ENVIRONMENTAL BALANCE IN DESIGN AND CONSTRUCTION

ENVIRONMENTAL IMPACT STATEMENT FOR THE PROPOSED MAIGHNE WIND FARM

VOLUME 2 – MAIN EIS

CHAPTER 8 – SOILS AND GEOLOGY

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8 SOILS AND GEOLOGY

8.1 Introduction

This chapter has been prepared to examine the potential impacts of the proposed Maighne Wind Farm, associated cables and turbine delivery route on the soils and geology in the local environment. The effects of the proposed development is considered, taking account of mitigation measures to reduce or eliminate any residual impacts on the soils and geology.

The proposed development consists of the erection of up to 47 no. wind turbines with a tip height of up to 169m, access tracks, a sub-station, a permanent metrological mast, borrow pits and associated works, temporary compounds as well as temporary minor alterations to the public road for the delivery of turbines to the site (turbine delivery route). The turbines are arranged in five wind farm clusters. The clusters are Ballynakill (10 turbines), Windmill (3 turbines), Drehid-Hortland (21 turbines), Derrybrennan (2 turbines) and Cloncumber (11 turbines). All clusters are connected via associated underground medium voltage (MV) cables which run predominately along the public road network linking back to a proposed sub-station on-site at Drehid. Here the power will be converted to AC up to a maximum voltage of 220kV for export to the Irish national grid via high voltage (HV) underground cables to either one of two existing substations located at Woodland, Co. Meath or Maynooth, Co. Kildare.

Whether the connection point to the national electricity transmission grid will be located at the Woodland or Maynooth substations will be determined by EirGrid plc, which is the statutory Transmission System Operator. Accordingly, the documentation submitted with this application for permission identified and evaluates 2 no. HV grid connection routes (which will operate at a voltage up to 220kV). The 2 no. HV grid connection cable routes included in this application will connect the proposed Maighne Wind Farm substation at Drehid to either one of two existing substations located at Woodland, Co. Meath or Maynooth, Co. Kildare. However, only one of these routes will be constructed following the identification of the preferred connection point by the Transmission System Operator.

8.2 Methodology

8.2.1 Study Area

The study area includes the land included within the red-line boundary of the wind farm, the turbine delivery route, grid connection routes and consideration of the immediate surrounding land (normally taken as a 1km buffer). Consideration of the impacts also takes into account the effect of the impact on the wider environment which includes local source quarries and the receiving environment for landslides or contamination. The layout of the proposed wind farm is also shown in Figure 2.1 which is included in Volume 2a of this EIS.

8.2.2 Relevant Guidance

This section presents the methodology used in assessing the baseline soil and geological environment. As well as considering the relevant EPA guidance (1) (2) with respect to the preparation of an EIS, the scope and methodology for the baseline assessment has been devised in consideration of the following guidelines and sources of information:

- Geology in Environmental Impact Statements (3)
- Geology of Kildare-Wicklow (4)
- Geology of Meath (5)
- General Soil Map of Ireland (6)
- Groundwater Protection Scheme for County Kildare (7)
- Groundwater Protection Scheme for County Meath (8)
- Online historic aerial photographs (9)
- DoEHLG Wind Farm Planning Guidelines (10)
- IWEA Best Practice Guidelines (11)
- Online landslide database (12)
- Online heritage database (13)

- Online Aggregate Potential Mapping database (14)
- EPA Envision Map Viewer (15)
- Peat Landslide Hazard and Risk Assessments, Best Practice Guide for Proposed Electricity Generation Developments (16)
- Kildare County Council Development Plan 2011-2017 (17)
- K.T Cullen & Co. Ltd, Source Protection Plan for the proposed well field at Johnstown Bridge, Co. Kildare (18)

8.2.3 Consultation

The scope for this assessment has been informed by consultation with An Bord Pleanála, statutory consultees, bodies with environmental responsibility and other interested parties as summarised in Chapter 4 of the EIS.

The Geological Survey of Ireland (GSI) responded to the Maighne Wind Farm Scoping Report in November 2014 with general advice regarding the geological heritage areas near the site (see section 8.3).

Kildare County Council also responded to the scoping report in November 2014. Kildare County Council requested that a full appraisal be made of all types of soil slippage which may occur due to excavation, changes in water level, loading etc.

8.2.4 Desk Study

Prior to undertaking a site walkover assessment, a desk study was undertaken in order to assist in determining the baseline conditions at the site and to provide background information in advance of the site walkover.

The desk study included an assessment of the sources of information and is presented within the existing environment for each cluster.

8.2.5 Field Assessment

A site walkover was undertaken initially during July 2013 and subsequently in October, November and December 2014 to provide additional information including ground truthing (probes, vanes and gouge cores) at the proposed turbine, access track and substation locations along with trial pits at proposed borrow pit locations. The information obtained is also referenced in this chapter.

8.2.6 Evaluation Criteria

During each phase (construction, operation, maintenance and decommissioning) of the proposed wind farm, a number of activities will take place on site, some of which will have the potential to cause impacts on the geological regime at the site and the associated soils and geology. These impacts are discussed in detail in Section 8.4.

8.3 Existing Environment

8.3.1 Ballynakill Cluster

The Ballynakill cluster comprises ten turbines, two borrow pits, a site compound, access tracks, cable routes and associated infrastructure. The cluster lies in County Kildare and County Meath, immediately north of the M4 motorway and south of the Royal Canal and to the south of Longwood (Co. Meath).

8.3.1.1 Bedrock Geology

The GSI 1:100,000 scale bedrock geology maps [4] [5] show that Carboniferous Limestone of the Lucan (Calp) Formation underlies the cluster. The bedrock geology of the cluster and surrounding area is shown in Figure 8.1.1 which is included in Volume 2a of the EIS.

The Lucan (Calp) Formation comprises dark grey, well bedded, cherty, graded limestone and calcarerous shale. No rock exposures were observed in the Ballynakill cluster.

The nearest fault is approximately 1km to the north of the cluster, passing through Longwood Town. The bedrock in the area dips approximately 25° to the east.

There are no karst features or other known geohazards on the site indicated on the GSI online mapping. The nearest feature of note is St Gorman's Spring, a geothermally heated spring, located at Ballynakill, approximately 2.5 km east of the Ballynakill cluster boundary. This feature is also of geological heritage importance (see Section 8.3.1.3).

8.3.1.2 Overburden Geology

The soils in this part of Co. Kildare and Co. Meath are Grey Brown Podzolics derived from limestone and shale glacial till with associated Gleys and Brown Earths [6].

The underlying quaternary soils identified at the cluster are limestone till, undifferentiated lake sediments and fluvioglacial sands and gravels. The Quaternary deposits are shown in Figure 8.2.1 which is included in Volume 2a of the EIS.

Overburden depths at Ballynakill are estimated as between 3m and 10m based on the desk study information and trial pit investigations.

8.3.1.3 Geological Heritage

The GSI were consulted in October 2014. Geological heritage sites in the area are shown on the GSI Public Data Viewer [13] and are also listed within the Kildare County Council Development Plan [17]. No specific sites of geological heritage or other areas of concern were identified by the GSI within the cluster. The GSI geological heritage database [13] shows the nearest site of significant geological heritage referred to as St Gorman's Spring, located 2.5km east of the proposed development as shown in Figure 8.6.1 which is included in Volume 2a of the EIS. The proposed development will have no perceivable impact on this or any other areas of geological heritage.

8.3.1.4 Economic Geology

The GSI online Aggregate Potential Mapping database [14] shows that the nearest listed quarry is located circa 0.5km west of the Ballynakill cluster at Bunglass. Several other active and disused pits, quarries and mineral exploration localities are also shown on the GSI database as shown in Figure 8.6.1 which is included in Volume 2a of the EIS.

8.3.1.5 Desk Study Summary

A summary of the information obtained for the Ballynakill cluster during the desk study is given in Table 8.1 over.

Table 8.1: Summary of Desktop Study Information – Ballynakill Cluster

<table>
<tr><th>Turbine No</th><th>Visual ground conditions (online)</th><th>Soils Teagasc Online mapping)</th><th>Bedrock (GSI Online database)</th><th>Nearest Geological Heritage Site (GSI Online Database)</th><th>Nearest Mineral Resource (GSI Online Database)</th><th>Nearest Recorded Landslide (GSI Online Database)</th></tr>
<tr><td>1</td><td rowspan="10">Farmland (grazing)</td><td rowspan="3">Undifferentiated Lake Sediments</td><td rowspan="10">Lucan Formation</td><td rowspan="10">St Gorman's Spring located 2.5km east of cluster</td><td rowspan="10">Bunglass Sand & Gravel Quarry located 0.5km west of cluster</td><td rowspan="10">Edenderry - 13km SSW of cluster</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td><td>Limestone Till</td></tr>
<tr><td>5</td><td>Undifferentiated Lake Sediments</td></tr>
<tr><td>6</td><td rowspan="3">Limestone Till</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td></tr>
<tr><td>9</td><td>Fluvio-glacial Sands & Gravels</td></tr>
<tr><td>10</td><td>Limestone Till</td></tr>
</table>

8.3.1.6 Proposed Borrow Pits

Two separate areas have been identified for possible sources of aggregate. The proposed borrow pit locations were identified by their raised surface topography (probable drumlins or eskers) and have been tested by excavating trial pits on the land. The material recovered was predominantly silty sandy gravel and cobbles with a thin overburden of topsoil (up to 0.5m). Further details are given on the trial pit logs in Appendix G2 (TPBP5A, TPBP5B, TPBP7A, TPBP7B). The locations of the trial pits are shown in Figure 8.3.1 which is included in Volume 2a of the EIS.

Excavation of the borrow pits will be undertaken using conventional hydraulic plant (by digging and ripping). Rock breakers may be required locally if large boulders are encountered. Due to the absence of any intact bedrock, blasting will not be required. Groundwater was not encountered within the trial pit excavations and dewatering of the borrow pits is not expected to be required.

It is proposed to use aggregate from the Ballynakill borrow pits to supply the Ballynakill cluster, the Windmill cluster and the Drehid-Hortland cluster.

It is expected that the material observed at the proposed borrow pits will be suitable for use in track construction but may not be suitable for use as structural fill beneath turbines, track surfacing, surfacing of crane hardstandings, compounds and substations (subject to further testing at detailed design stage). Estimates of aggregate requirements and borrow pit volumes are presented in potential impacts, Section 8.4.5.1.1.

8.3.1.7 Existing Slope Stability

A site walkover was undertaken initially on 11 June 2013, and also on 30 and 31 October 2014 (following layout changes) and included hand-held probes undertaken to determine the presence/depth of peat and/or soft soils on the site along with a number of trial pits at the proposed borrow pit locations. The trial pit records are presented in Appendix G2 and site walkover inspection records are presented in Appendix G3 of the EIS.

The Ballynakill Cluster is characterised by flat to very gently undulating firm grassland. No evidence of slope instability was observed on the site and there are no historical records of landslide activity on the site recorded on the GSI website.

The GSI online landslides database shows no landslides for the study area or near the Ballynakill cluster [(19)].

The GSI online database shows that the nearest recorded geohazard occurred at Edenderry, circa 13km south-southwest of the proposed development. A landslide occurred when a section of the Grand Canal cut through a peat bog failed following periods of heavy rain in 1916 and again in 1989. The proposed wind farm development (including cable routes and TDR) will not impact on this landslide location.

Following the site walkover, a review of the potential for a landslide hazard as outlined in Figure 3.1 of the Scottish Executive – Peat Landslide Hazard and Risk Assessments [(16)] was carried out.

The potential for a landslide risk is defined in the Scottish Executive publication as the following:

- "*Peat is present at the development site in excess of 0.5m depth, and;*
- *There is evidence of current or historical landslide activity of the site, or;*
- *Slopes > 2° are present on-site, or;*
- *The works will impinge on the peat covered areas and cannot be relocated to avoid peat covered areas*."

During the site walkover, peat was not encountered at any of the proposed turbine or infrastructure locations. As this did not exceed the criteria outlined above, the risk of slope instability and construction related landslide risk is considered to be negligible, hence a peat stability assessment is not considered necessary for this cluster.

A visual assessment of the geological stability of the remainder of the site was also made during the site walkover. The assessment did not highlight any areas of concern in terms of ground stability, steep slopes, unstable rocks etc. No particular mitigation measures are therefore required to maintain the long-term stability of the site although best practice will be followed as outlined in Section 8.5.1.1.

Table 8.2 shows a summary of the ground conditions encountered during the site walkover at each proposed turbine location.

Table 8.2: Summary of Hand Held Probes Undertaken at Ballynakill Cluster

Turbine	Peat Depth (m)	Slope	Notes
1	-	0°	Grassland – peaty topsoil
2	-	1°N	Grassland – peaty topsoil
3	-	0°	Grassland
4	-	0°	Grassland
5	-	2°E	Grassland – peaty topsoil
6	-	0°	Grassland
7	-	0°	Grassland
8	-	0°	Grassland
9	-	0°	Grassland
10	-	0°	Grassland

8.3.1.8 Soil Contamination

There is no known area of soil contamination on the site. As the site is agricultural land, it is possible that minor fuel spills and leaks may have occurred locally. The site walkover did not highlight any areas of particular concern.

