Appendix G

Geology & Slope Stability

Appendix G1: Peat Stability
Appendix G2: Trial Pit Logs
Appendix G3: Site Walkover Records

Appendix G1

Peat Stability Reports

Appendix G1A

Windmill Cluster

APPENDIX G1A

MAIGHNE WIND FARM - WINDMILL CLUSTER

PEAT STABILITY ASSESSMENT

User is Responsible for Checking the Revision Status of This Document

Rev. Nr.	Description of Changes	Prepared by:	Checked by:	Approved by:	Date:
0	Issue for planning	AG/MT	ME	COD	19/02/15

Client: Element Power

Keywords: Maighne Wind Farm, Windmill, geotechnical, ground investigation, peat stability

Abstract: This peat stability assessment has been undertaken to inform the risks associated with peat instability at the proposed turbine locations within the Windmill Cluster of Maighne Wind Farm. A site walkover was undertaken which included a series of peat probes, gouge cores and shear vane tests. A qualitative risk assessment was undertaken in addition to a quantitative slope stability assessment. The results showed that the turbine locations are assessed as being stable.

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1. INTRODUCTION

A site walkover was undertaken for the proposed Maighne Wind Farm (Windmill Cluster) on 11 June 2013 and also on 18 November 2014 (following layout changes) to determine the presence/depth of peat and/or soft soils on the site along with slope angles and any evidence of geotechnical instability.

The potential for a landslide risk is defined in the Scottish Executive Best Practice Guide for Proposed Electricity Generation Developments [1] as the following:

- *"Peat is present at the development site in excess of 0.5 m depth,*

and;

- *There is evidence of current or historical landslide activity of the site,*

or;

- *Slopes > 2^{o} are present on-site,*

or;

- *The works will impinge on the peat covered areas and cannot be relocated to avoid peat covered areas".*

The information obtained during the walkover and desk study shows that the Windmill cluster site is covered by thick deposits of basin peat which have been extensively harvested by milling. The desk study found no records or evidence of historical landslips at the site. As peat is present (at depths in excess of 0.5m on the site) and the works will impinge on peat covered areas, there is the potential for landslide hazard at the site and therefore a peat stability assessment was considered necessary.

This report presents a peat stability assessment for the proposed Maighne Wind Farm, Windmill cluster.

1.1 The Site

The Windmill cluster comprises three wind turbines and associated access tracks, cable trenches and associated infrastructure, located on level cutover bog in County Kildare. The site is located approximately 5km northeast of Edenderry.

The elevation of the site is approximately 90 m OD. The land use on the site comprises worked (milled) peat bog.

1.2 Methodology for the Peat Stability Assessment

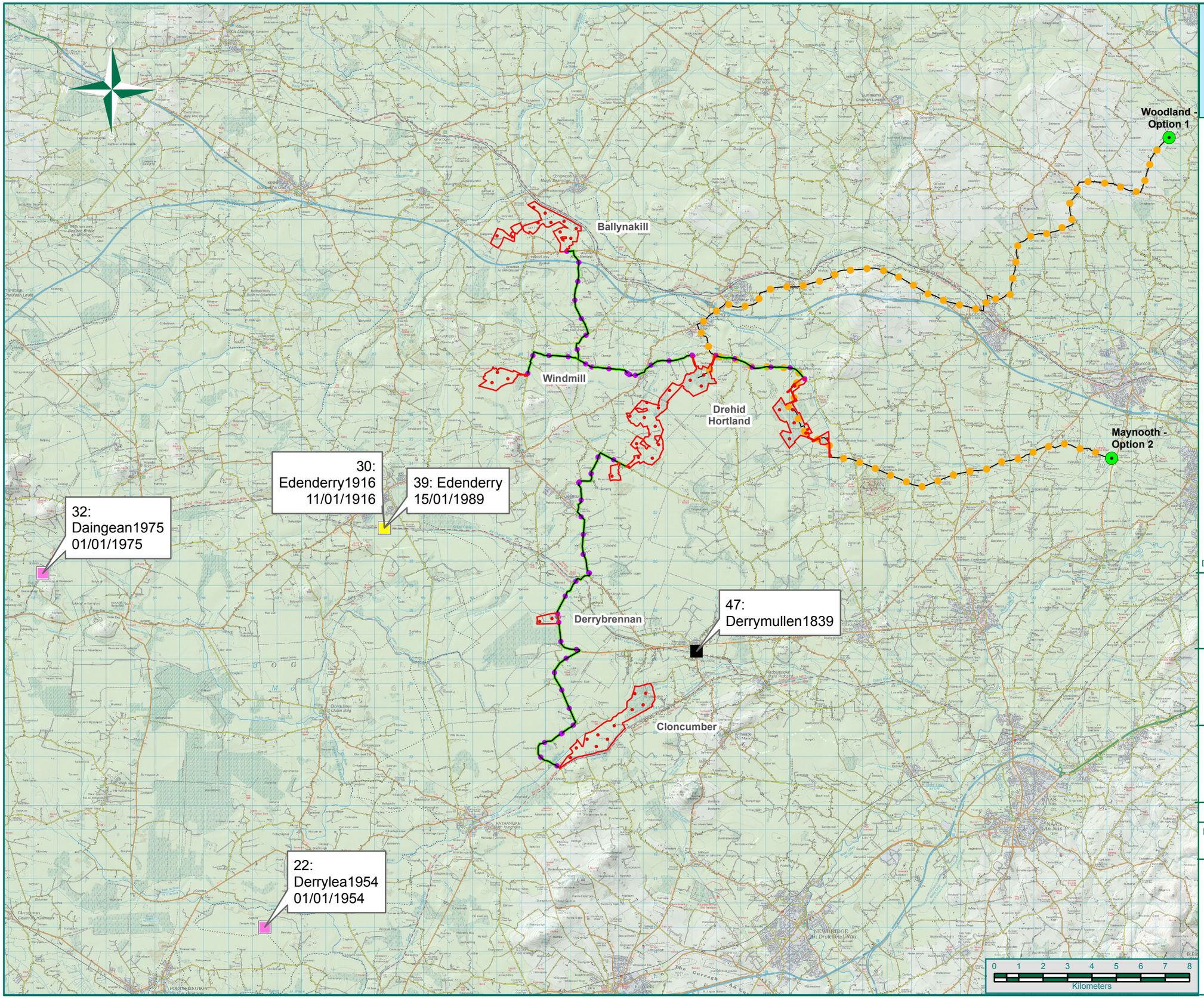
The peat stability assessment was carried out with particular reference to the following reports, papers and guide documents:

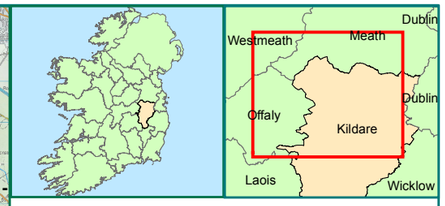
- General Soil Map of Ireland [2]
- Groundwater Protection Scheme for County Kildare [3]
- Geology of Kildare-Wicklow [4]
- DoEHLG Wind Farm Planning Guidelines [5]
- IWEA Best Practice Guidelines for the Irish Wind Energy Industry [6]
- IGI – Geology in Environmental Impact Statements [7]
- Scottish Executive – Peat Landslide Hazard and Risk Assessments [1]
- Welsh DoE - PPG14 – Development on Unstable Land [8]
- Landslides in Ireland [9]
- Guidelines for the risk management of peat slips on the construction of low volume/low cost roads over peat [10]
- Hydrological controls of surficial mass movements in peat [11]
- Slope Instability in Ireland with particular reference to peat failures [12]
- Peat slope failure in Ireland [13]
- Eurocode 7: Geotechnical Design [14]

The primary elements of the assessment include:

2. Undertaking a desk study assessment to obtain information available on existing geological conditions at the proposed site location
3. Undertaking a site reconnaissance to identify geological constraints across the site
4. Preparation of a Peat Stability Assessment Report.

R:\Map Production\2014\LE14\731\01\Workspace\EIS Maps\Chapter 8\LE14 731 01 _ Figure 4.1. Lanslide Incidence Map





Legend

- Turbine Location
- Wind Farm Cluster Boundary

GSI Landslide Incidence Database

- Debris
- Earth
- Mud
- Peat
- Peaty Soil
- Rock
- Unknown
- MV Cable Route (External to Cluster)
- Irish Grid Connection Points
- HV Cable Route

Date 19/03/2015

Name Of Client

Element Power Ireland

Name Of Job

Maighne Wind Farm

Title Of Figure

Landslide Incidence Map

Scale Used 1:150,000 @ A3

Figure No. 1.1

Rev A

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2. DESK STUDY

The soils present at Windmill comprise peat and glacial till overlying limestone bedrock at depth [15]. Due to the presence of peat deposits up to 4m thick at this site, it is considered that the potential for a landslide hazard exists at the proposed site.

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 and again in November 2014. No landslides have been identified on the GSI's landslides viewer [16] or on aerial photographs [17] for the study area or for the vicinity of the site, however several geohazards are shown on the GSI database in the region.

The GSI online 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 nearby landslides are shown in Figure 1.1.

A summary of the desk study information is presented in the following table.

Table 0.1: Desk Study Information Summary – Windmill

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 over glacial till	Lucan Formation limestone	Carbury Castle, 2km south	Kilglass Quarry, 1km north of Windmill	Edenderry, 7km southwest
25						
26						

3. SITE WALKOVER SURVEY

A site walkover survey was carried out by Fehily Timoney and Company (FTC) on 11 June 2013 and 18 November 2014 (after layout changes). The site walkover included a number of peat probes and gouge cores at the proposed turbine locations to confirm the depth, shear strength and classification of the peat across the site. Records were also made of the land use, peat depth, drainage features, geomorphology, slope, and any other features that could affect slope stability.

The findings of the site reconnaissance are presented on the site walkover inspection records in Appendix 3 of the EIS and summarised in the following table.

Table 0.1: Results of Hand Held Probes Undertaken During Site Walkover – Windmill

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 peat probing was carried out to identify areas of deep peat and assist in identifying areas of high risk. The co-ordinates for all investigation points were recorded using a GPS unit.

The peat recovered from the gouge cores was examined and described and included an assessment of the degree of humification and moisture content in accordance with the modified Von Post Classification Scale [18]. The peat depths recorded over the site varied between 1.8m to 4.0m. The results of the walkover investigations, along with photographs of the proposed turbine locations, are presented on the summary sheets in Appendix 3 of the EIS.

3.1 Peat Condition

The peat recovered from the gouge core is described as firm, spongy, brown fibrous or pseudo-fibrous (partly decomposed) peat with an average Von Post classification [18] of H7, which is a "*Strongly decomposed peat. Contains a high amount of amorphous material with faintly recognisable plant structure. When squeezed, about one half of the peat escapes between the fingers. The water, if any is released, is very dark brown and muddy*." The peat has an average Von Post moisture content of B3 (moderate moisture content). Details of the Von Post classification at each proposed turbine location are given in Appendix 3 of the EIS.

Hand vane shear tests were carried out by FTC at selected locations using a Geonor H-60 hand vane and provide indicative results for the in-situ shear strength of the peat at preliminary investigation stage. The uncorrected shear strength values recorded typically ranged from 28 to 60 kPa, with an average value of 35 kPa.

To account for the fibrous and heterogeneous nature of peat, a correction factor of 0.4 to 0.5 is recommended by Mesri & Ajlouni [19] for field vane shear strength values. In the absence of site-specific laboratory test data, a conservative correction factor of 0.4 has been applied to the field vane shear strengths. The corrected shear strengths range from 11 to 24 with an average value of 14 kPa.

3.2 Topography, Geomorphology and Drainage

The topography of the site is generally flat lying and level. Gentle slopes were locally recorded up to 1°.

Geomorphology and drainage features were noted from aerial photographs and during the site walkover. No areas of concern were noted from a slope stability point of view.

The drainage of the site is a highly modified one due to the historic use of the site for turf cutting which has resulted in drainage of large areas of land although wet areas of peat still exist away from the drains. The site is an open actively worked bog with man-made drainage ditches spaced approximately 10 m apart, running in a NE-SW direction.

4. GEOTECHNICAL QUALITATIVE HAZARD AND RISK ASSESSMENT

A qualitative hazard probability ranking matrix has been prepared for the site based on a combination of the site walkover details and site investigation results including topography, drainage, peat depth, Von Post classifications and assessed moisture content. The matrix outlines some of the possible contributing factors to peat movement. Each factor is assessed using the data acquired during the site walkover, site investigation and desk study and the scores are then used to provide a qualitative probability score to highlight any locations that could be at a greater risk of peat movement.

Table 1.3 outlines the contributing factors and hazard scoring system. Table 1.4 shows the hazard probability ranking scores at each proposed turbine locations.

The results of the assessment suggest that the land at the proposed turbine locations T24 to T26 and along the proposed new floating access tracks rank as 'Low' risk of peat instability.

Table 4.1: Landslide Hazard Probability Assessment Matrix [10]

Contributing Factor	Method of Assessment	Value/Indicator	Probability of contributing to peat movement	Hazard Score
Moisture Content of Peat	Visual (Von Post Scale)	B1 (dry)	Negligible	1
		B2 (damp)	Unlikely	2
		B3 (moist)	Probable	3
		B4 (wet)	Likely	4
		B5 (very wet)	Very likely	5
Degree of Humification	Visual (Von Post Scale)	H1-H2 (fibrous, clear water)	Negligible	1
		H3-H4 (fibrous, brown water)	Unlikely	2
		H5-H6 (pseudo-fibrous)	Probable	3
		H7-H8 (amorphous, some fibres)	Likely	4
		H9-H10 (amorphous paste)	Very likely	5
Peat Depth	Peat probes and Trial Pits	0 - 0.5m	Negligible	1
		0.6 - 1.0m	Unlikely	2
		1.1 - 1.5m	Probable	3
		1.6 - 2.0m	Likely	4
		> 2.0m	Very likely	5
Peat Strength (corrected)	Hand Vane Tests	>20 kPa	Negligible	1
		16 - 20 kPa	Unlikely	2
		11 - 15 kPa	Probable	3
		6 - 10 kPa	Likely	4
		0 - 5 kPa	Very likely	5
Slope Angle	Measured from contours	0 to 3	Negligible	1
		4 to 9	Unlikely	2
		10 to 15	Probable	3
		16 to 20	Likely	4
		20 +	Very likely	5
Cracking or evidence of slips	Visual	None evident	Negligible	1
		Few	Unlikely	2
		Frequent	Probable	3
		Many	Likely	4
		Continuous/significant	Very likely	5
Local Hydrology (gulleys, channels hags, pools, flushes, water courses)	Visual	None evident	Negligible	1
		Few	Unlikely	2
		Frequent	Probable	3
		Many	Likely	4

		Continuous/significant	Very likely	5
Weather	Weather Records	Previous very dry period in excess of 5yrs	Negligible	1
		Previous very dry period within 4 - 5yrs	Unlikely	2
		Previous very dry period within 3 - 4yrs	Probable	3
		Previous very dry period within 2 - 3yrs	Likely	4
		Previous very dry period within 1 - 2yrs	Very likely	5

Combined Hazard Score	Probability
33 to 40	Very High
28 to 32	High
23 to 27	Medium
18 to 22	Low
13 to 17	Very Low
8 to 12	Extremely Low

Table 4.2: Landslide Hazard Probability Ranking – Windmill

Factor	T24	T25	T26	Access Tracks
Moisture Content of Peat	4	4	4	4
Degree of Humification	4	3	3	4
Peat Depth	5	4	5	5
Peat Strength	4	2	2	2
Slope Angle	1	1	1	1
Cracking or evidence of slips	1	1	1	1
Local Hydrology (gulleys, channels hags, pools, flushes, water courses, blocked drains)	2	2	2	2
Weather	1	1	1	1
Total Scores	**22**	**18**	**19**	**20**

Combined Hazard Score	Probability
33 to 40	Very High
28 to 32	High
23 to 27	Medium
18 to 22	Low
13 to 17	Very Low
8 to 12	Extremely Low

5. QUANTITATIVE SLOPE STABILITY ANALYSES

Total stress analyses for translational slides within the peat have been undertaken in accordance with the principles of Eurocode 7-1: Geotechnical Design (IS EN 1997-1) Design Approach 3 [14]. This design approach is considered to be the most logical approach for slope stability analysis as it includes partial factors for both material properties and variable loads (for example traffic loads).

