REPORT ON

QUANTITATIVE RISK ASSESSMENT OF PEAT STABILITY DURING TREE FELLING

GARVAGH GLEBE WIND FARM

Prepared for:

Coillte

July 2009

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1 INTRODUCTION

1.1 Objectives

Applied Ground Engineering Consultants Ltd (AGEC) was engaged in June 2009 by Coillte to undertake an assessment of the potential risk of peat failure with respect to tree felling at the Garvagh Glebe Wind Farm site. The wind farm development is being carried out by Garvagh Glebe Power Ltd, a joint venture between Coillte and Hibernian Wind Power Limited.

The Garvagh Glebe Wind Farm, which comprises a North and South site, is located on Corry Mountain to the west of Lough Allen in County Leitrim.

The North site comprises 8 turbines and associated infrastructure and is located on the northwest part of Corry Mountain. The South site comprises 5 turbines and associated infrastructure and is located on the central north part of Corry Mountain.

During construction of Garvagh Glebe North in September 2008 a slope failure occurred in the peat slopes on the northern part of the site. Since the failure, the site has been further investigated and a risk assessment carried out with respect to the proposed wind farm construction.

Prior to re-commencing wind farm construction tree felling is required at Garvagh Glebe North and South.

This report provides a Quantitative Risk Assessment (QRA) of peat stability with respect to tree felling at Garvagh Glebe North, and also includes Garvagh Glebe South.

1.2 Quantitative Risk Assessment (QRA)

The QRA carried out in this report takes into account multiple factors that may be associated with slope failure on peat slopes. A critical combination of these factors would indicate areas that have an elevated risk of slope failure.

Areas of elevated risk determined from the QRA do not necessarily indicate that an area is more likely to fail, but merely identify areas where there are factors present that, without appropriate mitigation, may render an area more susceptible to slope failure.

The QRA adopted uses the factors identified by the developer following the slope failure at the Garvagh Glebe site (Appendix A).

Appropriate mitigation measures are adopted to reduce the risk of slope failure as a result of tree felling based on the QRA.

2 TREE FELLING OPERATIONS

2.1 Tree Felling at Garvagh Glebe

The extent of tree felling is shown on Drawings 1 and 2 (Appendix B).

No tree felling will be carried out in the area surrounding the September 2008 failure. The nearest felling will be within a forestry block some 100m to the west of the failure.

In some areas, tree felling is already underway following an earlier approved tree felling licence; these areas are southwest of Garvagh Glebe North and in the southern part of Garvagh Glebe South.

Tree felling will be carried out and controlled as per Coillte and Forest Service guidelines for sensitive sites and will comprise the following harvesting methods:

(1) Fell to road. This involves cutting trees and removal of all cut trees to pre-existing forestry roads for shipment off site. The harvesting machinery will consist of a harvester and forwarder and will be carried out on a grid of harvesting racks which will be located typically 16m apart. The racks will be formed using the brash and crown of the harvested trees and will be approximately 3m wide. All timber up to a minimum top diameter of 7cm will be removed as part of the harvesting operation.

(2) Fell to waste. The harvesting regime planned is the use of a low ground pressure machine with a cutting head to cut the trees and to leave them on site. The harvesting machine will use some of the harvested trees to form a brash mat to carry the machine.

This method is proposed for sensitive areas.

The weight of the brash mat per square metre is very low and is estimated at 0.23 tonnes per square metre, this is equivalent to no more than a depth of soil of 230mm deep.

It is expected that no windrowing will be carried out, the exception being in areas where the brash mat needs to be tidied up.

Note that Coillte would not re-plant for a period of at least 18 months following harvesting.

2.2 Tree Felling and Peat Slope Stability

We understand that Coillte have no recorded instances of tree felling works resulting in failure of peat slopes. Most of the recent recorded peat failures have been related to civil engineering works.

A general review of tree felling operations and their effects on peat slopes is given below.

(1) Methods of Tree Felling

- The method of tree felling in sensitive areas requires the use of low ground bearing (LGB) machinery with the addition of brash support in wetter areas.

- The use of an LGB is not considered to represent a stability issue as the LGB machinery obviously has a low ground bearing pressure which will reduce the loading on the peat.
- The width of the proposed machinery tyre tracks is notably less than 1m; therefore any stressing of the peat below the tyres will have dissipated within 1.5m depth. It is important that the loading effect is not transmitted to the interface of the peat and mineral soil (typically at greater than 2 to 2.5m depth)
- Due to the above, the effect of using an LGB machine would not be deemed a critical stability issue.
- Where stacking of felled logs is required then the location of the stacks needs to be carefully considered. The location of stacking needs to be in areas where the ability of the underlying ground to safely support the loading has been determined in advance. Any stacking will be adjacent to existing forestry roads.
- Main access routes would also need to be agreed in advance with the site geotechnical engineer.

(2) Effect on Ground Stability by Tree Felling

- The removal of trees could be seen as a benefit for stability, particularly as the roots will be left in situ. Tree roots will be left in situ and these will assist in binding together the upper peat layers and spreading surface loading.
- The external loading from trees appears to be seen as one of the primary detrimental influences on slope stability (Gray, 1995). However depending on the mode of potential instability, slope inclination and soil strength then tree weight may either be beneficial or detrimental to slope stability. The effect of tree weight on slope stability is complex.
- The placement of cut trees onto the ground surface will result in line loading of the ground. Due to the small width of the line loading this will only stress the ground to a short depth.
- Multiple felled trees on the ground surface will result in multiple line loads. The loading from felled trees left in situ is considered to be small and reasonably distributed across the slope not to represent an adverse loading.

(3) Presence of Sensitive Clay below Peat

- The presence of sensitive grey clay was considered a significant contributory factor in causing the September 2008 failure. However in isolation the presence of the grey clay alone would not result in failure. The failure at the site was likely attributable to multiple factors, but what must be borne in mind is the critical combination of these factors, such as:

  Weaker ground below the peat ie sensitive clay
  Weaker peat

Placing and trafficking of arisings on peat surface
Successive impact loading of peat arisings
Forestry furrows/drains aligned across slope
Proximity to stream headwaters eg area of concentrated water flow
Poor drainage eg tree in failed area were stunted

(4) Hydrological Effects of Tree Removal

- Removal of trees will not result in the underlying sensitive soil becoming more saturated and unstable.
- The low permeability of the peat essentially retards any significant movement of water downwards (note if there was significant downward movement of water there would be no peat).
- It is noted that the soils below the peat are essentially in a saturated condition and tree removal will not alter their natural moisture content.
- Whilst the trees would have intercepted water, the re-establishment of drains following the removal of trees would likely result in water being shed from the site more efficiently than when trees were present.

3 SITE DESCRIPTION

The Garvagh Glebe Wind Farm is divided into 2 sites, namely a North and South site.

The North site which comprises 8 turbines and associated infrastructure is located on the northwest part of Corry Mountain. The site is on gently sloping hillsides with slope inclination varying form about 2 to 5 degrees with locally steeper slopes. Within the northern site there is an area of level ground, which appears to be a topographic depression which has been infilled with peat. The area of thickest peat coincides with the depression.

The South site which comprises 5 turbines and associated infrastructure is located on the central north part of Corry Mountain. The site is on a gently sloping ridgeline with slope inclination varying from about 2 to 5 degrees with locally steeper slopes, where peat is absent or thins. The southern part of the site is mostly forested.

Within the South site the area of thickest peat coincides with the access onto the site, near T8. To the south the peat thins with T11 located in an area of thin peat cover.

4 QRA METHODOLOGY

4.1 Methodology

The QRA uses geotechnical, topographical, hydrological and hydrogeological characteristic factors that are considered to be indicative of slope instability. Other indirect factors such as vegetation, slide history, land use and aerial photography are also taken in account.

Within the QRA risk register, individual factors are scored and then the accumulation of these scores is used to provide an overall risk score. See Appendix A for further details.

The risk register includes the following factors:

- Peat depth, undrained shear strength, water content and degree of humification.
- Characteristics of the underlying soil or rock and at the interface with the peat.
- The slope angle at the ground surface and the base of the peat.
- The general topography and location relative to the topographical low point upslope from defined watercourses on the site.
- Surface groundwater conditions and site drainage.
- Evidence of subsurface water flow through pipes in the peat.

Other factors are also included which can be used to identify sites of particular susceptibility to peat slides, these include:

- Tree growth or vegetation.
- A history of previous slides on site or in the general area.
- Peat workings in the area.
- The stability of the peat and groundwater ingress in trial pit excavations on the site.
- Evidence of peat slides, subsurface drainage or other contributory factors which can be seen from aerial photography.

In the risk register, each factor is scored on a scale 1 to 3, 3 being high risk. The cumulative total of all the factor scores is expressed as a ratio of the total score, which only includes the factors that have been used in the assessment. Not all factors may be present.

Table 1 below shows the risk rating outlining the likelihood of a peat slide occurring corresponding to the risk score received from the risk register.

Table 1 Risk Rating Table

Risk Score	Risk Rating Without Construction Impact or Appropriate Mitigation Measures
< 40 %	Not Applicable
40-50 %	Negligible
51-60 %	Low
61-70 %	Possible
71-75 %	Very Possible
>75 %	Likely depending on Construction impacts and without appropriate mitigation measures

4.2 Zonation

For the QRA the Garvagh Glebe North and South sites were divided into zones of similar terrain characteristics. Garvagh Glebe North is divided into nine zones while the South site is divided into three zones.

For each zone, a risk register was compiled which provides a risk score.

The areas designated for tree felling approximately fall into the zones used for the QRA.

Tables 2 and 3 below describe the characteristics of each zone and the zones where tree felling is required.

Table 2 Garvagh Glebe North – Zones & Descriptions

Zone	Description	Tree Felling
1	Located in the southern part of the site, zone 1 is an area of relatively flat terrain. Peat depths in this area range from 2.5m - 4.0 m. There is no forestry located in this zone.	
2	Zone 2 is a ridge of high terrain located just north of zone 1. Slope angles in this zone are relatively steep, however peat depths are shallow. The zone is heavily forested.	Yes
3	Zone 3 is located just west of the centre of the site, in an area sloping westwards. Peat depths range from 2.0 m to 3.0 m and the zone is heavily forested.	
4	Zone 4 is located at the centre of the site, in an area of flat terrain with deep peat. Peat depths range from 3 m - 4.5 m. The zone is partially forested.	
5 and 5a	Zone 5 is located towards to southeast of the site. The zone is sloping at +6°. Peat depths range from 0.0 m to 2.0 m. The area is partly heavily forested in the north with recently planted trees in the south around Turbine 9.	Yes
	Zone 5a is an extension of zone 5 south. The zone is sloping at up to 15°. Peat depth range is from 0.0 m to locally 2.0 m. The area has recently been planted in the south around Turbine 9. At Turbine 9 there peat depth is less than 0.5m	Yes
6	Zone 6 is located towards the north end of the site and slopes at 4° to the east. Peat depths in this zone range from 1.0 m to 3.5 m. The zone is forested however tree growth is locally poor. September 2008 failure occurred in this zone.	Yes
7	Zone 7 is located in the northwest of the site and is an area of gently sloping terrain. Peat depths range from 3.0 m to 4.5 m and the zone is heavily forested.	Yes
8	Zone 8 is located in the southwest of the site and slopes westwards at 6.5°. Peat depths range from 0.5 m to 2.5 m and the zone is partly heavily forested.	Yes – but underway
9	Zone 9 is located just east of zone 4 and slopes at +5° towards to east. Peat depths range from 1 m to 4 m and is partially forested.	

Table 3 Garvagh Glebe South – Zones & Description

Zone	Description	Tree Felling
1	Zone 1 is in the northwest of the site and continues towards the centre of the site. Peat depths range from 1.0 m to3.5 m and the zone is heavily forested. The zone has undulating terrain with slopes of up to locally 8°.	Yes
2	Zone 2 is located in the south of the site and is an area of steep terrain to the west and begins to flatten out towards to east. The zone has relatively thin peat cover with depths ranging from 0.5 m to locally 2.0 m, and is heavily forested.	Yes
3	Zone 3 is located in the southeast of the site and is an area of higher terrain which slopes westwards towards zone 1. Peat depths range from 0.5 m to locally 2.0 m and the zone is mostly heavily forested	Yes

The location of the zones for the north and south sites are shown in Drawings 001 and 002 in Appendix B.

5 RESULTS

5.1 Garvagh Glebe North

The results from the QRA for Garvagh Glebe North ranged from 53% to 63% with an average of 59.7%. Zone 6 has the highest score of 63% while zone 2 has the lowest (see Appendix C). Table 4 below shows the scores for each zone.

