Planning and Environmental Consultants

Environmental Impact Assessment Report

Derrybrien Wind Farm Development Decommissioning Project – Prospective Development

Volume 2d: EIAR Appendix 8-3 to 13-8 & 13-10 to 16-2

APPENDIX 8-3

PEAT STABILITY RISK ASSESSMENT (PSRA) FOR DECOMMISSIONING OF POLESETS PS-1A TO PS-4 OF DERRYBRIEN TO AGANNYGAL OVERHEAD LINE

PEAT STABILITY RISK ASSESSMENT FOR DECOMMISSIONING OF POLESETS PS-1A TO PS-4 OF THE 110kV DERRYBRIEN TO ANNYGAL OVERHEAD LINE (OHL)

for

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PEAT STABILITY RISK ASSESSMENT FOR DECOMMISSIONING OF POLESETS PS-1A TO PS-4 OF THE 110kV DERRYBRIEN TO ANNYGAL OVERHEAD LINE (OHL)

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PEAT STABILITY RISK ASSESSMENT FOR DECOMMISSIONING OF POLESETS PS-1A TO PS-4 OF THE 110kV DERRYBRIEN TO ANNYGAL OVERHEAD LINE (OHL)

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PEAT STABILITY RISK ASSESSMENT FOR DECOMMISSIONING OF POLESETS PS-1A TO PS-4 OF THE 110kV DERRYBRIEN TO ANNYGAL OVERHEAD LINE (OHL)

1 INTRODUCTION

This report presents the results of the Peat Stability Risk Assessment (PSRA) that was carried out for the decommissioning of Polesets PS-1a to PS-4 at the upper end of the 110kV Overhead Line (OHL) between the Derrybrien Wind Farm and the Annygal Substation. The location of the polesets is shown on Figure 1-1.

The assessment has been carried out in accordance with the best practice guidelines in "Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Second Edition, April 2017)", by the Scottish Government Energy Consents Unit. The method of risk assessment is also consistent with the Institution of Civil Engineers' publication outlining UK best practice in "Managing Geotechnical Risk" (Clayton, 2001).

The 700m longsection of the OHL between polesets PS-1a and PS-4 has been split up into 2 No. representative zones with similar characteristics in terms of the peat depths, peat strengths and site topography: **Zone A**: PS-1a & PS-2 & **Zone B:** PS-3 & PS-4, as shown in Figure 1-2.

A qualitative risk assessment has been carried out for each zone to assess the **Risk Rating (R)** for a peat failure occurring during decommissioning of the OHL and twin polesets based on the interpreted **Likelihood (L)** (i.e. probability) of occurrence and **Impact (I)** of failure.

The **Likelihood (L)** of a peat failure has been assessed on a scale of 1-5 by evaluating factors related to peat and subsoil conditions, topography, site hydrology/hydrogeology and other significant contributory factors such as subsurface drainage, slide history and land use to determine where compounding conditions that could lead to an elevated risk of peat instability.

The potential **Impact (I)** of a peat failure in the area has been assessed on a scale of 1-5 by evaluating factors related to the potential volume of peat, degree of contamination, sensitivity of the receiving environment, access for intervention, and the land use and existing infrastructure within the potential run-out distance of a peat slide.

A **Risk Rating (R=L x I)** has then been calculated for each zone to characterise the risk of peat instability during decommissioning on a scale of 1-25, as summarised in Table 1-1.

The assessment was initially carried out for the existing site conditions prior to mitigation to identify where specific operational mitigation measures are required to reduce the risk of peat instability to an acceptable level.

The potential likelihood of a peat failure was then re-assessed for the site activities that will be carried out in the area during decommissioning of the 110kV OHL and twin polesets using appropriate mitigation measures and construction methodologies to minimise the impact on peat stability. It has been conservatively assumed that the mitigation measures that will be adopted will not reduce the potential impact of a peat slide in the area.

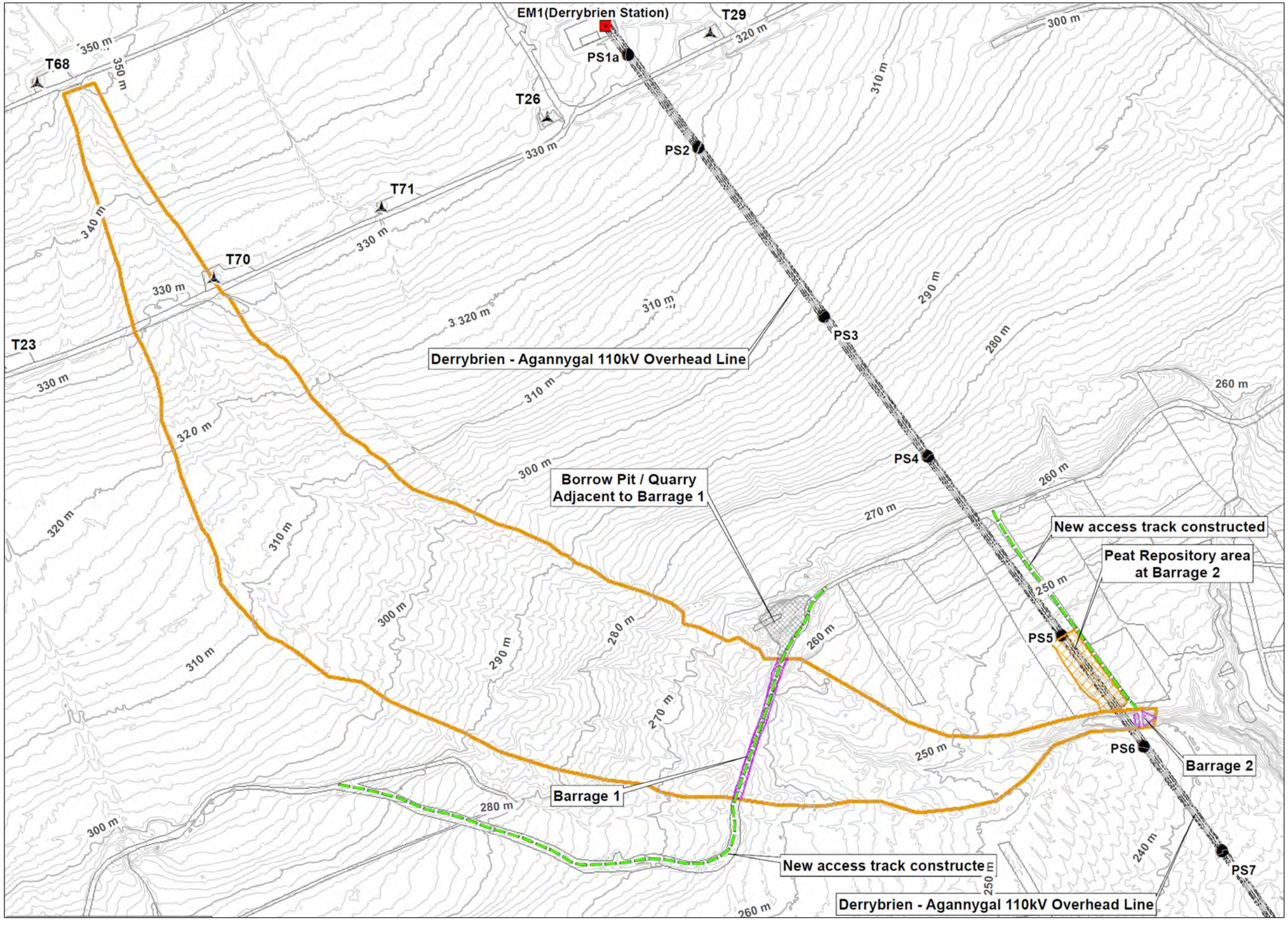


Figure 1-1 - Location of Polesets PS-1a to PS-4 along 110kV Derrybrien to Annygal Overhead Line (OHL)

Table 1-1 - Risk Rating Levels and Response

Risk Rating (R = L X I)		Response
1 to 5	Low (Trivial)	Monitor
6 to 10	Low to Medium (Tolerable)	Regular Attention
11 to 15	Medium (Significant)	Early Attention
16 to 20	Medium to High (Substantial)	Unacceptable
21 to 25	High (Intolerable)	Unacceptable

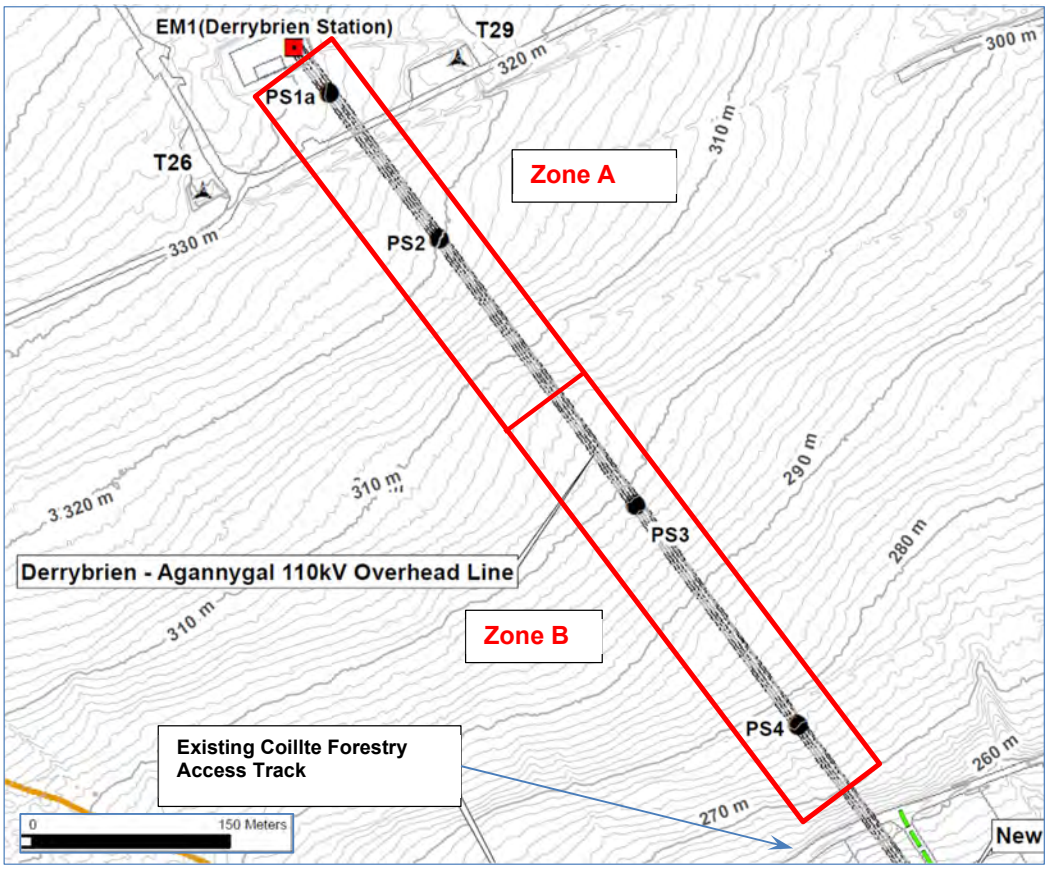


Figure 1-2 PSRA Zones for Polesets PS-1a to PS-4 along the 110kV Derrybrien-Agannygal OHL

2 PEAT STABILITY RISK ASSESSMENT (PSRA) PRIOR TO MITIGATION

Figure 2-1 shows the interpreted Risk Rating (R) for a peat slide occurring in the area based on the existing site conditions prior to the implementation of appropriate risk mitigation measures for decommissioning.

The **Likelihood** of peat slide in both areas prior to mitigation has been interpreted as **Possible (L=3)** using the worksheets in Appendix A. Other than the proximity to 2003 slide, which was 550m to the west on the same side of the mountain, there are no significant compounding high risk factors for peat instability along this section of the OHL. The interpreted likelihood of a peat slide is governed by the intermediate peat depths (1.0-2.2m) and relatively low peat strengths (c_u = 5.0-7.5kPa) that were recorded in the area combined with the convex breaking slopes to angles >5° at the polesets due to the terraced profile of the slopes. The polesets have generally been constructed on the more gently sloping terraces with slopes <4-5°.

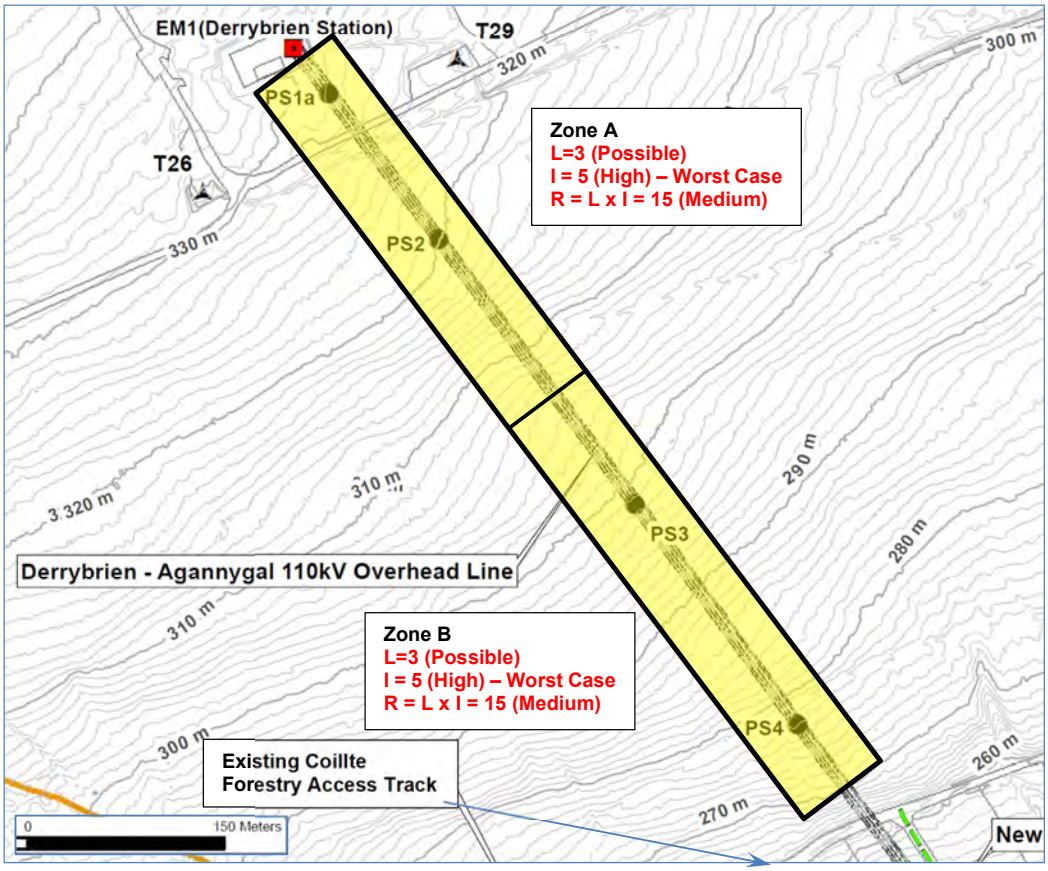


Figure 2-1 Interpreted Risk Rating (R) for a peat slide along OHL between PS-1a and PS-4 for existing conditions prior to mitigation

The conditions are slightly more unfavourable in Zone A (PS-1a & PS-2), where the peat is up to 1.9-2.2m deep and the lowest shear strengths were recorded (c_u = 5.0kPa).

In Zone B (PS-3 & PS-4) the peat depth was lower (1.0-1.9m) and the shear strengths were slightly higher (c_u = 7.5kPa). The slopes are locally steeper (up to 7°-10°) downslope from the polesets but the peat depths is shallower <0.5-1.0m.

Surface water conditions on the slopes are dry and favourable and there is no evidence of concentrated subsurface groundwater flow and the polesets are not located in a buried valley upslope from one of the streams on this side of the site.

The potential **Impact (I)** of a peat slide in the area has been assessed considering a large scale peat slide as the worst case scenario. The depth of peat reduces to 0.0-1.0m on the steep slopes downslope from PS-4, which will mitigate the extent and potential impact of a peat slide in this area. The existing Coillte track in the area is also constructed on glacial till or rock below the peat, which will impede the progression of a slide downslope from the track. Therefore, the potential Impact of a peat slide would be lower than the slide that occurred on the site in 2003 during construction.

In the worst case scenario, a large scale peat slide in the area under uncontrolled conditions could involve displacing approximately 35,000-50,000m^3 of peat up to 1.0-2.2m deep over an area of about 25Ha along the line of PS-1a to PS-4. The land within and downslop of the potential slide area is comprised of degraded blanket bog and coniferous forestry, which is of

low ecological importance. However, some of the remoulded peat slurry and organic sediment could enter the valley for the Owendalulleagh River and flow for a considerable distance downslope, potentially contaminating the watercourses and lakes downstream from the site, which would have a higher impact. There are also public roads on this side of the site which could be impacted by a peat slide. Therefore, the potential impact of a peat slide in the area has been assessed as **I=5 (High)**.

The resulting **Risk Rating**, R**,** for a peat slide in Zone A & Zone B prior to mitigation would be **R=15 (Medium)**, which is **Significant** requiring **Early Attention** based on the criteria in Table 1-1.

3 PEAT STABILITY RISK ASSESSMENT (PSRA) FOR DECOMMISSIONING

Decommissioning the OHL and twin polesets will involve trafficking across the surface peat to get to the polesets to take down the OHL, cut down the timber poles and transport them off site. This work will be carried out using low ground-bearing pressure wide-tracked excavators and ATVs suitable for working directly on the peat, similar to the equipment that would have been used to fell the conifer forests that were originally along the OHL corridor. The foundations for the polesets will also be left in place so there will be no excavations or temporary surcharge loading on the peat with spoil. Therefore, the Likelihood of a peat slide occurring during decommissioning of the OHL in Zones A & B under controlled conditions has been interpreted as **L=2 (Low).**

It has been conservatively assumed that the proposed construction methodology cannot reduce the potential Impact of a peat slide. Therefore, assuming that a large scale peat slide (35,00-50,000m^3) could occur in the worst case scenario, the potential Impact of the slide has been assessed as **I=5 (High)**.

Based on the criteria in Table 1-1, the corresponding **Risk Rating**, R**,** for a peat slide in Zone A & Zone B during decommissioning is **R=10 (Low to Medium)**, which is **Tolerable** requiring **Regular Attention** during the works, as illustrated in Figure 3-1.

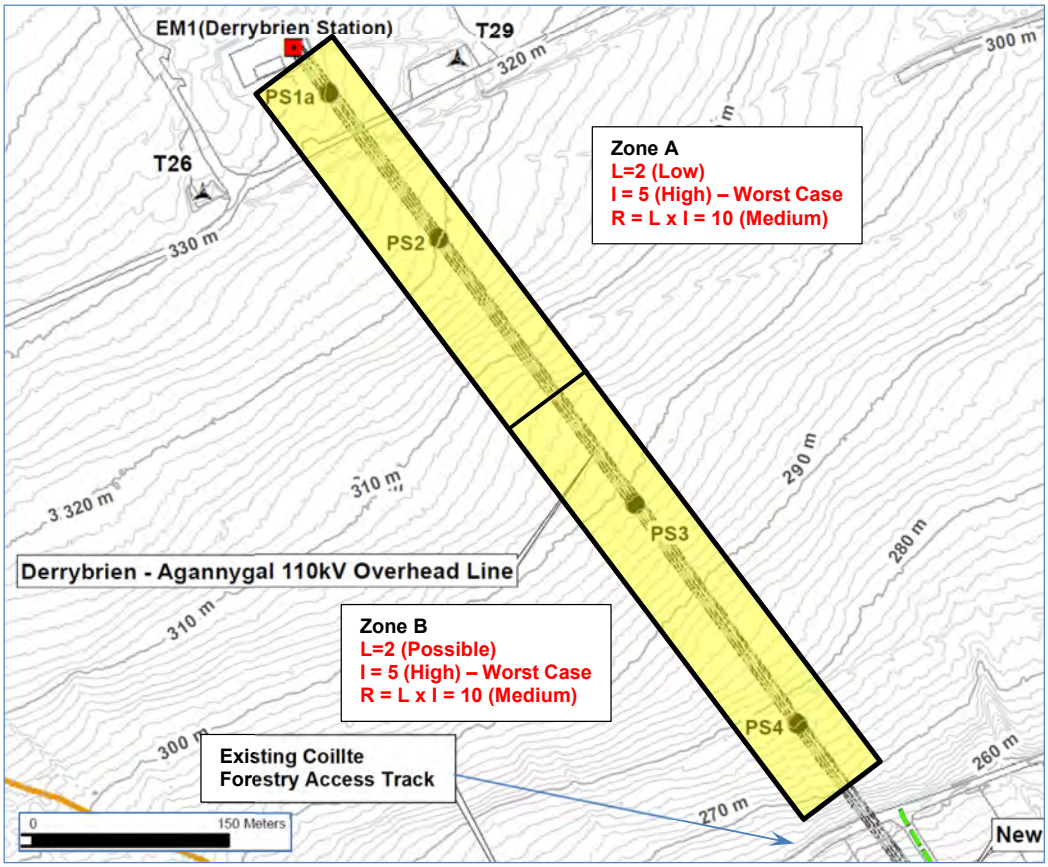


Figure 3-1 Interpreted Risk Rating (R) for a peat slide along OHL between PS-1a and PS-4 for proposed methodology for decommissioning.

Appendix A

Zonal Peat Stability Assessment (ZPSA) Worksheets

AGL CONSULTING GEOTECHNICAL ENGINEERS	**Derrybrien to Annygal 110kV Overhead Line (OHL) Peat Stability Assessment Worksheet (Hazard Likelihood) Zone A - Polesets P1a & P2**		
Factor	**Characteristic properties:**	**Hazard Rating**	
Peat/Subsoil Conditions	• **Peat depth:** 1.4 to 2.2m for PS-1a & PS-2 • **C_u (Geonor H-60) in Peat:** 5kPa (Conservatively use lower bound from ESBI VST data 2004-2005 – Geotech AB 140 x 280mm Vane). • **Water Content:** 1000-1500%* • **Max degree of humification:** H8-H10* • **Stability of peat in trial pits:** Slight spalling* • **Soft Clay layer at base of peat?:** No***** • **Subsoil conditions:** Cohesive Glacial Till*****	H	15
Topography	• **Slope angles:** Generally 4° at Polesets; locally steeper 5-6° between. • **General slope characteristics:** Polesets on intermediate slopes near the top of the mountain. Convex breaking slopes to steeper slopes south of PS-2. • **In broad flat or buried valley directly upslope from a watercourse?:** No • **Altitude:** 305-330mOD	H	10
Factors of Safety (Infinite Slope based on assumed min. Cu & worst case scenario)	**No surcharge:** • ****cu = 5kPa:** 2.9-3.9 • ****cu = 2.5kPa**: 1.4-2.0 – worst case scenario w/no surcharge; **13kPa surcharge (1m of Peat w/partial factor of 1.3)** • ****c_u = 5kPa:** 1.5-2.0 • ****c_u = 2.5kPa:** ≈ 1.0-1.5 – worst case scenario w/surcharge **Undrained shear strength at base of Peat*	H	10
Hydrology/ Hydrogeology	• **Surface Water:** Surface generally dry under foot. • **Drainage:** Generally well drained with downslope drains/furrows on steeper slopes and cross slope drains along firebreaks on terraces. • **Seepage in trial pits:** No trial pits – assume generally good groundwater conditions due to steeper slopes in the area. • **Evidence of piping/subsurface flow:** No	M	5
Significant Contributory Factors	• **Slide History:** Main slide area approximately 550m to west on same side of mountain. • **Tension Cracks:** No. • **Piping:** No • **Vegetation:** Conifer plantations felled along OHL. • **Peat Harvesting:** No	M	10
Notes: **1. Max hazard rating for each factor = 20 and ratings are assigned on the basis of interpreted significance, as follows: Negligible = 0, Low = 5, Medium = 10, High = 15, Very High = 20.** **2. Hazard Likelihood (L) prior to mitigation measures is interpreted from Total Hazard Rating as follows: 0-19: L=1 (Negligible); 20-39: L = 2 (Low); 40-59 L = 3 (Possible); 60-79: L = 4 (Very Possible); 80-100: L = 5 (Likely without appropriate mitigation measures).** ***Values conservatively assumed where information is not available based on general experience in this part of site.** **** Conservatively assumed Cu = 5kPa as lowest undrained shear strength for general condition at base of peat. 2.5kPa considered as worst case scenario if weak layer is present.**		**Total Hazard Rating**	50
		Hazard Likelihood (L)	3

AGL CONSULTING GEOTECHNICAL ENGINEERS	**Derrybrien to Annygal 110kV Overhead Line (OHL) Peat Stability Assessment Worksheet (Hazard Likelihood) Zone B - Polesets P3 & P4**		
Factor	**Characteristic properties:**	**Hazard Rating**	
Peat/Subsoil Conditions	• **Peat depth:** 1.0 to 1.9m for PS-3 & PS-4, <1.0m downslope from PS-4 • **C_u (Geonor H-60) in Peat:** 7.5-10kPa (Conservatively use lower bound from ESBI VST data 2004-2005 – Geotech AB 140 x 280mm Vane). • **Water Content:** 500-1000%* • **Max degree of humification:** H6-H8* • **Stability of peat in trial pits:** Stable* • **Soft Clay layer at base of peat?:** No***** • **Subsoil conditions:** Cohesive Glacial Till*****	H	10
Topography	• **Slope angles:** Locally 3.5-5.0° at Poleset PS-3; steeper 5-7° downslope to PS-4. Very steep slopes >10.0° in shallow peat downslope from PS-4. • **General slope characteristics:** Poleset PS-3 on terrace with convex break in slope to steep slopes down to PS-4. Convex break in slope to steep slopes >10° downslope from PS-4. • **In broad flat or buried valley directly upslope from a watercourse?:** No • **Altitude:** 265-305mOD	H	10
Factors of Safety (Infinite Slope based on assumed min. Cu & worst case scenario)	**No surcharge:** • ****cu = 5kPa:** 3.0-3.9 • ****cu = 2.5kPa**: 1.5-2.0 – worst case scenario w/no surcharge; **13kPa surcharge (1m of Peat w/partial factor of 1.3)** • ****c_u = 5kPa:** 1.6-2.0 • ****c_u = 2.5kPa:** ≈ 0.8-2.0 – worst case scenario w surcharge **Undrained shear strength at base of Peat*	H	5
Hydrology/ Hydrogeology	• **Surface Water:** Surface generally dry under foot. • **Drainage:** Generally well drained with downslope drains/furrows on steeper slopes and cross slope drains along firebreaks on terraces. • **Seepage in trial pits:** No trial pits – assume generally good groundwater conditions due to steeper slopes in the area. • **Evidence of piping/subsurface flow:** No	M	5
Significant Contributory Factors	• **Slide History:** Main slide area approximately 550m to west on same side of mountain. • **Tension Cracks:** No. • **Piping:** No • **Vegetation:** Conifer plantations felled along OHL. • **Peat Harvesting:** No	M	10
Notes: **1. Max hazard rating for each factor = 20 and ratings are assigned on the basis of interpreted significance, as follows: Negligible = 0, Low = 5, Medium = 10, High = 15, Very High = 20.** **2. Hazard Likelihood (L) prior to mitigation measures is interpreted from Total Hazard Rating as follows: 0-19: L=1 (Negligible); 20-39: L = 2 (Low); 40-59 L = 3 (Possible); 60-79: L = 4 (Very Possible); 80-100: L = 5 (Likely without appropriate mitigation measures).** ***Values conservatively assumed where information is not available based on general experience in this part of site.** **** Conservatively assumed Cu = 5kPa as lowest undrained shear strength for general condition at base of peat. 2.5kPa considered as worst case scenario if weak layer is present.**		**Total Hazard Rating**	40
		Hazard Likelihood (L)	3

TABLE A1 – PEAT/SUBSOIL CONDITIONS	Rating			
	Negligible	Low	Medium	High
Peat				
Peat Depth	<0.5 m	0.5 - 1.0	1.0 - 2.0	>2.0
Water Content	0-500%	500-1000%	1000-1500%	>1500%
Min Peak Undrained Shear Strength	>20 kPa	10-20 kPa	5-10 kPa	<=5 kPa
Peat Classification at c_u min	Very Fibrous	Fibrous	Pseudo-Fibrous/Slightly Fibrous	Amorphous/ Clayey
Stability of peat in trial pits	Stable	Slight spalling	Collapse @ >3 m Depth	Collapse/squeezing <3 m Depth
Very Soft Clay Layer Below Peat [applies to uniform clay of high plasticity, & excludes well-graded gravelly Cohesive Glacial Till or decomposed rock]				
Very soft clay layer at base of peat	No			Yes
Sensitivity Coefficient ($c_{u\ peak}/c_{u\ residual}$)	1.0	1.0-1.5	1.5 - 2.0	>2
Peak Undrained Shear Strength	>20 kPa	10-20 kPa	5-10 kPa	<=5 kPa
Residual Undrained Shear Strength	>20 kPa	10-20 kPa	5-10 kPa	<=5 kPa
Transition - Peat to Mineral Soil				
Sharp discontinuity (possible or potential shear plane) identified in peat or at base of peat in trial pits, probes or piston samples	No			Yes
Underlying Mineral Soil/Rock				
Granular soil/Fractured rock at base of peat	No			Yes
Nested Flat Boulders	No			Yes
Rock below Peat - Interface Characteristics	Rough/ Weathered	Rough/Fractured	Smooth Undulating	Smooth Planar

TABLE A2 - TOPOGRAPHY	Rating			
	Negligible	Low	Medium	High
Slope Angle	**Flat**	**Shallow**	**Intermediate**	**High**
Slope Angle - Ground Surface	**<1°**	**1-3°**	**3°-5°**	**>5°**
Slope Angle - Base of Peat	**<1°**	**1-3°**	**3°-5°**	**>5°**
In broad valley upslope from defined watercourses	**No**	**Yes, slopes <3°**	**Yes, slopes 3-5°**	**Yes, slopes > 5°**
Distance from topographical low-point upslope from defined watercourses	**>250 m**	**100-250 m**	**50-100 m**	**<50 m**
General slope characteristics downslope from road/turbine	**Concave**	**Planar to Concave**	**Planar to Convex**	**Convex**
Distance from break in convex slope	**>100 m**	**50-100 m**	**10-50 m**	**<10 m**

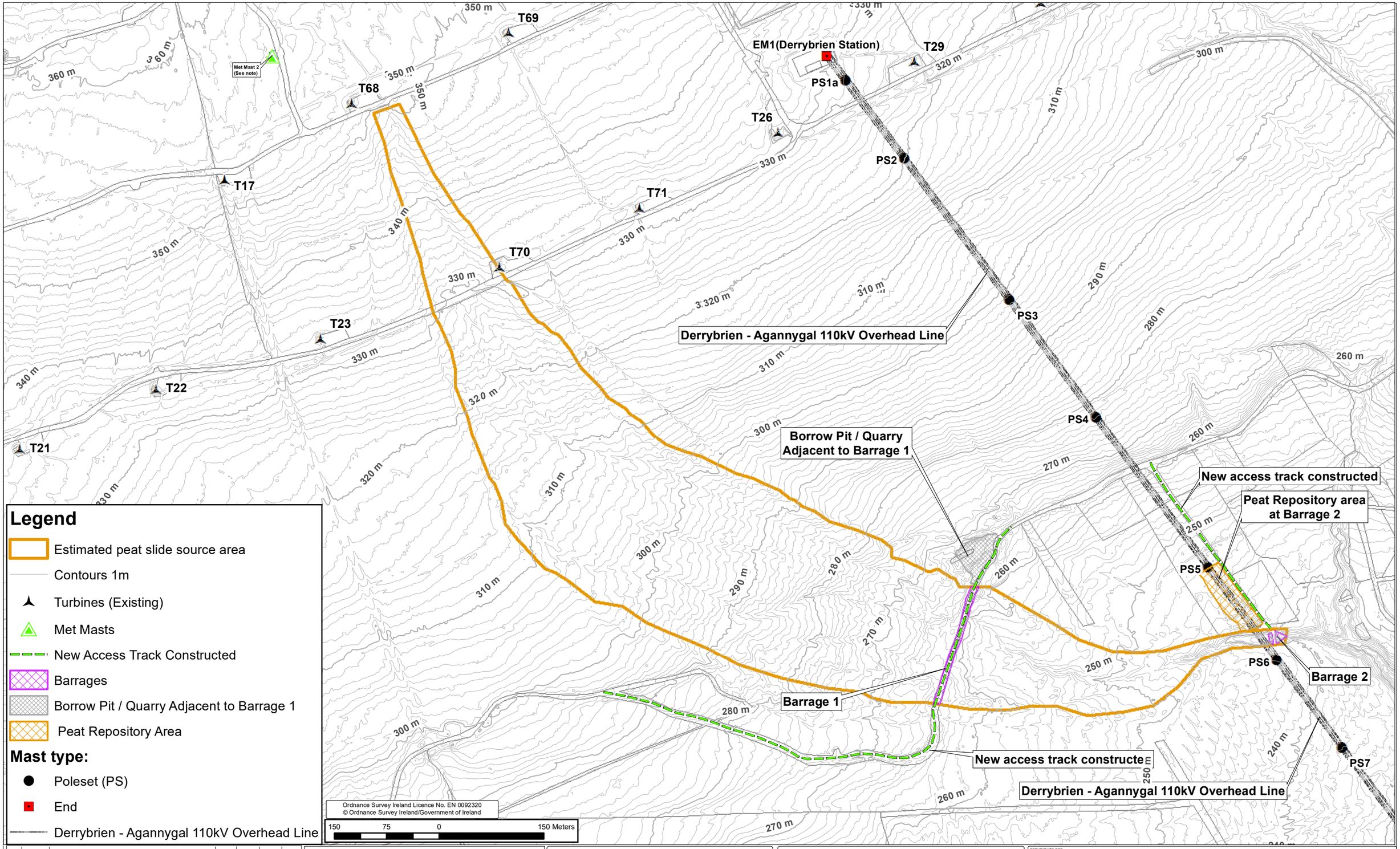
TABLE A3 – FACTOR OF SAFETY CALCULATIONS (INFINITE SLOPE)	Rating			
	Negligible	Low	Medium	High
FOS Infinite Slope - No Surcharge (Existing Condition)				
c_u = 5kPa (or minimum)	>3	2.0 - 3.0	1.5 - 2.0	<1.5
c_u = 2.5kPa (Worst Case)	>2	1.5 - 2.0	1.0 - 1.5	<1.0
FOS Infinite Slope - Surcharge of 1.0m Peat with Partial Factor = 1.3				
c_u = 5kPa (or minimum)	>3	2.0 - 3.0	1.5 - 2.0	<1.5
c_u = 2.5kPa (Worst Case)	>2	1.5 - 2.0	1.0 - 1.5	<1.0
FOS - Floating Road				
Planar Sliding (c_u = 5kPa)	>2	1.4 - 2.0	1.0 - 1.4	<1.0
Bearing Capacity	>2	1.4 - 2.0	1.0 - 1.4	<1.0
Extrusion	>2	1.4 - 2.0	1.0 - 1.4	<1.0

TABLE A4 – HYDROLOGY/HYDROGEOLOGY	Rating			
	Negligible	Low	Medium	High
Surface water	Dry	Localised/ Flowing in Drains	Ponded in drains	Springs/Surface Water
Existing drainage ditches	None/ Downslope	Varied (Gen. Downslope)	Varied (Gen. Across Slope)	Across slope
Groundwater observations in peat in trial pits.	Dry	Slight Seepage	Moderate Seepage	Strong Flow
Piping observed in trial pits	No	Slight Flow/Small Dia. (<25 mm)	Moderate Flow/Medium Dia. (25-50 mm)	Strong Flow/Large Dia. (>50 mm)
Seepage at Base of Peat	No			Yes
Evidence of piping from walkover survey	No	Possibly	Probably	Yes

TABLE A5 – OTHER CONTRIBUTORY FACTORS	Rating			
	Negligible	Low	Medium	High
Slide History				
Evidence of historic slides		General Area	On Site	<1 km
Tension Cracks in Peat				Yes
Aerial Photography				
Evidence of historic slides in area		Possibly	Probably	Yes
Evidence of subterranean drainage/piping		Possibly	Probably	Yes
Other notable contributory features		Possibly	Probably	Yes
Vegetation				
Tree Growth (Coniferous Forestry)	Good		Fair	Poor
Vegetation (no trees)	Grass/Crops	Improved Grass/Dry Heather	Wet grassland/juncus	Wetlands Sphagnum/ sedge
Land Use				
Peat Workings	None/Cutaway to <0.5 m Peat	Forestry	Turbury Plots	Sausage Cutter

Appendix B

Information On Site Characteristics, Peat Depth,
Peat Strength & Topography



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PURPOSE OF ISSUE - PRELIMINARY UNLESS INDICATED

CLIENT APPROVAL ☐ PLANNING ☒ TENDER ☐ CONSTRUCTION ☐ AS-BUILT ☐

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PROJECT: Derrybrien Wind Farm Project

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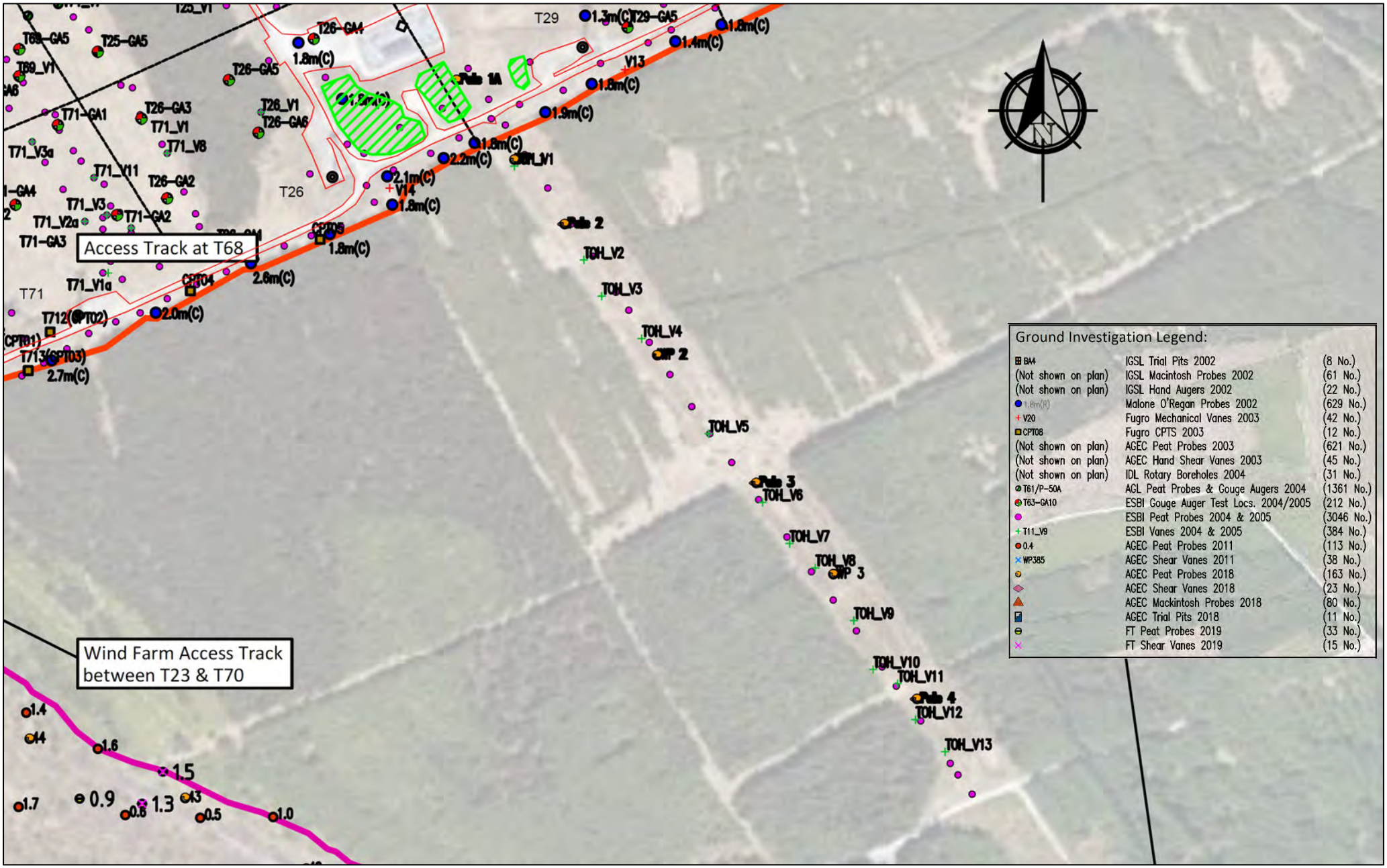

Figure 1 – Site Investigation Location Plan

Figure 2 – Aerial Photograph (Google Earth 2020)

Figure 3 – Hydrology & Ground Level Contours along OHL

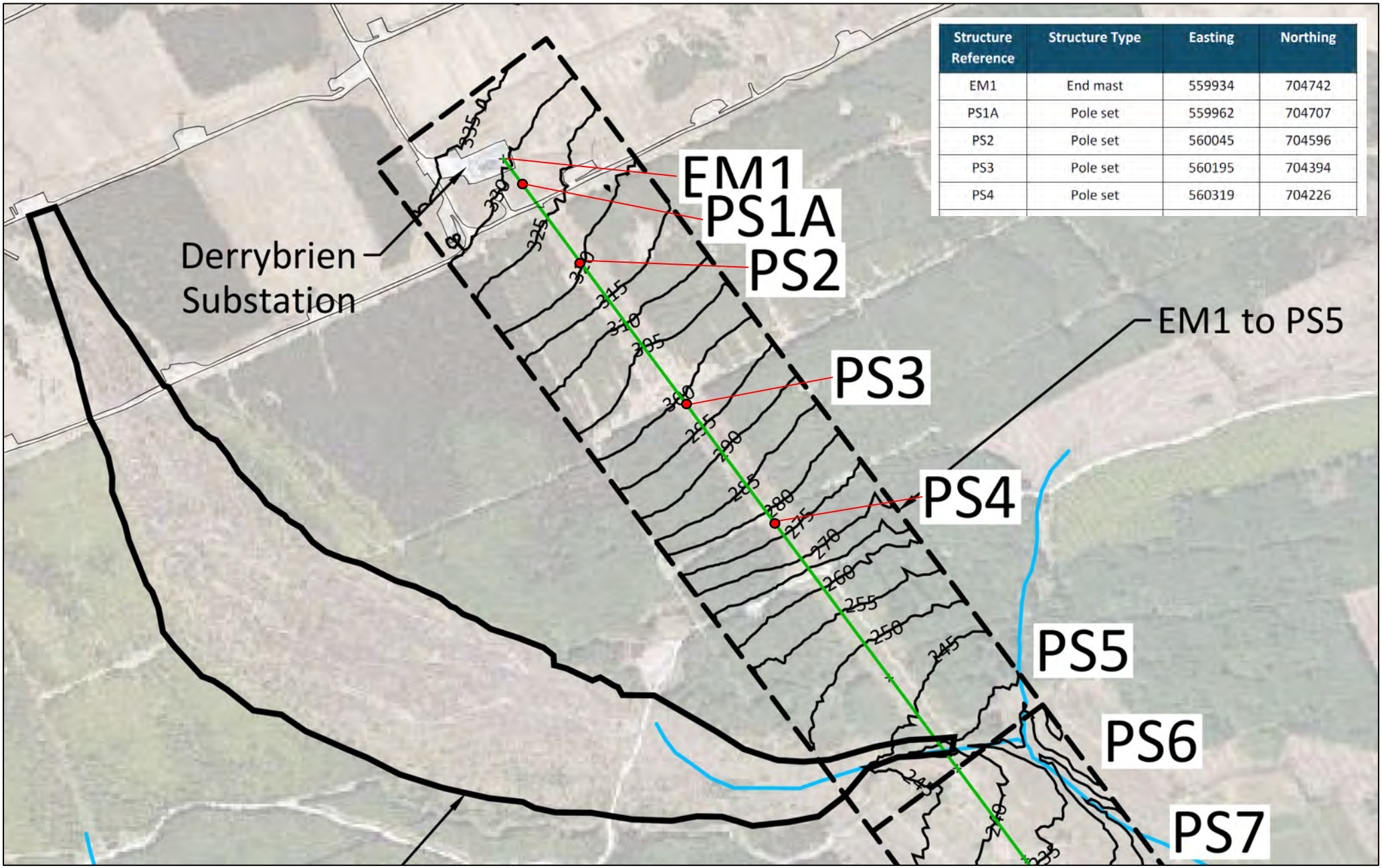

Figure 4 – Hydrology & Ground Level Contours along OHL PS-1A to PS-7

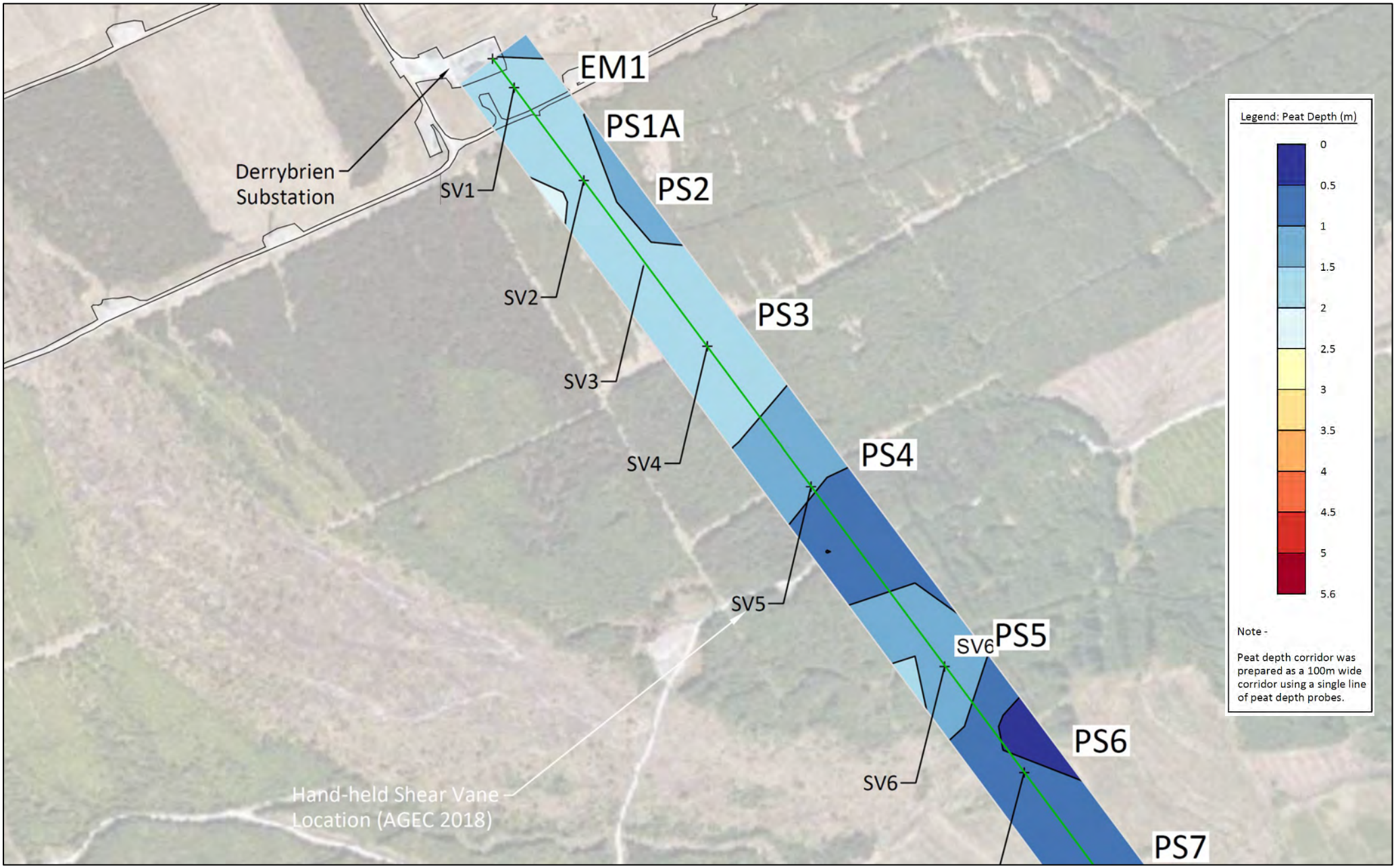

Figure 5 – Peat Depth along OHL PS-1A to PS-7

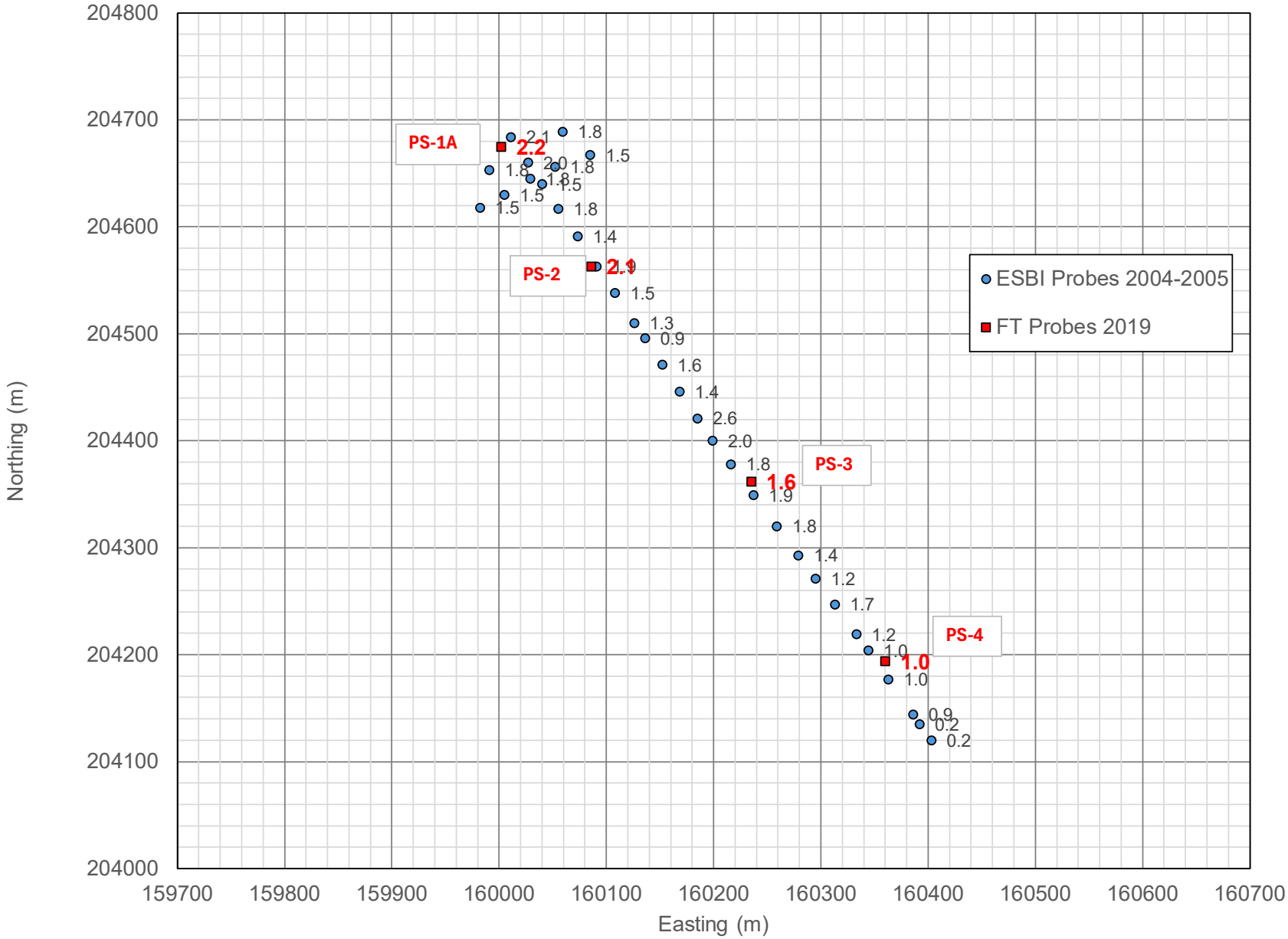

Figure 6 – Peat Depth from hand probes by ESBI (2004-2005) and Fehily Timoney (FT) along OHL PS-1A to PS-4

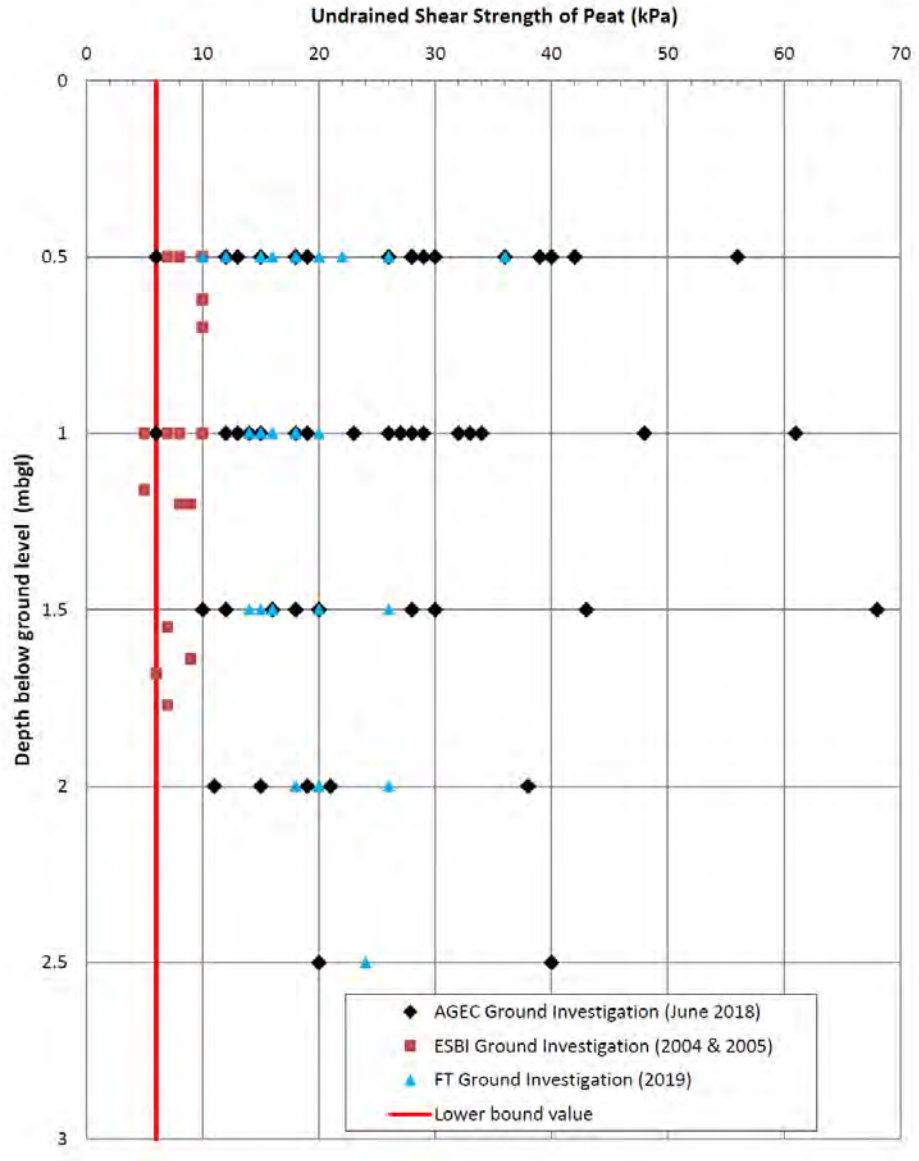

Figure 7 – Undrained Shear Strength, c_u, of Peat along OHL route measured by hand vane

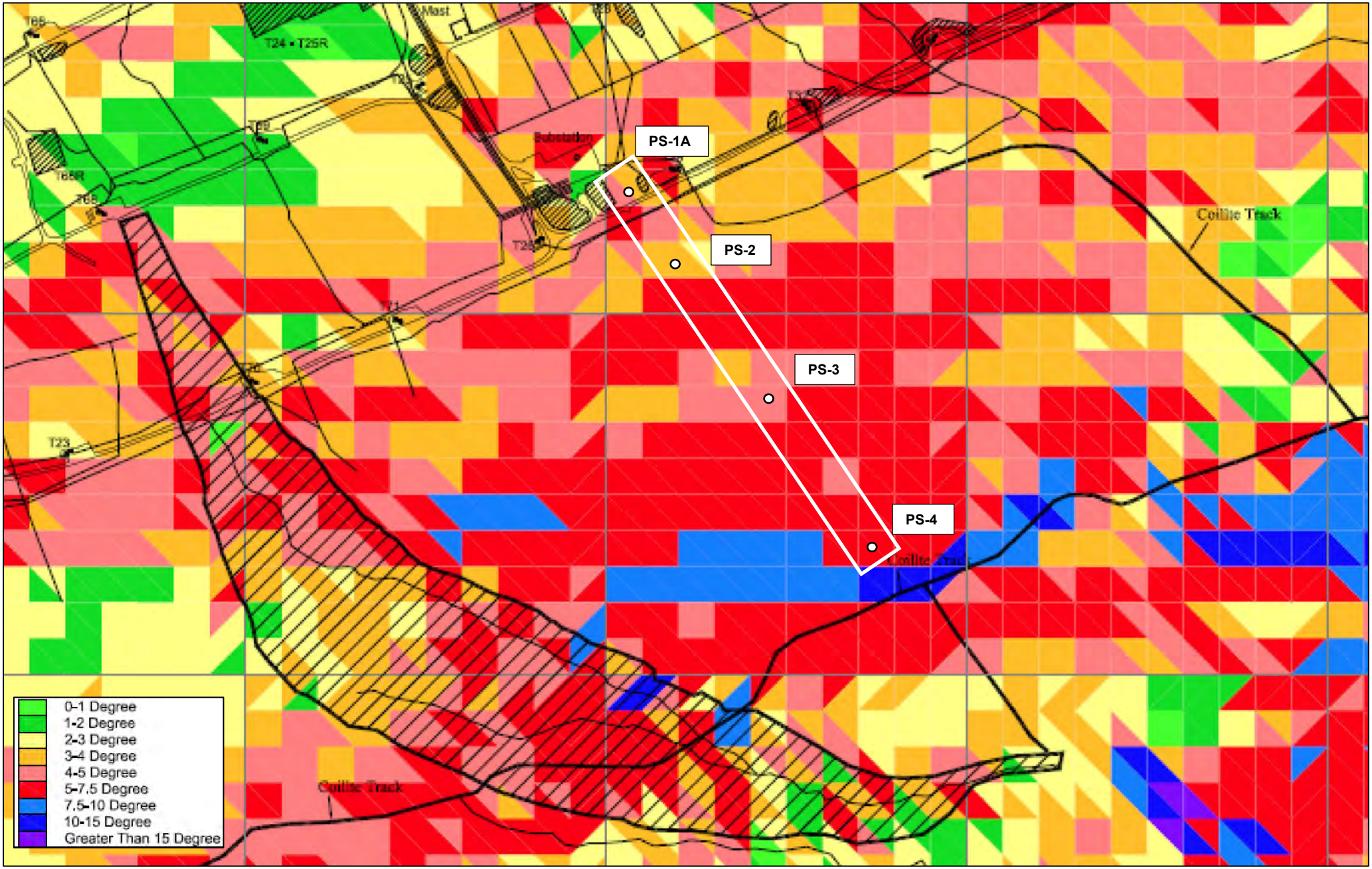

Figure 8 – Slope Angles along OHL PS-1A to PS-4

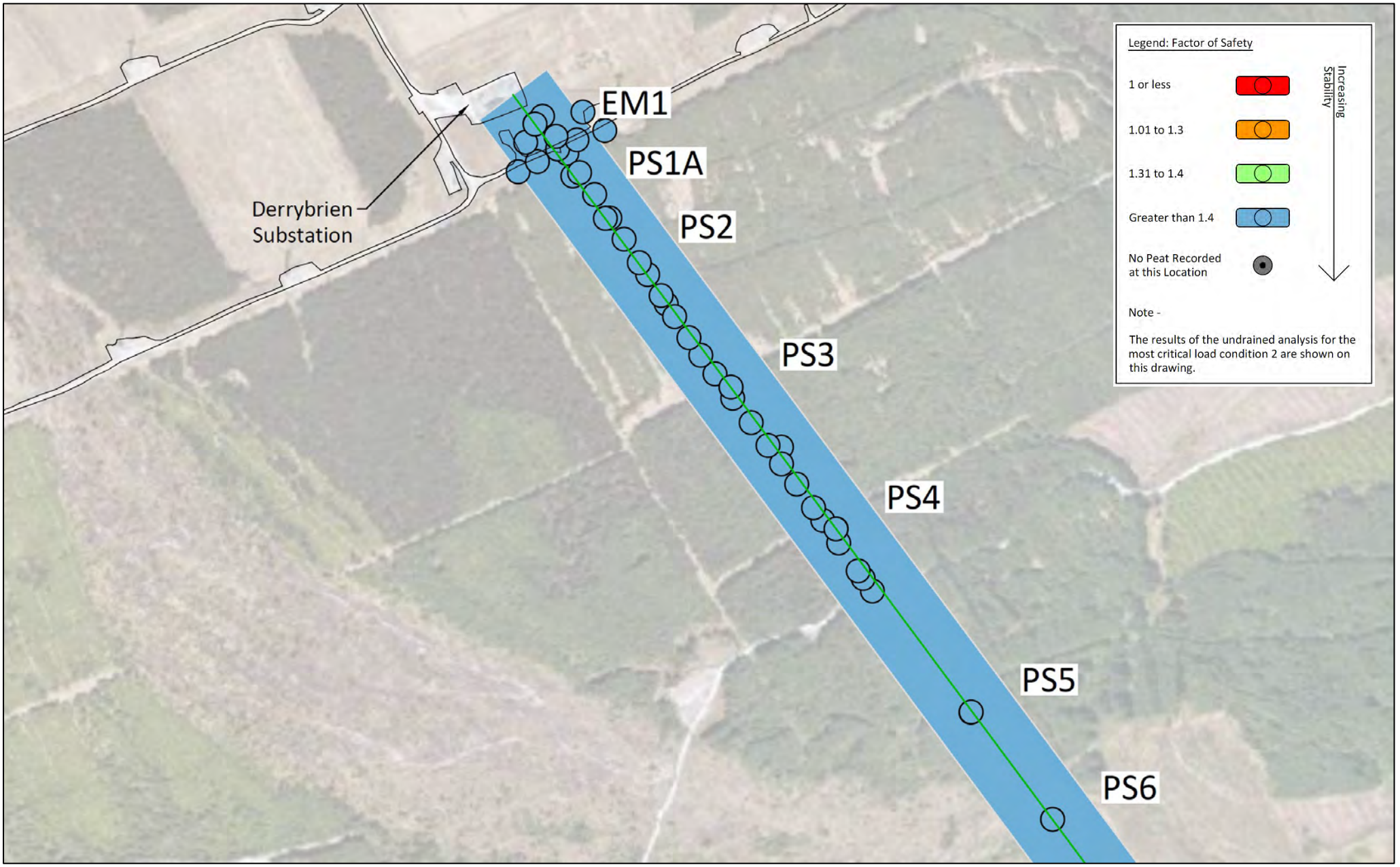

Figure 9 – Calculated Infinite Slope Factor of Safety (FoS) – Undrained Condition with 10kPa Surcharge (Condition 2 with c_u = 6kPa) along OHL PS-1A to PS-6

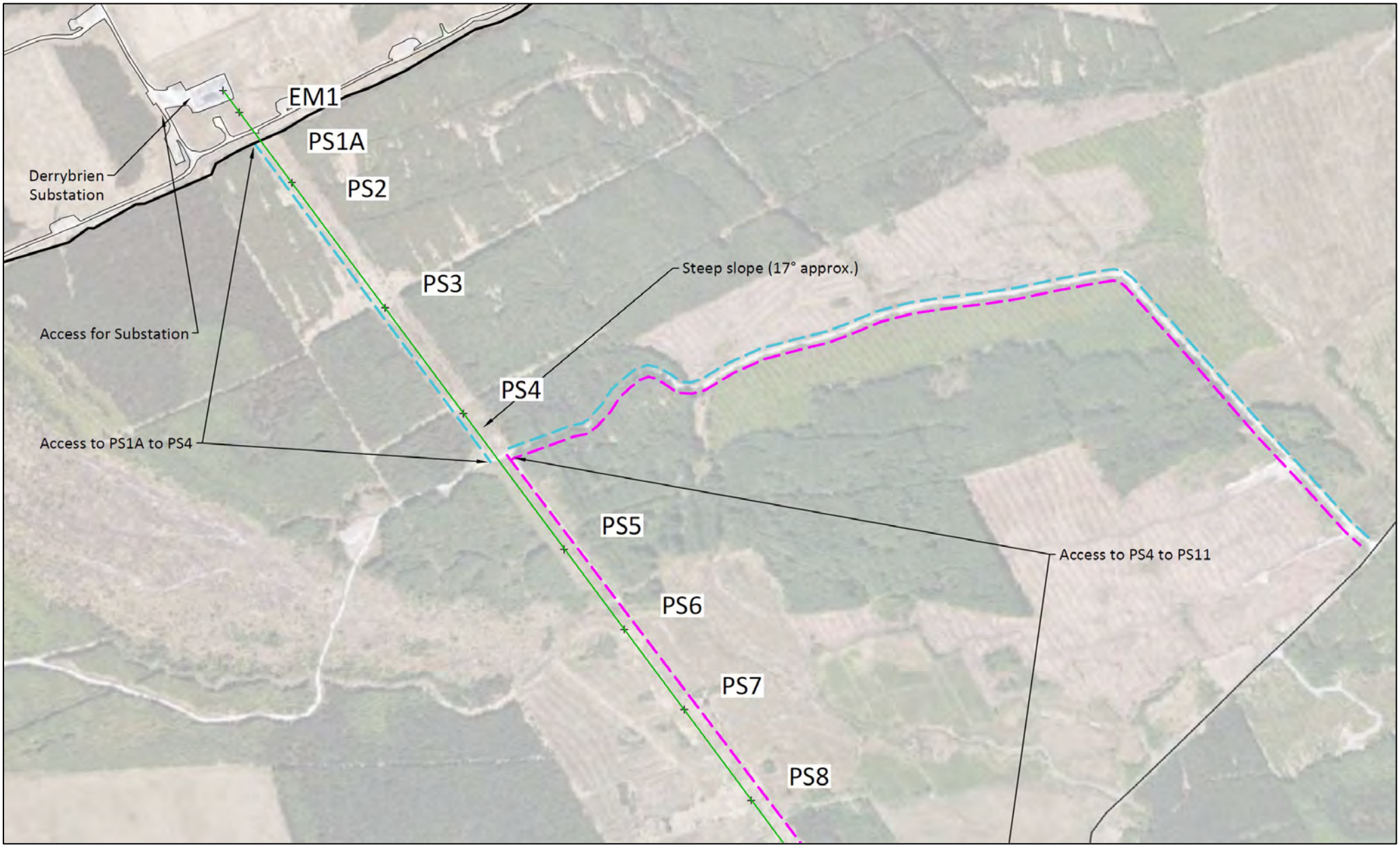

Figure 10 – Access to Polesets PS-1A to PS-4 along forestry access tracks for decommissioning of 110kV OHL

Table 1: Infinite Slope Factor of Safety (FoS) Calculations (Undrained) for 110kV OHL Polesets PS-1 to PS-4 [Fehily Timoney/AGEC Data]

Calculated FoS of Natural Peat Slopes for Derrybrien Wind Farm OHL (Undrained Analysis)									
Turbine No./Waypoint	Easting	Northing	Slope (Note 3)	Undrained shear strength	Bulk unit weight of Peat	Peat Depth (Note 5)	Surcharge Equivalent Placed Fill Depth (m) (Note 2)	Factor of Safety for Load Condition	
			β (deg)	c_u (kPa)	γ (kN/m^3)	(m)	Condition (2)	Condition (1)	Condition (2)
FT DATA (SEPTEMBER 2019)									
Pole 1A	160002	204675	5.0	6	10	2.2	3.2	**3.14**	**2.16**
Pole 2	160086	204563	6.0	6	10	2.1	3.1	**2.75**	**1.86**
Pole 3	160235	204362	4.0	6	10	1.6	2.6	**5.39**	**3.32**
Pole 4	160360	204194	6.0	6	10	1.0	2.0	**5.77**	**2.89**
AGEC DATA (JUNE 2018)									
Pole 1A	160002	204675	0.5	6	10	1.8	2.8	**38.20**	**24.56**
WP 1	160047	204613	3.0	6	10	1.4	2.4	**8.20**	**4.78**
Pole 2	160086	204563	0.5	6	10	2.4	3.4	**28.65**	**20.22**
WP 2	160158	204461	0.5	6	10	1.9	2.9	**36.19**	**23.71**
Pole 3	160235	204362	0.5	6	10	2.0	3.0	**34.38**	**22.92**
WP 3	160295	204291	0.5	6	10	1.8	2.8	**38.20**	**24.56**
Pole 4	160360	204194	6.0	6	10	1.1	2.1	**5.25**	**2.75**

Notes:

(1) Assuming a bulk unit weight of peat of 10 (kN/m^3)
(2) Assuming a surcharge equivalent to fill depth of 1m of peat i.e. 10kPa. (Condition 2)
(3) Slope inclination (β) based on site readings and contour survey plans of site.
(4) FoS is based on slope inclination and shear test results obtained from published data
(5) Peat depths based on probes carried out by AGEC and ESBI (June 2018)
(6) For load conditions see report text.
(7) Minimum acceptable factor of safety required of 1.3 for first-time failures based on BS: 6031:1981 Code of practice for Earthworks

Table 2: Infinite Slope Factor of Safety (FoS) Calculations (Undrained) for 110kV OHL Polesets PS-1 to PS-4 [Fehily Timoney/AGEC Data]

Calculated FoS of Natural Peat Slopes for Derrybrien Wind Farm OHL (Undrained Analysis)									
Turbine No./Waypoint	Easting	Northing	Slope (Note 3)	Undrained shear strength	Bulk unit weight of Peat	Peat Depth (Note 5)	Surcharge Equivalent Placed Fill Depth (m) (Note 2)	Factor of Safety for Load Condition	
Poleset (PS)			β (deg)	c_u (kPa)	γ (kN/m^3)	(m)	Condition (2)	Condition (1)	Condition (2)
ESBI DATA (2004 & 2005)									
1	160403	204120	4.0	6	10	0.2	1.2	**43.01**	**7.17**
2	160392	204135	6.0	6	10	0.2	1.2	**28.70**	**4.78**
3	160386	204144	6.0	6	10	0.9	1.9	**6.38**	**3.02**
4	160136	204496	0.5	6	10	0.9	1.9	**76.58**	**36.28**
PS-4 5	160363	204177	6.0	6	10	1.0	2.0	**5.77**	**2.89**
6	160344	204204	6.0	6	10	1.0	2.0	**5.77**	**2.89**
7	160333	204219	6.0	6	10	1.2	2.2	**4.78**	**2.61**
8	160295	204271	4.0	6	10	1.2	2.2	**7.21**	**3.93**
9	160126	204510	0.5	6	10	1.3	2.3	**53.18**	**30.06**
10	160279	204293	4.0	6	10	1.4	2.4	**6.18**	**3.60**
11	160168	204446	0.5	6	10	1.4	2.4	**49.23**	**28.72**
12	160073	204591	3.0	6	10	1.4	2.4	**8.19**	**4.78**
13	160108	204538	3.0	6	10	1.5	2.5	**7.66**	**4.60**
14	159982	204618	0.5	6	10	1.5	2.5	**45.84**	**27.50**
15	160005	204630	0.5	6	10	1.5	2.5	**45.90**	**27.54**
16	160040	204640	3.0	6	10	1.5	2.5	**7.65**	**4.59**
17	160085	204667	3.0	6	10	1.5	2.5	**7.64**	**4.59**
18	160152	204471	0.5	6	10	1.6	2.6	**42.97**	**26.45**
19	160313	204247	6.0	6	10	1.7	2.7	**3.38**	**2.13**
20	160259	204320	0.5	6	10	1.8	2.8	**38.25**	**24.59**
21	160216	204378	0.5	6	10	1.8	2.8	**38.20**	**24.56**
22	160055	204617	3.0	6	10	1.8	2.8	**6.40**	**4.12**
23	160029	204645	3.0	6	10	1.8	2.8	**6.37**	**4.09**
24	159991	204653	0.5	6	10	1.8	2.8	**38.20**	**24.56**
25	160052	204656	2.0	6	10	1.8	2.8	**9.56**	**6.15**
26	160059	204689	3.0	6	10	1.8	2.8	**6.38**	**4.10**
PS-3 27	160237	204349	0.5	6	10	1.9	2.9	**36.19**	**23.71**
PS-2 28	160091	204563	3.0	6	10	1.9	2.9	**6.04**	**3.96**
29	160199	204400	0.5	6	10	2.0	3.0	**34.43**	**22.95**
30	160027	204660	3.0	6	10	2.0	3.0	**5.73**	**3.82**
PS-1A 31	160011	204684	2.0	6	10	2.1	3.1	**8.20**	**5.55**
32	160185	204421	0.5	6	10	2.6	3.6	**26.45**	**19.10**

Table 3: Infinite Slope Factor of Safety (FoS) Calculations (Undrained) for 110kV OHL Polesets PS-1 to PS-4 [Fehily Timoney/AGEC Data]

Calculated FoS of Natural Peat Slopes for Derrybrien Wind Farm OHL (Drained Analysis)										
Turbine No./Waypoint	Slope (Note 3)	Design c'	Bulk unit weight of Peat	Unit weight of Water	100% Water to height of Peat	Depth of In situ Peat (Note 5)	Friction Angle	Equivalent Total Depth of Peat (m) (Note 2)	Factor of Safety for Load Condition	
	α (deg)	c' (kPa)	γ (kN/m^3)	γ_w (kN/m^3)	(m)	(m)	ø' (deg)	Condition (2)	Condition (1)	Condition (2)
									100% Water	100% Water
FT DATA (2019)										
Pole 1A	5.0	4	10.0	10.0	2.2	2.2	25	3.2	**2.09**	**3.11**
Pole 2	6.0	4	10.0	10.0	2.1	2.1	25	3.1	**1.83**	**2.67**
Pole 3	4.0	4	10.0	10.0	1.6	1.6	25	2.6	**3.59**	**4.78**
Pole 4	6.0	4	10.0	10.0	1.0	1.0	25	2.0	**3.85**	**4.14**
AGEC DATA (2018)										
Pole 1A	0.5	4	10.0	10.0	1.8	1.8	25	2.8	**25.47**	**35.45**
WP 1	3.0	4	10.0	10.0	1.4	1.4	25	2.4	**5.47**	**6.90**
Pole 2	0.5	4	10.0	10.0	2.4	2.4	25	3.4	**19.10**	**29.20**
WP 2	5.0	4	10.0	10.0	1.9	1.9	25	1.9	**2.42**	**2.42**
Pole 3	0.5	4	10.0	10.0	2.0	2.0	25	3.0	**22.92**	**33.09**
WP 3	0.5	4	10.0	10.0	1.8	1.8	25	1.8	**25.47**	**25.47**
Pole 4	6.0	4	10.0	10.0	1.1	1.1	25	2.1	**3.50**	**3.94**

Notes:

(1) Assuming a bulk unit weight of peat of 10 (kN/m^3)
(2) Assuming a surcharge equivalent to fill depth of 1m of peat i.e. 10kPa. (Condition 2)
(3) Slope inclination (β) based on site readings and contour survey plans of site.
(4) FoS is based on slope inclination and shear test results obtained from published data
(5) Peat depths based on probes carried out by AGEC and ESBI (June 2018)
(6) For load conditions see report text.
(7) Minimum acceptable factor of safety required of 1.3 for first-time failures based on BS: 6031:1981 Code of practice for Earthworks

Table 4: Infinite Slope Factor of Safety (FoS) Calculations (Undrained) for 110kV OHL Polesets PS-1 to PS-4 [Fehily Timoney/AGEC Data]

Calculated FoS of Natural Peat Slopes for Derrybrien Wind Farm OHL (Drained Analysis)										
Turbine No./Waypoint	Slope (Note 3)	Design c'	Bulk unit weight of Peat	Unit weight of Water	100% Water to height of Peat	Depth of In situ Peat (Note 5)	Friction Angle	Equivalent Total Depth of Peat (m) (Note 2)	Factor of Safety for Load Condition	
Poleset (PS)	α (deg)	c' (kPa)	γ (kN/m^3)	γ_w (kN/m^3)	(m)	(m)	ø' (deg)	Condition (2)	Condition (1)	Condition (2)
									100% Water	100% Water
ESBI DATA (2004 & 2005)										
1	4.0	4	10	10	0.2	0.2	25	1.2	**28.74**	**10.35**
2	6.0	4	10	10	0.2	0.2	25	1.2	**19.24**	**6.90**
3	6.0	4	10	10	0.9	0.9	25	1.9	**4.28**	**4.36**
4	0.5	4	10	10	0.9	0.9	25	1.9	**50.93**	**52.25**
PS-4 5	6.0	4	10	10	1.0	1.0	25	2.0	**3.85**	**4.14**
6	6.0	4	10	10	1.0	1.0	25	2.0	**3.85**	**4.14**
7	6.0	4	10	10	1.2	1.2	25	2.2	**3.21**	**3.77**
8	4.0	4	10	10	1.2	1.2	25	2.2	**4.79**	**5.64**
9	0.5	4	10	10	1.3	1.3	25	2.3	**35.26**	**43.16**
10	4.0	4	10	10	1.4	1.4	25	2.4	**4.11**	**5.17**
11	0.5	4	10	10	1.4	1.4	25	2.4	**32.74**	**41.36**
12	3.0	4	10	10	1.4	1.4	25	2.4	**5.47**	**6.90**
13	3.0	4	10	10	1.5	1.5	25	2.5	**5.10**	**6.62**
14	0.5	4	10	10	1.5	1.5	25	2.5	**30.56**	**39.71**
15	0.5	4	10	10	1.5	1.5	25	2.5	**30.56**	**39.71**
16	3.0	4	10	10	1.5	1.5	25	2.5	**5.10**	**6.62**
17	3.0	4	10	10	1.5	1.5	25	2.5	**5.10**	**6.62**
18	0.5	4	10	10	1.6	1.6	25	2.6	**28.65**	**38.18**
19	6.0	4	10	10	1.7	1.7	25	2.7	**2.26**	**3.07**
20	0.5	4	10	10	1.8	1.8	25	2.8	**25.47**	**35.45**
21	0.5	4	10	10	1.8	1.8	25	2.8	**25.47**	**35.45**
22	3.0	4	10	10	1.8	1.8	25	2.8	**4.25**	**5.91**
23	3.0	4	10	10	1.8	1.8	25	2.8	**4.25**	**5.91**
24	0.5	4	10	10	1.8	1.8	25	2.8	**25.47**	**35.45**
25	2.0	4	10	10	1.8	1.8	25	2.8	**6.37**	**8.86**
26	3.0	4	10	10	1.8	1.8	25	2.8	**4.25**	**5.91**
PS-3 27	0.5	4	10	10	1.9	1.9	25	2.9	**24.13**	**34.23**
PS-2 28	3.0	4	10	10	1.9	1.9	25	2.9	**4.03**	**5.71**
29	0.5	4	10	10	2.0	2.0	25	3.0	**22.92**	**33.09**
30	3.0	4	10	10	2.0	2.0	25	3.0	**3.83**	**5.52**
PS-1A 31	2.0	4	10	10	2.1	2.1	25	3.1	**5.46**	**8.01**
32	0.5	4	10	10	2.6	2.6	25	3.6	**17.63**	**27.58**

Photo 1: Pylon EM-1 and Poleset PS1 @ Substation

Photo 2: Looking South to Poleset PS-1

Photo 3: Looking North to Poleset PS-1

Photo 4: Looking South to Poleset PS-2

Photo 5: Looking North to Poleset PS-2

Photo 6: Poleset PS-3

Photo 7: Looking South from Poleset PS-3

Photo 8: Looking North to Poleset PS-2 from PS-3

Photo 9: Looking South at Poleset PS-4

Photo 10: Poleset PS-4

Appendix C

Infinite Slope Factor of Safety (FoS) Calculations

AGL CONSULTING GEOTECHNICAL ENGINEERS

Infinite Slope Calculations - 110kV OHL Polesets PS-1a to PS-4

Zone Number - PS-1a & PS-2

Case 1: 0m peat surcharge and Cu = 5.0kPa

Section & Slope	Slope, α (°)	Depth of Peat, D (m)	Unit Weight of Peat, γ (kN/m^3)	Undrained Shear Strength, c_u (kPa)	FOS - Infinite Slope
PS-1A	4.0	2.2	10.5	5.0	3.1
Between Polesets	5.0	1.4	10.5	5.0	3.9
Between Polesets	5.0	1.8	10.5	5.0	3.0
PS-2	4.0	2.1	10.5	5.0	3.3
Between Polesets	7.0	1.3	10.5	5.0	3.0
Between Polesets	6.0	1.6	10.5	5.0	2.9
$FoS = c_u/(D.\gamma.Cosa.Sina)$				Min FoS	2.9
				Max Fos	3.9

Zone Number - PS-1a & PS-2

Case 2: 0m peat surcharge and Cu = 2.5kPa (Worst Case Scenario with Weak Layer at Base of Peat but No Surcharge)

Section & Slope	Slope, α (°)	Depth of Peat, D (m)	Unit Weight of Peat, γ (kN/m^3)	Undrained Shear Strength, c_u (kPa)	FOS - Infinite Slope
PS-1A	4.0	2.2	10.5	2.5	1.6
Between Polesets	5.0	1.4	10.5	2.5	2.0
Between Polesets	5.0	1.8	10.5	2.5	1.5
PS-2	4.0	2.1	10.5	2.5	1.6
Between Polesets	7.0	1.3	10.5	2.5	1.5
Between Polesets	6.0	1.6	10.5	2.5	1.4
$FoS = c_u/(D.\gamma.Cosa.Sina)$				Min FoS	1.4
				Max Fos	2.0

Zone Number - PS-1a & PS-2

Case 3: 1.0m peat surcharge and Cu = 5.0kPa

Section & Slope	Slope, α (°)	Depth of Peat, D (m)	Unit Weight of Peat, γ (kN/m^3)	Undrained Shear Strength, c_u (kPa)	FOS - Infinite Slope
PS-1A	4.0	2.2	10.5	5.0	2.0
Between Polesets	5.0	1.4	10.5	5.0	2.0
Between Polesets	5.0	1.8	10.5	5.0	3.0
PS-2	4.0	2.1	10.5	5.0	2.0
Between Polesets	7.0	1.3	10.5	5.0	3.0
Between Polesets	6.0	1.6	10.5	5.0	2.9
$FoS = c_u/(D.\gamma.Cosa.Sina)$				Min FoS	2.0
				Max Fos	3.0

Zone Number - PS-1a & PS-2

Case 4: 1.0m peat surcharge and Cu = 2.5kPa (Worst Case Scenario with Surcharge & Weak Layer at Base of Peat)

Section & Slope	Slope, α (°)	Depth of Peat, D (m)	Unit Weight of Peat, γ (kN/m^3)	Undrained Shear Strength, c_u (kPa)	FOS - Infinite Slope
PS-1A	4.0	2.2	10.5	2.5	1.0
Between Polesets	5.0	1.4	10.5	2.5	1.0
Between Polesets	5.0	1.8	10.5	2.5	0.9
PS-2	4.0	2.1	10.5	2.5	1.0
Between Polesets	7.0	1.3	10.5	2.5	0.8
Between Polesets	6.0	1.6	10.5	2.5	0.8
$FoS = c_u/(D.\gamma.Cosa.Sina)$				Min FoS	0.8
				Max Fos	1.0

AGL CONSULTING GEOTECHNICAL ENGINEERS

Infinite Slope Calculations - 110kV OHL Polesets PS-1a to PS-4

Zone Number - PS3 & PS-4

Case 1: 0m peat surcharge and Cu = 5.0kPa

Section & Slope	Slope, α (°)	Depth of Peat, D (m)	Unit Weight of Peat, γ (kN/m^3)	Undrained Shear Strength, c_u (kPa)	FOS - Infinite Slope
Between Polesets	3.5	2.6	10.5	5.0	3.0
PS-3	4.5	1.9	10.5	5.0	3.2
Between Polesets	5.0	1.8	10.5	5.0	3.0
Between Polesets	7.0	1.2	10.5	5.0	3.3
Between Polesets	5.0	1.7	10.5	5.0	3.2
PS-4	7.0	1.0	10.5	5.0	3.9
$FoS = c_u/(D.\gamma.Cosa.Sina)$				Min FoS	3.0
				Max Fos	3.9

Zone Number - PS3 & PS-4

Case 2: 0m peat surcharge and Cu = 2.5kPa (Worst Case Scenario with Weak Layer at Base of Peat but No Surcharge)

Section & Slope	Slope, α (°)	Depth of Peat, D (m)	Unit Weight of Peat, γ (kN/m^3)	Undrained Shear Strength, c_u (kPa)	FOS - Infinite Slope
Between Polesets	3.5	2.6	10.5	2.5	1.5
PS-3	4.5	1.9	10.5	2.5	1.6
Between Polesets	5.0	1.8	10.5	2.5	1.5
Between Polesets	7.0	1.2	10.5	2.5	1.6
Between Polesets	5.0	1.7	10.5	2.5	1.6
PS-4	7.0	1.0	10.5	2.5	2.0
$FoS = c_u/(D.\gamma.Cosa.Sina)$				Min FoS	1.5
				Max Fos	2.0

Zone Number - PS3 & PS-4

Case 3: 1.0m peat surcharge and Cu = 5.0kPa

Section & Slope	Slope, α (°)	Depth of Peat, D (m)	Unit Weight of Peat, γ (kN/m^3)	Undrained Shear Strength, c_u (kPa)	FOS - Infinite Slope
Between Polesets	3.5	2.6	10.5	5.0	2.0
PS-3	4.5	1.9	10.5	5.0	1.9
Between Polesets	5.0	1.8	10.5	5.0	3.0
Between Polesets	7.0	1.2	10.5	5.0	1.6
Between Polesets	5.0	1.7	10.5	5.0	3.2
PS-4	7.0	1.0	10.5	5.0	3.9
$FoS = c_u/(D.\gamma.Cosa.Sina)$				Min FoS	1.6
				Max Fos	3.9

Zone Number - PS3 & PS-4

Case 4: 1.0m peat surcharge and Cu = 2.5kPa (Worst Case Scenario with Surcharge & Weak Layer at Base of Peat)

Section & Slope	Slope, α (°)	Depth of Peat, D (m)	Unit Weight of Peat, γ (kN/m^3)	Undrained Shear Strength, c_u (kPa)	FOS - Infinite Slope
Between Polesets	3.5	2.6	10.5	2.5	1.0
PS-3	4.5	1.9	10.5	2.5	1.0
Between Polesets	5.0	1.8	10.5	2.5	0.9
Between Polesets	7.0	1.2	10.5	2.5	0.8
Between Polesets	5.0	1.7	10.5	2.5	0.9
PS-4	7.0	1.0	10.5	2.5	0.9
$FoS = c_u/(D.\gamma.Cosa.Sina)$				Min FoS	0.8
				Max Fos	1.0

APPENDIX 8-4

PEAT STABILITY RISK ASSESSMENT (PSRA) FOR TURBARY PLOTS

DERRYBRIEN WINDFARM
PEAT STABILITY RISK ASSESSMENT (PSRA) FOR MECHANICAL PEAT HARVESTING IN TURBARY PLOTS AT EAST END OF WINDFARM SITE

for

ESB Engineering & Major Projects
One Dublin Airport Central
Dublin Airport
Cloghran
Co. Dublin

5th December, 2024
(Issue 03, Rev.3)

Document Approval Form

DERRYBRIEN WINDFARM
PEAT STABILITY RISK ASSESSMENT (PSRA) FOR MECHANICAL PEAT HARVESTING IN TURBARY PLOTS AT EAST END OF WINDFARM SITE

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DERRYBRIEN WINDFARM
PEAT STABILITY RISK ASSESSMENT (PSRA) FOR TURBARY PLOTS AT EAST END OF WINDFARM SITE

Non-Technical Summary

This report presents the results of the Peat Stability Risk Assessment (PSRA) that has been carried out for mechanical peat harvesting in the turbary plots on the east side of the Derrybrien Windfarm.

The Peat Stability Risk Assessment (PSRA) is an engineering risk assessment that has been carried out in accordance with the best practice guidelines in "Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Second Edition, April 2017)", by the Scottish Government Energy Consents Unit. The method of risk assessment is also consistent with the Institution of Civil Engineers' publication outlining UK best practice in "Managing Geotechnical Risk" (Clayton, 2001).

The turbary area has been split up into 181 No. representative zones of approximate equal area corresponding to the boundaries of the 136 No. individual turbary plots, some of which have been subdivided for the assessment. A qualitative risk assessment has been carried out for each zone to assess the **Risk Rating (R)** for a peat failure occurring due to mechanical peat harvesting in the turbary plots based on the interpreted **Likelihood (L)** (i.e. probability) of occurrence and **Impact (I)** of failure. The assessment identifies where specific design, construction & operational risk mitigation measures are required to reduce the risk to an acceptable level.

The **Likelihood (L)** of a peat failure in each zone has been assessed on a scale of 1-5 by evaluating factors related to the peat and subsoil conditions, topography, site hydrology/hydrogeology and other significant contributory factors such as the method of peat harvesting or slide history to determine where there are compounding conditions that could lead to a higher risk of a peat failure.

The potential **Impact (I)** of a peat failure in the turbary area has been assessed on a scale of 1-5 by evaluating factors related to the potential volume of peat, degree of contamination, sensitivity of the receiving environment, access for intervention, and the land use and existing infrastructure within the potential run-out distance.

A **Risk Rating (R=L x I)** has then been calculated for each zone to characterise the risk of peat instability due to mechanical peat harvesting in the turbary areas prior to implementing any mitigation measures to identify where specific operational mitigation measures are required to reduce the risk of peat instability to an acceptable level.

The results show that there are significant areas of the turbary plots where the likelihood of a peat failure due to mechanical peat harvesting under uncontrolled conditions and without appropriate mitigation measures is **Very Possible** to **Likely (L=4.0 to 5.0)**. These zones are located in areas where there are compounding risk factors in relation to peat instability, including, for example:

- The zone of deep weak peat (3-6m deep) along the subsurface drainage channel between Turbines T27 and T35 where there is a convex break in slope at the head of the watercourse that flows off site to the south of T35 (Plots #7-13, #148-154; #191-195);
- The zone of deep weak peat upslope from the central turbary road between T28 and T37 where there are indications of subsurface seepage in the peat to the convex breaking slope downslope from the road (Plots #14-22);
- The plots on the convex breaking slope downslope from the central turbary road in the area of deep peat between Turbines T28 and T37 where there are indications of subsurface seepage in the peat (Plots #155-164, #197-204) and low Factors of Safety for infinite slope stability;
- Along the watercourse channel in the peat at the west end of the turbary areas between Turbines T24 and T29 (Plots #1-5, #147 & #191);

- The area of relatively deep peat (2-3m) with the convex breaking slope at the southeast corner of the wind farm (Plots #219-221 & #229-232); and
- Various plots at the east end of the site where there is locally a convex breaking slope in relatively deep peat (2-4m) and locally low FoS for slope stability (e.g. Plots #30-36, between #168 & 176, and #213-214)

Together these account for approximately **47%** of the total number of turbary areas that have been assessed (i.e. 85 No. out of 181 No. total).

