintenance and continued development of the national energy infrastructure networks, and the electricity transmission system in particular, is strategically vital for Foreign Direct Investment and indigenous enterprise, for the economy and domestic consumers, and for regional economic development".*

3.3.6 Government Policy Statement on the Strategic Importance of Transmission and Other Energy Infrastructure 2012

In July 2012, the Department of Communications, Energy and Natural Resources published a *Government Policy Statement on the Strategic Importance of Transmission and Other Energy Infrastructure.* The policy statement notes that "*starting now, over the coming years, Ireland needs to deliver a world class electricity transmission system in all the regions which meets the needs of Ireland into the 21st Century*". Local Government planning authorities and ABP are required to have regard to this policy.

The key strategic policy elements are the affirmation of the need for development and renewal of energy networks to meet both economic and social policy goals. The investment in the Grid25 programme, including the Grid Link Project, is endorsed, the latter being a vital project for the south and east and for the economy and society as a whole. The major investment underway in the high voltage electricity transmission system under the Grid25 programme is stated as being the most important such investment in Ireland’s transmission system for several generations.

One of the key challenges raised in the policy statement is the need to find a pathway between the fundamental need for improved energy infrastructure (which is recognised as being in the national interest) and delivery of projects where acceptability by communities can be diminished due to concerns relating to environmental and social impacts. The policy statement sets an expectation of informed engagement by those tasked with planning, constructing and operating energy infrastructure in a safe, efficient and economic manner in accordance with their licences from the Commission for Energy Regulation (CER).

3.3.7 EirGrid Plans

Grid25 – A Strategy for the Development of Ireland’s Electricity Grid for a Sustainable and Competitive Future 2008 is a high level strategy, which provides an outline of how EirGrid plans to develop the transmission network to support long-term sustainable and reliable electricity supply, establishing the future grid requirements and how these will be met.

Estimated grid requirements include upgrades to the existing network and the provision of new circuits. Approximately 1,150km of new circuits are required, equating to an increase of about 20% of the total length of the transmission network. Of this, 800km needs to be at 220kV or 400kV with the remaining 350km at 110kV. Appendix A of Grid25 sets out the reasons for building at 400kV: the lines are more efficient than 220kV and provide greater power carrying capability with fewer lines.

EirGrid’s ***Transmission Development Plan 2012-2022*** sets out plans for the development of the transmission system over the 10 years from 2012 and presents those components of the overall long-term development of the transmission system where there is some level of certainty. In addition, other likely areas where development projects may soon be required are also discussed. It is expected that over the period of the plan and beyond that there will be a return to demand growth in terms of electricity consumption, albeit at more modest levels than those experienced over the previous decade. The plan identifies specific development projects coming on stream including expansion of the 400kV system to provide necessary bulk transfer capacity out of Dublin and Moneypoint, and between this system and the Northern Ireland system.

The ***Grid25 Implementation Programme 2011-2016*** is a practical strategic overview of how the strategy of Grid25 will be implemented in the short and medium terms. It seeks to ensure that appropriate procedures and resources are put in place for future electricity transmission in accordance with the provisions of Grid25. A high-level indicative overview of the general strategy for the future development of the grid which was originally presented in EirGrid’s *Draft Transmission Development*

Plan 2010 is included and defined in more detail on a regional basis (as identified in Grid25). The issues of relevance to the current Grid Link Project which were identified are:

1. In the Greater Dublin Area, EirGrid is considering the need for and options to expand its 400kV network through the alteration of existing routes or equipment or with entirely new overhead line or underground cable routes. Additional transformer capacity is planned at the two existing 400kV substations (including Dunstown, Co. Kildare).

2. Reinforcements in the south-east are identified to address anticipated strain from general demand growth, new generation connections within the region, the potential for additional transmission interconnection with the UK and mainland Europe based in the region and the significant amount of wind generation expected to materialise through the country, particularly in the south of the country. These reinforcements will include strengthening of the high voltage transmission links to both Dublin and Cork to facilitate increased power flows and strengthening of the networks supplying major cities and towns in the south-east region.

3. High levels of renewable electricity and conventional generation are expected in the south-west region along with the general growth in demand in the area. This will "*result in the requirement to build significant new high voltage electricity transmission infrastructure in the region"* and *"significant strengthening of capacity between the south-west and south-east regions to allow excess power to flow from both renewable and conventional sources to supply demand in other parts of the country".*

The ***Grid25 Implementation Programme 2011-2016*** was subject to Strategic Environmental Assessment (SEA) under S.I. 435 of 2004. This assessment identified the potential significant impacts of the implementation of the programme and provided mitigation to address such issues. This included the development of strategic environmental constraints mapping (completed in 2012) and preparation of evidence base studies (ongoing) to determine the actual impact from construction and operation of the transmission network. In addition, an Appropriate Assessment of the Grid25 Implementation Programme in accordance with the EU Habitats Directive (92/43/EEC) was also undertaken in parallel to the SEA. The Directive requires that any plan or programme with the potential to negatively impact on a Natura 2000 site (which includes Special Areas of Conservation (SAC) and Special Protection Areas (SPA)) must be subject to an Appropriate Assessment.

3.4 REGIONAL CONTEXT

The Planning and Development Act, 2000 (as amended) conferred on the Regional Authorities the power to make Regional Planning Guidelines (RPGs) - long term strategic planning frameworks - for their functional areas. The RPGs aim to give regional effect to the National Spatial Strategy (NSS) and to guide the development plans for each county. The study area for the Grid Link Project (see

Chapter 4 for details of the study area) extends into six regional authority areas which include the south-west, south-east, mid-west, midlands, mid-east and Dublin. Each of the authorities has produced RPGs for their individual region, all dated 2012-2022.

The South-East Region comprises the five counties of Carlow, Kilkenny, South Tipperary, Waterford and Wexford, all of which are located within the study area. Therefore the ***Regional Planning Guidelines for the South East Region, 2010-2022*** are those with the largest land area of relevance to the Grid Link Project.

Energy supply is one of the key measures considered necessary to achieve a wider and stronger economic base for the region, greater economic competitiveness and associated social progress. Measures identified as necessary include ensuring that energy supply networks have sufficient capacity to ensure growth in enterprise activity and supporting the development and improvement of energy generation and transmission networks generally, including renewable energies.

The RPGs for the South-East Region contain particular policy provisions in respect of 'Electrical Generation' and the 'National Transmission / Distribution Network', making specific reference to the future needs of the transmission network as set out in EirGrid's Grid25 document. It further states that:

> "*The South-East Regional Authority recognises the need to increase electrical infrastructure which will be required within the region, including development of new 'main' 400kV lines and strengthening of 220kV, 110kV transmission lines and equipment. The potential of a new interconnector to the UK or mainland Europe will strengthen the security of supply and provide opportunities to export and / or import electricity. The electrical distribution network will be upgraded/ maintained as required in order to ensure quality of power supply and minimise electrical faults. Early consultation by transmission system operators with planning authorities and other relevant bodies is encouraged".*

The regional authority also recognises the role of Gate 3 projects in promoting the use of renewable and sustainable forms of energy. This is encapsulated in policy PPO 6.5 which records that*: "The Regional Authority supports the sustainable development and expansion of the GRID network and future connections to renewable sources of energy (including Gate 3 projects), subject to appropriate assessment of all necessary environmental considerations."*

The RPGs for the Mid-East and Dublin Regions are combined in the ***Regional Planning Guidelines for the Greater Dublin Area (GDA) 2010-2022*** which are relevant for counties Wicklow and Kildare. These RPGs note the importance of the availability and quality of services and utilities to support economic development within the most populated region of the country, which thus has the most pressures and demands on finite resources. Improvements are acknowledged as being necessary in *"regional power infrastructure in order to maintain security of supply, to attract additional industry, and to allow for the connection of renewable energy sources to the grid".*

The GDA RPGs support and guide the provision of improved energy infrastructure. Such policies promote reinforcements and new infrastructure:

- To ensure future energy needs are met; direct local authorities to provide policies and plans to set targets for renewable energy generation;
- State that future corridors for energy transmission should avoid sterilising lands proximate to key public transport corridors;
- Seek the delivery of an integrated transmission network as necessary so that renewables can be linked to the grid in a sustainable and timely manner; and
- That Appropriate Assessments are carried out as necessary.

The ***Regional Planning Guidelines for the Midlands Region 2010-2022*** are considered as the study area incorporates part of County Laois. These RPGs highlight the long history of energy production in the region at the peat burning stations and various renewable energy sources, in particular wind development (which may be developed in the region in the future to reinforce and replace as appropriate, peat burning electricity generation). In terms of electricity transmission infrastructure requirements in the region, the guidelines refer to the need to increase the security and quality of supply to key parts of the network in the Midlands, and to reinforce transmission infrastructure equipment so as to facilitate the integration of new wind generation. The upgrading of the transmission network will facilitate power flows from both renewable and conventional sources to maximise the use of existing power corridors.

The ***Mid-West Regional Planning Guidelines 2010-2022*** are considered as the study area includes part of North Tipperary. These RPGs note that EirGrid has identified a need to strengthen the transmission network in the region. One such area of need is to make provision for the connection of renewable energy resources from suitable areas of the region. The RPGs in response acknowledge that they favour expediting connections and incorporating modifications proposed by EirGrid in respect of speedier connections to the national grid by way of a positive bias toward the development of grid infrastructure.

The ***Regional Planning Guidelines for the South-West Region 2010-2022*** are relevant as the study area includes part of County Cork.

The key principles of these RPGs include the promotion of security of energy supply and the sustainable development of renewable energy and delivery of integrated and cost effective transportation and infrastructure.

In addition to the importance of security of supply of energy for the economic development of the region in general, the RPGs also note the importance of the electricity transmission network to the renewable energy sector. Policy RTS-09, dealing specifically with 'Energy and Renewable Energy' advises that it is an objective of the authority *"to facilitate the sustainable development of additional electricity generation capacity throughout the region and to support the sustainable expansion of the network. National grid expansion is important in terms of ensuring adequacy of regional connectivity as well as facilitating the development and connectivity of sustainable renewable energy resources. It is an objective to ensure that future strategies and plans for the promotion of renewable energy development and associated infrastructure development in the region will promote the development of renewable energy resources in a sustainable manner".*

While the RPGs for the South-West Region cover the counties of Cork and Kerry, the Cork City and County region has a further layer of regional / sub-regional planning policy in the form of the ***Cork Area Strategic Plan (CASP) 2001*** and ***CASP Update 2008***.

Part B of the original 2001 Plan which pertains to 'Supporting Analysis Development Capacity and Potential', recognised that the delivery of power and the provision of the necessary infrastructure is an essential requirement for the economic development of the CASP study area. It noted that growth rates in electrical demand in Cork had been above the national average of 5% per annum for the previous eight years, but that there had not been a corresponding investment in transmission infrastructure to support this demand. The critical problem locally was identified as security of supply. The CASP noted that owing to an infrastructure deficit there may be problems maintaining service which acts as a deterrent to certain industries as a consistent supply cannot be guaranteed in Metropolitan Cork. The plan advised that the problem would be overcome by a 220kV link between Raffeen 220kV substation and Aghada 220kV substation, which would also allow other improvements to take place (this infrastructure has since been developed). The plan also states that where feasible, consideration should be given to putting infrastructure underground.

The *CASP Update* was formally adopted in July 2008. It takes account of revisions needed to reflect economic, market and policy developments. It also includes an increased focus on the economic and investment strategy.

The CASP Strategy recognises that the delivery of power and the provision of the necessary infrastructure is an essential requirement for the economic development of its study area.

3.5 COUNTY DEVELOPMENT PLAN CONTEXT

As set out in **Chapter 4** of this report, which describes the development of the study area for the Grid Link Project, the study area includes a number of counties including all of Carlow, Waterford, Wexford and Wicklow, most of Kilkenny, and to a lesser extent Cork, Kildare, Laois and Tipperary. A small portion of Limerick is also included. As part of the information gathering for the project, the Grid Link Project Team reviewed the local policy context for all counties within the study area. However, not all counties in the study area are traversed by feasible route corridor options (see **Chapter 9).** In the interests of brevity, the local policy context review in this report focuses on the particular counties traversed by the feasible corridors described in Chapter 9.

Local county development plans and policies illustrate the stated support for reinforcement of the existing transmission systems in order to promote growth and investment in the respective counties. All of the county plans have some level of policy guidance in respect of renewable energy in general and wind energy specifically. The county plans generally support the principles of sustainability, and acknowledge the need to tackle issues pertaining to climate change generally, reduce emissions and energy consumption. A number of counties also have distinct wind energy strategies, most of which have been incorporated into and adopted as part of their respective development plans. An overview of the County Development Plans and their content with respect to electricity transmission infrastructure and renewable energy development is provided in **Table 3.1.**

In addition to these strategic policies, local county development plans include policies relating to the need to avoid adverse environmental impacts or impacts on residential amenity. As the Grid Link Project progresses towards a least constrained corridor and line design, in accordance with EirGrid's Project Development and Consultation Roadmap (see **Chapter 1** of this report), regard will be had to such policies.

Table 3.1: County Development Plan Overview

County Development Plan	Policy on Grid Network/Electricity Transmission	Renewable Energy Policy
Carlow County Development Plan 2009-2015 (effective from 28th August 2009)	Policy acknowledges critical importance of energy availability to meet the overall objectives for the county and facilitating new development. It also recognises and supports all energy source providers in developing a suitable network in the south which can sustain the level of development proposed for the south-east. Secure and reliable electricity transmission infrastructure is considered key in terms of supporting economic development; renewal and development of the electricity networks is to be supported including OHLs as necessary.	Recognises the need to support the development of renewable energy resources.
Cork County Development Plan 2009-2015 (effective from 6th February 2009)	Seeks efficient provision of physical infrastructure and includes specific Objective INF 7.1(b) on safeguarding strategic corridors from encroachment by other developments that might compromise the provision of energy networks where these corridors have been identified.	The development plan does not include a renewable energy strategy but specific Objective INF 7-3 encourages in particular, energy production from biomass, waste material, solar, wave, micro hydro power and wind energy subject to normal planning considerations, especially impacts on areas of environmental or landscape sensitivity.
Kildare County Development Plan 2011-2017 (effective from 2nd May 2011)	Policy to facilitate energy supply and distribution within the county, includes: Policy ER1 which supports infrastructural renewal and development of electricity networks subject to amenity requirements; and	Policy support for the development of indigenous renewable energy sources.

County Development Plan	Policy on Grid Network/Electricity Transmission	Renewable Energy Policy
	Policy ER4 which advises that the local authority will have regard to the requirements of service providers in the context of strategic infrastructure but also provides that development (and specifically the location of high tension power lines) is controlled, especially where lines would adjoin existing dwellings, except where no other alternative can be shown to exist. Policy also acknowledges that future development of grid network is of vital strategic importance and specific projects identified in Grid25 are referenced. In particular, Policy TN3 provides strong support for the development and renewal of electricity networks within Co. Kildare.	
Kilkenny County Development Plan 2008-2014 (effective from 14th July 2008)	Policy supports efficient energy utilisation and the renewal and development of electricity networks including OHLs subject to amenity and health considerations.	Policy recognises the need to support the development of renewable energy resources.
Laois County Development Plan 2010-2016 (adopted on 11th November 2011)	Availability of energy is identified as a critical issue and Policy ET/005 seeks to support and facilitate electricity infrastructure development to ensure a secure supply. Energy policies are also identified to guide the location and form of future electricity network upgrades and / or additions. In this regard: Energy infrastructure is to be provided at suitable locations and enhanced electricity supplies and associated networks	County Laois is considered to be well placed to develop power generation facilities, both renewable and non-renewable. Policy supports expansion of wind energy industry and harnessing of geothermal energy. Policy ET9 / P04 encourages renewable energy production in particular, from biomass, waste material, solar, wave, micro hydro power and wind energy subject to normal planning considerations, especially impacts on areas of environmental

County Development Plan	Policy on Grid Network/Electricity Transmission	Renewable Energy Policy
	are to be supported and facilitated (Policy ET9 / P01 and P14). Policy ET9 / P17 seeks to safeguard strategic corridors from encroachment by other developments that might compromise energy network provision where such corridors have been identified. Policy ET9 / P21 restricts the development of high tension power lines – new high tension power lines will not be permitted adjoining existing dwellings unless no other alternative can be shown to exist. Policy ET9 / P24 outlines that networks will be generally facilitated subject to specified requirements including rationale, route identification, mitigation requirements, consistency with international best practice and compliance with policies and objectives of the plan.	or landscape sensitivity.
South Tipperary County Development Plan 2009-2015 (effective from 9th March 2009)	The development plan recognises that the development of secure, reliable electricity transmission infrastructure is a key factor in supporting economic development. It also supports renewal and development of networks including the continued expansion of medium and high power electricity supply networks, especially in support of new employment uses.	Plan supports development of natural wind energy resources available provided it is in accordance with Appendix 3 Policy on Wind Energy Development and other development plan policies.
Waterford County	INF 26 seeks to facilitate improvements in energy	Plan supports renewable energy (see INF 26 discussed

County Development Plan	Policy on Grid Network/Electricity Transmission	Renewable Energy Policy
Development Plan 2011-2017 (effective from 13th March 2011)	infrastructure and encourages its expansion at appropriate locations and to facilitate (where appropriate) future alternative renewable energy developments close to national grid and collaborate with EirGrid in accordance with Grid25 to facilitate quality connection, transmission and market services to those using the high voltage electricity system at appropriate locations.	herein). It also strives to become a 'Green County' with goals for development including managing the challenges of climate change, facilitating renewable energy infrastructure and promoting the use of renewable energy.
Wexford County Development Plan 2013-2019 (adopted 11th February 2013)	Policy supports the reinforcement of the electricity transmission grid to improve energy supply to the county. Where strategic route corridors have been identified, the Council will support the statutory providers of national grid infrastructure by safeguarding these corridors from encroachment by other developments that might compromise the provision of energy networks, provided that adverse impacts on residential amenity or the environment are not proposed. Where proposed high voltage lines traverse existing or proposed residential areas, the plan states that they should be located underground where appropriate. Objective EN04 refers and is supportive of the provision and improvement of energy networks provided need is demonstrated; the route has been identified with due regard to social, environmental and cultural impacts; the design will	The development plan contains a specific chapter on climate change (Chapter 5) which informs the energy policy of the plan. The plan supports development of sustainable renewable energy resources (including wind, energy crop and tidal energy). Objective CC04 seeks to minimise greenhouse gas emissions and Objective CC05 outlines the Council's intention to prepare a renewable energy strategy for the county within the lifetime of the plan. Renewable energy is seen as important for overall economic competitiveness and also as an important economic sector in its own right. Objective ED08 supports green industries including those related to renewable energy production subject to location and other requirements. Chapter 11 sets out detail on energy policy in relation to a wide range of sources of renewable energy. Sustainable energy zones are proposed in a number of locations.

County Development Plan	Policy on Grid Network/Electricity Transmission	Renewable Energy Policy
	achieve least environmental impact without incurring excessive cost; and mitigation is proposed as necessary and appropriate assessment has been carried out as necessary.	
Wicklow County Development Plan 2010-2016 (effective from 4th October 2010)	Strategic policy provision includes promoting and facilitating the development and expansion of the electricity transmission and distribution grid. Specifically: Policy GE1 seeks to support same, including the development of new lines, pylons and substations as required; Policy GE2 requires that development within 35m of existing 110kV / 220kV transmission lines is suitably managed; and Policy GE3 seeks to support and facilitate the development of landing locations for any cross-channel power interconnectors.	Policy *inter alia*: Seeks to address climate change, particularly in the areas of flooding and renewable energy; Undertakes to have regard to national policies in the development of appropriate strategies and objectives for the development of alternative and renewable energy, in particular wind energy; and Encourages wind energy development in accordance with the county wind energy strategy and to allow harnessing of wind energy in most areas, subject to designated conservation areas and other specified impacts (e.g. visual, residential and recreational amenity, material assets).

3.6 CONCLUSION

At all levels of the strategic and statutory planning policy contexts examined, the upgrading and increasing of capacity of the electricity transmission network of the country is supported in principle. Development of the transmission network is identified as being a key driver for economic development and also to facilitate connections to new renewable energy generators, in particular wind energy. The latter is of vital importance for Ireland to achieve its renewable electricity targets as set out under European and national legislation and guidelines.

While the principle of the Grid Link Project is clearly supported through strategic policies, the specifics of the project and the route chosen will be assessed in detail with reference to the provisions of the development plans of the counties through which it will pass.

The development plans of all of the counties within the Grid Link study area support the upgrade of the transmission network and many refer to the particular provisions and objectives of the Grid25 plan. All counties also support the generation of renewable forms of electricity.

The development plans for many of the towns located within the study area have not been included in this list at this stage. As the project progresses, plans at a lower level in the planning policy hierarchy, such as Local Area Plans for smaller settlements, will become relevant.

Local county development plans and policies illustrate the stated support for reinforcement of the existing transmission systems in order to promote growth and investment in the respective counties. All of the county plans have some level of policy guidance in respect of renewable energy in general and wind energy specifically. The county plans generally support the principles of sustainability, and acknowledge the need to tackle issues pertaining to climate change generally, reduce emissions and energy consumption.

In the majority of cases, the land use plans mentioned above are subject to environmental considerations in the form of Strategic Environmental Assessment and Appropriate Assessment of policies and objectives ensuring that environmental considerations are taken into account early in the planning process in addition to the detailed assessments associated with delivery of a project. This hierarchy of environmental protection policies have and will continue to inform all stages of the project development.

4 STUDY AREA

4.1 INTRODUCTION

This chapter outlines the rationale for the Grid Link Project study area. Following the rigorous process outlined in **Chapter 2**, EirGrid has determined that the Grid Link Project is to be a 400kV high voltage alternating current (HVAC) circuit linking the transmission substations at Dunstown in Co. Kildare to Knockraha in Co. Cork via Great Island in Co. Wexford.

4.2 STUDY AREA RATIONALE

The purpose of defining a suitable study area was to facilitate the identification of key constraints within that study area, to examine reasonable alternatives, to develop feasible corridor options and to carry out a systematic assessment of these options leading to the selection of a solution which will form the basis for the detailed design to follow.

4.3 GENERAL PRINCIPLES

A two-step approach was used to define the proposed study area for the Grid Link Project. In the first instance, general principles were applied to ensure the area would be wide enough to cater for the project needs. Secondly, administrative and physical boundaries were examined to help define the area.

The general principle used to define the location and extent of the proposed study area for the Grid Link Project was that it should be large enough to capture the following:

- The strategic objectives of the project;
- A range of technical options; and
- Three specified nodes.

4.4 JURISDICTIONAL / PHYSICAL BOUNDARIES

In drawing the actual boundary for the proposed study area, the general principle used was to broadly follow significant jurisdictional or physical boundaries, and specifically:

- To the north, the M50 motorway;

- To the east, the coastline and near shore areas including estuaries, harbours and bays;
- To the west, the South-East Regional Planning Authority Boundary and the M7/N7 and M8/N8 motorways; and
- To the south, the coastline and near shore areas including estuaries, harbours and bays.

It is noted that while these boundaries offer a broad outline to the study area for the proposed project, they should not be considered fixed or rigid. The study area may be altered to reflect more detailed information as the project develops, or it may be the case that the final solution may not be entirely within the original defined study area. This is consistent with the principles of EirGrid's Project Development and Consultation Roadmap (see **Chapter 1**).

4.5 DESCRIPTION OF THE STUDY AREA

The proposed study area has been derived based on the approach identified above and is illustrated in **Figure 4.1**. The boundary of the study area broadly follows the coast to its eastern and southern extents and includes the major estuaries along the south eastern coastline and in particular Waterford and Cork harbours to ensure that route options in the vicinity of Great Island and Knockraha strategic nodes can be fully explored.

The study area moves inland after Cork Harbour, where the boundary extends to the east of the Cork City boundary after which it broadly follows the route of the M8/N8 and M7/N7 motorways along the western extents of the study area and then follows an easterly direction along the vicinity of the M50 and onwards to the coastline.

The existing transmission system has also been considered in the development of the study area with the boundary of the study area taking cognisance of the major existing transmission lines in the region to ensure all reasonable alternatives can be fully considered in the development of project solutions.

Finally, although not specifically used to define the study area, international designations, such as Special Areas of Conservation (SAC) or Special Protection Areas (SPA), have been considered in refining and delineating the boundary in so far as an effort has been made to either fully include or exclude these sites rather than transect them. This has not always been possible, e.g. in the case of riverine sites.

The study area includes all of Counties Carlow, Waterford, Wexford and Wicklow, most of Kilkenny, and to a lesser extent Cork, Dublin, Kildare, Laois, and Tipperary. A small portion of County Limerick is also included within the study area. The gateway city of Waterford is located within the study area as are the major hub centres of Kilkenny City and Wexford Town.

There are numerous environmental designations in the area as identified in the Strategic Environmental Assessment (SEA) for the *Grid25 Implementation Programme*, and as addressed in more detail in **Chapter 5** of this Report. In terms of extent, the Wicklow Mountains SAC / SPA is the largest; other significant upland designations include the Comeragh Mountains and Blackstairs Mountains SACs. Many of the environmental designations in the study area are river based and tend to traverse long linear corridors which, whilst difficult to avoid, represent only a relatively small area over which to traverse. Designated rivers include the River Barrow / Nore SAC, River Nore SPA, Slaney River Valley SAC, the Lower River Suir SAC and the River Blackwater SAC. There are also major designations included within the estuarine waters of the study area including Cork Harbour SPA, Wexford Harbour and Slobs SPA, Dungarvan SPA and the Bannow Bay SPA.

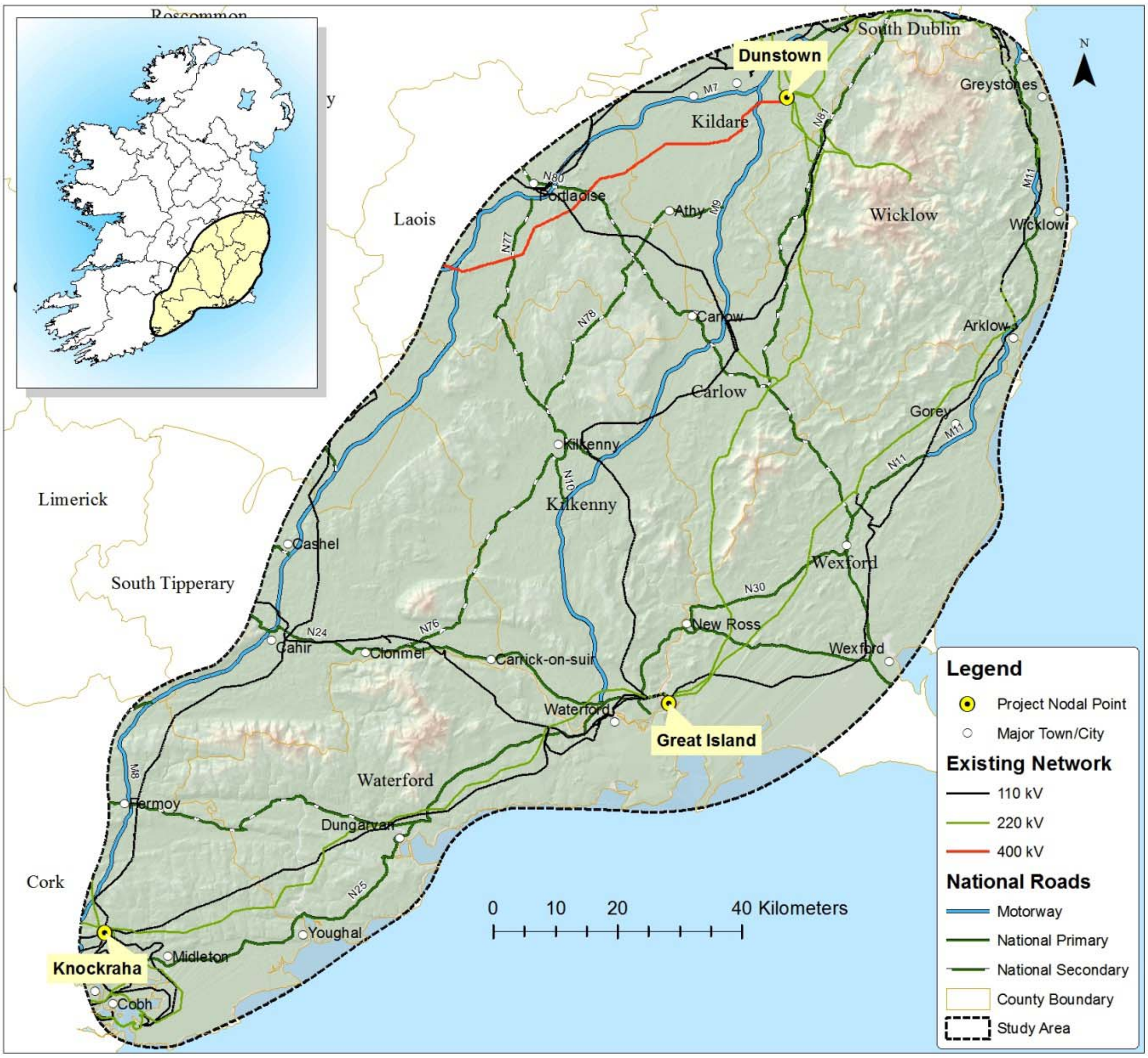


Figure 4.1: Grid Link Study Area

4.6 CONSULTATION AND KEY ISSUES RAISED

A comprehensive stakeholder engagement strategy has been put in place for the Grid Link Project. This includes a range of initiatives such as open days, information centres, a project website and face to face meetings with stakeholders. This section outlines details of the public consultation process at the very outset of the project, directly following launch and publication of *The Grid Link Project Study Area Paper* (April 2012) and associated study area map. Full details of the stakeholder engagement for this period can be found in a separate report, *Report on Consultation No.1* (August 2012), as published on the project website www.eirgridprojects.com/projects/gridlink.

The first phase of consultation commenced following the launch of the project on 12th April 2012. The consultation lasted for an 8 week period and concluded on the 8th June 2012.

4.6.1 Consultation Approach

A range of consultation tools were used to facilitate input by as many people as possible. This involved organising public events, establishing a full time project team presence within the study area and special briefing meetings as well as a phone line, online and traditional postal opportunities. The main communication activities are outlined below.

A network of four information centres was opened in the week following the launch of the project. The location and opening times are shown in **Table 4.1**.

Table 4.1: Information Centre Locations and Opening Hours

Centre	Address	Opening Hours
The EirGrid Midleton Information Centre	Oikoseen House, Castleredmond, Midleton, Co. Cork, and Market Green, Midleton, Co. Cork	Open every Monday from 12 noon to 6pm (information centre transferred from Oikoseen House to Market Green from Monday 20th May, 2013)
The EirGrid Carrick-on-Suir Information Centre	Carrick Community Business Centre at the Nano Nagle Centre, Carrick-on-Suir, Co. Tipperary	Open every Tuesday from 12 noon to 6pm
The EirGrid New Ross Information Centre	The Coach House, Marsh Lane, New Ross, Co. Wexford	Open every Wednesday from 12 noon to 6pm

Centre	Address	Opening Hours
The EirGrid Carlow Information Centre	Enterprise House, O'Brien Road, Carlow, Co. Carlow	Open every Thursday from 12 noon to 6pm

A series of open days was hosted during the consultation period. Experts from across the project team were available at each open day, including technical and environmental specialists. The details of each open day held during this consultation period are outlined in **Table 4.2**.

Table 4.2: Public Consultation No. 1: Open Day Venues, Dates and Times

County	Venue	Date and Time
Cork	Midleton Park Hotel, Midleton, Co. Cork	Wednesday, 2nd May 2012, 1:00p.m. to 8:00p.m.
Waterford	The Granville Hotel, Waterford, Co. Waterford	Tuesday, 8th May 2012, 1:00p.m. to 8:00p.m.
Kildare	Killashee House Hotel, Naas, Co. Kildare	Thursday, 10th May 2012, 1:00p.m. to 8:00p.m.
Tipperary	Clonmel Park Hotel, Clonmel, Co. Tipperary	Friday, 11th May 2012, 1:00p.m. to 8:00p.m.
Kilkenny	Kilkenny Ormonde Hotel, Kilkenny, Co. Kilkenny	Tuesday, 15th May 2012, 1:00p.m. to 8:00p.m.
Cork	Knockraha Community Centre, Knockraha, Co. Cork	Thursday 17th May 2012, 8.30p.m. – 11:00p.m.
Wicklow	Druids Glen, Newtownmountkennedy, Co. Wicklow	Tuesday, 22nd May 2012, 1:0 p.m. to 8:00p.m.
Wexford	Talbot Hotel, Wexford, Co. Wexford	Wednesday, 23rd May 2012, 1:00p.m. to 8:00p.m.

A series of printed materials was produced for this consultation as follows: *Information Brochure 1*; *Consultation Brochure 1*; and *Consultation No. 1 Poster*. Samples of all of this printed material can be found in the full *Report on Consultation No. 1*.

A dedicated section for the Grid Link Project was established on the EirGrid projects website. All relevant project information, including electronic versions of the project literature was made available online. The URL for the project website is www.eirgridproject.com/projects/gridlink.

A comprehensive information service was established to facilitate stakeholders making contact with the project team to ask questions or receive information about any aspect of the project. The information service can be availed of through the project phone line (Lo-call 1890 422 122), online at gridlink@eirgrid.com or via traditional mail at: The Grid Link Project Manager, EirGrid, P.O. Box 12213, Glenageary, Co. Dublin.

Specific stakeholder engagement was also undertaken. On the day of the project launch, all Senators, TDs and MEPs and all local elected representatives in county and city councils were issued with a briefing pack. In addition, meetings were held with many of the planning authorities within the study area. **Table 4.3** shows the relevant planning authorities and dates of the meetings held.

Table 4.3: Meetings with Planning Authorities

Planning Authority	Date of Meeting
Carlow County Council	10th July 2012
Cork County Council	26th July 2012
Kildare County Council	10th July 2012
Kilkenny County Council	16th July 2012
Tipperary South County Council	26th September 2012
Waterford City Council	14th June 2012
Waterford County Council	16th May 2012
Wexford County Council	21st May 2012

4.6.2 Focus of First Consultation

The focus of the first public consultation on the Grid Link Project was on the proposed study area and identification of locally important issues and constraints within that area. This was a non-statutory consultation designed to provide all interested stakeholders with an opportunity to participate, and to feed into the early development of the project. All submissions and feedback were reviewed and considered by the project team and a full consultation report on this phase of the project was produced following the close of the consultation period.

The terms of reference for the First Consultation were:

- Comment on the proposed study area map: Has EirGrid considered all relevant criteria when determining the study area? Should anything else have been considered?

- Identify constraints that should be considered for further review: Are you aware of any locally or regionally important features that you believe should be considered as the project develops? Constraints can be anything from natural features in the landscape to cultural or archaeological structures. They are mapped in the study area and taken into account when corridors are identified.

- Provide feedback on how corridors should be developed: How should constraints or features in the landscape be taken into account when corridors are defined for the project?

- Any other issues? If you have any other issues that you think should be taken into account at this stage of the project EirGrid would welcome your input.

- How would you like to be involved or communicated with, as the project progresses?

4.6.3 Key Themes Raised During Public Consultation

A wide range of issues were raised by participants in this consultation. For the purposes of this report the issues have been grouped into themes having regard to the layout and approach taken in the *Report on Consultation No. 1* referred to above. These themes comprise the following:

- Proposed Study Area;

- Agriculture and Bloodstock;

- Archaeology, Architecture and Cultural Heritage;

- Biodiversity and Ecology;

- Community;

- Existing or Planned Infrastructure;
- Landscape and Visual Impacts;
- Strategic Constraints;
- Water;
- Terrain;
- Tourism;
- Developing Corridors;
- Communications and Public Consultation; and
- Other Issues:
  - Project Need,
  - Cumulative Impacts, and
  - Issues with Existing Electricity Infrastructure.

It is noted that submissions received subsequent to this consultation period were nonetheless recorded and have been reviewed by the project team. They will be brought forward for consideration as part of the overall planning and evaluation process to follow.

5 CONSTRAINTS

5.1 INTRODUCTION

Following the identification of the study area, environmental and other constraints were identified and assessed. A constraint can be described as any physical, technical, legal, environmental, topographical or other consideration that may potentially affect, limit, restrict or confine the location or other aspect of the project within the study area. Environmental constraints are typically considered with reference to: Human Beings, Natural Environment, Built Environment, and Material Assets. Accordingly, for the purpose of this constraints section of this *Stage 1 Report*, the key environmental constraints are summarised under the following headings:

MANMADE:

- Population and Settlement;
- Cultural Heritage;
- Land Use; and
- Infrastructure and Utilities.

