The Grid West Project

Underground Route Options

Preliminary Evaluation Report

July 2014

TOBIN Consulting Engineers

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REPORT

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DOCUMENT AMENDMENT RECORD

Client:	**EirGrid PLC**
Project:	**Grid West Project**
Title:	**Underground Route Options Evaluation Report**

PROJECT NUMBER: 6424 –Stage 2				**DOCUMENT REF: 6424_UG Routes Prelim Evaluation Report July'14 RevA.doc**			
A	Issue to Client	NMcD/GC	16-06-14	BJD	01-07-14	BJD	July '14
Revision	**Description & Rationale**	**Originated**	**Date**	**Checked**	**Date**	**Authorised**	**Date**
TOBIN Consulting Engineers							

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY 1

2. INTRODUCTION 4

2.1 PURPOSE OF THIS REPORT 5

2.2 BACKGROUND 6

2.3 GENERAL METHODOLOGY 7

3. HVDC UNDERGROUND CABLE ROUTING INSTALLATION AND MAINTENANCE 9

3.1 ROUTING OF UNDERGROUND CABLE 9

3.2 TYPCIAL DUCT AND TRENCH ARRANGEMENT 9

3.3 CABLE JOINT BAYS 10

3.4 CABLE INSTALLATION – ACCESS 13

3.5 CROSSING OBSTACLES WITH HORIZONTAL DIRECTIONAL DRILLING (HDD) 13

4. IDENTIFICATION OF POSSIBLE CABLE ROUTES 16

4.1 DESCRIPTION OF ROUTE OPTIONS IDENTIFIED TO FLAGFORD 16

4.1.1 Route Options 1 and 2 17

4.1.2 Route Options 3 and 4 18

4.1.3 Route Options 5 and 6 19

4.1.4 Route Options 7 and 8 20

4.1.5 Route Options 9 and 10 21

4.2 DESCRIPTION OF ROUTE OPTIONS IDENTIFIED TO CASHLA 22

4.2.1 Route Options 11 and 12 23

4.2.2 Route Options 13 and 14 24

4.2.3 Route Options 15 and 16 25

4.2.4 Route Options 17 and 18 26

4.2.5 Route Options 19 and 20 27

4.2.6 Options 21 and 22 28

4.2.7 Options 23 and 24 29

4.2.8 Options 25 and 26 30

4.2.9 Option 27 31

4.2.10 Sub-Marine Options 32

5. LIASON WITH LOCAL AUTHORITIES AND THE NATIONAL ROADS AUTHORITY 34

5.1 ASSESSMENT CRITERIA 34

5.1.1 Length of Route 34

5.1.2 Existing Infrastructure 35

5.1.3 Roads Upgrade Programme 35

5.1.4 Traffic Diversions during Construction 36

5.1.5 Social Impact 36

5.1.6 Cultural Heritage 37

5.1.7 Environmental 37

6. PRELIMINARY ASSESSMENT OF UNDERGROUND ROUTE OPTIONS 38
6.1 PARTIAL SUBMARINE OPTIONS 38
6.2 LAND BASED OPTIONS 38

7. ANALYSIS OF ALL OPTIONS CONSIDERED 40
7.1 UNDERGROUND ROUTE TERMINUS IN CO. MAYO 40
7.2 ASSESSMENT OF ROUTE OPTIONS TO FLAGFORD 42
7.3 ASSESSMENT OF ROUTE OPTIONS TO CASHLA 43

8. IDENTIFIED LEAST CONSTRAINED AND PREFERRED OPTIONS 45
8.1 LEAST CONSTRAINED ROUTE OPTIONS 45
8.2 PREFERRED ROUTE FROM NORTH MAYO TO FLAGORD 45
8.3 PREFERRED ROUTE FROM NORTH MAYO TO CASHLA 46
8.4 PREFERRED ROUTE 47

9. HVDC CONVERTER STATION SITES 49
9.1 INTRODUCTION 49
9.2 CONVERTER STATION LAYOUT 49
9.3 EVALUATION CRITERIA 50
9.4 CONVERTER STATION LOCATIONS 51
9.4.1 North Mayo Converter Station Locations 51
9.4.2 Flagford Converter Station Zone 52
9.5 EVALUATION OF CONVERTER STATION LOCATIONS 53
9.5.1 Evaluation of north Mayo Converter Station Locations 53
9.5.2 Evaluation of Flagford Converter Station Locations 55

10. CONCLUSIONS 58
10.1 NEXT STEPS 58

APPENDIX A – DETAILED ROUTE OPTIONS ASSESSMENT SCORES
APPENDIX B – DRAWINGS

1. EXECUTIVE SUMMARY

In March 2013 the Lead Consultant's Stage 1 Report for the Grid West project was published, recommending *inter alia* that the technology best suited to the project is an overhead high voltage alternating current power line as opposed to an underground cable solution. The Report identified an emerging preferred overhead line route corridor running from north Mayo to an existing substation in Flagford Co. Roscommon. Since March 2013 EirGrid has progressed with the design of an overhead line option up to a point where landowner engagements were undertaken on an initial line route within the emerging preferred corridor.

Following public consultation and feedback on this and other EirGrid projects, EirGrid announced, on 28th January 2014, a set of initiatives (the Grid25 Initiatives) which seek to address the issues and concerns raised during public consultations in relation to major Grid25 projects. Included in the Grid25 Initiatives was a commitment to conduct a comprehensive underground analysis for the Grid Link and Grid West projects.

Following this announcement the Minister for Communications Energy and Natural Resources appointed an Independent Expert Panel (IEP) who will oversee the review and ensure that both overhead and underground options are given full and equal consideration.

This Preliminary Evaluation Report is an initial assessment of possible underground cable routes for the Grid West project. It is the first step, of bringing the underground option up to the same level of detail as the overhead line option, which will allow a full comparison of the two options to be made and submitted to the IEP.

A total of thirty one possible underground cable routes that could serve the Grid West project have been identified as follows:

- Ten routes from North Mayo to Flagford
- Seventeen routes from North Mayo to Cashla and
- Four partially submarine routes, two from North Mayo to Flagford and two to Cashla.

For reasons set out in Section 3 of this Report, an underground cable would be best constructed along the public road network rather than across country. For this reason a series of meetings and workshops were held with the relevant Local Authorities and the National Roads Authority to determine a set of assessment criteria against which the routes would be considered and to discuss the possible cable routes themselves. This set of assessment criteria are:

- Length of Route (km)
- Existing Infrastructure (number of crossings of bridges, railways, existing services etc.)
- Roads Upgrade Programme
- Diversions during Construction

- Social Impact
- Cultural Heritage Sites
- Natura 2000 sites (SPA/SAC)

An underground design solution over the length needed for Grid West will require a high voltage direct current (HVDC) solution rather than a high voltage alternating current (HVAC) solution. An HVDC underground cable will therefore require converter stations at either end to convert the DC to AC before connection to the power grid. Zones within which converter stations could be located were identified at each possible terminal point for an underground option.

The preliminary assessment and analysis of the thirty one identified underground routes and their associated converter station locations resulted in the following recommendations being made:

1. The optimum termination point in North Mayo for an underground option is in an area north-west of the village of Moygownagh rather than in the Bellacorick area.
2. The emerging preferred underground route option runs from the area north-west of Moygownagh to Flagford, Co. Roscommon (a distance of approximately 114km) rather than to Cashla Co. Galway.
3. Two possible converter station location zones were identified north-west of Moygownagh but further investigation will be required into (a) impact on local residents and (b) the construction of a converter station in peat, before a final decision can be made on the preferred location.
4. Of the six possible converter station location zones in the Flagford area a preferred zone approximately 1km east of the existing Flagford substation has been identified.

Figure 1.1 below shows the preferred underground cable route option and the emerging preferred overhead route corridor (October 2013) side by side. The next stage of the process will include developing an indicative overhead line route which can then be compared to the preferred underground cable route.

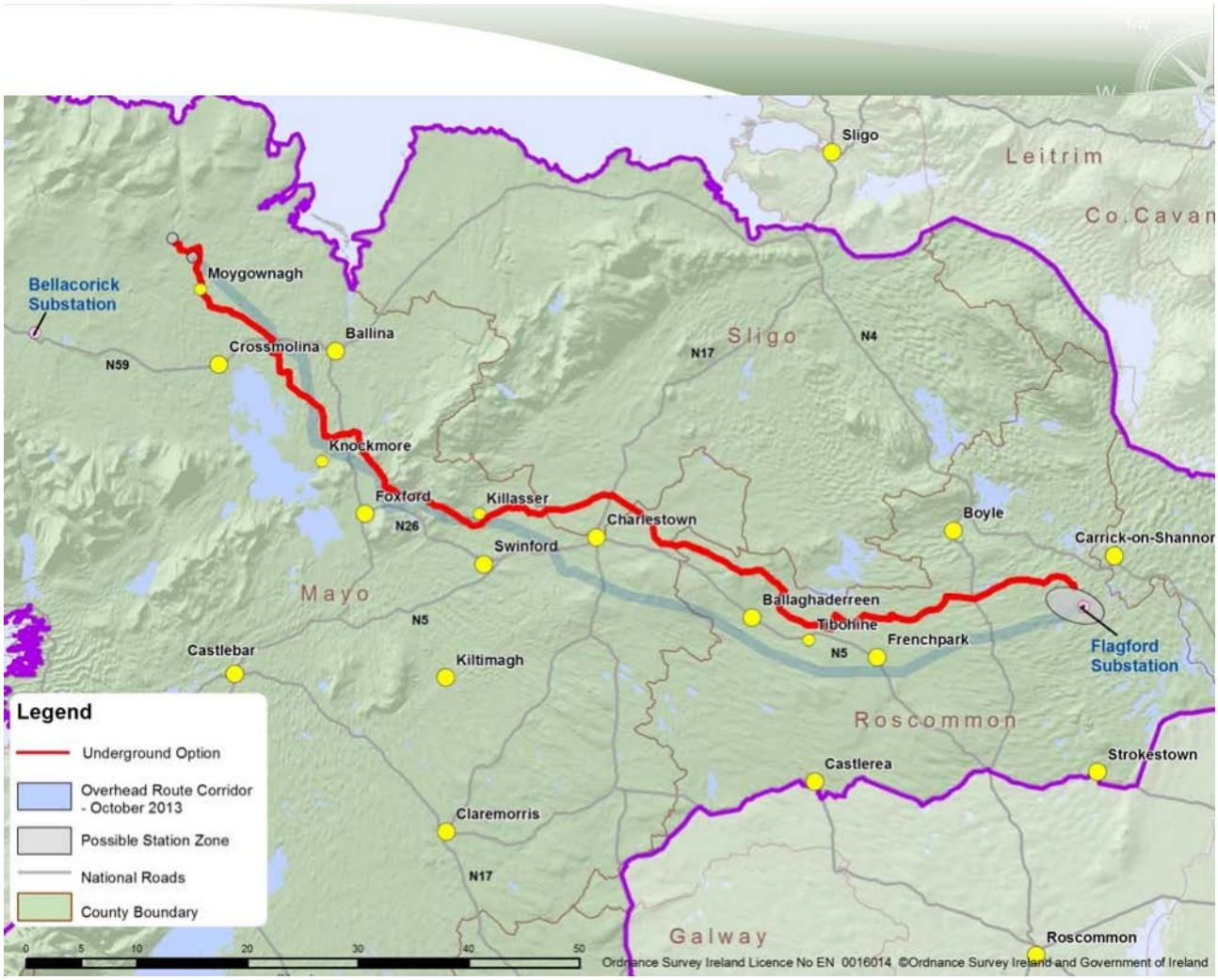

Figure 1.1 Grid West Underground Cable Route Preferred Option and Emerging Preferred Overhead Route Corridor

2. INTRODUCTION

The Grid West Project seeks to identify a 400kV connection from north Mayo to a bulk supply point on the national grid at either Flagford, Co. Roscommon or Cashla, Co. Galway. Following a process that began in January 2012 the project team established a study area for the project and then identified constraints within this area, including population centres, environmentally sensitive areas and cultural heritage sites, all of which were to be avoided as far as possible.

The first stage of the process, set out in the EirGrid Road Map, culminated in the publication of the Lead Consultants Stage 1 Report in March 2013. This report included an analysis of the different technical solutions that could be adopted for Grid West and concluded that a 400kV overhead line (OHL) offers the most acceptable technical solution, while noting that

> '…this analysis has been made at an early stage in the project development as is necessary at this stage. However, as with any development project, subsequent activities may require this analysis to be re-assessed, if new information or factors arise'

The Stage 1 Report also identified a Least Constrained Corridor for a 400kV overhead line from north Mayo to Flagford and this was the basis for public consultation open days held in June 2013.

In October 2013 a Corridor and Substation Evaluation Report was published which took account of feedback received during the June public consultation. This report confirmed the least constrained corridor, with minor modifications, as the Emerging Preferred Route Corridor (EPRC) for a High Voltage Alternating Current (HVAC) Overhead Line (OHL) solution, as shown in Figure 2.1 below.

Figure 2.1 Emerging Preferred OHL Route Corridor – October 2013

Further public consultation was carried out in October 2013, presenting the EPRC and seeking feedback from the public on this proposal. A programme of landowner engagement, consulting with land and property owners regarding an initial overhead line was also undertaken at this time, with feedback from this process informing a more detailed line design.

In January 2014, on foot of feedback received on all Grid25 projects across the country, EirGrid announced the Grid25 Initiatives, which included inter alia a review of the feasibility of an underground cable solution for Grid West. This review is to bring an underground design solution to the same level as the overhead line solution and to compare the two options in a report to be submitted to an Independent Expert Panel appointed by Government.

2.1 PURPOSE OF THIS REPORT

The objective of this report is to enable initial discussion on the underground cable route options identified for the Grid West Project. Since a fully underground solution for the length required for Grid West is not technically possible using the same technology as used for the rest of the electricity transmission system, i.e. high-voltage alternating current (HVAC). A fully underground solution will require the use of high voltage direct current (HVDC) electricity. This is a different technology and will require different equipment in order to operate it on the transmission system. The main difference is at the start and end points of the project where the construction of a converter station will be required. EirGrid has identified possible locations for converter stations in north Mayo, Flagford and Cashla, but further investigations will be required before final sites are selected.

The Grid West Project team have therefore identified potential route options for a High Voltage Direct Current (HVDC) Underground Cable (UGC) connecting the EirGrid system near Cashla, County Galway or Flagford, County Roscommon, to north Mayo.

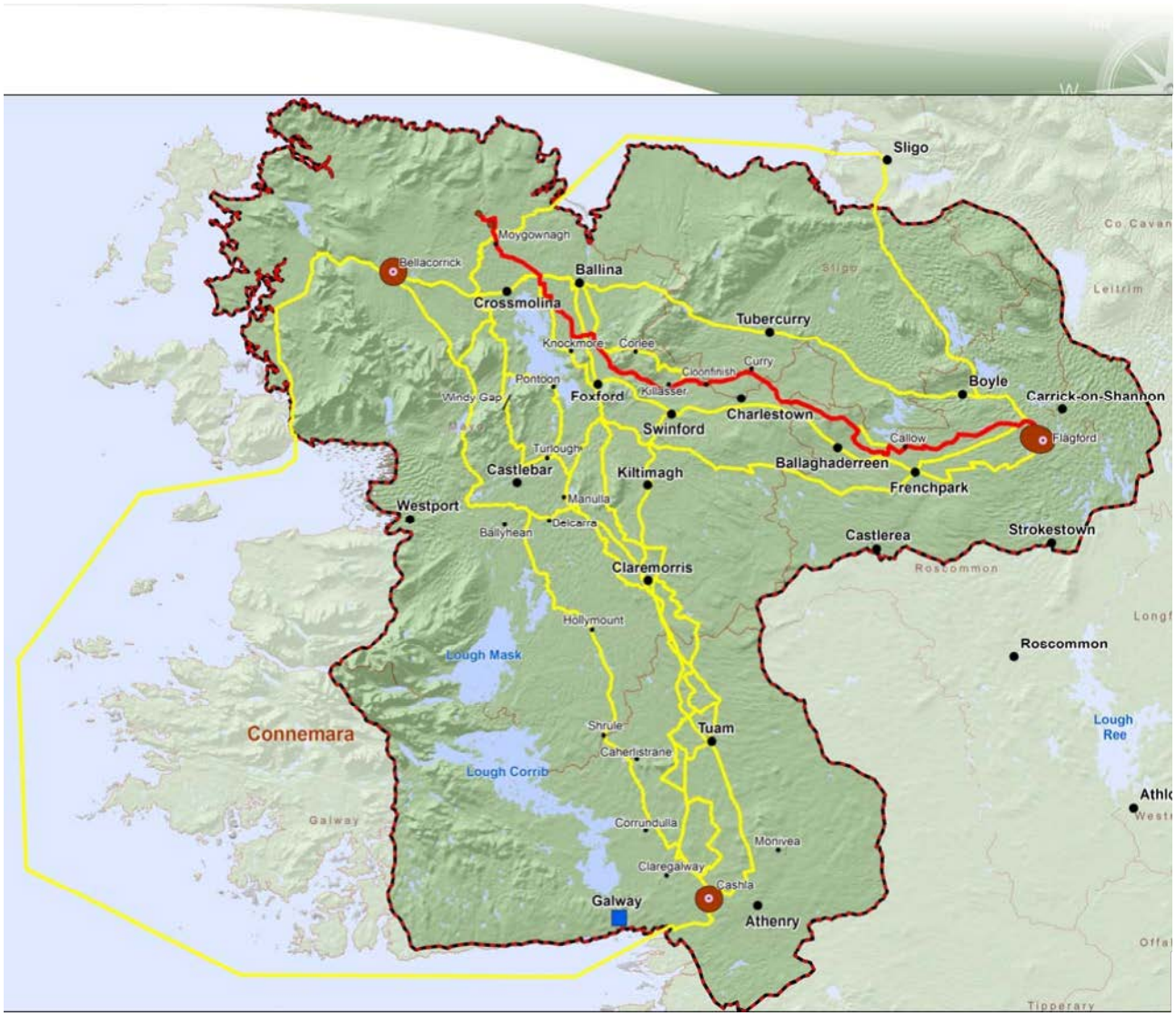

Figure 2.2 Underground Cable Route Options Identified within the Study Area (with Preferred Option in Red)

This report identifies 31 potential route options and their preliminary assessment which has been carried out through high-level desktop investigations, consultations with relevant Local Authorities and the National Roads Authority (NRA) and on-site inspection of the routes.

2.2 BACKGROUND

At an early stage in the Grid West project the Technical Foundations Report, which formed part of the Lead Consultant's Stage 1 Report, assessed the possible use of four technology solutions for Grid West namely –

- High Voltage Alternating Current Overhead Line (HVAC OHL);
- High Voltage Direct Current Overhead Line (HVDC OHL);
- High Voltage Alternating Current Underground Cable (HVAC UGC); and
- High Voltage Direct Current Underground Cable (HVDC UGC).

Eight selection criteria were adopted to assess each option as follows.

1. Operability
2. Maintainability
3. Constructability
4. Losses
5. Future expansion and flexibility (future proofing)
6. Environmental impact
7. Cost
8. Risk to the successful implementation of the project

Following assessment against the above criteria, HVAC OHL was taken forward as the preferred technology for the project. Appendix 3.2 of the Stage 1 Report sets out the assessment and conclusions in full and this report is available on the Grid West Project website (http://www.eirgridprojects.com/projects/gridwest/).