In the remaining turbary plots within the turbary area the Likelihood of a peat failure, due to mechanical peat harvesting under uncontrolled conditions and without appropriate mitigation measures would be characterised as **Possible to Very Possible (L=3.0 to 3.5)**. These were in areas where there were mitigating conditions that reduced the baseline risk of peat instability. For example:

- Areas of shallow (<1.0 m) or relatively shallow (1-2 m) peat;
- Areas of gently sloping ground (<3°) set well back from any convex break in slope to slopes >5°.
- Areas of relatively high infinite slope Factor of Safety (FoS >1.3);
- Zones where there is well-developed drainage, and which are not directly upslope from the rivers and streams outside the wind farm site.

The type of failure that could occur could range from a localised shear failure in the peat on the upslope side of an open excavation, to a small-scale peat slide that is contained within the turbary area, or a large-scale peat slide comparable to the slide that occurred on the windfarm site during construction.

The Risk Rating, R, for peat failures occurring as a result of mechanical peat harvesting in the turbary areas has conservatively been calculated based on the possible impact of a large peat slide **(Impact, I=5: High)** as the worst case scenario. Without appropriate mitigation measures the Risk Rating generally ranges from 17.5 to 25.0, which is **Medium to High** or **High** and **Unacceptable**.

The risk only applies in areas where mechanical peat harvesting is active and at the time that the work is being carried out on the site. Based on available information, mechanical peat harvesting is only active in about 35 No. of the 136 No. turbary plots in the area. The work is normally carried out once a year in late spring/early summer. Only a small number of plots are active at any one time and the work in each area is completed within a few days.

When no work is being carried out in the turbary plots the residual risk reduces to **Low to Medium (R=10)**, which is **Acceptable** with the inspections that are currently carried out periodically on the site.

In recent years peat failures have occurred in 2 No. turbary plots (Plot Nos. 30 and 161), where mechanical peat harvesting was a likely or possible contributory factor. In both areas the failures involved small-scale peat slides or zones of peat movement which were contained within the turbary area. Therefore, the impact of the failures was **Low to Medium (I=2.0)**. The peat within the failed area is stable and some drainage works have been carried out to relieve ponded groundwater in tension cracks to prevent any further progressive movement of the peat. Survey monitoring points were also established on the peat in and around the failed area to record movement of the peat. They show that little movement has occurred in the peat upslope and downslope from the failed area, which indicates that the area is stable. Higher movements of 60-120mm have been recorded within the failed area, which is indicative of ongoing creep of the rafts of displaced peat, which is to be expected. Most of this movement occurred before the end of 2021. Recent inspections of the area in 2024 indicate that the area is stable and the displaced peat is supported by the buttressing effect of the intact peat on the downslope side of the turbary plot.

The following mitigation measures have been recommended for future mechanical peat harvesting in the turbary plots to reduce the likelihood of further peat failures in the turbary area over the remaining operational life of the windfarm and during decommissioning:

- No peat harvesting should be carried out by saw cutting in any of the turbary plots;
- No mechanical peat harvesting should be carried out in the turbary plots where the likelihood of a peat failure without appropriate mitigation measures is interpreted as **Very Possible** to **Likely (L=4.0 to 5.0)**. Manual turf cutting can be carried out but should be done during the drier months between May and September;
- Where the likelihood of a peat failure without appropriate mitigation measures is interpreted as **Possible** to **Very Possible (L=3.0 to 3.5)** the limitations recommended in Section 6.0 of this report on the type and size of equipment that can be used for mechanical peat harvesting in the turbary plots and on the maximum level of surcharge loading on the peat should be implemented;
- The operational control measures recommended in Section 6.0 should be implemented by the turbary plot owner and their turf cutting contractor to manage the stability of peat excavations and to prevent excessive damage to the integrity of the vegetated surface of the peat;
- Communication should be established between the turbary plot owners, turf cutting contractors and the windfarm site manager for Gort Wind Farms Ltd. to give notice of mechanical peat harvesting activities and to report any peat instability on the site;
- Ongoing maintenance should be carried out on the existing drainage network, where required, during the drier months of May to September;
- Periodic inspections of the mechanical peat harvesting should be carried out by the wind farm site manager for Gort Wind Farms Ltd.;
- Peat movement should be monitored where the small-scale peat failures occurred in Turbary Plots 30 and 161 and the areas should be periodically inspected by experienced geotechnical engineers from ESB Engineering and Major Projects; and
- No mechanical peat harvesting should be carried out in the turbary area during the decommissioning stage of the windfarm project.

The potential impacts of mechanical peat harvesting on the wind farm site will not arise as a direct result of activities related to the wind farm, but from the separate and unrelated activities for mechanical peat harvesting in the turbary areas under established turbary rights, which are outside of the control of Gort Wind Farms Ltd.

Warning signs have been erected at the site by Gort Wind Farms Ltd. to raise awareness of the peat stability risks associated with mechanical peat harvesting in the turbary area and to highlight the recommended mitigation measures. Where possible, communication has been established between the turbary plot owners, turf cutting contractors and the windfarm site manager for Gort Wind Farms Ltd. to establish procedures to give notice of mechanical peat harvesting activities and to report any peat instability on the site. This peat stability risk assessment and the associated mitigation measures have also been shared with the turbary rights holders whose plots have been harvested by mechanical means.

Drainage works were carried out in Turbary Plot 161 by GWFL in early August 2020 to relieve ponded water in the tension cracks as a mitigation measure to prevent any further movement of the peat. Survey pegs were also established in and around the failed area to monitor movement of the peat.

Where the remaining mitigation measures are implemented by the turbary plot holders, then the likelihood of a peat failure occurring as a result of mechanical peat harvesting in the turbary plots will reduce to a residual level of **Low (L=2)**. This would correspond to a **Risk Rating, R, of 10** for the worst case scenario of a large peat slide **(Impact, I=5)**, which is **Low to Medium** and acceptable with periodic inspections.

DERRYBRIEN WINDFARM
PEAT STABILITY RISK ASSESSMENT (PSRA) FOR TURBARY PLOTS AT EAST END OF WINDFARM SITE

1.0 INTRODUCTION AND METHODOLOGY

1.1 Introduction

The east end of the Derrybrien Windfarm site is sub-divided into a number of plots where peat harvesting (turf cutting) has historically been carried out by individuals with turbary rights, i.e. the right to cut and take away turf from the bog for use as fuel.

The layout and numbering of the turbary plots in the area is shown on Figure 1-1. There are a total of 136 No. plots which generally range in size from about 0.55ha to 1.10ha over a total area of approximately 103ha. The majority of the plots are within the windfarm site. However, 22 No. are partially or fully outside the site boundary to the east and southeast, as shown on the layout plan (i.e. #41-45, 178-180, 219-221 & 223-232). Not all of the turbary plots are active. Peat is harvested seasonally from some of the plots for domestic use. There has been no large-scale or commercial peat harvesting on the site.

This report presents the results of a Peat Stability Risk Assessment for activities related to mechanical peat harvesting on the turbary plots on and adjacent to the Derrybrien Windfarm site. The report has been prepared as a supplemental report to AGL Report No. 11-147-R04 – "*Derrybrien Windfarm, Geotechnical Stability Report & Assessment of Stability Impacts of On-Site Activities*", which addresses the activities related to the windfarm project on the site.

1.2 Methodology for Peat Stability Risk Assessment

The Peat Stability Risk Assessment (PSRA) is an engineering risk assessment that has been carried out in accordance with the best practice guidelines for peat landslide risk assessments in the report - "Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Second Edition, April 2017)", by the Scottish Government Energy Consents Unit. The method of risk assessment is also consistent with the Institution of Civil Engineers' publication outlining UK best practice in "Managing Geotechnical Risk" (Clayton, 2001).

For this report, the turbary area has been split up into 181 No. representative zones of approximate equal area corresponding to the boundaries of the individual turbary plots, some of which have been subdivided for the assessment. A qualitative **Peat Stability Risk Assessment (PSRA)** has been carried out for each zone to assess the **Risk Rating (R)** for a peat failure as a result of mechanical peat harvesting based on the interpreted **Likelihood (L)** (i.e. probability) of occurrence and **Impact (I)** of failure. The assessment identifies where specific design, construction & operational risk mitigation measures are required to reduce the risk to an acceptable level.

The **Likelihood (L)** of a peat failure in each zone has been interpreted by evaluating factors related to the peat and subsoil conditions, topography, site hydrology/hydrogeology and other significant contributory factors such as the method of peat harvesting or slide history to determine where there are compounding conditions that could lead to a higher risk of a peat failure.

The potential **Impact (I)** of a peat failure in each zone has been interpreted by evaluating factors related to the potential volume of peat, degree of contamination, sensitivity of the receiving environment, access for intervention, and the land use and existing infrastructure within the potential run-out distance.

A baseline **Risk Rating (R=L x I)** has then been calculated for each zone to characterise the risk of peat instability across the site to identify where specific design, construction & operational mitigation measures are required to mitigate the risk of peat instability to an acceptable level.

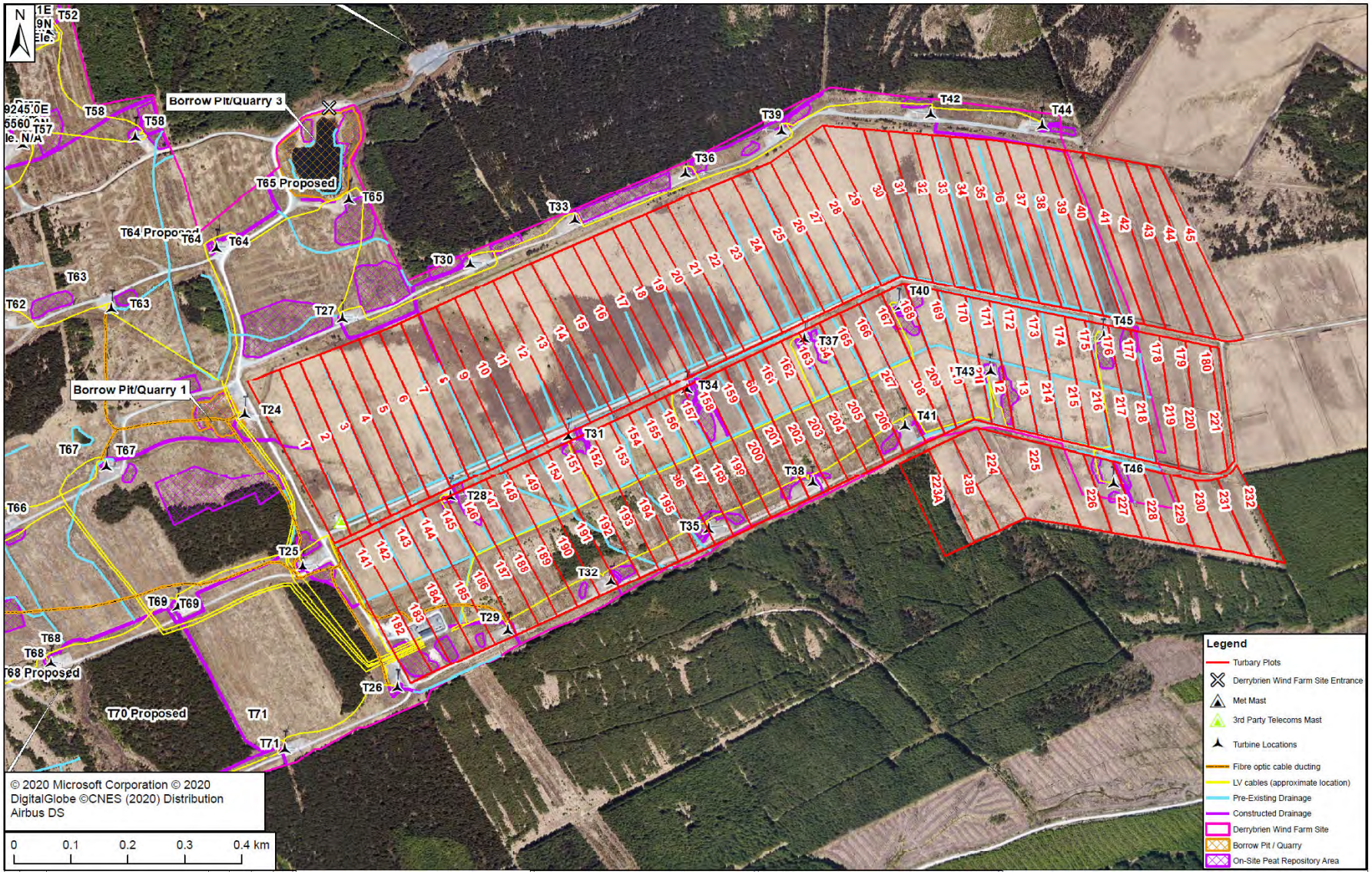


Figure 1-1 – Layout and numbering of turbary plots at the east end of the windfarm site

Zones of potential peat instability can be very localised, i.e. where there is a specific combination of factors on the site that can lead to a higher risk of a peat slide under uncontrolled conditions without appropriate mitigation measures, e.g. in deep peat within a buried channel at the head of a watercourse where the peat has been worked by peat harvesting. Therefore, the factors assessed are specific to each turbary area. In this way representative combinations of peat depth, shear strength and slope angles are used in the assessment. However, consideration is also given to the general characteristics of the site in the vicinity of the works that are interpreted to be relevant to peat stability at the works location, e.g. proximity to and location relative to watercourses or evidence of peat instability under similar conditions in the area or elsewhere on site.

The Risk Rating, R, has been assessed for mechanical peat harvesting in each zone in the turbary area for the existing baseline conditions prior to the implementation of appropriate mitigation measures. Mitigation and monitoring measures are then presented for reducing the risk to an acceptable level and the Risk Rating has been re-assessed for mechanical peat harvesting on the site over the remaining operational life of the windfarm, and during decommissioning.

The following is a more detailed description of the methodology that was used for interpreting the Likelihood, Impact and Risk Rating in the PSRA.

1.2.1.1 Likelihood (L) of a Peat Slide

For each zone of the site the **Likelihood (L)** of a peat slide has been assessed based on an evaluation of the principal geotechnical, topographical, hydrological and hydrogeological characteristics on the site that are considered to impact the stability of peat on upland bogs. Peat stability risk factors are sub-divided into 5 categories:

1. Peat & Subsoil Conditions
2. Topography
3. Factor of Safety Calculations
4. Hydrology
5. Other Contributory Factors

For the **peat and subsoil conditions** the depth, undrained shear strength, water content and degree of decomposition (humification) of the peat are considered, along with the characteristics of the subsoil and the interface with the peat. Higher risks of peat instability are associated with relatively deep deposits of low strength peat, which typically corresponds to high water contents and a higher degree of decomposition to less fibrous or clayey peat. The characteristics of the subsoil and the interface with the peat are also significant as previous peat slides in Ireland have been attributed to areas where there is a discontinuity at the interface (e.g. where the peat is directly on rock or nested boulders), where there is preferential flow of groundwater along permeable layers of granular soils or fractured rock at rockhead, or where there are weaker layers of sensitive low strength clayey soils at the base of the peat.

Topographical characteristics that are significant to peat stability include relatively steep slope angles (e.g. >5°), or the location of the turbary plots relative to a convex break in slope or a broad flat area directly upstream from a watercourse where there would be a higher risk of concentrated subsurface groundwater flow within or at the base of the peat that could contribute to a peat slide. Most of the peat slides that have occurred in Ireland have occurred above an elevation of 300mOD. Therefore, this is also considered in the assessment.

Topography is particularly significant where it is combined with other risk factors such as areas of deep low strength peat. Therefore, this is assessed by calculating **Factors of Safety (FoS)** against shear failure at the base of the peat as an index of peat stability on the slopes. This is done by infinite slope analysis, which assesses the resistance to shear failure on the inclined plane at the base of the peat under the downslope component of the gravitational loading due to the self-weight of the peat. The FoS is expressed as the ratio of the shear strength of the peat to the downslope shear force at the base of the

peat. An FoS >1.0 indicates that failure should not occur. An FoS >1.3 would provide a margin of safety against failure. To characterise the site the analyses are conservatively carried out assuming a low strength shear strength of 5kPa at the base of the peat. A worst case scenario is also assessed by assuming a residual shear strength of 2.5 kPa at the base of the peat, which would only apply where there is an existing failure surface of remoulded peat. The analyses are repeated under a surcharge load equivalent to the weight of 1.0 m of excavated peat on the slopes to characterise the sensitivity of the calculations.

Hydrology is very significant for assessing peat stability. Risk factors that are known to contribute to peat slides would include areas of poor drainage with ponded surface water, and areas where there is evidence of subsurface groundwater flow through open conduits called "pipes" within the peat, or along permeable layers of gravel or fractured rock at the base of the peat, which are typically identified in trial pits or exposures on site. The orientation of drains relative to the slope is also significant as drains that are cut across a peat slope in areas of deep peat have been known to contribute to peat instability by damaging the integrity of the vegetated crust of the peat and by restricting downslope surface runoff.

The PSRA also considers indirect **contributory factors** or site characteristics that can be used to identify sites or zones that could be particularly susceptible to peat slides, such as:

- Poor tree growth or wetlands vegetation and flushes associated with poor drainage;
- A history of previous slides on site or in the general area;
- Peat workings such as mechanical harvesting in turbary plots that impac the integrity of the peat mass, such as a saw-cutting machine;
- Evidence of peat slides, subsurface drainage or general anomalies such as disturbed peat or drainage patterns from aerial photographs; and
- The stability of peat and groundwater ingress in trial pit excavations on the site.

Each of the five risk categories is rated on a scale of **0** to **20** depending on how significant the corresponding factors are with respect to peat stability, as follows:

- Negligible = 0
- Low = 5
- Medium = 10
- High = 15
- Very High = 20

The individual ratings for each category are then added to calculate a **Total Hazard Rating** on a scale of **0-100** for each zone on the site. This is not a probability of occurrence of a peat slide. It is an index that takes into account the interaction between different risk factors to assess the relative risk of peat instability between zones across the site and to identify zones where there are compounding risk factors that could make them particularly susceptible to peat slides.

For example, in zones where there are steep slopes there would be a high hazard rating for topography. However, if this was compensated by lower peat depths and higher strength peat, which would reduce the risk of peat instability, then the combination of the two would reduce the overall Total Hazard Rating. On the other hand, if the steep slopes were associated with deeper deposits of low strength peat and other negative contributory factors, then the compounding effect of these factors would lead to an hig Total Hazard Rating and higher interpreted Likelihood of failure.

For the PRSA the interpreted Likelihood of a peat slide is correlated to the Total Hazard Rating on a scale of 1-5, as shown on Table 1-1.

Table 1-1 Total Hazard Rating and Likelihood (L) of a Peat Slide for Mechanical Peat Harvesting

Total Hazard Rating	Likelihood (L)		Indicative Probability of Occurrence (Event/yr – in each active turbary area)
0	**0**	Not Applicable (<0.5 m Peat)	<1/1000
0-19	**1.0**	Negligible	1/500 to 1/1000
20-39	**2.0**	Low	1/100 to 1/500
40-59	**3.0**	Possible	1/50 to 1/100
60-69	**3.5**	Possible to Very Possible	1/25 to 1/50
70-79	**4.0**	Very Possible	1/10 to 1/25
80-89	**4.5**	Very Possible to Likely	1/5 to 1/10
90-100	**5.0**	Likely	>1/5

Peat slides on upland bogs are still quite infrequent. Therefore, Table 1-1 lists possible ranges in probability of occurrence for each point on the Hazard Liklihood scale that are based on our experience with peat slides on windfarm sites in Ireland and on observations of recent small-scale peat failures that have occurred in the turbary area since the windfarm was completed. The probability of occurrence is expressed in terms of events per year for each turbary area.

The probability ranges in Table 1-1 are intended as indicative frequencies of failure for comparative purposes in a Qualitative Risk Assessment. They are not precise probabilities of occurrence calculated from a recorded database of case histories of peat slides that have occurred under similar conditions. Therefore, they should not be used for a Quantitative Risk Assessment.

It should also be noted that the failure frequencies listed in Table 1-1 do not reflect the **scale** of peat failures, which could range from small localised shear failures along the edge of an excavated peat bank, to a small-scale peat slide that is contained within the turbary area, or a large scale peat slide comparable to the slide that occurred at Turbine T68 on the windfarm site during construction. This is taken into account in the assessment of the **Impact** of a peat slide.

1.2.1.2 Impact of Occurrence:

The Impact of occurrence (**I**) is a qualitative assessment of the interpreted impact of a peat slide which has been assessed based on the following comprehensive list of primary impacts.

- Volume of peat in potential slide
- Possible run-out distance
- Sensitivity of the receiving environment & habitat
- Potential degree of contamination
- Access for intervention (onsite/offsite)
- Public / private infrastructure in potential peat flow path & within run-out distance (e.g. Roads, buildings, overhead power lines or telephone lines)
- Existing site infrastructure in potential peat flow path & within run-out distance (Access tracks, turbines, cable trenches, substations etc.)
- Land usage in potential peat flow path & within run-out distance

The volume of peat in a slide is assessed from the potential area that could be impacted by a slide and the depth of peat within that area. We have proposed the following bands based on past experience with peat slides in Ireland:

- Localised (<100 m^3)
- Very small (100-1,000m^3)
- Small (1,000-5,000 m^3)
- Medium (5,000 - 25,000 m^3)
- Large (25,000 - 100,000 m^3)
- Very Large (>100,000 m^3)

The potential run-out distances take into account the volume and nature of the peat as well as the topography and potential flow paths. For example, large-scale peat slides or bog bursts in deep very soft amorphous (non-fibrous) peat with a high water content upslope from a watercourse channel have the highest potential to become fluidised and to flow considerable distances along the river channel downslope from the site. On the other hand, a localised peat slide in shallow dry fibrous peat would have low mobility with a short run-out distance downslope from the slide.

In assessing the sensitivity of the receiving environment specific consideration is given to the ecological importance of protected habitats, National Heritage Areas or Special Areas of Conservation that could be disturbed by the slide, as well as the presence of protected freshwater fish or species in the watercourses downstream from the site.

The potential degree of contamination could range from diluted organic sediment from surface runoff, direct contamination by organic sediment, or direct inundation with a fluidised remoulded peat debris, which would have the greatest impact to a river or water body downstream from the theoretical slide.

On some sites rapid deployment of resources can be an effective measure to mitigate the impact of a peat slide, for example by the construction of rockfill bunds as barrages to stop the flow of peat downslope. However, this depends on the site access to key intervention points and many windfarms are constructed in remote areas with limited infrastructure, which can make intervention restrictive.

The remaining factors take into account public/private infrastructure within the potential run-out zone that might be directly or indirectly impacted by a peat slide. Land use within this area is also taken into account as it will have a bearing on the cost impact and the potential disruption to agricultural activity.

The potential **Impact** of a peat slide in the turbary areas has been qualitatively assessed for each zone on a scale of **1-5** based on the factors listed above. Table 1-2 gives some guidance on the corresponding environmental, cost and time impacts for each Impact rating. These bands are considered as general guidelines. The cost and time impact would typically be interrelated for activities on a construction project, and the time impact may only be significant for activities on a critical path. Also, where the environmental impact could be high or very high the cost of mitigation or remedial measures would need to be considered. In general, where there is a sensitive receptor within the potential run-outdistance downstream from the works, such as a stream or river in a Special Area of Conservation, then the impact of a medium to large peat slide is likely to be High (I=5). The upper limit of 5 on the Impact identifies zones where there are compounding risk factors which suggest that a peat slide would have a severe impact on cost and time, and also on the surrounding environment.

It should be noted that the “Impact” of a peat slide in this PSRA is different to the Impact of site activities in the environmental impact assessment methodology. The PSRA is an engineering impact assessment. Therefore, the possible Impact of a peat slide includes a broader assessment on the sensitivity of the receiving environment that is not limited to the direct impact on soils, geology and land. It also includes commercial impacts that can have a significant impact on cost or time for an engineering project, which is consistent with the guidelines in the Institution of Civil Engineers' publication outlining UK best practice in "*Managing Geotechnical Risk*" (Clayton, 2001).

Table 1-2 Impact of Occurrence (I)

Hazard Impact (I)	Environmental Impact	Cost Impact	Time Impact
1	Low	<€1,000	<1 week on activity
2	Low to Medium	€1,000 - €10,000	1-4 weeks on activity, none on completion
3	Medium	€10,000 - €100,000	>4 weeks on activity, <1 week on completion.
4	Medium to High	€100,000 - €1,000,000	> 1 week on completion
5	High	>€1,000,000	> 10 weeks on completion

1.2.1.3 Risk Rating before and after Mitigation Measures

The Risk Rating (R) is a product of the Likelihood of occurrence (L) and the Impact of failure (I) [i.e. R = L x I] and is calculated on a scale of 1 to 25. Table 1-3 and Table 1-4 show the different bands of Risk Rating ranging from Low (Trivial), to Medium (Significant) or High (Intolerable) with some intermediate levels. Where the interpreted risk of peat instability is unacceptably high (R=16-25) then risk mitigation measures are required to reduce the risk to an acceptable level.

Table 1-3 Risk Rating (R= L x I)

Likelihood (L)	Impact (I)				
	1	**2**	**3**	**4**	**5**
0	0	0	0	0	0
1.0	1	2	3	4	5
2.0	2	4	6	8	10
3.0	3	6	9	12	15
3.5	3.5	7	10.5	14	17.5
4.0	4	8	12	16	20
4.5	4.5	9	13.5	18	22.5
5.0	5	10	15	20	25

Table 1-4 - Risk Rating Levels and Response

Risk Rating (R = L X I)		Response
0 to 5	Low (Trivial)	Monitor
6 to 10	Low to Medium (Tolerable)	Regular Attention
11 to 15	Medium (Significant)	Early Attention
16 to 20	Medium to High (Substantial)	Unacceptable
21 to 25	High (Intolerable)	Unacceptable

The baseline PSRA for the site in its existing condition is presented in Section 4.0. It represents a characterisation of the relative risk of peat instability for mechanical peat harvesting across the turbary sites under uncontrolled conditions prior to the implementation of appropriate risk mitigation measures to reduce the likelihood or impact of a peat slide.

This report presents operational measures that will be implemented to mitigate against the risk of peat instability for mechanical peat harvesting on the site. The risk rating for a peat failure in each turbary area has then been re-assessed for mechanical peat harvesting on the site over the remaining operational life of the windfarm, and during decommissioning.

We have adopted the following general principles in re-assessing the risk rating with appropriate mitigation measures:

- Effective design, construction & operational risk mitigation measures and improvements in site conditions can be used to reduce the Likelihood of a peat slide to a low or negligible level, even in high risk zones.

However,

- The potential Impact of a peat slide at a particular location cannot be reduced significantly unless positive measures are taken to effectively contain the peat or sediment along potential flow paths prior to construction.

No further measures are currently scheduled to mitigate the Impact of a potential peat slide on the site of the Derrybrien Windfarm over the remaining operational life of the windfarm. Therefore, we have assumed that the Impact rating for a peat slide resulting from mechanical peat harvesting in the turbary area at the east end of the site will not be reduced, even after the mitigation measures are taken into account.

2.0 GROUND AND GROUNDWATER CONDITIONS IN THE TURBARY AREA

2.1 Introduction

This section of the report gives a characterisation of the baseline conditions for soils, geology and land on the site of the turbary plots in 1998, prior to the construction of the windfarm, as well as the existing ground and groundwater conditions on the site for the Peat Stability Risk Assessment.

All available information was used to establish the baseline conditions on the site, and in areas off-site that could be impacted by a peat slide. This included a comprehensive review of relevant information from the ground investigations that were carried out on the windfarm site, and a desk study review of historical aerial photographs, LiDAR topographical survey data, and relevant information on ground and groundwater conditions, bedrock, and geological heritage sites from online sources including the Geological Survey of Ireland (GSI), the Environmental Protection Agency (EPA) and the Ordnance Survey of Ireland (OSI).

Extensive ground investigations have been carried out across the windfarm site at different phases of the project, primarily at detailed design and construction stage, which would still be relevant to the baseline conditions for soils and geology on the site of the turbary plots. Comprehensive details of the geotechnical investigations that were carried out are presented in the AGL report titled "*Summary of supplemental investigations, stability analyses and peat stability risk mitigation measures adopted during the post-slide construction stage of the Derrybrien Windfarm*," Report No. 11-147-R01, dated 29th May, 2020. The investigations have largely been comprised of:

- An aerial LiDAR survey of the windfarm and surrounding area to obtain an accurate model of ground levels and topography across the site;
- Trial pits to determine the depth and characteristics of peat and subsoils, and the depth to bedrock at shallow depths up to 3.0-4.0 m;
- Extensive peat probing to establish a profile of the depth of peat across the site;
- In-site vane shear testing to establish the undrained shear strength of the peat;
- In-situ undisturbed piston sampling of the peat to obtain high-quality undisturbed samples for laboratory testing and inspection;
- Laboratory testing of the undisturbed samples to assess the material characteristics and undrained shear strength of the peat;
- Disturbed gouge-auger core samples of the peat and subsoil to inspect the characteristics of the peat at the interface with the underlying mineral soil; and
- Rotary coreholes to establish the depth to rock and the rock mass characteristics at a number of turbine locations; and

Further peat probing was carried out in the turbary plots in May/June 2020 by ESB Engineering & Major Projects to give a more detailed assessment of the depth of peat in the area. The results of the peat probing are presented in this report.

2.2 Site Conditions - Soils, Geology & Land Use

2.2.1 Land Use & Topography

Derrybrien Windfarm is located on the upper slopes of the Cashlaundrumlahan Mountain in the Slieve Aughty Mountains in Co. Galway. The site is primarily characterised by upland blanket bog which has historically been used for commercial conifer forestry over the central and western parts of the site, and turf cutting in turbary plots on the east side. An aerial photograph of the site taken in 2000 is shown on Figure 2-1. The photograph identifies the main features that were on the site prior to construction of the windfarm, including:

- The boundary of the windfarm site;
- The zone of turbary plots in the open blanket bog at the east end of the windfarm;
- The existing drainage network along the boundaries of the turbary plots;
- The existing access roads to the turbary plots, which were constructed as floating roads;
- The extent of the Coillte conifer forest plantations within the windfarm site, including those within turbary plots 182 to 207;
- The zones of darker vegetation associated with an area of deep peat and high water table along a natural subsurface drainage channel;
- A zone of possible concentrated subsurface flow in the peat upslope from the deep peat area;
- Existing watercourses and surface drainage channels; and
- A zone of patchy tree growth along the watercourse upslope from turbine T32.

Figure 2-2 shows a more recent aerial photograph of the turbary plots from circa 2015-2018. This shows the layout of the turbines, windfarm access tracks and substation at this end of the windfarm site. All of the new roads were constructed as floating roads on the peat. The existing turbary road was also upgraded with an additional layer of rockfill as capping for the construction of the windfarm. The turbine foundations are supported on bedrock below the peat and glacial till. The crane hardstandings are supported on the glacial till below the peat.

Most of the trees in turbary plots 182-207 were clear felled during the construction. A zone of trees along the watercourse at Turbine T32 were left in place. The felled area was not re-planted but some small trees have re-established naturally on the slopes. Figure 2-2 also shows indications of recent peat excavations, turf cutting and drainage in the turbary plots, as discussed in Section 3.0.

Figure 2-3 is a LiDAR survey showing the general topography of the site following completion of the windfarm (i.e. post 2005). With the exception of the areas at the borrow pit, turbines, crane hardstandings, and along the new site access tracks, the ground levels across the site would generally also be relevant to the original conditions on the site in 1998, prior to construction. Figure 2-4 shows the ground surface slope angles interpreted from the LiDAR survey.

Ground level in the turbary area falls from +353 mOD near Turbine T24 at the northwest corner, to +270mOD at the southeast corner of the turbary plots near Turbine T46. The ground surface is relatively flat or gently sloping on the north side of the central turbary access road. The slope angles are generally <3-4°, and locally up to 4-5° between Turbines T40 and T45 at the east end of the site. To the south of the central turbary road there is a convex break in slope to slope angles of up to 5.0-7.5°, particularly between Turbines T31 and T45, and at the south east corner of the turbary area.

The zone of deep peat and high water table identified on Figure 2-1 is on gently sloping ground with slope angles <3° upslope from the central turbary access road between Turbines T28 and T32.

2.2.2 Landslide Susceptibility Map

Figure 2-5 shows the Landslide Susceptibility Map for the turbary area from the Geological Survey of Ireland (GSI) superimposed on the OSI 1:50,000 Discovery Series map. This map provides information on areas which are pre-disposed to landslides using a classification system based on slope angle, soil type and a parameter referred to as the Topographic Flow Index (TFI), which is a measure of how overland flow of landslide debris is concentrated or dispersed by the terrain, also taking into account flow velocity.

The slope angle is derived from the 20m Digital Elevation Model (DEM) and values can range from 0 to 90 degrees. Soil types are generalised into 5 main groupings based on their grain size distribution (i.e. fine or coarse-grained), and/or particular characteristic, including Peat, which is particularly relevant for the turbary areas. The TFI is also derived from the 20m DEM and is calculated using factors related to slope angle, flow direction and flow accumulation.

The classification model is weighted by applying a known inventory of landslide events to particular combinations of factors that have a higher incidence of landslides. This includes the area where the peat slide occurred at Turbine T68, during construction of the windfarm, which is recorded on the GSI database. The location and extent of the peat slide are also identified on Figure 2-5.

The results are banded into four categories of landslide susceptibility ranging in classification from Low to High. The resolution of the mapping is on a local to regional level based on the accuracy of the DEM (20m) and the scale of the base mapping (1:50,000).

Figure 2-5 indicates that the turbary plots are classified as being of **Low** susceptibility to landslides on the gently sloping ground with slope angles typically <3-4° to the north (upslope) of the central access road between Turbines T25 and T40, and at the east end of the site.

The turbary plots on the steeper slopes with slope angles of 4.0-7.5° to the south of the central access road between T25 and T45, north of the road between T37 and T45, and in the turbary plots at the southeast corner of the site are classified as being of **Moderately Low** susceptibility to landslides.

A localised area in turbary plots 201-204, upslope from Turbine T38, has been classified as being of **Moderately High** susceptibility to landslides.

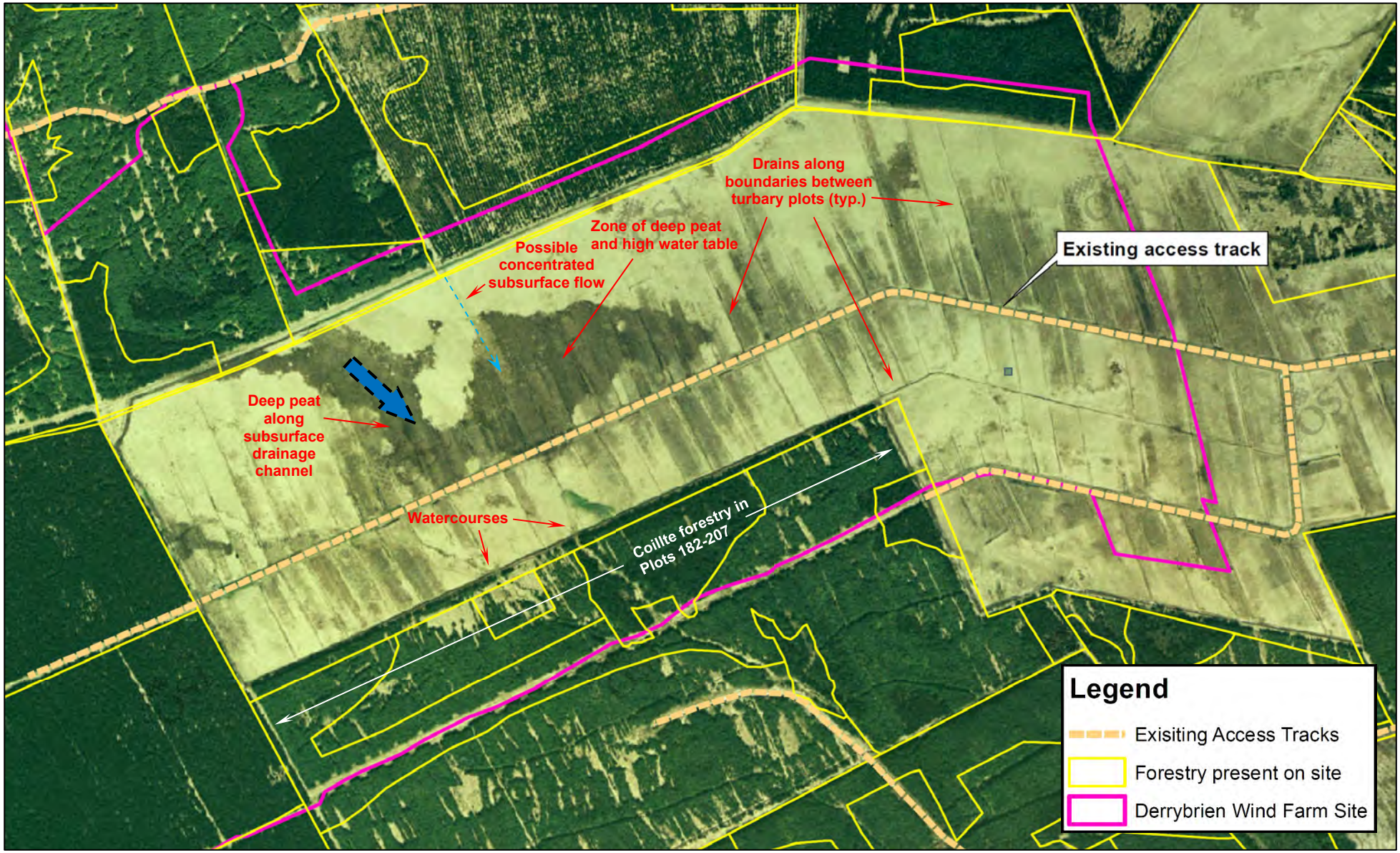


Figure 2-1 –Aerial Photograph of the turbary plots in 2000 (from ESBI Drawing No. QS-000280-01-D460-011-001-000)

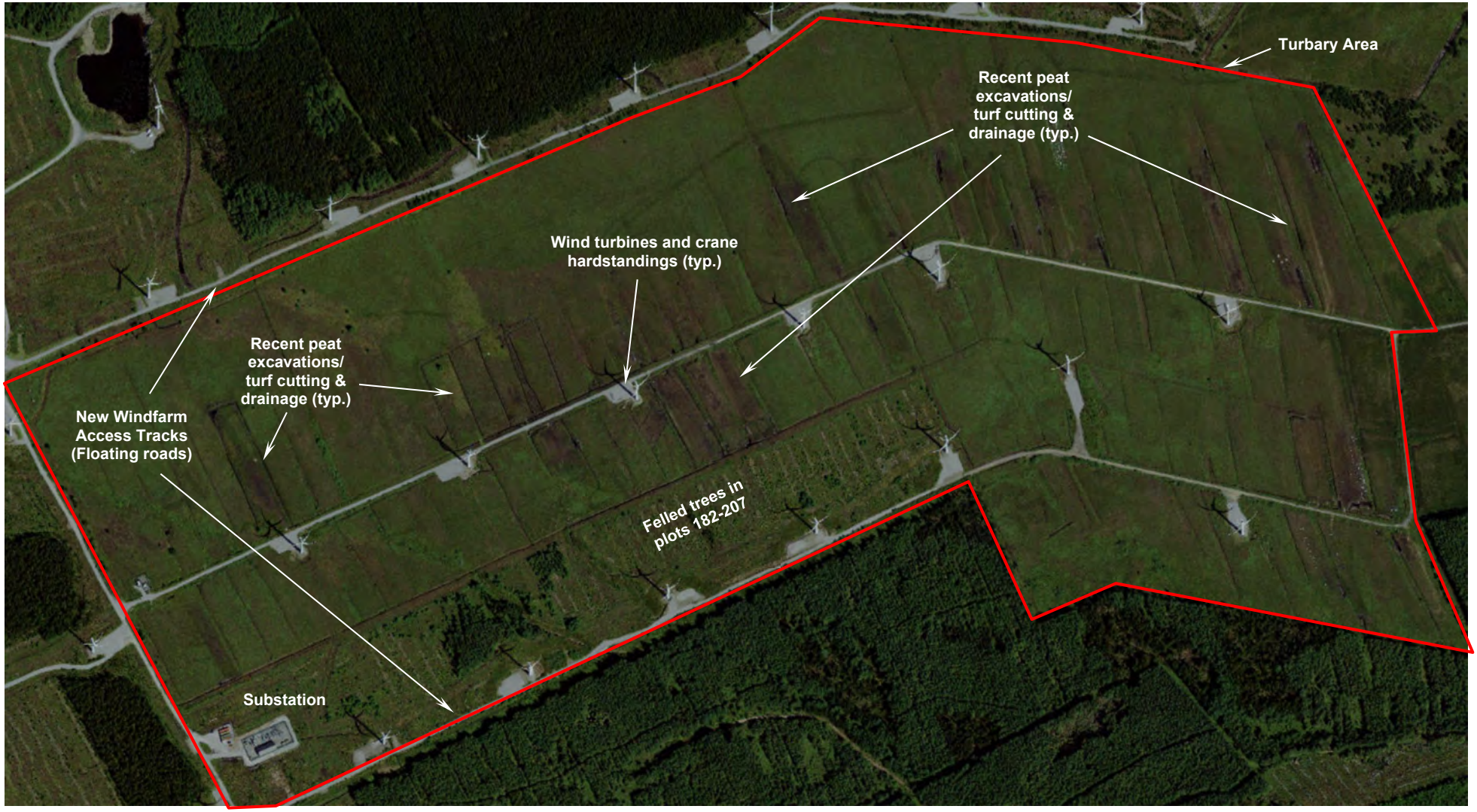


Figure 2-2 – Aerial Photograph of the turbary plots c2015-2018 (www.geohive.ie, July 2020)

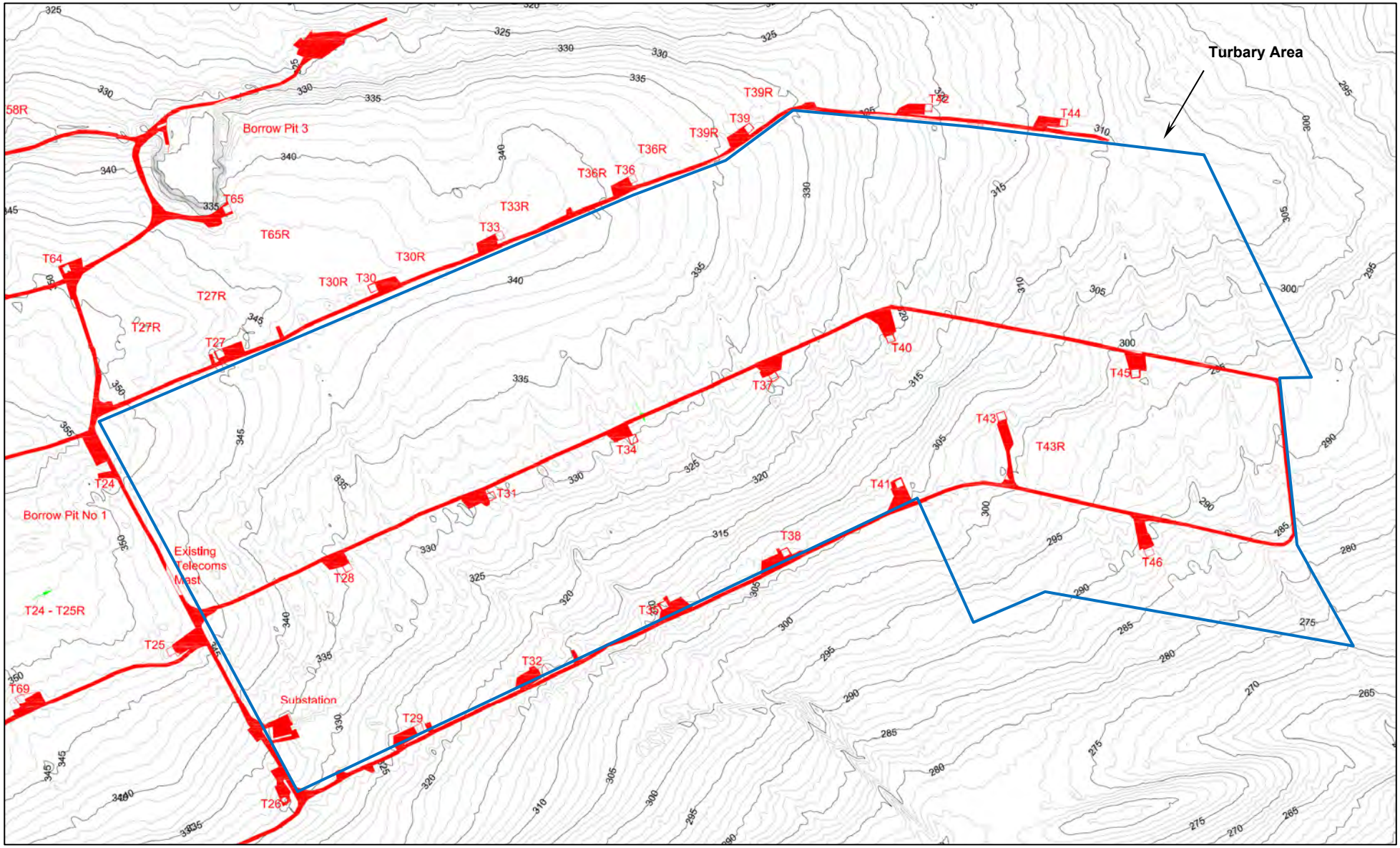


Figure 2-3 – LiDAR survey of turbary area

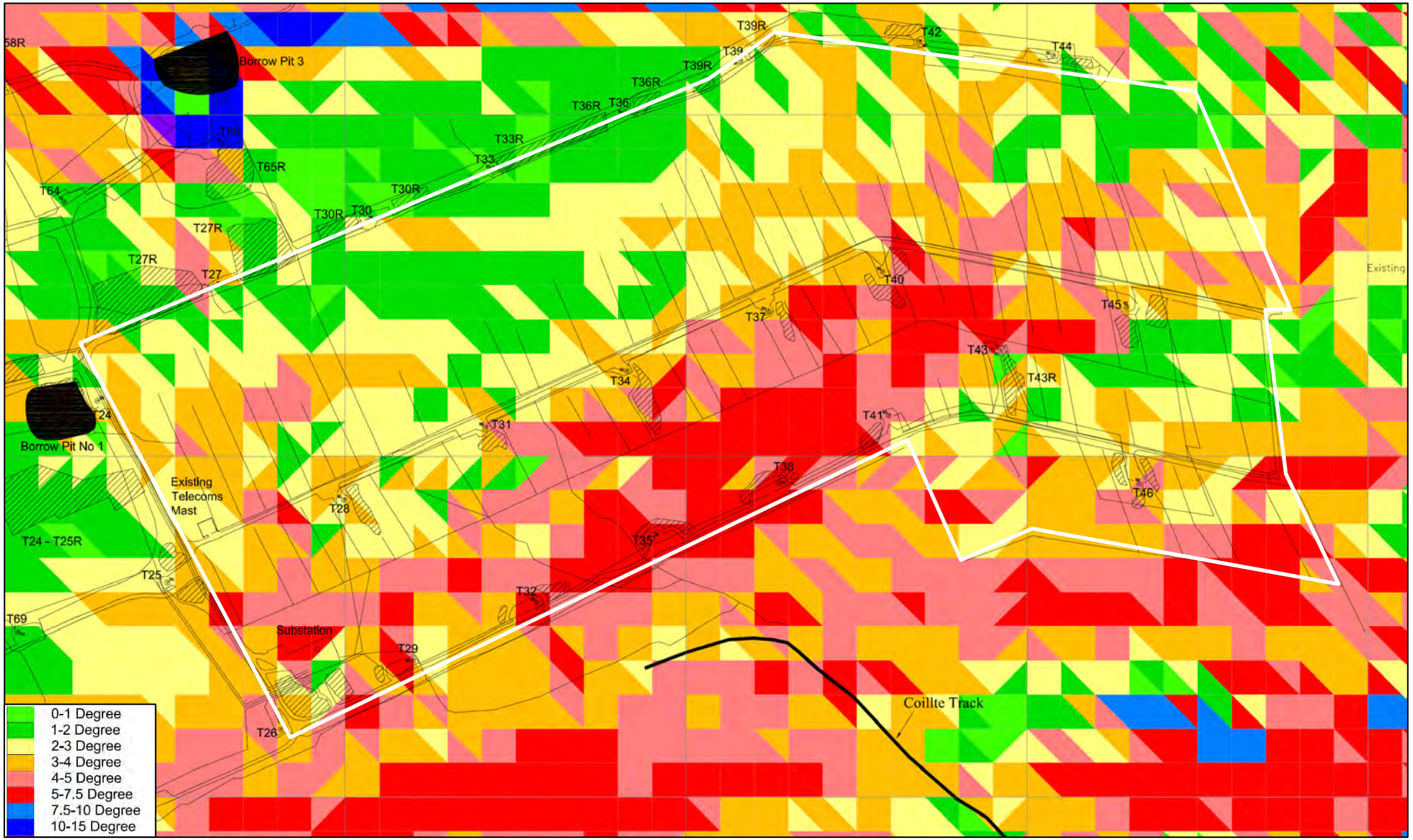


Figure 2-4 – Ground surface slope angles in turbary area

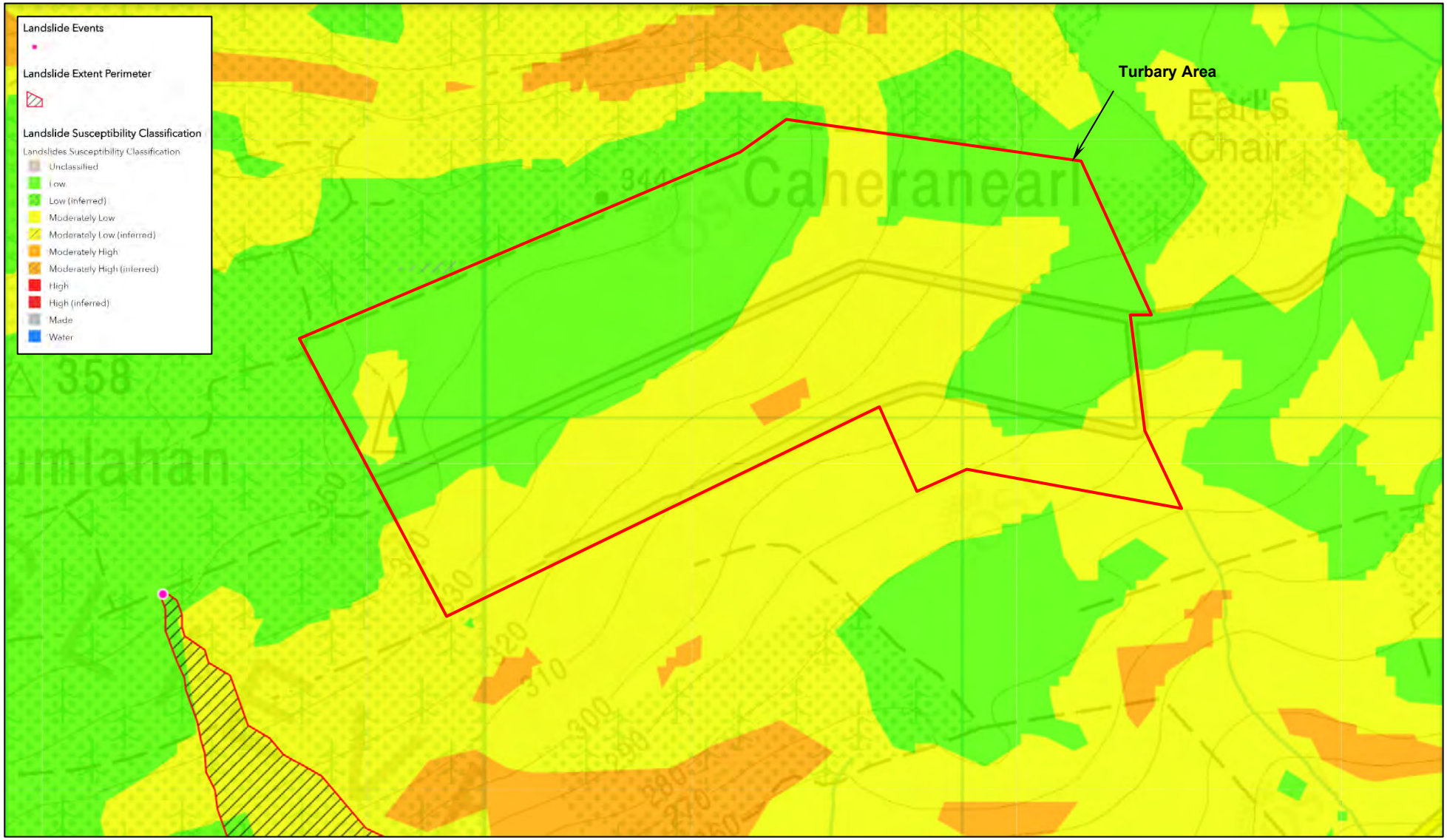


Figure 2-5 - Landslide susceptibility map for turbary area

2.2.3 Geotechnical Characterisation of Site Conditions

2.2.3.1 Peat

Figure 2-6 shows a map of the Quaternary Geology for the turbary area from the Geological Survey of Ireland online database. It shows that the area has a continuous cover of upland blanket peat (BkPt). Exposures of outcropping bedrock (Rck) are identified along the watercourse channel downslope from the turbary plots at the southeast corner of the windfarm site.

Extensive probing has been carried out to determine the depth of peat in the turbary plots. The location of the probes and the depth of peat at the each location are shown on Figure 2-7, which includes the probes that were carried out recently in the area in May/June 2020. Figure 2-8 shows contours of peat depth across the turbary area, which have been interpreted from the probes.

In general, the depth of peat is proportional to the slope angles. The areas of peat up to 3-6 m deep correspond to the broad flat or gently sloping ground with slope angles <3-4° on the north side of the central turbary access tracks (see Figure 2-4), along the subsurface drainage channel between Turbines T27 and T35, and at the southeast corner of the windfarm.

The areas of peat <2.0m deep are generally located along the steeper slopes up to 4.0-7.5° on the south side of the central access road between T25 and T45, north of the road between T37 and T45, and along the watercourse between T24 and T31 at the west end of the turbary area.

There is a broad zone of shallow peat <1.0m along the southern boundary of the windfarm site between Turbines T32 and T36.

The peat would generally be classified as very soft brown fibrous, slightly fibrous or amorphous (clayey) PEAT. The degree of decomposition (humification) of the peat varies with depth – typically ranging from fibrous in the upper vegetated layer (the acrotelm) where there is still living plant matter (Von Post H4-H6), to slightly fibrous, amorphous or clayey with depth in the underlying catotelm peat, which is comprised of dead plant matter generally below the water table (Von Post H7-H10). There is a more significant variability in the characteristics of the peat in the areas of deeper peat >2-3 m.

Figure 2-9 shows typical profiles of unfactored undrained shear strength recorded in the peat by AGL/BAM with the Geonor H-10 in-situ penetration vane during the construction stage of the project. In accordance with BS5930:2015 – BS Code of Practice for Site Investigations, the peat would be classified as Extremely Low Strength with an undrained shear strength <10 kN/m^2. The results were generally in the range of 5-10 kN/m^2, with a few locally lower values of 3.5-4.0 kN/m^2.

Specialised laboratory tests carried out on undisturbed samples of peat from the site by Trinity College Dublin indicated that the undrained shear strength of the samples tested in direct simple shear was generally greater than 4.5-6.0 kPa. However, some very low strengths on the order of 2.0-4.5 kPa were recorded on samples collected near the base of the peat in the vicinity of the slide that occurred during construction at Turbine T68 (average = 3.5 kPa).

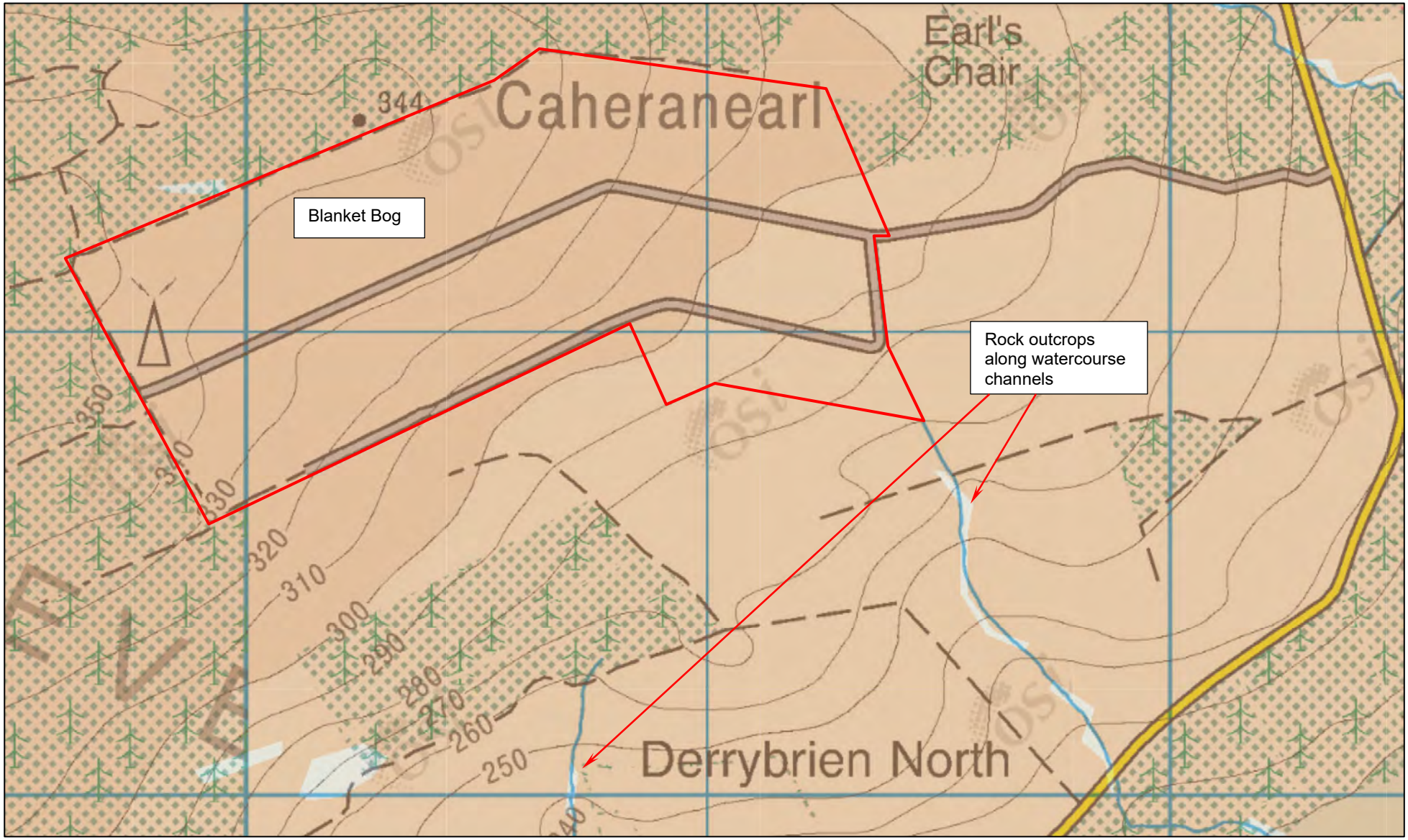


Figure 2-6 – Quaternary geology map for the turbary area (www.gsi.ie, July 2020)

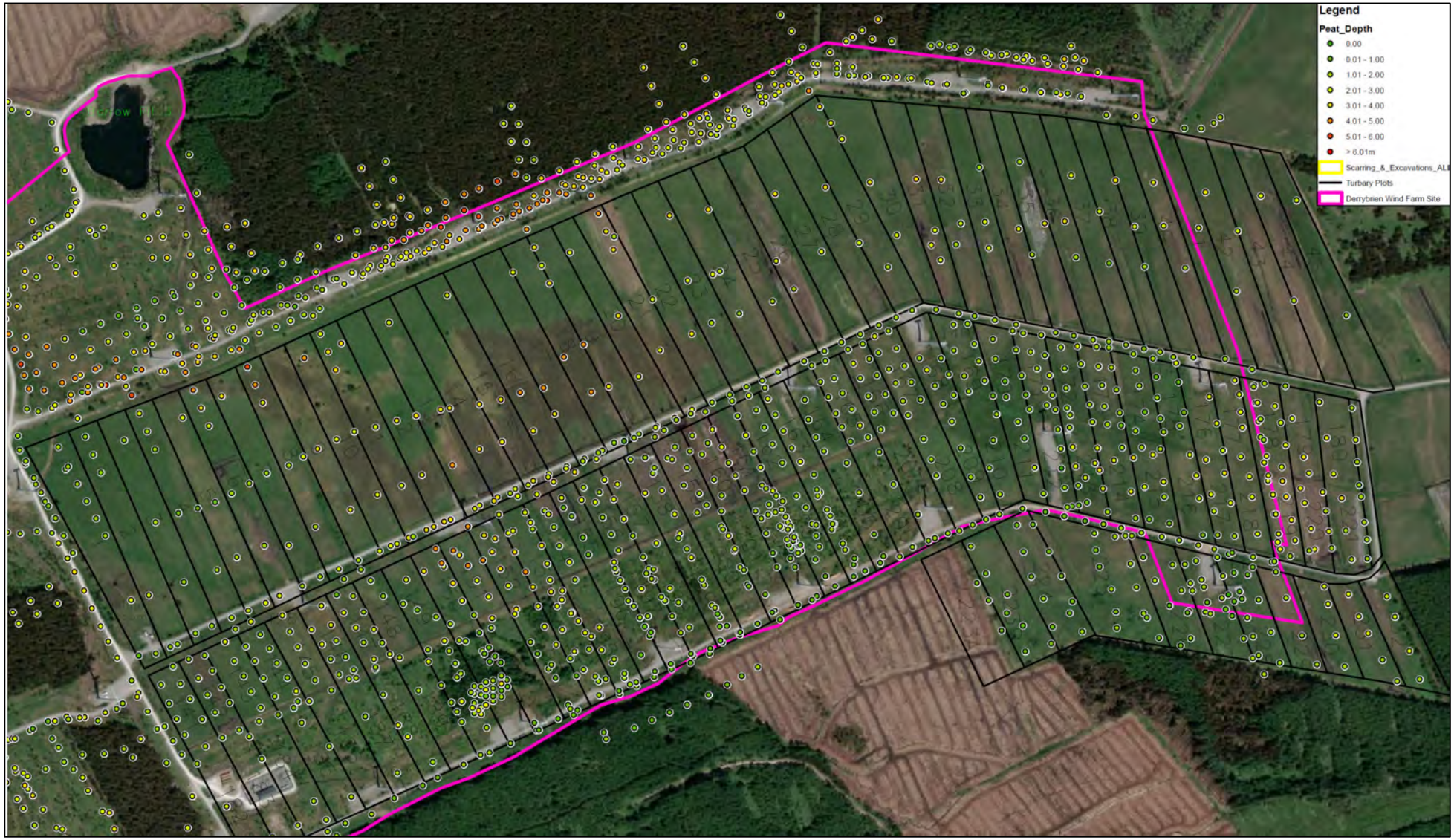


Figure 2-7 – Peat depth probes in the turbary area

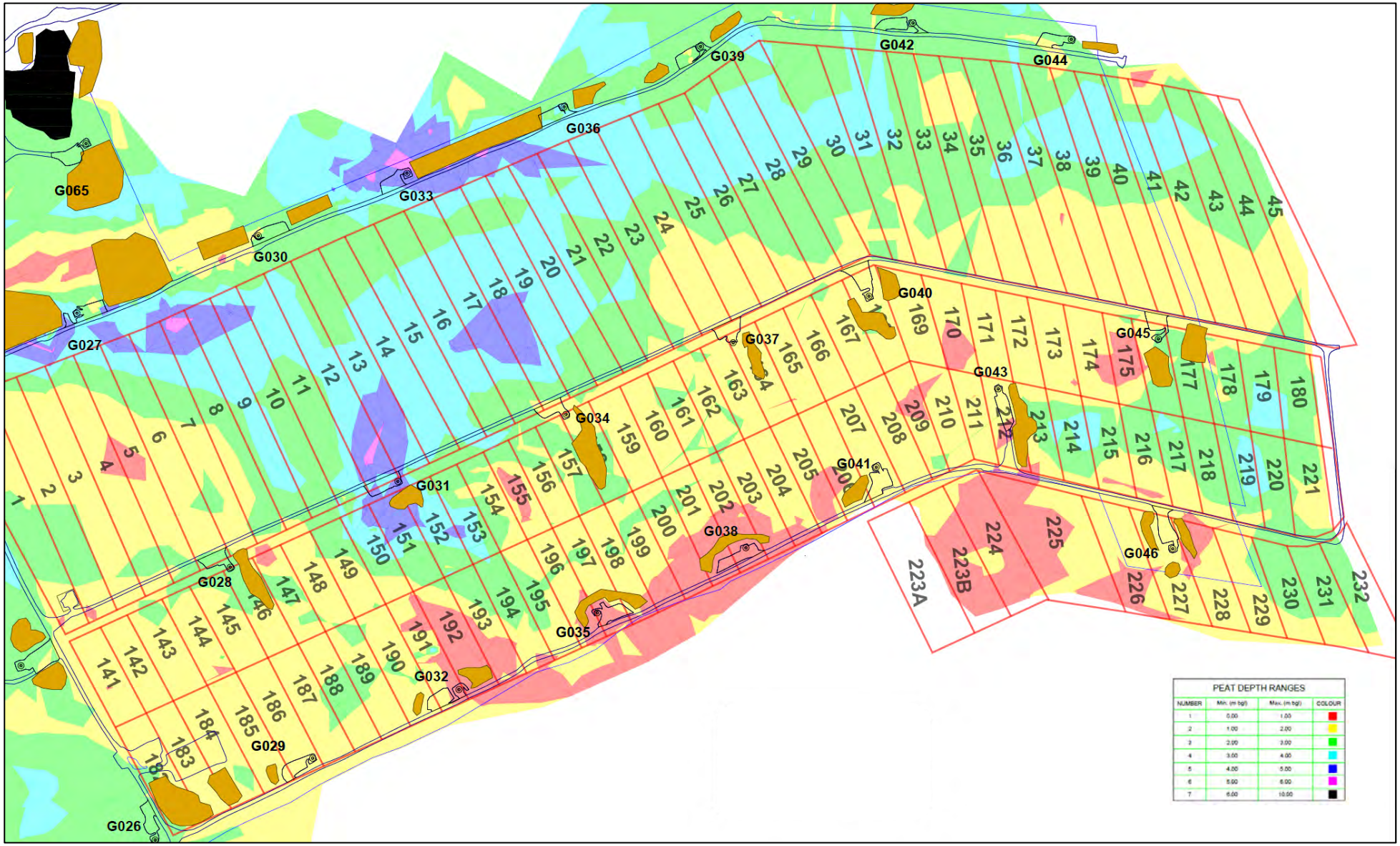


Figure 2-8 – Peat depth in the turbary area

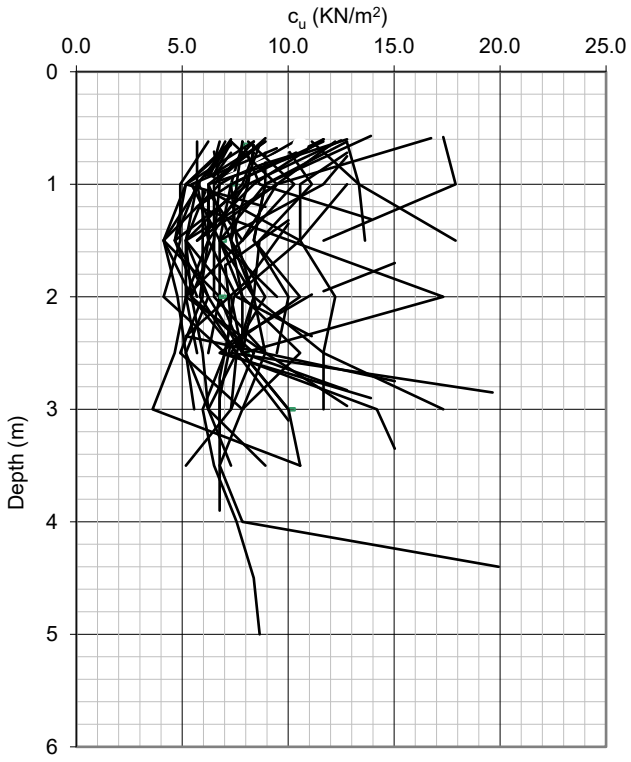


Figure 2-9: Profile of undrained shear strengths (c_u) with depth recorded in the peat with the Geonor H-10 penetration vane

2.2.3.2 Mineral Subsoil & Bedrock

The GSI map of Quaternary Geology for the windfarm site indicates that the blanket bog is underlain by glacial till derived from Devonian Sandstones (TDSs).

Where the full depth of peat was penetrated in 4 No. of the trial pits carried out by IGSL Ltd. prior to construction of the windfarm, the peat was shown to be underlain by a 0.1-0.6 m thick layer of soft grey-white sandy SILT over glacial till described as Firm purple sandy gravelly CLAY.

Within the turbary area rotary coreholes were carried out for the windfarm by Irish Drilling Ltd. at Turbines T30, T31, T33, T36 and T39. Bedrock was encountered at a depth of 3.5 to 6.0m. At T30 and T31 there was 1.7-3.2m of glacial till over the rock. SPT N-Values in the till ranged from 6 at T31, to 14-33 at T30. This would correspond to an undrained shear strength (c_u) of 30 to 165kPa using the approximate empirical correlation $c_u \approx 5 \times N_{SPT}$. In accordance with BS 5930 the strength of the till would therefore be classified as Low (20-40 kPa) to Very High Strength (150-300 kPa).

At Turbines T33, T36 and T39 the coreholes indicated that the peat was underlain directly by the rock at a depth of 3.5 to 5.4m. However, samples of the overburden recovered by conventional rotary coring may not be representative of the in-situ conditions.

The 1:100,000 Geological Map from the Geological Survey of Ireland (GSI) indicates that bedrock in the turbary area is comprised of Mudstones, Siltstones and Conglomerates from the Ayle River Formation.

Bedrock recovered in the rotary coreholes by IDL at T30, T31, T33, T36 and T39 was generally comprised of fresh to slightly weathered, strong to very strong, thinly bedded, locally thinly laminated, purple fine to medium and fine to coarse-grained SANDSTONE.

2.2.4 Hydrology and Hydrogeology

2.2.4.1 Groundwater Conditions

In the pre-construction ground investigation carried out by IGSL Ltd. water strikes were recorded in the trial pits at depths of 1.0m to 1.5m and were described as "seepage" in the peat. The trial pits were not left open long enough for the water to stabilize at the natural groundwater level so they only indicate where relatively permeable strata or pockets were encountered below the water table.

During construction, standpipes were installed by AGL Consulting at 6 No. locations along a north-south axis from the centre to the south of the windfarm in the vicinity of the peat slide to get a profile of the depth of groundwater down the slope. The readings that were taken from 17th November 2003 to 4th December 2003 indicated that the depth to groundwater ranged from 0.1m to 1.1mBGL.

In 2004, 3 No. electronic vibrating-wire piezometers (Pz-7 to Pz-9) were installed in a cluster in the peat in Turbary Plot 158, downslope from Turbine T34 and approximately 5m upslope from the 1.3m deep collector drain that runs east-west across the end of the turbary plot. Initially the piezometers indicated that the depth to groundwater generally fluctuated between 0.3 and 1.1 mBGL when construction on the windfarm was completed in 2005. Figure 2-10 shows the changes that occurred to the groundwater level over time after construction. The readings indicate that, on average, between December 2005 and November 2011 the groundwater level in the peat gradually dropped by about 0.7m due to drainage in the nearby drains.

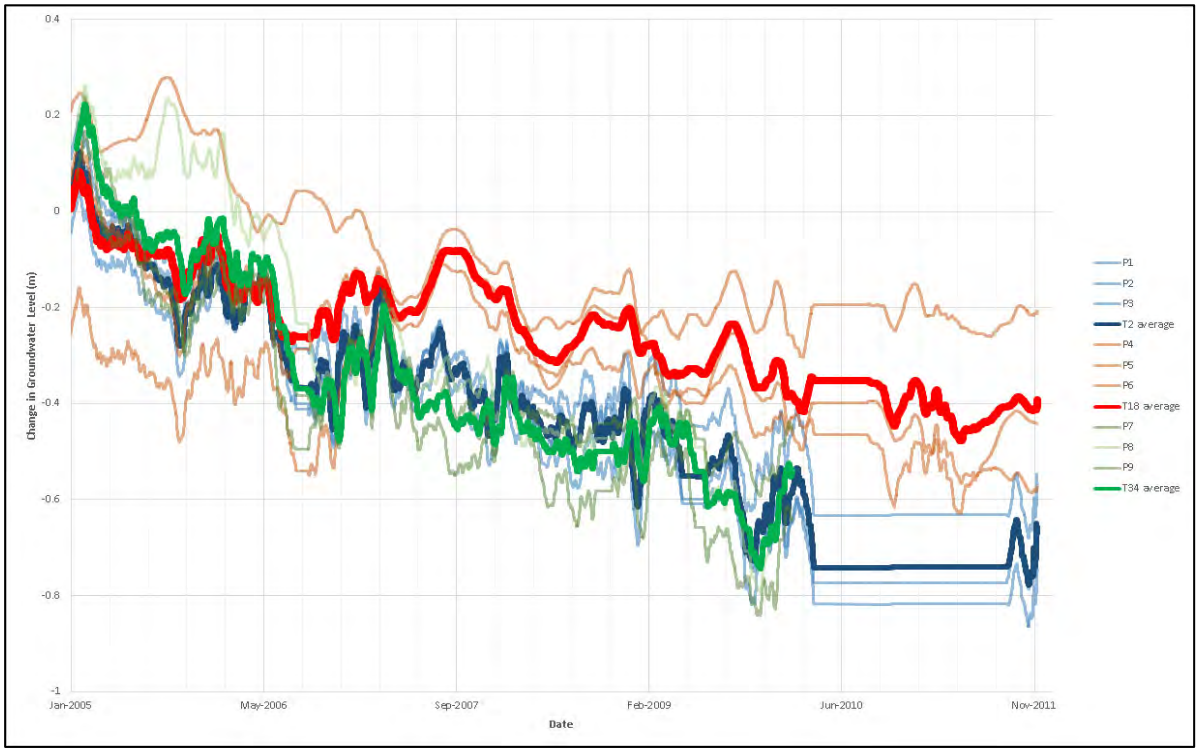


Figure 2-10 – Post-construction change in groundwater level readings from electronic piezometers in Turbary Plot 158 at Turbine T34

The aerial photograph in Figure 2-1 identifies an area of high groundwater and deep peat where the surface vegetation is darker on gently sloping ground upslope from the central turbary road between Turbines T31 and T37. The figure also identifies an area of possible concentrated subsurface groundwater flow in the peat between Turbines T30 and T33 along the northern boundary of the windfarm site.

The peat depth contours in Figure 2-8 would indicate that there is a subsurface channel in the zone of deep peat between Turbines T27 and T35. Groundwater in these areas would flow downslope through a network of natural open pipes within the peat as well as possibly through an open joint network in the underlying bedrock.

2.2.4.2 Hydrology - Surface Water, Drainage and Natural Watercourses

Figure 2-11 shows the network of natural watercourses and man-made drains in the peat in the turbary area prior to the construction of the windfarm. It also shows the additional drains that were constructed for the windfarm.

Prior to the construction of the windfarm there was an extensive network of drainage in the turbary area. The majority of the existing drains are shallow open drains within the peat, typically 1-2 m deep, which run along the north-south boundaries between turbary plots. There are also east-west collector drains that run along the length of the turbary area along the downslope side of the turbary plots. These connect the turbary drains with the network of natural and improved watercourses on the south side of the windfarm in this area.

Figure 2-12 shows the regional hydrology in the area from the EPA online Water Maps (www.epa.ie). All of the drains in the turbary area flow into the stream at the southeast corner of the windfarm, which is in sub-catchment SC7(a). This is a tributary of the Owendalulleegh River, which flows west into Lough Cutra.

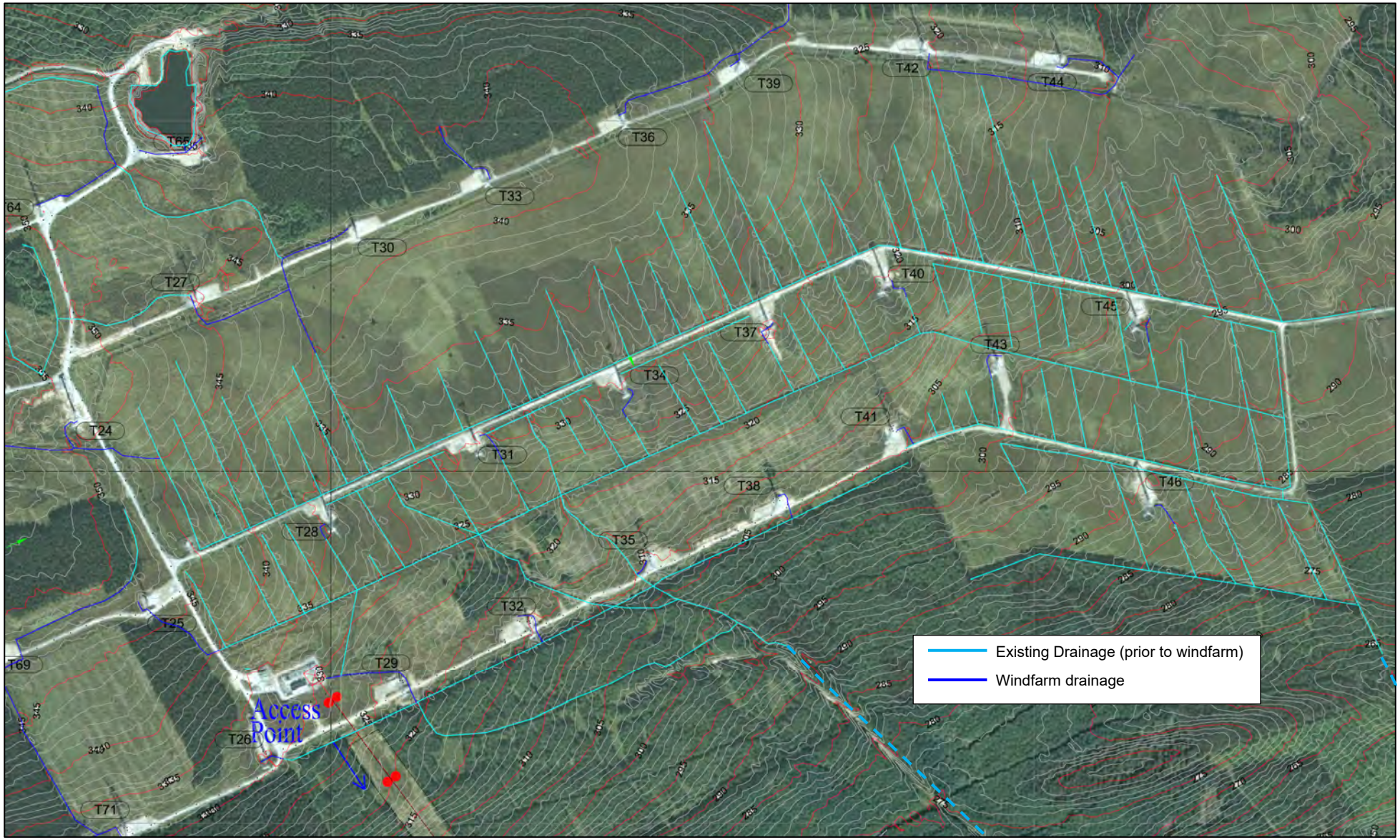


Figure 2-11: Surface hydrology and drainage network in the turbary area

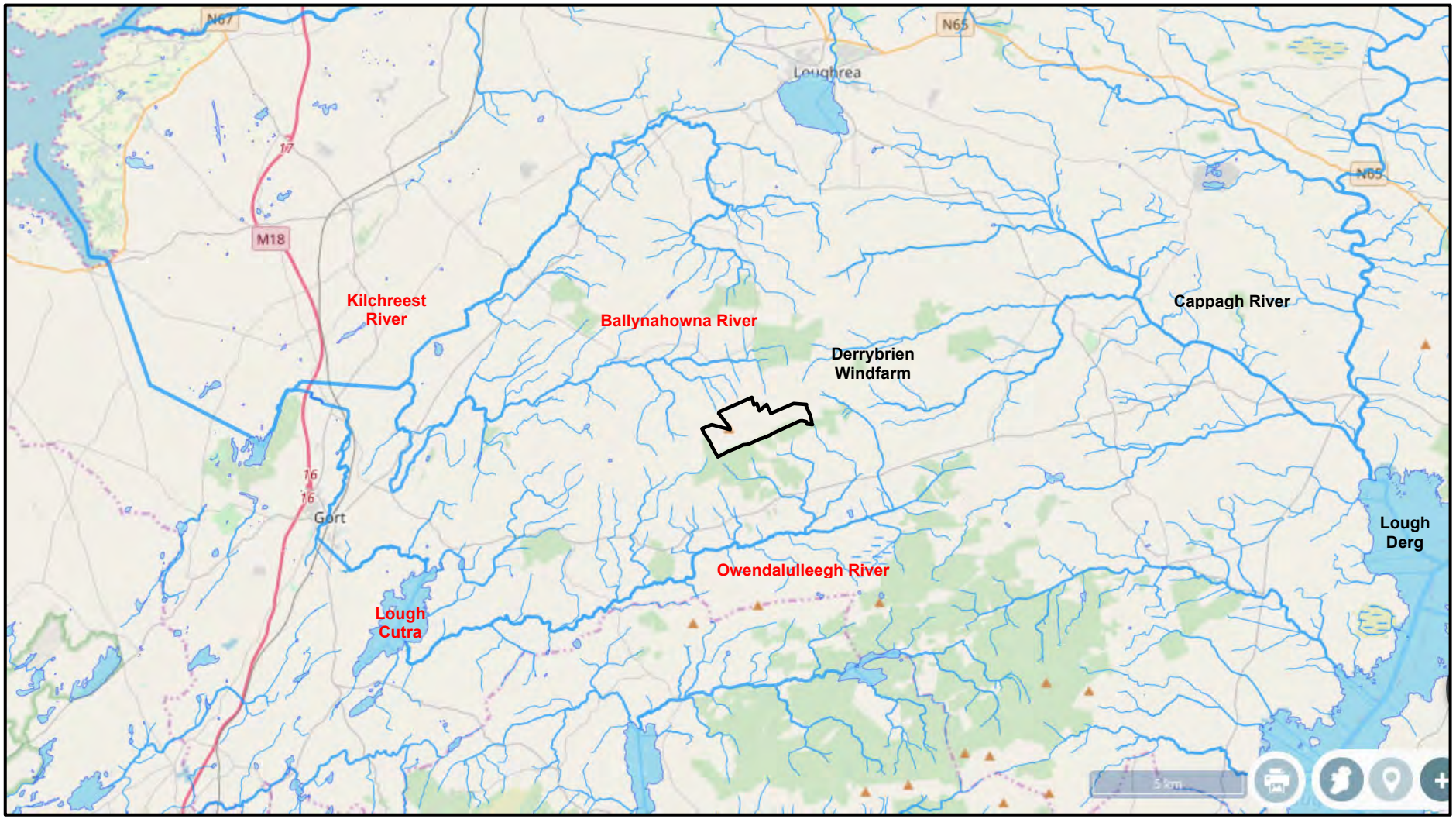


Figure 2-12: Regional hydrology (EPA Water Maps, www.epa.ie, July 2020)

3.0 SITE ACTIVITIES IN TURBARY PLOTS

3.1 Peat Harvesting (Turf Cutting)

There are no records for the mechanical peat harvesting or turf cutting that has been carried out in the turbary area since 1998, or prior to then. The following is a summary of general information on recent activity in the area which has been obtained from consultations with the windfarm manager for Gort Wind Farms Ltd. and with a local peat cutting contractor, who has worked on the site since 2012. It is not a complete or comprehensive record of mechanical peat harvesting on the site, but it does give an indication of the general nature of the methods of mechanical peat harvesting that have recently been utilised as well as the possible extent of mechanical peat harvesting in the turbary area.

- The extent of mechanical peat harvesting in the area up to 2012 is not known. However, the level of turf cutting after the windfarm was constructed has generally been low. Historically, turf cutting was carried out by hand on a number of plots, normally in late Spring/early Summer.
- Since 2012 a local peat cutting contractor has been retained by some of the plot owners to mechanically cut turf so there has been an increase in the number of plots where mechanical turf cutting has been carried out. The contractor has worked in 34 No. of the turbary plots as follows: **6, 7, 9, 10, 15, 24, 27-29, 31-35, 39, 40, 42-44, 142, 143, 155, 159-162, 219-221, 228-232.** These are identified on the aerial photograph in Figure 3-1. Figure 3-2 identifies typical evidence of recent mechanical peat harvesting and drainage that was evident in April 2020.
- The mechanical peat harvesting was carried out by the contractor with a wide track low ground bearing pressure hydraulic excavator and a Difco Bogmiser hopper, similar to that which is shown in Plate 3-1 . It is a specialised track-mounted self-propelled diesel-powered machine for peat harvesting that has a rear-mounted hopper and auger system to hold, compress, extrude and cut the peat into sods of turf. The peat below the vegetated surface layer is first loaded into the hopper by a hydraulic excavator that excavates the peat from the active bank or trench excavation. When fully-loaded, the hopper is then driven away from the excavation area and the peat is extruded in 8 No. continuous rows of turf sods 100mmx 90mm in cross-sectional area over an 80m long strip on the surface of the peat in the turbary plot to allow it to dry. Subsequent loads are laid out in parallel strips across the turbary area. They are left to air-dry over a number of weeks before being bagged and collected for transport off site.

Plate 3-1 – Difco Bogmiser Peat Hopper extruding rows of peat sods

- When the hopper is fully loaded with peat it weighs on the order of 32 tonnes (≈315 kN). The hopper is fitted with low ground bearing pressure wide-tracks to spread the load out on the surface of the peat. Each track is 1.5m wide x 6.0m long so that, when the hopper is fully-loaded the bearing pressure under the tracks is on the order of 17.5 kN/m^2. This is equivalent to the surcharge load from approximately a 1.75m thick layer of intact peat over the same area.
- The mechanical turf cutting is typically only carried out once in each turbary plot each year, in late Spring/early Summer. The volume of peat that is extracted in each area is on the order of 50-75m^3, which is equivalent to 8-10 hopper loads with each hopper load creating a single row of 8No. 80 m long strips of peat sods along the length of the turbary plot and spaced evenly out across the width of the plot.
- Peat is not extracted from all of the turbary plots each year. However, if all 34 No. of the plots operated by the peat cutting contractor were active each year, then this could involve the excavation of up to about 2,500m^3 of peat.
- Turf cutting has been carried out by saw cutting in 1 No. additional turbary plot between plots 20 and 30. The aerial photographs would indicate that this could have been in Plot #21 (Figure 3-2). Plate 3-2 shows a typical saw cutting device for peat harvesting. It is a specialised attachment that fits to the back of a tractor that resembles a large chainsaw. It cuts a narrow slot up to about 1.2m deep into the peat. Similar to the hopper system, an auger then compresses and extrudes the excavated peat directly into continuous rows of turf sods on the surface of the peat adjacent to the saw cut line. Again, the sods are left to air-dry over a number of weeks before being bagged and collected for transport off site. The saw cutting is normally carried out along closely-spaced parallel rows. The aerial photograph in Figure 3-2 indicates that these could be aligned north-south along the long axis of the turbary plot #21. Saw cutting is sometimes also carried out along perpendicular lines. However, this is not reflected in the marks on the peat and the narrow plot would make saw cutting less efficient across the width of the plot.

Plate 3-2 – Typical saw cutting attachment for extracting peat

- Traditionally peat harvesting would have been carried out in the turbary plots by hand using a specialised turf spade called a slane. Manual turf cutting is still carried out in a turbary plot in the general area, but not in the plots shown on or immediately adjacent to the windfarm site.

3.2 Drainage

Some minor drainage works have also been carried out in the area by or on behalf of the turbary plot owners, i.e.:

- The east-west collector drain along the downslope side of the turbary plots downslope from the central access road, has been cleared out once since the windfarm was constructed to ensure that the water is draining effectively from the area;
- When carrying out routine maintenance on the drainage for the windfarm, Gort Wind Farms Ltd. also cleared out a drain that had become blocked on one of the turbary plots on behalf of the plot owner;
- Recently, open drains have been excavated around the perimeter of some of the turbary plots that have become recently active for machine cutting, as shown on Figure 3-2.