8.3.2 Windmill Cluster

The Windmill Cluster comprises three turbines located on a cutover worked bog along with proposed access tracks and cable trenches. The site is generally level and contains numerous man-made drainage ditches.

The soils at Windmill comprise worked peat overlying glacial till. It is expected that the access tracks will be floating construction. The turbine bases and hardstandings may be piled, however excavation of peat down to approximately 4m (average 3m) will be required during construction. The distribution of the proposed floating access tracks are shown in Figure 8.4.2 which is included in Volume 2a of the EIS.

8.3.2.1 Bedrock Geology

The GSI 1:100,000 scale bedrock geology map (4) shows that Carboniferous limestones and shales underlie this cluster (Lucan "Calp" Formation). The bedrock geology of the cluster and surrounding area is shown in Figure 8.1.2 which is included in Volume 2a of the EIS.

The Calp comprises varied dark grey to black basinal limestone and shale in several different formations. No rock exposures were observed in the cluster area.

The geological map for the area shows no faults cross the cluster. The bedrock in this area dips gently to the east (about 10°).

There are no karst features or other geohazards close to the cluster indicated on the GSI online mapping.

8.3.2.2 Overburden Geology

The main soil associations within this part of Co. Kildare are Basin Peat with Minimal Grey Brown Podzolics derived from the parent limestone glacial till with associated Gleys and Brown Earths (6).

The main underlying Quaternary sediments identified in this area of Co. Kildare are glacial till deposits derived from the underlying limestone with large areas of cut peat [20]. The Quaternary deposits are shown in Figure 8.2.2 which is included in Volume 2a of the EIS.

Overburden depths at Windmill are estimated as between 3m and 10m based on the desk study information.

8.3.2.3 Geological Heritage

The GSI were consulted in October 2014. No sites of geological heritage of other areas of concern were identified by the GSI within the Windmill cluster. The GSI geological heritage database [13] shows several sites of significant geological heritage close to the proposed development with the nearest geological heritage features located near Carbury Castle, some 2km south of the cluster (Calp slump feature) and at Carrick Hill, some 4km west of the cluster (Edenderry Oolite exposed in old quarry). The proposed development will have no perceivable impact on any areas of geological heritage. The heritage areas near Windmill are shown in Figure 8.6.2 which is included in Volume 2a of the EIS.

8.3.2.4 Economic Geology

The GSI online minerals database accessed via the Public Data Viewer [20] shows that the nearest quarry which was active in 2001 is located at Kilglass, approximately 1km north of the Windmill cluster (NGR 268333, 238668). This is believed to be a gravel quarry which supplies various aggregates and concrete products.

The GSI online Aggregate Potential Mapping Database [14] also lists several disused quarries or mineral localities near Edenderry, none of which are shown within the Windmill cluster boundary. These locations are not expected to impact on the proposed development or vice versa. These localities are also shown on the GSI database as shown in Figure 8.6.2 which is included in Volume 2a of the EIS.

8.3.2.5 Desk Study Summary

A summary of the information obtained during the desk study is given in Table 8.3.

Table 8.3: Desk Study Information Summary – Windmill Cluster

Turbine No	Visual ground conditions (online)	Soils Teagasc Online mapping)	Bedrock (GSI Online database)	Nearest Geological Heritage Site (GSI Online Database)	Nearest Mineral Resource (GSI Online Database)	Nearest Recorded Landslide (GSI Online Database)
24	Milled peat bog	Cut peat	Lucan Formation	Carbury Castle, 2km south of Windmill	Kilglass Quarry, 1km north of Windmill	Edenderry, 7km southwest
25						
26						
Access tracks						

8.3.2.6 Proposed Borrow Pit

Due to the depth of peat at the cluster, no areas have been identified for use as borrow pits within the Windmill cluster. It is proposed that aggregate from the Ballynakill Cluster will be used for this cluster for track construction. Some imported aggregate will also be required from local quarries for use as structural fill and track surfacing. Estimates of aggregate requirements are presented in potential impacts, Section 8.4.5.1.1.

8.3.2.7 Existing Slope Stability

A site walkover was carried initially out on 11 June 2013 and again on 18 November 2014 (following layout changes) and included a series of hand-held probes and gouge cores undertaken to determine the presence/depth of peat and/or soft soils on the site. The site walkover inspection records are presented in Appendix G3 of the EIS.

The land use across the cluster generally consists of level, worked (milled) bog. The slopes of the cluster are characterised by level ground or gentle slopes up to 1° to the south. No evidence of slope instability was observed at the cluster and there are no historical records of landslide activity at the cluster recorded on the GSI website.

An initial step in the assessment of pre-existing landslide risk is the determination of landslide history in the area. The GSI website was consulted in September 2013. No landslides have been identified on the GSI's database or on aerial photographs for or in the vicinity of the cluster, however several landslides are shown on the GSI database nearby.

The GSI online landslides database shows that the nearest recorded geohazard is near Edenderry, some 7km southwest of Windmill where a breach occurred in the Grand Canal in 1916 and 1989. The proposed wind farm development (including cable routes and TDR) will not impact on this landslide location.

Following the site walkover, a review of the potential for a landslide hazard as outlined in Figure 3.1 of the Scottish Executive – Peat Landslide Hazard and Risk Assessments (15) was carried out.

The potential for a landslide risk is defined in the Scottish Executive publication as the following:

- "*Peat is present at the development site in excess of 0.5m depth, and;*
- *There is evidence of current or historical landslide activity of the site, or;*
- *Slopes > 2° are present on-site, or;*
- *The works will impinge on the peat covered areas and cannot be relocated to avoid peat covered areas.*"

During the site walkover, hand-held probes and gouge cores were undertaken at turbine locations in order to determine the presence of any peat/soft ground on the site. A maximum probe depth of 4m was recorded within the worked bog. A summary of the peat probes is presented in Table 8.4.

Table 8.4: Results of Hand Held Probes Undertaken during Windmill Site Walkover

Turbine / ID	Probe Depth (m)	Slope	Notes
T24	4.0	1° W	Milled peat bog
T25	1.8	<1°S	Milled peat bog
T26	2.3	<1°S	Milled peat bog
Access Tracks	4.0	<1°S	Milled peat bog

The site walkover did not find any evidence of active peat development at the cluster, however areas of cutover peat were observed up to a maximum of 4m in depth with gentle slopes of up to 1°.

Based on the desk study combined with information gathered during the site walkover, it is considered that conditions conducive to peat instability may be present on the site. A peat stability assessment was therefore undertaken for the cluster and is included in Appendix G1A.

The peat stability assessment concluded that the risks associated with peat instability are considered to be low and the construction-related peat landslide risk before, during and after construction is considered to negligible. A visual assessment of the geological stability of the remainder of the cluster was also made during the site walkover. The assessment did not highlight any areas of concern in terms of ground stability, steep slopes, unstable rocks etc. No particular mitigation measures are therefore required to maintain the long-term stability at the cluster although best practice will be followed as outlined in Section 8.5.1.1.

8.3.2.8 Soil Contamination

There are no known areas of soil contamination at the cluster. As the site is regularly used by agricultural type equipment associated with commercial peat milling, it is possible that minor fuel spills and leaks have occurred locally in the past. The site walkover did not however highlight any areas of concern.

8.3.3 Drehid-Hortland Cluster

The Drehid-Hortland Cluster comprises a total of 21 wind turbines, two temporary construction compounds, access tracks, substation, cable routes and associated infrastructure covering the area of Drehid and Hortland in Co. Kildare. The cluster lies to the south of Enfield, Co. Meath.

8.3.3.1 Bedrock Geology

The GSI 1:100,000 scale bedrock geology map [(4)] shows that Lucan Formation (Calp) underlies majority of the Drehid-Hortland cluster. A small part of the cluster, southwest of turbine T23 is underlain by Waulsortian limestone. The bedrock geology of the Drehid-Hortland cluster and surrounding area is shown in Figure 8.1.3 which is included in Volume 2a of the EIS.

The Lucan Formation comprises varied dark grey to black basinal limestone and shale.

The Waulsortian Formation is pale grey limestone which is commonly dolomitised and karstified.

The geological map for the area shows no faults cross the cluster however a fault running E-W is located to the south of Hortland and may cross part of the southern access track. The bedrock in this area dips to the east (at about 25°).

There are no karst features or other geohazards close to the cluster indicated on the GSI online mapping.

8.3.3.2 Overburden Geology

The main soil associations within this part of Co. Kildare are Gleys, Basin Peat and Podzolics [(6)].

The main underlying Quaternary sediments identified in this area of Co. Kildare are glacial till deposits derived from the underlying limestone with large areas of basin peat [(20)]. The Quaternary deposits are shown in Figure 8.2.3 which is included in Volume 2a of the EIS.

Overburden depths at Drehid-Hortland are estimated as between 3m and greater than 10m based on the desk study information.

8.3.3.3 Geological Heritage

The GSI were consulted in October 2014. No sites of geological heritage of other areas of concern were identified by the GSI. The GSI geological heritage database [(13)] shows no sites of significant geological heritage within the proposed cluster.

The GSI website shows that the nearest geological heritage feature is St. Peters Well which is located 1km south of the Drehid-Hortland cluster boundary (2km south of T40). This is a warm spring located at ING 281905 233080 and is shown in Figure 8.6.3 which is included in Volume 2a of the EIS.

8.3.3.4 Economic Geology

The GSI online minerals database accessed via the Public Data Viewer [20] shows that the nearest listed quarry is located at Ballynamullagh, located approximately 0.5km west of the Drehid-Hortland cluster boundary, however this quarry is currently closed and being restored.

The GSI online Aggregate Potential Mapping Database [14] also lists several other disused quarries or mineral localities, however none of which are shown within the site boundary. These locations are not expected to impact on the proposed development or vice versa. The localities are also shown on the GSI database as shown in Figure 8.6.3 which is included in Volume 2a of the EIS.

8.3.3.5 Desk Study Summary

A summary of the information obtained during the desk study is given in Table 8.5.

Table 8.5: Desk Study Information Summary – Drehid-Hortland Cluster

<table>
<tr><th>Turbine No</th><th>Visual ground conditions (online)</th><th>Soils Teagasc Online mapping)</th><th>Bedrock (GSI Online database)</th><th>Nearest Geological Heritage Site (GSI Online Database)</th><th>Nearest Mineral Resource (GSI Online Database)</th><th>Nearest Recorded Landslide (GSI Online Database)</th></tr>
<tr><td>T11</td><td>Mature Forestry</td><td>Cut Peat</td><td rowspan="13">Lucan Formation Limestone</td><td rowspan="13">St Peters Well, 1km south of Hortland Boundary</td><td rowspan="13">Ballynamullagh Quarry 0.5km west of Drehid boundary (disused)</td><td rowspan="13">Derrymullen, 7.5km south of Drehid boundary</td></tr>
<tr><td>T12</td><td rowspan="2">Peat Bog</td><td rowspan="5">Cut Peat</td></tr>
<tr><td>T13</td></tr>
<tr><td>T14</td><td>Harvested Forestry</td></tr>
<tr><td>T15</td><td>Scrubland</td></tr>
<tr><td>T16</td><td rowspan="2">Young Forestry</td></tr>
<tr><td>T17</td><td>Limestone Till</td></tr>
<tr><td>T18</td><td rowspan="6">Grassland</td><td>Cut Peat</td></tr>
<tr><td>T19</td><td>Limestone Till</td></tr>
<tr><td>T20</td><td>Cut Peat</td></tr>
<tr><td>T21</td><td>Limestone Till</td></tr>
<tr><td>T22</td><td>Cut Peat</td></tr>
<tr><td>T23</td><td>Limestone Till</td></tr>
</table>

Turbine No	Visual ground conditions (online)	Soils Teagasc Online mapping)	Bedrock (GSI Online database)	Nearest Geological Heritage Site (GSI Online Database)	Nearest Mineral Resource (GSI Online Database)	Nearest Recorded Landslide (GSI Online Database)
T40	Forestry	Cut peat				
T41	Grassland					
T42	Forestry					
T43						
T44						
T45						
T46	Grassland					
T47		Limestone Till				

8.3.3.6 Proposed Borrow Pit

Due to the thickness of peat and the lack of suitable sub-soil, no areas have been identified for use as borrow pits within the Drehid-Hortland Cluster. Several trial pits were excavated within the Drehid cluster, however these proved unsuitable for use. It is proposed that aggregate will be sourced from borrow pits located within the Ballynakill cluster. The majority of subsoil excavated will be transported to Ballynakill and will be re-used to reinstate the borrow pits. Estimates of aggregate requirements and borrow pit volumes are presented in potential impacts, Section 8.4.5.1.1.

The location of the Drehid trial pits are shown in Figure 8.3.3 which is included in Volume 2a of the EIS. The location of floating access tracks are shown in Figure 8.4.3 which is included in Volume 2a of the EIS. The trial pit logs are presented in Appendix G2.