As announced in January 2014, as part of the Grid25 Initiatives, the Minister for Communications Energy and Natural Resources has appointed an Independent Expert Panel (IEP) to review a comparison of overhead line and underground cable options for the Grid West and other projects. The Grid West project team will therefore need to develop, in parallel with the initial design of an overhead line, an underground cable option to the same level of detail as the overhead line. The two options will then be presented in a report to the IEP who will review the process and methodology used to ensure that both options have been given equal consideration.

2.3 GENERAL METHODOLOGY

The Grid West project's main objective is to connect renewable energy in north Mayo to a strong point on the nation grid, either to the existing substation at Flagford in Co. Roscommon or at Cashla Co. Galway. In the case of an overhead line solution for Grid West, seventeen possible route corridor options were assessed and an emerging preferred route corridor was identified, running from an area north-west of the village of Moygownagh, Co. Mayo to the existing substation at Flagford. However, it could not be assumed that the best route for an underground cable solution would also run to Flagford and therefore it was necessary to assess all cable route options. A total of thirty one routes were identified, primarily running along the public roads network, but four partially submarine options were also assessed.

As set out in Section 3 of this report, it is preferable that an underground cable route follows the public roads network, primarily for access, maintenance and reduced environmental impact.
In identifying a preferred underground cable route option from north Mayo to either Flagford or Cashla the following general methodology has been followed:

1. Identify possible cable routes from north Mayo to Flagford and to Cashla.
2. Identify possible zones where converter stations could be located and serviced at the potential terminal ends in north Mayo and at Flagford and Cashla
3. Carry out a preliminary assessment of the identified routes and identify the least constrained routes.
4. Meet with Local Authorities and the National Roads Authority to review and determine criteria for assessment.
5. Present results of the preliminary assessment and the identified least constrained routes to the Local Authorities and the National Roads Authority.
6. Review the preliminary assessment of routes against the identified criteria
7. Confirm the least constrained route options
8. Identify refinements to the least constrained route options
9. Following refinements, identify the preferred underground route option

Once the preferred underground route is identified, there will be consultation on it and the constraints within the converter station zones (identified in Step 2) associated with that route. The feedback received will assist in identifying the preferred converter station locations.

3. HVDC UNDERGROUND CABLE ROUTING INSTALLATION AND MAINTENANCE

3.1 ROUTING OF UNDERGROUND CABLE

In general, it is preferable to route underground high voltage cables along public roads to allow ease of access for monitoring and maintenance of the cable. Weekly surveys along the cable routes would need to be carried out to monitor any construction activities in the vicinity of the cable to ensure that no damage occurs to what would be a vital infrastructural asset. While cable faults are rare, when they do occur, prolonged access to the cable for a number of weeks (and maybe months) may be required to identify and repair any faults. For this reason, initial investigations have focused on routing the cable largely in existing public roads. This will result in an option that is easier to install and maintain. It is also cheaper and will have less impact on the environment.

A cross-country cable route would require the construction of permanent access roads to allow maintenance crews access to the cable ducts with heavy machinery. This would result in significant construction costs in addition to increased environmental impact. Furthermore these access roads would have to be maintained over the design life of the cable, which would add significantly to the whole life cost of this project. By constructing the cable in the existing public roads, access would be automatically provided. There is also an additional advantage in that the local roads which are upgraded to facilitate the cable are available for public use.

It should be noted that the requirement for access roads for an underground cable route is more significant than the access requirements for an overhead line. This is because the cable drums and the rigs required to pull the cable are significantly heavier than the overhead line towers, which are made of smaller lighter components that can be assembled on site. In some jurisdictions OHL access for maintenance is carried out by helicopter.

3.2 TYPCIAL DUCT AND TRENCH ARRANGEMENT

For the Grid West project three power cable ducts, and two communications cable ducts would typically be installed in the cable trench. The width of the trench would be approximately 1.1m. The tops of the cables are typically 1.1m deep, with the overall depth of the trench being 1.35m. This is illustrated in Figure 3.1. The cable ducts are surrounded by cement bound material (CBM4) to provide mechanical protection and improve the thermal properties of the surrounding soil to ensure the cables can dissipate their heat and maintain the rating.

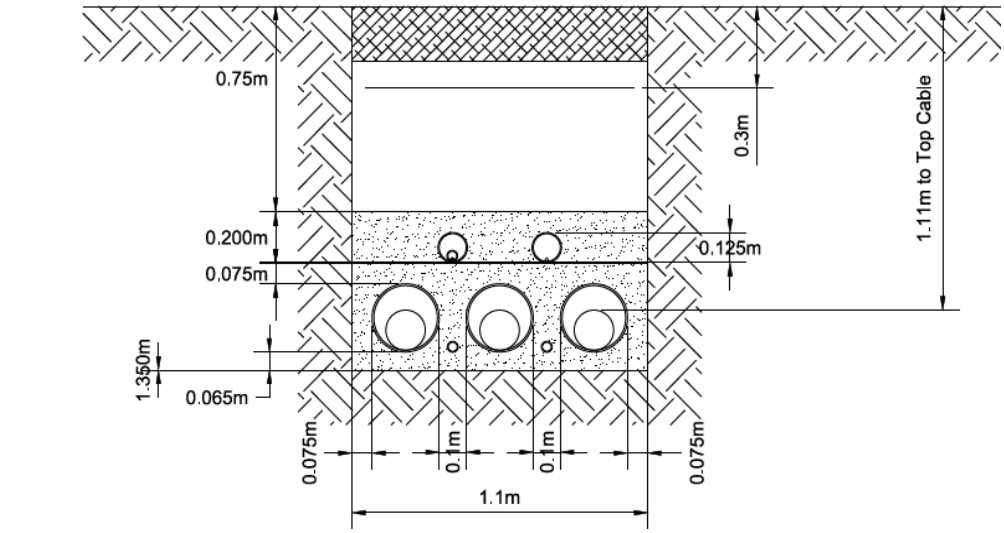

Figure 3.1 Typical Cross Section of Cable Trench

Figure 3.2 Cable Duct Installation

Figure 3.3 Cable Trench

Due to the nature of power cables and the requirement to dissipate heat into the surrounding soil, the depth of the cable needs to be within a tight margin over the life of the cable. Where the depth of the cable is increased, or where there is an area with poor soil resistivity, the cables would need to be placed at wider spacing to ensure effective heat dissipation. Therefore, in addition to installing the cable in a road, EirGrid would require some level of control over any planned redevelopment of that road, to ensure that the cables are not disturbed and that the depth below the finished road surface is maintained. Examples of cable ducts being installed on the recent EirGrid HVDC East-West Interconnector Project are shown in Figure 3.2 and Figure 3.3.

3.3 CABLE JOINT BAYS

Cables are manufactured and delivered to site on cable drums. The length of cable that can be delivered on a cable drum is limited to the local conditions and logistics of handling the cable drum on

site. The maximum size of cable drum that can be practically accommodated on the local roads, can hold approximately 1200m of cable. These sections of cable then need to be joined together, which is a complex and delicate process.

A typical cable joint pit is shown in Figure 3.4 and Figure 3.5. Each pit requires an excavation approximately 20m long, 3.0m wide and 1.5m deep to accommodate a concrete pit. Jointing high voltage cables requires significant time and locations are generally selected to minimise disruption. The cable route is designed to minimise the number of joints, but short sections may be required to accommodate cable pulling lengths restricted by horizontal or vertical alignment changes.

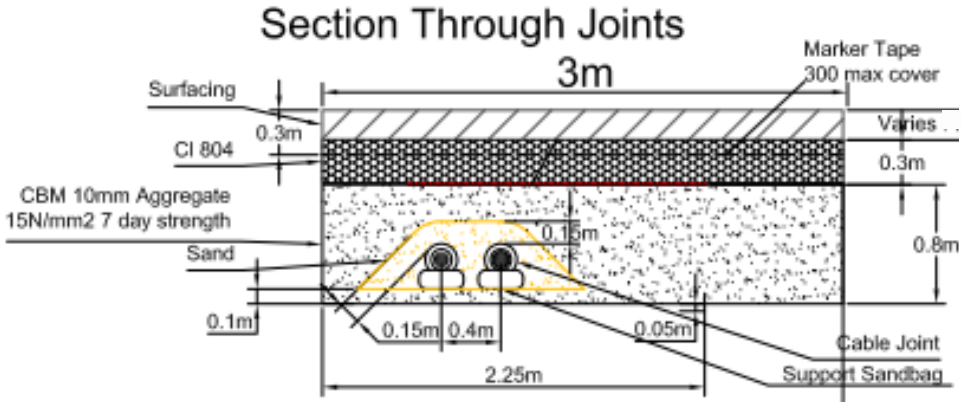

Figure 3.4 Cross Section of Typical Cable Joint Bay

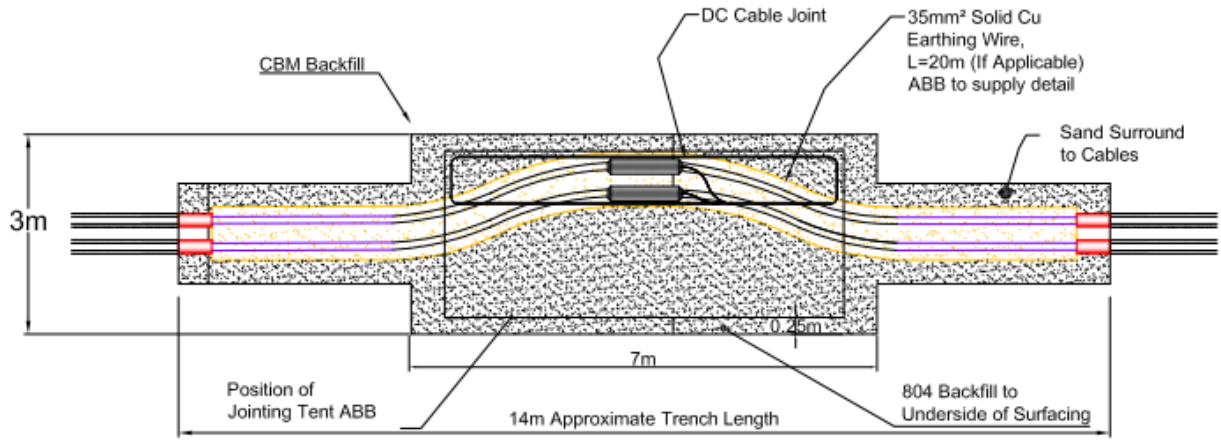

Figure 3.5 Typical Cable Joint Bay (Plan view)

Cable jointing for a high voltage cable is a very specialist process and is carried out in a clean room environment. The operation can take a number of days for each cable joint, and even up to a number of weeks depending on the cable type used. Illustrations of a cable jointing environment are shown in Figure 3.6 and Figure 3.7.

Figure 3.6 –Cable Jointing Tent

Figure 3.7 – Cable Jointing Tent

3.4 CABLE INSTALLATION – ACCESS

Cables are delivered to site on large cylindrical drums, typically 4.5m diameter, 3.0m wide and up to 22 tonnes in weight. The drums are generally delivered on low loaders and therefore the access routes for drum deliveries require careful consideration to ensure they are feasible. Cable drum trailers/carriers can be used to deliver or move cable drums locally but, given some of the relatively narrow road widths that may be encountered in the west of Ireland, close consultation with the local Roads Authorities and residents as to how and when cable drums can be moved on to site will be needed. Cables are then pulled through the cable ducts between joint bays as illustrated in Figure 3.8 and Figure 3.9.

Figure 3.8 Cable Installation

Figure 3.9 Cable Installation

3.5 CROSSING OBSTACLES WITH HORIZONTAL DIRECTIONAL DRILLING (HDD)

It is inevitable that with a cable route of the length required for Grid West, many physical obstacles will need to be negotiated along the cable route. While technology is available to enable even the most difficult crossings, these should be minimised where possible to reduce the technical complexity and cost of installation. For wider crossings, a technique known as Horizontal Directional Drilling (HDD) can be used. The size and nature of the HDD rig required for any crossing is determined by the length of the crossing. Examples of some HDD rigs used on the recent EirGrid HVDC East-West Interconnector Project are shown in Figure 3.10 and Figure 3.11.

Rivers

Where ducts for cables pass under rivers or larger watercourses it is typical that ducts be installed by HDD, particularly when these rivers are Special Protection Areas or Special Areas of Conservation (SPA/SAC). In these cases, the route selection and crossing positions will require careful consideration.

Figure 3.10 – Example of compound size and working area required for Horizontal Directional Drilling (HDD)

Figure 3.11 Example of Horizontal Directional Drilling rig (HDD)

Smaller Bridges and Water Crossings

In most instances where small bridges or culverts pass below existing roads there is no adequate depth to accommodate a cable duct crossing in the bridge deck or above the culvert. To enable ducting to pass these areas, it will be necessary to locate ducts to the side of the road and to cross the feature off-road either by open trench excavation or directional drilling.

Where a cable route crosses smaller surface water drainage, foul sewers or field drainage pipes, it is anticipated that cable ducts will simply be constructed above or below the pipe, depending on the depth at which the existing service is encountered.

4. IDENTIFICATION OF POSSIBLE CABLE ROUTES

The purpose of the Grid West project is to connect renewable energy sources from north Mayo to a strong point on the national grid, at either Flagford, Co. Roscommon or Cashla, Co Galway. As set out in Section 2.3 of this Report, possible underground route options for Grid West were first identified in a desk top examination of the Study Area.

Since a fully underground solution for the length required for Grid West is not technically possible using the same technology as used for the rest of the electricity transmission system, a fully underground solution will require the use of high voltage direct current (HVDC) technology. The main difference is at the start and end points of the project where the construction of a converter station will be required. Zones within which these converter stations could be located were identified in north Mayo and at Flagford and Cashla and these zones are denoted by the brown coloured areas on Figures 4.1 to 4.31 inclusive.

Following a preliminary assessment of the thirty one identified routes, a series of meetings and workshops were held with the relevant Local Authorities and the NRA. At these meetings the assessment criteria used were reviewed. The zones within which converter stations could be located were discussed and the results of an initial assessment of underground routes were presented for comments and feedback. During these meetings the least constrained route options, one to Flagford and one to Cashla, which resulted from the initial assessment of routes, were confirmed.

Following the meetings possible refinements to the least constrained route options were investigated and a final comparison was undertaken to identify the emerging preferred route option. Maps illustrating this emerging preferred underground route option can be viewed at the following link:

http://www.eirgridprojects.com/projects/gridwest/overview/undergroundrouteoption-maps/

The development of the assessment criteria and consultation with relevant Local Authorities and the NRA is discussed in Section 5 of this report.

4.1 DESCRIPTION OF ROUTE OPTIONS IDENTIFIED TO FLAGFORD

Ten route options to Flagford have been identified, essentially comprising of five pairs of routes running from either the area of the existing Bellacorick substation or from an area north-west of the village of Moygownagh. The route options are numbered in sequence with odd route numbers denoting a route coming from the Bellacorick area, and even numbered routes denoting origin in the Moygownagh area. Each route pair is described in the text below.

All option pairs follow an identical route to Flagford from a common point on the N59 west of Ballina. Odd numbered options (1, 3, 5, 7, 9) travel along the N59 national road from Bellacorick through Crossmolina and on towards Ballina, while even numbered options (2, 4, 6, 8, 10) traverse south-eastward along local roads from the Moygownagh area to meet the Bellacorick route options at the common point on the N59.

4.1.1 Route Options 1 and 2

The route options 1 (from Bellacorick) and 2 (from the Moygownagh area) run along the lines described above before passing through Ballina. They then travel along the R294 crossing the highland region near Lough Talt in Co. Sligo. The route then travels through Tubercurry and Boyle before terminating in Flagford as shown in Figures 4.1 and 4.2 below.

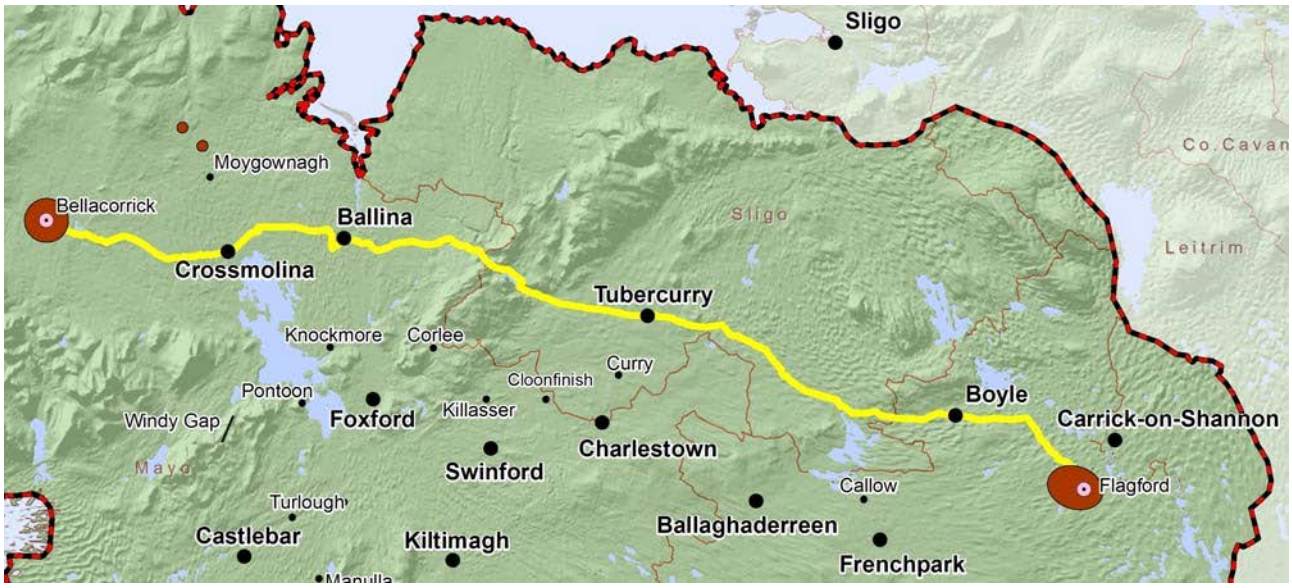

Figure 4.1 Underground Route Option 1

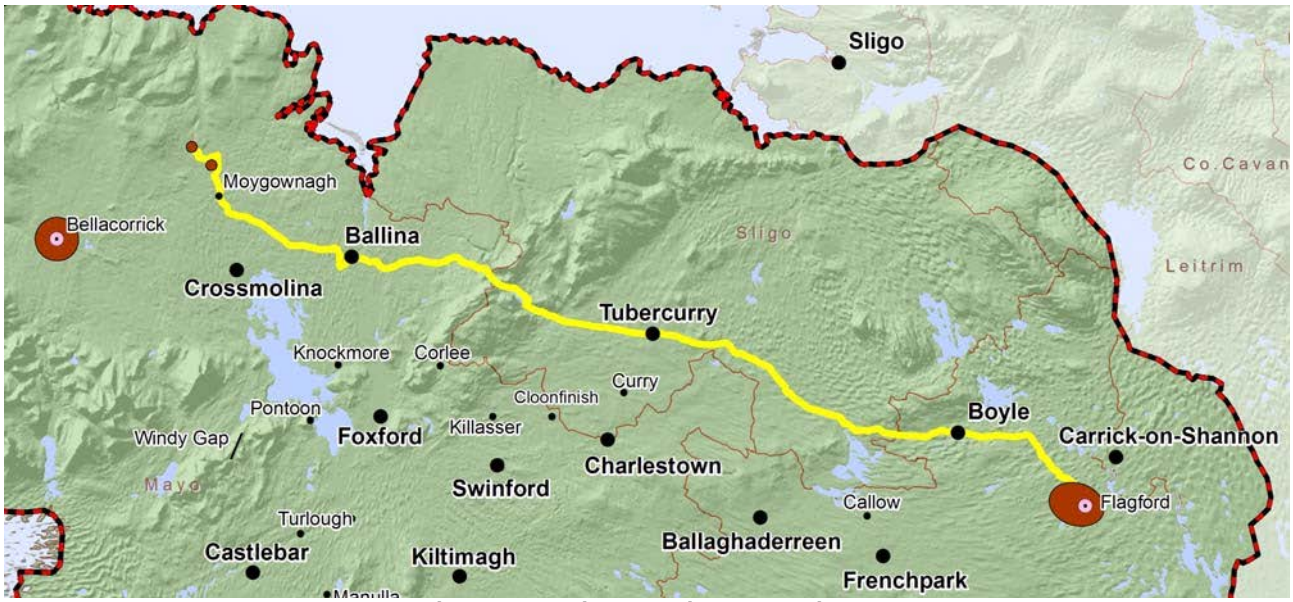

Figure 4.2 Underground Route Option 2

4.1.2 Route Options 3 and 4

Route Options 3 and 4 are shown in Figures 4.3 and 4.4. Following the same routes as Options 1 and 2 west of Ballina, from Ballina they run south in local roads, before turning eastwards to head over high ground near to Corlee. The route then travels in local roads to the north of the N5, passing near to Cloonfinish, Curry, to the north of Charlestown, and Callow to the South of Lough Gara, before finishing in Flagford.