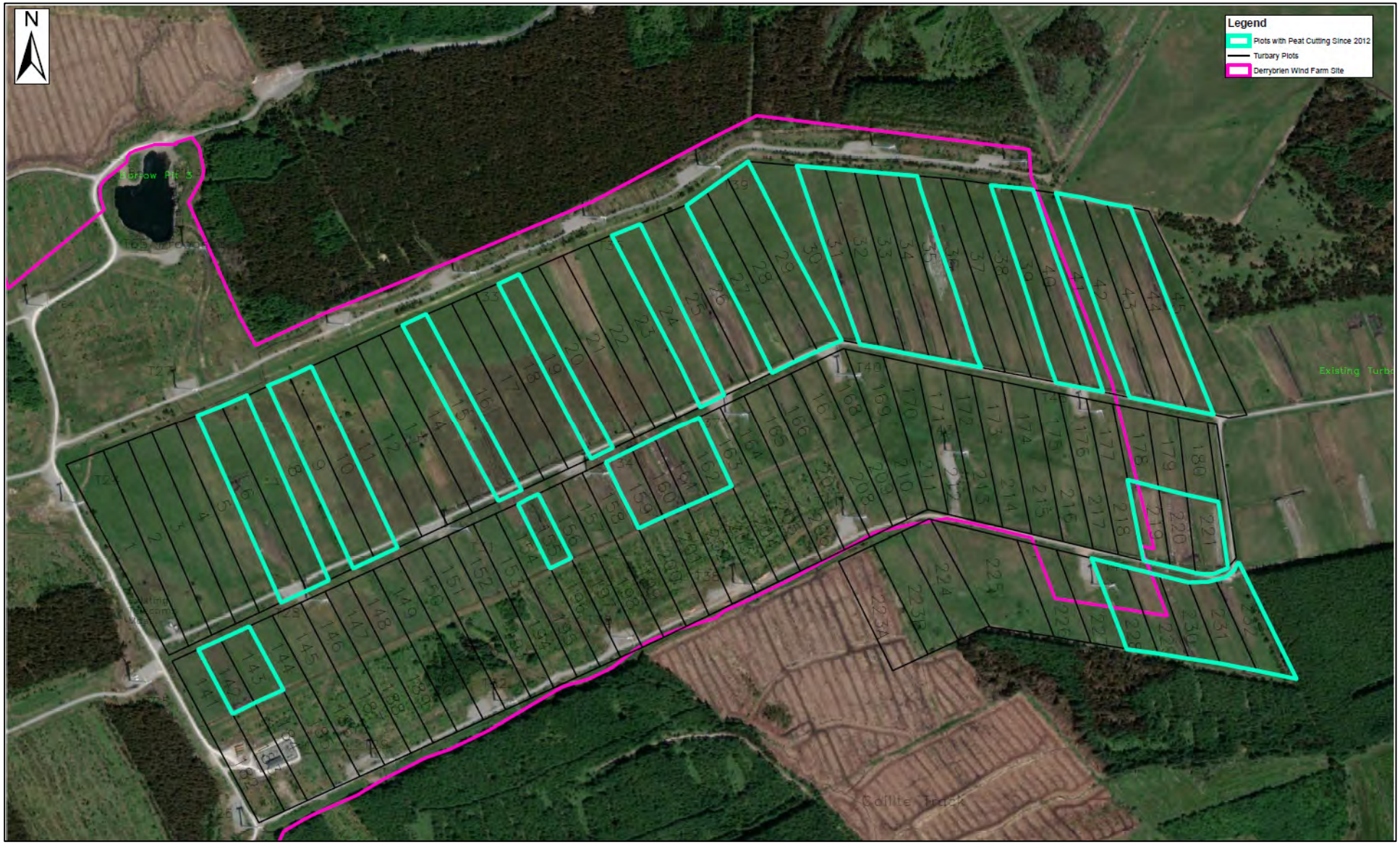


Figure 3-1 - Turbary plots where mechanical peat harvesting has been carried out by a local contractor since 2012

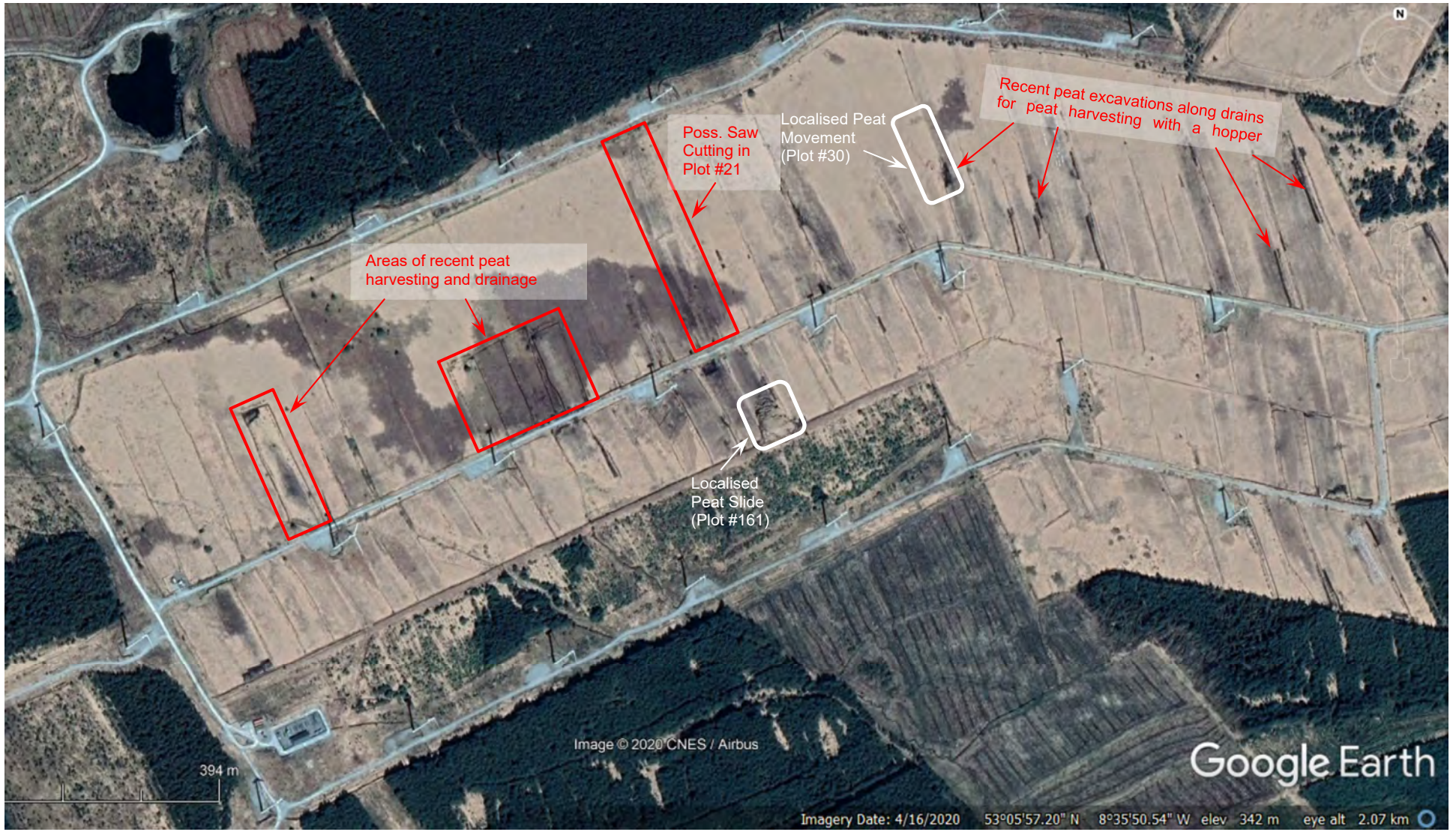


Figure 3-2 – Recent aerial photo of turbary plots illustrating recent peat harvesting (turf cutting) activities

4.0 PEAT STABILITY RISK ASSESSMENT (PSRA) - PRIOR TO IMPLEMENTATION OF RISK MITIGATION MEASURES.

A Peat Stability Risk Assessment (PSRA) has been carried out for the turbary plots to characterise the relative risk of peat instability in each plot prior to implementation of risk mitigation measures. The purpose of the PSRA is to identify where there are elevated risk factors that determine where mitigation measures are required to ensure that the risk of peat instability can be reduced to an acceptable level for mechanical peat harvesting. The assessment has been carried out based on existing site characteristics in each plot, also taking into account the level of mechanical harvesting that has been undertaken on the site since 2012.

There are a total of 136 No. turbary plots on the site, which are numbered as follows, as shown on Figure 1-1:

- 1-45
- 144-180
- 182-221
- 223A, 223B and 224-232

Plots 1-45 are relatively long and almost double the size of the other turbary plots on the site. Therefore, for this assessment they have been split up into two zones (north and south) that are of comparable area to the other turbary plots, as shown on Figure 4-1. Each of the zones has an area of about 0.55ha and there are a total of **181 No. zones** in the turbary area.

A qualitative risk assessment has been carried out for each turbary plot to assess the **Risk Rating (R)** for a peat failure occurring as a result of mechanical peat harvesting in the plot based on the interpreted **Likelihood (L)** (i.e. probability) of occurrence and **Impact (I)** of failure **(i.e. R = L x I)**.

In this assessment peat failures that could occur as a result of mechanical peat harvesting in the turbary plots could range from a localised shear failure in the peat on the upslope side of an open excavation, to a small-scale peat slide that is contained within the turbary area, or a large-scale peat slide comparable to the slide that occurred at Turbine T68 on the windfarm site in October 2003, which would be the worst case scenario. Further details on the methodology of the assessment are provided in Section 1.2. The following is a summary of the results of the assessment.

4.1.1 Likelihood (L)

The **Likelihood (L)** of a peat failure in each zone has been interpreted by evaluating factors related to the peat and subsoil conditions, topography, site hydrology/hydrogeology and other significant contributory factors such as the method of peat harvesting or slide history to determine where there are compounding conditions that could lead to a higher risk of a peat failure.

Tables A2 to A6 in Appendix A give guidance on the different factors that can contribute to peat instability that were evaluated in the assessment. Appendix A also includes figures showing the calculated Factor of Safety (FoS) against shear failure at the base of the peat across the turbary area for the following criteria:

- c_u = 5.0kPa, Surcharge = 0kPa (Figure A-1)
- c_u = 5.0kPa, Surcharge = 10kPa (Figure A-2)
- c_u = 2.5kPa, Surcharge = 0kPa (Figure A-3)
- c_u = 2.5kPa, Surcharge = 10kPa (Figure A-4)

Where:

- **c_u** is the assumed undrained shear strength at the base of the peat; and
- the surcharge load is an additional load applied at the surface of the peat and 10kPa is approximately equivalent to the weight of 1.0m of peat.

For each set of conditions the FoS have been calculated across the turbary area for the infinite slope condition using the peat depths interpreted from the probes (Figure 2-8) and the slope angles that were interpreted from the LiDAR survey (Figure 2-4). The FoS is calculated as the ratio of the downslope component of the self-weight of the peat on the slopes to the undrained shear strength at the base of the peat. A FoS ≥1.0 indicates that the shear strength of the peat is sufficient to support the peat on the slopes and an FoS >1.3 provides a margin of safety.

The resulting FoS without the surcharge load give an index of the stability of the slope in the undisturbed condition for the assumed lower bound strength criteria. The majority of the in-situ vane shear test results in the peat were in the range of 5-10kPa. An undrained shear strength of 2.5kPa would represent the worst case scenario where there was very weak or remoulded peat at the base of the peat. This would generally only apply where some movement or shear has already occurred in the peat.

The application of the surcharge load is a sensitivity analysis that is used to identify areas that might be more susceptible to a peat failure if a small load is applied to the surface of the peat, e.g. from turf cutting equipment or stockpiles of excavated peat.

Because of the range in the strength of the intact peat, the FoS calculations on their own do not indicate where a peat failure is likely to occur. The method of assessment that has been used for the PSRA in accordance with current best practice guidelines takes into account all of the contributory factors listed under the different criteria in Tables A1 to A6 to identify areas where there are compounding factors that could lead to a higher risk of a peat failure.

The results of the assessment are presented in Table A-1 in Appendix A and on Figure 4-1. Although mechanical peat harvesting is only being carried out in a small number of the turbary plots (see Section 3.0), it has conservatively been assumed that the activities are not restricted to those areas so that the assessment is applicable if mechanical peat harvesting is carried out in all of the turbary plots.

The results show that there are significant areas of the turbary plots where the likelihood of a peat failure due to mechanical peat harvesting under uncontrolled conditions and without appropriate mitigation measures is **Very Possible** to **Likely (L=4.0 to 5.0)**. These zones are located in areas where there are compounding risk factors in relation to peat instability, including, for example:

- The zone of deep weak peat (3-6m deep) along the subsurface drainage channel between Turbines T27 and T35 where there is a convex break in slope at the head of the watercourse that flows off site to the south of T35 (Plots #7-13, #148-154; #191-195);
- The zone of deep weak peat upslope from the central turbary road between T28 and T37 where there are indications of subsurface seepage in the peat to the convex breaking slope downslope from the road (Plots #14-22);
- The plots on the convex breaking slope downslope from the central turbary road in the area of deep peat between Turbines T28 and T37 where there are indications of subsurface seepage in the peat (Plots #155-164, #197-204) and low Factors of Safety for infinite slope stability;
- Along the watercourse channel in the peat at the west end of the turbary areas between Turbines T24 and T29 (Plots #1-5, #147 & #191);
- The area of relatively deep peat (2-3m) with the convex breaking slope at the southeast corner of the wind farm (Plots #219-221 & #229-232); and
- Various plots at the east end of the site where there is locally a convex breaking slope in relatively deep peat (2-4m) and locally low FoS for slope stability (e.g. Plots #30-36, between #168 & 176, and #213-214)

Together these account for approximately **47%** of the total number of zones on Figure 4-1 (i.e. 85 No. out of 181 No. total).

In the remaining turbary plots across the site the Likelihood of a peat failure, due to mechanical peat harvesting under uncontrolled conditions and without appropriate mitigation measures would be characterised as **Possible to Very Possible (L=3.0 to 3.5)**. These were in areas where there were mitigating conditions that reduced the risk of peat instability. For example:

- Areas of shallow (<1.0 m) or relatively shallow (1-2 m) peat;
- Areas of gently sloping ground (<3°) set well back from any convex break in slope where the slope angle increases to >5°.
- Areas of relatively high infinite slope Factor of Safety (FoS >1.3);
- Zones where there is well-developed drainage, and which are not directly upslope from the rivers and streams outside the wind farm site.

4.1.2 Impact (I)

The potential **Impact (I)** of a peat failure in each zone has been interpreted by evaluating factors related to the potential volume of peat, degree of contamination, sensitivity of the receiving environment, access for intervention, land use and existing infrastructure within the potential run-out distance.

As stated previously, in assessing the likelihood of a peat failure consideration has been given to the full range of failures that could occur as a result of mechanical peat harvesting in the turbary areas, from a localised shear failure in the peat on the upslope side of an open excavation, to a small-scale peat slide that is contained within the turbary area, or a large-scale peat slide comparable to the slide that occurred at Turbine T68 on the windfarm site in October 2003, which would be the worst case scenario.

The impact of a localised shear failure or small-scale peat slide would be relatively low as it would only involve a small volume of peat, which would be contained on site without direct inundation of the downslope watercourses. The degraded bog in the turbary area that would be impacted by the slide is of medium to low ecological importance and the risk of contamination to watercourses would be limited to sediment laden surface runoff, which can be mitigated or contained on site. The impact on land use would be limited to the loss of peat in the turbary plot. Depending on the proximity to the windfarm infrastructure a small-scale peat slide could damage a section of floating road, or some of the buried electrical transmission or fibre-optic communication cables. However, it is unlikely to cause significant damage to a wind turbine.

In comparison, although there would be a lower likelihood of a large-scale peat slide occurring on the site due to mechanical peat harvesting in the turbary areas, the impact of a large peat slide would be significantly higher.

Based on the extent and characteristics of the peat slide that occurred at the windfarm site during construction in October 2003, a large peat slide could result in the shear failure of a large volume of peat over a wide area on the side slopes of Cashlaundrumlahan Mountain, downslope from the turbary area. This would result in the loss of the blanket bog habitat within the slide, which could extend outside the site boundary on the upper slopes of the mountain.

The nature of peat slides such as these is that they typically occur directly upslope from natural watercourses, particularly where poor drainage is a contributory factor. Therefore, a significant portion of the failed peat would become fluidised into a viscous mass of remoulded peat debris that would flow down into the watercourse channels directly inundating the streams and rivers downslope. The material that remains within the failure scar on the upper slopes would typically be comprised of detached rafts of intact fibrous peat, remoulded peat debris and a thin cover of intact basal peat over the underlying mineral soil and rock.

The fluidised peat debris could have significant run-out distances along the river valleys, which could occur in pulses over a number of days if the peat becomes re-mobilised by subsequent periods of heavy rainfall. Where the volume of peat exceeds the capacity of the valley on flatter slopes it can spread out over the surrounding land to either side. Where rivers or streams cross public roads the peat can block culverts or bridges, sometimes overtopping the road and blocking public access. The downstream impact of the remoulded peat attenuates with distance from the site. The extent of organic sediment transported downstream would be a function of the volume and characteristics of the peat and the hydrological characteristics of the river and stream networks.

Drawing No. QS-000192-01-D451-018 by ESBI in Appendix A shows a map of the environmental constraints that have been identified in the region of the Derrybrien Windfarm. The following characteristics of the site and surrounding area are relevant in assessing the impact of a peat slide in the turbary area at the east end of the windfarm site:

- The turbary area is located within the Slieve Aughty Mountains Special Protection Area (SPA) which has Special Conservation Interest for Hen Harrier and Merlin;
- The Slieve Aughty Bog NHA identified on the south side of the R353 near Derrybrien village could be impacted by remoulded peat from a large-scale peat slide on the south side of the windfarm entering the stream in sub-catchment SC7(a), which flows through the NHA.
- The stream in sub-catchment SC7(a) is a tributary of the Owendalulleegh River on the south of the windfarm. Although the Owendalluleagh River does not have protected status, approximately 11 km southwest of the site the Owendalulleegh River flows into Lough Cutra, which is a designated SAC.
- Although the area is generally sparsely populated, particularly to the north of the windfarm, Derrybrien village is located along the R353 Regional Road approximately 2 km downslope from the south side of the site. At this distance, the impact of a peat slide would be concentrated in the areas where the tributaries to the Owendalulleegh River cross the R353 and a slide would be unlikely to impact the dwellings, monuments or Architectural Heritage features in the village. Access to the village could be restricted if the road becomes blocked.
- As the windfarm has been completed, the existing site infrastructure could be directly impacted by a peat slide on the site, particularly the site access tracks that have been constructed as floating roads, and the 110 kV overhead line that connects the substation on the site to the national grid at the Agannygal Substation, approximately 7.7 km south of the site.
- Land use in the turbary area and downslope from the windfarm site is limited to non-commercial peat harvesting and commercial forestry, with some agriculture on the lower slopes, where the land has relatively low agricultural value. These activities would be directly impacted by a large peat slide in the turbary area.

Also, a very large peat slide would have a significant commercial impact. In addition to the costs of remedial works to mitigate the impact of the peat slide on the receiving environment, the commercial impact could include the loss of windfarm infrastructure, damage to local or regional public infrastructure (bridges, roads etc), and/or loss of commercial forestry, turbayr areas and agricultural land. It could also lead to sustained periods of power outages where the windfarm is shut down or disconnected from the grid.

On the basis of these factors, the potential **Impact** of a large peat slide occurring as a result of mechanical peat harvesting in the tubary areas would be classified as **High (I=5)** and this has conservatively been applied to all of the zones in the turbary areas as the worst case scenario.

4.1.3 Risk Rating

A baseline **Risk Rating (R=L x I)** has then been calculated for mechanical peat harvesting in each turbary area to characterise the risk of peat instability across the site prior to the implementation of risk mitigation measures to identify where specific design, construction & operational mitigation measures are required to mitigate the risk of peat instability to an acceptable level.

The results of the baseline PSRA are presented in Figure 4-1 and in Table A-1 in Appendix A.

Assuming that the impact of a peat failure could reflect the potential impact a large peat slide in the worst case scenario (i.e. I=5), which is consistent with the methodology for the assessment of stability impacts for the wind farm:

- In the 85 No. zones (≈47%) where the likelihood of a peat failure due to mechanical peat harvesting without appropriate mitigation measures is **Very Possible** to **Likely (L=4.0 to 5.0)**, then the **Risk Rating, R**, for a peat failure in these areas would be between **20** and **25**, which is **Medium to High or High** (see Table 1-4).
- In the remaining 92 No. zones (≈53%) where the likelihood of a peat failure due to mechanical peat harvesting is generally **Possible** to **Very Possible (L=3.5)**, then the **Risk Rating, R**, for a peat failure in these areas would be **17.5**, which is **Medium to High**.

These risk ratings would be classified as unacceptable which means that appropriate mitigation measures would be required to reduce the risk of a peat failure to an acceptable level.

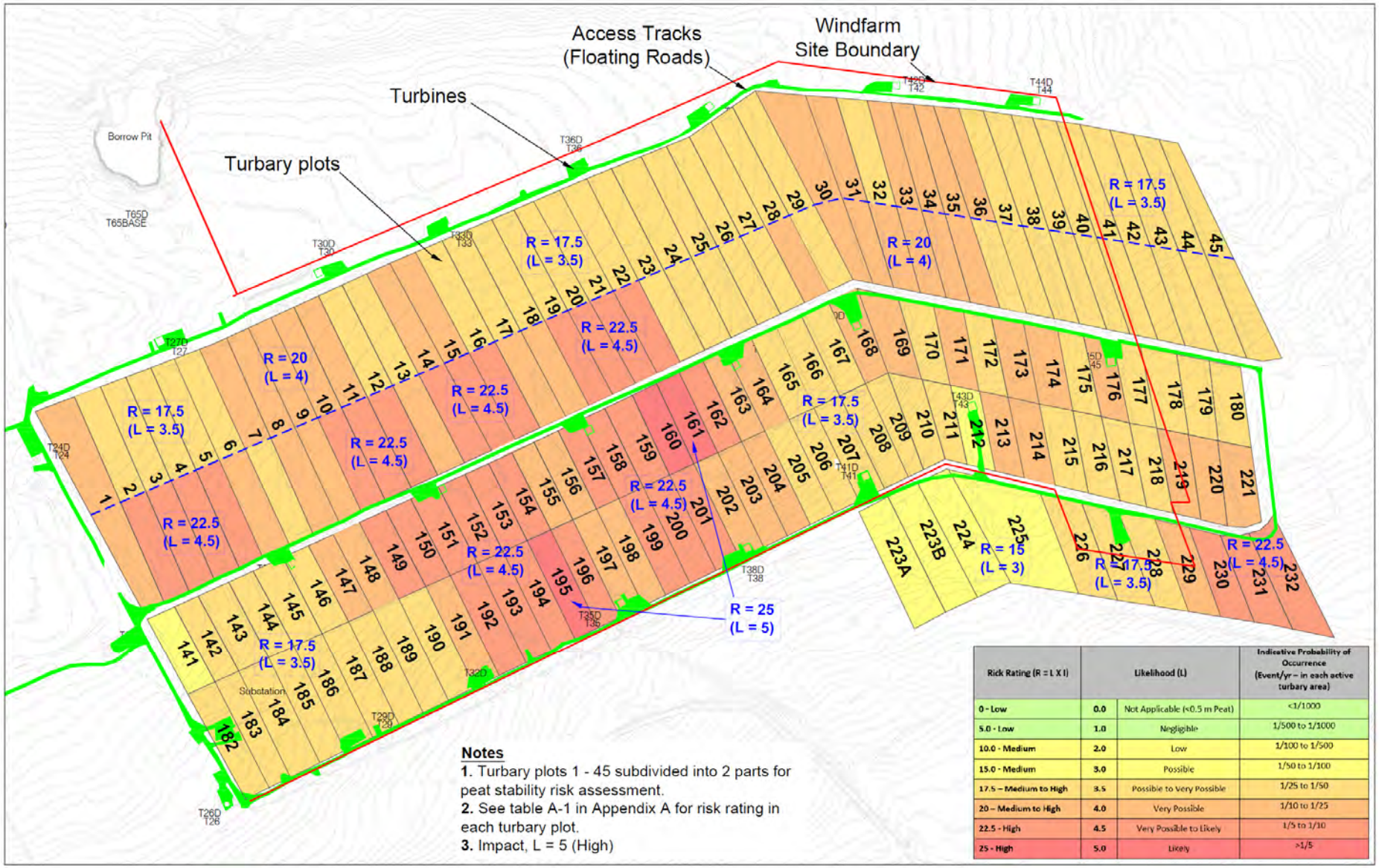
As stated previously, the likelihood of a peat failure in this assessment includes the full range of failures that could occur as a result of mechanical peat harvesting in the turbary plots - from a localised shear failure in the peat on the upslope side of an open excavation, to a small-scale peat slide that is contained within the turbary area, or a large-scale peat slide comparable to the slide that occurred at Turbine T68 on the windfarm site during construction. The likelihood of a large peat slide occurring would be comparatively lower. However, the assessment of the risk rating in this report has conservatively been calibrated by the potential impact of a large peat slide as the worst case scenario.

As summarised in Section 3.0, since 2012 mechanical peat harvesting has only being carried out in about 35 No. of the 136 No. turbary plots, not all of these are cut each year, and no mechanical peat harvesting is currently being carried out in Plots No. 182 to 207 along the southern boundary of the site, which were used for forestry by Coillte prior to the construction of the windfarm. Therefore, the risk rating for a peat failure shown on Figure 4-1 is limited to those areas where mechanical peat harvesting is actually carried out on the site

The risk rating for a peat failure is also only applicable for when the mechanical peat harvesting is being carried out on the site. The active turbary plots are only cut seasonally once a year in late spring/early summer so the frequency of the risk of a peat failure in any turbary plot is **Occasional**.

Harvesting is only active in a small number of turbary plots on any day and the mechanical peat harvesting within a turbary plot only takes a few days. Therefore, the duration of the risk in each area is **Brief**.

As will be discussed in Section 7.0, the residual likelihood of a peat failure in the turbary areas when there is no mechanical peat harvesting being carried out on the site would be **Low (L=2)**. This would correspond to a **Risk Rating, R, of 10** in the worst case scenario, which is **Low to Medium** and acceptable with periodic inspections.



Rick Rating (R = L X I)	Likelihood (L)		Indicative Probability of Occurrence (Event/yr – in each active turbary area)
0 - Low	0.0	Not Applicable (<0.5 m Peat)	<1/1000
5.0 - Low	1.0	Negligible	1/500 to 1/1000
10.0 - Medium	2.0	Low	1/100 to 1/500
15.0 - Medium	3.0	Possible	1/50 to 1/100
17.5 – Medium to High	3.5	Possible to Very Possible	1/25 to 1/50
20 – Medium to High	4.0	Very Possible	1/10 to 1/25
22.5 - High	4.5	Very Possible to Likely	1/5 to 1/10
25 - High	5.0	Likely	>1/5

Figure 4-1 – Baseline Peat Stability Risk Assessment for the site – prior to implementation of risk mitigation measures

5.0 PEAT STABILITY ON THE SITE – RECENT OBSERVATIONS

No large or very large-scale peat failures have occurred in the turbary plots on or immediately adjacent to the Derrybrien Wind Farm site during construction or during the operational life of the project. However, there are 2 No. areas where localised peat instability has occurred in the turbary plots, which are identified on the aerial photograph in Figure 3-2. The failures occurred in Plots No. 161 and 30.

5.1 Plot 161

Plate 5-1 shows an image of the peat failure that has occurred at the south (downslope) end of Turbary Plot No. 161, which is directly upslope from Turbine T38.

The slide occurred as a planar slide in peat up to 2.0m deep over an area of approximately 2,500m^2 on the steeper lower slopes of the turbary plot. There is a convex break in slope to angles of 5.0°-7.5° at this end, compared to slopes of 3.0°-4.0° on the upper half of the plot, near the central access track that runs between Turbines T34 and T37. The peat at the downslope end of the turbary plot has sheared along a surface at or near the base of the peat and slipped into the large open drain that runs along the southern edge of the turbary plots on this side of the site. The peat failure involved about 5,000m^3 of peat over an area of about 2,500m^2, which is a small-scale peat slide (1,000-5,000m^3).

The majority of the vegetated surface layer of the failed peat has remained intact. There are large open water-filled tension cracks at the upslope end of the failed area (Plate 5-2). At the downslope end the drain has been completely infilled and the displaced peat has "buckled" and spilled over onto the surface of the peat in the firebreak that runs along the downslope side of the open drain, where the slope angle is locally flatter (Plate 5-3).

Plate 5-1 – Peat slide in turbary plot #161 (Site Photo May 2020)

Plate 5-2 – Water-filled tension cracks at upslope end of peat slide in turbary plot #161 (AGL photo 7/5/2020)

Plate 5-3 - Infilled drain and "crumple zone" along the firebreak at the downslope end of turbary plot 161 (AGL photo 7/5/2020).

Plate 5-4 – Aerial view of slide area - 9th April, 2015 (Google Earth)

Plate 5-5 – Aerial view of slide area – 3rd July, 2018 (Google Earth)

Based on historical aerial photographs from Google Earth, the peat slide initiated sometime between April 2015 (Plate 5-4), when there were no tension cracks visible, and July 2018, when the tension cracks were visible in the peat and the drain on the downslope side had closed over (Plate 5-5). By May 2020 the peat failure had extended further upslope and formed a wider area of tension cracks on the upslope side. The main body of peat at the downslope end of the failed area has also been pushed further onto the firebreak, indicating progressive downslope movement of the peat between July 2018 and May 2020. Some drainage works were carried out in 2020 to relieve ponded water in the tension cracks as a mitigation measure to prevent the slide progressing further upslope, as recommended in this report. The area was inspected again in January 2024 by AGL and appeared to be stable. There was no apparent significant upslope progression of the slide, or downslope movement of the peat within the failed area.

The peat slide was not caused by site activities related to the wind farm. The slope was intact up to April 2015, approximately 10 years after construction of the wind farm was completed, and the slide is remote to the wind turbines and site access tracks. The trench for the electrical transmission cables along the firebreak at the south end of the turbary plot was also not impacted by the peat movement.

It is likely that the slide was caused by a combination of factors including groundwater seepage from the area of deep peat upslope from the turbary plot, poor or impeded drainage within the turbary plot, undercutting of the toe of the slope for the drain that runs across the downslope end of the plot, and possibly by the surcharge loads on the peat from mechanical harvesting equipment. Recent mechanical peat harvesting has been limited to the zone upslope from the failed area. However, there is evidence of old machine track marks on the peat within the failed area and there are excavations for peat harvesting along the edge of the drain to the east and west.

5.2 Plot 30

Plate 5-6 shows an aerial view of the peat failure that has occurred at the centre of Turbary Plot No. 30. The failure occurred as planar shear failure and downslope movement of peat 1.7 to 2.7m deep over an area of approximately 2,500m^2 along the boundary with Plot No.31 to the east. There is a local shallow convex break in slope to angles of 3.0°-4.0° in the area. The peat appears to have failed upslope from an excavation for peat harvesting in Plot No. 31. The peat has moved into the excavation and closed over a section of the drain along the boundary between the two turbary plots (Plate 5-7).

The peat failure involved about 5,000m^3 of peat over an area of about 2,500m^2, which is a small-scale peat slide (1,000-5,000m^3). The majority of the vegetated surface layer of the failed peat has remained intact. However, tension cracks have opened up along the edge of the failed area, within Plot No. 30 (Plate 5-8).

Based on historical aerial photographs from Google Earth and the OSI Geohive online portal, there may have been some movement of the peat in this area prior to 2011. However, it appears that the main movement occurred and the tension cracks formed when peat was excavated from the open excavation along the drain for peat harvesting sometime around 2018. Therefore, this is the most likely cause of the recent movement. Undercutting of the toe of the slope in the drain along the site boundary would also have contributed to the peat movement.

The area was re-inspected by AGL in January 2024 and appeared to be stable. There has been no apparent further movement of the peat, and the tension cracks are not as evident because thicker vegetation has established in the area.

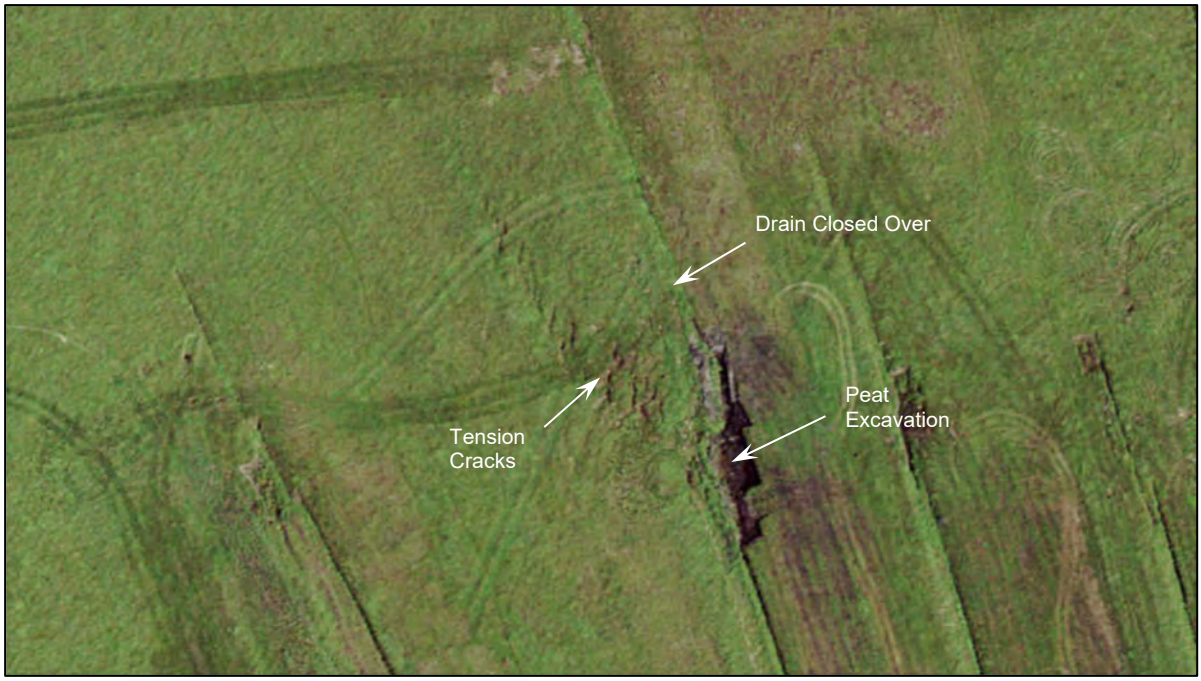


Plate 5-6 – Peat Movement in Turbary Plot #30 c2015-2018 (OSI Geohive Portal, 2020)

Plate 5-7 – Closed drain due to peat movement between turbary plots 30 and 31

Plate 5-8 – Tension cracks in the peat within the failed area (Plot 30)

5.3 Impact Assessment & Monitoring in Plot 161

Both of these peat failures involved about 5,000m^3 of peat over an area of about 2,500m^2, which are small scale peat slides (1,000-5,000m^3). The baseline sensitivity of the degraded blanket bog in the area has been classified as **Medium**. Therefore, the combined effect of the peat slides on the disturbed

peat would be classified as **Low** and only **Slightly Significant**. As these are pre-existing peat failures they will not lead to any cumulative impacts on the peat during the decommissioning of the windfarm.

Some drainage was carried out in Turbary Plot 161 in early August 2020 to relieve ponded water in the tension cracks as a mitigation measure to prevent any further movement of the peat. The details are shown on ESB Drawing No. QS-000314-01-D476-001-001-000 which is included as Figure 5-1.

Drains were hand excavated along the sides of the failed area to relieve the ponded water trapped in the tension cracks and divert it into the large open radial drain that runs east-west along the south end of the plots through this part of the site. Plot 161 is at a watershed along the drain so that the water diverted to either side of the failed area flows away from the turbary plot to the east and west. The existing drain along the west side of the turbary plot was also cleared out up to the access road between Turbines T34 and T27 at the north end of the plot. Check dams were installed in the radial drain for erosion and sediment control. The remedial drainage works were completed by early August 2020.

20 No. survey monitoring points were also installed on the surface of the peat within and around the failed area in Turbary Plot 161. The locations of the monitoring points are shown on the ESB Drawing reproduced in Figure 5-2. Points No. 10-20 are the most relevant in and around the failed area.

The location and elevation of the monitoring points was recorded to ITM coordinates by GPS survey over an initial period of 7 months between 21st May and 22nd December 2020 (Day 0 to Day 215). Follow up sets of readings were then taken on the 23rd November 2021 and again on the 23rd November, 2023.

Some of the points were damaged over the course of the monitoring period (#5, #8, #12 and #13) and had to be reset. Point No. 14 could not be located for the final set of readings in December 2021.

Figure 5-3 shows the change in the Northing coordinate for each of the monitoring points over the survey period. A negative reading represents downslope movement of the peat to the South, which would be the main direction that the failed peat could move if the slide area was unstable. Given the remote location and the variability in the readings, the degree of accuracy of the measurements is probably on the order of **+/- 10-20mm**. The peat could also exhibit movements of this order due to seasonal changes in moisture content and groundwater level.

Monitoring point MP-14 was located on the main body of displaced peat in the failed area. Although it could not be located for the set of readings taken in December 2021, the readings that were taken over the 7-month period between May and December 2020 indicated that the movement of the peg was within the range of +/-20mm (i.e. upslope/downslope), which is within the expected range of accuracy and indicates that main body of peat in the failed area is stable.

MP-17 to MP-20 were located along the approximate line of the wind farm underground cables along the south side of the drain downslope from the turbary plots in this area. MP-18 and MP-19 are on the downslope side of the peat slide. By November 2021 MP-18 and MP-19 had moved downslope by **<5mm** and **<25mm**, respectively. Most of this movement was recorded prior to the end of June 2020, which indicates that there has been no further movement in the peat downslope from the failed area since then. The failed peat is being supported by the buttressing effect of the intact peat downslope from the turbary plot. More recently an upslope change in position was recorded between the readings taken in 2021 and 2023. This could be an error or the survey pegs may have been disturbed. Nevertheless, the movements are slight and there is no indication of any significant downslope movement at this end of the slide, which confirms that the area of failed peat is stable.

Downslope movement of **60 mm** and **120mm** has been recorded at monitoring points MP-11 and MP-15, which are located on the surface of blocks of peat between tension cracks in and around the margins of the failed area. This is consistent with the movement that could occur in these areas due to the potential for the displaced blocks of peat to move or slump downslope into the tension cracks,

particularly when the ponded water was drained away. Significant eastward displacement of approximately 500mm was also recorded at MP-15, which is consistent with the location of the peg on the west side of the slide area. This is directly upslope from MP-18 where no downslope movement has been recorded. This indicates that the movement at MP-15 is localised displacement along the margins of the failed area, which is to be expected. MP-11 has been stable since 2021.

Downslope movement of about **50mm** has been recorded at monitoring point MP-16, which is on intact peat at the downslope end of Turbary Plot #159, to the west of the failed area. The aerial photo in Figure 5-1 indicates that the arterial drain at the south end of this plot could have partially closed over. This would be consistent with the movement that was recorded at MP-16 and identifies the risk of a potential peat failure in this area if any further mechanical peat extraction is carried out along the drain at the south end of the turbary plot, which could undermine the slope. MP-16 has been stable since 2011 and no downslope movement was recorded at MP-17 on the southern bank of the arterial drain, which indicates that the potential movement in the peat is localised to the upslope side of the drain.

The movements recorded at MP-1 to MP-10 and at MP-12 in 2023 were all very low and possibly within the degree of accuracy of the survey readings (i.e. ±10-15mm). Therefore, they indicate that the peat upslope from the failed area is stable, and that the peat slide has not progressed further upslope from the extent observed in Turbary Plot 161 in 2020.

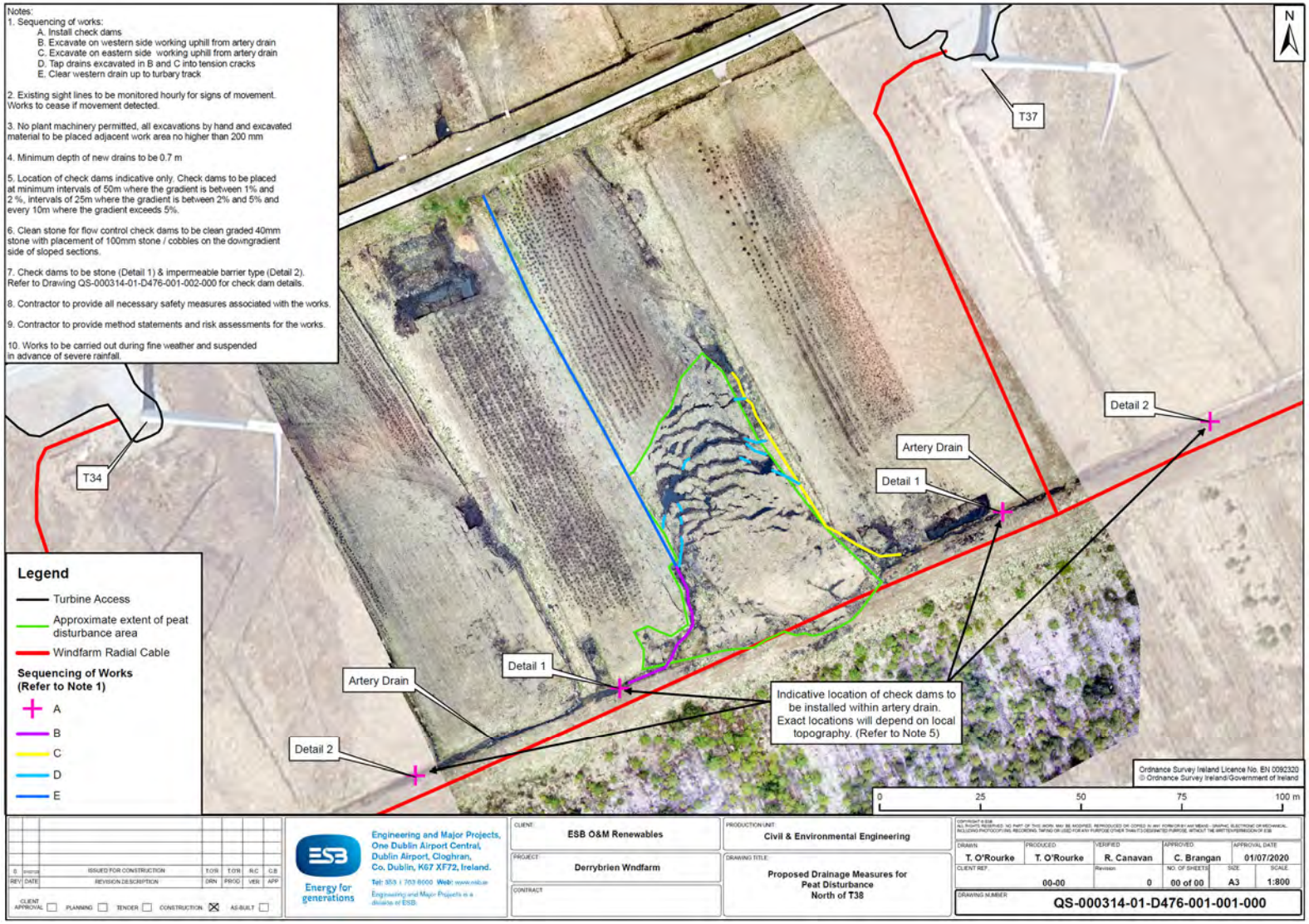


Figure 5-1 – Drainage works carried out in early August 2020 to relieve water pressures in zone of peat failure in Turbary Plot 161

Figure 5-2 – Survey monitoring points on the surface of the peat in and around the zone of peat failure in Turbary Plot 161

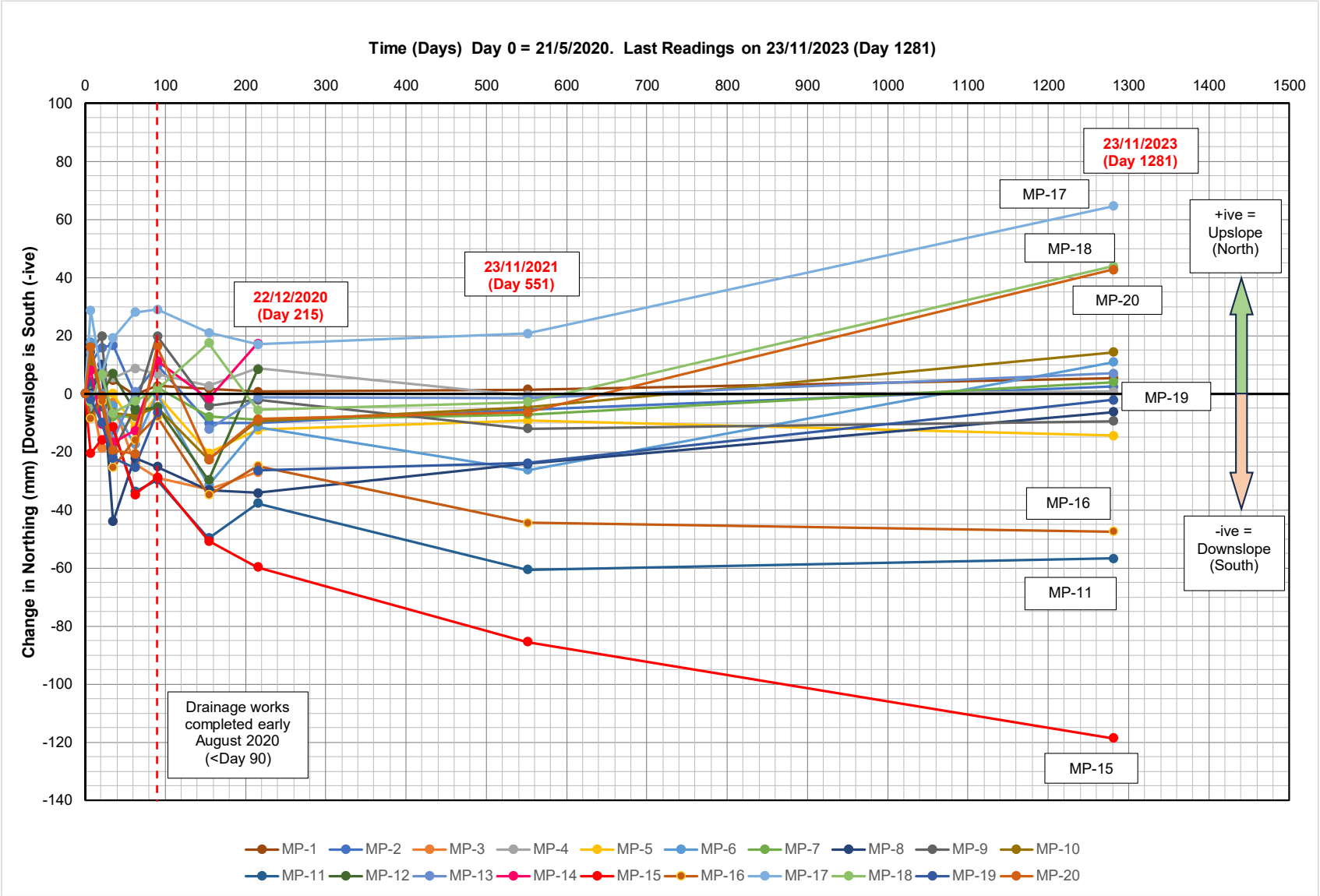


Figure 5-3 – Surveyed movement of monitoring points in zone of peat failure in Turbary Plot 161 in 2020/2021 (Day 0 = 21/5/2020)

6.0 MITIGATION AND MONITORING

As discussed in Section 1.2.1.3, effective risk mitigation measures can be used to reduce the Likelihood of a peat failure to a low level, even in high risk zones. Therefore, this section of the report presents the recommended mitigation measures for future mechanical peat harvesting in the turbary plots to reduce the risk of a peat failure to an acceptable level over the remaining operational life of the Derrybrien Windfarm and during decommissioning.

6.1 Turbary Areas where L=4.0 to 5.0 (Very Possible to Likely) for Mechanical Peat Harvesting Prior to Mitigation Measures

It is recommended that the following mitigation and monitoring measures should be implemented for the areas where the interpreted likelihood of a peat failure due to mechanical harvesting prior to mitigation measures is **Very Possible to Likely (L=4.0 to 5.0)**:

- No mechanical peat harvesting should be carried out in these areas during the decommissioning stage of the wind farm.
- Turf cutting can be carried out by hand excavation but should only be done during the months of May to September.
- Drainage works should be carried out where necessary between May and September to clear out blocked drains and to maintain the capacity and efficiency of the existing drainage network.
- The turbary plots and site drainage should be inspected in the periodic inspections by ESB Engineering & Major Projects, particularly where the small peat failures occurred in Plots #161 and #30.
- In area of the small-scale peat slide in Plot #161:
    - Additional drainage measures should be implemented by hand excavation to relieve water pressures in the tension cracks at the upslope end of the slide area;
    - The east-west collector drain running along the south end of the turbary plots in this area should be cleared out where necessary to ensure that the water is draining away from the failed area along the length of the drain to the east and west;
    - Monitoring points that have been established on the surface of the peat within the slide area should be surveyed periodically along with aerial drone surveys and photographs to monitor for further peat movement;
    - No mechanical peat harvesting should be carried out within the slide area.
- In area of the localised peat failure in Plot #30
    - Additional drainage measures should be implemented by hand excavation to relieve water pressures in the tension cracks and drain along the boundary between plots #30 and 31.
    - No further mechanical peat harvesting should be carried out in the zone of failed peat.

6.2 Turbary Areas where L=3.0 to 3.5 (Possible to Very Possible) for Mechanical Peat Harvesting Prior to Mitigation Measures

It is recommended that the following mitigation and monitoring measures should be implemented for the areas where the interpreted likelihood of a peat failure due to mechanical harvesting prior to mitigation measures is **Possible to Very Possible (L=3.0 to 3.5)**:

- Drainage works should be carried out in these areas between May and September, where necessary, to clear out blocked drains and to maintain the capacity and efficiency of the existing drainage network.
- No further peat harvesting by saw cutting should be carried out in the peat;
- Turf cutting can be carried out by hand excavation but should only be done during the months of May to September.
- The following restrictions and operational control measures should be implemented for mechanical peat harvesting by hydraulic excavator and sod hopper in the turbary plots:
    - The works should only be carried out between the months of May and September, inclusive;
    - The hydraulic excavator should be limited to a low ground bearing pressure (LGBP) wide-tracked excavator with a maximum operating weight of 10 tonnes;
    - The hopper should be limited to a LGBP wide-track sod machine, or equivalent rubber tyred machine, with an operating weight <5 tonnes when empty;
    - The volume of peat placed in the hopper for each load should be limited so that the maximum bearing pressure under the tracks or wheels is 12.5kN/m^2;
    - The contractor should adopt good practice when operating plant and machinery on the bog to avoid damaging the surface of the peat by excessive tracking, turning or track rotation;
    - The hopper and excavator should not be positioned on peat directly upslope from open peat excavations when the hopper is being loaded;
    - The excavator operator should monitor the stability of the excavated peat face and should backfill the excavation and stop mechanical peat harvesting immediately if any instability or peat movement is observed at any stage over the course of the works;
    - No further mechanical peat harvesting should be carried out in areas where instability or peat movement is observed;
    - The contractor should ensure that none of the existing drains are blocked or damaged over the course of the works, and that no surface water ponds in the areas where the peat has been excavated.
- Communication should be established between the turbary plot owners, turf cutting contractors and the windfarm site manager for Gort Wind Farms Ltd. to coordinate the works on site, i.e.:
    - The turbary plot owner and/or turf cutting contractor should notify the windfarm site manager at least 1 week in advance of starting the works on site.
    - The turbary plot owner and/or turf cutting contractor should notify the windfarm site manager if any peat instability is observed;
- Periodic inspections of the mechanical peat harvesting should be carried out by the wind farm site manager;
- No mechanical peat harvesting should be carried out during decommissioning of the wind farm.

6.3 Mitigation Measures Implemented by Gort Wind Farms Ltd.

The potential impacts of mechanical peat harvesting on the wind farm site will not arise as a direct result of activities related to the wind farm, but from the separate and unrelated activities for mechanical peat harvesting in the turbary areas under established turbary rights, which are outside of the control of Gort Wind Farms Ltd. Therefore, the following mitigation measures have been implemented by Gort Wind Farms Ltd to reduce the likelihood of a peat failure occurring:

- The peat stability risk assessment and the associated mitigation measures have been shared with the turbary rights holders whose plots have been or are proposed to be harvested by mechanical means, and the turbary rights holders have been made aware of the potential site stability risks associated with mechanical peat harvesting methods in the absence of mitigation;
- Warning signs have been erected at the site by Gort Wind Farms Ltd. to raise awareness of the peat stability risks associated with mechanical peat harvesting in the turbary area and to highlight the recommended mitigation measures;
- Where possible, communication has been established between the turbary plot owners, turf cutting contractors and the windfarm site manager for Gort Wind Farms Ltd. to establish procedures to give notice of mechanical peat harvesting activities and to report any peat instability on the site;
- Gort Wind Farms Ltd. have implemented the recommended remedial drainage works and survey monitoring in the failed area at the south end of Turbary Plot 161 to ensure that the peat there is stable.
- Periodic inspections of the mechanical peat harvesting are being carried out by the wind farm site manager for Gort Wind Farms Ltd.

Drainage works were carried out in Turbary Plot 161 in early August 2020 to relieve ponded water in the tension cracks as a mitigation measure to prevent any further movement of the peat. The details are shown on ESB Drawing No. QS-000314-01-D476-001-001-000 which is included as Figure 5-1.

Drains were hand excavated along the sides of the failed area to relieve the ponded water trapped in the tension cracks and divert it into the large open radial drain that runs east-west along the south end of the plots through this part of the site. Plot 161 is at a watershed along the drain so that the water diverted to either side of the failed area flows away from the turbary plot to the east and west. The existing drain along the west side of the turbary plot was also cleared out up to the access road between Turbines T34 and T27 at the north end of the plot. Check dams were installed in the radial drain for erosion and sediment control. The remedial drainage works were completed by early August 2020.

Any further maintenance that is required to maintain the existing drainage network will be carried out during decommissioning of the wind farm.

7.0 PEAT STABILITY RISK ASSESSMENT (PSRA) - AFTER IMPLEMENTATION OF MITIGATION MEASURES

Warning signs will be erected at the site by Gort Wind Farms Ltd. to raise awareness of the peat stability risks associated with mechanical peat harvesting in the turbary area and to highlight the mitigation measures recommended in Section 6.0 of this report. This peat stability risk assessment and the associated mitigation measures will also be shared with the turbary rights holders whose plots have been harvested by mechanical means. Where the mitigation measures are implemented, then the likelihood of a peat failure occurring as a result of mechanical peat harvesting in the turbary plots will reduce to a residual level of **Low (L=2),** as shown on Figure 7-1.

Gort Wind Farms Ltd. will implement the monitoring and remedial drainage works recommended for the areas where the peat failures occurred in Turbary Plots 161 and 30 and the areas will be inspected by geotechnical engineers from ESB Engineering & Major Projects during their periodic windfarm inspections. The windfarm site manager will also carry out periodic inspections of mechanical peat harvesting works that are active on the site over the remaining operational life of the windfarm.

No further measures are scheduled to mitigate the potential Impact of a peat slide in the area over the remaining operational life of the windfarm. Therefore, we have conservatively assumed that the Impact of a peat failure related to mechanical peat harvesting in the turbary plots will remain as **High (I=5)** to represent the worst case scenario of a large peat slide occurring at the site.

This would correspond to a **Risk Rating, R, of 10**, which is **Low to Medium** and acceptable with periodic inspections.

This would also represent the current residual level of risk with no mechanical peat harvesting in the turbary areas in their existing condition.

Plots #41-45, #178-180, #219-221, #223A, #223B, #224-232 are outside the boundary of the windfarm site. Due to the topography in the area, a peat failure in the turbary plots should not impact the windfarm as none of the windfarm infrastructure is in the potential flow path of a peat slide.

Between Turbines T41 and T45 the windfarm site access track was constructed as a floating road along the edge of turbary plots 223A, 223B and 224 to 227. However, the turbary plots are downslope from the track, the peat is generally shallow in the area (typ. <1.0m) and the site conditions in terms of topography and hydrology are relatively good in the area, which is reflected in the comparatively lower Likelihood of a peat failure due to mechanical peat harvesting prior to mitigation measures, as shown on Figure 4-1 (i.e. L=3.0). Therefore, there would be a low risk of the windfarm access track being impacted by a peat failure in the turbary plots. The turbines and crane hardstanding are constructed on the glacial till and rock below the peat so there is a negligible risk of them being impacted by a peat failure in the adjacent turbary plots downslope.

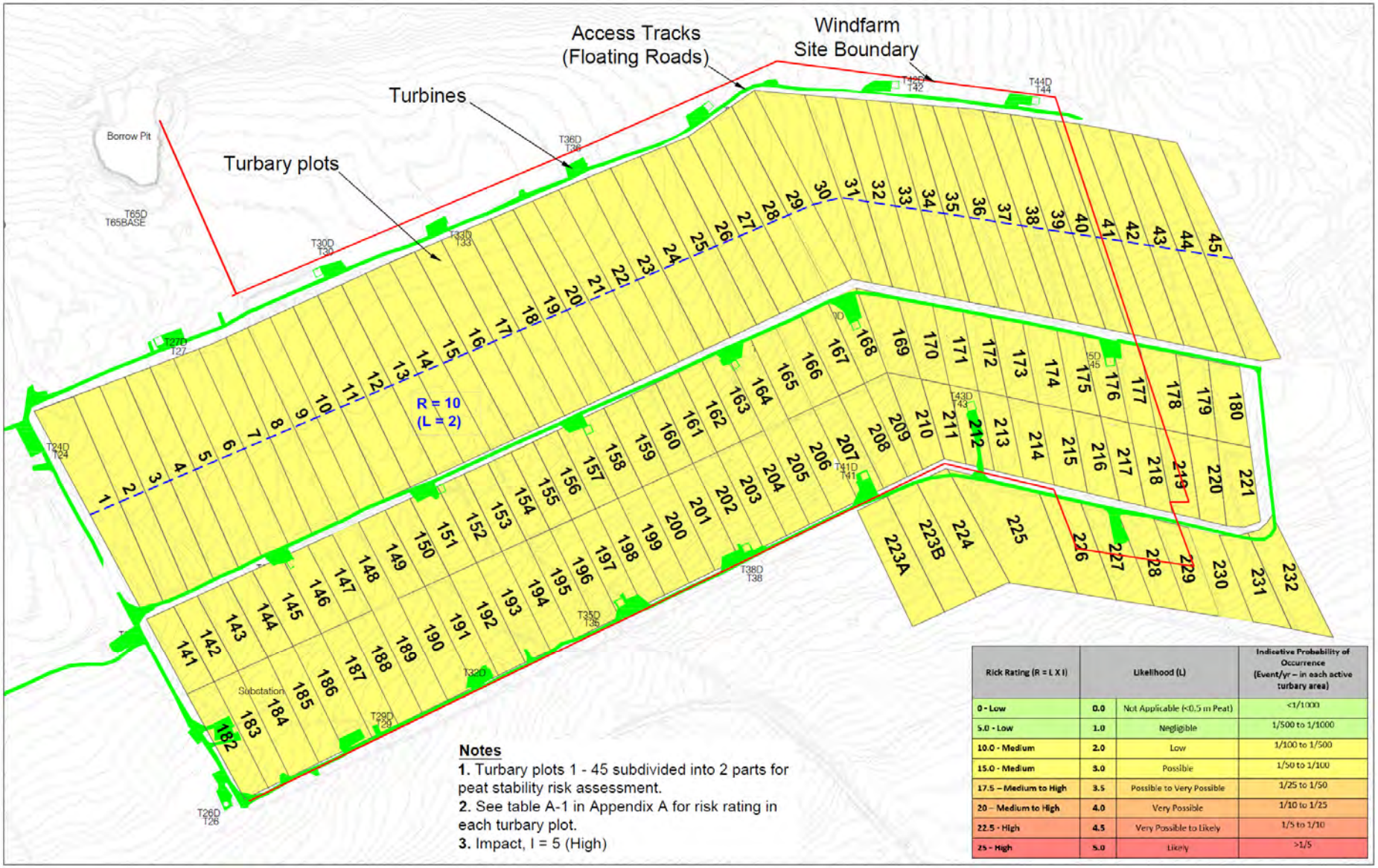


Figure 7-1 – Peat Stability Risk Assessment for turbary areas after implementation of mitigation measures

8.0 REFERENCES

1. Clayton, C.R.I, (2001) *Managing Geotechnical Risk: Improving Productivity in UK Building and Construction*, Published by the Department of the Environment, Transport and the Regions, and the Institution of Civil Engineers (Great Britain)
2. Scottish Government, Energy Consent Unit (2017) - *"Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Projects* (2nd Edition, April 2017).

APPENDIX A

RESULTS OF PEAT STABILTY RISK ASSESSMENT (PSRA)
FOR TURBARY AREAS

Table A-1 - Peat Stability Risk Assessment for Turbary Plots

Turbary Plot No.	North End									South End								
	Peat/Subsoil Conditions	Topography	FoS Calculations	Hydrology/ Hydrogeology	Other Contributary Factors	Total Hazard Rating	Likelihood (L)	Impact (I)	Risk Rating (R = LxI)	Peat/Subsoil Conditions	Topography	FoS Calculations	Hydrology/ Hydrogeology	Other Contributary Factors	Total Hazard Rating	Likelihood (L)	Impact (I)	Risk Rating (R = LxI)
1	15	15	10	15	15	70.0	4.0	5.0	20.0	20	15	10	10	15	70	**4.0**	5.0	**20.0**
2	15	15	10	10	10	60.0	3.5	5.0	17.5	20	15	10	15	20	80	**4.5**	5.0	**22.5**
3	15	15	10	10	10	60.0	3.5	5.0	17.5	15	15	15	15	20	80	**4.5**	5.0	**22.5**
4	15	15	10	10	10	60.0	3.5	5.0	17.5	15	15	15	15	20	80	**4.5**	5.0	**22.5**
5	15	10	10	15	10	60.0	3.5	5.0	17.5	15	15	15	15	20	80	**4.5**	5.0	**22.5**
6	20	10	10	15	10	65.0	3.5	5.0	17.5	15	15	10	15	20	75	**4.0**	5.0	**20.0**
7	20	10	15	15	15	75.0	4.0	5.0	20.0	15	10	15	10	10	60	**3.5**	5.0	**17.5**
8	20	10	15	15	15	75.0	4.0	5.0	20.0	20	10	15	15	15	75	**4.0**	5.0	**20.0**
9	20	10	10	15	20	75.0	4.0	5.0	20.0	20	10	10	15	15	70	**4.0**	5.0	**20.0**
10	20	10	10	15	20	75.0	4.0	5.0	20.0	20	10	15	15	20	80	**4.5**	5.0	**22.5**
11	20	10	10	15	20	75.0	4.0	5.0	20.0	20	10	15	15	20	80	**4.5**	5.0	**22.5**
12	20	10	10	10	10	60.0	3.5	5.0	17.5	20	10	15	15	20	80	**4.5**	5.0	**22.5**
13	20	10	10	10	10	60.0	3.5	5.0	17.5	20	10	15	10	20	75	**4.0**	5.0	**20.0**
14	20	10	10	15	20	75.0	4.0	5.0	20.0	20	10	15	15	20	80	**4.5**	5.0	**22.5**
15	20	10	10	15	20	75.0	4.0	5.0	20.0	20	10	15	15	20	80	**4.5**	5.0	**22.5**
16	20	10	10	10	15	65.0	3.5	5.0	17.5	20	10	15	15	20	80	**4.5**	5.0	**22.5**
17	20	10	10	10	10	60.0	3.5	5.0	17.5	20	10	15	10	15	70	**4.0**	5.0	**20.0**
18	20	10	10	10	10	60.0	3.5	5.0	17.5	20	10	15	10	15	70	**4.0**	5.0	**20.0**
19	20	10	10	10	10	60.0	3.5	5.0	17.5	20	10	15	15	20	80	**4.5**	5.0	**22.5**
20	20	10	10	10	10	60.0	3.5	5.0	17.5	20	10	15	15	20	80	**4.5**	5.0	**22.5**
21	20	10	10	10	15	65.0	3.5	5.0	17.5	20	10	15	15	20	80	**4.5**	5.0	**22.5**
22	20	10	10	10	10	60.0	3.5	5.0	17.5	20	10	15	15	20	80	**4.5**	5.0	**22.5**
23	20	10	10	10	10	60.0	3.5	5.0	17.5	20	15	10	10	10	65	**3.5**	5.0	**17.5**
24	20	10	10	10	10	60.0	3.5	5.0	17.5	15	15	10	10	10	60	**3.5**	5.0	**17.5**

Table A-1 - Peat Stability Risk Assessment for Turbary Plots

Turbary Plot No.	North End									South End								
	Peat/Subsoil Conditions	Topography	FoS Calculations	Hydrology/ Hydrogeology	Other Contributary Factors	Total Hazard Rating	Likelihood (L)	Impact (I)	Risk Rating (R = LxI)	Peat/Subsoil Conditions	Topography	FoS Calculations	Hydrology/ Hydrogeology	Other Contributary Factors	Total Hazard Rating	Likelihood (L)	Impact (I)	Risk Rating (R = LxI)
25	20	10	10	10	10	60.0	3.5	5.0	17.5	15	15	10	10	10	60	**3.5**	5.0	**17.5**
26	20	10	10	10	15	65.0	3.5	5.0	17.5	15	15	10	10	15	65	**3.5**	5.0	**17.5**
27	20	10	10	10	15	65.0	3.5	5.0	17.5	20	15	10	10	10	65	**3.5**	5.0	**17.5**
28	20	10	10	10	10	60.0	3.5	5.0	17.5	20	15	10	10	15	70	**4.0**	5.0	**20.0**
29	20	10	10	10	10	60.0	3.5	5.0	17.5	20	15	10	10	10	65	**3.5**	5.0	**17.5**
30	20	15	15	10	15	75.0	4.0	5.0	20.0	20	20	15	10	10	75	**4.0**	5.0	**20.0**
31	20	10	10	15	15	70.0	4.0	5.0	20.0	20	20	10	10	15	75	**4.0**	5.0	**20.0**
32	20	10	10	10	15	65.0	3.5	5.0	17.5	20	15	10	10	15	70	**4.0**	5.0	**20.0**
33	20	15	15	10	10	70.0	4.0	5.0	20.0	20	15	15	10	15	75	**4.0**	5.0	**20.0**
34	20	15	15	10	15	75.0	4.0	5.0	20.0	20	15	15	10	15	75	**4.0**	5.0	**20.0**
35	20	15	15	10	15	75.0	4.0	5.0	20.0	15	15	15	10	15	70	**4.0**	5.0	**20.0**
36	20	15	15	10	10	70.0	4.0	5.0	20.0	15	15	15	10	10	65	**3.5**	5.0	**17.5**
37	20	10	15	10	10	65.0	3.5	5.0	17.5	15	15	15	10	10	65	**3.5**	5.0	**17.5**
38	20	10	10	10	10	60.0	3.5	5.0	17.5	15	15	10	10	10	60	**3.5**	5.0	**17.5**
39	20	10	10	10	10	60.0	3.5	5.0	17.5	15	15	10	10	10	60	**3.5**	5.0	**17.5**
40	20	10	10	10	15	65.0	3.5	5.0	17.5	15	15	10	10	15	65	**3.5**	5.0	**17.5**
41	20	10	10	10	15	65.0	3.5	5.0	17.5	15	15	10	10	15	65	**3.5**	5.0	**17.5**
42	20	10	10	10	10	60.0	3.5	5.0	17.5	15	15	10	10	15	65	**3.5**	5.0	**17.5**
43	20	10	10	10	15	65.0	3.5	5.0	17.5	15	15	10	10	15	65	**3.5**	5.0	**17.5**
44	20	10	10	10	15	65.0	3.5	5.0	17.5	15	15	10	10	15	65	**3.5**	5.0	**17.5**
45	20	10	10	10	10	60.0	3.5	5.0	17.5	15	15	10	10	10	60	**3.5**	5.0	**17.5**

Table A-1 - Peat Stability Risk Assessment for Turbary Plots

Turbary Plot No.	Peat/Subsoil Conditions	Topography	FoS Calculations	Hydrology/ Hydrogeology	Other Contributary Factors	Total Hazard Rating	Likelihood (L)	Impact (I)	Risk Rating (R = LxI)
141	10	15	10	10	10	55	**3.0**	5.0	**15.0**
142	10	15	10	10	15	60	**3.5**	5.0	**17.5**
143	15	15	10	10	10	60	**3.5**	5.0	**17.5**
144	15	15	10	10	10	60	**3.5**	5.0	**17.5**
145	15	15	10	10	10	60	**3.5**	5.0	**17.5**
146	20	10	10	10	15	65	**3.5**	5.0	**17.5**
147	20	10	10	15	15	70	**4.0**	5.0	**20.0**
148	15	10	15	15	20	75	**4.0**	5.0	**20.0**
149	20	15	15	15	20	85	**4.5**	5.0	**22.5**
150	20	15	15	15	20	85	**4.5**	5.0	**22.5**
151	20	15	15	15	20	85	**4.5**	5.0	**22.5**
152	20	15	15	15	20	85	**4.5**	5.0	**22.5**
153	20	15	15	15	20	85	**4.5**	5.0	**22.5**
154	15	20	15	15	20	85	**4.5**	5.0	**22.5**
155	10	20	15	15	20	80	**4.0**	5.0	**20.0**
156	15	20	15	10	15	75	**4.0**	5.0	**20.0**
157	20	20	15	10	15	80	**4.5**	5.0	**22.5**
158	20	20	15	10	20	85	**4.5**	5.0	**22.5**
159	15	20	15	15	20	85	**4.5**	5.0	**22.5**
160	20	20	15	15	20	90	**5.0**	5.0	**25.0**
161	20	20	15	15	20	90	**5.0**	5.0	**25.0**
162	20	20	15	10	15	80	**4.5**	5.0	**22.5**
163	15	20	15	10	10	70	**4.0**	5.0	**20.0**
164	15	15	15	10	15	70	**4.0**	5.0	**20.0**
165	15	20	10	10	10	65	**3.5**	5.0	**17.5**
166	15	20	10	10	10	65	**3.5**	5.0	**17.5**
167	15	20	10	10	10	65	**3.5**	5.0	**17.5**
168	15	20	15	10	15	75	**4.0**	5.0	**20.0**
169	15	20	15	10	10	70	**4.0**	5.0	**20.0**
170	10	20	15	10	10	65	**3.5**	5.0	**17.5**
171	15	20	15	10	10	70	**4.0**	5.0	**20.0**

Table A-1 - Peat Stability Risk Assessment for Turbary Plots

Turbary Plot No.	Peat/Subsoil Conditions	Topography	FoS Calculations	Hydrology/ Hydrogeology	Other Contributary Factors	Total Hazard Rating	Likelihood (L)	Impact (I)	Risk Rating (R = LxI)
172	15	20	10	10	10	65	**3.5**	5.0	**17.5**
173	15	20	15	10	10	70	**4.0**	5.0	**20.0**
174	15	20	15	10	10	70	**4.0**	5.0	**20.0**
175	10	20	15	10	10	65	**3.5**	5.0	**17.5**
176	15	20	15	10	15	75	**4.0**	5.0	**20.0**
177	20	10	10	10	10	60	**3.5**	5.0	**17.5**
178	20	10	10	10	10	60	**3.5**	5.0	**17.5**
179	20	10	10	10	10	60	**3.5**	5.0	**17.5**
180	20	10	10	10	10	60	**3.5**	5.0	**17.5**
182	15	15	10	10	10	60	**3.5**	5.0	**17.5**
183	15	15	10	10	10	60	**3.5**	5.0	**17.5**
184	15	15	10	10	10	60	**3.5**	5.0	**17.5**
185	15	15	10	10	10	60	**3.5**	5.0	**17.5**
186	15	15	10	10	10	60	**3.5**	5.0	**17.5**
187	15	15	10	10	10	60	**3.5**	5.0	**17.5**
188	20	15	10	10	10	65	**3.5**	5.0	**17.5**
189	20	15	10	10	10	65	**3.5**	5.0	**17.5**
190	15	15	10	10	10	60	**3.5**	5.0	**17.5**
191	10	20	10	15	15	70	**4.0**	5.0	**20.0**
192	10	20	15	15	20	80	**4.5**	5.0	**22.5**
193	15	20	15	15	20	85	**4.5**	5.0	**22.5**
194	20	20	15	10	20	85	**4.5**	5.0	**22.5**
195	20	20	15	15	20	90	**5.0**	5.0	**25.0**
196	15	20	15	15	15	80	**4.5**	5.0	**22.5**
197	15	20	15	10	10	70	**4.0**	5.0	**20.0**
198	15	20	15	10	10	70	**4.0**	5.0	**20.0**
199	15	20	15	15	20	85	**4.5**	5.0	**22.5**
200	15	20	15	15	20	85	**4.5**	5.0	**22.5**
201	15	20	15	15	15	80	**4.5**	5.0	**22.5**
202	15	20	15	10	15	75	**4.0**	5.0	**20.0**
203	15	20	15	10	10	70	**4.0**	5.0	**20.0**

Table A-1 - Peat Stability Risk Assessment for Turbary Plots

Turbary Plot No.	Peat/Subsoil Conditions	Topography	FoS Calculations	Hydrology/ Hydrogeology	Other Contributary Factors	Total Hazard Rating	Likelihood (L)	Impact (I)	Risk Rating (R = LxI)
204	15	20	15	10	10	70	**4.0**	5.0	**20.0**
205	15	20	10	10	10	65	**3.5**	5.0	**17.5**
206	15	20	10	10	10	65	**3.5**	5.0	**17.5**
207	15	20	10	10	10	65	**3.5**	5.0	**17.5**
208	15	20	10	10	10	65	**3.5**	5.0	**17.5**
209	10	20	10	10	10	60	**3.5**	5.0	**17.5**
210	15	20	10	10	10	65	**3.5**	5.0	**17.5**
211	15	15	10	10	10	60	**3.5**	5.0	**17.5**
212	10	15	10	10	10	55	**3.0**	5.0	**15.0**
213	20	15	15	10	10	70	**4.0**	5.0	**20.0**
214	20	15	15	10	10	70	**4.0**	5.0	**20.0**
215	20	15	10	10	10	65	**3.5**	5.0	**17.5**
216	20	15	10	10	10	65	**3.5**	5.0	**17.5**
217	20	15	10	10	10	65	**3.5**	5.0	**17.5**
218	20	15	10	10	10	65	**3.5**	5.0	**17.5**
219	20	15	10	10	15	70	**4.0**	5.0	**20.0**
220	20	15	10	10	15	70	**4.0**	5.0	**20.0**
221	20	20	10	10	15	75	**4.0**	5.0	**20.0**
223A	10	10	10	15	10	55	**3.5**	5.0	**17.5**
223B	10	15	10	10	10	55	**3.5**	5.0	**17.5**
224	10	15	10	10	10	55	**3.0**	5.0	**15.0**
225	10	15	10	10	10	55	**3.0**	5.0	**15.0**
226	15	15	10	10	10	60	**3.5**	5.0	**17.5**
227	15	15	10	10	10	60	**3.5**	5.0	**17.5**
228	15	20	10	10	10	65	**3.5**	5.0	**17.5**
229	15	20	10	10	15	70	**4.0**	5.0	**20.0**
230	20	20	15	10	15	80	**4.5**	5.0	**22.5**
231	20	20	15	10	15	80	**4.5**	5.0	**22.5**
232	20	20	15	10	15	80	**4.5**	5.0	**22.5**

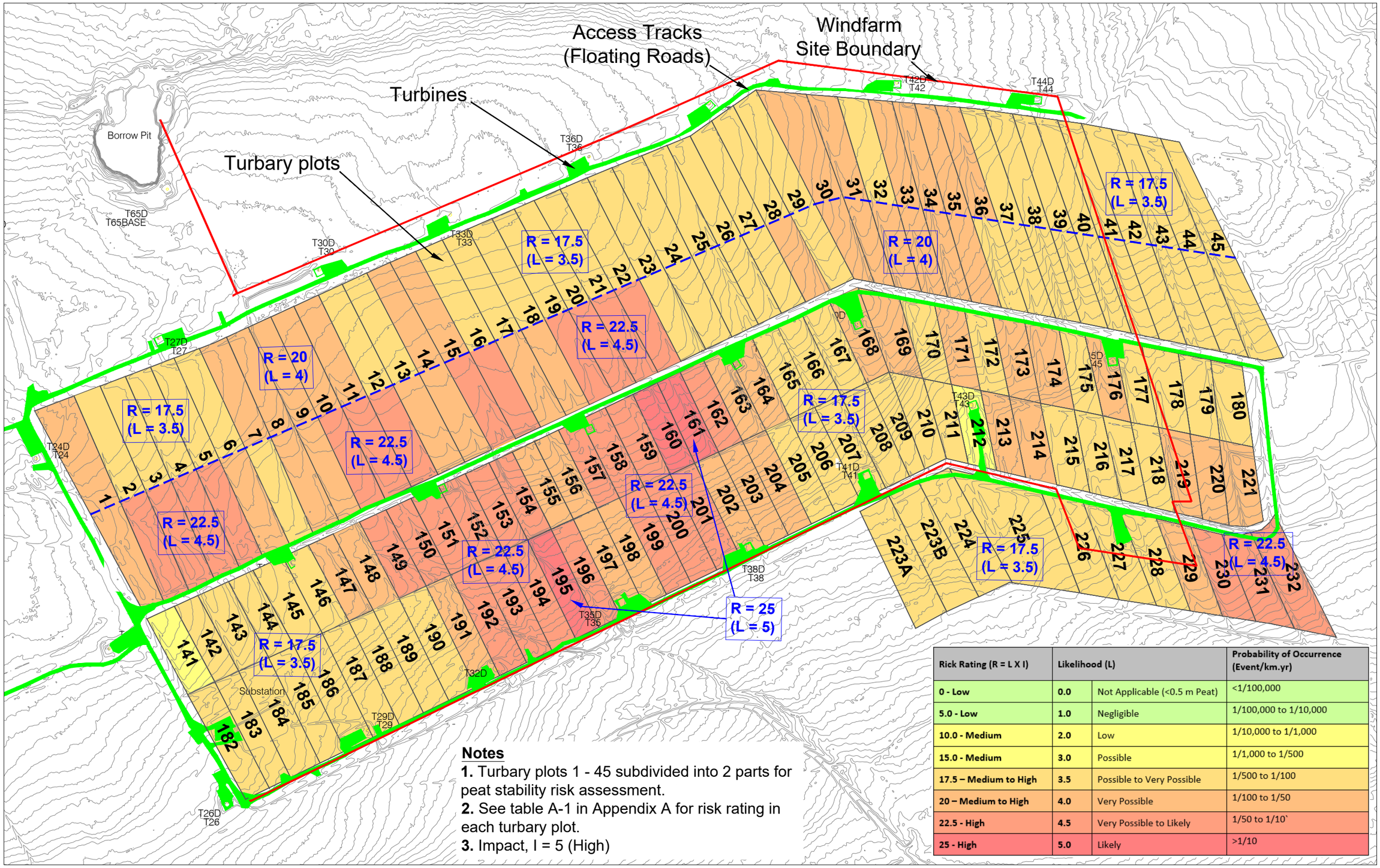
TABLE A1 – PEAT/SUBSOIL CONDITIONS	Rating			
	Negligible	Low	Medium	High
Peat				
Peat Depth	<0.5 m	0.5 - 1.0	1.0 - 2.0	>2.0
Water Content	0-500%	500-1000%	1000-1500%	>1500%
Min Peak Undrained Shear Strength	>20 kPa	10-20 kPa	5-10 kPa	<=5 kPa
Peat Classification at c_u min	Very Fibrous	Fibrous	Pseudo-Fibrous/Slightly Fibrous	Amorphous/ Clayey
Stability of peat in trial pits	Stable	Slight spalling	Collapse @ >3 m Depth	Collapse/squeezing <3 m Depth
Very Soft Clay Layer Below Peat [applies to uniform clay of high plasticity, & excludes well-graded gravelly Cohesive Glacial Till or decomposed rock]				
Very soft clay layer at base of peat	No			Yes
Sensitivity Coefficient ($c_{u\ peak}/c_{u\ residual}$)	1.0	1.0-1.5	1.5 - 2.0	>2
Peak Undrained Shear Strength	>20 kPa	10-20 kPa	5-10 kPa	<=5 kPa
Residual Undrained Shear Strength	>20 kPa	10-20 kPa	5-10 kPa	<=5 kPa
Transition - Peat to Mineral Soil				
Sharp discontinuity (possible or potential shear plane) identified in peat or at base of peat in trial pits, probes or piston samples	No			Yes
Underlying Mineral Soil/Rock				
Granular soil/Fractured rock at base of peat	No			Yes
Nested Flat Boulders	No			Yes
Rock below Peat - Interface Characteristics	Rough/ Weathered	Rough/Fractured	Smooth Undulating	Smooth Planar

TABLE A2 - TOPOGRAPHY	Rating			
	Negligible	Low	Medium	High
Slope Angle	**Flat**	**Shallow**	**Intermediate**	**High**
Slope Angle - Ground Surface	**<1°**	**1-3°**	**3°-5°**	**>5°**
Slope Angle - Base of Peat	**<1°**	**1-3°**	**3°-5°**	**>5°**
In broad valley upslope from defined watercourses	**No**	**Yes, slopes <3°**	**Yes, slopes 3-5°**	**Yes, slopes > 5°**
Distance from topographical low-point upslope from defined watercourses	**>250 m**	**100-250 m**	**50-100 m**	**<50 m**
General slope characteristics downslope from road/turbine	**Concave**	**Planar to Concave**	**Planar to Convex**	**Convex**
Distance from break in convex slope	**>100 m**	**50-100 m**	**10-50 m**	**<10 m**

TABLE A3 – FACTOR OF SAFETY CALCULATIONS (INFINITE SLOPE)	Rating			
	Negligible	Low	Medium	High
FOS Infinite Slope - No Surcharge (Existing Condition)				
c_u = 5kPa (or minimum)	>3	2.0 - 3.0	1.5 - 2.0	<1.5
c_u = 2.5kPa (Worst Case)	>2	1.5 - 2.0	1.0 - 1.5	<1.0
FOS Infinite Slope - Surcharge of 1.0m Peat with Partial Factor = 1.3				
c_u = 5kPa (or minimum)	>3	2.0 - 3.0	1.5 - 2.0	<1.5
c_u = 2.5kPa (Worst Case)	>2	1.5 - 2.0	1.0 - 1.5	<1.0
FOS - Floating Road				
Planar Sliding (c_u = 5kPa)	>2	1.4 - 2.0	1.0 - 1.4	<1.0
Bearing Capacity	>2	1.4 - 2.0	1.0 - 1.4	<1.0
Extrusion	>2	1.4 - 2.0	1.0 - 1.4	<1.0

TABLE A4 – HYDROLOGY/HYDROGEOLOGY	Rating			
	Negligible	Low	Medium	High
Surface water	Dry	Localised/ Flowing in Drains	Ponded in drains	Springs/Surface Water
Existing drainage ditches	None/ Downslope	Varied (Gen. Downslope)	Varied (Gen. Across Slope)	Across slope
Groundwater observations in peat in trial pits.	Dry	Slight Seepage	Moderate Seepage	Strong Flow
Piping observed in trial pits	No	Slight Flow/Small Dia. (<25 mm)	Moderate Flow/Medium Dia. (25-50 mm)	Strong Flow/Large Dia. (>50 mm)
Seepage at Base of Peat	No			Yes
Evidence of piping from walkover survey	No	Possibly	Probably	Yes

TABLE A5 – OTHER CONTRIBUTORY FACTORS	Rating			
	Negligible	Low	Medium	High
Slide History				
Evidence of historic slides		General Area	On Site	<1 km
Tension Cracks in Peat				Yes
Aerial Photography				
Evidence of historic slides in area		Possibly	Probably	Yes
Evidence of subterranean drainage/piping		Possibly	Probably	Yes
Other notable contributory features		Possibly	Probably	Yes
Vegetation				
Tree Growth (Coniferous Forestry)	Good		Fair	Poor
Vegetation (no trees)	Grass/Crops	Improved Grass/Dry Heather	Wet grassland/juncus	Wetlands Sphagnum/ sedge
Land Use				
Peat Workings	None/Cutaway to <0.5 m Peat	Forestry	Turbury Plots	Sausage Cutter



Notes

1. Turbary plots 1 - 45 subdivided into 2 parts for peat stability risk assessment.

2. See table A-1 in Appendix A for risk rating in each turbary plot.

3. Impact, I = 5 (High)

Rick Rating (R = L X I)	Likelihood (L)		Probability of Occurrence (Event/km.yr)
0 - Low	0.0	Not Applicable (<0.5 m Peat)	<1/100,000
5.0 - Low	1.0	Negligible	1/100,000 to 1/10,000
10.0 - Medium	2.0	Low	1/10,000 to 1/1,000
15.0 - Medium	3.0	Possible	1/1,000 to 1/500
17.5 – Medium to High	3.5	Possible to Very Possible	1/500 to 1/100
20 – Medium to High	4.0	Very Possible	1/100 to 1/50
22.5 - High	4.5	Very Possible to Likely	1/50 to 1/10`
25 - High	5.0	Likely	>1/10

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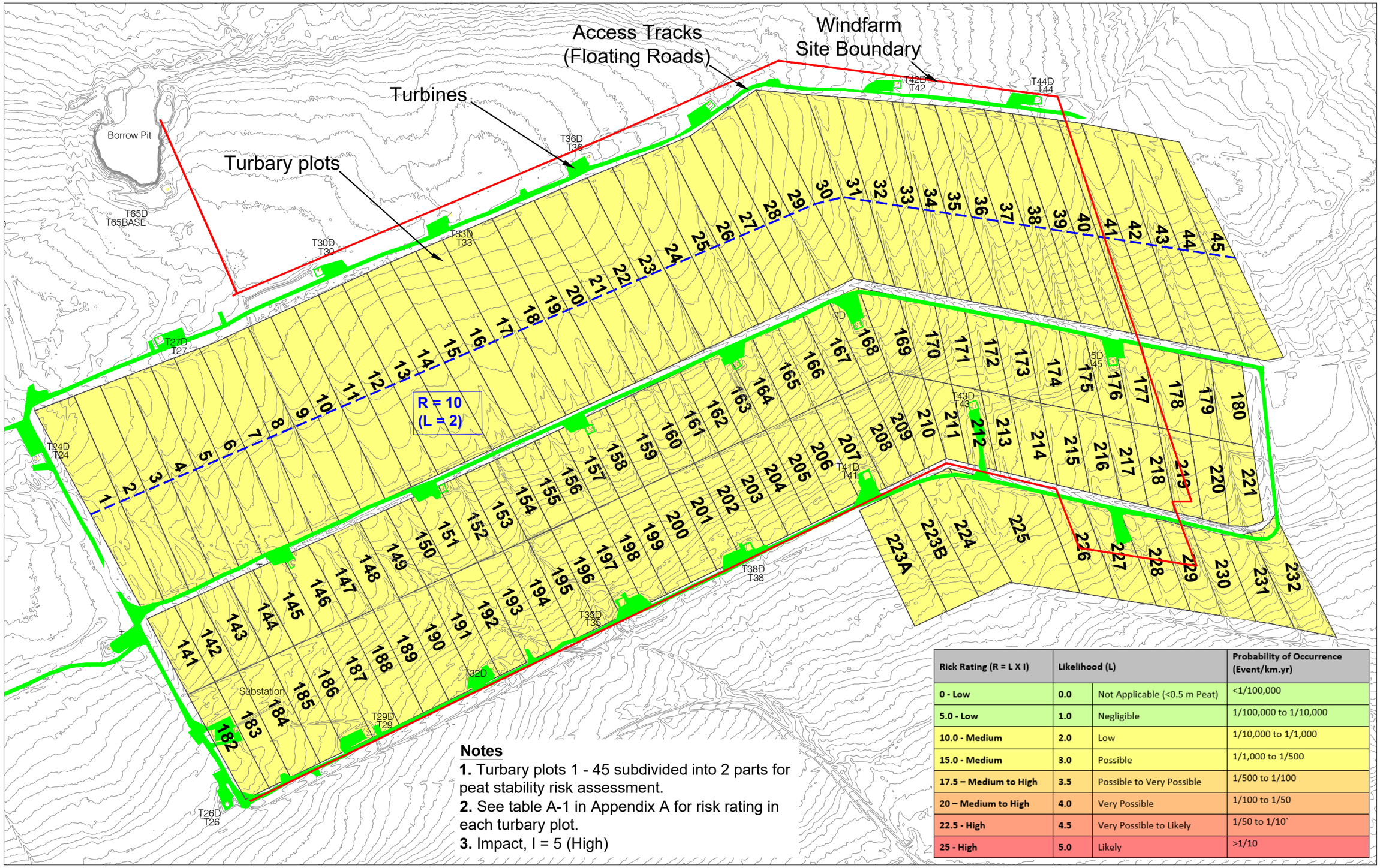
Peat Stability Risk Assessment for Turbary Areas

Project: Derrybrien Wind Farm

Title: Likelihood of Peat Failure & Risk Rating Prior to Mitigation Measures

Scales	Date	Page no.	
1:10,000	16/07/2020	1 of 1	Figure A-1
Version: Final	Drawn: NK	Checked: COD	



Rick Rating (R = L X I)	Likelihood (L)		Probability of Occurrence (Event/km.yr)
0 - Low	0.0	Not Applicable (<0.5 m Peat)	<1/100,000
5.0 - Low	1.0	Negligible	1/100,000 to 1/10,000
10.0 - Medium	2.0	Low	1/10,000 to 1/1,000
15.0 - Medium	3.0	Possible	1/1,000 to 1/500
17.5 – Medium to High	3.5	Possible to Very Possible	1/500 to 1/100
20 – Medium to High	4.0	Very Possible	1/100 to 1/50
22.5 - High	4.5	Very Possible to Likely	1/50 to 1/10`
25 - High	5.0	Likely	>1/10

Notes

1. Turbary plots 1 - 45 subdivided into 2 parts for peat stability risk assessment.

2. See table A-1 in Appendix A for risk rating in each turbary plot.

3. Impact, I = 5 (High)

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Peat Stability Risk Assessment for Turbary Areas

Project: Derrybrien Wind Farm			
Title: Likelihood of Peat Failure & Risk Rating Prior to Mitigation Measures			
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Version: Final	Drawn: NK	Checked: COD	