NATURAL:

- Soils and Geology;
- Biodiversity;
- Water; and
- Landscape and Visual;

5.2 CONSTRAINTS MAPPING

To facilitate the management of the data for such a large study area, a Geographical Information System (GIS) for the project was developed and has formed a substantial element of the work to date. Datasets covering population, landscape, biodiversity, water, soils, land use, infrastructure, geology and cultural heritage have been sourced and collated from numerous stakeholders with in excess of 100 datasets obtained from local authorities, state agencies and other stakeholders. Once collated, the GIS was used to generate constraints mapping. Each individual constraint layer was separately illustrated in the suite of constraints maps, where they were seen in the context of the study area and the existing substation sites at Dunstown, Great Island and Knockraha. The following is a list of the constraints mapping, developed for *The Grid Link Project Constraints Report* (August 2012) and presented in Volume 1 of that report as published in August 2012:

Figure 4.1: Project Study Area.

Figure 8.1.3: Population Density.

Figure 8.2.1: Record of Monuments and Places (RMP Distribution Map).

Figure 8.2.2: National Monument, Preservation Order, Register of Historic Monuments and World Heritage Tentative Distribution Map.

Figure 8.2.3: Record of Protected Structures (RPS) Distribution Map.

Figure 8.2.4: NIAH Distribution Map.

Figure 8.2.5: NIAH Historic Garden and Designed Landscape Survey Distribution Map.

Figure 8.3.1: Land Uses Within the Study Area - Corine Land Cover.

Figure 8.3.2: Land Uses Within the Study Area – Other.

Figure 8.3.3: Marine Uses Within the Study Area.

Figure 8.4.1: Infrastructure - Transport and Topography.

Figure 8.4.2: Infrastructure - Energy and Water.

Figure 8.5.1: Aquifer Vulnerability.

Figure 8.5.2: Geological Heritage Sites and Landslide Susceptibility.

Figure 8.6.1: Biodiversity (European) Within the Study Area.

Figure 8.6.2: Biodiversity (Terrestrial) Within the Study Area.

In addition to the established datasets listed above, the public have provided local information on features of interest within the study area during consultation. As far as possible these features and locations have been recorded and mapped on an on-going basis in the GIS to help inform the project as it progresses. The features / information provided ranged from notification of sensitive landscapes and views to archaeological monuments, walking routes and commercial enterprises. In the case of specific features from recognised datasets, e.g. archaeological sites, these have been verified as far as possible against the constraint mapping.

5.3 CONSTRAINTS REPORT

The purpose of *The Grid Link Project Constraints Report* (August 2012) [referred to hereafter as the *Constraints Report*] was to map and record all relevant constraints within the study area in advance of identifying potential corridors for the proposed Grid Link Project. The data collection was focused on determining what constraints exist that could influence the project. In the context of the report, a constraint is described as any physical, technical, legal, environmental, topographical or other consideration that may potentially affect, limit, restrict or confine the location or other aspect of the project, within the study area. This broad description of 'constraint' incorporates two strands. It includes factors which could comprise potential obstacles in the identification of substation locations, route corridors and line routes, and might best be avoided where possible or appropriate. It also includes considerations which will assist in defining the final nature of the project. Constraints as defined above have been identified to ensure a comprehensive understanding of the study area.

The *Constraints Report* was compiled based on desktop studies with reference to national, regional and local datasets. Site visits and consultation with a number of strategic stakeholders and the public also contributed to the report. A summary of the main considerations in the report is provided below.

5.3.1 Population

Twelve counties and fifteen local authorities are represented within the study area as follows:

Carlow	Cork	Dublin*	Kildare
Kilkenny City & County	Laois	Limerick	South Tipperary
North Tipperary	Waterford City & County	Wexford	Wicklow

*Dun Laoghaire Rathdown and South Dublin local authority areas

While the study area is highly urbanised in parts, it remains largely rural in character. Of note is the partial inclusion of the Greater Dublin Area (GDA) in the northern part of the study area. Waterford City and its environs is also included within the study area and has previously been identified as a 'Gateway City' in the National Spatial Strategy (NSS). Similarly, Cork City and its suburbs has also previously been identified as a 'Gateway City' in the NSS and is also partially included within the study area.

Kilkenny City and environs and Wexford Town and environs have both been identified as supporting 'hubs' to the Waterford Gateway. Other towns linked to the gateways and development hub within the study area include, *inter alia,* Wicklow, Naas, Carlow, Dungarvan, Clonmel and Portlaoise.

Major settlements (e.g. cities, towns, villages, suburban and residential areas) represent a significant constraint within the study area. Along both the southern and eastern coastline (particularly scenic areas) there are concentrated dispersed settlement patterns, which include *inter alia* holiday homes / accommodation (e.g. Wexford, Waterford and Cork coastlines). Outside major settlements, there are high levels of one-off and clustered rural housing and these will be an important consideration at detailed route alignment stage.

The *Constraints Report* has mapped all major population centres (cities, major towns and small towns) and population density for the whole study area. In addition, amenity areas such as major tourist attractions, recreational beaches, rivers and high amenity landscape areas were identified.

5.3.2 Cultural Heritage

From the *Constraints Report* it is clear there is a large archaeological resource within the study area and a substantial amount of architectural heritage sites with varying degrees of statutory protection. There are two sites located within the study area on the tentative list for nomination onto the UNESCO World Heritage List: Dún Ailinne, Co. Kildare and the Early Medieval Monastic Site of Glendalough, Co. Wicklow. In addition, a total of 21,795 Record of Monuments and Places (RMP) sites, belonging to various periods, were identified within the study area indicating a continuance of activity and settlement in the region since at least the Neolithic era with some early Mesolithic activity along the coast. There are over 8,733 Record of Protected Structures (RPS) sites and 13,831 National Inventory of Architectural Heritage (NIAH) sites that are of regional significance and above in the study area. All archaeological and historic sites / features and properties with statutory designation in each county will be key considerations for the project and the identification of a least constrained corridor.

These archaeological and architectural sites and features present a widespread constraint within the study area. A significant issue in relation to overhead lines (OHL) relates to potential impacts on setting and visual amenity of these sites and features, in addition to potential direct physical impacts arising from OHL structures and substation infrastructure.

As part of the *Constraints Report,* the following features were mapped: the distribution of known archaeological (RMPs, national monuments, preservation orders, record of historical structures and tentative UNESCO sites), and architectural (RPS and NIAH including gardens and historic landscapes) features which are currently available in digital format from the Department of Arts, Heritage and the Gaeltacht and from local authorities within the study area.

5.3.3 Land Use

The study area is characterised by a number of land uses and activities including: economic; tourist, recreation; social / community; forestry / woodlands; quarries, mines and landfills; and agriculture and food.

As part of the *Constraints Report* the gross land use within the study area was mapped based on the Corine (Coordination of Information on the Environment) land cover dataset which indicates that the majority of the study area falls within various categories of agricultural land. More specific land uses have been mapped where datasets were available.

It is noted that existing transmission lines and infrastructure are evident throughout the study area traversing a variety of land uses and co-existing with the various activities undertaken therein.

5.3.4 Infrastructure and Utilities

All of the known relevant utilities within the study area have been identified and mapped as far as possible. These features represent a constraint or opportunity in that the route of any proposed corridor must take due consideration of the location of any existing utilities and infrastructure. Those of particular relevance at this stage are ones to which essential or statutory operating clearance is required (i.e. requiring avoidance or buffering, e.g. Waterford Airport). Other infrastructure and utilities considerations will be important at detailed line design stage.

5.3.5 Soils & Geology

The most relevant features within the study area in relation to soils, geology, hydrology and hydrogeology, are namely;

- Areas susceptible to peat failure, e.g. relic landslide location and based on RPS qualitative susceptible mapping;
- Compressible and erodible soils, e.g. peat, alluvial deposits;
- Geological heritage sites, e.g. includes geological features such as significant / rare formations, fossilisations and karst;
- Karst areas, e.g. swallow holes, depressions, springs, caves;
- Vulnerable aquifers, i.e. ones which are closer to the surface or where a low permeability drainage path exists to the aquifer; and
- Sensitive surface water channels / water bodies, e.g. Special Areas of Conservation (SAC) and Salmonid waters.

These areas have been identified and mapped as part of the *Constraints Report*.

5.3.6 Biodiversity

Ireland has designated sites and species of conservation value and / or concern in an effort to protect its biodiversity resource. There are three primary categories of designated sites for nature conservation in Ireland; Special Areas of Conservation (SAC), Special Protection Areas (SPA), and Natural Heritage Areas (NHA). The first two have EU significance and the latter has national significance. A key issue for the project will be avoidance of significant impact, particularly on EU designated sites (also known as Natura 2000 sites). Under the EU Habitats Directive (92/43/EEC), any plan or project with the potential to impact on a Natura 2000 site must undergo an appropriate assessment of its implications for the site in view of the sites conservation objectives. An Appropriate Assessment will be required as the Grid Link Project progresses.

The study area has a large number of these sites including over twenty SPA designations for birds, forty three SAC designations for habitats and species and over 200 proposed and fully designated NHA designations for various habitats and species. Many of the Natura 2000 sites in the study area are associated with rivers and therefore have a strong linear distribution throughout the area making avoidance difficult. Presence of freshwater pearl mussel is also a significant feature of many of the rivers and / or tributaries in the study area. The majority of the study area falls within catchments identified for the freshwater pearl mussel. Birds are also an important aspect of the biodiversity within the study area due to such a large coastal presence and some major river systems such as the Blackwater River. Other constraints of note include the Wicklow Mountains National Park in the north east of the study area and shellfish designated waters around Wexford and Waterford harbours.

Potential issues for biodiversity relate to possible collision of birds with overhead lines and disturbance of habitats and species during the construction period and fragmentation of habitats due to loss or damage to hedgerows, tree lines and riverine corridors which are important wildlife corridors for numerous species, particularly bats.

As part of the *Constraints Report* all Natura 2000 sites and also terrestrial and aquatic biodiversity within the study area have been mapped based on national and regional datasets for biodiversity.

5.3.7 Water

Under the Water Framework Directive (2000/60/EC), an holistic approach to water management has been adopted throughout the European Union. This has included the designation of river basin districts (RBD) and the development of river basin management plans. In Ireland, seven RBD have been identified and the study area for Grid Link includes a portion of three of these: the east, the south east, and the west. The River Basin Management Plans prepared for these RBD will bring incremental improvement leading to the majority of waters reaching at least 'good status' by 2027 at the latest.

Within the study area there are 80 rivers, 3 lakes and 1 coastal water classified as being of high status. These sites are important for supporting aquatic species which are sensitive to enrichment or siltation such as the protected, but declining, freshwater pearl mussel and juvenile salmon. The presence of high status sites along a river system can contribute significantly to the overall species diversity and recolonisation of species to rehabilitated stretches. These sites play an important part in conserving individual species and overall catchment biodiversity. Where waters are currently at less than good status, they must be improved until they reach good status and there must be no deterioration in the existing status of waters. The Grid Link Project cannot be allowed to impact on achievement of these objectives under the WFD.

A Register of Protected Areas has been established under Article 6 of the Water Framework Directive (2000/60/EEC) for all River Basin Districts in Ireland. The protected areas listed include: Drinking Waters, Economically Significant Aquatic Species (Shellfish Waters), Recreational Waters (Bathing Waters), Nutrient Sensitive Areas, Water Dependent Habitats and Species (SAC, SPA and Salmonid Waters). All such protected areas have been identified on constraints mapping.

Key issues for the Grid Link Project in relation to watercourses relate to avoidance of pollution events and physical damage. Pollution events, (should they occur), are principally related to the construction period, e.g. accidental spillage of fuel, chemicals or sewage, suspended solid release during topsoil stripping and installation of foundations. Any works that take place in close proximity to a water body have the potential to cause physical damage which in turn can impact on the hydromorphology of the watercourse and therefore the ecological status. The *Constraints Report* has mapped all such protected sites as well as areas of high status and high pressures.

Alongside the WFD, the EU has also published a directive on the assessment and management of flood risks or the Floods Directive [2007/60/EC] which came into force in 2007. This directive sets out a best-practice framework for flood risk management and seeks to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. This process is underway for the east, south-east and south-west River Basin Districts and the final plans are anticipated by 2015. Areas at risk of flooding can pose a risk to locating any new substations or extending the footprint of existing substations. In addition, repeated flooding could lead to erosion of material at the base of OHL structures.

As the plans are only in preparation at this stage, the Grid Link Project constraints mapping could not incorporate this information, however, the project team will keep in regular contact with the relevant authorities to ensure that any available information is appropriately taken into consideration as the project progresses. In the meantime, the *Constraints Report* has mapped historical OPW floodplain data which will be updated once data is available under the Floods Directive.

5.3.8 Landscape and Visual

The study area for the Grid Link Project incorporates all or part of fifteen local authority areas as follows: all of counties Carlow, Waterford, Wexford and Wicklow, most of Kilkenny, to a lesser extent Cork, Kildare, Laois and Tipperary and a small portion of County Limerick, South Dublin and Dun Laoghaire Rathdown. There is currently no national landscape mapping in Ireland therefore the approach taken by individual local authorities is not standardised. Each local authority uses its own terminology to describe parts of the landscape considered to be of significant aesthetic or recreational value on a county scale.

For the purposes of the *Constraints Report*, data was requested directly from each local authority and Protected Areas, Scenic Routes, Views and Prospects were collated and mapped where possible. To supplement this, landscape character areas were also reviewed, alongside relevant landscape and visual text within each development plan. This combined data was used to develop a more standardised mapping representative of the more sensitive areas across the study area.

5.3.9 Engineering Considerations

The terms of reference for the Grid Link Project have been set by EirGrid, i.e. a 400kV HVAC circuit linking the transmission substations at Dunstown in Co. Kildare to Knockraha in Co. Cork via Great Island in Co. Wexford. EirGrid will undertake reviews of its technology assumptions concerning the required nature and extent of the development during the lifecycle of the Grid Link Project to make sure they remain valid.

The main engineering elements of the project are the construction of substations and overhead transmission lines. The main technical considerations for substations relate to:

- connection to both the existing 220kV substations and the new 400kV lines;
- ground suitability and area for a substation;
- access during construction and operation; and
- extendibility.

Key considerations for the overhead transmission lines fall into three principal categories:

- existing infrastructure;
- topography and land features; and
- access and ease of construction.

The *Constraints Report* has mapped the key features under these categories. The engineering design for the Grid Link Project will be undertaken in accordance with international best practice.

5.3.10 Conclusion

The *Constraints Report* identified the key environmental and other constraints within the defined study area. The outputs from the constraints stage, i.e. *Constraints Report* and Mapping, formed the basis of the second round of public consultation which took place in 2012. The outputs from the constraints stage, together with feedback from the public consultation described below have been used to inform the identification of feasible corridors within the study area. The process of identification is outlined in **Chapter 8** of this report.

5.4 CONSULTATION AND KEY ISSUES RAISED

This section outlines details of the public consultation process for the Constraints Study stage of the project. Full details of the stakeholder engagement for this period can be found in a separate report, *Report on Consultation No. 2*, as published on the project website www.eirgridprojects.com/projects/gridlink.

EirGrid launched the second phase of consultation on the Grid Link Project on the 27th of August 2012. The focus of the second consultation was the project's *Constraints Report* and the process surrounding the development of corridors. The consultation lasted for an eight week period and concluded on the 22nd of October 2012.

5.4.1 Consultation Approach

The consultation approach outlined in **Chapter 4** was carried through to the second public consultation, including use of the existing four information centres (see **Table 5.1**).

A second series of open days was hosted during the consultation period. Experts from across the project team were available at each open day, including technical and environmental specialists. The details of each open day held during this consultation period are outlined in **Table 5.1.**

Table 5.1: Public Consultation No. 2: Open Day Venues, Dates and Times

County	Venue	Date and Time
Kilkenny	Springhill Court Hotel, Kilkenny, Co. Kilkenny	Tuesday, 4th September 2012, 12:30p.m. to 8:00p.m.
Campile	Campile Parochial Hall, Campile, Co. Wexford	Wednesday, 5th September 2012, 6:00p.m. to 10:00p.m.

County	Venue	Date and Time
Wexford	Ashdown Park Hotel, Gorey, Co. Wexford	Thursday, 6th September 2012, 12:30p.m. to 8:00p.m.
Kildare	Killashee House Hotel, Naas, Co. Kildare	Friday, 7th September 2012, 12:30p.m. to 8:00p.m.
Dublin	Dun Laoghaire-Rathdown County Council, County Hall, Dun Laoghaire, Co. Dublin	Monday, 10th September 2012, 10:00a.m. to 5:00p.m.
Wicklow	Glenview Hotel, Co. Wicklow	Tuesday, 11th September 2012, 12:30p.m. to 8:00p.m.
Cork	Midleton Park Hotel, Midleton, Co. Cork	Wednesday, 12th September 2012, 12:30p.m. to 8:00p.m.
Tipperary	Clonmel Park Hotel, Clonmel, Co. Tipperary	Thursday, 13th September 2012, 12:30p.m. to 8:00p.m.
Waterford	Dungarvan Park Hotel, Co. Waterford	Monday, 17th September 2012, 12:30p.m. to 8:00p.m.
Knockraha	Knockraha Community Hall, Knockraha, Co. Cork	Tuesday, 18th September 2012, 6:00p.m. to 10:00p.m.
Carlow	Seven Oaks Hotel, Carlow, Co. Carlow	Thursday, 20th September 2012, 12:30p.m. to 8:00p.m.
Laois	Abbeyleix Manor Hotel, Abbeyleix, Co. Laois	Friday, 21st September 2012, 12:30p.m. to 8:00p.m.
Kilcullen	Kilcullen Community Theatre & Heritage Centre, Kilcullen, Co. Kildare	Wednesday 3rd October 2012, 6:00p.m. to 10:00p.m.

As for the first period of consultation, a series of printed materials was produced for this consultation as follows: *Information Brochure 2*; *Consultation Brochure 2*, and *Consultation No. 2 Poster*. Samples of all of this printed material can be found in the *Report on Consultation No. 2*.

5.4.2 Focus of Second Stage Consultation

The focus of the second stage of public consultation on the Grid Link Project was on gathering feedback on the *Constraints Report* and on how EirGrid should develop corridors for the project. The terms of reference for the second consultation were:

1. Comment on the Constraints Report:

    - Are you aware of any other constraints – national or regional – that should be taken into account, within the project study area?

    - Has EirGrid identified key features that should be taken into account at this point in the project? These features (constraints) include cultural heritage, infrastructure, ecology, landscape features, etc.

    - Are the key features of your area captured in our *Constraints Report?*

2. Provide feedback on how EirGrid should develop corridors for the project:

    - How should EirGrid consider constraints when determining corridors?

    - Are the categories of constraints appropriate for the development of corridors?

    - What mitigation measures should EirGrid consider when evaluating constraints?

    - What opportunities should be considered when determining corridors?

5.4.3 Key Themes Raised During Public Consultation

A wide range of issues were raised by participants in this consultation. For the purposes of this report the issues have been grouped into themes having regard to the layout and approach taken in the *Report on Consultation No. 2* referred to above. These themes comprise the following:

1. Feedback on Constraints;

    - Community
    - Tourism and Leisure
    - Communications
    - Ecology

- Agriculture and Bloodstock
- Mapping
- Health
- Water
- Noise
- Landscape and Visual
- Existing Infrastructure
- Terrain
- Cultural Heritage
- Operational Issues
- Substations
- Renewable Energy

2. Feedback on Corridor Identification; and

3. Strategic Need and Planning.

As noted in **Chapter 4**, submissions received subsequent to this consultation period were nonetheless recorded and have been reviewed by the project team. They will be brought forward for consideration as part of the overall planning and evaluation process to follow.

6 TECHNOLOGY ALTERNATIVES

There are several technology alternatives by which the Grid Link transmission circuit could in theory be implemented. However, the solution selected as the most sustainable and appropriate must comply with EirGrid's statutory and regulatory obligations and meet the identified need of the project.

This chapter addresses the alternative technologies and methods for delivery that are considered appropriate for the Grid Link Project. It outlines the principal reasons for justifying the use of the proposed High Voltage Alternating Current Overhead Line (HVAC OHL) solution, as opposed to other technology options, supporting the findings of EirGrid's technical foundation analysis (see **Chapter 2**). It also discusses other relevant technology alternatives that may be considered through subsequent stages of the Grid Link Project.

6.1 HIGH VOLTAGE ALTERNATING CURRENT (HVAC) AND HIGH VOLTAGE DIRECT CURRENT (HVDC)

There are two principal methods of power transmission which initially could be considered when defining a reinforcement option, namely: HVAC (High Voltage Alternating Current); and HVDC (High Voltage Direct Current) technology.

The existing electricity transmission system in Ireland is, as in every other country in the world, a HVAC system. Any reinforcement option that utilises HVAC would therefore be an extension of the existing technology.

HVDC is an alternative method of transmitting electricity. HVDC technology is mostly used to transmit bulk power from one point to another over long distances where HVAC is not technically or environmentally feasible (e.g. a submarine cable) or where it is linking independent (synchronous) HVAC systems (e.g. an interconnector).

Inserting a HVDC circuit between any two points in a predominantly HVAC network would require the HVAC electricity to be converted into HVDC electricity, transmitted through cable or overhead line to the receiving end, where it is converted back from DC to AC, and then transmitted back into a HVAC network. This is somewhat inefficient, but it is technically feasible. In addition, due to the complexity of the systems that are required to control the power flows on the HVDC circuit, a HVDC circuit cannot be naturally accommodated into an HVAC transmission network.

There are two main HVDC convertor station technologies – Current Source Convertors (CSC) also known as Line Commutated Converters (LCC) and the emerging Voltage Source Converters (VSC). Both can be applied in combination with overhead lines and underground cables (see **Section 6.2** below). LCC DC technology utilises thyristors with high voltage and current capacity to enable the conversion of DC to AC. It has very high power transmission capacity and therefore offers greater efficiency for bulk transfer of power (multiple GWs) over long distances. Also LCC DC provides a higher efficiency compared to VSC DC and therefore reduces on-going operational costs.

VSC DC is considered a more flexible technology than LCC DC as it can be less difficult to integrate into an AC grid. The ultimate goal, as the technology matures, is for VSC converters to be able to fully replicate the operational characteristics of equivalent AC components. As well as offering system benefits, physically VSC technology occupies 40-60% less space than an equivalent LCC station. This technology continues to develop with converter stations becoming more efficient, reliable and compact.

6.1.1 Application of HVAC and HVDC Technology in the Grid Link Project

Both HVAC and HVDC technologies were considered by EirGrid as viable technology alternatives for the Grid Link Project. Both alternatives feature in the technology solution options identified and assessed by EirGrid during its initial feasibility studies. However, as set out in **Chapter 2,** following comparative evaluation, a 400kV HVAC circuit is considered to represent the preferred solution to address the identified need to reinforce the transmission system in the south-east of Ireland, having regard to a broad set of criteria.

6.2 OVERHEAD LINE (OHL) AND UNDERGROUND CABLE (UGC)

There are two main technology choices for building a new circuit, whether HVAC or HVDC: overhead line (OHL) or underground cable (UGC). As some of the required connection points (or node points) are relatively close to the coast, subsea cable was also considered.

6.2.1 Overhead Line (OHL)

OHL technology conventionally utilises steel lattice towers with one or more conductors per phase, supported on insulator strings which allow a sufficient air gap to insulate the live conductors from the earthed tower. As the construction of an OHL requires limited civil works with a simple mechanical construction, it is very cost effective compared to a UGC system which has a more complicated construction and design. **Section 6.4** provides a description of OHL structures.

OHLs have a high level of reliability, i.e. most faults are temporary and automatically cleared without impacting the integrity of the transmission network, and the permanent faults can be located easily and quickly repaired. Where there is a temporary fault (e.g. a lightning strike) restoration can occur within a number of seconds or even in the case of permanent faults, restoration times are normally still in the order of a number of days[9].

OHLs result in a relatively low physical impact to the land they cross (limited to the tower locations and land within the OHL corridor). It is a very flexible technology which can be routed and constructed in a wide variety of topographies. With longer spans it can also be constructed to pass over waterways or obstacles. Landscape and visual impacts are two of the primary environmental impacts resulting from OHL and its visual impact is considered to be significant by comparison to other technologies. However, there have been developments in recent years to try and make the conventional OHL more visually attractive through redesign or other mitigation (see **Section 6.4.2**).

The mechanical properties of an OHL as outlined above are applicable to both AC and DC technology options. HVAC OHL technology is considered international best practice and is a proven technical solution for transmission of high voltage electricity. It is the technology around which the transmission network in Ireland has been developed to date. In the case of HVDC OHL technology, a lighter lattice steel tower can be utilised compared to HVAC transmission towers. This is due to the reduced mechanical loading on the tower as only two conductors per circuit are required as a minimum for HVDC OHL compared to the minimum three with HVAC OHLs.

6.2.2 Underground Cable (UGC)

UGC technology involves installation of specialised insulated cables under the ground. There are two main types of high voltage cable, self-contained fluid filled (SCFF) and cross linked polyethylene insulated cable (XLPE) which is the most widely used for high voltage. The installation methods for UGC technology can either be directly buried or within ducts / concrete trenches or tunnels. Direct burial installation requires the use of heavy equipment, not only for excavation but also for the transport and 'pulling' of cables. However, they do not require the level of civil engineering required by cut and cover deep bore tunnelling type installations. In the case of cable tunnels, they are very costly to build and are typically used over short distances and typically only in densely developed urban areas where neither OHLs nor direct buried cables can be used. The laying of UGC is highly dependent on soil type. There are two main influences: excavation and backfill. Trenching for

[9] Between 2005 – 2009 in Ireland, over 2,200km of 220kV, 275kV and 400kV OHL, the average duration of a circuit being out of service for repair is less than 1 day (source: EirGrid).

underground cables requires the excavation of significant quantities of soil. The suitability of the soil as a backfill material and its thermal resistivity are important considerations. Special techniques such as directional drilling are also used for crossings under roads, railways and waterways resulting in minimal disturbance to the surrounding environment.

Whatever the installation method, the cost of using UGC is generally a number of times more expensive than using OHL.

In terms of reliability of UGCs, reference is made to the most comprehensive study to date carried out by Cigré in 2009[10]. This study was based on the results of a survey of 73 utilities from around the world. The study found, that once located, the average time taken to repair a fault on a 400kV XLPE cable (a cable type which would be considered for Grid Link) is 25 days if the cable is direct buried, and 45 days if installed in ducts/troughs/tunnels. On the basis of potential for prolonged unplanned circuit outages, OHLs are therefore considered to have a better service availability than UGCs.

Long term reliability is also considered to be an issue. The expectation and international experience is that as an UGC gets older, it becomes less reliable. This is principally due to deterioration of the material used in the manufacture of the cable and the long term impact of electrical and thermal stresses over the operational life of the cable.

In relation to the use of UGC for HVAC transmission, the high capacitance of the cable presents design and operational difficulties. The most notable of these is the risk of temporary high voltages within the network which exceed the rating of the cable and can cause critical failure of either the cable equipment or transmission assets in a wider area. The *International Expert Commission (IEC) Report on the Meath-Tyrone Project* (Normark, B., et al, 2011) recommended against using a total HVAC UGC solution for that particular project advising that *"AC cables are technically possible, but have never been found attractive for long distance, high power transmission"* and *"For AC connections, the solution by underground cables is only used for limited distances".* In fact, there are no 400kV HVAC UGC in the world that approach the length required for the Grid Link Project.

One of the main advantages of installing UGCs is largely the reduction in landscape and visual impacts associated with the OHL option. However installing buried cables introduces environmental issues specific to that technology, e.g. potential impact on archaeology as a result of excavation works. Furthermore, buried cables occupy a significant amount of land and introduce restrictions on

.[10] Cigré. *Update of Service Experience of HV Underground and Cable Systems, ISBN 978 -2-85873-066-7* (2009), available from http://www.cigre.org on request.

the building of any structures over the cable route (due to the risk of damage during construction and preventing cable access if required).

Because of their higher cost and lower reliability, cables are generally only used in urban areas or wherever a constraint has been identified such that no alternative exists other than to use a cable. This is covered in EirGrid's *Policy on the Use of Overhead Line and / or Underground Cable* (CDC0IR001-00, 2nd April 2008)[11]. This position is consistent with international best practice.

EirGrid's policies and practices relating to the planning and development of OHL and UGC transmission infrastructure are used and summarised in Appendix A of Grid25[12]. This appendix confirms that UGC will generally only be considered where an OHL solution is not practical or environmentally feasible, for example:

- In densely populated areas and where no alternative exists;
- In congested areas of infrastructure where no alternative exists;
- Where it is necessary to cross water **and** no alternative exists; and
- Where no alternative exists but to route through an environmentally sensitive area and undergrounding is deemed to be less of an impact on the environment.

Subsea cables introduce differences in design, production, installation practices and repair actions due to their position on / in the seabed, with sometimes great water depth. The cable design is more or less similar to that of an onshore cable except for the armouring which is needed to ensure sufficient mechanical strength during laying of long lengths of cable. The installation methods available for subsea cables also differ significantly from those for UGC onshore. Installation from a ship allows for longer cable lengths than onshore, reducing the number of cable joints required. However, the vagaries of seabed conditions, weather and availability of suitable ships introduces risks in relation to installation and repairs.

For HVAC offshore cables, the maximum lengths are limited as for onshore UGCs. The limitation in length is determined by the increased dielectric capacitance of the cable giving rise to extremely high voltages within the cable. Technical limits of submarine cable change due to both installation and construction of the circuit but in general the practical maximum length of an HVAC offshore 400kV

[11] *Policy on the Use of Overhead Line and / or Underground Cable*, GDC-IR001-00, 2 April 2008

[12] EirGrid (2012) *Grid25 A Strategy for the Development of Ireland's Electricity Grid for a Sustainable and Competitive Future*.

cable is approximately 90km[13]. However this length is not likely to be commonly achievable with a cable connected into the Irish network which, as a small synchronous network, is less able to accommodate a cable of this length without further technical network problems or unacceptable risk.

HVDC submarine cables have different electrical characteristics that make them more suitable for long distance connections and therefore are commonly utilised in offshore development.

6.2.3 Application of OHL and UGC Technologies for the Grid Link Project

As discussed in the preceding section, UGC is less reliable and more costly than OHL. The average time to repair a fault on the circuit is considered to be significantly longer for a UGC than for an OHL[14]. Consequently, the use of OHL will offer a higher level of reliability on this project which will form a key piece of the backbone of the transmission network. Most significantly for the Grid Link Project, a total underground HVAC UGC solution is not a technically viable option due to the distances involved. Similarly, a HVAC offshore option is not a technically suitable or cost effective solution for the Grid Link Project.

While a HVDC underground or subsea cable is technically feasible, the use of HVDC is not considered the best option for Grid Link because of the significantly higher capital and operational cost and due to its inherent lack of flexibility and extendibility, as outlined in **Chapter 2**.

Therefore EirGrid's preferred technology choice for the Grid Link project is HVAC overhead line (OHL) which is considered to be the most practicable, reliable and cost effective solution.

6.2.3.1 Partial Undergrounding

As set out in **Section 6.2.3** above, using an entirely HVAC UGC solution was discounted as a viable option to be brought forward. However, the use of a partial underground HVAC solution (i.e. a combination of HVAC UGC and HVAC OHL) is theoretically a viable option having regard to EirGrid's policies and practices as set out in Appendix A of Grid25, and as summarised above. However, there are inherent technical problems associated with the introduction of significant lengths of HVAC UGC onto an AC transmission network. An all-island system-wide study to consider the implications for overall reliability and stability of incorporating any long lengths of / large quantities of HVAC UGC

---

[13] *EirGrid (2011) Offshore Grid Study*

[14] Ecofys & Golder Associates, *Study of the Comparative Merits of Overhead Electricity Transmission Lines Versus Underground Cables,* 30 May 2008

transmission infrastructure would be necessary in advance of considering it as a viable option for the Grid Link Project.

In the event that a constraint has been identified and there is no other practical OHL option, then partial undergrounding will be considered as a mitigation measure. This is subject to the partial undergrounded section of the circuit being technically viable.

Partial undergrounding of the project will require a 400kV circuit interface between the OHL and UGC, i.e. it is necessary to construct a substation at every location where the 400kV circuit changes from OHL to UGC. The exception to this is where underground cable is used on approach to a substation. In these cases, suitable infrastructure may already be in place to offset the need for interface infrastructure at the termination point.

Where a substation is required solely for the purpose of accommodating a transition from UGC to OHL, it is known as a 'transition station' or as a 'sealing end compound'. A typical 400kV transition station has the same appearance as a small 400kV substation (see **Figure 6.1**). It would require a land take of approximately one hectare. It would at least consist of an inner compound enclosing the live equipment and a small building, with a buffer strip around the compound to accommodate an earth berm, and / or vegetation, for screening.

Figure 6.1: Example of a 400kV Underground Cable to Overhead Line Transition Station

For the Grid Link Project, the impact of partial undergrounding must be carefully considered in particular due to its effects on system reliability, security of supply, cost and its own environmental impact. Consequently, the objective is to first seek a viable and environmentally acceptable 400kV

OHL solution. The use of short lengths of 400kV UGC can be considered only where it can be technically viable in an all-island system-wide context and proven to be an environmentally advantageous and cost effective way of overcoming an otherwise avoidable constraint to the preferred OHL.

The potential requirement for partial undergrounding as part of the Grid Link Project has already been considered in respect of the development of feasible route corridors as set out in **Chapter 8** and **Appendix 4** of this report. Its potential will continue to be considered, where appropriate, as part of the Grid Link Project development and Environmental Impact Assessment (EIA) process.

6.3 SUBSTATIONS

A substation is an essential part of electrical systems and acts as a point of common connection or 'node' for several circuits. They allow the connection or 'meshing' of several circuits and may interface with lower voltage networks through transformers. In essence a domestic homes distribution board (or 'fuse board') can be seen as a mini substation and performs many of the same functions providing connection to different devices, i.e. cooker, lights, and sockets and separate fuses for rooms/areas in the home. This is achieved by using equipment in the substation such as switches and circuit breakers. All of this equipment together is known as a substation. There are two principal types of substation technology available: Air Insulated Switchgear (AIS) and Gas Insulated Switchgear (GIS).

6.3.1 Air Insulated Switchgear (AIS)

An AIS substation uses atmospheric air as the main insulation for the exposed electrical conductors. The switchgear is normally connected together by bare metallic conductors mounted on support structures overhead in the station called gantries or post insulators. As a poorer insulation but cheaper and constantly available medium, air in an AIS substation requires larger electrical and safety clearance distances than those required for a GIS station. This is due to the comparatively low dielectric strength of atmospheric air. This requirement drives the need for a greater substation footprint. This would be one of the main disadvantages of AIS switchgear, particularly at 400kV.

The approximate site area requirement (footprint) for an AIS substation is in the order of 400m x 400m. AIS switchgear and transformers are usually installed outdoors. A separate control building is also required which houses protection and control equipment associated with the switchgear and other HV equipment and which will also house the auxiliary power supplies for the station.

An important advantage of the AIS substation over the alternative GIS technology is the relative ease of future expansion and refurbishment with minimum impact on operation. For this reason and because of historical cost differences, AIS substations have tended to be the most generally used at 400kV; however examples of GIS substations are also to be found. AIS substation compatible switchgear will continue to be available in future which means provision for future upgrading and equipment supply does not need to be built in at the outset, unlike GIS where it must be considered at the initial stage.

A well designed AIS substation is more advantageous for expansion as the electrical connections between items of equipment are exposed to the air, facilitating future connection or modification as opposed to a GIS substation where the electrical contacts are surrounded by pressurised Sulphur Hexafluoride gas (SF6 gas) in a metallic enclosure.

The only provision that must be assured for possible future extension of an AIS substation is that the site must be of sufficient size and that the equipment can be suitably located within it.