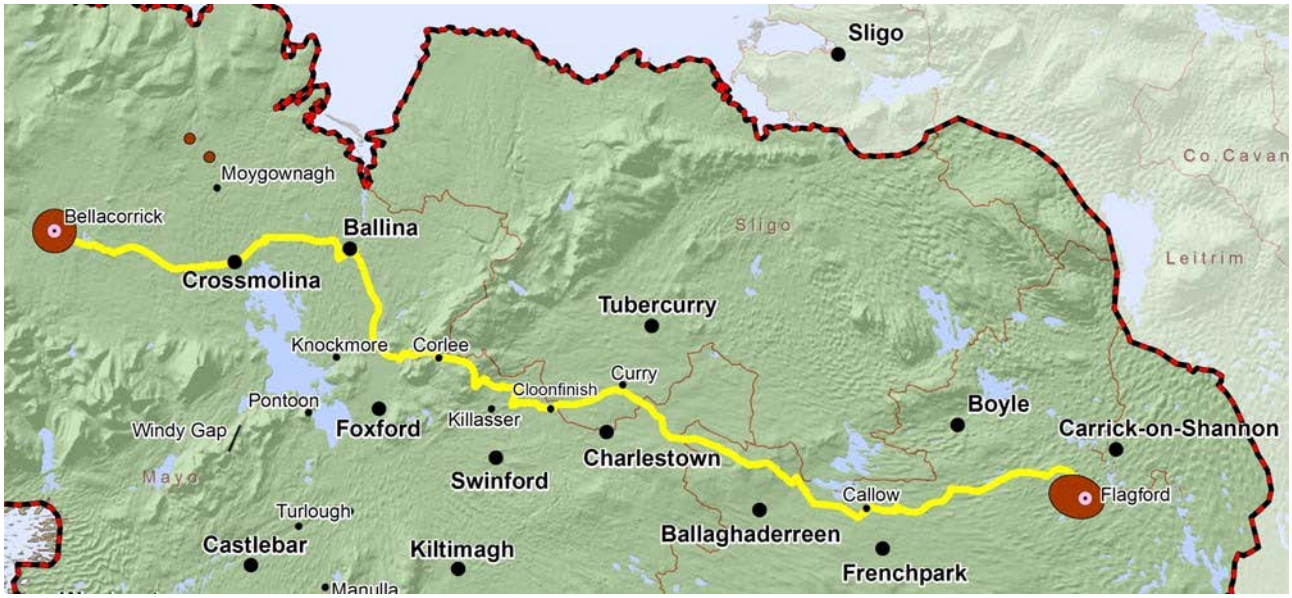

Figure 4.3 Underground Route Option 3

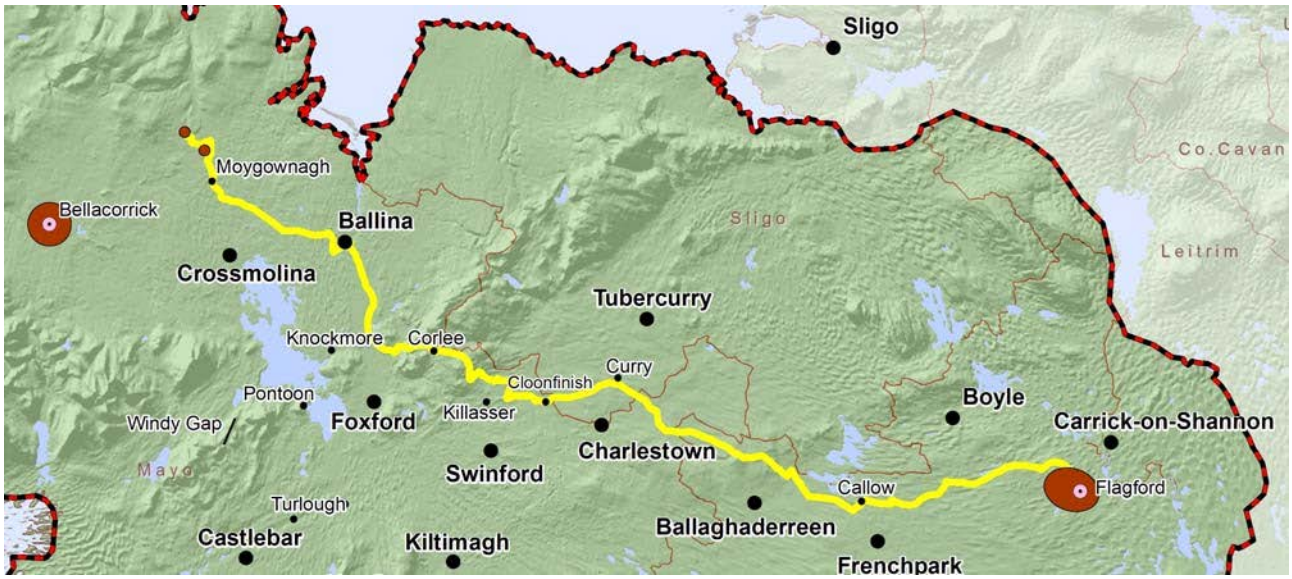

Figure 4.4 Underground Route Option 4

4.1.3 Route Options 5 and 6

This pair of route options are identical to routes 3 and 4 with the exception that from the point where the routes cross the River Moy, east of Killasser, they swing south of Killasser and along a more southerly route, closer to Foxford, as far as Carrowkeribly lake, where they re-join routes 3 and 4. This pair of route options are shown in Figures 4.5 and 4.6.

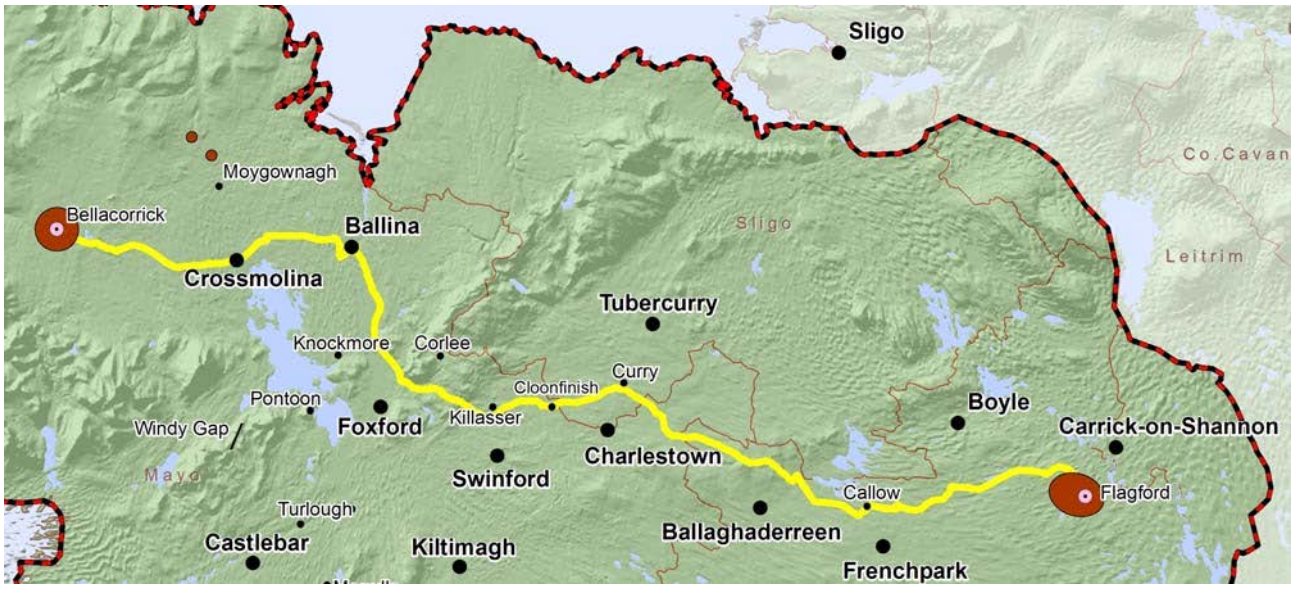

Figure 4.5 Underground Route Option 5

Figure 4.6 Underground Route Option 6

4.1.4 Route Options 7 and 8

This route pair runs largely along the National roads. From Ballina they are routed southward along the N26 to Foxford, and through to Swinford, from where they run in the N5 national road through Ballaghaderreen, and Frenchpark, before turning onto the R361 and R370 regional roads to terminate in Flagford. This route option pair are illustrated in Figures 4.7 and 4.8.

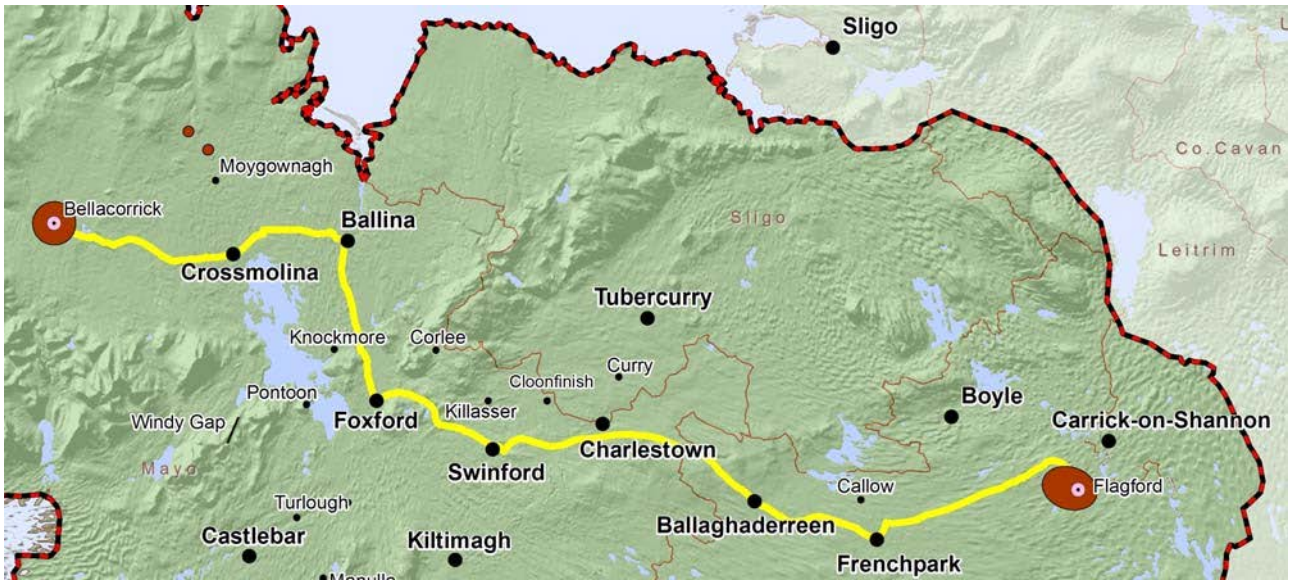

Figure 4.7 Underground Route Option 7

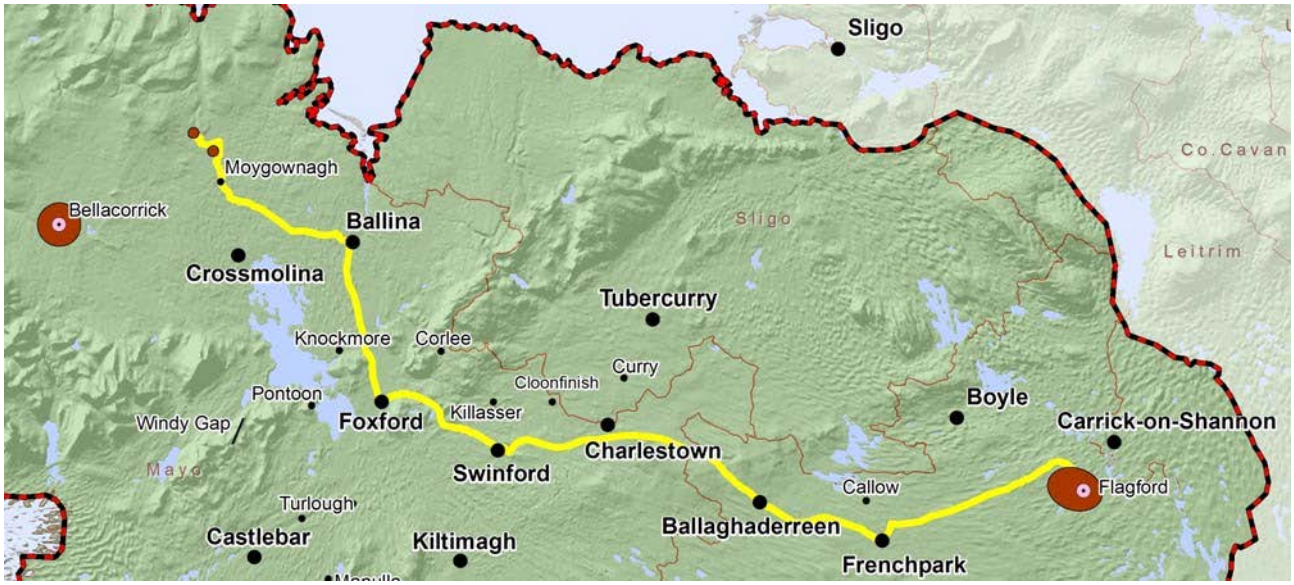

Figure 4.8 Underground Route Option 8

4.1.5 Route Options 9 and 10

From the junction of the route pair between Crossmolina and Ballina, route options 9 and 10 run southward in local roads along the eastern shore of Lough Conn, passing through Knockmore and Foxford. From Foxford as far as Frenchpark the routes run roughly parallel to and west of the N26 and south of the N5 national roads. From Frenchpark as far as the Flagford area the pair runs roughly parallel to and south of the R370 regional road. This route option is illustrated in Figures 4.9 and 4.10.

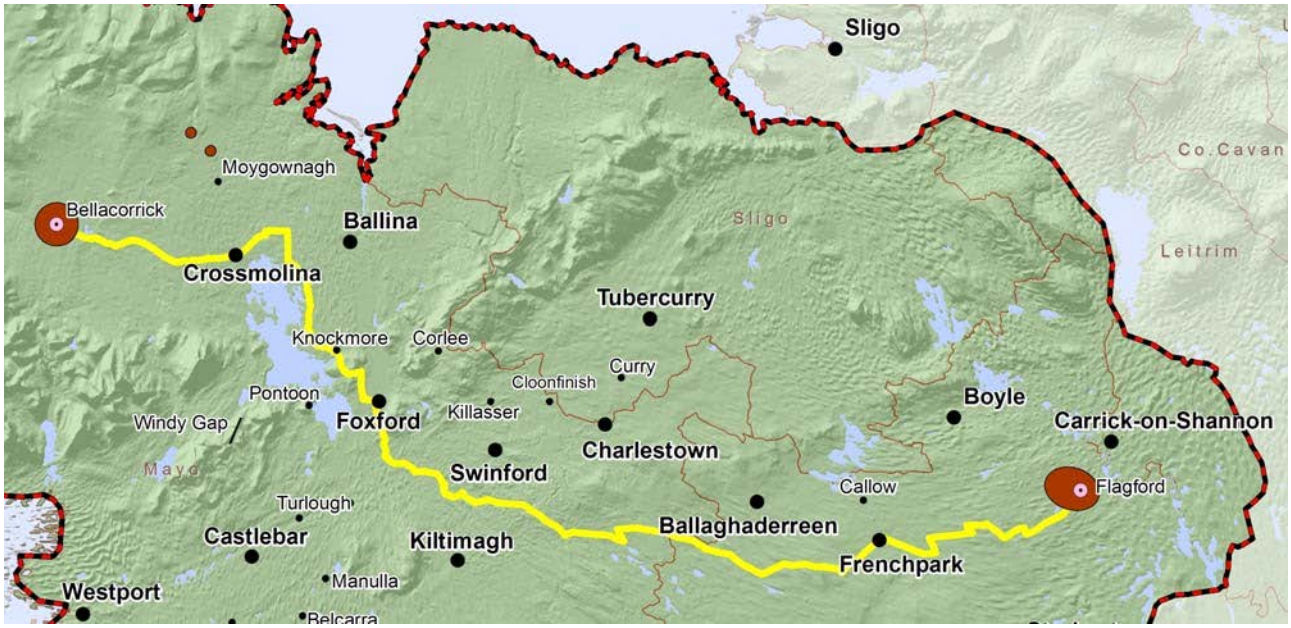

Figure 4.9 Underground Route Option 9

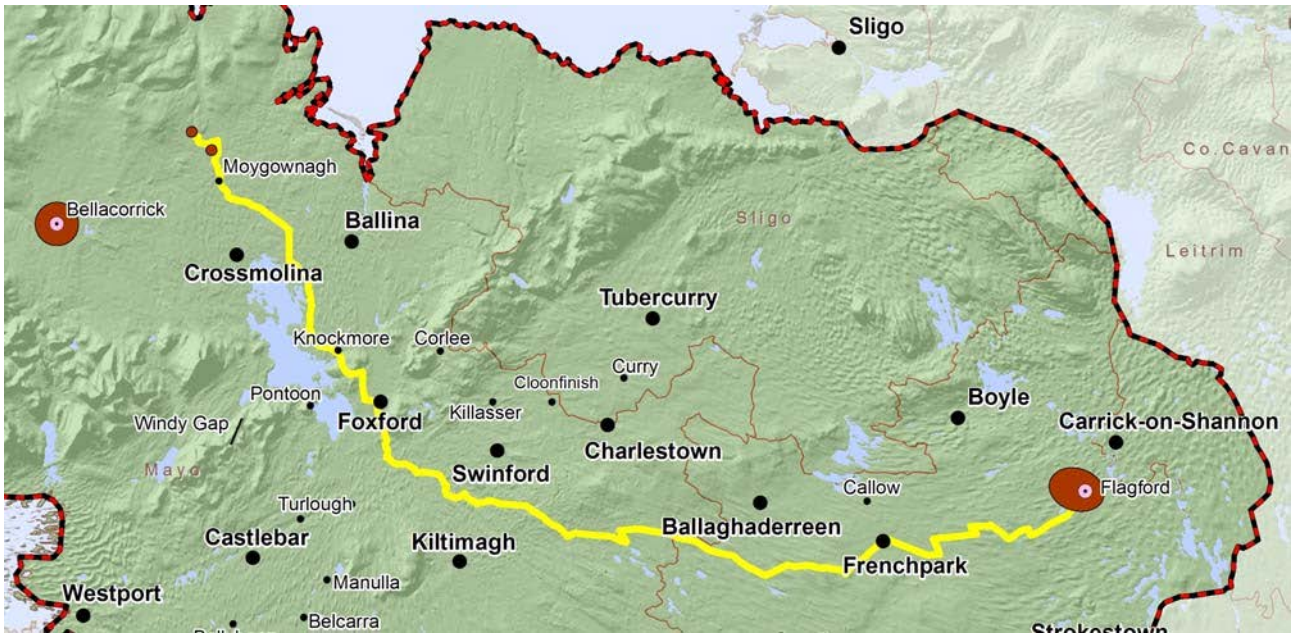

Figure 4.10 Underground Route Option 10

4.2 DESCRIPTION OF ROUTE OPTIONS IDENTIFIED TO CASHLA

Seventeen possible cable route options (numbered 11 to 27) to Cashla have been identified. These route options can be grouped into eight pairs running from either the Bellacorick or Moygownagh areas to Cashla. As before, options are numbered in sequence with odd numbered options coming from the Bellacorick area and even numbers from the Moygownagh area. Following discussions with Local Authorities an additional option (numbered 27) has also been considered, running from the Moygownagh area to Cashla, and using significant lengths of disused railway line between Athenry and Swinford.