8.3.3.7 Existing Slope Stability

A site walkover was carried out on 6 and 7 June 2013 and again on 4 and 5 November 2014, and 25 November 2014 (following layout changes) and included a series of hand-held probes and gouge cores undertaken to determine the presence/depth of peat and/or soft soils at the cluster. Additionally, a number of trial pits were excavated at the proposed substation location in Drehid and at the location of possible borrow pits (deemed not suitable for use). The trial pit records are presented in Appendix G2 and site walkover inspection records are presented in Appendix G3 of the EIS.

The land use across the cluster generally consists of semi mature and mature forestry, natural and worked bog and soft to firm grassland.

The slopes of the cluster are characterised by gentle slopes of between 1° and 3°. No evidence of slope instability was observed at the cluster and there are no historical records of landslide activity at the cluster on the GSI website.

No landslides have been identified on the GSI's landslides database (12) or on aerial photographs (9) for the study area or for the vicinity of the cluster, however several landslides are shown on the GSI database nearby.

The database shows that the nearest recorded geohazard is a landslide at Derrymullen, approximately 7.5km south of the Drehid cluster boundary. This was a landslide which occurred in peat bog adjacent to the Grand Canal in 1839. The proposed wind farm development (including cable routes and TDR) will not impact on this landslide location.

Following the site walkover, a review of the potential for a landslide hazard as outlined in Figure 3.1 of the Scottish Executive – Peat Landslide Hazard and Risk Assessments (16) was carried out.

The potential for a landslide risk is defined in the Scottish Executive publication as the following:

- *"Peat is present at the development site in excess of 0.5m depth, and;*
- *There is evidence of current or historical landslide activity of the site, or;*
- *Slopes > 2° are present on-site, or;*
- *The works will impinge on the peat covered areas and cannot be relocated to avoid peat covered areas"*.

During the site walkover, hand-held probes and gouge cores were undertaken at turbine locations in order to determine the presence of any peat/soft ground on the site. A maximum probe depth of 4m was recorded. A summary of the peat probes is presented in Table 8.6.

Table 8.6: Results of Hand Held Probes Undertaken during Drehid-Hortland Cluster Site Walkover

Turbine/ ID	Peat Depth (m)	Slope	Vegetation/Comments
T11	0.3	1°SW	Mature forestry
T12	3.4	0°	Semi-mature forestry. Boggy
T13	3.0	1°N	Semi-mature forestry. Boggy
T14	0.8	2°W	Young forestry
T15	0.5	1°N	Semi-mature forestry. Boggy
T16	-	2°S	Semi-mature forestry
T17	-	3°S	Semi-mature forestry
T18	-	2°E	Firm grassland
T19	-	1°N	Firm grassland
T20	-	2°SW	Firm grassland
T21	-	2°SW	Firm grassland
T22	-	3°S	Firm grassland
T23	-	1°S	Firm grassland
T40	0.8	2°N	Mature forestry

Turbine/ ID	Peat Depth (m)	Slope	Vegetation/Comments
T41	-	3°NW	Soft grassland
T42	0.8	3°SE	Semi-mature forestry
T43	0.9	2°SE	Harvested forestry
T44	2.5	3°E	Mature forestry
T45	-	2°S	Soft grassland
T46	-	1°S	Firm grassland
T47	-	3°E	Firm grassland
Drehid substation	3.0	0°	Forestry
Drehid Tracks	4.0 (max)	1°	Forestry
Hortland Tracks	2.7 (max)	3°	Forestry

The site walkover did find evidence of active peat development at the cluster, however areas of cutover peat were observed up to 4m in depth with gentle slopes of up to 3°. Based on the desk study combined with information gathered during the site walkover, it is considered that conditions conducive to peat instability may be present at the cluster. A peat stability assessment was therefore undertaken for the cluster and is included in Appendix G1B. The peat stability assessment concludes that the risks associated with peat instability are considered to be low. Calculations given in the peat stability report show that the construction-related peat landslide risk is also low.

A visual assessment of the geological stability of the remainder of the cluster was also made during the site walkover. The assessment did not highlight any areas of concern in terms of ground stability, steep slopes, unstable rocks etc. No particular mitigation measures are therefore required to maintain the long-term stability of the cluster although best practice will be followed as outlined in Section 8.5.1.1.

8.3.3.8 Soil Contamination

There is no known area of soil contamination at the cluster. As the site is regularly used by agricultural equipment, it is possible that minor fuel spills and leaks have occurred locally in the past. The site walkover did not highlight any areas of particular concern.

8.3.4 Derrybrennan Cluster

The Derrybrennan cluster comprises two turbines and associated access tracks located within arable land in Co. Kildare.

8.3.4.1 Bedrock Geology

The GSI 1:100,000 scale bedrock geology map (4) shows that Carboniferous Limestones of the Allenwood Formation and Boston Hill Formation underlie the cluster. The bedrock geology of the cluster and surrounding area is shown in Figure 8.1.4 which is included in Volume 2a of the EIS.

The Allenwood Formation comprises mainly pale grey, clean massive shelf limestones which are commonly dolomitised. The Boston Hill Formation comprises mainly nodular and irregularly bedded argillaceous limestones, commonly dolomitised and subordinate calcareous shale and distinctive laminated limestone.

There is a fault running north-south along the western part of the cluster and another running east-west past the northern part of the cluster as shown in Figure 8.9, which is included in Volume 2a of the EIS, however these are not expected to impact on the cluster infrastructure.

There are no karst features or other known geohazards close to the cluster indicated on the GSI online mapping.

8.3.4.2 Overburden Geology

The main soil association within this part of Co. Kildare is cutover basin peat [(6)].

The main underlying Quaternary sediments identified at the cluster are cutover peat and limestone derived glacial till [(16)]. The underlying Quaternary soils map for the area is shown in Figure 8.2.4 of Volume 2a of the EIS.

Overburden depths at Derrybrennan are estimated as between 3m and 10m based on the desk study information.

8.3.4.3 Geological Heritage

The GSI were consulted in October 2014. No specific sites of geological heritage of other areas of concern were identified by the GSI. The GSI geological heritage database [(13)] shows a site of significant geological heritage referred to as Carbury Castle, a disused limestone quarry exposure, lies 7km north of the proposed cluster. A second site, the Hill of Allen, is located 8km south of the proposed cluster. The Hill of Allen is a large working quarry with a large exposed part of the Allen Andesite Formation which comprises massive andesitic lava which is porphyritic in places within the quarry exposure.

The proposed wind farm will not impact these geological heritage sites unless the Hill of Allen quarry is used as a source for some of the aggregate for the wind farm.

8.3.4.4 Economic Geology

The GSI online minerals database accessed via the Public Data Viewer [(20)] shows that the nearest operational quarry is located approximately 6km south of Derrybrennan at Glenaree, Rathangan and comprises sand and gravel. A second quarry is located at Lowtown, approximately 6.5km southeast of the Derrybrennan Cluster and the Hill of Allen quarry is 8km south.

The GSI database also shows that there are no disused pits or quarries located within the cluster boundary. The localities nearby are shown on the GSI database as shown in Figure 8.6.4 which is included in Volume 2a of the EIS.

8.3.4.5 Desk Study Summary

A summary of the information obtained during the desk study is given in Table 8.7.

Table 8.7: Desk Study Information Summary – Derrybrennan Cluster

<table>
<tr><th>Turbine No</th><th>Visual ground conditions (online)</th><th>Soils Teagasc Online mapping)</th><th>Bedrock (GSI Online database)</th><th>Nearest Geological Heritage Site (GSI Online Database)</th><th>Nearest Mineral Resource (GSI Online Database)</th><th>Nearest Recorded Landslide (GSI Online Database)</th></tr>
<tr><td>27</td><td rowspan="2">Farmland</td><td rowspan="2">Cutover peat</td><td rowspan="2">Allenwood Formation Limestone</td><td rowspan="2">Carbury Castle 7km north

Hill of Allen 8km south</td><td rowspan="2">Glenaree Quarry, 6km south</td><td rowspan="2">Derrymullen, 6km east</td></tr>
<tr><td>28</td></tr>
</table>

8.3.4.6 Proposed Borrow Pit

There are no proposed borrow pits at the Derrybrenann cluster. It is proposed to import as much of the required aggregate from the nearby Cloncumber borrow pits, however additional aggregate will also be imported from other local quarries for turbine bases, cable trenches, and track/hardstanding surfacing. Estimates of aggregate requirements are presented in potential impacts, Section 8.4.5.1.1.

8.3.4.7 Existing Slope Stability

A site walkover was undertaken on 6 and 7 June 2013 and 20 August 2013 and included hand-held probes undertaken to determine the presence/depth of peat and/or soft soils at the cluster. The site walkover inspection records are presented in Appendix G3 of the EIS.

The land use on site comprises flat grassland and tillage fields and one turbine location in a small wooded area on peat.

The cluster is characterised by flat terrain. No evidence of slope instability was observed at the cluster and there are no historical records of landslide activity at the cluster recorded on the GSI website.

The GSI online landslides database shows no landslides for the study area or anywhere near the cluster (12). The online aerial photographs for the cluster (9) show no active or historic landslides on the site or in the vicinity of the cluster.

The GSI online database shows that the nearest recorded geohazard occurred at Derrymullen, circa 6km east of the Derrybrennan cluster. This landslide occurred in 1839 but no further details are available regarding this event. The proposed wind farm development (including cable routes and TDR) will not impact on this landslide location.

Following the site walkover, a review of the potential for a landslide hazard as outlined in Figure 3.1 of the Scottish Executive – Peat Landslide Hazard and Risk Assessments(16) was carried out.

The potential for a landslide risk is defined in the Scottish Executive publication as the following:

- "*Peat is present at the development site in excess of 0.5m depth, and;*
- *There is evidence of current or historical landslide activity of the site, or;*
- *Slopes > 2° are present on-site, or;*
- *The works will impinge on the peat covered areas and cannot be relocated to avoid peat covered areas*".

During the site walkover, shallow peat was encountered at one of the proposed turbine locations and along the access tracks to a maximum depth of 0.5m. As the peat depth does not exceed the criteria outlined above, the risk of slope instability and construction-related peat landslide risk is considered to be negligible and no specific peat stability assessment is considered necessary.

Table 8.8 shows a summary of the ground conditions encountered during the site walkover of the Derrybrennan cluster.

Table 8.8: Results of Hand Held Probes Undertaken During Site Walkover – Derrybrennan Cluster

Turbine/ ID	Peat Depth (m)	Slope	Vegetation/Comments
27	0.5	2°W	Edge of woodland/arable
28	-	1°W	Grasslands
Access tracks	0.5	2°W	Woodland/arable

8.3.4.8 Soil Contamination

There is no known area of soil contamination on the site. As the cluster is used by agricultural/forestry equipment, it is possible that minor fuel spills and leaks have occurred locally in the past. In addition, the site walkover observed that fly-tipping was common in the area.

8.3.5 Cloncumber Cluster

The Cloncumber cluster comprises 11 wind turbines, access tracks, temporary construction compound, borrow pits, and associated infrastructure. The cluster is located southwest of Allenwood and northeast of Carbury, Co. Kildare.

8.3.5.1 Bedrock Geology

The GSI 1:100,000 scale bedrock geology map (4) shows that Boston Hill Formation underlie the majority of the cluster. The extreme south-western end of the cluster is underlain by the Allenwood Formation. The bedrock geology of the cluster and surrounding area is shown in Figure 8.1.5 which is included in Volume 2a of the EIS.

The Boston Hill Formation comprises mainly nodular and irregularly bedded argillaceous limestones, commonly dolomitised and subordinate calcareous shale and distinctive laminated limestone. The Allenwood Formation comprises mainly pale grey, clean massive shelf limestones which are commonly dolomitised.

The geological map for the area shows three faults cross the cluster running northwest-southeast with one of the faults passing close to a turbine location as shown in Figure 8.1.5 which is included in Volume 2a of the EIS.

There are no karst features or other geohazards close to the cluster indicated on the GSI online mapping.

8.3.5.2 Overburden Geology

The main soil associations within this part of Co. Kildare are Gleys and Basin Peat (6).

The main underlying Quaternary sediments identified in this area of Co. Kildare are cutover peat, alluvium and limestone till deposits derived from the underlying limestone with some alluvium areas present (20). The Quaternary deposits are shown in Figure 8.2.5 which is included in Volume 2a of the EIS.

Overburden depths at Cloncumber are estimated as between 3m and 10m based on the desk study and trial pit information.

8.3.5.3 Geological Heritage

The GSI were consulted in October 2014. No specific sites of geological heritage of other areas of concern were identified by the GSI. The GSI geological heritage database (13) shows no sites of significant geological heritage within the proposed cluster.

The closest geological heritage site is located at the Hill of Allen which is part of the Allen Andesite formation a massive andesitic lava flow, This is located 2.7 km southeast of the cluster (ING 275700 220600) as shown in Figure 8.6.5 which is included in Volume 2a of the EIS.