Table 4 Garvagh Glebe North – Zones, Brief Description & Score

Zone	Brief Description	Score (%)	Tree Felling
1	Located in the southern part of the site	57	
2	Zone 2 is a ridge of high terrain located just north of zone 1	53	Yes
3	Zone 3 is located just west of the centre of the site	57	
4	Zone 4 is located at the centre of the site	62	
5 and 5a	Zone 5 is located towards to southeast of the site	62	Yes
	Zone 5a is an extension of zone 5 south		Yes
6	Zone 6 is located towards the north of the site	68	Yes
7	Zone 7 is located in the northwest of the site	61	Yes
8	Zone 8 is located in the southwest of the site	56	Yes – but underway
9	Zone 9 is located just east of zone 4	63	

The results for Garvagh Glebe North show that zones 1, 2, 3 and 8 have a **LOW** risk rating without construction impact or appropriate mitigation measures, and zones 4, 5, 6, 7 and 9 have a **POSSIBLE** risk rating without construction impact or appropriate mitigation measures. See Appendix C for the quantitative risk assessment sheets.

The highest result corresponds to the zone where the September 2008 failure occurred.

5.2 Garvagh Glebe South

The results from the QRA for Garvagh Glebe South ranged from 55% to 59% with an average of 56.6%. Zone 1 has the highest score while zone 3 he lowest (see Appendix D). Table 5 below shows the scores for each zone.

Table 5 Garvagh Glebe South – Zones, Brief Description & Score

Zone	Brief Description	Score (%)	Tree Felling
1	Zone 1 is in the northwest of the site	59	Yes
2	Zone 2 is located in the south of the site	56	Yes
3	Zone 3 is located in the southeast of the site	55	Yes

The results for Garvagh Glebe South show that zones 1, 2 and 3 have a **LOW** risk rating without construction impact or appropriate mitigation measures. See Appendix D for the quantitative risk assessment sheets.

Garvagh Glebe South has a lower risk score than Garvagh Glebe North, and this would be expected based on geotechnical investigations at both sites.

6 MITIGATION MEASURES

The following mitigation measures (Tables 6 and 7) are based on the results of the QRA and inspection of the zones. The mitigation measures below have taken into account the felling method proposed by Coillte.

It is considered that the felling method proposed by Coillte and the adoption of the mitigation measures will minimise the risk of slope failure as a result of tree felling operations.

Table 6 Garvagh Glebe North – Mitigation Measures

Zone	Description	Score (%)	Tree Felling	Mitigation Measures (see Notes)
1	Located in the southern part of the site	57		Not applicable
2	Zone 2 is a ridge of high terrain located just north of zone 1	53	Yes	• Tree fell to waste • Prior to felling trial pitting to be carried out • Geotechnical assessment of trial pit results and stability analysis, as appropriate. • Movement monitoring stakes to be placed at critical locations, as determined from stability analysis • Ongoing geotechnical inspection during cutting operations • No stacking of trees • No wind-rowing • Ensure all drainage channels remain clear • Cessation of works during periods of intense rainfall
3	Zone 3 is located just west of the centre of the site	57		Not applicable
4	Zone 4 is located at the centre of the site	62		Not applicable
5 and 5a	Zone 5 is located towards to southeast of the site	62	Yes	• Part tree fell to waste and fell to road • Prior to felling trial pitting to be carried out • Geotechnical assessment of trial pit results and stability analysis, as appropriate. • Movement monitoring stakes to be placed at critical locations, as determined from stability analysis • Ongoing geotechnical inspection during cutting operations • No stacking of trees • No wind-rowing • Ensure all drainage channels remain clear • Cessation of works during periods of intense rainfall
	Zone 5a is an extension of zone 5 south		Yes	

Zone	Description	Score (%)	Tree Felling	Mitigation Measures (see Notes)
6	Zone 6 is located towards the north of the site	68	Yes	• Tree fell to waste • Prior to felling trial pitting to be carried out • Geotechnical assessment of trial pit results and stability analysis, as appropriate. • Movement monitoring stakes to be placed at critical locations, as determined from stability analysis • Ongoing geotechnical inspection during cutting operations • No stacking of trees • No wind-rowing • Ensure all drainage channels remain clear • Cessation of works during periods of intense rainfall
7	Zone 7 is located in the northwest of the site	61	Yes	• Tree fell to waste • Prior to felling trial pitting to be carried out • Geotechnical assessment of trial pit results and stability analysis. • Movement monitoring stakes to be placed at critical locations, as determined from stability analysis • No stacking of trees • No wind-rowing • Ensure all drainage channels remain clear • Cessation of works during periods of intense rainfall
8	Zone 8 is located in the southwest of the site	56	Yes – but underway	• Part tree fell to waste and fell to road • Prior to felling trial pitting to be carried out • Geotechnical assessment of trial pit results and stability analysis, as appropriate. • Movement monitoring stakes to be placed at critical locations, as determined from stability analysis • Ongoing geotechnical inspection during cutting operations • Geotechnical inspection of areas where tree stacking to be carried out beside existing forestry roads • Ensure that ground at tree stacking location is stable and away from any steep slopes • Ensure all drainage channels remain clear • Cessation of works during periods of intense rainfall
9	Zone 9 is located just east of zone 4	63		Not applicable

Table 7 Garvagh Glebe South – Mitigation Measures

Zone	Description	Score (%)	Tree Felling	Mitigation Measures (see Notes)
1	Zone 1 is in the northwest of the site	59	Yes	• Part tree fell to waste and fell to road • Prior to felling trial pitting to be carried out • Geotechnical assessment of trial pit results and stability analysis, as appropriate. • Movement monitoring stakes to be placed at critical locations, as determined from stability analysis • Ongoing geotechnical inspection during cutting operations • Geotechnical inspection of areas where tree stacking to be carried out beside existing forestry roads • Ensure that ground at tree stacking location is stable and away from any steep slopes • Ensure all drainage channels remain clear • Cessation of works during periods of intense rainfall
2	Zone 2 is located in the south of the site	56	Yes	
3	Zone 3 is located in the southeast of the site	55	Yes	

Notes

(1) Geotechnical inspection of areas where tree stacking is to be carried out shall comprise one or all the following depending on the selected location: visual inspection of ground surface, peat probing, or trial pitting.

(2) Geotechnical assessment of trial pit results is to confirm ground conditions as given in the QRA (in this report). Where ground conditions are adversely materially different (eg significant greater peat depth, presence of sensitive clay) then further stability analysis shall be carried out.

APPENDIX A

CONSULTING
GEOTECHNICAL ENGINEERS

GARVAGH GLEBE WINDFARM

GUIDANCE NOTES ON RISK REGISTERS FOR PEAT STABILITY FOR ACCESS ROADS, CRANE HARDSTANDINGS AND TURBINE EXCAVATIONS

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GARVAGH GLEBE WINDFARM

GUIDANCE NOTES ON RISK REGISTERS FOR PEAT STABILITY FOR ACCESS ROADS, CRANE HARDSTANDINGS AND TURBINE EXCAVATIONS

The registers follow the general guidelines in the reports by Mac Culloch (2006) and the Scottish Executive (2006) with regard to peat stability and risk assessments for planar peat slides and bog bursts on upland bogs during the construction of windfarms or low volume roads on peat. However, we have developed the qualitative risk assessment procedures proposed by Mac Culloch to produce a more quantitative risk assessment procedure that accounts for the compounding effect of particular risk factors to identify sites that could be particularly susceptible to planar slides or bog bursts during the construction stage of a windfarm project. The risk register has also been updated to include risk factors that may have contributed to the slide that occurred in Derrybrien in 2004, and to slides that occurred in Garvagh Glebe and in other slides in Co. Kerry 2008. The resulting risk assessment is also compatible with the risk management procedures in the ICE publication "Managing Geotechnical Risk" by Clayton (2001).

The risk registers assess the principal geotechnical, topographical, hydrological and hydrogeological characteristics on the site that are considered to impact the stability of peat on upland bogs, including:

- Peat depth, undrained shear strength, water content and degree of humification.
- Characteristics of the underlying soil or rock and at the interface with the peat.
- The slope angle at the ground surface and the base of the peat.
- The general topography and location relative to the topographical low point upslope from defined watercourses on the site.
- Surface groundwater conditions and site drainage.
- Evidence of subsurface water flow through pipes in the peat.

It also includes indirect contributory factors which can be used to identify sites that could be particularly vulnerable to peat slides or bog bursts, such as those related to:

- Tree growth or vegetation
- A history of previous slides on site or in the general area.
- Peat workings such as harvesting in turbury plots or with a sausage cutter.
- Evidence of peat slides, subsurface drainage or general anomalies such as disrupted peat or drainage patterns from aerial photographs.
- The stability of peat and groundwater ingress in trial pit excavations on the site.

This register is a comprehensive list of possible risk factors that can be assessed on the basis of a desk study, walkover survey and ground investigation. However, it is not an exhaustive list and it should be considered as a live document that can be

updated as necessary to include additional factors that are considered relevant, some of which may be site specific.

A score has been applied to each risk factor on a scale of **1** to **3** in increasing level of risk. The cumulative total of all of these is expressed as a ratio in percent of the maximum score, which only includes those factors that have been used in the assessment. The risk ratio allows for a comparative assessment of the different sites.

A risk rating has been applied to the part of the site covered by the register on a scale of 0.0 to 2.5. This scale would be comparable to the lower half of a typical 6-point risk rating on a scale of 0-5 listed in Table No.1.

Table No.1 – Qualitative scale for risk assessment

Risk Rating	**Likelihood**	**Chance per section of work**
0	Not Applicable	<1 in 1000
1	Negligible	1 in 1000 to 1 in 100
2	Possible	1 in 100 to 1 in 10
3	Likely	1 in 10 to 1 in 2
4	Probable	1 in 2 to 1 in 1
5	Almost Certain	Approx. 1 in 1

The natural occurrence of peat slides or bog bursts on upland bogs in Ireland is very rare and most virgin sites would have a risk rating between **0.0** and **1.0** without any impact from windfarm development.

The risk registers are based on existing conditions prior to construction and do not take into account the potential impact of construction methods or proposed mitigation measures. The intent of the register is to identify areas where there is a higher risk of a peat slide during construction so that the appropriate construction methods or mitigation measures can be adopted.

Peat slides are still a relatively rare occurrence during construction on windfarm sites on upland bogs in Ireland. However, the risk is greater than on a virgin site. Therefore, during construction there would be a scaling factor of about 2 on risk factors based on existing conditions so that most windfarm sites on upland bogs would be classified with a risk rating in the range of 0.0 to 2.0 (negligible to possible), possibly slightly higher. The upper limit of 2.5 on the risk register identifies areas where there are compounding risk factors that could make them particularly vulnerable to peat slides during construction so that the appropriate mitigation measures could be implemented.

There is still some judgement in interpreting the risk of planar slides or bog bursts on a site and this should be based on the interpretation of an experienced geotechnical engineer. It would be recommended to ensure that appropriate construction procedures and mitigation measures are taken to ensure that the risk rating does not exceed 2.0 during construction and is in the range of 0.0 – 1.0 after construction.

The main risk of planar slides due to shear failure typically occurs on intermediate slopes (4-7°) at the topographical low point upslope from a defined watercourse where the peat depth is about 2-4 m, and the strength of the peat is locally weak, less than about 4-5 kPa. The risk of a slides can be exacerbated by site drainage or subsurface groundwater flow through pipes in the peat. The slides can also occur in the clay layer below the peat where the material is very sensitive with a low peak shear strength, and a particularly low residual strength.

Planar slides can also occur due to hydrostatic uplift of peat where there is a granular soil or permeable fractured rock below the peat, particularly where the interface between the two materials is not reinforced by fibres from the peat. These types of slides typically occur during periods of heavy rainfall after an extended period of dry weather, which can dry out the peat and reduce its self weight. Hydrostatic pressures can build up in the permeable soils below the peat during subsequent periods of heavy rainfall, which can lift the peat and cause shear failure at the interface with the underlying soil.

The main risk of bog bursts occurs in areas of deep (>3-5 m) very soft peat with a high water content and high water table, particularly at the break in slope, or directly upslope from a watercourse originating in the deep peat. There have been instances where a planar slide in relatively shallow peat (<3 m) has initiated a bog burst in an adjacent deep soft ground area. Therefore, where the two conditions exist in close proximity then the risk of a planar failure could be the same.