All odd numbered routes, with the exception of Options 19 and 27, travel from an area near to Bellacorick eastwards along the N59 to a point approximately 4km west of Crossmolina. Options 11 and 13 travel on eastwards towards Crossmolina, while Options 15, 17, 21, 23, and 25 travel southwards from the N59 along local roads west of Lough Conn towards Laherdaun on the R315 regional road.

All even numbered options have their origin in an area near to the village of Moygownagh. Options 12, and 14 travel in a south easterly direction towards Ballina, while Options 16, 18, 20, 22, 24, and 26, travel in a southerly direction in local class 3 roads, west of Lough Conn as before, crossing the N59 4km west of Crossmolina, heading either towards Laherdaun on the R315, or towards the R312 via the R316 regional road.

4.2.1 Route Options 11 and 12

Option 11 runs from the Bellacorick area eastward along the N59 through Crossmolina where it is joined at a point approximately 3.5km east of Crossmolina by Option12, which comes south from the Moygownagh area along local roads to the N59. This route pair then runs along the eastern side of Lough Conn southwards through Knockmore and Foxford. South of Foxford the routes run along a section of the N58 before taking predominantly 3rd class local roads, to the west of Kiltimagh, to the east of Claremorris and west of Tuam, and on to Cashla as shown on Figures 4.11 and 4.12 below.

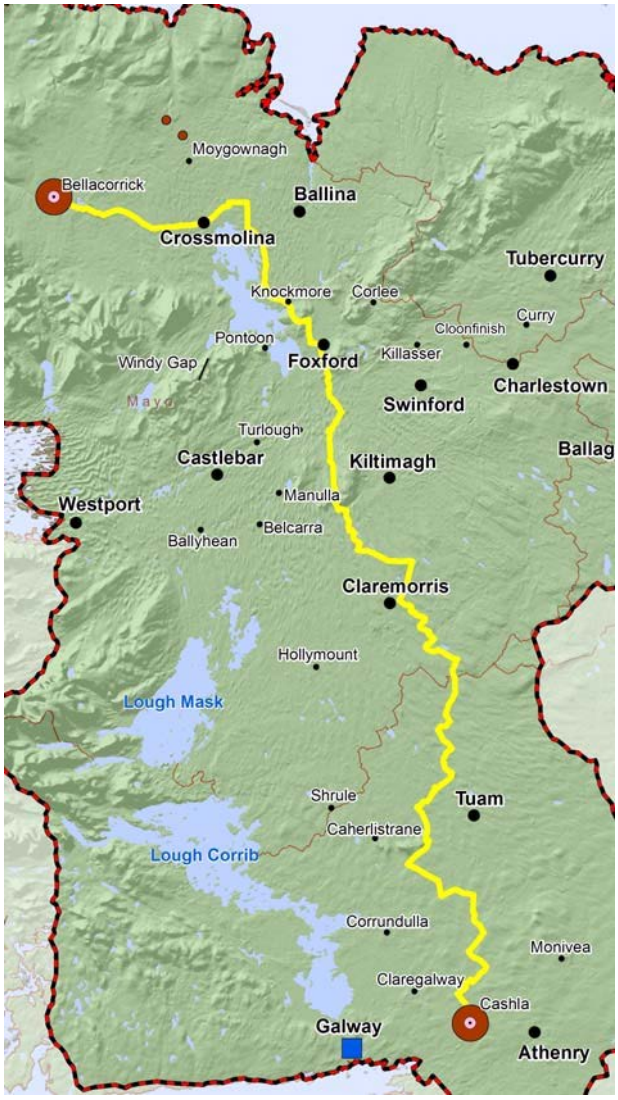

Figure 4.11 Underground Route Option 11

Figure 4.12 Underground Route Option 12

4.2.2 Route Options 13 and 14

This route pair runs from north Mayo to Cashla predominantly in national roads. From the joining point of the two routes on the N59 between Crossmolina and Ballina the route runs eastwards to Ballina. From Ballina the routes follow the N26 south to Foxford and then the N58 to Bellavarry. The route then follows third class local roads from Bellavarry to Manulla on the N60 national road, where it turns south west as far as Claremorris. From Claremorris the route follows the N17, through Tuam and on to a point about 4km north of Claregalway. From here it takes a route along third class local roads as far as the Cashla area. These pair of route options are illustrated in Figures 4.13 and 4.14.

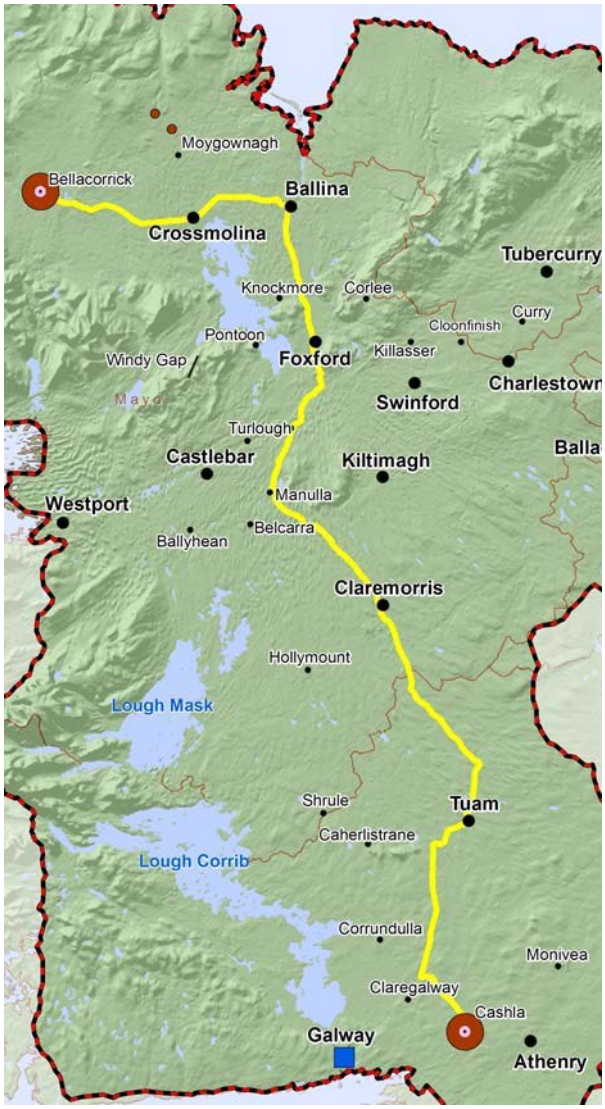

Figure 4.13 Underground Route Option 13

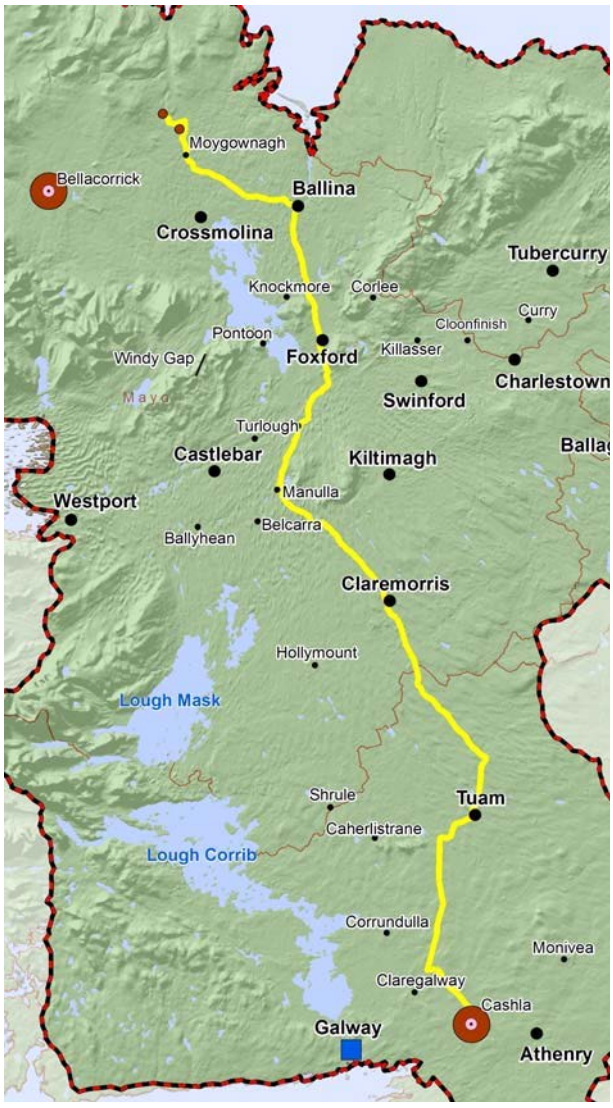

Figure 4.14 Underground Route Option 14

4.2.3 Route Options 15 and 16

This route pair, shown in Figures 4.15 and 4.16 below, runs from the Bellacorick and Moygownagh areas largely along the regional road, R315, west of Lough Conn as far as Pontoon. From Pontoon the routes follow local third class roads, crossing the N5 near Turlough, west of Castlebar, and staying largely on local roads as far as Claremorris. From Claremorris the routes follow the line of a disused railway as far south as where the railway line crosses the regional road R339 south west of Monivea, Co. Galway. From here the routes follow local and regional roads into the Cashla area.

Figure 4.15 Underground Route Option 15

Figure 4.16 Underground Route Option 16

4.2.4 Route Options 17 and 18

Route Options 17 and 18, shown in Figures 4.17 and 4.18 respectively, follow the same route as Options 15 and 16 except for a section west of Lough Conn. Whereas Options 15 and 16 followed the R315 road to Pontoon, Options 17 and 18 take the local roads further west, through the Windy Gap.

Figure 4.17Underground Route Option 17

Figure 4.18 Underground Route Option 18

4.2.5 Route Options 19 and 20

Route Option 19 runs from the Bellacorick area along the regional road R312 southward towards Castlebar. Its corresponding route option from the Moygownagh area (Option 20) follows local roads south, crossing the N59 west of Crossmolina, and continuing along local roads as far as the R316. Route 20 then follows the R316 south westward until it meets the R312 and Route Option 19. The route pair then passes to the west of Castlebar, past Islandeady Lake, and then east along the N5 for a length of approximately 2.5km. The routes then leave the N5 and follow local third class roads, crossing the N84 north of Ballyhean before turning south, passing to the east of Lough Carra, through Hollymount and Shrule, passing west of Caherlistrane, east of Corrundulla and crossing the N17 north of Claregalway before running into the Cashla area. These route options are illustrated in Figures 4.19 and 4.20 below.

Figure 4.19 Underground Route Option 19

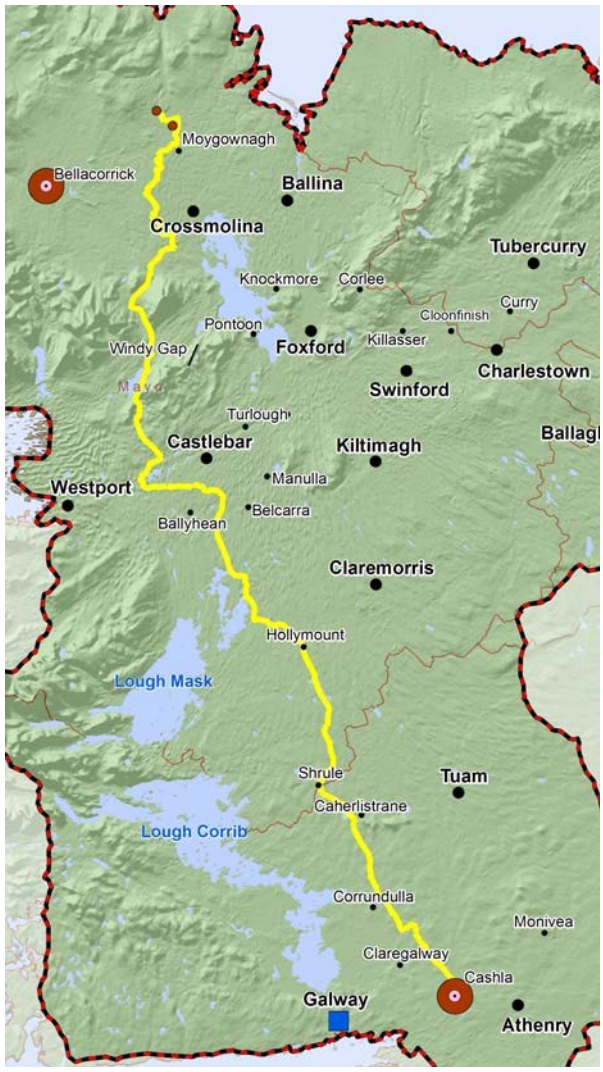

Figure 4.20 Underground Route Option 20

4.2.6 Options 21 and 22

This route pair runs from north Mayo to Cashla predominantly in national roads. From the junctions of the two routes on the N59 between Crossmolina and Ballina, the routes run eastwards to Ballina. From Ballina they follow the N26 south to Foxford and then the N58 to Bellavarry. The routes follow third class local roads from Bellavarry to Manulla, then head west crossing the Manulla river, before turning south, passing to the east of Lough Carra, through Hollymount and Shrule, passing west of Caherlistrane, east of Corrundulla and crossing the N17 north of Claregalway before running into the Cashla area. These route options are illustrated in Figures 4.21 and 4.22

Figure 4.21 Underground Route Option 21

Figure 4.22 Underground Route Option 22

4.2.7 Options 23 and 24

This route pair, shown in Figures 4.23 and 4.24 below, runs from the Bellacorick and Moygownagh areas largely along the regional road, R315, west of Lough Conn as far as Pontoon. From Pontoon the routes follow local third class roads, crossing the N5 near Turlough, west of Castlebar, then heading west through Belcarra, before turning south, passing to the east of Lough Carra, through Hollymount and Shrule, passing west of Caherlistrane, east of Corrundulla and crossing the N17 north of Claregalway before running into the Cashla area.

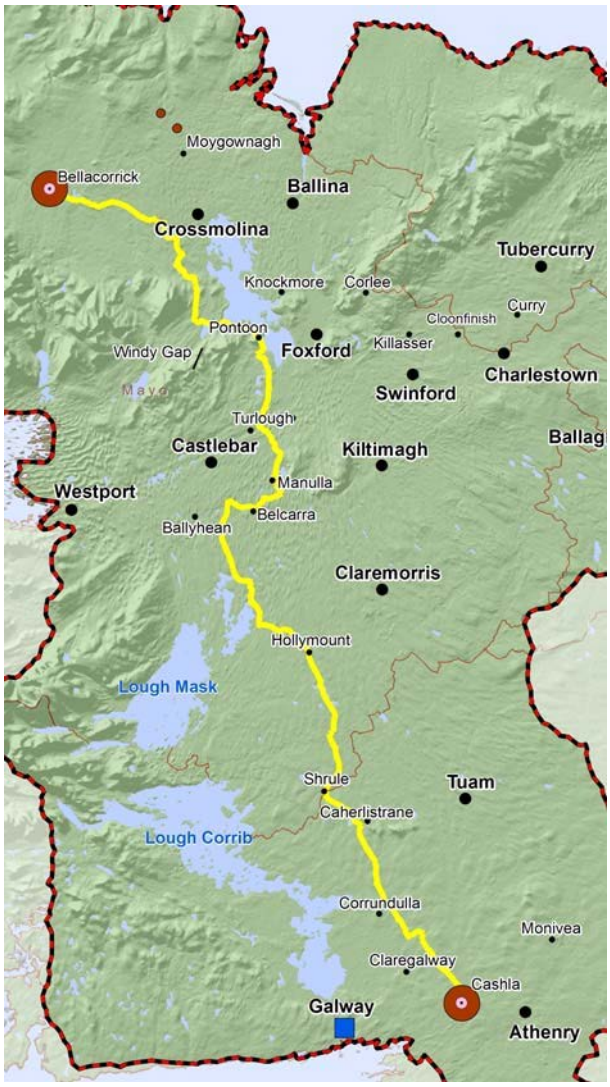

Figure 4.23 Underground Route Option 23

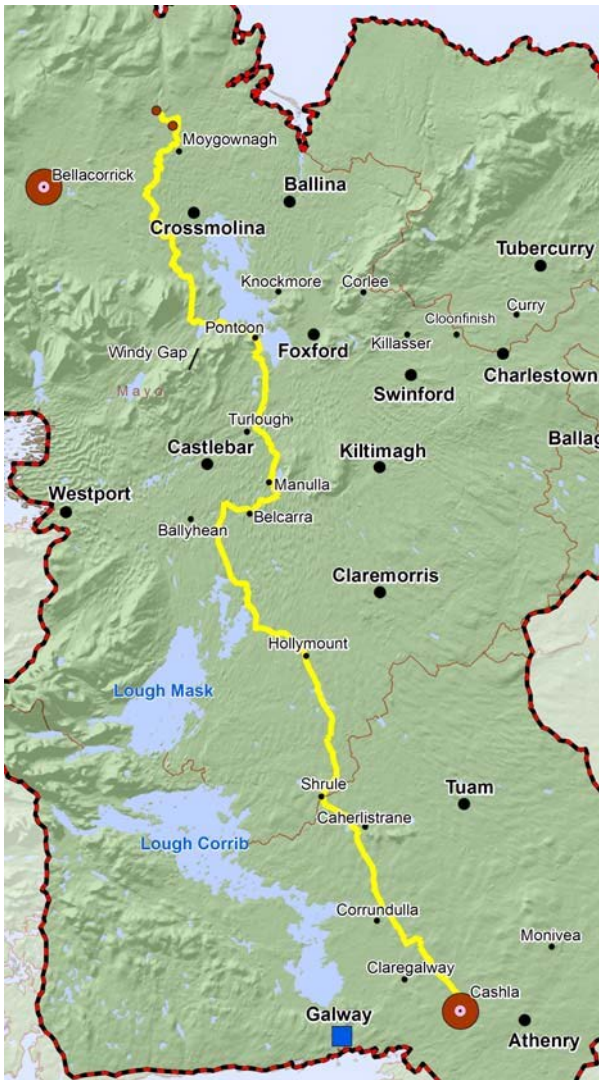

Figure 4.24 Underground Route Option 24

4.2.8 Options 25 and 26

Route Options 25 and 26 follow the same route as Options 23 and 24 except for a section west of Lough Conn. Whereas Options 23 and 24 followed the R315 road to Pontoon, Options 25 and 26 take the local roads further west, through the Windy Gap, as shown in Figures 4.25 and 4.26 below.