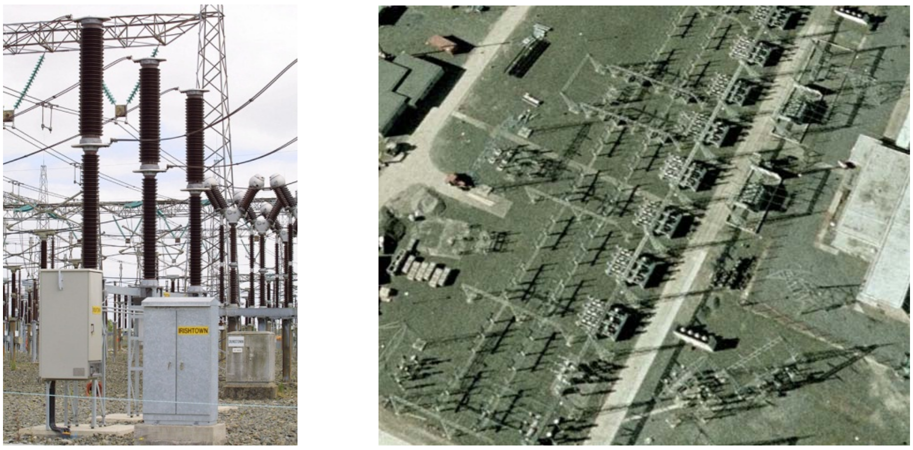


Figure 6.2: Examples of AIS

6.3.2 Gas Insulated Switchgear (GIS)

A GIS substation uses SF6 gas, which has a higher dielectric strength than air, to provide the insulation for the switchgear. The conductors and switchgear contacts are insulated by pressurised SF6 gas requiring much smaller clearances than those of AIS substations and hence the footprint of a typical GIS substation compound would be approximately 300m x 200m. Although the switchgear is smaller, the same space is required for the transformers, terminal towers and site screening. As a rule GIS switchgear is installed indoors but often with outdoor transformers. The building height for a GIS substation would typically be in the range of 15m to 17m high.

It is normal to locate the switchgear in a building, which needs to be large enough to accommodate the switchgear and provides adequate space for access to replace components if necessary (see **Figure 6.3).** The same transformers are used for GIS as for AIS and OHL terminal towers requiring the same space for these large items of equipment regardless whether a substation is GIS or AIS.

There are several manufacturers of GIS switchgear and designs evolve so that each design is superseded over a number of years. New designs are rarely compatible with earlier versions. Therefore it is often necessary to install additional equipment than is actually required for the initial installation to cater for possible future extensions. This is a disadvantage of the technology.

Figure 6.3: Example of GIS

6.3.3 Application of AIS and GIS Technology for the Grid Link Project

With respect to substation technology, both AIS and GIS are well proven technologies and have been implemented successfully in Ireland and elsewhere in the world. Both AIS and GIS substation technologies are considered acceptable for the requirements of the Grid Link Project. Both technologies offer advantages, depending on the application and the selected substation site. A GIS substation has an advantage in terms of space constraints. It is also housed in a building, which assists in reducing the visual impact. Both technologies will be considered for the substation site identification and evaluation process. The decision on which to use will depend on the selected site and the space restrictions of that site, whether the site is exposed to severe pollution and the need to reduce visual impact depending on the location of the site. The decision will be made on the basis of further information gathered during later stages of the project development.

6.4 OVERHEAD LINE STRUCTURES

6.4.1 Tower Types

Towers are one of the most significant components of OHL, in terms of their potential visibility and direct impact on land (i.e. their footprint). There are two types of tower typically used for OHL transmission developments to support either single or double-circuit transmission lines[15]. These are detailed below:

- **Intermediate or Suspension Towers** are only used on straight sections of line. Electricity conductors hang on, or are suspended from, the cross arms of these towers resulting in these towers being somewhat taller and slimmer than angle towers and typically requiring smaller foundations.

- **Angle/Tension Towers.** These towers are used at points when the OHL changes direction, where the line terminates (such as at substations) or in order to break a long linear span to maintain tension. This requires the angle/tension tower to have a greater mechanical strength than the intermediate tower. Angle towers use heavier steel members and can also be shorter than comparable intermediate towers (while still maintaining the same minimum clearance between the ground and the electricity conductor). This gives the towers the appearance of being 'stockier' than the intermediate tower. Due to the required increase in mechanical strength angle towers will also typically have much larger foundations than intermediate towers.

In addition, transposition towers may be required to change the physical position of the conductors on a transmission line while maintaining electrical phase separation and clearance. Transposition phases can be important over long linear lengths as it balances electrical losses[16] between the conductors or three phases of a circuit.

Tower design has implications for the maximum achievable span length, angles of deviation and clearance requirements over obstacles. Therefore tower design is an important consideration for the

[15] A single-circuit transmission line carries conductors for only one circuit. For a three-phase system each tower supports three conductors. A double-circuit transmission line has two circuits. For three-phase systems, each tower supports and insulates six conductors. Double circuit towers are higher than single circuits because of the vertical configuration of the circuits and clearance requirements.

[16] Electrical impedance is a measure of the opposition that a circuit presents to the passage of the electrical current as the length of the circuit increases.

line design process and location of individual towers. Different tower designs also have their own particular characteristics and associated costs.

6.4.2 Towers under Consideration and Review for Outline Design Purposes for Planning

Steel lattice towers are the most common form of transmission support structure in Ireland (from 110kV up to 400kV). This conventional HVAC tower design combines steel lattice sections to accommodate loadings caused by the weight of the conductors, wind pressure, electrical forces and ice weight hanging upon the tower and the conductors.

Steel lattice towers are rigid and often have a mechanical reserve that may allow the uprate of the existing towers to accommodate a different type of conductor (which would allow a higher power transport capacity - a cost effective reinforcement option). However, the dimensions of towers are not easily changed to facilitate a higher voltage.

EirGrid is considering the use of a range of single and double circuit lattice steel tower designs for outline design purposes for future projects which include the IVI type, VVV type and inverted delta type tower designs for 400kV. These are described below and illustrated in **Figure 6.4**.

- **IVI 400kV Tower:** The 400kV IVI lattice steel tower is designed to maintain the insulator (shown in blue in **Figure 6.4**) configuration design of existing 400kV single circuit towers in Ireland. The tower's overall shape comprises a diamond located at the top of a relatively narrow body. The tower has a centre 'v' shape insulator configuration which is held within the diamond shape. Located on either side are two supporting arms for the conductors located at the end of two vertical 'I' shaped insulators. In addition to the conductors two earthwires are attached at the top using smaller cross arms or wings. These principally protect the conductors from lightning. In both front and side elevation of the tower forms a symmetrical structure comprised of a typical steel lattice framework composed of a large number of smaller members.

- **VVV 400kV Tower:** The VVV 400kV lattice steel tower is similar in design to the IVI tower with the exception that all insulators are arranged using the 'v' shape including cross arms. The centre 'v' shape insulators are held within a diamond shape. The earthwires are attached using smaller wings then the IVI tower.

- **Inverted Delta 400kV Tower:** The Inverted Delta 400kV lattice steel tower has a similar base structure to both the VVV and IVI towers. The conductors are strung through an inverted Delta steel frame in an inverted triangular shape. The two higher conductors are connected to the steel frame of the top of the inverted delta by 'v' shaped insulators while the lower conductor is attached to both sides of the steel frame by insulators and cross arms. The earthwires are attached to the top of each structure.

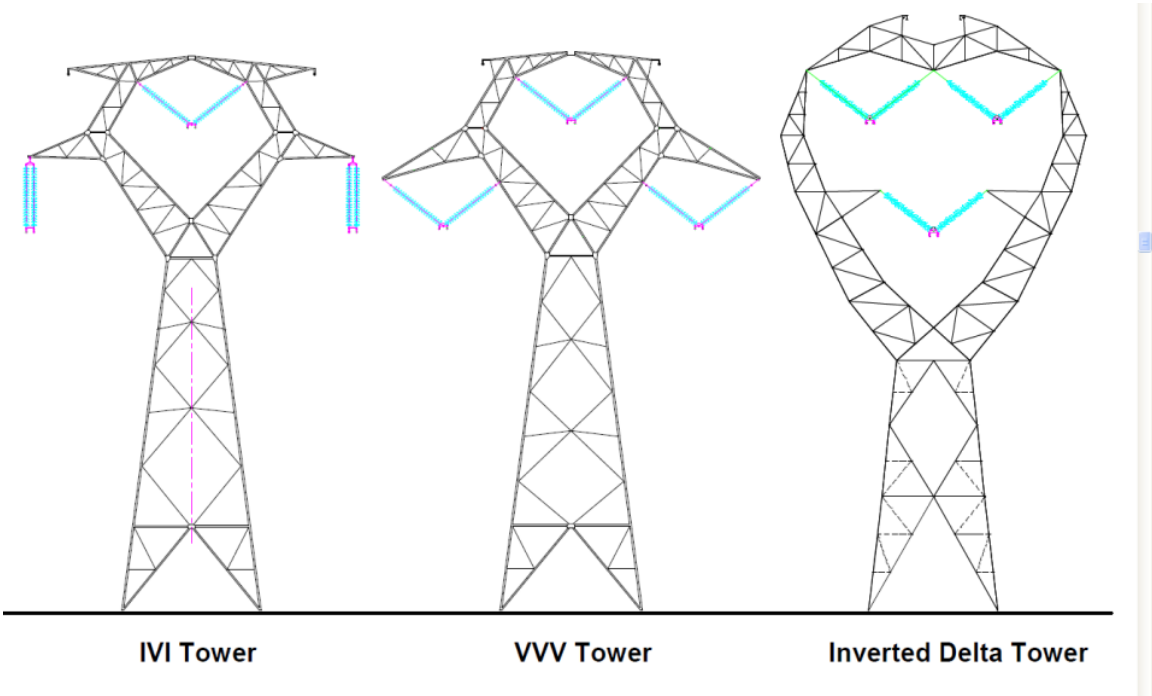


Figure 6.4: Outline Drawings of 400kV Single Circuit Lattice Steel Towers

Of the towers discussed above, the IVI is the only single circuit tower currently being proposed for 400kV projects by EirGrid. The *Tower Outline Evaluation and Selection Report* prepared by ESBI in November 2009 for the Meath-Tyrone 400kV Interconnection Development Project examined the standard 401 (existing 400kV tower), the IVI configuration, VVV configuration and inverted delta configuration. The report concluded that the tower design that would most satisfy all required criteria is an IVI tower. The *Visual Assessment of New Tower Outline Report* for the same project examined the same suite of four towers and it concluded that the IVI tower configuration had the least visual impact. It was therefore recommended that the IVI tower be used as the support structure for that project and be taken forward to be included as part of a planning application.

The use of a double circuit lattice steel tower design for outline design purposes for planning the transmission grid is also available. Similar to the IVI single circuit the conductors on the new double circuit tower design are connected to the lattice structure by horizontal lattice cross arms and by vertical insulators. The earthwire is connected at the top of the structure. Double circuit lattice steel towers are already in use along short sections of the transmission grid as illustrated below in **Figure 6.5** which shows the existing 400kV double circuit lattice steel tower on the approach to Dunstown 400kV substation.

Figure 6.5: Existing 400kV Double Circuit Lattice Steel Tower on the Approach to Dunstown 400kV Substation

In addition to conventional lattice steel towers, there have been many developments in recent years to make the conventional HVAC OHL a more visually attractive option (ref. Normark, B. 2011, et al; Cigre Working Group B2.08, 2010 *Innovative solutions for Overhead Line Supports* (2010); and the Royal Institution of British Architects (RIBA) 2011 UK tower design competition). These alternative solutions, including monopole designs, may increase the cost and risk to the project due to the unfamiliar nature of the technologies in Ireland. This includes *inter alia* delays to the delivery of the project while new tower designs are being developed, tested and approved and installation problems due to lack of experience and increased maintenance and repair constraints. Nonetheless, with careful assessment these alternative designs may be used as a suitable mitigation measure at locations where it is necessary to provide a compromise between technical, environmental and visual requirements for aspects of the Grid Link Project.

Additional 400kV towers are currently under consideration and review by EirGrid for outline design purposes for planning these include the Terna Tower and single and double circuit monopole. These are described below and illustrated in **Figure 6.6** and **Figure 6.7**.

- **Terna 400kV Tower[17]:** This 400kV tower was designed by architect and designer Sir Norman Foster and has been built near Tuscany in Italy. The tower is shaped similar to an X and is lattice in design with all three phases being maintained in the centre of the tower in an inverted triangle shape and held together by a system of interconnected insulators. The earthwires will be connected to top of both sides of the steel structure.

Photomontages of all the tower types discussed above can be found in **Appendix 1** to this report. The photomontages are designed to give the reader a perspective of what each tower looks like in a typical rural environment.

Figure 6.6: Terna 400kV Tower (Source Google Images)

[17] Rights for utilising this design may not be given. An alternate tower type may be considered.

- **Monopole (single and double circuit):** The monopole is constructed out of a vertical pole. The conductors are connected to the vertical pole by horizontal cross arms and then by vertical insulators. The single earthwire is connected at the top of the structure. The monopole is generally constructed from rolled steel or reinforced concrete. Monopoles are traditionally used for power lines from 10kV up to 110kV, although new designs are used for 400kV.

  From a structural point of view monopoles exert a high level of elastic deformation when compared to lattice steel towers. In addition the forces experienced by the pole are further exaggerated by its inherent physical load imbalance caused by the majority of loads being exerted near the pole top and dissipated at the base. This can add significantly to the overall diameter and expense of the pole as high levels of reinforcement are required to compensate for these forces. It also potentially requires additional structures compared to lattice towers. The design also presents a single point of failure at the base of the tower, which would result in extended outage of the line. Accordingly, further design and detailed technical analysis is required for all monopole tower types.

  The potential benefits of a monopole design includes a relatively small footprint which means they can sometimes be preferred in urban or semi-urban areas due to a combination of their reduced visual impact and reduced corridor width.

Single circuit 400kV Monopole

Double circuit 400kV Monopole

Figure 6.7: Monopole Designs

The typical height[18] and footprint dimensions of the various tower designs outlined above (where available) are set out in **Table 6.1**. The dimensions shown are approximate values and are provided for general guidance purposes. The table gives dimensions for intermediate towers only. Angle towers and transposition towers are not included. These will be examined on a case by case basis. As previously noted, photomontages of tower options are included in **Appendix 1**.

Table 6.1: Typical Height and Footprint Dimensions of Various Tower Designs

Tower Type and Circuit Type		Typical Height	Typical Footprint Dimension
Lattice IVI 400kV Tower (single circuit)	Intermediate	Approx. 27 – 43m	Approx. 6.5m x 6.5m to 11m x 11m
Lattice VVV 400kV Tower (single circuit)	Intermediate	Approx. 35m	Approx. 8m x 8m
Lattice Inverted Delta 400kV Tower (single circuit)	Intermediate	Approx. 35m	Approx. 8m x 8m
Lattice 400kV Tower (double circuit)	Intermediate	Approx. 60m	Approx. 11m X 11m
Terna Tower 400kV (single circuit)	Intermediate	Approx. 45m	Approx.13m x 5m
Monopole 400kV (single circuit)	Intermediate	Approx. 40m	Approx. 1.5m to 2.5m in diameter
Monopole 400kV (double circuit)	Intermediate	Approx. 50m	Approx. 2m to 3.5m in diameter

6.4.3 Alternative Conductor and Insulator Technologies

Conductors generally consist of high capacity and high-strength strands of wire wound into cable that carries the electricity. Typical conductors consist of a number of conducting aluminium wires around a high strength core consisting of steel wire (see **Figure 6.8**). Each phase typically consists of a

[18] Tower heights are measured above ground level at the centre point of the tower and to a height at the centre point of the tallest tower. Variances in measurement will naturally arise depending on topography and local ground conditions.

number of single conductors forming a conductor bundle. Generally, the higher the voltage level, the higher the number of conductors in the bundle. At 400kV in Ireland, EirGrid has to date always used a twin bundle configuration separated by spacers at regular intervals.

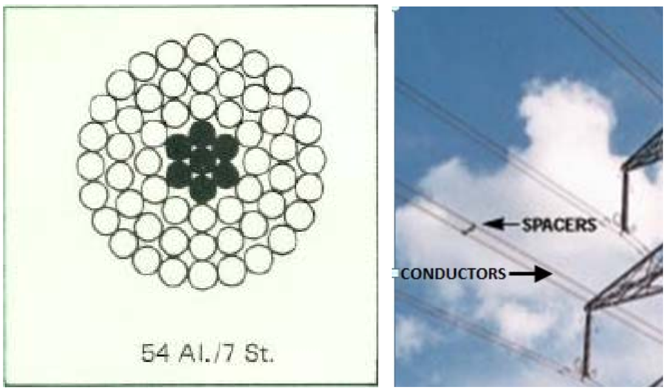


Figure 6.8: Cross Section of a Typical Conductor and Twin Bundle Configuration

Conductor technologies are continually advancing. The operation, weight and characteristic of the conductor are one of the single most influential aspects of OHL design and therefore advances in conductor technology can have a major impact and consequently are periodically revaluated by EirGrid.

Insulators support the conductors providing an insulation barrier from the live wire to the metallic structure and have to withstand both normal operating voltage and surges i.e. from lightning strikes. For transmission lines these tend to be suspended below the structure and comprise a number of glass disks, the number of which increases for the higher voltages dictating the height of the support structure. However, over the last few decades, insulators of composite material have been introduced which allows them to be shorter and gain more ground clearance. Composite insulators are not comprised of individual disks, they consists of a solid unit moulded into the exaggerated ribbed shape.

6.4.4 Tower Design, Conductor Technology and the Grid Link Project

EirGrid will further consider the advantages and disadvantages of available alternative tower designs for the Grid Link Project before finalising the project solution. This may include consideration of other alternative tower designs not mentioned above. A solution decision will be made on the basis of further information and technical analysis of alternative tower types gathered during later stages of the project development.

It should also be noted the preferred line route for the Grid Link Project may utilise the free side of the existing double circuit towers on the Moneypoint-Dunstown 400kV OHL on the approach to Dunstown 400kV station.

7 SUBSTATIONS

7.1 INTRODUCTION

In parallel with the development of corridor options, substation requirements and alternatives have also been considered at each of the three node points identified for the Grid Link Project:

- Dunstown in Co. Kildare;
- Great Island in Co. Wexford; and
- Knockraha in Co. Cork.

The objective of this *Stage 1 Report*, in relation to substations options, is to clearly set out the technical requirements at each of the three node points and to describe the process of substation site identification. The aim of the site identification process for this report is to identify areas of opportunity. The possible substation sites and their interface with the least constrained OHL corridor will be identified at the next stage of the project.

This report establishes the additional infrastructure and / or substation sites required to accommodate the Grid Link Project at the three node points. It also identifies substation zones within which feasible substation solutions will be investigated including at or in direct proximity to the existing nodes and it identifies areas of opportunity for more detailed assessment. While options in proximity to or remote from the existing substations are possibilities, it is noted that co-location with the existing substation is the optimum technical solution.

7.1.1 Terminology

It should be noted that in this chapter, the following terminology is used:

- **Substation Zone**: A zone of land of up to 8km in radius, within which feasible substation solutions will be explored including both co-location and off-site options. OHLs approaching the substations may fall anywhere within the relevant zone subject to avoidance of identified constraints where possible.

- **Substation Area of Opportunity:** An area of land, within the substation zone which avoids environmental constraints as far as possible and within which further study will be undertaken to determine if feasible substation sites and OHL interface can be found.

- **Substation Sites:** Specific defined sites which are feasible substation sites for either Air Insulated Switchgear (AIS) or Gas Insulated Switchgear (GIS) solutions and which can be aligned to the least constrained route corridor option once chosen. Substation sites will be developed in the next phase of the Grid Link Project and are not featured in this *Stage 1 Report.*

7.2 APPROACH TO SUBSTATION SITE IDENTIFICATION

The substation site identification process considers sites with potential for both Air Insulated Switchgear (AIS) and Gas Insulated Switchgear (GIS). **Chapter 6** gives a more detailed description of these technologies. The substation sites have been identified in a process involving the following stages:

1. Preparatory work to determine requirements at each node point to address the following (which is further detailed in **Section 7.3** of this report);

    - **The technical requirements for each node:** The technical requirements of the Grid Link Project will influence substation alternatives at each node.

    - **Identification of zones around each node within which identification of opportunities for substation development could be explored.** In summary, a 5–8km zone was initially proposed surrounding each of the existing nodes. The extent of the zone was developed with regard to the project objectives, technical considerations at each location and because it provides sufficient lands to facilitate consideration of reasonable alternatives. The extent of the zones was then refined having regard to the parallel process of corridor identification and alignment with the corridor option approach area (see **Chapter 8** for full details of OHL corridor routing process). In the case of Dunstown, the zone was drawn in the context of line entry modifications only as no new substation infrastructure is required at that location.

      It is noted that the interface connection between the overhead line (OHL) approach and the substation will not be finalised at this stage as it will be dependent on the outcome of the evaluation of corridor options at the next stage of the process (Stage 2 of EirGrid Roadmap).

2. Identification of technical and environmental constraints and considerations for substation sites and refinement of substation zones to areas of opportunity within which either AIS or GIS could be accommodated (see **Section 7.4**).

Each of the node areas at Dunstown, Great Island and Knockraha, were visited to get a general appreciation of the surrounding topography and countryside and to gain familiarity with the sites and the surrounding areas. These visits supplemented existing knowledge which was based on verifiable datasets, e.g. National Parks and Wildlife Services (NPWS) designations and previous experience of the areas, and having regard to OS mapping and environmental information available at that time. Familiarity from the site visits together with reference to existing information has assisted in development of options as addressed in **Sections 7.3**, **7.4** and **7.5.**

7.3 PREPARATORY WORK TO DETERMINE REQUIREMENTS AT EACH NODE

7.3.1 Dunstown

Technical Requirements: the Grid Link Project requires one 400kV bay in the existing 400kV AIS Dunstown substation to accommodate one additional 400kV circuit into the substation.

The existing substation occupies approximately 9ha and has capacity for additional infrastructure within the existing footprint. The connection of an additional 400kV line as part of the Grid Link Project will require relatively minor additional infrastructural modifications to the existing substation. In this regard, there is a spare 400kV bay situated at the north-west corner of the compound. There are opportunities to optimise the entry of the new required 400kV circuit into the existing substation taking account of the existing circuits.

Receiving Environment: The substation is located just south of Naas, on flat land, and is well screened from surrounding roads (see **Figure 7.1** and **Figure 7.2**).

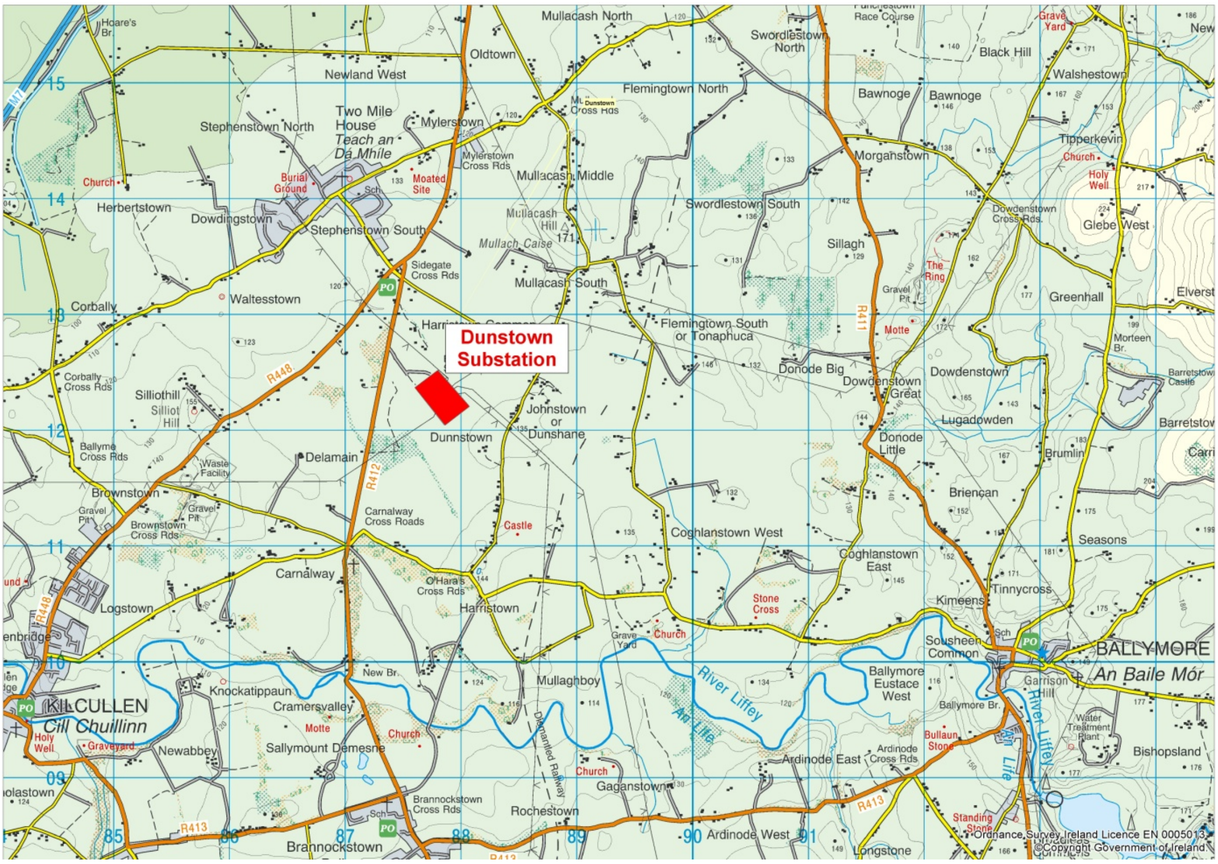


Figure 7.1: Location of Dunstown Substation

Figure 7.2: Dunstown Substation Site (Aerial View)

The area is rural in character with few houses in close proximity to the substation. The closest house is approximately 450m away. There are few significant environmental features in the immediate vicinity of the substation, however it is noted that Dún Ailinne, believed to be the royal site of the kings of Leinster, which is currently on the UNESCO Tentative List[19] is located 7km south-west of the station. This will be a significant consideration in terms of the alignment of any OHL entry in the area. Also of significance is the presence of the existing Moneypoint 400kV OHL which approaches the station from the west and which may have to be crossed by any OHL approaching from the south, i.e. from Great Island. Grid Link will necessitate one additional line entry to the area or alternatively it may be possible to utilise the free side of the existing double circuit towers on the Moneypoint 400kV line on its approach to Dunstown.

Substation Zone: At Dunstown, OHL corridors approaching the station were identified in the south and south-west quadrant, therefore this area has been highlighted (see **Chapter 8** for full details of OHL corridor routing process). As the substation already has available space to accommodate a 400kV connection, no off-site options needed to be considered, therefore, the search area forms an arc with a reduced radius of 5km to the south and south-west to take account of possible line entry modifications that might be necessary. No further refinement was carried out at this stage in the zone around Dunstown (see **Figure 7.3**).

Figure 7.3: Substation Zone at Dunstown

[19] United Nations Educational, Scientific and Cultural Organization (UNESCO) inventory of sites which members have proposed to add to the official list of cultural and natural heritage with outstanding universal value.

7.3.2 Great Island

Technical Requirements: the Grid Link Project requires a new 400kV substation which would take up an area in the order of 400m x 400m. The size of the substation will vary depending on the technology used. At this site, control buildings, electrical equipment including 400 / 220kV transformers and connections to existing Great Island 220kV substation will also be required. In addition, two new 400kV circuits will be required to connect into this new 400kV substation.

Great Island is an existing 220 / 110kV AIS substation[20] and is one of the main transmission stations for the south-east of Ireland. The approach to the substation is heavily congested with the convergence of 220kV and 110kV lines including three 220kV OHL circuits and four 110kV OHL circuits.

Options under consideration include extensions of the existing site, a new site in the immediate vicinity of the existing substation or a new site remote from the existing substation. From a technical perspective it should be noted that the optimum solution is for co-location of the new 400kV development with the existing 220kV substation. This would facilitate a direct connection to the existing substation and use of existing support infrastructure, e.g. access roads, all in a landscape already containing similar infrastructure. Off-site options will require new access roads and additional 220kV OHL infrastructure would also be required to connect the new 400kV substation back to the existing 220kV substation.

Receiving Environment: The existing substation is located in County Wexford at the confluence of the River Barrow and River Suir and is separated from both County Waterford and County Kilkenny by the river channel (see **Figure 7.4** and **Figure 7.5**).

[20] It is noted that this in the process of being replaced by a 220kV GIS substation

Figure 7.4: Location of Great Island Substation Site

Figure 7.5: Great Island Substation Site (Aerial View)

It is located in a rural landscape and the land use surrounding the substation is predominantly agricultural, however, immediately south of the substation is the Great Island Power Plant site. The closest settlement to the existing substation is Cheekpoint in County Waterford (approximately 1km south), while the nearest settlement in County Wexford is Campile, (approximately 3.5km east of the site). The nearest residential property is approximately 400m away although a building listed as commercial is less than 300m away. The existing station is located adjacent to a number of significant biodiversity designations. These include two Natura 2000 sites designated under the EU Habitats Directive: the River Barrow and River Nore SAC; and the Lower River Suir SAC. Further along the estuary and extending into Waterford Harbour has been designated as a Shellfish Water under the EU Shellfish Waters Directive 2006 (2006/113/EC).

Substation Zone: At Great Island, OHL corridor options approaching the station from Dunstown are generally from a northerly direction and the corridor options going to Knockraha are generally running in a westerly direction (see **Chapter 8** for full details of OHL corridor routing process). Therefore the search area forms an arc from north-west to north-east with a radius of 8km as off-site solutions may need to be explored (see **Figure 7.6**).

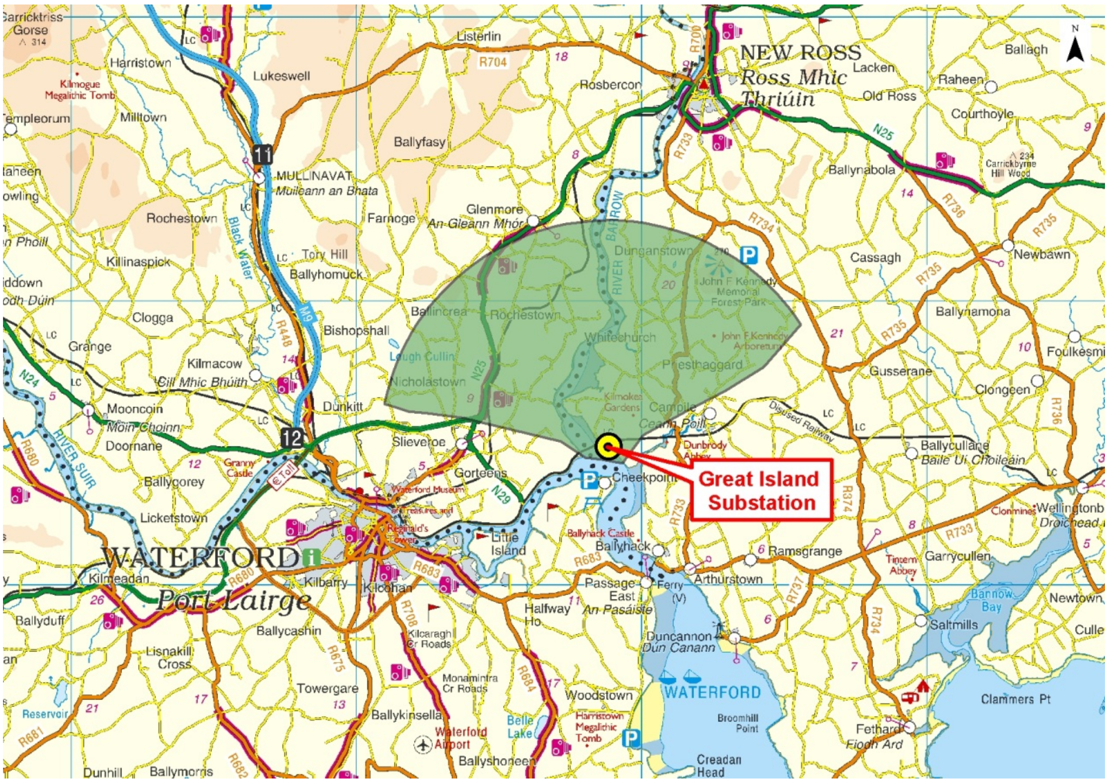


Figure 7.6: Substation Zone at Great Island

7.3.3 Knockraha

Technical Requirements: the Grid Link Project requires a new 400kV substation which would take up an area in the order of 400m x 400m. The size of the substation will vary depending on the technology used. At this site, control buildings, electrical equipment including 400 / 220kV transformers and connections to the existing Knockraha 220kV substation will also be required. In addition, one new 400kV circuit will be required to connect into this new 400kV substation.

Knockraha is an existing 220 / 110kV AIS substation and is one of the main transmission stations in County Cork. The existing substation is equipped with 220kV and 110kV AIS switchgear and currently has three 220 / 110kV transformers. There are six 220kV OHL circuits and six 110kV OHL circuits connecting into the station. Grid Link will necessitate one additional line entry to the area.

Options under consideration to accommodate the new 400kV station include extensions of the existing site, a new site in the immediate vicinity of the existing substation or a new site remote from the existing substation. From a technical perspective it should be noted that the optimum solution is for co-location of the new 400kV development with the existing 220kV substation. This would facilitate a direct connection to the existing substation and use of existing support infrastructure e.g. access roads, all in a landscape already containing similar infrastructure. Off-site options will require new access roads, additional 220kV OHL infrastructure to connect the new 400kV substation back to the existing 220kV substation and all in a relatively greenfield setting.

Receiving Environment: The substation at Knockraha is located approximately 10km north-east of Cork City and approximately 1km east of the village of Knockraha (see **Figure 7.7**). The area is predominantly rural, however, there are a number of dwellings adjacent to the substation on both sides of the public road to the west of the site and these are the closest grouping of properties to the site boundary. There is greater separation distance between the substation and the main grouping of properties to the east of the site.

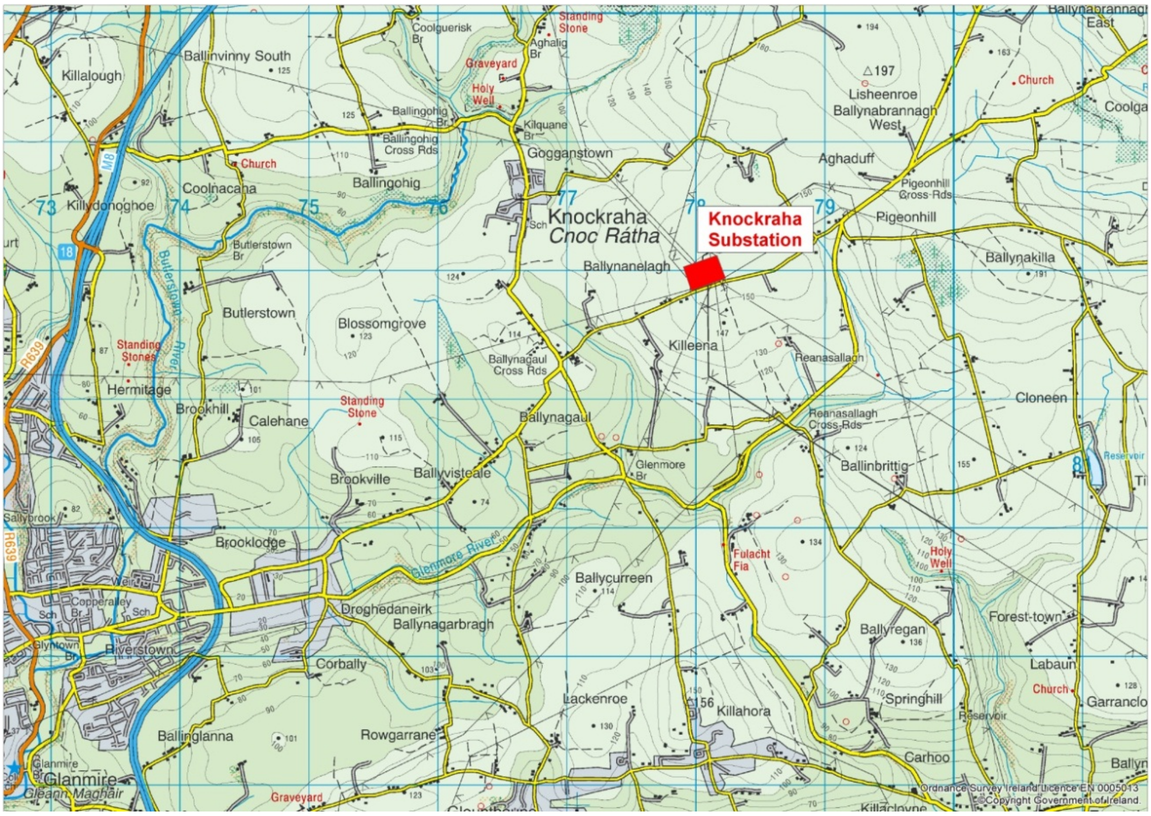


Figure 7.7: **Location of Knockraha Substation Site**

Figure 7.8: **Knockraha Substation Site (Aerial View)**

There are five residential properties located south-west of the substation. The closest of these is approximately 80m away. The closest properties to the north-east are over 600m away from the north-eastern edge of the station.