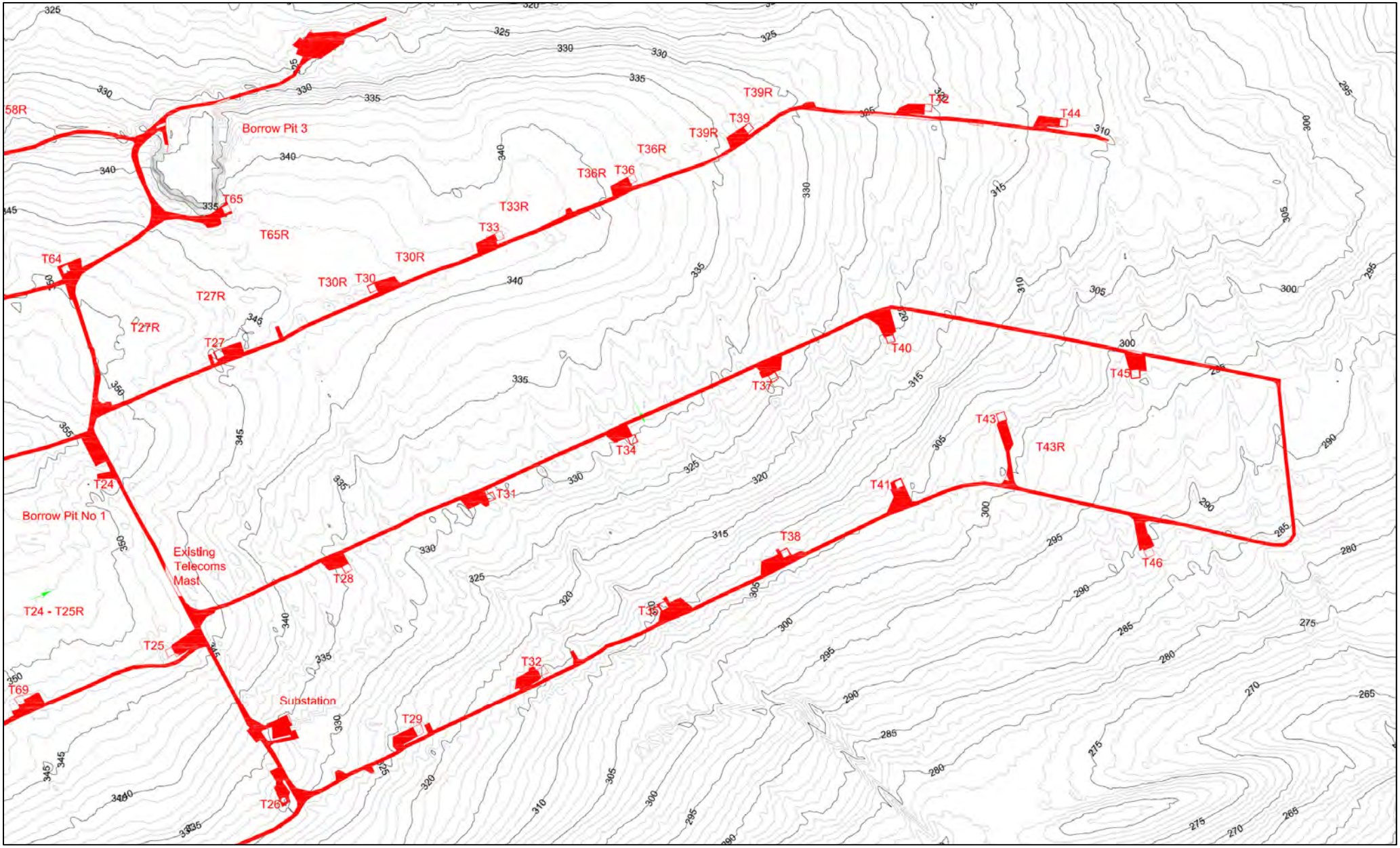


Figure A-3 – LiDAR Survey showing topography in turbary area

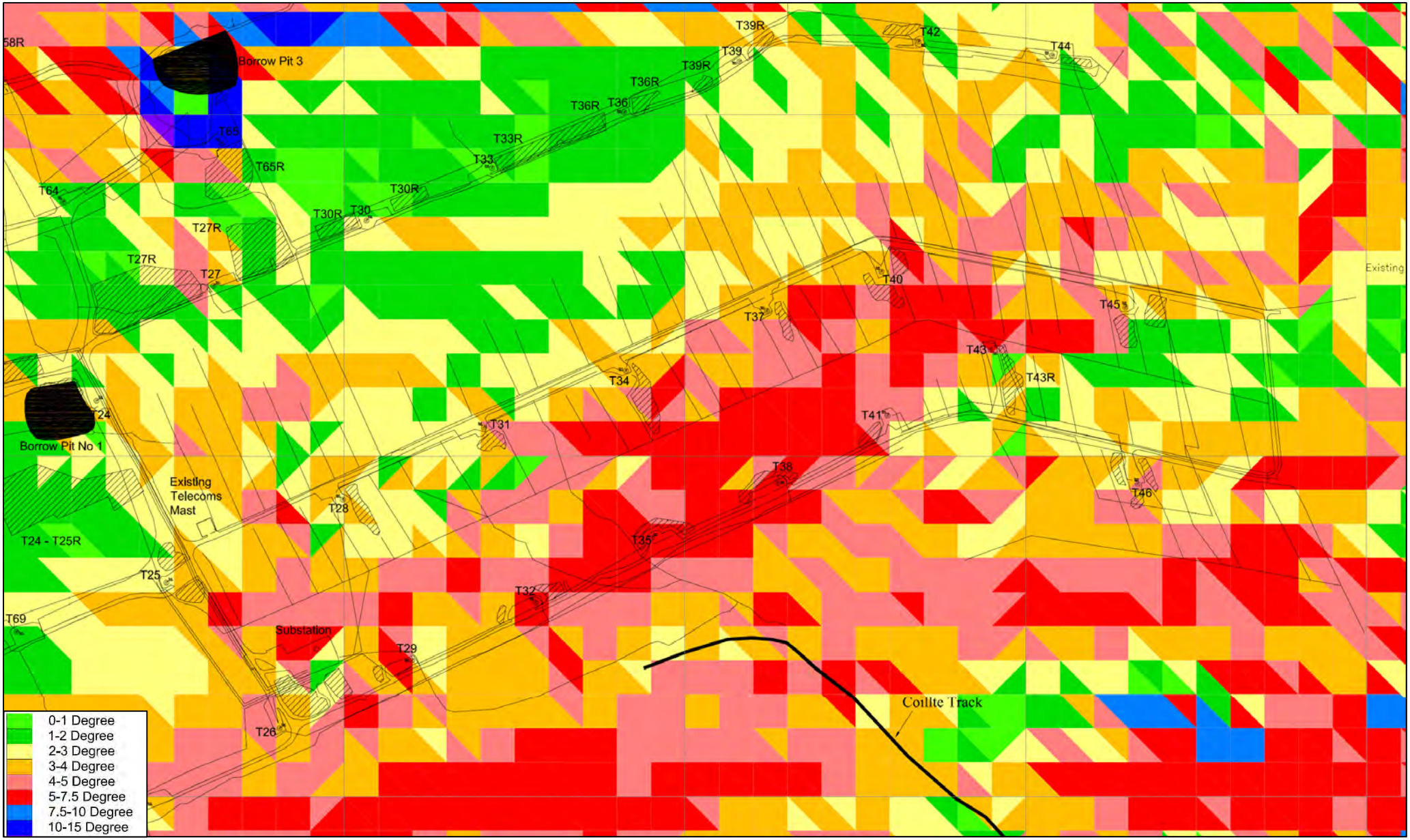


Figure A-4 – Ground surface slope angles in turbary area interpreted from LiDAR Survey

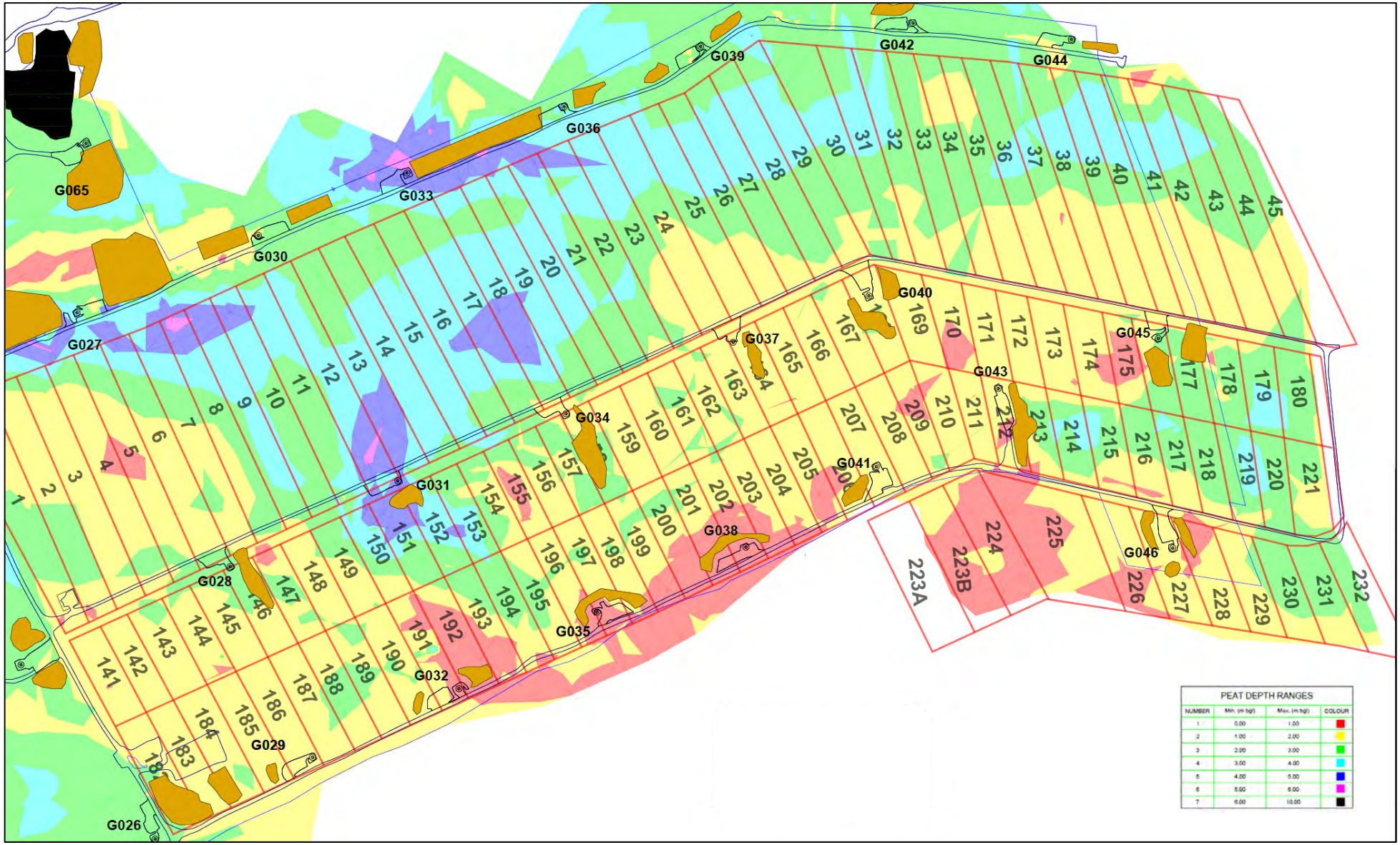


Figure A-5 – Peat depth in turbary area interpreted from LiDAR Survey

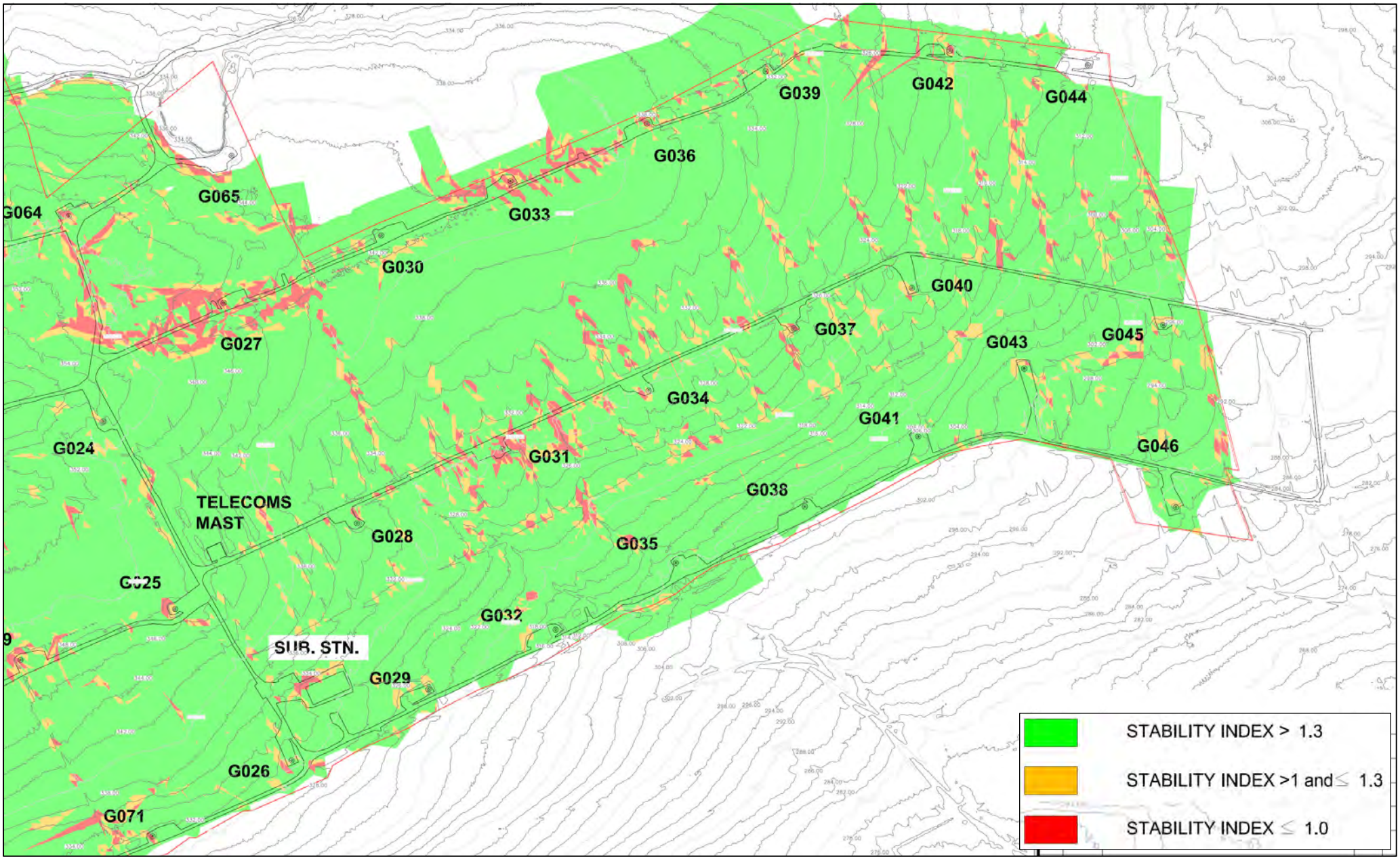


Figure A-6 – Infinite Slope Factor of Safety (FoS/Stability Index) [c_u = **5kPa** at base of peat, **0kPa** Surcharge on surface of peat]

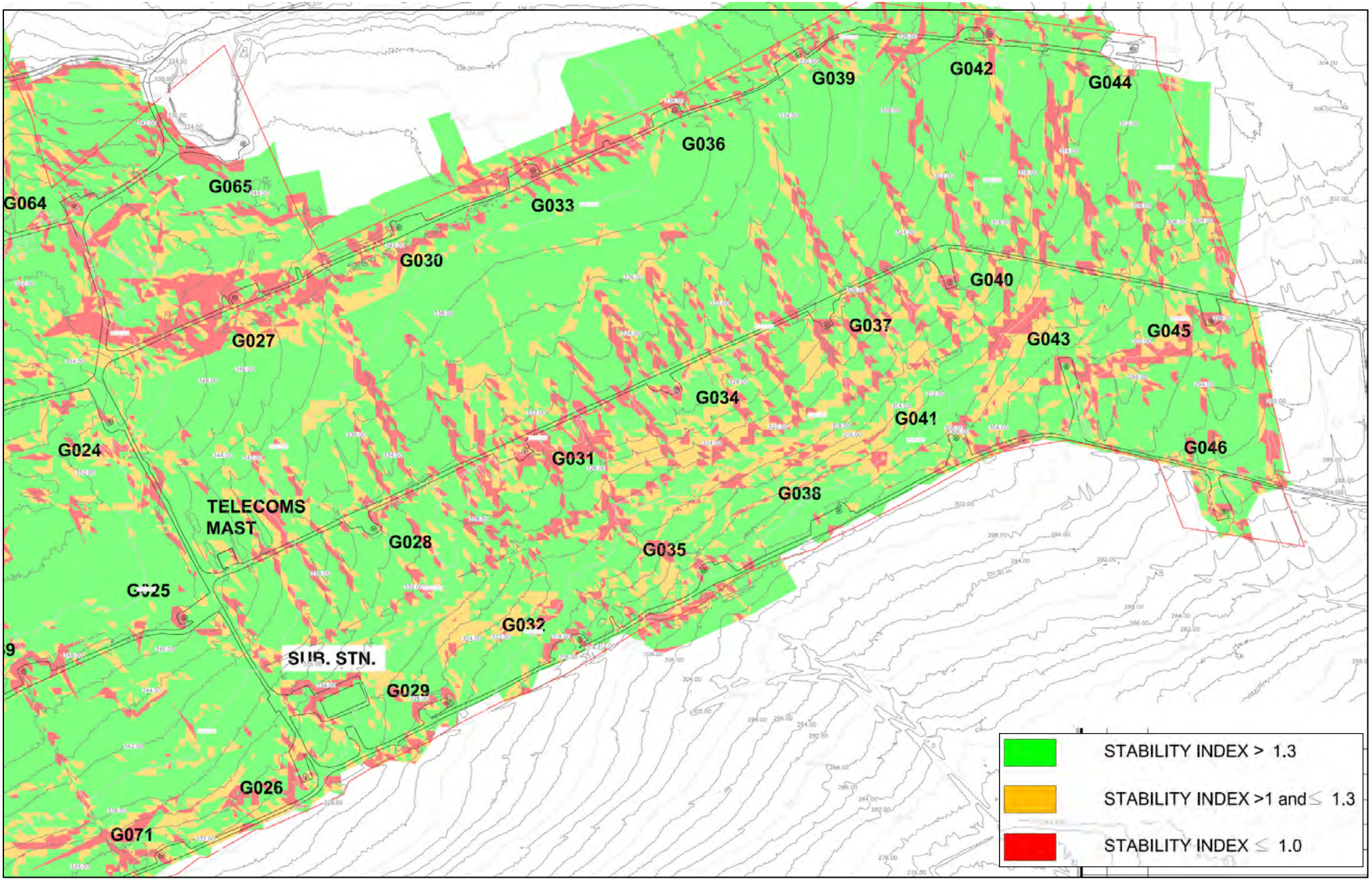


Figure A-7 – Infinite Slope Factor of Safety (FoS/Stability Index) [c_u = **5kPa** at base of peat, **10kPa** Surcharge on surface of peat]

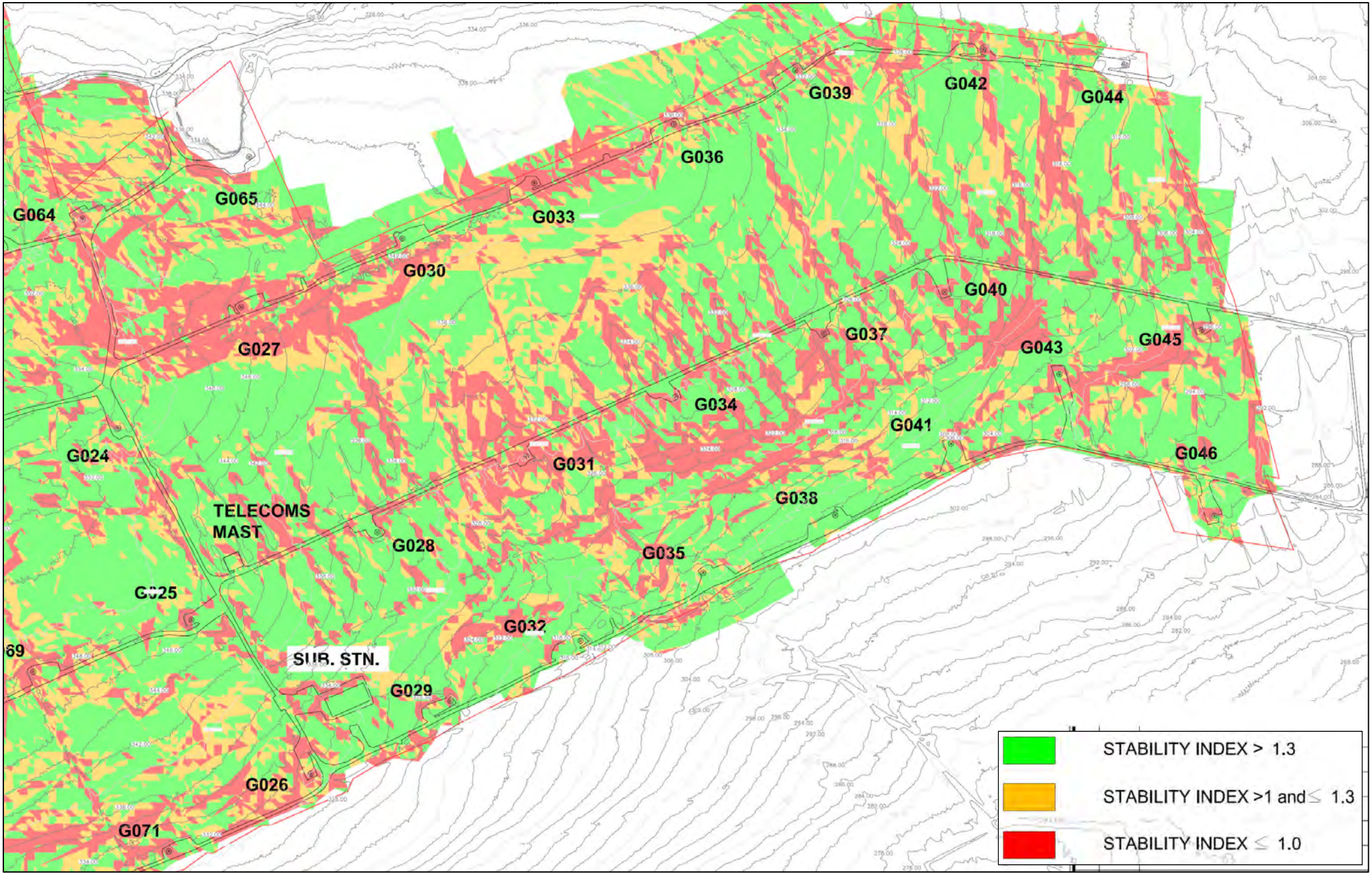


Figure A-8 – Infinite Slope Factor of Safety (FoS/Stability Index) [c_u = **2.5kPa** at base of peat, **0kPa** Surcharge on surface of peat]

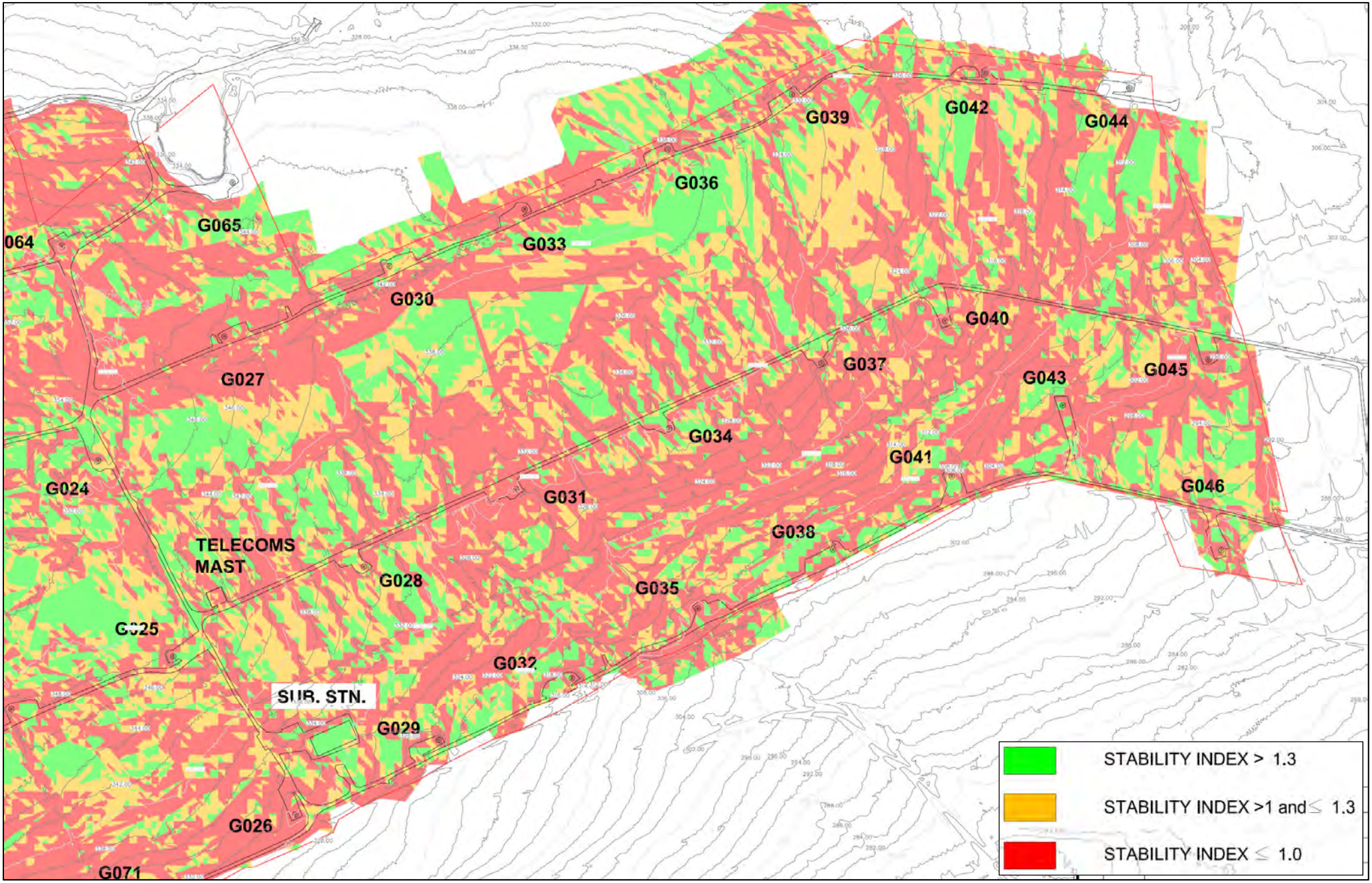
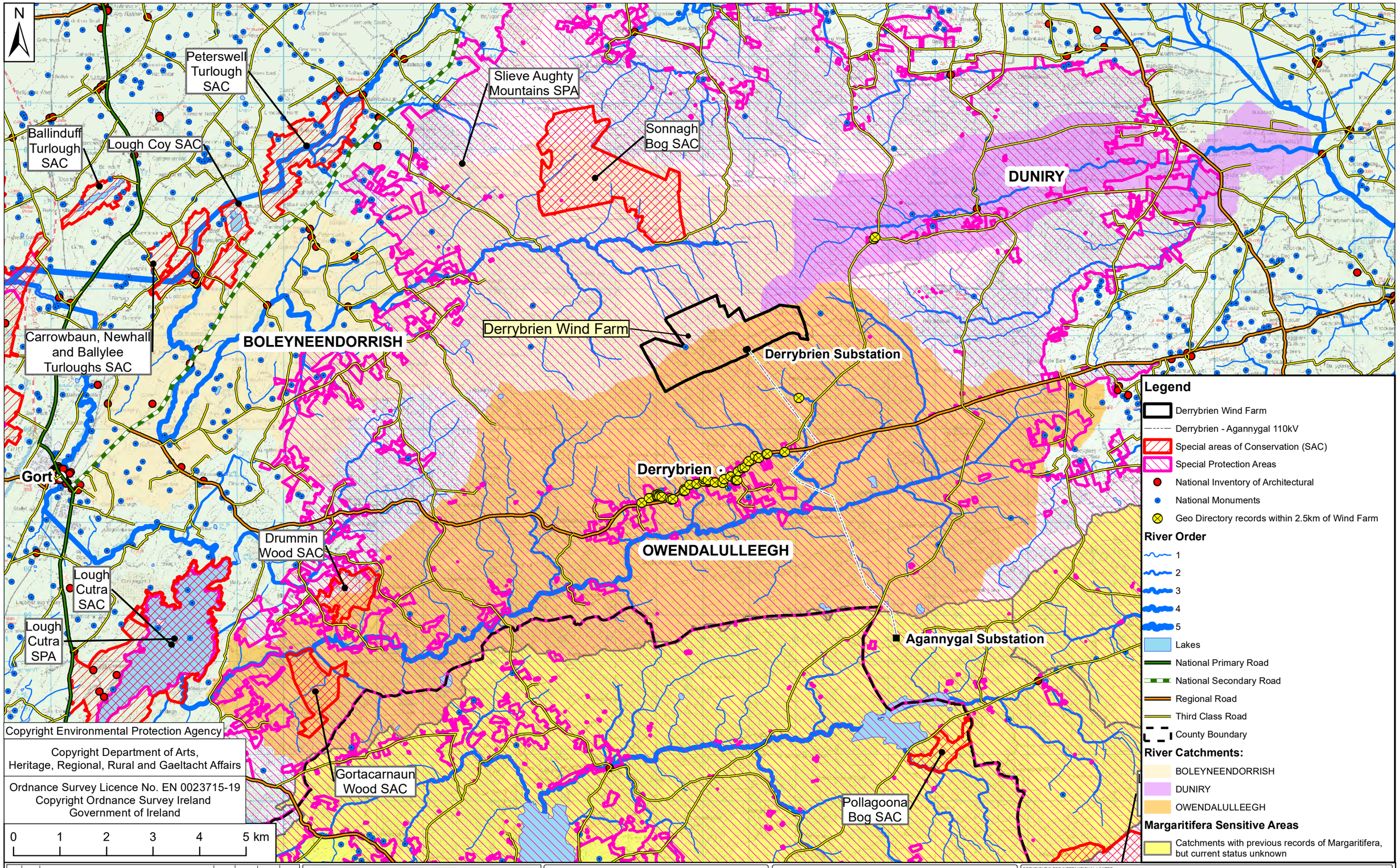


Figure A-9 – Infinite Slope Factor of Safety (FoS/Stability Index) [c_u = **2.5kPa** at base of peat, **10kPa** Surcharge on surface of peat]



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T. O'Rourke	T.O'Rourke	R.O'Donovan	J.Fitzpatrick	30/10/2018

CLIENT REF.	NO. OF SHEETS	SIZE	SCALE
00-00	00-00	A3	1:75,000

DRAWING NUMBER: QS-000192-01-D451-018

APPENDIX 8-5

GEOTECHNICAL & PEAT STABILITY REPORT (JANAURY 2023)

FEHILY TIMONEY

CONSULTANTS IN ENGINEERING, ENVIRONMENTAL SCIENCE & PLANNING

GEOTECHNICAL & PEAT STABILITY REPORT

DERRYBRIEN WIND FARM – GRID CONNECTION AND ANCILLARY WORKS

Prepared for: **ESB**

Date: January 2023

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GEOTECHNICAL & PEAT STABILITY ASSESSMENT REPORT

DERRYBRIEN WIND FARM – GRID CONNECTION AND ANCILLARY WORKS

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Abstract: The report contains the findings of a geotechnical assessment along the route of the grid connection from the Derrybrien Wind Farm site to the Agannygal substation. The geotechnical assessment includes a deterministic and qualitative peat stability risk assessment of the grid connection route.

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1. INTRODUCTION

1.1 General

Fehily Timoney and Company (FT) was engaged in August 2022 by ESB to undertake a geotechnical assessment of the grid connection route from the Derrybrien wind farm site to the Agannygal substation. The grid connection comprises the Derrybrien-Agannygal 110kV Overhead Line (OHL) and Agannygal Substation and ancillary works. The geotechnical assessment carried out includes an assessment of the peat stability of the 110kV OHL route, Agannygal substation site and associated permanent and temporary works during the proposed decommissioning of Derrybrien Wind Farm.

The Derrybrien wind farm project is located on Cashlaundrumlahan Mountain in the Slieve Aughty Mountains some 11km south of the town of Loughrea in County Galway (Figure 1).

The wind farm comprises 70 wind turbines and associated infrastructure and was constructed over the period 2003 to 2005. The wind farm became operational in December 2005.

The OHL route connects the substation on the Derrybrien wind farm site to a substation in the townland of Agannygal and is 7.8km in length. The OHL and substation were constructed between 2003 and 2005.

For the purposes of assessment, the OHL route was broken into 8 subsections (including the substation at Agannygal). These subsections were chosen based on having similar topography and peat depth within each individual section (Drawing 0001).

1.2 General

This report presents the findings of a geotechnical assessment of the OHL route connecting Derrybrien wind farm site with Agannygal Substation, and comprises the following elements:

(1) Desk Study Review
The review included the following:
- Review of previous relevant reports
- Review of publicly available information

(2) Summary of FT walkover survey findings (2022)
The walkover included the following:
- OHL route (excluding polesets 1-4)
- Access routes from the public road to the OHL route
- Agannygal substation

(3) Summary of AGEC ground investigation (2018)
The ground investigation included the following:
- Peat depth probing and shear vane strength testing along the OHL route
- Trial pits at the Agannygal substation

(4) Peat stability assessment
A deterministic stability assessment and qualitative peat stability risk assessment of the peat along the OHL route and at the substation, which includes:

- Methodology for deterministic stability assessment of peat
- Analysis to determine factor of safety
- Peat stability risk assessment methodology
- Results of stability analysis and risk assessments

(5) Conclusions

2. PREVIOUS RELEVANT REPORTS

2.1 Foundation Records at Mast Locations

During construction of the OHL masts from 2004 to 2005 a number of trial pits were carried out at mast locations to record ground conditions to a depth of typically 3m. In total, trial pits were carried out at 18 no. mast locations at each of the 4 mast legs giving a total of 72 no. trial pits. The records included a description of the ground conditions encountered and depths.

2.2 ESB Report on Slope Stability for Section of the OHL

ESB (2006) assessed the stability of the peat along the OHL route between the Derrybrien wind farm substation and containment barrage 2 (Figure 1). Containment barrage 2 was constructed following a peat slide in 2003 at the wind farm site within the flow path of the peat slide to prevent further propagation of the peat slide and to prevent possible further release of debris into watercourses downstream.

The stability of the peat in this area was assessed based on shear vane tests carried out over a section 700m in length directly south of the wind farm substation, as this area was considered the critical section in terms of existing slope angles and peat thickness. The infinite slope method of Skempton and DeLory (1957) was used to check for stability in combination with an external surcharge of 20kPa. Peat depths up to 2.0m were recorded and peat strengths ranged from 5 to 10kPa. A “lumped” or overall factor of safety of at least 1.4 under a 20kPa surcharge was shown for the OHL route between the substation and containment barrage 2, which is considered an acceptable level of safety.

3. DECSRIPTION OF OVERHEAD LINE ROUTE

3.1 General Description

The existing Derrybrien to Agannygal OHL connects the onsite substation at Derrybrien Wind Farm (ITM coordinates: E 559914, N 704737) to the substation at Agannygal (ITM coordinates: E 563119, N 698591), approximately 7km to the south. The layout of the OHL is shown in Figure 1 and Drawing 0001. The OHL is 7.8km long.

The pole sets, intermediate masts, angle masts, and end masts along the route are numbered 1 to 41. A typical timber pole set is shown in Photo 1 (Appendix A) and a typical steel angle mast is shown in Photo 2. A listing of the pole sets and masts is given in Table 3.1 and the locations of the substations, pole sets, and masts are shown in Drawing 0001.

Table 3.1: Peat Depth & Slope Angle along Grid Connection Route

Structure Reference	Structure Type	Easting (1)	Northing(1)
EM1(2)	End mast	559934	704742
PS1A(2)	Pole set	559962	704707
PS2(2)	Pole set	560045	704596
PS3(2)	Pole set	560195	704394
PS4(2)	Pole set	560319	704226
PS5	Pole set	560480	704011
PS6	Pole set	560578	703879
PS7	Pole set	560671	703754
PS8	Pole set	560777	703612
PS9	Pole set	560883	703469
PS10	Pole set	561011	703298
PS11	Pole set	561145	703117
PS12	Pole set	561252	702972
PS13	Pole set	561345	702847
AM14	Angle mast	561432	702731
PS15	Pole set	561337	702624
PS16	Pole set	561167	702437
PS17	Pole set	560990	702239
AM18	Angle mast	560840	702074
PS19	Pole set	560951	701972
AM20	Angle mas	561049	701883

Structure Reference	Structure Type	Easting (1)	Northing(1)
PS21	Pole set	561216	701810
PS22	Pole set	561373	701743
PS23	Pole set	561599	701646
AM24	Angle mast	561758	701577
PS25	Pole set	561814	701428
PS26	Pole set	561919	701145
PS27	Pole set	561975	700996
PS28	Pole set	562055	700784
PS28A	Pole set	562090	700690
PS29	Pole set	562148	700535
IM30	Intermediate mast	562211	700366
PS31	Pole set	562293	700146
PS32	Pole set	562366	699953
PS33	Pole set	562429	699785
PS34	Pole set	562470	699676
PS35	Pole set	562664	699481
PS36	Pole set	562761	699383
PS37	Pole set	562836	699308
AM38	Angle mast	563022	699121
PS39	Pole set	563062	698923
PS40	Pole set	563094	698766
EM41	End mast	563118	698643

Notes:
(1) Coordinates are in ITM format and were provided by ESB.
(2) Polesets 1-4 do not form part of this report, and are covered in the report by AGL on the Derrybrien Wind Farm Site

3.2 Description and Topography of OHL

The Derrybrien wind farm site is located on the upper slopes of Cashlaundrumlahan Mountain, within the Slieve Aughty Mountains. The OHL route is 7.8km long and is aligned essentially north-south. The topography of the route is illustrated in Drawing 001.

Slope angles at the pole set and mast locations typically range from 0 to 15 degrees. The topography is relatively steep (10 - 15 degrees) initially over the initial c. 1.5km of the route and then crosses the more gently sloping terrain (0 - 8 degrees) of the Owendalluleagh River valley to the Agannygal substation where the site has been cut and filled locally to provide a level platform.

The OHL route corridor starts within the boundaries of the wind farm site at the Derrybrien substation at an elevation of approximately 330mAOD. From the Derrybrien substation, the elevation along the route falls to a flat-bottomed valley where it crosses the R353 road and the tributaries of the Owendalulleagh River at an elevation of approximately 130mAOD. From here, the route skirts around the Slieve Aughty Bog NHA (site number 001229) before gaining elevation again as it passes Lough Agannygal, at about 195mAOD. The route ends at the Agannygal Substation, which is located to the southeast of Cashlaundrumlahan Mountain and about 1km north of Lough Atorick, at an elevation of approximately 190mAOD.

The land adjacent to the OHL route corridor and the Agannygal Substation is dominated by commercial forestry plantations which have been planted over the blanket bog. Directly along the OHL route corridor appears to have been colonised by conifer and deciduous tree growth from the adjacent plantations (regrowth of previously felled area).

The route crosses the lower end of the source area of the peat slide of 16 October 2003 between pole sets 5 and 6, and also passes close to 2 no. containment barrages (barrages 2 and 3, Figure 1). The containment barrages were constructed following the peat slide to prevent propagation of the peat slide and to restrict possible further release of debris into watercourses downstream.

3.3 Description of Infrastructure and Construction

The OHL mainly consists of double timber pole sets with galvanised steel angle masts at changes in direction and an intermediate galvanised steel mast (IM30) on a longer straight section. These angle masts and other mast structures were located as close as possible to existing roads and access tracks, in order to minimise trafficking on undisturbed ground. This section of this report sets out the methods of construction based on observations made during the walkover and information provided by ESB.

None of the OHL structures are constructed within the area of the peat slide, and no access was required through the peat slide area to access the OHL pole set locations.

3.3.1 Access to Pole Sets and Angle Masts

Where trees were present on the OHL route, then within a 60m corridor width all trees were felled mostly by machine using Coillte subcontractors. Where the trees were felled, they were cut as close as possible to the ground. The trunks and roots were left in place so that there was no excavation or disturbance of the peat. The surface of the peat was tracked over by the harvesting machines and forwarders that were used to cut, gather and stockpile the timber for transport off-site. In areas where the surface of the peat was very soft, brash and small branches were placed on the ground under the tracks of the harvester. Where the trees were small or where tree growth was poor the trees were felled by hand, arranged in windrows and left in place on the slopes.

Following this the location of pole sets and angle, intermediate and end masts were identified and set out.

The methods used to access the pole sets/angle masts during the construction of the OHL were recorded where they were visible during the OHL survey. The access routes recorded consisted of two types:

(1) There are a number of locations, primarily around the angle masts, where the peat has been stripped away exposing the mineral soil beneath. These areas are typically located in close proximity to existing forestry access tracks (see Photos 3 & 4) to facilitate the import of additional fill material and members for the angle masts, and for foundation construction.

(2) In other areas, primarily around the pole sets in areas of deep peat, timber sleepers from felled trees were used by construction plant to gain access for erecting the line, where necessary. This method of construction was particularly noticeable around pole set 36 where peat depths of over 4m were recorded. An example of such an access route is shown in Photo 5.

Access to the masts/pole sets was most likely from nearby roads and forestry tracks. Access from the existing tracks to the mast locations was generally achieved by the excavation of the peat and any tree stumps to a competent material. In order to access AM24, the Owendalulleagh River was crossed from the south side of the river at the location of a ford along the founded access track. In order to access AM38, existing trees were felled and placed to form a temporary floating access track from the south.

3.3.2 Foundations for Pole Sets and Angle Masts

Foundations varied according to ground conditions along the OHL route. In some locations where the depth to competent material was deeper than the embedment of the pole, stone and/or timber sleepers were used to strengthen the foundation and timber sleepers were used to fill to the correct level and as support to pole sets for stability. A greater number of timber sleepers would have been used to support pole sets in deep peat.

A number of pole sets in peat have been secured using timber baulks, fixed to the lower part of each pole and set in excavated holes in the peat which were backfilled with imported granular fill.

The angle masts and end masts are founded on concrete footings cast on mineral soil. Peat, where present, was excavated over the footprint of the foundation and working area prior to the construction of the foundation for these masts. The excavated peat was typically stored adjacent to the foundation excavations.

3.3.3 Agannygal Substation

The substation at Agannygal comprises a stone platform, substation equipment and a single storey control building. Construction of the substation required the excavation of overburden in order to create a level platform on which to build the substation. Excavated material was stored to the south of the substation compound. A stone platform approximately 1-1.5m thick was then constructed on the overburden using imported crushed rock fill. The platform is approximately 65m in length and 50m in width. In order to provide access to construct the substation, approximately 2.9km of existing forestry track was upgraded by adding imported stone fill and a thin surfacing layer. A permanent access road, around 140m in length, was also constructed from the adjacent local road to the substation.

The site of the substations and current topographical levels are provided on Drawing 0006.

3.3.4 Cuttings

During the site walkover of the OHL route, several cuttings were recorded, primarily around the footprint of a number of pole sets and angle masts. These included cuttings through the undulating ground from local access tracks to gain entrance for construction plant and materials, such as that shown in Photo 7. Minor cuttings are also present where stripping/excavation of peat/mineral soil was undertaken to form a suitable area to erect the masts and pole sets.

Founded access tracks constructed by others for the purpose of accessing the forested areas surrounding the overhead line required cutting through the undulating ground. Several cut sections were identified during the

site walkover. It is considered that these access tracks were already in existence and not created for the purpose of the construction of the OHL, however these were used for the construction of the OHL.

Between pole set 28A and 29 the OHL route crosses the Moneypoint-Oldstreet 400kV overhead line. This area is shown in Photos 8 and 9. A cut approximately 25m wide and 120m long was formed in the mineral soil to allow the OHL from the Derrybrien substation to pass beneath the 400kV line, allowing sufficient clearance for trafficking under the route and removal of forestry that could pose a risk to the OHL route. The location and extent of this cutting is shown on Drawing 0006 . This cutting is up to 3.8m deep and the slope angle ranges between 25 and 39 degrees, based on site readings. The average slope angle is approximately 32 degrees, based on the available topographic survey information of the area.

Another significant cutting is located adjacent to Agannygal substation and shown in Photo 12. This cutting is up to 3.0m deep and has an average slope angle of 35 degrees in mineral soil, which was excavated in order to create a level platform for the construction of the substation.

Additional, less significant cuttings included drainage ditches in the vicinity of the pole sets/angle masts and the access tracks.

4. GROUND CONDITIONS

4.1 Soils and Geology

The deposits along the OHL route comprise the following main types:

(1) Peat

(2) Glacial till and subsoil

(3) Alluvium

(4) Weathered/solid rock

(5) Peat debris within peat slide scar

4.1.1 Peat

Based on a review of the soils map of Ireland (Geological Survey of Ireland, 2022), the OHL route is covered in blanket peat. The walkover survey and ground investigation undertaken by AGEC and FT indicates that the upper 1m of the peat is generally very fibrous and also locally desiccated in appearance. The base of the peat, from observations within the peat slide scar and in exposures in excavations and along drains, was described using BS 5930 (BSI, 2015) as very soft brown amorphous Peat with recognisable plant structure. Peat appeared to lay directly on bedrock or a weathered rock/glacial till.

Shear strength profiles were measured using a Geonor H-60 hand vane tester at thirteen locations by ESB in 2004 and 2005 (ESB, 2006). 27 no. shear vane strength tests were undertaken at depths from 0.5m bgl to 1.8m bgl. Values for vane shear strength measured ranged from 5kPa to 10kPa with an average of 8.3kPa. Shear strength testing was also undertaken by AGEC in 2018 and FT in 2019 and 2022. 95 no. shear vane strength tests were undertaken at depths from 0.5m bgl to 3.5m bgl. Values for vane shear strength measured ranged from 3kPa to 68kPa with an average of 20kPa. The values are plotted in Figure 2.

Peat depth probing was also undertaken by ESB and the results of this are used, along with recent peat depth probing carried out by AGEC and FT, to plot peat depth contours shown in Drawings 0002 and 0003. The depth of peat recorded along the OHL route ranged from 0.2 to 5.6m bgl with an average depth of 1.3m bgl.

4.1.2 Glacial Till and Subsoil

Based on the available data, varying thicknesses of glacial till are present beneath the peat along of the OHL route. The publicly available GSI (2022) mapping shows glacial till in the vicinity of the site to be derived from Devonian sandstones. Exposures of glacial till showed a reddish brown or whiteish brown well-graded material consisting of sandy slightly gravelly Clay/Silt with occasional sub-angular to rounded cobbles and boulders of sandstone.

Typically, glacial till was encountered below the peat at depths that ranged from 0.2 to 5.6m, though locally glacial till was at or close to the surface below a layer of peaty topsoil.

The GSI (2022) mapping shows a line of ribbed moraines, which are hummocky wave ridges of sediment deposited by glacial movement, trending in a west-south-west to east-north-east direction traversing the OHL route around the Owendalulleagh River.

4.1.3 Alluvium

Alluvium recorded along the OHL route is associated with the Owendalulleagh River which runs between pole sets 25 and 26. It was observed during the site walkover that the Owendalulleagh River riverbed consisted of sand, gravel, cobbles, and boulders, and hence it is expected that this alluvium is predominantly coarse-grained.

4.1.4 Weathered/Solid Bedrock

The bedrock geology along the OHL route comprises the Ayle River Formation, the Derryfadda Formation, the Scalpnagown Formation, and Undifferentiated Visean Limestone. The Ayle River Formation consists of red siltstones, mudstones with carbonate concretions, sandstones, conglomerates and mud-flake breccia from the Ayle River Formation, the Derryfadda Formation consists of greywackes, siltstones, and mudstones, and the Scalpnagown Formation consists of conglomerate, sandstone & siltstone. The Undifferentiated Visean Limestones are impure Dinantian limestones (GSI, 2003 & 2019).

Rare bedrock exposures, consisting of sandstone, were observed in the vicinity of containment barrage 1 and 3. The bedding was horizontal to sub-horizontal. Exposed bedrock was not encountered elsewhere.

4.1.5 Peat Debris within Peat Slide Source Area

Peat debris within the 2003 peat slide area at the Derrybrien site was encountered only between pole sets 5 and 6. The debris within the peat slide area comprises mainly non-intact peat. As the extent of the material is extremely limited, it is not considered further in this report.

4.2 Hydrology

Several watercourses exist within the footprint of the OHL route (see Drawing 0001 for locations), the largest being the Owendalulleagh River, which is approximately 6m wide where it passes beneath the OHL between pole sets 25 and 26 (Photo 6). Major hydrological features tend to run east to west across the OHL corridor, with minor tributary features aligned approximately north to south to tie into the major drainage features.

There are several flat areas where local ponding of surface water occurs. Such a feature, Lough Agannygal, is located between pole set 37 and angle mast 38 (Photos 10 and 11).

Streams and ditches have typically been regraded for use as forestry drainage where land use is commercial forestry. It is reported that this commercial forestry was established in the 1970's (ESB, 2006). This is consistent with observations made on site that several areas have been clear felled and replanted.

4.3 Hydrogeology

Based on information from the GSI database, the majority of the OHL route and the substation is underlain by rock which is considered a poor aquifer (bedrock which is generally unproductive except for local zones).

However, the segment of the route underlain by Visean Limestone (between pole set 23 and 26 approximately) is considered a locally important aquifer (bedrock which is moderately productive only in local zones) although no evidence for groundwater usage from this aquifer was found.

Groundwater vulnerability (GSI, 2022) ranges from low to extreme across the route, due to the generally shallow depth to bedrock. All drainage features along the OHL route are noted as giving rise to extreme groundwater vulnerability.

4.4 Previous Landslides

A review of historical records of peat slides/landslides (GSI, 2022) indicates that peat slides have occurred in the Slieve Aughty Mountains in the past. With the exception of the 2003 peat slide on the Derrybrien wind farm site, two previous slides have been noted within 5km of the OHL. One was in 1890 and occurred at a location some 2.5km to the east of the substation at the southern end of the OHL, in an area called Loughatorick North. An area of 100 acres was covered with a 'foot' of peat, the upper part of the 'bog subsiding 10 to 15 feet'. The peat slide was described as a flow within blanket peat. The other slide occurred 5km to the north of the OHL, on the Sonnagh Old Wind Farm site. This occurred during October 2003 and is described as a flow in blanket peat adjacent to an access road.

As part of the national landslide susceptibility mapping project carried out by the Geological Survey Ireland all areas of land across the country are designated a landslide susceptibility rating. The landslide susceptibility rating is based on a number of factors including incidences of previous peat slides, topography, type of deposits, etc. The OHL route and substation is classified as having 'low' to 'moderately low' peat/landslide susceptibility with locally 'moderately high' susceptibility (GSI, 2022).

As stated above, the land susceptibility rating/bands typically relates to the type of deposits, topography in an area, incidences of previous peat/landslides, etc. For example, a rating of 'moderately high' can be assigned where rock is close to the surface, slope angles range from 10 to 20 degrees, etc. Hence the rating of 'moderately high' does not necessarily relate to a risk of peat slide.

It should be noted that at the time of the 2003 peat slide no national landslide register/database existed.

5. SITE WALKOVER SURVEY

5.1 Background to Walkover Survey

The purpose of the walkover survey was to investigate the ground conditions at the pole set and angle mast locations, identify geotechnical constraints and to gather data for a peat stability assessment along the OHL route.

The walkover survey comprised an inspection of the OHL route and likely access points to the OHL. This was carried out from 11 to 12 October 2022. Weather conditions for the site visit were light to heavy mist/rain with some dry periods. A previous walkover of the OHL route and the Agannygal Substation had been undertaken by AGEC in June 2018 and FT in September 2019. The findings below are a combination of the findings from the three walkover surveys (2018, 2019 and 2022)

5.2 Findings of Walkover Survey

The findings of the walkover survey are as follows:

(1) The OHL route is located approximately 10km south of Loughrea and is constructed on undulating terrain. The majority of the route is covered by shallow to locally deep blanket peat that was previously colonised by commercially grown conifer and deciduous forest. Some regrowth has occurred along the OHL since the original felling works. There are a number of areas where peat has been removed from the footprint of the pole sets/angle masts and overburden is exposed at the ground surface.

(2) The elevation along the OHL route falls from the wind farm substation (c. 330m AOD) to pole set 11 (c. 180m AOD). From pole set 11 the elevation decreases over undulating ground to angle mast 14 (c. 170m AOD) and crosses the local R353 road. The terrain gently undulates as it descends from the R353 (public road) to pole set 22 (c. 115m AOD) from where the OHL route crosses several relatively shallow watercourses. The ground level rises significantly over a short distance to pole set 23 (c. 130m AOD), then levels and quickly descends again between pole set 25 and 26 (c. 125m AOD). The terrain undulates gently as it ascends towards pole set 38 (c. 195m AOD), levels over localised deep deposits of peat and gently falls from pole set 38 to the substation at Agannygal.

(3) Peat thicknesses were recorded during the site walkover with in excess of 150 peat probes undertaken. Peat thicknesses measured ranged from 0m to 5.6m. Approximately 50 percent of the probes recorded peat depths of less than 1.0m. Over 80 percent of peat depth probes recorded peat depths of less than 2.5m. Several localised readings were recorded where peat depths of between 2.5 and 5.6m are present. The deepest peat (5.6m) was recorded close to the location of angle mast 38 where the topography is flatter than the remainder of the route.

(4) The peat depths recorded at the pole sets and angle masts varied from 0.0m to 5.6m. 28 no. of the pole sets and angle masts have less than 1.0m thickness of peat in their vicinity. 6 no. of the pole sets and angle masts have greater than 2.0m thickness of peat. The greatest depth of peat encountered, a depth of 5.6m, was recorded close to the location of angle mast 38.

(5) The undrained shear strengths of peat recorded ranged from 3kPa to 68kPa with an average of 20kPa. Peat shear strength is discussed in Section 8.

(6) There are a number of locations, primarily around the angle masts, where the peat has been locally removed exposing the mineral soil beneath. This was primarily to do with gaining access for construction of the angle masts. An example of such an area is shown in Photo 7.

(7) In other areas, primarily around the pole sets in areas of deep peat, timber sleepers from felled trees have been used by machinery to gain access during construction, as shown in Photo 5.

(8) The mineral soil composition along the OHL route, based on a visual inspection of exposures, is a sandy gravelly silt or clay with gravel, cobbles and boulders of various sizes and lithology. The mineral soil colour is primarily red-brown, as shown in Photos 7 and 9, with localised areas of white-grey, situated around pole sets 19 and 20. Dispersed throughout the white-grey mineral soil are gravels and small cobbles, which appear to be a mixture of marble, quartz and sandstone in nature. Elsewhere the cobbles and boulders present appear to be sandstone in nature and sandstone would appear to be the dominant rock type present along the route.

(9) Slope angles at the pole set and mast locations typically range from 0 to 15 degrees. There were several steeper slope angles between pole set and mast locations, particularly south of pole set 25 and near the Owendalulleagh River, where an inclination of about 35 degrees was recorded.

(10) The peat situated towards the northern end of the route has a notable vegetation cover, which is generally indicative of relatively well-drained (stronger) peat. However, there are some areas towards the south of the OHL route where poorly-drained (weaker) peat deposits were recorded in deforested areas.

(11) Localised areas of waterlogged peat and surface water are present at numerous areas along the OHL route, particularly between pole set 37 and AM 38 (Photos 10 and 11). This is not unexpected given the flat nature of the terrain and watercourses present along the OHL route, including Lough Agannygal.

(12) Apart from where the OHL crosses the 2003 peat slide source area, which is between pole sets 5 and 6, no evidence of past peat slides were recorded on the OHL route or directly adjacent to it.

(13) The Agannygal Substation is constructed on the edge of a forested area to the north of Lough Atorick. The substation compound has been created by excavating material along the eastern side of the site to create a level platform on competent ground. A cutting 3m deep is present along the eastern side of the substation compound.

(14) Several cuttings were identified along the OHL route, see Section 3.3.4 for details. Of these, the most significant were between pole set 28A and 29 and at Agannygal Substation. Between pole set 28A and 29, the cutting is up to 3.8m deep and the cutting slopes have an average slope angle of around 32 degrees in glacial till. There is evidence of minor surface erosion leading to the washing out of soil in local areas of this cutting. At Agannygal Substation the cutting is up to 3m deep and has an average slope angle of 35 degrees in glacial till. Based on a visual inspection these cutting slopes appear to be stable. Minor surface erosion was noted in the vicinity of pole set 28A and 29 which would not give rise to a concern over a deeper and more significant slip occurring.

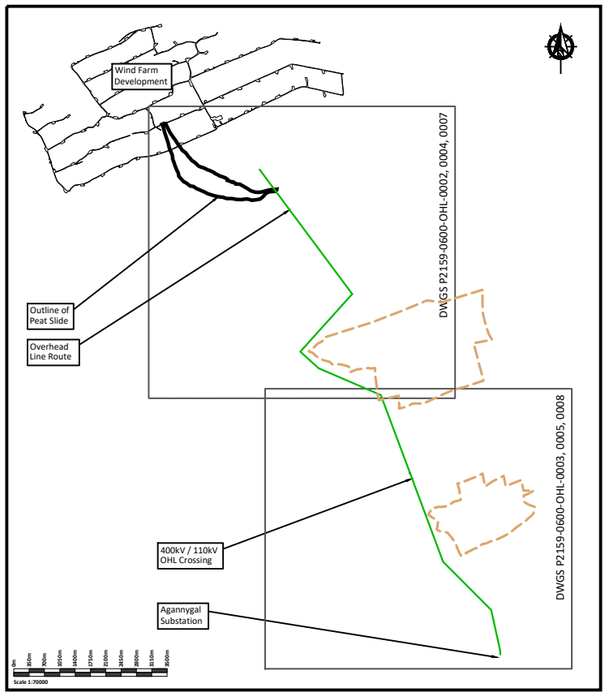
(15) The conclusions from the walkover survey are as follows:

(a) The peat depths recorded at the pole sets/angle masts varied from 0m to 5.6m. 28 no. of the surveyed poleset/angle mast locations have less than 1.0m thickness of peat.

(b) The peat depths recorded near pole set 28 and 36, ranging from 2.5m to 5.6m, would be considered relatively deep. Further, peat strengths in this area were relatively low, ranging from 6kPa to 20kPa. Suitable access techniques and plant such as the use of bog mats and low load bearing machinery would be required when operating in these areas.

(c) Mitigation/control measures for access and potential decommissioning activities at each subsection of the OHL route and substation are given in the Peat Stability Risk Register (Appendix D).

(d) Cuttings up to 3.8m deep in glacial till were observed. These appear to be stable based on a visual assessment.



KEYPLAN

Scale 1:70000

PEAT DEPTH CORRIDOR PLAN

Scale 1:14000

Legend: Peat Depth (m)

0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.6

Note -

Peat depth corridor was prepared as a 100m wide corridor using a single line of peat depth probes.

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Rev.	Description	App By	Date
A	FOR INFORMATION	BDH	20.01.23

PROJECT: DERRYBRIEN WIND FARM DECOMMISSIONING

CLIENT: ESB EMP

SHEET: PEAT DEPTH CONTOUR PLAN DRAWING 1 OF 2

Date: 20.01.23

Project number: P22-133

Scale (@ A3)

Drawn by: POR

Checked by: IH

Drawing Number: P22-133-0600-OHL-0002

Rev: A

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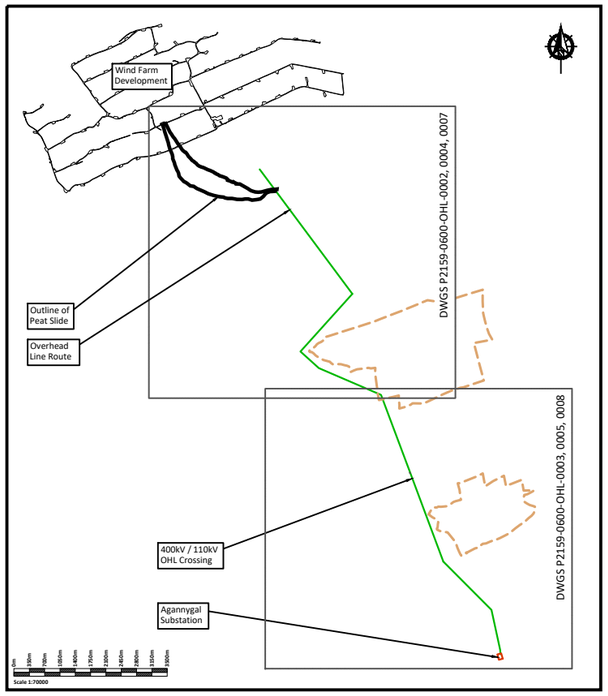
Friday 20 January 2023



KEYPLAN

Scale 1:70000

Legend: Peat Depth (m)

0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.6

Note -

Peat depth corridor was prepared as a 100m wide corridor using a single line of peat depth probes.

PEAT DEPTH CORRIDOR PLAN

Scale 1:14000

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Rev.	Description	App By	Date
A	FOR INFORMATION	BDH	20.01.23

PROJECT: DERRYBRIEN WIND FARM DECOMMISSIONING

CLIENT: ESB EMP

SHEET: PEAT DEPTH CONTOUR PLAN DRAWING 2 OF 2

Date: 20.01.23

Project number: P22-133

Scale (@ A3)

Drawn by: POR

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Drawing Number: P22-133-0600-OHL-0003

Rev: A

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Friday 20 January 2023

6. AGEC GROUND INVESTIGATION (2018)

The ground investigation carried out by AGEC along the OHL route and at the Agannygal Substation in June 2018 comprised peat depth probes, hand shear vanes and 2 no. trial pits. The locations of the trial pits are shown in Drawings 0001 and 0006. Additional peat depth probes and hand shear vanes were undertaken by FT in 2019 and 2022.

6.1 Peat Probing and Shear Vane Testing

During the walkover survey, peat depth probing and shear vane testing were carried out at each pole set, mast location and at selected intermediate points along the OHL route to provide representative coverage of indicative peat depths and strengths.

The results of peat depth probing are presented as a peat depth contour plan in Drawings 0002 and 0003 and indicate peat depths ranging from 0 to 5.6m bgl. The depth of peat varies from sections where there is little to no peat over the footprint of 4 or 5 consecutive pole sets to deep areas of peat, especially near the Agannygal substation site, although inspection of the substation itself shows that it is founded on mineral soil.

Shear vane testing was carried out using a Geonor H-60 hand field vane tester. From FT's experience hand vanes give indicative results for the in-situ undrained shear strength of peat and would be considered best practice for the field assessment of peat strength. 75 no. hand shear vane strength tests were undertaken by AGEC at depths from 0.5 to 2.5m bgl. The hand vane results indicate undrained shear strengths in the range 3 to 68kPa with an average value of 26kPa. Peat strength values are plotted in Figure 2.

6.2 Trial Pits

2 no. trial pits were excavated out at Agannygal Substation in June 2018, referred to as TP10 and TP11. The trial pit locations are shown on Drawings 0001 and 0006 and are downslope of the substation. The results of these trial pits are presented in the logs included as Appendix B. Trial pit TP10 found 1.0m of fill over natural ground consisting of mineral soil to a depth of 2.9m bgl. Trial pit TP11 found 0.7m of peaty fill over natural ground consisting of soft slightly organic clay to 1.7m bgl over mineral soil to 2.5m bgl.

The 2 no. trial pits are consistent with each other and suggest a ground profile consisting of deposited construction arisings from the substation excavation over a natural ground profile of soft organic topsoil over glacial till. A cutting is exposed at the Agannygal Substation site, shown in Photo 12, and the exposed soil here is consistent with the descriptions from the trial pits.

7. PROPOSED DECOMMISSIONING WORKS

7.1 Description of Decommissioning works

The OHL including the conductors, pole sets and masts will be decommissioned and the methodology is included below. This work would involve the removal of the OHL infrastructure between the Derrybrien and Agannygal Substations, as well as the removal of the above ground infrastructure at the Agannygal substation.

7.1.1 Access for Decommissioning works

Based on the observations made during the walkover surveys, the access routes for decommissioning works which would likely be used are presented in Drawings DMP 01, DMP 02 and DMP 14. These access routes are presented as preliminary suggestions only and would be subject to detailed design. The proposed routes are briefly summarised below. The existing forestry access tracks typically comprise a 3m wide track constructed of crushed rock which has been founded on the mineral soil underlying the peat. Minor upgrades of sections of these tracks may be required.

Notable constraints encountered included several steep slope angles between pole set and mast locations, particularly south of pole set 25 and near the Owendalulleagh River, where an inclination of about 35 degrees was recorded. Where constraints have been identified, alternative access routes are proposed (Drawings DMP 01 and 14). For example, the proposed access routes allow the steep slopes between pole set 3 and pole set 4 and between pole set 25 and pole set 26 to be avoided.

New access construction may include the use of low ground bearing pressure (LGBP) plant and bog mats to provide access to pole sets.

PS5 to PS11
Route follows existing founded access track from local road north to close to PS4. Existing (floating) track from founded access track to containment barrage 2, located between PS5 and PS6, may be upgraded to allow access to this section of the OHL Access to PS6-PS10 requires the use of LGBP plant or bog mats along the OHL route, depending on level of access required for decommissioning works. PS11 is located immediately adjacent to a local road and can be accessed directly from the local road.

PS12 to AM14
Route follows existing founded access track from local road north to AM14, which would require upgrading. Access from AM14 to PS12 requires the use of LGBP plant or bog mats along the OHL route , depending on level of access required for decommissioning works.

PS15 to PS22
Route follows existing founded access track from local road south to PS22. The track may require upgrading between PS19 and PS21.

PS23 to PS25
Route follows existing founded access track from local road north to PS25. This access may require the upgrade of the existing ford at the Owendalulleagh River and the use of LGBP plant or bog mats along the OHL route, depending on the level of access required for decommissioning works.

PS26 to PS27

Route follows existing founded access track from local road north towards PS26. Access from PS26 to PS27 requires the use of LGBP plant or bog mats along the OHL route, depending on level of access required for decommissioning works.

PS28 to PS31
Route follows existing founded access track from local road north to PS28A. Access from PS28A to PS28 and PS31 requires the use of LGBP plant or bog mats along OHL route, depending on level of access required for decommissioning works.

PS32 to PS34
Route follows existing founded access track from local road north to PS34. Access from PS34 to PS32 requires the use of LGBP plant or bog mats along OHL route, depending on level of access required for decommissioning works.

PS35 to PS37
Requires the use of LGBP plant or bog mats from local road north to PS35 and south to PS37 along OHL route, depending on level of access required for decommissioning works.

AM38 to EM41
Requires the use of LGBP plant or bog mats from Agannygal substation north to AM38 along OHL route, depending on level of access required for decommissioning works.

Substation Access
Access to the substation would use the previously upgrade Coillte track that runs from the local road some 2.5km away.

7.1.2 Methodology for the Decommissioning of the Overhead Line

As advised by ESB, the proposed methodology for the decommissioning of the OHL and timber pole sets is as follows:

(1) Decommissioning works will be undertaken using low ground pressure (LGBP) machinery.

(2) It is currently expected that decommissioning works will be carried out using a lightweight tracked dumper with a winch and 2 no. tracked excavators fitted with pole handling equipment.

(3) Conductor lines will be de-tensioned and removed at various points along the OHL route.

(4) A winch will be brought to the site of the particular pole set to be removed by means of lightweight tracked dumper.

(5) The winch will be attached to the steel cross member of the pole set from ground level.

(6) The cross member will be un-bolted from the pole on the opposite side as the winch.

(7) The winch will allow the cross member to rotate until it is hanging vertical and it will then be lowered to the ground.

(8) The first excavator, fitted with pole handling equipment, will grab the poles at about mid height or higher.

(9) The second excavator will loosen the ground around the base of the pole.

(10) Once the ground is sufficiently loosened, the pole will be raised from its hole and lowered to the ground by the first excavator.

(11) The empty hole will be backfilled and made safe.

(12) If one excavator is capable of carrying it, the pole will be removed by that excavator to a suitable loading point. If one excavator cannot safely carry the pole, both excavators will be used.

(13) Steps (8) to (12) are repeated for the second pole.

(14) The OHL poles and mast elements will be removed from site for reuse and if necessary, disposal in accordance with the relevant legislation.

As advised by ESB, the proposed methodology for the removal of angle masts, intermediate masts and ends masts is as follows:

(1) Conductor lines will be de-tensioned and removed at various points along the OHL route.

(2) Rope access personnel (linesmen) will climb the particular mast to be decommissioned and will work to dismantle the structural members of the mast one by one.

(3) A light pulley block will be secured to the mast and the selected member for removal. The selected member for removal will be unbolted or cut away from the mast structure. Alternatively, if there are no site restrictions then a mobile crane is usually used on site for the dismantling.

(4) The dismantled member will be winched safely to the ground using the pulley system and loaded onto a light weight tracked dumper for disposal. Depending on the type of transportation available, the dismantled member may need to be cut up into smaller segments for transportation.

(5) The workers will progress through each mast, member by member, in this manner.

(6) Where steel structural members are cast into concrete foundations, steel members will be cut flush with the concrete foundation.

(7) The concrete foundations will typically be left in place, this may vary depending on site requirements. Generally, the concrete foundations are removed to 1m below ground level. This would be done using an excavator with a rock breaker. All removed concrete and steel would be removed to a registered waste disposal facility.

It is expected that a uniform surcharge loading of 10kPa over the affected ground surface will adequately model the pressure imposed on the ground by the plant involved. For access and egress purposes bog mats may be deployed to spread the loading of the plant where deemed necessary, thus avoiding the construction of stone access tracks.

8. DETERMINISTIC PEAT STABILITY ASSESSMENT

The main approaches for assessing peat stability include the following:

(a) Geomorphological

(b) Qualitative (judgement)

(c) Index/Probabilistic (probability)

(d) Deterministic (factor of safety)

Approaches (a) to (c) listed above would be considered subjective and do not provide a definitive indication of stability; in addition, a high level of judgement/experience is required which makes it difficult to relate the findings to real conditions. FT apply a more objective approach, the deterministic approach.

As part of FT's deterministic approach, a qualitative risk assessment is also carried out (see Section 9) taking into account qualitative factors, which cannot necessarily be quantified, such as the presence of mechanically cut peat, quaking peat, bog pools, sub peat water flow, slope characteristics and numerous other factors. The qualitative factors used in the risk assessment are compiled based on FT's experience of assessments and construction in peat land sites and peat slides throughout Ireland and the UK. This approach takes into account current guidelines for geotechnical/peat stability risk assessments as given in Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (PLHRAG, 2017) and MacCulloch (2005).

8.1 Methodology for Deterministic Peat Stability Assessment

Stability of a peat slope is dependent on several factors working in combination. The main factors that influence peat stability are slope angle, shear strength of peat, depth of peat, pore water pressure and loading conditions.

An adverse combination of factors could potentially result in peat sliding. An adverse condition of one of the above-mentioned factors alone is unlikely to result in a peat slide. To assess the factor of safety for a peat slide, undrained and drained analyses have been undertaken to determine the stability of the peat slopes along the OHL route and at the substation.

The infinite slope model (Skempton and DeLory, 1957) is used to combine these factors to determine a factor of safety against peat sliding. This model is based on a translational slide, which is a reasonable representation of the dominant mode of movement for peat slides.

8.2 Peat Strength

Undrained (short term stability) and drained (long term stability) analyses were carried out to determine the stability of the peat slopes on the site.

(1) The undrained loading condition applies in the short term typically following the application of a load and until load induced pore water pressures have dissipated. Most anthropogenic peat slides occur in the undrained condition i.e. in fully saturated conditions. The undrained condition uses undrained strength parameters in the assessment. The undrained conditions is considered to be the more relevant for the Decommissioning Phase however the drained condition is included for completeness.

(2) The drained loading condition applies in the long-term following partial or full dissipation of excess pore water pressure from the peat over time. In the drained condition the pre water pressure (groundwater level) is in equilibrium with in-situ conditions which can vary with seasonal changes. The drained condition examines the effect of the change in groundwater level as a result of rainfall on the stability of the peat slope (following the draining or partial draining of the peat). As a worst case and for the purpose of the assessment the groundwater level is assumed to be at the surface of the peat, to reflect an extreme rainfall event. The drained condition uses effective strength parameters in the assessment.

Undrained shear strength values (c_u) for peat recorded on site using the hand shear vane are used for the undrained analysis.

For the analysis of the peat slopes along the OHL route a lower bound value of 6kPa for the undrained shear strength of the peat was used (Figure 2). This is based on the analysis of a total of 90 no. shear vane tests (carried out by FT (2019, 2022) AGEC (2018) and ESB (2006)) which have provided undrained shear strength values for the peat. Of 123 test results, 3 results showed a shear strength value of less than 6kPa. This value would be considered appropriate and conservative for the undrained condition.

A drained analysis requires effective cohesion (c') and effective friction angle (ø') values for the calculations. These values can be difficult to obtain because of disturbance experienced when sampling peat and the difficulties in interpreting test results due to the excessive strain induced within the peat. To determine suitable drained strength values a review of published information on peat was carried out.

Table 8.1 shows a summary of the published information on peat together with drained strength values.

Table 8.1: List of Effective Cohesion and Friction Angle Values for Peat

Reference	Cohesion, c' (kPa)	Friction Angle, ø' (degs)	Testing Apparatus/ Comments
Hanrahan et al (1967)	5 to 7	36 to 43	From triaxial apparatus
Rowe and Mylleville (1996)	2.5	28	From simple shear apparatus
Landva (1980)	2 to 4	27.1 to 32.5	Mainly ring shear apparatus for normal stress greater than 13kPa
	5 to 6	-	At zero normal stress
Carling (1986)	6.5	0	-
Farrell and Hebib (1998)	0	38	From ring shear and shear box apparatus. Results are not considered representative.
	0.61	31	From direct simple shear (DSS) apparatus. Result considered too low therefore DSS not considered appropriate
Rowe, Maclean and Soderman (1984)	1.1	26	From simple shear apparatus
	3	27	From DSS apparatus
McGreever and Farrell (1988)	6	38	From triaxial apparatus using soil with 20% organic content

	6	31	From shear box apparatus using soil with 20% organic content
Hungr and Evans (1985)	3.3	-	Back-analysed from failure
Dykes and Kirk (2006)	3.2	30.4	Test within acrotelm
Dykes and Kirk (2006)	4	28.8	Test within catotelm
Warburton et al (2003)	5	23.9	Test in basal peat
Warburton et al (2003)	8.74	21.6	Test using fibrous peat
Hendry et al (2012)	0	31	Remoulded test specimen
Komatsu et al (2011)	8	34	Remoulded test specimen
Zwanenburg et al (2012)	2.3	32.3	From DSS apparatus
Den Haan & Grognet (2014)	-	37.4	From large DSS apparatus
O'Kelly & Zhang (2013)	0	28.9 to 30.3	Tests carried out on reconstituted, undisturbed and blended peat samples

From Table 8.1 the values for c' ranged from 1.1 to 8.74kPa and ø' ranged from 21.6 to 43°. The average c' and ø' values are 4.5kPa and 30° respectively. Based on the above, it was considered to adopt a conservative approach and to use design values less than the average.

For design the following general drained strength values have been used for the site:

c' = 4kPa
ø' = 25 degrees.

8.3 Analysis to Determine Factor of Safety (Deterministic Approach)

The purpose of the analysis was to determine the Factor of Safety (FoS) of the peat slopes along the OHL route. As the analysis uses generalised lower bound peat strength values, the results provide an indication of areas where instability might occur. The analysis assumes that all areas have lower bound peat strength, which in the majority of instances is not the case.

The FoS provides a direct measure of the degree of stability of the slope. A FoS of less than unity indicates that a slope is unstable, a FoS of greater than unity indicates a stable slope.

The acceptable safe range for FoS typically ranges from 1.3 to 1.4. Where there is minimal risk from a slope slide a FoS of just greater than 1 may in some cases be acceptable. The previous code of practice for earthworks BS 6031:1981 (BSI, 1981), provided advice on design of earthworks slopes. It stated that for a first-time slide with a good standard of site investigation the design FoS should be greater than 1.3. A FoS of 1.4 is taken as indicative of sufficient stability within this report, which would be deemed a conservative approach.

As a general guide the FoS limits for peat slopes in this report are summarised in Table 8.2.

Table 8.2: Factor of Safety Limits for Slopes

Factor of Safety (FoS)	Degree of Stability
Less than 1.0	Unstable (red)
Between 1.0 and 1.3	Marginally stable (yellow)
1.3 or greater	Acceptable (green)

Eurocode 7 (EC7) (I.S. EN 1997-1:2005+AC: 2013) now serves as the reference document and the basis for design geotechnical engineering works. The design philosophy used in EC7 applies partial factors to soil parameters, actions and resistances. Unlike the traditional approach, EC7 does not provide a direct measure of stability, since global Factors of Safety are not used.

As such, and in order to provide a direct measure of the level of safety on a site, EC7 partial factors have not been used in this stability assessment. The results are given in terms of FoS. This is considered to be in line with best practice guidance as provided in PLHRAG (2017).

The formula used to determine the factor of safety for the undrained condition in the peat (Bromhead, 1986) is as follows:

$$F = \frac{c_u}{\gamma z \sin\alpha \cos\alpha}$$

Where:

- F = Factor of Safety
- c_u = Undrained strength
- γ = Bulk unit weight of material
- z = Depth to failure plane assumed as depth of peat
- α = Slope angle

The formula used to determine the factor of safety for the drained condition in the peat (Bromhead, 1986) is as follows:

$$F = \frac{c' + (\gamma z - \gamma_w h_w)\cos^2 \alpha \tan \phi'}{\gamma z \sin \alpha \cos \alpha}$$

Where:

F = Factor of Safety
c' = Effective cohesion
γ = Bulk unit weight of material
z = Depth to failure plane assumed as depth of peat
γ_w = Unit weight of water
h_w = Height of water table above failure plane
α = Slope angle
ϕ' = Effective friction angle

For the drained analysis the level of the water table above the failure surface is required to calculate the factor of safety for the slope. Since the water level in blanket peat can be variable and can be recharged by rainfall, it is not feasible to establish its precise location throughout the site. Therefore, a sensitivity analysis using water level ranging between 0% and 100% of the peat depth was conducted, where 0% equates to the peat being completely dry and 100% equates to the peat been fully saturated.

The following general assumptions were used in the analysis of peat slopes at each location:

(1) Peat depths are based on the maximum peat depth recorded at each location from the walkover surveys (2018, 2019 and 2022).

(2) For the analysis of the peat slopes across the site a lower bound value of 6kPa for the undrained shear strength of the peat was used (Figure 2).

(3) Slope angle at base of sliding assumed to be parallel to ground surface.

For the stability analysis two load conditions were examined, namely

Condition (1): no surcharge loading
Condition (2): surcharge of 10 kPa, equivalent to 1m of stockpiled peat assumed as a worst case. This case assumes that the groundwater stays at the original surface level.

8.4 Results of the Stability Analysis for the OHL

8.4.1 Undrained Analysis

The results of the undrained stability analysis for the OHL route and Agannygal Substation are graphically shown in Drawings 0004 and 0005 and are tabulated in Appendix E.

For the peat slopes the calculated FoS for load condition (1) and (2) is typically in excess of 1.4 for each location analysed.

A summary of the FoS range calculated for load condition (1) and load condition (2) are presented in Table 8.3 along with their respective percentage of site area.

Table 8.3: Summary of Undrained Slope Stability Results

Factor of Safety (FoS)	% of OHL Route (Condition 1)	% of OHL Route (Condition 2)
Less than 1.0	0	0
1.0 to 1.3	0	1
1.3 to 1.4	0	0
Greater than 1.4	100	99

For Condition (1), 100% of the OHL route and substation has a FoS greater than 1.0 and for Condition (2) 99% of the OHL route has a FoS greater than 1.4. Analysis of the spatial distribution of the areas (1 location) where the lower FoS are present for load condition (2) shows that it is located in areas where steeper slopes are present between pole sets i.e. typically between 10 and 15 degrees. This is located between PS25 and PS26, between PS25 and the Owendalulleagh River, in an area where no works are proposed. Information on mitigation measures for these areas is provided within the Peat Stability Risk Assessment in Appendix D. No FoS values of less than 1.4 was recorded at a pole set or angle mast location.

In general, the factors of safety less than 1.4 generated from the analysis are not unexpected as generalised lower bound peat strength values are used in the analysis, which cannot take into account areas of higher strength peat. The analysis is intended to provide an indication of likely peat instability and is to be used as an input to a further qualitative risk assessment of the peat stability along the OHL route.

8.4.2 Drained Analysis

The results of the drained stability analysis for the OHL route and Agannygal Substation can be found in Appendix E.

For the peat slopes the calculated FoS for load condition (1) and (2) is in excess of 1.4 for each location analysed. A summary of the various FoS's calculated for load condition (1) and load condition (2) are presented in Table 8.4 along with their respective percentage of site area.

Table 8.4: Summary of Drained Slope Stability Results

Factor of Safety (FoS)	% of OHL Route (Condition 1)	% of OHL Route (Condition 2)
Less than 1.0	0	0
1.0 to 1.3	0	0
1.3 to 1.4	0	0
Greater than 1.4	100	100

From Table 8.4 for load condition (1) 100% of the OHL route and substation has a FoS greater than 1.4 and for Condition (2) 100% of the OHL route has a FoS greater than 1.4. No FoS of less than 1.4 was recorded at a pole set or angle mast location.

While it has been found, somewhat counterintuitively, that Condition (1), the natural condition, presents a less favourable outcome than Condition (2), where the slope is surcharged, this is reasonable due to the effective stress analysis undertaken. In this analysis, an increase in the surface loading and hence the vertical effective stress leads to an increase in the confining pressure on the potential failure plane under consideration and therefore a greater resistance to movement on that plane.

In general, the factors of safety less than 1.4 generated from the analysis are not unexpected as generalised lower bound peat strength values are used in the analysis, which cannot take into account areas of higher strength peat. The analysis is used to provide an indication of the likely susceptibility of instability within the OHL route and at the substation.

8.5 Stability of Agannygal Substation Site

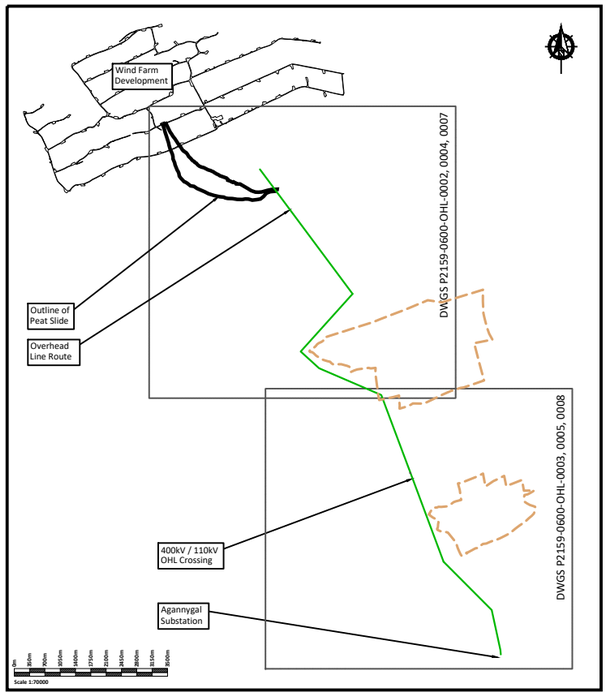
The Agannygal Substation site is founded on mineral soil, which would be considered a competent founding medium. As the peat was stripped away as part of the construction and there is no peat present within the footprint the Agannygal substation site, the substation site is not included in the stability analysis as it is considered stable.

8.6 Summary

The analysis was carried out to provide an indication of likely peat instability along the OHL route. The analysis showed that, using conservative strength parameters, the peat generally has an adequate factor of safety and hence a low risk of instability. However, the use of conservative undrained and drained strength parameters has contributed to a small number (1 number) of relatively low FoS results, particularly around areas of high slope angles. This is located between PS25 and PS26.

In general, the areas of relatively low FoS generated from the analysis are not unexpected as generalised lower bound peat strength values are used in the analysis, which cannot take into account areas of higher strength peat. The analysis is intended to provide an indication of likely peat instability.

The deterministic and quantitative results obtained from the analysis presented in this section are used in Section 9 of this report to undertake a peat stability risk assessment. As part of this assessment, appropriate control measures will be identified to mitigate the risk of a peat slide.



KEYPLAN

Scale 1:70000

FOS CORRIDOR PLAN

Scale 1:14000

Legend: Factor of Safety

- 1 or less
- 1.01 to 1.3
- 1.31 to 1.4
- Greater than 1.4
- No Peat Recorded at this Location

Increasing Stability

Note -

The results of the undrained analysis for the most critical load condition 2 are shown on this drawing.

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Rev.	Description	App By	Date
A	FOR INFORMATION	BDH	20.01.23

PROJECT: **DERRYBRIEN WIND FARM DECOMMISSIONING**

CLIENT: **ESB EMP**

SHEET: **FACTOR OF SAFETY FOR PEAT SLOPES DRAWING 1 OF 2**

Date: 20.01.23 | Project number: P22-133 | Scale (@ A3):

Drawn by: POR | Drawing Number: P22-133-0600-OHL-0004 | Rev: A

Checked by: IH

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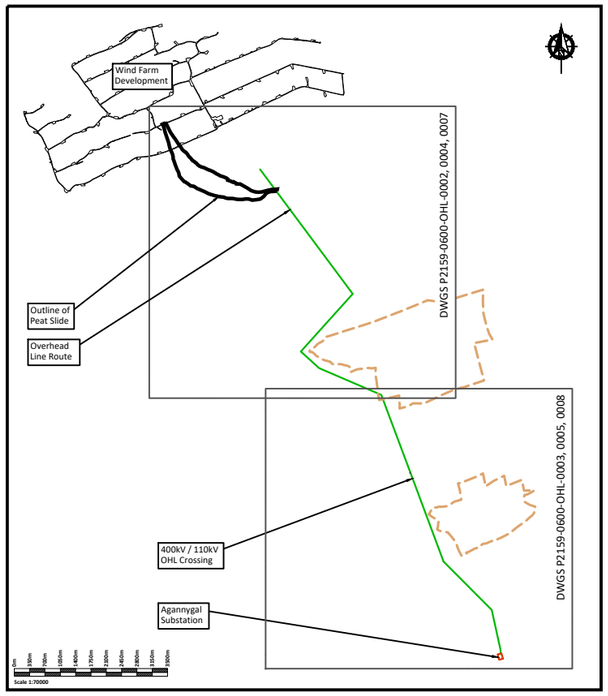
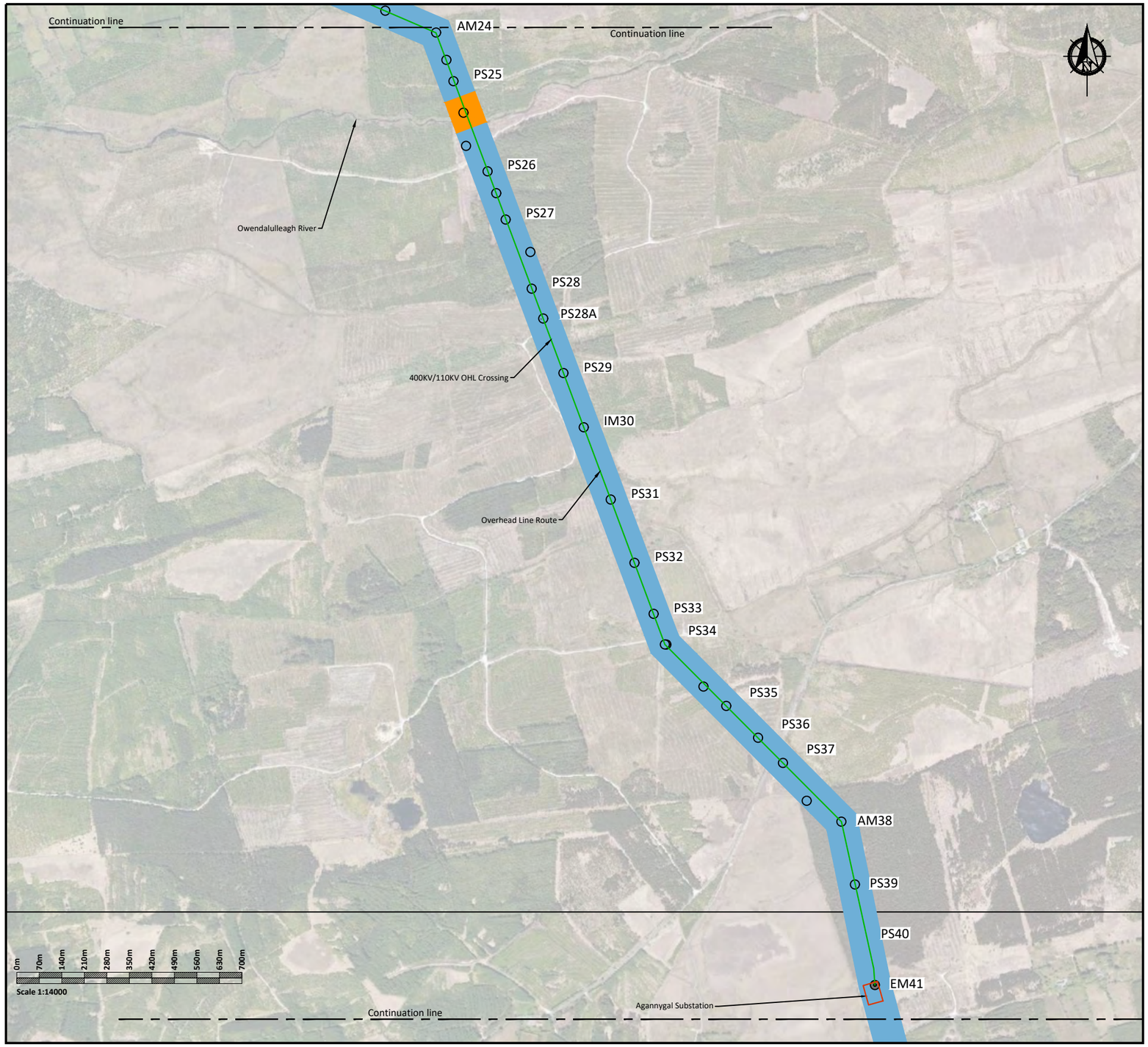
Friday 20 January 2023



KEYPLAN

Scale 1:70000



Legend: Factor of Safety

- 1 or less
- 1.01 to 1.3
- 1.31 to 1.4
- Greater than 1.4
- No Peat Recorded at this Location

Increasing Stability

Note -

The results of the undrained analysis for the most critical load condition 2 are shown on this drawing.

PEAT DEPTH CORRIDOR PLAN

Scale 1:14000

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A	FOR INFORMATION	BDH	20.01.23

PROJECT: DERRYBRIEN WIND FARM DECOMMISSIONING

CLIENT: ESB EMP

SHEET: FACTOR OF SAFETY FOR PEAT SLOPES DRAWING 2 OF 2

Date: 20.01.23 | Project number: P22-133 | Scale (@ A3) |

Drawn by: POR | Drawing Number: P22-133-0600-OHL-0005 | Rev: A

Checked by: IH

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Friday 20 January 2023

9. PEAT STABILITY RISK ASSESSMENT

9.1 Methodology

A peat stability risk assessment was carried out for the OHL infrastructure and Agannygal substation. This approach takes into account guidelines for geotechnical/peat stability risk assessments as given in PLHRAG (2017) and MacCulloch (2005).

The risk assessment uses the results of the stability analysis (deterministic approach) in combination with qualitative factors, which cannot be reasonably included in a stability calculation but nevertheless may affect the occurrence of peat instability, to assess the risk for each infrastructure element.

As previously outlined, the OHL route was broken into 8 no. subsections (including the substation at Agannygal) for assessment. These subsections were chosen based on having similar topography and peat depth within each individual section

For each subsection of the OHL, a risk rating (product of probability and impact) is calculated for every contributory/qualitative factor in the subsection. The range of risk ratings is shown in Table 9.1.

The risk rating assigned to any subsection is based on the highest risk rating calculated for any contributory/qualitative factor within that subsection.