Figure 4.25 Underground Route Option 25

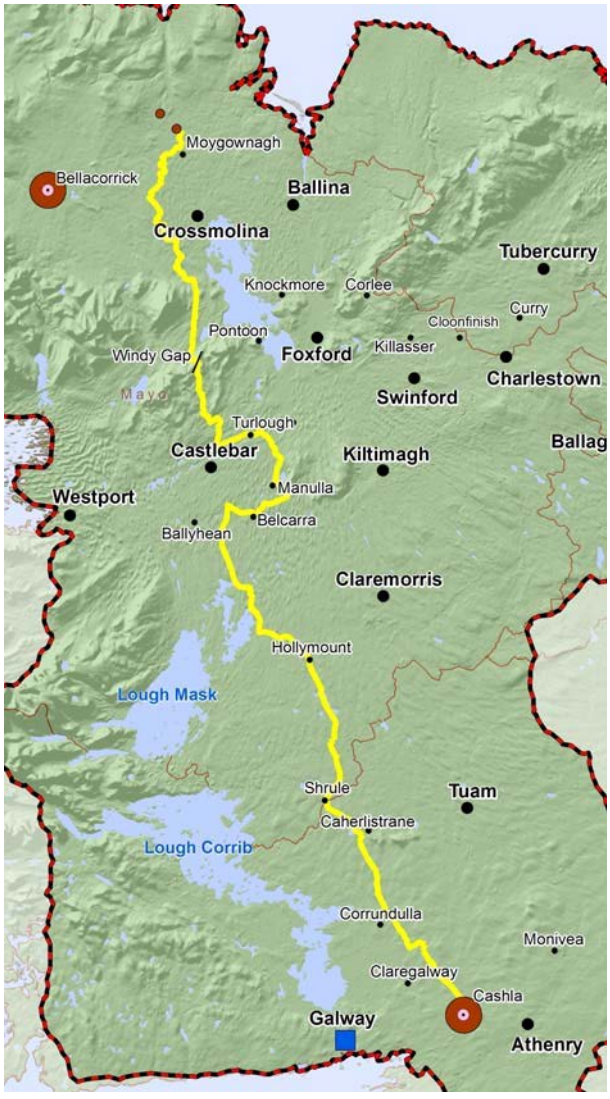

Figure 4.26 Underground Route Option 26

4.2.9 Option 27

During discussions with the County Councils it was highlighted that there is a disused railway running between Athenry and Swinford, which should be considered as a possible route option. Option 27 has its origin near to Moygownagh, and runs through local roads between Moygownagh and Ballina before heading on to Foxford. The route option then heads to Swinford to join the disused rail line. It then runs from Swinford, to Kiltimagh, Claremorris, and Tuam, and finishes at an area east of Cashla.

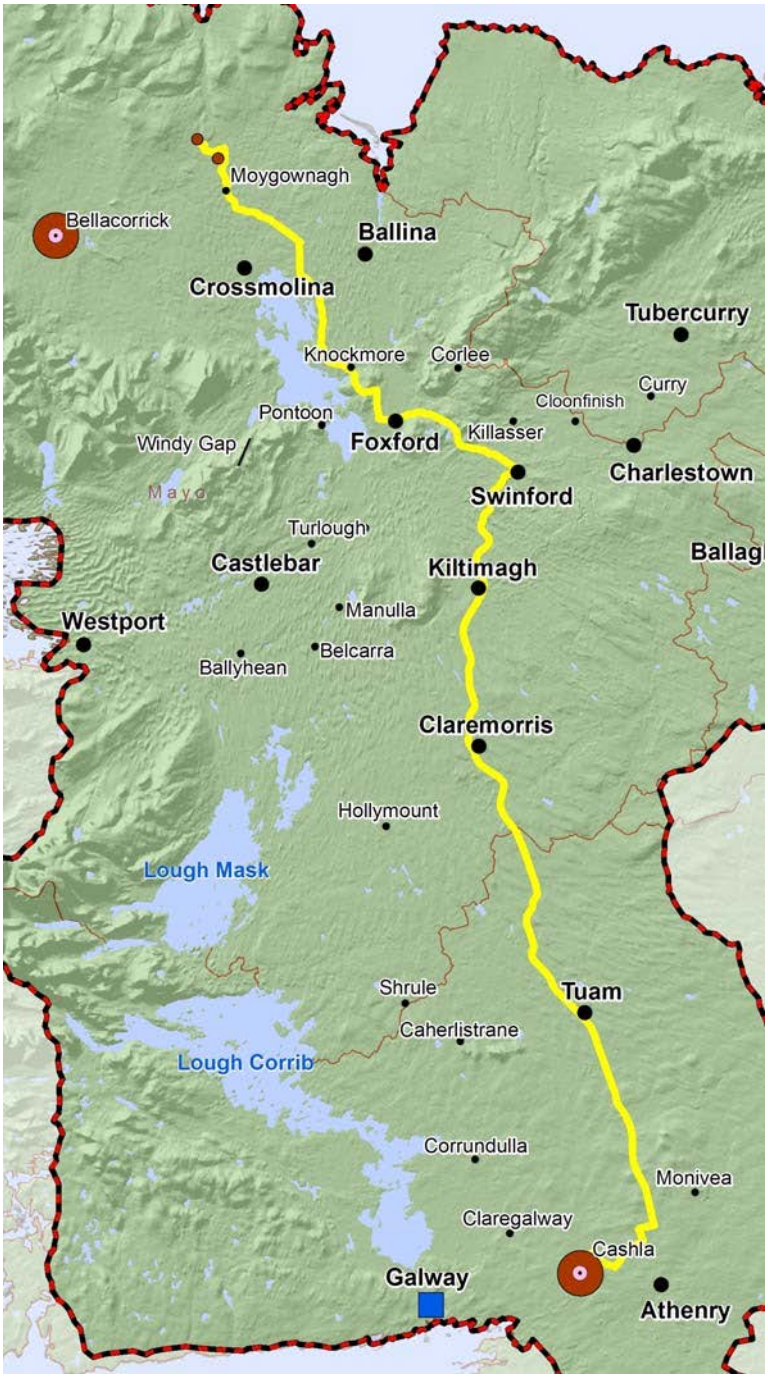

Figure 4.27 Underground Route Option 27

4.2.10 Sub-Marine Options

In addition to the land based options described above, consideration was given to possible sub-marine options to both Flagford and Cashla, as illustrated in Figures 4.28 to 4.30 below.

The pair of submarine route options to Flagford, as shown in Figures 4.28 and 4.29, would be laid northward in Kilalla Bay and then follow the Co. Sligo coastline eastward towards Sligo Bay. From Sligo the routes run southward towards Boyle in north Co. Roscommon and on to the Flagford area.

The submarine routes to Cashla would be considerably longer, travelling from north Mayo westward and then south towards Clew Bay near Mulranny. The submarine section would then be laid off the west Mayo and Galway coast before turning eastward into Galway Bay, reaching landfall near Oranmore, Co. Galway, before running east to the area of the existing Cashla substation.

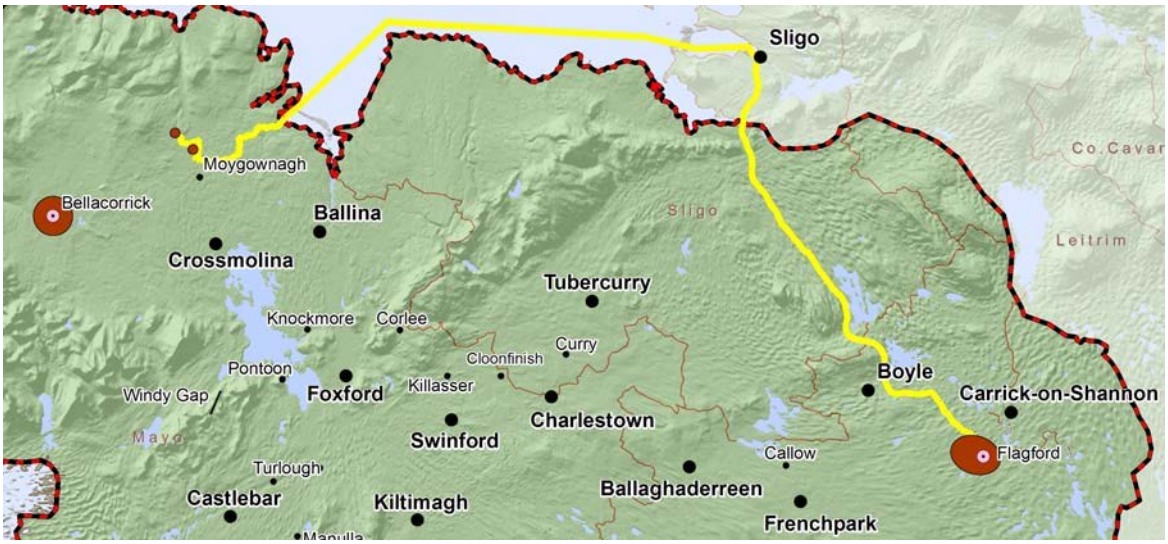

Figure 4.28 Underground Route Option 28

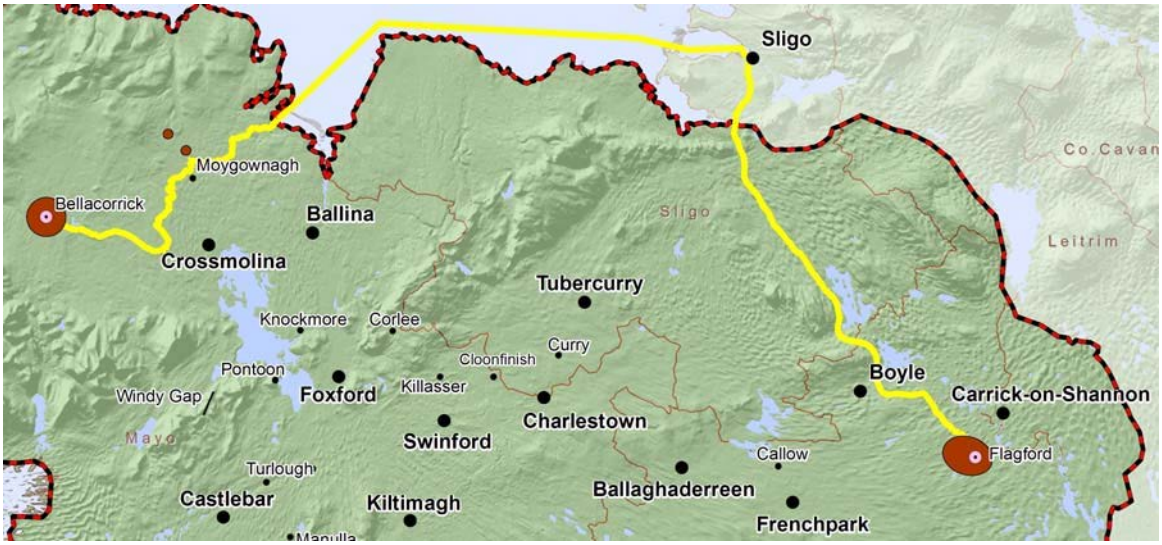

Figure 4.29 Underground Route Option 29

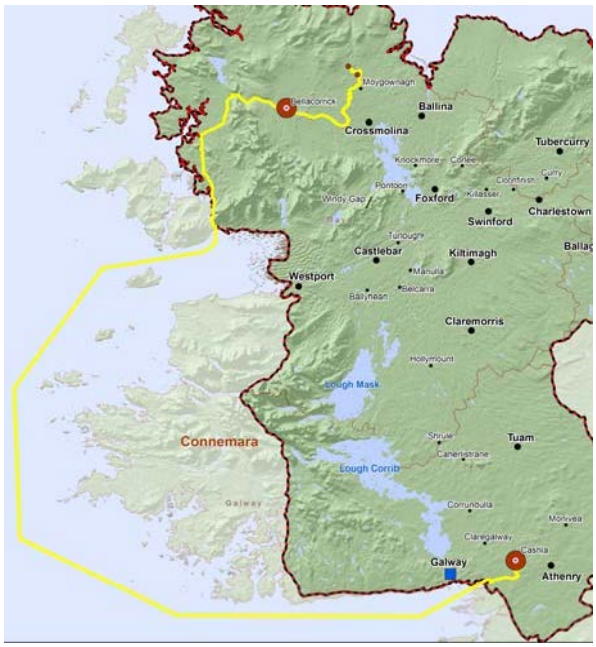

Figure 4.30 Underground Route Option 30

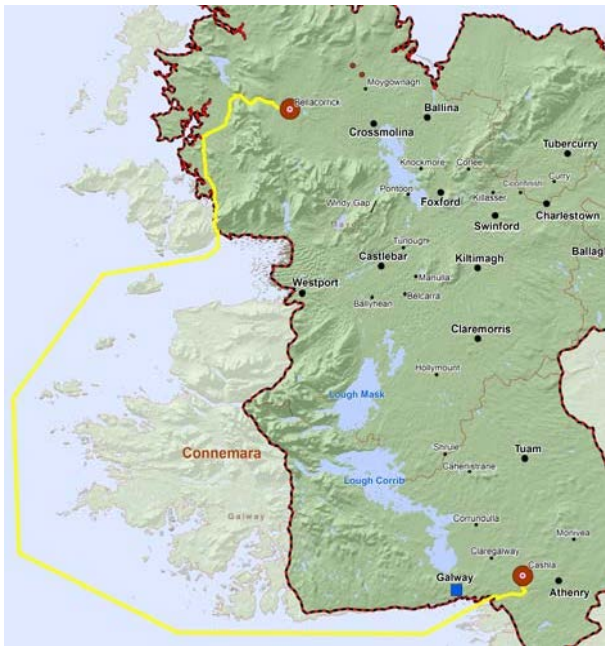

Figure 4.31 Underground Route Option 31

5. LIASON WITH LOCAL AUTHORITIES AND THE NATIONAL ROADS AUTHORITY

The project team held a series of meetings and workshops with the Mayo, Roscommon Galway and Sligo County Councils and the NRA to discuss the possible route options along public roads and to determine a set of criteria against which the various routes would be assessed. The background to the Grid25 Initiatives and the need for a review of the HVDC underground option was set out at meetings with the individual County Councils. Two follow up workshops were held, one to review the assessment criteria for the underground evaluation and to assess potential routes to Flagford and the second to assess potential routes to Cashla.

5.1 ASSESSMENT CRITERIA

In consultation with the Local Authorities and the NRA, the following underground cable assessment criteria were identified:

- Length of Route (km)
- Existing Infrastructure
- Roads Upgrade Programme
- Diversions during Construction
- Social Impact
- Cultural Heritage Sites
- Natura 2000 sites (SPA/SAC)

Each criterion can be broken down into a number of sub – criteria and a brief description of these is set out below.

5.1.1 Length of Route

The length of the route will have a significant impact on the disruption to the public during the construction phase of the project. The length of the cable will also have a significant impact on the cost of the overall project, and should be minimised where possible. In considering the route length the following factors are also considered:

- Ground condition
- Impact of construction activities
- Health and Safety during construction
- Cost of repair and maintenance

With regard to ground conditions, these were assessed on the basis of known areas of blanket bog, fen peat and cutaway bog and on the basis of general knowledge of ground conditions available from previous projects in the west of Ireland. In general relatively poor ground conditions, areas of karst or of shallow rock can be expected along any of the routes investigated.

It is inevitable that the cable will cross and run parallel to a host of buried services along the route. These services included gas, other electricity cables, water pipes, sewers, and telecommunications cables. Typically it would be preferable to avoid towns as there is inevitably a concentration of buried services in these areas. Although, most high voltage cables in the world are laid in cities, so buried services can be avoided if a route is preferred for other reasons. Specific buried services which may need to be considered and, where possible, avoided include:

- Buried metallic services which run in parallel and in close proximity to the proposed cable route. These must be separated from an underground high voltage cable and this applies to metal pipes, buried telecommunications and other metal services and structures. It is noted that there is a high pressure gas pipeline running from the north Mayo coast, to the west of Lough Conn and on south to Galway.
- Asbestos Water pipes. These pipes are very brittle, and if broken require complex and lengthy repairs. Engagement with local councils has begun to determine the locations/concentrations of infrastructure which may be damaged by the construction process.

5.1.2 Existing Infrastructure

Consideration must be given to the number of physical barriers encountered along each route in the form primarily of river and stream crossings but also of road bridges. The number of crossings of railways, both existing and disused must also be taken into account along each of the route options. In general, crossing streams, rivers or railway lines may require sections of the route to be constructed off road, usually by the means of a horizontal directional drilling underneath the obstruction.

The fewer crossings encountered in any route, the lower the risk of environmental impact during construction and the lower the construction costs will be. In summary, crossings will be required at:

- Bridges - Roads
- Bridges - Rivers
- Navigable Waterways
- Railways

5.1.3 Roads Upgrade Programme

For reasons outlined in Section 3 of this report, the cable route will be primarily in public roads. In considering the roads to be used on the routes, the project team will consider the length of each route in each of the following road types and the likely impact and implications of using these roads for an underground option:

- Motorways
- National and regional roads
- Local roads
- Proposed new roads
- Proposed road realignments and upgrades

The only motorway of relevance to the Grid West project will be the new M17/M18 motorway south of Tuam. This project has already been tendered and awarded as a Design/Build/Operate (DBO) project and attempts to add ducting for HV cable at this stage would be complicated and expensive.

While cables could be laid along National Roads these would have to be accommodated in the hard shoulder where it exists and only if other services are not present.

The Ten-T network is a European designation of strategic national routes, coordinated by European Commission Ten-T Agency. In Ireland it represents a subset of the national primary network. Under new Regulations from Ten-T, published in 2013, all Ten-T routes must be upgraded to Expressway (2+2 / dual-carriageway) standard by 2050. This is of significance to the Grid West project as the N5 and N17 north of Tuam are among the comprehensive network routes that will require upgrade in that time horizon. If a high voltage cable was constructed along these roads it would be necessary to switch out the cable and divert it at some later date to accommodate the road upgrade. This would not be practical for a critical piece of strategic infrastructure such as Grid West. Therefore, underground routes that run along these sections of national roads will be identified as significantly constrained.

Cables laid along local or narrower regional roads will in all likelihood lead to road closures to accommodate construction. In areas of poor ground or where the existing road is in poor condition prior to construction, it is possible that local roads will not be of a standard that will withstand the damage created during construction and full road reconstruction may be required once the cable is laid. Even so, the lower level of disruption to traffic in local roads and the avoidance of the issues associated with laying cables in national roads make routes in these smaller roads less constrained.

5.1.4 Traffic Diversions during Construction

The impact of traffic diversions during construction on businesses and residents as a consequence of selecting any particular road as the route for an underground cable has to be considered.

- Impact on businesses
- Impact on significant tourist routes
- Impact of construction deliveries
- Impact to local residents

At this stage the impacts listed above are assessed in a qualitative way, taking into account the likely length of diversions, the types of vehicles that would need to be diverted and the nature of the area in which the diversions will be required.