The risk registers also include a section for mitigation measures that should be adopted during construction to reduce the risk to an acceptable level. The mitigation measures would typically address:

- Method of construction of access roads (excavate/replace or floating roads)
- Controls on storage of spoil (e.g. location, depth, containment, etc.a)
- Micro-siting of turbine locations.
- Stability control measures for excavations in peat.
- Hydrological controls
- Site drainage
- Monitoring procedures
- Restrictions on working after periods of heavy rainfall.

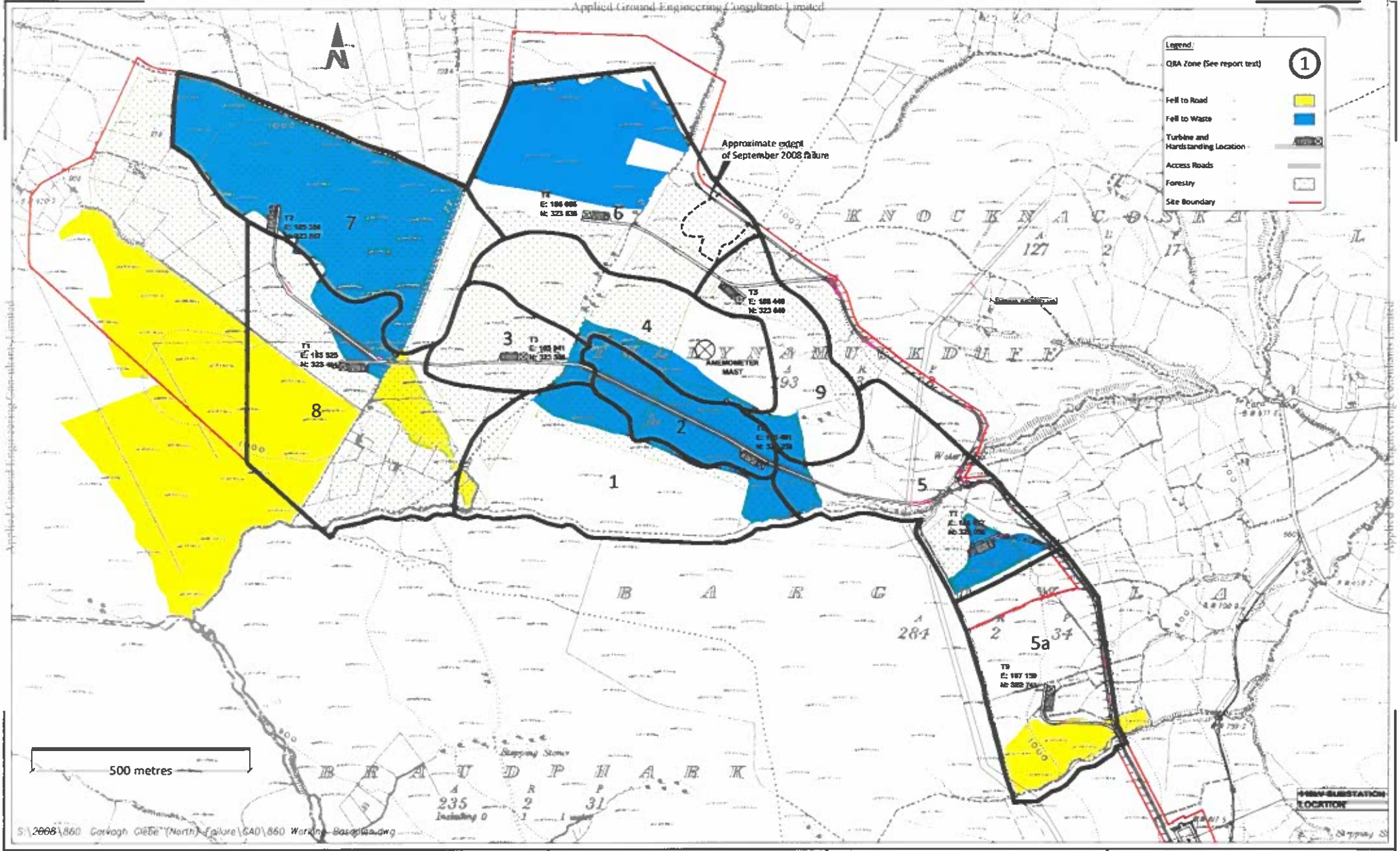
References:

Scottish Executive – "*Peat Landslide Hazard and Risk Assessments – Best Practice Guide for Proposed Electricity Generation Developments*", December 2006

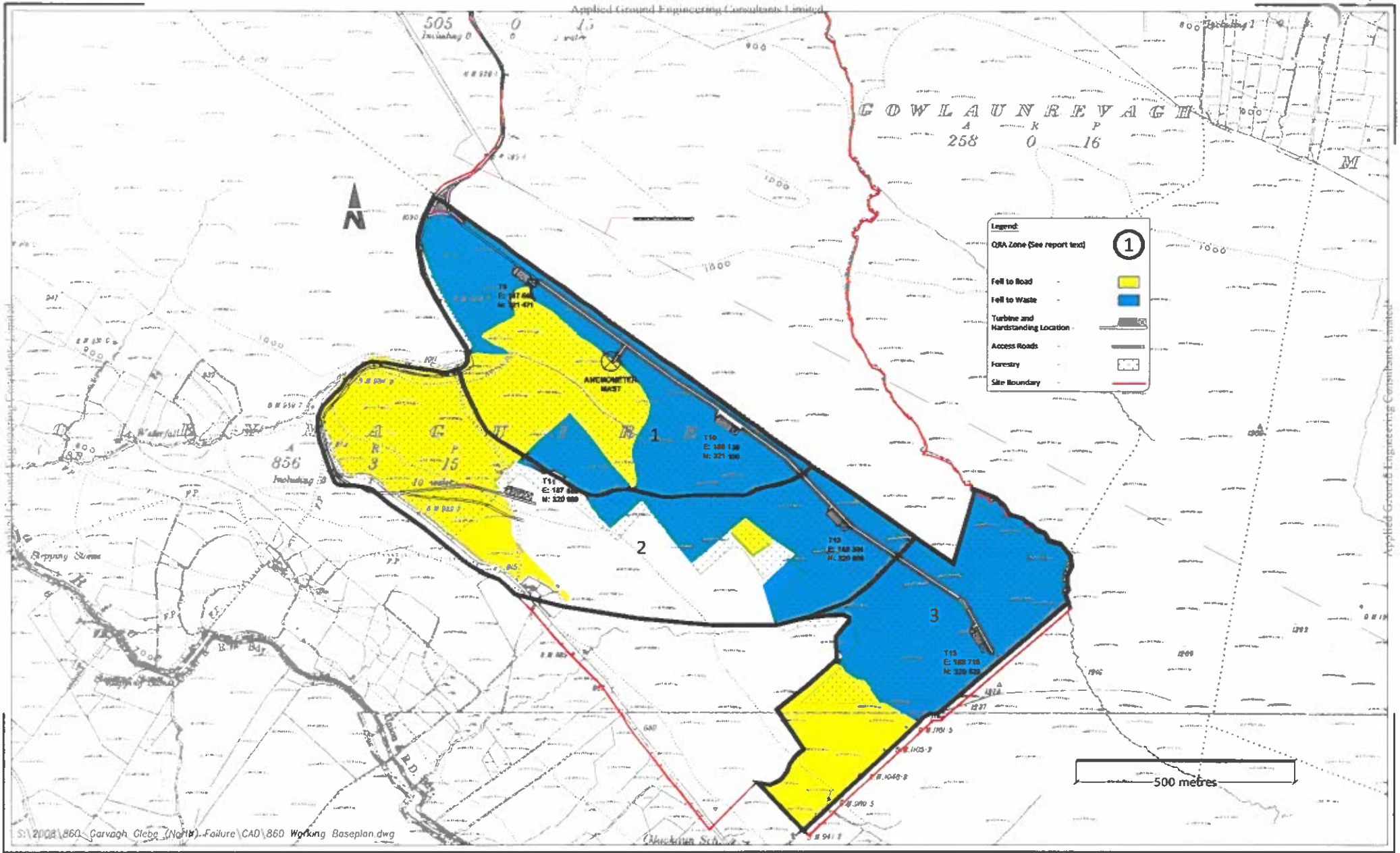
Mac Culloch, F. – "*Guidelines for the Risk Management of Peat Slips on the Construction of Low Volume/Low Cost Roads over Peat*", Forestry Civil Engineering, Forestry Commission, Scotland, January 2006

Clayton, C.R.I. – "*Managing Geotechnical Risk – Improving Productivity in UK Building and Construction*", report prepared under the DETR Partners in Technology Programme, Institution of Civil Engineers and Thomas Telford Ltd, 2001

APPENDIX B



Notes:	Client: ESB International	Job: WIND FARM AT GARVAGH GLEBE, CORRY MOUNTAIN, CO. LEITRIM	Drawing 001 Title: Garvagh Glebe North Site Layout Risk Assessment Zones For Tree Felling	AGEC Ltd The Grainstore Singletons Lane Bagenalstown Carlow Ireland Tel: +353 59 9723800 Fax: +353 59 9723793 www.agec.ie info@agec.ie
Scale: 1:8000 (A3) / Checked: P.J Date: 15 July 2009 / Revision: A Drawn: P.O.R. / Based on.				



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Client: ESB International

Job: WIND FARM AT GARVAGH GLEBE, CORRY MOUNTAIN, CO. LEITRIM

Drawing 002

Title: Garvagh Glebe South Site Layout Risk Assessment Zones For Tree Felling

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APPENDIX C

Garvagh Glebe - North							
Item	Factor	Rating			Zone 1		
		1	2	3	Value	Rating	Comment
	Stratigraphy						
	Peat						
1	Peat Depth	0.00 - 1.0	1.0 - 2.0	>2.0	4.5 m	1	Peat Depth Plan
2	Water Content	0 - 1000%	1000 - 2000%	>2000%	NA		
3	Min Peak Undrained Shear Strength	>10kPa	5-10 kPa	<5 kPa	6 kPa	2	Infinite Slope
4	Peat Classification at c_u min	Very fibrous	Fibrous	Slightly Fibrous/Clayey	NA		
	Sensitive Clay Layer Below Peat						
5	Very soft sensitive clay layer at base of peat	No	Possibly/ Discontenuous	Yes	NA		No Trial Pits
6	Sensitivity Coefficient ($c_{u,max}/c_{u,min}$)	1.0-1.5	1.5-2.0	>2	NA		No Trial Pits
7	Peak Undrained Shear Strength	>10kPa	5 - 10 kPa	< = 5 kPa	NA		No Trial Pits
8	Residual Undrained Shear Strength	>10kPa	5 - 10 kPa	< 5kPa	NA		No Trial Pits
	Transition - Peat to Mineral Soil						
9	Peat fibres continuous across transition to glacial till at base of peat	Yes	Partially	No	Partially	2	Assumed - No Trial Pit
	Underlying Soil/Rock						
10	Granular soil at base of peat	No		Yes	No	1	Assumed - No Trial Pit
11	Rock below Peat - Interface Characteristics	Rough/ Weathered	Smooth Undulating	Smooth Planar	NA		
	Topography/ Hydrology						
	Slope Angle	Shallow	Intermediate	High			
12	Slope Angle - Ground Surface	<3°	3° - 5°	>5°	4.2 °	2	Contour Plan Of Site
13	Slope Angle - Base of Peat	<3°	3° - 5°	>5°	4.2 °	2	Assumed Parallel to ground surface
	Topography/ Hydrology						
14	In broad valley upslope from defined watercourses	No	Yes, slopes <3°	Yes, slopes >3°	Yes, slopes >3°	3	OSI Data + Contour Plan
15	Distance from topographical low-point upslope from defined watercourses	>250m	100-250m	<100m	<100m	3	OSI Data + Contour Plan
16	General Slope Characteristics downslope from road/turbine	Concave	Planar	Convex	Concave	1	OSI Data + Contour Plan
17	Distance from Break Slope	>100m	50-100m	<50m	<50m	3	OSI Data + Contour Plan
18	Surface Water	Localised	Ponded in drains	Springs	Localised	1	OSI Data + IGSL Trial Pit Data
19	Existing Drainage Ditches	Downslope	Varies	Across slope	NA		No Drainage Ditches
20	Evidence of Piping	No	Possibly	Yes	No	1	OSI Data + Contour Plan
	Factor of Safety - Infinite Slope (Undrained) @ peat strength						
21	$FS_{@base\ slope}$ - Ground Slope	>2	1.5 - 2.0	<1.5	3.6	1	Infinite Slope
22	$FS_{@base\ slope}$ - Base of Peat	>2	1.5 - 2.0	<1.5			
23	$FS_{@base\ slope}$ - Ground Surface + 1m Peat	>2	1.5 - 2.0	<1.5	2.88	1	Infinite Slope
24	$FS_{@base\ slope}$ - Base of Peat + 1m Peat	>2	1.5 - 2.0	<1.5			
	Vegetation						
25	Tree Growth	Good	Fair	Poor	NA		No Forestry
26	Vegetation (no trees)	Dry Heather	Grassland	Wetlands	Grassland	2	OSI Data
	Slide History						
27	Evidence of previous slides	No	General Area	On site	General Area	2	Site Observation
28	Tension Cracks in Peat	No		Yes	No	1	Site Observation
	Land Use						
29	Peat Workings	None	Cutaway/Turbary	Sausage Cutter	None	1	Site Observation + OSI Data
	Aerial Photography						
30	Evidence of previous slides in area	No	Possibly	Yes	No	1	OSI Data
31	Evidence of subterranean drainage	No	Possibly	Yes	Possibly	2	OSI Data
32	Other notable contributary features	No	Possibly	Yes	No	1	OSI Data
	Trial Pit Observations						
33	Slides Stable	Stable	Unstable/Spalling	Squeezing	NA		No Trial Pits
34	Groundwater	Dry/Slight seepage	Seepage	Strong Flow	NA		No Trial Pits
35	Piping	No	Slight	Yes	NA		No Trial Pits
36	Peat Classification at base of peat	Very Fibrous	Fibrous	Slightly Fibrous/Clayey	NA		No Trial Pits
37	Very soft sensitive clay layer at base of peat	No	Discontinuous	Yes	NA		No Trial Pits
38	Granular soil at base of Peat	No		Yes	NA		No Trial Pits