In accordance with the principles of Eurocode 7, rather than using a global factor of safety as per previous design codes, partial factors are applied to the chosen characteristic values to obtain design values. Actions (influences) are multiplied by the partial factors, while resistances are divided by the partial factors.

Table 1.5 shows the partial factors that have been applied to the characteristic values to give the design values used in the slope stability analyses.

Table 5.1: IS EN 1997-1 Partial Factors Used to Derive Design Parameters

Set	Partial Factor		Parameter
M2	γ_{cu}	1.4	Corrected undrained shear strength
	γ_{γ}	1	Soil density
A2	γ_{Q}	1.3	Traffic Loading (variable unfavourable)
R3	$\gamma_{R;e}$	1	Earth resistance

In accordance with Eurocode 7, geotechnical checks must be carried out to ensure that the resistance preventing a slide is greater than or equal to the actions which cause a slide, i.e.:

$$E_d <= R_d$$

Where

E_d = Sum of design actions
R_d = Sum of design resistances

In order to verify that this condition is met, the following formula has been applied, using the design values obtained using the partial factors given in Table 1.5. The resulting "safety ratio" must be equal or greater than 1.0 in order to verify that the above condition is met. i.e.:

$$\frac{Cu}{\gamma z \cos\beta \sin\beta} => 1.0$$

Where

Cu = corrected shear strength of peat (value obtained from hand shear vane)
γ = density of peat (normally assumed to be 1.0 Mg/m^3)
z = thickness of peat layer in metres (measured from probes/trial pits)
β = slope angle at turbine location

5.1 Limitations of Slope Stability Analyses

The application of traditional stability analysis should therefore be used with caution due to the compressibility of peat and because the analysis does not account for the fibrous nature of the peat.

Cognisant of the organic and highly variable nature of peat, uncertainties related to the directional dependence on which the strength of peat is based, the reliability of traditional methods of field shear strength measurement, presence of gas within the peat and the combination of factors (some not quantifiable or applicable in a calculation matrix) triggering slope failure, the failure mechanisms being employed in the traditional analysis may not necessarily be representative of in-situ failure mechanisms.

Despite the limitations outlined above, this method of slope analysis is still considered useful as an indicator of possible areas of instability and is in accordance with current industry best practice.

5.2 Shear Strength Values

The shear strength values were obtained using a Geonor H-60 hand-held shear vane with a correction factor of 0.4 based on published correlation data [19]. The results are considered conservative and are therefore appropriate for preliminary analysis of the slope sections for preliminary design purposes.

Shear strength at the base of a peat mass is often the governing factor in peat stability and analysis; therefore shear strength values chosen for the stability analysis are based on a characteristic value representative of the shear strength of the peat recorded generally within 0.5m of the base of the peat body in the vicinity of the turbines, unless this is significantly higher than the typical shear strengths recorded at shallower depths, in which case the lower value is normally used.

Based on the field vane shear strength data, a corrected shear strength values of 11 kPa was determined as the characteristic value for the slope stability analysis. No differentiation between the upper acrotelm (where present) and lower catotelm layers has been assumed for the purpose of the stability analysis in order to provide a more conservative analysis.

5.3 Slope Stability Analyses Results

The calculated in-situ safety ratio at the proposed turbine locations T24 to T26 is presented in Table 1.6 along with the typical peat depth, characteristic corrected shear strength and slope angle. A ratio of less than 1.0 indicates that the slope currently has an inadequate factor of safety against failure and therefore is potentially unstable. Ratios greater than 1.0 indicate an adequate factor of safety against failure and are considered stable. No measurable depth of peat was recorded at the other turbine locations hence they are not included here.

In order to attempt to replicate the effect of traffic loading or stockpiling on the peat during construction, a surcharge load of 20 kPa has been applied to the calculations. This is the equivalent load of approximately 2m of peat or the effect of a loading from the proposed new floating road. The resulting safety ratio is also presented in Table 1.6. This is considered to represent the worst case scenario during construction and operation.

Table 5.1: Slope Stability Inputs and Calculated Safety Ratios

Location	Slope angle	Peat Depth	Corrected Peat Strength	Safety Ratio (no surcharge)	Safety Ratio (20kPa surcharge)
T24	1°	4.0 m	11 kPa	11.2	6.8
T25	1°	1.8 m	11 kPa	25.0	10.2
T26	1°	2.3 m	11 kPa	19.6	9.2

Location	Slope angle	Peat Depth	Corrected Peat Strength	Safety Ratio (no surcharge)	Safety Ratio (20kPa surcharge)
Access tracks	1°	4.0 m	11 kPa	11.2	6.8

5.4 Slope Stability Analyses Conclusions

Based on the analyses presented, the development areas are considered stable. The results give rise to in-situ safety ratios for translational slides which are above the minimum required value for all turbine locations analysed.

It should be noted that vehicular access to areas of deep peat (>1 m) during construction will be restricted to low ground pressure vehicles, with all construction vehicles travelling on existing access tracks whenever possible. Nevertheless the slope stability analyses show that the site is expected to remain stable before, during and after construction.

Given the limitations of measuring the shear strength of peat and the variability of the ground conditions (slope, peat depth, groundwater levels etc), the slope stability calculations should not be regarded as definitive. Rather, where the calculated safety ratio is close to 1.0, this is taken as an indicator of a higher risk area requiring special consideration during detailed design. As shown in Table 1.6, no areas of high risk were identified. If areas of deeper peat are encountered, care should be taken not to load or surcharge the peat in these areas by stockpiling or with the use of heavy machinery.

6. CONCLUSIONS & RECOMMENDATIONS

The desk study has identified that the site comprises limestone bedrock overlain by cut peat overlying glacial till.

A site walkover was undertaken which comprised peat probes at the proposed turbine locations and gouge auger sampling of the peat. Hand vane tests were also undertaken at the proposed turbine locations and along the proposed access tracks to determine the lateral and vertical variation of shear strength across the site. The investigation found a maximum depth of peat of 4 m. Additionally, the gouge core sample found that the majority of the peat was highly decomposed with a moderate moisture content and a low shear strength.

A qualitative landslide hazard risk analysis was undertaken using information gained from the gouge cores, desk study and site walkover. The proposed turbine locations ranked as 'Low' risk.

A quantitative translational landslide stability analysis was also undertaken using information gained from the site walkover, in particular slope angles and peat shear strengths. The results showed that the safety ratios at the turbine locations and along the proposed access tracks were well above the minimum safety factor required for long term stability.

In light of the information gained to date from the desk study, site reconnaissance and the ground investigations, the site is considered to be stable in its current and future condition.

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Appendix G1B

Drehid-Hortland Cluster

APPENDIX G1B

MAIGHNE WIND FARM – DREHID-HORTLAND CLUSTER

PEAT STABILITY ASSESSMENT

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0	Issue for Planning	AG/MT	ME	COD	19.02.15

Client: Element Power

Keywords: Maighne wind farm, geotechnical, ground investigation, peat stability, Drehid-Hortland cluster

Abstract: A peat stability assessment has been undertaken to inform the risks associated with peat instability at the proposed turbine locations within the Drehid-Hortland Cluster. A site walkover was undertaken which included a series of peat probes, gouge cores and shear vane tests. A qualitative risk assessment was undertaken in addition to a quantitative slope stability assessment. The results showed that the turbine locations are assessed as being stable.

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1. INTRODUCTION

A site walkover was undertaken for the proposed Drehid-Hortland Wind Farm Cluster in June 2013 and later in November and December 2014 (following layout changes) to determine the presence/depth of peat and/or soft soils on the site along with slope angles and evidence of geotechnical instability.

The potential for a landslide risk is defined in the Scottish Executive Best Practice Guide for Proposed Electricity Generation Developments[1] as the following:

- *Peat is present at the development site in excess of 0.5 m depth,*

and;

- *There is evidence of current or historical landslide activity of the site,*

or;

- *Slopes > 2º are present on-site,*

or;

- *The works will impinge on the peat covered areas and cannot be relocated to avoid peat covered areas.*

The information obtained during the walkover and desk study shows that parts of the Drehid-Hortland cluster are covered by deposits of basin peat, although harvesting of the peat has taken place over most of the peat deposits. The desk study found no records or evidence of historical landslips on the site. As peat is present (at depths in excess of 0.5m on the site) and the works will impinge on peat covered areas, there is the potential for landslide hazard at the site and therefore a peat stability assessment was considered necessary.

This report presents a peat stability assessment for the proposed turbine cluster at Drehid- Hortland.

1.1 The Site

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

The elevation of the site is approximately 70m to 90m OD. The land use on the site comprises forestry, grazing and arable land use.

1.2 Methodology for the Peat Stability Assessment

The peat stability assessment was carried out with particular reference to the following reports, papers and guide documents:

- General Soil Map of Ireland[2]
- Groundwater Protection Scheme for County Kildare[3]
- Geology of Kildare-Wicklow [4]
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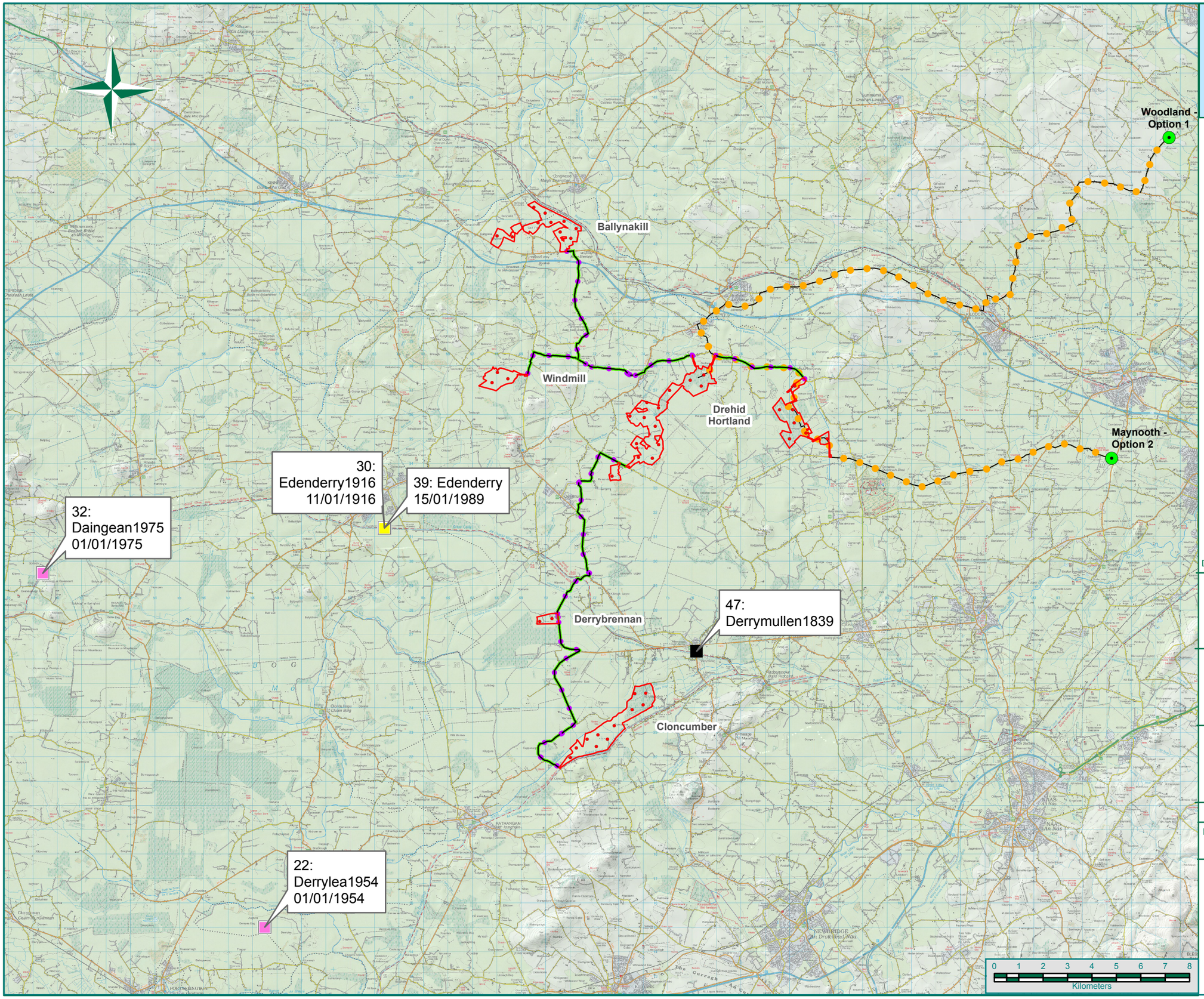
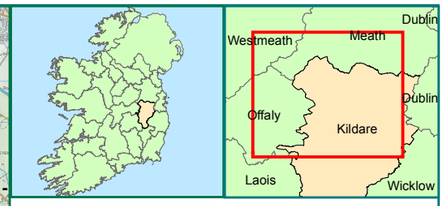
Consideration was also given to consultation responses received from the GSI.

The primary elements of the assessment include:

2. Undertaking a desk study assessment to obtain information available on existing geological conditions at the proposed site location.
3. Undertaking a site reconnaissance to identify geological constraints across the site.
4. Preparation of a Peat Stability Assessment Report.

R:\Map Production\2014\LE14\731\01\Workspace\EIS Maps\Chapter 8\LE14 731 01 _ Figure 4.1. Lanslide Incidence Map





Legend

- Turbine Location
- Wind Farm Cluster Boundary

GSI Landslide Incidence Database

- Debris
- Earth
- Mud
- Peat
- Peaty Soil
- Rock
- Unknown
- MV Cable Route (External to Cluster)
- Irish Grid Connection Points
- HV Cable Route

Date 19/03/2015

Name Of Client

Element Power Ireland

Name Of Job

Maighne Wind Farm

Title Of Figure

Landslide Incidence Map

Scale Used 1:150,000 @ A3

Figure No. 1.1

Rev A

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2. DESK STUDY

The soils present at the Drehid-Hortland cluster comprise cutover peat, alluvium and glacial till overlying Calp and limestone bedrock at depth[15]. Due to the presence of deep peat deposits, it is considered that the potential for a landslide hazard exists at the proposed site.