5.1.5 Social Impact

It is desirable to minimise the impact of the construction of an underground option on people and community facilities, insofar as this is possible. Therefore consideration has been given to the following along each potential cable route:

- Number of Residences
- Number of Commercial Buildings
- Number of Schools
- Number of Sports clubs
- Other public amenities e.g. parks, likely to be impacted

5.1.6 Cultural Heritage

All impact to cultural heritage sites should be avoided, and proximity to the following cultural heritage sites has been considered:

- National Monuments
- Sites and Monuments Records
- Religious Sites
- Preservation Orders
- Protected Structures – within a 30m corridor

5.1.7 Environmental

As any underground option will primarily be constructed in public roads, the environmental impact of the construction process would not be as significant as that generated by a cross country cable route. Nonetheless consideration must be given to potential construction impact on areas of environmental sensitivity and the length of underground option in such areas should be minimised where possible. Consideration is therefore given to the length of each route which passes through European designated sites, i.e. Special Protection Areas (SPAs) and Special Areas of Conservation (SACs). Although roads are not designated SPAs or SACs the impact of construction in the area needs to be considered.

- Length of route in SPA (km)
- Length of route in SAC (km)

6. PRELIMINARY ASSESSMENT OF UNDERGROUND ROUTE OPTIONS

6.1 PARTIAL SUBMARINE OPTIONS

The four partial submarine options described in sub-section 4.2.10 above represent the longest routes of all those considered. The main issue with a sub-marine cable is the risk of unavailability due to the difficulty of access for maintenance and repair. It can take a number of months to find and contract a vessel suitable to investigate and locate a fault in a sub-marine cable. Therefore, taking into consideration factors such as ease of access and maintenance, full life cost and system security, a sub-marine cable option would not compare favourably with any of the other options being considered. For this reason Options 28 to 31 inclusive were not considered further at this stage.

6.2 LAND BASED OPTIONS

Following desktop studies, drive over surveys and consultation with the relevant Local Authorities and the NRA, the various route options were assessed against one another. Each route was rated against each of the assessment criteria as identified. Detailed results of the assessment are presented in Appendix A, and a summary of the results is set out in Tables 6.1 and 6.2.

The summary tables record whether, in respect of a certain criterion, a route is 'more constrained' or 'less constrained', based on information and knowledge obtained to date. The degree of constraint for each route against any particular criterion is indicated by the colour allocated. The lighter colour showing the less constrained option, the darker colour showing the more constrained. A commentary on the assessment of routes is set out in Section 7.

	Route Option No.									
Assessment Criteria	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Length *										
Existing Infrastructure										
Roads Upgrade Programme										
Social Impact										
Cultural Heritage Sites										
Natura 2000 Sites										
Diversions										

** The Assessment of Length includes a desktop assessment of ground conditions.*

Table 6.1 – Results of north Mayo to Flagford Route Options

Assessment Criteria	Route Option No.																
	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Length *																	
Existing Infrastructure																	
Roads Upgrade Programme																	
Social Impact																	
Cultural Heritage Sites																	
Natura 2000 Sites																	
Diversions																	

** The Assessment of Length includes a desktop assessment of ground conditions.*

Table 6.2 – Results of North Mayo to Cashla Route Options

Least Constrained Most Constrained

7. ANALYSIS OF ALL OPTIONS CONSIDERED

All land based options were considered in parallel based upon the criteria identified in Section 5. The results of that assessment are set out in summary in Section 6 and in detail in Appendix A of this report. As described in Section 3, the route options run to either Flagford, Co. Roscommon or Cashla, Co. Galway where there are existing AC substations on the national grid. In Co. Mayo the terminus for a cable route will be either in the vicinity of an existing substation in Bellacorick or in an area north-west of the village of Moygownagh. The first analysis then is to determine which of the areas in Mayo will be the start point for an underground cable route.

7.1 UNDERGROUND ROUTE TERMINUS IN CO. MAYO

Figure 7.1 below shows the possible underground routes options from (a) a terminus near Bellacorick and (b) a terminus north-west of Moygownagh village. All of the five cable routes from a terminus in Bellacorick travelling to Flagford will of necessity follow the N59 national road, at least as far as a point approximately 5.5 m east of Crossmolina. Of the ten options travelling from Bellacorick to Cashla, nine run along the N59 and one runs south from Bellacorick along the R312.

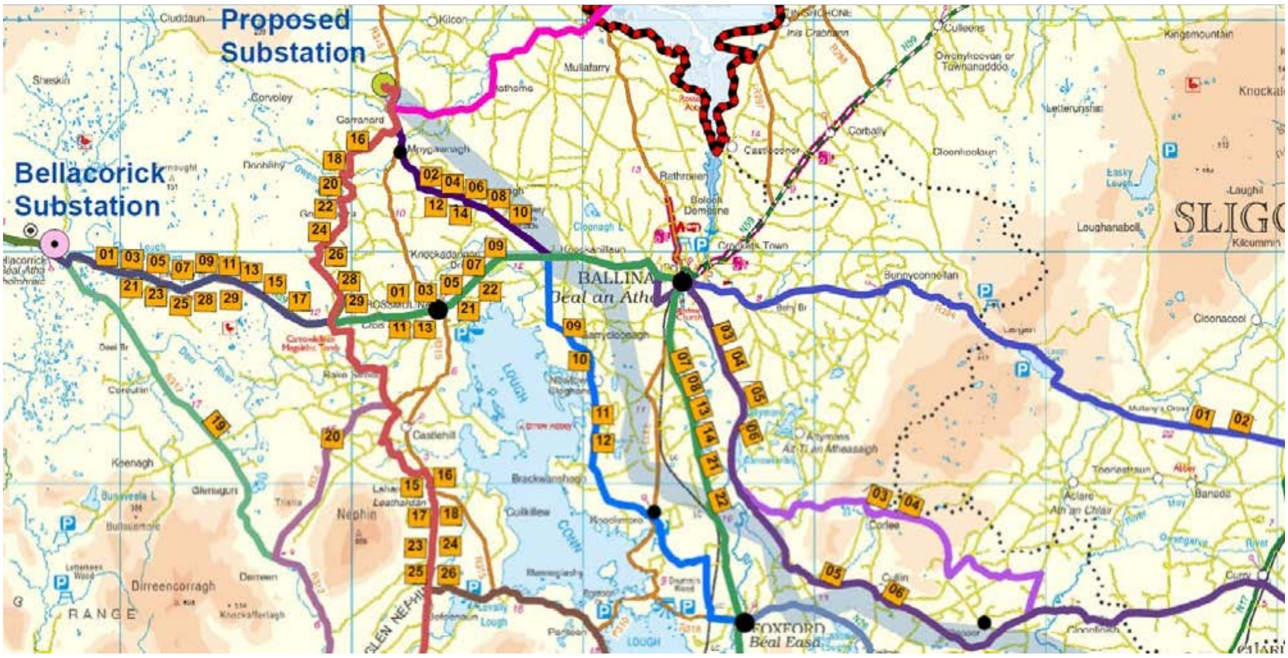

Figure 7.1 Possible Underground Cable Routes in North Mayo

During consultations with statutory bodies, the NRA indicated that routing a high voltage cable in the N59 national road would present significant difficulties as the installation of a cable in this road would result in serious disruption to traffic during construction. Due to the width of the road along some sections and the poor ground conditions that are likely to be encountered, particularly west of Crossmolina, the entire road may need to be closed for a number of months to facilitate construction, with limited options for diversion of traffic. Even if lengthy diversion routes away from the N59 were acceptable, diverting heavy goods vehicles (HGVs) along narrow local roads would create difficulty and possibly safety issues. Furthermore the existence of a high voltage cable in a national road would

create problems for any future upgrade or realignment of the road. There are long term plans to upgrade the N59 and it would not be practical for any high voltage transmission cable in the road to be switched out for any period to accommodate such upgrade works.

From an environmental point of view the N59 west of Crossmolina traverses a bog terrain that is part of an SAC. While the road itself is not part of the SAC it would be necessary to go off road with the trench at river and stream crossings. Such impacts on an SAC would significantly constrain such a route option, particularly when there are alternatives available with no such impacts.

Significant disruption to traffic was also considered likely due to the installation of a cable within the R312, i.e. routes to the west of Lough Conn. Due to the width of the road and likely poor ground conditions or rock, both of which have the potential to slow the installation rate of the cable ducts. In many locations the entire road may need to be closed for a number of months to facilitate the construction with significant disruption. If the R312 road were closed there would be no easy diversion for traffic which uses this route and while this road is not as heavily trafficked as the N59, there would be significant disruption and inconvenience to local traffic.

In contrast with the difficulties associated with finding a cable route from Bellacorick that avoids SACs and national roads, it is possible to find a cable route that runs from the Moygownagh area that avoids both.

Following consultations with Mayo County Council and the NRA and subsequent workshops, it was determined that the terminus in Co. Mayo for a high voltage underground route should be in the area north-west of Moygownagh village. The options thus set out in Sections 7.2 and 7.3 below consider the routes from this area north-west of Moygownagh to areas around either Flagford or Cashla.

7.2 ASSESSMENT OF ROUTE OPTIONS TO FLAGFORD

Considering the summary assessment shown in Section 6 of this report and bearing in mind that the routes with even numbers are those that terminate near Moygownagh, it is clear that routes 4 and 6 to Flagford emerge as the least constrained.

	Route Option No.				
Assessment Criteria	**2**	**4**	**6**	**8**	**10**
Length (including ground conditions)					
Existing Infrastructure					
Roads Upgrade Programme					
Social Impact					
Cultural Heritage Sites					
Natura 2000 Sites					
Diversions During Construction					

Table 7.1 – Comparison of North Mayo to Flagford Route Options

While Option 2 is physically the shortest route, it runs along the R294, past Lough Talt in the Ox Mountains, and construction on this road would create lengthy diversions and disruption. At the workshop on 13th May, Roscommon Co. Co. observed that this route is an important road to traffic heading west from the area around Boyle. Furthermore the route has a heavy social and cultural heritage impact, passing by a number of schools and sporting clubs as well as sites on the Sites and Monuments Record (SMR) and other protected structures.

Option 8 runs largely along national roads and, as indicated earlier, at the workshops with the Local Authorities and the NRA, running a cable route along national roads that are planned for future upgrade will cause serious issues due to traffic disruption and the constraint that the presence of a high voltage cable would impose on future road construction work, both for the NRA and the electricity transmission system. Social impact and cultural heritage sites also generate greater constraints on this route option compared to Option 10 and, in particular, Options 4 and 6.

Option 10 runs along local and regional roads but, as it takes a more southerly route than Options 4 and 6, it has a greater overall length. It has a greater number of crossings to be encountered and also, relative to Options 4 and 6, it runs past a greater number of community buildings and schools and generates a greater level of traffic disruption.

Options 4 and 6 differ only in that Option 4 takes a route further north than Option 6, over high ground near to Corlee and running north of Kilasser before rejoining Option 4 east of Kilasser. The route that Option 6 takes in this divergence from Option 4 is through difficult terrain with steep gradients and winding roads. Rock outcrops adjacent to the road suggest that the construction on this route will be slow due to the difficulty in excavating rock and consequent relative additional expense. The routes pass adjacent to and, in some areas, through an SAC to the south of Lough Gara in Co. Roscommon.

However, unlike the SACs encountered on the N59 and R312 referred to earlier, it is possible to find an alternative route around this SAC.

Given that Option 4 traverses the more difficult route for the section over which Options 4 and 6 diverge, Option 6 is the preferred route over Option 4 and therefore the preferred route to Flagford.

7.3 ASSESSMENT OF ROUTE OPTIONS TO CASHLA

	Route Option No.								
Assessment Criteria	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**27**
Length (including ground conditions)									
Existing Infrastructure									
Roads Upgrade Programme									
Social Impact									
Cultural Heritage Sites									
Natura 2000 Sites									
Diversions During Construction									

Table 7.2 – Comparison of North Mayo to Cashla Route Options

The route options travelling from north Mayo to Cashla are compared in Table 7.2 above. While Option 12 is more constrained under the Length criterion than Options 14, 26 or 27, and also has a slightly higher social impact than some other routes, overall it is the least constrained of the options considered.

Option 14 rates poorly in the categories of Roads Upgrade Programme, Social Impact, Cultural Heritage and Diversions during Construction. This option follows national roads along 93km of its total 127km length, a proportion that (due to the comments made earlier in relation to routing in National Roads) makes it a severely constrained option.

Option 16 makes use of the disused railway between Claremorris and Athenry for 46.6km of its total 138km length, (as does Option 18 which has a total length of 141km). Option 27 runs in disused railway for 75.1 km of its 133km length. While use of the old railway network may appear attractive there are a number of difficulties associated with this.

Firstly - while activity may have receded in recent years, there is still the possibility of railways in the west of Ireland being rehabilitated as part of Western Corridor project. Local Authorities have indicated that at this stage they would be reluctant to commit to anything that may exclude the possibility of future rehabilitation of the railways.

Secondly - the level of dispute over ownership of old railway lines has increased in recent years, where it has been sought to develop old railways into greenways and cycle routes.

Thirdly - if a greenway were developed as part of the construction of an underground route option along the old railway line, the transmission system operator may find it difficult to carry out routine inspection and maintenance of the cable as the access provided by a greenway would be narrow and difficult for the type of plant and machinery that would be needed for such work. Access for repair work may consequently be difficult.

Options 16 and 18 rate poorly in comparison to Option 12 under all the other criteria except for Social Impact where they compare marginally more favourably.

Option 20 runs from north-west of Moygownagh, west of Lough Conn and Castlebar, passing through 4.5km of SAC along its way. West of Castlebar it runs, of necessity, along the N5 between Castlebar and Westport for a distance of 5.2km. This is a relatively short section of national road, given the overall length of 139km for Option 20. However this particular section of the N5 is quite narrow and winding, raising the possibility that the road would have to be closed during construction. The NRA noted that this would likely give rise to serious disruption and lengthy diversions for traffic along a busy section of road. The presence of a cable in this section of the N5 may also compromise future plans to upgrade the road.

Option 22 runs along national roads for 46.3km of its 149km length, including the N59, N26 and N58. While this is not as great a proportion of national roads as there is in Option 14, it is sizeable and includes roads that are being considered for upgrade. Given the comments of the NRA referred to earlier regarding the difficulties that would be caused by having to accommodate a high voltage underground cable while carrying out road upgrades, Option 22 becomes more constrained than Option 12.

Options 24 and 26 run from north-west of Moygownagh south along the western shore of Lough Conn largely in the R315. The routes diverge north of Pontoon, with Option 24 following the R315 as far as Pontoon and Option 26 taking a more westerly route through The Windy Gap. The two routes merge again north-east of Castlebar, on the Castlebar / Pontoon Road. Relative to Option12, these routes are more constrained in terms of the number of crossings of existing infrastructure, cultural heritage, length in SAC and the length and impact of required traffic diversions during construction.

8. IDENTIFIED LEAST CONSTRAINED AND PREFERRED OPTIONS

8.1 LEAST CONSTRAINED ROUTE OPTIONS

It can be seen from the assessment and discussion set out in Section 7 that the Least Constrained Route Option from north Mayo to Flagford is Route Option 6 while the Least Constrained Route Option to Cashla is Route Option 12.

These two route options were studied in more detail and refinements to both were considered, taking on board comments and suggestions made at the workshops with the Local Authorities and the NRA.

8.2 PREFERRED ROUTE FROM NORTH MAYO TO FLAGORD

Following additional assessment of Route Option 6, from Flagford to Moygownagh, it was identified that refinements were possible to further improve this route. The main constraints that needed to be avoided were

- section along N59 west of Ballina
- Ballina town
- River Moy crossing in Ballina and
- SAC south of Lough Gara in Co. Roscommon.

It was recognised that the first three of these could be avoided by combining the northern section of route option 12 with route option 6. Essentially this means that rather than following the N59 eastward into Ballina and then travelling southward along local roads as far as Carrowkeribly Lough, the cable could cross the N59 and follow local roads southward along the eastern side of Lough Conn and along the R310 towards Knockmore, turning eastward off the R310 onto local roads again at a point north of Knockmore and travelling towards the N26. The amended route would then cross the N26 approximately 8km north of Foxford from where it would travel across country, under the River Moy and return to the original Option 6 route on local roads at Carrowkeribly Lough.

With regard to the SAC at Lough Gara, Option 6 can be amended to travel further south along the R293 regional road, leave this road north of Ballaghaderreen, turning south eastwards along a partially cross country route under the River Lung and rejoining the original Option 6 route on local roads near Ballinlough.

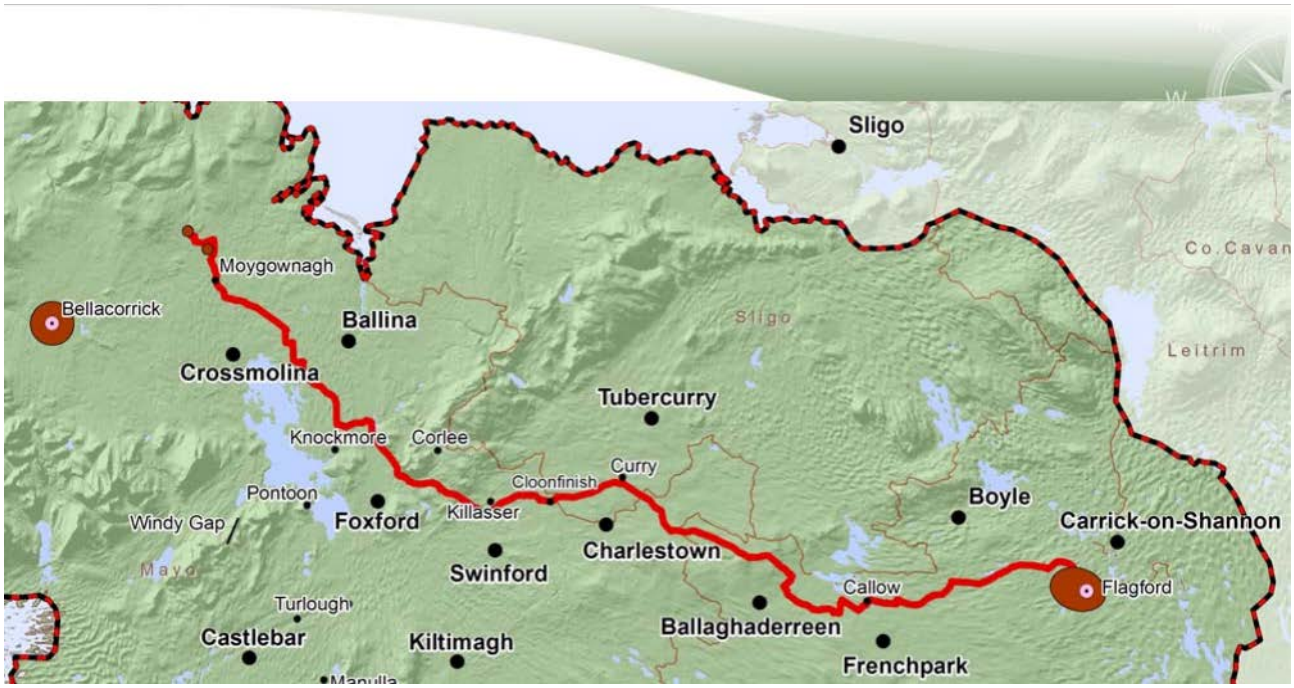

Figure 8.1 Underground Route Option A

The amended Route Option 6 is designated as Option A as shown in Figure 8.1. While the diversions around Ballina have made this route slightly more constrained in terms of length, it has reduced its environmental impact.

8.3 PREFERRED ROUTE FROM NORTH MAYO TO CASHLA

Following additional assessment of Route Option 12 to Cashla, it was identified that refinements were possible to shorten the length of this route. The amended route will follow the same line as that described for Route A above, but will continue on the R310 through Knockmore village and turning south eastwards towards Foxford by way of local roads. A short section of cross country route will be required to avoid the cable running through Foxford itself, but will allow a crossing of the River Moy at a point approximately 1km south of Foxford.