Failure Potential	
Total	36
Max	63 21 Factors Used
Failure Potential Score (%)	57.1

Garvagh Glebe - North						
Factor	Rating			Zone 2		
	1	2	3	Value	Rating	Comment
Stratigraphy						
Peat						
Peat Depth	0.00 - 1.0	1.0 - 2.0	>2.0	2.5 m	3	Peat Depth Plan
Water Content	0 - 1000%	1000- 2000%	>2000%	0 - 1000%	1	KGSL Data
Min Peak Undrained Shear Strength	>10 kPa	5-10 kPa	<5 kPa	6 kPa	2	Infinite Slope
Peat Classification at z_{min}	Very fibrous	Fibrous	Slightly Fibrous/ Clayey	Fibrous	2	KGSL Data
Sensitive Clay Layer Below Peat						
Very soft sensitive clay layer at base of peat	No	Possibly/ Discontinuous	Yes	No	1	KGSL Data - T6
Sensitivity Coefficient ($c_{u\,peak}/c_{u\,remould}$)	1.0-1.5	1.5-2.0	>2			
Peak Undrained Shear Strength	>10 kPa	5 - 10 kPa	< = 5 kPa			
Residual Undrained Shear Strength	> 10 kPa	5 - 10 kPa	< 5 kPa			
Transition Peat to Mineral Soil						
Peat fibres continuous across transition to glacial till at base of peat	Yes	Partially	No	Partially	2	KGSL Data - T6
Underlying Soil/Rock						
Granular soil at base of peat	No		Yes	No	1	KGSL Data - T6
Rock below Peat - Interface Characteristics	Rough/ Weathered	Smooth Undulating	Smooth Planar	NA		
Topography/ Hydrology						
Slope Angle	Shallow	Intermediate	High			
Slope Angle - Ground Surface	<3°	3° - 5°	>5°	10.7 °	3	Contour Plan Of Site
Slope Angle - Base of Peat	<3°	3° - 5°	>5°	10.7 °	3	Assumed Parallel to ground surface
Topography/ Hydrology						
In broad valley upslope from defined watercourses	No	Yes, slopes <3°	Yes, slopes >3°	No	1	OSI Data + Contour Plan
Distance from topographical low point upslope from defined watercourses	>250m	100-250m	<100m	<100m	3	OSI Data + Contour Plan
General Slope Characteristics downslope from road/turbine	Concave	Planar	Convex	convex	3	OSI Data + Contour Plan
Distance from Break Slope	>100m	50-100m	<50m	<50m	3	OSI Data + Contour Plan
Surface Water	Localised	Ponded in drains	Springs	Localised	1	OSI Data + KGSL Trial Pit Data
Existing Drainage Ditches	Downslope	Varies	Across slope	Downslope	1	OSI Data + Contour Plan
Evidence of Piping	No	Possibly	Yes	No	1	OSI Data + Contour Plan
Factor of Safety - Infinite Slope (Undrained) @ peat strength						
$FS_{(Infinite\ Slope)}$ - Ground Slope	>2	1.5 - 2.0	<1.5	3.63	1	Infinite Slope
$FS_{(Infinite\ Slope)}$ - Base of Peat	>2	1.5 - 2.0	<1.5			
$FS_{(Infinite\ Slope)}$ - Ground Surface + 1m Peat	>2	1.5 - 2.0	<1.5	2.88	1	Infinite Slope
$FS_{(Infinite\ Slope)}$ - Base of Peat + 1m Peat	>2	1.5 - 2.0	<1.5			
Vegetation						
Tree Growth	Good	Fair	Poor	Good	1	OSI Data
Vegetation (no trees)	Dry Heather	Grassland	Wetlands	NA		Forested Area
Slide History						
Evidence of previous slides	No	General Area	On site	General Area	2	Site Observation
Tension Cracks in Peat	No		Yes	No	1	Site Observation
Land Use						
Peat Workings	None	Cutaway/Turbary	Sausage Cutter	None	1	Site Observation + OSI Data
Aerial Photography						
Evidence of previous slides in area	No	Possibly	Yes	No	1	OSI Data
Evidence of subterranean drainage	No	Possibly	Yes	No	1	OSI Data
Other notable contributary features	No	Possibly	Yes	No	1	OSI Data
Trial Pit Observations						
Slides Stable	Stable	Unstable/Spalling	Squeezing	Unstable/Spalling	2	KGSL Data - T6
Groundwater	Dry/Slight seepage	Seepage	Strong Flow	Dry/Slight seepage	1	KGSL Data - T6
Piping	No	Slight	Yes	No	1	KGSL Data - T6
Peat Classification at base of peat	Very Fibrous	Fibrous	Slightly Fibrous/Clayey	Fibrous	2	KGSL Data - T6
Very soft sensitive clay layer at base of peat	No	Discontinuous	Yes	No	1	KGSL Data - T6
Granular soil at base of Peat	No		Yes	No	1	KGSL Data - T6

Failure Potential	
Total	49
Max	93
Failure Potential Score (%)	52.7

31 Factors Used

Garvagh Glebe - North						
Factor	Rating			Zone 3		
	1	2	3	Value	Rating	Comment
Stratigraphy						
Peat						
Peat Depth	0.00 - 1.0	1.0 - 2.0	>2.0	3 m	3	Peat Depth Plan
Water Content	0 - 1000%	1000 - 2000%	>2000%	0 - 1000%	1	IGSL Data
Min Peak Undrained Shear Strength	>10 kPa	5-10 kPa	<5 kPa	6 kPa	2	Infinite Slope
Peat Classification at c_u min	Very fibrous	Fibrous	Slightly Fibrous/ Clayey	Fibrous	1	IGSL Data
Sensitive Clay Layer Below Peat						
Very soft sensitive clay layer at base of peat	No	Possibly/ Discontinuous	Yes	Possibly/ Discontinuous	2	IGSL Data - T3
Sensitivity Coefficient ($c_{u\,peak}$/ $c_{u\,remould}$)	1.0-1.5	1.5-2.0	>2	1.5-2.0	2	Assumed - No values given
Peak Undrained Shear Strength	>10 kPa	5 - 10 kPa	< = 5 kPa	5 - 10 kPa	2	Assumed - No values given
Residual Undrained Shear Strength	> 10 kPa	5 - 10 kPa	< 5 kPa	5 - 10 kPa	2	Assumed - No values given
Transition - Peat to Mineral Soil						
Peat fibres continuous across transition to glacial till at base of peat	Yes	Partially	No	Partially	2	IGSL Data - T3
Underlying Soil/Rock						
Granular soil at base of peat	No		Yes	NO	1	IGSL Data - T3
Rock below Peat - Interface Characteristics	Rough/ Weathered	Smooth Undulating	Smooth Planar	NA		
Topography/ Hydrology						
Slope Angle	Shallow	Intermediate	High			
Slope Angle - Ground Surface	<3°	3° - 5°	>5°	5.7°	1	Contour Plan Of Site
Slope Angle - Base of Peat	<3°	3° - 5°	>5°	5.7°	1	Assumed Parallel to ground surface
Topography/ Hydrology						
In broad valley upslope from defined watercourses	No	Yes, slopes <3°	Yes, slopes >3°	No	1	OSI Data + Contour Plan
Distance from topographical low point upslope from defined watercourses	>250m	100-250m	<100m	<100m	1	OSI Data + Contour Plan
General Slope Characteristics downslope from road/turbine	Concave	Planar	Convex	Planar	2	OSI Data + Contour Plan
Distance from Break Slope	>100m	50-100m	<50m	<50m	1	OSI Data + Contour Plan
Surface Water	Localised	Ponded in drains	Springs	Localised	1	OSI Data + IGSL Trial Pit Data
Existing Drainage Ditches	Downslope	Varies	Across slope	Varies	2	OSI Data + Contour Plan
Evidence of Piping	No	Possibly	Yes	No	1	OSI Data + Contour Plan
Factor of Safety - Infinite Slope (Undrained) @ peat strength						
$FS_{(Ground\ Slope)}$ - Ground Slope	>2	1.5 - 2.0	<1.5	4.54	1	Infinite Slope
$FS_{(Ground\ Slope)}$ - Base of Peat	>2	1.5 - 2.0	<1.5			
$FS_{(Ground\ Slope)}$ - Ground Surface +1m Peat	>2	1.5 - 2.0	<1.5	3.5	1	Infinite Slope
$FS_{(Ground\ Slope)}$ - Base of Peat +1m Peat	>2	1.5 - 2.0	<1.5			
Vegetation						
Tree Growth	Good	Fair	Poor	Fair	2	OSI Data
Vegetation (no trees)	Dry Heather	Grassland	Wetlands	NA		Forested Area
Slide History						
Evidence of previous slides	No	General Area	On site	General Area	2	Site Observation
Tension Cracks in Peat	No		Yes	No	1	Site Observation
Land Use						
Peat Workings	None	Cutaway/Turbary	Sausage Cutter	None	1	Site Observation + OSI Data
Aerial Photography						
Evidence of previous slides in area	No	Possibly	Yes	No	1	OSI Data
Evidence of subterranean drainage	No	Possibly	Yes	Possibly	2	OSI Data
Other notable contributary features	No	Possibly	Yes	No	1	OSI Data
Trial Pit Observations						
Slides Stable	Stable	Unstable/Spalling	Squeezing	Stable	1	IGSL Data - T3
Groundwater	Dry/Slight seepage	Seepage	Strong Flow	Dry/Slight seepage	1	IGSL Data - T3
Piping	No	Slight	Yes	No	1	IGSL Data - T3
Peat Classification at base of peat	Very Fibrous	Fibrous	Slightly Fibrous/Clayey	Fibrous	2	IGSL Data - T3
Very soft sensitive clay layer at base of peat	No	Discontinuous	Yes	Possibly/ Discontinuous	2	IGSL Data - T3
Granular soil at base of Peat	No		Yes	No	1	IGSL Data - T3