OHLs and associated structures are visible to the south, north-east and north-west of the station, across the wider landscape. Given the rural character of the surrounding area and the agricultural nature of activities ongoing in the area, the presence of the OHL structures is visually evident.

Substation Zone: At Knockraha OHL corridor options from Great Island are generally approaching from northerly and easterly directions, therefore, the search area forms an arc from north to east with a radius of 8km as off-site solutions may need to be explored here also (see **Figure 7.9**) (see **Chapter 8** for full details of OHL corridor routing process).

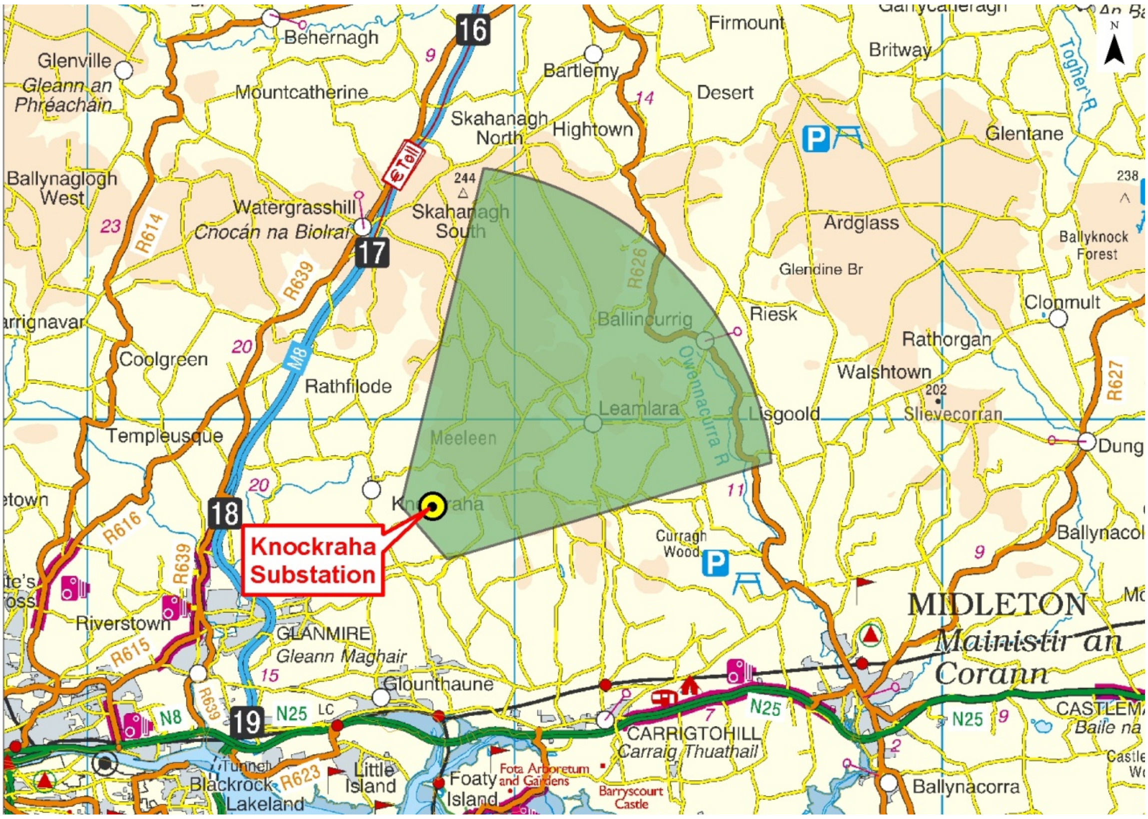


Figure 7.9: Substation Zone at Knockraha

7.4 REFINEMENT OF SUBSTATION ZONES

7.4.1 Technical Constraints and Considerations

In order to identify areas of opportunity within the substation zones, the following technical considerations were taken into account.

- **Connection of Proposed 400kV OHL**: The substation position and orientation must be compatible with any indicative corridors for the proposed Grid Link 400kV OHL. If possible, the 400kV substations should be located such that the 400kV lines approach the substations without crossing any of the existing 220kV lines. It is noted that this information will be dependent on the outcome of the evaluation of OHL corridor options (Stage 2 of the EirGrid Roadmap);

- **Connection to Existing 220kV Substations**: The 400kV substation for the Grid Link Project is to be connected to the existing 220kV Substations at Knockraha and Great Island. Co-location and off-site options will be considered within an 8km radius of the existing substations and having regard to the direction of line entry of the 1km corridor options;

- **Ground Area:** The land area required for a substation depends on the type of switchgear to be installed. Gas Insulated Switchgear (GIS) requires less space than Air Insulated Switchgear (AIS). An area of approximately 400m x 400m would be required for an AIS and approximately 300m x 200m for a GIS;

- **Topography:** The site must not be liable to flooding or crossed by significant water courses. It should also be unencumbered by existing structures which cannot be dismantled. It is preferable to avoid prominent and exposed positions where possible and to be on reasonably level ground,

- **Ground Suitability**: The ground must be suitable to meet technical standards with regard to earthing requirements;

- **Access for Construction**: Building a substation requires heavy construction plant as well as large and heavy electrical equipment. Therefore it must be possible to construct an adequate access track from a suitable public road;

- **Operational Access:** 24 hour access is required for cars and vans and on rare occasions for larger loads; and

- **Extendibility:** The position and orientation of the substation should not prohibit developments (i.e. upgrading works or extension of substation) which may be required in the future.

7.4.2 Environmental Constraints

In addition to the technical constraints discussed above, environmental constraints relevant to substation development and interface options connecting corridor options to the relevant substations were also reviewed using information contained in the Grid Link GIS database. An overview of the environmental constraints at the three nodes is provided below.

Dunstown – Overview of Environmental Constraints

Natural Environment: The existing substation is covered by concrete and offers no ecological value however the area immediately around the site has developed as low shrub and hedgerow which offer potential for birds and bats. Discussions with NPWS in 2012 identified an area to the north of Dunstown substation which is sensitive for the Marsh Fritillary butterfly and also bryophytes but the area has no national or EU nature conservation designations. The main river running through the zone is the River Liffey. This river is not currently designation for any biodiversity related designations however the river corridor is recognised as a high amenity area.

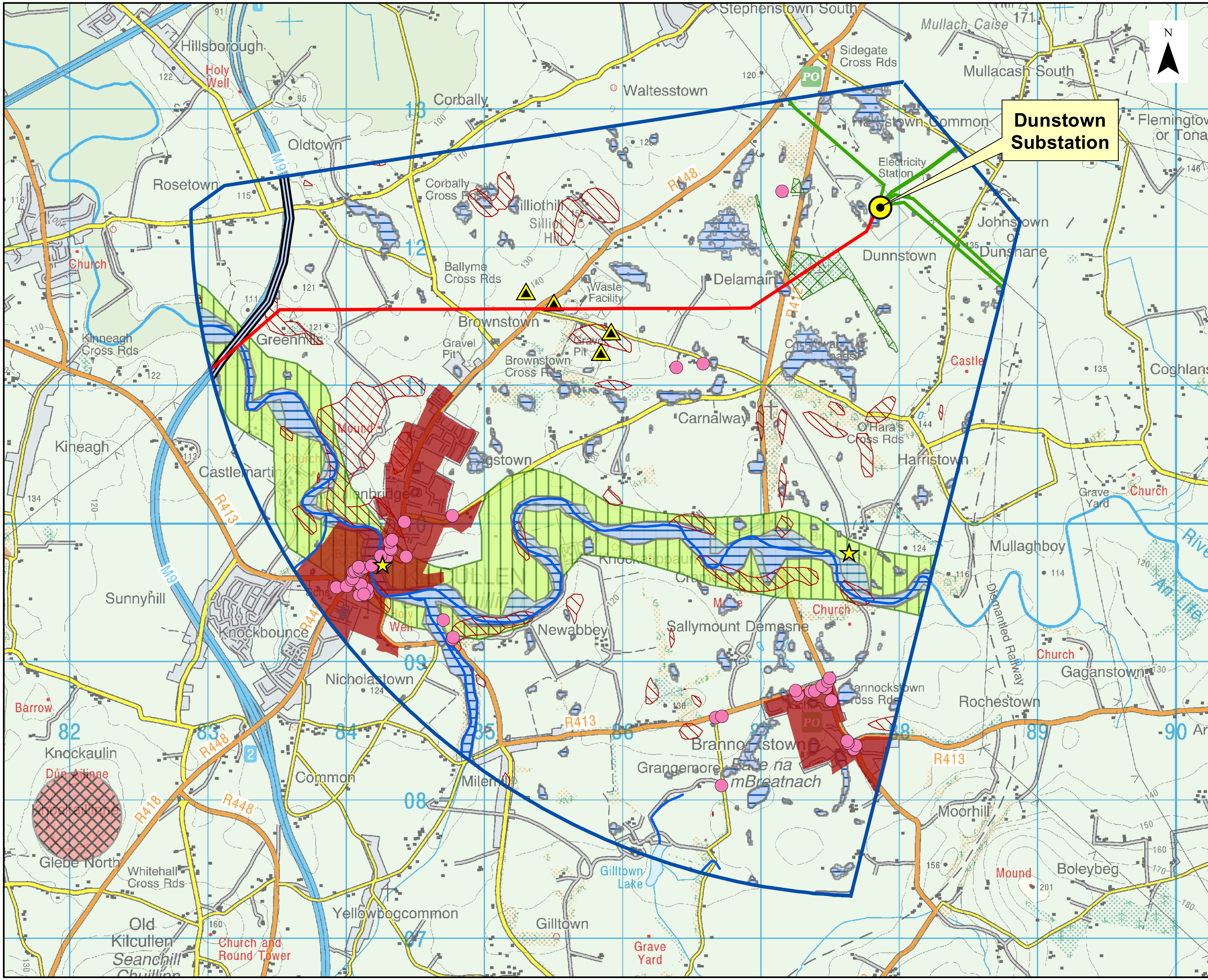
Cultural Environment: There are no recorded RMP NIAH or RPS sites at the existing Dunstown Station. Within the substation zone there are 53 RMP sites including a church and a castle. There are concentrations of NIAH in both Brannockstown and Kilcullen however a small number of isolated other NIAH features are also present in the zone. These include 2 listed as nationally important. As noted earlier, Dún Ailinne, believed to be the royal site of the kings of Leinster, and currently on the UNESCO Tentative List is located 7km south-west of the station. Although outside the substation zone, it is noted that as a site on the UNESCO Tentative List it would be subject to a management plan if fully designated and this could extend into the substation zone. The Grid Link Project Team will therefore liaise with the relevant bodies including the DAHG to monitor the progress of any change to the current designation.

Built Environment: The major towns and villages that occur in the Dunstown substation zone are Kilcullen to the southwest and Brannockstown to the south. These locations offer the main community services available in the area. The nearest residential property to the existing substation is over 230m to the perimeter fence (NW corner). One off housing and housing clusters make up the remaining residential element in the immediate surrounds of the substation.

The existing substation is serviced by the R448 local road and is accessed by a long laneway which provides good separation from the surrounding residential properties. The existing substation is located in a rural landscape and the land use surrounding the station is predominantly agricultural. A number of quarries / mines are located in the Brownstown area to the west of the existing station.

The Dunstown Moneypoint 400 kV OHL, one of only two 400 kV OHL in the country leaves the station heading in a westerly direction. In addition, a further four 220 kV OHL emanate from Dunstown substation in a broadly northwest to southeast orientation.

Figure 7.10 shows the constraints within the substation zone for Dunstown.



Legend

- Existing Substation
- Dunstown Segment - 5km

Existing Transmission Network

- 110kV
- 220kV
- 400kV
- Tourist Site
- NIAH (International/ National/Regional)
- Quarry / Mine / Landfill
- Motorway / Primary Road
- River
- Coillte Commercial Forestry
- Slope >7% (equivalent to 4 degrees)
- Settlement
- Flooding
- Area of High Amenity/ Special Amenity
- UNESCO Site (on Tentative List)

Client

EIRGRID

THE GRID LINK PROJECT

Figure 7.10

Dunstown Substation Zone Constraints

RPS

West Pier Business Campus, Dun Laoghaire, Co Dublin, Ireland.
T +353 (0) 1 4882900
F +353 (0) 1 2835676
E ireland@rpsgroup.com
W rpsgroup.com/ireland

Issue Details

Drawn By: N. O'Neill		Project No. MDR0835	
Checked By: A. Gaughran		File Ref: MDR0835Arc_EV0247F01	
Approved By: J. Shalloe			
Scale: 1: 35,000 (A4)		Drawing No. Arc_EV0247	Rev: F01
Date: 29/08/2013			

NOTE:
1. This drawing is the property of RPS Group Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent.
2. Ordnance Survey Ireland Licence EN 0005013 ©Copyright Government of Ireland.

0 0.5 1
Kilometers

Great Island Substation Zone – Overview of Environmental Constraints

Natural Environment: The existing substation is covered by hard surfaces and offers no ecological value, however, the area immediately around the site has developed as low shrub and hedgerow which offer potential for birds and bats. Common pipistrelle, Soprano pipistelle and Leisler's bat were noted to be feeding within the area of Great Island during survey works completed as part of the Great Island Proposed Power Plant EIS in 2009. These species were also recorded by Bat Conservation Ireland (BCI) at various locations within the 8km radius of the existing substation. All bat species are protected in Ireland (there are 42 BCI bat survey sites in the Great Island substation zone).

There are several landscape designations associated with the substation zone. Along the western flank of the River Barrow there is a Kilkenny Area of High Amenity and along the eastern flank is the Wexford Policy Area 2 (Lowlands – Barrow River Corridor). The River Barrow Corridor would be considered sensitive to development. Beyond the river valley, the landscape is one of low undulating hills and open farmland. There are several scenic routes in Kilkenny and Waterford some of which are characterised as 'visually vulnerable'. There are also approximately 26 protected views / prospects within the Great Island substation zone. Slieve Coilte forms the highest area of elevation within the zone at 270m and includes a viewing point of the wider area.

The existing station is located adjacent to a number of significant biodiversity designations. These include two Natura 2000 sites designated under the EU Habitats Directive namely, the River Barrow and River Nore SAC and the Lower River Suir SAC. The River Barrow and River Nore SAC has been designated for the presence of habitats such as estuaries, mudflats, petrifying springs and alluvial woodland and for species such as the Nore freshwater pearl mussel, sea, brook and river lamprey and twaite shad. The Lower River Suir SAC is designated for similar species. In addition to the SAC designation, the Barrow River is also designated as pNHA as the River Barrow Estuary. The Lower River Barrow is a regionally important site for wintering wildfowl and waders. The Conservation Objectives developed for the River Barrow and River Nore SAC include locations which are known to be important for various protected habitats and species, e.g. petrifying springs, freshwater pearl mussel. These will be particularly relevant for any OHL river crossings that may be required upstream of the station. Other proposed NHAs in the zone include Lough Cullin, King's Channel and Ballykelly Marsh. To the south, the zone overlaps the Designated Shellfish Waters of Waterford Harbour. A Pollution Reduction Programme which establishes a programme of measures to reduce pollution pressures in the designated water will be a relevant consideration.

The Barrow and Suir rivers are both prone to flooding (in coastal, pluvial and fluvial flood categories).

Cultural Environment: There are a variety of RMP sites (approximately 250) within the Great Island substation zone. These range from fulacht fias and souterrains to castle towers, enclosures and forts. Other monuments of national and historic importance are also present, including Dunbrody Abbey.

There is significant archaeological potential along the River Suir and in the River Suir / Barrow Estuary (along the bays and inlets of the coast). In addition, Kilmokea Fort in Great Island contains many medieval features within a large zone of potential and is adjacent to a large rampart site; it also has associated gardens. To the south-east of this is a large deserted medieval settlement site containing many earthworks.

There are 37 RPS sites, including various country houses and railway structures. There are also a number of NIAH sites – 6 of national, 124 of regional and 8 of local importance. In addition there are 44 historic gardens within the zone. Other attractions include the Kilmokea and Abbey Road gardens.

Built Environment: The major cities / towns and villages that occur in the Great Island substation zone are Waterford City and suburbs, Campile, Sliverue and Cheekpoint villages. The closest settlements to the existing substation are Cheekpoint in Waterford and Campile in Wexford. These locations offer the main community services available in the area. One off housing and housing clusters make up the remaining residential element in the immediate surrounds of the substation.

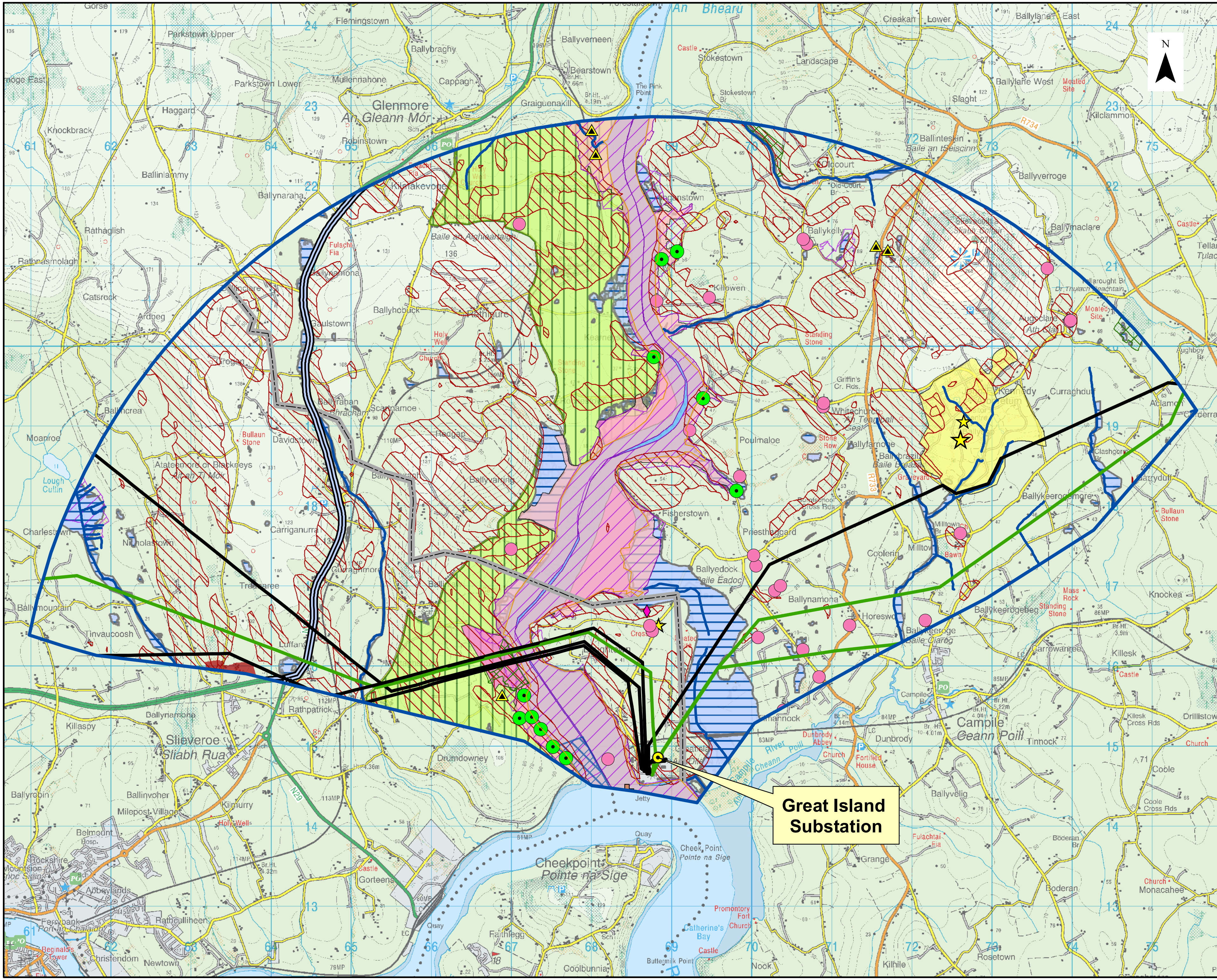
The existing substation is located in a rural landscape and the land use surrounding the station is predominantly agricultural, however, south of the substation is the Great Island Power Plant. The combination of the substation and the power plant has introduced an element of urban / industrial structure into the otherwise rural surround. This is compounded by the presence of a number of existing 220kV and 110kV OHLs converging on the Great Island Substation from both the east (3 OHLs) and west (4 OHLs). These lines cross the river estuary north of the station and given the open nature of the river and estuary the OHL structures are very evident in the landscape.

The principal road servicing the existing substation is the regional road the R733. The EIS for the adjacent Power Plant at Great Island noted the following: *The site is accessed via a 5 kilometre section of local road. This section of local road forms a priority junction with the R733 at Ballinamona. The section of local road accessing the site is generally rural in character with road widths varying between 4.0 to 5.0 meters along the majority of this 5 kilometre section. This section of local road exhibits a number of acute changes in horizontal alignment with a particularly "tight" bend at Fisherstown. The road also narrows to approximately 3.5 meters in width for a section of approximately 400 metres along the "causeway".* The R733 connects to various local roads including the R734 and R735 to the east and the N25 to the north.

A railway line passes north of the existing station in an east-west direction, crossing the estuary at Barrow Bridge to the west and passing through Campile to the east. This is the main Waterford to Rosslare line.

JFK Arboretum and Visitor Centre, the William Vincent Wallace Plaza and the Dunbrody Abbey Visitor Centre are also present in this substation zone.

Figure 7.11 shows the constraints within the substation zone for Great Island.



Legend

- Existing Substation
- Great Island Segment - 8km

Existing Transmission Network

- 110kV
- 220kV
- 400kV
- Annex I Habitat (NPWS Confirmed)
- National Monument
- Register of Historic Monuments
- NIAH (International / National / Regional)
- Quarry / Mine / Landfill
- Geological Heritage Area
- Tourist Site
- Port
- Motorway / Primary Road
- Underground Service (Gas Pipeline)
- River
- Coillte Commercial Forestry
- Slope >7% (equivalent to 4 degrees)
- Settlement
- Shellfish Area
- Proposed Natural Heritage Area
- Special Area of Conservation
- Annex I Habitat (CORINE)
- Recreational Area (CORINE)
- Lake / Estuary
- Expanse of Water >300m Width
- Flooding
- Area of High Amenity/ Special Amenity

Client

EIRGRID

THE GRID LINK PROJECT

Figure 7.11

Great Island Substation Zone Constraints

RPS
West Pier Business Campus, Dun Laoghaire, Co Dublin, Ireland.
T +353 (0) 1 4882900
F +353 (0) 1 2835676
E ireland@rpsgroup.com
W rpsgroup.com/ireland

Issue Details

Drawn By:	N. O'Neill	**Project No.**	MDR0835
Checked By:	A. Gaughran	**File Ref:**	MDR0835Arc_EV0190F01
Approved By:	J. Shalloe		
Scale:	1: 60,000 (A4)	**Drawing No.**	**Rev:**
Date:	29/08/2013	Arc_EV0190	F01

NOTE:

1. This drawing is the property of RPS Group Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent.
2. Ordnance Survey Ireland Licence EN 0005013 ©Copyright Government of Ireland.

0 0.5 1 2

Kilometers

Knockraha – Overview of Environmental Constraints

Natural Environment: Most of the existing substation is covered by hard surfaces and offers no ecological value. However the area immediately around the compound has developed as low shrub and hedgerow which offer potential for birds and bats. These species were also recorded by Bat Conservation Ireland (BCI) at various locations within the 8km radius of the existing station. All bat species are protected in Ireland and there are 2 BCI bat survey sites in the Knockraha Substation zone.

One landscape designation occurs in the substation zone, a scenic route associated with County Cork. The general topography within the Knockraha substation zone is one of lowlands and gentle hills, with land use comprised mainly of pastures and heterogeneous agricultural areas. Coolquane forms the highest area of elevation within the zone at 244m.

There are no Natura 2000 sites in the Knockraha substation zone, however, there is one proposed NHA present, Leamlara Wood. It is approximately 5km to the east of the existing substation and runs along the south-west bank of the Leamlara River valley. It forms one of the few semi-natural oakwoods in east Cork. There is also one area of Annex I habitat (currently not protected by an EU or national designations) at Corbally South. This corresponds to an NPWS native woodland site.

The rivers in the Knockraha substation zone are prone to flooding (in both pluvial and fluvial flood categories). The two major rivers include the Owenacurra and Leamlara rivers and their tributaries. Inland Fisheries Ireland has noted that the Owenacurra River has good stocks of sea trout.

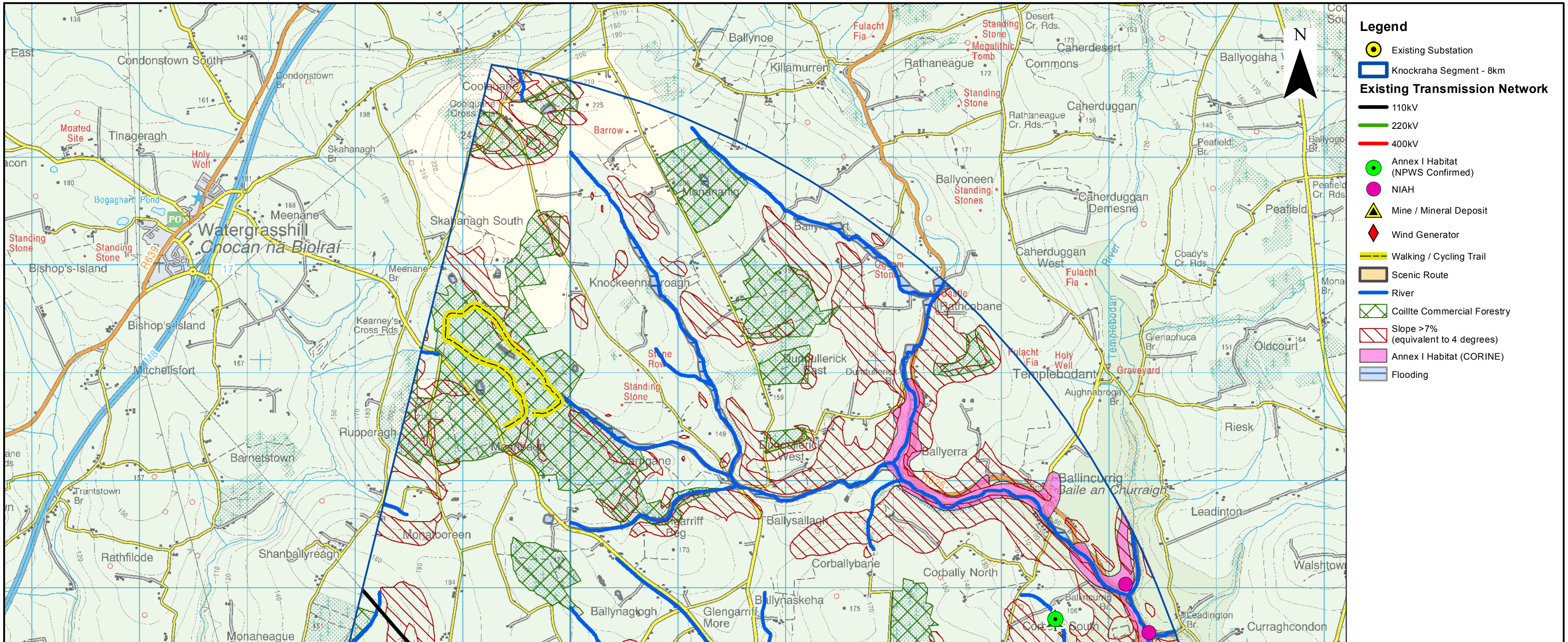
Cultural Environment: There are approximately 103 RMP sites within the Knockraha substation zone. These range from souterrains and standing stones to enclosures and ringforts. Additionally there are 3 RPS sites and 9 NIAH sites of regional importance. There are also 4 historic gardens, including Leamlara House, Corbally House and Dundullerick House.

Built Environment: The main settlement is Watergrasshill, which lies partially in the north-west corner of the substation zone and includes an industrial development area. Knockraha village is outside the zone boundary. Cork City and its suburbs lie to the south-west. These locations offer the main community services available in the area. One-off housing and housing clusters make up the remaining residential element in the immediate surrounds of the substation. The existing substation is located in a rural landscape and the land use surrounding the station is predominantly agricultural. A number of existing 220kV and 110kV OHL converge on the Knockraha Substation from all directions. Given the lowland nature of the surrounding land, the substation structures are very visible approaching from a north / north-west direction. There is also a wind generator located near Pigeon Hill, approximately 1.6km to the west of the substation.

There are no rail services in the substation zone and the road infrastructure is comprised for the most part of local roads, with the regional road R626 passing though the eastern edge and the M8 motorway skirting east of Watergrasshill and overlapping the north-west corner of the zone.

There is a Coillte recreational walking / cycling trail located in an elevated area amidst Coillte-owned forest, near Kearney’s Cross Roads.

Figure 7.12 shows the constraints within the substation zone for Knockraha.



Client

EIRGRID

THE GRID LINK PROJECT

Figure 7.12

Knockraha Substation Zone Constraints

RPS
West Pier Business Campus,
Dun Laoghaire,
Co Dublin, Ireland.
T +353 (0) 1 4882900
F +353 (0) 1 2835676
E ireland@rpsgroup.com
W rpsgroup.com/ireland

Issue Details

Drawn By: S. Khan		**Project No.** MDR0835	
Checked By: A. Gaughran		**File Ref:** MDR0835Arc_EV0199F01	
Approved By: J. Shalloe			
Scale:	1: 50,000 (A4)	**Drawing No.**	**Rev:**
Date:	29/08/2013	Arc_EV0199	F01

NOTE:
1. This drawing is the property of RPS Group Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent.
2. Ordnance Survey Ireland Licence EN 0005013 ©Copyright Government of Ireland.

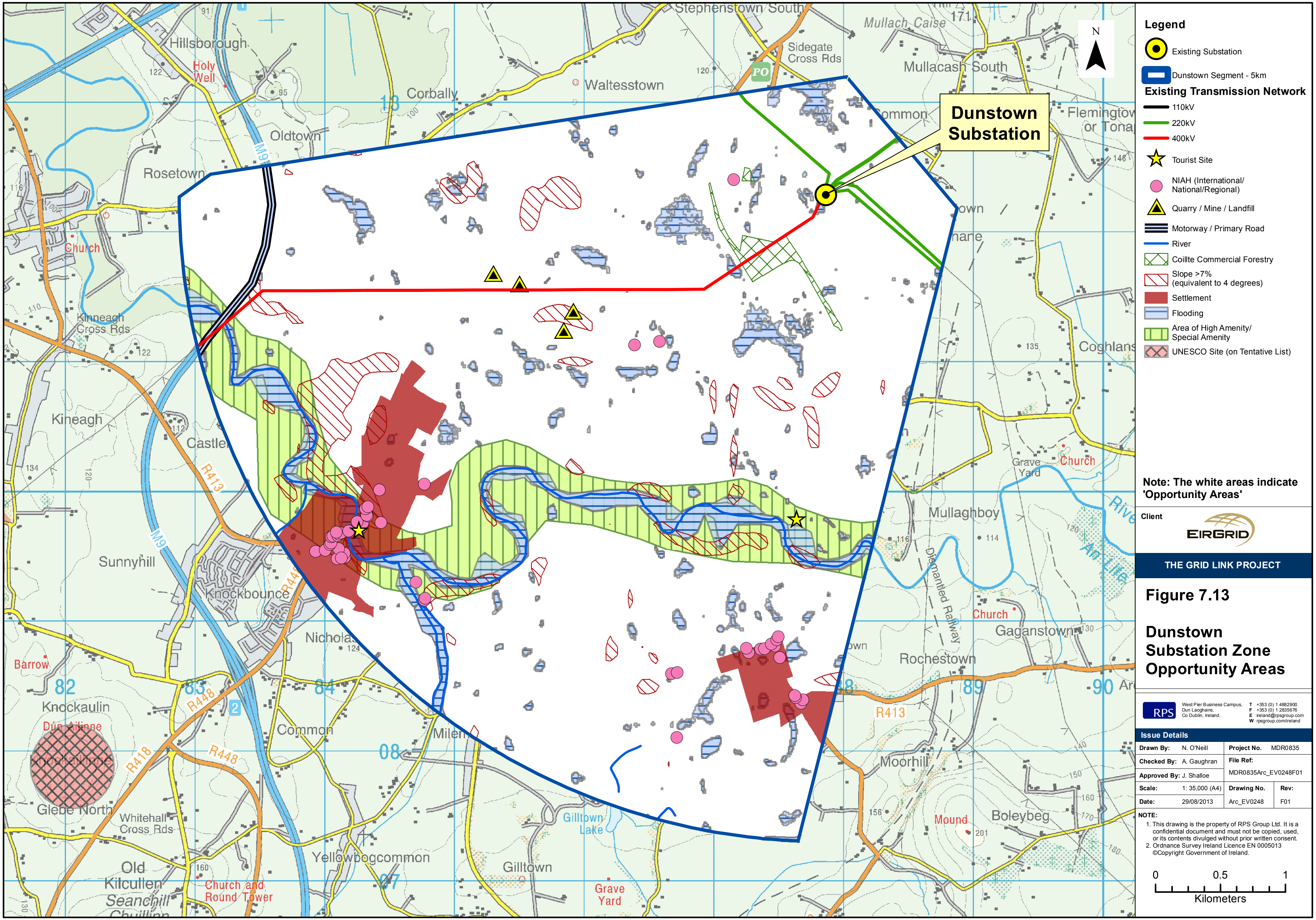
0 0.75 1.5
Kilometers

7.5 SUBSTATION OPPORTUNITY AREAS

Applying the technical and environmental constraints (See **Appendix 2** for further details on constraints) to the three substation nodes has resulted in identification of broad areas of opportunity with limited or no constraints within which further studies and field survey work will be undertaken to identify specific substation sites at Great Island and Knockraha and interface options connecting corridor options to the relevant substations at all three substations. The opportunity areas are those areas shown in white on **Figures 7.13, Figure 7.14** and **Figure 7.15.**

7.6 NEXT STEPS

As the project enters Stage 2 of EirGrid's Project Development and Consultation Roadmap (see **Chapter 1** of this Report), specific substation site options will be identified for Great Island and Knockraha where new infrastructure is required. In addition, interface options connecting corridor options to the relevant substations will also be identified at Dunstown, Great Island and Knockraha where tie-ins will be required. The substation options and the interface options will be evaluated in the context of their connection to the corridor options identified in **Chapter 8** of this report.