Where a subsection is rated 'Medium' or 'High', specific control measures are required to reduce the risk to at least a 'Low' risk rating. Where a subsection is rated 'Low' or 'Negligible', only routine control measures, if any, are required. The control measures are targeted at the specific contributory/qualitative factors that give the highest risk rating.

Table 9.1: Risk Rating Legend

17 to 25	High: avoid works in area or significant control measures required
11 to 16	Medium: notable control measures required
5 to 10	Low: only routine control measures required
1 to 4	Negligible: none or only routine control measures required

A full methodology for the peat stability risk assessment is given in Appendix C.

The impact of a peat slide on the receiving environment within and beyond the OHL route and substation is assessed based on the potential travel distance and potential volume of a peat slide and the effect on receptors such as local property, infrastructure, and the natural environment.

Where a peat slide enters a watercourse it can travel a considerable distance downstream. Therefore, the proximity of a potential peat slide to a drainage feature is a significant indicator of the likely potential impact. Furthermore, given the elevation of the terrain along the OHL route, the topography in some areas may result in the formation of potential flow paths through naturally occurring features such as dips and falls in the terrain, valleys, etc. Such features would have the effect of increasing the travel distance of and the areas affected by any potential peat slide.

The potential damage to private property is also assessed using this approach. The OHL is located in a sparsely populated location; however, landowners and domestic dwellings may still be at risk in certain areas if a peat slide were to occur. In addition, property such as pasture and tillage farms, private landholdings, and communication/power infrastructure can be susceptible to peat slides. The list of such potential features or receptors identified are outlined in Table 9.2.

Table 9.2: Potential Receptors

Receptor	Control
Watercourse (rivers, streams, flow channels, etc.)	Topography
Dwellings (domestic)	
Road (local roads excluding wind farm access tracks)	
Infrastructure (overhead lines, communications infrastructure, etc.)	
Agricultural Land (pasture, etc.)	
Natural Heritage Area (Slieve Aughty Bog NHA)	

The primary controlling aspect when determining the impact of a potential peat slide, once that slide has occurred, is the topography along the slide run-out route.

9.2 Summary of Risk Assessment Results

The results of the risk assessment for potential of a peat slide at the 8 no. subsections are presented in Appendix D and are summarised in Table 9.3.

The risk rating for the identified areas of infrastructure along the OHL route and the substation is designated low or less following mitigation/control measures being implemented. If any sections of new temporary access track are required for any decommissioning works on the OHL, these should be subject to the same mitigation/control measures that apply to that particular subsection of the OHL. Where the proposed access routes use the existing founded forest tracks the risk rating is considered to be negligible, due to the minor nature of any required upgrade works and the absence of peat beneath the tracks.

Details of the required mitigation/control measures can be found for each OHL subsection in Appendix D.

The upgrade of the c. 2.5km of access track to access the Agannygal substation site during construction is not considered to present a risk of instability given the minor nature of the work involved and the relatively flat topography of the area.

Table 9.3: Summary of Peat Stability Risk Assessment

Infrastructure	Pre-Control Measure Implementation Risk Rating	Post-Control Measure Implementation Risk Rating
PS5 to AM14	Medium	Negligible
AM14 to AM18	Negligible	Negligible
AM18 to AM24	Medium	Negligible
AM24 to PS28A	Medium	Low
PS28A to PS34	Medium	Negligible
PS34 to AM38	Medium	Negligible
AM38 to EM41	Medium	Negligible
Agannygal Substation	Negligible	Negligible

Note
(1) For mitigation/control measures refer to Appendix D.

9.3 Likelihood of Instability – Combining Deterministic and Qualitative Factors

The results of the stability analysis (Section 8) have been combined with qualitative factors, to provide an indication of the probability of instability. The qualitative factors are given in Appendix C.

The purpose of combining deterministic and qualitative factors is to provide a likelihood of failure that can be applied to a variety of potential specific receptors, other than those included in this report, see Table C in Appendix C. The peat stability risk assessment included in Section **Error! Reference source not found.**.2 of this report uses a number of general receptors such as local property, infrastructure, and the natural environment.

The deterministic factor of safety and qualitative factors are combined as follows:

- The deterministic factor of safety and qualitative factors are scored from 0 to 5 using Table B in Appendix C.
- The maximum score that can be obtained by combining the deterministic factor of safety and qualitative factors, that is a total of 12 factors (5 x 12), is 60, and the lowest score is 0. The greater the total combined score the greater the likelihood of failure.
- Where the stability analysis is not applicable because, for example, no peat is present, then the deterministic score is 0, and combined score defaults to negligible irrespective of the qualitative factors.
- Where stability analysis shows FoS less than 1 then the likelihood defaults to very likely irrespective of qualitative score
- In all cases, experienced engineering judgement is used, the actual combined scoring provides a guide.

Error! Reference source not found. shows the peat landslide combined likelihood ranges for the lifetime of a proposed development, and Table 9.5 provides the combined likelihood score for each of the sections assessed.

Table 9.4: Summary of Peat Stability Liklihood and Probability

Scale	Likelihood	Combined Score	Probability of Occurrence (Event / year)
0	Not applicable	0	Not applicable
1	Negligible	1 to 10	>1 in 100,000 to 1 in 10,000
2	Unlikely	11 to 30	>1 in 10,000 to 1 in 1,000
3	Probable	31 to 40	>1 in 1,000 to 1 in 100
4	Likely	41 to 50	>1 in 100 to 1 in 10
5	Very Likely	51 to 60	>1 in 10

Table 9.5: Summary of Peat Stability Likelihood along OHL

Infrastructure	Combined Likelihood Score	Likelihood of Failure Pre-Control Measure Implementation
PS5 to AM14	13	Unlikely
AM14 to AM18	3	Negligible
AM18 to AM24	9	Negligible
AM24 to PS28A	19	Unlikely
PS28A to PS34	12	Unlikely
PS34 to PS38	17	Unlikely
AM38 to EW41	14	Unlikely
Agannygal	2	Negligible

10. CONCLUSIONS

The following conclusions are given.

(1) Fehily Timoney & Company (FT) was engaged by ESB to undertake a geotechnical stability assessment of the OHL route from the Derrybrien wind farm site to the Agannygal Substation. In line with the brief, the assessment took account of the geotechnical stability of the route and the substation during its construction phase, operational phase and during possible decommissioning works in the future.

(2) The geotechnical stability assessment included the completion of a desk study, a site walkover, and an additional ground investigation. A deterministic peat stability assessment and a qualitative peat stability risk assessment were undertaken.

(3) Apart from the peat slide scar left by the peat slide in October 2003, which is between pole sets 5 and 6, no evidence of past peat slides have been recorded on the OHL route. The nearest other historical peat slide was located approximately 2.5km east of the offsite substation and occurred in 1890.

(4) Cuttings up to 3.8m deep in glacial till were observed. These appear to be stable based on a visual inspection and are considered to have a low risk of future instability.

(5) The deterministic peat stability assessment found that the peat along the OHL route generally has an adequate factor of safety against peat slide and hence a low risk of instability. However, the use of conservative shear strength parameters for the peat has contributed to a small number (1 no. – 1% of total route) of low FoS results, particularly around areas of high slope angles. The Risk Assessments in Appendix D provide mitigation measures for these areas.

(6) A qualitative peat stability risk assessment was carried out by separating the OHL route into 8 no. subsections and assessing these subsections based on the probability of a peat slide for a number of indicators and the likely impact of a peat slide, should it occur. The peat stability risk assessment found that 6 no. subsections were assigned a ‘medium’ risk rating while the remaining subsections were assigned ‘low’ or ‘negligible’ risk ratings.

(7) To bring the risks of a peat slide at the locations where a ‘medium’ risk exists to ‘low’ or ‘negligible’ levels, it is recommended that control measures are implemented. These include routine measures such as avoiding accessing the areas of peat with the greatest slopes with plant, the use of suitable plant and equipment, and adequate monitoring of the works. Other control measures are outlined in Appendix D.

(8) Overall the stability of the OHL and Agannygal Substation with respect to peat slide risk is considered to be acceptable. Where localised areas of elevated risk have been identified the level of risk can be reduced by the application of routine control measures.

(9) Should any sections of new temporary access track be required for any decommissioning works running below the OHL, these should be subject to the same mitigation/control measures that apply to that particular subsection of the OHL. Where the proposed access routes use the existing founded forest tracks the risk rating is considered to be negligible, due to the minor nature of any required upgrade works and the absence of peat beneath the tracks.

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CONSULTANTS IN ENGINEERING, ENVIRONMENTAL SCIENCE & PLANNING

FIGURES

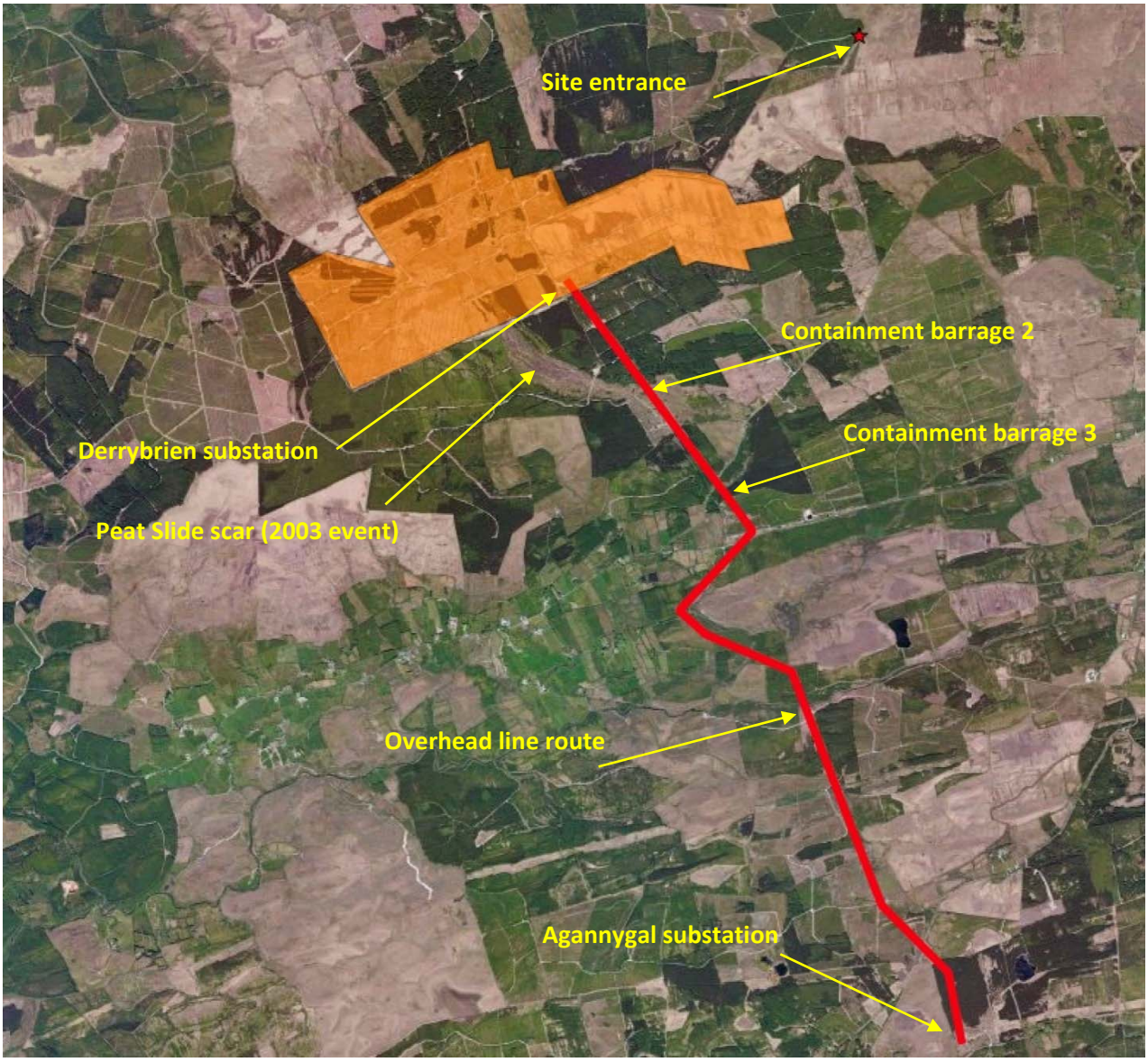
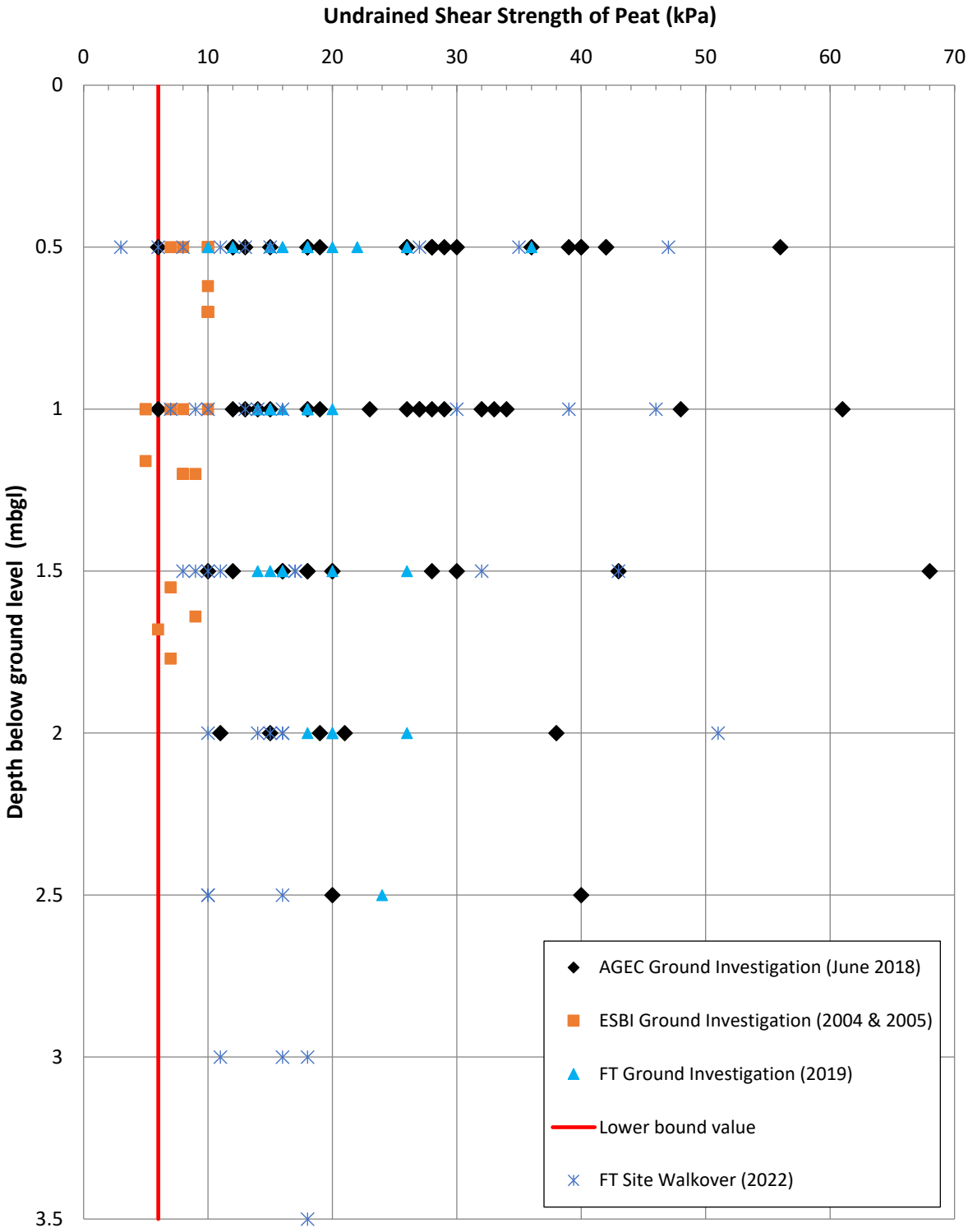
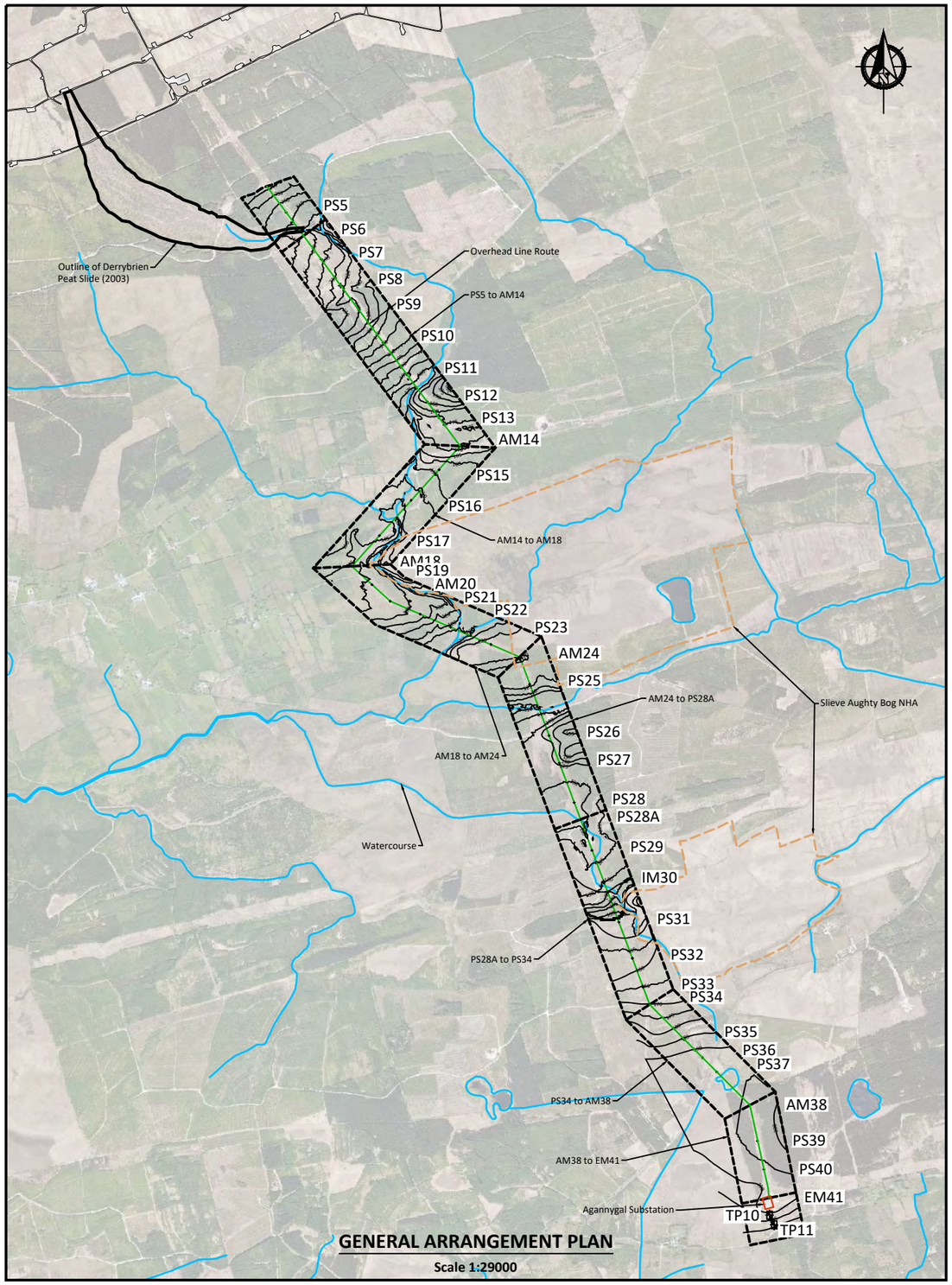


Figure 1 Location of Grid Connection (source: Bing Maps)

Figure 2 Undrained Shear Strength of Peat along Overhead Line Route





GENERAL ARRANGEMENT PLAN

Scale 1:29000

GI Legend and notes:

AGEC Trial Pit Locations (June 2018)

Background aerial mapping shown taken from the latest available Bing Mapping.

Notes:

1. The OHL route was broken into a number of subsections (including the substation at Agannygal) for assessment. These subsections were chosen based on having comparable topography and peat depth.

0m 145m 290m 435m 580m 725m 870m 1015m 1160m 1305m 1450m

Scale 1:29000

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PROJECT	DERRYBRIEN WIND FARM DECOMMISSIONING
CLIENT	ESB EMP
SHEET	GENERAL ARRANGMENT
Date	20.01.23
Project number	P22-133
Scale (@ A3)	
Drawn by	POR
Checked by	IH
Drawing Number	P22-133-0600-OHL-0001
Rev	A

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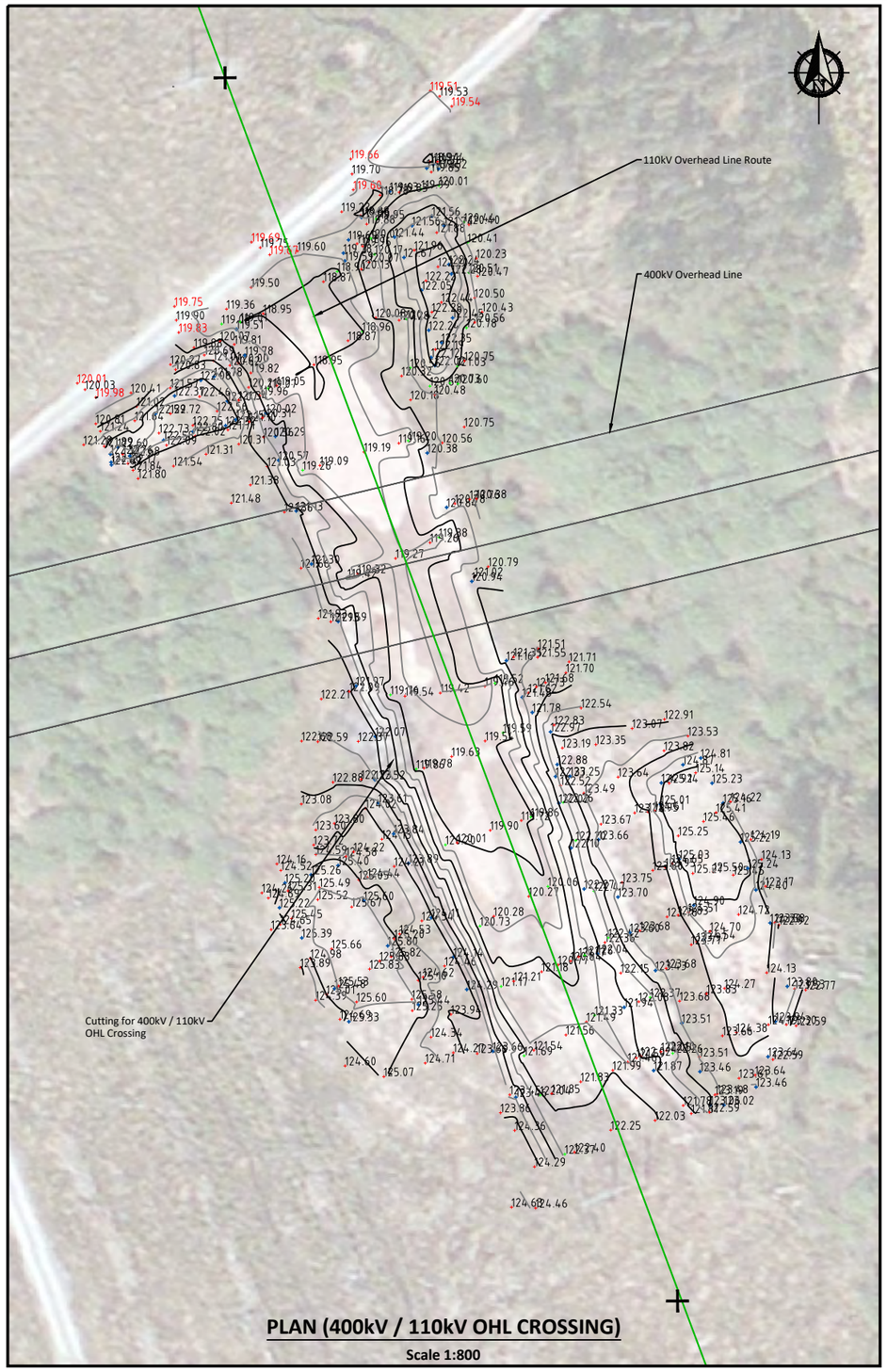
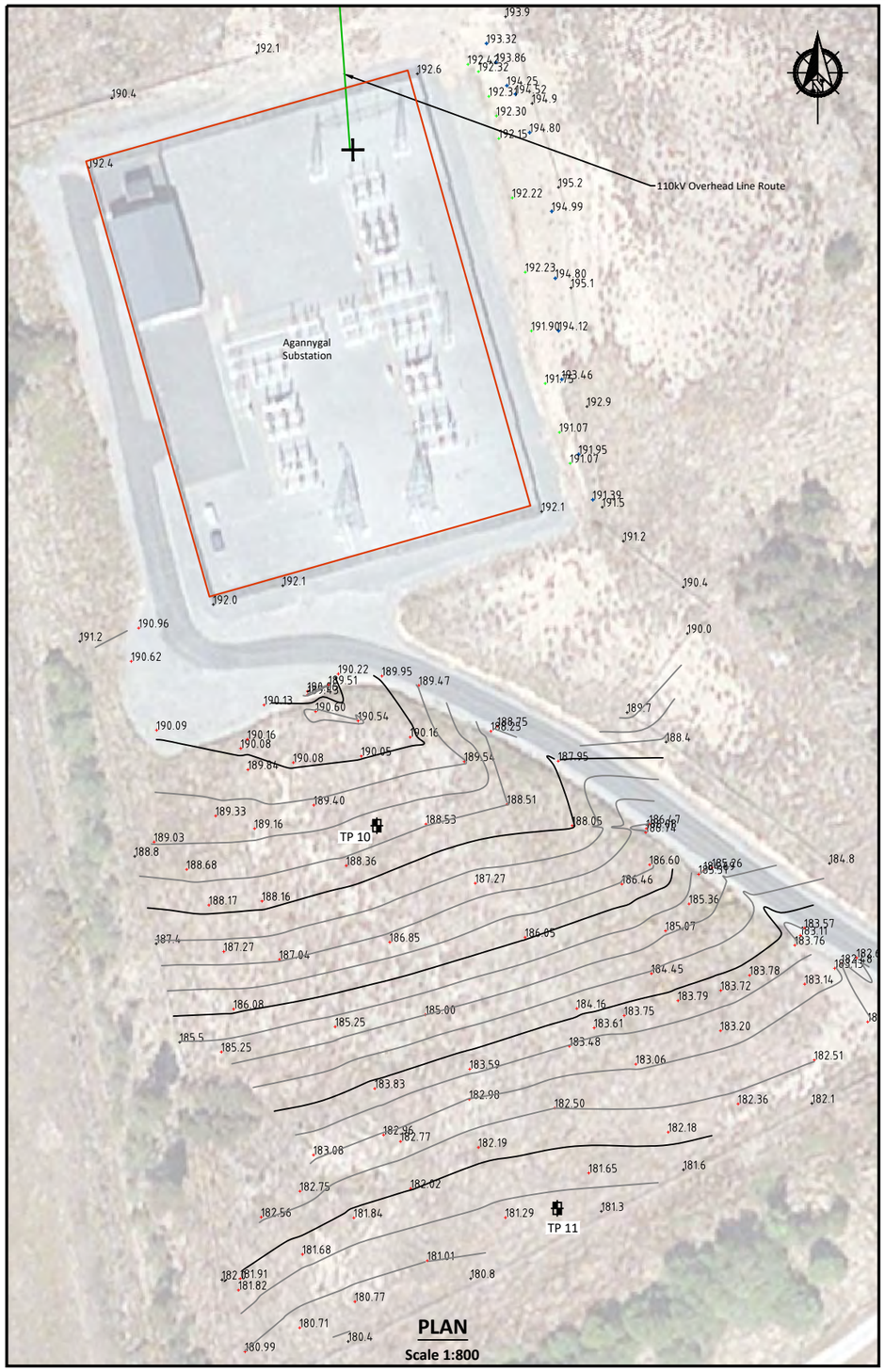


PLAN (400kV / 110kV OHL CROSSING)

Scale 1:800



PLAN

Scale 1:800

GI Legend and notes:

AGEC Trial Pit Locations (June 2018)

Background aerial mapping shown taken from the latest available Bing Mapping.

Notes:

1. Topographical survey information shown on this drawing is based on survey data recorded on site by ESBI in 2018.

0m 4m 8m 12m 16m 20m 24m 28m 32m 36m 40m

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A	FOR INFORMATION	BDH	20.01.23

PROJECT: DERRYBRIEN WIND FARM DECOMMISSIONING

CLIENT: ESB EMP

SHEET: DETAILS OF 400kV / 100kV CROSSING & AGANNYGAL SUBSTATION

Date: 20.01.23	Project number: P22-133	Scale (@ A3):	
Drawn by: POR	Drawing Number: P22-133-0600-OHL-0006		Rev: A
Checked by: IH			

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N

EM1(Derrybrien Station)

PS1a

Derrybrien Substation

PS2

PS3

PS4

PS5

PS6

PS7

PS8

PS9

PS10

PS11

PS12

PS13

AM14

PS15

PS16

PS17

AM18

PS19

AM20

PS21

PS22

PS23

AM24

PS25

Black Road

R353

Point D
E-561084.25
N-702394.884

Point C
E-561040.6337
N-702331.6321

Point A
E-561123.4388
N-702367.5429

Point B
E-561061.14
N-702260.8798

Insert Map

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See Insert Map

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0 0.5 1 1.5 2 km

Legend

Derrybrien - Agannygal 110 kV Overhead Line

Decommissioning Access Routes:

- Decommissioning access route EM1 to PS4
- Decommissioning access route PS12 to PS14
- Decommissioning access route PS15 to PS22
- Alternative Decommissioning access route to PS15 to PS22
- Alternative Decommissioning access route to PS 17 to PS22
- Decommissioning access route PS23 to PS25
- Decommissioning access route PS26 to PS27
- Decommissioning access route PS5 to PS11

Mast type:

- Poleset (PS)
- Angle Mast (AM)
- End Mast (EM)

REV	DATE	REVISION DESCRIPTION	DRN	PROD	VER	APP
0	21/11/2023	Issued for Decommissioning Application	E.O'S	***	***	***

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CLIENT APPROVAL ☐ PLANNING ☒ TENDER ☐ CONSTRUCTION ☐ AS-BUILT ☐

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CLIENT: Gort Windfarms Ltd

PRODUCTION UNIT: Civil Environmental & Renewable Engineering

PROJECT: Derrybrien Wind Farm Decommissioning Project

DRAWING TITLE: Figure DMP 01 - Derrybrien - Agannygal OHL - Indicative Decommissioning Access Routes (Sheet 1 of 2)

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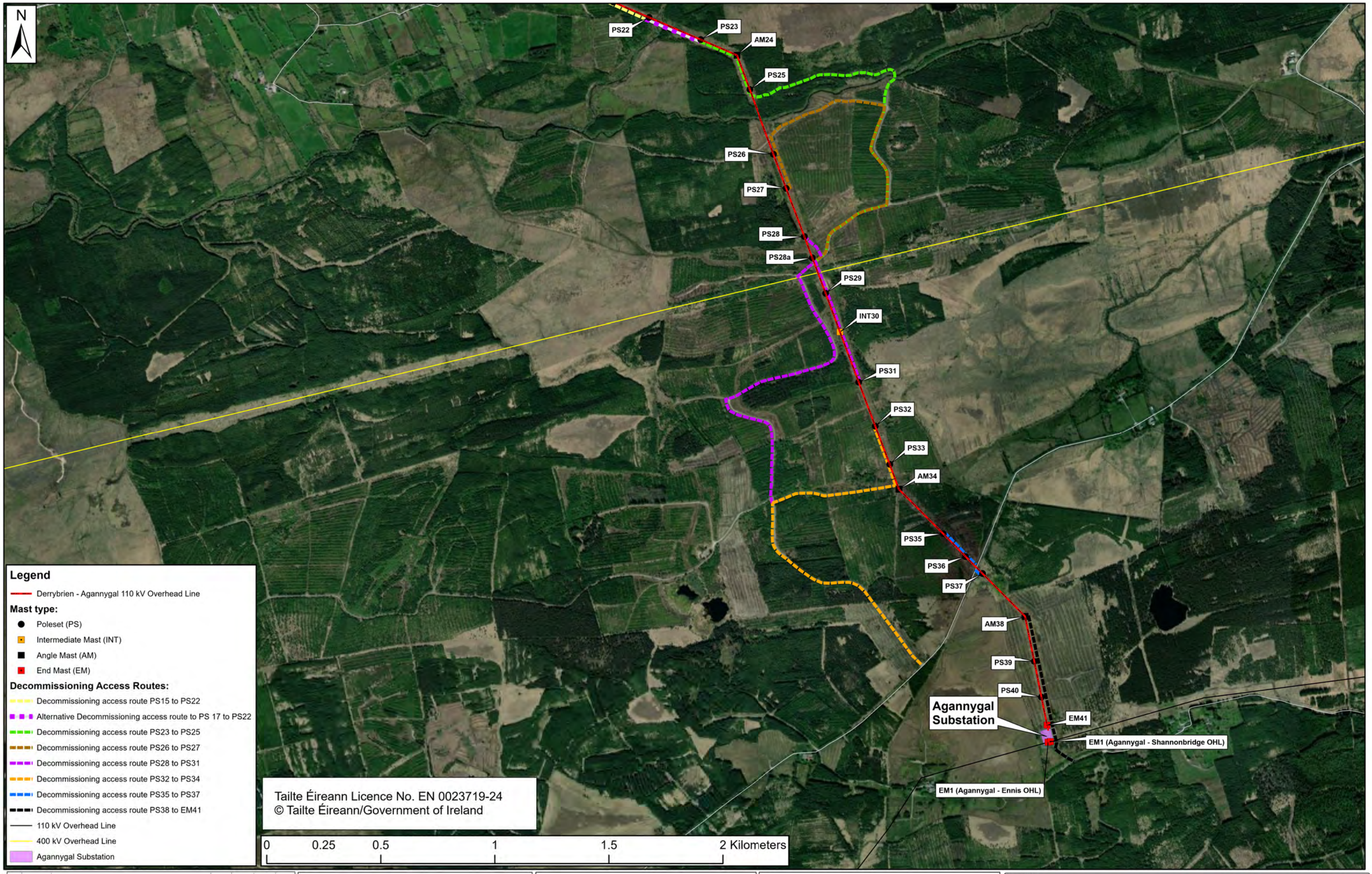
CLIENT REF.	NO. OF SHEETS	SIZE	SCALE
00-00	1/2	A3	1:15,000

DRAWING NUMBER: **DRAFT FOR INFORMATION ONLY**



REV	DATE	REVISION DESCRIPTION	E.O'S	DRN	PROD	VER	APP
0	xx/xx/xx	Issued for Decommissioning Application	E.O'S	XXX	XXX	XXX	

PURPOSE OF ISSUE - PRELIMINARY UNLESS INDICATED

CLIENT APPROVAL ☐ PLANNING ☒ TENDER ☐ CONSTRUCTION ☐ AS-BUILT ☐

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PROJECT: Derrybrien Wind Farm Decommissioning Project

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PRODUCTION UNIT: Civil Environmental & Renewable Engineering

DRAWING TITLE: Figure DMP 02 - Derrybrien - Agannygal OHL - Indicative Decommissioning Access Routes (Sheet 2 of 2)

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N

S37

AM38

PS39

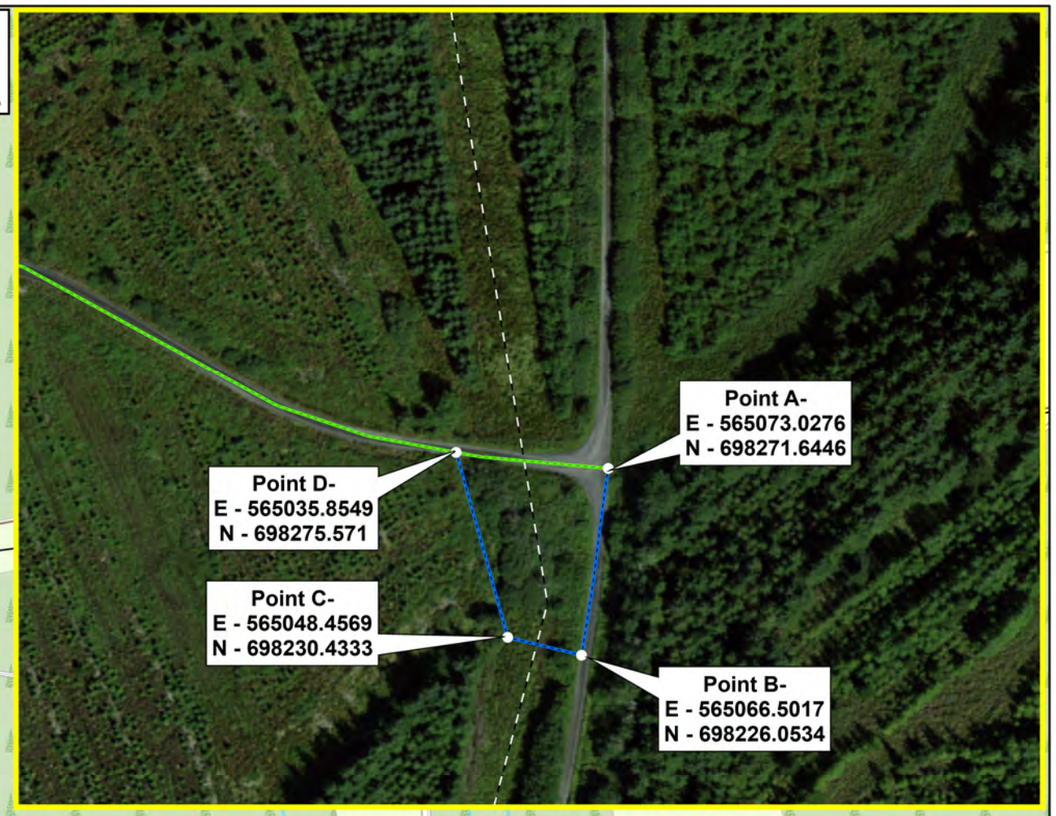
PS40

Agannygal Substation

EM41

EM1 (Agannygal - Shannonbridge OHL)

EM1 (Agannygal - Ennis OHL)



Legend

- Decomissioning Access Route to Substation
- Alternative Decomissioning Access Route to Substation

Mast type:

- Poleset (PS)
- Angle Mast (AM)
- End Mast (EM)
- Derrybrien - Agannygal 110 kV Overhead Line
- 110 kV Overhead Line
- Agannygal Substation

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0 0.13 0.25 0.5 0.75 1 Kilometers

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CLIENT: Gort Windfarms Ltd

PROJECT: Derrybrien Wind Farm Decommissioning Project

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DRAWING TITLE:

Figure DMP 14 - Agannygal Substation - Indicative Decommissioning Access Route

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00-00	1/1	A3	1:8,000

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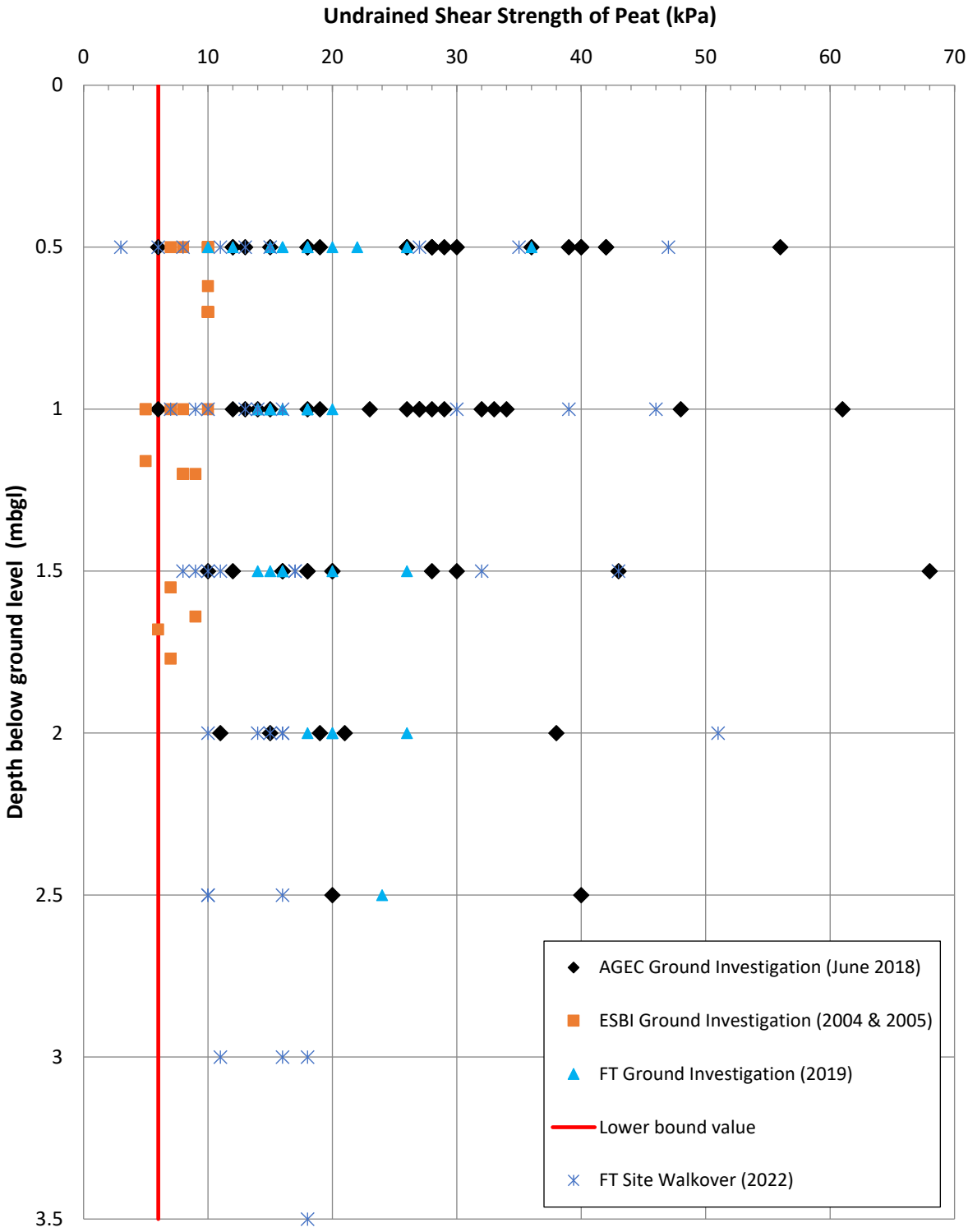
Figure 2 Undrained Shear Strength of Peat along Overhead Line Route



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APPENDIX A

Photos from Site Walkover

Photo 1 Typical timber pole set

Photo 2 Typical steel angle mast

Photo 3 Typical forest track access route

Photo 4 Access track to pole sets PS5 to PS10

Photo 5 Remnants of sleepers from felled trees as access

Photo 6 Owendalluleagh River crossing (access to pole sets PS22 to PS25)

Photo 7 Shallow cutting in exposed mineral soil as access to pole set PS22

Photo 8 Cutting at 400 kV crossing looking south (400 kV line runs left to right in image)

Photo 9 Cutting at 400 kV crossing looking north (400 kV line runs left to right in image)

Photo 10 View of area between pole set PS37 and angle mast AM38 looking north showing Lough Agannygal

Photo 11 Existing forestry access track leading to Agannygal substation

Photo 12 Cutting in mineral soil at Agannygal substation

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APPENDIX B

AGEC Ground Investigation (2018) – Relevant Trial Pit Logs

Trial Pit Log

agec geotechnical engineering consultants

Trialpit No **TP10** Sheet 1 of 1

Project Name: Derrybrien Wind Farm	Project No. 1806	Co-ords: 163168.00 - 198491.00 Level: 0.00	Date 19/06/2018
Location: Co. Galway		Dimensions (m): 3 × 1.3, Depth 2.90	Scale 1:25
Client: ESBI			Logged M.L.

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							Soft to firm light orange grey, brown, grey, slightly gravelly slightly sandy CLAY with some cobbles and occasional boulders, (Sub-angular to sub-rounded), and some wood, pockets of peat etc. (Made ground.)
				0.60	-0.60		Soft woody brown fibrous PEAT with branches, brash and vegetation. (Possible made ground or disturbed ground.)
				1.00	-1.00		Soft greyish brown slightly gravelly sandy organic CLAY and clayey organic SAND with decaying rootlets and some cobbles and occasional boulders. (up to 1.0m) (Sub-angular to sub-rounded)
				1.50	-1.50		Firm becoming stiff to very stiff light reddish brown sandy very gravelly SILT/CLAY with many cobbles and some boulders. (Sub-rounded to sub-angular)
				2.00	-2.00		Stiff to very stiff light reddish brown sandy very gravelly (weak siltstone) SILT/CLAY with many cobbles and some boulders. (Sub-rounded to sub-angular)
				2.90	-2.90		End of pit at 2.90 m

1 2 3 4 5

Remarks: TP - DRY.
End of TP - Hard digging.

Stability: Generally stable, minor spalling.

Trial Pit Log

agec geotechnical engineering consultants

Trialpit No **TP11** Sheet 1 of 1

Project Name: Derrybrien Wind Farm	Project No. 1806	Co-ords: 163193.00 - 198438.00 Level: 0.00	Date 19/06/2018
Location: Co. Galway		Dimensions (m): 3 × 1.5 Depth 2.50	Scale 1:25
Client: ESBI			Logged M.L.

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							Soft to firm light orange grey, reddish brown, brown, grey slightly gravelly slightly sandy CLAY with some cobbles and occasional boulders, (Sub-angular to sub-rounded), and some wood, pockets of peat etc. (Made ground.)
				0.60	-0.60		Disturbed peaty layer - discontinuous.
				0.70	-0.70		Soft grey and orange brown slightly gravelly sandy organic CLAY and clayey organic SAND with decaying rootlets and some cobbles and occasional large boulders. (Sub-angular to sub-rounded)
				1.70	-1.70		Stiff to very stiff light reddish brown sandy very gravelly SILT/CLAY with many cobbles and some boulders. (Sub-rounded to sub-angular)
				2.50	-2.50		End of pit at 2.50 m

1 2 3 4 5

Remarks: No water strike - dry.
End of TP - Hard digging.

Stability: Generally stable, minor spalling.

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APPENDIX C

Methodology for Peat Stability Risk Assessment

Methodology for Peat Stability Risk Assessment

A peat stability risk assessment was carried out for the OHL route between the Derrybrien substation and Agannygal substation. This approach takes into account guidelines for geotechnical/peat stability risk assessments as given in PLHRAG (2017) and MacCulloch (2005). The degree of risk is determined as a Risk Rating (R), which is the product of probability (P) and impact (I). How these factors are determined and applied in the analysis is described below.

The main approaches for assessing peat stability include the following:

(a) Geomorphological
(b) Qualitative (judgement)
(c) Index/Probabilistic (probability)
(d) Deterministic (factor of safety)

Approaches (a) to (c) listed above would be considered subjective and do not provide a definitive indication of stability; in addition, a high level of judgement/experience is required which makes it difficult to relate the findings to real conditions. FT apply a more objective approach, the deterministic approach. As part of FT's deterministic approach, a qualitative risk assessment is also carried out taking into account qualitative factors, which cannot necessarily be quantified.

Probability

The likelihood of a peat failure occurring was assessed based on the results of both the quantitative results of stability calculations (deterministic approach using factors of safety) and the assessment of the severity of several qualitative factors which cannot be reasonably included in a stability calculation but nevertheless may affect the occurrence of peat instability.

The qualitative factors used in the risk assessment are outlined in Table A and have been compiled based on FT's experience of assessments and construction in peat land sites and peat failures throughout Ireland and the UK.

Table A: Qualitative Factors used to Assess Potential for Peat Failure

Qualitative Factor	Type of Feature/Indicator for each Qualitative Factor [1]	Explanation/Description of Qualitative Factor
Evidence of sub peat water flow	No	Based on site walkover observations. Sub peat water flow generally occurs in the form of natural piping at the base of peat. Where there is a constriction or blockage in natural pipes a build-up of water can occur at the base of the peat causing a reduction in effective stress at the base of the peat resulting in failure; this is particularly critical during periods of intense rainfall.
	Possibly	
	Probably	
	Yes	
	Dry	

Qualitative Factor	Type of Feature/Indicator for each Qualitative Factor [1]	Explanation/Description of Qualitative Factor
Evidence of surface water flow	Localised/Flowing in drains	Based on site walkover observations. The presence of surface water flow indicates if peat in an area is well drained or saturated and if any additional loading from the ponding of surface water onto the peat is likely.
	Ponded in drains	
	Springs/surface water	
Evidence of previous failures/slips	No	Based on site walkover observations. The presence of clustering of relict failures may indicate that particular pre-existing site conditions predispose a site to failure.
	In general area	
	On site	
	Within 500m of location	
Type of vegetation	Grass/Crops	Based on site walkover observations. The type of vegetation present indicates if peat in an area is well drained, saturated, etc. Vegetation that indicates wetter ground may also indicate softer underlying peat deposits.
	Improved Grass/Dry Heather	
	Wet Grassland/Juncus (Rushes)	
	Wetlands Sphagnum (Peat moss)	
General slope characteristics upslope/downslope from infrastructure location	Concave	Based on site walkover observations. Slope morphology in the area of the infrastructure location is an important factor. A number of recorded peat failures have occurred in close proximity to a convex break in slope.
	Planar to concave	
	Planar to convex	
	Convex	
Evidence of very soft/soft clay at base of peat	No	Based on inspection of exposures in general area from site walkover. Several reported peat failures identify the presence of a weak layer at the base of the peat along which shear failure has occurred.
	Yes	
Evidence of mechanically cut peat	No	Based on site walkover observations. Mechanically cut peat typically cut using a ‘sausage’ machine to extract

Qualitative Factor	Type of Feature/Indicator for each Qualitative Factor [1]	Explanation/Description of Qualitative Factor
	Yes	peat for harvesting. Areas which have been cut in this manner have been linked to peat instability. The mechanical cuts can notably reduce the intrinsic strength of the peat and also allow ingress of rainfall/surface water.
Evidence of quaking or buoyant peat	No	Based on site walkover observations. Quaking/buoyant peat is indicative of highly saturated peat, which would generally be considered to have a low strength. Quaking peat is a feature on sites that have been previously linked with peat instability.
	Yes	
Evidence of bog pools	No	Based on site walkover observations. Bog pools are generally an indicator of areas of weak, saturated peat. Commonly where there are open areas of water within peat these can be interconnected, with the result that there may be sub-surface bodies of water. The presence of bog pools have been previously linked with peat instability.
	Yes	
Other	Varies	In addition to the above features/ indicators and based on site recordings the following are some of the features which may be identified: Excessively deep peat, weak peat, overly steep slope angles, etc.

Note (1) The list of features/indicators for each qualitative factor are given in increasing order of probability of leading to peat instability/failure.

It should be noted that the presence of one of the qualitative factors alone from Table A is unlikely to lead to peat instability/failure. Peat instability/failure at a site is generally the combination of a number of these factors occurring at the same time at a particular location.

The probability rating assigned to the quantitative and qualitative factors is judged on a 5-point scale from 1 (indicating negligible or no probability of failure) to 5 (indicating a very likely failure), as outlined in Table B. Not applicable occurs where it is not physically possible for failure to occur, for example where no peat is present.

Table B: Probability Scale

Scale	Factor of Safety	Probability
1	1.30 or greater	Negligible/None
2	1.29 to 1.20	Unlikely
3	1.19 to 1.11	Likely
4	1.01 to 1.10	Probable
5	≤1.0	Very Likely

Scale	Likelihood of Qualitative Factor leading to Peat Failure	Probability of Failure
1	Negligible/None	Least
2	Unlikely	
3	Probable	
4	Likely	
5	Very Likely	Greatest

Impact

The severity of the risk is also assessed qualitatively in terms of impact. The impact of a peat slide on the receiving environment within and beyond the overhead line route is assessed based on the potential travel distance and potential volume of a peat slide and the effect on receptors such as local property, infrastructure, and the natural environment.

Where a peat slide enters a watercourse it can travel a considerable distance downstream. Therefore, the proximity of a potential peat slide to a drainage feature is a significant indicator of the likely potential impact. Furthermore, given the elevation of the terrain along the OHL route, the topography in some areas may result in the formation of potential flow paths through naturally occurring features such as dips and falls in the terrain, valleys, etc. Such features would have the effect of increasing the travel distance of and the areas affected by any potential peat slide .

The potential damage to private property is also assessed using this approach. The OHL is located in a sparsely populated location; however, land owners and domestic dwellings may still be at risk in certain areas if a peat slide were to occur. In addition, property such as pasture and tillage farms, private landholdings, and communication/power infrastructure can be susceptible to peat slide. The list of such potential features or receptors identified are outlined in Table C.

Table C: Potential Receptors

Receptor	Control
Watercourse (rivers, streams, flow channels, etc.)	Topography
Dwellings (domestic)	
Road (local roads excluding wind farm access tracks)	
Infrastructure (overhead lines, communications infrastructure, etc.)	
Agricultural Land (pasture, etc.)	
Natural Heritage Area (Slieve Aughty Bog NHA)	

Taking the above into consideration, the primary controlling aspect when determining the impact of a potential peat slide, once that slide has occurred, is the topography along the route. For the purposes of this report, the route has been divided into 9 no. subsections for ease of assessment and risk identification.

Topographical data for each subsection has been used to identify the potential flow path(s) in a peat slide situation and as such will be used for determining the severity of the impact. The risk is determined based on the combination of hazard and impact. A 5-point qualitative scale has been devised for the impact of the hazard based on the distance of a potential peat slide arising from works on or near the OHL subsection to a receptor and this is shown in Table D.

Table D: Impact Scale

Scale	Criteria	Impact
1	Proposed infrastructure element greater than 150m of watercourse	Negligible/None
2	Proposed infrastructure element within 150 to 101m of watercourse	Low
3	Proposed infrastructure element within 100 to 51m of watercourse	Medium
4	Proposed infrastructure element within 50 m of watercourse	High
5	Proposed infrastructure element within 50 m of watercourse, in an environmentally sensitive area	Extremely High

Risk Rating

The degree of risk is determined as the product of probability (P) and impact (I), which gives the Risk Rating (R) as follows:

The Risk Rating is calculated from: $R = P \times I$

Due to the 5-point scales used to assess Probability and Impact, the Risk Rating can range from 1 to 25 as shown in Table E.

Table E: Qualitative Risk Rating

Impact \ Probability	1	2	3	4	5
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5

Risk Rating & Control Measures	
17 to 25	High: avoid working in area or significant control measures required
11 to 16	Medium: notable control measures required
5 to 10	Low: only routine control measures required
1 to 4	Negligible: none or only routine control measures required

The risk rating is calculated individually for each contributory factor. Control measures are required to reduce the risk to at least a 'Low' risk rating for every individual contributory factor. The control measures in response to the qualitative risk ratings are included in the peat stability risk registers for each OHL subsection in Appendix D. The control measures are targeted at the specific contributory factors that give the highest risk rating.

The risk rating assigned to any subsection is based on the highest risk rating calculated for any contributory factor within that subsection.

Note that some geotechnical interpretation of the results is required as it is the combination of individual contributory factors that are important in determining the risk of a peat slide. For example, in certain sections deep peat may be present that would be given a high risk rating but where the section is on level ground then the risk of a peat slide is not significant.

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APPENDIX D

Results of Peat Stability Risk Assessment

Derrybrien Wind Farm (OHL) - Peat Stability Risk Register (Rev 1)

Location:	**PS5 to AM14**

Start of Subsection (Easting, Northing):	**560480**	**704010**
End of Subsection (Easting, Northing):	**564133**	**702732**
Worst Case Receptor(s):	**Road**	
Potential Impact on Receptor (Note 4):	**High**	
Peat Depth Range (m):	**0.0 to 1.9**	
Control Required:	**Yes**	

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory/Qualitative Factors to Potential Peat Failure	Prob (Note 5)	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during decommissioning	Prob	Impact	Risk	Risk Rating
1	FOS (worst case) = 1.56(u), 2.03(d)	1	4	4	Negligible	Yes	See Below	1	4	4	Negligible
2	Evidence of sub peat water flow	0	4	0	Not Applicable	No		0	4	0	Not Applicable
3	Evidence of surface water flow	1	4	4	Negligible	No		1	4	4	Negligible
4	Evidence of previous failures/slips	2	4	8	Low	Yes		1	4	4	Negligible
5	Type of vegetation	3	4	12	Medium	Yes		1	4	4	Negligible
6	General slope characteristics upslope/downslope across section	4	4	16	Medium	Yes		1	4	4	Negligible
7	Evidence of very soft/soft clay at base of peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
8	Evidence of mechanically cut peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
9	Evidence of quaking or buoyant peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
10	Evidence of bog pools	0	4	0	Not Applicable	No		0	4	0	Not Applicable
11	Low peat strength (<10kPa)	0	4	0	Not Applicable	No		0	4	0	Not Applicable
12	Relatively deep peat	2	4	8	Low	Yes		1	4	4	Negligible

	Control Measures to be Implemented during Decommissioning for **PS5 to AM14**
i	Due to relatively deep peat in the section, this will require additional measures such as : - Refer to Drawing no. 0007 & 0008 Plan Drawing for Decommissioning of Overhead Line for suitable access routes - use of suitable low load bearing track machinery to gain access to works area - use of suitable plant and equipment for completion of works - routine detailed inspection of area, while works are being carried out - contractor to provide method statement for any proposed works in areas of peat/sloping ground/overhead power lines etc
ii	Maintain hydrology of area as far as possible;
iii	Use of experienced contractors and trained operators to carry out the work;
iv	Use of experienced geotechnical staff for site supervision.

Note

(1) Location PS5 to AM14 is an abbreviation for Pole Set 5 to Angle Mast 14
(2) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.
(3) Slope characteristics are typically 10 degrees across the section. Locally steep around pole set 12 and barrage 2, up to 20 degree inclination recorded
(4) Impact based on presence of road crossing OHL route within 100m downslope of a PS.
(5) Probability assessed as per Table A and B of Appendix C

Derrybrien Wind Farm (OHL) - Peat Stability Risk Register (Rev 1)

Location:	AM14 to AM18

Start of Subsection (Easting, Northing):	564133	702732
End of Subsection (Easting, Northing):	560840	702074
Worst Case Receptor(s):	Watercourse	
Potential Impact on Receptor (Note 3):	High	
Peat Depth Range (m):	0.2 to 0.6	
Control Required:	No	

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory/Qualitative Factors to Potential Peat Failure	Prob (Note 4)	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during decommissioning	Prob	Impact	Risk	Risk Rating
1	FOS (worst case) = 5.32(u), 7.64(d)	1	4	4	Negligible	No	See Below	1	4	4	Negligible
2	Evidence of sub peat water flow	0	4	0	Not Applicable	No		0	4	0	Not Applicable
3	Evidence of surface water flow	0	4	0	Not Applicable	No		0	4	0	Not Applicable
4	Evidence of previous failures/slips	0	4	0	Not Applicable	No		0	4	0	Not Applicable
5	Type of vegetation	1	4	4	Negligible	No		1	4	4	Negligible
6	General slope characteristics upslope/downslope across section	1	4	4	Negligible	No		1	4	4	Negligible
7	Evidence of very soft/soft clay at base of peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
8	Evidence of mechanically cut peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
9	Evidence of quaking or buoyant peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
10	Evidence of bog pools	0	4	0	Not Applicable	No		0	4	0	Not Applicable
11	Low peat strength (<10kPa)	0	4	0	Not Applicable	No		0	4	0	Not Applicable
12	Other	0	4	0	Not Applicable	No		0	4	0	Not Applicable

	Control Measures to be Implemented during Decommissioning for **AM14 to AM18**
i	Although specific control measures are not required in the area, good practice should be followed, such as; - Refer to Drawing no. 0007 & 0008 Plan Drawing for Decommissioning of Overhead Line for suitable access routes - use of suitable low load bearing track machinery to gain access to works area - use of suitable plant and equipment for completion of works - routine detailed inspection of area, while works are being carried out - contractor to provide method statement for any proposed works in areas of peat/sloping ground/overhead power lines etc
ii	Maintain hydrology of area as far as possible;
iii	Use of experienced contractors and trained operators to carry out the work;
iv	Use of experienced geotechnical staff for site supervision.

Note

(1) Location AM14 to AM18 is an abbreviation for Angle Mast 14 to Angle Mast 18
(2) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.
(3) Impact based on OHL route crossing a watercourse with a PS within 100m upslope of the watercourse.
(4) Probability assessed as per Table A and B of Appendix C

Derrybrien Wind Farm (OHL) - Peat Stability Risk Register (Rev 1)

Location:	AM18 to AM24

Start of Subsection (Easting, Northing):	560840	702074
End of Subsection (Easting, Northing):	561759	701578
Worst Case Receptor(s):	Watercourse	
Potential Impact on Receptor (Note 4):	High	
Peat Depth Range (m):	0.2 to 0.8	
Control Required:	No	

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory/Qualitative Factors to Potential Peat Failure	Prob (Note 5)	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during decommissioning	Prob	Impact	Risk	Risk Rating
1	FOS (worst case)= 1.85(u), 2.57(d)	1	4	4	Negligible	No	See Below	1	4	4	Negligible
2	Evidence of sub peat water flow	0	4	0	Not Applicable	No		0	4	0	Not Applicable
3	Evidence of surface water flow	2	4	8	Low	Yes		1	4	4	Negligible
4	Evidence of previous failures/slips	0	4	0	Not Applicable	No		0	4	0	Not Applicable
5	Type of vegetation	3	4	12	Medium	Yes		1	4	4	Negligible
6	General slope characteristics upslope/downslope across section	3	4	12	Medium	Yes		1	4	4	Negligible
7	Evidence of very soft/soft clay at base of peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
8	Evidence of mechanically cut peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
9	Evidence of quaking or buoyant peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
10	Evidence of bog pools	0	4	0	Not Applicable	No		0	4	0	Not Applicable
11	Low peat strength (<10kPa)	0	4	0	Not Applicable	No		0	4	0	Not Applicable
12	Other	0	4	0	Not Applicable	No		0	4	0	Not Applicable

	Control Measures to be Implemented during Decommissioning for **AM18 to AM24**
i	Although specific control measures are not required in the area, good practice should be followed, such as; - Refer to Drawing no. 0007 & 0008 Plan Drawing for Decommissioning of Overhead Line for suitable access routes - use of suitable low load bearing track machinery to gain access to works area - use of suitable plant and equipment for completion of works - routine detailed inspection of area, while works are being carried out - contractor to provide method statement for any proposed works in areas of peat/sloping ground/overhead power lines etc
ii	Maintain hydrology of area as far as possible;
iii	Use of experienced contractors and trained operators to carry out the work;
iv	Use of experienced geotechnical staff for site supervision.

Note

(1) Location AM18 to AM24 is an abbreviation for Angle Mast 18 to Angle Mast 24
(2) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.
(3) Slope characteristics are typically 3-4 degrees across the section. Locally steep between pole set 22 and 23, up to 15 degree inclination recorded
(4) Impact based on OHL route crossing a watercourse with a PS within 100m upslope of the watercourse.
(5) Probability assessed as per Table A and B of Appendix C

Derrybrien Wind Farm (OHL) - Peat Stability Risk Register (Rev 1)

Location:	AM24 to PS28A

Start of Subsection (Easting, Northing):	**561759**	**701578**
End of Subsection (Easting, Northing):	**562092**	**700690**
Worst Case Receptor(s):	**Watercourse**	
Potential Impact on Receptor (Note 6):	**High**	
Peat Depth Range (m):	**0.1 to 3.8**	
Control Required:	**Yes**	

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory/Qualitative Factors to Potential Peat Failure	Prob (Note 7)	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during decommissioning	Prob	Impact	Risk	Risk Rating
1	FOS (worst case) = 1.09(u), 3.02(d)	4	4	16	Medium	Yes	See Below	1	4	4	Negligible
2	Evidence of sub peat water flow	0	4	0	Not Applicable	No		0	4	0	Not Applicable
3	Evidence of surface water flow	2	4	8	Low	Yes		1	4	4	Negligible
4	Evidence of previous failures/slips	0	4	0	Not Applicable	No		0	4	0	Not Applicable
5	Type of vegetation	2	4	8	Low	Yes		1	4	4	Negligible
6	General slope characteristics upslope/downslope across section	4	4	16	Medium	Yes		2	4	8	Low
7	Evidence of very soft/soft clay at base of peat	2	4	8	Low	Yes		1	4	4	Negligible
8	Evidence of mechanically cut peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
9	Evidence of quaking or buoyant peat	1	4	4	Negligible	No		1	4	4	Negligible
10	Evidence of bog pools	1	4	4	Negligible	No		1	4	4	Negligible
11	Low peat strength (<10kPa)	0	4	0	Not Applicable	No		0	4	0	Not Applicable
12	Relatively deep peat	3	4	12	Medium	Yes		1	4	4	Negligible

	Control Measures to be Implemented Prior to/and During Construction for **AM24 to PS28A**
i	Due to the depth of peat in the section, this will require additional measures such as : - Refer to Drawing No. 0007 & 0008 Plan Drawing for Decommissioning of Overhead Line for suitable access routes - use of suitable low load bearing track machinery to gain access to works area - use of suitable plant and equipment for completion of works - routine detailed inspection of area, while works are being carried out - monitoring (in the form of timber stakes as sightlines) to be installed in working areas and monitored regularly during the works - contractor to provide method statement for any proposed works in areas of peat/sloping ground/overhead power lines etc
ii	Maintain hydrology of area as far as possible;
iii	Use of experienced contractors and trained operators to carry out the work;
iv	Use of experienced geotechnical staff for site supervision.

Note

(1) Location AM24 to PS28A is an abbreviation for Angle Mast 24 to Pole Set 28A
(2) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.
(3) Slope characteristics are typically 3-5 degrees across the section. Locally steep south of pole set 25, up to 30 degree inclination recorded
(4) Localised areas of very soft, waterlogged and buoyant peat between pole set 27 and 28A
(5) Deepest peat recorded around pole set 28
(6) Impact based on OHL route crossing a watercourse with a PS within 100m upslope of the watercourse.
(7) Probability assessed as per Table A and B of Appendix C

Derrybrien Wind Farm (OHL) - Peat Stability Risk Register (Rev 1)

Location:	**PS28A to PS34**

Start of Subsection (Easting, Northing):	**562092**	**700690**
End of Subsection (Easting, Northing):	**562470**	**699676**
Worst Case Receptor(s):	**Watercourse**	
Potential Impact on Receptor (Note 3):	**High**	
Peat Depth Range (m):	**0.2 to 3.1**	
Control Required:	**Yes**	

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory/Qualitative Factors to Potential Peat Failure	Prob (Note 4)	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during decommissioning	Prob	Impact	Risk	Risk Rating
1	FOS (worst case)= 1.69(u), 1.49(d)	1	4	4	Negligible	No	See Below	1	4	4	Negligible
2	Evidence of sub peat water flow	0	4	0	Not Applicable	No		0	4	0	Not Applicable
3	Evidence of surface water flow	1	4	4	Negligible	No		1	4	4	Negligible
4	Evidence of previous failures/slips	0	4	0	Not Applicable	No		0	4	0	Not Applicable
5	Type of vegetation	2	4	8	Low	Yes		1	4	4	Negligible
6	General slope characteristics upslope/downslope across section	2	4	8	Low	Yes		1	4	4	Negligible
7	Evidence of very soft/soft clay at base of peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
8	Evidence of mechanically cut peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
9	Evidence of quaking or buoyant peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
10	Evidence of bog pools	0	4	0	Not Applicable	No		0	4	0	Not Applicable
11	Low peat strength (<10kPa)	4	4	16	Medium	Yes		1	4	4	Negligible
12	Other	2	4	8	Low	Yes		1	4	4	Negligible

	Control Measures to be Implemented Prior During Decommissioning for **PS28A to PS34**
i	Due to the depth of peat in the section, this will require additional measures such as : - Refer to Drawing no. 0007 & 0008 Plan Drawing for Decommissioning of Overhead Line for suitable access routes - use of suitable low load bearing track machinery to gain access to works area - use of suitable plant and equipment for completion of works - routine detailed inspection of area, while works are being carried out - contractor to provide method statement for any proposed works in areas of peat/sloping ground/overhead power lines etc
ii	Maintain hydrology of area as far as possible;
iii	Use of experienced contractors and trained operators to carry out the work;
iv	Use of experienced geotechnical staff for site supervision.

Note

(1) Location PS28A to PS34 is an abbreviation for Pole Set 28A to Pole Set 34
(2) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.
(3) Impact based on OHL route crossing a watercourse with a PS within 100m upslope of the watercourse.
(4) Probability assessed as per Table A and B of Appendix C

Derrybrien Wind Farm (OHL) - Peat Stability Risk Register (Rev 1)

Location:	PS34 to AM38

Start of Subsection (Easting, Northing):	562470	699676
End of Subsection (Easting, Northing):	563020	699126
Worst Case Receptor(s):	Road	
Potential Impact on Receptor (Note 6):	High	
Peat Depth Range (m):	0.0 to 5.6	
Control Required:	Yes	

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory/Qualitative Factors to Potential Peat Failure	Prob (Note 7)	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during decommissioning	Prob	Impact	Risk	Risk Rating
1	FOS (worst case)= 1.98(u), 2.39(d)	1	4	4	Negligible	Yes	See Below	1	4	4	Negligible
2	Evidence of sub peat water flow	0	4	0	Not Applicable	No		0	4	0	Not Applicable
3	Evidence of surface water flow	1	4	4	Negligible	No		1	4	4	Negligible
4	Evidence of previous failures/slips	0	4	0	Not Applicable	No		0	4	0	Not Applicable
5	Type of vegetation	3	4	12	Medium	Yes		1	4	4	Negligible
6	General slope characteristics upslope/downslope across section	3	4	12	Medium	Yes		1	4	4	Negligible
7	Evidence of very soft/soft clay at base of peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
8	Evidence of mechanically cut peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
9	Evidence of quaking or buoyant peat	3	4	12	Medium	Yes		1	4	4	Negligible
10	Evidence of bog pools	0	4	0	Not Applicable	No		0	4	0	Not Applicable
11	Low peat strength (<10kPa)	3	4	12	Medium	No		0	4	0	Not Applicable
12	Very deep peat	3	4	12	Medium	Yes		1	4	4	Negligible

	Control Measures to be Implemented during Decommissioning for **PS34 to AM38**
i	Due to the depth of peat in the section, this will require additional measures such as : - Refer to Drawing no. 0007 & 0008 Plan Drawing for Decommissioning of Overhead Line for suitable access routes - use of suitable low load bearing track machinery to gain access to works area - use of suitable plant and equipment for completion of works - routine detailed inspection of area, while works are being carried out - monitoring (in the form of timber stakes as sightlines) to be installed in working areas and monitored regularly during the works - contractor to provide method statement for any proposed works in areas of peat/sloping ground/overhead power lines etc
ii	Maintain hydrology of area as far as possible;
iii	Use of experienced contractors and trained operators to carry out the work;
iv	Use of experienced geotechnical staff for site supervision.

Note

(1) Location PS34 to AM38 is an abbreviation for Pole Set 34 to Angle Mast 38
(2) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.
(3) Slope characteristics are typically 3-5 degrees across the section. Locally steep north of pole set 35, up to 21 degree inclination recorded
(4) Significant area of very soft, waterlogged and buoyant peat between pole set 37 and 38
(5) Deepest peat recorded angle mast 38, about 5.6m deep
(6) Impact based on OHL route crossing a road with a PS within 100m upslope of the road.
(7) Probability assessed as per Table A and B of Appendix C

Derrybrien Wind Farm (OHL) - Peat Stability Risk Register (Rev 1)

Location:	**AM38 to EM41**

Start of Subsection (Easting, Northing):	**563020**	**699126**
End of Subsection (Easting, Northing):	**563124**	**698618**
Worst Case Receptor(s):	**Dwelling**	
Potential Impact on Receptor (Note 6):	**High**	
Peat Depth Range (m):	**0.0 to 5.6**	
Control Required:	**Yes**	

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory/Qualitative Factors to Potential Peat Failure	Prob (Note 7)	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during decommissioning	Prob	Impact	Risk	Risk Rating
1	FOS (worst case)= 4.31(u), 5.75(d)	1	4	4	Negligible	No	See Below	1	4	4	Negligible
2	Evidence of sub peat water flow	0	4	0	Not Applicable	No		0	4	0	Not Applicable
3	Evidence of surface water flow	1	4	4	Negligible	No		1	4	4	Negligible
4	Evidence of previous failures/slips	0	4	0	Not Applicable	No		0	4	0	Not Applicable
5	Type of vegetation	3	4	12	Medium	Yes		1	4	4	Negligible
6	General slope characteristics upslope/downslope across section	2	4	8	Low	No		1	4	4	Negligible
7	Evidence of very soft/soft clay at base of peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
8	Evidence of mechanically cut peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
9	Evidence of quaking or buoyant peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
10	Evidence of bog pools	0	4	0	Not Applicable	No		0	4	0	Not Applicable
11	Low peat strength (<10kPa)	4	4	16	Medium	No		0	4	0	Not Applicable
12	Very deep peat	3	4	12	Medium	Yes		1	4	4	Negligible

	Control Measures to be Implemented Prior to/and During Construction for **AM38 to PS41**
i	Due to the depth of peat in the section, this will require additional measures such as : - Refer to Drawing no. 0007 & 0008 Plan Drawing for Decommissioning of Overhead Line for suitable access routes - use of suitable low load bearing track machinery to gain access to works area - use of suitable plant and equipment for completion of works - routine detailed inspection of area, while works are being carried out - monitoring (in the form of timber stakes as sightlines) to be installed in working areas and monitored regularly during the works - contractor to provide method statement for any proposed works in areas of peat/sloping ground/overhead power lines etc
ii	Maintain hydrology of area as far as possible;
iii	Use of experienced contractors and trained operators to carry out the work;
iv	Use of experienced geotechnical staff for site supervision.

Note

(1) Location AM38 to PS41 is an abbreviation for Angle Mast 38 to Pole Set 41
(2) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.
(3) Slope characteristics are typically 3-5 degrees across the section.
(4) Deepest peat recorded around angle mast 38, about 5.6m deep
(5) Impact based on OHL route 500m upslope of the dwelling in an area of deep peat.
(6) Probability assessed as per Table A and B of Appendix C

Derrybrien Wind Farm (OHL) - Peat Stability Risk Register (Rev 1)

Location:	Sub-station

Start of Subsection (Easting, Northing):	563123	698619
End of Subsection (Easting, Northing):	563123	698619
Worst Case Receptor(s):	Infrastructure	
Potential Impact on Receptor (Note 2):	Negligable	
Peat Depth Range (m):	0.0 to 0.0	
Control Required:	No	

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory/Qualitative Factors to Potential Peat Failure	Prob (Note 3)	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during decommissioning	Prob	Impact	Risk	Risk Rating
1	FOS = na(u), na(d)	1	1	1	Negligible	No	See Below	1	1	1	Negligible
2	Evidence of sub peat water flow	0	1	0	Not Applicable	No		0	1	0	Not Applicable
3	Evidence of surface water flow	0	1	0	Not Applicable	No		0	1	0	Not Applicable
4	Evidence of previous failures/slips	0	1	0	Not Applicable	No		0	1	0	Not Applicable
5	Type of vegetation	0	1	0	Not Applicable	No		0	1	0	Not Applicable
6	General slope characteristics upslope/downslope across section	1	1	1	Negligible	No		1	1	1	Negligible
7	Evidence of very soft/soft clay at base of peat	0	1	0	Not Applicable	No		0	1	0	Not Applicable
8	Evidence of mechanically cut peat	0	1	0	Not Applicable	No		0	1	0	Not Applicable
9	Evidence of quaking or buoyant peat	0	1	0	Not Applicable	No		0	1	0	Not Applicable
10	Evidence of bog pools	0	1	0	Not Applicable	No		0	1	0	Not Applicable
11	Low peat strength (<10kPa)	0	1	0	Not Applicable	No		0	1	0	Not Applicable
12	Other	0	1	0	Not Applicable	No		0	1	0	Not Applicable

	Control Measures to be Implemented during Decommissioning for **Agannygal Sub-Station**
i	Maintain hydrology of area as far as possible;
ii	Use of experienced contractors and trained operators to carry out the work;

Note
(1) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.
(2) Impact based on absence of peat.
(3) Probability assessed as per Table A and B of Appendix C

FEHILY TIMONEY

CONSULTANTS IN ENGINEERING, ENVIRONMENTAL SCIENCE & PLANNING

APPENDIX E

Calculated FoS for Peat Slopes

Calculated FoS of Natural Peat Slopes for Derrybrien Wind Farm OHL (Undrained Analysis)

Turbine No./Waypoint	Easting	Northing	Slope (Note 3)	Undrained shear strength	Bulk unit weight of Peat	Peat Depth (Note 5)	Surcharge Equivalent Placed Fill Depth (m) (Note 2)	Factor of Safety for Load Condition	
			β (deg)	c_u (kPa)	γ (kN/m^3)	(m)	Condition (2)	Condition (1)	Condition (2)
FT DATA (OCTOBER 2022)									
Pole 5	560479	704010	3.0	6	10	1.5	2.5	**7.65**	**4.59**
Pole 8	560779	703609	3.0	6	10	1.8	2.8	**6.38**	**4.10**
Pole 17	560991	702242	3.0	6	10	0.2	1.2	**57.40**	**9.57**
Angle Mast 18	560840	702075	5.0	6	10	0.2	1.2	**34.55**	**5.76**
Pole 19	560951	701974	2.0	6	10	0.6	1.6	**28.67**	**10.75**
Angle Mast 20	561050	701884	3.0	6	10	0.2	1.2	**57.40**	**9.57**
Pole 21	561215	701812	5.0	6	10	0.4	1.4	**17.28**	**4.94**
Pole 22	561380	701741	10.0	6	10	0.6	1.6	**5.85**	**2.19**
Pole 23	561601	701647	3.0	6	10	0.5	1.5	**22.96**	**7.65**
Angle Mast 24	561759	701579	3.0	6	10	0.3	1.3	**38.27**	**8.83**
Pole 25	561813	701428	10.0	6	10	0.2	1.2	**17.54**	**2.92**
Pole 28	562056	700783	1.0	6	10	3.4	4.4	**10.11**	**7.81**
Pole 28A-WP 22	562092	700690	1.0	6	10	1.4	2.4	**24.56**	**14.33**
Pole 33	562435	699773	2.0	3	10	2.3	3.3	**3.74**	**2.61**
Angle Mast 34	562470	699678	2.0	6	10	2.2	3.2	**7.82**	**5.38**
Pole 36	562760	699388	1.0	6	10	3.7	4.7	**9.29**	**7.32**
Angle Mast 38	563019	699127	2.0	6	10	3.4	4.4	**5.06**	**3.91**
Pole 39	563061	698932	2.0	6	10	2.2	3.2	**7.82**	**5.38**
WP27	564711	689241	3.0	6	10	0.2	1.2	**57.40**	**9.57**
WP28	564229	698041	3.0	6	10	0.3	1.3	**38.27**	**8.83**
WP29	563549	697849	0.5	6	10	5.8	6.8	**11.85**	**10.11**
WP30	563276	698049	3.0	6	10	0.5	1.5	**22.96**	**7.65**
Point A	561123	702367	4.0	No peat encountered					
Point B	561061	702260	4.0	6	10	0.3	1.3	**28.74**	**6.63**
Point C	561040	702331	5.0	No peat encountered					
Point D	561084	702394	3.0	6	10	0.3	1.3	**45.92**	**9.18**
Point 1	565073	698271	1.0	6	10	3.6	4.6	**9.55**	**7.47**
Point 2	565066	698226	1.0	6	10	2.0	3.0	**17.19**	**11.46**
Point 3	565048	698230	1.0	6	10	3.5	4.5	**9.82**	**7.64**
Point 4	565035	698275	2.0	6	10	2.2	3.2	**7.82**	**5.38**
FT DATA (SEPTEMBER 2019)									
Pole 1A	160002	204675	5.0	6	10	2.2	3.2	**3.14**	**2.16**
Pole 2	160086	204563	6.0	6	10	2.1	3.1	**2.75**	**1.86**
Pole 3	160235	204362	4.0	6	10	1.6	2.6	**5.39**	**3.32**
Pole 4	160360	204194	6.0	6	10	1.0	2.0	**5.77**	**2.89**
Pole 5	160520	203976	3.0	6	10	1.3	2.3	**8.83**	**4.99**
Pole 6	160617	203849	3.0	6	10	0.6	1.6	**19.13**	**7.18**
Pole 7	160712	203721	3.0	6	10	0.9	1.9	**12.76**	**6.04**
Pole 8	160820	203575	3.0	6	10	1.5	2.5	**7.65**	**4.59**
Pole 9	160921	203439	4.0	6	10	0.5	1.5	**17.24**	**5.75**
Pole 10	161053	203263	4.0	6	10	0.8	1.8	**10.78**	**4.79**
Pole 11	161183	203088	4.0	6	10	0.1	1.1	**86.22**	**7.84**
Pole 12	161294	202940	4.0	6	10	0.5	1.5	**17.24**	**5.75**
Pole 13	161386	202815	2.0	6	10	0.2	1.2	**86.01**	**14.34**
Angle Mast 14	161474	202698	1.0	6	10	0.7	1.7	**49.12**	**20.23**
Pole 15	161359	202569	3.0	6	10	0.5	1.5	**22.96**	**7.65**
Pole 16	161206	202401	2.0	6	10	0.3	1.3	**57.34**	**13.23**
Pole 17	161032	202208	2.0	6	10	0.6	1.6	**28.67**	**10.75**
Angle Mast 18	160881	202041	5.0	6	10	0.3	1.3	**23.04**	**5.32**
Pole 19	160992	201940	2.0	6	10	0.9	1.9	**19.11**	**9.05**
Angle Mast 20	161091	201850	3.0	6	10	0.2	1.2	**57.40**	**9.57**
Pole 21	161256	201778	5.0	6	10	0.4	1.4	**17.28**	**4.94**
Pole 22	161421	201707	10.0	6	10	0.5	1.5	**7.02**	**2.34**
Pole 23	161642	201613	3.0	6	10	0.5	1.5	**22.96**	**7.65**
Angle Mast 24	161800	201545	4.0	6	10	0.8	1.8	**10.78**	**4.79**
Pole 25	161854	201394	10.0	6	10	0.2	1.2	**17.54**	**2.92**
Pole 26	161960	201114	6.0	6	10	0.6	1.6	**9.62**	**3.61**
Pole 27	162016	200964	10.0	6	10	0.5	1.5	**7.02**	**2.34**
Pole 28	162097	200749	2.0	6	10	3.8	4.8	**4.53**	**3.58**
Pole 28A	162133	200656	2.0	6	10	0.8	1.8	**21.50**	**9.56**
Pole 29	162196	200487	2.0	6	10	0.9	1.9	**19.11**	**9.05**
Angle Mast 30	162259	200318	4.0	6	10	0.1	1.1	**86.22**	**7.84**
Pole 31	162343	200093	7.0	6	10	0.4	1.4	**12.40**	**3.54**
Pole 32	162417	199897	3.0	6	10	0.3	1.3	**38.27**	**8.83**
Pole 33	162476	199738	2.0	6	10	2.3	3.3	**7.48**	**5.21**
Angle Mast 34	162511	199643	3.0	No peat encountered					
Pole 35	162702	199452	5.0	6	10	1.1	2.1	**6.28**	**3.29**
Pole 36	162801	199353	3.0	6	10	3.2	4.2	**3.59**	**2.73**
Pole 37	162878	199275	1.0	6	10	0.5	1.5	**68.77**	**22.92**
Angle Mast 38	163060	199092	1.0	6	10	2.5	3.5	**13.75**	**9.82**
Pole 39	163102	198897	2.0	6	10	1.8	2.8	**9.56**	**6.14**
Pole 40	195225	363039	4.0	6	10	1.0	2.0	**8.62**	**4.31**
Angle Mast 41	163164	198584	2.0	No peat encountered					

Calculated FoS of Natural Peat Slopes for Derrybrien Wind Farm OHL (Undrained Analysis)

Turbine No./Waypoint	Easting	Northing	Slope (Note 3)	Undrained shear strength	Bulk unit weight of Peat	Peat Depth (Note 5)	Surcharge Equivalent Placed Fill Depth (m) (Note 2)	Factor of Safety for Load Condition	
			β (deg)	c_u (kPa)	γ (kN/m^3)	(m)	Condition (2)	Condition (1)	Condition (2)
AGEC DATA (JUNE 2018)									
Pole 1A	160002	204675	0.5	6	10	1.8	2.8	**38.20**	**24.56**
WP 1	160047	204613	3.0	6	10	1.4	2.4	**8.20**	**4.78**
Pole 2	160086	204563	0.5	6	10	2.4	3.4	**28.65**	**20.22**
WP 2	160158	204461	0.5	6	10	1.9	2.9	**36.19**	**23.71**
Pole 3	160235	204362	0.5	6	10	2.0	3.0	**34.38**	**22.92**
WP 3	160295	204291	0.5	6	10	1.8	2.8	**38.20**	**24.56**
Pole 4	160360	204194	6.0	6	10	1.1	2.1	**5.25**	**2.75**
Pole 5	160520	203976	2.0	6	10	1.8	2.8	**9.56**	**6.14**
Pole 6	160617	203849	3.0	6	10	1.0	2.0	**11.48**	**5.74**
Pole 7	160712	203721	6.0	6	10	0.5	1.5	**11.54**	**3.85**
WP 4	160867	203534	6.0	6	10	1.9	2.9	**3.04**	**1.99**
Pole 8	160820	203575	0.5	6	10	1.7	2.7	**40.45**	**25.47**
Pole 9	160921	203439	0.5	6	10	0.8	1.8	**85.95**	**38.20**
WP 5	161003	203325	0.5	6	10	0.5	1.5	**137.52**	**45.84**
Pole 10	161053	203263	4.0	6	10	0.8	1.8	**10.78**	**4.79**
WP 6	161114	203187	4.0	6	10	0.2	1.2	**43.11**	**7.19**
Pole 11	161183	203088	0.5	No peat encountered					
WP 7	161247	203003	20.0	6	10	0.2	1.2	**9.33**	**1.56**
Pole 12	161294	202940	0.5	6	10	0.3	1.3	**229.19**	**52.89**
WP 8	161357	202861	0.5	6	10	0.8	1.8	**85.95**	**38.20**
Pole 13	161386	202815	0.5	No peat encountered					
WP 9	161425	202749	0.5	6	10	0.5	1.5	**137.52**	**45.84**
Angle Mast 14	161474	202698	5.0	No peat encountered					
Pole 15	161359	202569	12.0	No peat encountered					
WP 10	161252	202448	5.0	No peat encountered					
Pole 16	161206	202401	4.0	6	10	0.2	1.2	**43.11**	**7.19**
WP11	161097	202274	0.5	6	10	0.5	1.5	**137.52**	**45.84**
Pole 17	161032	202208	4.0	6	10	0.2	1.2	**43.11**	**7.19**
WP 12	160960	202126	4.0	6	10	0.6	1.6	**14.37**	**5.39**
Angle Mast 18	160881	202041	0.5	No peat encountered					
Pole 19	160992	201940	4.0	No peat encountered					
Pole 20	161091	201850	0.5	No peat encountered					
Pole 21	161256	201778	0.5	6	10	0.8	1.8	**85.95**	**38.20**
Pole 22	161421	201707	6.0	6	10	0.8	1.8	**7.21**	**3.21**
WP 15	161522	201668	0.5	6	10	0.5	1.5	**137.52**	**45.84**
WP 16	161540	201659	15.0	6	10	0.3	1.3	**8.00**	**1.85**
Pole 23	161642	201613	0.5	6	10	0.6	1.6	**114.60**	**42.97**
Pole 24	161800	201545	7.0	6	10	0.4	1.4	**12.40**	**3.54**
WP 17	161832	201460	2.0	6	10	1.5	2.5	**11.47**	**6.88**
Pole 25	161854	201394	7.0	6	10	0.2	1.2	**24.80**	**4.13**
WP 18	161885	201296	12.0	6	10	1.7	2.7	**1.74**	**1.09**
WP 19	161893	201193	5.0	6	10	0.9	1.9	**7.68**	**3.64**
Pole 26	161960	201114	12.0	6	10	0.6	1.6	**4.92**	**1.84**
WP 20	161987	201046	3.0	6	10	0.2	1.2	**57.40**	**9.57**
Pole 27	162016	200964	8.0	6	10	0.2	1.2	**21.77**	**3.63**
WP 21	162093	200863	0.5	6	10	2.6	3.6	**26.45**	**19.10**
Pole 28	162097	200749	0.5	6	10	3.8	4.8	**18.09**	**14.32**
Pole 28A-WP 22	162133	200656	0.5	6	10	1.6	2.6	**42.97**	**26.45**
Pole 29	162196	200487	0.5	6	10	1.4	2.4	**49.11**	**28.65**
Pole 30	162259	200318	0.5	6	10	0.4	1.4	**171.90**	**49.11**
Pole 31	162343	200093	7.0	6	10	0.2	1.2	**24.80**	**4.13**
Pole 32	162417	199897	0.5	6	10	0.4	1.4	**171.90**	**49.11**
Pole 33	162476	199738	5.0	6	10	3.1	4.1	**2.23**	**1.69**
Pole 34	162511	199643	3.0	6	10	2.2	3.2	**5.22**	**3.59**
WP23	162631	199512	2.0	6	10	0.6	1.6	**28.67**	**10.75**
Pole 35	162702	199452	8.0	6	10	1.2	2.2	**3.63**	**1.98**
Pole 36	162801	199353	0.5	6	10	4.7	5.7	**14.63**	**12.06**
Pole 37	162878	199275	0.5	6	10	1.2	2.2	**57.30**	**31.25**
WP 26	162952	199157	1.0	6	10	2.2	3.2	**15.63**	**10.75**
Angle Mast 38	163060	199092	0.5	6	10	5.6	6.6	**12.28**	**10.42**
Pole 39	163102	198897	0.5	6	10	2.2	3.2	**31.25**	**21.49**
Pole 40	195225	363039	0.5	6	10	1.1	2.1	**62.51**	**32.74**
Angle Mast 41	163164	198584	0.5	No peat encountered					

Calculated FoS of Natural Peat Slopes for Derrybrien Wind Farm OHL (Undrained Analysis)

Turbine No./Waypoint	Easting	Northing	Slope (Note 3)	Undrained shear strength	Bulk unit weight of Peat	Peat Depth (Note 5)	Surcharge Equivalent Placed Fill Depth (m) (Note 2)	Factor of Safety for Load Condition	
			β (deg)	c_u (kPa)	γ (kN/m^3)	(m)	Condition (2)	Condition (1)	Condition (2)
ESBI DATA (2004 & 2005)									
1	160403	204120	4.0	6	10	0.2	1.2	**43.01**	**7.17**
2	160392	204135	6.0	6	10	0.2	1.2	**28.70**	**4.78**
3	160386	204144	6.0	6	10	0.9	1.9	**6.38**	**3.02**
4	160136	204496	0.5	6	10	0.9	1.9	**76.58**	**36.28**
5	160363	204177	6.0	6	10	1.0	2.0	**5.77**	**2.89**
6	160344	204204	6.0	6	10	1.0	2.0	**5.77**	**2.89**
7	160333	204219	6.0	6	10	1.2	2.2	**4.78**	**2.61**
8	160295	204271	4.0	6	10	1.2	2.2	**7.21**	**3.93**
9	160126	204510	0.5	6	10	1.3	2.3	**53.18**	**30.06**
10	160279	204293	4.0	6	10	1.4	2.4	**6.18**	**3.60**
11	160168	204446	0.5	6	10	1.4	2.4	**49.23**	**28.72**
12	160073	204591	3.0	6	10	1.4	2.4	**8.19**	**4.78**
13	160108	204538	3.0	6	10	1.5	2.5	**7.66**	**4.60**
14	159982	204618	0.5	6	10	1.5	2.5	**45.84**	**27.50**
15	160005	204630	0.5	6	10	1.5	2.5	**45.90**	**27.54**
16	160040	204640	3.0	6	10	1.5	2.5	**7.65**	**4.59**
17	160085	204667	3.0	6	10	1.5	2.5	**7.64**	**4.59**
18	160152	204471	0.5	6	10	1.6	2.6	**42.97**	**26.45**
19	160313	204247	6.0	6	10	1.7	2.7	**3.38**	**2.13**
20	160259	204320	0.5	6	10	1.8	2.8	**38.25**	**24.59**
21	160216	204378	0.5	6	10	1.8	2.8	**38.20**	**24.56**
22	160055	204617	3.0	6	10	1.8	2.8	**6.40**	**4.12**
23	160029	204645	3.0	6	10	1.8	2.8	**6.37**	**4.09**
24	159991	204653	0.5	6	10	1.8	2.8	**38.20**	**24.56**
25	160052	204656	2.0	6	10	1.8	2.8	**9.56**	**6.15**
26	160059	204689	3.0	6	10	1.8	2.8	**6.38**	**4.10**
27	160237	204349	0.5	6	10	1.9	2.9	**36.19**	**23.71**
28	160091	204563	3.0	6	10	1.9	2.9	**6.04**	**3.96**
29	160199	204400	0.5	6	10	2.0	3.0	**34.43**	**22.95**
30	160027	204660	3.0	6	10	2.0	3.0	**5.73**	**3.82**
31	160011	204684	2.0	6	10	2.1	3.1	**8.20**	**5.55**
32	160185	204421	0.5	6	10	2.6	3.6	**26.45**	**19.10**
							Minimum =	**1.74**	**1.09**
							Maximum =	**229.19**	**52.89**
							Average =	**30.76**	**11.91**

Notes:

(1) Assuming a bulk unit weight for peat of 10kN/m^3

(2) Assuming a surcharge equivalent to fill depth of 1m of peat i.e. 10kPa. (Condition 2

(3) Slope inclination (β) based on site readings and site contour plans

(4) A lower bound undrained shear strength, cu for the peat of 6kPa was selected for the assessment. It should be noted that a cu of 6kPa for the pea is considered a conservative value for the analysis and is not representative of all peat present across the site. In reality the peat on site typically has a significantly higher undrained strength.