An initial step in the assessment of pre-existing landslide risk is the determination of landslide history in the area. No landslides have been identified on the GSI's landslides viewer[16] or on aerial photographs[17] for the study area or close to the site, however several landslides are shown on the GSI database nearby. The GSI database shows that the nearest recorded geohazard is near Derrymullen, some 6km south of Timahoe as shown in Figure 1.

A summary of the desk study information is given in Table 1.1 below.

Table 2.1: Desk Study Information Summary

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)
T11	Mature Forestry	Cut Peat	Lucan Formation Limestone	Carbury Castle 4.5km west of Drehid St Peters Well, 1km south of Hortland Boundary	Ballynamulla-gh Quarry 1.5km west of Drehid boundary	Derrymullen, 6km south of Timahoe
T12	Peat Bog	Cut Peat				
T13						
T14	Harvested Forestry					
T15	Scrubland					
T16	Young Forestry					
T17		Limestone Till				
T18	Grassland	Cut Peat				
T19		Limestone Till				
T20		Cut Peat				
T21		Limestone Till				
T22		Cut Peat				
T23		Limestone Till				
T40	Forestry	Cut peat				
T41	Grassland					

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)
T42	Forestry					
T43						
T44						
T45						
T46	Grassland					
T47		Limestone Till				

3. SITE WALKOVER SURVEY

A site walkover survey was carried out by Fehily Timoney and Company (FTC) initially on 6 June, 7 June and 12 June 2013, and following layout changes, on 4 November, 5 November, 25 November and 2 December 2014. The site walkover included a number of peat probes and gouge cores at the proposed turbine locations to confirm the depth, shear strength and classification of the peat across the site. Records were also made of the land use, peat depth, drainage features, geomorphology, slope, and any other features that could affect slope stability.

The findings of the site reconnaissance are presented in Appendix 3 of the EIS and summarised below.

Table 3.1: Results of Hand Held Probes Undertaken During 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
T41	-	3°NW	Soft grassland
T42	2.5	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 Access Tracks	4.0	1°	Forestry
Hortland Access tracks	2.7	2°	Forestry

The topography is categorised as predominantly flat, level ground with localised slopes up to 3°. The site is categorised by forestry to the north and farmland to the south.

The peat probing was carried out to identify areas of deep peat and assist in identifying areas of high risk. The co-ordinates for all investigation points was marked using GPS units.

The peat recovered from the gouge cores was examined and described and included an assessment of the degree of Humification and Moisture Content in accordance with the modified Von Post Classification Scale[18]. The results of the walkover investigations are presented in Appendix 3 of the EIS.

3.1 Peat Condition

The peat recovered from the gouge cores is described as firm, spongy, brown fibrous or pseudo-fibrous (partly decomposed) peat with an average Von Post classification[18] of H4 in the shallower peats, which is a "*Moderately decomposed peat which, when squeezed, releases very "muddy" water with a very small amount of amorphous granular peat escaping between the fingers. The structure of the plant remains is quite indistinct although it is still possible to recognize certain features. The residue is very pasty .Moderate decomposed peat".* In the areas of Deeper peat a typical Von Post classification of H7 which is a *"Highly decomposed peat. Contains a lot of amorphous material with very faintly recognizable plant structure. When squeezed, about one-half of the peat escapes between the fingers. The water, if any is released, is very dark and almost pasty"* The peat has an average Von Post moisture content of B2 (Low moisture content). Details of the Von Post classification at each proposed turbine location are given in Appendix 3 of the EIS.

Hand vane shear tests were carried out by FTC at selected locations using a Geonor H-60 hand vane and provide indicative results for the in-situ shear strength of the peat at preliminary investigation stage. The uncorrected shear strength values recorded typically ranged from 5 to 50 kPa, with an average value of 32 kPa.

To account for the fibrous and heterogeneous nature of peat, a correction factor of 0.4 to 0.5 is recommended by Mesri & Ajlouni[19] for field vane shear strength values. In the absence of site-specific laboratory test data, a conservative correction factor of 0.4 has been applied to the field vane shear strengths during the slope stability calculations. The corrected shear strengths range from 7 to 20 kPa with an average value of 11 kPa.

3.2 Topography, Geomorphology and Drainage

The topography of the site is generally gently sloping. Gentle slopes were locally recorded up to 3°.

Geomorphology and drainage features were noted from aerial photographs and during the site walkover. No areas of concern were noted from a slope stability point of view.

The drainage of the site is highly modified with areas of forestry having extensive shallow drains present. The grassland areas have previously been drained using land drainage and deep surface drains were evident at most locations.

4. GEOTECHNICAL QUALITATIVE HAZARD AND RISK ASSESSMENT

A qualitative hazard probability ranking matrix has been prepared for the site based on a combination of the site walkover details and site investigation results including topography, drainage, peat depth, Von Post classifications and assessed moisture content. The matrix outlines some of the possible contributing factors to peat movement. Each factor is assessed using the data acquired during the site walkover, site investigation and desk study and the scores are then used to provide a qualitative probability score to highlight any locations that could be at a greater risk of peat movement.

Table 1.3 outlines the contributing factors and hazard scoring system. Tables 1.4a and 1.4b show the hazard probability ranking scores at each proposed turbine locations.

The results of the assessment suggest that the land at the proposed turbine locations in peat rank as 'Very Low' to 'Low' risk of peat instability. The remaining locations may be assumed to have negligible risk of peat instability due to having 0.5m of peat or less at these locations.

Table 4.1: Landslide Hazard Probability Assessment Matrix[10]

Contributing Factor	Method of Assessment	Value/Indicator	Probability of contributing to peat movement	Hazard Score
Moisture Content of Peat	Visual (Von Post Scale)	B1 (dry)	Negligible	1
		B2 (damp)	Unlikely	2
		B3 (moist)	Probable	3
		B4 (wet)	Likely	4
		B5 (very wet)	Very likely	5
Degree of Humification	Visual (Von Post Scale)	H1-H2 (fibrous, clear water)	Negligible	1
		H3-H4 (fibrous, brown water)	Unlikely	2
		H5-H6 (pseudo-fibrous)	Probable	3
		H7-H8 (amorphous, some fibres)	Likely	4
		H9-H10 (amorphous paste)	Very likely	5
Peat Depth	Peat probes and Trial Pits	0 - 0.5m	Negligible	1
		0.6 - 1.0m	Unlikely	2
		1.1 - 1.5m	Probable	3
		1.6 - 2.0m	Likely	4
		> 2.0m	Very likely	5
Peat Strength (corrected)	Hand Vane Tests	>20 kPa	Negligible	1
		16 - 20 kPa	Unlikely	2
		11 - 15 kPa	Probable	3
		6 - 10 kPa	Likely	4
		0 - 5 kPa	Very likely	5
Slope Angle	Measured from contours	0 to 3	Negligible	1
		4 to 9	Unlikely	2
		10 to 15	Probable	3
		16 to 20	Likely	4
		20 +	Very likely	5
Cracking or evidence of slips	Visual	None evident	Negligible	1
		Few	Unlikely	2
		Frequent	Probable	3
		Many	Likely	4

		Continuous/significant	Very likely	5
Local Hydrology (gulleys, channels hags, pools, flushes, water courses)	Visual	None evident	Negligible	1
		Few	Unlikely	2
		Frequent	Probable	3
		Many	Likely	4
		Continuous/significant	Very likely	5
Weather	Weather Records	Previous very dry period in excess of 5yrs	Negligible	1
		Previous very dry period within 4 - 5yrs	Unlikely	2
		Previous very dry period within 3 - 4yrs	Probable	3
		Previous very dry period within 2 - 3yrs	Likely	4
		Previous very dry period within 1 - 2yrs	Very likely	5

Combined Hazard Score	Probability
33 to 40	Very High
28 to 32	High
23 to 27	Medium
18 to 22	Low
13 to 17	Very Low
8 to 12	Extremely Low

Table 4.2a: Landslide Hazard Probability Ranking – Drehid

Factor	T12	T13	T14	T15	Sub-station	Access Tracks
Moisture Content of Peat	4	3	2	3	4	4
Degree of Humification	4	3	3	3	4	4
Peat Depth	5	5	2	1	5	5
Peat Strength	4	4	3	4	4	4
Slope Angle	1	1	1	1	1	1
Cracking or evidence of slips	1	1	1	1	1	1
Local Hydrology (gulleys, channels hags, pools, flushes, water courses, blocked drains)	1	1	1	1	1	1
Weather	1	1	1	1	1	1
Total Scores	**21**	**19**	**14**	**15**	**21**	**21**

Combined Hazard Score	Probability
33 to 40	Very High
28 to 32	High
23 to 27	Medium
18 to 22	Low
13 to 17	Very Low
8 to 12	Extremely Low

Table 4.2b: Landslide Hazard Probability Ranking – Hortland

Factor	Hortland T40	Hortland T42	Hortland T43	Hortland T44	Access Tracks
Moisture Content of Peat	2	3	2	3	3
Degree of Humification	3	3	3	3	3
Peat Depth	2	5	2	5	5
Peat Strength	4	4	2	4	4
Slope Angle	1	1	1	1	1
Cracking or evidence of slips	1	1	1	1	1
Local Hydrology (gulleys, channels hags, pools, flushes, water courses, blocked drains)	1	1	1	1	1
Weather	1	1	1	1	1
Total Scores	**15**	**19**	**13**	**19**	**19**

Combined Hazard Score	Probability
33 to 40	Very High
28 to 32	High
23 to 27	Medium
18 to 22	Low
13 to 17	Very Low
8 to 12	Extremely Low

5. QUANTITATIVE SLOPE STABILITY ANALYSES

Total stress analyses for translational slides within the peat have been undertaken in accordance with the principles of Eurocode 7-1: Geotechnical Design (IS EN 1997-1) Design Approach 3[14]. This design approach is considered to be the most logical approach for slope stability analysis as it includes partial factors for both material properties and variable loads (for example traffic loads).

In accordance with the principles of Eurocode 7, rather than using a global factor of safety as per previous design codes, partial factors are applied to the chosen characteristic values to obtain design values. Actions (influences) are multiplied by the partial factors, while resistances are divided by the partial factors.

Table 1.5 shows the partial factors that have been applied to the characteristic values to give the design values used in the slope stability analyses.

Table 5.1: IS EN 1997-1 Partial Factors Used to Derive Design Parameters

Set	Partial Factor		Parameter
M2	γ_{cu}	1.4	Corrected undrained shear strength
	γ_{γ}	1	Soil density
A2	γ_{Q}	1.3	Traffic Loading (variable unfavourable)
R3	$\gamma_{R;e}$	1	Earth resistance

In accordance with Eurocode 7, geotechnical checks must be carried out to ensure that the resistance preventing a slide is greater than or equal to the actions which cause a slide, i.e.:

$E_d <= R_d$

Where

E_d = Sum of design actions
R_d = Sum of design resistances

In order to verify that this condition is met, the following formula has been applied, using the design values obtained using the partial factors given in Table 1.5. The resulting "safety ratio" must be equal or greater than 1.0 in order to verify that the above condition is met. i.e.:

$$\frac{Cu}{\gamma z \cos\beta \sin\beta} => 1.0$$

Where

Cu = corrected shear strength of peat (value obtained from hand shear vane)
γ = density of peat (normally assumed to be 1.0 Mg/m^3)
z = thickness of peat layer in metres (measured from probes/trial pits)
β = slope angle at turbine location

5.1 Limitations of Slope Stability Analyses

The application of traditional stability analysis should therefore be used with caution due to the compressibility of peat and because the analysis does not account for the fibrous nature of the peat.

Cognisant of the organic and highly variable nature of peat, uncertainties related to the directional dependence on which the strength of peat is based, the reliability of traditional methods of field shear strength measurement, presence of gas within the peat and the combination of factors (some not quantifiable or applicable in a calculation matrix) triggering slope failure, the failure mechanisms being employed in the traditional analysis may not necessarily be representative of in-situ failure mechanisms.

Despite the limitations outlined above, this method of slope analysis is still considered useful as an indicator of possible areas of instability and is in accordance with current industry best practice.

5.2 Shear Strength Values

The shear strength values were obtained using a Geonor H-60 hand-held shear vane with a correction factor of 0.4 based on published correlation data[19]. The results are considered conservative and are therefore appropriate for preliminary analysis of the slope sections for preliminary design purposes.

Shear strength at the base of a peat mass is often the governing factor in peat stability and analysis; therefore shear strength values chosen for the stability analysis are based on a characteristic value representative of the shear strength of the peat recorded generally within 0.5 m of the base of the peat body in the vicinity of the turbines, unless this is significantly higher than the typical shear strengths recorded at shallower depths, in which case the lower value is normally used.

Based on the field vane shear strength data at the base of the peat, corrected shear strength values of 7 to 20kPa were determined as the characteristic values for the slope stability analysis. No differentiation between the upper acrotelm (where present) and lower catotelm layers has been assumed for the purpose of the stability analysis in order to provide a more conservative analysis.

5.3 Slope Stability Analyses Results

The calculated in-situ safety ratio at the proposed turbines located in peat in the Drehid-Hortland cluster is presented in Table 1.6 along with the typical peat depth, characteristic corrected shear strength and slope angle. A ratio of less than 1.0 indicates that the slope currently has an inadequate factor of safety against failure and therefore is potentially unstable. Ratios greater than 1.0 indicate an adequate factor of safety against failure and are considered stable. No measurable depth of peat was recorded at the other turbine locations hence they are not included here.

In order to attempt to replicate the effect of traffic loading or temporary stockpiling on the peat during construction, a surcharge load of 20 kPa has been applied to the calculations. The resulting safety ratio is also presented in Table 1.6. This is considered to represent the worst case scenario during construction.

Table 5.2: Slope Stability Inputs and Safety Ratios

Location	Slope angle	Peat Depth	Corrected Peat Strength	Safety Ratio (no surcharge)	Safety Ratio (20kPa surcharge)
Drehid T12	0.5°	3.4 m	8 kPa	19.2	10.9
Drehid T13	1°	3.0 m	8 kPa	10.9	5.9
Drehid T14	2°	0.8 m	13 kPa	33.3	7.8
Drehid T15	1°	0.5 m	8 kPa	65.5	10.6
Drehid Substation	0.5°	3.0 m	8 kPa	21.8	11.7
Drehid Access Tracks	1°	4.0	8kPa	8.2	5.0
Hortland T40	2°	0.8 m	10 kpa	25.6	6.0
Hortland T42	3°	2.5 m	10 kpa	5.5	2.7
Hortland T43	2°	0.9 m	16 kpa	36.4	9.4
Hortland T44	3°	2.5 m	10 kpa	5.5	2.7
Hortland Access Tracks	2°	2.7m	10 kPa	7.6	3.9

5.4 Slope Stability Analyses Conclusions

Based on the analyses presented, the development areas are considered stable. The results give rise to in-situ safety ratios for translational slides which are well above the minimum required value for all turbine and infrastructure locations analysed.