Dunstown Substation
Legend
Existing Substation
Dunstown Segment - 5km
Existing Transmission Network
110kV
220kV
400kV
Tourist Site
NIAH (International/ National/Regional)
Quarry / Mine / Landfill
Motorway / Primary Road
River
Coillte Commercial Forestry
Slope >7% (equivalent to 4 degrees)
Settlement
Flooding
Area of High Amenity/ Special Amenity
UNESCO Site (on Tentative List)
Note: The white areas indicate 'Opportunity Areas'
Client
EIRGRID
THE GRID LINK PROJECT
Figure 7.13
Dunstown Substation Zone Opportunity Areas
RPS
West Pier Business Campus, Dun Laoghaire, Co Dublin, Ireland.
T +353 (0) 1 4882900
F +353 (0) 1 2835676
E ireland@rpsgroup.com
W rpsgroup.com/ireland
Issue Details
Drawn By: N. O'Neill
Project No. MDR0835
Checked By: A. Gaughran
File Ref: MDR0835Arc_EV0248F01
Approved By: J. Shalloe
Scale: 1: 35,000 (A4)
Drawing No. Arc_EV0248
Rev: F01
Date: 29/08/2013
NOTE:
1. This drawing is the property of RPS Group Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent.
2. Ordnance Survey Ireland Licence EN 0005013 ©Copyright Government of Ireland.
0 0.5 1
Kilometers

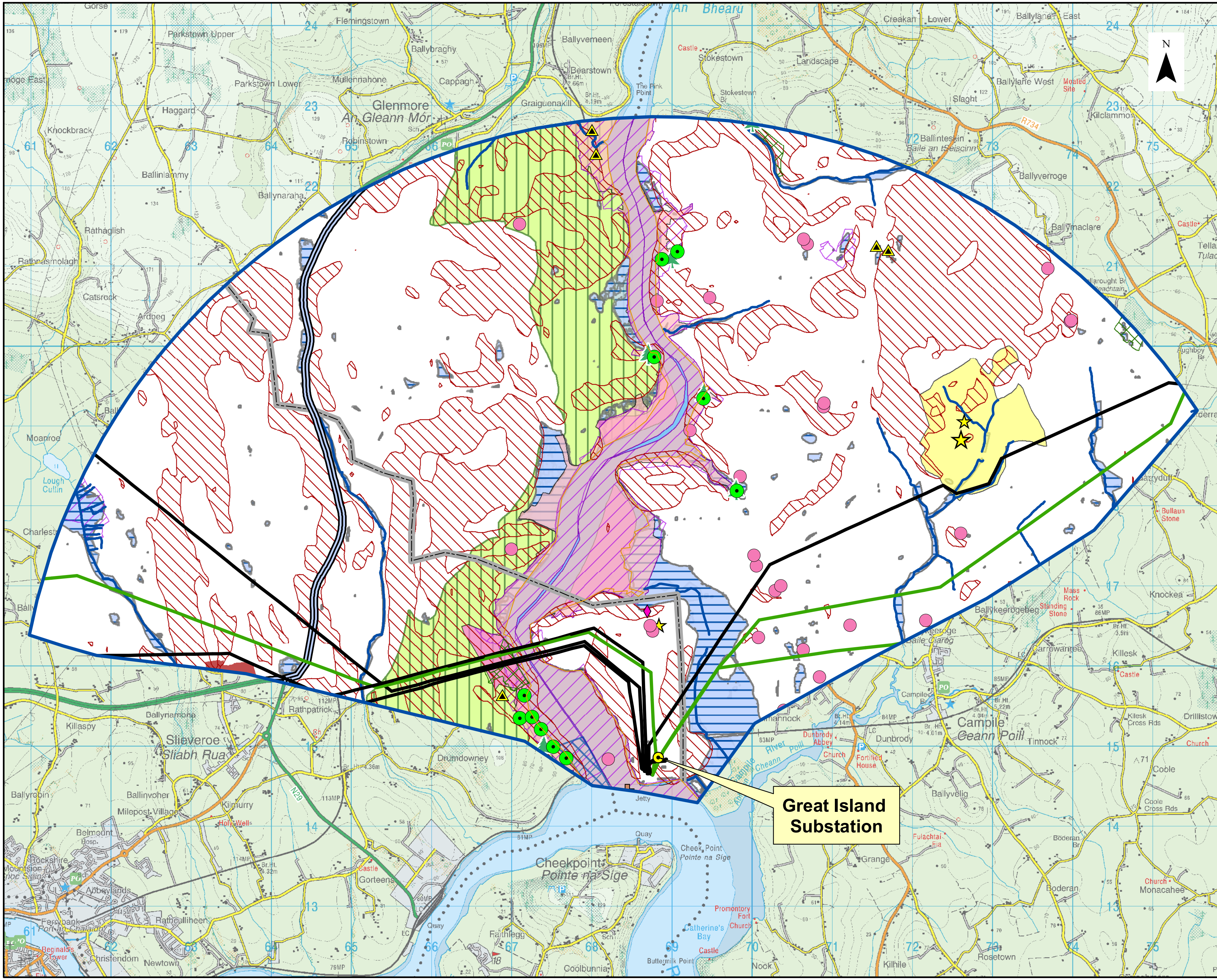


Figure 7.14

Great Island Substation Zone Opportunity Areas

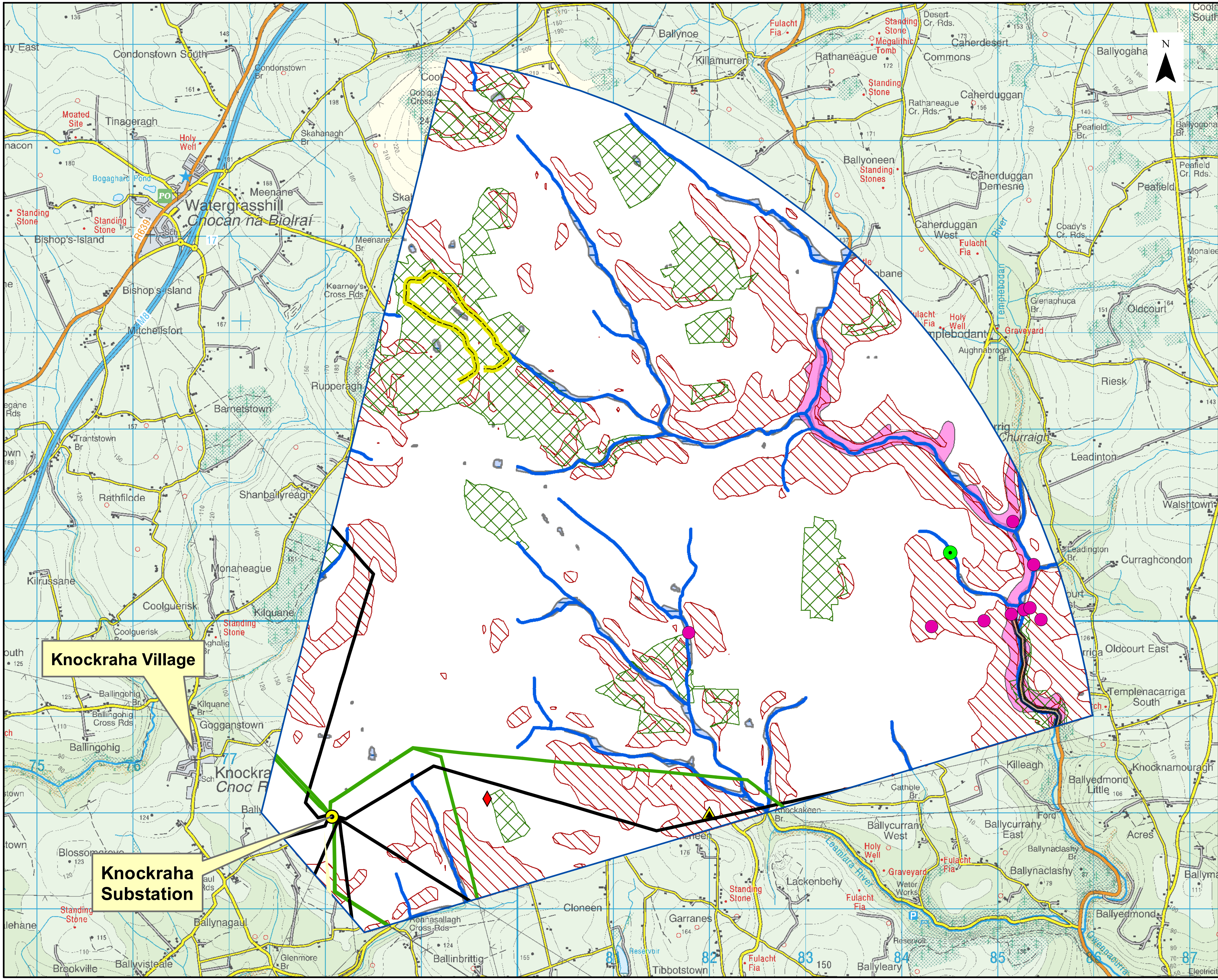
RPS
West Pier Business Campus, Dun Laoghaire, Co Dublin, Ireland.
T +353 (0) 1 4882900
F +353 (0) 1 2835676
E ireland@rpsgroup.com
W rpsgroup.com/ireland

Issue Details

Drawn By:	N. O'Neill	**Project No.**	MDR0835
Checked By:	A. Gaughran	**File Ref:**	
Approved By:	J. Shalloe	MDR0835Arc_EV0198F01	
Scale:	1: 60,000 (A4)	**Drawing No.**	**Rev:**
Date:	29/08/2013	Arc_EV0198	F01

NOTE:

1. This drawing is the property of RPS Group Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent.
2. Ordnance Survey Ireland Licence EN 0005013 ©Copyright Government of Ireland.



Legend

- Existing Substation
- Knockraha Segment - 8km

Existing Transmission Network

- 110kV
- 220kV
- 400kV
- Annex I Habitat (NPWS Confirmed)
- NIAH
- Mine / Mineral Deposit
- Wind Generator
- Walking / Cycling Trail
- Scenic Route
- River
- Coillte Commercial Forestry
- Slope >7% (equivalent to 4 degrees)
- Annex I Habitat (CORINE)
- Flooding

Note: The white regions indicate 'Opportunity Areas'

Client

EIRGRID

THE GRID LINK PROJECT

Figure 7.15

Knockraha Substation Zone Opportunity Areas

RPS
West Pier Business Campus, Dun Laoghaire, Co Dublin, Ireland.
T +353 (0) 1 4882900
F +353 (0) 1 2835676
E ireland@rpsgroup.com
W rpsgroup.com/ireland

Issue Details

Drawn By:	N. O'Neill	Project No.	MDR0835
Checked By:	A. Gaughran	File Ref:	MDR0835ArcEV0200F01
Approved By:	J. Shalloe		
Scale:	1: 50,000 (A4)	Drawing No.	Rev:
Date:	29/08/2013	Arc_EV0200	F01

NOTE:
1. This drawing is the property of RPS Group Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent.
2. Ordnance Survey Ireland Licence EN 0005013 ©Copyright Government of Ireland.

0 0.25 0.5 1
Kilometers

8 ROUTE CORRIDOR IDENTIFICATION PROCESS

8.1 INTRODUCTION

As set out in **Chapter 2**, a 400kV high voltage alternating current overhead line (HVAC OHL) solution connecting the existing substations Knockraha, Great Island and Dunstown has been determined to be the best technical solution for the Grid Link Project.

This chapter of the report sets out the methodology used to identify feasible 1km corridor options for the Grid Link Project. The process had three main phases which each included a number of activities (referred to as tasks) and, although described individually below, it is acknowledged that they often overlapped and informed each other. Therefore the descriptions are more realistically considered as part of an overall process. The three main phases are described below and are illustrated in **Figure 8.1**:

- **Phase 1 - The identification of strategic connection options**. These are high-level connection options could form the required 400kV link between Dunstown, Great Island and Knockraha.

- **Phase 2 - The identification of broad corridors**. These are indicative geographical areas developed between the connection nodes, the borders of which are defined with reference to the avoidance of the most sensitive primary constraints and early consideration of routing principles e.g. comparatively direct routes between the nodes. This process was based on available constraints information and predominantly comprised desk top work but was also supported by vantage point surveys.

- **Phase 3 – Identification of feasible 1km wide corridors.** The identification of feasible corridors of an indicative width (for comparative purposes) of 1km. These are corridors within which an alignment could potentially be developed. The identification process sought to avoid primary and secondary constraints to the greatest extent possible, and it relied on the application of OHL routing principles. However, it should be noted that it was not possible to avoid all such constraints for the purposes of corridor identification, although this may be possible with subsequent identification of a line route within the indicative corridor. Site visits were important during this process to understand the topography, landscape, visibility and other constraints and considerations associated with each broad corridor and the identification of feasible 1km route corridors therein.

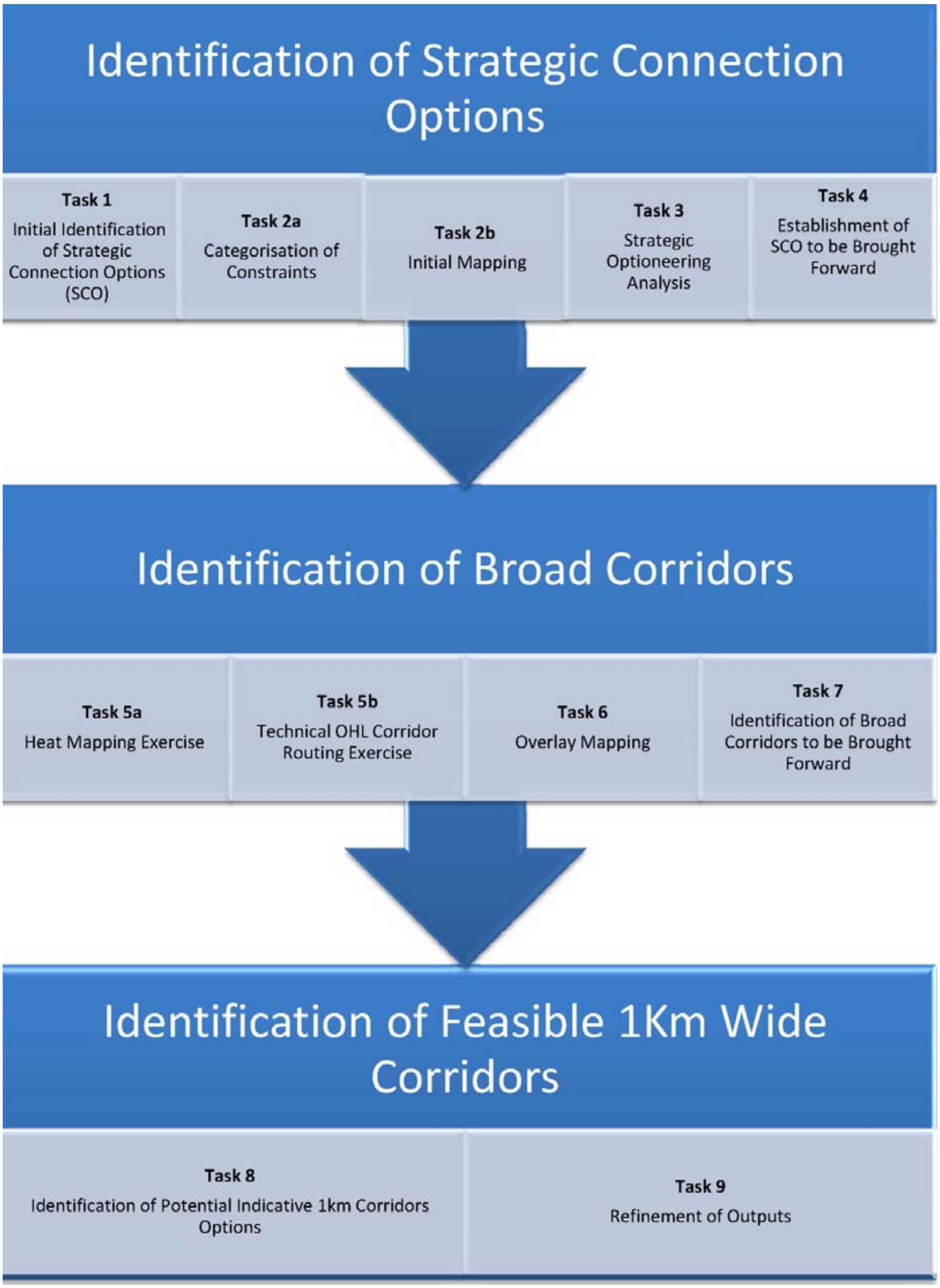


Figure 8.1: Main Phases in Corridor Identification Process

The most effective method of avoiding or minimising potential impacts associated with an OHL development is through appropriate route selection. The identification of technically feasible corridor options which avoid identified environmental and other constraints, to the greatest extent possible, and within which a 400kV OHL might be appropriately routed, has therefore been the main focus of the Grid Link project team during this stage of the project.

8.2 STRATEGIC CONNECTION OPTIONS

8.2.1 Task 1 – Initial Identification of Strategic Connection Options

Following the review of baseline data relevant to the project (based on the results of *The Grid Link Project Constraints Report* August 2012[21] referred to hereafter as the *Constraints Report*, associated mapping and the second round of public and stakeholder consultation), a preliminary review of project objectives and scope was undertaken. Given the geographic positioning of the three connection nodes, i.e. Dunstown (County Kildare), Great Island (County Wexford) and Knockraha (County Cork), and in the context of the requirement to consider reasonable alternatives, the project team identified a number of strategic connection options which could link Dunstown to Knockraha, via Great Island. The main strategic connection options are illustrated in **Figure 8.2**.

Figure 8.2: Strategic Connection Options

[21] Available at www.eirgridprojects.com/projects/gridlink/constraintsreport

The main strategic connection options are:

- Dunstown – Great Island (Eastern Option); or Dunstown – Great Island (Central Option).

With

- Great Island – Knockraha (Southern Option).

OR

- Dunstown – Knockraha with link to Great Island (Western Option).

Prior to investigating the strategic connection options further, the project team presented them to EirGrid to make sure that the suggested strategic connection options met the technical requirements that were intended for the Grid Link Project. It was noted that one of the suggestions, the Western Option (Dunstown to Knockraha with a link to Great Island), would require a 400kV OHL arrangement consisting of a single circuit from Dunstown to the point where a long length of double circuit OHL would link into and out of Great Island followed by a single circuit continuing to Knockraha.

While double circuits do exist on the Irish transmission system today, in general they are used over short distances where an area is very congested such as the approach to stations or in urban areas. In assessing the appropriateness of using double circuits for longer distances, it is necessary to consider the risk such applications present to the system. The primary concern relates to common cause failure i.e. the failure of two or more circuits, systems or components due to a single specific event or cause. Such events could arise due to onerous weather conditions, caused for example by wind, lightning, or ice build-up, acts of vandalism, terrorism, or accidents. The impact to the system of a double circuit outage depends on the capacity of the remaining network. In some transmission systems such as National Grid, UK, double circuits are used where redundancy and capacity have been designed into the system to allow for their loss. This level of redundancy has not been designed into the Irish system and for these reasons, amongst others, the use of double circuit line configurations is seen to pose a risk to the reliability of the Irish transmission network. This risk has to be managed and minimised as far as possible.

In particular, the use of double circuits as proposed for the Western Option present an inherent risk that a single event major fault or problem could impact on the operation of both circuits simultaneously. In such an event the power previously flowing on these lines would transfer instantaneously onto other remaining circuits. Because of the lack of available capacity, the remaining underlying 220kV and / or 110kV networks would not be able to accommodate the potentially large power flows that could occur. This would then result in thermal overloading of circuits, potentially leading to cascading outages and the loss of supply to extended areas across the south of the country. If this method of construction was used additional reinforcement would need to be implemented to provide the essential capacity and redundancy. For the reasons outlined above, EirGrid concluded it is not feasible (in terms of meeting the necessary technical requirements) to use long lengths of double circuit for the Grid Link Project. However, in accordance with general practice, some short lengths of double circuit may be acceptable where essential to mitigate specific constraints or to address congestion concerns where accessing substations.

Furthermore, with due consideration and by application of best practice routing principles the use of two single circuit 400kV lines to form the tee-off connection to Great Island could not be justified. Accordingly, the Western Option was discounted at this point, however the bottom half of the western strategic corridor remained as potential connections between Great Island and Knockraha may be found in this area.

8.2.2 Task 2 – Categorisation and Mapping of Constraints

Task 2a – Categorisation of Constraints

In parallel with the identification of strategic connection options, the project team undertook a review of the constraints identified in the *Constraints Report* and mapping of those constraints identified during subsequent consultation. The review included a number of workshops with planning, technical, and environmental specialists to agree categorisation of constraints as either primary (i.e. constraints that should be avoided in the first instance) or secondary (constraints that should be avoided where possible). For more detailed information on the classification of constraints developed by the project team for the Grid Link Project refer to **Appendix 2**.

The focus at this early stage of the route corridor identification process was on the most sensitive primary constraints in the study area. These related principally to the legal protections afforded to sites / features at an International or European level (i.e. World Heritage Sites, Special Areas of Conservation (SAC) and Special Protection Areas (SPA)).

Task 2b – Initial Mapping of Primary Constraints

To assist the project team with analysis of the baseline constraints data, international / European designations (most sensitive primary constraints) were coloured dark red on mapping and other technical and land use constraints (primary constraints) were coloured light red. The identification of primary constraints in this manner, within the study area, is illustrated in **Figure 8.3.**

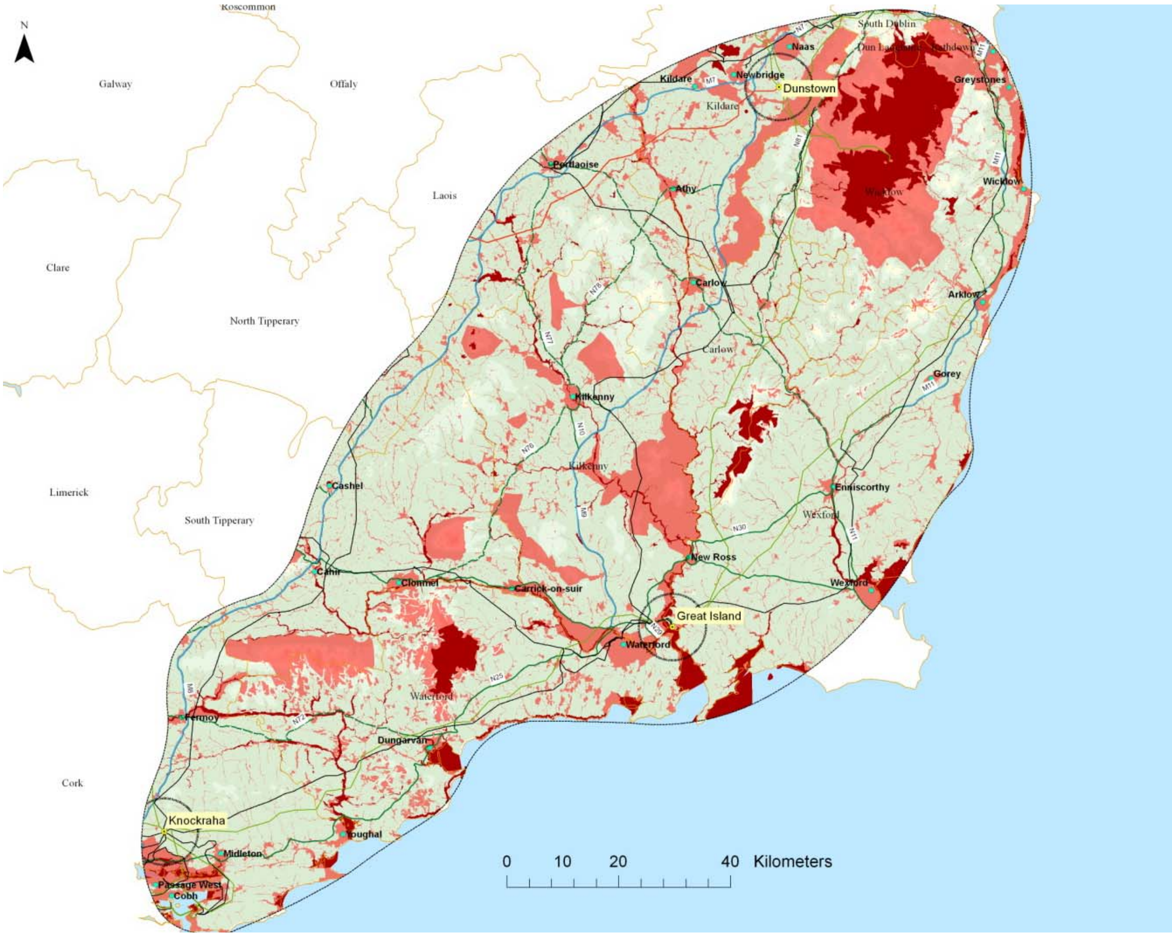


Figure 8.3: Primary Constraints within the Study Area[22]

8.2.3 Task 3 - Strategic Optioneering Analysis

A strategic optioneering exercise focusing on strategic environmental considerations was then undertaken to determine whether the connection options (identified during Task 1) should be investigated further (i.e. brought forward to the route corridor identification process).

The initial mapping enabled the project team to visualise the geographic extent of the constraints in the context of the proposed strategic connections options. While primary constraints featured to some degree along all strategic connection options, in the case of the most northerly section of the Eastern Option, the level of congestion and sensitivity having regard to the cumulative extent of primary constraints in this area was noted, specifically in terms of the following:

---

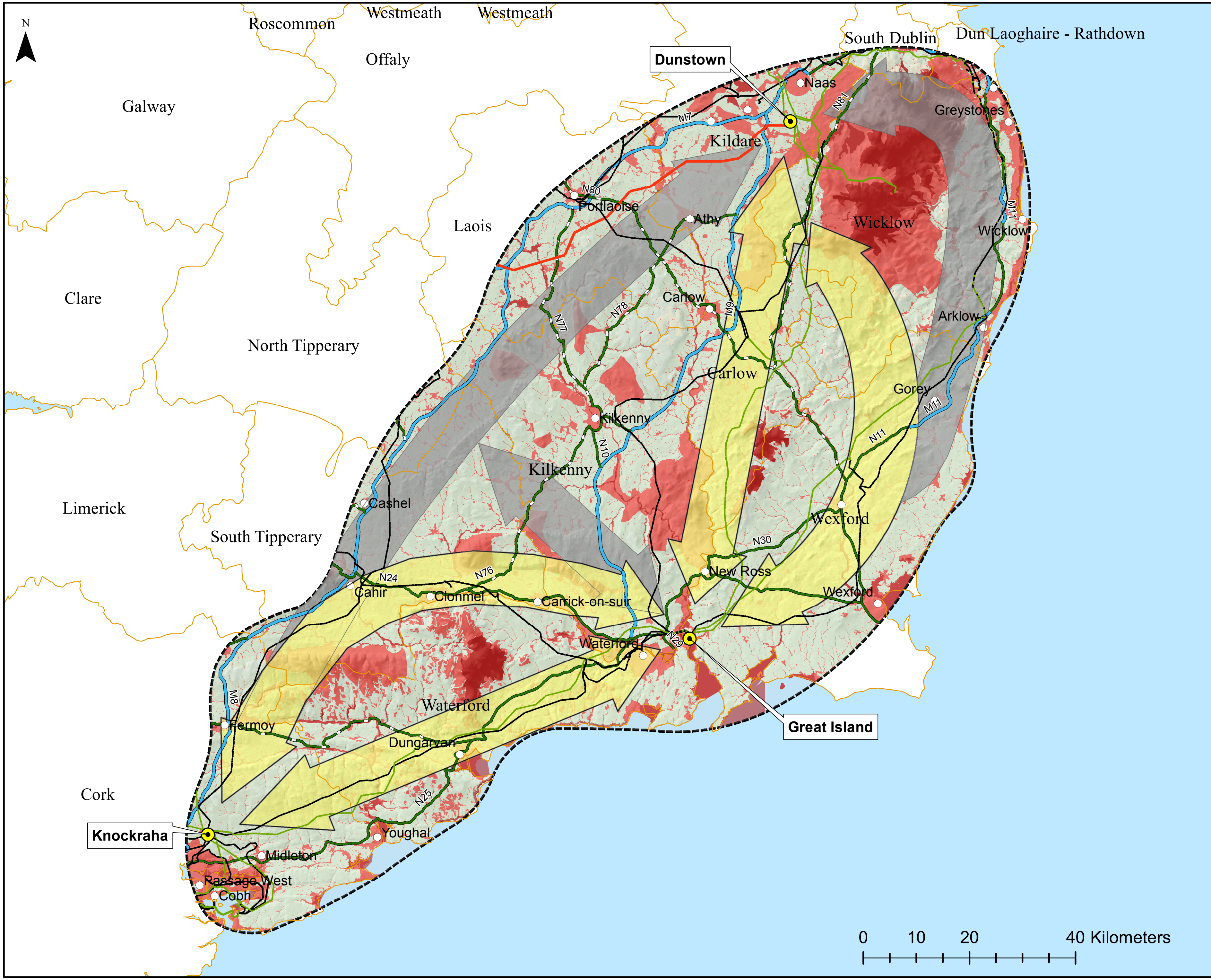
[22] The collection, up-dating and categorisation of constraints is, and will continue to be, an on-going task for the project team. This figure is an early representation of primary constraints for the Grid Link Study Area.

- Elevation of Wicklow Mountains;
- Presence of National Park;
- SAC/SPA designation;
- Urban fringe of Dun Laoghaire Rathdown County and South Dublin County;
- Settlements of Greystones and Bray; and
- Landscape designations for Wicklow and South Dublin County.

In this regard, the level of congestion and sensitivity of the northerly section of the Dunstown – Great Island link (Eastern Option) and the cumulative extent of primary constraints in this area (specifically landscape, topography, ecology, urban fringe and slope related constraints) was considered by the project team to be disproportionate to the other options. The fact that this option was also noticeably longer was also a relevant consideration having regard to best practice routing principles. Accordingly, this northern section of the eastern option was discounted at this point. A possible strategic connection south of the Wicklow Mountains in a less congested area which could link the southern section of that option across to Dunstown is included for further consideration.

8.2.4 Task 4 - Establishment of Strategic Connection Options to be Brought Forward

The refinement of the strategic connection options to be included for further consideration is illustrated on **Figure 8.4**.



Legend

- Existing Substation
- Major Town/City

Existing Network

- 110 kV
- 220 kV
- 400 kV

National Roads

- Motorway
- National Primary
- National Secondary
- County Boundary
- Study Area
- Primary Constraints (Very Extreme)
- Primary Constraints (Extreme)
- Refined Strategic Connection Options
- Discounted Strategic Connection Options

Client

EIRGRID

THE GRID LINK PROJECT

Figure 8.4

Refinement of Strategic Connection Options

RPS
West Pier Business Campus,
Dun Laoghaire,
Co Dublin, Ireland.
T +353 (0) 1 4882900
F +353 (0) 1 2835676
E ireland@rpsgroup.com
W rpsgroup.com/ireland

Issue Details

Drawn By: S. Khan	**Project No.** MDR0835
Checked By: A. Gaughran	**File Ref:** MDR0835Arc_EV0081F01
Approved By: J. Shalloe	
Scale: as stated	**Drawing No.** Arc_EV0081 / **Rev:** F01
Date: 29/08/2013	

NOTE:

8.3 BROAD CORRIDOR OPTIONS

8.3.1 Task 5 - Identification of Broad Corridors

The next step was to develop broad corridors. The objective of this primarily desktop exercise was to identify corridors on the basis of the strategic connection options using Ordnance Survey Ireland (OSI) mapping and avoiding international and European designations and major settlements in the first instance. This process relied on the professional expertise and experience of the project team and involved two parallel but inter-dependent exercises which were then brought together and culminated in the identification of broad corridors (ref. **Section 8.3.2**).

For the purpose of this stage in the process, it was assumed that each broad corridor would link with a defined zone around each of the nodes within which a suitable substation configuration could be accommodated. Further details on substation zone development can be found in **Chapter 7**.

Task 5a - Heat Mapping Exercise

For this task, the environmental and Geographical Information System (GIS) team members examined how constraints data could be most effectively represented to assist in the corridor identification process.

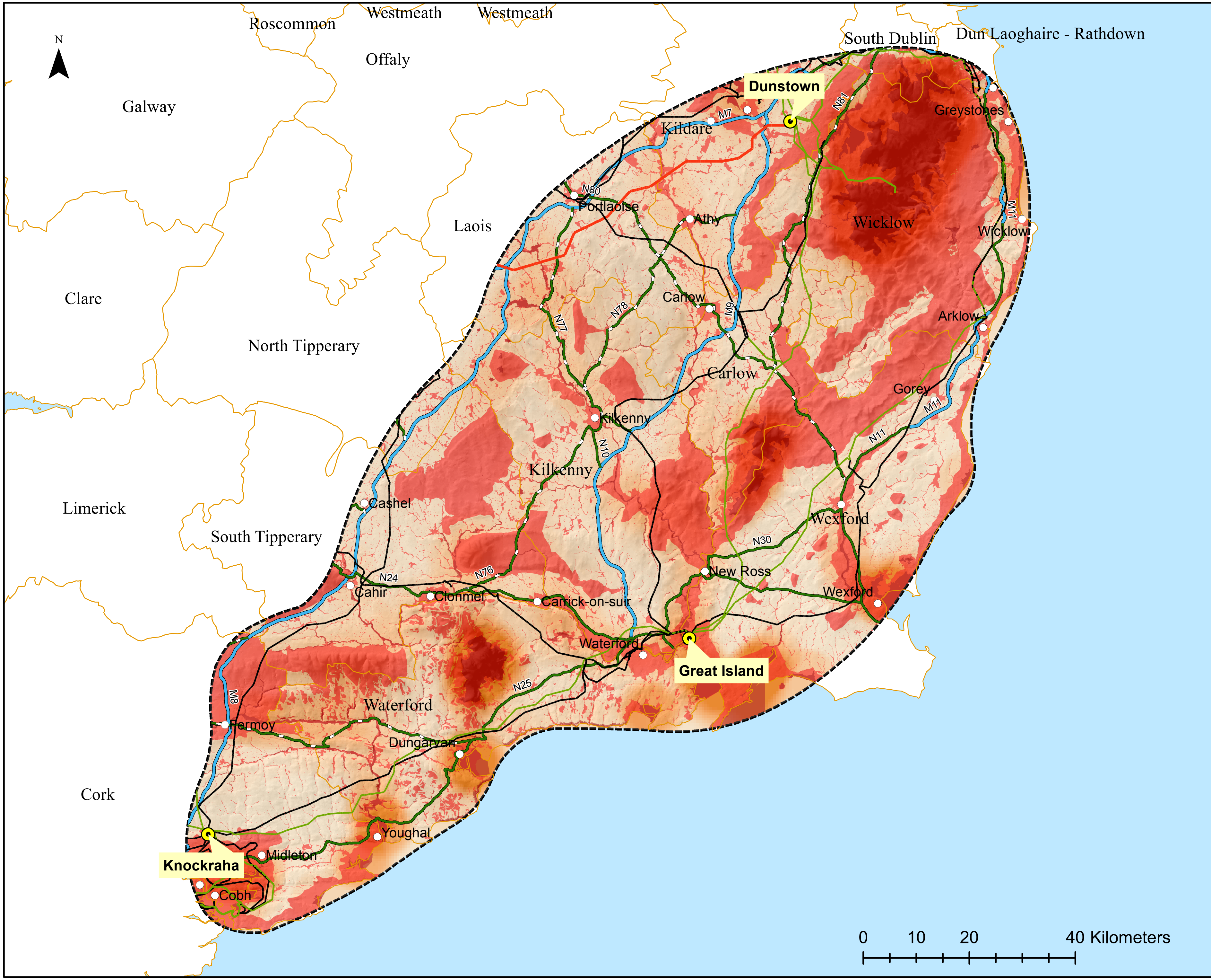
As part of the constraints data gathering exercise, each dataset was compiled into a mapping layer in the GIS programme which allowed for these layers to be viewed separately or in combination to ensure the project team had a comprehensive understanding of constraints and how they interact within the study area. These layers were then overlaid onto a map of the study area (i.e. the background layer). Building on this visualisation tool, using the initial mapping and categorisation of constraints referred to in **Section 8.2.2** and GIS software, the primary constraints were coloured red and the secondary constraints were coloured amber. The software was then programmed to reflect constraints resulting in a heat map displaying a spectrum of colour from amber through to dark red. While all constraints fed into the development of heat mapping, only dark red and light red constraints (primary constraints) were actively referred to during this phase of the project (i.e. the identification of broad corridors). Further details on how GIS and heat mapping informed the feasible route corridor process can be found in **Appendix 3**.

The display of constraints data as heat mapping also offered the project an effective tool for communication between the team and enhancing the understanding of the spatial distribution of constraints within the study area. It is also noted that refinement of heat mapping was ongoing throughout the process as additional datasets were inputted to the GIS. This output from the constraints heat mapping exercise is illustrated in **Figure 8.5.**

The key primary constraints considered for the purpose of the identification of broad corridors were:

- Gradient where slope >30 percent (primary constraint);
- Substation location for node points (primary constraint);
- Cities and towns (primary constraint);
- UNESCO sites (most sensitive primary constraint);
- Airports / airfields (primary constraint);
- Windfarms (existing or committed[23] development only) (primary constraint);
- Expanses of Water >300m width approximately (primary constraint);
- Areas of high peat slope instability (primary constraint);
- SAC /SPA /Ramsar (most sensitive primary constraint);
- National Parks (primary constraint);
- NPWS confirmed Annex 1 Habitat outside designated areas (primary constraint);
- Freshwater pearl mussel survey data (primary constraint);
- Floodplains (primary constraint for substations only);
- Areas of outstanding natural beauty (primary constraint); and
- High amenity or special amenity areas (primary constraint).