Another geological heritage site is the Chair of Kildare, an inlier of Ordovician rocks surrounded by much younger rocks which is located 7km south of the cluster (ING 272590 217750).

8.3.5.4 Economic Geology

The GSI online minerals database accessed via the Public Data Viewer (20) shows that the nearest quarry is located at Glenaree Quarry, approximately 0.5km south of the cluster.

The GSI online Aggregate Potential Mapping Database (14) also lists several disused quarries or mineral localities, none of which are shown within the cluster boundary. The localities nearby are shown on the GSI database as shown in Figure 8.6.5 which is included in Volume 2a of the EIS.

8.3.5.5 Desk Study Summary

A summary of the information obtained during the desk study is given in Table 8.9.

Table 8.9: Desk Study Information Summary - Cloncumber

Turbine No	Visual ground conditions (online)	Soils Teagasc Online mapping)	Bedrock (GSI Online database)	Nearest Geological Heritage Site (GSI Online Database)	Nearest Mineral Resource (GSI Online Database)	Nearest Recorded Landslide (GSI Online Database)
29		Alluvium				
30	Forestry					
31						
32		Cut peat				
33						
34			Boston Hill Formation Limestone	Hill of Allen, 2.7km southeast	Glenaree Quarry, 0.5km south	Derrymullen, 2.3km northeast
35						
36	Farmland					
37		Alluvium				
38						
39						

8.3.5.6 Proposed Borrow Pits

Two areas have been identified in Cloncumber as possible borrow pits to source the aggregate required for the Cloncumber, Hortland and Derrybrennan clusters. The proposed borrow pit locations were identified by their raised surface topography (probable drumlins) and have been tested by excavating trial pits on the land. Several trial pits were excavated at the locations shown in Figure 8.3.5 which is included in Volume 2a of the EIS. The material recovered was predominantly silty sandy gravel and cobbles with a thin overburden of topsoil (up to 0.3m). Further details are given on the trial pit logs in Appendix G2 (TPBP1A, TPBP1B, TPBP2A, TPBP2B). The proposed floating road layout is shown in Figure 8.4.5 which is included in Volume 2a of the EIS. Estimates of aggregate requirements and borrow pit volumes are presented in potential impacts, Section 8.4.5.1.1.

It is expected that the material observed at the proposed borrow pits will be suitable for re-use in track construction but may be unsuitable for use as structural fill beneath turbines (subject to further testing at detailed design stage). Groundwater was encountered at depth within some of the trial pits located within the lower part of the site, hence some local dewatering may be required. In general, the excavations will remain above the water table.

8.3.5.7 Existing Slope Stability

The site walkover undertaken as part of the EIA was carried out initially on 6 June 2013 and also on 30 October and 4 November 2014 (after layout changes), included a series of hand-held probes and gouge cores undertaken to determine the presence/depth of peat and/or soft soils at the cluster. Additionally, a number of trial pits were excavated at the proposed borrow pit locations. The trial pit records are presented in Appendix G2 and site walkover inspection records are presented in Appendix G3 of the EIS.

The land use across this cluster comprises a mixture of forestry (to the north) and farmland (to the south).

The slopes of the site are characterised by flat conditions with slopes of between 0° and 1° recorded. No evidence of slope instability was observed on the cluster and there are no historical records of landslide activity on the cluster recorded on the GSI website.

An initial step in the assessment of pre-existing landslide risk is the determination of landslide history in the area. The GSI landslides viewer was consulted in September 2013 (12). No landslides have been identified on the GSI's database or on aerial photographs (9) for the study area or for the vicinity of this cluster, however several landslides are shown on the GSI database nearby.

The GSI online database shows that the nearest recorded geohazard is at Derrymullen, some 2.3km northeast of Cloncumber where a landslide occurred in cutover peat near the Grand Canal in 1893. The proposed wind farm development (including cable routes and TDR) will not impact on this landslide location.

Following the site walkover, a review of the potential for a landslide hazard as outlined in Figure 3.1 of the Scottish Executive – Peat Landslide Hazard and Risk Assessments (16) was carried out.

The potential for a landslide risk is defined in the Scottish Executive publication as the following:

- "*Peat is present at the development site in excess of 0.5m depth, and;*
- *There is evidence of current or historical landslide activity of the site, or;*
- *Slopes > 2° are present on-site, or;*
- *The works will impinge on the peat covered areas and cannot be relocated to avoid peat covered areas*".

During the site walkover, hand-held probes and gouge cores were undertaken at turbine locations in order to determine the presence of any peat/soft ground at the cluster. A summary of the peat probes is presented in Table 8.10 over.

Table 8.10: Results of Hand Held Probes Undertaken during Site Walkover Cloncumber

Turbine/ID	Peat Depth (m)	Slope	Vegetation/Comments
29	1.75	0°	Mature forestry
30	0.3	0°	Harvested forestry & scrub
31	3.7	1°N	Semi-mature forestry
32	2.7	1°S	Mature forestry
33	-	1°S	Tillage
34	-	0°	Firm grassland
35	-	1°S	Firm grassland
36	-	0°	Firm grassland
37	-	1°S	Firm grassland
38	-	0°	Firm grassland
39	-	1°S	Firm grassland
Access tracks	3.0	1°	Forestry/grassland

The site walkover did find evidence of active peat development within the cluster, however areas of forested peat were observed up to 3.7m in depth with gentle slopes of up to 1°. Based on the desk study combined with information gathered during the site walkover, it is considered that conditions conducive to peat instability may be present at the cluster.

A peat stability assessment was therefore undertaken for this cluster and is included in Appendix G1C. The peat stability assessment concludes that the risks associated with peat instability are assessed as very low to low. The construction-related peat landslide risk has also been assessed by modelling the results with the addition of a surcharge to model the effects of construction traffic and floating access tracks. The construction risks are also calculated as low.

A visual assessment of the geological stability of the remainder of the cluster was also made during the site walkover. The assessment did not highlight any areas of concern in terms of ground stability, steep slopes, unstable rocks etc. No particular mitigation measures are therefore required to maintain the long-term stability of the cluster although best practice will be followed as outlined in Section 8.5.1.1.

8.3.5.8 Soil Contamination

There is no known area of soil contamination at the cluster. As it is regularly used by agricultural equipment, it is possible that minor fuel spills and leaks have occurred locally in the past. The site walkover did not highlight any areas of particular concern.

8.3.6 Cable Routes and Turbine Delivery Routes

The proposed internal cable routes within each wind farm cluster are shown on Figure 2.1 in Section 2 of the EIA. The Medium Voltage (MV) cable routes and High Voltage (HV) Irish Grid Connection Routes are shown in Figure 2.7 which is included in Volume 2a of the EIS. The proposed Turbine Delivery Routes (TDR) are shown in Figure 2.10 which is included in Volume 2a of the EIS.

The internal cable routes within each wind farm cluster will be buried underground adjacent to the internal access tracks. The connecting MV and HV cable routes will generally run within the existing roads or adjacent verges (where present). Construction of the cable routes will involve trench excavation to a depth of about 1m and backfilling within an imported sand bedding around the cable. Trenchless techniques will be used for major road and river crossings.

The precise connection point to the national electricity transmission grid will be determined by EirGrid plc, which is the statutory transmission system operator. For the purposes of this planning application, 2 no. HV grid connection routes (which will operate at a voltage up to 220kV) have been identified and evaluated as shown in Figure 2.7 which is included in Volume 2a of the EIS.

The 2 no. HV grid connection cable routes included in this application propose to connect the proposed Maighne Wind Farm substation at Drehid to either one of two existing substations located at Woodland, Co. Meath or Maynooth, Co. Kildare. However, only one of these routes will be constructed following the identification of the preferred connection point by EirGrid. The impacts associated with the grid connection and cables will be similar to those associated with road excavations but will be generally of reduced magnitude.

The TDR's will utilise existing public roads as shown in Figure 2.10 which is included in Volume 2a of the EIS. Minor modifications to the roads will be necessary at bends and roundabouts which will involve removal of topsoil and backfilling with imported granular fill.

8.3.6.1 Bedrock Geology

The GSI 1:100,000 scale bedrock geology map [(4)] shows that the northern clusters including Ballynakill, Windmill, Drehid-Hortland and the majority of the grid connections northeast to Woodland are underlain by the Lucan ("Calp") Formation. The southern clusters of Derrybrennan and Cloncumber and grid connections towards Maynooth are predominantly underlain by Carboniferous limestones of the Waulsortian, Boston Hill and Allenwood Formations. The HV cables routes east to Woodland and Maynooth also pass through relatively small areas of Carboniferous Namurian, Tober Colleen and Ballysteen Formations. The bedrock geology of the site and surrounding area is shown in Figure 8.16 which is included in Volume 2a of the EIS.

The Lucan Formation comprises varied dark grey to black basinal limestone and shale. The remaining formations comprise mainly limestones (occasionally karstified or dolomitised) with occasional sandstones, siltstones and shales.

Several faults are shown crossing the sites, particularly near Cloncumber as shown in Figure 8.1 which is included in Volume 2a of the EIS. No impact is expected on the development by the faults or vice versa.

8.3.6.2 Overburden Geology

The main soil associations within this part of Ireland are Gleys and Basin Peat [(6)].

The main underlying Quaternary sediments identified within the study areas are cutover peat (within Windmill, Derrybrennan, Drehid-Hortland and Cloncumber) and limestone till deposits derived from the underlying limestone/sandstone with some minor alluvium areas present [(20)]. The Quaternary deposits are shown in Figure 8.2 which is included in Volume 2a of the EIS.

Overburden depths along the cable routes and TDRs are typically between 3m and 10m, but occasionally less than 3m, based on the desk study information.

8.3.6.3 Geological Heritage

The GSI were consulted in October 2014. No specific sites of geological heritage of other areas of concern were identified by the GSI. The GSI geological heritage database [(13)] shows no sites of significant geological heritage will be affected by the proposed development. The heritage areas are shown in Figure 8.6 which is included in Volume 2a of the EIS.

The closest geological heritage sites are the Hill of Allen which is part of the Allen Andesite formation a massive andesitic lava flow, This is located 2.7 km southeast of the Cloncumber cluster (ING 275700 220600) and the Kilbrook Spring, a warm spring within a disused gravel pit (ING 281460 242200), located about 3km east of Enfield and approximately 0.5km north of the potential HV Grid Connection route to Woodland.

8.3.6.4 Economic Geology

The GSI online minerals database accessed via the Public Data Viewer [(20)] shows that the nearest quarry is located at Glenaree Quarry, approximately 0.5km south of the Cloncumber cluster.

The GSI online Aggregate Potential Mapping Database [14] also lists several disused quarries or mineral localities, none of which will be impacted by the proposed development. The localities nearby are shown on the GSI database as shown in Figure 8.6 which is included in Volume 2a of the EIS.

8.3.6.5 Existing Slope Stability

The land use across this cluster comprises a mixture of forestry, farmland and commercial peat harvesting.

The slopes of the site are characterised by mostly flat conditions with slopes of between 0° and 3° being typical. No evidence of slope instability was observed on the site and there are no historical records of landslide activity on the site recorded on the GSI website.

No landslides have been identified on the GSI's database or on aerial photographs [9] for the study area or for the vicinity of this cluster, however several landslides are shown on the GSI database nearby.

The GSI online database shows that the nearest recorded geohazard is at Derrymullen, some 2.3km northeast of Cloncumber where a landslide occurred in cutover peat near the Grand Canal in 1893. The proposed wind farm development (including cable routes and TDR) will not impact on this landslide location.

The risk associated with peat or slope instability for the cable routes and TDRs is assessed to be low in line with the assessed risks within the windfarm clusters.

A visual assessment of the geological stability of the site was also made during the site walkovers. The assessment did not highlight any areas of concern in terms of ground stability, steep slopes, unstable rocks etc. However elevated floating roads will be used for turbine delivery and cable routes. The associated impacts and mitigation measures are discussed in sections 8.4 and 8.5 respectively.

8.3.6.6 Soil Contamination

There is no known area of soil contamination on the site. As the cable routes and TDRs are along public roads, it is possible that fuel spills and leaks may have occurred locally in the past (along with fly-tipping of potentially contaminated materials). Contaminated fill material may also have been used during road construction. The site walkover did not highlight any areas of particular concern.

8.4 Potential Impacts

During each phase of the wind farm development (construction, operation maintenance and decommissioning), a number of activities will take place on site, some of which will have the potential to affect the geological regime at the site or its vicinity.

The potential impacts for increase in erosion, sedimentation and pollution risk with neighbouring developments and specific impacts during the various phases of the wind farm development are outlined below.

8.4.1 Do Nothing Impact

If the proposed wind farm is not constructed, it is likely that the land will continue to be largely used for agricultural uses for the foreseeable future including grazing, peat extraction/milling, arable and forestry uses. The impact on the soils and geology would remain largely unaltered as a result.

8.4.2 Assessment of Significance of Geological Impact on the Receiving Environment

An impact rating has been developed for each of the phases of development of the wind farm based on the National Roads Authority (NRA) guidance [21] as recommended by the Institute of Geologists of Ireland (IGI) [3]. The sensitivity of the receiving environment was first identified. Then the magnitude of the potential hydrological impact was estimated.