It should be noted that vehicular access to areas of deep peat (>1 m) in advance of construction will be restricted to low ground pressure vehicles, with all construction vehicles travelling on existing access tracks wherever possible.

Given the limitations of measuring the shear strength of peat and the variability of the ground conditions (slope, peat depth, groundwater levels etc), the slope stability calculations should not be regarded as definitive. Rather, where the calculated safety ratio is close to 1.0, this should be taken as an indicator of a higher risk area requiring special consideration during detailed design. In areas of deeper peat which result in a slightly elevated risk of instability, care should be taken not to load or surcharge the peat in these areas by stockpiling or with the use of heavy machinery[19].

6. CONCLUSIONS & RECOMMENDATIONS

The desk study has identified that the site comprises limestone bedrock overlain by basin peat, glacial till, sand & gravel or alluvium.

A site walkover was undertaken which comprised peat probes at the proposed turbine locations and gouge auger sampling of the peat. Hand vane tests were also undertaken at the proposed turbine locations to determine the lateral and vertical variation of shear strength across the site. The investigation found a maximum depth of peat of 4m. Additionally, the gouge core sample found that the majority of the peat was highly decomposed with a moderate moisture content and a low shear strength.

A qualitative landslide hazard risk analysis was undertaken using information gained from the gouge cores, desk study and site walkover. The proposed turbine locations in peat ranked as 'Very Low' to 'Low' risk of peat instability. The remaining locations can be assumed to have negligible risk of peat instability due to having 0.5m or less of peat along with low slopes.

A quantitative translational landslide stability analysis was also undertaken using information gained from the site walkover, in particular slope angles and peat shear strengths. The results showed that the safety ratios at the infrastructure locations were above the minimum safety factor required for long term stability. The addition of a loading of 20kPa to model the effect of heavy traffic or a floating road also gives an adequate safety ratio for long-term stability.

In light of the information gained to date from the desk study, site reconnaissance and the ground investigations, the site is considered to be stable before, during and after construction.

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Appendix G1C

Cloncumber Cluster

APPENDIX G1C

MAIGHNE WIND FARM –CLONCUMBER CLUSTER

PEAT STABILITY ASSESSMENT

User is Responsible for Checking the Revision Status of This Document

Rev. Nr.	Description of Changes	Prepared by:	Checked by:	Approved by:	Date:
0	Issue for Planning	AG/MT	COD	COD	19/02/15

Client: Element Power Ireland Ltd.

Keywords: Maighne wind farm, geotechnical, ground investigation, peat stability, Cloncumber Cluster

Abstract: A peat stability assessment has been undertaken to inform the risks associated with peat instability at the proposed turbine locations within the Cloncumber Cluster. A site walkover was undertaken which included a series of peat probes, gouge cores and shear vane tests. A qualitative risk assessment was undertaken in addition to a quantitative slope stability assessment. The results showed that the turbine locations are assessed as being stable.

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1. INTRODUCTION

A site walkover was undertaken for the proposed Cloncumber Cluster on 12 June 2013 to determine the presence/depth of peat and/or soft soils on the site along with slope angles and evidence of geotechnical instability.

The potential for a landslide risk is defined in the Scottish Executive Best Practice Guide for Proposed Electricity Generation Developments [1] as the following:

- *"Peat is present at the development site in excess of 0.5 m depth,*

and;

- *There is evidence of current or historical landslide activity of the site,*

or;

- *Slopes > 2º are present on-site,*

or;

- *The works will impinge on the peat covered areas and cannot be relocated to avoid peat covered areas".*

The information obtained during the walkover and desk study shows that parts of the Cloncumber cluster are covered by deposits of basin peat, although harvesting of the peat has taken place over most of the peat deposits. The desk study found no records or evidence of historical landslips on the site. As peat is present (at depths in excess of 0.5 m) and works will impinge on peat covered areas, there is the potential for landslide hazard within this cluster and therefore a peat stability assessment was considered necessary.

This report presents a peat stability assessment for the nine proposed turbines at Cloncumber.

1.1 The Site

The site is located on young, mature and harvested forestry overlying peat and soft to firm grassland in County Kildare. The site is shown to be on 2 distinct parcels of land and these are located between approximately 3 km and 6 km south west of Allenwood county Kildare.

The elevation of the site is approximately 70 m OD. The land use on the site comprises semi mature, mature and harvested forestry and soft to firm pastureland.

1.2 Methodology for the Peat Stability Assessment

The peat stability assessment was carried out with particular reference to the following reports, papers and guide documents:

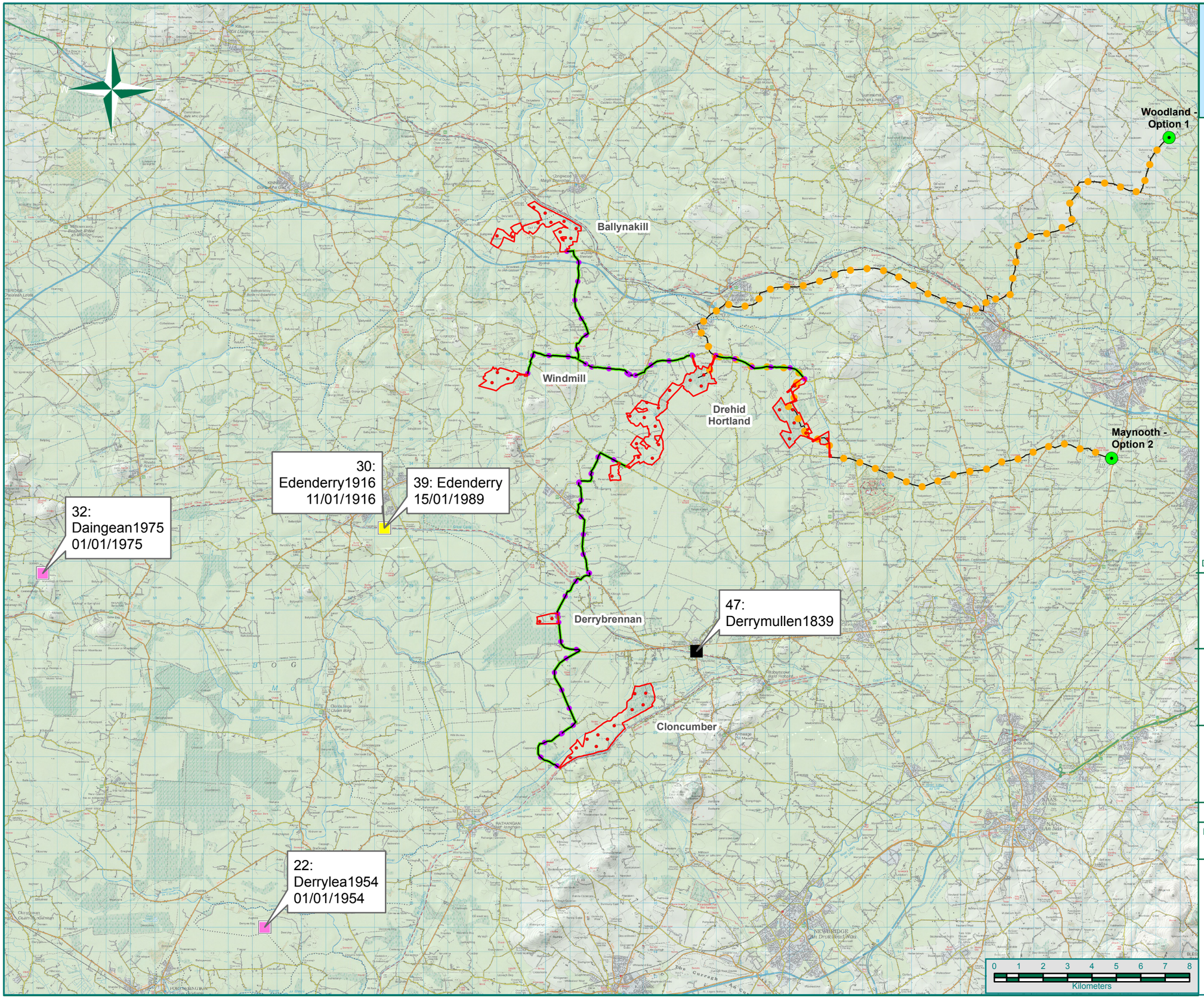
- General Soil Map of Ireland [2]
- Groundwater Protection Scheme for County Kildare [3]
- Geology of Kildare-Wicklow [4]
- DoEHLG Wind Farm Planning Guidelines [5]
- IWEA Best Practice Guidelines for the Irish Wind Energy Industry [6]
- IGI – Geology in Environmental Impact Statements [7]
- Scottish Executive – Peat Landslide Hazard and Risk Assessments [1]
- Welsh DoE - PPG14 – Development on Unstable Land [8]
- Landslides in Ireland [9]
- Guidelines for the risk management of peat slips on the construction of low volume/low cost roads over peat [10]
- Hydrological controls of surficial mass movements in peat [11]
- Slope Instability in Ireland with particular reference to peat failures [12]
- Peat slope failure in Ireland [13]
- Eurocode 7: Geotechnical Design [14]

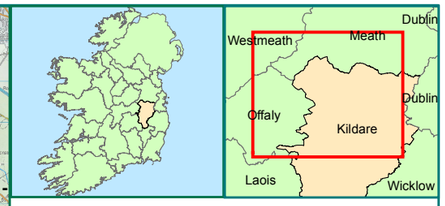
Consideration was also given to consultation responses received from the GSI.

The primary elements of the assessment include:

2. Undertaking a desk study assessment to obtain information available on existing geological conditions at the proposed site location.
3. Undertaking a site reconnaissance to identify geological constraints across the site.
4. Preparation of a Peat Stability Assessment Report.

R:\Map Production\2014\LE14\731\01\Workspace\EIS Maps\Chapter 8\LE14 731 01 _ Figure 4.1. Lanslide Incidence Map





Legend

- Turbine Location
- Wind Farm Cluster Boundary

GSI Landslide Incidence Database

- Debris
- Earth
- Mud
- Peat
- Peaty Soil
- Rock
- Unknown
- MV Cable Route (External to Cluster)
- Irish Grid Connection Points
- HV Cable Route

Date 19/03/2015

Name Of Client

Element Power Ireland

Name Of Job

Maighne Wind Farm

Title Of Figure

Landslide Incidence Map

Scale Used 1:150,000 @ A3

Figure No. 1.1

Rev A

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2. DESK STUDY

The soils present at the Cloncumber cluster comprise basin peat overlying Boston Hill formation bedrock at depth [15]. Due to the presence of peat deposits (up to 3.7m thick) at the site, it is considered that the potential for a landslide hazard exists at the proposed site.

An initial step in the assessment of pre-existing landslide risk is the determination of landslide history in the area. The GSI landslides viewer [16] was consulted in September 2013. No landslides have been identified on the GSI's landslides database or on aerial photographs [17] for the study area or for the vicinity of the site, 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 13 km west of Cloncumber where a breach occurred in the Grand Canal in 1916 and 1989 as shown in Figure 1.1.

A summary of the desk study information is given in table 1.1.

Table 2.1: 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	Forestry	Alluvium	Boston Hill Formation Limestone	Hill of Allen, 2.7km southeast	Glenaree Quarry, 0.5km south	Derrymullen, 2.3km northeast
30		Cut peat				
31						
32						
33	Farmland					
34						
35		Alluvium				
36						
37						
38						
39						

3. SITE WALKOVER SURVEY

A site walkover survey was carried out by FTC on 6 June 2013 and included a number of peat probes and gouge cores at the proposed turbine locations to confirm the depth, shear strength and classification of the peat across the site. Records were also made of the land use, peat depth, drainage features, geomorphology, slope, and any other features that could affect slope stability.

The findings of the site walkover are presented in Appendix 3 of the EIS and summarised below.

Table 3.1: 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 (max)	1°	Forestry/grassland

The topography is categorised as predominantly flat, level ground with localised slopes up to 1°. The site is split between 2 distinct parcels of ground which comprise, semi mature, mature and harvested forestry and soft to firm grassland.

During the walkover, records were made of the land use, peat depth, drainage features, geomorphology, slope, and any other features that could affect slope stability.

Peat depth probing (depth to bedrock and/or competent subsoils), hand shear vane and gouge cores were undertaken at the turbine locations.

The peat probing was carried out to identify areas of deep peat and assist in identifying areas of high risk. The co-ordinates for all investigation points was marked using GPS units.

The peat recovered from the gouge cores was examined and described and included an assessment of the degree of Humification and Moisture Content in accordance with the modified Von Post Classification Scale [18]. The results of the walkover investigations are presented in Appendix 3 of the EIS.

3.1 Peat Condition

The peat recovered from the gouge core is described as firm, spongy, brown fibrous or pseudo-fibrous (partly decomposed) peat with an average Von Post classification [18] of H5 in the shallower peats, which is a "Moderately decomposed peat which, when squeezed, releases very muddy water with a very small amount of amorphous granular peat escaping between the fingers.

The structure of the plant remains is quite indistinct although it is still possible to recognize certain features. The residue is very pasty". The shallow peat has an average Von Post moisture content of B2 (Low moisture content).

The peat has a typical Von Post classification of H6 which is a" Moderately strongly decomposed peat. Contains a lot of amorphous material with an indistinct plant structure. When squeezed, about one-third of the peat escapes between the fingers. The water, if any is released, is very dark brown."

The peat has a typical Von Post moisture content of B2 (low moisture content). Details of the Von Post classification at each proposed turbine location are given in Appendix 3 of the EIS.

Hand vane shear tests were carried out by FTC at selected locations using a Geonor H-60 hand vane and provide indicative results for the in-situ shear strength of the peat at preliminary investigation stage. The uncorrected shear strength values recorded in the peat ranged from 25 to 70 kPa, with an average value of 44 kPa.

To account for the fibrous and heterogeneous nature of peat, a correction factor of 0.4 to 0.5 is recommended by Mesri & Ajlouni [19] to be applied to field vane shear strength values. In the absence of site-specific laboratory test data, a conservative correction factor of 0.4 has been applied to the field vane shear strengths during the slope stability calculations. The corrected shear strengths range from 10 to 28 kPa with an average value of 18 kPa.

3.2 Topography, Geomorphology and Drainage

The topography of the site is generally level with gentle slopes. Gentle slopes were locally recorded up to 1°.

Geomorphology and drainage features were noted from aerial photographs and during the site walkover. No areas of concern were noted from a slope stability point of view.

The drainage of the site is highly modified with areas of forestry having extensive shallow drains present. The grassland areas have previously been drained using land drainage and deep surface drains were evident at most locations.

4. GEOTECHNICAL QUALITATIVE HAZARD AND RISK ASSESSMENT

A qualitative hazard probability ranking matrix has been prepared for the site based on a combination of the site walkover details and site investigation results including topography, drainage, peat depth, Von Post classifications and assessed moisture content. The matrix outlines some of the possible contributing factors to peat movement. Each factor is assessed using the data acquired during the site walkover, site investigation and desk study and the scores are then used to provide a qualitative probability score to highlight any locations that could be at a greater risk of peat movement.

Table 1.3 outlines the contributing factors and hazard scoring system. Table 1.4 shows the hazard probability ranking scores at each proposed turbine locations.