[23] Committed development includes those wind farms already constructed, under construction or with a valid planning permission



Legend

- Existing Substation
- Major Town/City

Existing Network

- 110 kV
- 220 kV
- 400 kV

National Roads

- Motorway
- National Primary
- National Secondary

- County Boundary
- Study Area
- Primary Constraints (Very Extreme)
- Primary Constraints (Extreme)
- High
- Low

Client

EIRGRID

THE GRID LINK PROJECT

Figure 8.5

Heat Mapping

RPS
West Pier Business Campus, Dun Laoghaire, Co Dublin, Ireland.
T +353 (0) 1 4882900
F +353 (0) 1 2835676
E ireland@rpsgroup.com
W rpsgroup.com/ireland

Issue Details

Drawn By: S. Khan	**Project No.** MDR0835
Checked By: A. Gaughran	**File Ref:** MDR0835Arc_EV0083F01
Approved By: J. Shalloe	
Scale: as stated	**Drawing No.** Arc_EV0083 / **Rev:** F01
Date: 29/08/2013	

NOTE:

Task 5b - Technical OHL Corridor Routing Exercise

In tandem with the mapping work, a technical OHL corridor routing exercise was being undertaken by the OHL design team. This process used professional expertise and experience and followed comparatively direct routes between the nodes in order to generate a first draft of possible potential broad corridors. The particular considerations of relevance are detailed below:

- **OSI Mapping**: This provided information relating to key topographical features namely higher ground, major settlements and expanses of water which, it was considered, should be avoided in the first instance.

- **Route length**: The most direct or shorter route is generally considered as 'best practice' for OHL routing. The objective was to develop broad corridors with comparatively direct routes between the nodes.

- **International and European Designations**: The objective was to develop broad corridors which avoided, as far as possible, international and European designations (e.g. SAC, SPA, NHA), where they extended over an obvious geographical area. Other linear or discrete designated areas did not influence the corridors at this time.

8.3.2 Task 6 - Overlay Mapping

The next stage in the process was to refine the broad corridors identified in Task 5b and their respective boundaries**.** This entailed representatives from the technical, planning and environment teams collectively reviewing each of the draft broad corridors in detail.

Overlay mapping techniques were used to spatially assess the initial output from the technical team in the context of the constraints as represented on the heat mapping output. The objective of this step was to identify the degree of overlap on primary constraints in the first instance (i.e. dark red or light red areas) and to determine if conflict could be avoided through refinement of the boundary of the corridor.

The boundaries and extent of each corridor were interrogated with reference to OSI mapping, the heat mapping and the supporting constraints information. Where the corridor traversed or encroached on any identified constraints (focusing in particular on dark red and light red primary constraints) the specific detail of the constraint was investigated to determine how it should influence the corridor.

Best practice routing techniques also influenced the refinement process. The relevant considerations during this process were:

- Finding comparatively direct routes between pinch points (e.g. valleys between high ground, open space between settlements, etc.).

- Finding appropriate crossing points of expanses of water (rivers, navigable waterways and estuaries <300 m width approximately) which would not exceed the maximum achievable span length[24].

- Avoiding areas of population settlement such as cities, towns and large villages. However, other forms of settlement including small villages, 'ribbon' development, and scattered housing could not be avoided and could be present within the broad corridor. Such development will be taken into consideration at OHL routing stage.

- Taking slope into consideration. Sloping ground requires more complex ground works including foundation construction and is an additional health and safety risk. Furthermore, from an environmental perspective, slope indicates higher ground which is often the location of environmental, scenic and other relevant constraints or considerations.

- Minimising and finding appropriate crossing points and angles for motorway/dual carriageway primary roads, railways and the existing high voltage electricity transmission network. In general a right angle (with up to a 30^o spread either side) is the technical optimum.

- Areas of known poor ground conditions, e.g. bog and areas of peat slope instability, are best avoided. A cluster or close grouping of quarries /mines / landfill is also best avoided.

Other relevant considerations which fed into this refinement process included stakeholder feedback.

Where it was possible to avoid primary constraints, the corridor width or direction was amended. This refinement process is illustrated in **Appendix 2**. Where it was not possible to avoid a significant constraint, alternatives were considered. This included looking at other identified corridors, new corridor options in unconstrained areas or splitting the corridor in two in order to avoid a particular constraint (e.g. towns). A section (or sections) of constrained corridor was deleted only where a feasible alternative(s) existed.

Relevant observations from this stage of the process included that it was not possible to completely remove conflict between corridors and primary constraints, i.e. dark red or light red areas. This is

[24] Actual permissible span lengths will depend on the tower design and range of tower heights available.

particularly relevant in respect of linear SAC / SPA designations associated with rivers which cannot be avoided.

Other observations included:

- The presence of sensitive archaeology and cultural heritage could not be fully reflected at the scale of the study area.

- The dispersed nature of landscape designations, particularly in the south of the study area.

These conflict areas were the subject of further discussion within the project team resulting in a refinement of the categorisation of certain primary constraints[25]. There was also acceptance that where conflict remained and no alternative existed it was reasonable to proceed on the basis that refinement at subsequent stages of the project (e.g. line route identification) could reduce the potential for impact. For example, while many of the rivers in the study area are designated as SAC (Natura 2000 sites) and are therefore categorised as primary (dark red) constraints, it is considered to be technically possible to span rivers generally and in this regard there is potential to avoid or reduce significant negative impacts on such features through line alignment and/or mitigation measures. It has therefore been concluded that including these linear primary constraints at this early stage is acceptable.

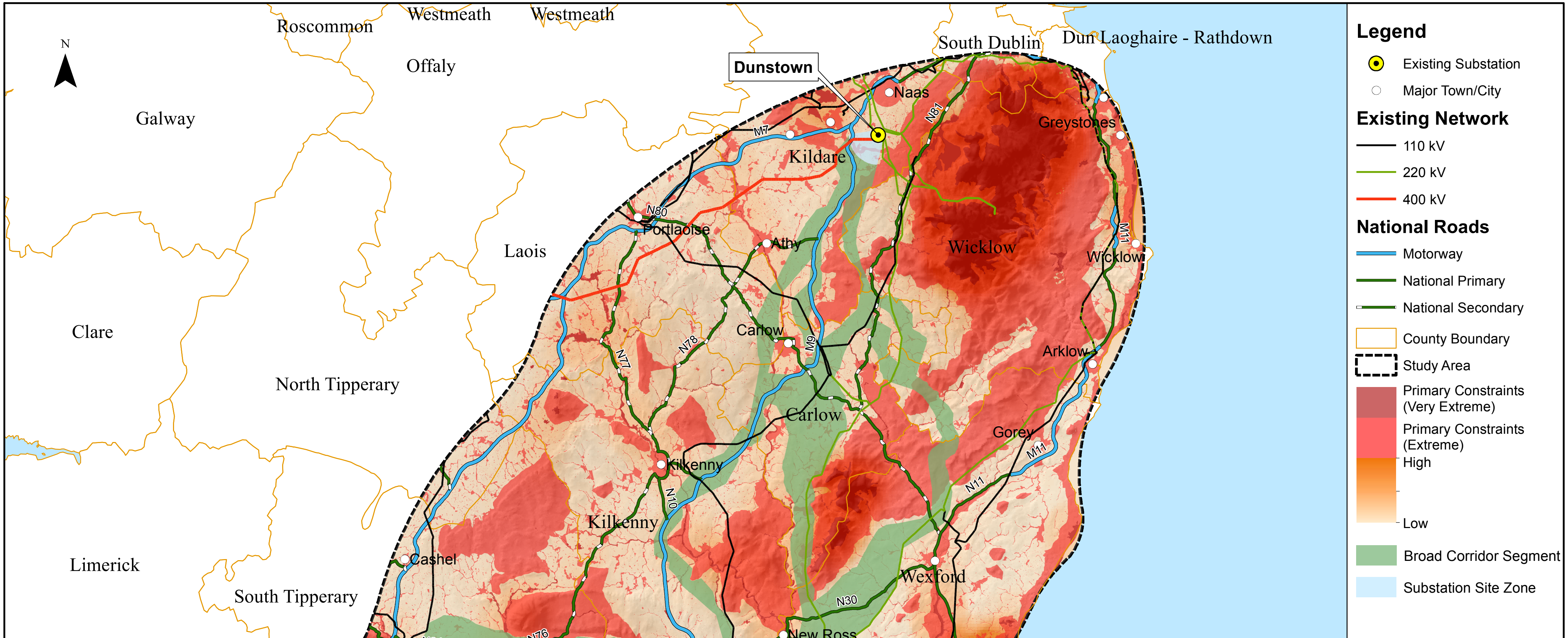
In addition to desktop work the refinement process involved site visits made by the project team to the Grid Link study area. Vantage point surveys were principally undertaken by the technical team and focused on the general carrying capacity of the topography and landscape and the characteristics of pinch points (i.e. those locations where particular and / or competing constraints influence the direction and / or width of corridors).

8.3.3 Task 7 – Identification of Broad Corridors to be Brought Forward

The above process identified a number of broad corridor options which were considered suitable to meet the technical objectives for the project while avoiding the most sensitive parts of the study area. These options are illustrated in **Figure 8.6** in the context of updated heat mapping.

---

[25] To categorise certain cultural heritage features (e.g. national monuments, preservation orders) as primary constraints for subsequent stages of corridor and line development process in the knowledge that the presence of sensitive archaeology and cultural heritage is not fully reflected at the scale of the study area and it is not possible to avoid them at the broad corridor stage.



Client

EIRGRID

THE GRID LINK PROJECT

Figure 8.6

Broad Corridors

RPS
West Pier Business Campus,
Dun Laoghaire,
Co Dublin, Ireland.
T +353 (0) 1 4882900
F +353 (0) 1 2835676
E ireland@rpsgroup.com
W rpsgroup.com/ireland

Issue Details

Drawn By: S. Khan	**Project No.** MDR0835	
Checked By: A. Gaughran	**File Ref:** MDR0835Arc_EV0203F01	
Approved By: J. Shalloe		
Scale: as stated	**Drawing No.**	**Rev:**
Date: 29/08/2013	Arc_EV0203	F01

NOTE:

8.4 FEASIBLE CORRIDOR OPTIONS

The broad corridors identified in **Section 8.3** provided the geographical areas within which feasible route corridors could be developed. The process of identification of feasible 1km corridors is detailed in **Appendix 4** (*Feasible Route Corridor Identification Report*) and summarised below. These corridors are of an indicative 1km width for comparative purposes.

8.4.1 Task 8 - Identification of Potential Indicative 1km Wide Corridor Options

The development of potential indicative corridors comprised identification and mapping of the primary and secondary technical constraints. The technical constraints are detailed below:

- **Effect on Existing Electrical Infrastructure:** For reasons of operating the electrical system, it is preferable to minimise the crossing of existing or proposed / future OHLs (220kV and 110kV) along the corridor and at substations, as crossing of existing lines will require outages (both lines) for future maintenance and decommissioning. Crossings also introduce additional systems risk (multiple failures) and require additional infrastructure as higher towers would be needed to facilitate the crossing locations. This in turn has an additional cost implication.

- **Engineering Constraints (including roads, rivers, railways, quarries, karst areas, navigable watercourses (> 300m wide) and gas transmission pipelines):** From a routing perspective the crossing of railways and motorways / dual carriageways (but not necessarily national or regional roads) is to be minimised as they may require tall crossing towers. The crossing of navigable watercourses (> 300m wide), depending on the type of water craft traffic, is also to be minimised due to the exceptional clearance needed for shipping mast heights which require special tall river crossing towers. This specialised infrastructure needed to facilitate the crossing locations in turn has an additional cost implication. Additionally repeated access across gas transmission pipelines or running in parallel to gas transmission pipelines and existing OHL for long distances could impact on existing infrastructure.

- **Quarries/Mines/Landfills Should be Avoided where Possible.** Quarries in particular are significant engineering constraints. Depending on the size of the quarry excavation, taller towers may be required, and the positioning of individual towers may be constrained by slope stability issues. This would require careful consideration and appropriate mitigation measures should it not be possible to avoid.

The technical constraints were combined with the other primary and secondary constraints (as identified in Column 4, Table 1 in **Appendix 2**) to create a full picture of the natural and man-made aspects within the broad corridors.

Best practice routing principles also informed this desk top exercise. Relevant considerations included *inter alia* that the corridors should connect each substation node using the most direct route possible and cross the constraints at the narrowest points or to join with existing infrastructure at established crossing points. **Appendix 4** provides further details in the role of best practice routing principles in the identification of feasible 1km wide route corridors.

The output of this process is identified in **Figure 8.7**.

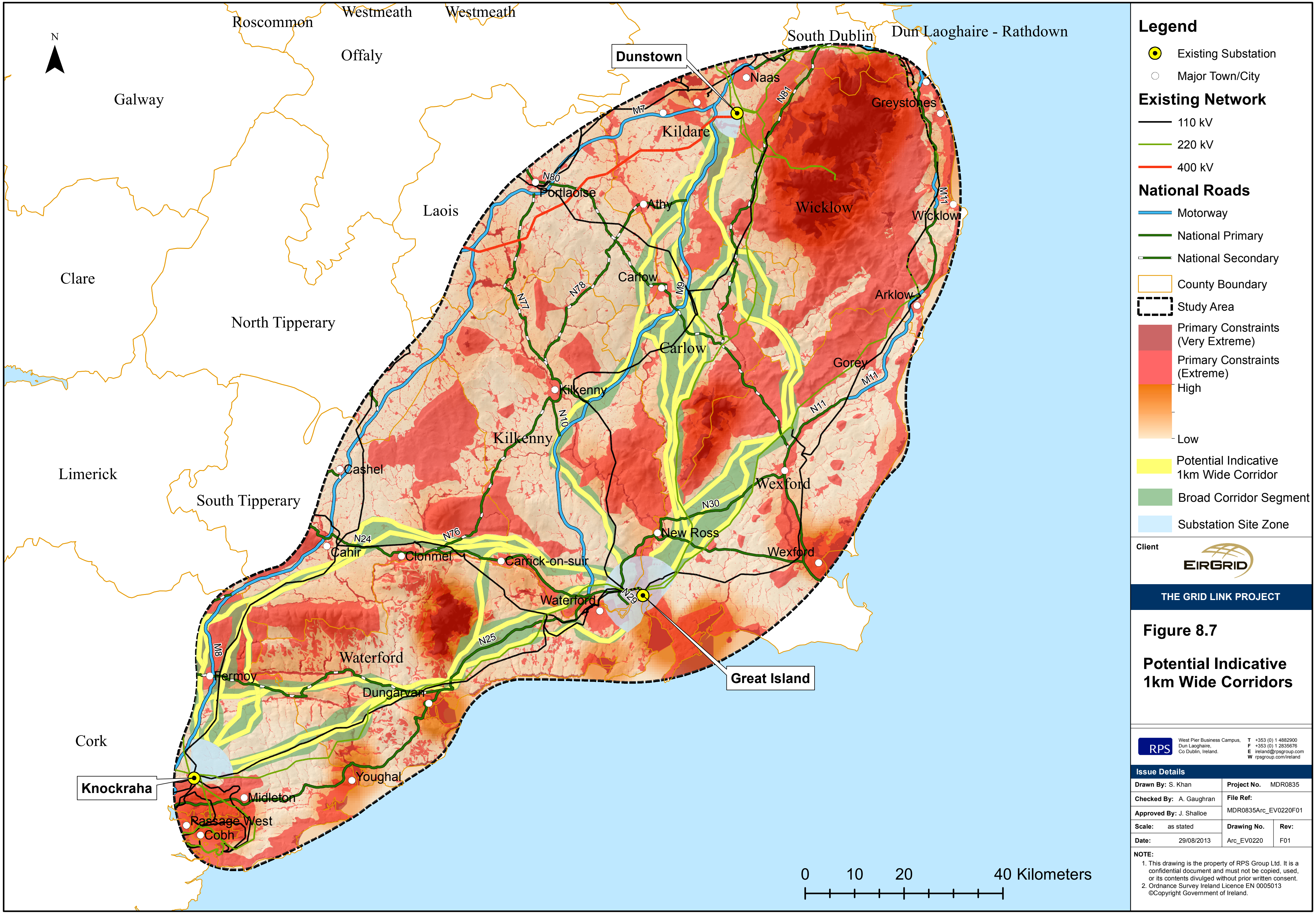


Figure 8.7

Potential Indicative 1km Wide Corridors

8.4.2 Task 9 – Refinement of Outputs

The potential indicative corridors were then reviewed following site visits in order to determine and present a series of feasible 1km wide corridor options. The review also considered where alternative technological solutions may be necessary to overcome existing constraints (e.g. consideration of partial undergrounding).

Four key criteria were considered as part of the review which focused on compliance levels of each potential indicative corridor with the best practice routing principles. These are summarised below and described in more detail in **Appendix 4**.

- **System Complexity**: For the purposes of this section of the report, system complexity comprises technology, length and effect on electricity transmission infrastructure (the context of each is described in detail in **Appendix 4**, Section 2.11). The corridors that show maximum compliance with this criterion, i.e. a non-complex technological solution, a relatively short line and with as few crossings as possible of existing high voltage OHL, are considered to demonstrate best practice routing principles.

- **CIGRE Guidance on Routing[26] and Holford Rules[27]:** Appropriate routing of the corridors at this early stage of the Grid Link Project will help to mitigate future visual impacts of the OHL. Routing principles are acknowledged in industry related guidance documents published by the International Council on Large Electric Systems (CIGRE). A high level of compliance with the CIGRE guidance on routing is required for a corridor to demonstrate best practice routing principles.

- **Engineering Constraints:** The corridors that minimise the crossing of engineering constraints will show maximum compliance with this criterion and are considered to demonstrate best practice routing principles.

- **Constructability and Access for Maintenance:** The corridors that run close to existing roads or access tracks for the majority of their length will show maximum compliance with this criterion and are considered to demonstrate best practice routing principles.

---

[26] Cigré (1999). *High Voltage Overhead Lines – Environmental Concerns, Procedures, Impacts and Mitigations. Publication Ref. No. 147*

[27] 'Holford Rules' are not published as a single work but they are referred to in a number of planning publications used by National Grid UK including George A. Goulty (1989). *Visual Amenity Aspects of High Voltage Transmission* and RJB Carruthers (1987) Research Studies Press Ltd, Letchworth. *Planning Overhead Power Line Routes*.

Section 3.0 of **Appendix 4** discusses the range of site features which affect compliance levels of each potential indicative corridor with the best practice routing principles.

8.4.2.1 Examples of the Refinement Process

Examples of the rationale for not taking particular Potential Indicative Corridors forward in the route corridor development process (having regard to best practice routing principles, as outlined above) are provided below and further examples are described in **Appendix 4** (and illustrated in Appendix 4 Figure 3.3).

(1) Between Rathvilly (Co. Carlow) and Ferns (Co. Wexford) and generally parallel to and west of Feasible Corridor DSN1 a section of Potential Indicative Corridor was also considered.

In the northern part between Rathvilly and Shillelagh the landscape in this area is relatively flat and open and it was considered that a future OHL along the route of the Potential Indicative Corridor would be highly visible and seen against the skyline. The Potential Indicative Corridor between Rathvilly and Shillelagh therefore demonstrated less favourable compliance with CIGRE Guidance and Holford Rules which are industry standards on routing principles for OHL to minimise visual impact. While Feasible Corridor DSN1 is also partially set in flat open landscape, it would be seen against a solid backdrop of low hills close to Gowle and Ballymarroge in Co Wicklow which are in the foothills of the Wicklow Mountains.

In the lower part of this section between Shillelagh and Ferns, the Feasible Corridor (DSN1) is more favourable as it runs closer to high ground to the east of Ballyroebuck, Co Wexford and therefore demonstrates good compliance with CIGRE Guidance and Holford Rules.

Therefore, for reasons of lower compliance with CIGRE Guidance and Holford Rules the section of Potential Indicative Corridor between Rathvilly and Ferns demonstrated less favourable compliance with best practice routing principles.

(2) From Kyleballyhue to Oldleighlin and Oldleighlin to Leighlinbridge south of Carlow town, two parallel sections of Potential Indicative Corridors running in an east –west direction were developed to link Feasible Corridor DSN5 and DSN8 with DSN9.

Whilst these sections of Potential Indicative Corridors showed good levels of compliance with System Complexity and Constructability both cross the M9 motorway, the Kilkenny to Carlow railway line, the River Barrow, a high pressure gas pipe line, a landfill site and a quarry (which are Engineering constraints) plus many sites of cultural heritage interest. In addition, the landscape of this area is relatively flat and open and a future OHL would be highly visible and seen against the skyline.

Therefore due to a high number of Engineering constraints which both sections of corridor would have to cross, and a setting in which it was difficult to conform with CIGRE Guidance and Holford Rules, the section of Potential Indicative Corridors between Kyleballyhue to Oldleighlin and Oldleighlin to Leighlinbridge demonstrated less favourable compliance with best practice routing principles and hence were not taken forward in the route corridor development process.

(3) The broad corridor from Great Island to Knockraha which passes to the north of Carrick-on-Suir and Clonmel (both in Co. Tipperary) and to the east of Mitchelstown (Co. Cork) includes Feasible Corridors KRA1 and KRA2. A parallel section of Potential Indicative Corridor was considered running to the south of Feasible Corridors KRA1 and KRA2.

The landscape in the southern part of the broad corridor is flatter and more open and is perceived visually in places to form part of the River Suir valley. Furthermore there are engineering constraints in this part of the broad corridor including a high pressure gas pipeline and an existing 110kV OHL, both of which run in parallel.

Feasible Corridors KRA1 and KRA2 pass along the northern side of the broad corridor which is on higher sloping ground where an OHL would be seen against a solid backdrop of the foothills of Slievenamon Mountain and they therefore demonstrate a higher level of compliance with CIGRE Guidance and Holford Rules.

The Potential Indicative Corridor was not taken forward in the route corridor development process as it demonstrated less favourable compliance in terms of System Complexity or with CIGRE Guidance and Holford Rules; did not minimise the crossing of Engineering constraints; and there would be technical constraints during construction.

(4) A section of Potential Indicative Corridor from Great Island (Co. Wexford) and passing around the southern side of Waterford City (Co Waterford) and on to the east side of Dungarvan was considered. The section of Potential Indicative Corridor was developed from the Great Island existing substation and would require crossing the River Suir estuary.

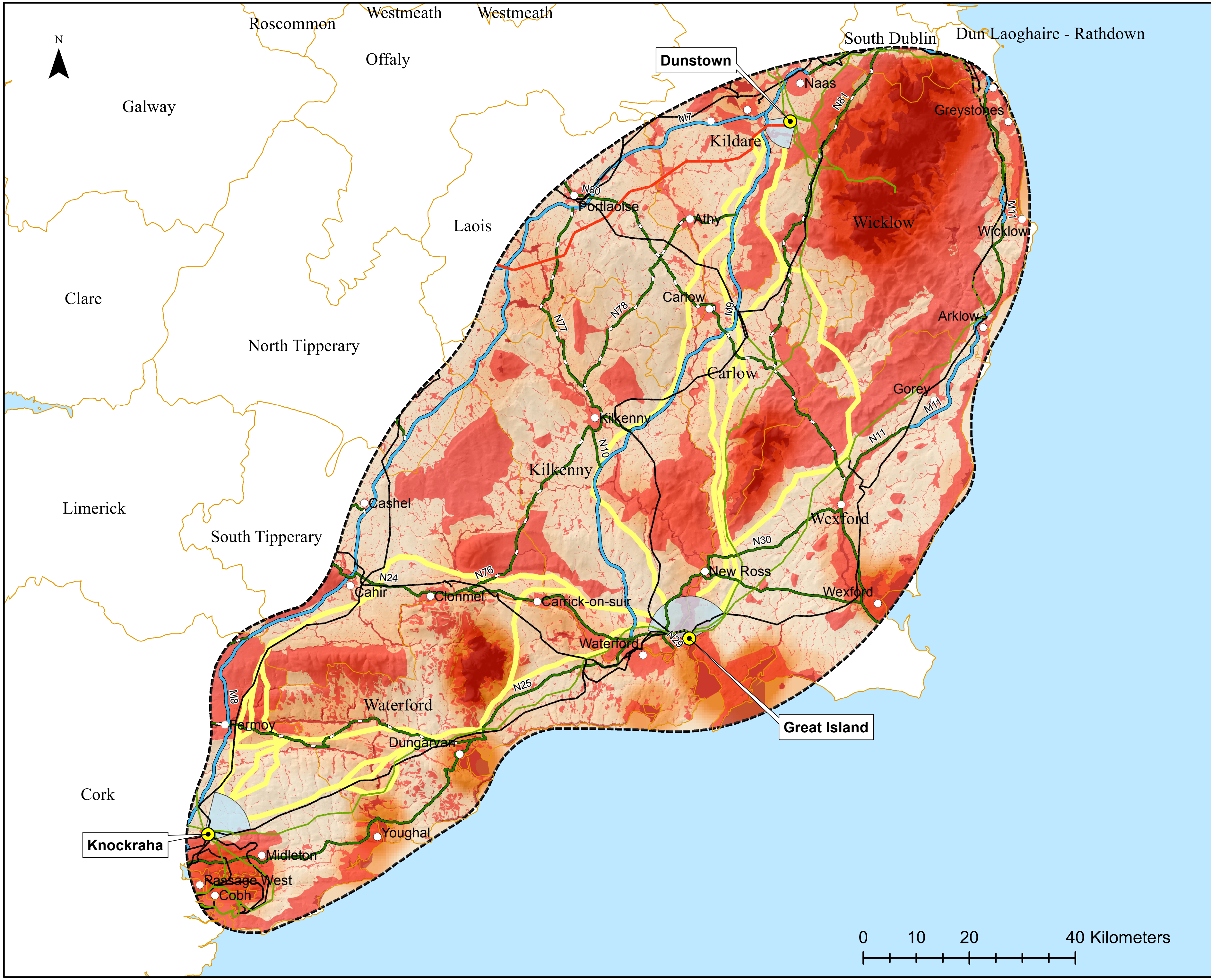
The crossing point of the Suir would occur at a wide stretch of the river (over 1km) and the span length would exceed the maximum permissible design span possible for an OHL and therefore an alternative technical solution would be required. South of Waterford City the landscape is relatively flat and open, and includes existing 110kV and 200kV OHL which run parallel to the N25 road corridor. A future OHL would be highly visible and seen against the skyline and could potentially create cumulative visual impacts with the existing OHL.

The Potential Indicative Corridor south of Waterford City was not therefore taken forward in the route corridor development process as it would introduce a complex technological solution (System

Complexity) and would demonstrate less favourable compliance with CIGRE Guidance and Holford Rules.

Following this refinement process, a number of corridor options were identified. **Figure 8.8** shows the corridors overlaid on heat mapping. The corridors are briefly described in **Chapter 9** Corridor Descriptions and in further detail in **Appendix 4**. These feasible 1 km wide corridor options will be taken forward for multi-criteria evaluation with reference to technical, cost and environmental considerations in Stage 2 (see **Chapter 1** for further details on EirGrid's Development Roadmap).

The proposed approach to evaluation is set out in **Chapter 10**.



Legend

- Existing Substation
- Major Town/City

Existing Network

- 110 kV
- 220 kV
- 400 kV

National Roads

- Motorway
- National Primary
- National Secondary
- County Boundary
- Study Area
- Primary Constraints (Very Extreme)
- Primary Constraints (Extreme)
- High
- Low
- Feasible 1km Wide Corridor
- Substation Site Zone

Client

EirGrid

THE GRID LINK PROJECT

Figure 8.8

Feasible 1km Wide Corridors Overlaid on Heat Mapping

RPS
West Pier Business Campus,
Dun Laoghaire,
Co Dublin, Ireland.
T +353 (0) 1 4882900
F +353 (0) 1 2835676
E ireland@rpsgroup.com
W rpsgroup.com/ireland

Issue Details

Drawn By: S. Khan	**Project No.** MDR0835
Checked By: A. Gaughran	**File Ref:** MDR0835Arc_EV0221F01
Approved By: J. Shalloe	
Scale: as stated	**Drawing No.** Arc_EV0221 / **Rev:** F01
Date: 29/08/2013	

NOTE:

9 ROUTE CORRIDOR DESCRIPTIONS

9.1 INTRODUCTION

Following the route corridor identification process outlined in **Chapter 8**, a number of refined, corridor options, with an indicative width of 1km for comparative purposes, were identified in which to site the 400kV High Voltage Alternating Current overhead transmission line (HVAC OHL). In the context of this report, a feasible corridor can be described as a linear band of land, of a representative 1km in width, within which a high voltage line route can later be positioned, linking the nodal substations and routed so as to avoid as many environmental, technical and other constraints as possible.

The corridors have been divided into two main groupings: those linking the identified substation zones of Dunstown and Great Island, of which there are 9, and those linking the identified substation zones of Great Island and Knockraha, of which there are 8, as addressed in **Chapter 8** of this Report. An overview of the corridors in these two groupings is listed in **Table 9.1** and **9.2** and displayed in **Figure 9.1** below.

This chapter presents an overview map of each of the identified corridors with key locational features noted for context. More detailed descriptions and more detailed maps of each route are presented in **Appendix 4** and the reader should refer to this appendix for additional information and clarity**.**

There are 9 corridors identified linking Dunstown to Great Island. Descriptions are presented from north (Dunstown) to south (Great Island) in all cases and the following notation is used: DSN (Dunstown), GI (Great Island). Corridors all commence from the edge of the 5km substation zone identified for Dunstown within which line entries will be refined in the next stage of the project and all options terminate at the edge of the 8km substation zone at Great Island within which a substation solution will be identified (see **Chapter 7** for further details of the substation zones and the substation refinement process).

There are 8 corridors identified linking Great Island to Knockraha. Descriptions are presented from east (Great Island) to west (Knockraha) in all cases and the following notation is used: GI (Great Island) and KRA (Knockraha). Corridors all commence from the edge of the 8km substation zone at GI within which a substation solution will be identified and all options terminate at the edge of the 8km substation zone for KRA within which a substation solution will be identified (see **Chapter 7** of the main report for further details of the substation zones and the substation refinement process).

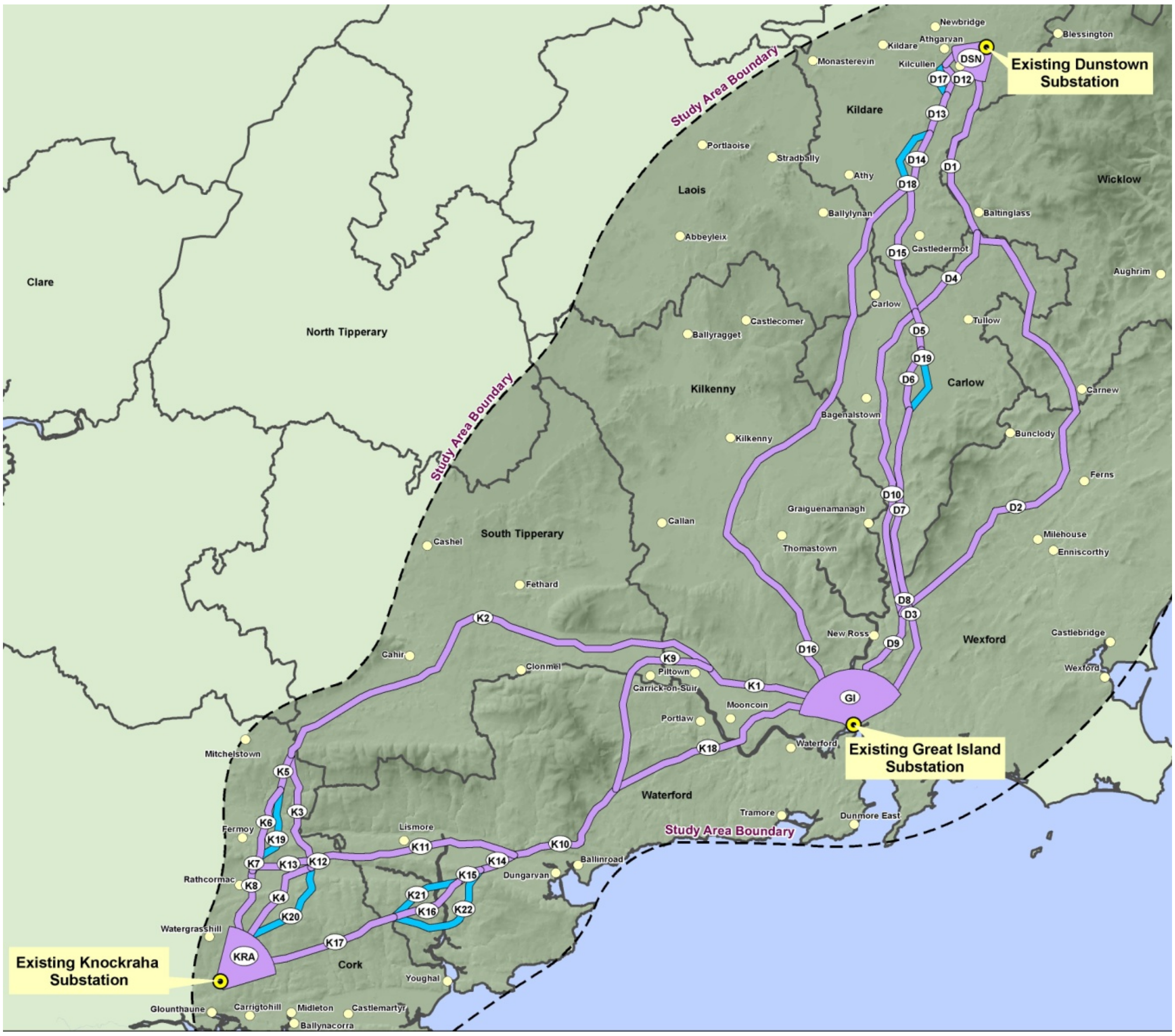


Figure 9.1: Overview of the Feasible 1km Corridors Identified for the Grid Link Project

9.2 CORRIDOR NAMING

The standard abbreviations used for the three substations involved are DSN for Dunstown, GI for Great Island and KRA for Knockraha. At the earlier stages of the corridor development the individual segments were named alphabetically from substation to substation that is from Dunstown to Great Island and Great Island to Knockaraha and numerically from east to west. Over the course of corridor development, the segments naming and corridor names were further standardised. Great Island (GI) being the confluence for the corridors and on the basis that the 'I' could be confused with '1' or 'L' therefore all segments from Dunstown to Great Island are named as D1, D2, ... D19 and the segments from Great Island to Knockraha are named as K1, K2, K22. Subsequently the final 1km route corridors from Dunstown to Great Island are named as DSN1, DSN2...DSN9 and all routes from Great Island to Knockraha are named as KRA1, KRA2...KRA8.