The construction of the new M17/M18 motorway which is scheduled to be completed in 2017 will result in the declassification of the N17 as a national road, south of Tuam. Route Option 12 could therefore take a more direct route along the declassified N17 south of Tuam as far as Claregalway rather than taking the lengthier route along local roads originally envisaged.

The amended Route Option 12 was designated as Route Option B and is illustrated in Figure 8.2 below. While these amendments improve the overall length and social impact of this option they have a negative effect on its cultural heritage impact.

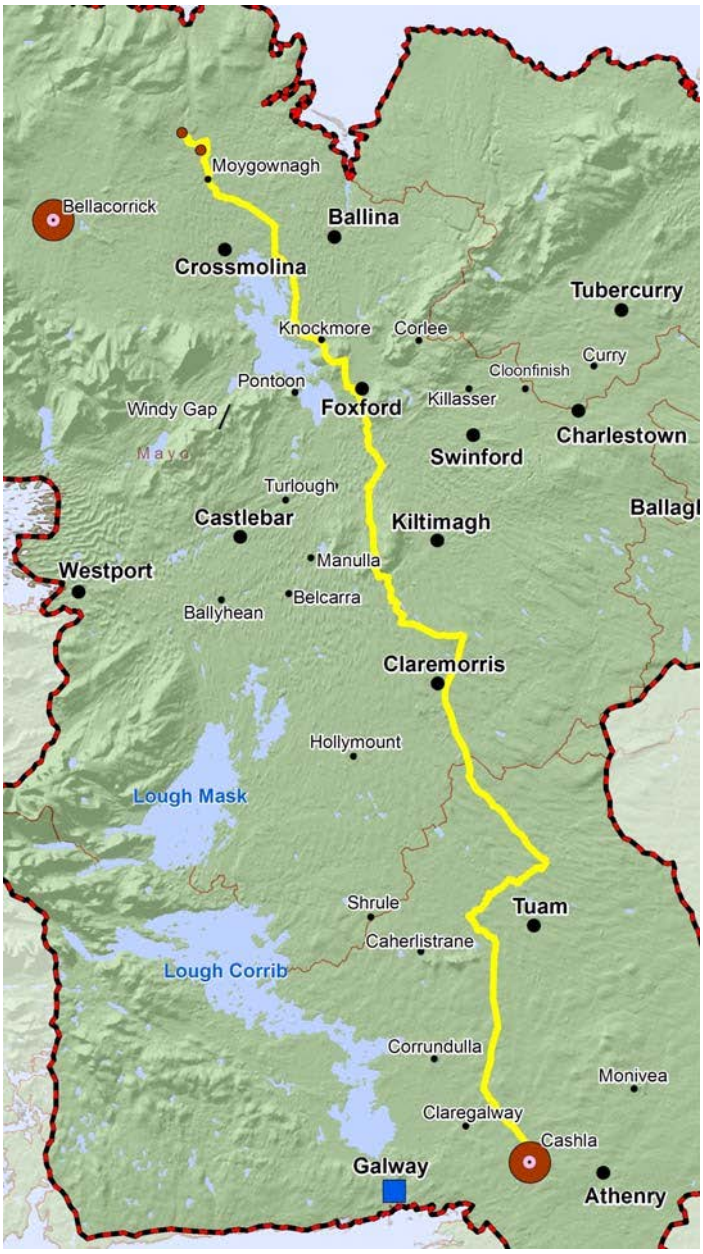

Figure 8.2 Underground Route Option B

8.4 PREFERRED ROUTE

A comparison of the two least constrained routes, now designated Option A to Flagford and Option B to Cashla, is summarised in Table 8.1 below. Detailed analysis of these routes are presented in Appendix A. While Option A, at 112.5km is approximately 20km shorter than Option B, it is more likely to encounter poorer ground conditions. Option B, however, has a greater number of crossings along its route and has more than twice as many cultural heritage sites within 30m as Option A.

The environmental impact of Option A is reduced by the avoidance of the Lough Gara SAC.

Assessment Criteria	Route Option			
	6	A	12	B
Length (including ground conditions)				
Existing Infrastructure				
Roads Upgrade Programme				
Social Impact				
Cultural Heritage Sites				
Natura 2000 Sites				
Diversions During Construction				

Table 8.1 Least Constrained and Preferred Options

Least Constrained Most Constrained

It is recommended therefore that Route Option A is the underground cable route that should be used for comparison with the overhead line option for the Grid West project.

9. HVDC CONVERTER STATION SITES

9.1 INTRODUCTION

In order to provide a fully underground solution for the Grid West project, it is not technically possible to use the same technology as used for the rest of the electricity transmission system, i.e. high voltage alternating current (HVAC).

A fully underground solution will require the use of High Voltage Direct Current (HVDC) electricity. This is a different technology and will require different equipment in order to operate it on the transmission system. The main difference is at the station locations at the ends of circuit, i.e. the underground HVDC solution will necessitate the construction of a converter station at the start and end points of the project. EirGrid has identified the zones in north Mayo and Flagford in which these converter stations can be located.

It was therefore necessary to identify potential zones within which these converter stations could be located since ultimately the preferred routing for the HVDC link must also take into account the availability of suitable sites for the converter stations. Since a number of factors will determine the final exact converter station site, at this early stage only potential converter station locations have been identified. These are areas of land 1km in diameter in which it is considered reasonably practical to locate a suitable converter station site.

9.2 CONVERTER STATION LAYOUT

HVDC converter stations will be required at each end of an underground cable route. To accommodate the proposed wind generation in north Mayo a minimum of one converter station will be required at either end of the circuit.

For security of supply, availability and future growth in the region the selected site must be capable of accommodating a possible second converter station in the future.

As this is very early stage of design development, the preferred technology for a fully underground solution has not been finalised. Typical dimensions of the converter stations sites are 240m x 170m. These layouts have been based on the existing 500MW converter station constructed at Woodland in Co. Meath for the East-West Interconnector project (see Photograph 9.1), with allowances made for the possibility of a second converter station, the increased rating or different voltages.

Photograph 9.1: East-West Interconnector Portan Converter Station

9.3 EVALUATION CRITERIA

In order to identify reasonably suitable converter station locations, it is important to have determined the criteria that will be used to evaluate the preferred location, within any zone.

The following criteria are proposed for the evaluation of the converter station locations:

- **Proximity to housing:** HVDC converter stations are large complex facilities that do generate some noise. As such the distance to any housing should be maximised.
- **Proximity to the existing substation:** For system operational reasons it is preferred that the converter station is as close as possible to the substation or power generation source that it is to connect to.
- **Topography:** The converter station requires a large area. It is preferred that the site is relatively flat to minimise the requirement for extensive earthworks to create the level platform needed for the converter station.
- **Geotechnical Conditions/Subsoil:** The converter station incorporates large and heavy equipment requiring good foundation conditions. Sites in peat bog or with poor ground conditions are therefore less preferable.
- **Access –** proximity to a suitable public road: The converter stations site should be located such that good access to a suitable public road, capable of allowing the transport of the equipment is available.
- **Landscape and Visual Impact**: The converter station will have the potential to impact negatively on the landscape and therefore the potential to mitigate this impact is an important consideration in the selection of potential sites and their evaluation.

- **Cultural Heritage**: The location/site of the converter station should be selected so as to minimise the impact on any known cultural heritage.
- **Ecology**: The zone/site of the converter station should be selected so as to avoid any designated areas and minimise the impact on any ecological constraints.

The above criteria will be considered during initial selection of locations within each zone so as to ensure that locations that are unsuitable for a converter station are not included and then to evaluate the different sites in order to determine the preferred site.

9.4 CONVERTER STATION LOCATIONS

9.4.1 North Mayo Converter Station Locations

The proposed converter station zone and associated converter station locations in the north of Mayo are shown in Figure 9.3 and in the drawing included in Appendix B. The zone is centred on an area approximately 3km north-west of Moygownagh.

Within this zone only two reasonably suitable locations have been identified, designated DCB1 and DCB2. These two locations generally align with the substation locations SB2 and SB3A identified for the proposed overhead line option. Given this limited number of potential locations, the search was widened to look for sites outside the zone. This resulted in further locations being identified, designated as DCB3, DCB4 and DCB5.

In addition to these locations, two other locations were considered but in both cases were not taken forward. These are:

i. Existing Bellacorick Substation: There is an area of land adjacent to the existing Bellacorick Substation where the former peat-fired power station was located. However, as discussed in the cable routing section, it is undesirable to route the HVDC cables to this location along a national road (N59) or through SACs and therefore this site is not considered suitable.

ii. A location centred around the overhead line substation location SB3, (as identified in the EirGrid Stage 1 Report, March 2013). This location is well within the Cluddaun Wind Farm boundary and therefore is not suitable for the same reasons that it was not suitable for the construction of the HVAC substation, namely that future connections to the site could not be routed through the wind farm.

Figure 9.1; Typical View of Location DCB2

Figure 9.2: Typical View of Location DCB1

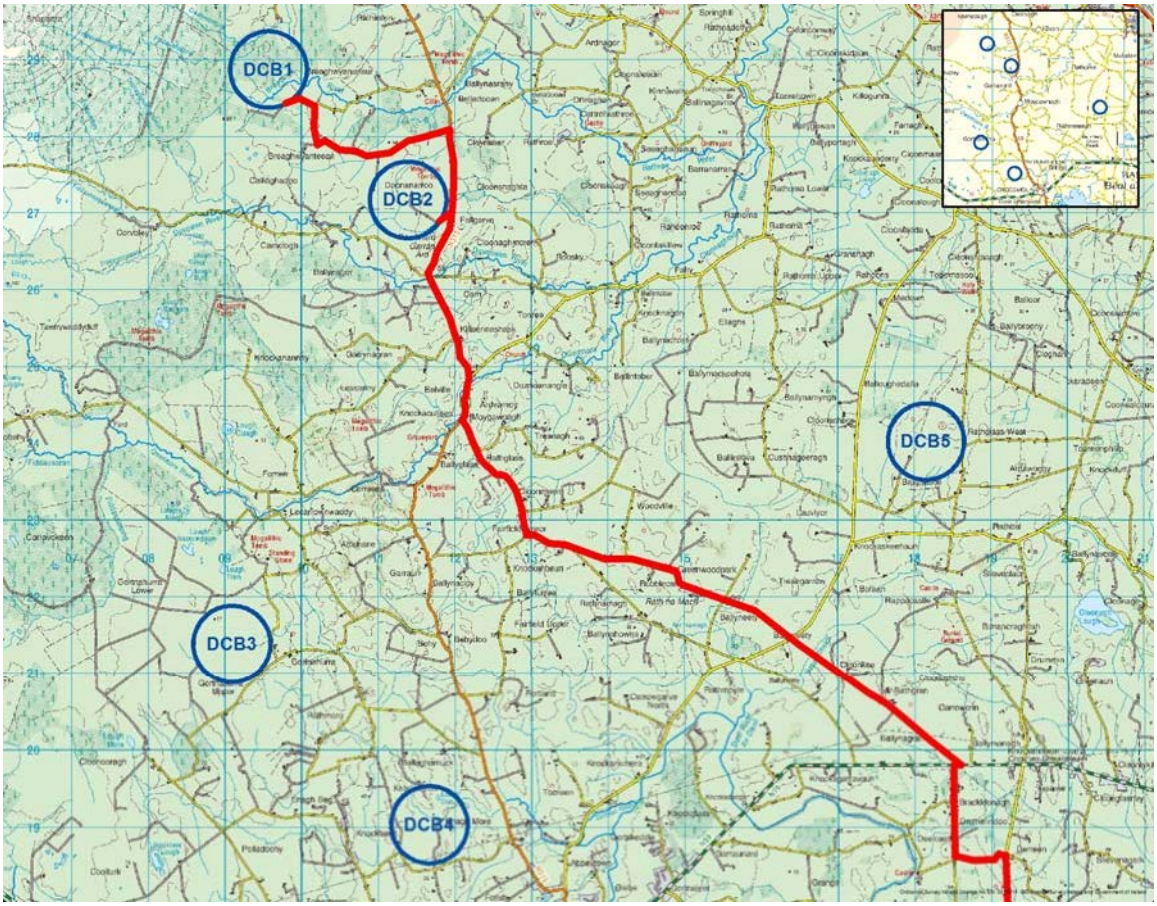

Figure 9.3: North Mayo HVDC Converter Station Locations

9.4.2 Flagford Converter Station Zone

The proposed converter station zone and associated converter station locations for Flagford are shown in Figure 9.4 and in the drawing included in Appendix B. The zone is centred on the existing Flagford substation.

There were several potential locations within this zone, of which the six most suitable locations have been selected for further evaluation. These have been designated as DCF1 to DCF6.

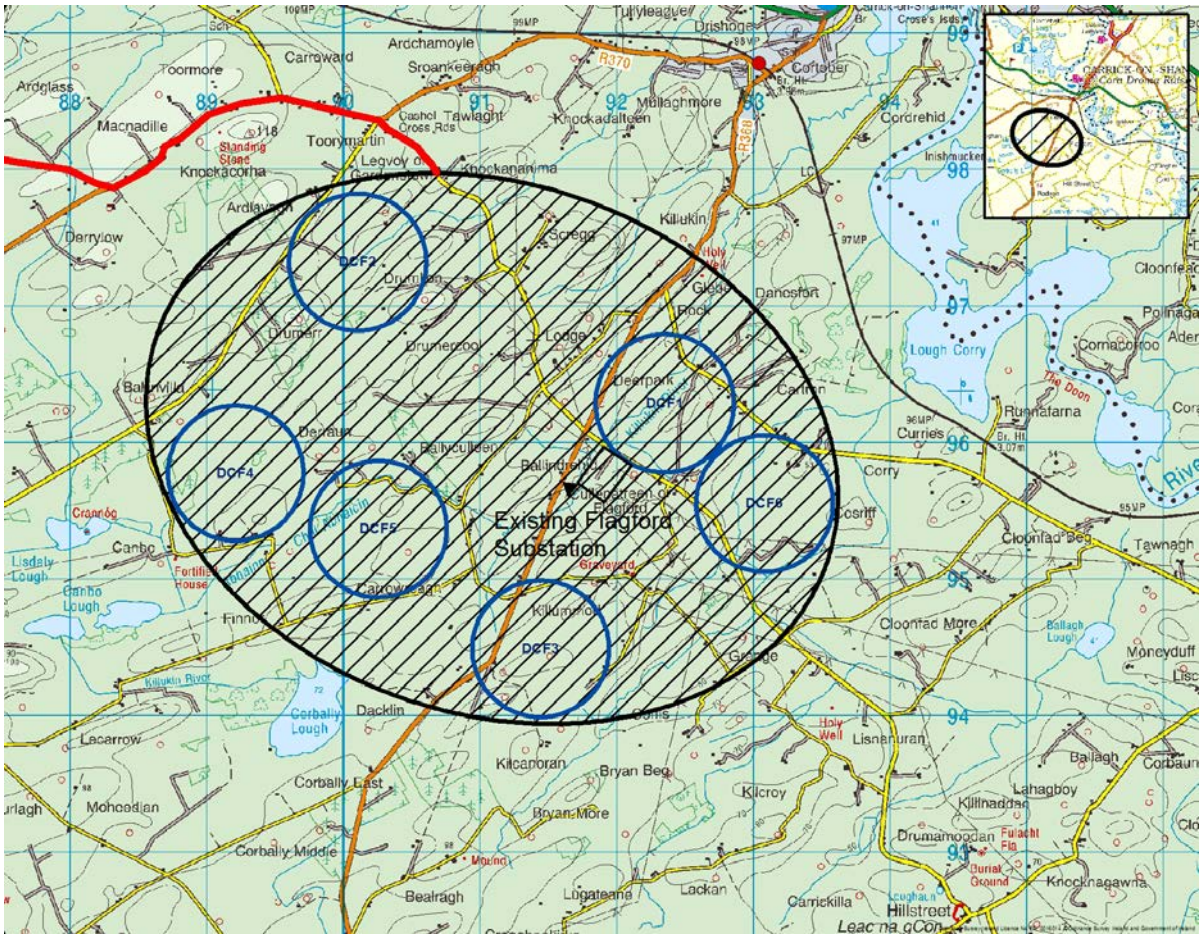

Figure 9.4: Flagford HVDC Converter Station Zone

9.5 EVALUATION OF CONVERTER STATION LOCATIONS

In this section the converter station locations identified for north Mayo and Flagford are evaluated against the criteria set out in Section 9.3. At the outset of the evaluation process, the locations were initially screened against the different criteria and if any were found to be clearly unsuitable these were not taken forward for the detailed evaluation.

9.5.1 Evaluation of north Mayo Converter Station Locations

Of the five potential converter station locations identified in north Mayo, three are located outside the converter station zone. The converter station will need to connect to the existing 110kV network, with five 110kV lines being needed for the initial Grid West phase of the works. Of these five lines at least the three lines connecting to the Cluddaun and Owenniney wind farms will become longer by approximately 8km each. It would be necessary for these lines to be constructed as overhead lines in

order to limit the length of 110kV underground circuits to mitigate the negative effects of underground circuits on the grid. It is considered that adding this number of additional overhead lines into the area is undesirable. Given that none of these have any particularly significant advantages, particularly in relation to housing, these sites have not been taken forward for evaluation.

The following are the key points taken into consideration in evaluating the remaining two locations DCB1 and DCB2 against the assessment criteria[1]:

- **Proximity to housing:** For DCB1 there are no houses within the location and a total of 11 houses within 1km of the centre of the zone. For location DCB2 there are no houses within the location, and 15 houses within 1km of the centre of the zone. DCB1 therefore has less impact on local settlements than DCB2.

- **Topography:** both locations are generally relatively level, with only gentle gradients across the sites. There is little to separate the two sites on this criterion.

- **Geotechnical/Subsoil conditions:** Location DCB1 is within the Bellacorick Peat complex located within peat up to at least 3m deep. DCB2 is in an area with generally good ground conditions although there are small areas of localised peat. The ground conditions in location DCB1 would create significant engineering challenges for the construction of a facility of the size and nature of an HVDC converter station. Further the associated impact on the local ecology would require further more detailed investigation.

- **Access:** DCB2 is relatively close to the R315, providing much better access than is available to DCB1 where at least 2km of local roads would have to be upgraded and a further kilometre of new road, generally across peat, would have to be constructed.

- **Landscape and visual:** Location DB2 is located on a low ridge with limited opportunity for screening, while DCB1 is located against elevated ground with offers good opportunities for visual screening, thereby reducing its impact on the landscape.

- **Cultural heritage:** There is one megalith located within location DCB2 and a second just outside to the north-west (MA21:28 & 029), which causes this location to be more constrained than DCB1. However as the monument within the location is on the northern edge of the location, close to houses, the final site of the converter station could be selected so as to not impact on this monument.

- **Ecology:** The area of location DCB2 is generally grazing farm land and the construction of a converter station in this location is unlikely to have significant impact on the local ecology.

[1] Proximity to existing substation is not a criterion in assessing these locations, since a practical location close to or adjacent to the existing Bellacorick substation is not available.

However DCB1 is located in the peat, close to the Breaghwy River. To construct an HVDC Converter Station within this location would require excavation of the peat down to the underlying ground, with the drainage through the site being designed to ensure that the site does not flood. Substantial quantities of make up ground would need to be imported to create a platform for the station that would not be subject to flooding. The impact on the local ecology in the peat and the impact on areas outside of the local site, such as on fresh water pearl mussel sites would need further detailed consideration.