(5) Peat depths based on probes carried out by FT (2019 and 2022), AGEC and ESBI (June 2018

(6) For load conditions see report text.

Calculated FoS of Natural Peat Slopes for Derrybrien Wind Farm OHL (Drained Analysis)

Turbine No./Waypoint	Slope (Note 3)	Design c'	Bulk unit weight of Peat	Unit weight of Water	100% Water to height of Peat	Depth of In situ Peat (Note 5)	Friction Angle	Equivalent Total Depth of Peat (m) (Note 2)	Factor of Safety for Load Condition	
	α (deg)	c' (kPa)	γ (kN/m^3)	γ_w (kN/m^3)	(m)	(m)	ø' (deg)	Condition (2)	Condition (1)	Condition (2)
									100% Water	100% Water
FT DATA (2022)										
Pole 5	3.0	4	10.0	10.0	1.5	1.5	25	2.5	**5.10**	**6.62**
Pole 8	3.0	4	10.0	10.0	1.8	1.8	25	1.8	**4.25**	**4.25**
Pole 17	3.0	4	10.0	10.0	0.2	0.2	25	0.2	**38.27**	**38.27**
Angle Mast 18	5.0	4	10.0	10.0	0.2	0.2	25	0.2	**23.04**	**23.04**
Pole 19	2.0	4	10.0	10.0	0.6	0.6	25	0.6	**19.11**	**19.11**
Angle Mast 20	3.0	4	10.0	10.0	0.2	0.2	25	0.2	**38.27**	**38.27**
Pole 21	5.0	4	10.0	10.0	0.4	0.4	25	0.4	**11.52**	**11.52**
Pole 22	10.0	4	10.0	10.0	0.6	0.6	25	0.6	**3.90**	**3.90**
Pole 23	3.0	4	10.0	10.0	0.5	0.5	25	0.5	**15.31**	**15.31**
Angle Mast 24	3.0	4	10.0	10.0	0.3	0.3	25	0.3	**25.51**	**25.51**
Pole 25	10.0	4	10.0	10.0	0.2	0.2	25	0.2	**11.70**	**11.70**
Pole 28	1.0	4	10.0	10.0	3.4	3.4	25	3.4	**6.74**	**6.74**
Pole 28A-WP 22	1.0	4	10.0	10.0	1.4	1.4	25	1.4	**16.37**	**16.37**
Pole 33	2.0	4	10.0	10.0	2.3	2.3	25	2.3	**4.99**	**4.99**
Angle Mast 34	2.0	4	10.0	10.0	2.2	2.2	25	2.2	**5.21**	**5.21**
Pole 36	1.0	4	10.0	10.0	3.7	3.7	25	3.7	**6.20**	**6.20**
Angle Mast 38	2.0	4	10.0	10.0	3.4	3.4	25	3.4	**3.37**	**3.37**
Pole 39	2.0	4	10.0	10.0	2.2	2.2	25	2.2	**5.21**	**5.21**
WP27	3.0	4	10.0	10.0	0.2	0.2	25	0.2	**38.27**	**38.27**
WP28	3.0	4	10.0	10.0	0.3	0.3	25	0.3	**25.51**	**25.51**
WP29	0.5	4	10.0	10.0	5.8	5.8	25	5.8	**7.90**	**7.90**
WP30	3.0	4	10.0	10.0	0.5	0.5	25	0.5	**15.31**	**15.31**
Point A	4.0	No peat encountered								
Point B	4.0	4	10.0	10.0	0.3	0.3	25	0.3	**19.16**	**19.16**
Point C	5.0	No peat encountered								
Point D	3.0	4	10.0	10.0	0.3	0.3	25	0.3	**25.51**	**25.51**
Point 1	1.0	4	10.0	10.0	3.6	3.6	25	3.6	**6.37**	**6.37**
Point 2	1.0	4	10.0	10.0	2.0	2.0	25	2.0	**11.46**	**11.46**
Point 3	1.0	4	10.0	10.0	3.5	3.5	25	3.5	**6.55**	**6.55**
Point 4	2.0	4	10.0	10.0	2.2	**2.2**	25	2.2	**5.21**	**5.21**
FT DATA (2019)										
Pole 1A	5.0	4	10.0	10.0	2.2	2.2	25	3.2	**2.09**	**3.11**
Pole 2	6.0	4	10.0	10.0	2.1	2.1	25	3.1	**1.83**	**2.67**
Pole 3	4.0	4	10.0	10.0	1.6	1.6	25	2.6	**3.59**	**4.78**
Pole 4	6.0	4	10.0	10.0	1.0	1.0	25	2.0	**3.85**	**4.14**
Pole 5	3.0	4	10.0	10.0	1.3	1.3	25	2.3	**5.89**	**7.20**
Pole 6	3.0	4	10.0	10.0	0.6	0.6	25	1.6	**12.76**	**10.34**
Pole 7	3.0	4	10.0	10.0	0.9	0.9	25	1.9	**8.50**	**8.71**
Pole 8	3.0	4	10.0	10.0	1.5	1.5	25	2.5	**5.10**	**6.62**
Pole 9	4.0	4	10.0	10.0	0.5	0.5	25	1.5	**11.50**	**8.28**
Pole 10	4.0	4	10.0	10.0	0.8	0.8	25	1.8	**7.19**	**6.90**
Pole 11	4.0	4	10.0	10.0	0.1	0.1	25	1.1	**57.48**	**11.29**
Pole 12	4.0	4	10.0	10.0	0.5	0.5	25	1.5	**11.50**	**8.28**
Pole 13	2.0	4	10.0	10.0	0.2	0.2	25	1.2	**57.34**	**20.68**
Angle Mast 14	1.0	4	10.0	10.0	0.7	0.7	25	1.7	**32.75**	**29.20**
Pole 15	3.0	4	10.0	10.0	0.5	0.5	25	1.5	**15.31**	**11.03**
Pole 16	2.0	4	10.0	10.0	0.3	0.3	25	1.3	**38.23**	**19.09**
Pole 17	2.0	4	10.0	10.0	0.6	0.6	25	1.6	**19.11**	**15.51**
Angle Mast 18	5.0	4	10.0	10.0	0.3	0.3	25	1.3	**15.36**	**7.64**
Pole 19	2.0	4	10.0	10.0	0.9	0.9	25	1.9	**12.74**	**13.06**
Angle Mast 20	3.0	4	10.0	10.0	0.2	0.2	25	1.2	**38.27**	**13.79**
Pole 21	5.0	4	10.0	10.0	0.4	0.4	25	1.4	**11.52**	**7.10**
Pole 22	10.0	4	10.0	10.0	0.5	0.5	25	1.5	**4.68**	**3.32**
Pole 23	3.0	4	10.0	10.0	0.5	0.5	25	1.5	**15.31**	**11.03**
Angle Mast 24	4.0	4	10.0	10.0	0.8	0.8	25	1.8	**7.19**	**6.90**
Pole 25	10.0	4	10.0	10.0	0.2	0.2	25	1.2	**11.70**	**4.15**
Pole 26	6.0	4	10.0	10.0	0.6	0.6	25	1.6	**6.41**	**5.18**
Pole 27	10.0	4	10.0	10.0	0.5	0.5	25	1.5	**4.68**	**3.32**
Pole 28	2.0	4	10.0	10.0	3.8	3.8	25	4.8	**3.02**	**5.17**
Pole 28A-WP 22	2.0	4	10.0	10.0	0.8	0.8	25	1.8	**14.34**	**13.79**
Pole 29	2.0	4	10.0	10.0	0.9	0.9	25	1.9	**12.74**	**13.06**
Angle Mast 30	4.0	4	10.0	10.0	0.1	0.1	25	1.1	**57.48**	**11.29**
Pole 31	7.0	4	10.0	10.0	0.4	0.4	25	1.4	**8.27**	**5.07**
Pole 32	3.0	4	10.0	10.0	0.3	0.3	25	1.3	**25.51**	**12.73**
Pole 33	2.0	4	10.0	10.0	2.3	2.3	25	3.3	**4.99**	**7.52**
Angle Mast 34	3.0	No peat encountered								
Pole 35	5.0	4	10.0	10.0	1.1	1.1	25	2.1	**4.19**	**4.73**
Pole 36	3.0	4	10.0	10.0	3.2	3.2	25	4.2	**2.39**	**3.94**
Pole 37	1.0	4	10.0	10.0	0.5	0.5	25	1.5	**45.85**	**33.09**
Angle Mast 38	1.0	4	10.0	10.0	2.5	2.5	25	3.5	**9.17**	**14.18**
Pole 39	2.0	4	10.0	10.0	1.8	1.8	25	2.8	**6.37**	**8.86**
Pole 40	4.0	4	10.0	10.0	1.0	1.0	25	2.0	**5.75**	**6.21**
Angle Mast 41	2.0	No peat encountered								

Calculated FoS of Natural Peat Slopes for Derrybrien Wind Farm OHL (Drained Analysis)

Turbine No./Waypoint	Slope (Note 3)	Design c'	Bulk unit weight of Peat	Unit weight of Water	100% Water to height of Peat	Depth of In situ Peat (Note 5)	Friction Angle	Equivalent Total Depth of Peat (m) (Note 2)	Factor of Safety for Load Condition	
	α (deg)	c' (kPa)	γ (kN/m^3)	γ_w (kN/m^3)	(m)	(m)	ø' (deg)	Condition (2)	Condition (1)	Condition (2)
									100% Water	100% Water
AGEC DATA (2018)										
Pole 1A	0.5	4	10.0	10.0	1.8	1.8	25	2.8	**25.47**	**35.45**
WP 1	3.0	4	10.0	10.0	1.4	1.4	25	2.4	**5.47**	**6.90**
Pole 2	0.5	4	10.0	10.0	2.4	2.4	25	3.4	**19.10**	**29.20**
WP 2	5.0	4	10.0	10.0	1.9	1.9	25	1.9	**2.42**	**2.42**
Pole 3	0.5	4	10.0	10.0	2.0	2.0	25	3.0	**22.92**	**33.09**
WP 3	0.5	4	10.0	10.0	1.8	1.8	25	1.8	**25.47**	**25.47**
Pole 4	6.0	4	10.0	10.0	1.1	1.1	25	2.1	**3.50**	**3.94**
Pole 5	2.0	4	10.0	10.0	1.8	1.8	25	2.8	**6.37**	**8.86**
Pole 6	3.0	4	10.0	10.0	1.0	1.0	25	2.0	**7.65**	**8.28**
Pole 7	6.0	4	10.0	10.0	0.5	0.5	25	1.5	**7.70**	**5.52**
WP 4	6.0	4	10.0	10.0	1.9	1.9	25	2.9	**2.03**	**2.86**
Pole 8	0.5	4	10.0	10.0	1.7	1.7	25	2.7	**26.96**	**36.77**
Pole 9	0.5	4	10.0	10.0	0.8	0.8	25	1.8	**57.30**	**55.15**
WP 5	0.5	4	10.0	10.0	0.5	0.5	25	1.5	**91.68**	**66.18**
Pole 10	4.0	4	10.0	10.0	0.8	0.8	25	1.8	**7.19**	**6.90**
WP 6	4.0	4	10.0	10.0	0.2	0.2	25	1.2	**28.74**	**10.35**
Pole 11	4.0	No peat encountered								
WP 7	20.0	4	10.0	10.0	0.2	0.2	25	1.2	**6.22**	**2.10**
Pole 12	0.5	4	10.0	10.0	0.3	0.3	25	1.3	**152.80**	**76.36**
WP 8	0.5	4	10.0	10.0	0.8	0.8	25	1.8	**57.30**	**55.15**
Pole 13	2.0	No peat encountered								
WP 9	0.5	4	10.0	10.0	0.5	0.5	25	1.5	**91.68**	**66.18**
Angle Mast 14	1.5	No peat encountered								
Pole 15	12.0	No peat encountered								
WP 10	5.0	No peat encountered								
Pole 16	0.5	4	10.0	10.0	0.2	0.2	25	1.2	**229.19**	**82.73**
WP11	0.5	4	10.0	10.0	0.5	0.5	25	1.5	**91.68**	**66.18**
Pole 17	4.0	4	10.0	10.0	0.2	0.2	25	1.2	**28.74**	**10.35**
WP 12	4.0	4	10.0	10.0	0.6	0.6	25	1.6	**9.58**	**7.76**
Angle Mast 18	0.5	No peat encountered								
Pole 19	4.0	No peat encountered								
Pole 20	0.5	No peat encountered								
Pole 21	0.5	4	10.0	10.0	0.8	0.8	25	1.8	**57.30**	**55.15**
Pole 22	6.0	4	10.0	10.0	0.8	0.8	25	1.8	**4.81**	**4.60**
WP 15	0.5	4	10.0	10.0	0.5	0.5	25	1.5	**91.68**	**66.18**
WP 16	15.0	4	10.0	10.0	0.3	0.3	25	1.3	**5.33**	**2.57**
Pole 23	0.5	4	10.0	10.0	0.6	0.6	25	1.6	**76.40**	**62.05**
Pole 24	0.5	4	10.0	10.0	0.4	0.4	25	1.4	**114.60**	**70.91**
WP 17	0.5	4	10.0	10.0	1.5	1.5	25	2.5	**30.56**	**39.71**
Pole 25	7.0	4	10.0	10.0	0.2	0.2	25	1.2	**16.53**	**5.92**
WP 18	2.0	4	10.0	10.0	1.7	1.7	25	2.7	**6.75**	**9.19**
WP 19	5.0	4	10.0	10.0	0.9	0.9	25	1.9	**5.12**	**5.23**
Pole 26	12.0	4	10.0	10.0	0.6	0.6	25	1.6	**3.28**	**2.60**
WP 20	3.0	4	10.0	10.0	0.2	0.2	25	1.2	**38.27**	**13.79**
Pole 27	8.0	4	10.0	10.0	0.2	0.2	25	1.2	**14.51**	**5.18**
WP 21	2.5	4	10.0	10.0	2.6	2.6	25	3.6	**3.53**	**5.52**
Pole 28	0.5	4	10.0	10.0	3.8	3.8	25	4.8	**12.06**	**20.68**
Pole 28A-WP 22	0.5	4	10.0	10.0	1.6	1.6	25	2.6	**28.65**	**38.18**
Pole 29	0.5	4	10.0	10.0	1.4	1.4	25	2.4	**32.74**	**41.36**
Pole 30	0.5	4	10.0	10.0	0.4	0.4	25	1.4	**114.60**	**70.91**
Pole 31	7.0	4	10.0	10.0	0.2	0.2	25	1.2	**16.53**	**5.92**
Pole 32	0.5	4	10.0	10.0	0.4	0.4	25	1.4	**114.60**	**70.91**
Pole 33	5.0	4	10.0	10.0	3.1	3.1	25	4.1	**1.49**	**2.42**
Pole 34	3.0	4	10.0	10.0	2.2	2.2	25	3.2	**3.48**	**5.17**
WP23	2.0	4	10.0	10.0	0.6	0.6	25	1.6	**19.11**	**15.51**
Pole 35	8.0	4	10.0	10.0	1.2	1.2	25	2.2	**2.42**	**2.83**
Pole 36	0.5	4	10.0	10.0	4.7	4.7	25	5.7	**9.75**	**17.42**
Pole 37	0.5	4	10.0	10.0	1.2	1.2	25	2.2	**38.20**	**45.12**
WP 26	1.0	4	10.0	10.0	2.2	2.2	25	3.2	**10.42**	**15.51**
Angle Mast 38	0.5	4	10.0	10.0	5.6	5.6	25	6.6	**8.19**	**15.04**
Pole 39	0.5	4	10.0	10.0	2.2	2.2	25	3.2	**20.84**	**31.02**
Pole 40	0.5	4	10.0	10.0	1.1	1.1	25	2.1	**41.67**	**47.27**
Angle Mast 41	0.5	No peat encountered								

Calculated FoS of Natural Peat Slopes for Derrybrien Wind Farm OHL (Drained Analysis)

Turbine No./Waypoint	Slope (Note 3)	Design c'	Bulk unit weight of Peat	Unit weight of Water	100% Water to height of Peat	Depth of In situ Peat (Note 5)	Friction Angle	Equivalent Total Depth of Peat (m) (Note 2)	Factor of Safety for Load Condition	
	α (deg)	c' (kPa)	γ (kN/m^3)	γ_w (kN/m^3)	(m)	(m)	ø' (deg)	Condition (2)	Condition (1)	Condition (2)
									100% Water	100% Water
ESBI DATA (2004 & 2005)										
1	4.0	4	10	10	0.2	0.2	25	1.2	**28.74**	**10.35**
2	6.0	4	10	10	0.2	0.2	25	1.2	**19.24**	**6.90**
3	6.0	4	10	10	0.9	0.9	25	1.9	**4.28**	**4.36**
4	0.5	4	10	10	0.9	0.9	25	1.9	**50.93**	**52.25**
5	6.0	4	10	10	1.0	1.0	25	2.0	**3.85**	**4.14**
6	6.0	4	10	10	1.0	1.0	25	2.0	**3.85**	**4.14**
7	6.0	4	10	10	1.2	1.2	25	2.2	**3.21**	**3.77**
8	4.0	4	10	10	1.2	1.2	25	2.2	**4.79**	**5.64**
9	0.5	4	10	10	1.3	1.3	25	2.3	**35.26**	**43.16**
10	4.0	4	10	10	1.4	1.4	25	2.4	**4.11**	**5.17**
11	0.5	4	10	10	1.4	1.4	25	2.4	**32.74**	**41.36**
12	3.0	4	10	10	1.4	1.4	25	2.4	**5.47**	**6.90**
13	3.0	4	10	10	1.5	1.5	25	2.5	**5.10**	**6.62**
14	0.5	4	10	10	1.5	1.5	25	2.5	**30.56**	**39.71**
15	0.5	4	10	10	1.5	1.5	25	2.5	**30.56**	**39.71**
16	3.0	4	10	10	1.5	1.5	25	2.5	**5.10**	**6.62**
17	3.0	4	10	10	1.5	1.5	25	2.5	**5.10**	**6.62**
18	0.5	4	10	10	1.6	1.6	25	2.6	**28.65**	**38.18**
19	6.0	4	10	10	1.7	1.7	25	2.7	**2.26**	**3.07**
20	0.5	4	10	10	1.8	1.8	25	2.8	**25.47**	**35.45**
21	0.5	4	10	10	1.8	1.8	25	2.8	**25.47**	**35.45**
22	3.0	4	10	10	1.8	1.8	25	2.8	**4.25**	**5.91**
23	3.0	4	10	10	1.8	1.8	25	2.8	**4.25**	**5.91**
24	0.5	4	10	10	1.8	1.8	25	2.8	**25.47**	**35.45**
25	2.0	4	10	10	1.8	1.8	25	2.8	**6.37**	**8.86**
26	3.0	4	10	10	1.8	1.8	25	2.8	**4.25**	**5.91**
27	0.5	4	10	10	1.9	1.9	25	2.9	**24.13**	**34.23**
28	3.0	4	10	10	1.9	1.9	25	2.9	**4.03**	**5.71**
29	0.5	4	10	10	2.0	2.0	25	3.0	**22.92**	**33.09**
30	3.0	4	10	10	2.0	2.0	25	3.0	**3.83**	**5.52**
31	2.0	4	10	10	2.1	2.1	25	3.1	**5.46**	**8.01**
32	0.5	4	10	10	2.6	2.6	25	3.6	**17.63**	**27.58**
								Minimum =	**1.49**	**2.10**
								Maximum =	**229.19**	**82.73**
								Average =	**22.44**	**18.66**

Notes:

(1) Assuming a bulk unit weight of peat of 10 (kN/m^3)
(2) Assuming a surcharge equivalent to fill depth of 1m of peat i.e. 10kPa. (Condition 2
(3) Slope inclination (β) based on site readings and contour survey plans of site
(4) FoS is based on slope inclination and shear test results obtained from published data
(5) Peat depths based on probes carried out by AGEC, FT and ESBI (June 2018)
(6) For load conditions see report text.
(7) Minimum acceptable factor of safety required of 1.3 for first-time failures based on BS: 6031:1981 Code of practice for Earthworks

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APPENDIX F

ESB Report on Slope Stability Assessment of a Section of Ground below the OHL

Hibernian Wind Power

Derrybrien Wind Farm, Co Galway

Slope stability assessment of a section of ground under overhead line

Report Number: P78015-R476-002

ESBI Engineering and Facilities Management

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www.esbi.ie

16th February 2006

ESB INTERNATIONAL

ESB INTERNATIONAL

File Reference: *P78015-F476-030*

Client: *Hibernian Wind Power*

Project Title: *Derrybrien Wind Farm, Co. Galway*

Report Title: *Slope stability assessment of a section of ground under overhead line*

Report No.: **P78015-R476-002**

Rev. No.:

Volume 1 of 1

PRODUCED: Samir Hebib	*DATE: 16th February 2006*
CHECKED: Con Sheahan	*DATE: 16th February 2006*
APPROVED: Con Sheahan *TITLE: Senior Project Manager*	*DATE: 16th February 2006*

Latest Revision Summary:

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Change History of Report

Date	New Rev	Author	Summary of Change

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2.0 Slope stability assessment 1

3.0 Conclusion 3

4.0 References 3

FIGURES 1

figures

Summary

A slope stability assessment of a section of ground under the existing overhead line between the windfarm substation and the containment barrage BD2 has been carried out.

Results of that assessment shows that the ground has adequate factor of safety against a slip failure under an external surcharge of 20kPa.

1.0 Introduction

A geotechnical site investigation was carried out along a section of the overhead line at the Derrybrien windfarm. The investigation focused on a section of ground, under the overhead line, between the windfarm substation and a location approximately 700m south of the substation, which coincides with an existing Coillte track, as this section was considered to be the most critical one in terms of existing slope gradients and thickness of peat subsoil. The remaining section of ground, under the overhead line, extending south from the Coillte track to the containment barrage BD2, see Figure 2, is characterised by shallower slope gradients and a peat thickness of less than 1m; rock exposures can in fact be observed in the vicinity of the containment barrage. Furthermore, a 0.5m thick peat layer has been laid out on the existing peat surface close to the containment barrage.

The geotechnical investigation comprised measurement of ground slope angles at regular intervals; frequency was dictated by changes in ground topography, probing of the ground using 0.9m long coupled rods to assess in-situ peat thickness and shear vane tests to assess the shear strength of the peat subsoil. The shear vane tests were carried out subsequent to slope angle measurements and probing of peat depth in order to concentrate in locations which were considered to present a critical combination of steep slope angles and thick peat layer – see Figure 2 for location of shear vane tests and Figure 1 for a profile of the ground topography and peat depths.

2.0 Slope stability assessment

The stability of the existing ground was assessed at different locations along the section investigated assuming critical combination of slope angle, peat depth and shear strength and using an infinite slope method of analysis (Skempton & Delory, 1957). This method is suited to long downslope lengths where the mode of failure is translational sliding, such as that which occurred at the site in October 2003. The infinite slope method is conservative in that no end resistance is assumed.

Stability of the existing ground was assessed assuming two different loading conditions: (1) load condition no.1 where no external load is imposed on the peat surface and (2) load condition no.2 where an external load of 20kPa is applied on the peat surface to simulate pressure applied by a typical 20t weight tracked construction plant. The British Standard "Code of Practice for Earthworks" BS6031:1981 states that for a first time failure with a good standard of site investigation, the design factor of safety should be between 1.3 and 1.4. For the purpose of this exercise a factor of safety of 1.4 was used.

Results of slope stability analyses for the section of ground, described above are shown in Table 1. These results have been also presented in a previous report on ESBIE geotechnical testing (report 78015-C11-R1-REV1). For the remaining section of ground, under the overhead line, between the Coillte track and the containment barrage BD2, a conservative slope angle of 5deg and peat thickness of 1m was assumed throughout. A

minimum required shear strength value for the peat was therefore computed in order to achieve a factor of safety of 1.4. This minimum value was subsequently compared to the lowest results obtained from the shear vane tests carried out north of the Coillte track.

Table 1: Results of stability analyses

Vane ID	Shear vane result (lowest unless stated) (kPa)	Slope angle (deg)	Peat depth at vane location (m)	Factor of safety for load condition 1 (no surcharge)	Factor of safety for Load condition 2 (20kPa surcharge)	Acceptable surcharge to achieve factor of Safety of 1.4 (kPa)
TOH_V1	6.48	5	1.8	4.15	1.96	35
TOH_V2	5.07	6	1.5	3.25	1.39	20
TOH_V3	4.79	6	1.3	3.54	1.40	20
TOH_V4	5.44	6	1.5	3.49	1.50	22
TOH_V5	7.43	5	2	4.28	2.14	41
TOH_V6	7.69	6	1.85	4.00	1.92	34
TOH_V7	7.49	6	1.8	4.00	1.90	33
TOH_V8	7.05	7	1.4	4.16	1.71	28
TOH_V9	8.11	3.5	1.7	7.83	3.60	78
TOH_V10	8.73	5	1.2	8.38	3.14	60
TOH_V11	9.59	8	1	6.96	2.32	40
TOH_V12	9.59	7	0.95	8.35	2.69	47
TOH_V13	9.59	6	0.85	10.85	3.24	57

3.0 Conclusion

Results of slope stability analyses for the section of ground, under the overhead line, between the windfarm substation and the Coillte track show that the ground exhibits a factor of safety above 1.4 when analysed using the lowest shear strength at each location and assuming a surcharge loading of 20kPa. For the remaining section, under the overhead line, from the Coillte track to the containment barrage BD2, the minimum shear strength value for the peat required to achieve a factor of safety of 1.4 under an external surcharge of 20kPa is of the order of 3.6kPa which is well below the lowest shear strength values measured north of the Coillte track.

Therefore, it can be concluded that the portion of ground, under existing overhead line, between the windfarm substation and the containment barrage BD2 is considered to have adequate factor of safety against a slip failure under an external surcharge of 20kPa. This also infers that the factor of safety will be higher in a situation where no external loading is applied.

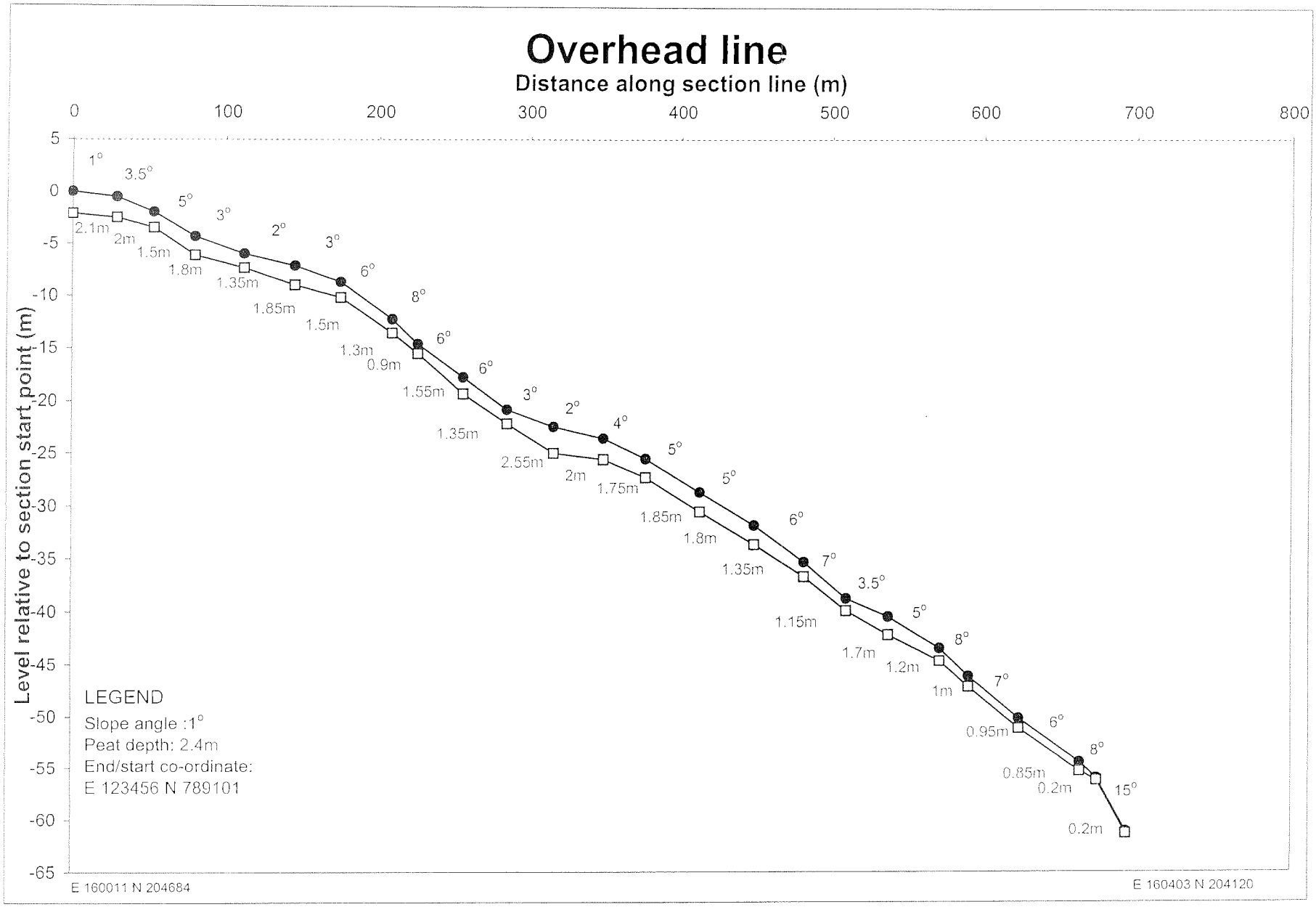
The 0.5m thick peat layer currently laid out on top of the existing peat surface in the vicinity of containment barrage BD2 is not considered to be undermining stability of the existing ground at that location. The surcharge applied by that peat layer would be of the order of 5kPa which well below the 20kPa surcharge assumed in the stability assessment.

4.0 References

1 Skempton, A.W.& DeLory, F.A. (1957). "*Stability of natural slopes in London Clay*". Proc. 4th Int. Conf. on Soil Mechanics and Foundation Engineering, Rotterdam, Vol. 2.

FIGURES

Figure 1 Profile of ground topography and peat depths
Figure 2 Location of shear vane tests


Overhead line
Distance along section line (m)
0
100
200
300
400
500
600
700
800
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
Level relative to section start point (m)
1°
3.5°
5°
3°
2°
3°
6°
8°
6°
6°
3°
2°
4°
5°
5°
6°
7°
3.5°
5°
8°
7°
6°
8°
15°
2.1m
2m
1.5m
1.8m
1.35m
1.85m
1.5m
1.3m
0.9m
1.55m
1.35m
2.55m
2m
1.75m
1.85m
1.8m
1.35m
1.15m
1.7m
1.2m
1m
0.95m
0.85m
0.2m
0.2m
LEGEND
Slope angle :1°
Peat depth: 2.4m
End/start co-ordinate:
E 123456 N 789101
E 160011 N 204684
E 160403 N 204120

A1 CAD

Notes :–

1. All dimensions are in millimetres – figured dimensions to be taken in preference to scaled dimensions.
2. All levels are in metres.

Legend:

Forestry

Streams/Drains

Boundary

10m Contour

50m Contour

Existing Road

Site Area 345ha

Turbine Foundation shown thus

Concreted Turbine Base (T##)

Site Compound

Borrow Pit 3

Clay Borrow Pit

Existing Telecoms Mast

Borrow Pit 2

110kV Substation & Compound Ref. Drg. No. 20206-31

Existing Turbary Road

Coillte Track

Coillte Track

Coillte Track

Approximate Line Of New 110kV Overhead Line

TOH-V1 TOH-V2 TOH-V3 TOH-V4 TOH-V5 TOH-V6 TOH-V7 TOH-V8 TOH-V9 TOH-V10 TOH-V11 TOH-V12 TOH-V13

Containment Barrage BD2

Coillte Forestry

Coillte Forestry

Coillte Forestry

Coillte Forestry

T1 T2 T3 T4 T5 T6 T7 T8 T9 T10 T11 T12 T13 T14 T15 T16 T17 T18 T19 T20 T21 T22 T23 T24 T25 T26 T27 T28 T29 T30 T31 T32 T33 T34 T35 T36 T37 T38 T39 T40 T41 T42 T43 T44 T45 T46 T48 T49 T50 T51 T52 T53 T54 T55 T56 T57 T58 T59 T60 T61 T62 T63 T64 T65 T66 T67 T68 T69 T70 T71

Site Layout Plan

Scale 1 : 10,000

0 100 200 300 400 500m

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REV.	DATE	REVISION DESCRIPTION	DRN	CHK'D	APPR.
0		ISSUED FOR INFORMATION	PM	SH	CS

PURPOSE OF ISSUE – PRELIMINARY UNLESS INDICATED

TENDER ☐ CLIENT APPROVAL ☐ CONSTRUCTION ☐ AS-BUILT ☐ REVISED ☐

CLIENT: GORT WINDFARM LTD

PROJECT: DERRYBRIEN WIND FARM Co. GALWAY

CONTRACT: DERRYBRIEN WINDFARM

DRAWING TITLE: SLOPE STABILITY ASSESSMENT OF SECTION OF GROUND UNDER OVERHEAD LINE LINE

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DRAWN	CHECKED	APPROVED	APPD DATE
PM	SH	CS	18.02.06

CLIENT REF	SIZE	SHEET	REV	SCALE
N/A	A3	1/1	0	NTS

Figure 2 (P378015-D01-84)

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APPENDIX 8-6

GEOTECHNICAL STABILITY REPORT (JULY 2020)

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GEOTECHNICAL STABILITY REPORT 3
DERRYBRIEN WIND FARM
GRID CONNECTION AND ANCILLARY WORKS

Prepared for: **ESB**

Date: July 2020

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GEOTECHNICAL STABILITY REPORT 3

DERRYBRIEN WIND FARM

GRID CONNECTION AND ANCILLARY WORKS

User is responsible for Checking the Revision Status of This Document

Rev. Nr.	Description of Changes	Prepared by:	Checked by:	Approved by:	Date:
0	Draft report for comment	IH	TC	BdeH	21/10/19
1	Updated following initial comments	IH	GK	BdeH	29/11/19
2	Updated following comments on EIAR chapter	IH	PJ	BdeH	16/04/20
3	Updated following comments on EIAR chapter	IH/PJ	PJ	BdeH	21/07/20
4	Updated following comments	IH/PJ	PJ	BdeH	30/07/20

Client: **ESB**

Keywords: Grid connection, peat stability

Abstract: The report contains the findings of a geotechnical assessment along the route of the grid connection from the Derrybrien to the Agannygal substation. The geotechnical assessment includes a deterministic and qualitative peat stability risk assessment of the grid connection route.

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DMP 14 Agannygal Substation - Indicative Decommissioning Access Route

APPENDICES

Appendix A Site Photographs from FT Site Walkover (2019)
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1 INTRODUCTION

1.1 General

Fehily Timoney and Company (FT) was engaged in August 2019 by ESB to undertake a geotechnical assessment of the grid connection route from the Derrybrien wind farm site to the Agannygal substation. The grid connection comprises the Derrybrien-Agannygal 110kV Overhead Line (OHL) and Agannygal Substation and ancillary works. The geotechnical assessment carried out includes an assessment of the peat stability of the 110kV OHL route, substation site and associated permanent and temporary works during construction, operation (maintenance) and during possible decommissioning works in the future.

The Derrybrien wind farm project is located on Cashlaundrumlahan Mountain in the Slieve Aughty Mountains some 11km south of the town of Loughrea in County Galway (Figure 1).

The wind farm comprises 70 wind turbines and associated infrastructure and was constructed over the period 2003 to 2005. The wind farm became operational in December 2005.

The OHL route connects the substation on the Derrybrien wind farm site to a substation in the townland of Agannygal and is approximately 7.8km in length. The OHL and substation were constructed between 2003 and 2005.

For the purposes of assessment, the OHL route was broken into 9 subsections (including the substation at Agannygal). These subsections were chosen based on having similar topography and peat depth within each individual section (Drawing 0001).

1.2 Contents of Report

This report presents the findings of a geotechnical assessment of the OHL route connecting Derrybrien wind farm site with Agannygal substation, and comprises the following elements:

(1) Desk Study Review

The review included the following:

- Review of previous relevant reports
- Review of publicly available information

(2) Summary of FT walkover survey findings (2019)

The walkover included the following:

- OHL route
- Access routes from the public road to the OHL route
- Agannygal substation

(3) Summary of AGEC ground investigation (2018)

The ground investigation included the following:

- Peat depth probing and shear vane strength testing along the OHL route
- Trial pits at the Agannygal substation

(4) Peat stability assessment

A deterministic stability assessment and qualitative peat stability risk assessment of the peat along the OHL route and at the substation, which includes:

- Methodology for deterministic stability assessment of peat
- Analysis to determine factor of safety
- Peat stability risk assessment methodology
- Results of stability analysis and risk assessments

(5) Conclusions

2 PREVIOUS RELEVANT REPORTS

2.1 Foundation Records at Mast Locations

During construction of the OHL masts from 2004 to 2005 a number of trial pits were carried out at mast locations to record ground conditions to a depth of typically 3m. In total, trial pits were carried out at 18 no. mast locations at each of the 4 mast legs giving a total of 72 no. trial pits. The records included a description of the ground conditions encountered and depths.

2.2 ESB Report on Slope Stability for Section of OHL

ESB (2006) assessed the stability of the peat along the OHL route between the Derrybrien wind farm substation and containment barrage 2 (Figure 1). Containment barrage 2 was constructed following a peat slide in 2003 at the wind farm site within the flow path of the peat slide to prevent further propagation of the peat slide and to prevent possible further release of debris into watercourses downstream.

The stability of the peat in this area was assessed based on shear vane tests carried out over a section 700m in length directly south of the wind farm substation, as this area was considered the critical section in terms of existing slope angles and peat thickness. The infinite slope method of Skempton and DeLory (1957) was used to check for stability in combination with an external surcharge of 20kPa. Peat depths up to 2.0m were recorded and peat strengths ranged from 5 to 10kPa. A “lumped” or overall factor of safety of at least 1.4 under a 20kPa surcharge was shown for the OHL route between the substation and containment barrage 2, which is considered an acceptable level of safety.

3 DESCRIPTION OF OVERHEAD LINE ROUTE

3.1 General Description

The existing Derrybrien to Agannygal OHL connects the onsite substation at Derrybrien wind farm (ITM coordinates: E 559914, N 704737) to the substation at Agannygal (ITM coordinates: E 563119, N 698591), approximately 7km to the south. The layout of the OHL is shown in Figure 1 and Drawing 0001. The OHL is about 7.8km long.

The pole sets, intermediate masts, angle masts, and end masts along the route are numbered 1 to 41. A typical timber pole set is shown in Photo 1 (Appendix A) and a typical steel angle mast is shown in Photo 2. A listing of the pole sets and masts is given in Table 3.1 and the locations of the substations, pole sets, and masts are shown in Drawing 0001.

Table 3.1: Summary of Overhead Line Structures

Structure Reference	Structure Type	Easting	Northing
EM1	End mast	559934	704742
PS1A	Pole set	559962	704707
PS2	Pole set	560045	704596
PS3	Pole set	560195	704394
PS4	Pole set	560319	704226
PS5	Pole set	560480	704011
PS6	Pole set	560578	703879
PS7	Pole set	560671	703754
PS8	Pole set	560777	703612
PS9	Pole set	560883	703469
PS10	Pole set	561011	703298
PS11	Pole set	561145	703117
PS12	Pole set	561252	702972
PS13	Pole set	561345	702847
AM14	Angle mast	561432	702731
PS15	Pole set	561337	702624
PS16	Pole set	561167	702437
PS17	Pole set	560990	702239
AM18	Angle mast	560840	702074
PS19	Pole set	560951	701972
AM20	Angle mas	561049	701883

Structure Reference	Structure Type	Easting	Northing
PS21	Pole set	561216	701810
PS22	Pole set	561373	701743
PS23	Pole set	561599	701646
AM24	Angle mast	561758	701577
PS25	Pole set	561814	701428
PS26	Pole set	561919	701145
PS27	Pole set	561975	700996
PS28	Pole set	562055	700784
PS28A	Pole set	562090	700690
PS29	Pole set	562148	700535
IM30	Intermediate mast	562211	700366
PS31	Pole set	562293	700146
PS32	Pole set	562366	699953
PS33	Pole set	562429	699785
PS34	Pole set	562470	699676
PS35	Pole set	562664	699481
PS36	Pole set	562761	699383
PS37	Pole set	562836	699308
AM38	Angle mast	563022	699121
PS39	Pole set	563062	698923
PS40	Pole set	563094	698766
EM41	End mast	563118	698643

Notes:
(1) Coordinates are in ITM format and were provided by ESB.

3.2 Description and Topography of Overhead Line Route

The Derrybrien wind farm site is located on the upper slopes of Cashlaundrumlahan Mountain, within the Slieve Aughty Mountains. The OHL route is 7.8km long and is aligned essentially north-south. The topography of the route is illustrated in Drawing 001.

Slope angles at the pole set and mast locations typically range from 0 to 15 degrees. The topography is relatively steep (10 - 15 degrees) initially over the initial c. 1.5km of the route and then crosses the more gently sloping terrain (0 - 8 degrees) of the Owendalluleagh River valley to the Agannygal substation where the site has been cut and filled locally to proide a level platform.

The OHL route starts within the boundaries of the wind farm site at the Derrybrien substation at an elevation of approximately 330mAOD. From the Derrybrien substation, the elevation along the route falls to a flat-

bottomed valley where it crosses the R353 road and the tributaries of the Owendalulleagh River at an elevation of approximately 130mAOD. From here, the route skirts around the Slieve Aughty Bog NHA (site number 001229) before gaining elevation again as it passes Lough Agannygal, at about 195mAOD. The route ends at the Agannygal substation, which is located to the south east of Cashlaundrumlahan Mountain and about 1km north of Lough Atorick, at an elevation of approximately 190mAOD.

The land adjacent to the OHL route and the substation location is dominated by commercial forestry plantations which have been planted over the blanket bog. Directly along the OHL route appears to have been colonised by conifer and deciduous tree growth from the adjacent plantations (regrowth of previously felled area).

The route crosses the lower end of the source area of the peat slide of 16 October 2003 between pole sets 5 and 6, and also passes close to 2 no. containment barrages (Figure 1). The containment barrages were constructed following the peat slide to prevent propagation of the peat slide and to restrict possible further release of debris into watercourses downstream.

3.3 Description of Infrastructure and Construction

The OHL mainly consists of double timber pole sets with galvanised steel angle masts at changes in direction and an intermediate galvanised steel mast (IM30) on a longer straight section. These angle masts and other mast structures were located as close as possible to existing roads and access tracks, in order to minimise trafficking on undisturbed ground. This section of this report sets out the methods of construction based on observations made during the walkover and information provided by ESB.

None of the OHL structures are constructed within the area of the peat slide, and no access was required through the peat slide area to access the OHL pole set locations.

3.3.1 Access to Pole sets/Angle Masts

Where trees were present on the OHL route, then within a 60m corridor width all trees were felled mostly by machine using Coillte subcontractors. Where the trees were felled, they were cut as close as possible to the ground. The trunks and roots were left in place so that there was no excavation or disturbance of the peat. The surface of the peat was tracked over by the harvesting machines and forwarders that were used to cut, gather and stockpile the timber for transport off-site. In areas where the surface of the peat was very soft, brash and small branches were placed on the ground under the tracks of the harvester. Where the trees were small or where tree growth was poor the trees were felled by hand, arranged in windrows and left in place on the slopes

Following this the location of pole sets and angle, intermediate and end masts were identified and set out.

The methods used to access the pole sets/angle masts during the construction of the OHL were recorded where they were visible during the OHL survey. The access routes recorded consisted of two types:

(1) There are a number of locations, primarily around the angle masts, where the peat has been stripped away exposing the mineral soil beneath. These areas are typically located in close proximity to existing forestry access tracks (see Photos 3 & 4) to facilitate the import of additional fill material and members for the angle masts, and for foundation construction.

(2) In other areas, primarily around the pole sets in areas of deep peat, timber sleepers from felled trees were used by construction plant to gain access for erecting the line, where necessary. This method of construction was particularly noticeable around pole set 36 where peat depths of over 4m were recorded. An example of such an access route is shown in Photo 5.

Access to the masts/pole sets was most likely from nearby roads and forestry tracks. Access from the existing tracks to the mast locations was generally achieved by the excavation of the peat and any tree stumps to a competent material. In order to access AM24, the Owendalulleagh River was crossed from the south side of the river at the location of a ford along the founded access track. In order to access AM38, existing trees were felled and placed to form a temporary floating access track from the south.

3.3.2 Foundations for Pole Sets and Angle Masts

Foundations varied according to ground conditions along the OHL route. In some locations where the depth to competent material was deeper than the embedment of the pole, stone and/or timber sleepers were used to strengthen the foundation and timber sleepers were used to fill to the correct level and as support to pole sets for stability. A greater number of timber sleepers would have been used to support pole sets in deep peat.

A number of pole sets in peat have been secured using timber baulks, fixed to the lower part of each pole and set in excavated holes in the peat which were backfilled with imported granular fill.

The angle masts and end masts are founded on concrete footings cast on mineral soil. Peat, where present, was excavated over the footprint of the foundation and working area prior to the construction of the foundation for these masts. The excavated peat was typically stored adjacent to the foundation excavations.

3.3.3 Agannygal Substation

The substation at Agannygal comprises a stone platform, substation equipment and a single storey control building. Construction of the substation required the excavation of overburden in order to create a level platform on which to build the substation. Excavated material was stored to the south of the substation compound. A stone platform approximately 1-1.5m thick was then constructed on the overburden using imported crushed rock fill. The platform is approximately 65m in length and 50m in width. In order to provide access to construct the substation, approximately 2.9km of existing forestry track was upgraded by adding imported stone fill and a thin surfacing layer. A permanent access road, around 140m in length, was also constructed from the adjacent local road to the substation.

The site of the substations and current topographical levels are provided on Drawing 0006.

3.3.4 Cuttings

During the site walkover of the OHL route, several cuttings were recorded, primarily around the footprint of a number of pole sets and angle masts. These included cuttings through the undulating ground from local access tracks to gain entrance for construction plant and materials, such as that shown in Photo 7. Minor cuttings are

also present where stripping/excavation of peat/mineral soil was undertaken to form a suitable area to erect the masts and pole sets.

Founded access tracks constructed by others for the purpose of accessing the forested areas surrounding the overhead line required cutting through the undulating ground. Several cut sections were identified during the site walkover. It is considered that these access tracks were already in existence and not created for the purpose of the construction of the OHL, however these were used for the construction of the OHL.

Between pole set 28A and 29 the OHL route crosses a 400kV overhead line route. This area is shown in Photos 8 and 9. A cut approximately 25m wide and 120m long was formed in the mineral soil to allow the OHL from the Derrybrien substation to pass beneath the 400kV line, allowing sufficient clearance for trafficking under the route and removal of forestry that could pose a risk to the OHL route. The location and extent of this cutting is shown on Drawing 0006 . This cutting is up to 3.8m deep and the slope angle ranges between 25 and 39 degrees based on site readings. The average slope angle is approximately 32 degrees, based on the available topographic survey information of the area.

Another significant cutting is located adjacent to Agannygal substation and shown in Photo 12. This cutting is up to 3.0m deep and has an average slope angle of 35 degrees in mineral soil, which was excavated in order to create a level platform for the construction of the substation.

Additional, less significant cuttings included drainage ditches in the vicinity of the pole sets/angle masts and the access tracks.

4 GROUND CONDITIONS

4.1 Soils and Geology

The deposits along the OHL route comprise the following main types:

(1) Peat
(2) Glacial till and subsoil
(3) Alluvium
(4) Weathered/solid rock
(5) Peat debris within peat slide scar

4.1.1 Peat

Based on a review of the soils map of Ireland (Geological Survey of Ireland, 2018), the OHL route is covered in blanket peat. The walkover survey and ground investigation taken by AGEC and FT indicates that the upper 1m of the peat is generally very fibrous and also locally desiccated in appearance. The base of the peat, from observations within the peat slide scar and in exposures in excavations and along drains, was described using BS 5930 (BSI, 2015) as very soft brown amorphous Peat with recognisable plant structure. Peat appeared to lay directly on bedrock or a weathered rock/glacial till.

Shear strength profiles were measured using a Geonor H-60 hand vane tester at thirteen locations by ESB in 2004 and 2005 (ESB, 2006). 27 no. shear vane strength tests were undertaken at depths from 0.5m bgl to 1.8m bgl. Values for vane shear strength measured ranged from 5kPa to 10kPa with an average of 8.3kPa. Shear strength testing was also undertaken by AGEC in 2018 and FT in 2019. 95 no. shear vane strength tests were undertaken at depths from 0.5m bgl to 2.5m bgl. Values for vane shear strength measured ranged from 6kPa to 68kPa with an average of 23kPa. The values are plotted in Figure 2.

Peat depth probing was also undertaken by ESB and the results of this are used, along with recent peat depth probing carried out by AGEC and FT, to plot peat depth contours shown in Drawings 0002 and 0003. The depth of peat recorded along the OHL route ranged from 0.2 to 5.6m bgl with an average depth of 1.1m bgl.

4.1.2 Glacial Till and Subsoil

Based on the available data, varying thicknesses of glacial till are present beneath the peat along of the OHL route. The publicly-available GSI (2018) mapping shows glacial till in the vicinity of the site to be derived from Devonian sandstones. Exposures of glacial till showed a reddish brown or whiteish brown well-graded material consisting of sandy slightly gravelly Clay/Silt with occasional sub-angular to rounded cobbles and boulders of sandstone.

Typically, glacial till was encountered below the peat at depths that ranged from 0.2 to 5.6m, though locally glacial till was at or close to the surface below a layer of peaty topsoil.

The GSI (2018) mapping shows a line of ribbed moraines, which are hummocky wave ridges of sediment deposited by glacial movement, trending in a west-south-west to east-north-east direction traversing the OHL route around the Owendalulleagh River.

4.1.3 Alluvium

Alluvium recorded along the OHL route is associated with the Owendalulleagh River which runs between pole sets 25 and 26. It was observed during the site walkover that the Owendalulleagh River riverbed consisted of sand, gravel, cobbles, and boulders, and hence it is expected that this alluvium is predominantly coarse-grained.

4.1.4 Weathered/Solid Rock

The bedrock geology along the OHL route comprises the Ayle River Formation, the Derryfadda Formation, the Scalpnagown Formation, and Undifferentiated Visean Limestone. The Ayle River Formation consists of red siltstones, mudstones with carbonate concretions, sandstones, conglomerates and mud-flake breccia from the Ayle River Formation, the Derryfadda Formation consists of greywackes, siltstones, and mudstones, and the Scalpnagown Formation consists of conglomerate, sandstone & siltstone. The Undifferentiated Visean Limestones are impure Dinantian limestones (GSI, 2003 & 2019).

Rare bedrock exposures, consisting of sandstone, were observed in the vicinity of containment barrage 1 and 3. The bedding was horizontal to sub-horizontal. Exposed bedrock was not encountered elsewhere.

4.1.5 Peat Debris within Peat Slide Source Area

Peat debris within the 2003 peat slide source area at the Derrybrien site was encountered only between pole sets 5 and 6. The debris within the peat slide source area comprises mainly non-intact peat. As the extent of the material is extremely limited, it is not considered further in this report.

4.2 Hydrology

Several watercourses exist within the footprint of the OHL route (see Drawing 0001 for locations), the largest being the Owendalulleagh River, which is approximately 6m wide where it passes beneath the OHL between pole sets 25 and 26 (Photo 6). Major hydrological features tend to run east to west across the OHL corridor, with minor tributary features aligned approximately north to south to tie into the major drainage features.

There are several flat areas where local ponding of surface water occurs. Such a feature, Lough Agannygal, is located between pole set 37 and angle mast 38 (Photos 10 and 11).

Streams and ditches have typically been regraded for use as forestry drainage where land use is commercial forestry. It is reported that this commercial forestry was established in the 1970's (ESB, 2006). This is consistent with observations made on site that several areas have been clear felled and replanted.

4.3 Hydrogeology (Groundwater)

Based on information from the GSI database, the majority of the OHL route and the substation is underlain by rock which is considered a poor aquifer (bedrock which is generally unproductive except for local zones). However, the segment of the route underlain by Visean Limestone (between pole set 23 and 26 approximately) is considered a locally important aquifer (bedrock which is moderately productive only in local zones) although no evidence for groundwater usage from this aquifer was found.

Groundwater vulnerability (GSI, 2019) ranges from low to extreme across the route, due to the generally shallow depth to bedrock. All drainage features along the OHL route are noted as giving rise to extreme groundwater vulnerability.

4.4 Previous Landslides

A review of historical records of peat slides/landslides (GSI, 2019) indicates that peat slides have occurred in the Slieve Aughty Mountains in the past. With the exception of the 2003 peat slide on the Derrybrien wind farm site, two previous slides have been noted within 5km of the OHL. One was in 1890 and occurred at a location some 2.5km to the east of the substation at the southern end of the OHL, in an area called Loughatorick North. An area of 100 acres was covered with a 'foot' of peat, the upper part of the 'bog subsiding 10 to 15 feet'. The peat slide was described as a flow within blanket peat. The other slide occurred 5km to the north of the OHL, on the Sonnagh Old Wind Farm site. This occurred during October 2003 and is described as a flow in blanket peat adjacent to an access road.

As part of the national landslide susceptibility mapping project carried out by the Geological Survey Ireland (GSI, 2007-2013) for Ireland, all areas of land across the country are designated a landslide susceptibility rating including the OHL route, substation and surrounding area. The landslide susceptibility rating is based on a number of factors including incidences of previous peat slides, topography, type of deposits, etc.

The OHL route and substation is classified as having 'low' to 'moderately low' peat/landslide susceptibility with locally 'moderately high' susceptibility (GSI, 2019).

As stated above, the land susceptibility rating/bands typically relates to the type of deposits, topography in an area, incidences of previous peat/landslides, etc.. For example, a rating of 'moderately high' can be assigned where rock is close to the surface, slope angles range from 10 to 20 degrees, etc. Hence the rating of 'moderately high' does not necessarily relate to a risk of peat slide.

It should be noted that at the time of the 2003 peat slide no national landslide register/database existed.

5 SITE WALKOVER SURVEY

5.1 Background to Walkover Survey

The purpose of the walkover survey was to investigate the ground conditions at the pole set and angle mast locations, identify geotechnical constraints and to gather data for a peat stability assessment along the OHL route.

The walkover survey comprised an inspection of the entire length of the OHL route and likely access points to the OHL. This was carried out from 24 September to 2 October 2019. Weather conditions for the site visit were light to heavy mist/rain with some dry periods. A previous walkover of the OHL route and the substation had been undertaken by AGEC in June 2018. The findings below are a combination of the findings from the two walkover surveys (2018 and 2019)

5.2 Findings of Walkover Survey

The findings of the walkover survey are as follows:

(1) The OHL route is located approximately 10km south of Loughrea and is constructed on undulating terrain. The majority of the route is covered by shallow to locally deep blanket peat that was previously colonised by commercially grown conifer and deciduous forest. Some regrowth has occurred along the OHL since the original felling works. There are a number of areas where peat has been removed from the footprint of the pole sets/angle masts and overburden is exposed at the ground surface.

(2) The elevation along the OHL route falls from the wind farm substation (c. 330m AOD) to pole set 11 (c. 180m AOD). From pole set 11 the elevation decreases over undulating ground to angle mast 14 (c. 170m AOD) and crosses the local R353 road. The terrain gently undulates as it descends from the R353 (public road) to pole set 22 (c. 115m AOD) from where the OHL route crosses several relatively shallow watercourses. The ground level rises significantly over a short distance to pole set 23 (c. 130m AOD), then levels and quickly descends again between pole set 25 and 26 (c. 125m AOD). The terrain undulates gently as it ascends towards pole set 38 (c. 195m AOD), levels over localised deep deposits of peat and gently falls from pole set 38 to the substation at Agannygal.

(3) Peat thicknesses were recorded during the site walkover with in excess of 200 peat probes. Peat thicknesses measured ranged from 0m to 5.6m. Approximately 70 percent of the probes recorded peat depths of less than 1.0m. Over 90 percent of peat depth probes recorded peat depths of less than 2.5m. Several localised readings were recorded where peat depths of between 2.5 and 5.6m are present. The deepest peat (5.6m) was recorded in the area of angle mast 38 where the topography is flatter than the remainder of the route.

(4) The peat depths recorded at the pole sets and angle masts varied from 0.0m to 5.6m. 28 no. of the pole sets and angle masts have less than 1.0m thickness of peat in their vicinity. 6 no. of the pole sets

and angle masts have greater than 2.0m thickness of peat. The greatest depth of peat encountered, a depth of 5.6m, was recorded at the location of angle mast 38.

(5) The undrained shear strengths of peat recorded ranged from 6kPa to 68kPa with an average of 23kPa. Peat shear strength is discussed in Section 8.

(6) There are a number of locations, primarily around the angle masts, where the peat has been locally removed exposing the mineral soil beneath. This was primarily to do with gaining access for construction of the angle masts. An example of such an area is shown in Photo 7.

(7) In other areas, primarily around the pole sets in areas of deep peat, timber sleepers from felled trees have been used by machinery to gain access during construction, as shown in Photo 5.

(8) The mineral soil composition along the OHL route, based on a visual inspection of exposures, is a sandy gravelly silt or clay with gravel, cobbles and boulders of various sizes and lithology. The mineral soil colour is primarily red-brown, as shown in Photos 7 and 9, with localised areas of white-grey, situated around pole sets 19 and 20. Dispersed throughout the white-grey mineral soil are gravels and small cobbles, which appear to be a mixture of marble, quartz and sandstone in nature. Elsewhere the cobbles and boulders present appear to be sandstone in nature and sandstone would appear to be the dominant rock type present along the route.

(9) Slope angles at the pole set and mast locations typically range from 0 to 15 degrees. There were several steeper slope angles between pole set and mast locations, particularly south of pole set 25 and near the Owendalulleagh River, where an inclination of about 35 degrees was recorded.

(10) The peat situated towards the northern end of the route has a notable vegetation cover, which is generally indicative of relatively well-drained (stronger) peat. However, there are some areas towards the south of the OHL route where poorly-drained (weaker) peat deposits were recorded in deforested areas.

(11) Localised areas of waterlogged peat and surface water are present at numerous areas along the OHL route, particularly between pole sets 37 and AM 38 (Photos 10 and 11). This is not unexpected given the flat nature of the terrain and watercourses present along the OHL route, including Lough Agannygal.

(12) Apart from where the OHL crosses the 2003 peat slide source area, which is between pole sets 5 and 6, no evidence of past peat slides were recorded on the OHL route or directly adjacent to it.

(13) The Agannygal substation is constructed on the edge of a forested area to the north of Lough Atorick. The substation compound has been created by excavating material along the eastern side of the site to create a level platform on competent ground. A cutting 3m deep is present along the eastern side of the substation compound.

(14) Several cuttings were identified along the OHL route, see Section 3.3.4 for details. Of these, the most significant were between pole set 28A and 29 and at Agannygal substation. Between pole set 28A and 29, the cutting is up to 3.8m deep and the cutting slopes have an average slope angle of around 32 degrees in glacial till. There is evidence of minor surface erosion leading to the washing out of soil in local areas of this cutting. At Agannygal substation the cutting is up to 3m deep and has an average slope angle of 35 degrees in glacial till. Based on a visual inspection these cutting slopes appear to be stable. Minor surface erosion was noted in the vicinity of pole set 28A and 29 which would not give rise to a concern over a deeper and more significant slip occurring.

(15) The conclusions from the walkover survey are as follows:

(a) The peat depths recorded at the pole sets/angle masts varied from 0m to 5.6m. 28 no. of the surveyed poleset/angle mast locations have less than 1.0m thickness of peat.

(b) The peat depths recorded near pole set 28 and 36, ranging from 2.5m to 5.6m, would be considered relatively deep. Further, peat strengths in this area were relatively low, ranging from 12kPa to 30kPa. Suitable access techniques and plant such as the use of bog mats and low load bearing machinery would be required when operating in these areas.

(c) Mitigation/control measures for access and potential decommissioning activities at each subsection of the OHL route and substation are given in the Peat Stability Risk Register (Appendix D).

(d) Cuttings up to 3.8m deep in glacial till were observed. These appear to be stable based on a visual assessment.

6 AGEC GROUND INVESTIGATION (2018)

The ground investigation carried out by AGEC along the OHL route and at the Agannygal substation in June 2018 comprised peat depth probes, hand shear vanes and 2 no. trial pits. The locations of the trial pits are shown in Drawings 0001 and 0006. Additional peat depth probes and hand shear vanes were undertaken by FT in 2019.

6.1 Peat Depth Probing and Shear Vane Testing

During the walkover survey, peat depth probing and shear vane testing were carried out at each pole set, mast location and at selected intermediate points along the OHL route to provide representative coverage of indicative peat depths and strengths.

The results of peat depth probing are presented as a peat depth contour plan in Drawings 0002 and 0003 and indicate peat depths ranging from 0 to 5.6m bgl. The depth of peat varies from sections where there is no peat over the footprint of 4 or 5 consecutive pole sets to deep areas of peat, especially near the Agannygal substation site, although inspection of the substation itself shows that it is founded on mineral soil.

Shear vane testing was carried out using a Geonor H-60 hand field vane tester. From FT's experience hand vanes give indicative results for the in-situ undrained shear strength of peat and would be considered best practice for the field assessment of peat strength. 75 no. hand shear vane strength tests were undertaken by AGEC at depths from 0.5 to 2.5m bgl. The hand vane results indicate undrained shear strengths in the range 6 to 68kPa with an average value of 26kPa. Peat strength values are plotted in Figure 2.

6.2 Trial Pits

2 no. trial pits were excavated out at Agannygal substation in June 2018, referred to as TP10 and TP11. The trial pit locations are shown on Drawings 0001 and 0006 and are downslope of the substation. The results of these trial pits are presented in the logs included as Appendix B. Trial pit TP10 found 1.0m of fill over natural ground consisting of mineral soil to a depth of 2.9m bgl. Trial pit TP11 found 0.7m of peaty fill over natural ground consisting of soft slightly organic clay to 1.7m bgl over mineral soil to 2.5m bgl.

The 2 no. trial pits are consistent with each other and suggest a ground profile consisting of deposited construction arisings from the substation excavation over a natural ground profile of soft organic topsoil over glacial till. A cutting is exposed at the Agannygal substation site, shown in Photo 12, and the exposed soil here is consistent with the descriptions from the trial pits.

7 MAINTENANCE AND DECOMMISSIONING

7.1 Description of Maintenance Works

At the time of writing this report, the only planned maintenance works along the OHL which would have an impact on the site stability involves the cutting back of tree growth under the OHL route.

7.2 Methodology for the Cutting back of Tree Growth

Where tree regrowth beneath the OHL has occurred, it is planned that cutting back of this tree growth will take place. Trees will be cut but not extracted. As advised by ESB, the proposed methodology for the cutting back of tree growth is outlined as follows:

(1) Cutting works will be undertaken using a 10-tonne low ground pressure machinery and is envisaged to be minimally invasive.

(2) The excavator will have a saw head attachment rather than a digging bucket.

(3) All of the trimmed vegetation will be cut and left in place on the peat slopes with no additional handling, which minimises machine movements and loading on the peat.

It is expected that a uniform surcharge loading of 10kPa over the affected ground surface will adequately model the pressure imposed on the ground by the plant involved.

7.3 Description of Decommissioning Works

The OHL including the conductors, pole sets and masts may be decommissioned in the future and for completeness the methodology is included below. This work would involve the removal of the OHL infrastructure between the Derrybrien and Agannygal substations, as well as the removal of the above ground infrastructure at the Agannygal substation.

7.3.1 Access for Decommissioning Works

Based on the observations made during the walkover survey, the access routes for decommissioning works which would likely be used are presented in Drawings DMP 01, DMP 02 and DMP 14. These access routes are presented as preliminary suggestions only and would be subject to detailed design. The proposed routes are briefly summarised below. The existing forestry access tracks typically comprise a 3m wide track constructed of crushed rock which has been founded on the mineral soil underlying the peat. Minor upgrades of sections of these tracks may be required.

Notable constraints encountered included several steep slope angles between pole set and mast locations, particularly south of pole set 25 and near the Owendalulleagh River, where an inclination of about 35 degrees was recorded. Where constraints have been identified, alternative access routes are proposed (Drawings DMP

01 and 14). For example, the proposed access routes allow the steep slopes between pole set 3 and pole set 4 and between pole set 25 and pole set 26 to be avoided.

New access construction may include the use of low ground bearing pressure (LGBP) plant and bog mats to provide access to pole sets.

EM1 to PS4

Route follows existing OHL route from Derrybrien substation, requiring possible construction of new access, depending on level of access required for decommissioning works. Alternate access to PS4 is from a local road following an existing track north with access upslope towards the substation using LGBP plant or bog mats.

PS5 to PS11

Route follows existing founded access track from local road north to close to PS4. Existing (floating) track from founded access track to containment barrage 2, located between PS5 and PS6, may be upgraded to allow access to this section of the OHL Access to PS6-PS10 requires the use of LGBP plant or bog mats along the OHL route, depending on level of access required for decommissioning works. PS11 is located immediately adjacent to a local road and can be accessed directly from the local road.

PS12 to AM14

Route follows existing founded access track from local road north to AM14, which would require upgrading. Access from AM14 to PS12 requires the use of LGBP plant or bog mats along the OHL route , depending on level of access required for decommissioning works.

PS15 to PS22

Route follows existing founded access track from local road south to PS22. The track may require upgrading between PS19 and PS21.

PS23 to PS25

Route follows existing founded access track from local road north to PS25. This access may require the upgrade of the existing ford at the Owendalulleagh River and the use of LGBP plant or bog mats along the OHL route, depending on the level of access required for decommissioning works.

PS26 to PS27

Route follows existing founded access track from local road north towards PS26. Access from PS26 to PS27 requires the use of LGBP plant or bog mats along the OHL route, depending on level of access required for decommissioning works.

PS28 to PS31

Route follows existing founded access track from local road north to PS28A. Access from PS28A to PS28 and PS31 requires the use of LGBP plant or bog mats along OHL route, depending on level of access required for decommissioning works.

PS32 to PS34

Route follows existing founded access track from local road north to PS34. Access from PS34 to PS32 requires the use of LGBP plant or bog mats along OHL route, depending on level of access required for decommissioning works.

PS35 to PS37

Requires the use of LGBP plant or bog mats from local road north to PS35 and south to PS37 along OHL route, depending on level of access required for decommissioning works.

AM38 to EM41

Requires the use of LGBP plant or bog mats from Agannygal substation north to AM38 along OHL route, depending on level of access required for decommissioning works.

Substation Access

Access to the substation would use the previously upgrade Coillte track that runs from the local road some 2.5km away.

7.3.2 Methodology for the Decommissioning of the Overhead Line

As advised by ESB, the proposed methodology for the decommissioning of the OHL and timber pole sets is as follows:

(1) Decommissioning works will be undertaken using low ground pressure (LGBP) machinery.

(2) It is currently expected that decommissioning works will be carried out using a light-weight tracked dumper with a winch and 2 no. tracked excavators fitted with pole handling equipment.

(3) Conductor lines will be de-tensioned and removed at various points along the OHL route.

(4) A winch will be brought to the site of the particular pole set to be removed by means of light-weight tracked dumper.

(5) The winch will be attached to the steel cross member of the pole set from ground level.

(6) The cross member will be un-bolted from the pole on the opposite side as the winch.

(7) The winch will allow the cross member to rotate until it is hanging vertical and it will then be lowered to the ground.

(8) The first excavator, fitted with pole handling equipment, will grab the poles at about mid height or higher.

(9) The second excavator will loosen the ground around the base of the pole.

(10) Once the ground is sufficiently loosened, the pole will be raised from its hole and lowered to the ground by the first excavator.

(11) The empty hole will be backfilled and made safe.

(12) If one excavator is capable of carrying it, the pole will be removed by that excavator to a suitable loading point. If one excavator cannot safely carry the pole, both excavators will be used.

(13) Steps (8) to (12) are repeated for the second pole.

(14) The OHL poles and mast elements will be removed from site for reuse and if necessary, disposal in accordance with the relevant legislation.

As advised by ESB, the proposed methodology for the removal of angle masts, intermediate masts and ends masts is as follows:

(1) Conductor lines will be de-tensioned and removed at various points along the OHL route.

(2) Rope access personnel (linesmen) will climb the particular mast to be decommissioned and will work to dismantle the structural members of the mast one by one.

(3) A light pulley block will be secured to the mast and the selected member for removal. The selected member for removal will be unbolted or cut away from the mast structure. Alternatively, if there are no site restrictions then a mobile crane is usually used on site for the dismantling.

(4) The dismantled member will be winched safely to the ground using the pulley system and loaded onto a light weight tracked dumper for disposal. Depending on the type of transportation available, the dismantled member may need to be cut up into smaller segments for transportation.

(5) The workers will progress through each mast, member by member, in this manner.

(6) Where steel structural members are cast into concrete foundations, steel members will be cut flush with the concrete foundation.

(7) The concrete foundations will typically be left in place, this may vary depending on site requirements. Generally, the concrete foundations are removed to 1m below ground level. This would be done using an excavator with a rock breaker. All removed concrete and steel would be removed to a registered waste disposal facility.

It is expected that a uniform surcharge loading of 10kPa over the affected ground surface will adequately model the pressure imposed on the ground by the plant involved. For access and egress purposes bog mats may be deployed to spread the loading of the plant where deemed necessary, thus avoiding the construction of stone access tracks.

7.3.3 Summary of Geotechnical Implications of Decommissioning

The geotechnical implications of the decommissioning process detailed above are as follows:

- Increased risk of a peat slide due to increased surcharge loading over the peat surface during the works.
- Increased risk of peat slide due to loading from temporary floating access roads, if temporary floating access roads are built to gain access to sites for decommissioning, although it is not envisaged that this will be necessary given the available forestry access tracks across the OHL route and the intended use of LGBP plant.
- Local alteration of the surface water flow regime or the surface profile by disturbances during the works, allowing for ponding of surface water on the peat, and hence a potential increase in the risk of a peat slide.

In general, the likely geotechnical impacts of decommissioning are related to an increased risk of a peat slide in the areas of the site where peat is present. In areas where peat is not present, the geotechnical impacts will be insignificant.

The geotechnical implications of any maintenance works are considered negligible.

8 DETERMINISTIC PEAT STABILITY ASSESSMENT

The main approaches for assessing peat stability include the following:

(a) Geomorphological

(b) Qualitative (judgement)

(c) Index/Probabilistic (probability)

(d) Deterministic (factor of safety)

Approaches (a) to (c) listed above would be considered subjective and do not provide a definitive indication of stability; in addition, a high level of judgement/experience is required which makes it difficult to relate the findings to real conditions. FT apply a more objective approach, the deterministic approach.

As part of FT's deterministic approach, a qualitative risk assessment is also carried out (see Section 10) taking into account qualitative factors, which cannot necessarily be quantified, such as the presence of mechanically cut peat, quaking peat, bog pools, sub peat water flow, slope characteristics and numerous other factors. The qualitative factors used in the risk assessment are compiled based on FT's experience of assessments and construction in peat land sites and peat slides throughout Ireland and the UK. This approach takes into account current guidelines for geotechnical/peat stability risk assessments as given in Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (PLHRAG, 2017) and MacCulloch (2005).

8.1 Methodology for Deterministic Peat Stability Assessment

Stability of a peat slope is dependent on several factors working in combination. The main factors that influence peat stability are slope angle, shear strength of peat, depth of peat, pore water pressure and loading conditions.

An adverse combination of factors could potentially result in peat sliding. An adverse condition of one of the above-mentioned factors alone is unlikely to result in a peat slide. To assess the factor of safety for a peat slide, undrained and drained analyses have been undertaken to determine the stability of the peat slopes along the OHL route and at the substation.

The infinite slope model (Skempton and DeLory, 1957) is used to combine these factors to determine a factor of safety against peat sliding. This model is based on a translational slide, which is a reasonable representation of the dominant mode of movement for peat slides.

8.2 Peat Strength

Undrained (short term stability) and drained (long term stability) analyses were carried out to determine the stability of the peat slopes on the site.

(1) The undrained loading condition applies in the short term typically following the application of a load and until load induced pore water pressures have dissipated. Most anthropogenic peat slides occur in the undrained condition i.e. in fully saturated conditions. The undrained condition uses undrained strength parameters in the assessment. Given the timeframe since the OHL was constructed, the drained condition would be deemed the most relevant however the undrained condition is included for completeness.

(2) The drained loading condition applies in the long-term following partial or full dissipation of excess pore water pressure from the peat over time. In the drained condition the pre water pressure (groundwater level) is in equilibrium with in-situ conditions which can vary with seasonal changes. The drained condition examines the effect of the change in groundwater level as a result of rainfall on the stability of the peat slope (following the draining or partial draining of the peat). As a worst case and for the purpose of the assessment the groundwater level is assumed to be at the surface of the peat, to reflect an extreme rainfall event. The drained condition uses effective strength parameters in the assessment.

Undrained shear strength values (c_u) for peat recorded on site using the hand shear vane are used for the undrained analysis.

For the analysis of the peat slopes along the OHL route a lower bound value of 6kPa for the undrained shear strength of the peat was used (Figure 2). This is based on the analysis of a total of over 100 no. shear vane tests (carried out by FT (2019) AGEC (2018) and ESB (2006)) which have provided undrained shear strength values for the peat. Of 123 test results, 3 results showed a shear strength value of less than 6kPa. This value would be considered appropriate and conservative for the undrained condition.

A drained analysis requires effective cohesion (c') and effective friction angle (ø') values for the calculations. These values can be difficult to obtain because of disturbance experienced when sampling peat and the difficulties in interpreting test results due to the excessive strain induced within the peat. To determine suitable drained strength values a review of published information on peat was carried out.

Table 8.1 shows a summary of the published information on peat together with drained strength values.

Table 8.1: List of Effective Cohesion and Friction Angle Values for Peat

Reference	Cohesion, c' (kPa)	Friction Angle, ø' (degs)	Testing Apparatus/ Comments
Hanrahan et al (1967)	5 to 7	36 to 43	From triaxial apparatus
Rowe and Mylleville (1996)	2.5	28	From simple shear apparatus
Landva (1980)	2 to 4	27.1 to 32.5	Mainly ring shear apparatus for normal stress greater than 13kPa
	5 to 6	-	At zero normal stress
Carling (1986)	6.5	0	-
Farrell and Hebib (1998)	0	38	From ring shear and shear box apparatus. Results are not considered representative.

Reference	Cohesion, c' (kPa)	Friction Angle, ø' (degs)	Testing Apparatus / Comments
	0.61	31	From direct simple shear (DSS) apparatus. Result considered too low therefore DSS not considered appropriate
Rowe, Maclean and Soderman (1984)	1.1	26	From simple shear apparatus
	3	27	From DSS apparatus
McGreever and Farrell (1988)	6	38	From triaxial apparatus using soil with 20% organic content
	6	31	From shear box apparatus using soil with 20% organic content
Hungr and Evans (1985)	3.3	-	Back-analysed from failure
Dykes and Kirk (2006)	3.2	30.4	Test within acrotelm
Dykes and Kirk (2006)	4	28.8	Test within catotelm
Warburton et al (2003)	5	23.9	Test in basal peat
Warburton et al (2003)	8.74	21.6	Test using fibrous peat
Hendry et al (2012)	0	31	Remoulded test specimen
Komatsu et al (2011)	8	34	Remoulded test specimen
Zwanenburg et al (2012)	2.3	32.3	From DSS apparatus
Den Haan & Grognet (2014)	-	37.4	From large DSS apparatus
O'Kelly & Zhang (2013)	0	28.9 to 30.3	Tests carried out on reconstituted, undisturbed and blended peat samples

From Table 8.1 the values for c' ranged from 1.1 to 8.74kPa and ø' ranged from 21.6 to 43°. The average c' and ø' values are 4.5kPa and 30° respectively. Based on the above, it was considered to adopt a conservative approach and to use design values less than the average.

For design the following general drained strength values have been used for the site:

c' = 4kPa
$ø'$ = 25 degrees.

8.3 Analysis to Determine Factor of Safety

The purpose of the analysis was to determine the Factor of Safety (FoS) of the peat slopes along the OHL route. As the analysis uses generalised lower bound peat strength values, the results provide an indication of areas where instability might occur. The analysis assumes that all areas have lower bound peat strength, which in the majority of instances is not the case.

The FoS provides a direct measure of the degree of stability of the peat slope. A FoS of less than unity indicates that a slope is unstable, an FoS of greater than unity indicates a stable slope.

The acceptable safe range for FoS typically ranges from 1.3 to 1.4. Where there is minimal risk from a slope slide a FoS of just greater than 1 may in some cases be acceptable. The previous code of practice for earthworks BS 6031:1981 (BSI, 1981), provided advice on design of earthworks slopes. It stated that for a first-time slide with a good standard of site investigation the design FoS should be greater than 1.3. A FoS of 1.4 is taken as indicative of sufficient stability within this report, which would be deemed a conservative approach.

Eurocode 7 (EC7) (I.S. EN 1997-1:2005+AC: 2013) serves as the reference document and the basis for design geotechnical engineering works. The design philosophy used in EC7 applies partial factors to soil parameters, actions and resistances. Unlike the traditional approach, EC7 does not provide a direct measure of stability, since global Factors of Safety are not used.

As such, and in order to provide a direct measure of the level of safety on a site, EC7 partial factors have not been used in this stability assessment. The results are given in terms of FoS.

The formula used to determine the factor of safety for the undrained condition in the peat (Bromhead, 1986) is as follows:

$$F = \frac{c_u}{\gamma z \sin\alpha \cos\alpha}$$

Where,

F = Factor of Safety
c_u = Undrained strength
γ = Bulk unit weight of material
z = Depth to failure plane assumed as depth of peat
α = Slope angle

The formula used to determine the factor of safety for the drained condition in the peat (Bromhead, 1986) is as follows:

$$F = \frac{c' + (\gamma z - \gamma_w h_w)\cos^2\alpha \tan\phi'}{\gamma z \sin\alpha \cos\alpha}$$

Where,

F = Factor of Safety
c' = Effective cohesion
γ = Bulk unit weight of material
z = Depth to failure plane assumed as depth of peat
γ_w = Unit weight of water
h_w = Height of water table above failure plane
α = Slope angle
ϕ' = Effective friction angle

For the drained analysis the level of the water table above the peat slide surface is required to calculate the factor of safety for the slope. Since the water level in upland peat can be variable, it is not feasible to establish

its precise location along the OHL route. Therefore, a worst-case approach was assumed, and the water level is taken to be at the surface of the peat i.e. at 100% of the peat depth which equates to the peat been fully saturated.

The following general assumptions were used in the analysis of peat slopes at each location:

(1) Peat depths are based on the maximum peat depth recorded at each location from the walkover surveys (2018 and 2019).

(2) For the analysis of the peat slopes across the site a lower bound value of 6kPa for the undrained shear strength of the peat was used (Figure 2).

(3) Slope angle on base of sliding assumed to be parallel to ground surface.

For the stability analysis two load conditions were examined, namely:

Condition (1): no surcharge loading

Condition (2): surcharge of 10kPa, equivalent to construction, operational and decommissioning plant and access loading

8.4 Results of the Stability Analysis for the Overhead Line Route

8.4.1 Undrained Analysis

The results of the undrained stability analysis for the OHL route and substation are graphically shown in Drawings 0004 and 0005 and are tabulated in Appendix E.

For the peat slopes the calculated FoS for load condition (1) and (2) is typically in excess of 1.4 for each location analysed.

A summary of the FoS range calculated for load condition (1) and load condition (2) are presented in Table 8.2 along with their respective percentage of site area.

Table 8.2: Summary of Undrained Slope Stability Results

Factor of Safety (FoS)	% of OHL Route (Condition 1)	% of OHL Route (Condition 2)
Less than 1.0	0	0
1.0 to 1.3	0	3.5
1.3 to 1.4	0	0
Greater than 1.4	100	96.5

For Condition (1), 100% of the OHL route and substation has a FoS greater than 1.0 and for Condition (2) 96.5% of the OHL route has a FoS greater than 1.4. Analysis of the spatial distribution of the areas (3 locations) where the lower FoS are present for load condition (2) shows that they are located in areas where steeper slopes are present between pole sets i.e. typically between 10 and 15 degrees. These are located between PS8 and PS9, PS25 and PS26, and PS34 and PS35, as shown on Drawing 0004 and 0005. Information on mitigation measures

for these areas is provided within the Peat Stability Risk Assessment in Appendix D. In one case a low FoS is present where the slope angle is particularly steep, being 21 degrees (between PS34 and PS35), however the peat depth at this location is shallow (0.6m) and no peat instability issues are envisaged either for the maintenance period or during decommissioning. No FoS of less than 1.4 was recorded at a pole set or angle mast location.

In general, the factors of safety less than 1.4 generated from the analysis are not unexpected as generalised lower bound peat strength values are used in the analysis, which cannot take into account areas of higher strength peat. The analysis is intended to provide an indication of likely peat instability and is to be used as an input to a further qualitative risk assessment of the peat stability along the OHL route.

8.4.2 Drained Analysis

The results of the drained stability analysis for the OHL route and substation can be found in Appendix E.

For the peat slopes the calculated FoS for load condition (1) and (2) is typically in excess of 1.4 for each location analysed. A summary of the various FoS's calculated for load condition (1) and load condition (2) are presented in Table 8.3 along with their respective percentage of site area.

Table 8.3: Summary of Drained Slope Stability Results

Factor of Safety (FoS)	% of OHL Route (Condition 1)	% of OHL Route (Condition 2)
Less than 1.0	0	0
1.0 to 1.3	1	0
1.3 to 1.4	0	0
Greater than 1.4	99	100

From Table 8.3 for load condition (1) 99% of the OHL route and substation has a FoS greater than 1.4 and for Condition (2) 100% of the OHL route has a FoS greater than 1.4. No FoS of less than 1.4 was recorded at a pole set or angle mast location.

While it has been found, somewhat counterintuitively, that Condition (1), the natural condition, presents a less favourable outcome than Condition (2), where the slope is surcharged, this is reasonable due to the effective stress analysis undertaken. In this analysis, an increase in the surface loading and hence the vertical effective stress leads to an increase in the confining pressure on the potential failure plane under consideration and therefore a greater resistance to movement on that plane.

In general, the factors of safety less than 1.4 generated from the analysis are not unexpected as generalised lower bound peat strength values are used in the analysis, which cannot take into account areas of higher strength peat. The analysis is used to provide an indication of the likely susceptibility of instability within the OHL route and at the substation.

8.5 Stability of Agannygal Substation Site

The Agannygal substation site is founded on mineral soil, which would be considered a competent founding medium. As the peat was stripped away as part of the construction and there is no peat present within the footprint the Agannygal substation site, the substation site is not included in the stability analysis as it is considered stable.

8.6 Summary

The analysis was carried out to provide an indication of likely peat instability along the OHL route. The analysis showed that, using conservative strength parameters, the peat generally has an adequate factor of safety and hence a low risk of instability. However, the use of conservative undrained and drained strength parameters has contributed to a small number (3 number) of relatively low FoS results, particularly around areas of high slope angles and deep deposits of peat. These are located between PS8 and PS9, between PS25 and PS26, and between PS34 and PS35.

In general, the areas of relatively low FoS generated from the analysis are not unexpected as generalised lower bound peat strength values are used in the analysis, which cannot take into account areas of higher strength peat. The analysis is intended to provide an indication of likely peat instability.

An estimate of potential peat slide volume and run-out distance has been undertaken for the three areas with relatively lower FoS results. This is to provide an indication of the scale of a potential peat slide, it does not imply that a slide would occur. The potential peat slide volume has been calculated based on information recorded on site. The run-out distance is based on a comparison with historical peat slides in Ireland. These are plotted on Figure 3. The potential peat slide volumes range from 8,000m^3 to 16,000m^3 based on peat depth readings in these areas. Run-out distances are from 500m to 700m based on comparisons with historical peat slides.

The deterministic and quantitative results obtained from the analysis presented in this section are used in Section 9 of this report to undertake a peat stability risk assessment. As part of this assessment, appropriate control measures will be identified to mitigate the risk of a peat slide.

9 PEAT STABILITY RISK ASSESSMENTS

9.1 Methodology

A peat stability risk assessment was carried out for the OHL infrastructure and Agannygal substation. This approach takes into account guidelines for geotechnical/peat stability risk assessments as given in PLHRAG (2017) and MacCulloch (2005).

The risk assessment uses the results of the stability analysis (deterministic approach) in combination with qualitative factors, which cannot be reasonably included in a stability calculation but nevertheless may affect the occurrence of peat instability, to assess the risk for each infrastructure element.

As previously outlined, the OHL route was broken into 9 no. subsections (including the substation at Agannygal) for assessment. These subsections were chosen based on having similar topography and peat depth within each individual section

For each subsection of the OHL, a risk rating (product of probability and impact) is calculated for every contributory/qualitative factor in the subsection. The range of risk ratings is shown in Table 9.1.

The risk rating assigned to any subsection is based on the highest risk rating calculated for any contributory/qualitative factor within that subsection.

Where a subsection is rated 'Medium' or 'High', specific control measures are required to reduce the risk to at least a 'Low' risk rating. Where a subsection is rated 'Low' or 'Negligible', only routine control measures, if any, are required. The control measures are targeted at the specific contributory/qualitative factors that give the highest risk rating.

Table 9.1: Risk Rating Legend

17 to 25	High: avoid works in area or significant control measures required
11 to 16	Medium: specific control measures required
5 to 10	Low: only routine control measures required
1 to 4	Negligible: none or only routine control measures required

A full methodology for the peat stability risk assessment is given in Appendix C.

The impact of a peat slide on the receiving environment within and beyond the OHL route and substation is assessed based on the potential travel distance and potential volume of a peat slide and the effect on receptors such as local property, infrastructure, and the natural environment.

Where a peat slide enters a watercourse it can travel a considerable distance downstream. Therefore, the proximity of a potential peat slide to a drainage feature is a significant indicator of the likely potential impact. Furthermore, given the elevation of the terrain along the OHL route, the topography in some areas may result in the formation of potential flow paths through naturally occurring features such as dips and falls in the terrain, valleys, etc. Such features would have the effect of increasing the travel distance of and the areas affected by any potential peat slide.

The potential damage to private property is also assessed using this approach. The OHL is located in a sparsely populated location; however, land owners and domestic dwellings may still be at risk in certain areas if a peat slide were to occur. In addition, property such as pasture and tillage farms, private landholdings, and communication/power infrastructure can be susceptible to peat slides. The list of such potential features or receptors identified are outlined in Table 9.2.

Table 9.2: Potential Receptors

Receptor	Control
Watercourse (rivers, streams, flow channels, etc.)	Topography
Dwellings (domestic)	
Road (local roads excluding wind farm access tracks)	
Infrastructure (overhead lines, communications infrastructure, etc.)	
Agricultural Land (pasture, etc.)	
Natural Heritage Area (Slieve Aughty Bog NHA)	

The primary controlling aspect when determining the impact of a potential peat slide, once that slide has occurred, is the topography along the slide run-out route.

9.2 Summary of Risk Assessment Results

The results of the risk assessment for potential of a peat slide at the 9 no. subsections are presented in Appendix D and are summarised in Table 9.3.

The risk rating for the identified areas of infrastructure along the OHL route and the substation is designated low or less following mitigation/control measures being implemented. If any sections of new temporary access track are required for any decommissioning works on the OHL, these should be subject to the same mitigation/control measures that apply to that particular subsection of the OHL. Where the proposed access

routes use the existing founded forest tracks the risk rating is considered to be negligible, due to the minor nature of any required upgrade works and the absence of peat beneath the tracks.