This is the notation used to describe corridors in this Chapter and in **Appendix 4.**

9.3 CORRIDOR OPTIONS

Table 9.1: Corridor Options Dunstown to Great Island

Corridor Option Ref. Name	Relevant Segments	Appendix 4 Detailed Map Reference
DSN1	DSN; D1; D2; D3; GI	28_12049_081
DSN2	DSN; D1; D2; D8; D9; GI	28_12049_082
DSN3	DSN; D1; D4; D5; D6/D19 D7;D3; GI	28_12049_083
DSN4	DSN; D1; D4; D5; D6/D19 D7;D8;D9; GI	28_12049_084
DSN5	DSN; D1; D4; D10; D9; GI	28_12049_085
DSN6	DSN; D11; D12/D17; D13; D14/D18; D15; D5; D6/D19; D7; D3; GI	28_12049_086
DSN7	DSN; D11; D12/D17; D13; D14/D18; D15; D5; D6/D19; D7; D8; D9; GI	28_12049_087
DSN8	DSN; D11; D12/D17; D13; D14/D18; D15; D10; D9; GI	28_12049_088
DSN9	DSN; D11; D12/D17; D13; D14/D18; D16; GI	28_12049_089

*Variants shown in blue

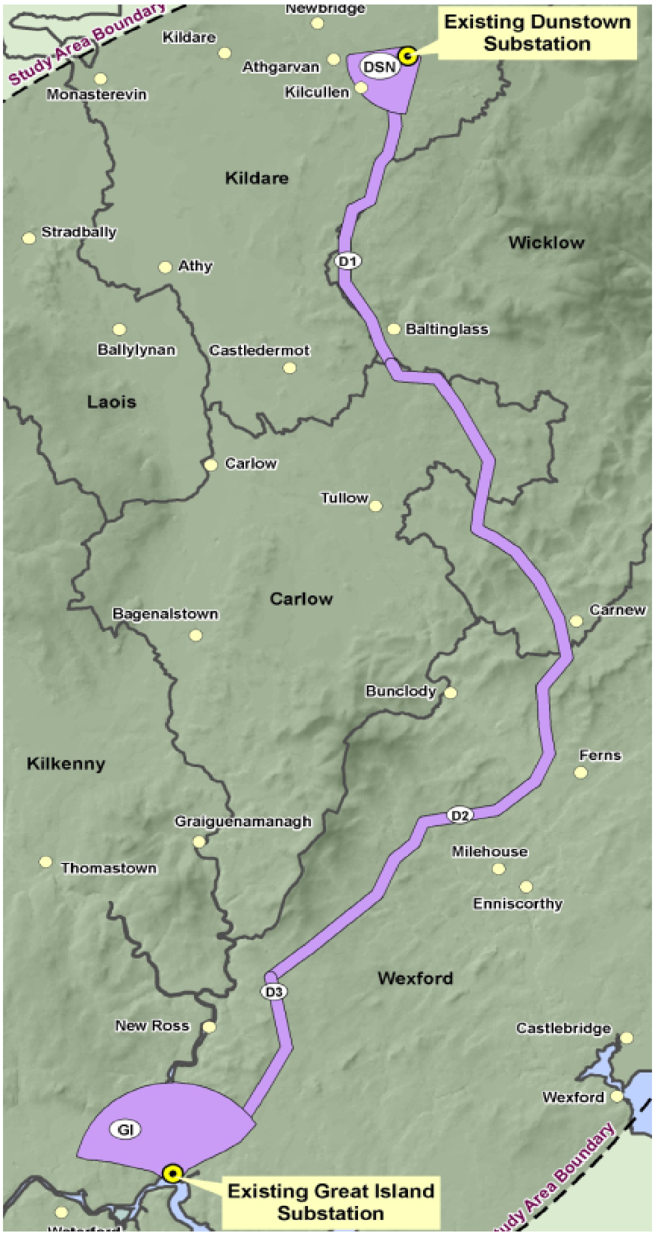
Table 9.2: Corridor Options Great Island to Knockraha

Corridor Option Ref. Name	Relevant Segments	Appendix 4 Detailed Map Reference
KRA1	GI; K1; K2; K3; K4/K20; KRA	28_12049_090
KRA2	GI; K1; K2; K5; K6/K19; K7; K8; KRA	28_12049_091
KRA3	GI; K1; K9; K10; K11; K12; K4/K20; KRA	28_12049_092
KRA4	GI; K1; K9; K10; K11; K13; K8;KRA	28_12049_093
KRA5	GI; K1; K9; K10; K14; K15; K16/K21/K22; K17; KRA	28_12049_094
KRA6	GI; K18; K10; K11; K12; K4/K20; KRA	28_12049_095
KRA7	GI; K18; K10; K11; K13; K8;KRA	28_12049_096
KRA8	GI; K18; K10; K14; K15; K16/K21/K22; K17; KRA	28_12049_097

*Variants shown in blue

9.4 CORRIDOR DESCRIPTIONS

9.4.1 Corridor Option DSN1



Commences at the edge of the Dunstown substation zone.

Passes to the west of Dunlavin and Baltinglass.

Crosses the River Slaney and N81 national road between Baltinglass and Rathvilly.

Crosses the Dereen River west of Hacketstown.

Passes to the west of Shillelagh and Carnew.

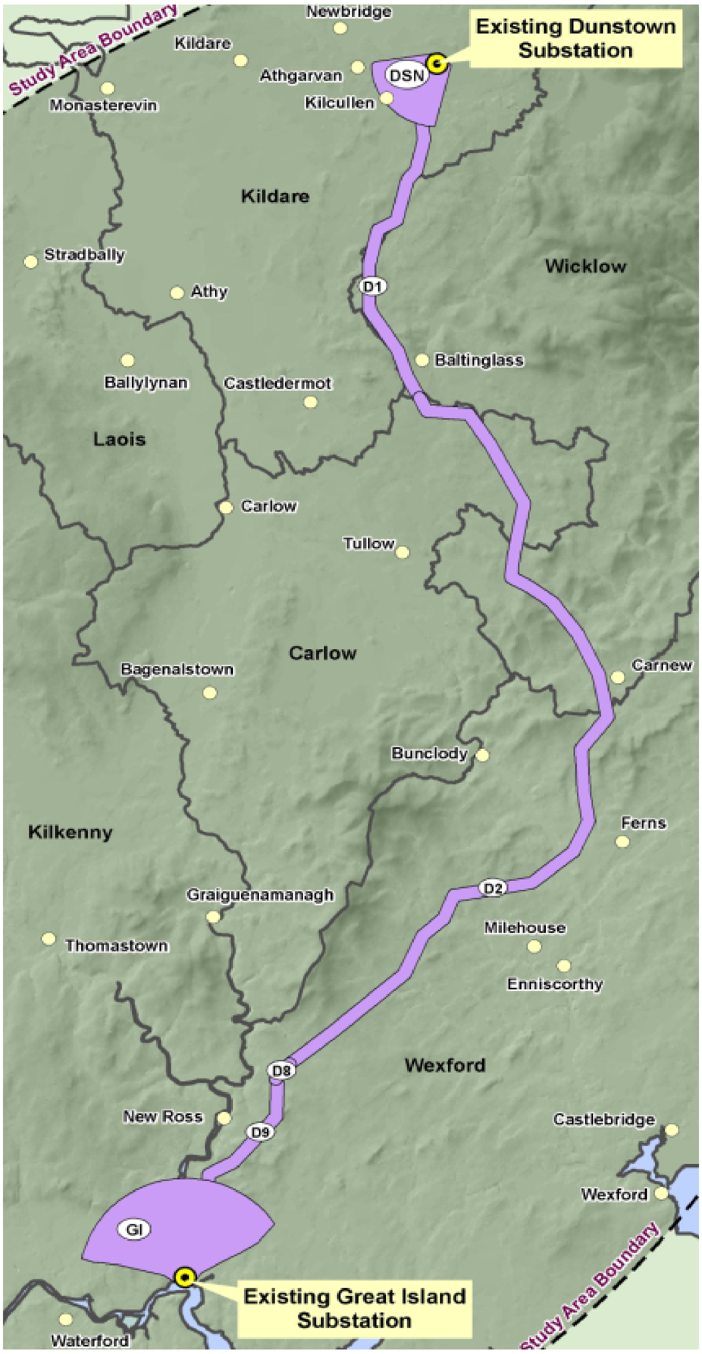
Crosses the River Slaney and the N80 national road west of Ferns.

Passes west of Enniscorthy, paralleling the R731 regional road toward New Ross.

Crosses over the N30 and N25 national roads east of New Ross.

Approaches the Great Island substation zone east of the JF Kennedy Memorial Forest Park.

9.4.2 Corridor Option DSN2



Commences at the edge of the Dunstown substation zone.

Passes to the west of Dunlavin and Baltinglass.

Crosses the River Slaney and N81 national road between Baltinglass and Rathvilly.

Crosses the Dereen River west of Hacketstown.

Passes to the west of Shillelagh and Carnew.

Crosses the River Slaney and the N80 national road west of Ferns.

Passes west of Enniscorthy, paralleling the R731 regional road toward New Ross.

Crosses over the N30 and N25 national roads east of New Ross.

Approaches the Great Island substation zone west of the JF Kennedy Memorial Forest Park.

9.4.3 Corridor Option DSN3

Commences at the edge of the Dunstown substation zone.

Passes to the west of Dunlavin, Baltinglass and Rathvilly.

Meets the M9 where it intersects with the R725 regional road between Carlow Town and Tullow.

Crosses the N80 at Ballyveal.

Variant 1 [D6]: Passes to the east of Fennagh.

Variant 2 [D19]: Passes to the west of Fennagh.

Passes east of Bagenalstown.

Crosses tributaries of the River Barrow east of Borris, northeast of Graiguenamanagh, east of St. Mullins and west of Ballywilliam.

Crosses over the N30 and N25 national roads east of New Ross.

Approaches the Great Island substation zone east of the JF Kennedy Memorial Forest Park.

9.4.4 Corridor Option DSN4

Commences at the edge of the Dunstown substation zone.

Passes to the west of Dunlavin, Baltinglass and Rathvilly.

Meets the M9 where it intersects with the R725 regional road between Carlow Town and Tullow.

Crosses the N80 at Ballyveal.

Variant 1 [D6]: Passes to the west of Fennagh.

Variant 2 [D19]: Passes to the east of Fennagh.

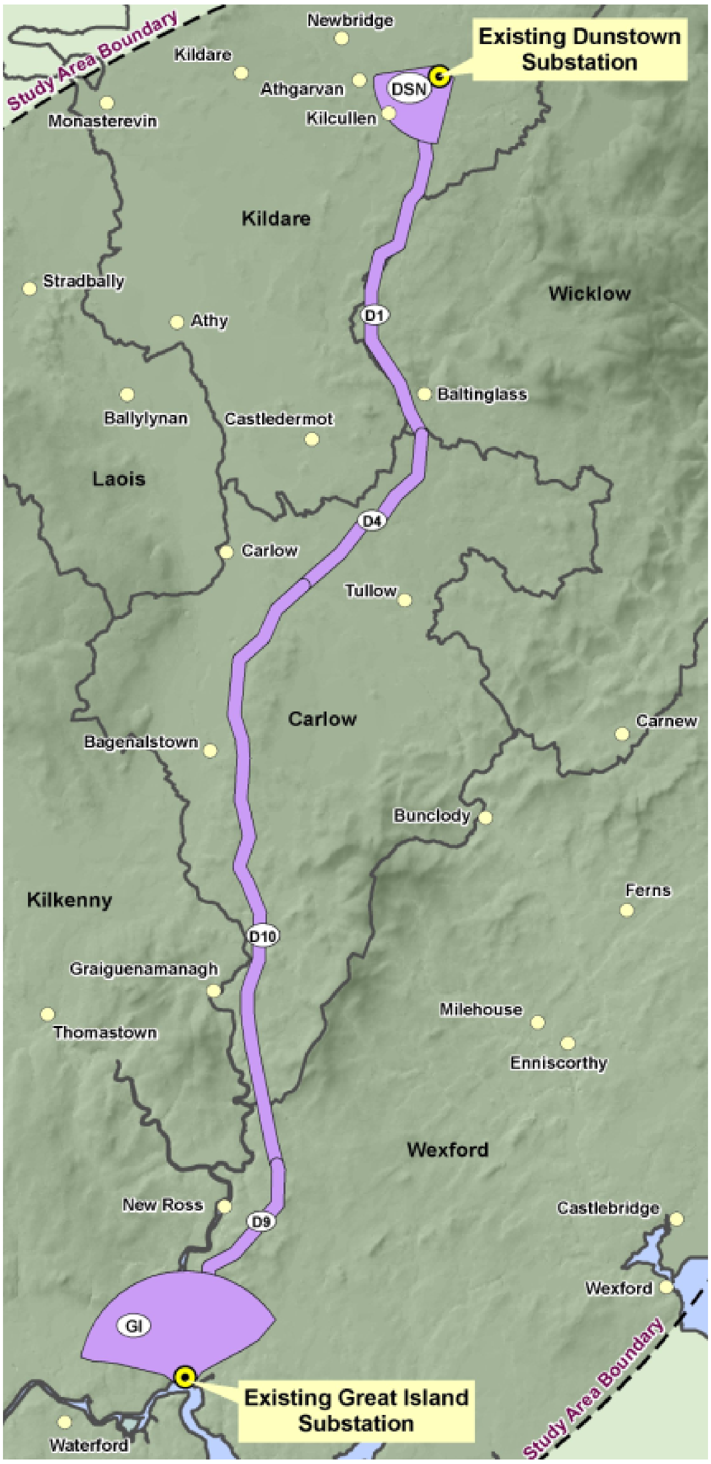
Passes east of Bagenalstown.

Crosses tributaries of the River Barrow east of Borris, northeast of Graiguenamanagh, east of St. Mullins and northwest of Ballywilliam.

Crosses over the N30 and N25 national roads east of New Ross.

Approaches the Great Island substation zone west of the JF Kennedy Memorial Forest Park.

9.4.5 Corridor Option DSN5



Commences at the edge of the Dunstown substation zone.

Passes to the west of Dunlavin, Baltinglass and Rathvilly.

Meets the M9 where it intersects with the R725 regional road between Carlow Town and Tullow.

Follows the line of the M9 until it crosses the N80 national road.

Stays east of the River Barrow, passing between Nurney and Leighlinbridge.

Passes east of Bagenalstown, Borris, Graiguenamanagh and St. Mullins.

Crosses tributaries of the River Barrow east of Borris, northeast of Graiguenamanagh, east of St. Mullins and northwest of Ballywilliam.

Includes a crossing of the N30 and N25 national roads east of New Ross

Approaches the Great Island substation zone west of the JF Kennedy Memorial Forest Park.

9.4.6 Corridor Option DSN6

Commences at the edge of the Dunstown substation zone [D11].

Variant 1 [D12]: Passes to the east of Knockaulin Hillfort.

Variant 2 [D17]: Passes to the west of Knockaulin Hillfort.

Remains west of the M9 [D13].

Variant 3 [D14]: Parallels and overlaps the M9.

Variant 4 [D18]: Remains west of the M9.

Passes west of Castledermot and east of Carlow town.

Crosses the M9 and Burren river east of Moyle.

Crosses the N80 national road at Ballyveal.

Variant 5 [D6]: Passes to the west of Fennagh.

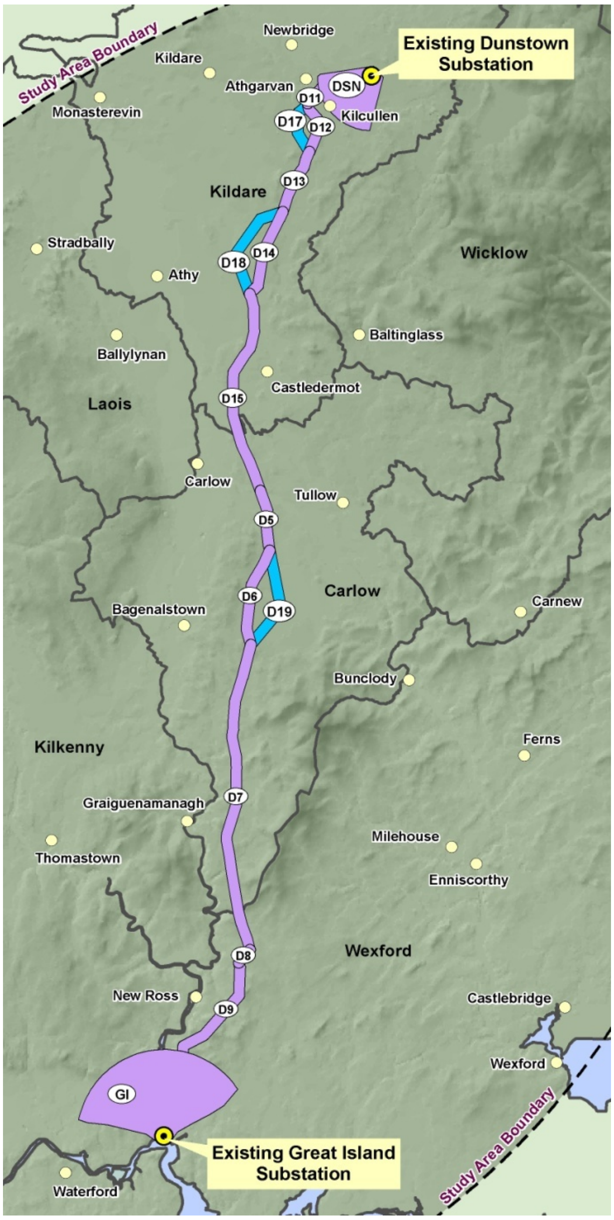
Variant 6 [D19]: Passes to the east of Fennagh.

Crosses tributaries of the River Barrow east of Borris, northeast of Graiguenamanagh, east of St. Mullins and west of Ballywilliam.

Crosses over the N30 and N25 national roads east of New Ross.

Approaches the Great Island substation zone east of the JF Kennedy Memorial Forest Park.

9.4.7 Corridor Option DSN7



Commences at the edge of the Dunstown substation zone.

Variant 1 [D12]: Passes to the east of Knockaulin Hillfort.

Variant 2 [D17]: Passes to the west of Knockaulin Hillfort.

Remains west of the M9.

Variant 3 [D14]: Parallels and overlaps the M9.

Variant 4 [D18]: Remains west of the M9.

Passes west of Castledermot and east of Carlow town.

Crosses the M9 and Burren river east of Moyle.

Crosses the N80 national road at Ballyveal.

Variant 5 [D6]: Passes to the west of Fennagh.

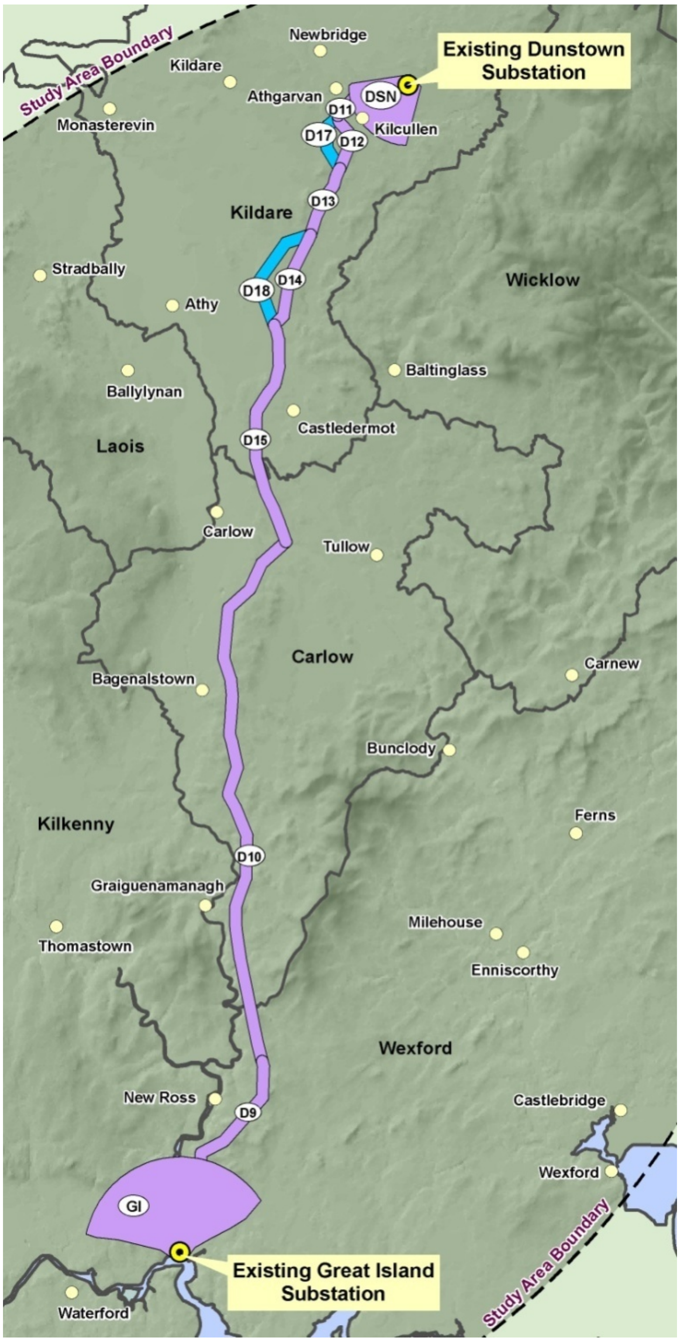
Variant 6 [D19]: Passes to the east of Fennagh.

Crosses tributaries of the River Barrow east of Borris, northeast of Graiguenamanagh, east of St. Mullins and west of Ballywilliam.

Crosses over the N30 and N25 national roads east of New Ross.

Approaches the Great Island substation zone west of the JF Kennedy Memorial Forest Park.

9.4.8 Corridor Option DSN8



Commences at the edge of the Dunstown substation zone.

Variant 1 [D12]: Passes to the east of Knockaulin Hillfort.

Variant 2 [D17]: Passes to the west of Knockaulin Hillfort.

Remains west of the M9.

Variant 3 [D14]: Parallels and overlaps the M9.

Variant 4 [D18]: Remains west of the M9.

Stays east of the River Barrow, passing between Nurney and Leighlinbridge.

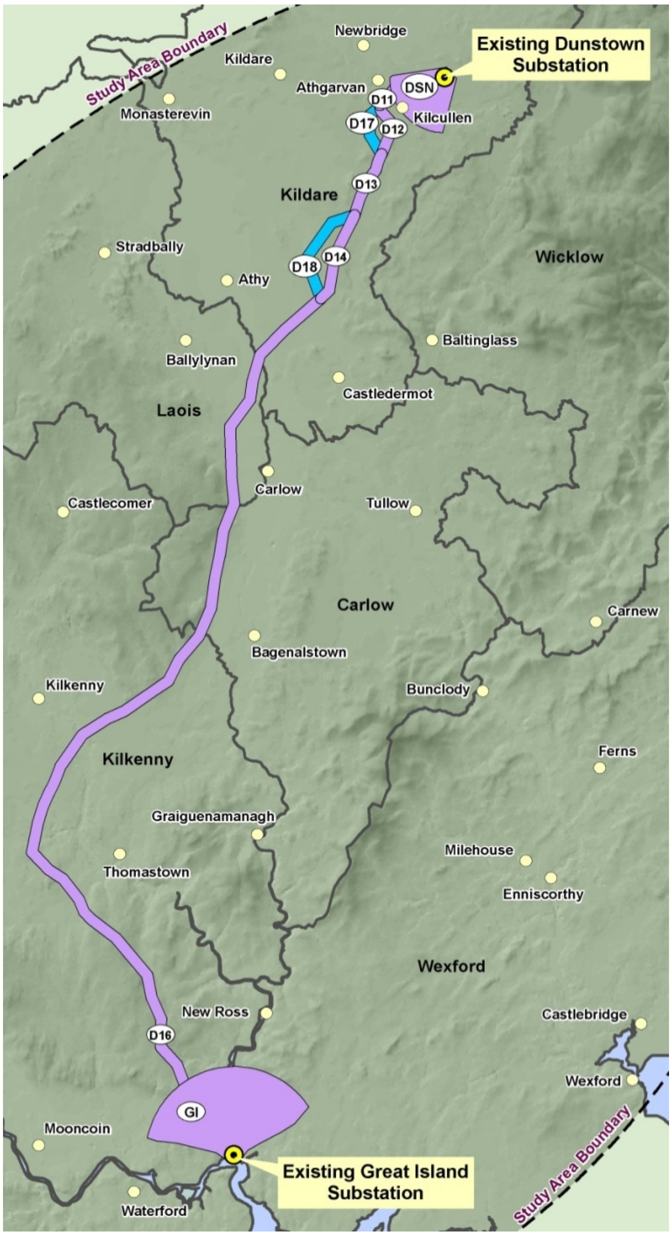
Passes east of Bagenalstown, Borris, Graiguenamanagh and St. Mullins.

Crosses tributaries of the River Barrow east of Borris, northeast of Graiguenamanagh, east of St. Mullins and northwest of Ballywilliam.

Includes a crossing of the N30 and N25 national roads east of New Ross.

Approaches the Great Island substation zone west of the JF Kennedy Memorial Forest Park.

9.4.9 Corridor Option DSN9



Commences at the edge of the Dunstown substation zone.

Variant 1 [D12]: Passes to the east of Knockaulin Hillfort.

Variant 2 [D17]: Passes to the west of Knockaulin Hillfort.

Remains west of the M9.

Variant 3 [D14]: Parallels and overlaps the M9.

Variant 4 [D18]: Remains west of the M9.

Crosses the river Barrow northwest of Maganey.

Crosses the N80 National road east of Killashin and west of Carlow town.

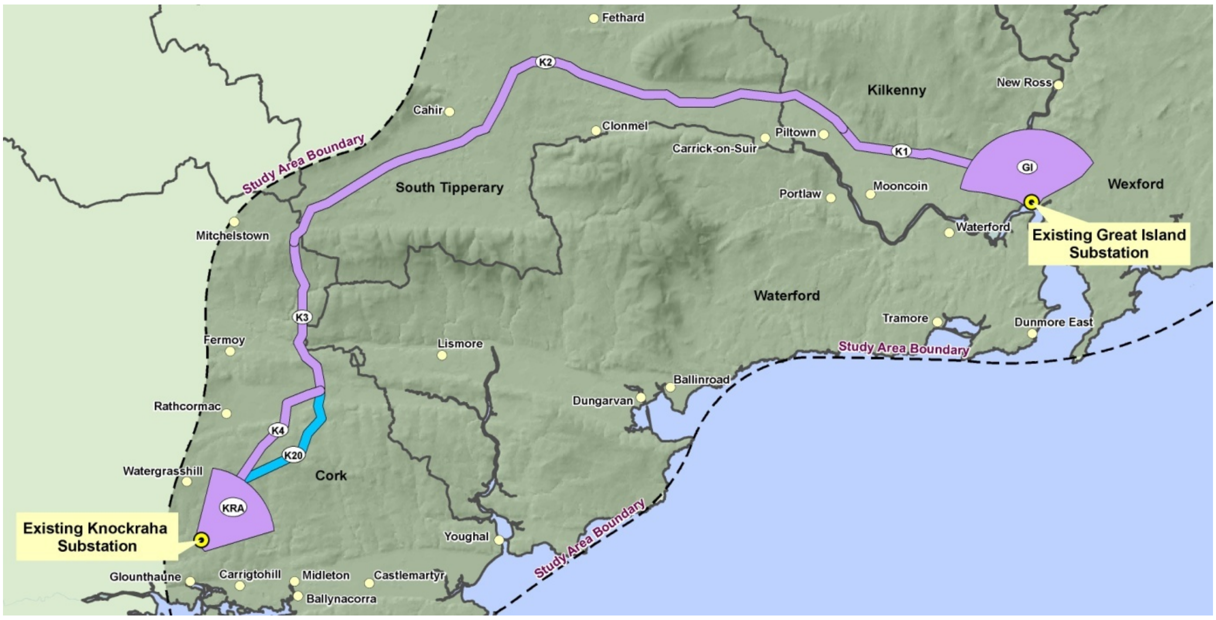
Parallels the M9 toward its junction with the N10 east of Kilkenny.

Crosses the M9 and the Nore River between Kells and Stoneyford.

Passes west of Knocktopher and Ballyhale.

Enters the Great Island substation zone east of Glenmore.

9.4.10 Corridor Option KRA1



Commences at the Great Island substation zone (8km from the existing substation at Great Island).

Crosses the M9 motorway south of Mullinavat.

Crosses the N76 north-east of Clonmel and passes between Lisronagh and Ballyclerahan.

Crosses the N24 national road east of Cahir and crosses the River Suir south of the Caher Park Wood.

Parallels the M8 motorway to east of Ballyporeen.

Passes east of Mitchelstown and Fermoy.

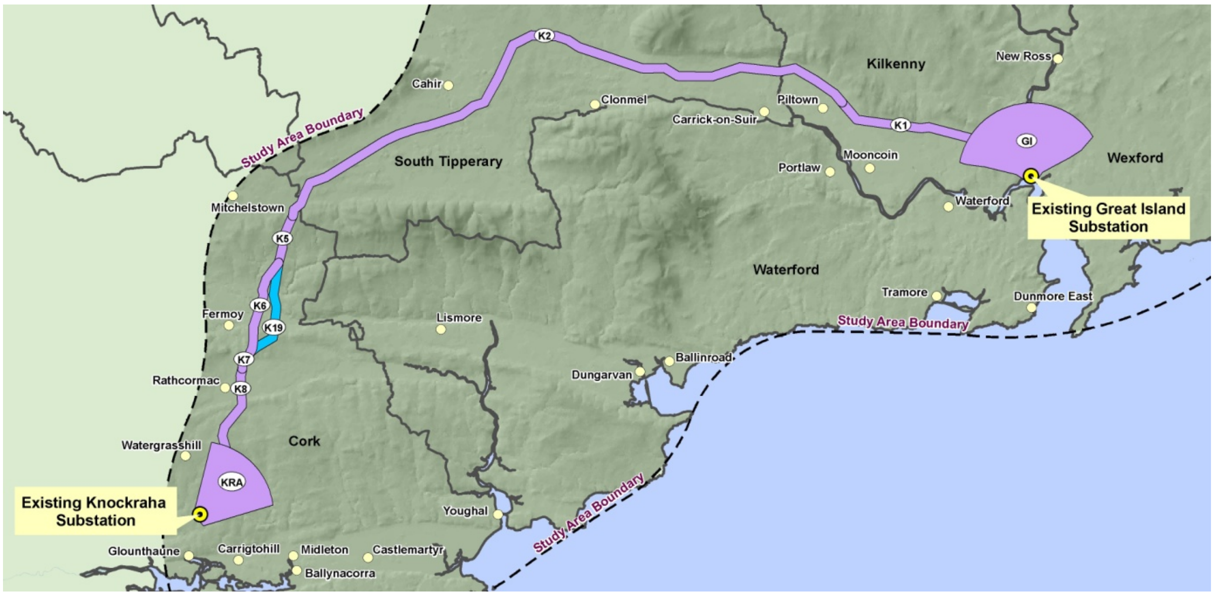
Crosses the Argalin River and the Blackwater River.

Variant 1[K4]: Crosses the River Bride east of Castlelyons.

Variant 2 [K20]: Crosses the River Bride and River Togher west of Conna.

Enters the Knockraha substation zone northwest of Ballincurrig.

9.4.11 Corridor Option KRA2



Commences at the Great Island substation zone (8km from the existing substation at Great Island).

Crosses the M9 motorway north of Waterford City.

Crosses the N76 north-east of Clonmel.

Passes North of Clonmel.

Crosses the N24 National Road east of Cahir and crosses the River Suir south of the Caher Park Wood.

Passes east of the M8 Motorway.

Variant 1 [K6]: Crosses the Blackwater River between Fermoy and Condulane.

Variant 2 [K19]: Crosses the Blackwater River west of Condulane

Enters the Knockraha substation zone (8km from the existing substation at Knockraha).

9.4.12 Corridor Option KRA3

Commences at the Great Island substation zone (8km from the existing substation at Great Island).

Crosses the M9 motorway north of Waterford City.

Crosses the N24 west of Carrick-on-Suir.

Passes west of Kilmacthomas and Lemybrien.

Passes north of Dungarvan.

Crosses the N72 and Blackwater River south of Cappoquin.

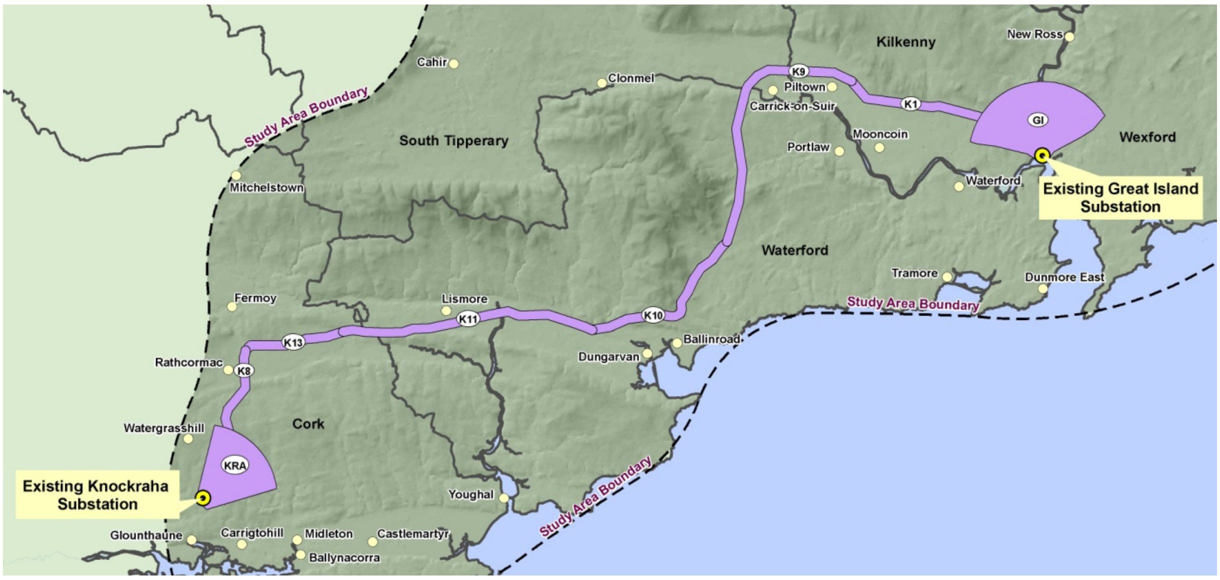
Crosses the N72 between Tallow and Lismore.

Variant 1[K4]: Crosses the River Bride east of Castlelyons.

Variant 2 [K20]: Crosses the River Bride and the River Togher west of Conna.

Enters the Knockraha substation zone (8km from the existing substation at Knockraha).

9.4.13 Corridor Option KRA4



Commences at the Great Island substation zone (8km from the existing substation at Great Island).

Crosses the M9 motorway north of Waterford City.

Crosses the N24 west of Carrick-on-Suir.

Passes west of Kilmacthomas and Lemybrien.

Overlaps the N25 northeast of Dungarvan then runs parallel to the N72 National Road.

Crosses the N72 and River Blackwater South of Cappoquin.

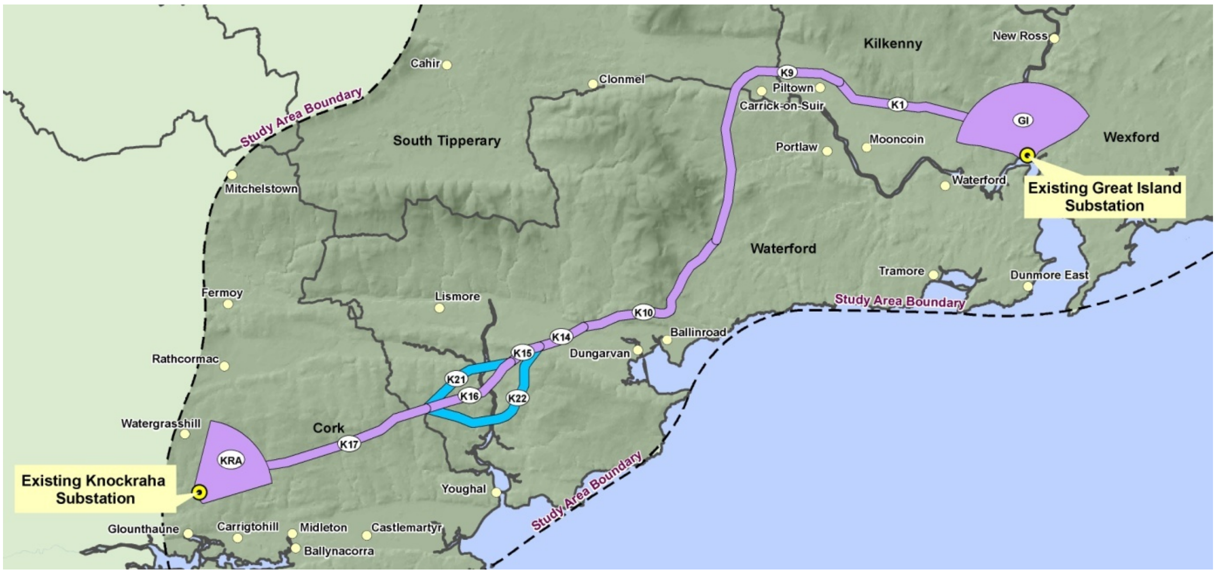
Crosses the N72 national road south of Lismore.

Crosses the N72 national road east of Currabeha.

Passes to the north of Conna then west of Castlelyons.

Enters the Knockraha substation zone (8km from the existing substation at Knockraha).