Failure Potential	
Total	58
Max	102
Failure Potential Score (%)	56.9

34 Factors Used

Garvagh Glebe - North						
Factor	Rating			Zone 4		
	1	2	4	Value	Rating	Comment
Stratigraphy						
Peat						
Peat Depth	0.00 - 1.0	1.0 - 2.0	>2.0	4.5 m	4	Peat Depth Plan
Water Content	0 - 1000%	1000 - 2000%	>2000%	NA		
Min Peak Undrained Shear Strength	>10 kPa	5-10 kPa	<5 kPa	2 kPa	4	Infinite Slope
Peat Classification at $c_{u\,min}$	Very fibrous	Fibrous	Slightly Fibrous/ Clayey	NA		
Sensitive Clay Layer Below Peat						
Very soft sensitive clay layer at base of peat	No	Possibly/ Discontinuous	Yes	NA		No Trial Pits
Sensitivity Coefficient [$c_{u\,peak}$/ $c_{u\,remould}$]	1.0-1.5	1.5-2.0	>2	NA		No Trial Pits
Peak Undrained Shear Strength	>10 kPa	5 - 10 kPa	< = 5 kPa	NA		No Trial Pits
Residual Undrained Shear Strength	> 10 kPa	5 - 10 kPa	< 5 kPa	NA		No Trial Pits
Transition - Peat to Mineral Soil						
Peat fibres continuous across transition to glacial till at base of peat	Yes	Partially	No	Partially	2	Assumed - No Trial Pit
Underlying Soil/Rock						
Granular soil at base of peat	No		Yes	No	1	Assumed - No Trial Pit
Rock below Peat - Interface Characteristics	Rough/ Weathered	Smooth Undulating	Smooth Planar	NA		
Topography/ Hydrology						
Slope Angle	Shallow	Intermediate	High			
Slope Angle - Ground Surface	<3°	3° - 5°	>5°	2 °	1	Contour Plan Of Site
Slope Angle - Base of Peat	<3°	3° - 5°	>5°	2 °	1	Assumed Parallel to ground surface
Topography/ Hydrology						
In broad valley upslope from defined water courses	No	Yes, slopes < 3°	Yes, slopes >3°	Yes, slopes < 3°	2	OSI Data + Contour Plan
Distance from topographical low-point upslope from defined watercourses	>250m	100-250m	<100m	<100m	4	OSI Data + Contour Plan
General Slope Characteristics downslope from road/turbine	Concave	Planar	Convex	Planar	2	OSI Data + Contour Plan
Distance from Break Slope	>100m	50-100m	<50m	<50m	4	OSI Data + Contour Plan
Surface Water	Localised	Ponded in drains	Springs	Localised	1	OSI Data + IGSL Trial Pit Data
Existing Drainage Ditches	Downslope	Varies	Across slope	Downslope	1	OSI Data + Contour Plan
Evidence of Piping	No	Possibly	Yes	No	1	OSI Data + Contour Plan
Factor of Safety - Infinite Slope (Undrained) @ peat strength						
$FS_{(\alpha\,ground\,slope)}$ - Ground Slope	>2	1.5 - 2.0	<1.5	0.55	3	Infinite Slope
$FS_{(\alpha\,base\,slope)}$ - Base of Peat	>2	1.5 - 2.0	<1.5			
$FS_{(\alpha\,ground\,slope)}$ - Ground Surface +1m Peat	>2	1.5 - 2.0	<1.5	0.45	3	Infinite Slope
$FS_{(\alpha\,base\,slope)}$ - Base of Peat +1m Peat	>2	1.5 - 2.0	<1.5			
Vegetation						
Tree Growth	Good	Fair	Poor	Poor	1	OSI Data
Vegetation (no trees)	Dry Heather	Grassland	Wetlands	NA		Forested Area
Slide History						
Evidence of previous slides	No	General Area	On site	Onsite	1	Site Observation
Tension Cracks in Peat	No		Yes	No	1	Site Observation
Land Use						
Peat Workings	None	Cutaway/Turbary	Sausage Cutter	None	1	Site Observation + OSI Data
Aerial Photography						
Evidence of previous slides in area	No	Possibly	Yes	No	1	OSI Data
Evidence of subterranean drainage	No	Possibly	Yes	No	1	OSI Data
Other notable contributary features	No	Possibly	Yes	No	1	OSI Data
Trial Pit Observations						
Slides Stable	Stable	Unstable/Spalling	Squeezing	NA		No Trial Pits
Groundwater	Dry/Slight seepage	Seepage	Strong flow	NA		No Trial Pits
Piping	No	Slight	Yes	NA		No Trial Pits
Peat Classification at base of peat	Very Fibrous	Fibrous	Slightly Fibrous/Clayey	NA		No Trial Pits
Very soft sensitive clay layer at base of peat	No	Discontinuous	Yes	NA		No Trial Pits
Granular soil at base of Peat	No		Yes	NA		No Trial Pits

Failure Potential	
Total	41
Max	66 22 Factors Used
Failure Potential Score (%)	62.1

Garvagh Glebe - North						
Factor	Rating			Zone S		
	1	2	3	Value	Rating	Comment
Stratigraphy						
Peat						
Peat Depth	0.00 - 1.0	1.0 - 2.0	>2.0	2 m	3	Peat Depth Plan
Water Content	0 - 1000%	1000 - 2000%	>2000%	0 - 1000%	1	IGSL Data
Min Peak Undrained Shear Strength	>10 kPa	5-10 kPa	<5 kPa	6 kPa	2	Infinite Slope
Peat Classification at c_u min	Very fibrous	Fibrous	Slightly fibrous/ Clayey	Fibrous	2	IGSL Data - T7
Sensitive Clay Layer Below Peat						
Very soft sensitive clay layer at base of peat	No	Possibly/ Discontinuous	Yes	Possibly/ Discontinuous	2	IGSL Data - T7
Sensitivity Coefficient($c_{u,peak}$/ $c_{u,residual}$)	1.0-1.5	1.5-2.0	>2	1.5-2.0	2	Assumed - No values given
Peak Undrained Shear Strength	>10 kPa	5 - 10 kPa	<= 5 kPa	5 - 10 kPa	2	Assumed - No values given
Residual Undrained Shear Strength	> 10 kPa	5 - 10 kPa	< 5 kPa	5 - 10 kPa	2	Assumed - No values given
Transition - Peat to Mineral Soil						
Peat fibres continuous across transition to glacial till at base of peat	Yes	Partially	No	Partially	2	IGSL Data - T7
Underlying Soil/Rock						
Granular soil at base of peat	No		Yes	No	1	IGSL Data - T7
Rock below Peat - Interface Characteristics	Rough/ Weathered	Smooth Undulating	Smooth Planar	NA		
Topography/ Hydrology						
Slope Angle	Shallow	Intermediate	High			
Slope Angle - Ground Surface	<3°	3° - 5°	>5°	6.8 °	3	Contour Plan Of Site
Slope Angle - Base of Peat	<3°	3° - 5°	>5°	6.8 °	3	Assumed Parallel to ground surface
Topography/ Hydrology						
In broad valley upslope from defined water courses	No	Yes, slopes <3°	Yes, slopes >3°	Yes, slopes >3°	3	OSI Data + Contour Plan
Distance from topographical low-point upslope from defined water courses	>250m	100-250m	<100m	<100m	3	OSI Data + Contour Plan
General Slope Characteristics downslope from road/turbine	Concave	Planar	Convex	Planar	2	OSI Data + Contour Plan
Distance from Break Slope	>100m	50-100m	<50m	<50m	3	OSI Data + Contour Plan
Surface Water	Localised	Ponded in drains	Springs	Localised	1	OSI Data + IGSL Trial Pit Data
Existing Drainage Ditches	Downslope	Varies	Across slope	Varies	2	OSI Data + Contour Plan
Evidence of Piping	No	Possibly	Yes	No	1	OSI Data + Contour Plan
Factor of Safety - Infinite Slope (Undrained) @ peat strength						
$FS_{(\text{Infinite Slope})}$ - Ground Slope	>2	1.5 - 2.0	<1.5	4.54	1	Infinite Slope
$FS_{(\text{Infinite Slope})}$ - Base of Peat	>2	1.5 - 2.0	<1.5			
$FS_{(\text{Infinite Slope})}$ - Ground Surface + 1m Peat	>2	1.5 - 2.0	<1.5	1.75	2	Infinite Slope
$FS_{(\text{Infinite Slope})}$ - Base of Peat + 1m Peat	>2	1.5 - 2.0	<1.5			
Vegetation						
Tree Growth	Good	Fair	Poor	Good	1	OSI Data
Vegetation (no trees)	Dry Heather	Grassland	Wetlands	NA		Forested Area
Slide History						
Evidence of previous slides	No	General Area	On site	General Area	2	Site Observation
Tension Cracks in Peat	No		Yes	No	1	Site Observation
Land Use						
Peat Workings	None	Cutaway/Turbary	Sausage Cutter	None	1	Site Observation + OSI Data
Aerial Photography						
Evidence of previous slides in area	No	Possibly	Yes	No	1	OSI Data
Evidence of subterranean drainage	No	Possibly	Yes	Yes	3	OSI Data
Other notable contributary features	No	Possibly	Yes	Yes	3	OSI Data, evidence of possible water flushes into watercourse
Trial Pit Observations						
Slides Stable	Stable	Unstable/Spalling	Squeezing	Stable	1	IGSL Data - T7
Groundwater	Dry/Slight seepage	Seepage	Strong Flow	Seepage	2	IGSL Data - T7
Piping	No	Slight	Yes	No	1	IGSL Data - T7
Peat Classification at base of peat	Very Fibrous	Fibrous	Slightly Fibrous/Clayey	Fibrous	2	IGSL Data - T7
Very soft sensitive clay layer at base of peat	No	Discontinuous	Yes	Possibly/Discontinuous	2	IGSL Data - T7
Granular soil at base of Peat	No		Yes	No	1	IGSL Data - T7

Failure Potential	
Total	63
Max	102 34 Factors Used
Failure Potential Score (%)	61.8

Garvagh Glebe - North						
Factor	Rating			Zone 6		
	1	2	3	Value	Rating	Comment
Stratigraphy						
Peat						
Peat Depth	0.00 - 1.0	1.0 - 2.0	>2.0	4.5 m	3	Peat Depth Plan
Water Content	0 - 1000%	1000 - 2000%	>2000%	1000 - 2000%	2	IGSL Data
Min Peak Undrained Shear Strength	>10 kPa	5-10 kPa	<5 kPa	4 kPa	3	Infinite Slope
Peat Classification at c_{u} min	Very Fibrous	Fibrous	Slightly Fibrous/ Clayey	Slightly Fibrous/ Clayey	3	IGSL Data
Sensitive Clay Layer Below Peat						
Very soft sensitive clay layer at base of peat	No	Possibly/ Discontinuous	Yes	Possibly/ Discontinuous	2	IGSL Data - T4
Sensitivity Coefficient ($c_{u,peak}$/ $c_{u,remould}$)	1.0-1.5	1.5-2.0	>2	1.5-2.0	2	Assumed - No values given
Peak Undrained Shear Strength	>10 kPa	5 - 10 kPa	<= 5 kPa	5 - 10 kPa	2	Assumed - No values given
Residual Undrained Shear Strength	> 10 kPa	5 - 10 kPa	< 5 kPa	5 - 10 kPa	2	Assumed - No values given
Transition - Peat to Mineral Soil						
Peat fibres continuous across transition to glacial till at base of peat	Yes	Partially	No	Partially	2	IGSL Data - T4
Underlying Soil/Rock						
Granular soil at base of peat	No		Yes	No	1	IGSL Data - T4
Rock below Peat - Interface Characteristics	Rough/ Weathered	Smooth Undulating	Smooth Planar	NA		
Topography/ Hydrology						
Slope Angle	Shallow	Intermediate	High			
Slope Angle - Ground Surface	<3°	3° - 5°	>5°	4.5°	2	Contour Plan Of Site
Slope Angle - Base of Peat	<3°	3° - 5°	>5°	4.5°	2	Assumed Parallel to ground surface
Topography/ Hydrology						
In broad valley upslope from defined water courses	No	Yes, slopes <3°	Yes, slopes >3°	Yes, slopes >3°	3	OSI Data + Contour Plan
Distance from topographical low-point upslope from defined water courses	>250m	100-250m	<100m	<100m	3	OSI Data + Contour Plan
General Slope Characteristics downslope from road/turbine	Concave	Planar	Convex	Planar	2	OSI Data + Contour Plan
Distance from Break Slope	>100m	50-100m	<50m	<50m	3	OSI Data + Contour Plan
Surface Water	Localised	Ponded in drains	Springs	Localised	1	OSI Data + IGSL Trial Pit Data
Existing Drainage Ditches	Downslope	Varies	Across slope	Across	3	OSI Data + Contour Plan
Evidence of Piping	No	Possibly	Yes	No	1	OSI Data + Contour Plan
Factor of Safety - Infinite Slope (Undrained) @ peat strength						
$FS_{(Infinite\ Slope)}$ - Ground Slope	>2	1.5 - 2.0	<1.5	0.78	3	Infinite Slope
$FS_{(Infinite\ Slope)}$ - Base of Peat	>2	1.5 - 2.0	<1.5			
$FS_{(Infinite\ Slope)}$ - Ground Surface + 1m Peat	>2	1.5 - 2.0	<1.5	0.66	3	Infinite Slope
$FS_{(Infinite\ Slope)}$ - Base of Peat + 1m Peat	>2	1.5 - 2.0	<1.5			
Vegetation						
Tree Growth	Good	Fair	Poor	Poor	3	OSI Data
Vegetation (no trees)	Dry Heather	Grassland	Wetlands	NA		Forested Area
Slide History						
Evidence of previous slides	No	General Area	On site	On site	3	Site Observation
Tension Cracks in Peat	No		Yes	No	1	Site Observation
Land Use						
Peat Workings	None	Cutaway/Turbary	Sausage Cutter	None	1	Site Observation + OSI Data
Aerial Photography						
Evidence of previous slides in area	No	Possibly	Yes	No	1	OSI Data
Evidence of subterranean drainage	No	Possibly	Yes	Yes	3	OSI Data + Site Observation
Other notable contributary features	No	Possibly	Yes	No	1	OSI Data
Trial Pit Observations						
Slides Stable	Stable	Unstable/Spalling	Squeezing	Unstable/Spalling	2	IGSL Data - T4
Groundwater	Dry/Slight seepage	Seepage	Strong Flow	Strong Flow	3	IGSL Data - T4
Piping	No	Slight	Yes	No	1	IGSL Data - T4
Peat Classification at base of peat	Very Fibrous	Fibrous	Slightly Fibrous/Clayey	Slightly Fibrous/ Clayey	3	IGSL Data - T4
Very soft sensitive clay layer at base of peat	No	Discontinuous	Yes	Possibly/ Discontinuous	2	IGSL Data - T4
Granular soil at base of Peat	No		Yes	No	1	IGSL Data - T4