The importance of the geological features are first rated followed by the magnitude of the impact. This determines the significance of the impact prior to application of mitigation measures.

The criteria for rating site importance of the geological features is set out in Table 8.11 over.

Table 8.11: Criteria for Rating Site Importance of Geological Features

Importance	Criteria	Typical Example
Very High	Attribute has a high quality, significance or value on a regional or national scale. Degree or extent of soil contamination is significant on a national or regional scale. Volume of peat and/or soft organic soil underlying the site is significant on a national or regional scale.	• Geological feature on a regional or national scale (NHA). • Large existing quarry or pit. • Proven economically extractable mineral resource.
High	Attribute has a high quality, significance or value on a local scale. Degree or extent of soil contamination is significant on a local scale. Volume of peat and/or soft organic soil underlying the site is significant on a local scale.	• Contaminated soil on site with previous heavy industrial usage • Large recent landfill site for mixed wastes • Geological feature of high value on a local scale (County Geological Site) • Well drained and/or high fertility soils • Moderately sized existing quarry or pit • Marginally economic extractable mineral resource
Medium	Attribute has a medium quality, significance or value on a local scale. Degree or extent of soil contamination is moderate on a local scale. Volume of peat and/or soft organic soil underlying the site is moderate on a local scale	• Contaminated soil on site with previous light industrial usage • Small recent landfill site for mixed wastes • Moderately drained and/or moderate fertility soils • Small existing quarry or pit • Sub- economic extractable mineral resource
Low	Attribute has a low quality, significance or value on a local scale. Degree or extent of soil contamination is minor on a local scale. Volume of peat and/or soft organic soil underlying the site is small on a local scale	• Large historical and/or recent site for construction and demolition wastes • Small historical and/or recent landfill site for construction and demolition wastes • Poorly drained and/or low fertility soils • Uneconomic extractable mineral resource

There are no geological heritage sites within the proposed wind farm of County, National or International significance; there are no known economic extractable mineral resources within the proposed wind farm that will be impacted; there is peat, which is / was milled on a small part of the wind farm (Windmill) which is / was of local/regional importance, but the wind farm will not limit its extraction; there was no land contamination identified – hence the Maighne site is considered to be of Medium Importance.

8.4.3 Assessment of Magnitude of the Impact on Geology Attribute

The assessment of the magnitude of an impact incorporates the timing, scale, size and duration of the potential impact. The magnitude criteria for geological impacts are defined as set out in Table 8.12.

Table 8.12: Estimation of Magnitude of Impact on Geological Features

Magnitude	Criterion	Description and Example
Large Adverse	Results in loss of attribute	• Loss of high proportion of future quarry or pit reserves • Irreversible loss of high proportion of local high fertility soils • Removal of entirety of geological heritage feature • Requirement to excavate / remediate entire waste site • Requirement to excavate and replace high proportion of peat, organic soils and/or soft mineral soils beneath alignment
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	• Loss of moderate proportion of future quarry or pit reserves • Removal of part of geological heritage feature • Irreversible loss of moderate proportion of local high fertility soils • Requirement to excavate / remediate significant proportion of waste site • Requirement to excavate and replace moderate proportion of peat, organic soils and/or soft mineral soils beneath alignment
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	• Loss of small proportion of future quarry or pit reserves • Removal of small part of geological heritage feature • Irreversible loss of small proportion of local high fertility soils and/or • high proportion of local low fertility soils • Requirement to excavate / remediate small proportion of waste site • Requirement to excavate and replace small proportion of peat, organic soils and/or soft mineral soils beneath alignment
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	• No measurable changes in attributes
Minor Beneficial	Results in minor improvement of attribute quality	• Minor enhancement of geological heritage feature
Moderate Beneficial	Results in moderate improvement of attribute quality	• Moderate enhancement of geological heritage feature

Magnitude	Criterion	Description and Example
Major Beneficial	Results in major improvement of attribute quality	• Major enhancement of geological heritage feature

In general, the wind farm will result in a "Small Adverse" effect as the result of:

- Loss of small proportion of future quarry or pit reserves
- Irreversible loss of small proportion of local high fertility soils
- Requirement to excavate / remediate small proportion of waste site
- Requirement to excavate and replace small proportion of peat, organic soils and/or soft mineral soils beneath alignment.

8.4.4 Assessment of Significance of Geological Impacts

The matrix in Table 8.13 determines the significance of the impacts based on the importance and magnitude of the impacts as determined by Tables 8.11 and 8.12.

Table 8.13: Ratings Significance of Environmental Impacts for Geology

Importance of Attribute	Magnitude of Impact			
	Negligible	Small Adverse	Moderate Adverse	Large Adverse
Very High	Imperceptible	Significant/ Moderate	Profound/ Significant	Profound
High	Imperceptible	Moderate/ Slight	Significant/ Moderate	Profound/Significant
Medium	Imperceptible	**Slight**	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight/Moderate

The determination of the significance of each impact for this site is determined in Section 8.4.5. Generally, the significance of the geological impacts is considered to be slight due to a combination of a "Small Adverse" magnitude upon an attribute of "Medium Importance".

8.4.5 Potential Impacts during Construction

8.4.3.1 Potential Direct Impacts

The following on-site activities have been identified as the sources of potential risks to the soils and geology on the site:

- Construction of wind turbine foundations and hardstanding areas
- Construction of access tracks
- Construction of bridges at river crossings
- Minor alterations to public roads for turbine delivery
- Construction of substation
- Construction of site compounds
- Cable trench and grid connection construction
- Soil and rock excavation/reuse and storage
- Borrow pit excavation
- Temporary material storage
- Drainage
- Tree Felling
- Vehicular movement

- Piling of foundations
- Storage and use of diesel
- Installation of wastewater treatment for site compound and substation

The excavation for turbine foundations, hardstanding areas, access tracks and roads, bridges, substation, borrow pits, drainage trenches and cable trenches have the potential to give rise to direct permanent impacts on the exposed soils and rock in the form of increased erosion and sediment release that could also have additional impacts on water quality due to sedimentation of water courses (see Chapter 10 Water Quality). Tree felling may also have the potential for similar impacts on the existing soils due to erosion and sediment release.

Existing tracks have been utilised and upgraded where appropriate. Elsewhere, new haulage tracks will be constructed. The tracks will permit access for construction vehicles and for maintenance vehicles during the operational phase. The tracks will be approximately 4.5m wide along straight sections and wider at turns. The tracks will not be surfaced: however, they will be well drained and culverted. Drainage is discussed in more detail in Chapter 9 Hydrology of this report.

Where present, the peat depth is generally less than 1m depth as a result of extensive peat harvesting over Maighne Wind Farm and all peat will be excavated during construction unless a floating construction is undertaken (see below). It is envisaged that the track formation will consist of a minimum 500mm hardcore on geotextile after removal of peat and soft soils. This will be subject to detail design at construction stage. The construction methodology for newly excavated tracks will be as follows:

- Peat/topsoil will be excavated and locally placed and graded to one or both sides of the track.
- The formation will be prepared to receive geotextile.
- Stone will be placed and compacted in layers to minimum 500 mm depth.
- A drainage ditch will be formed, within excavated width, along sides of the track.
- Surplus excavated material will be placed along each side of the track, and dressed to blend in with surrounding landscaping and partially obscure sight of the track.

Although some existing floating roads will be used within the Maighne Wind Farm site, many of these are in poor condition as a result of settlement/subsidence and may require upgrading during construction. It will also be necessary to construct new floating roads in areas where excavation is not possible or where peat/soft ground is deep.

In this case, a geotextile/geogrid will be placed over the existing track, followed by a minimum of 500mm of granular material which may also be split by a second layer of geotextile/geogrid. The maximum length of floated roads expected to be constructed for Maighne Wind Farm is of the order 4km.

The proposed Maighne Wind Farm will connect to the Drehid Substation via an underground cable which will be predominately located on the public road. The precise connection point to the national electricity transmission grid will be determined by EirGrid plc, which is the statutory transmission system operator. For the purposes of this planning application, 2 no. HV grid connection routes (which will operate at a voltage up to 220kV) have been identified and evaluated as shown in Figure 2.7 which is included in Volume 2a of the EIS. The 2 no. HV grid connection cable routes included in this application propose to connect the proposed Maighne Wind Farm substation at Drehid to either one of two existing substations located at Woodland, Co. Meath or Maynooth, Co. Kildare. However, only one of these routes will be constructed following the identification of the preferred connection point by EirGrid. The impacts associated with the grid connection and cables will be similar to those associated with road excavations but will be generally of reduced magnitude. Slightly higher impacts however may occur at the river where trenchless techniques will be employed. This may involve digging of access pits at either side of the river crossing during construction depending on the technique used. Excavation of floating roads may also give rise to stability issues and in some cases may cause the road to subside.

Turbine delivery will be along delivery routes as shown in Figure 2.10 which is included in Volume 2a of the EIS. The associated impacts are the result of stripping of topsoil at bends and roundabouts where minor modifications to the road network will be required. Impacts will be similar to those associated with road excavation and construction but of reduced magnitude.

The excavation, storage and removal of soil and rock during construction of Maighne Wind Farm and interference with existing site drainage is a direct permanent effect that, without mitigation, will alter the existing geology of the site.

During construction, the use of construction plant and equipment may result in accidental contamination of soil and rock due to oil/fuel or chemical leakages.

Construction activities on areas of deep peat or unstable ground have the potential to cause slope failure resulting in loss of ground, sedimentation, erosion and possible injury or damage to property (see Peat Stability Assessment Reports in Appendix G1). Additionally, deep excavations for borrow pits or turbine bases especially within granular soils, alluvium or peat may give rise to instability or loss of ground due to stockpiling, vibration or over-steepening of side slopes which may cause collapse or liquefaction of unstable soils.

Although no karst limestone features have been identified by the desk study or site walkover, karst features are common in limestone areas, particularly within the Waulsortian Limestone which is common along the cable routes and may underlie parts of the clusters, at Drehid, Derrybrennan and Cloncumber. If unmitigated, construction work and unregulated release of water could give rise to collapse or cavities within the limestone.

Soil compaction may occur due to movement of construction traffic and the storage of soils or other materials. This has the potential to occur particularly within areas of topsoil and peat which are highly compressible. Construction of floating roads will also lead to consolidation of peat. This could lead to an increase in runoff, decrease in drainage and subsequently to an increase in erosion. It is noted however that the peat at Windmill is already extensively drained and machine cut and hence some consolidation of the peat will already have occurred.

In areas where the peat or topsoil is underlain by soft cohesive or loose granular soils, it is possible that piled foundations may be required. The potential impacts associated with piling include compaction of the soils (especially driven piles) and removal of soils (bored piles). Additionally, contamination of the soils have the potential to occur due to equipment leakage or poor construction practice (using contaminated equipment). Although the impact on the soils is generally less than is associated with conventional excavated foundations, the impact has the potential to extend to a greater depth due to the possibility of the pile acting as a vertical pathway for contaminants if not properly constructed.

Contamination of topsoil, subsoil or bedrock could also occur due to leakage from stored diesel or other liquids, particularly at the site compound and the substation if unmitigated. Wastewater treatment at the substation and compound may also result in contamination if not properly mitigated.

The significance of these potential impacts, prior to mitigation, is considered to be of slight significance.

8.4.5.1.1 Materials Balance and Storage

Due to the possibility of soil-borne diseases, all topsoil/peat recovered from any farm property will remain on the same property. Topsoil will be used for landscaping and will also be used for reinstatement purposes around turbines bases and hardstandings. Where a farm property includes a borrow pit, some of the excavated topsoil will be used in the reinstatement and re-vegetation of the borrow pit. Subsoil and surplus/unsuitable rock material from all excavations will be used for reinstatement of the borrow pits in order to achieve a suitable finished profile.

Some temporary stockpiles of material will be necessary adjacent to the borrow pits prior to reinstatement and adjacent to excavations in clusters without borrow pits prior to transportation. However no permanent stockpiles of material will remain after construction. Excavated subsoil will be used for the reinstatement of borrow pits. Excavated topsoil and peat will be used for landscaping, berms and for final reinstatement of the borrow pits. The location of the proposed temporary material storage areas (MSAs) are shown in Figures 8.5. Estimates of the volumes of aggregate required, excavation volumes and borrow pit volumes for each cluster are presented in the following pages.

Ballynakill

The total quantity of soil to be excavated at the Ballynakill cluster from tracks, hardstandings, turbine bases, compounds, substations, drainage ponds and swales is estimated to be approximately 46,175m³. Of this, approximately 13,795m³ will be topsoil which will be used mainly for landscaping of trackside berms, borrow pits, around turbine bases, hardstanding and compounds, and approximately 32,380m³ is subsoil which will be used for reinstatement of the Ballynakill borrow pits (along with some of the topsoil if recovered from the same farm property as the borrow pit and about 40,889m³ of subsoil from the other clusters).