9.4.14 Corridor Option KRA5



Commences at the Great Island substation zone (8km from the existing substation at Great Island).

Crosses the M9 motorway north of Waterford City.

Crosses the N24 west of Carrick-on-Suir.

Passes west of Kilmacthomas and Lemybrien.

Crosses the N72 National Road northwest of Dungarvan.

Variant 1 [K16]: Passes between Villiertown and Aglish then crosses the Goish River and the River Blackwater.

Variant 2 [K21]: Passes south of Villiertown, and then crosses the Goish River and the River Blackwater.

Variant 3 [K22]: Passes south of Aglish then crosses the River Goish and the River Blackwater.

Passes partially through Clonmult.

Enters the Knockraha substation zone (8km from the existing substation at Knockraha).

9.4.15 Corridor Option KRA6

Commences at the Great Island substation zone (8km from the existing substation at Great Island).

Crosses the M9 motorway north of Waterford City.

Crosses the River Suir south of Mooncoin.

Passes north of Kilmacthomas and Lemybrien.

Crosses the N72 national road northeast of Dungarvan.

Crosses the River Blackwater South of Cappoquin

Crosses the N72 national road between Lismore and Tallow

Crosses the N72 again south of Currabeha

Variant 1[K4]: Crosses the River Bride east of Castlelyons.

Variant 2 [K20]: Crosses the River Bride and the River Togher west of Conna.

Enters the Knockraha substation zone (8km from the existing substation at Knockraha).

9.4.16 Corridor Option KRA7

Commences at the Great Island substation zone (8km from the existing substation at Great Island).

Crosses the M9 motorway north of Waterford City.

Crosses the River Suir south of Mooncoin.

Passes north of Kilmacthomas and Lemybrien.

Crosses the N72 national road northeast of Dungarvan.

Crosses the River Blackwater South of Cappoquin

Crosses the N72 national road between Lismore and Tallow.

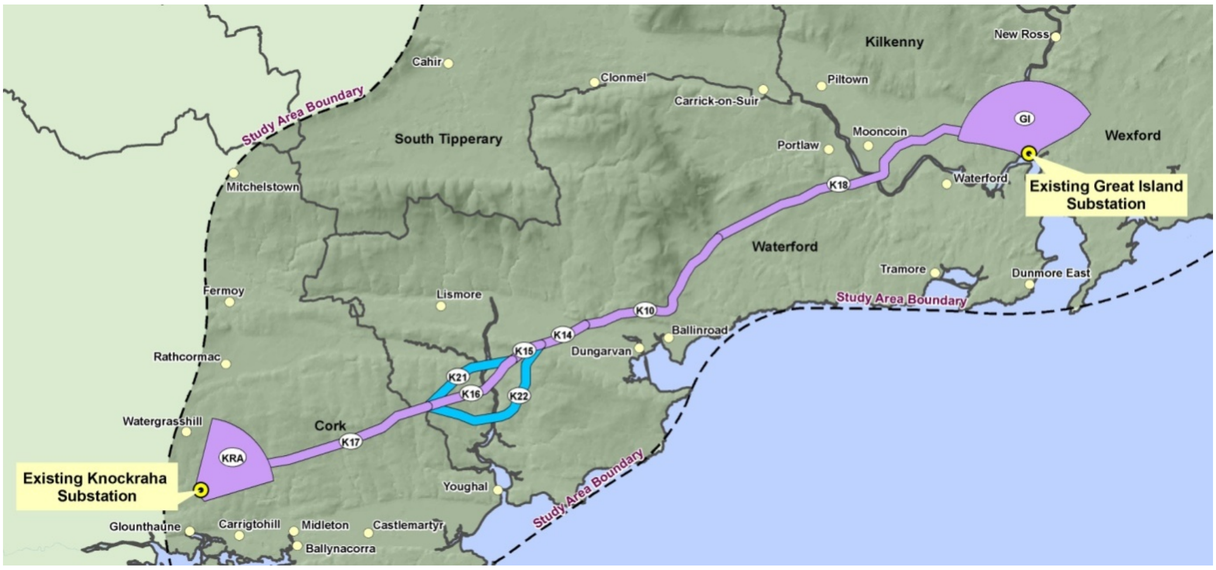
Crosses the N72 again south of Currabeha.

Passes north of Castlelyons.

Passes east of Rathcormack.

Enters the Knockraha substation zone (8km from the existing substation at Knockraha).

9.4.17 Corridor Option KRA8



Commences at the Great Island substation zone (8km from the existing substation at Great Island).

Crosses the M9 motorway southeast of Kilmacow.

Passes North of Waterford City.

Crosses the N24 national road and River Suir south of Mooncoin.

Passes north of Kilmacthomas and west of Lemybrien.

Crosses the N72 National Road northwest of Dungarvan.

Variant 1 [K16]: Passes between Villiertown and Aglish then crosses the Goish River and the River Blackwater.

Variant 2 [K21]: Passes south of Villiertown, then crosses the Goish River and the River Blackwater.

Variant 3 [K22]: Passes south of Aglish then crosses the River Goish and the River Blackwater.

Passes partially through Clonmult.

Enters the Knockraha substation zone (8km from the existing substation at Knockraha).

10 EVALUATION CRITERIA

10.1 INTRODUCTION

This chapter sets out current proposals in respect of the criteria which will inform a comparative evaluation of the identified overhead line (OHL) route corridor options and substation sites for the Grid Link Project. As part of the structured public and stakeholder consultation process associated with the publication of this Stage 1 Report, EirGrid is seeking feedback on the evaluation criteria identified. Relevant feedback will inform the final evaluation methodology, including final evaluation criteria, and the identification of a least constrained route corridor and substation sites which will in turn be used to identify the indicative line route for the Grid Link Project.

10.1.1 Approach to Criteria Selection

The objective of the evaluation process will be to compare the various identified route corridor options and substation sites (including any associated tie-ins), taking account of a wide range of technical, environmental, social and other criteria with a view to identifying the least constrained corridor and associated substation sites. Potentially suitable relevant criteria have been informed by:-

- The professional expertise of EirGrid, the project team and its technical experts.
- Strategic technical and environmental assessments carried out as part of the constraints and route corridor identification process.
- Published best practice technical guidance for the routing and siting of electricity transmission infrastructure, such as technical brochures from CIGRE (the Council on Large Electric Systems), the Holford Rules, and the Horlock Rules.
- Published best practice environmental guidelines including NRA's 2010 Project Management Guidelines and associated Environmental Planning Guidelines and EirGrid's Ecology Guidelines for Electricity Transmission Projects.
- Information elicited during stakeholder and public consultation.

In developing the proposed criteria, the project team looked to identify individual criteria which, from a particular specialist perspective, were capable of differentiating whether an option is more or less constrained in respect of a particular criterion.

The project team also sought to avoid matters which will be more appropriately addressed during subsequent stages of the project. For example, it is during the detailed routing and detailed line design stage that the project team will seek to minimise potential impacts on individual buildings, dwellings, landholdings and particular land uses and activities.

The project team also sought to avoid the potential for 'double counting' of particular evaluation criteria; while the same criteria may be identified under different topics they inform different aspects of the route corridor evaluation process. For example, the number of rivers crossed has implications from a technical perspective (in terms of span length and angle of approach), and it also has implications from an environmental perspective (in terms of water quality).

Taking all of the above into consideration, the proposed evaluation criteria headings are as follows:-

- Technical.
- Cost.
- Environmental (including social):
    - Population and Settlement;
    - Land Use;
    - Soils and Geology;
    - Water;
    - Hydrogeology;
    - Hydrology;
    - Ecology;
    - Landscape and Visual Impact; and
    - Archaeology, Architectural and Cultural Heritage.

The criteria relevant to OHL are presented in **Tables 10.1 to 10.6**. While the majority of criteria are relevant for both route corridor options and substation sites, there are additional criteria of particular relevance for the selection of substation sites. For this reason, criteria relevant to substations are presented separately in **Table 10.7**. The criteria will take into account the various technologies available to the Grid Link Project as outlined in **Chapter 2** and **Chapter 6**.

10.1.2 Approach to Evaluation

The least constrained route corridor option and substation site (including tie-in) for the Grid Link Project will present what is considered to constitute the most appropriate balance between the various technical, cost and environmental (including social) criteria based on application of professional expertise and experience with respect to the identified criteria.

Qualitative evaluation is a long established and accepted process of decision making. The approach records whether, in respect of a particular criterion, a corridor is 'more constrained' or 'less constrained', based on information and knowledge available, without implying whether one criterion is of greater or lesser importance than another. Essential to such an evaluation approach is the need for a clear explanation and rationale for each conclusion reached. Therefore, quantitative attributes based on factual or documented information will be referred to where possible, for example, the number of Special Areas of Conservation (SAC) that a corridor may traverse or settlements within a corridor. In considering these quantitative figures, the experience of the specialist will be used to arrive at a qualitative assessment of the relative importance of these figures to the evaluation process.

When evaluating the corridors relative to each other, particular emphasis will be placed on those constraints identified as Primary Constraints (refer to **Chapter 8**). Emphasis will also be placed on the significance of the likely impact, i.e. is it temporary or permanent, short, medium or long-term, etc. In this regard, it is reasonable to consider that if there are likely to be long term adverse significant residual impacts which cannot be mitigated, in respect of a particular criterion, that these will be deemed to be more sensitive than a potential impact which can be mitigated. The evaluation process is therefore focused on the strategic consideration of the potential for mitigation. It should be noted, however, that the detailed consideration of mitigation measures (to specifically address or minimise identified potential impacts) will be considered during the subsequent detailed route design and environmental assessment stages of the project.

The following sections outline the technical, cost, environmental and social criteria to be considered in the corridor evaluation process.

10.2 TECHNICAL AND COST EVALUATION CRITERIA FOR CORRIDOR OPTIONS

As described in **Chapter 8**, technical considerations and routing principles have informed the route corridor identification process to date. However, for each route corridor option there remains, to varying degrees, potential technical and cost related challenges. These provide the focus for the **technical evaluation criteria** identified in **Table 10.1.**

From a transmission system perspective, each option must be considered in the context of EirGrid's statutory obligation to operate and ensure the maintenance of and, develop a safe, secure, reliable, economical and efficient electricity transmission system. This would consider *inter alia* potential to add complexity and risk in terms of the operation and maintenance of the system depending on the route corridor option. Other technical criteria relevant to routing are also identified in **Table 10.1.** In terms of cost, the proposed evaluation criteria focus on capital costs, maintenance costs and Life Cycle Costs.

Table 10.1 Technical and Cost Evaluation Criteria

Technical	Cost
Issue and Criteria	Issue and Criteria
Strategic Intent: • Compliance with Grid25 criteria. **System Operability and Complexity:** • Number of locations per corridor where a combination of technologies is likely, e.g. an OHL in combination with partial undergrounding. • Overall length of route corridor (km). • Number of existing 110kV, 220kV and 400kV crossings per corridor. **CIGRE Routing Principles / Holford Rules:** • Approximate % of route corridor length in compliance with routing principles (km and % of overall length). **Engineering Constraints:** • Number of quarries, mines, karst areas and landfills located in route corridor. • Number of motorway and railway crossings per route corridor. • % of route corridor within 1 in 100 year flood plain. • Distance from boundary of corridor to limit of Airport Safety Zone. • Number of crossings of high-pressure gas pipelines per route corridor. • % of route corridor paralleling high pressure gas pipeline. • Number of windfarms within 3 x rotor diameter	• Capital costs • Annualised maintenance costs • Life Cycle costs

Technical	Cost
of corridor boundary. • Number of rivers crossed >300m wide. **Access for construction and maintenance:** • Number of areas where access for construction, (e.g. areas steeper than 30 degrees), maintenance and decommissioning of OHL could be difficult.	

10.3 ENVIRONMENT AND SOCIAL CRITERIA FOR CORRIDOR OPTIONS

In addition to technical and cost criteria, there is a wide range of environmental and social criteria that must be taken into consideration in terms of evaluating route corridors. These are particularly relevant in respect of EirGrid's obligation to develop a safe, secure and reliable electricity transmission system having due regard to the environment. The criteria are outlined in **Sections 10.3.1 to 10.3.5** below.

10.3.1 Population and Settlement and Land Use

The objective of the population and settlement set of evaluation criteria as set out in Table 10.2 is to provide a comparative indication of the settlement pattern, number of dwellings and population within and proximate to the different route corridor options. The intention is to differentiate each option in terms of the number of people and the degree to which they may potentially be affected from a social, general amenity and community perspective.

New transmission infrastructure can also potentially impact, directly or indirectly, on land uses and related activities especially within or in proximity to existing settlements. It may also impact tourism and recreational areas, facilities or activities. The intention of the land use evaluation criteria is to provide a comparative indication of the potential land use sensitivities for the different route corridor options.

Table 10.2 Population and Settlement and Land Use Evaluation Criteria

Population and Settlement	Land Use
Issue and Criteria	**Issue and Criteria**
Potential to impact settlements: • Number of settlements with population greater than 1,000 within the route corridors (as identified by CSO census). • Number of settlements with population greater than 1,000 within 1 km of the	**Potential to impact on land zoned for development:** • Area of route corridor traversing land zoned for development. • Area of route corridor traversing land zoned for residential use.

boundary of the route corridors (as identified by CSO census). • Number of settlements with population less than 1,000 within the route corridors (as identified by CSO census). • Number of settlements with population less than 1,000 within 1 km of the boundary of the route corridors (as identified by CSO census). **Potential to impact population:** • Average population density per sq. km (based on GeoDirectory data and average house size as per CSO 2011). **Potential to impact residential properties:** • Number of dwellings within the route corridors based on GeoDirectory data. • Average dwellings per sq. km based on GeoDirectory data. **Potential to impact on communities:** • Number of community facilities within the corridor.	**Potential to impact on tourism:** • Number and nature of Bord Failte top visitor attractions located within route corridor. • Number of Bord Failte facilities located within the route corridor. **Potential to impact on recreational amenity:** • Area of route corridor traversing land zoned for high amenity.

10.3.2 Soils, Geology and Water

It is proposed to consider both geological designations and features as evaluation criteria for the Grid Link Project. Geological natural heritage areas ((p)NHAs) are generally designated as a result of a specific geological interest (e.g. rare fossils or bedrock exposures within active quarries), while County Geological Sites (CGS) have a lesser sensitivity and importance than NHAs but may be of local importance. Other features of relevance to the project include *inter alia* landfills, quarries and mines in terms of the potential for contamination and / or impact on extractive activities.

The evaluation criteria in respect of water focus on the potential to cause pollution and sedimentation to surface or ground water during construction or maintenance activities, and hydromorphology impact arising from physical damage caused by works in close proximity to a water body.

Table 10.3 Soils, Geology and Water Evaluation Criteria

Soils and Geology	Water
Issue and Criteria	**Issue and Criteria**
Potential impact on Geological Natural Heritage Areas (NHAs) including potential sites: • Number of (p)NHAs within the route corridor. **Potential impact on County Geological Sites (CGS) including potential sites:** • Number of CGS within the route corridor. **Potential impact on contaminated land:** • Number of known contaminated sites within the route corridor including landfills, backfilled quarries, former industrial sites. **Potential impact on quarries & mines:** • Number of active mines or quarries within the route corridor. **Potential impact on high quality soils:** • Length of route traversing such soils (km).	**Potential to impact negatively on Water Framework Directive (WFD) status of water bodies not covered elsewhere:** • Number of sites on WFD Register of Protected Areas within corridor (excluding those areas designated for the protection of habitats and species which are already included under SAC/SPA criterion). **Potential to impact on other rivers:** • Number of river crossings (as defined by WFD) that may be potentially impacted by the development and not covered under separate criteria i.e. SAC rivers, salmonid rivers. **Potential to impact on lakes:** • Number of lakes that may be potentially impacted by the development.

10.3.3 Hydrogeology and Hydrology

The **hydrogeology** evaluation criteria focus on the potential of the different route corridor options to impact on: the groundwater quality of existing public water supplies, regionally important vulnerable aquifers, springs, turloughs, estavelles and caves, and groundwater quality close to groundwater dependant ecosystems, e.g. fens and turloughs.

The **hydrology** evaluation criteria focus *inter alia* on the potential for accidental spillage of fuel, chemicals or sewage causing pollution to surface or ground water during construction or maintenance activities. It is also proposed to consider the cumulative impact of hydrological changes on adjacent aquatic ecological sites close to crossing points.

Table 10.4 Hydrogeology and Hydrology Evaluation Criteria

Hydrogeology	Hydrology
Issue and Criteria	**Issue and Criteria**
Public groundwater supplies: • Number of source protection zones and length of protection zones crossed. **Groundwater bodies:** • The extent to which the route corridor crosses regionally important aquifers where vulnerability is high or extreme. • Natural hydrogeological or karst features: • Number of hydrogeological or karst features along the route corridor. **Groundwater dependant ecosystems (GWDTE):** Number of GWDTE which the route corridor crosses.	**Potential to impact negatively on WFD status of water bodies:** • Number of water courses crossed by each route corridor. **Aquatic ecological sites:** • Number of aquatic ecological sites close to crossings. **Potential to impact on lakes:** • Number of lakes that may be potentially impacted by the development. **Drinking water abstractions:** • Number of surface water abstractions close to the route corridor. **Flooding risk:** • Number of flood risk sites along the route corridor.

10.3.4 Ecology and Landscape and Visual Impact

The proposed **ecological evaluation criteria** can be divided into potential for direct and / or indirect impact on designated sites for nature conservation (including SACs, SPAs, NHAs), protected habitats and species (including Annex I Habitats) and other sensitive habitats.

The proposed **landscape and visual assessment criteria** focus on the potential of the corridor options to impact upon international, national and county landscape designations. In this regard, high amenity areas are considered to be areas of outstanding natural beauty and / or have unique interest value. Such areas are generally sensitive to development and the introduction of an OHL and associated infrastructure to such areas could result in impacts on that landscape. The introduction of an OHL to an area also has the potential to impact on protected views, scenic routes and viewing points. The evaluation criteria also considers the landscape character of the options as determined by desktop study, fieldwork completed to date and information contained in the County Landscape Character Assessments (which are referred to in the County Development Plans). The ability of the area to absorb overhead transmission lines will therefore vary depending on the landscape character type. While major towns and villages have been avoided as far as possible, one-off housing, housing clusters and significant stretches of linear housing development along roads are a feature of the route corridor options, albeit to varying degrees. The construction of an OHL can impede on visual receptor views.

Table 10.5 Ecology and Landscape and Visual Impact

Ecology	Landscape/Visual Impact
Issue and Criteria	**Issue and Criteria**
Potential to impact on Natura 2000 sites [SAC or SPA]: • Number of times route corridor traverses a Natura 2000 site. • Potential to impact on Natura 2000 sites outside the route corridor. **Indirect impact on riverine SACs:** • Number tributaries crossed, discharging directly to downstream SAC. **Cumulative impacts on Natura 2000 sites:** • Number of Natura 2000 sites with more than one crossing. **Potential to impact on protected habitats and species (NHA, pNHA, confirmed Annex 1 habitat outside of Natura 2000 sites, protected species habitat):** • No. of times route corridor traverses other protected habitats. • Potential to impact on protected habitats outside the route corridor options. **Potential to impact on other areas of Biodiversity Value (wetlands, bogs, native woodland, unconfirmed Annex 1 habitat outside of Natura 2000 sites):** • Number of other areas of biodiversity value crossed by route corridor. • Proximity to important bird areas other than SPA outside route corridor. **Potential to impact on designated salmonid waters:** • Number of designated salmonid watercourses crossed by route corridor (designated under S.I. 293/1988, European Communities (Quality of Salmonid Waters) Regulations). **Disturbance to Bats:** • Number of bat roosts [from BCI data] within the route corridor.	**Potential Impact on Landscape Designations including protected views, scenic routes, Areas of Outstanding Natural Beauty (AONB):** • Number and nature of designations within or crossed by the route corridor. • Number and nature of landscape designations with potential for indirect impact outside route corridor. **Potential Impact on Landscape Character:** • Length of sensitive landscape crossed by route corridor (km). **Potential to impact on visual amenity of residential dwellings:** • Number of dwellings within the route corridors based on GeoDirectory data. **Potential to impact on visual amenity of community facilities:** • Number of community facilities within the corridor. • Number of community facilities with potential for indirect impact outside route corridor.

10.3.5 Archaeology, Architecture and Cultural Heritage

Throughout the study area and identified route corridors there is a variety of archaeological, architectural and cultural heritage, including structures / buildings of architectural heritage significance and distinctive character that are worthy of protection. The objective of the evaluation criteria set out in **Table 10.6** is to provide a comparative indication of the potential direct and indirect impact (to include impacts on setting) of the route corridor options on identified archaeological and architectural assets. Two different types of archaeological and architectural resources are identified – those afforded international, national or county wide protection, and other cultural heritage assets of potential merit.

Table 10.6 Archaeology, Architectural and Cultural Heritage

Archaeology, Architectural and Cultural Heritage	
Issue and Criteria	**Other Issue and Criteria**
Potential to impact UNESCO World Heritage Sites (including candidate UNESCO World Heritage Sites): • Number of UNESCO World Heritage Sites and candidate sites within route corridor with potential for direct and indirect impact. • Number of UNESCO World Heritage Sites and candidate sites with potential for indirect impact outside route corridor. **Potential to impact on National Monuments (including Temporary Preservation Orders and Register of Historic Monuments, Potential National Monuments in Local Authority Ownership where known):** • Number of National Monuments within route corridor with potential for direct and indirect impact. • Number of National Monuments with potential for indirect impact outside route corridor. **Potential to impact on Recorded Archaeological Sites / Monuments (RMP sites):** • Number of RMP sites within route corridor with potential for direct and indirect impact. • Number of RMP sites with potential for indirect impact outside of the route corridor (professional judgement). **Potential to impact on Architectural Conservation Areas (ACA's):** • Number of ACA's within route corridor with potential for direct and indirect impacts. • Number of ACA's with potential for indirect impact outside route corridor. **Potential to impact on protected structures (Record of Protected Structures (RPS) in**	**Potential to impact on National Inventory & Architectural Heritage (NIAH) sites:** • Number of NIAH sites of regional and above rating within route corridor with potential for direct and indirect impact. • Number of NIAH sites of regional and above rating with potential for indirect impact outside route corridor. **Potential to impact on NIAH Designed (Demesne) Landscapes/Garden Landscapes:** • Number of Designed (Demesne) Landscapes / Garden Landscapes within route corridor with potential for direct impact. • Number of Designed (Demesne) Landscapes / Garden Landscapes within route corridor with potential for indirect impact outside route corridor. **Potential to impact on features of undesignated archaeological / architectural and cultural heritage sites of merit / significance:** • Number of features of significant cultural heritage merit within route corridor with potential for direct and indirect impact. • Number of features of significant cultural heritage merit with potential for indirect impact outside route corridor. **Potential to impact on sub-surface archaeological sites:** • Number of sub-surface archaeological sites within route corridor with potential for direct and indirect impact. • Number of sub-surface archaeological sites with potential for indirect impact outside route corridor.

Archaeology, Architectural and Cultural Heritage	
Issue and Criteria	**Other Issue and Criteria**
the County Development Plans): • Number of RPS sites of regional and above rating within route corridor with potential for direct and indirect impact. • Number of RPS sites of regional and above rating with potential for indirect impact outside route corridor.	

10.4 SUBSTATION EVALUATION CRITERIA

Where appropriate the evaluation criteria detailed in the previous section will be equally relevant for substation site evaluation and associated tie-in. However, the substation evaluation process will also require specific consideration of those issues identified in **Chapter 7** of this report. It is noted that the evaluation of the substation sites will also include the section of OHL contained within the substation zones as presented in **Chapter 7** of this document. The relevant criteria for substation site evaluation are identified in **Table 10.7.**

Table 10.7 Substation Evaluation Criteria

Technical	Cost
System Operability and Complexity: • Compatibility with the indicative corridors for connection of proposed 400kV OHL. • Availability of direct connection from 400kV line to switchgear without intervening underground cable. • Compatibility with connection to existing 220kV substations. • Availability of 220kV connection without requiring UGC. **CIGRE Routing Principles / Horlock Rules:** • Compliance with siting principles. **Engineering Constraints:** • Adequacy of site dimensions and shape (Ground Area). • Percentage of site incorporating <3% slope (Topography). • Percentage of site containing ground suitable for construction and substation earthing (Ground Suitability).	**Cost:** • Capital cost. • Annualised maintenance cost. • Life cycle costs.

• Percentage of site outside a flood risk zone. • Percentage of site unencumbered by waterbodies within site boundary. • Compliance with zoning. • Percentage of site unencumbered by existing structures within the site which cannot be dismantled. • Potential to facilitate future extensions (Extendibility). **Access for Construction and Maintenance:** • Percentage of site without areas where access for construction, (e.g. areas steeper than 30 degrees), operation, maintenance and decommissioning of substation could be difficult.	
Population and Settlement	**Land Use**
Potential to impact on settlements: • Number of settlements within 1km of site boundary. **Potential to impact population:** • Average population density per sq. km (based on GeoDirectory data and average house size as per CSO 2011). **Potential to impact residential properties:** • Number of properties within 150m of site boundary based on GeoDirectory data. • Number of properties within 300m of site boundary based on GeoDirectory data. • No. of properties within 1km of site boundary based on GeoDirectory data. **Potential to impact on communities:** • Number of community facilities within 1km of site.	**Potential to impact on land zoned for development:** • Compliance with site zoning. **Potential to impact on tourism:** • Number and nature of Bord Failte top visitor attractions located within 1km of site. • Number of Bord Failte facilities located within 1km of site.
Soils and Geology	**Water**
Potential impact on Geological Natural Heritage Areas (NHAs) including potential sites: • Number of (p)NHAs within the site. **Potential impact on County Geological Sites (CGS) including potential sites:** • Number of CGS within the site. **Potential impact on contaminated land:**	**Potential to impact negatively on Water Framework Directive (WFD) status of water bodies not covered elsewhere:** • Number of sites on WFD Register of Protected Areas within site (excluding those areas designated for the protection of habitats and species which are already included under SAC / SPA criterion). **Potential to impact on other rivers:** • Number of river crossings (as defined by

• Number of known contaminated sites within the site including landfills, backfilled quarries, former industrial sites. **Potential impact on quarries & mines:** • Number of active mines or quarries within the site. **Potential impact on high quality soils:** • Presence of high quality soils within site.	WFD) that may be potentially impacted by the development and not covered under separate criteria i.e. SAC rivers, salmonid rivers. **Potential to impact on lakes:** • Number of lakes that may be potentially impacted by the development.
Hydrogeology	**Hydrology**
Public groundwater supplies: • Number of source protection zones crossed by site. **Groundwater bodies:** • The extent to which the site crosses regionally important aquifers where vulnerability is high or extreme. **Natural hydrogeological or karst features:** • Presence of hydrogeological or karst features within site. **Groundwater dependant ecosystems (GWDTE):** • Number of GWDTE within site.	**Potential to impact negatively on WFD status of water bodies:** • Number of water courses crossed by site. **Aquatic ecological sites:** • Number of aquatic ecological sites within the site. **Potential to impact on lakes:** • Number of lakes that may be potentially impacted by the development. **Drinking water abstractions:** • Number of surface water abstractions close to the site. **Flooding risk:** • Percentage of site within a flood risk zone.
Ecology	**Landscape/Visual Impact**
Potential to impact on Natura 2000 sites [SAC or SPA]: • Number of SAC / SPA within site. • Potential to impact on Natura 2000 sites outside the site. **Indirect impact on riverine SACs:** • Number of tributaries crossed, discharging directly to downstream SAC. **Cumulative impacts on Natura 2000 sites**: • Number of Natura 2000 sites with more than one crossing. **Potential to impact on protected habitats and**	**Potential Impact on Landscape Designations including protected views, scenic routes, Areas of Outstanding Natural Beauty (AONB):** • Number and nature of designations within or adjacent to the site. • Number and nature of landscape designations with potential for indirect impact outside site. **Potential Impact on Landscape Character:** • Presence of sensitive landscape within site. **Potential to impact on visual amenity of residential dwellings:**

species (NHA, pNHA, confirmed Annex 1 habitat outside of Natura 2000 sites, protected species habitat): • Number of other protected habitats within the site. • Potential to impact on protected habitats outside site. **Potential to impact on other areas of Biodiversity Value (wetlands, bogs, native woodland, unconfirmed Annex 1 habitat outside of Natura 2000 sites):** • Number of noteworthy habitats within site. • Proximity to important bird areas other than SPA outside site. **Potential to impact on designated salmonid waters:** • Number of designated salmonid watercourses crossed by route corridor (designated under S.I. 293/1988, European Communities (Quality of Salmonid Waters) Regulations). **Disturbance to Bats:** • Number of bat roosts [from BCI data] within the site.	• Number of dwellings within 150m of site based on GeoDirectory data. **Potential to impact on visual amenity of community facilities:** • Number of community facilities within site. • Number of community facilities with potential for indirect impact outside site.
Cultural Heritage	**Cultural Heritage**
Potential to impact UNESCO World Heritage Sites (including candidate UNESCO World Heritage Sites): • Number of UNESCO World Heritage Sites and candidate sites within the site with potential for direct and indirect impact. • Number of UNESCO World Heritage Sites and candidate sites with potential for indirect impact outside the site. **Potential to impact on National Monuments (including Temporary Preservation Orders and Register of Historic Monuments, Potential National Monuments in Local Authority Ownership where known):** • Number of National Monuments within site with potential for direct and indirect impact. • Number of National Monuments with potential for indirect impact outside site (professional judgement). **Potential to impact on Recorded Archaeological Sites/Monuments (RMP sites):** • Number of RMP sites within site with potential	**Potential to impact on NIAH sites:** • No. of NIAH sites of regional and above rating within the site with potential for direct and indirect impact. • Number of NIAH sites of regional and above rating with potential for indirect impact outside the site. **Potential to impact on NIAH Designed (Demesne) Landscapes/Garden Landscapes:** • Number of Designed (Demesne) Landscapes / Garden Landscapes within the site with potential for direct impact. • Number of Designed (Demesne) Landscapes / Garden Landscapes within the site with potential for indirect impact outside the site. **Potential to impact on features of undesignated archaeological/ architectural and cultural heritage sites of merit/ significance:** • Number of features of significant cultural

for direct and indirect impact. • Number of RMP sites with potential for indirect impact outside the site (professional judgment). **Potential to impact on Architectural Conservation Areas (ACA's):** • Number of ACA's within the site with potential for direct and indirect impacts. • Number of ACA's with potential for indirect impact outside the site. **Potential to impact on protected structures (Record of Protected Structures (RPS) in the County Development Plans):** • Number of RPS sites of regional and above rating within the site with potential for direct and indirect impact. • Number of RPS sites of regional and above rating with potential for indirect impact outside the site.	heritage merit within the site with potential for direct and indirect impact. • Number of features of significant cultural heritage merit with potential for indirect impact outside the site. **Potential to impact on sub-surface archaeological sites:** • Number of sub-surface archaeological sites within the site with potential for direct and indirect impact. • Number of sub-surface archaeological sites with potential for indirect impact outside the site.

11 NEXT STEPS

11.1 PUBLIC CONSULTATION ON STAGE 1 REPORT

One of the key objectives of this report is to document the route corridor and substation zone identification process. All feedback arising from stakeholder engagement will inform the next stage of project development, namely the route corridor and substation site evaluation process. The Terms of Reference (ToR) for this Public Consultation Phase will be as follows:

- Share your views on the work that has been carried out to date;
- Tell us if other constraints in your local area should be considered;
- Tell us any other information you would like us to consider when assessing the corridor options; and
- Share your views on what factors should be considered when determining the least constrained corridor.

This Stage 1 Report will be placed on public display from 3rd September 2013 to 26th November 2013. As in previous rounds of consultation, stakeholder engagement will take the form of public open days within the study area, engagement with the media, stakeholder meetings and fora, etc.

11.2 IDENTIFICATION OF A LEAST CONSTRAINED CORRIDOR

Following the third round of public consultation, the project team will review submissions and comments received. A review of the feedback received on the evaluation criteria will also be undertaken. The criteria outlined in **Chapter 10, Tables 10.1 to 10.6** will then be feed into a multi-criteria analysis of the feasible route corridors with the objective of identifying a least constrained corridor.

11.3 IDENTIFICATION OF SUBSTATION SITES AND A LEAST CONSTRAINED SITE

In parallel with the evaluation of corridors, further work will be undertaken on the substation zones to identify feasible sites at Knockraha and Great Island to accommodate the required updates for connection of the 400kV OHL to the grid. The criteria outlined in **Chapter 10, Table 10.7** will then feed into a multi-criteria analysis of the feasible substation sites with the objective of identifying a least constrained site at Great Island and Knockraha where new 400kV substations are required (see **Chapter 7** for further details).

11.4 IDENTIFICATION OF INDICATIVE LINE ROUTE AND SUBSTATION SITES

Following identification of a least constrained corridor and substation sites, an indicative line route will be developed within the 1km wide least constrained corridor, linking the three node points of Dunstown, Great Island and Knockraha, via the identified substation sites.

The indicative line route will be developed with reference to best practice routing guidelines which have thus far guided the corridor identification and evaluation process albeit with a focus now within a single 1km corridor. Relevant guidance includes *inter alia* CIGRE guidance on routing and the Holford Rules (see **Appendix 4**).

The indicative line route will also be developed to avoid or minimise the potential impact on land use, ecology, visual, archaeology and other localised constraints, including avoidance of residential dwellings. In this respect, on the grounds of general amenity, where possible EirGrid will avoid routing overhead transmission lines close to residential areas. With respect to individual houses, the aim at route alignment stage will be to achieve the maximum separation distance between existing dwellings and a planned line route, while also seeking to avoid, or minimise impact upon, other identified technical and environmental constraints. In this context, EirGrid will seek, where possible, to achieve a lateral clearance of 50 metres from the centre of the indicative line route to the nearest point of a dwelling. It should be noted that the 50 metre distance is only a routing aim and is not associated with distances that are required for electrical clearance.

About EirGrid

EirGrid, a state-owned company, is the national operator of the electricity grid.

The national grid is an interconnected network of high voltage power lines and cables, comparable to the motorways, dual carriage ways and main roads of the national road network. It is operated at three voltage levels, 400kV, 220kV and 110kV, and is approximately 6,400km in overall length.

The grid is the backbone of Ireland's power system and is vital to ensuring that all customers, including industrial, commercial and residential, from both rural and urban areas, have a safe, secure, reliable, economic and efficient electricity supply.

Contact Details

EirGrid is committed to ensuring that the public is fully aware of the project and we encourage you to participate in public consultation. If you would like to discuss the project or to meet with a member of the project team, please visit our website for regular updates.

The Grid Link Project Manager, EirGrid, PO Box 12213, Glenageary, Co. Dublin, Ireland

Lo-call 1890 422 122

gridlink@eirgrid.com

www.eirgridprojects.com/projects/gridlink

Text: If you wish to receive text updates on the Grid Link Project text Grid Link and the name of your county (e.g. Grid Link Carlow) to 51444 (standard SMS rates apply).

Visit: The Grid Link Project Information Centres:

Where?	Address	Opening Hours
Midleton, County Cork	Unit 5, Market Green Shopping Centre, Midleton, Co. Cork	Every Monday from 12 noon to 6pm
Kilcullen, County Kildare	Market Square, Kilcullen, Co. Kildare	Every Monday from 12 noon to 6pm
Carrick-on-Suir, County Tipperary	Carrick Community Business Centre at the Nano Nagle Centre, Carrick-on-Suir, Co. Tipperary	Every Tuesday from 12 noon to 6pm
New Ross, County Wexford	The Coach House, Marsh Lane, New Ross, Co. Wexford	Every Wednesday from 12 noon to 6pm
Carlow, County Carlow	Enterprise House, O'Brien Road, Carlow, Co. Carlow	Every Thursday from 12 noon to 6pm

Note: Project Information Centres are closed on Bank Holidays

What is Grid25?

Grid25 is a major initiative to put in place a safe, secure and affordable electricity supply throughout Ireland, supporting economic growth and utilising our renewable energy resource to its maximum potential.

Development of the grid is essential to provide a platform for renewed economic growth and regional development, and is vital if we are to effectively tap into our abundant renewable energy resources.

Grid25 will involve upgrading the high voltage system and an overall investment of approximately €3.2 billion in the period up to 2025. This new infrastructure is every bit as essential to the future growth of the country as any investment in road, rail and broadband.

The Grid Link Project is a major part of the Grid25 initiative.