Failure Potential	
Total	69
Max	102 34 Factors Used
Failure Potential Score (%)	67.6

Garvagh Glebe - North						
Factor	Rating			Zone 7		
	1	2	3	Value	Rating	Comment
Stratigraphy						
Peat						
Peat Depth	0.00 - 1.0	1.0 - 2.0	>2.0	4.5 m	3	Peat Depth Plan
Water Content	0 - 1000%	1000- 2000%	>2000%	0 - 1000%	1	IGSL Data
Min Peak Undrained Shear Strength	>10 kPa	5-10 kPa	<5 kPa	4 kPa	3	Infinite Slope
Peat Classification at c_{u} min	Very fibrous	Fibrous	Slightly fibrous / Clayey	Fibrous	2	IGSL Data
Sensitive Clay Layer Below Peat						
Very soft sensitive clay layer at base of peat	No	Possibly/ Discontinuous	Yes	Possibly/ Discontinuous	2	IGSL Data - T2
Sensitivity Coefficient ($c_{u,peak}$/ $c_{u,remould}$)	1.0-1.5	1.5-2.0	>2	1.5-2.0	2	Assumed - No values given
Peak Undrained Shear Strength	>10 kPa	5 - 10 kPa	< = 5 kPa	5 - 10 kPa	2	Assumed - No values given
Residual Undrained Shear Strength	> 10 kPa	5 - 10 kPa	< 5 kPa	5 - 10 kPa	2	Assumed - No values given
Transition - Peat to Mineral Soil						
Peat fibres continuous across transition to glacial till at base of peat	Yes	Partially	No	Partially	2	IGSL Data - T2
Underlying Soil/Rock						
Granular soil at base of peat	No		Yes	No	1	IGSL Data - T2
Rock below Peat - Interface Characteristics	Rough/ Weathered	Smooth Undulating	Smooth Planar	NA		
Topography/ Hydrology						
Slope Angle	Shallow	Intermediate	High			
Slope Angle - Ground Surface	<3°	3° - 5°	>5°	3.8 °	2	Contour Plan Of Site
Slope Angle - Base of Peat	<3°	3° - 5°	>5°	3.8 °	2	Assumed Parallel to ground surface
Topography/ Hydrology						
In broad valley upslope from defined watercourses	No	Yes, slopes <3°	Yes, slopes >3°	Yes, slopes >3°	3	OSI Data + Contour Plan
Distance from topographical low-point upslope from defined watercourses	>250m	100-250m	<100m	<100m	3	OSI Data + Contour Plan
General Slope Characteristics downslope from road/turbine	Concave	Planar	Convex	Planar	2	OSI Data + Contour Plan
Distance from Break Slope	>100m	50-100m	<50m	<50m	3	OSI Data + Contour Plan
Surface Water	Localised	Ponded in drains	Springs	Localised	1	OSI Data + IGSL Trial Pit Data
Existing Drainage Ditches	Downslope	Varies	Across slope	Varies	2	OSI Data + Contour Plan
Evidence of Piping	No	Possibly	Yes	No	1	OSI Data + Contour Plan
Factor of Safety - Infinite Slope (Undrained) @ peat strength						
$FS_{(@ peak strength)}$ - Ground Slope	>2	1.5 - 2.0	<1.5	1.34	3	Infinite Slope
$FS_{(@ peak strength)}$ - Base of Peat	>2	1.5 - 2.0	<1.5			
$FS_{(@ peak strength)}$ - Ground Surface + 1m Peat	>2	1.5 - 2.0	<1.5	1.05	3	Infinite Slope
$FS_{(@ peak strength)}$ - Base of Peat + 1m Peat	>2	1.5 - 2.0	<1.5			
Vegetation						
Tree Growth	Good	Fair	Poor	Good	1	OSI Data
Vegetation (no trees)	Dry Heather	Grassland	Wetlands	NA		Forested Area
Slide History						
Evidence of previous slides	No	General Area	On site	General Area	2	Site Observation
Tension Cracks in Peat	No		Yes	No	1	Site Observation
Land Use						
Peat Workings	None	Cutaway/Turbary	Sausage Cutter	None	1	Site Observation + OSI Data
Aerial Photography						
Evidence of previous slides in area	No	Possibly	Yes	No	1	OSI Data
Evidence of subterranean drainage	No	Possibly	Yes	No	1	OSI Data
Other notable contributary features	No	Possibly	Yes	No	1	OSI Data
Trial Pit Observations						
Sides Stable	Stable	Unstable/Spalling	Squeezing	Stable	1	IGSL Data - T2
Groundwater	Dry/Slight seepage	Seepage	Strong Flow	Seepage	2	IGSL Data - T2
Piping	No	Slight	Yes	No	1	IGSL Data - T2
Peat Classification at base of peat	Very Fibrous	Fibrous	Slightly Fibrous/Clayey	Fibrous	2	IGSL Data - T2
Very soft sensitive clay layer at base of peat	No	Discontinuous	Yes	Possibly/ Discontinuous	2	IGSL Data - T2
Granular soil at base of Peat	No		Yes	No	1	IGSL Data - T2

Failure Potential	
Total	62
Max	102 34 Factors Used
Failure Potential Score (%)	60.8

Garvagh Glebe - North						
Factor	Rating			Zone 8		
	1	2	3	Value	Rating	Comment
Stratigraphy						
Peat						
Peat Depth	0.00 - 1.0	1.0 - 2.0	>2.0	3 m	3	Peat Depth Plan
Water Content	0 - 1000%	1000 - 2000%	>2000%	0 - 1000%	1	IGSL Data
Min Peat Undrained Shear Strength	>10 kPa	5-10 kPa	<5 kPa	6 kPa	2	Infinite Slope
Peat Classification at $c_{u\,min}$	Very fibrous	Fibrous	Slightly Fibrous/ Clayey	Very Fibrous	1	IGSL Data - T1
Sensitive Clay Layer Below Peat						
Very soft sensitive clay layer at base of peat	No	Possibly/ Discontinuous	Yes	Possibly/ Discontinuous	2	IGSL Data - T1
Sensitivity Coefficient ($c_{u\,peak}$/ $c_{u\,remould}$)	1.0-1.5	1.5-2.0	>2	1.0-1.5	1	Assumed - No values given
Peak Undrained Shear Strength	>10 kPa	5 - 10 kPa	< 5 kPa	>10 kPa	1	Assumed - No values given
Residual Undrained Shear Strength	> 10 kPa	5 - 10 kPa	< 5 kPa	> 10 kPa	1	Assumed - No values given
Transition - Peat to Mineral Soil						
Peat fibres continuous across transition to glacial at base of peat	Yes	Partially	No	Partially	2	IGSL Data - T1
Underlying Soil/Rock						
Granular soil at base of peat	No		Yes	No	1	IGSL Data - T1
Rock below Peat - Interface Characteristics	Rough/ Weathered	Smooth Undulating	Smooth Planar	NA		
Topography/ Hydrology						
Slope Angle	Shallow	Intermediate	High			
Slope Angle - Ground Surface	<3°	3° - 5°	>5°	6.8 °	3	Contour Plan Of Site
Slope Angle - Base of Peat	<3°	3° - 5°	>5°	6.8 °	3	Assumed Parallel to ground surface
Topography/ Hydrology						
In broad valley upslope from defined watercourses	No	Yes, slopes <3°	Yes, slopes >3°	Yes, slopes >3°	3	OSI Data + Contour Plan
Distance from topographical low point upslope from defined watercourses	>250m	100-250m	<100m	<100m	3	OSI Data + Contour Plan
General Slope Characteristics downslope from road/turbine	Concave	Planar	Convex	Planar	2	OSI Data + Contour Plan
Distance from Break Slope	>100m	50-100m	<50m	<50m	3	OSI Data + Contour Plan
Surface Water	Localised	Ponded in drains	Springs	Localised	1	OSI Data + IGSL Trial Pit Data
Existing Drainage Ditches	Downslope	Varies	Across slope	Varies	2	OSI Data + Contour Plan
Evidence of Piping	No	Possibly	Yes	No	1	OSI Data + Contour Plan
Factor of Safety - Infinite Slope (Undrained) @ peat strength						
$FS_{(p\,bulk\,density)}$ - Ground Slope	>2	1.5 - 2.0	<1.5	4.38	1	Infinite Slope
$FS_{(p\,bulk\,density)}$ - Base of Peat	>2	1.5 - 2.0	<1.5			
$FS_{(p\,bulk\,density)}$ - Ground Surface +1m Peat	>2	1.5 - 2.0	<1.5	2.79	1	Infinite Slope
$FS_{(p\,bulk\,density)}$ - Base of Peat +1m Peat	>2	1.5 - 2.0	<1.5			
Vegetation						
Tree Growth	Good	Fair	Poor	Good	1	OSI Data
Vegetation (no trees)	Dry Heather	Grassland	Wetlands	NA		Forested Area
Slide History						
Evidence of previous slides	No	General Area	On site	General Area	2	Site Observation
Tension Cracks in Peat	No		Yes	No	1	Site Observation
Land Use						
Peat Workings	None	Cutaway/Turbary	Sausage Cutter	None	1	Site Observation + OSI Data
Aerial Photography						
Evidence of previous slides in area	No	Possibly	Yes	No	1	OSI Data
Evidence of subterranean drainage	No	Possibly	Yes	Yes	3	OSI Data
Other notable contributary features	No	Possibly	Yes	No	1	OSI Data
Trial Pit Observations						
Slides Stable	Stable	Unstable/Spalling	Squeezing	Stable	1	IGSL Data - T1
Groundwater	Dry/Slight seepage	Seepage	Strong Flow	Seepage	2	IGSL Data - T1
Piping	No	Slight	Yes	Slight	2	IGSL Data - T1
Peat Classification at base of peat	Very Fibrous	Fibrous	Slightly Fibrous/Clayey	Very Fibrous	1	IGSL Data - T1
Very soft sensitive clay layer at base of peat	No	Discontinuous	Yes	Possibly/ Discontinuous	2	IGSL Data - T1
Granular soil at base of Peat	No		Yes	No	1	IGSL Data - T1

Failure Potential	
Total	57
Max	102 34 Factors Used
Failure Potential Score (%)	55.9