Preliminary calculations show that the amount of aggregate required for the construction of the Ballynakill cluster will be of the order 45,965m³ (29,721m³ from borrow pits and 16,244m³ imported aggregate including sand but excluding concrete containing aggregate) as shown in Table 8.14. It is proposed that the site won material will be sourced from the on-site borrow pits at Ballynakill. The total surface area of these two proposed borrow pits is of the order 45,109m². The maximum depth of excavation proposed at the borrow pits is 4m, with an estimated useable depth of about 3.0m. The borrow pits will therefore supply up to 135,327m³, giving an aggregate surplus of about 102,606m³, some of which will be used to supply aggregate to other wind farm clusters.

Table 8.14: Aggregate and Excavation Volumes – Ballynakill

Aggregate Requirements (on site borrow pits)	No.	Length (m)	Width (m)	Depth (m)	Volume (m³)
New Tracks*	1	5,687	5.0	0.5	14,218*
Existing tracks widened	1	503	2.0	0.5	503
Turbine hardstandings	10	50	30	1.0	15000
				TOTAL	**29,721**
Imported Aggregate	**No.**	**Length (m)**	**Width (m)**	**Depth (m)**	**Volume (m³)**
Off Road Cable Trench backfill (sand)	1	6,190	0.5	0.5	1,548
Turbine base structural fill	10	25	25	0.5	3,125
Track Surfacing (Cl. 804)	1	6,190	4.5	0.2	5,571
Hardstand Surfacing	10	50	30	0.2	3,000
Compound	1	100	100	0.3	3,000
				TOTAL	**16,244**
Turbine base concrete	10	20	20	2.0	8,000
Excavation Volumes	**No.**	**Length (m)**	**Width (m)**	**Depth (m)**	**Volume (m³)**
New Tracks	1	5,687	5.0	0.5	14,218
Existing tracks widened	1	503	2.0	0.5	503
Hardstandings	10	50	30	0.5	7,500
Turbine bases	10	25	25	3.0	18,750
Compound	1	100	100	0.2	2,000
Off Road Cable Trenches (net)	1	6,190	0.5	0.5	1,548
Drainage Swales	1	6,190	0.203m² (section)	-	1,257
Drainage Ponds	10	40m³ (volume)	-	-	400

Excavation Volumes	No.	Length (m)	Width (m)	Depth (m)	Volume (m^3)
				TOTAL	**46,175**
Borrow pit No.	**Near**	**Area (m^2)**		**Effective Depth (m)**	**Volume (m^3)**
BPA	T2	15,053		3.0	45,159
BPB	T10	30,056		3.0	90,168
	Total	**45,109**		**TOTAL**	**135,327**

*It is expected that some of the aggregate required for the tracks will be recovered from excavation of the turbine bases (estimated at 25% or around 5,000m^3) which will reduce the volume of aggregate take required from the borrow pits and reduce the amount of spoil to be removed.

Windmill

The total quantity of soil to be excavated is estimated to be approximately 19,856m^3, most of which will be peat. It is intended that this material will be spread over the existing worked bog within a level area to the east of T24 which has been extensively worked in the past.

It is intended to temporarily place the excavated peat to a depth of approximately 1m over an area of approximately 20,000m^2 at the location shown in Figure 8.5.2 which is included in Volume 2a of the EIS. This material will then be removed and processed along with the adjacent areas of peat which will continue to be worked after construction of the wind farm.

Preliminary calculations show that the amount of aggregate required during construction will be in the order of 35,367m^3 as shown in Table 8.15. It is proposed that most of this material will be sourced from the Ballynakill or Cloncumber cluster borrow pits (approximately 30,166m^3), however some surfacing and structural aggregate may also need to be sourced from local quarry sources (approximately 5,201m^3). These volumes do not includes volumes of concrete for turbine bases (approximately 2,400m^3 in total) which will also contain imported aggregate as shown in Table 8.15.

Table 8.15: Aggregate and Excavation Volume - Windmill

Aggregate Requirements (from borrow pits)	No.	Length (m)	Width (m)	Depth (m)	Volume (m^3)
New Tracks (floated)	1	2,704	6.0	1.0	16,224
Existing tracks widened	1	221	2.0	1.0	442
Turbine hardstandings	3	50	30	3.0	13,500
				TOTAL	**30,166**
Imported Aggregate	**No.**	**Length (m)**	**Width (m)**	**Depth (m)**	**Volume (m3)**
Off Road Cable Trench backfill (sand)	1	2,925	0.5	0.5	731
Turbine base structural fill	3	25	25	0.5	938
Hardstand Surfacing	3	50	30	0.2	900
Track Surfacing (Cl. 804)	1	2,925	4.5	0.2	2,633
				TOTAL	**5,201**
Turbine base concrete	3	20	20	2.0	2,400

Excavation Volumes	No.	Length (m)	Width (m)	Depth (m)	Volume (m³)
New Tracks (floated)	1	2,704	-	-	-
Existing tracks widened	1	221	-	-	-
Hardstandings	3	50	30	3.0	13,500
Turbine bases	3	25	25	3.0	5,625
Off Road Cable Trenches (net)	1	2,925	0.5	0.5	731
				TOTAL	**19,856**

<u>Drehid-Hortland</u>

Due to the possibility of soil-borne diseases, all topsoil/peat recovered from each farm property will remain on the same property. Topsoil will be used for landscaping berms alongside existing and new access tracks where suitable and will also be used for reinstatement purposes around turbines bases and hardstandings. Subsoil and surplus/unsuitable rock material from the excavations will be used for reinstatement of the borrow pits at Ballynakill and Cloncumber. Some temporary stockpiles of material will be necessary adjacent to the excavations prior to transport, however no permanent stockpiles of material will remain after construction.

The total quantity of soil to be excavated from tracks, hardstandings, turbine bases, compounds, substations, drainage ponds and swales at Drehid-Hortland is of the order 135,052m³. Of this, approximately 88,459m³ will be peat and topsoil which will be used mainly for landscaping purposes at the cluster and approximately 46,593m³ is subsoil which will be partially used for sub-base for tracks and hardstanding (if acceptable) and partially used for reinstatement of the borrow pits in Ballynakill and/or Cloncumber.

Preliminary calculations show that the amount of aggregate required during construction at Drehid-Hortland will be in the order of 131,379m³ (85,790m³ from borrow pits and 45,589m³ imported from local quarries but excluding 16,800m³ of concrete) as shown in Table 8.16. It is proposed that site won material will be sourced from the Ballynakill and/or Cloncumber borrow pits, however the structural fill for turbine bases, track surfacing stone and cable trench sand may be imported from nearby quarries.

Table 8.16: Aggregate and Excavation Volumes – Drehid-Hortland

Aggregate Requirements (from borrow pits)	No.	Length (m)	Width (m)	Depth (m)	Volume (m³)
New Tracks (excavated)	1	9,750	5.0	0.5	24,375*
New Tracks (floated)	1	3,808	6.0	1.0	22,848
Existing excavated tracks widened	1	1,993	2.0	0.5	1,993
Existing Floating Tracks widened	1	2,537	2.0	1.0	5,074
Turbine hardstandings	21	50	30	1.0	31,500
				TOTAL	**85,790**
Imported Aggregate	**No.**	**Length (m)**	**Width (m)**	**Depth (m)**	**Volume (m3)**
Off Road Cable Trenches (sand)	1	18,088	0.5	0.5	4,522
Turbine base structural fill	21	25	25	0.5	6,563
Hardstand surfacing	21	50	30	0.2	6,300
Track Surfacing (Cl. 804)	1	18,088	4.5	0.2	16,279
Drehid Substation	1	105	85	1.0	8,925

Imported Aggregate	No.	Length (m)	Width (m)	Depth (m)	Volume (m3)
Drehid Compound	1	100	100	0.3	3,000
				TOTAL	**45,589**
Turbine base concrete	21	20	20	2.0	16,800
Excavation Volumes	**No.**	**Length (m)**	**Width (m)**	**Depth (m)**	**Volume (m^3)**
New Tracks (excavated)	1	9,750	5.0	0.5	24,375
New Tracks (floated)	1	3,808	6.0	-	-
Existing excavated tracks widened	1	1,993	2.0	0.5	1,993
Existing Floating Tracks widened	1	2,537	2.0	-	-
Hardstandings	21	50	30	1.0	31,500
Turbine bases	21	25	25	3.0	39,375*
Substation	1	105	85	3.0	26,775
Compound	1	100	100	0.2	2,000
Off Road Cable Trenches (net)	1	18,088	0.5	0.5	4,522
Drainage Swales	1	18,088	0.203m^2 (section)	-	3,672
Drainage Ponds	21	40m^3 (volume)	-	-	840
				TOTAL	**135,052**

*It is expected that some of the aggregate required for the tracks will be recovered from excavation of the turbine bases (estimated at 25% or about 10,000m^3) which will reduce the volume of aggregate take required from the borrow pits and spoil required for removal.

Derrybrennan

Subsoil and surplus/unsuitable rock material from the excavations will be used for reinstatement of the borrow pits at the Cloncumber cluster. Some temporary stockpiles of material may be necessary adjacent to the excavations prior to transport to the borrow pit for beneficial re-use, however no permanent stockpiles of material will remain after construction.

The total quantity of soil to be excavated from tracks, hardstandings, turbine bases, compounds, drainage ponds and swales is estimated to be approximately 15,288m^3. Of this, approximately 4,961m^3 will be peat and topsoil which will be used mainly for berms and landscaping purposes adjacent to tracks, turbines and hardstandings and approximately 10,327m^3 is subsoil which will be used in the reinstatement of the borrow pits in Cloncumber.

Preliminary calculations show that the amount of aggregate required during construction will be of the order 7,098m^3 (10,833m^3 from borrow pits and 6,316m^3 imported from nearby quarries) as shown in Table 8.17. It is proposed that most of this material will be sourced from the Cloncumber borrow pits although some additional material will be required for structural fill, track surfacing and cable trench sand which will be sourced from a local quarry.

Table 8.17: Aggregate and Excavation Volumes - Derrybrennan

Aggregate Requirements	No.	Length (m)	Width (m)	Depth (m)	Volume (m^3)
Proposed new tracks – (internal)	1	733	5.0	0.5	1,833
Existing tracks upgraded – (internal)	1	113	2.0	0.5	113
Proposed new tracks – (external)	1	1537	5.0	0.5	3,843
Existing tracks upgraded – (external)	1	2044	2.0	0.5	2,044
Turbine hardstandings	2	50	30	1.0	3,000
				TOTAL	**10,833**
Imported Aggregate	**No.**	**Length (m)**	**Width (m)**	**Depth (m)**	**Volume (m3)**
Off Road Cable Trenches (sand)	1	4,427	0.5	0.5	1,107
Turbine base aggregate	2	25	25	0.5	625
Hardstand surfacing	2	50	30	0.2	600
Track Surfacing (Cl. 804)	1	4,427	4.5	0.2	3,984
				TOTAL	**6,316**
Turbine base concrete	2	20	20	2.0	1,600
Excavation Volumes	**No.**	**Length (m)**	**Width (m)**	**Depth (m)**	**Volume (m^3)**
Proposed new tracks – (internal)	1	733	5.0	0.5	1,833
Existing tracks upgraded – (internal)	1	113	2.0	0.5	113
Proposed new tracks – (external)	1	1537	5.0	0.5	3,843
Existing tracks upgraded – (external)	1	2044	2.0	0.5	2,044
Hardstandings	2	50	30	0.5	1,500
Turbine bases	2	25	25	3.0	3,750
Off Road Cable Trenches (net)	1	4,427	0.5	0.5	1,107
Drainage Swales	1	4,427	$0.203m^2$ (section)	-	899
Drainage Ponds	2	$40m^3$ (volume)	-	-	80
				TOTAL	**15,167**

<u>Cloncumber</u>

Due to the possibility of soil-borne diseases, all topsoil/peat recovered from each farm property will remain on the same property. Topsoil will be used for landscaping berms alongside existing and new access tracks where suitable and will also be used for reinstatement purposes around turbine bases and hardstandings. Where a property also includes a borrow pit, some of the topsoil will also be used to help in the reinstatement and revegetation of the borrow pit. Subsoil and surplus/unsuitable rock material from the excavations will be used in the reinstatement of the borrow pits. Some temporary stockpiles of material may be necessary adjacent to the borrow pits within this cluster prior to reinstatement, however no permanent stockpiles of material will remain after construction and no surplus/waste soil or rock will be removed from the wind farm.

The total quantity of soil to be excavated from tracks, hardstandings, turbine bases, compounds, drainage ponds and swales at Cloncumber is estimated to be approximately 57,486m³. Of this, approximately 33,182m³ will be peat and topsoil which will be used mainly for landscaping purposes and approximately 24,304m³ is subsoil which will be used in the reinstatement of the borrow pits.

Preliminary calculations show that the amount of aggregate required during construction will be of the order 62,462m³ (42,243m³ from borrow pits and 20,219m³ imported from local quarries) but excluding 8,800m³ of concrete as shown in Table 8.18. It is proposed that the site won material will be sourced from on-site borrow pits located within the Cloncumber cluster. Structural fill and track surfacing stone will be imported from local quarries.