Details of the required mitigation/control measures can be found for each OHL subsection in Appendix D.

The upgrade of the c. 2.5km of access track to access the substation site during construction is not considered to present a risk of instability given the minor nature of the work involved and the relatively flat topography of the area.

Table 9.3: Summary of Peat Stability Risk Assessment

Infrastructure	Pre-Control Measure Implementation Risk Rating	Post-Control Measure Implementation Risk Rating
EM1 to PS5	Low	Negligible
PS5 to AM14	Medium	Negligible
AM14 to AM18	Negligible	Negligible
AM18 to AM24	Medium	Negligible
AM24 to PS28A	Medium	Low
PS28A to PS34	Low	Negligible
PS34 to AM38	Medium	Negligible
AM38 to EM41	Medium	Negligible
Agannygal Substation	Negligible	Negligible

Note
(1) For mitigation/control measures refer to Appendix D.

9.3 Likelihood of Instability - Combining Deterministic and Qualitative Factors

The results of the stability analysis (Section 8) have been combined with qualitative factors, to provide an indication of the probability of instability. The qualitative factors are given in Appendix C.

The purpose of combining deterministic and qualitative factors is to provide a likelihood of failure that can be applied to a variety of potential specific receptors, other than those included in this report, see Table C in Appendix C. The peat stability risk assessment included in Section 9.2 of this report uses a number of general receptors such as local property, infrastructure, and the natural environment.

The deterministic factor of safety and qualitative factors are combined as follows:

- The deterministic factor of safety and qualitative factors are scored from 0 to 5 using Table B in Appendix C.
- The maximum score that can be obtained by combining the deterministic factor of safety and qualitative factors, that is a total of 12 factors (5 x 12), is 60, and the lowest score is 0. The greater the total combined score the greater the likelihood of failure.
- Where the stability analysis is not applicable because, for example, no peat is present, then the deterministic score is 0, and combined score defaults to negligible irrespective of the qualitative factors.
- Where stability analysis shows FoS less than 1 then the likelihood defaults to very likely irrespective of qualitative score
- In all cases, experienced engineering judgement is used, the actual combined scoring provides a guide.

Table 9.4 shows the peat landslide combined likelihood ranges for lifetime of proposed development.

Table 9.4: Peat Stability Combined Likelihood Ranges

Scale	Likelihood	Combined Score	Probability of Occurrence (Event/year)
0	Not applicable	0	Not applicable
1	Negligible	1 to 10	>1 in 100,000 to 1 in 10,000
2	Unlikely	11 to 30	>1 in 10,000 to 1 in 1,000
3	Probable	31 to 40	>1 in 1,000 to 1 in 100
4	Likely	41 to 50	>1 in 100 to 1 in 10
5	Very Likely	50 to 60	>1 in 10

shows the results of the peat stability combined likelihood for the 9 no. subsections presented in Appendix D.

Table 9.5: Summary of Peat Stability Likelihood

Infrastructure	Combined Likelihood Score	Likelihood of Failure Pre-Control Measure Implementation
EM1 to PS5	10	Negligible
PS5 to AM14	14	Low
AM14 to AM18	3	Negligible
AM18 to AM24	9	Negligible
AM24 to PS28A	19	Low
PS28A to PS34	10	Negligible

Infrastructure	Combined Likelihood Score	Likelihood of Failure Pre-Control Measure Implementation
PS34 to AM38	16	Low
AM38 to EM41	10	Negligible
Agannygal Substation	2	Negligible

10 CONCLUSIONS

The following conclusions are given.

(1) Fehily Timoney & Company (FT) was engaged by ESB to undertake a geotechnical stability assessment of the OHL route from the Derrybrien wind farm site to the Agannygal substation. In line with the brief, the assessment took account of the geotechnical stability of the route and the substation during its construction phase, operational phase and during possible decommissioning works in the future.

(2) The geotechnical stability assessment included the completion of a desk study, a site walkover, and an additional ground investigation. A deterministic peat stability assessment and a qualitative peat stability risk assessment were undertaken.

(3) Apart from the peat slide scar left by the peat slide in October 2003, which is between pole sets 5 and 6, no evidence of past peat slides have been recorded on the OHL route. The nearest other historical peat slide was located approximately 2.5km east of the offsite substation and occurred in 1890.

(4) Cuttings up to 3.8m deep in glacial till were observed. These appear to be stable based on a visual inspection and are considered to have a low risk of future instability.

(5) The deterministic peat stability assessment found that the peat along the OHL route generally has an adequate factor of safety against peat slide and hence a low risk of instability. However, the use of conservative shear strength parameters for the peat has contributed to a small number (3 no. – 3.5% of total route) of low FoS results, particularly around areas of high slope angles and relatively deep deposits of peat. The Risk Assessments in Appendix D provide mitigation measures for these areas.

(6) Potential peat slide volumes and run-out distance have been calculated for these three areas with relatively lower FoS. This is to provide an indication of the scale of a potential peat slide, it does not imply that a slide would occur. The potential slide volumes range from 8,000m^3 to 16,000m^3 and the run-out distance ranges from 500m to 700m.

(7) A qualitative peat stability risk assessment was carried out by separating the OHL route into 9 no. subsections and assessing these subsections based on the probability of a peat slide for a number of indicators and the likely impact of a peat slide, should it occur. The peat stability risk assessment found that 5 no. subsections were assigned a 'medium' risk rating while the remaining subsections were assigned 'low' or 'negligible' risk ratings.

(8) To bring the risks of a peat slide at the locations where a 'medium' risk exists to 'low' or 'negligible' levels, it is recommended that control measures are implemented. These include routine measures such as avoiding accessing the areas of peat with the greatest slopes with plant, the use of suitable plant and equipment, and adequate monitoring of the works. Other control measures are outlined in Appendix D.

(9) Overall the stability of the OHL and Agannygal substation with respect to peat slide risk is considered to be acceptable. Where localised areas of elevated risk have been identified the level of risk can be reduced by the application of routine control measures.

(10) Should any sections of new temporary access track be required for any decommissioning works running below the OHL, these should be subject to the same mitigation/control measures that apply

to that particular subsection of the OHL. Where the proposed access routes use the existing founded forest tracks the risk rating is considered to be negligible, due to the minor nature of any required upgrade works and the absence of peat beneath the tracks.

(11) Based on the results of both the deterministic and qualitative stability assessments, there are two subsections where control/mitigation measures are required at the decommissioning stage to reduce the level of risk to an acceptable level (Appendix D). These localised areas are between PS5 and AM14 and between AM24 and PS28A. Both of these areas recorded relatively low FoS results as well as containing areas of steeper slopes.

11 REFERENCES

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Figures

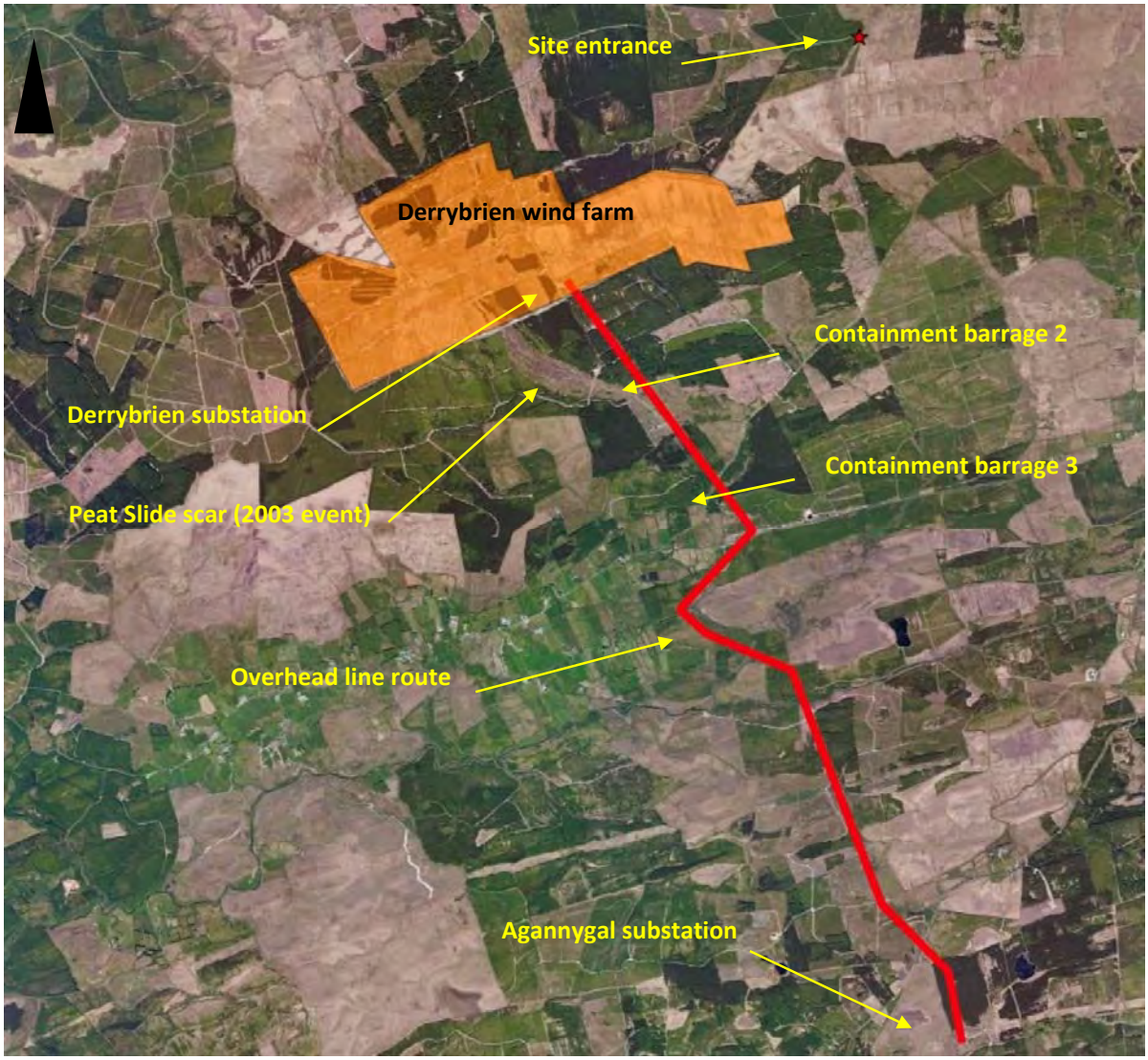


Figure 1 Location of Grid Connection (source: Bing Maps)

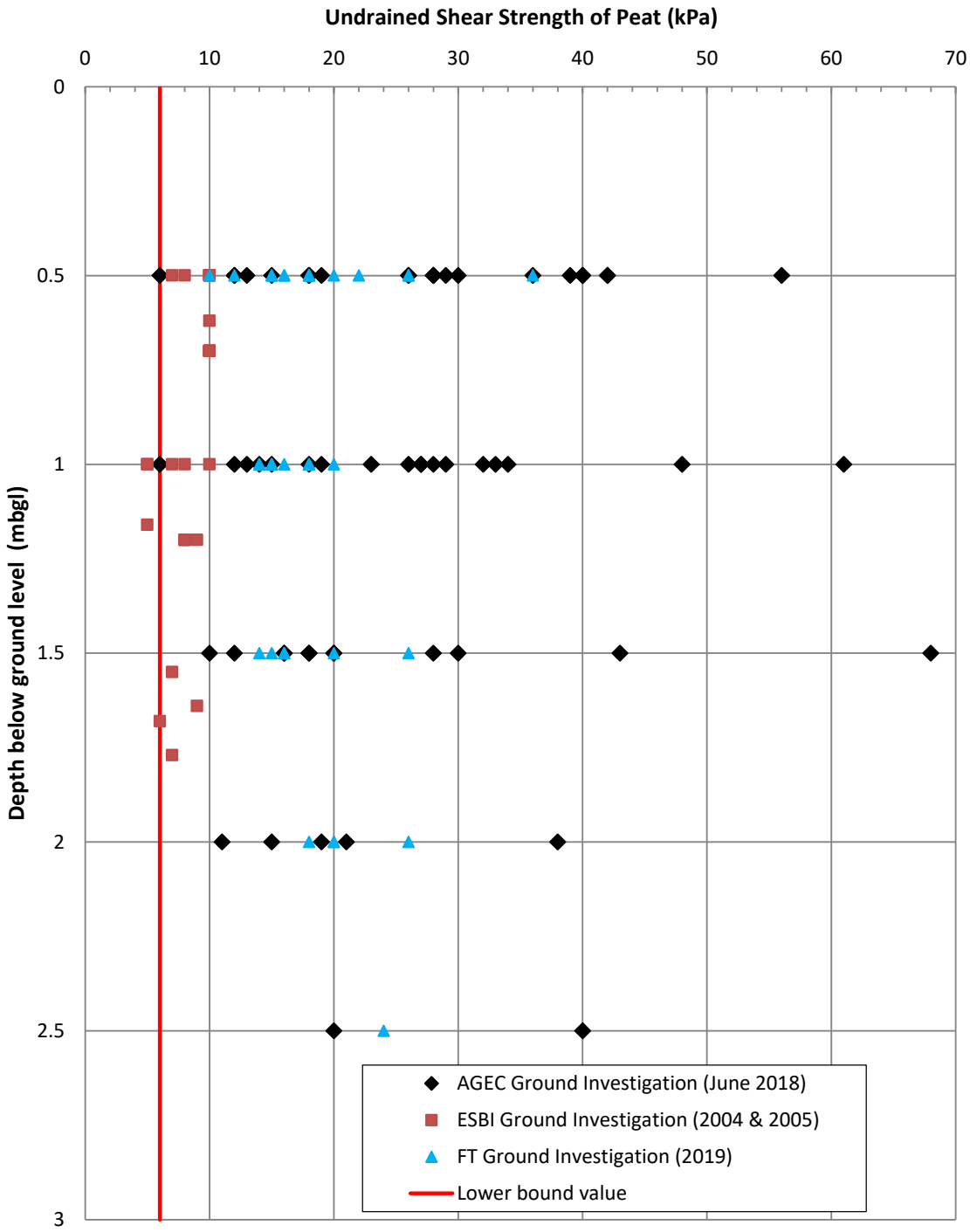


Figure 2 Undrained Shear Strength of Peat along Overhead Line Route

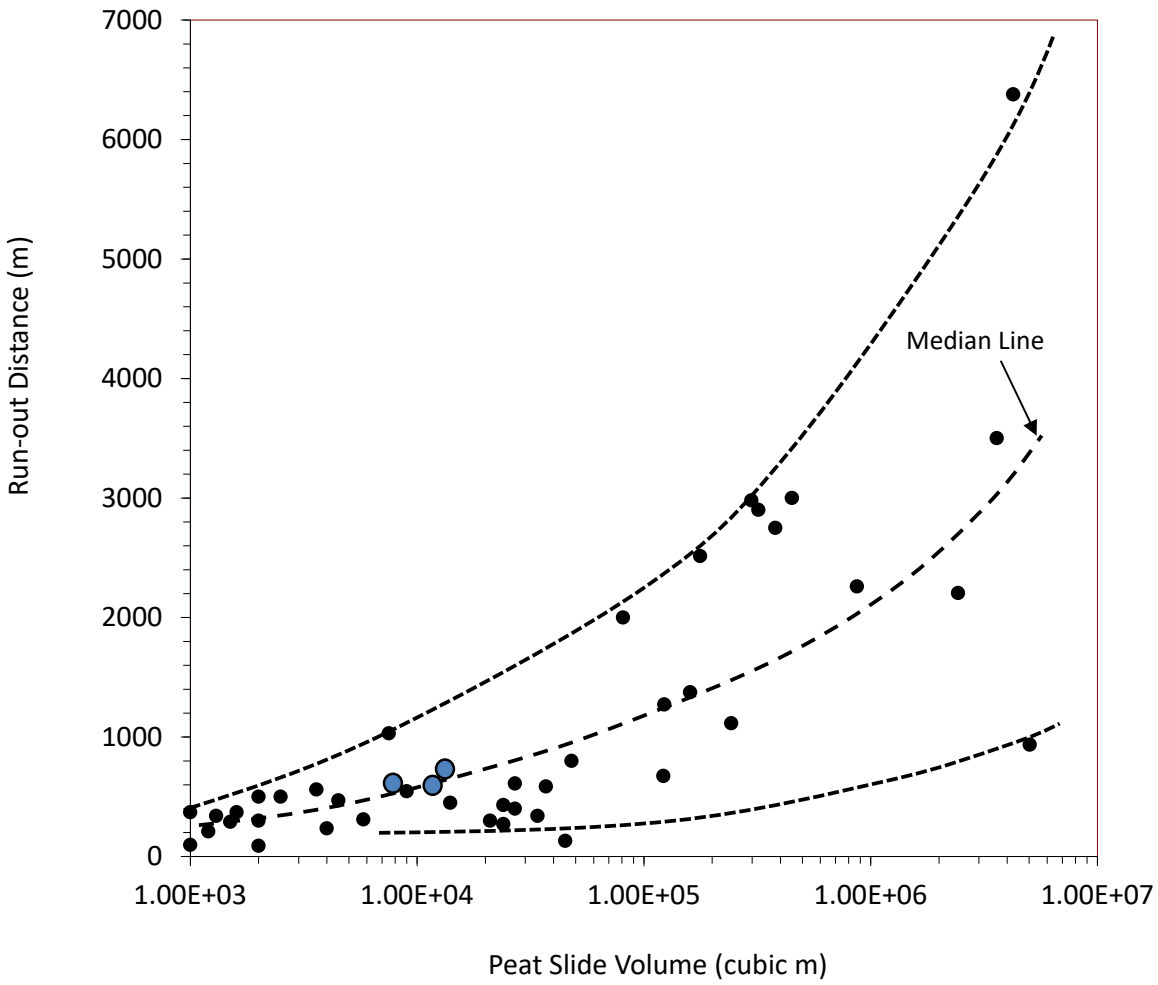
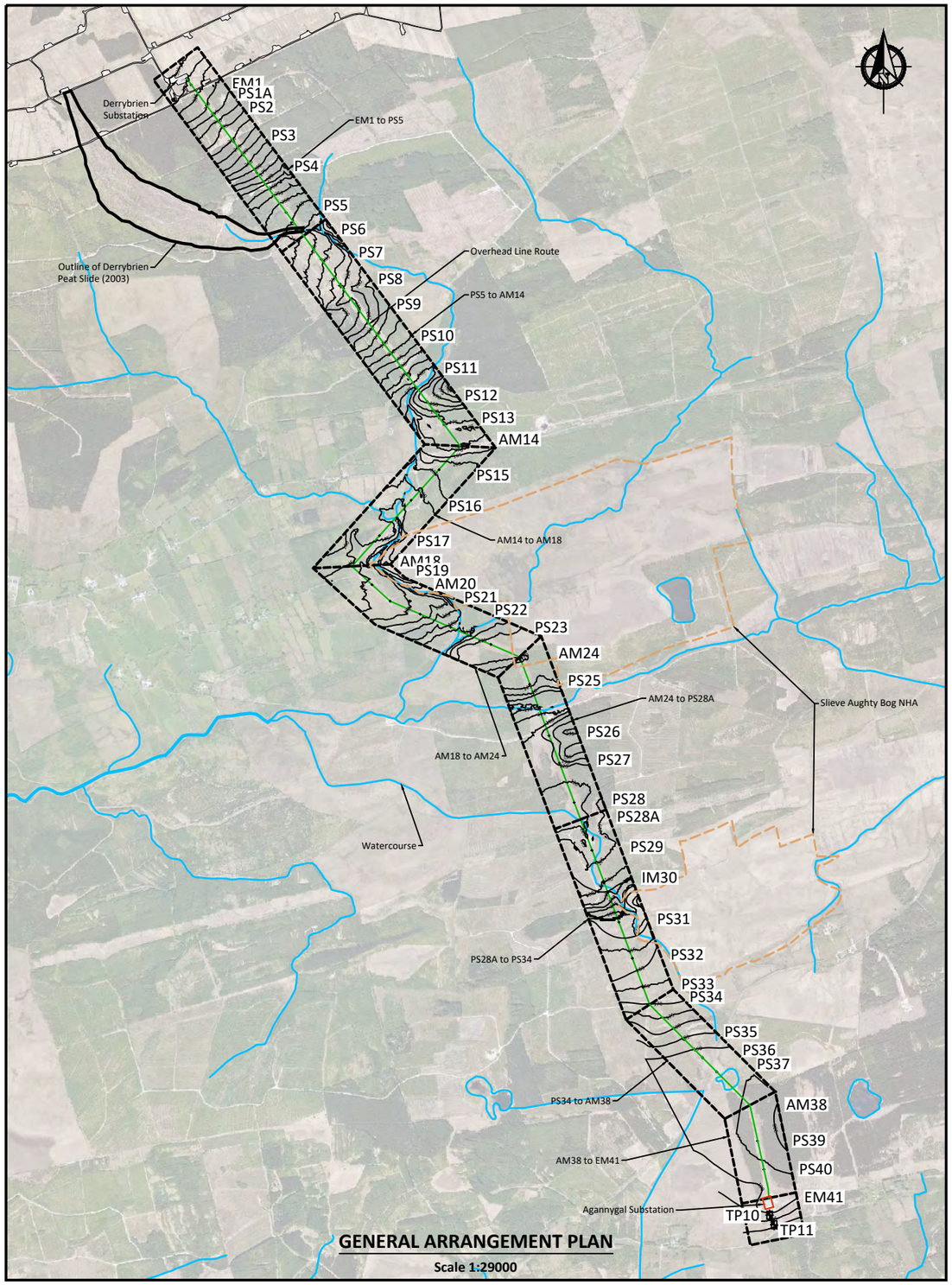


Figure 3 Peat slide volume versus run-out distance

Notes:

(1) Potential future peat slides shown with blue dot.

Drawings



GENERAL ARRANGEMENT PLAN

Scale 1:29000

GI Legend and notes:

AGEC Trial Pit Locations (June 2018)

Background aerial mapping shown taken from the latest available Bing Mapping.

Notes:

1. The OHL route was broken into a number of subsections (including the substation at Agannygal) for assessment. These subsections were chosen based on having comparable topography and peat depth.

0m 145m 290m 435m 580m 725m 870m 1015m 1160m 1305m 1450m

Scale 1:29000

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A	FOR INFORMATION	BDH	23.10.19
B	FOR INFORMATION	BDH	30.03.20
C	FOR INFORMATION	BDH	31.07.20

PROJECT: DERRYBRIEN WIND FARM PROJECT - REIAR

CLIENT: ESB

SHEET: GENERAL ARRANGMENT

Date: 31.07.20

Project number: P2159

Scale (@ A3): 1:29000

Drawn by: POR

Checked by: IH

Drawing Number: P2159-0600-OHL-0001

Rev: C

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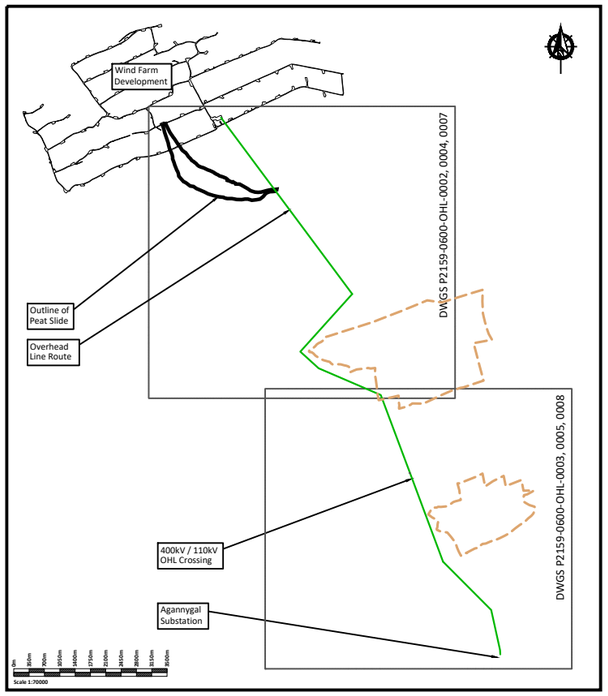
Friday 31 July 2020



KEYPLAN

Scale 1:70000

PEAT DEPTH CORRIDOR PLAN

Scale 1:14000

Legend: Peat Depth (m)

0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.6

Note -

Peat depth corridor was prepared as a 100m wide corridor using a single line of peat depth probes.

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C	FOR INFORMATION	BDH	31.07.20

PROJECT	DERRYBRIEN WIND FARM PROJECT - REIAR
CLIENT	ESB
SHEET	PEAT DEPTH CONTOUR PLAN DRAWING 1 OF 2
Date	31.07.20
Project number	P2159
Scale (@ A3)	1:14000
Drawn by	POR
Checked by	IH
Drawing Number	P2159-0600-OHL-0002
Rev	C

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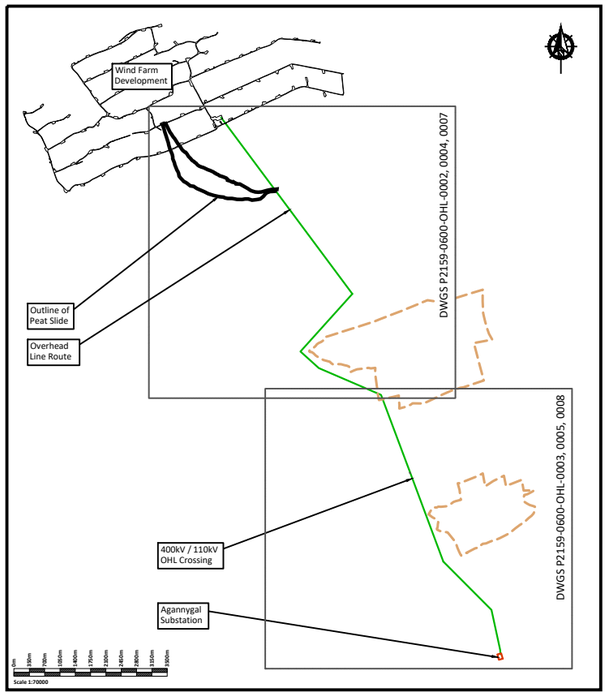

KEYPLAN

Scale 1:70000

Legend: Peat Depth (m)

0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.6

Note -

Peat depth corridor was prepared as a 100m wide corridor using a single line of peat depth probes.

PEAT DEPTH CORRIDOR PLAN

Scale 1:14000

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PROJECT: DERRYBRIEN WIND FARM PROJECT - REIAR	CLIENT: ESB
SHEET: PEAT DEPTH CONTOUR PLAN DRAWING 2 OF 2	Date: 31.07.20 · Project number: P2159 · Scale (@ A3): 1:14000
	Drawn by: POR · Checked by: IH · Drawing Number: P2159-0600-OHL-0003 · Rev: C

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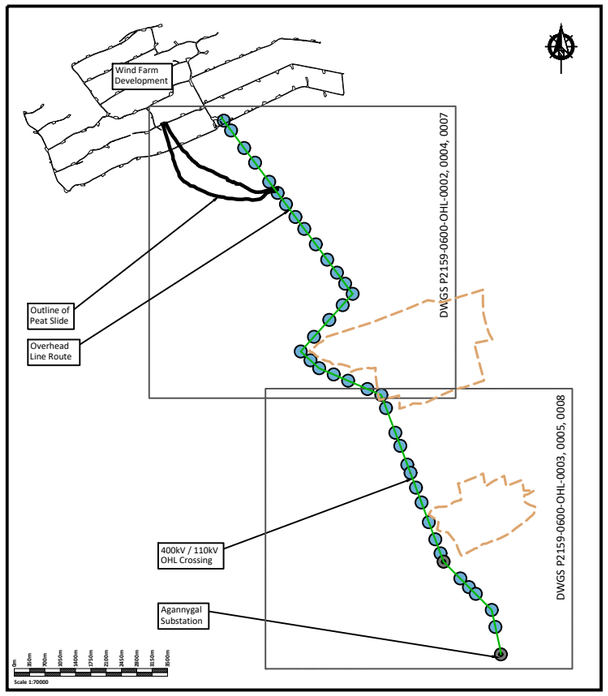

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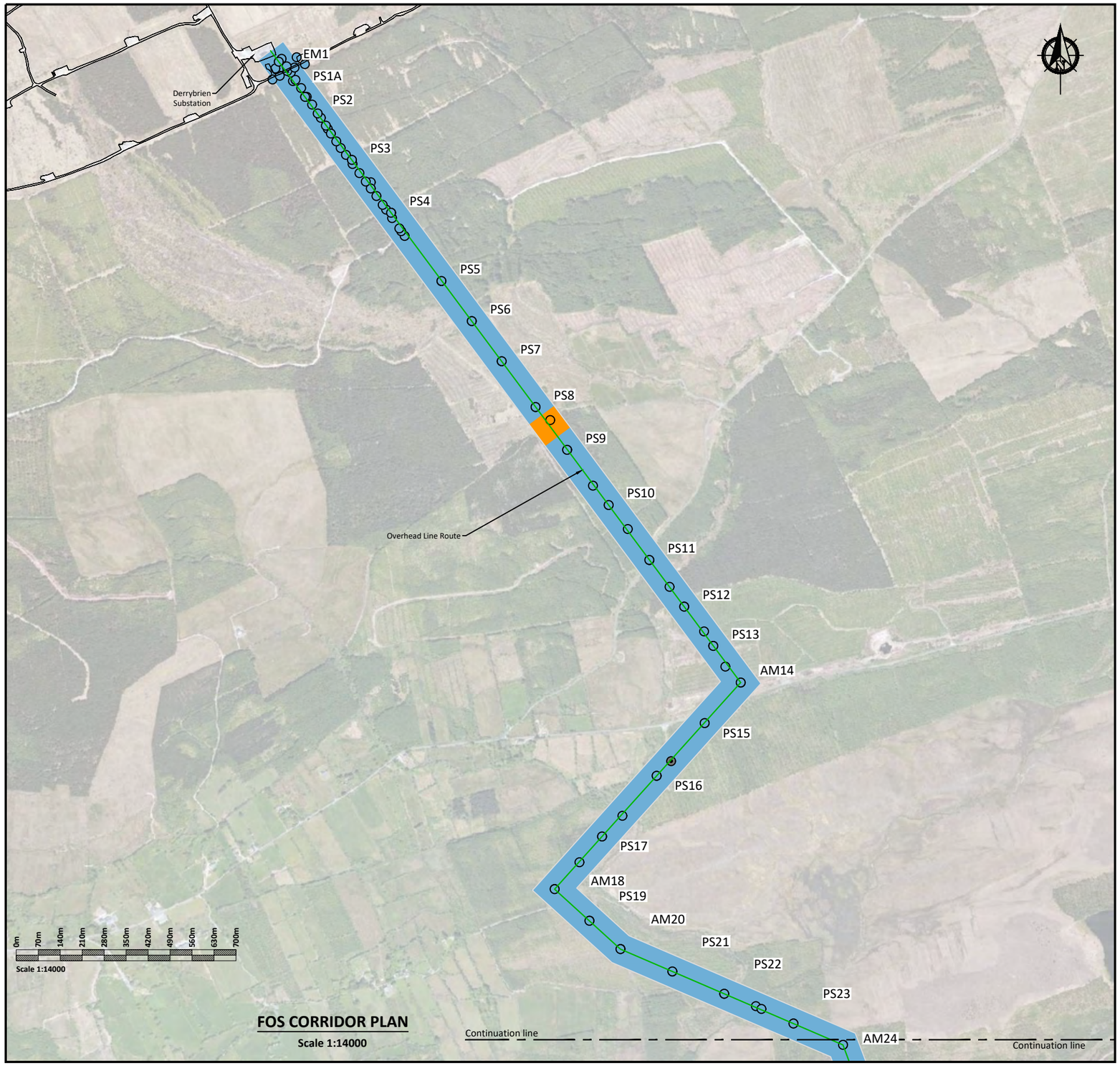

FOS CORRIDOR PLAN

Scale 1:14000

Legend: Factor of Safety

- 1 or less
- 1.01 to 1.3
- 1.31 to 1.4
- Greater than 1.4
- No Peat Recorded at this Location

Increasing Stability

Note -

The results of the undrained analysis for the most critical load condition 2 are shown on this drawing.

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PROJECT: **DERRYBRIEN WIND FARM PROJECT - REIAR**

CLIENT: **ESB**

SHEET: **FACTOR OF SAFETY FOR PEAT SLOPES DRAWING 1 OF 2**

Date: 31.07.20

Project number: P2159

Scale (@ A3): 1:14000

Drawn by: POR

Checked by: IH

Drawing Number: **P2159-0600-OHL-0004**

Rev: **C**

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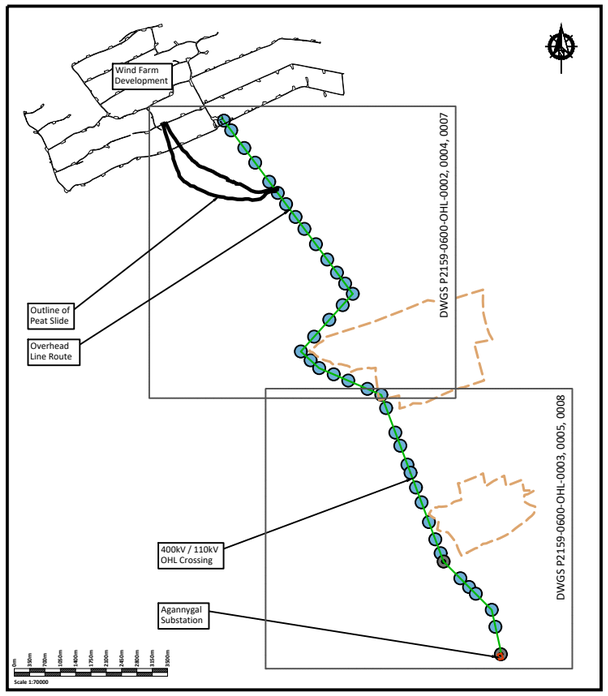

KEYPLAN

Scale 1:70000

Legend: Factor of Safety

- 1 or less
- 1.01 to 1.3
- 1.31 to 1.4
- Greater than 1.4
- No Peat Recorded at this Location

Increasing Stability

Note -

The results of the undrained analysis for the most critical load condition 2 are shown on this drawing.

PEAT DEPTH CORRIDOR PLAN

Scale 1:14000

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PROJECT: DERRYBRIEN WIND FARM PROJECT - REIAR

CLIENT: ESB

SHEET: FACTOR OF SAFETY FOR PEAT SLOPES DRAWING 2 OF 2

Date: 31.07.20 | Project number: P2159 | Scale (@ A3): 1:14000

Drawn by: POR | Drawing Number: P2159-0600-OHL-0005 | Rev: C

Checked by: IH

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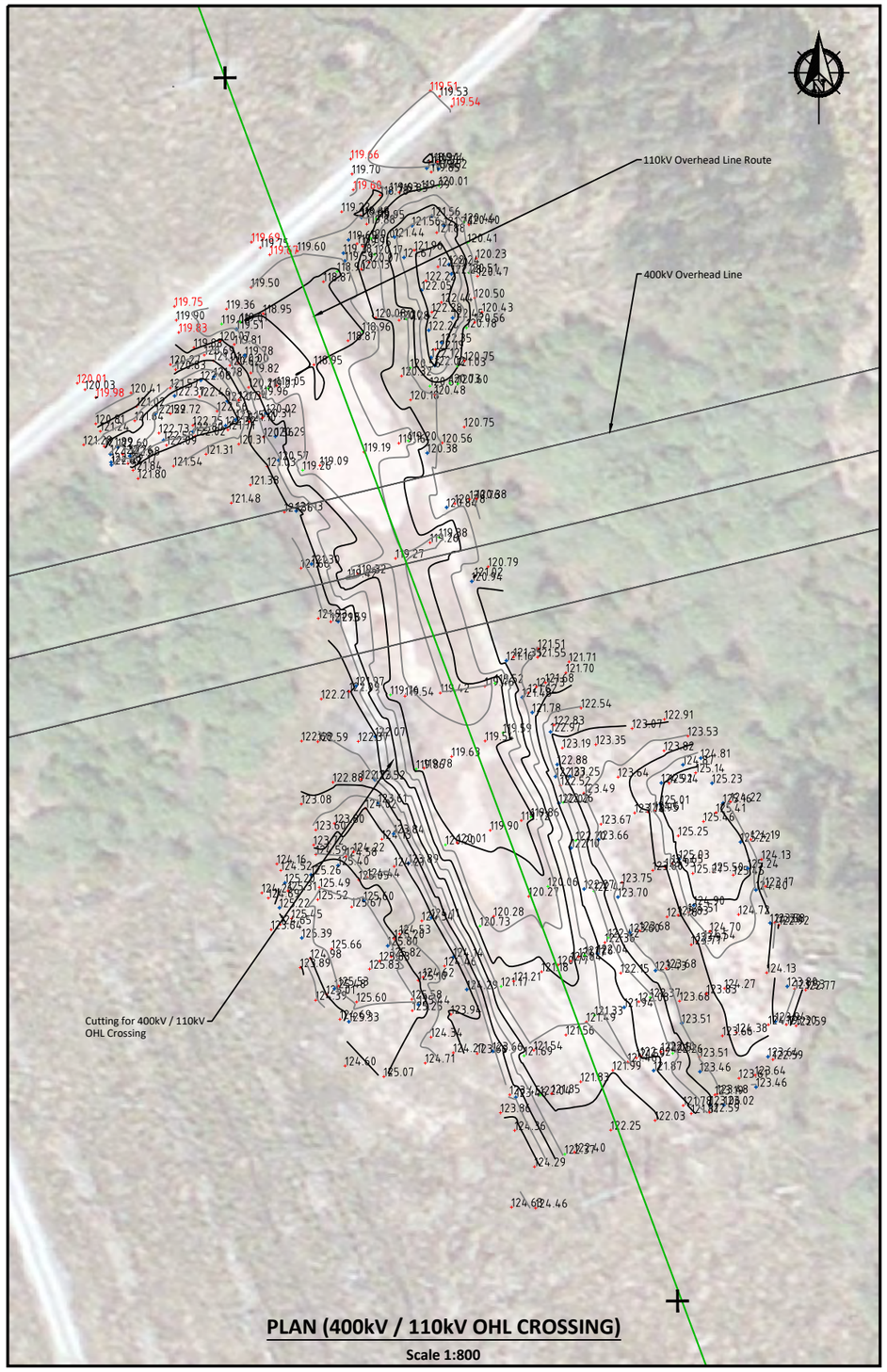
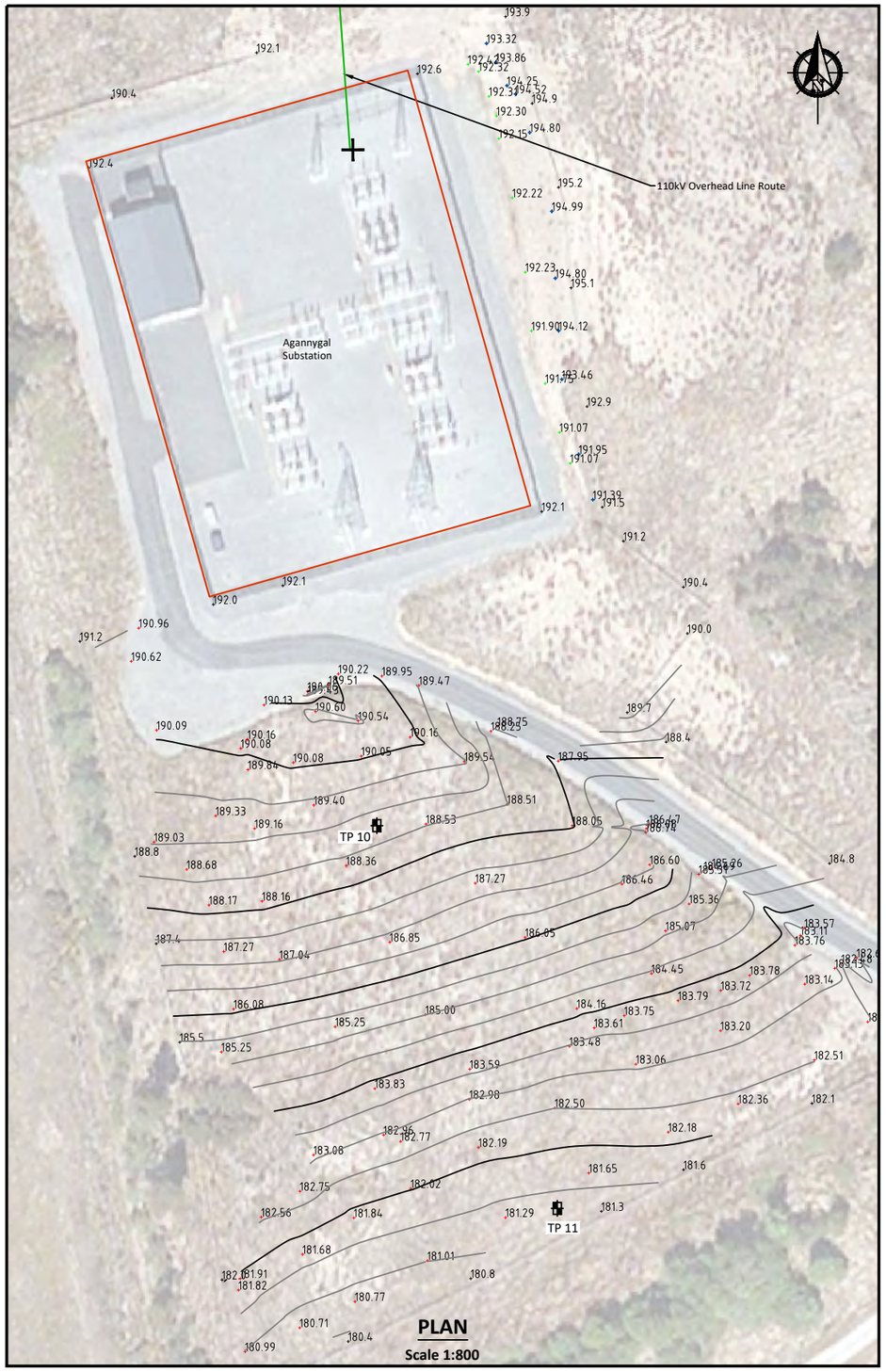


PLAN (400kV / 110kV OHL CROSSING)

Scale 1:800



PLAN

Scale 1:800

GI Legend and notes:

AGEC Trial Pit Locations (June 2018)

Background aerial mapping shown taken from the latest available Bing Mapping.

Notes:

1. Topographical survey information shown on this drawing is based on survey data recorded on site by ESBI in 2018.

0m 4m 8m 12m 16m 20m 24m 28m 32m 36m 40m

Scale 1:800

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C	FOR INFORMATION	BDH	31.07.20

PROJECT: **DERRYBRIEN WIND FARM PROJECT - REIAR**

CLIENT: **ESB**

SHEET: **DETAILS OF 400kV / 100kV CROSSING & AGANNYGAL SUBSTATION**

Date 31.07.20	Project number P2159	Scale (@ A3) 1:800	
Drawn by POR	Drawing Number P2159-0600-OHL-0006		Rev C
Checked by IH			

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Friday 31 July 2020

N

EM1(Derrybrien Station)

PS1a

Derrybrien Substation

PS2

PS3

PS4

PS5

PS6

PS7

PS8

PS9

PS10

PS11

PS12

PS13

AM14

PS15

PS16

PS17

AM18

PS19

AM20

PS21

PS22

PS23

AM24

PS25

Black Road

R353

Point D
E-561084.25
N-702394.884

Point C
E-561040.6337
N-702331.6321

Point A
E-561123.4388
N-702367.5429

Point B
E-561061.14
N-702260.8798

Insert Map

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See Insert Map

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0 0.5 1 1.5 2 km

Legend

Derrybrien - Agannygal 110 kV Overhead Line

Decommissioning Access Routes:

- Decommissioning access route EM1 to PS4
- Decommissioning access route PS12 to PS14
- Decommissioning access route PS15 to PS22
- Alternative Decommissioning access route to PS15 to PS22
- Alternative Decommissioning access route to PS 17 to PS22
- Decommissioning access route PS23 to PS25
- Decommissioning access route PS26 to PS27
- Decommissioning access route PS5 to PS11

Mast type:

- Poleset (PS)
- Angle Mast (AM)
- End Mast (EM)

REV	DATE	REVISION DESCRIPTION	DRN	PROD	VER	APP
0	21/11/2023	Issued for Decommissioning Application	E.O'S	***	***	***

PURPOSE OF ISSUE - PRELIMINARY UNLESS INDICATED

CLIENT APPROVAL ☐ PLANNING ☒ TENDER ☐ CONSTRUCTION ☐ AS-BUILT ☐

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CLIENT: Gort Windfarms Ltd

PRODUCTION UNIT: Civil Environmental & Renewable Engineering

PROJECT: Derrybrien Wind Farm Decommissioning Project

DRAWING TITLE: Figure DMP 01 - Derrybrien - Agannygal OHL - Indicative Decommissioning Access Routes (Sheet 1 of 2)

CONTRACT

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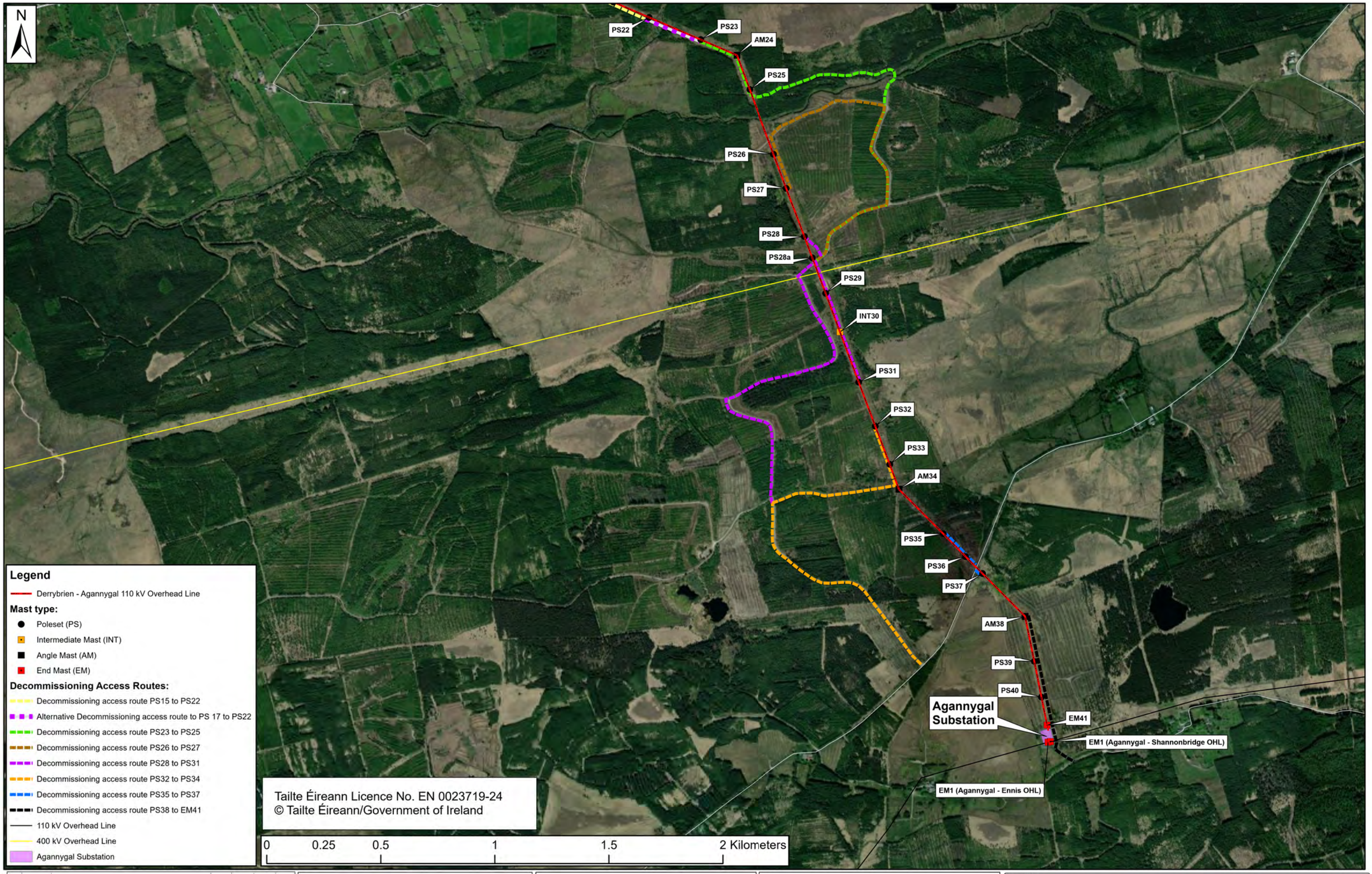
E.O'Shea	**********	*********	*********	21/11/2023

CLIENT REF.	NO. OF SHEETS	SIZE	SCALE
00-00	1/2	A3	1:15,000

DRAWING NUMBER: **DRAFT FOR INFORMATION ONLY**



REV	DATE	REVISION DESCRIPTION	E.O'S	DRN	PROD	VER	APP
0	xx/xx/xx	Issued for Decommissioning Application	E.O'S	XXX	XXX	XXX	

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DRAWING TITLE: Figure DMP 02 - Derrybrien - Agannygal OHL - Indicative Decommissioning Access Routes (Sheet 2 of 2)

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CLIENT REF.	NO. OF SHEETS	SIZE	SCALE
00-00	2/2	A3	1:15,000

DRAWING NUMBER: **DRAFT FOR INFORMATION ONLY**

N

S37

AM38

PS39

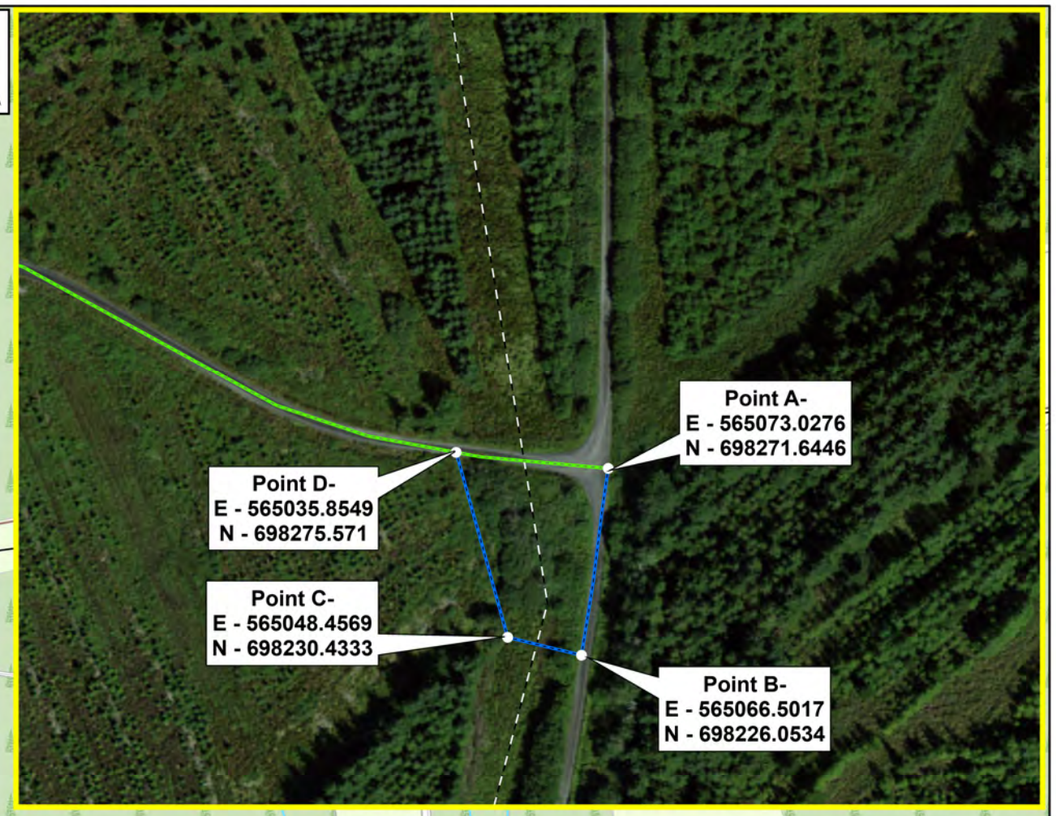
PS40

Agannygal Substation

EM41

EM1 (Agannygal - Shannonbridge OHL)

EM1 (Agannygal - Ennis OHL)



Legend

- Decomissioning Access Route to Substation
- Alternative Decomissioning Access Route to Substation

Mast type:

- Poleset (PS)
- Angle Mast (AM)
- End Mast (EM)
- Derrybrien - Agannygal 110 kV Overhead Line
- 110 kV Overhead Line
- Agannygal Substation

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0 0.13 0.25 0.5 0.75 1 Kilometers

REV	DATE	REVISION DESCRIPTION	DRN	PROD	VER	APP
0	05/05/20	Issued for Decommissioning Application	E.O'S	XXX	XXX	XXX

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PROJECT: Derrybrien Wind Farm Decommissioning Project

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DRAWING TITLE:

Figure DMP 14 - Agannygal Substation - Indicative Decommissioning Access Route

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CLIENT REF.	NO. OF SHEETS	SIZE	SCALE
00-00	1/1	A3	1:8,000

DRAWING NUMBER: **DRAFT FOR INFORMATION ONLY**

Appendix A

Site Photographs from FT Site Walkover (2019)

Photo 1 Typical timber pole set

Photo 2 Typical steel angle mast

Photo 3 Typical forest track access route

Photo 4 Access track to pole sets PS5 to PS10

Photo 5 Remnants of sleepers from felled trees as access

Photo 6 Owendalluleagh River crossing (access to pole sets PS22 to PS25)

Photo 7 Shallow cutting in exposed mineral soil as access to pole set PS22

Photo 8 Cutting at 400 kV crossing looking south (400 kV line runs left to right in image)

Photo 9 Cutting at 400 kV crossing looking north (400 kV line runs left to right in image)

Photo 10 View of area between pole set PS37 and angle mast AM38 looking north showing Lough Agannygal

Photo 11 View of area between pole set PS37 and angle mast AM38 looking south showing Lough Agannygal (mast 38 in background)

Photo 12 Cutting in mineral soil at Agannygal substation

Appendix B

AGEC Ground Investigation (2018) – Relevant Trial Pit Logs

Trial Pit Log

agec geotechnical engineering consultants

Trialpit No **TP10** Sheet 1 of 1

Project Name: Derrybrien Wind Farm	Project No. 1806	Co-ords: 163168.00 - 198491.00 Level: 0.00	Date 19/06/2018
Location: Co. Galway		Dimensions (m): 3 × 1.3, Depth 2.90	Scale 1:25
Client: ESBI			Logged M.L.

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							Soft to firm light orange grey, brown, grey, slightly gravelly slightly sandy CLAY with some cobbles and occasional boulders, (Sub-angular to sub-rounded), and some wood, pockets of peat etc. (Made ground.)
				0.60	-0.60		Soft woody brown fibrous PEAT with branches, brash and vegetation. (Possible made ground or disturbed ground.)
				1.00	-1.00		Soft greyish brown slightly gravelly sandy organic CLAY and clayey organic SAND with decaying rootlets and some cobbles and occasional boulders. (up to 1.0m) (Sub-angular to sub-rounded)
				1.50	-1.50		Firm becoming stiff to very stiff light reddish brown sandy very gravelly SILT/CLAY with many cobbles and some boulders. (Sub-rounded to sub-angular)
				2.00	-2.00		Stiff to very stiff light reddish brown sandy very gravelly (weak siltstone) SILT/CLAY with many cobbles and some boulders. (Sub-rounded to sub-angular)
				2.90	-2.90		End of pit at 2.90 m

1 2 3 4 5

Remarks: TP - DRY.
End of TP - Hard digging.

Stability: Generally stable, minor spalling.

Trial Pit Log

agec geotechnical engineering consultants

Trialpit No **TP11** Sheet 1 of 1

Project Name: Derrybrien Wind Farm	Project No. 1806	Co-ords: 163193.00 - 198438.00 Level: 0.00	Date 19/06/2018
Location: Co. Galway		Dimensions (m): 3 × 1.5 Depth 2.50	Scale 1:25
Client: ESBI			Logged M.L.

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							Soft to firm light orange grey, reddish brown, brown, grey slightly gravelly slightly sandy CLAY with some cobbles and occasional boulders, (Sub-angular to sub-rounded), and some wood, pockets of peat etc. (Made ground.)
				0.60	-0.60		Disturbed peaty layer - discontinuous.
				0.70	-0.70		Soft grey and orange brown slightly gravelly sandy organic CLAY and clayey organic SAND with decaying rootlets and some cobbles and occasional large boulders. (Sub-angular to sub-rounded)
				1.70	-1.70		Stiff to very stiff light reddish brown sandy very gravelly SILT/CLAY with many cobbles and some boulders. (Sub-rounded to sub-angular)
				2.50	-2.50		End of pit at 2.50 m

1 2 3 4 5

Remarks: No water strike - dry.
End of TP - Hard digging.

Stability: Generally stable, minor spalling.

Appendix C

Methodology for Peat Stability Risk Assessment

Methodology for Peat Stability Risk Assessment

A peat stability risk assessment was carried out for the OHL route between the Derrybrien substation and Agannygal substation. This approach takes into account guidelines for geotechnical/peat stability risk assessments as given in PLHRAG (2017) and MacCulloch (2005). The degree of risk is determined as a Risk Rating (R), which is the product of probability (P) and impact (I). How these factors are determined and applied in the analysis is described below.

The main approaches for assessing peat stability include the following:

(a) Geomorphological
(b) Qualitative (judgement)
(c) Index/Probabilistic (probability)
(d) Deterministic (factor of safety)

Approaches (a) to (c) listed above would be considered subjective and do not provide a definitive indication of stability; in addition, a high level of judgement/experience is required which makes it difficult to relate the findings to real conditions. FT apply a more objective approach, the deterministic approach, in combination with qualitative factors.

Probability

The likelihood of a peat slide occurring is been assessed based on the results of both the quantitative results of stability calculations (deterministic approach using factors of safety) and the assessment of the severity of several qualitative factors which cannot be reasonably included in a stability calculation but nevertheless may affect the occurrence of peat instability.

The qualitative factors used in the risk assessment are outlined in Table A and have been compiled based on FT's experience of assessments and construction in peat land sites and peat slides throughout Ireland and the UK.

Table A Qualitative Factors used to Assess Potential for Peat Failure

Qualitative Factor	Type of Feature / Indicator for each Qualitative Factor (1)	Explanation / Description of Qualitative Factor
Evidence of sub peat water flow	No	Based on site walkover observations. Sub peat water flow generally occurs in the form of natural piping at the base of peat. Where there is a constriction or blockage in natural pipes a build-up of water can occur at the base of the peat causing a reduction in effective stress at the base of the peat resulting in failure; this is particularly critical during periods of intense rainfall.
	Possibly	
	Probably	
	Yes	
Evidence of surface water flow	Dry	Based on site walkover observations. The presence of surface water flow indicates if peat in an area is well drained or saturated and if any additional loading
	Localised/Flowing in drains	

Qualitative Factor	Type of Feature / Indicator for each Qualitative Factor [1]	Explanation / Description of Qualitative Factor
	Ponded in drains	from the ponding of surface water onto the peat is likely.
	Springs/surface water	
Evidence of previous failures/slips	No	Based on site walkover observations. The presence of clustering of relict failures may indicate that particular pre-existing site conditions predispose a site to failure.
	In general area	
	On site	
	Within 500m of location	
Type of vegetation	Grass/Crops	Based on site walkover observations. The type of vegetation present indicates if peat in an area is well drained, saturated, etc. Vegetation that indicates wetter ground may also indicate softer underlying peat deposits.
	Improved Grass/Dry Heather	
	Wet Grassland/Juncus (Rushes)	
	Wetlands Sphagnum (Peat moss)	
General slope characteristics upslope/downslope from infrastructure location	Concave	Based on site walkover observations. Slope morphology in the area of the infrastructure location is an important factor. A number of recorded peat failures have occurred in close proximity to a convex break in slope.
	Planar to concave	
	Planar to convex	
	Convex	
Evidence of very soft/soft clay at base of peat	No	Based on inspection of exposures in general area from site walkover. Several reported peat failures identify the presence of a weak layer at the base of the peat along which shear failure has occurred.
	Yes	
Evidence of mechanically cut peat	No	Based on site walkover observations. Mechanically cut peat typically cut using a 'sausage' machine to extract peat for harvesting. Areas which have been cut in this manner have been linked to peat instability. The mechanical cuts can notably reduce the intrinsic strength of the peat and also allow ingress of rainfall/surface water.
	Yes	

Qualitative Factor	Type of Feature / Indicator for each Qualitative Factor (1)	Explanation / Description of Qualitative Factor
Evidence of quaking or buoyant peat	No	Based on site walkover observations. Quaking/buoyant peat is indicative of highly saturated peat, which would generally be considered to have a low strength. Quaking peat is a feature on sites that have been previously linked with peat instability.
	Yes	
Evidence of bog pools	No	Based on site walkover observations. Bog pools are generally an indicator of areas of weak, saturated peat. Commonly where there are open areas of water within peat these can be interconnected, with the result that there may be sub-surface bodies of water. The presence of bog pools have been previously linked with peat instability.
	Yes	
Other	Varies	In addition to the above features/ indicators and based on site recordings the following are some of the features which may be identified: Excessively deep peat, weak peat, overly steep slope angles, etc.

Note (1) The list of features/indicators for each qualitative factor are given in an approximate increasing order of probability of leading to peat instability/failure.

It should be noted that the presence of one of the qualitative factors alone from Table A is unlikely to lead to peat instability. Peat instability at a site is generally the combination of a number of these factors occurring at the same time at a particular location.

The probability rating assigned to the quantitative and qualitative factors is judged on a 5-point scale from 1 (indicating negligible or no probability of failure) to 5 (indicating a very likely failure), as outlined in Table B. Not applicable occurs where it is not physically possible for failure to occur, for example where no peat is present.

Table B Probability Scale

Scale	Factor of Safety	Probability of Failure
0	Not applicable	Not applicable
1	1.30 or greater	Negligible
2	1.29 to 1.20	Low
3	1.19 to 1.11	Possible
4	1.01 to 1.10	Very Possible
5	≤1.0	Likely

Scale	Likelihood of Qualitative Factor leading to Peat Failure	Probability of Failure
0	Not applicable	Least
1	Negligible	
2	Low	
3	Possible	
4	very Possible	
5	Likely	Greatest

Impact

The severity of the risk is also assessed qualitatively in terms of impact. The impact of a peat slide on the receiving environment within and beyond the overhead line route is assessed based on the potential travel distance and potential volume of a peat slide and the effect on receptors such as local property, infrastructure, and the natural environment.

Where a peat slide enters a watercourse it can travel a considerable distance downstream. Therefore, the proximity of a potential peat slide to a drainage feature is a significant indicator of the likely potential impact. Furthermore, given the elevation of the terrain along the OHL route, the topography in some areas may result in the formation of potential flow paths through naturally occurring features such as dips and falls in the terrain, valleys, etc. Such features would have the effect of increasing the travel distance of and the areas affected by any potential peat slide .

The potential damage to private property is also assessed using this approach. The OHL is located in a sparsely populated location; however, land owners and domestic dwellings may still be at risk in certain areas if a peat slide were to occur. In addition, property such as pasture and tillage farms, private landholdings, and communication/power infrastructure can be susceptible to peat slide. The list of such potential features or receptors identified are outlined in Table C.

Table C Potential Receptors

Receptor	Control
Watercourse (rivers, streams, flow channels, etc.)	Topography
Dwellings (domestic)	
Road (local roads excluding wind farm access tracks)	
Infrastructure (overhead lines, communications infrastructure, etc.)	
Agricultural Land (pasture, etc.)	
Natural Heritage Area (Slieve Aughty Bog NHA)	

Taking the above into consideration, the primary controlling aspect when determining the impact of a potential peat slide, once that slide has occurred, is the topography along the route. For the purposes of this report, the route has been divided into 9 no. subsections for ease of assessment and risk identification.

Topographical data for each subsection has been used to identify the potential flow path(s) in a peat slide situation and as such will be used for determining the severity of the impact. The risk is determined based on the combination of hazard and impact. A 5-point qualitative scale has been devised for the impact of the hazard based on the distance of a potential peat slide arising from works on or near the OHL subsection to a receptor and this is shown in Table D.

Table D Impact Scale

Scale	Criteria	Impact
1	OHL element without potential to effect watercourses, dwellings, infrastructure elements, etc.	Negligible
2	OHL element with low potential to effect watercourses, dwellings, infrastructure elements, etc.	Low
3	OHL element with medium potential to effect watercourses, dwellings, infrastructure elements, etc.	Medium
4	OHL element with high potential to effect watercourses, dwellings, infrastructure elements, etc.	High
5	OHL element with extremely high potential to effect watercourses, dwellings, infrastructure elements, etc.	Extremely High

Each subsection of the route is assigned an impact rating based on a qualitative assessment taking into account the topography and the distance between the OHL route and the receptor and any aggravating or mitigating factors observed during the walkover survey. The location of potential flow paths, watercourses, dwellings, infrastructure, and other such receptors and features are based on topographic maps, aerial imagery, and site observations made during the walkover survey. Note that not all features are shown on maps.

Risk Rating

The degree of risk is determined as the product of probability (P) and impact (I), which gives the Risk Rating (R) as follows:

$$R = P \times I$$

Due to the 5-point scales used to assess Probability and Impact; the Risk Rating can range from 1 to 25 as shown in Table E.

Table E Qualitative Risk Rating

Impact \ Probability	**1**	**2**	**3**	**4**	**5**
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5

Risk Rating & Control Measures	
17 to 25	High: avoid working in area or significant control measures required
11 to 16	Medium: specific control measures required
5 to 10	Low: only routine control measures required
1 to 4	Negligible: none or only routine control measures required

The risk rating is calculated individually for each contributory factor. Control measures are required to reduce the risk to at least a 'Low' risk rating for every individual contributory factor. The control measures in response to the qualitative risk ratings are included in the peat stability risk registers for each OHL subsection in Appendix D. The control measures are targeted at the specific contributory factors that give the highest risk rating.

The risk rating assigned to any subsection is based on the highest risk rating calculated for any contributory factor within that subsection.

Note that some geotechnical interpretation of the results is required as it is the combination of individual contributory factors that are important in determining the risk of a peat slide. For example, in certain sections deep peat may be present that would be given a high risk rating but where the section is on level ground then the risk of a peat slide is not significant.

Appendix D

Results of Peat Stability Risk Assessment

Derrybrien Wind Farm (OHL) - Peat Stability Risk Register (Rev 1)

Location:	**EM1 to PS5**

Start of Subsection (Easting, Northing):	**559935**	**704743**
End of Subsection (Easting, Northing):	**560480**	**704010**
Worst Case Receptor(s):	**Watercourse**	
Potential Impact on Receptor (Note 4):	**High**	
Peat Depth Range (m):	**1.0 to 2.4**	
Control Required:	**Yes**	

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory/Qualitative Factors to Potential Peat Failure	Prob (Note 5)	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during decommissioning	Prob	Impact	Risk	Risk Rating
1	FOS (worst case) = 2.75(u), 1.83(d)	1	4	4	Negligible	No	See Below	1	4	4	Negligible
2	Evidence of sub peat water flow	0	4	0	Not Applicable	No		0	4	0	Not Applicable
3	Evidence of surface water flow	1	4	4	Negligible	No		1	4	4	Negligible
4	Evidence of previous failures/slips	0	4	0	Not Applicable	No		0	4	0	Not Applicable
5	Type of vegetation	2	4	8	Low	Yes		1	4	4	Negligible
6	General slope characteristics upslope/downslope across section	2	4	8	Low	Yes		1	4	4	Negligible
7	Evidence of very soft/soft clay at base of peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
8	Evidence of mechanically cut peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
9	Evidence of quaking or buoyant peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
10	Evidence of bog pools	0	4	0	Not Applicable	No		0	4	0	Not Applicable
11	Low peat strength (<10kPa)	2	4	8	Low	Yes		1	4	4	Negligible
12	Relatively deep peat	2	4	8	Low	Yes		1	4	4	Negligible

	Control Measures to be Implemented during Decommissioning for **EM1 to PS5**
i	Due to relatively deep peat in the section, this will require additional measures such as : - access the working area from the north only, alternative access to the south of pole set 4. Refer to Drawing no. 0007& 0008 Plan Drawing for Decommissioning of Overhead line - use of suitable low load bearing track machinery to gain access to works area - use of suitable plant and equipment for completion of works - routine detailed inspection of area, while works are being carried out - monitoring (in the form of timber stakes as sightlines) to be installed in working areas and monitored regularly during the works - contractor to provide method statement for any proposed works in areas of peat/sloping ground/overhead power lines etc
ii	Maintain hydrology of area as far as possible;
iii	Use of experienced contractors and trained operators to carry out the work;
iv	Use of experienced geotechnical staff for site supervision.

Note Ref

(1) Location M1 to PS5 is an abbreviation for Mast 1 to Pole Set 5
(2) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.
(3) Slope characteristics are typically 6-8 degrees across the section. Locally steep between pole set 4 and 5, up to 17 degree inclination recorded
(4) Impact based on OHL route crossing a watercourse with a PS within 100m upslope of the watercourse.
(5) Probability assessed as per Table A and B of Appendix C

Derrybrien Wind Farm (OHL) - Peat Stability Risk Register (Rev 1)

Location:	**PS5 to AM14**

Start of Subsection (Easting, Northing):	**560480**	**704010**
End of Subsection (Easting, Northing):	**564133**	**702732**
Worst Case Receptor(s):	**Road**	
Potential Impact on Receptor (Note 4):	**High**	
Peat Depth Range (m):	**0.0 to 1.9**	
Control Required:	**Yes**	

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory/Qualitative Factors to Potential Peat Failure	Prob (Note 5)	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during decommissioning	Prob	Impact	Risk	Risk Rating
1	FOS (worst case) = 1.21(u), 1.23(d)	2	4	8	Low	Yes	See Below	1	4	4	Negligible
2	Evidence of sub peat water flow	0	4	0	Not Applicable	No		0	4	0	Not Applicable
3	Evidence of surface water flow	1	4	4	Negligible	No		1	4	4	Negligible
4	Evidence of previous failures/slips	2	4	8	Low	Yes		1	4	4	Negligible
5	Type of vegetation	3	4	12	Medium	Yes		1	4	4	Negligible
6	General slope characteristics upslope/downslope across section	4	4	16	Medium	Yes		1	4	4	Negligible
7	Evidence of very soft/soft clay at base of peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
8	Evidence of mechanically cut peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
9	Evidence of quaking or buoyant peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
10	Evidence of bog pools	0	4	0	Not Applicable	No		0	4	0	Not Applicable
11	Low peat strength (<10kPa)	0	4	0	Not Applicable	No		0	4	0	Not Applicable
12	Relatively deep peat	2	4	8	Low	Yes		1	4	4	Negligible

	Control Measures to be Implemented during Decommissioning for **PS5 to AM14**
i	Due to relatively deep peat in the section, this will require additional measures such as : - Refer to Drawing no. 0007 & 0008 Plan Drawing for Decommissioning of Overhead Line for suitable access routes - use of suitable low load bearing track machinery to gain access to works area - use of suitable plant and equipment for completion of works - routine detailed inspection of area, while works are being carried out - contractor to provide method statement for any proposed works in areas of peat/sloping ground/overhead power lines etc
ii	Maintain hydrology of area as far as possible;
iii	Use of experienced contractors and trained operators to carry out the work;
iv	Use of experienced geotechnical staff for site supervision.

Note

(1) Location PS5 to AM14 is an abbreviation for Pole Set 5 to Angle Mast 14
(2) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.
(3) Slope characteristics are typically 10 degrees across the section. Locally steep around pole set 12 and barrage 2, up to 20 degree inclination recorded
(4) Impact based on presence of road crossing OHL route within 100m downslope of a PS.
(5) Probability assessed as per Table A and B of Appendix C

Derrybrien Wind Farm (OHL) - Peat Stability Risk Register (Rev 1)

Location:	AM14 to AM18

Start of Subsection (Easting, Northing):	**564133**	**702732**
End of Subsection (Easting, Northing):	**560840**	**702074**
Worst Case Receptor(s):	**Watercourse**	
Potential Impact on Receptor (Note 3):	**High**	
Peat Depth Range (m):	**0.2 to 0.6**	
Control Required:	**No**	

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory/Qualitative Factors to Potential Peat Failure	Prob (Note 4)	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during decommissioning	Prob	Impact	Risk	Risk Rating
1	FOS (worst case) = 5.39(u), 7.76(d)	1	4	4	Negligible	No	See Below	1	4	4	Negligible
2	Evidence of sub peat water flow	0	4	0	Not Applicable	No		0	4	0	Not Applicable
3	Evidence of surface water flow	0	4	0	Not Applicable	No		0	4	0	Not Applicable
4	Evidence of previous failures/slips	0	4	0	Not Applicable	No		0	4	0	Not Applicable
5	Type of vegetation	1	4	4	Negligible	No		1	4	4	Negligible
6	General slope characteristics upslope/downslope across section	1	4	4	Negligible	No		1	4	4	Negligible
7	Evidence of very soft/soft clay at base of peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
8	Evidence of mechanically cut peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
9	Evidence of quaking or buoyant peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
10	Evidence of bog pools	0	4	0	Not Applicable	No		0	4	0	Not Applicable
11	Low peat strength (<10kPa)	0	4	0	Not Applicable	No		0	4	0	Not Applicable
12	Other	0	4	0	Not Applicable	No		0	4	0	Not Applicable

	Control Measures to be Implemented during Decommissioning for **AM14 to AM18**
i	Although specific control measures are not required in the area, good practice should be followed, such as; - Refer to Drawing no. 0007 & 0008 Plan Drawing for Decommissioning of Overhead Line for suitable access routes - use of suitable low load bearing track machinery to gain access to works area - use of suitable plant and equipment for completion of works - routine detailed inspection of area, while works are being carried out - contractor to provide method statement for any proposed works in areas of peat/sloping ground/overhead power lines etc
ii	Maintain hydrology of area as far as possible;
iii	Use of experienced contractors and trained operators to carry out the work;
iv	Use of experienced geotechnical staff for site supervision.

Note
(1) Location AM14 to AM18 is an abbreviation for Angle Mast 14 to Angle Mast 18
(2) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.
(3) Impact based on OHL route crossing a watercourse with a PS within 100m upslope of the watercourse.
(4) Probability assessed as per Table A and B of Appendix C

Derrybrien Wind Farm (OHL) - Peat Stability Risk Register (Rev 1)

Location:	**AM18 to AM24**

Start of Subsection (Easting, Northing):	**560840**	**702074**
End of Subsection (Easting, Northing):	**561759**	**701578**
Worst Case Receptor(s):	**Watercourse**	
Potential Impact on Receptor (Note 4):	**High**	
Peat Depth Range (m):	**0.2 to 0.8**	
Control Required:	**No**	

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory/Qualitative Factors to Potential Peat Failure	Prob (Note 5)	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during decommissioning	Prob	Impact	Risk	Risk Rating
1	FOS (worst case)= 1.85(u), 2.57(d)	1	4	4	Negligible	No	See Below	1	4	4	Negligible
2	Evidence of sub peat water flow	0	4	0	Not Applicable	No		0	4	0	Not Applicable
3	Evidence of surface water flow	2	4	8	Low	Yes		1	4	4	Negligible
4	Evidence of previous failures/slips	0	4	0	Not Applicable	No		0	4	0	Not Applicable
5	Type of vegetation	3	4	12	Medium	Yes		1	4	4	Negligible
6	General slope characteristics upslope/downslope across section	3	4	12	Medium	Yes		1	4	4	Negligible
7	Evidence of very soft/soft clay at base of peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
8	Evidence of mechanically cut peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
9	Evidence of quaking or buoyant peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
10	Evidence of bog pools	0	4	0	Not Applicable	No		0	4	0	Not Applicable
11	Low peat strength (<10kPa)	0	4	0	Not Applicable	No		0	4	0	Not Applicable
12	Other	0	4	0	Not Applicable	No		0	4	0	Not Applicable

	Control Measures to be Implemented during Decommissioning for **AM18 to AM24**
i	Although specific control measures are not required in the area, good practice should be followed, such as; - Refer to Drawing no. 0007 & 0008 Plan Drawing for Decommissioning of Overhead Line for suitable access routes - use of suitable low load bearing track machinery to gain access to works area - use of suitable plant and equipment for completion of works - routine detailed inspection of area, while works are being carried out - contractor to provide method statement for any proposed works in areas of peat/sloping ground/overhead power lines etc
ii	Maintain hydrology of area as far as possible;
iii	Use of experienced contractors and trained operators to carry out the work;
iv	Use of experienced geotechnical staff for site supervision.

Note

(1) Location AM18 to AM24 is an abbreviation for Angle Mast 18 to Angle Mast 24
(2) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.
(3) Slope characteristics are typically 3-4 degrees across the section. Locally steep between pole set 22 and 23, up to 15 degree inclination recorded
(4) Impact based on OHL route crossing a watercourse with a PS within 100m upslope of the watercourse.
(5) Probability assessed as per Table A and B of Appendix C

Derrybrien Wind Farm (OHL) - Peat Stability Risk Register (Rev 1)

Location:	AM24 to PS28A

Start of Subsection (Easting, Northing):	561759	701578
End of Subsection (Easting, Northing):	562092	700690
Worst Case Receptor(s):	Watercourse	
Potential Impact on Receptor (Note 6):	High	
Peat Depth Range (m):	0.1 to 3.8	
Control Required:	Yes	

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory/Qualitative Factors to Potential Peat Failure	Prob (Note 7)	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during decommissioning	Prob	Impact	Risk	Risk Rating
1	FOS (worst case) = 1.09(u), 2.60(d)	4	4	16	Medium	Yes	See Below	1	4	4	Negligible
2	Evidence of sub peat water flow	0	4	0	Not Applicable	No		0	4	0	Not Applicable
3	Evidence of surface water flow	2	4	8	Low	Yes		1	4	4	Negligible
4	Evidence of previous failures/slips	0	4	0	Not Applicable	No		0	4	0	Not Applicable
5	Type of vegetation	2	4	8	Low	Yes		1	4	4	Negligible
6	General slope characteristics upslope/downslope across section	4	4	16	Medium	Yes		2	4	8	Low
7	Evidence of very soft/soft clay at base of peat	2	4	8	Low	Yes		1	4	4	Negligible
8	Evidence of mechanically cut peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
9	Evidence of quaking or buoyant peat	1	4	4	Negligible	No		1	4	4	Negligible
10	Evidence of bog pools	1	4	4	Negligible	No		1	4	4	Negligible
11	Low peat strength (<10kPa)	0	4	0	Not Applicable	No		0	4	0	Not Applicable
12	Relatively deep peat	3	4	12	Medium	Yes		1	4	4	Negligible

	Control Measures to be Implemented Prior to/and During Construction for **AM24 to PS28A**
i	Due to the depth of peat in the section, this will require additional measures such as : - Refer to Drawing No. 0007 & 0008 Plan Drawing for Decommissioning of Overhead Line for suitable access routes - use of suitable low load bearing track machinery to gain access to works area - use of suitable plant and equipment for completion of works - routine detailed inspection of area, while works are being carried out - monitoring (in the form of timber stakes as sightlines) to be installed in working areas and monitored regularly during the works - contractor to provide method statement for any proposed works in areas of peat/sloping ground/overhead power lines etc
ii	Maintain hydrology of area as far as possible;
iii	Use of experienced contractors and trained operators to carry out the work;
iv	Use of experienced geotechnical staff for site supervision.

Note
(1) Location AM24 to PS28A is an abbreviation for Angle Mast 24 to Pole Set 28A
(2) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.
(3) Slope characteristics are typically 3-5 degrees across the section. Locally steep south of pole set 25, up to 30 degree inclination recorded
(4) Localised areas of very soft, waterlogged and buoyant peat between pole set 27 and 28A
(5) Deepest peat recorded around pole set 28
(6) Impact based on OHL route crossing a watercourse with a PS within 100m upslope of the watercourse.
(7) Probability assessed as per Table A and B of Appendix C

Derrybrien Wind Farm (OHL) - Peat Stability Risk Register (Rev 1)

Location:	**PS28A to PS34**

Start of Subsection (Easting, Northing):	**562092**	**700690**
End of Subsection (Easting, Northing):	**562470**	**699676**
Worst Case Receptor(s):	**Watercourse**	
Potential Impact on Receptor (Note 3):	**High**	
Peat Depth Range (m):	**0.2 to 3.1**	
Control Required:	**Yes**	

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory/Qualitative Factors to Potential Peat Failure	Prob (Note 4)	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during decommissioning	Prob	Impact	Risk	Risk Rating
1	FOS (worst case)= 1.69(u), 1.49(d)	1	4	4	Negligible	No	See Below	1	4	4	Negligible
2	Evidence of sub peat water flow	0	4	0	Not Applicable	No		0	4	0	Not Applicable
3	Evidence of surface water flow	1	4	4	Negligible	No		1	4	4	Negligible
4	Evidence of previous failures/slips	0	4	0	Not Applicable	No		0	4	0	Not Applicable
5	Type of vegetation	2	4	8	Low	Yes		1	4	4	Negligible
6	General slope characteristics upslope/downslope across section	2	4	8	Low	Yes		1	4	4	Negligible
7	Evidence of very soft/soft clay at base of peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
8	Evidence of mechanically cut peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
9	Evidence of quaking or buoyant peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
10	Evidence of bog pools	0	4	0	Not Applicable	No		0	4	0	Not Applicable
11	Low peat strength (<10kPa)	2	4	8	Low	Yes		1	4	4	Negligible
12	Other	2	4	8	Low	Yes		1	4	4	Negligible

	Control Measures to be Implemented Prior During Decommissioning for **PS28A to PS34**
i	Due to the depth of peat in the section, this will require additional measures such as : - Refer to Drawing no. 0007 & 0008 Plan Drawing for Decommissioning of Overhead Line for suitable access routes - use of suitable low load bearing track machinery to gain access to works area - use of suitable plant and equipment for completion of works - routine detailed inspection of area, while works are being carried out - contractor to provide method statement for any proposed works in areas of peat/sloping ground/overhead power lines etc
ii	Maintain hydrology of area as far as possible;
iii	Use of experienced contractors and trained operators to carry out the work;
iv	Use of experienced geotechnical staff for site supervision.

Note
(1) Location PS28A to PS34 is an abbreviation for Pole Set 28A to Pole Set 34
(2) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.
(3) Impact based on OHL route crossing a watercourse with a PS within 100m upslope of the watercourse.
(4) Probability assessed as per Table A and B of Appendix C

Derrybrien Wind Farm (OHL) - Peat Stability Risk Register (Rev 1)

Location:	**PS34 to AM38**

Start of Subsection (Easting, Northing):	**562470**	**699676**
End of Subsection (Easting, Northing):	**563020**	**699126**
Worst Case Receptor(s):	**Road**	
Potential Impact on Receptor (Note 6):	**High**	
Peat Depth Range (m):	**0.0 to 5.6**	
Control Required:	**Yes**	

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory/Qualitative Factors to Potential Peat Failure	Prob (Note 7)	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during decommissioning	Prob	Impact	Risk	Risk Rating
1	FOS (worst case)= 1.12(u), 1.51(d)	3	4	12	Medium	Yes	See Below	1	4	4	Negligible
2	Evidence of sub peat water flow	0	4	0	Not Applicable	No		0	4	0	Not Applicable
3	Evidence of surface water flow	1	4	4	Negligible	No		1	4	4	Negligible
4	Evidence of previous failures/slips	0	4	0	Not Applicable	No		0	4	0	Not Applicable
5	Type of vegetation	3	4	12	Medium	Yes		1	4	4	Negligible
6	General slope characteristics upslope/downslope across section	3	4	12	Medium	Yes		1	4	4	Negligible
7	Evidence of very soft/soft clay at base of peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
8	Evidence of mechanically cut peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
9	Evidence of quaking or buoyant peat	3	4	12	Medium	Yes		1	4	4	Negligible
10	Evidence of bog pools	0	4	0	Not Applicable	No		0	4	0	Not Applicable
11	Low peat strength (<10kPa)	0	4	0	Not Applicable	No		0	4	0	Not Applicable
12	Very deep peat	3	4	12	Medium	Yes		1	4	4	Negligible

	Control Measures to be Implemented during Decommissioning for **PS34 to AM38**
i	Due to the depth of peat in the section, this will require additional measures such as : - Refer to Drawing no. 0007 & 0008 Plan Drawing for Decommissioning of Overhead Line for suitable access routes - use of suitable low load bearing track machinery to gain access to works area - use of suitable plant and equipment for completion of works - routine detailed inspection of area, while works are being carried out - monitoring (in the form of timber stakes as sightlines) to be installed in working areas and monitored regularly during the works - contractor to provide method statement for any proposed works in areas of peat/sloping ground/overhead power lines etc
ii	Maintain hydrology of area as far as possible;
iii	Use of experienced contractors and trained operators to carry out the work;
iv	Use of experienced geotechnical staff for site supervision.

Note

(1) Location PS34 to AM38 is an abbreviation for Pole Set 34 to Angle Mast 38
(2) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.
(3) Slope characteristics are typically 3-5 degrees across the section. Locally steep north of pole set 35, up to 21 degree inclination recorded
(4) Significant area of very soft, waterlogged and buoyant peat between pole set 37 and 38
(5) Deepest peat recorded angle mast 38, about 5.6m deep
(6) Impact based on OHL route crossing a road with a PS within 100m upslope of the road.
(7) Probability assessed as per Table A and B of Appendix C

Derrybrien Wind Farm (OHL) - Peat Stability Risk Register (Rev 1)

Location:	AM38 to EM41

Start of Subsection (Easting, Northing):	**563020**	**699126**
End of Subsection (Easting, Northing):	**563124**	**698618**
Worst Case Receptor(s):	**Dwelling**	
Potential Impact on Receptor (Note 6):	**High**	
Peat Depth Range (m):	**0.0 to 5.6**	
Control Required:	**Yes**	

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory/Qualitative Factors to Potential Peat Failure	Prob (Note 7)	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during decommissioning	Prob	Impact	Risk	Risk Rating
1	FOS (worst case)= 10.42(u), 8.19(d)	1	4	4	Negligible	No	See Below	1	4	4	Negligible
2	Evidence of sub peat water flow	0	4	0	Not Applicable	No		0	4	0	Not Applicable
3	Evidence of surface water flow	1	4	4	Negligible	No		1	4	4	Negligible
4	Evidence of previous failures/slips	0	4	0	Not Applicable	No		0	4	0	Not Applicable
5	Type of vegetation	3	4	12	Medium	Yes		1	4	4	Negligible
6	General slope characteristics upslope/downslope across section	2	4	8	Low	No		1	4	4	Negligible
7	Evidence of very soft/soft clay at base of peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
8	Evidence of mechanically cut peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
9	Evidence of quaking or buoyant peat	0	4	0	Not Applicable	No		0	4	0	Not Applicable
10	Evidence of bog pools	0	4	0	Not Applicable	No		0	4	0	Not Applicable
11	Low peat strength (<10kPa)	0	4	0	Not Applicable	No		0	4	0	Not Applicable
12	Very deep peat	3	4	12	Medium	Yes		1	4	4	Negligible

	Control Measures to be Implemented Prior to/and During Construction for **AM38 to PS41**
i	Due to the depth of peat in the section, this will require additional measures such as : - Refer to Drawing no. 0007 & 0008 Plan Drawing for Decommissioning of Overhead Line for suitable access routes - use of suitable low load bearing track machinery to gain access to works area - use of suitable plant and equipment for completion of works - routine detailed inspection of area, while works are being carried out - monitoring (in the form of timber stakes as sightlines) to be installed in working areas and monitored regularly during the works - contractor to provide method statement for any proposed works in areas of peat/sloping ground/overhead power lines etc
ii	Maintain hydrology of area as far as possible;
iii	Use of experienced contractors and trained operators to carry out the work;
iv	Use of experienced geotechnical staff for site supervision.