The results of the assessment suggest that the land at the proposed turbine locations in peat rank as "Very Low" to "Low" risk of peat instability. The remaining locations are considered to have a negligible risk of peat instability due to having 0.5m or less of peat cover.

Table 4.1: Landslide Hazard Probability Assessment Matrix [10]

Contributing Factor	Method of Assessment	Value/Indicator	Probability of contributing to peat movement	Hazard Score
Moisture Content of Peat	Visual (Von Post Scale)	B1 (dry)	Negligible	1
		B2 (damp)	Unlikely	2
		B3 (moist)	Probable	3
		B4 (wet)	Likely	4
		B5 (very wet)	Very likely	5
Degree of Humification	Visual (Von Post Scale)	H1-H2 (fibrous, clear water)	Negligible	1
		H3-H4 (fibrous, brown water)	Unlikely	2
		H5-H6 (pseudo-fibrous)	Probable	3
		H7-H8 (amorphous, some fibres)	Likely	4
		H9-H10 (amorphous paste)	Very likely	5
Peat Depth	Peat probes and Trial Pits	0 - 0.5m	Negligible	1
		0.6 - 1.0m	Unlikely	2
		1.1 - 1.5m	Probable	3
		1.6 - 2.0m	Likely	4
		> 2.0m	Very likely	5
Peat Strength (corrected)	Hand Vane Tests	>20 kPa	Negligible	1
		16 - 20 kPa	Unlikely	2
		11 - 15 kPa	Probable	3
		6 - 10 kPa	Likely	4
		0 - 5 kPa	Very likely	5
Slope Angle	Measured from contours	0 to 3	Negligible	1
		4 to 9	Unlikely	2
		10 to 15	Probable	3
		16 to 20	Likely	4
		20 +	Very likely	5
Cracking or evidence of slips	Visual	None evident	Negligible	1
		Few	Unlikely	2
		Frequent	Probable	3
		Many	Likely	4

Local Hydrology (gulleys, channels hags, pools, flushes, water courses)	Visual	Continuous/significant None evident	Very likely Negligible	5 1
		Few	Unlikely	2
		Frequent	Probable	3
		Many	Likely	4
		Continuous/significant	Very likely	5
Weather	Weather Records	Previous very dry period in excess of 5yrs	Negligible	1
		Previous very dry period within 4 - 5yrs	Unlikely	2
		Previous very dry period within 3 - 4yrs	Probable	3
		Previous very dry period within 2 - 3yrs	Likely	4
		Previous very dry period within 1 - 2yrs	Very likely	5

Combined Hazard Score	Probability
33 to 40	Very High
28 to 32	High
23 to 27	Medium
18 to 22	Low
13 to 17	Very Low
8 to 12	Extremely Low

Table 4.2: Landslide Hazard Probability Ranking – Cloncumber

Factor	T29	T31	T32	Access Tracks
Moisture Content of Peat	3	2	2	3
Degree of Humification	3	3	3	3
Peat Depth	4	5	5	5
Peat Strength	4	3	3	3
Slope Angle	1	1	1	1
Cracking or evidence of slips	1	1	1	1
Local Hydrology (gulleys, channels hags, pools, flushes, water courses, blocked drains)	2	1	1	1
Weather	1	1	1	1
Total Scores	**19**	**17**	**17**	**18**

Combined Hazard Score	Probability
33 to 40	Very High
28 to 32	High
23 to 27	Medium
18 to 22	Low
13 to 17	Very Low
8 to 12	Extremely Low

5. QUANTITATIVE SLOPE STABILITY ANALYSES

Total stress analyses for translational slides within the peat have been undertaken in accordance with the principles of Eurocode 7-1: Geotechnical Design (IS EN 1997-1) Design Approach 3 [14]. This design approach is considered to be the most logical approach for slope stability analysis as it includes partial factors for both material properties and variable loads (for example traffic loads).

In accordance with the principles of Eurocode 7, rather than using a global factor of safety as per previous design codes, partial factors are applied to the chosen characteristic values to obtain design values. Actions (influences) are multiplied by the partial factors, while resistances are divided by the partial factors.

Table 1.5 shows the partial factors that have been applied to the characteristic values to give the design values used in the slope stability analyses.

Table 5.1: IS EN 1997-1 Partial Factors Used to Derive Design Parameters

Set	Partial Factor		Parameter
M2	γ_{cu}	1.4	Corrected undrained shear strength
	γ_{γ}	1	Soil density
A2	γ_{Q}	1.3	Traffic Loading (variable unfavourable)
R3	$\gamma_{R;e}$	1	Earth resistance

In accordance with Eurocode 7, geotechnical checks must be carried out to ensure that the resistance preventing a slide is greater than or equal to the actions which cause a slide, i.e.:

$$E_d <= R_d$$

Where

E_d = Sum of design actions
R_d = Sum of design resistances

In order to verify that this condition is met, the following formula has been applied, using the design values obtained using the partial factors given in Table 1.5. The resulting "safety ratio" must be equal or greater than 1.0 in order to verify that the above condition is met. i.e.:

$$\frac{Cu}{\gamma z \cos\beta \sin\beta} => 1.0$$

Where

Cu = corrected shear strength of peat (value obtained from hand shear vane)
γ = density of peat (normally assumed to be 1.0 Mg/m^3)
z = thickness of peat layer in metres (measured from probes/trial pits)
β = slope angle at turbine location

5.1 Limitations of Slope Stability Analyses

The application of traditional stability analysis should be used with caution due to the compressibility of peat and because the analysis does not account for the fibrous nature of the peat.

Cognisant of the organic and highly variable nature of peat, uncertainties related to the directional dependence on which the strength of peat is based, the reliability of traditional methods of field shear strength measurement, presence of gas within the peat and the combination of factors (some not quantifiable or applicable in a calculation matrix) triggering slope failure, the failure mechanisms being employed in the traditional analysis may not necessarily be representative of in-situ failure mechanisms.

Despite the limitations outlined above, this method of slope analysis is still considered useful as an indicator of possible areas of instability and is in accordance with current industry best practice.

5.2 Shear Strength Values

The shear strength values were obtained using a Geonor H-60 hand-held shear vane with a correction factor of 0.4 based on published correlation data [19]. The results are considered conservative and are therefore appropriate for preliminary analysis of the slope sections for preliminary design purposes.

Shear strength at the base of a peat mass is often the governing factor in peat stability and analysis; therefore shear strength values chosen for the stability analysis are based on a characteristic value representative of the shear strength of the peat recorded generally within 0.5 m of the base of the peat body in the vicinity of the turbines, unless this is significantly higher than the typical shear strengths recorded at shallower depths, in which case the lower value is normally used.

Based on the field vane shear strength data, corrected shear strength values of 10 to 12 kPa were determined as the characteristic values for the slope stability analysis. No differentiation between the upper acrotelm (where present) and lower catotelm layers has been assumed for the purpose of the stability analysis in order to provide a more conservative analysis.

5.3 Slope Stability Analyses Results

The calculated in-situ safety ratios at the proposed turbine locations in peat are presented in Table 1.6 along with the typical peat depth, characteristic corrected shear strength and slope angle. A ratio of less than 1.0 indicates that the slope currently has an inadequate factor of safety against failure and therefore is potentially unstable. Ratios greater than 1.0 indicate an adequate factor of safety against failure and are considered stable. No measurable depth of peat was recorded at the other turbine locations hence they are not included here.

In order to attempt to replicate the effect of traffic loading, floating roads or temporary stockpiling on the peat during construction, a surcharge load of 20 kPa has been applied to the calculations. This is the equivalent load of approximately 2 m of peat or the effect of construction traffic on a floating road. The resulting safety ratio is also presented in Table 1.6. This is considered to represent the worst case scenario during and after construction.

Table 5.2: Slope Stability Inputs and Calculated Safety Ratios

Location	Slope angle	Peat Depth	Corrected Peat Strength	Calculated Safety Ratio (no surcharge)	Calculated Safety Ratio (20kPa surcharge)
T29	0.5°	1.75m	10kpa	46.8	18.8
T31	1°	3.7m	12kPa	13.3	7.8
T32	1°	2.7m	12kPa	18.2	9.3
Access tracks	1°	3.0m	10kPa	13.6	7.3

5.4 Slope Stability Analyses Conclusions

Based on the analyses presented, the development areas are considered stable. The results give rise to in-situ safety ratios for translational slides which are well above the minimum required value for all infrastruture locations analysed.

It should be noted that vehicular access to areas of deep peat (>1 m) in advance of construction will be restricted to low ground pressure vehicles, with all construction vehicles travelling on existing access tracks whenever possible.

Given the limitations of measuring the shear strength of peat and the variability of the ground conditions (slope, peat depth, groundwater levels etc.), the slope stability calculations should not be regarded as definitive. Rather, where the calculated safety ratio is close to 1.0, this is taken as an indicator of a higher risk area requiring special consideration during detailed design.

6. CONCLUSIONS & RECOMMENDATIONS

The desk study has identified that the site comprises limestone bedrock overlain by cutover peat and limestone till.

A site walkover was undertaken which comprised peat probes at the proposed turbine locations and gouge auger sampling of the peat. Hand vane tests were also undertaken at the proposed turbine locations to determine the lateral and vertical variation of shear strength across the site. The investigation found a maximum depth of peat of 3.7m. Additionally, the gouge core sample found that the majority of the peat was highly decomposed with a low moisture content and a low shear strength.

A qualitative landslide hazard risk analysis was undertaken using information gained from the gouge cores, desk study and site walkover. The proposed turbine locations in peat ranked as “Very Low” to “Low” risk of peat instability. The remaining infrastructure locations rank as negligible risk due to having 0.5m or less of peat cover

A quantitative translational landslide stability analysis was also undertaken using information gained from the site walkover, in particular slope angles and peat shear strengths. The results showed that the safety ratios at the turbine locations were well above the minimum safety factor required for long term stability.

In light of the information gained to date from the desk study, site reconnaissance and the ground investigations, the site is considered to be stable before, during and after construction.

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Appendix G2

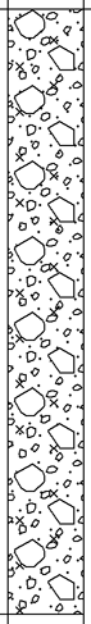
Trial Pit Records

TRIAL PIT LOG

Fehily Timoney & Company
Core House Pouladuff Road
Cork
Telephone: 00353214964133
Fax: 00353214964464

JOB NUMBER	LE14-731-04	**HOLE NO.**	**BP6**
CO-ORDINATES	269,993 E 244,079 N		
PROJECT Maighne Wind Farm		**GROUND LEVEL (m)**	**SHEET** 1 of 1

DATE STARTED	31/10/2014	**CLIENT**	Element Power
DATE COMPLETED	31/10/2014	**SITE**	Co. Kildare
LOGGED ON		**METHOD**	(None)

Description	Depth (m)	Legend	Elevation	Water	Standpipe Details	Sample Type	Field Records V/R	Cu (kN/m^2)	MC (%)	LL/PL (%)
Grey silty sandy GRAVEL with high cobble content observed in existing borrow pit. Ridges of gravel adjacent to borrow pit.										
	4.00									

Groundwater Details

Groundwater Conditions:

Stability: N/A

Remarks: Jack Carpenters land, Ballynakill. Existing B Pit observation

Logged By	Scale (m)
AG	1:50

TRIAL PIT LOG

Fehily Timoney & Company
Core House Pouladuff Road
Cork
Telephone: 00353214964133
Fax: 00353214964464

JOB NUMBER	LE14-731-04	**HOLE NO.**	**TPBP1A**
CO-ORDINATES	271,173 E 221,962 N		
PROJECT Maighne Wind Farm		**GROUND LEVEL (m)**	**SHEET** 1 of 1

DATE STARTED	30/10/2014	**CLIENT**	Element Power
DATE COMPLETED	30/10/2014	**SITE**	Co. Kildare
LOGGED ON		**METHOD**	(14T excavator)

Description	Depth (m)	Legend	Elevation	Water	Standpipe Details	Sample Type	Field Records V/R	Cu (kN/m^2)	MC (%)	LL/PL (%)
Firm brown sandy gravelly silt TOPSOIL										
Loose brown silty SAND and GRAVEL	0.20									
Grey brown silty sandy GRAVEL with high cobble content. Cobbles and gravel are subangular to rounded limestone and occasional sandstone. Boulders up to 500mm.	0.50									
	4.00									

Groundwater Details

Groundwater Conditions:

Stability: Unstable, Dry

Remarks: David Connels land, Concumber

Logged By	Scale (m)
AG	1:50

FTC TRIAL PIT LOG MAIGHNE WIND FARM.GPJ FEHILY TIMONEY & CO.GDT 14/11/14

TRIAL PIT LOG

Fehily Timoney & Company
Core House Pouladuff Road
Cork
Telephone: 00353214964133
Fax: 00353214964464

JOB NUMBER	LE14-731-04	**HOLE NO.**	**TPBP1B**
CO-ORDINATES	271,303 E 222,032 N		
PROJECT Maighne Wind Farm		**GROUND LEVEL (m)**	**SHEET** 1 of 1

DATE STARTED	30/10/2014	**CLIENT**	Element Power
DATE COMPLETED	30/10/2014	**SITE**	Co. Kildare
LOGGED ON		**METHOD**	(14T excavator)

Description	Depth (m)	Legend	Elevation	Water	Standpipe Details	Sample Type	Field Records V/R	Cu (kN/m^2)	MC (%)	LL/PL (%)
Brown silty gravelly sandy TOPSOIL										
Loose, brown, silty SAND and GRAVEL	0.30									
Grey silty sandy GRAVEL with low to medium cobble content. Gravel is subangular to rounded. Cobbles subangular to rounded, limestone.	0.70			1						
	4.00									

Groundwater Details

Groundwater Conditions:

Stability: Unstable below 3.5m

Remarks: David Connels land, Concumber

Logged By	Scale (m)
AG	1:50

TRIAL PIT LOG

Fehily Timoney & Company
Core House Pouladuff Road
Cork
Telephone: 00353214964133
Fax: 00353214964464

		JOB NUMBER LE14-731-04	**HOLE NO.** TPBP2A
		CO-ORDINATES 271,678 E 222,095 N	
	PROJECT Maighne Wind Farm	**GROUND LEVEL (m)**	**SHEET** 1 of 1

DATE STARTED 30/10/2014	**CLIENT** Element Power
DATE COMPLETED 30/10/2014	**SITE** Co. Kildare
LOGGED ON	**METHOD** (14T excavator)

Description	Depth (m)	Legend	Elevation	Water	Standpipe Details	Sample Type	Field Records V/R	Cu (kN/m^2)	MC (%)	LL/PL (%)
Soft brown silty sandy clay TOPSOIL										
Firm grey brown sandy gravelly SILT	0.30									
Damp grey silty sandy GRAVEL with high cobble content. Gravel is subanular to rounded. Cobbles subangular to rounded granite and occasional boulders.	1.10			1						
	3.00									

Groundwater Details

Groundwater Conditions:

Stability: Unstable below 2m

Remarks: John O'Connels land, Cloncumber

Logged By	Scale (m)
AG	1:50

FTC TRIAL PIT LOG MAIGHNE WIND FARM.GPJ FEHILY TIMONEY & CO.GDT 14/11/14

TRIAL PIT LOG

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Telephone: 00353214964133
Fax: 00353214964464