The total surface area of the proposed borrow pits is in the order of 27,676m², hence an effective depth of about 3.0m will provide approximately 83,028m³ of aggregate, giving a surplus of about 40,785m³ which will be partly used to supply other clusters. The typical depth of excavation proposed at the borrow pits however will be about 4m in order to allow for variations in material quality and stone requirements and to ensure that excavation below the water table is not required, particularly close to the canal.

Table 8.18: Aggregate and Excavation Volumes - Cloncumber

Aggregate Requirements	No.	Length (m)	Width (m)	Depth (m)	Volume (m³)
New Tracks (excavated)	1	5,183	5.0	0.5	12,958
New tracks (floated)	1	1,440	6.0	1.0	8,640
Existing excavated tracks widened	1	835	2.0	0.5	835
Existing floating tracks widened	1	1,655	2.0	1.0	3,310
Turbine Hardstandings	11	50	30	1.0	16,500
				TOTAL	**42,243**
Imported Aggregate	**No.**	**Length (m)**	**Width (m)**	**Depth (m)**	**Volume (m3)**
Off Road Cable Trenches (sand)	1	9,113	0.5	0.5	2,278
Turbine base structural fill	11	25	25	0.5	3,438
Hardstand surfacing	11	50	30	0.2	3,300
Compound	1	100	100	0.3	3,000
Track Surfacing (Cl. 804)	1	9,113	4.5	0.2	8,202
				TOTAL	**20,217**
Turbine base concrete	11	20	20	2.0	8,800
Excavation Volumes	**No.**	**Length (m)**	**Width (m)**	**Depth (m)**	**Volume (m³)**
New Tracks (excavated)	1	5,183	5.0	0.5	12,958
New Tracks (floated)	1	1,440	6.0	-	-
Existing excavated tracks widened	1	835	2.0	0.5	835
Existing floating tracks widened	1	1,655	2.0	-	-
Hardstandings	11	50	30	1.0	16,500
Turbine bases	11	25	25	3.0	20,625
Compound	1	100	100	0.2	2,000

Excavation Volumes	No.	Length (m)	Width (m)	Depth (m)	Volume (m^3)
Off Road Cable Trenches (net)	1	9,113	0.5	0.5	2,278
Drainage Swales	1	9,113	0.203m^2 (section)	-	1,850
Drainage Ponds	11	40m^3 (volume)	-	-	440
				TOTAL	**57,486**
Borrow pit No.	**Near**	**Area (m^2)**		**Effective Depth (m)**	**Volume (m^3)**
BPA	T39	6,408		3.0	19,224
BPB	T39	21,268		3.0	63,804
	Total	**27,676**		**TOTAL**	**83,028**

*It is expected that some of the aggregate required for the tracks will be recovered from excavation of the turbine bases (estimated at 25% or about 5,000m^3) which will reduce the volume of aggregate take required from the borrow pits and the amount of spoil for disposal.

External Cable Routes and TDRs

The total quantity of soil to be excavated from new roads, road widening and cable trench excavations is estimated at 40,756m^3 for the Maynooth option and 44,860m^3 for the Woodland option. It is expected that this material will be a mixture of road construction material, made ground and granular fill. Following testing for suitability and contamination, this material may be re-used for road construction or borrow pit backfill locally. Any unsuitable material will be disposed of at a suitably licenced facility.

Cable trenches along the roads will be ducted and will be backfilled using imported cement-bound material (CBM). Some of the excavated road material may also be used to backfill the trenches if suitable. Following testing for contamination, any surplus material will be disposed of at a suitably licenced facility.

An estimated volume of imported aggregate will be required for TDR widening and cable trench backfill (granular or CBM backfill and Clause 804 aggregate) of 40,756m^3 for the Maynooth option and 44,860m^3 for the Woodland option. This material will be imported from locally available quarry sources.

Table 8.19: Aggregate and Excavation Volumes – Cable Route & TDRs

Imported Aggregate (Maynooth Option)	No.	Length (m)	Width (m)	Depth (m)	Volume (m^3)
MV Cable backfill (granular fill + CBM)	1	36,000	0.6	1.14	24,624
HV Cable Backfill (granular fill +CBM)	1	23,000	0.6	1.14	15,732
TDR Road Widening aggregate	1	1000	2.0	0.2	400
				TOTAL	**40,756**
Imported Aggregate (Woodland Option)	**No.**	**Length (m)**	**Width (m)**	**Depth (m)**	**Volume (m^3)**
MV Cable backfill (granular fill + CBM)	1	36,000	0.6	1.14	24,624
HV Cable Backfill (granular fill +CBM)	1	29,000	0.6	1.14	19,836
TDR Road Widening aggregate	1	1000	2.0	0.2	400
				TOTAL	**44,860**

Excavation Volumes (Maynooth Option)	No.	Length (m)	Width (m)	Depth (m)	Volume (m^3)
MV Cable	1	36,000	0.6	1.14	24,624
HV Cable	1	23,000	0.6	1.14	15,732
TDR Road Widening	1	1000	2.0	0.2	400
				TOTAL	**40,756**
Excavation Volumes (Woodland Option)	**No.**	**Length (m)**	**Width (m)**	**Depth (m)**	**Volume (m^3)**
MV Cable	1	36,000	0.6	1.14	19,220
HV Cable	1	29,000	0.6	1.14	19,904
TDR Road Widening	1	1000	2.0	0.2	400
				TOTAL	**44,860**

8.4.5.2 Potential Indirect Impacts

Construction of the turbines, hardstanding areas, access tracks and cable trenches will require excavation of the soil/rock to founding level with access being provided from existing and newly constructed tracks. The importation of granular fill and other products in the form of concrete or other construction related products will have a permanent impact on the source quarries or borrow pits.

Imported materials also have the potential to introduce contaminated materials into the existing environment. Conversely, any contaminated materials encountered on site will be removed and have the potential to contaminate the receiving environment.

Impacts associated with slope failure or instability have the potential to result in injury, damage to property, land or resources which are down-gradient of the wind farm site.

The significance of these potential impacts, prior to mitigation, is considered to be of slight significance.

8.4.5.3 Potential Cumulative Impacts

There are currently no other significant developments planned in the area.

The following neighbouring wind farms were examined for potential cumulative impacts on soils and geology with the proposed development:

- Crowinstown Wind Farm, a 3 turbine permitted wind farm at Delvin, Co. Westmeath, approximately 19.7 km north-north-west of the proposed development
- Dryderstown Wind Farm, a 1 turbine wind permitted farm at Delvin, Co. Westmeath, approximately 20.8 km north west of the proposed development
- Mountlucas Wind Farm, a 28 turbine existing wind farm at Derrylesk, Co. Offaly, approximately 17 km west of the proposed development
- Yellow River Wind Farm, a 32 turbine permitted wind farm at Rhode, Co. Offaly, approximately 10.5 km west of the proposed development

The existing neighbouring wind farms outlined above are not located within any of the same waterbody catchments or groundwater bodies as the proposed Maighne Wind Farm development. The distances are far enough that the potential cumulative impact on soils and geology is considered to be negligible as there is no cumulative risk of an increase in sediment/contamination to waterbodies (surface or groundwater) or to the underlying / surrounding soils and geology.

There are a number of commercial businesses and industries in the vicinity of the proposed Maighne Wind Farm clusters, namely Carbury Compost Ltd, Bord na Móna Drehid Waste Management Facility, Allenwood Business Park, Monaghan Mushrooms, Clairstone Ltd, Moyvalley Meats, Brady's Family Ham, Doran Nurseries, Irish Industrial Explosives Ltd. and peat extraction. These were examined for potential cumulative impacts on soils and geology.

The discharges from these licenced facilities are regulated in addition to the requirement for licensees to carry out water quality monitoring up and downstream of their facilities and in addition the waste management facility has attenuation facilities to mitigate the potential impact of sediment on nearby watercourses. Although minor contamination of soils is possible, the potential cumulative impact on the soils and geology in the area is considered to be negligible.

There are a number of quarries and gravel pits in the area, which are discussed in Section 8.3 of this EIS and have the potential for minor cumulative impacts due to depletion of quarry reserves and the potential for contamination of the underlying geology.

Bord na Móna commercially harvests peat in the vicinity of the Derrybrennan, Drehid-Hortland and the Cloncumber clusters. Bord na Móna turf extraction works traverse access points into the Derrybrennan and Cloncumber clusters and a small portion of the bogs owned by Bord na Móna traverse the study area of the Drehid-Hortland cluster. In the absence of mitigation measures, there is a potential cumulative impact on groundwater quality and this may impact on the underlying soils if contamination occurs. Additional compaction and excavation of the soils will also occur by use of on-site peat harvesting and construction machinery. During construction and operation of the wind farm, there will be measures in place to mitigate any impact. The drainage of the excavated material is discussed in detail in Section 9.6.7 of the hydrology chapter and in the section on mitigation measures during construction in this chapter.

The proposed HV cable routes were reviewed for facilities that lie in the same groundwater body for cumulative impact. No EPA licensed facilities or quarries were noted along the route. There is a distribution centre (Musgraves) at Boycetown, on the western outskirts of Kilkcock. There is a commercial park at Barstown near Woodland. The installation of the cable route will not result in any potential cumulative impacts on soils and geology with these facilities.

The potential cumulative impact on soils and geology overall is considered to be negligible. Potential cumulative hydrological and water quality impacts have been assessed in Chapters 9 Hydrology and 10 Water Quality of this EIS.

8.4.6 Potential Impacts during Operation

8.4.6.1 Potential Direct Impacts

No additional direct impacts are envisaged during operation. The potential direct impacts during operation will be similar to those during construction but of much reduced magnitude.

Some traffic will be associated with the maintenance of turbines and these maintenance vehicles and activities could result in minor accidental leaks or spills of fuel/oil.

Maintenance of access tracks will also require the use of plant or machinery which could result in minor contamination as a result of leaks or spills due to an accident, breakdown or poor maintenance.

The grid transformer at the Drehid substation will be oil cooled and if not properly maintained or bunded, could result in contamination of the underlying/adjacent soils.

8.4.6.2 Potential Indirect Impacts

A small amount of imported granular material may be required to maintain access tracks during operation which could impact the source quarry.

8.4.6.3 Potential Cumulative Impacts

No cumulative impacts on soils and geology are envisaged during operation.

8.4.7 Potential Impacts during Decommissioning

The potential impacts associated with decommissioning will be similar to those associated with construction but of reduced magnitude.

During decommissioning, it may be possible to reverse or at least reduce some of the impacts caused during construction by rehabilitating construction areas such as turbine bases, hardstanding areas, substation and site compounds. This will be done by covering with locally sourced topsoil to encourage vegetation growth and reduce run-off and sedimentation. Other impacts such as possible soil compaction and contamination by fuel leaks will remain but will be of reduced magnitude.

8.4.8 Summary of Potential Impacts

A summary of unmitigated potential impacts on geology due to the development of the proposed wind farm is provided in Table 8.19. The sensitivity of the environments is based on the perceived importance of the receptor on a local, national or international scale as discussed in Section 8.4.2.

Table 8.19: Summary of Potential Geological Impact Significance on Geological Attributes

Activity	Potential Impact	Attribute	Importance	Prior to Mitigation	
				Magnitude	Significance
Construction Phase					
Excavations for site tracks, grid connection cabling, TDR modifications, turbine construction, crane pad construction, sub-station construction, opening of borrow pits, construction compounds	Removal of material, soil compaction, increased runoff causing erosion, potential for localised soil contamination	Soil & Rock. Moderately fertile moderately well drained soils. Local thin deposits of peat and organic soils.	Medium	Small adverse	Slight
Construction of tracks and turbine bases, turbine delivery	Slope failure	Soil & Rock. Moderately fertile moderately well drained soils. Local thin deposits of peat and organic soils.	Medium	Small adverse	Slight
Operation Phase					
Use and maintenance of site access tracks, crane pads, sub-station	Increase in rate of run-off causing erosion. Potential for localised soil contamination from traffic and substation equipment	Soil & Rock. Moderately fertile moderately well drained soils. Local thin deposits of peat and organic soils.	Medium	Small adverse	Slight

Activity	Potential Impact	Attribute	Importance	Prior to Mitigation	
				Magnitude	Significance
Site access tracks & material storage areas	Soil erosion and compaction, possible contamination from imported soils	Soil & Rock. Moderately fertile moderately well drained soils. Local thin deposits of peat and organic soils.	Medium	Small adverse	Slight
Decommissioning Phase					
Rehabilitation of site access tracks, crane pad, sub-station, trenches and materials storage areas	Positive impact of Reduced rate of run-off and sedimentation. Potential for contamination from machinery or imported soils and soil compaction from machinery	Soil & Rock. Moderately fertile moderately well drained soils. Local thin deposits of peat and organic soils.	Medium	Small Adverse	Slight

It can be observed from Table 8.20 that some activities during the construction of the wind farm, if unmitigated, could have a "Small Adverse" effect on the receiving environment. Operation, maintenance and decommissioning activities are also not expected to have a significant effect on the site geology.