Garvagh Glebe - North						
Factor	Rating			Zone 9		
	1	2	3	Value	Rating	Comment
Stratigraphy						
Peat						
Peat Depth	0.00 - 1.0	1.0 - 2.0	>2.0	4.5 m	3	Peat Depth Plan
Water Content	0 - 1000%	1000 - 2000%	>2000%	0 - 1000%	1	IGSL Data
Min Peak Undrained Shear Strength	>10 kPa	5 10 kPa	<5 kPa	6 kPa	2	Infinite Slope
Peat Classification at c_u min	Very fibrous	Fibrous	Slightly Fibrous / Clayey	Slightly Fibrous / Clayey	3	IGSL Data
Sensitive Clay Layer Below Peat						
Very soft sensitive clay layer at base of peat	No	Possibly / Discontinuous	Yes	Possibly / Discontinuous	2	IGSL Data - TS
Sensitivity Coefficient($c_{u\ peak}$/ $c_{u\ remould}$)	1.0-1.5	1.5-2.0	>2	1.5-2.0	2	Assumed - No values given
Peak Undrained Shear Strength	>10 kPa	5 - 10 kPa	<= 5 kPa	5 - 10 kPa	2	Assumed - No values given
Residual Undrained Shear Strength	> 10 kPa	5 - 10 kPa	< 5 kPa	5 - 10 kPa	2	Assumed - No values given
Transition Peat to Mineral Soil						
Peat fibres continuous across transition to glacial till at base of peat	Yes	Partially	No	Partially	2	IGSL Data - TS
Underlying Soil/Rock						
Granular soil at base of peat	No		Yes	No	1	IGSL Data - TS
Rock below Peat - Interface Characteristics	Rough/ Weathered	Smooth Undulating	Smooth Planar	NA		
Topography/ Hydrology						
Slope Angle	Shallow	Intermediate	High			
Slope Angle - Ground Surface	<3°	3° - 5°	>5°	4.8 °	2	Contour Plan Of Site
Slope Angle - Base of Peat	<3°	3° - 5°	>5°	4.8 °	2	Assumed Parallel to ground surface
Topography/ Hydrology						
In broad valley upslope from defined watercourses	No	Yes, slopes < 3°	Yes, slopes >3°	Yes, slopes >3°	3	OSI Data + Contour Plan
Distance from topographical low-point upslope from defined watercourses	>250m	100-250m	<100m	<100m	3	OSI Data + Contour Plan
General Slope Characteristics downslope from road/turbine	Concave	Planar	Convex	Planar	2	OSI Data + Contour Plan
Distance from Break Slope	>100m	50-100m	<50m	<50m	3	OSI Data + Contour Plan
Surface Water	Localised	Ponded in drains	Springs	Localised	1	OSI Data + IGSL Trial Pit Data
Existing Drainage Ditches	Downslope	Varies	Across slope	Downslope	1	OSI Data + Contour Plan
Evidence of Piping	No	Possibly	Yes	No	1	OSI Data + Contour Plan
Factor of Safety - Infinite Slope (Undrained) @ peat strength						
$FS_{(\phi=0,\ slope)}$ - Ground Slope	>2	1.5 - 2.0	<1.5	2.78	1	Infinite Slope
$FS_{(\phi=0,\ slope)}$ - Base of Peat	>2	1.5 - 2.0	<1.5			
$FS_{(\phi=0,\ slope)}$ - Ground Surface + 1 m Peat	>2	1.5 - 2.0	<1.5	2.24	1	Infinite Slope
$FS_{(\phi=0,\ slope)}$ - Base of Peat + 1 m Peat	>2	1.5 - 2.0	<1.5			
Vegetation						
Tree Growth	Good	Fair	Poor	Poor	3	OSI Data
Vegetation (No trees)	Dry Heather	Grassland	Wetlands	NA		Forested Area
Slide History						
Evidence of previous slides	No	General Area	On site	On site	3	Site Observation
Tension Cracks in Peat	No		Yes	No	1	Site Observation
Land Use						
Peat Workings	None	Cutaway/Turbary	Sausage Cutter	None	1	Site Observation + OSI Data
Aerial Photography						
Evidence of previous slides in area	No	Possibly	Yes	No	1	OSI Data
Evidence of subterranean drainage	No	Possibly	Yes	Yes	3	OSI Data Site Observation
Other notable contributary features	No	Possibly	Yes	No	1	OSI Data
Trial Pit Observations						
Slides Stable	Stable	Unstable/Spalling	Squeezing	Unstable/Spalling	2	IGSL Data - TS
Groundwater	Dry/Slight seepage	Seepage	Strong flow	Seepage	2	IGSL Data - TS
Piping	No	Slight	Yes	No	1	IGSL Data - TS
Peat Classification at base of peat	Very Fibrous	Fibrous	Slightly Fibrous/Clayey	Slightly Fibrous/Clayey	3	IGSL Data - TS
Very soft sensitive clay layer at base of peat	No	Discontinuous	Yes	Possibly/ Discontinuous	2	IGSL Data - TS
Granular soil at base of Peat	No		Yes	No	1	IGSL Data - TS

Failure Potential	
Total	64
Max	102	16 Factors Used
Failure Potential Score (%)	62.7

APPENDIX D

Garvagh Glebe - South							
Item	Factor	Rating			Zone 1		
		1	2	3	Value	Rating	Comment
	Stratigraphy						
	Peat						
1	Peat Depth	0.00 - 1.0	1.0 - 2.0	>2.0	3 m	3	Peat Depth Plan
2	Water Content	0 - 1000%	1000 - 2000%	>2000%	0 - 1000%	1	IGSL Data
3	Min Peak Undrained Shear Strength	>10 kPa	5-10 kPa	<5 kPa	4 kPa	2	Infinite Slope
4	Peat Classification at $c_{u\,min}$	Very fibrous	Fibrous	Slightly Fibrous/ Clayey	Fibrous	2	IGSL Data
	Sensitive Clay Layer Below Peat						
5	Very soft sensitive clay layer at base of peat	No	Possibly/ Discontinuous	Yes	No	1	IGSL Data + TB
6	Sensitivity Coefficient ($c_{u\,peak}/c_{u\,base\,of\,peat}$)	1.0-1.5	1.5-2.0	>2	NA		
7	Peak Undrained Shear Strength	>10 kPa	5 - 10 kPa	< = 5 kPa	NA		
8	Residual Undrained Shear Strength	> 10 kPa	5 - 10 kPa	< 5 kPa	NA		
	Transition - Peat to Mineral Soil						
9	Peat fibres continuous across transition to glacial till at base of peat	Yes	Partially	No	Yes	1	IGSL Data + TB
	Underlying Soil/Rock						
10	Granular soil at base of peat	No		Yes	No	1	IGSL Data + TB
11	Rock below Peat - Interface Characteristics	Rough/ Weathered	Smooth Undulating	Smooth Planar	NA		
	Topography/ Hydrology						
	Slope Angle	Shallow	Intermediate	High			
12	Slope Angle - Ground Surface	<3°	3° - 5°	>5°	7.6°	3	Contour Plan of Site
13	Slope Angle - Base of Peat	<3°	3° - 5°	>5°	7.6°	3	Assumed Parallel to Ground Surface
	Topography/ Hydrology						
14	In broad valley upslope from defined watercourses	No	Yes, slopes <3°	Yes, slopes >3°	No	1	OSI Data + Contour Plan
15	Distance from topographical low-point upslope from defined watercourses	>250m	100-250m	<100m	100-250m	2	OSI Data + Contour Plan
16	General Slope Characteristics downslope from road/turbine	Concave	Planar	Convex	Convex	3	OSI Data + Contour Plan
17	Distance from Break Slope	>100m	50-100m	<50m	<50m	3	OSI Data + Contour Plan
18	Surface Water	Localised	Ponded in drains	Springs	Localised	1	OSI Data + IGSI Data - TB
19	Existing Drainage Ditches	Downslope	Varies	Across slope	Varies	2	OSI Data + Contour Plan
20	Evidence of Piping	No	Possibly	Yes	No	1	OSI Data + Contour Plan
	Factor of Safety - Infinite Slope (Undrained) @ peat strength						
21	$FS_{(\beta\ Ground\ Slope)}$ - Ground Slope	>2	1.5 - 2.0	<1.5	1.17	3	Infinite Slope
22	$FS_{(\beta\ Base\ Slope)}$ - Base of Peat	>2	1.5 - 2.0	<1.5			
23	$FS_{(\beta\ Ground\ Slope)}$ - Ground Surface + 1m Peat	>2	1.5 - 2.0	<1.5	0.78	3	Infinite Slope
24	$FS_{(\beta\ Base\ Slope)}$ - Base of Peat + 1m Peat	>2	1.5 - 2.0	<1.5			
	Vegetation						
25	Tree Growth	Good	Fair	Poor	Good	1	OSI Data
26	Vegetation (no trees)	Dry Heather	Grassland	Wetlands	NA		Forested Area
	Slide History						
27	Evidence of previous slides	No	General Area	Onsite	General Area	2	Site Observation
28	Tension Cracks in Peat	No		Yes	No	1	Site Observation
	Land Use						
29	Peat Workings	None	Cutaway/Turbary	Sausage Cutter	None	1	Site Observation + OSI Data
	Aerial Photography						
30	Evidence of previous slides in area	No	Possibly	Yes	No	1	OsI Data
31	Evidence of subterranean drainage	No	Possibly	Yes	Possibly	2	OsI Data
32	Other notable contributary features	No	Possibly	Yes	No	1	OsI Data
	Trial Pit Observations						
33	Slides Stable	Stable	Unstable/Spalling	Squeezing	Unstable/Spalling	2	IGSL Data + TB
34	Groundwater	Dry/Slight seepage	Seepage	Strong Flow	Seepage	2	IGSL Data + TB
35	Piping	No	Slight	Yes	No	1	IGSL Data + TB
36	Peat Classification at base of peat	Very Fibrous	Fibrous	Slightly Fibrous/Clayey	Fibrous	2	IGSL Data + TB
37	Very soft sensitive clay layer at base of peat	No	Discontinuous	Yes	No	1	IGSL Data + TB
38	Granular soil at base of Peat	No		Yes	No	1	IGSL Data + TB

Failure Potential	
Total	55
Max	93
Failure Potential Score (%)	59.1

31 Factors Used

Garvagh Glebe - South						
Factor	Rating			Zone 2		
	1	2	3	Value	Rating	Comment
Stratigraphy						
Peat						
Peat Depth	0.00 - 1.0	1.0 - 2.0	>2.0	2 m	2	Peat Depth Plan
Water Content	0 - 1000%	1000 - 2000%	>2000%	0 - 1000%	1	IGSL Data
Min Peak Undrained Shear Strength	>10 kPa	5-10 kPa	<5 kPa	6 kPa	2	Infinite Slope
Peat Classification at c_{u} min	Very fibrous	Fibrous	Slightly Fibrous/ Clayey	Slightly Fibrous/ Clayey	1	IGSL Data
Sensitive Clay Layer Below Peat						
Very soft sensitive clay layer at base of peat	No	Possibly/ Discontinuous	Yes	No	1	IGSL Data - T11 + T12
Sensitivity Coefficient ($c_{u\ peak}$/ $c_{u\ remould}$)	1.0-1.5	1.5-2.0	>2	NA		
Peak Undrained Shear Strength	>10 kPa	5 - 10 kPa	< = 5 kPa	NA		
Residual Undrained Shear Strength	> 10 kPa	5 - 10 kPa	< 5 kPa	NA		
Transition - Peat to Mineral Soil						
Peat fibres continuous across transition to glacial till at base of peat	Yes	Partially	No	Yes	1	IGSL Data - T11 + T12
Underlying Soil/Rock						
Granular soil at base of peat	No		Yes	No	1	IGSL Data - T11 + T12
Rock below Peat - Interface Characteristics	Rough/ Weathered	Smooth Undulating	Smooth Planar	NA		
Topography/ Hydrology						
Slope Angle	Shallow	Intermediate	High			
Slope Angle - Ground Surface	<3°	3° - 5°	>5°	9.1 °	3	Contour Plan of Site
Slope Angle - Base of Peat	<3°	3° - 5°	>5°	9.1 °	3	Assumed Parallel to Ground Surface
Topography/ Hydrology						
In broad valley upslope from defined watercourses	No	Yes, slopes <3°	Yes, slopes >3°	Yes, slopes <3°	2	OSI Data + Contour Plan
Distance from topographical low-point upslope from defined watercourses	>250m	100-250m	<100m	<100m	3	OSI Data + Contour Plan
General Slope Characteristics downslope from road/turbine	Concave	Planar	Convex	Planar	2	OSI Data + Contour Plan
Distance from Break Slope	>100m	50-100m	<50m	<50m	3	OSI Data + Contour Plan
Surface Water	Localised	Ponded in drains	Springs	Localised	1	OSI Data + IGSL Data
Existing Drainage Ditches	Downslope	Varies	Across slope	Varies	2	OSI Data + Contour Plan
Evidence of Piping	No	Possibly	Yes	No	1	OSI Data + Contour Plan
Factor of Safety - Infinite Slope (Undrained) @ peak strength						
$FS_{(\text{no tree slope})}$ - Ground Slope	>2	1.5 - 2.0	<1.5	2.95	1	Infinite Slope
$FS_{(\text{no tree slope})}$ - Base of Peat	>2	1.5 - 2.0	<1.5			
$FS_{(\text{no tree slope})}$ - Ground Surface + 1m Peat	>2	1.5 - 2.0	<1.5	1.5	2	Infinite Slope
$FS_{(\text{no tree slope})}$ - Base of Peat + 1m Peat	>2	1.5 - 2.0	<1.5			
Vegetation						
Tree Growth	Good	Fair	Poor	Fair	2	OSI Data
Vegetation (no trees)	Dry Heather	Grassland	Wetlands	NA		Forested Area
Slide History						
Evidence of previous slides	No	General Area	On site	General Area	2	Site Observation
Tension Cracks in Peat	No		Yes	No	1	Site Observation
Land Use						
Peat Workings	None	Cutaway/Turbary	Drainage Cutter	None	1	Site Observation + OSI Data
Aerial Photography						
Evidence of previous slides in area	No	Possibly	Yes	No	1	OSI Data
Evidence of subterranean drainage	No	Possibly	Yes	No	1	OSI Data
Other notable contributary features	No	Possibly	Yes	No	1	OSI Data
Trial Pit Observations						
Slides Stable	Stable	Unstable/Spalling	Squeezing	Stable	1	IGSL Data - T11 + T12
Groundwater	Dry/Slight seepage	Seepage	Strong Flow	Seepage	2	IGSL Data - T11 + T12
Piping	No	Slight	Yes	No	1	IGSL Data - T11 + T12
Peat Classification at base of peat	Very Fibrous	Fibrous	Slightly Fibrous/Clayey	Slightly Fibrous/Clayey	2	IGSL Data - T11 + T12
Very soft sensitive clay layer at base of peat	No	Discontinuous	Yes	No	1	IGSL Data - T11 + T12
Granular soil at base of Peat	No		Yes	No	1	IGSL Data - T11 + T12