JOB NUMBER	LE14-731-04	**HOLE NO.**	**TPBP2B**
CO-ORDINATES	271,517 E 222,075 N		
PROJECT Maighne Wind Farm		**GROUND LEVEL (m)**	**SHEET** 1 of 1

DATE STARTED	30/10/2014	**CLIENT**	Element Power
DATE COMPLETED	30/10/2014	**SITE**	Co. Kildare
LOGGED ON		**METHOD**	(14T excavator)

Description	Depth (m)	Legend	Elevation	Water	Standpipe Details	Sample Type	Field Records V/R	Cu (kN/m^2)	MC (%)	LL/PL (%)
Soft brown silty sandy TOPSOIL										
Brown silty sandy GRAVEL	0.30									
Grey silty sandy GRAVEL with high cobble content. Gravel and cobbles are subangular to rounded limestone	0.60									
	4.00									

Groundwater Details

Groundwater Conditions:

Stability: Stable, dry

Remarks: John O'Connels land, Cloncumber

Logged By	Scale (m)
AG	1:50

FTC TRIAL PIT LOG MAIGHNE WIND FARM.GPJ FEHILY TIMONEY & CO.GDT 14/11/14

TRIAL PIT LOG

Fehily Timoney & Company
Core House Pouladuff Road
Cork
Telephone: 00353214964133
Fax: 00353214964464

JOB NUMBER	LE14-731-04	**HOLE NO.**	**TPBP3A**
CO-ORDINATES	272,178 E 222,993 N		
PROJECT Maighne Wind Farm		**GROUND LEVEL (m)**	**SHEET** 1 of 1

DATE STARTED	30/10/2014	**CLIENT**	Element Power
DATE COMPLETED	30/10/2014	**SITE**	Co. Kildare
LOGGED ON		**METHOD**	(14T excavator)

Description	Depth (m)	Legend	Elevation	Water	Standpipe Details	Sample Type	Field Records V/R	Cu (kN/m^2)	MC (%)	LL/PL (%)
Soft brown gravelly sandy TOPSOIL										
Grey silty sandy GRAVEL with medium to high cobble content. Gravel is subangular to subrounded limestone.	0.30									
Brown fine silty SAND	2.30									
Stiff grey sandy gravelly CLAY	2.50									
	3.50									

Groundwater Details

Groundwater Conditions:

Stability: Stable. Seepage at 2.3m

Remarks: John Paynes land, Cloncumber

Logged By	Scale (m)
AG	1:50

TRIAL PIT LOG

Fehily Timoney & Company
Core House Pouladuff Road
Cork
Telephone: 00353214964133
Fax: 00353214964464

JOB NUMBER	LE14-731-04	**HOLE NO.** TPBP4A
CO-ORDINATES	268,077 E 242,923 N	
PROJECT Maighne Wind Farm	**GROUND LEVEL (m)**	**SHEET** 1 of 1

DATE STARTED	30/10/2014	**CLIENT**	Element Power
DATE COMPLETED	30/10/2014	**SITE**	Co. Kildare
LOGGED ON		**METHOD**	(14T excavator)

Description	Depth (m)	Legend	Elevation	Water	Standpipe Details	Sample Type	Field Records V/R	Cu (kN/m^2)	MC (%)	LL/PL (%)
Soft brown silty sandy TOPSOIL										
Stiff grey sandy gravelly CLAY with medium cobble content and occasional boulders	0.40									
Soft dark grey slightly gravelly SILT	2.50									
	3.50									

Groundwater Details

Groundwater Conditions:

Stability: Stable, Dry

Remarks: Michael McKeve's land, Ballynakill

Logged By	Scale (m)
AG	1:50

TRIAL PIT LOG

Fehily Timoney & Company
Core House Pouladuff Road
Cork
Telephone: 00353214964133
Fax: 00353214964464

JOB NUMBER	LE14-731-04	**HOLE NO.**	**TPBP4B**
CO-ORDINATES	268,200 E 242,900 N		
PROJECT Maighne Wind Farm		**GROUND LEVEL (m)**	**SHEET** 1 of 1

DATE STARTED	30/10/2014	**CLIENT**	Element Power
DATE COMPLETED	30/10/2014	**SITE**	Co. Kildare
LOGGED ON		**METHOD**	(14T excavator)

Description	Depth (m)	Legend	Elevation	Water	Standpipe Details	Sample Type	Field Records V/R	Cu (kN/m^2)	MC (%)	LL/PL (%)
Soft brown silty sandy TOPSOIL										
Loose grey brown fine to medium silty SAND with rare cobbles and gravel	0.30									
	4.00									

Groundwater Details

Groundwater Conditions:

Stability: Stable, dry

Remarks: Michael McKeve's land, Ballynakill

Logged By	Scale (m)
AG	1:50

TRIAL PIT LOG

Fehily Timoney & Company
Core House Pouladuff Road
Cork
Telephone: 00353214964133
Fax: 00353214964464

JOB NUMBER	LE14-731-04	**HOLE NO.**	**TPBP5A**
CO-ORDINATES	270,758 E 242,853 N		
PROJECT Maighne Wind Farm		**GROUND LEVEL (m)**	**SHEET** 1 of 1

DATE STARTED	31/10/2014	**CLIENT**	Element Power
DATE COMPLETED	31/10/2014	**SITE**	Co. Kildare
LOGGED ON		**METHOD**	(14T excavator)

Description	Depth (m)	Legend	Elevation	Water	Standpipe Details	Sample Type	Field Records V/R	Cu (kN/m^2)	MC (%)	LL/PL (%)
Firm brown sandy silty TOPSOIL										
Grey silty sandy GRAVEL with high cobble content. Gravel is subangular to subrounded limestone. Cobbles are subangular to subrounded. Boulders up to 300mm.	0.50									
Grey silty very sandy GRAVEL with low cobble content.	2.50									
	3.50									

Groundwater Details

Groundwater Conditions:

Stability: Unstable, dry

Remarks: Marian Cusack's land, Ballynakill

Logged By	Scale (m)
AG	1:50

TRIAL PIT LOG

Fehily Timoney & Company
Core House Pouladuff Road
Cork
Telephone: 00353214964133
Fax: 00353214964464

JOB NUMBER	LE14-731-04	**HOLE NO.**	**TPBP5B**
CO-ORDINATES	270,487 E 242,792 N		
PROJECT Maighne Wind Farm		**GROUND LEVEL (m)**	**SHEET** 1 of 1

DATE STARTED	31/10/2014	**CLIENT**	Element Power
DATE COMPLETED	31/10/2014	**SITE**	Co. Kildare
LOGGED ON		**METHOD**	(14T excavator)

Description	Depth (m)	Legend	Elevation	Water	Standpipe Details	Sample Type	Field Records V/R	Cu (kN/m^2)	MC (%)	LL/PL (%)
Dark brown sandy gravelly silty TOPSOIL										
Grey brown silty sandy GRAVEL with medium cobble content. Gravel and cobbles are subangular to subrounded	0.20									
Orange brown silty very sandy GRAVEL	2.90									
	4.00									

Groundwater Details

Groundwater Conditions:

Stability: Unstable, dry

Remarks: Marian Cusack's land, Ballynakill

Logged By	Scale (m)
AG	1:50

FTC TRIAL PIT LOG MAIGHNE WIND FARM.GPJ FEHILY TIMONEY & CO.GDT 14/11/14

TRIAL PIT LOG

Fehily Timoney & Company
Core House Pouladuff Road
Cork
Telephone: 00353214964133
Fax: 00353214964464

		JOB NUMBER LE14-731-04	**HOLE NO.** TPBP6A
		CO-ORDINATES 276,437 E 237,658 N	
	PROJECT Maighne Wind Farm	**GROUND LEVEL (m)**	**SHEET** 1 of 1

DATE STARTED 02/12/2014
DATE COMPLETED 02/12/2014
LOGGED ON

CLIENT Element Power
SITE Co. Kildare
METHOD (14T excavator)

Description	Depth (m)	Legend	Elevation	Water	Standpipe Details	Sample Type	Field Records V/R	Cu (kN/m^2)	MC (%)	LL/PL (%)
Firm brown pseudo-fibrous PEAT (H5, B2)										
Firm slightly sandy slightly gravelly SILT/CLAY	0.50									
	3.00									

Groundwater Details

Groundwater Conditions:

Stability: Stable, dry

Remarks: Drehid nr T1

Logged By	Scale (m)
AG	1:50

FTC TRIAL PIT LOG MAIGHNE WIND FARM.GPJ FEHILY TIMONEY & CO.GDT 3/12/14

TRIAL PIT LOG

Fehily Timoney & Company
Core House Pouladuff Road
Cork
Telephone: 00353214964133
Fax: 00353214964464

		JOB NUMBER LE14-731-04	**HOLE NO.** TPBP6B
		CO-ORDINATES 276,425 E 237,767 N	
	PROJECT Maighne Wind Farm	**GROUND LEVEL (m)**	**SHEET** 1 of 1

DATE STARTED 02/12/2014	**CLIENT** Element Power
DATE COMPLETED 02/12/2014	**SITE** Co. Kildare
LOGGED ON	**METHOD** (14T excavator)

Description	Depth (m)	Legend	Elevation	Water	Standpipe Details	Sample Type	Field Records V/R	Cu (kN/m^2)	MC (%)	LL/PL (%)
Soft, darkk brown pseudo-fibrous PEAT										
Soft grey very sandy SILT with rare gravel. Below 3.0m: very gravelly	1.00									
	3.50									

Groundwater Details

Groundwater Conditions:

Stability: Unstable, dry

Remarks: Drehid nr T1

Logged By	Scale (m)
AG	1:50

TRIAL PIT LOG

Fehily Timoney & Company
Core House Pouladuff Road
Cork
Telephone: 00353214964133
Fax: 00353214964464

		JOB NUMBER LE14-731-04	**HOLE NO.** TPBP6C
		CO-ORDINATES 276,482 E 237,470 N	
	PROJECT Maighne Wind Farm	**GROUND LEVEL (m)**	**SHEET** 1 of 1

DATE STARTED 02/12/2014	**CLIENT** Element Power
DATE COMPLETED 02/12/2014	**SITE** Co. Kildare
LOGGED ON	**METHOD** (14T excavator)

Description	Depth (m)	Legend	Elevation	Water	Standpipe Details	Sample Type	Field Records V/R	Cu (kN/m^2)	MC (%)	LL/PL (%)
Soft brown PEAT (H6, B3)										
Soft, grey very sandy SILT	2.50									
	3.50									

Groundwater Details

Groundwater Conditions:

Stability: Stable, dry

Remarks: Drehid south of T1

Logged By	Scale (m)
AG	1:50

TRIAL PIT LOG

Fehily Timoney & Company
Core House Pouladuff Road
Cork
Telephone: 00353214964133
Fax: 00353214964464

	PROJECT Maighne Wind Farm	**GROUND LEVEL (m)**	**SHEET** 1 of 1

JOB NUMBER LE14-731-04

CO-ORDINATES 270,137 E 244,087 N

HOLE NO. TPBP7A

DATE STARTED 02/12/2014
DATE COMPLETED 02/12/2014
LOGGED ON

CLIENT Element Power
SITE Co. Kildare
METHOD (14T excavator)

Description	Depth (m)	Legend	Elevation	Water	Standpipe Details	Sample Type	Field Records V/R	Cu (kN/m^2)	MC (%)	LL/PL (%)
Firm brown clayey sandy TOPSOIL										
Brown silty sandy GRAVEL. Below 3m: Very clayey with groundwater seepage	0.30									
	3.20									

Groundwater Details

Groundwater Conditions:

Stability: Stable. Seepage below 3m.

Remarks: Ballynakill Jack Carpenters land

Logged By	Scale (m)
AG	1:50

FTC TRIAL PIT LOG MAIGHNE WIND FARM.GPJ FEHILY TIMONEY & CO.GDT 3/12/14

TRIAL PIT LOG

Fehily Timoney & Company
Core House Pouladuff Road
Cork
Telephone: 00353214964133
Fax: 00353214964464

JOB NUMBER	LE14-731-04	**HOLE NO.**	**TPBP7B**
CO-ORDINATES	270,198 E 244,124 N		
PROJECT Maighne Wind Farm		**GROUND LEVEL (m)**	**SHEET** 1 of 1

DATE STARTED	02/12/2014	**CLIENT**	Element Power
DATE COMPLETED	02/12/2014	**SITE**	Co. Kildare
LOGGED ON		**METHOD**	(14T excavator)

Description	Depth (m)	Legend	Elevation	Water	Standpipe Details	Sample Type	Field Records V/R	Cu (kN/m^2)	MC (%)	LL/PL (%)
TOPSOIL										
Grey silty sandy GRAVEL with occasional cobbles. Below 1m: groundwater seepage. Fast seepage below 3m.	0.30									
	3.00									

Groundwater Details

Groundwater Conditions:

Stability: Unstable. Seepage below 1m.

Remarks: Ballynakill Jack Carpenters land

Logged By	Scale (m)
AG	1:50

TRIAL PIT LOG

Fehily Timoney & Company
Core House Pouladuff Road
Cork
Telephone: 00353214964133
Fax: 00353214964464

		JOB NUMBER LE14-731-04	**HOLE NO.** TPSS1
		CO-ORDINATES 276,230 E 237,600 N	
	PROJECT Maighne Wind Farm	**GROUND LEVEL (m)**	**SHEET** 1 of 1

DATE STARTED 02/12/2014	**CLIENT** Element Power
DATE COMPLETED 02/12/2014	**SITE** Co. Kildare
LOGGED ON	**METHOD** (14T excavator)

Description	Depth (m)	Legend	Elevation	Water	Standpipe Details	Sample Type	Field Records V/R	Cu (kN/m^2)	MC (%)	LL/PL (%)
Soft brown pseudo-fibrous PEAT (H7, B4)	3.00									

Groundwater Details

Groundwater Conditions:

Stability: Unstable, saturated

Remarks: Drehid substation

Logged By	Scale (m)
AG	1:50

Appendix G3

Site Walkover Records

GEOLOGICAL SITE WALKOVER

Site: Drehid Substation	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Substation	**Date: 2/12/14**

Topography: Flat lying.

Vegetation: Semi-mature mixed forestry.

Peat Thickness: 3m.

Features: Soft brown pseudo-fibrous peat over soft to firm silt.

Von Post Classification: H7 B4

Uncorrected Shear Strength: 20kPa @ 0.5m, 20 kPa @ 1.0m, 30kPa @ 1.5m, 30kPa @ 2.0m.

Water Courses/Drainage: Numerous dry drainage ditches E-W at 10 to 20m spacing

Assessed Peat Slide Risk: Low

Created By: AG	**Checked By:** TPR

GEOLOGICAL SITE WALKOVER

Site: Ballynakill	**Job No: LE14-731-04**
Client: Element Power	**Weather: Heavy Showers**
Position ID: Turbine 1	**Date: 11/6/13**

Topography: Flat to slightly undulating terrain

Vegetation: Grassland

Peat Thickness: None present

Features: Firm underfoot.