8.5 Mitigation Measures

8.5.1 Mitigation Measures during Construction

The following sections outline appropriate mitigation measures to avoid or reduce the potential impact of the proposed development.

8.5.1.1 Mitigation Measures for Slope Stability

With regard to slope stability issues, although the sites all rank as low to negligible risk, detailed design best practice will be implemented as follows:

- The works will be designed and checked by a suitably qualified and experienced geotechnical engineer or engineering geologist, and hydrologist or drainage engineer
- Identified risks will be minimised by the application of the principles of avoidance, prevention and protection. Information on risks are outlined in the Outline CEMP. This will be reviewed and updated prior to commencement of construction
- A detailed method statement for each element of the works will be prepared prior to any element of the work being carried out. An outline of the methods are given in the Outline CEMP. This will be reviewed and updated prior to commencement of construction
- Details of the relevant assumptions, relating to methods and sequencing of work are provided in the Outline CEMP. This will be reviewed and updated prior to commencement of construction
- No amendments to the designed works will be made without the prior approval of a suitably qualified and experienced engineering geologist or geotechnical engineer familiar with wind farm construction works

- An outline CEMP has been submitted to the board with this EIS. Prior to construction, a site-specific environmental management plan for construction will be prepared, which will incorporate all measures set out in the Outline CEMP, in consultation with the relevant statutory bodies, including the planning authority, Waterways Ireland and the NPWS
- The environmental management plan for construction will provide for the checking by suitably qualified and experienced staff of equipment, materials storage and materials transfer areas, as well as drainage structures and their attenuation ability, on a regular basis
- Excavation works will be monitored by suitably qualified and experienced geotechnical personnel
- The programming of the works will be such that earthworks are not scheduled to be carried out during severe weather conditions.

8.5.1.2 Mitigation Measures for Construction

One of the primary mitigation measures employed at the preliminary design stage is the minimisation of volumes of soil excavation and lengths of track and trench construction.

The proposed turbine locations have been carefully selected in areas of the site which is relatively close to the existing access tracks to minimise the length of new access tracks required. Drainage will be towards the existing drainage network.

To mitigate against erosion of the exposed soil or rock, all excavations will be constructed and backfilled as quickly as possible. Excavations will stop during or immediately after heavy rainfall.

Excavation will precede the turbine, cable trench and access track construction, whereby topsoil and soft soils will be excavated and replaced with granular fill where required. Excavation will be carried out from access tracks where possible in order to reduce the compaction of topsoil.

Surplus soil or rock excavated during the course of the works will be temporarily stored in a level area adjacent to the proposed borrow pits and will be either used for reinstatement of the borrow pits (following construction) or will be re-used on site in the form of landscaping and berms (during construction). Temporary storage may also be required after excavation and prior to transportation.

No spoil stockpiles will be left on site after construction.

Any contaminated soils will be handled, removed and disposed of in accordance with the requirements of the local authority and/or EPA and waste management legislation. In particular, the following measures will be implemented:

- Contaminated material will be left in-situ and covered, where possible until such time as WAC (Waste Acceptance Criteria) testing is undertaken in accordance with recommended standards and in-line with the acceptance criteria at a suitably licenced landfill or treatment facility. This will determine firstly the nature of the contamination and secondly the materials classification i.e. inert, non-hazardous or hazardous
- If the material is deemed to be contaminated, consultation will take place with the respective local authority and/or EPA on the most appropriate measures. Such materials will be excavated, transported by a contractor with a valid waste collection permit and recovered/disposed of at an appropriate facility.

All temporary cuts/excavations will be carried out such that they are stable or adequately supported. Gravel fill will be used to provide additional support to drains where appropriate. Where appropriate and necessary, temporary cuts and excavations will be protected against the ingress of water or erosion by covering during adverse weather. Where necessary sheet piling or other measures will be used to provide integrity for unstable excavations, particularly within peat, alluvial, gravel or for excavations below the water table. Support may also be required to support elevated floating roads which are being excavated for the installation of cable trenches. The stability of all excavations will be assessed in advance by an experienced geotechnical engineer. Temporary works will be such that they do not adversely interfere with existing drainage channels/regimes by the provision of silt traps and silt fencing as required (refer to Chapter 9 - Hydrology chapter).

Unregulated drainage will be not permitted within the wind farm. Any pumping of excavations will be directed into existing drainage networks via settlement ponds and will not be allowed to discharge directly to the ground except under licence. Generally, the overburden is of sufficient thickness and low permeability so that karst features will not be common.

All fuel and liquids will be stored on site in fully bunded areas as described in detail in Chapter 10 - Water Quality of the EIS. In addition, an effluent holding tank along with other protection measures will be used at the substation in order to protect the Source Protection Zone at Drehid and prevent any discharges to ground. These include:

- The location of the substation on impermeable hardstand to prevent any risks associated with infiltration to groundwater
- The bunding of the transformer, oil storage tanks, diesel generator and any diesel or fuel oils stored at the substation. The bund capacity will be sufficient to contain 110% of the tank's maximum capacity. Where there is more than one tank within the bund, the capacity will be sufficient to accommodate 110% of the largest tank's maximum capacity or 25% of the total maximum capacities of all tanks, whichever is the greater. Design and installation of fuel tanks will be in accordance with best practice guidelines BPGCS005 (Oil Storage Guidelines)
- A sealed drainage system will be provided, extending past the area of significance i.e. concrete dished channels with a kerbed perimeter at the substation hardstanding. The concrete dished channels will drain to a stilling pond, located 200m from the Inner SPZ, which will in turn drain via forestry drains to the receiving watercourse, which is at a distance of 1km from the location of the substation.
- A petrol and oil interceptor will be installed to deal with all substation surface water drainage.

To increase the time of concentration of the surface water run-off contribution from the substation, tanked permeable paving is a viable alternative to the sealed drainage system and this may be considered at detailed design stage. At the upslope side of the substation overland flows will be intercepted in channels and discharged diffusely over vegetated areas. Further details on the drainage design of the substation is provided in Chapter 9 - Hydrology.

Other mitigation measures relating to soils and geology include the following:

- Haul roads will be capped as soon as practicably possible to cover exposed subsoils and as such reduce the concentration of suspended solids in the run-off
- A suitably qualified person will be appointed by the developer to ensure the effective operation and maintenance of drainage and other mitigation measures during the construction process
- A ground investigation will be carried out at each turbine (and other infrastructure) for detailed design. This would include trial pits, drilling and geophysical survey, as appropriate. This will inform depth of excavations, foundation type and size, and the construction method.
- Due to the dispersed nature of the site, refuelling of plant during construction will be carried out at a number of dedicated refuelling station locations on site, typically at each compound or at least 100m from a watercourse using mobile bowsers.
- Each station will be fully equipped for a spill response and a specially trained and dedicated environmental and emergency spill response team will be appointed before commencement on site. Drip trays and spill kits will be kept available on site, to ensure that any spills from the vehicle are contained and removed off site. Only emergency breakdown maintenance will be carried out on site and appropriate containment facilities will be provided to ensure that any spills from breakdown maintenance vehicles are contained and removed off site.
- Portaloos and/or containerised toilets and welfare units will be used to provide toilet facilities for site personnel during construction. Sanitary waste will be removed from site via a permitted waste contractor.

8.5.1.3 Mitigation Measures for on-site Borrow Pits

When infilling each borrow pit, a shallow profile will be created using the overburden material initially removed from the borrow pits and from other sources within Maighne wind farm. As the borrow pits are located on farmland, they will be capped with local topsoil (in consultation with the landowner or farm manager). The growth of vegetation on the restored borrow pits will be monitored to ensure that it returns to its original state. Appropriate measures will be taken if it is found that natural re-vegetation is too slow or if the area is being taken over by inappropriate species. The final profile of the borrow pit will be similar to the original profile.

There is the potential for impacts on local watercourses (including the canals) and groundwater, during construction of the borrow pits. This has been taken into account in the design of the borrow pit infrastructure and suitable mitigation measures have been included (see Water Quality and Hydrology chapters).

To ensure stability of the excavations, a maximum side slope of 1 vertical: 2 horizontal will be adopted for the borrow pits (subject to detailed investigation and design). The stability of all slopes will be checked and assessed by a suitably qualified and experienced engineer to ensure the stability and safety of the excavations. By avoiding excavations below the water table, stability of the sides should not be an issue. Where groundwater is encountered locally, sheet piling or other measures will be used to provide integrity to the excavation, to prevent collapse of the sides and to reduce the groundwater inflow into excavations.

8.5.2 Mitigation Measures during Operation

Due to the reduced magnitude of the impacts, no additional mitigation measures are required for the maintenance and operation of the wind farm, over and above those incorporated into the design of the substation transformer, which will be bunded to protect soils against accidental leakages of oil.

8.5.3 Mitigation Measures during Decommissioning

Mitigation measures applied during decommissioning activities will be similar to those applied during construction where relevant.

Some of the impacts associated with reinstatement of the site (excavation of turbine bases, access tracks etc.) will be avoided by leaving these in place where possible. The bases will be rehabilitated by covering with locally sourced topsoil (in consultation with the landowner or farm manager) in order to regenerate vegetation which will reduce run-off and sedimentation effects. Access tracks which are not required for farm use will also be covered with topsoil and rehabilitated in a similar manner. Further details are provided in the CEMP included in Appendix D of Volume 3 of the EIS.

The Irish Wind Energy Association (IWEA) [(11)] states that when decommissioning a wind farm "*the concrete bases could be removed, but it may be better to leave them under the ground, as this causes less disturbanc*e".

It is proposed to leave the access tracks in-situ at the decommissioning stage. IWEA also state that "*it may be best*" to leave site tracks in-situ depending on the size and geography of the development.

It is considered that leaving the turbine foundations, access tracks and hardstanding areas in-situ will cause less environmental damage than removing and recycling them. Removal of this infrastructure would result in considerable disruption to the local environment in terms of increased sedimentation, erosion, dust, noise, traffic and an increased possibility of contamination of the local water table. However if removal is deemed to be required by the respective local authority all infrastructure will be removed with mitigation measures similar to those during construction being employed.

Mitigation measures to avoid contamination by accidental fuel leakage and compaction of soil by on-site plant will be implanted as per the construction phase mitigation measures in Section 8.5.1.2.

8.6 Residual Impacts

The residual impact is summarised in Table 8.20, using the impact assessment methodology outlined above in Section 8.4 and taking account of mitigation measures in Section 8.5 of this document.

It can be observed from Table 8.20 that, following the implementation of mitigation measures, the residual impact significance to the receiving environment would be imperceptible during the construction period and imperceptible in all the respects assessed during the operation of the wind farm. Mitigation measures will be monitored throughout the construction and operation phases.

The proposed Maighne Wind Farm is not expected to contribute to any significant, negative cumulative effects of other existing developments in the vicinity. When the mitigation measures are implemented in full, any residual effects on the receiving environment will be negligible.

Table 8.20: Residual Geological Impact Significance for Sensitive Receptors

Activity	Potential Impact	Attribute	Importance	Before Mitigation		After Mitigation	
				Magnitude	Significance	Magnitude	Residual Significance
Construction Phase							
Excavations for internal access tracks, grid connection cabling, TDR modifications, turbine construction, crane pad construction, sub-station construction, opening of borrow pits, construction compounds	Removal of material, soil compaction, increased runoff causing erosion, potential for localised soil contamination	Soil & Rock. Moderately fertile moderately well drained soils. Local thin deposits of peat and organic soils.	Medium	Small Adverse	Slight	Negligible	Imperceptible
Construction of access tracks and turbine bases, turbine delivery	Slope failure	Soil & Rock. Moderately fertile moderately well drained soils. Local thin deposits of peat and organic soils.	Medium	Small Adverse	Slight	Negligible	Imperceptible
Operation & Maintenance Phase							
Use and maintenance of site access tracks, crane pads, sub-station	Increase in rate of run-off causing erosion. Potential for localised soil contamination from traffic and substation equipment	Soil & Rock. Moderately fertile moderately well drained soils. Local thin deposits of peat and organic soils.	Medium	Small Adverse	Slight	Negligible	Imperceptible
Site access tracks and material storage areas	Soil erosion and compaction, possible contamination	Soil & Rock. Moderately fertile moderately well drained soils.	Medium	Small Adverse	Slight	Negligible	Imperceptible

Activity	Potential Impact	Attribute	Importance	Before Mitigation		After Mitigation	
				Magnitude	Significance	Magnitude	Residual Significance
	from imported soils	Local thin deposits of peat and organic soils.					
Decommissioning Phase							
Rehabilitation of site access tracks, crane pad, sub-station, trenches and materials storage areas	Positive impact of reduced rate of run-off and sedimentation. Potential for contamination from machinery or imported soils and soil compaction from machinery	Soil & Rock. Moderately fertile moderately well drained soils. Local thin deposits of peat and organic soils.	Medium	Small Adverse	Slight	Negligible	Imperceptible

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