Failure Potential	
Total	52
Max	93 31 Factors Used
Failure Potential Score (%)	55.9

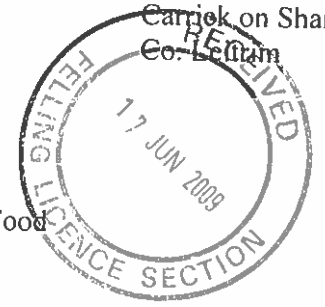
Garvagh Glebe - South						
Factor	Rating			Zone 3		
	1	2	3	Value	Rating	Comment
Stratigraphy						
Peat						
Peat Depth	0.00 - 1.0	1.0 - 2.0	>2.0	2	2	Peat Depth Plan
Water Content	0 - 1000%	1000 - 2000%	>2000%	0 1000%	1	IGSI Data
Min Peak Undrained Shear Strength	>10 kPa	5-10 kPa	<5 kPa	6 kPa	2	Infinite Slope
Peat Classification at c_u min	Very fibrous	Fibrous	Slightly Fibrous/ Clayey	Slightly Fibrous/ Clayey	1	IGSI Data
Sensitive Clay Layer Below Peat						
Very soft sensitive clay layer at base of peat	No	Possibly/ Discontinuous	Yes	No	1	IGSI Data - T13
Sensitivity Coefficient($c_{u\,peak}$/ $c_{u\,Remould}$)	1.0-1.5	1.5-2.0	>2	NA		
Peak Undrained Shear Strength	>10 kPa	5 - 10 kPa	< =5 kPa	NA		
Residual Undrained Shear Strength	> 10 kPa	5 - 10 kPa	< 5 kPa	NA		
Transition - Peat to Mineral Soil						
Peat fibres continuous across transition to glacial till at base of peat	Yes	Partially	No	Partially	2	IGSI Data - T13
Underlying Soil/Rock						
Granular soil at base of peat	No		Yes	No	1	IGSI Data - T13
Rock below Peat - Interface Characteristics	Rough/ Weathered	Smooth Undulating	Smooth Planar	NA		
Topography/ Hydrology						
Slope Angle	Shallow	Intermediate	High			
Slope Angle - Ground Surface	<3°	3° - 5°	>5°	5.6°	3	Contour Plan of Site
Slope Angle - Base of Peat	<3°	3° - 5°	>5°	5.6°	3	Assumed Parallel to Ground Surface
Topography/ Hydrology						
In broad valley upslope from defined water courses	No	Yes, slopes <3°	Yes, slopes >3°	Yes, slopes >3°	3	OSI Data + Contour Plan
Distance from topographical low-point upslope from defined water courses	>250m	100-250m	<100m	<100m	3	OSI Data + Contour Plan
General Slope Characteristics downslope from road/turbine	Concave	Planar	Convex	Planar	2	OSI Data + Contour Plan
Distance from Break Slope	>100m	50-100m	<50m	<50m	3	OSI Data + Contour Plan
Surface Water	Localised	Ponded in drains	Springs	Localised	1	OSI Data + IGSI Data
Existing Drainage Ditches	Downslope	Varies	Across slope	Varies	2	OSI Data + Contour Plan
Evidence of Piping	No	Possibly	Yes	No	1	OSI Data + Contour Plan
Factor of Safety - Infinite Slope (Undrained) @ peat strength						
$FS_{(0\,kPa\,Slope)}$ - Ground Slope	>2	1.5 - 2.0	<1.5	4.2	1	Infinite Slope
$FS_{(0\,kPa\,Slope)}$ - Base of Peat	>2	1.5 - 2.0	<1.5			
$FS_{(0\,kPa\,Slope)}$ - Ground Surface + 1m Peat	>2	1.5 - 2.0	<1.5	2.43	1	Infinite Slope
$FS_{(0\,kPa\,Slope)}$ - Base of Peat + 1m Peat	>2	1.5 - 2.0	<1.5			
Vegetation						
Tree Growth	Good	Fair	Poor	Good	1	OSI Data
Vegetation (no trees)	Dry Heather	Grassland	Wetlands	NA		Forested Area
Slide History						
Evidence of previous slides	No	General Area	Onsite	General Area	2	Site Observation
Tension Cracks in Peat	No		Yes	No	1	Site Observation
Land Use						
Peat Workings	None	Cutaway/Turbary	Sausage Cutter	None	1	Site Observation + OSI Data
Aerial Photography						
Evidence of previous slides in area	No	Possibly	Yes	No	1	OSI Data
Evidence of subterranean drainage	No	Possibly	Yes	No	1	OSI Data
Other notable contributary features	No	Possibly	Yes	No	1	OSI Data
Trial Pit Observations						
Slides Stable	Stable	Unstable/Spalling	Squeezing	Stable	1	IGSI Data - T13
Groundwater	Dry/Slight seepage	Seepage	Strong Flow	Dry/Slight seepage	1	IGSI Data - T13
Piping	No	Slight	Yes	No	1	IGSI Data - T13
Peat Classification at base of peat	Very Fibrous	Fibrous	Slightly Fibrous/Clayey	Slightly Fibrous/Clayey	3	IGSI Data - T13
Very soft sensitive clay layer at base of peat	No	Discontinuous	Yes	No	1	IGSI Data - T13
Granular soil at base of Peat	No		Yes	No	1	IGSI Data - T13

Failure Potential	
Total	51
Max	93 33 Factors Used
Failure Potential Index (%)	54.8

Shannon Regional Fisheries Board
Bord Iascaigh Réigiúnach na Sionainne

Fisheries Ireland
Our Natural Heritage

Shannon Regional Fisheries Board
Drumsna
Carrick on Shannon
Co. Leitrim



Felling Section
Forest Service
The Department of Agriculture & Food
Johnstown Castle Estate
Co. Wexford

8th June 2009

Re:Felling Licence application from Coillte Teoranta in respect of lands at Garvagh Glebe, Co. Leitrim.

Dear Sir/Madam

The Owengar and Diffagher rivers rise in the area surrounding these proposed felling sites, both rivers are trout bearing tributaries of Lough Allen and the Shannon Regional Fisheries Board is concerned about potential pollution to these watercourses.

In response to your letter dated 3rd June 2009, the Board has serious concerns about soil stability in this area following a large scale landslide in September 2008. In view of the proximity of the sites to the source of the landslide we would ask that no felling takes places in these areas, pending the submission of a geotechnical report of soil stabilities in this area and the risks of further landslides. This report should also include any mitigating measures which could be employed to reduce such risks. On receipt of this submission the Board will assess this information and provide a response.

Please note in relation to any replanting proposals that no aerial fertilisation would be permitted in this area.
Please do not hesitate to contact me should you have any queries.

Yours sincerely

Catherine Kerins

Catherine Kerins
Fisheries Environmental Officer

The Shannon Regional Fisheries Board
Ashbourne Business Park
Dock Road
Limerick
T: (061) 300238
F: (061) 300308
E: info@shrfb.com
www.shannon-fishery-board.ie

Crowe, Sean

From: OCallaghan, Pat
Sent: 28 May 2009 15:54
To: Foley, Noel; Kelly, Senan; McAree, Diarmuid
Cc: Crowe, Sean; Farrington, Pat
Subject: RE: Coillte GFL application Windfarm - Garvagh Glebe, Co. Leitrim

Mr Foley,
I agree with your assessment and final decission in recommending the granting of a Felling Licence.

You correctly point the lack of mention of the felling in the EIA for the project for which the competant authority is responsible ie the Local Authority.

This begs the question on termination of the project, winding up of the wind farm project,what hapens to the land. Under normal EIA procedures lands should be restored to their origional use ie rowing trees.
I recommend that this is a condition of the licence.

I also recommend that in future all felling, clearance for roads etc, for similar projects be part of the EIA and all treated as one project, not as individual projects. Access is part of the project including access for monitoring of wind, water, soils, geology, etc.

The applicants should be instructed of same.

P J O Callaghan.

-----Original Message-----
From: Foley, Noel
Sent: 28 May 2009 10:06
To: Kelly, Senan; McAree, Diarmuid; OCallaghan, Pat
Cc: Crowe, Sean; Farrington, Pat
Subject: Coillte GFL application Windfarm - Garvagh Glebe, Co. Leitrim

To Diarmuid McAree, Senan Kelly, Pat O'Callaghan,
cc Sean Crowe, Pat Farrington.

Please find beneath (attachment on the far right - 090526 Recomm) my recommendation re the above Felling License application.

I sent that recommendation to Sean Crowe and Pat Farrington from my personal PC on the evening of last Tuesday May 26th.

The other attachments were received from Coillte. The most important one is the one second from right and (in the context of landslides) that which is 3rd from left (i.e. Appndx2 AGLDR)

Regards,
Noel Foley,
Forest Service, Oliver Plunkett Road, Letterkenny, Co. Donegal.
* 074 9121848/087 2515525. Fax 074 9122791

-----Original Message-----
From: Myles McDonagh [mailto:Myles.McDonagh@coillte.ie]
Sent: 08 May 2009 15:55
To: Foley, Noel; ocallaghan.pat@agriculture.gov.ie; Crowe, Sean
Subject: Garvagh Glebe Felling Licence

<<Garvagh Glebe-Windfarm Development_notes REPLY.doc>> Ge <<Appndx 1 eia doc Harvesting garva glebe EIA.pdf>> nt <<Appndx 2 AGL DRAFT Recommendations for Risk Assessment and Mitigation - Garvagh Glebe

Crowe, Sean

From: tnoelfoley@eircom.net
Sent: 26 May 2009 22:42
To: Crowe, Sean
Cc: Farrington, Pat; Foley, Noel
Subject: Coillte GFL Application SO100009 /LM06009/LM080009- Garvagh Glebe Windfarm

090526
ommendation[1]

Sean,

Please fnd my recommendation attached in relation to this application. I will copy this to the the named c recipients when I return to my office next Thursday. Please revert to me if you require clarification or additional information.

Noel Foley
----- "Noel Foley" <Noel.Foley@agriculture.gov.ie> wrote:
> Sean,
> You may delete this email.
> I am sending it to you and copying to my home PC with the intention of
> working on my recommendtion this evening and emailing it to you from
> my home email by doing "reply to all". This saves me a bit of bother!
>
> Regards,
> Noel Foley,
> Forest Service, Oliver Plunkett Road, Letterkenny, Co. Donegal.
> * 074 9121848/087 2515525. Fax 074 9122791
>
>
>
> _____
> Department of Agriculture, Fisheries and Food
>
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>
> An Roinn Talmhaíochta, Iascaigh agus Bia
>
> Tá an t-eolais san ríomhphost seo, agus in aon ceangláin leis, faoi
> phribhléid agus faoi rún agus le h-aghaigh an seolaí amháin.
> D'fhéadfadh ábhar an seoladh seo bheith faoi phribhléid profisiúnta nó
> dlíthiúil. Mura tusa an seolaí a bhí beartaithe leis an ríomhphost seo
> a fháil, tá cosc air, nó aon chuid de, a úsáid, a chóipeál, nó a
> scaoileadh. Má tháinig sé chugat de bharr dearmad, téigh i dteagmháil
> leis an seoltóir agus scrios an t-ábhar ó do ríomhaire le do thoil.