Assessment Criteria	Location	
	DCB1	DCB2
Proximity to Housing		
Topography		
Geotechnical Conditions		
Access		
Landscape & Visual Impact		
Cultural Heritage		
Ecology		

Least Constrained Most Constrained

Table 9.1: North Mayo Converter Station Location Evaluation Matrix

Consideration of the above evaluation matrix indicates that location DCB2 is less constrained than location DCB1. However the increased impact of DCB2 on settlements needs further consultation. Also further investigation into the construction of an HVDC converter station in the peat and the associated impact on the local ecology would need further consideration before a final decision can be made on the preferred location.

9.5.2 Evaluation of Flagford Converter Station Locations

In contrast to the north Mayo converter station locations, all six locations in the Flagford converter station zone are reasonably suitable technically. Thus all six have been taken forward into the evaluation.

An analysis of each of the locations against each of the criteria is set out in Table 9.3 below. Based on this analysis Table 9.2 shows the initial evaluation of the six converter station locations for Flagford against each of the evaluation criteria.

Assessment Criteria	Location					
	DCF1	DCF2	DCF3	DCF4	DCF5	DCF6
Proximity to Housing						
Proximity to substation						
Topography						
Geotechnical Conditions						
Access						
Landscape & Visual Impact						
Cultural Heritage						
Ecology						

Table 9.2: Flagford Converter Station Locations Evaluation Matrix

The following are the key points taken into consideration in evaluating the potential locations:

- While DCF1 and DCF3 have the most impact on local settlements, in the case of DCF1 this is partially offset by the proximity of the existing Flagford Substation.
- DCF2 is located on an area of sloping ground, which would make construction more difficult given the area of the converter station site.
- Clearly DCF1 is the closest location to the existing Flagford substation. This not only facilitates the interconnection of the two but also allows easier access to the potential site.
- The converter station is a large prominent facility that will have a significant impact on the visual amenity. The least constrained are locations DCF6 and DCF2 as these can be screened in views from nearest local roads. The location DCF4 is the least preferred due to close proximity to Lisdaly Lough, Canbo Lough and Killukin River followed by second least preferred locations – DCF1 and DCF3 mainly due to topography and low roadside vegetation that would allow views of the development from the nearest roads.
- There are no protected ecological sites in the vicinity of any location. The network of streams and drains near all locations means aquatic receptors could be sensitive to construction stage impacts.

Consideration of the above evaluation matrix indicates that location DCF6 is the least constrained location, with DCF1 the next least constrained location. The overall level of constraint is similar for DCF1 and DCF6, with the increased proximity of DCF1 to settlements making it more constrained than DCF6. Subject to any issues arising from consultation, it is likely that the specific sites available for the converter station within these two locations will determine the preferred site for the converter station.

Location	Location DCF1	Location DCF2	Location DCF3	Location DCF4	Location DCF5	Location DCF6
Proximity to Housing	- 7 houses within location - - 38 houses within 1km of the centre of the location	-1 house within location -24 houses within 1km of the centre of the location	7 houses within location - 26 houses within 1km of the centre of the location	- 0 houses within location - 14 houses within 1km of the centre of the location	- 2 houses within location - 23 houses within 1km of the centre of the location	-3 houses within location -26 houses within 1km of the centre of the location
Proximity to Existing Substation	Within 500m	Approx 2.5km	Approx 2km	Approx 4km	Approx 2km	Approx 1.5km
Topography	Flat terrain	Sloping area	Gently sloping	Gently sloping	Gently sloping	Flat terrain
Geotechnical Conditions[2]	Good	Good	Good	Good	Good	Good
Access	Good – opposite Flagford substation	Accessible from local road	Good access of R368	Accessible from local road	Accessible from local road	Accessible from local road
Landscape & Visual Impact	Low roadside vegetation resulting in open views from the nearest local road, close to Killukin River.	Not far from local roads but in between hills and could be screened by topography, in most views it will be seen against a backdrop of a hill	Low roadside vegetation resulting in open views from the nearest road – R368, within 1.5km from Corbally Lough	Within 1km from Lisdaly Lough, Canbo Lough and 0.5km from Killukin River and 1.5km from Corbally Lough. Open views from nearest local road	Close to Killukin River and within 1km from Corbally Lough	Close to local road but if carefully placed can be screened in views by topography or vegetation
Cultural Heritage	No known cultural heritage sites in the immediate vicinity.	There is a ringfort (RO011-034) located in the vicinity of this location at the south east.	RO011-101 (Ringfort) located at southern end of this location.	No known cultural heritage sites in the immediate vicinity.	There is a ringfort (RO011-094) located in the vicinity of this location. It is situated on top of a hill and is a prominent and well preserved site.	No known cultural heritage sites in the immediate vicinity.
Ecology	No protected sites	No protected sites	No protected sites	No protected sites	No protected sites	No protected sites

Table 9.3: Analysis of Flagford Converter Station Locations

[2] Geotechnical conditions assessed using available geological mapping

10. CONCLUSIONS

This Report has found that the preferred route for an underground option for the Grid West project will run from an area north-west of the village of Moygownagh, Co. Mayo to an area near the existing substation in Flagford Co. Roscommon. The preferred route will have an overall length of 112.5km and will run primarily in local Class 3 roads, with two short sections of cross country route to (a) cross the river Moy between Ballina and Foxford and (b) to avoid SAC at Lough Gara in Co. Roscommon.

A preliminary assessment of converter station sites has been carried out and least constrained sites identified in north Mayo and in the Flagford area.

10.1 NEXT STEPS

EirGrid will announce details of the preliminary underground cable route at the end of June 2014. Open Days will be held in early July 2014 to get feedback on the proposed cable route and to allow any further refinements or amendments that may be beneficial.

EirGrid will continue work on both underground and overhead options and this analysis will be brought together into a single report later this year. This report will be submitted first to the Independent Expert Panel and, subject to their approval, published for public consultation. This consultation on both technologies will inform EirGrid's decision on the best solution for the Grid West project and that solution will go forward as a planning application to An Bord Pleanála in 2015.

APPENDIX A

DETAILED ROUTE OPTIONS ASSESSMENT SCORES

UG Route Option	1	2	3	4	5	6	7	8	9	10
Length (km)	111.8	99.1	125.4	112.7	122.7	110.6	121.3	109.0	131.8	119.3
Length (km) Detailed	**111.8**	**99.1**	**125.6**	**113.0**	**122.8**	**109.2**	**122.6**	**110.0**	**132.5**	**120.0**
Bridges*	14	15	14	15	10	11	15	16	13	14
Road Crossing **	N/R	N/R	19	13	17	11	N/R	N/R	27	21
Navigable Waterways	0	0	0	0	0	0	0	0	0	0
Railway Crossings	4	4	1	1	1	1	2	2	2	2
Total Crossings	18	19	34	29	28	23	17	18	42	37
SAC (intersecting)(km)	2.0	0.5	6.0	4.6	6.5	5.1	4.6	0.8	4.3	2.9
SPA (intersecting) (km)										
Total SPA + SAC	2.0	0.5	6.0	4.6	6.5	5.1	4.6	0.8	4.3	2.9
GAA/Sports Clubs-within 500m	6	6	3	3	3	3	5	5	3	3
Primary Schools -within 500m	17	17	7	7	6	6	14	14	13	13
Secondary Schools-within 500m	5	4	2	1	2	1	5	4	2	1
Third Level Schools -within 500m	0	0	0	0	0	0	0	0	0	0
Golf Course-within 500m	2	2	0	0	0	0	0	0	0	0
Nursing Homes -within 500m	2	2	1	1	1	1	2	2	1	1
Total Amenity	**32**	**31**	**13**	**12**	**12**	**11**	**26**	**25**	**19**	**18**
Length in Blanket Peat (intersecting)	14.4	4.9	12.4	2.9	9.5	0	8.3	0	9.5	0
Length in Fen Peat (intersecting)										
Length in Cutover Peat (intersecting)	9.4	11.5	29.4	31.4	30.1	32.2	13.7	15.8	18.3	20.6
Total Length in Peat (intersecting)	**23.8**	**16.4**	**41.8**	**34.3**	**39.6**	**32.2**	**22.0**	**15.8**	**27.8**	**20.6**
National Road -DD in km	32.5	10.5	27.1	5.1	27.1	6.3	96.9	75	29	7.1
Regional Road --DD in km	66.4	69.3	3.5	6.5	3.5	7.3	19.4	22.3	9.5	12.5
Total National + Regional Roads	**98.9**	**79.8**	**30.6**	**11.6**	**30.6**	**13.6**	**116.3**	**97.3**	**38.5**	**19.6**
Local Road --DD in km	12.8	19.2	94.9	101.3	92.1	95.6	6.2	12.7	93.9	100.3
Railway										
Other-Detailed Digitalization in km										
Commercial buildings – within 50 m	563	509	335	279	339	283	422	375	301	245
Residential buildings – within 50 m	1540	1368	902	731	895	724	1293	1134	1055	884
Total Buildings	**2103**	**1877**	**1237**	**1010**	**1234**	**1007**	**1715**	**1509**	**1356**	**1129**
National Monuments – within 30 m	1	1	1	1	1	1	0	0	0	0
SMR – within 30 m	16	12	11	7	10	6	26	21	21	17
Religious Sites – within 30 m	0	0	0	0	1	1	0	0	2	2
Preservation Orders – within 30 m	0	0	0	0	0	0	0	0	0	0
Protected Structures – within 30 m	20	20	1	1	1	1	15	15	4	4
Total Cultural Heritage	**37**	**33**	**13**	**9**	**13**	**9**	**41**	**36**	**27**	**23**

Table A.1

UG Route Option	11	12	13	14	15	16	17	18
Length (km)	156.6	144.4	139.8	127.4	135.2	138.1	139.7	138.8
Length (km) Detailed	**157.1**	**144.1**	**139.7**	**127.2**	**137.1**	**138.6**	**139.7**	**141.2**
Bridges*	12	11	14	13	14	14	14	14
Road Crossing **	34		N/R	N/R	26	22	22	22
Navigable Waterways	0	0	0	0	0	0	0	0
Railway Crossings	4	4	10	10	2	2	2	2
Total Crossings	50	15	24	23	42	38	38	38
SAC (intersecting)(km)	3.3	0.5	3.4	1.3	5.7	4.5	3.4	2.3
SPA (intersecting) (km)					0.2	0.2		
Total SPA + SAC	3.3	0.5	3.4	1.3	5.9	4.7	3.4	2.3
GAA/Sports Clubs-within 500m	4	4	6	6	3	3	3	3
Primary Schools -within 500m	14	14	23	23	13	14	13	14
Secondary Schools-within 500m	3	2	7	6	3	3	3	3
Third Level Schools -within 500m	0	0	0	0	0	0	0	0
Golf Course-within 500m	1	1	1	1	2	2	2	2
Nursing Homes -within 500m	1	1	7	7	4	4	4	4
Total Amenity	**23**	**22**	**44**	**43**	**25**	**26**	**25**	**26**
Length in Blanket Peat (intersecting)	9.6	0	9.5	0	12.3	7.3	11.3	6.3
Length in Fen Peat (intersecting)								
Length in Cutover Peat (intersecting)	8.6	10.9	6.7	8.8	17.1	18.1	17.2	18.3
Total Length in Peat (intersecting)	**18.2**	**10.9**	**16.2**	**8.8**	**29.4**	**25.4**	**28.5**	**24.6**
National Road -DD in km	38.2	16.3	119	96.3	14.8	2.8	14.8	2.8
Regional Road --DD in km	5.9	9.3	3	5.9	13.2	15	5.7	7.5
Total National + Regional Roads	**44.1**	**25.6**	**122**	**102**	**28**	**17.8**	**20.5**	**10.3**
Local Road --DD in km	113	118	17.4	24.9	62.5	74.2	72.5	84.2
Railway					46.6	46.6	46.6	46.6
Other-Detailed Digitalization in km					46.6	46.6	46.6	46.6
Commercial buildings – within 50 m	383	332	571	516	192	189	218	217
Residential buildings – within 50 m	1502	1347	1984	1811	706	703	788	799
Total Buildings	**1885**	**1679**	**2555**	**2327**	**898**	**892**	**1006**	**1016**
National Monuments – within 30 m	0	0	1	1	2	2	1	1
SMR – within 30 m	17	12	36	32	25	26	24	26
Religious Sites – within 30 m	0	0	4	4	7	6	8	8
Preservation Orders – within 30 m	0	0	0	0	0	0	0	0
Protected Structures – within 30 m	1	1	8	8	8	7	5	6
Total Cultural Heritage	**18**	**13**	**49**	**45**	**42**	**41**	**38**	**41**

Table A.2

UG Route Option	19	20	21	22	23	24	25	26	27
Length (km)	125.6	139.2	148.3	148.7	140.2	140.8	143.8	144.4	
Length (km) Detailed	**126.9**	**139.4**	**148.1**	**149.0**	**140.4**	**141.8**	**143.7**	**145.2**	**133.3**
Bridges*	10	12	15	14	16	16	17	16	14
Road Crossing **	19	19	26	21	24	22	23	20	N/R
Navigable Waterways	0	0	0	0	0	0	0	0	0
Railway Crossings	1	1	2	2	2	2	2	2	1
Total Crossings	30	32	43	37	42	40	42	38	15
SAC (intersecting)(km)	8.6	4.5	3.9	2.0	5.6	4.4	3.3	2.0	2.1
SPA (intersecting) (km)					0.2	0.2			0
Total SPA + SAC	8.6	4.5	3.9	2.0	5.8	4.6	3.3	2.0	2.1
GAA/Sports Clubs-within 500m	4	3	6	6	3	3	3	3	4
Primary Schools -within 500m	12	14	20	21	14	15	14	15	17
Secondary Schools-within 500m	0	0	3	3	0	0	0	0	4
Third Level Schools -within 500m	0	0	0	0	0	0	0	0	0
Golf Course-within 500m	1	1	1	1	1	1	1	1	1
Nursing Homes -within 500m	1	1	3	3	1	1	1	1	5
Total Amenity	**18**	**19**	**33**	**34**	**19**	**20**	**19**	**20**	**31**
Length in Blanket Peat (intersecting)	16.6	10.6	9.5	4.1	12.3	6.9	11.3	5.9	0
Length in Fen Peat (intersecting)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0
Length in Cutover Peat (intersecting)	6.4	7.8	7.6	8.6	4.9	5.8	5.0	5.9	19.6
Total Length in Peat (intersecting)	**23.2**	**18.6**	**17.3**	**12.9**	**17.4**	**12.9**	**16.5**	**12.0**	**19.6**
National Road -DD in km	5.9	5.2	58.9	46.3	15.6	5.2	14.9	2.8	13
Regional Road --DD in km	40.1	34.4	3.2	5	11.6	12.9	3.7	5.5	8.7
Total National + Regional Roads	**46**	**39.6**	**62.1**	**51.3**	**27.2**	**18.1**	**18.6**	**8.3**	**21.7**
Local Road --DD in km	80.9	99.7	85.6	97.6	113	124	125	137	36.5
Railway									75.1
Other-Detailed Digitalization in km									75.1
Commercial buildings – within 50 m	210	224	439	434	277	273	298	294	274
Residential buildings – within 50 m	990	1036	1791	1785	1269	1265	1340	1338	1094
Total Buildings	**1200**	**1260**	**2230**	**2219**	**1546**	**1538**	**1638**	**1632**	**1368**
National Monuments – within 30 m	0	0	0	0	2	2	0	0	0
SMR – within 30 m	5	7	22	24	25	27	16	18	13
Religious Sites – within 30 m	0	0	2	2	5	5	3	3	0
Preservation Orders – within 30 m	0	0	0	0	0	0	0	0	0
Protected Structures – within 30 m	5	5	6	6	7	7	5	5	8
Total Cultural Heritage	**10**	**12**	**30**	**32**	**39**	**41**	**24**	**26**	**21**

Table A3

UG Route Option	28	29	30	31
Length (km)	120.5	146.1	269.8	241.1
Length (km) Detailed	**121.2**	**147.3**	**271.7**	**243.0**
Bridges*	10	12	8	3
Road Crossing **	submarine	submarine	submarine	submarine
Navigable Waterways	0	0	0	0
Railway Crossings	1	1	1	1
Total Crossings	11	13	9	4
SAC (intersecting)(km)	11.6	15.6	31.0	27.8
SPA (intersecting) (km)	11.5	11.5	15.2	15.2
Total SPA + SAC	23.1	27.1	46.2	43.0
GAA/Sports Clubs-within 500m	1	1	2	2
Primary Schools -within 500m	7	9	7	4
Secondary Schools-within 500m	0	0	1	1
Third Level Schools -within 500m	0	0	0	0
Golf Course-within 500m	0	0	1	1
Nursing Homes -within 500m	2	2	0	0
Total Amenity	**10**	**12**	**11**	**8**
Length in Blanket Peat (intersecting)	0	13.9	42.6	28.7
Length in Fen Peat (intersecting)				
Length in Cutover Peat (intersecting)	6.1	5.9	0.9	0
Total Length in Peat (intersecting)	**6.1**	**19.8**	**43.5**	**28.7**
National Road -DD in km	46.5	59.1	56.9	44.3
Regional Road --DD in km	1.7	1.6	8.7	6.9
Total National + Regional Roads	**48.2**	**60.7**	**65.6**	**51.2**
Local Road --DD in km	20.1	33.6	19.4	5
Railway				
Other-Detailed Digitalization in km	Marine-52.9	Marine-52.9	Marine-186.7	Marine-186.7
Commercial buildings – within 50 m	62	80	78	58
Residential buildings – within 50 m	261	301	241	197
Total Buildings	**323**	**381**	**319**	**255**
National Monuments – within 30 m	0	0	0	0
SMR – within 30 m	30	32	3	1
Religious Sites – within 30 m	1	1	0	0
Preservation Orders – within 30 m	0	0	0	0
Protected Structures – within 30 m	3	3	0	0
Total Cultural Heritage	**34**	**36**	**3**	**1**

Table A.4

UG Route Option	OPTION A	OPTION B
Length (km)		
Length (km) Detailed	**112.5**	**132**
Bridges*	11	13
Road Crossing **	13	23
Navigable Waterways	0	0
Railway Crossings	2	8
Total Crossings	26	44
SAC (intersecting)(km)	0.9	0.6
SPA (intersecting) (km)	0	0
Total SPA + SAC	0.9	0.6
GAA/Sports Clubs-within 500m	2	4
Primary Schools -within 500m	3	13
Secondary Schools-within 500m	0	3
Third Level Schools -within 500m	0	0
Golf Course-within 500m	0	0
Nursing Homes -within 500m	0	5
Total Amenity	**5**	**25**
Length in Blanket Peat (intersecting)	0	0
Length in Fen Peat (intersecting)	0	0
Length in Cutover Peat (intersecting)	31.3	12.2
Total Length in Peat (intersecting)	**31.3**	**12.2**
National Road -DD in km	0.3	45.6
Regional Road --DD in km	10.1	8.4
Total National + Regional Roads	**10.4**	**54**
Local Road --DD in km	100.1	77.4
Railway	0.0	0.0
Other-Detailed Digitalization in km	1.9 km off-road	0.6km off-road
Commercial buildings – within 50 m	177	273
Residential buildings – within 50 m	525	984
Total Buildings	**702**	**1257**
National Monuments – within 30 m	0	0
SMR – within 30 m	10	22
Religious Sites – within 30 m	1	3
Preservation Orders – within 30 m	0	0
Protected Structures – within 30 m	1	0
Total Cultural Heritage	**12**	**25**

Table A.5

APPENDIX B
DRAWINGS