Von Post Classification: Not Applicable

Uncorrected Shear Strength: Not Applicable

Water Courses/Drainage: Deep drainage ditch 50m west of turbine location and in surrounding field boundaries. Royal Canal 350m northeast of turbine location.

Assessed Peat Slide Risk: Not Applicable

Created By: NS	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Ballynakill	**Job No: LE14-731-04**
Client: Element Power	**Weather: Fine**
Position ID: Turbine 2	**Date: 31/10/14**

Topography: Slightly undulating Terrain with 1° N slope at the turbine location.

Vegetation: Grassland

Peat Thickness: None present. Peaty topsoil to 0.5m

Features: Firm underfoot

Von Post Classification: Not Applicable

Uncorrected Shear Strength: 50kPa at 0.5m

Water Courses/Drainage: Drainage ditches in surrounding field boundaries. Royal Canal 200m northeast of turbine location

Assessed Peat Slide Risk: Not Applicable

Created By: AG	**Checked By:** TPR

GEOLOGICAL SITE WALKOVER

Site: Ballynakill	**Job No: LE14-731-04**
Client: Element Power	**Weather: Heavy Showers**
Position ID: Turbine 3	**Date: 11/6/13**

Topography: Flat terrain

Vegetation: Grassland

Peat Thickness: None present

Features: Firm underfoot.

Von Post Classification: Not Applicable

Uncorrected Shear Strength: Not Applicable

Water Courses/Drainage: Deep drainage ditches in surrounding field boundaries.

Assessed Peat Slide Risk: Not Applicable

Created By: NS	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Greenwire Longwood Extension	**Job No: LE11-731-09**
Client: Element Power	**Weather: Heavy Showers**
Position ID: Turbine 4	**Date: 11/6/13**

Topography: Flat Terrain

Vegetation: Grassland

Peat Thickness: None present

Features: Firm underfoot

Von Post Classification: Not Applicable

Uncorrected Shear Strength: Not Applicable

Water Courses/Drainage: No drainage features identified close to turbine location.

Assessed Peat Slide Risk: Not Applicable

Created By: NS	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Ballynakill	**Job No: LE14-731-04**
Client: Element Power	**Weather: Fine**
Position ID: Turbine 5	**Date: 30/10/14**

Topography: Gently undulating terrain with 2° east slope at turbine location.

Vegetation: Grassland with abundant rushes at lowest point in poorly drained field.

Peat Thickness: None present. 0.5m peaty topsoil.

Features: Soft underfoot (Topsoil only). Firm below 0.20m BGL

Von Post Classification: Not Applicable

Uncorrected Shear Strength: 50kPa at 0.5m

Water Courses/Drainage: Drainage ditches in surrounding field boundaries.

Assessed Peat Slide Risk: Not Applicable

Created By: AG	**Checked By:** TPR

GEOLOGICAL SITE WALKOVER

Site: Greenwire Longwood Extension	**Job No: LE11-731-09**
Client: Element Power	**Weather: Heavy Showers**
Position ID: Turbine 6	**Date: 11/6/13**

Topography: Flat Terrain

Vegetation: Grassland

Peat Thickness: None present

Features: Firm underfoot

Von Post Classification: Not Applicable

Uncorrected Shear Strength: Not Applicable

Water Courses/Drainage: Deep drains in surrounding field boundaries.

Assessed Peat Slide Risk: Not Applicable

Created By: NS	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Ballynakill	**Job No: LE14-731-04**
Client: Element Power	**Weather: Heavy Showers**
Position ID: Turbine 7	**Date: 11/6/13**

Topography: Flat Terrain

Vegetation: Grassland

Peat Thickness: None present

Features: Firm underfoot

Von Post Classification: Not Applicable

Uncorrected Shear Strength: Not Applicable

Water Courses/Drainage: No drainage features identified close to turbine location. Royal Canal 250m northeast of turbine location

Assessed Peat Slide Risk: Not Applicable

Created By: NS	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Ballynakill	**Job No: LE14-731-04**
Client: Element Power	**Weather: Fine**
Position ID: Turbine 8	**Date: 31/10/14**

Topography: Flat Terrain

Vegetation: Firm Grassland. Well drained

Peat Thickness: None present

Features: Firm underfoot. Possible gravel

Von Post Classification: Not Applicable

Uncorrected Shear Strength: Not Applicable

Water Courses/Drainage: No drainage features identified close to turbine location. Royal Canal 150m northeast of turbine location

Assessed Peat Slide Risk: Not Applicable

Created By: AG	**Checked By:** TPR

GEOLOGICAL SITE WALKOVER

Site: Ballynakill	**Job No: LE14-731-04**
Client: Element Power	**Weather: Heavy Showers**
Position ID: Turbine 9	**Date: 11/6/13**

Topography: Flat Terrain

Vegetation: Grassland

Peat Thickness: None present

Features: Firm underfoot

Von Post Classification: Not Applicable

Uncorrected Shear Strength: Not Applicable

Water Courses/Drainage: No drainage features identified close to turbine location. Royal Canal 150m northeast of turbine location

Assessed Peat Slide Risk: Not Applicable

Created By: Neil Sandes	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Ballynakill	**Job No: LE14-731-04**
Client: Element Power	**Weather: Fine**
Position ID: Turbine 10	**Date: 31/10/14**

Topography: Flat Terrain

Vegetation: Grassland. Well drained.

Peat Thickness: None present. Possible gravel at 0.2m.

Features: Firm underfoot

Von Post Classification: Not Applicable

Uncorrected Shear Strength: Not Applicable

Water Courses/Drainage: No drainage features identified close to turbine location.

Assessed Peat Slide Risk: Not Applicable

Created By: AG	**Checked By:** TPR

GEOLOGICAL SITE WALKOVER

Site: Drehid	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 11	**Date: 7-6-2013 & 25-11-14**

Topography: The ground gently slopes 1° SW.

Vegetation: Mature Coniferous Forestry.

Peat Thickness: Peat 0.30m deep.

Features: Soft brown fibrous peat overlying clay or gravel.

Von Post Classification: H6, B3

Uncorrected Shear Strength: 40kPa at 0.5m (clay)

Water Courses/Drainage: Numerous dry drainage ditches flowing E-W at 10 to 20m spacing. Small pond 20m from turbine location.

Assessed Peat Slide Risk: Very Low

Created By: Andrew Jaworski	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Drehid	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 12	**Date: 5/11/14**

Topography: Flat lying, boggy ground.

Vegetation: Edge of semi-mature forestry and clear felled area

Peat Thickness: 3.4m peat over grey sandy clay.

Features: Soft brown spongy fibrous peat becoming amorphous with depth.

Von Post Classification: H7 B4

Uncorrected Shear Strength: 20KPa at 0.50m, 20KPa at 1.0m, 12KPa at 1.50m, 20KPa at 2.0m, 25KPa at 2.50m, 25KPa at 3.0m, 50KPa at 3.50m

Water Courses/Drainage: Blocked forestry drains nearby

.

Assessed Peat Slide Risk: Low

Created By: Andrew Jaworski	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Drehid	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 13	**Date: 05/11/14**

Topography: The ground gently slopes 1° N max.

Vegetation: Semi-mature mixed forestry and bog, heather, grasses

Peat Thickness: 3m.

Features: Soft brown spongy fibrous peat becoming amorphous with depth.

Von Post Classification: H6 B3

Uncorrected Shear Strength: 20KPa at 0.50m, 30KPa at 1.0m, 40KPa at 1.50m, 50KPa at 2.0m, 50KPa at 2.5m

Water Courses/Drainage: drainage ditches evident 30-40m spacing. Boggy.

Assessed Peat Slide Risk: Low

Created By: Andrew Jaworski	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Drehid	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 14	**Date: 7-6-2013**

Topography: The ground gently slopes 2°W.

Vegetation: Harvested forestry replanted with deciduous trees overlying peat.

Peat Thickness: 0.80m probe peat.

Features: Soft brown spongy fibrous peat.

Von Post Classification: H6 B2

Uncorrected Shear Strength: 32KPa at 0.25m, 36KPa at 0.5m.

Water Courses/Drainage: Drainage ditches evident 10-20m spacing.

Assessed Peat Slide Risk: Very Low

Created By: Andrew Jaworski	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Drehid	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 15	**Date: 5/11/14**

Topography: The ground gently slopes 1° N .

Vegetation: Semi-mature mixed forestry over Peat.

Peat Thickness: 0.5m peat.

Features: Soft brown spongy fibrous peat.

Von Post Classification: H6 B3

Uncorrected Shear Strength: 20KPa at 0.25m

Water Courses/Drainage: drainage ditches evident 10-20m spacing.

Assessed Peat Slide Risk: Very Low

Created By: AG	**Checked By:** TPR

GEOLOGICAL SITE WALKOVER

Site: Drehid	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 16	**Date: 7-6-2013**

Topography: The ground gently slopes 2° S.

Vegetation: Semi Mature forestry (sycamore) planted over clayey topsoil.

Peat Thickness: Probe depth 0.30m No peat Present.

Features: Firm brown slightly sandy Clay.

Von Post Classification: Not Applicable

Uncorrected Shear Strength: Not tested

Water Courses / Drainage: drainage ditches at edge of forestry none evident within forestry

Assessed Peat Slide Risk: Not Applicable

Created By: Andrew Jaworski	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Drehid	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 17	**Date: 7-6-2013**

Topography: The ground gently slopes 3° S.

Vegetation: Semi Mature forestry planted over clayey topsoil.

Peat Thickness: None Present.

Features: Firm brown slightly sandy Clay.

Von Post Classification: Not Applicable

Uncorrected Shear Strength: No Penetration

Water Courses / Drainage: Dry drainage ditches at 20-25m apart within forestry.

Assessed Peat Slide Risk: Not Applicable

Created By: Andrew Jaworski	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Drehid	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 18	**Date: 7-6-2013**

Topography: The ground gently slopes 2° E.

Vegetation: Firm Grassland

Peat Thickness: None Present.

Features: Firm brown slightly sandy gravelly Clay.

Von Post Classification: Not Applicable

Uncorrected Shear Strength: No Penetration

Water Courses / Drainage: Drainage ditches 2-3m deep at field boundaries.

Assessed Peat Slide Risk: Not Applicable

Created By: Andrew Jaworski	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Drehid	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 19	**Date: 05/11/14**

Topography: The ground gently slopes 1° N.

Vegetation: Firm Grassland

Peat Thickness: None Present.

Features: 0.3m topsoil over firm brown slightly sandy gravelly Clay.

Von Post Classification: Not Applicable

Uncorrected Shear Strength: Not tested

Water Courses/Drainage: Fear English River 100m east of turbine

Assessed Peat Slide Risk: Not Applicable

Created By: AG	**Checked By:** TPR

GEOLOGICAL SITE WALKOVER

Site: Drehid	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 20	**Date: 6-6-2013**

Topography: The ground gently slopes 2° SW.

Vegetation: Firm Grassland

Peat Thickness: None Present.

Features: Firm brown slightly sandy gravelly Clay.

Von Post Classification: Not Applicable

Uncorrected Shear Strength: No Penetration

Water Courses / Drainage: None Visible.

Assessed Peat Slide Risk: Not Applicable.

Created By: Andrew Jaworski	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Drehid	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 21	**Date: 6-6-2013**

Topography: The ground gently slopes up to 2° SW

Vegetation: Firm Grassland

Peat Thickness: None Present.

Features: gently sloping grassland over brown topsoil.

Von Post Classification: Not Applicable

Uncorrected Shear Strength: No Penetration

Water Courses / Drainage: None Visible.

Assessed Peat Slide Risk: Not Applicable.

Created By: Andrew Jaworski	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Drehid	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 22	**Date: 6-6-2013**

Topography: The ground gently slopes 3° S.

Vegetation: Firm Grassland

Peat Thickness: None Present.

Features: gently sloping grassland over brown topsoil.

Von Post Classification: Not Applicable

Uncorrected Shear Strength: No Penetration

Water Courses/Drainage: None Visible.

Assessed Peat Slide Risk: Not Applicable.

Created By: Andrew Jaworski	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Drehid	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 23	**Date: 5/11/14**

Topography: The ground gently slopes 1° S.

Vegetation: Firm Grassland

Peat Thickness: None Present probe depth 0.20m.

Features: gently sloping grassland over firm brown topsoil.

Von Post Classification: Not Applicable

Uncorrected Shear Strength: No Penetration

Water Courses/Drainage: Field drains approx 50m from turbine

Assessed Peat Slide Risk: Not Applicable.

Created By: Andrew Jaworski	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Windmill	**Job No: LE14-731-04**
Client: Element Power	**Weather: Wet Overcast**
Position ID: Turbine T24	**Date: 11-6-2013 & 18-11-2014**

Topography: Site Slope <1° E-W.

Vegetation: Worked (Milled) Peat bog.

Peat Thickness: 4.0m.

Features: Soft brown fibrous peat overlying brown amorphous peat. Gouge core stopped on suspected root / wood material at 3.0m

Von Post Classification: H7, B3

Uncorrected Shear Strength: 35kPa at 0.50m, 30KPa at 1.0m, 28KPa at 1.50m, 40KPa at 2.0m 60KPa at 2.50m.

Water Courses / Drainage: Numerous drains running approx N-S at 10m spacing

Assessed Peat Slide Risk: Low

Created By: Andrew Jaworski	**Checked By:** A Garne

GEOLOGICAL SITE WALKOVER

Site: Windmill	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine T25	**Date: 18-04-14**

Topography: Site Slope <1° S.

Vegetation: Worked (Milled) Peat bog.

Peat Thickness: 1.8m.

Features: Soft brown fibrous peat overlying brown amorphous peat gouge core stopped on granular material at 1.8m

Von Post Classification: H7, B4

Uncorrected Shear Strength: 28kPa at 0.50m, 30KPa at 1.0m, 28KPa at 1.50m

Water Courses / Drainage: Numerous drains running approx N-S at 10m spacings

Assessed Peat Slide Risk: Low

Created By: Andrew Jaworski	**Checked By:** A Garne

GEOLOGICAL SITE WALKOVER

Site: Windmill	**Job No: LE14-731-04**
Client: Element Power	**Weather: Wet Overcast**
Position ID: Turbine T26	**Date: 11-6-2013 & 18-11-2014**

Topography: Site Slope <1° N-S.

Vegetation: Worked (Milled) Peat bog.

Peat Thickness: 2.30m.

Features: Soft brown spongy pseudofibrous peat with some root material at depth. Gouge core stopped in stiff grey brown slightly sandy slightly gravelly Clay at 2.30m

Von Post Classification: H7, B3

Uncorrected Shear Strength: 40kPa at 0.50m, 40KPa at 1.0m, 32KPa at 1.50m, 28KPa at 2.0m

Water Courses/Drainage: Numerous drains running approx N-S at 20m spacing.

Assessed Peat Slide Risk: Low

Created By: Andrew Jaworski	**Checked By:** A Garne

GEOLOGICAL SITE WALKOVER

Site: Derrybrennan	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry, Sunny**
Position ID: Turbine 27	**Date: 7/6/13**

Topography: Elevated, flat peat bank surrounded by tillage fields

Vegetation: Woodland on Peat

Peat Thickness: 0.5m

Features: Dark brown pseudo-fibrous Peat

Von Post Classification: H5, B2

Uncorrected Shear Strength: 63kPa @ 0.5m

Water Courses/Drainage: Peat cracked in numerous places.

Assessed Peat Slide Risk: Extremely Low

Created By: Neil Sandes	**Checked By: AG**

GEOLOGICAL SITE WALKOVER

Site: Derrybrennan	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry, Sunny**
Position ID: Turbine 28	**Date: 7/6/13**

Topography: Very slight (1°) east to west slope

Vegetation: Grassland

Peat Thickness: 0.3m

Features: Peaty Topsoil

Von Post Classification: Not Sampled

Uncorrected Shear Strength: 50kPa @ 0.3m BGL

Water Courses/Drainage: No drainage features identified close to turbine location.

Assessed Peat Slide Risk: Not Applicable

Created By: Neil Sandes	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Cloncumber	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 29	**Date: 4/11/14**

Topography: Flat Terrain

Vegetation: Mature forestry

Peat Thickness: 1.75m.

Features: Moist light brown Peat

Von Post Classification: H6, B3

Uncorrected Shear Strength: 30kPa @0.5m, 25kPa @1m, 30kPa @ 1.5m

Water Courses/Drainage: Moderate drainage. 5m spaced blocked drains.

Assessed Peat Slide Risk: Low

Created By: Neil Sandes	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Cloncumber	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 30	**Date: 4/11/14**

Topography: Flat boggy terrain

Vegetation: Sedge grasses and newly planted forestry in clearfelled area

Peat Thickness: 0.3m.

Features: Boggy underfoot

Von Post Classification: Not applicable

Uncorrected Shear Strength: Not tested

Water Courses/Drainage: 20m from nearest drain. Poor drainage.

Assessed Peat Slide Risk: Negligible

Created By: Neil Sandes	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Cloncumber	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry, Sunny**
Position ID: Turbine 31	**Date: 04/11/14**

Topography: Flat Terrain. Max 1°N

Vegetation: Semi-mature mixed forestry on Peat

Peat Thickness: 3.7m.

Features: Slightly moist dark brown amorphous Peat

Von Post Classification: H6, B2

Uncorrected Shear Strength: 30kPa @ 0.5m BGL, 30kPa @ 1m BGL, 35kPa @ 1.5m BGL, 35kPa @ 2.0m BGL, 50kPa @ 2.5m BGL, 60kPa @ 3.0m BGL, 60kPa @ 3.5m BGL,

Water Courses/Drainage: Forest drains throughout. 5m spacing. Well drained.

Assessed Peat Slide Risk: Very Low

Created By: Neil Sandes	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Cloncumber	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry, Sunny**
Position ID: Turbine 32	**Date: 04/11/14**

Topography: Flat Terrain. Max slope 1° S

Vegetation: Mature mixed forestry on Peat

Peat Thickness: 2.7m

Features: Slightly moist brown Peat

Von Post Classification: H6, B2

Uncorrected Shear Strength: 30kPa @ 0.5m BGL, 70kPa @ 1m BGL, 50kPa @ 1.5m BGL, 70kPa @ 2m BGL, 60kPa @ 2.5m BGL

Water Courses/Drainage: Drainage ditches throughout forestry. Slate River and Grand Canal close by

Assessed Peat Slide Risk: Very Low

Created By: AG	**Checked By:** TPR

GEOLOGICAL SITE WALKOVER

Site: Cloncumber	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry, Sunny**
Position ID: Turbine 33	**Date: 04/11/14**

Topography: Gentle slope 1° S

Vegetation: Tillage Field

Peat Thickness: None present. Probe 0.3m.

Features: Firm underfoot. Possible ring fort located 50m southeast of turbine

Von Post Classification: Not Applicable

Uncorrected Shear Strength: Not Applicable

Water Courses/Drainage: Drainage ditches located on field boundaries. Slate River 220m north of turbine location

Assessed Peat Slide Risk: Not Applicable

Created By: Neil Sandes	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Cloncumber	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry, Sunny**
Position ID: Turbine 34	**Date: 30/10/14**

Topography: Flat Terrain

Vegetation: Grassland

Peat Thickness: No peat. 0.5m peaty topsoil over possible boulder clay

Features: Soft to Firm underfoot

Von Post Classification: Not Sampled

Uncorrected Shear Strength: 50kPa @ 0.3m BGL

Water Courses/Drainage: Field drain approximately 20m from turbine.

Assessed Peat Slide Risk: Not applicable

Created By: Neil Sandes	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Cloncumber	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry, Sunny**
Position ID: Turbine 35	**Date: 30/10/14**

Topography: Flat Terrain. Max slope 1°S.

Vegetation: Grassland

Peat Thickness: None present. Probe 0.1m

Features: Firm underfoot

Von Post Classification: Not Applicable

Uncorrected Shear Strength: Not Applicable

Water Courses/Drainage: Drainage ditches located on field boundaries. River Slate 170m northwest of turbine location.

Assessed Peat Slide Risk: Not Applicable

Created By: Neil Sandes	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Cloncumber	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 36	**Date: 30/10/14**

Topography: Flat Terrain

Vegetation: Grassland

Peat Thickness: Peaty topsoil 1m deep. Hard refusal

Features: Soft to firm underfoot.

Von Post Classification: Not Applicable

Uncorrected Shear Strength: 30kpa at 0.5m

Water Courses/Drainage: Drainage ditches located about 50m from turbine.

Assessed Peat Slide Risk: Not Applicable

Created By: Neil Sandes	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Cloncumber	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 37	**Date: 04/11/14**

Topography: Flat Terrain. Max slope 1° S

Vegetation: Grassland

Peat Thickness: Peaty topsoil to 0.5m BGL over grey sandy gravelly silt (seen in nearby recently excavated drain)

Features: Firm – No penetration with probe.

Von Post Classification: Not Applicable

Uncorrected Shear Strength: 30kPa @ 0.4m

Water Courses/Drainage: Deep drainage ditch located 20m south Slate River located 300m northwest.

Assessed Peat Slide Risk: Not Applicable

Created By: Neil Sandes	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Cloncumber	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 38	**Date: 30/10/14**

Topography: Flat Terrain

Vegetation: Grassland with abundant rushes.

Peat Thickness: Peaty topsoil to 0.5m BGL

Features: Soft underfoot. Brown peaty clay.

Von Post Classification: Not Applicable

Uncorrected Shear Strength: 55kPa @ 0.3mBGL, 150kPa @ 0.5m

Water Courses/Drainage: Deep drainage ditch located 30m north of turbine location. Slate River located 200m northwest.

Assessed Peat Slide Risk: Not Applicable

Created By: Neil Sandes	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Cloncumber	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 39	**Date: 30/10/14**

Topography: Flat Terrain. Max 1°S

Vegetation: Boggy grassland with occasional rushes.

Peat Thickness: Peaty topsoil to 0.5m BGL

Features: Soft underfoot. Brown peaty clay.

Von Post Classification: Not Applicable

Uncorrected Shear Strength: Not applicable

Water Courses/Drainage: 50m from field drain

Assessed Peat Slide Risk: Not Applicable

Created By: Neil Sandes	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Hortland	**Job No: LE14-731-03**
Client: Element Power	**Weather: Overcast**
Position ID: Turbine 40	**Date: 12-6-2013**

Topography: The ground slopes 2° N.

Vegetation: Mature coniferous forestry overlying soft brown fibrous peat.

Peat Thickness: 0.80m Peat. Soft brown fibrous peat. 0.80m grey mottled black organic clay.

Features: Forestry

Von Post Classification: H5, B2

Uncorrected Shear Strength: 25KPa at 0.50m,45KPa at 1.0m

Water Courses/Drainage: Dry drainage ditches at 10m intervals in forestry.

Assessed Peat Slide Risk: Very Low.

Created By: Andrew Jaworski	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Hortland	**Job No: LE14-731-03**
Client: Element Power	**Weather: Overcast**
Position ID: Turbine 41	**Date: 12-6-2013**

Topography: The ground slopes 3° NW.

Vegetation: Grassland, topsoil, over brown sandy clay.

Peat Thickness: None Present

Features: Soft grassland

Von Post Classification: Not Applicable

Uncorrected Shear Strength: No Penetration

Water Courses/Drainage: 1.5m deep drainage ditches at field boundaries.

Assessed Peat Slide Risk: Not Applicable.

Created By: Andrew Jaworski	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Hortland	**Job No: LE14-731-04**
Client: Element Power	**Weather: Overcast**
Position ID: Turbine 42	**Date: 12-6-2013**

Topography: The ground slopes 3° E

Vegetation: Mature Forestry

Peat Thickness: 2.50m. Soft brown pseudofibrous peat becoming amorphous Peat with depth.

Features: Mature coniferous forestry.

Von Post Classification: H6, B3

Uncorrected Shear Strength: 25KPa at 0.50m, 28KPa at 1.0m, 25KPa at 1.5m,30KPa at 2.0m, 35KPa at 2.5m.

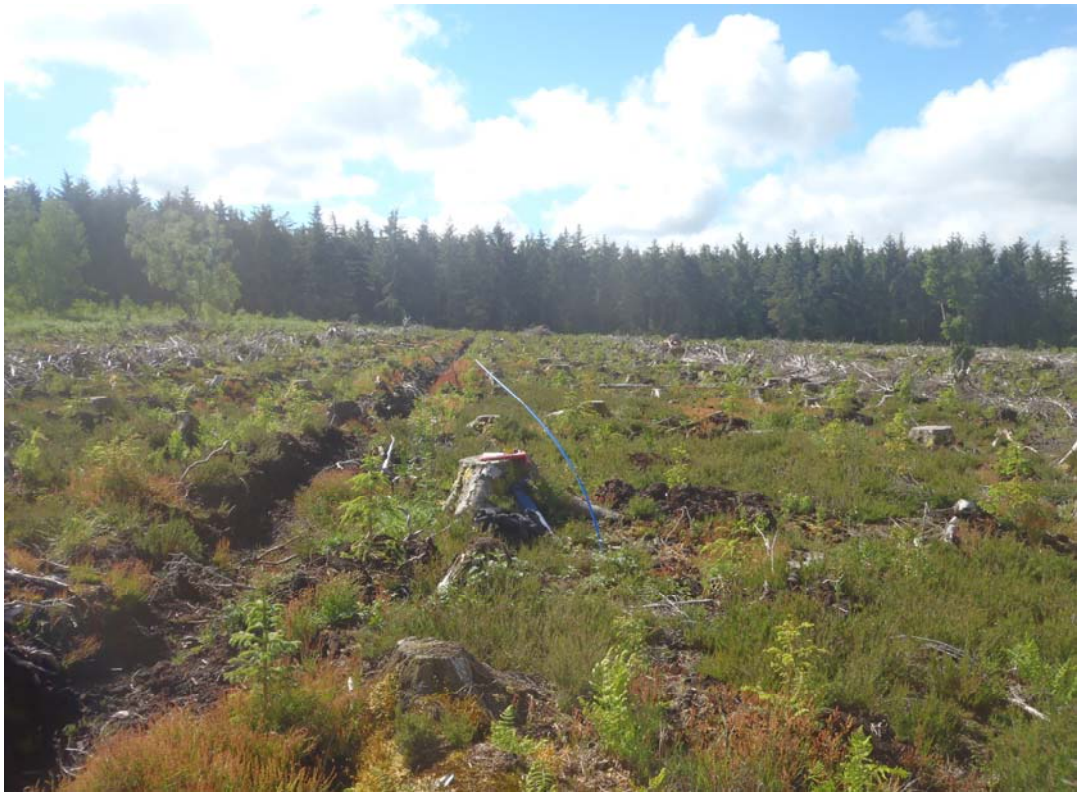
Water Courses / Drainage: Drainage ditches at 10m intervals within forestry

Assessed Peat Slide Risk: Low.

Created By: Andrew Jaworski	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Hortland	**Job No: LE14-731-03**
Client: Element Power	**Weather: Overcast**
Position ID: Turbine 43	**Date: 12-6-2013**



Topography: The ground slopes 2° SE.

Vegetation: Harvested forestry overlying soft brown pseudofibrous spongy peat. Peat

Peat Thickness: 0.90m. Soft brown fibrous peat

Features: Harvested forestry

Von Post Classification: H5 B2

Uncorrected Shear Strength: 40KPa at 0.50m,45KPa at 0.90m

Water Courses/Drainage: Dry drainage ditches at 10m intervals.

Assessed Peat Slide Risk: Very Low.

Created By: Andrew Jaworski	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Hortland	**Job No: LE14-731-04**
Client: Element Power	**Weather: Overcast**
Position ID: Turbine 44	**Date: 12-6-2013**

Topography: The ground slopes 3° E

Vegetation: Mature Forestry

Peat Thickness: 2.50m. Soft brown pseudofibrous peat becoming amorphous Peat with depth.

Features: Mature coniferous forestry.

Von Post Classification: H6, B3

Uncorrected Shear Strength: 25KPa at 0.50m, 28KPa at 1.0m, 25KPa at 1.5m,30KPa at 2.0m, 35KPa at 2.5m.

Water Courses/Drainage: Drainage ditches at 10m intervals within forestry

Assessed Peat Slide Risk: Low.

Created By: Andrew Jaworski	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Hortland	**Job No: LE14-731-04**
Client: Element Power	**Weather: Fine**
Position ID: Turbine 45	**Date: 12-6-2013**

Topography: The ground gently slopes 2° S.

Vegetation: Soft grassland

Peat Thickness: None present 0.5m peaty topsoil.

Features: Flat pastureland surrounded by forestry to the E, W and S.

Von Post Classification: Not Applicable

Uncorrected Shear Strength: 23KPa at 0.50m.

Water Courses / Drainage: Drainage ditch at edge of forestry

Assessed Peat Slide Risk: Not applicable.

Created By: Andrew Jaworski	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Hortland	**Job No: LE14-731-04**
Client: Element Power	**Weather: Fine**
Position ID: Turbine 46	**Date: 12-6-2013**

Topography: The ground gently slopes 1° S.

Vegetation: Firm grassland

Peat Thickness: None Present. Firm topsoil over brown slightly sandy gravelly clay.

Features: Flat pastureland.

Von Post Classification: Not Applicable

Uncorrected Shear Strength: Not tested

Water Courses / Drainage: Drainage ditch to SE within 10m of Turbine

Assessed Peat Slide Risk: Not Applicable.

Created By: Andrew Jaworski	**Checked By:** AG

GEOLOGICAL SITE WALKOVER

Site: Drehid-Hortland	**Job No: LE14-731-04**
Client: Element Power	**Weather: Dry**
Position ID: Turbine 47	**Date: 6-6-2013**

Topography: The ground gently slopes 3° E.

Vegetation: Firm Grassland (Evidence of being soft in Wet weather deep animal ruts)

Peat Thickness: None Present probe depth 0.20m.

Features: gently sloping grassland over brown topsoil.

Von Post Classification: Not Applicable

Uncorrected Shear Strength: No Penetration

Water Courses / Drainage: None Visible.

Assessed Peat Slide Risk: Not Applicable.

Created By: Andrew Jaworski	**Checked By:** AG