Note

(1) Location AM38 to PS41 is an abbreviation for Angle Mast 38 to Pole Set 41
(2) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.
(3) Slope characteristics are typically 3-5 degrees across the section.
(4) Deepest peat recorded around angle mast 38, about 5.6m deep
(5) Impact based on OHL route 500m upslope of the dwelling in an area of deep peat.
(6) Probability assessed as per Table A and B of Appendix C

Derrybrien Wind Farm (OHL) - Peat Stability Risk Register (Rev 1)

Location:	Sub-station

Start of Subsection (Easting, Northing):	**563123**	**698619**
End of Subsection (Easting, Northing):	**563123**	**698619**
Worst Case Receptor(s):	**Infrastructure**	
Potential Impact on Receptor (Note 2):	**Negligable**	
Peat Depth Range (m):	**0.0 to 0.0**	
Control Required:	**No**	

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory/Qualitative Factors to Potential Peat Failure	Prob (Note 3)	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during decommissioning	Prob	Impact	Risk	Risk Rating
1	FOS = na(u), na(d)	1	1	1	Negligible	No	See Below	1	1	1	Negligible
2	Evidence of sub peat water flow	0	1	0	Not Applicable	No		0	1	0	Not Applicable
3	Evidence of surface water flow	0	1	0	Not Applicable	No		0	1	0	Not Applicable
4	Evidence of previous failures/slips	0	1	0	Not Applicable	No		0	1	0	Not Applicable
5	Type of vegetation	0	1	0	Not Applicable	No		0	1	0	Not Applicable
6	General slope characteristics upslope/downslope across section	1	1	1	Negligible	No		1	1	1	Negligible
7	Evidence of very soft/soft clay at base of peat	0	1	0	Not Applicable	No		0	1	0	Not Applicable
8	Evidence of mechanically cut peat	0	1	0	Not Applicable	No		0	1	0	Not Applicable
9	Evidence of quaking or buoyant peat	0	1	0	Not Applicable	No		0	1	0	Not Applicable
10	Evidence of bog pools	0	1	0	Not Applicable	No		0	1	0	Not Applicable
11	Low peat strength (<10kPa)	0	1	0	Not Applicable	No		0	1	0	Not Applicable
12	Other	0	1	0	Not Applicable	No		0	1	0	Not Applicable

	Control Measures to be Implemented during Decommissioning for **Agannygal Sub-Station**
i	Maintain hydrology of area as far as possible;
ii	Use of experienced contractors and trained operators to carry out the work;

Note
(1) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.
(2) Impact based on absence of peat.
(3) Probability assessed as per Table A and B of Appendix C

Appendix E

Calculated FOS for Peat Stability of Slopes

Calculated FoS of Natural Peat Slopes for Derrybrien Wind Farm OHL (Undrained Analysis)

Turbine No./Waypoint	Easting	Northing	Slope (Note 3)	Undrained shear strength	Bulk unit weight of Peat	Peat Depth (Note 5)	Surcharge Equivalent Placed Fill Depth (m) (Note 2)	Factor of Safety for Load Condition	
			β (deg)	c_u (kPa)	γ (kN/m^3)	(m)	Condition (2)	Condition (1)	Condition (2)
FT DATA (SEPTEMBER 2019)									
Pole 1A	160002	204675	5.0	6	10	2.2	3.2	**3.14**	**2.16**
Pole 2	160086	204563	6.0	6	10	2.1	3.1	**2.75**	**1.86**
Pole 3	160235	204362	4.0	6	10	1.6	2.6	**5.39**	**3.32**
Pole 4	160360	204194	6.0	6	10	1.0	2.0	**5.77**	**2.89**
Pole 5	160520	203976	3.0	6	10	1.3	2.3	**8.83**	**4.99**
Pole 6	160617	203849	3.0	6	10	0.6	1.6	**19.13**	**7.18**
Pole 7	160712	203721	3.0	6	10	0.9	1.9	**12.76**	**6.04**
Pole 8	160820	203575	3.0	6	10	1.5	2.5	**7.65**	**4.59**
Pole 9	160921	203439	4.0	6	10	0.5	1.5	**17.24**	**5.75**
Pole 10	161053	203263	4.0	6	10	0.8	1.8	**10.78**	**4.79**
Pole 11	161183	203088	4.0	6	10	0.1	1.1	**86.22**	**7.84**
Pole 12	161294	202940	4.0	6	10	0.5	1.5	**17.24**	**5.75**
Pole 13	161386	202815	2.0	6	10	0.2	1.2	**86.01**	**14.34**
Angle Mast 14	161474	202698	1.0	6	10	0.7	1.7	**49.12**	**20.23**
Pole 15	161359	202569	3.0	6	10	0.5	1.5	**22.96**	**7.65**
Pole 16	161206	202401	2.0	6	10	0.3	1.3	**57.34**	**13.23**
Pole 17	161032	202208	2.0	6	10	0.6	1.6	**28.67**	**10.75**
Angle Mast 18	160881	202041	5.0	6	10	0.3	1.3	**23.04**	**5.32**
Pole 19	160992	201940	2.0	6	10	0.9	1.9	**19.11**	**9.05**
Angle Mast 20	161091	201850	3.0	6	10	0.2	1.2	**57.40**	**9.57**
Pole 21	161256	201778	5.0	6	10	0.4	1.4	**17.28**	**4.94**
Pole 22	161421	201707	10.0	6	10	0.5	1.5	**7.02**	**2.34**
Pole 23	161642	201613	3.0	6	10	0.5	1.5	**22.96**	**7.65**
Angle Mast 24	161800	201545	4.0	6	10	0.8	1.8	**10.78**	**4.79**
Pole 25	161854	201394	10.0	6	10	0.2	1.2	**17.54**	**2.92**
Pole 26	161960	201114	6.0	6	10	0.6	1.6	**9.62**	**3.61**
Pole 27	162016	200964	10.0	6	10	0.5	1.5	**7.02**	**2.34**
Pole 28	162097	200749	2.0	6	10	3.8	4.8	**4.53**	**3.58**
Pole 28A	162133	200656	2.0	6	10	0.8	1.8	**21.50**	**9.56**
Pole 29	162196	200487	2.0	6	10	0.9	1.9	**19.11**	**9.05**
Angle Mast 30	162259	200318	4.0	6	10	0.1	1.1	**86.22**	**7.84**
Pole 31	162343	200093	7.0	6	10	0.4	1.4	**12.40**	**3.54**
Pole 32	162417	199897	3.0	6	10	0.3	1.3	**38.27**	**8.83**
Pole 33	162476	199738	2.0	6	10	2.3	3.3	**7.48**	**5.21**
Angle Mast 34	162511	199643	3.0	No peat encountered					
Pole 35	162702	199452	5.0	6	10	1.1	2.1	**6.28**	**3.29**
Pole 36	162801	199353	3.0	6	10	3.2	4.2	**3.59**	**2.73**
Pole 37	162878	199275	1.0	6	10	0.5	1.5	**68.77**	**22.92**
Angle Mast 38	163060	199092	1.0	6	10	2.5	3.5	**13.75**	**9.82**
Pole 39	163102	198897	2.0	6	10	1.8	2.8	**9.56**	**6.14**
Pole 40	195225	363039	4.0	6	10	1.0	2.0	**8.62**	**4.31**
Angle Mast 41	163164	198584	2.0	No peat encountered					

Calculated FoS of Natural Peat Slopes for Derrybrien Wind Farm OHL (Undrained Analysis)

Turbine No./Waypoint	Easting	Northing	Slope (Note 3)	Undrained shear strength	Bulk unit weight of Peat	Peat Depth (Note 5)	Surcharge Equivalent Placed Fill Depth (m) (Note 2)	Factor of Safety for Load Condition	
			β (deg)	c_u (kPa)	γ (kN/m^3)	(m)	Condition (2)	Condition (1)	Condition (2)
AGEC DATA (JUNE 2018)									
Pole 1A	160002	204675	0.5	6	10	1.8	2.8	**38.20**	**24.56**
WP 1	160047	204613	3.0	6	10	1.4	2.4	**8.20**	**4.78**
Pole 2	160086	204563	0.5	6	10	2.4	3.4	**28.65**	**20.22**
WP 2	160158	204461	0.5	6	10	1.9	2.9	**36.19**	**23.71**
Pole 3	160235	204362	0.5	6	10	2.0	3.0	**34.38**	**22.92**
WP 3	160295	204291	0.5	6	10	1.8	2.8	**38.20**	**24.56**
Pole 4	160360	204194	6.0	6	10	1.1	2.1	**5.25**	**2.75**
Pole 5	160520	203976	2.0	6	10	1.8	2.8	**9.56**	**6.14**
Pole 6	160617	203849	3.0	6	10	1.0	2.0	**11.48**	**5.74**
Pole 7	160712	203721	6.0	6	10	0.5	1.5	**11.54**	**3.85**
WP 4	160867	203534	10.0	6	10	1.9	2.9	**1.85**	**1.21**
Pole 8	160820	203575	0.5	6	10	1.7	2.7	**40.45**	**25.47**
Pole 9	160921	203439	0.5	6	10	0.8	1.8	**85.95**	**38.20**
WP 5	161003	203325	0.5	6	10	0.5	1.5	**137.52**	**45.84**
Pole 10	161053	203263	4.0	6	10	0.8	1.8	**10.78**	**4.79**
WP 6	161114	203187	4.0	6	10	0.2	1.2	**43.11**	**7.19**
Pole 11	161183	203088	0.5	No peat encountered					
WP 7	161247	203003	20.0	6	10	0.2	1.2	**9.33**	**1.56**
Pole 12	161294	202940	0.5	6	10	0.3	1.3	**229.19**	**52.89**
WP 8	161357	202861	0.5	6	10	0.8	1.8	**85.95**	**38.20**
Pole 13	161386	202815	0.5	No peat encountered					
WP 9	161425	202749	0.5	6	10	0.5	1.5	**137.52**	**45.84**
Angle Mast 14	161474	202698	5.0	No peat encountered					
Pole 15	161359	202569	12.0	No peat encountered					
WP 10	161252	202448	5.0	No peat encountered					
Pole 16	161206	202401	4.0	6	10	0.2	1.2	**43.11**	**7.19**
WP11	161097	202274	0.5	6	10	0.5	1.5	**137.52**	**45.84**
Pole 17	161032	202208	4.0	6	10	0.2	1.2	**43.11**	**7.19**
WP 12	160960	202126	4.0	6	10	0.6	1.6	**14.37**	**5.39**
Angle Mast 18	160881	202041	0.5	No peat encountered					
Pole 19	160992	201940	4.0	No peat encountered					
Pole 20	161091	201850	0.5	No peat encountered					
Pole 21	161256	201778	0.5	6	10	0.8	1.8	**85.95**	**38.20**
Pole 22	161421	201707	6.0	6	10	0.8	1.8	**7.21**	**3.21**
WP 15	161522	201668	0.5	6	10	0.5	1.5	**137.52**	**45.84**
WP 16	161540	201659	15.0	6	10	0.3	1.3	**8.00**	**1.85**
Pole 23	161642	201613	0.5	6	10	0.6	1.6	**114.60**	**42.97**
Pole 24	161800	201545	7.0	6	10	0.4	1.4	**12.40**	**3.54**
WP 17	161832	201460	2.0	6	10	1.5	2.5	**11.47**	**6.88**
Pole 25	161854	201394	7.0	6	10	0.2	1.2	**24.80**	**4.13**
WP 18	161885	201296	12.0	6	10	1.7	2.7	**1.74**	**1.09**
WP 19	161893	201193	5.0	6	10	0.9	1.9	**7.68**	**3.64**
Pole 26	161960	201114	12.0	6	10	0.6	1.6	**4.92**	**1.84**
WP 20	161987	201046	3.0	6	10	0.2	1.2	**57.40**	**9.57**
Pole 27	162016	200964	8.0	6	10	0.2	1.2	**21.77**	**3.63**
WP 21	162093	200863	0.5	6	10	2.6	3.6	**26.45**	**19.10**
Pole 28	162097	200749	0.5	6	10	3.8	4.8	**18.09**	**14.32**
Pole 28A-WP 22	162133	200656	0.5	6	10	1.6	2.6	**42.97**	**26.45**
Pole 29	162196	200487	0.5	6	10	1.4	2.4	**49.11**	**28.65**
Pole 30	162259	200318	0.5	6	10	0.4	1.4	**171.90**	**49.11**
Pole 31	162343	200093	7.0	6	10	0.2	1.2	**24.80**	**4.13**
Pole 32	162417	199897	0.5	6	10	0.4	1.4	**171.90**	**49.11**
Pole 33	162476	199738	5.0	6	10	3.1	4.1	**2.23**	**1.69**
Pole 34	162511	199643	3.0	6	10	2.2	3.2	**5.22**	**3.59**
WP23	162631	199512	21.0	6	10	0.6	1.6	**2.99**	**1.12**
Pole 35	162702	199452	8.0	6	10	1.2	2.2	**3.63**	**1.98**
Pole 36	162801	199353	0.5	6	10	4.7	5.7	**14.63**	**12.06**
Pole 37	162878	199275	0.5	6	10	1.2	2.2	**57.30**	**31.25**
WP 26	162952	199157	1.0	6	10	2.2	3.2	**15.63**	**10.75**
Angle Mast 38	163060	199092	0.5	6	10	5.6	6.6	**12.28**	**10.42**
Pole 39	163102	198897	0.5	6	10	2.2	3.2	**31.25**	**21.49**
Pole 40	195225	363039	0.5	6	10	1.1	2.1	**62.51**	**32.74**
Angle Mast 41	163164	198584	0.5	No peat encountered					

Calculated FoS of Natural Peat Slopes for Derrybrien Wind Farm OHL (Undrained Analysis)

Turbine No./Waypoint	Easting	Northing	Slope (Note 3)	Undrained shear strength	Bulk unit weight of Peat	Peat Depth (Note 5)	Surcharge Equivalent Placed Fill Depth (m) (Note 2)	Factor of Safety for Load Condition	
			β (deg)	c_u (kPa)	γ (kN/m^3)	(m)	Condition (2)	Condition (1)	Condition (2)
ESBI DATA (2004 & 2005)									
1	160403	204120	4.0	6	10	0.2	1.2	**43.01**	**7.17**
2	160392	204135	6.0	6	10	0.2	1.2	**28.70**	**4.78**
3	160386	204144	6.0	6	10	0.9	1.9	**6.38**	**3.02**
4	160136	204496	0.5	6	10	0.9	1.9	**76.58**	**36.28**
5	160363	204177	6.0	6	10	1.0	2.0	**5.77**	**2.89**
6	160344	204204	6.0	6	10	1.0	2.0	**5.77**	**2.89**
7	160333	204219	6.0	6	10	1.2	2.2	**4.78**	**2.61**
8	160295	204271	4.0	6	10	1.2	2.2	**7.21**	**3.93**
9	160126	204510	0.5	6	10	1.3	2.3	**53.18**	**30.06**
10	160279	204293	4.0	6	10	1.4	2.4	**6.18**	**3.60**
11	160168	204446	0.5	6	10	1.4	2.4	**49.23**	**28.72**
12	160073	204591	3.0	6	10	1.4	2.4	**8.19**	**4.78**
13	160108	204538	3.0	6	10	1.5	2.5	**7.66**	**4.60**
14	159982	204618	0.5	6	10	1.5	2.5	**45.84**	**27.50**
15	160005	204630	0.5	6	10	1.5	2.5	**45.90**	**27.54**
16	160040	204640	3.0	6	10	1.5	2.5	**7.65**	**4.59**
17	160085	204667	3.0	6	10	1.5	2.5	**7.64**	**4.59**
18	160152	204471	0.5	6	10	1.6	2.6	**42.97**	**26.45**
19	160313	204247	6.0	6	10	1.7	2.7	**3.38**	**2.13**
20	160259	204320	0.5	6	10	1.8	2.8	**38.25**	**24.59**
21	160216	204378	0.5	6	10	1.8	2.8	**38.20**	**24.56**
22	160055	204617	3.0	6	10	1.8	2.8	**6.40**	**4.12**
23	160029	204645	3.0	6	10	1.8	2.8	**6.37**	**4.09**
24	159991	204653	0.5	6	10	1.8	2.8	**38.20**	**24.56**
25	160052	204656	2.0	6	10	1.8	2.8	**9.56**	**6.15**
26	160059	204689	3.0	6	10	1.8	2.8	**6.38**	**4.10**
27	160237	204349	0.5	6	10	1.9	2.9	**36.19**	**23.71**
28	160091	204563	3.0	6	10	1.9	2.9	**6.04**	**3.96**
29	160199	204400	0.5	6	10	2.0	3.0	**34.43**	**22.95**
30	160027	204660	3.0	6	10	2.0	3.0	**5.73**	**3.82**
31	160011	204684	2.0	6	10	2.1	3.1	**8.20**	**5.55**
32	160185	204421	0.5	6	10	2.6	3.6	**26.45**	**19.10**
							Minimum =	**1.74**	**1.09**
							Maximum =	**229.19**	**52.89**
							Average =	**32.53**	**12.88**

Notes:

(1) Assuming a bulk unit weight for peat of 10kN/m^3

(2) Assuming a surcharge equivalent to fill depth of 1m of peat i.e. 10kPa. (Condition 2)

(3) Slope inclination (β) based on site readings and site contour plans.

(4) A lower bound undrained shear strength, cu for the peat of 6kPa was selected for the assessment. It should be noted that a cu of 6kPa for the pea is considered a conservative value for the analysis and is not representative of all peat present across the site. In reality the peat on site has a significantly higher undrained strength.

(5) Peat depths based on probes carried out by FT (2019), AGEC and ESBI (June 2018

(6) For load conditions see report text.

Calculated FoS of Natural Peat Slopes for Derrybrien Wind Farm OHL (Drained Analysis)

Turbine No./Waypoint	Slope (Note 3)	Design c'	Bulk unit weight of Peat	Unit weight of Water	100% Water to height of Peat	Depth of In situ Peat (Note 5)	Friction Angle	Equivalent Total Depth of Peat (m) (Note 2)	Factor of Safety for Load Condition	
	α (deg)	c' (kPa)	γ (kN/m^3)	γ_w (kN/m^3)	(m)	(m)	ø' (deg)	Condition (2)	Condition (1)	Condition (2)
									100% Water	100% Water
FT DATA (2019)										
Pole 1A	5.0	4	10.0	10.0	2.2	2.2	25	3.2	**2.09**	**3.11**
Pole 2	6.0	4	10.0	10.0	2.1	2.1	25	3.1	**1.83**	**2.67**
Pole 3	4.0	4	10.0	10.0	1.6	1.6	25	2.6	**3.59**	**4.78**
Pole 4	6.0	4	10.0	10.0	1.0	1.0	25	2.0	**3.85**	**4.14**
Pole 5	3.0	4	10.0	10.0	1.3	1.3	25	2.3	**5.89**	**7.20**
Pole 6	3.0	4	10.0	10.0	0.6	0.6	25	1.6	**12.76**	**10.34**
Pole 7	3.0	4	10.0	10.0	0.9	0.9	25	1.9	**8.50**	**8.71**
Pole 8	3.0	4	10.0	10.0	1.5	1.5	25	2.5	**5.10**	**6.62**
Pole 9	4.0	4	10.0	10.0	0.5	0.5	25	1.5	**11.50**	**8.28**
Pole 10	4.0	4	10.0	10.0	0.8	0.8	25	1.8	**7.19**	**6.90**
Pole 11	4.0	4	10.0	10.0	0.1	0.1	25	1.1	**57.48**	**11.29**
Pole 12	4.0	4	10.0	10.0	0.5	0.5	25	1.5	**11.50**	**8.28**
Pole 13	2.0	4	10.0	10.0	0.2	0.2	25	1.2	**57.34**	**20.68**
Angle Mast 14	1.0	4	10.0	10.0	0.7	0.7	25	1.7	**32.75**	**29.20**
Pole 15	3.0	4	10.0	10.0	0.5	0.5	25	1.5	**15.31**	**11.03**
Pole 16	2.0	4	10.0	10.0	0.3	0.3	25	1.3	**38.23**	**19.09**
Pole 17	2.0	4	10.0	10.0	0.6	0.6	25	1.6	**19.11**	**15.51**
Angle Mast 18	5.0	4	10.0	10.0	0.3	0.3	25	1.3	**15.36**	**7.64**
Pole 19	2.0	4	10.0	10.0	0.9	0.9	25	1.9	**12.74**	**13.06**
Angle Mast 20	3.0	4	10.0	10.0	0.2	0.2	25	1.2	**38.27**	**13.79**
Pole 21	5.0	4	10.0	10.0	0.4	0.4	25	1.4	**11.52**	**7.10**
Pole 22	10.0	4	10.0	10.0	0.5	0.5	25	1.5	**4.68**	**3.32**
Pole 23	3.0	4	10.0	10.0	0.5	0.5	25	1.5	**15.31**	**11.03**
Angle Mast 24	4.0	4	10.0	10.0	0.8	0.8	25	1.8	**7.19**	**6.90**
Pole 25	10.0	4	10.0	10.0	0.2	0.2	25	1.2	**11.70**	**4.15**
Pole 26	6.0	4	10.0	10.0	0.6	0.6	25	1.6	**6.41**	**5.18**
Pole 27	10.0	4	10.0	10.0	0.5	0.5	25	1.5	**4.68**	**3.32**
Pole 28	2.0	4	10.0	10.0	3.8	3.8	25	4.8	**3.02**	**5.17**
Pole 28A-WP 22	2.0	4	10.0	10.0	0.8	0.8	25	1.8	**14.34**	**13.79**
Pole 29	2.0	4	10.0	10.0	0.9	0.9	25	1.9	**12.74**	**13.06**
Angle Mast 30	4.0	4	10.0	10.0	0.1	0.1	25	1.1	**57.48**	**11.29**
Pole 31	7.0	4	10.0	10.0	0.4	0.4	25	1.4	**8.27**	**5.07**
Pole 32	3.0	4	10.0	10.0	0.3	0.3	25	1.3	**25.51**	**12.73**
Pole 33	2.0	4	10.0	10.0	2.3	2.3	25	3.3	**4.99**	**7.52**
Angle Mast 34	3.0	No peat encountered								
Pole 35	5.0	4	10.0	10.0	1.1	1.1	25	2.1	**4.19**	**4.73**
Pole 36	3.0	4	10.0	10.0	3.2	3.2	25	4.2	**2.39**	**3.94**
Pole 37	1.0	4	10.0	10.0	0.5	0.5	25	1.5	**45.85**	**33.09**
Angle Mast 38	1.0	4	10.0	10.0	2.5	2.5	25	3.5	**9.17**	**14.18**
Pole 39	2.0	4	10.0	10.0	1.8	1.8	25	2.8	**6.37**	**8.86**
Pole 40	4.0	4	10.0	10.0	1.0	1.0	25	2.0	**5.75**	**6.21**
Angle Mast 41	2.0	No peat encountered								

Calculated FoS of Natural Peat Slopes for Derrybrien Wind Farm OHL (Drained Analysis)

Turbine No./Waypoint	Slope (Note 3)	Design c'	Bulk unit weight of Peat	Unit weight of Water	100% Water to height of Peat	Depth of In situ Peat (Note 5)	Friction Angle	Equivalent Total Depth of Peat (m) (Note 2)	Factor of Safety for Load Condition	
	α (deg)	c' (kPa)	γ (kN/m^3)	γ_w (kN/m^3)	(m)	(m)	ø' (deg)	Condition (2)	Condition (1)	Condition (2)
									100% Water	100% Water
AGEC DATA (2018)										
Pole 1A	0.5	4	10.0	10.0	1.8	1.8	25	2.8	**25.47**	**35.45**
WP 1	3.0	4	10.0	10.0	1.4	1.4	25	2.4	**5.47**	**6.90**
Pole 2	0.5	4	10.0	10.0	2.4	2.4	25	3.4	**19.10**	**29.20**
WP 2	5.0	4	10.0	10.0	1.9	1.9	25	1.9	**2.42**	**2.42**
Pole 3	0.5	4	10.0	10.0	2.0	2.0	25	3.0	**22.92**	**33.09**
WP 3	0.5	4	10.0	10.0	1.8	1.8	25	1.8	**25.47**	**25.47**
Pole 4	6.0	4	10.0	10.0	1.1	1.1	25	2.1	**3.50**	**3.94**
Pole 5	2.0	4	10.0	10.0	1.8	1.8	25	2.8	**6.37**	**8.86**
Pole 6	3.0	4	10.0	10.0	1.0	1.0	25	2.0	**7.65**	**8.28**
Pole 7	6.0	4	10.0	10.0	0.5	0.5	25	1.5	**7.70**	**5.52**
WP 4	10.0	4	10.0	10.0	1.9	1.9	25	2.9	**1.23**	**1.72**
Pole 8	0.5	4	10.0	10.0	1.7	1.7	25	2.7	**26.96**	**36.77**
Pole 9	0.5	4	10.0	10.0	0.8	0.8	25	1.8	**57.30**	**55.15**
WP 5	0.5	4	10.0	10.0	0.5	0.5	25	1.5	**91.68**	**66.18**
Pole 10	4.0	4	10.0	10.0	0.8	0.8	25	1.8	**7.19**	**6.90**
WP 6	4.0	4	10.0	10.0	0.2	0.2	25	1.2	**28.74**	**10.35**
Pole 11	4.0	No peat encountered								
WP 7	20.0	4	10.0	10.0	0.2	0.2	25	1.2	**6.22**	**2.10**
Pole 12	0.5	4	10.0	10.0	0.3	0.3	25	1.3	**152.80**	**76.36**
WP 8	0.5	4	10.0	10.0	0.8	0.8	25	1.8	**57.30**	**55.15**
Pole 13	2.0	No peat encountered								
WP 9	0.5	4	10.0	10.0	0.5	0.5	25	1.5	**91.68**	**66.18**
Angle Mast 14	1.5	No peat encountered								
Pole 15	12.0	No peat encountered								
WP 10	5.0	No peat encountered								
Pole 16	0.5	4	10.0	10.0	0.2	0.2	25	1.2	**229.19**	**82.73**
WP11	0.5	4	10.0	10.0	0.5	0.5	25	1.5	**91.68**	**66.18**
Pole 17	4.0	4	10.0	10.0	0.2	0.2	25	1.2	**28.74**	**10.35**
WP 12	4.0	4	10.0	10.0	0.6	0.6	25	1.6	**9.58**	**7.76**
Angle Mast 18	0.5	No peat encountered								
Pole 19	4.0	No peat encountered								
Pole 20	0.5	No peat encountered								
Pole 21	0.5	4	10.0	10.0	0.8	0.8	25	1.8	**57.30**	**55.15**
Pole 22	6.0	4	10.0	10.0	0.8	0.8	25	1.8	**4.81**	**4.60**
WP 15	0.5	4	10.0	10.0	0.5	0.5	25	1.5	**91.68**	**66.18**
WP 16	15.0	4	10.0	10.0	0.3	0.3	25	1.3	**5.33**	**2.57**
Pole 23	0.5	4	10.0	10.0	0.6	0.6	25	1.6	**76.40**	**62.05**
Pole 24	0.5	4	10.0	10.0	0.4	0.4	25	1.4	**114.60**	**70.91**
WP 17	0.5	4	10.0	10.0	1.5	1.5	25	2.5	**30.56**	**39.71**
Pole 25	7.0	4	10.0	10.0	0.2	0.2	25	1.2	**16.53**	**5.92**
WP 18	2.0	4	10.0	10.0	1.7	1.7	25	2.7	**6.75**	**9.19**
WP 19	5.0	4	10.0	10.0	0.9	0.9	25	1.9	**5.12**	**5.23**
Pole 26	12.0	4	10.0	10.0	0.6	0.6	25	1.6	**3.28**	**2.60**
WP 20	3.0	4	10.0	10.0	0.2	0.2	25	1.2	**38.27**	**13.79**
Pole 27	8.0	4	10.0	10.0	0.2	0.2	25	1.2	**14.51**	**5.18**
WP 21	2.5	4	10.0	10.0	2.6	2.6	25	3.6	**3.53**	**5.52**
Pole 28	0.5	4	10.0	10.0	3.8	3.8	25	4.8	**12.06**	**20.68**
Pole 28A-WP 22	0.5	4	10.0	10.0	1.6	1.6	25	2.6	**28.65**	**38.18**
Pole 29	0.5	4	10.0	10.0	1.4	1.4	25	2.4	**32.74**	**41.36**
Pole 30	0.5	4	10.0	10.0	0.4	0.4	25	1.4	**114.60**	**70.91**
Pole 31	7.0	4	10.0	10.0	0.2	0.2	25	1.2	**16.53**	**5.92**
Pole 32	0.5	4	10.0	10.0	0.4	0.4	25	1.4	**114.60**	**70.91**
Pole 33	5.0	4	10.0	10.0	3.1	3.1	25	4.1	**1.49**	**2.42**
Pole 34	3.0	4	10.0	10.0	2.2	2.2	25	3.2	**3.48**	**5.17**
WP23	21.0	4	10.0	10.0	0.6	0.6	25	1.6	**1.99**	**1.51**
Pole 35	8.0	4	10.0	10.0	1.2	1.2	25	2.2	**2.42**	**2.83**
Pole 36	0.5	4	10.0	10.0	4.7	4.7	25	5.7	**9.75**	**17.42**
Pole 37	0.5	4	10.0	10.0	1.2	1.2	25	2.2	**38.20**	**45.12**
WP 26	1.0	4	10.0	10.0	2.2	2.2	25	3.2	**10.42**	**15.51**
Angle Mast 38	0.5	4	10.0	10.0	5.6	5.6	25	6.6	**8.19**	**15.04**
Pole 39	0.5	4	10.0	10.0	2.2	2.2	25	3.2	**20.84**	**31.02**
Pole 40	0.5	4	10.0	10.0	1.1	1.1	25	2.1	**41.67**	**47.27**
Angle Mast 41	0.5	No peat encountered								

Calculated FoS of Natural Peat Slopes for Derrybrien Wind Farm OHL (Drained Analysis)

Turbine No./Waypoint	Slope (Note 3)	Design c'	Bulk unit weight of Peat	Unit weight of Water	100% Water to height of Peat	Depth of In situ Peat (Note 5)	Friction Angle	Equivalent Total Depth of Peat (m) (Note 2)	Factor of Safety for Load Condition	
	α (deg)	c' (kPa)	γ (kN/m^3)	γ_w (kN/m^3)	(m)	(m)	ø' (deg)	Condition (2)	Condition (1)	Condition (2)
									100% Water	100% Water
ESBI DATA (2004 & 2005)										
1	4.0	4	10	10	0.2	0.2	25	1.2	**28.74**	**10.35**
2	6.0	4	10	10	0.2	0.2	25	1.2	**19.24**	**6.90**
3	6.0	4	10	10	0.9	0.9	25	1.9	**4.28**	**4.36**
4	0.5	4	10	10	0.9	0.9	25	1.9	**50.93**	**52.25**
5	6.0	4	10	10	1.0	1.0	25	2.0	**3.85**	**4.14**
6	6.0	4	10	10	1.0	1.0	25	2.0	**3.85**	**4.14**
7	6.0	4	10	10	1.2	1.2	25	2.2	**3.21**	**3.77**
8	4.0	4	10	10	1.2	1.2	25	2.2	**4.79**	**5.64**
9	0.5	4	10	10	1.3	1.3	25	2.3	**35.26**	**43.16**
10	4.0	4	10	10	1.4	1.4	25	2.4	**4.11**	**5.17**
11	0.5	4	10	10	1.4	1.4	25	2.4	**32.74**	**41.36**
12	3.0	4	10	10	1.4	1.4	25	2.4	**5.47**	**6.90**
13	3.0	4	10	10	1.5	1.5	25	2.5	**5.10**	**6.62**
14	0.5	4	10	10	1.5	1.5	25	2.5	**30.56**	**39.71**
15	0.5	4	10	10	1.5	1.5	25	2.5	**30.56**	**39.71**
16	3.0	4	10	10	1.5	1.5	25	2.5	**5.10**	**6.62**
17	3.0	4	10	10	1.5	1.5	25	2.5	**5.10**	**6.62**
18	0.5	4	10	10	1.6	1.6	25	2.6	**28.65**	**38.18**
19	6.0	4	10	10	1.7	1.7	25	2.7	**2.26**	**3.07**
20	0.5	4	10	10	1.8	1.8	25	2.8	**25.47**	**35.45**
21	0.5	4	10	10	1.8	1.8	25	2.8	**25.47**	**35.45**
22	3.0	4	10	10	1.8	1.8	25	2.8	**4.25**	**5.91**
23	3.0	4	10	10	1.8	1.8	25	2.8	**4.25**	**5.91**
24	0.5	4	10	10	1.8	1.8	25	2.8	**25.47**	**35.45**
25	2.0	4	10	10	1.8	1.8	25	2.8	**6.37**	**8.86**
26	3.0	4	10	10	1.8	1.8	25	2.8	**4.25**	**5.91**
27	0.5	4	10	10	1.9	1.9	25	2.9	**24.13**	**34.23**
28	3.0	4	10	10	1.9	1.9	25	2.9	**4.03**	**5.71**
29	0.5	4	10	10	2.0	2.0	25	3.0	**22.92**	**33.09**
30	3.0	4	10	10	2.0	2.0	25	3.0	**3.83**	**5.52**
31	2.0	4	10	10	2.1	2.1	25	3.1	**5.46**	**8.01**
32	0.5	4	10	10	2.6	2.6	25	3.6	**17.63**	**27.58**
								Minimum =	**1.23**	**1.51**
								Maximum =	**229.19**	**82.73**
								Average =	**24.06**	**19.46**

Notes:

(1) Assuming a bulk unit weight of peat of 10 (kN/m^3)
(2) Assuming a surcharge equivalent to fill depth of 1m of peat i.e. 10kPa. (Condition 2)
(3) Slope inclination (β) based on site readings and contour survey plans of site.
(4) FoS is based on slope inclination and shear test results obtained from published data
(5) Peat depths based on probes carried out by AGEC and ESBI (June 2018)
(6) For load conditions see report text.
(7) Minimum acceptable factor of safety required of 1.3 for first-time failures based on BS: 6031:1981 Code of practice for Earthworks

Appendix F

ESB Report on Slope Stability Assessment of a Section of Ground under OHL

Hibernian Wind Power

Derrybrien Wind Farm, Co Galway

Slope stability assessment of a section of ground under overhead line

Report Number: P78015-R476-002

ESBI Engineering and Facilities Management

Stephen Court 18/21 St Stephen's Green Dublin 2 Ireland
Telephone+353-1-703 8000 Fax+353-1-661 6600
www.esbi.ie

16th February 2006

ESB INTERNATIONAL

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File Reference: *P78015-F476-030*

Client: *Hibernian Wind Power*

Project Title: *Derrybrien Wind Farm, Co. Galway*

Report Title: *Slope stability assessment of a section of ground under overhead line*

Report No.: **P78015-R476-002**

Rev. No.:

Volume 1 of 1

PRODUCED: Samir Hebib	*DATE: 16th February 2006*
CHECKED: Con Sheahan	*DATE: 16th February 2006*
APPROVED: Con Sheahan *TITLE: Senior Project Manager*	*DATE: 16th February 2006*

Latest Revision Summary:

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Change History of Report

Date	New Rev	Author	Summary of Change

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Summary i

1.0 Introduction 1

2.0 Slope stability assessment 1

3.0 Conclusion 3

4.0 References 3

FIGURES 1

figures

Summary

A slope stability assessment of a section of ground under the existing overhead line between the windfarm substation and the containment barrage BD2 has been carried out.

Results of that assessment shows that the ground has adequate factor of safety against a slip failure under an external surcharge of 20kPa.

1.0 Introduction

A geotechnical site investigation was carried out along a section of the overhead line at the Derrybrien windfarm. The investigation focused on a section of ground, under the overhead line, between the windfarm substation and a location approximately 700m south of the substation, which coincides with an existing Coillte track, as this section was considered to be the most critical one in terms of existing slope gradients and thickness of peat subsoil. The remaining section of ground, under the overhead line, extending south from the Coillte track to the containment barrage BD2, see Figure 2, is characterised by shallower slope gradients and a peat thickness of less than 1m; rock exposures can in fact be observed in the vicinity of the containment barrage. Furthermore, a 0.5m thick peat layer has been laid out on the existing peat surface close to the containment barrage.

The geotechnical investigation comprised measurement of ground slope angles at regular intervals; frequency was dictated by changes in ground topography, probing of the ground using 0.9m long coupled rods to assess in-situ peat thickness and shear vane tests to assess the shear strength of the peat subsoil. The shear vane tests were carried out subsequent to slope angle measurements and probing of peat depth in order to concentrate in locations which were considered to present a critical combination of steep slope angles and thick peat layer – see Figure 2 for location of shear vane tests and Figure 1 for a profile of the ground topography and peat depths.

2.0 Slope stability assessment

The stability of the existing ground was assessed at different locations along the section investigated assuming critical combination of slope angle, peat depth and shear strength and using an infinite slope method of analysis (Skempton & Delory, 1957). This method is suited to long downslope lengths where the mode of failure is translational sliding, such as that which occurred at the site in October 2003. The infinite slope method is conservative in that no end resistance is assumed.

Stability of the existing ground was assessed assuming two different loading conditions: (1) load condition no.1 where no external load is imposed on the peat surface and (2) load condition no.2 where an external load of 20kPa is applied on the peat surface to simulate pressure applied by a typical 20t weight tracked construction plant. The British Standard "Code of Practice for Earthworks" BS6031:1981 states that for a first time failure with a good standard of site investigation, the design factor of safety should be between 1.3 and 1.4. For the purpose of this exercise a factor of safety of 1.4 was used.

Results of slope stability analyses for the section of ground, described above are shown in Table 1. These results have been also presented in a previous report on ESBIE geotechnical testing (report 78015-C11-R1-REV1). For the remaining section of ground, under the overhead line, between the Coillte track and the containment barrage BD2, a conservative slope angle of 5deg and peat thickness of 1m was assumed throughout. A

minimum required shear strength value for the peat was therefore computed in order to achieve a factor of safety of 1.4. This minimum value was subsequently compared to the lowest results obtained from the shear vane tests carried out north of the Coillte track.

Table 1: Results of stability analyses

Vane ID	Shear vane result (lowest unless stated) (kPa)	Slope angle (deg)	Peat depth at vane location (m)	Factor of safety for load condition 1 (no surcharge)	Factor of safety for Load condition 2 (20kPa surcharge)	Acceptable surcharge to achieve factor of Safety of 1.4 (kPa)
TOH_V1	6.48	5	1.8	4.15	1.96	35
TOH_V2	5.07	6	1.5	3.25	1.39	20
TOH_V3	4.79	6	1.3	3.54	1.40	20
TOH_V4	5.44	6	1.5	3.49	1.50	22
TOH_V5	7.43	5	2	4.28	2.14	41
TOH_V6	7.69	6	1.85	4.00	1.92	34
TOH_V7	7.49	6	1.8	4.00	1.90	33
TOH_V8	7.05	7	1.4	4.16	1.71	28
TOH_V9	8.11	3.5	1.7	7.83	3.60	78
TOH_V10	8.73	5	1.2	8.38	3.14	60
TOH_V11	9.59	8	1	6.96	2.32	40
TOH_V12	9.59	7	0.95	8.35	2.69	47
TOH_V13	9.59	6	0.85	10.85	3.24	57

3.0 Conclusion

Results of slope stability analyses for the section of ground, under the overhead line, between the windfarm substation and the Coillte track show that the ground exhibits a factor of safety above 1.4 when analysed using the lowest shear strength at each location and assuming a surcharge loading of 20kPa. For the remaining section, under the overhead line, from the Coillte track to the containment barrage BD2, the minimum shear strength value for the peat required to achieve a factor of safety of 1.4 under an external surcharge of 20kPa is of the order of 3.6kPa which is well below the lowest shear strength values measured north of the Coillte track.

Therefore, it can be concluded that the portion of ground, under existing overhead line, between the windfarm substation and the containment barrage BD2 is considered to have adequate factor of safety against a slip failure under an external surcharge of 20kPa. This also infers that the factor of safety will be higher in a situation where no external loading is applied.

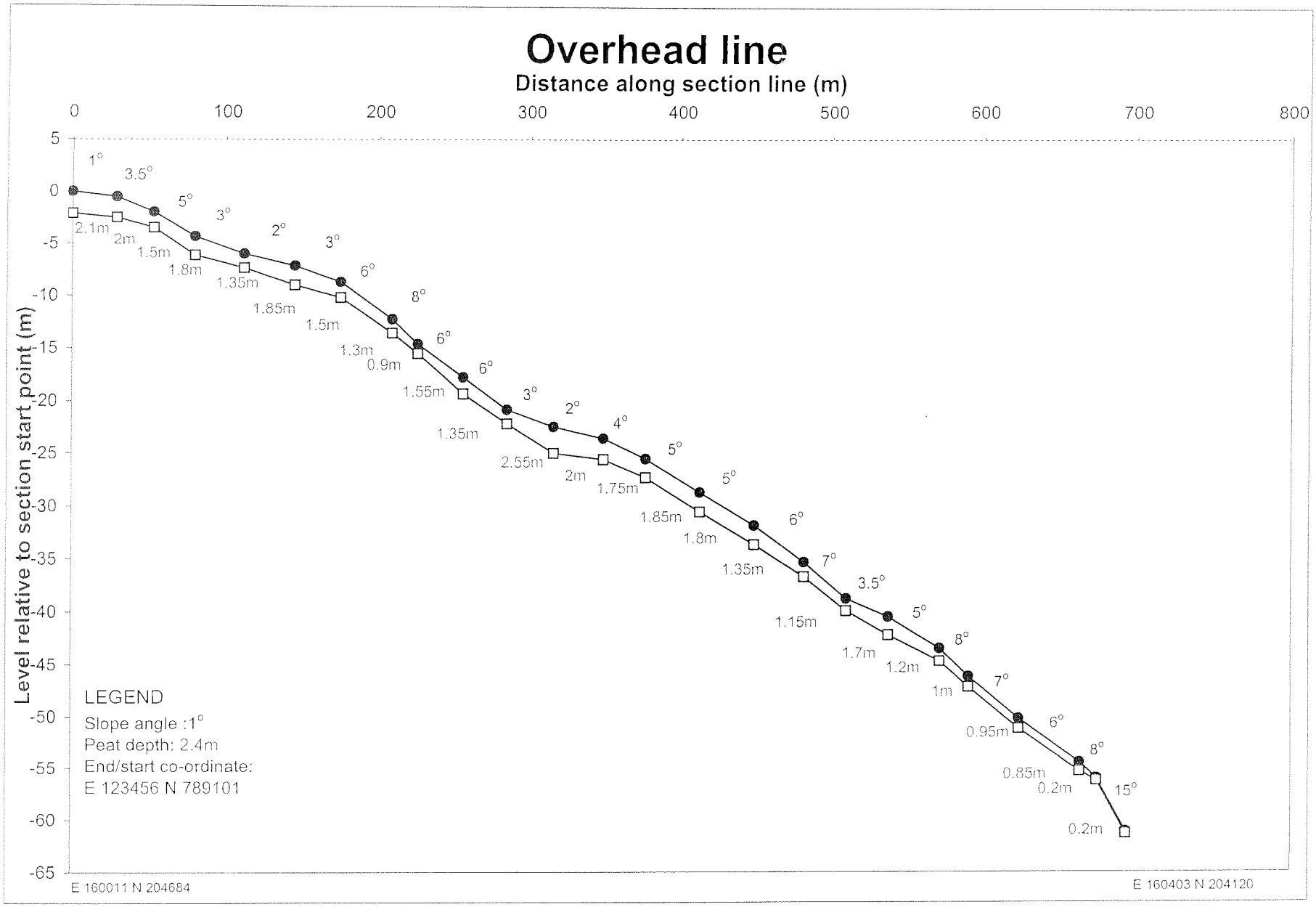
The 0.5m thick peat layer currently laid out on top of the existing peat surface in the vicinity of containment barrage BD2 is not considered to be undermining stability of the existing ground at that location. The surcharge applied by that peat layer would be of the order of 5kPa which well below the 20kPa surcharge assumed in the stability assessment.

4.0 References

1 Skempton, A.W.& DeLory, F.A. (1957). "*Stability of natural slopes in London Clay*". Proc. 4th Int. Conf. on Soil Mechanics and Foundation Engineering, Rotterdam, Vol. 2.

FIGURES

Figure 1 Profile of ground topography and peat depths
Figure 2 Location of shear vane tests


Overhead line
Distance along section line (m)
0
100
200
300
400
500
600
700
800
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
Level relative to section start point (m)
1°
3.5°
5°
3°
2°
3°
6°
8°
6°
6°
3°
2°
4°
5°
5°
6°
7°
3.5°
5°
8°
7°
6°
8°
15°
2.1m
2m
1.5m
1.8m
1.35m
1.85m
1.5m
1.3m
0.9m
1.55m
1.35m
2.55m
2m
1.75m
1.85m
1.8m
1.35m
1.15m
1.7m
1.2m
1m
0.95m
0.85m
0.2m
0.2m
LEGEND
Slope angle :1°
Peat depth: 2.4m
End/start co-ordinate:
E 123456 N 789101
E 160011 N 204684
E 160403 N 204120

A1 CAD

Notes :–

1. All dimensions are in millimetres – figured dimensions to be taken in preference to scaled dimensions.
2. All levels are in metres.

Legend:

Forestry

Streams/Drains

Boundary

10m Contour

50m Contour

Existing Road

Site Area 345ha

Turbine Foundation shown thus

Concreted Turbine Base (T##)

Site Compound

Borrow Pit 3

Clay Borrow Pit

Existing Telecoms Mast

Borrow Pit 2

110kV Substation & Compound Ref. Drg. No. 20206-31

Existing Turbary Road

Coillte Track

Coillte Track

Coillte Track

Approximate Line Of New 110kV Overhead Line

TOH-V1 TOH-V2 TOH-V3 TOH-V4 TOH-V5 TOH-V6 TOH-V7 TOH-V8 TOH-V9 TOH-V10 TOH-V11 TOH-V12 TOH-V13

Containment Barrage BD2

Coillte Forestry

Coillte Forestry

Coillte Forestry

Coillte Forestry

T1 T2 T3 T4 T5 T6 T7 T8 T9 T10 T11 T12 T13 T14 T15 T16 T17 T18 T19 T20 T21 T22 T23 T24 T25 T26 T27 T28 T29 T30 T31 T32 T33 T34 T35 T36 T37 T38 T39 T40 T41 T42 T43 T44 T45 T46 T48 T49 T50 T51 T52 T53 T54 T55 T56 T57 T58 T59 T60 T61 T62 T63 T64 T65 T66 T67 T68 T69 T70 T71

Site Layout Plan

Scale 1 : 10,000

0 100 200 300 400 500m

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PURPOSE OF ISSUE – PRELIMINARY UNLESS INDICATED

TENDER ☐ CLIENT APPROVAL ☐ CONSTRUCTION ☐ AS-BUILT ☐ REVISED ☐

CLIENT: GORT WINDFARM LTD

PROJECT: DERRYBRIEN WIND FARM Co. GALWAY

CONTRACT: DERRYBRIEN WINDFARM

DRAWING TITLE: SLOPE STABILITY ASSESSMENT OF SECTION OF GROUND UNDER OVERHEAD LINE LINE

ESB INTERNATIONAL

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DRAWN	CHECKED	APPROVED	APPD DATE
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CLIENT REF	SIZE	SHEET	REV	SCALE
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Figure 2 (P378015-D01-84)

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APPENDIX 8-7

FEHILY TIMONEY FIGURES

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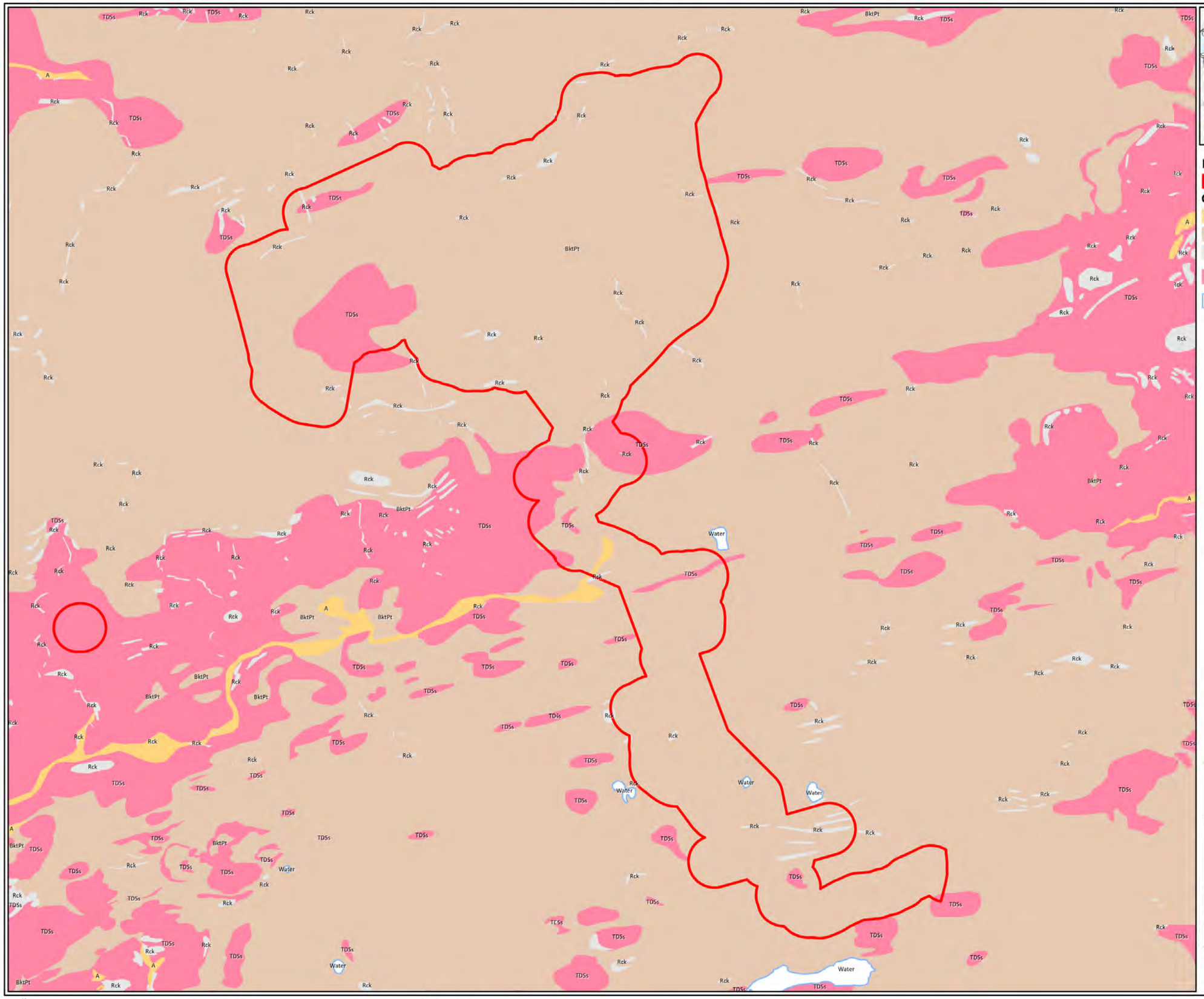

Legend

- Site Boundary

Quaternary Sediments

- A, Alluvium
- BktPt, Blanket Peat
- Rck, Bedrock outcrop or subcrop
- TDSs, Till derived from Devonian sandstones
- Water

TITLE:	Quaternary Geology		
PROJECT:	Derrybrien Wind Farm OHL Decommissioning		
FIGURE NO:	8-xx		
CLIENT:	ESB EMP		
SCALE:	1:40,000	**REVISION:**	0
DATE:	22/04/2025	**PAGE SIZE:**	A3

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N W E S

0 1 2 4 Kilometers

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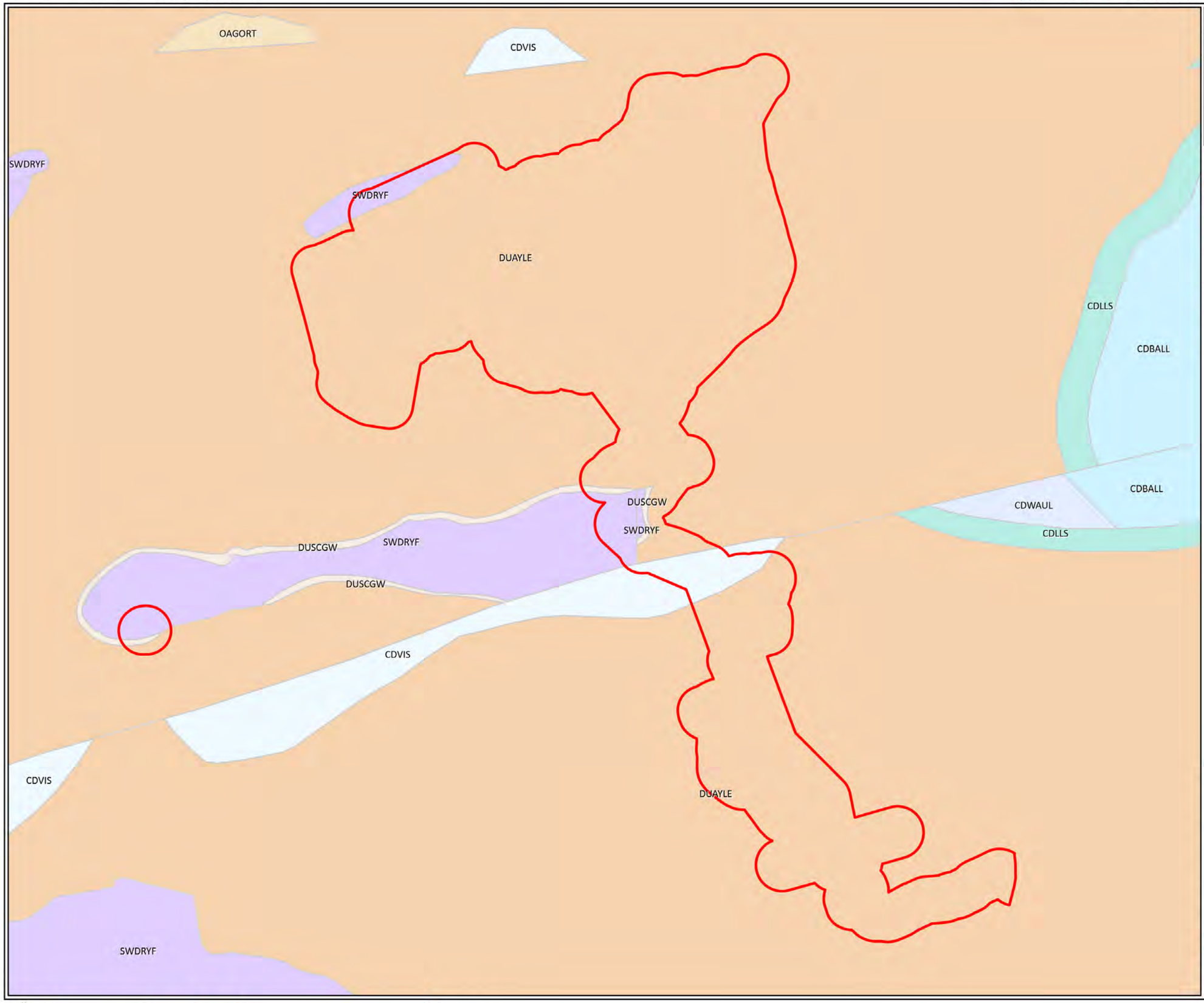

Legend

Site Boundary

Bedrock Geology

- Ballysteen Formation
- Lower Limestone Shale
- Visean Limestones (undifferentiated
- Waulsortian Limestones
- Ayle River Formation
- Scalpnagown Formation
- Gortnagleav Formation
- Derryfadda Formation

TITLE:	Bedrock Geology		
PROJECT:	Derrybrien Wind Farm OHL Decommissioning		
FIGURE NO:	8-xx		
CLIENT:	ESB EMP		
SCALE:	1:40,000	**REVISION:**	0
DATE:	22/04/2025	**PAGE SIZE:**	A3

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N W E S

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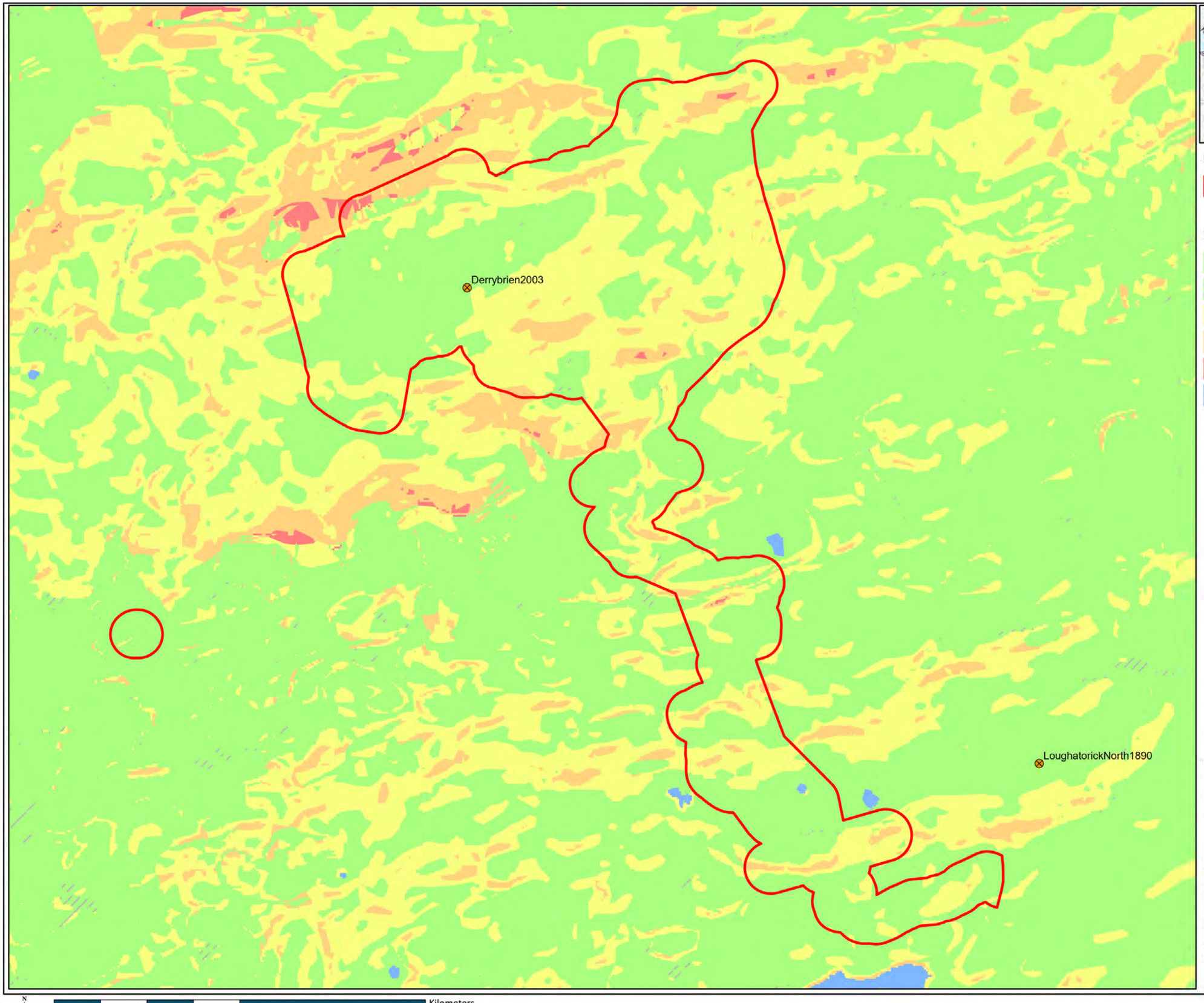

Legend

- Site Boundary
- Landslide Events

Landslide Susceptibility Classification

- Low
- Low (inferred)
- Moderately Low
- Moderately High
- High
- Water

TITLE:	Landslide Susceptibility		
PROJECT:	Derrybrien Wind Farm OHL Decommissioning		
FIGURE NO:	8-xx		
CLIENT:	ESB EMP		
SCALE:	1:40,000	**REVISION:**	0
DATE:	22/04/2025	**PAGE SIZE:**	A3

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Legend

Site Boundary

Bedrock Aquifers

LI: Locally Important Aquifer - Bedrock Mod Productive Locally

PI: Poor Aquifer Bedrock Generally Unproductive Except Locally

Karst Features

Enclosed Depression

Spring

TITLE:	Groundwater Productivity		
PROJECT:	Derrybrien Wind Farm OHL Decommissioning		
FIGURE NO:	8-xx		
CLIENT:	ESB EMP		
SCALE:	1:40,000	**REVISION:**	0
DATE:	22/04/2025	**PAGE SIZE:**	A3

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N W E S

0 1 2 4 Kilometers

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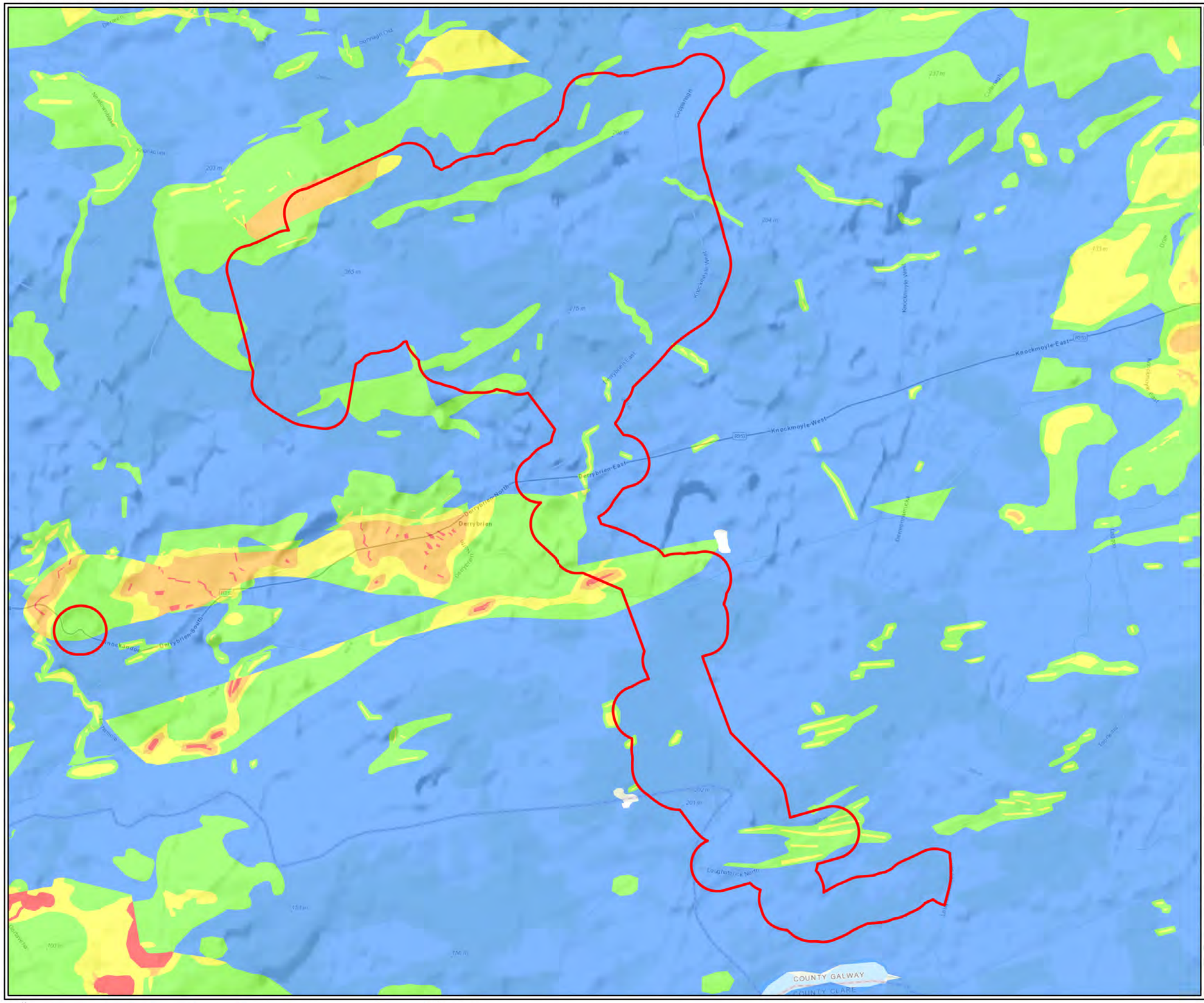

Legend

Site Boundary

Crushed Rock Potential

- Very High potential
- High potential
- Moderate potential
- Low potential
- Very Low potential

N W E S

0 1 2 4 Kilometers

TITLE:	Crushed Rock Potential		
PROJECT:	Derrybrien Wind Farm OHL Decommissioning		
FIGURE NO:	8-xx		
CLIENT:	ESB EMP		
SCALE:	1:40,000	**REVISION:**	0
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APPENDIX 9-1

FLOOD RISK ASSESSMENT

Derrybrien Wind Farm Development Decommissioning Project – Prospective Development

Gort Windfarms Ltd.

Flood Risk Assessment

Document No.: QS-000280-01-R460-010-000

November 2024

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Project Location and Setting

The boundaries of the Derrybrien Wind Farm Development area on a regional scale lie almost entirely in the Kinvara Water Management Unit (total drainage area of 637 km^2) within the Western River Basin District (RBD) (hydrometric area 29). A small area (<0.02 km^2) to the north-east corner of the wind farm site lies within the neighbouring Shannon Upper and Lower Water Management Unit within the Shannon International RBD (IRBD) (Figure 1).

The Derrybrien Wind Farm Development lies on Cashlaundrumlahan Mountain in the northern part of the Slieve Aughty Mountains in south County Galway, 12.7 km east-northeast of Gort, 12.7 km due south of Loughrea and 25 km west of Portumna. The lands within the wind farm site comprise disturbed peat bog, all of which was formerly used either for commercial Coillte forestry plantation (263 ha) or turbary bog lands (81 ha) (i.e. cut-over bog). The overall area of the wind farm site is approximately 344 ha (3.44 km^2) but the wind farm infrastructure comprises approximately 5% of the site area in terms of tracks, turbine bases and access areas). Site elevations range from 320–365 mOD on the upper hill slope forming the wind farm, which form a gently sloping plateau aligned on a northeast to southwest axis. Slopes range from less than 3 degrees locally up to 10 degrees in places with the typical slopes falling between 3 and 7.5 degrees (Figure 2). There is a broad zone that runs across the full width of the site for a distance of approximately 250 – 300 m to the north and south of the peak of the mountain where the ground surface slopes gently away from the peak at slope angles of less than 3 degrees, representing almost a plateau top. This is within the central three rows of turbines. To the south of this zone the slope is convex in profile with slopes generally increasing up to 4 – 5 degrees and locally 5.0 – 7.5 degrees within the site boundary, particularly between Turbines T21 and T41. In general, the depth of peat is inversely proportional to the slope angles, i.e. peat is deeper across the middle of the site and shallower around the boundaries.

Downslope from the site in this area the slopes increase up to 7.5 degrees more consistently and locally up to 10.0 degrees. The peat slide during construction in 2003, occurred within this zone of locally steeper slopes between Turbines T68 and T70.

The full site had been drained in the past, prior to any wind farm construction, by a series of parallel open ditches to facilitate peat production (Turf cutting and peat harvesting) and commercial forestry. These ditches and drains in the worked bog and forestry areas discharged to the natural surface watercourses conveying downstream to the south the hill slope runoff (Plate 1 and Plate 2).

Turf cutting (peat harvesting) continues to take place on the eastern part of the site. Farming is also undertaken in the lower lying areas away from the site. The principal economic activity in the immediate area is forestry and farming, the latter being dominated by grazing of cattle. Commercial forestry at various stages of planting, growing and harvesting continues on adjacent lands to the wind farm site but not on the wind farm site itself.

The roads on site prior to the wind farm project generally followed an east-west axis parallel to topographical contours. The road layout of the wind farm also, generally follows an east-west orientation, with a number of spur roads connecting these from north to south, including along the internal boundary of the wind farm site.

Plate 1 Typical site land at Derrybrien Wind Farm

Plate 2 Original drainage channel at Derrybrien

In addition to the wind farm site, the study area also comprises the approximately 10 m wide corridor of the 7.7 km overhead line running southward from the wind farm site and the grid connection substation at Agannygal connecting the wind farm to the National Grid (Figure 3). The elevation along the route falls to a flat-bottomed valley where it crosses the R353 road and the tributaries of the Owendalulleegh River at an elevation of approximately 130 mOD. From here, the route skirts around the outside of the Slieve Aughty Bog Natural Heritage Area (NHA, site number 001229) before gaining elevation again as it passes Lough Agannygal, at about 195 mOD. The route ends at the Agannygal Substation, which is located to the southeast of Cashlaundrumlahan Mountain and north of Lough Atorick, at an elevation of approximately 190 mOD.

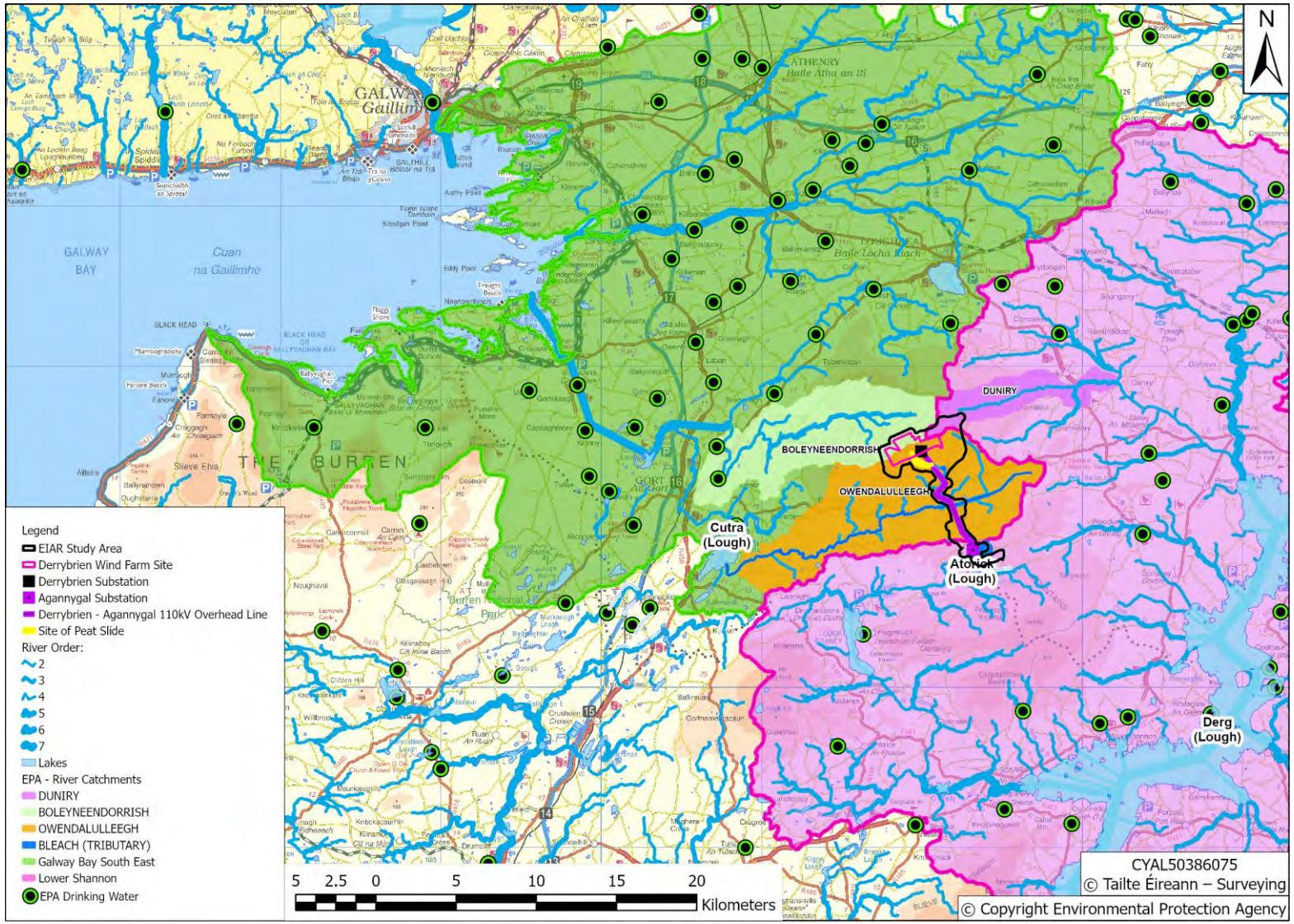

Figure 1 Catchments in relation to Derrybrien Wind Farm Development

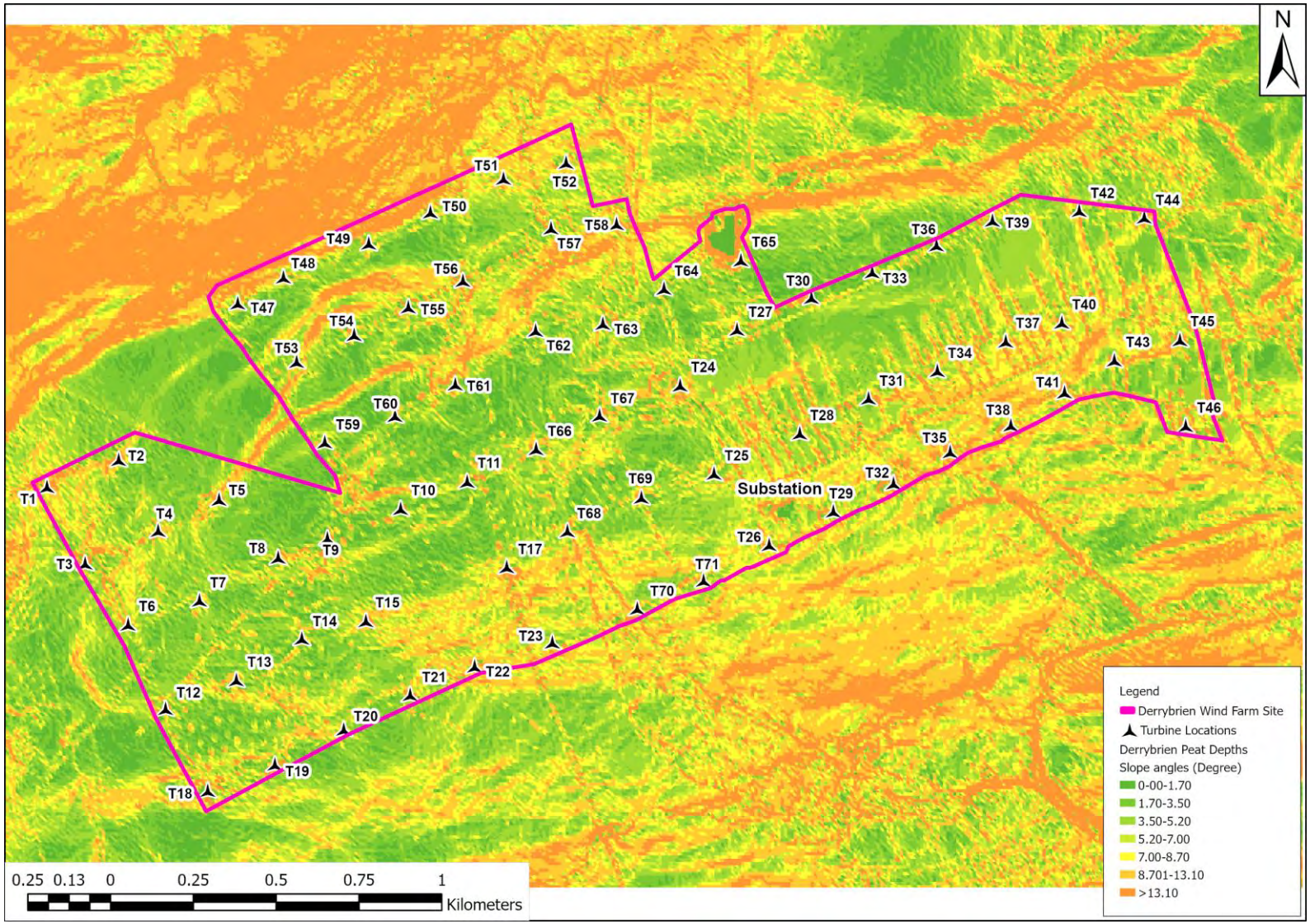

Figure 2 Ground surface slope angles based on post construction LIDAR Survey

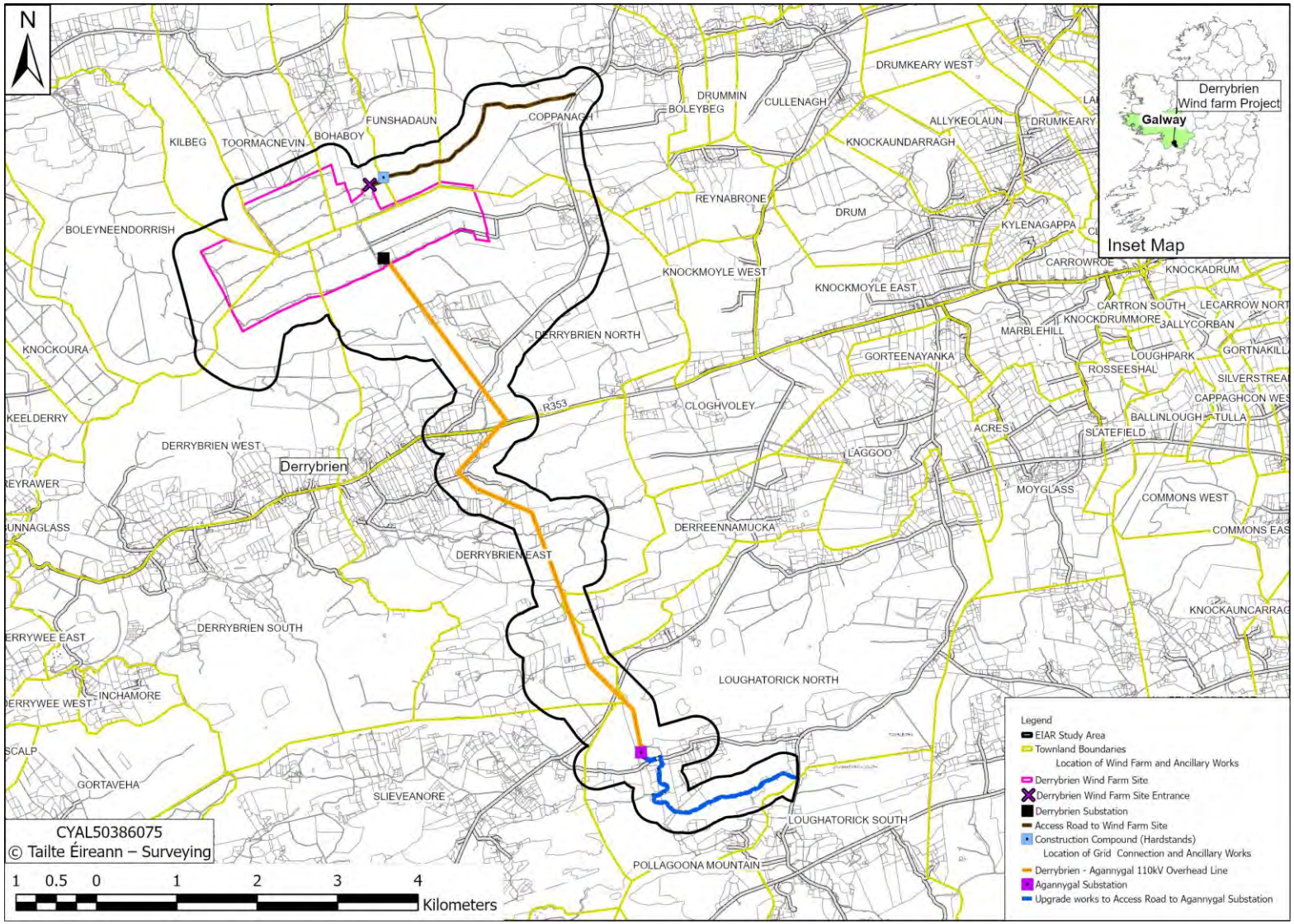

Figure 3 Location of the Derrybrien Wind Farm Development Project - Prospective Works

Scope

This assessment considers the following:

I. The Department of Environment, Heritage and Local Government guideline document to Planning Authorities in relation to Flood Risk Management (November 2009);
II. Climate Change;
III. Review of data on recorded historic floods;
IV. Flood Risk to the Project Areas from flood fluvial flows in neighbouring watercourses and direct rainfall causing pluvial flooding;
V. Risk of flooding from groundwater;
VI. The impact of surface water runoff from the Project Areas on the flow regimes in downstream watercourses;
VII. Loss of floodplain.

I. Planning Guidelines

In November 2009 the Department of Environment, Heritage and Local Government issued "The Planning System and Flood Risk Management Guidelines for Planning Authorities".

These Guidelines set out the policy on development and flood risk in Ireland and provide a framework for the integration of flood risk assessment into the planning process. The objective is to ensure that flood risk is taken into account at all stages in the planning process and as a result to:

- Avoid inappropriate development in areas at risk of flooding,
- Avoid new developments that cause an increase in flood risk elsewhere,
- Ensure effective management of residual risks for development permitted within floodplains.

The Guidelines set out a staged approach for the consideration of flood risk in relation to developments as follows: -

"*Stage 1: Flood risk identification – to identify whether there may be any flooding or surface water management issues related to either the area of regional planning guidelines, development plans and LAP's or a proposed development site that may warrant further investigation at the appropriate lower level plan or planning application levels;*"

"*Stage 2: Initial flood risk assessment – to confirm sources of flooding that may affect a plan area or proposed development site, to appraise the adequacy of existing information and to scope the extent of the risk of flooding which may involve preparing indicative flood zone maps. Where hydraulic models exist the potential impact of a development on flooding elsewhere and of the scope of possible mitigation measures can be assessed. In addition, the requirements of the detailed assessment should be scoped;*" and

"*Stage 3: Detailed flood risk assessment – to assess flood risk issues in sufficient detail and to provide a quantitative appraisal of potential flood risk to a proposed or existing development or land to be zoned, of its potential impact on flood risk elsewhere and of the effectiveness of any proposed mitigation measures.*"

The Guidelines classify developments into three vulnerability classes based on the effects of flooding

i) Highly vulnerable development,

ii) Less vulnerable development and

iii) Water Compatible development.

Essential infrastructure such as electricity substations and wind turbines are classed as highly vulnerable developments.

The Guidelines classify land areas within three flood zones based on the probability of flooding. Flood zones are defined as follows in the Guidelines:

- Zone A is at high risk. In any one year, Zone A has a 1 in 100 year (1%) chance of flooding from rivers and a 1 in 200 year (0.5%) chance of flooding from the sea.
- Zone B is at moderate risk. The outer limit of Zone B is defined by the 1 in 1,000 year (or 0.1%) flood from rivers and the sea.
- Zone C is at low risk. In any one year, Zone C has less than 1 in 1,000 year (<0.1%) chance of flooding from rivers, estuaries or the sea.

In the identification of flood zones, no account should be taken of any flood defences present (i.e. flood relief walls or embankments), as though such flood defences did not exist.

Development Classification	**Flood Zone A (High Probability of Flooding)**	**Flood Zone B (Moderate Probability of Flooding)**	**Flood Zone C (Low Probability of Flooding)**
Highly Vulnerable Development (including essential infrastructure)	Justification Test	Justification Test	Appropriate
Less Vulnerable Development	Justification Test	Appropriate	Appropriate
Water-Compatible Development	Appropriate	Appropriate	Appropriate

Table 1 Matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test (reproduced from Planning Guidelines)

Table 1, which is reproduced from the guideline document to Planning Authorities in relation to Flood Risk Management states that essential infrastructure, including electricity substations and electricity generating wind turbines should be located within the low flood risk zone - Flood Zone C (as highlighted above). Given the proposed Project is to decommission this infrastructure, the development shall ultimately be reclassified as a Less Vulnerable Development and a moderate probability of flooding is therefore acceptable.

Table 1 refers to the use of a Justification Test under certain circumstances. In cases where there are insufficient sites available to locate a development in the appropriate low flood risk zone, the guideline documents allows for consideration of sites within flood risk zones. A Justification Test is then required to assess such proposals in the light of proper planning and sustainable development objectives.

II. Climate Change

The Planning System and Flood Risk Management Guidelines for Planning Authorities recommend that climate change be factored into consideration for flood risk assessments although there is no national guideline on how to account for the additional risk. The Guidelines instead recommend a precautionary approach to climate change effects in respect to flooding due to the high level of uncertainty in predicting its effects.

However, as the scope of this EIAR is limited to the works to decommission specific features of the existing Derrybrien Wind Farm and not the retained development beyond the decommissioning phase, it is considered that accounting for climate change is not appropriate for this flood risk assessment. It should be noted that climate change is considered for the flood risk assessment of the retained development as part of a separate application.

III. Historical Floods

A desk review of historical flooding was undertaken primarily using OPW website floodinfo.ie. The 'Past Flood Events' layer forms a record of all available flood records held by the OPW, all local authorities and other relevant state organisations such as the EPA and the Department of Communications, Climate Action and Environment. There are no mapped reports of recurring flooding within the site and there is no significant risk of flooding due to the elevated nature of the majority of the Project area relative to the surrounding area (Figure 4). The nearest area downstream affected by extensive flooding in the catchment which drains the north side of the wind farm site is 15 km downstream at Ballylee on the Streamstown River. The nearest area downstream affected by extensive flooding in the catchment draining the south side of the wind farm is over 20 km downstream close to Gort. The history of flooding in the Gort Lowlands area is discussed in detail in Appendix 9-2.

There is no "liable to flood lands" or flood symbols on the historical 6" or 25" mapping for the Project areas that identifies areas that are "prone to flooding" within or immediately downstream of the site. There are also no areas within the site or immediately downstream of it mapped as "Benefiting Lands" and are indicative of areas of land identified as subject to flooding or poor drainage which have been the subject of an public works drainage scheme, either as an OPW arterial drainage scheme or a Local Authority drainage district. The nearest such drainage district to the Project study area is the Annagh Drainage District located downstream of Peterswell in the Boleyneendorrish catchment.

With regard specifically to groundwater flood risk, there is no history of groundwater flooding arising on the wind farm site, the Geological Survey of Ireland (GSI) has produced a national-scale flood map presenting the maximum historic observed extent of karst groundwater flooding. The map is primarily based on the winter 2015/2016 flood event, which in most areas including south Galway represented the largest groundwater flood event on record. The map was produced based on remote sensing imagery of the 2015/2016 event as well as any available supplementary evidence. The floods were classified by flood type differentiating between floods dominated by groundwater (GW) and floods with significant contribution of groundwater and surface water (GWSW) (https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=848f83c85799436b808652f9c735b1cc – accessed 23rd October 2024). The mapping does not indicate historical groundwater flooding affecting the Derrybrien wind farm site.

The wind farm site has been managed for almost 20 years and there is no record of any serious flooding on or in the vicinity of the Project areas in that time despite a number of large flood events affecting the surrounding region. Gort Town was and is affected by flooding with an OPW Flood Relief Scheme successfully implemented for the Main Street bridge area in 1997. However, the areas downstream of Gort have experienced inundation during prolonged winter floods. Lough Cutra is gauged by the OPW and the lake level generally rises and falls by 1.2 m over the course of a year between the driest and wettest periods.

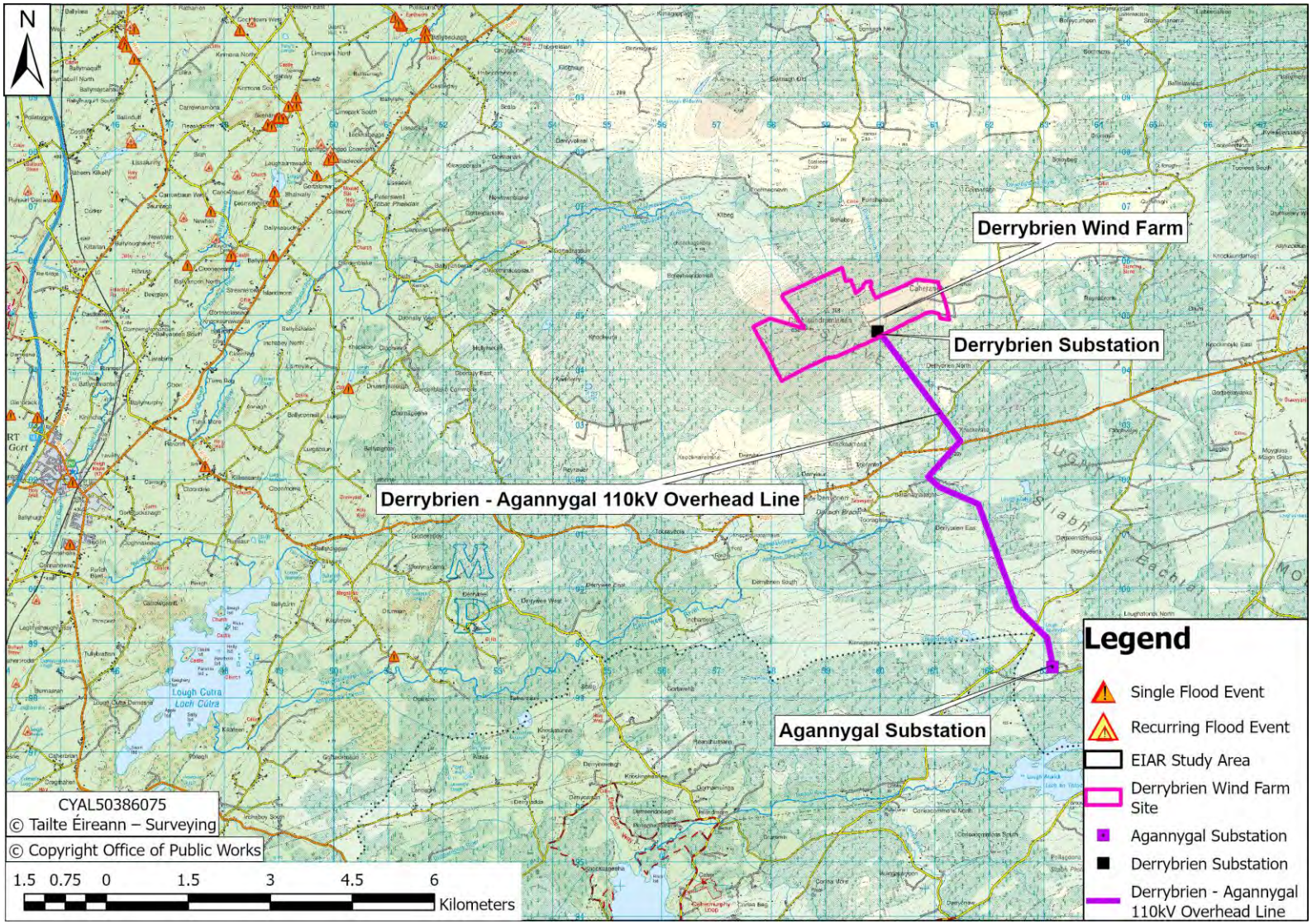

Figure 4 Past Flood Events mapped by OPW

IV. Flooding Risk to Project Area

CFRAMS and NIFM Mapping

As part of Ireland's obligations under the EU "Floods" Directive (Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks), the OPW is currently engaged in the generation of new mapping which will provide predictive estimates of the extent of floodplains as part of its CFRAM Studies. This programme is being undertaken on a River Basin District basis. The Derrybrien Wind Farm Project site is primarily located within the Western River Basin District with a very small section of the site within the Shannon District. The Western CFRAMS programme was carried out between 2011 and 2016. Finalised flood maps were released through floodinfo.ie in April 2018. The OPW CFRAMS river flood maps and CFRAMS National Indicative Fluvial Mapping (NIFM) maps were consulted to identify those areas at risk of flooding.

The NIFM mapping shows the extents of the indicative 100-year flood zone which relates to fluvial (river) flood events. This mapping is based on fluvial sources for catchments in excess of 5km^2 and assumes within channel has capacity for 80% of the annual flood and remainder floods its overbanks based on hydraulic modelling using a DTM ground level model. There is no 100-year or 1000-year fluvial flood zone mapped within the Project area, which includes the overhead line (OHL) route and Agannygal substation (Figure 5). Where it is mapped in close proximity to the development, it typically exists in close proximity to the main Owendalulleegh and Boleyneendorrish River channels or its contributing second or third order streams. No pluvial flood zones are mapped within the site, as would be expected in mountainous rural terrain with sloping topography. CFRAMS interactive flood mapping (www.floodinfo.ie) does not identify and analyse areas at risk of flooding close to the wind farm site as it was not considered by the OPW as an Area for Further Assessment (AFA) as part of the CFRAMS programme.

During the post-construction phase of the wind farm, the drainage network has experienced a variety of large storm events. These have ranged from intense short-duration events in which approximately 60 mm of rain fell in 24 hours (as measured at Gort Derrybrien II Met Station) (7th June 2012, Storm Desmond on 5th December 2015) to long-duration winter floods which saturated the wider area (November 2009, December 2015 to January 2016, February 2020).

The drainage network on the wind farm has to date demonstrated sufficient capacity to convey floodwaters without excessive flooding of access tracks and turbine bases or erosion of drainage channels. Similarly, the drainage networks associated with both substations have no record of flooding issues since commissioning (14 years). It is reasonable to conclude that the wind farm site, OHL route and Agannygal substation site, being on elevated upland sites, with the exception of a small area on the OHL line, are located in Flood Zone C and are therefore at low risk of flooding as defined by the Planning Guidelines. Notwithstanding the low fluvial and pluvial flood risk, the raised bog acts as a saturated sponge and retains the water table at or close to ground level in undrained areas.

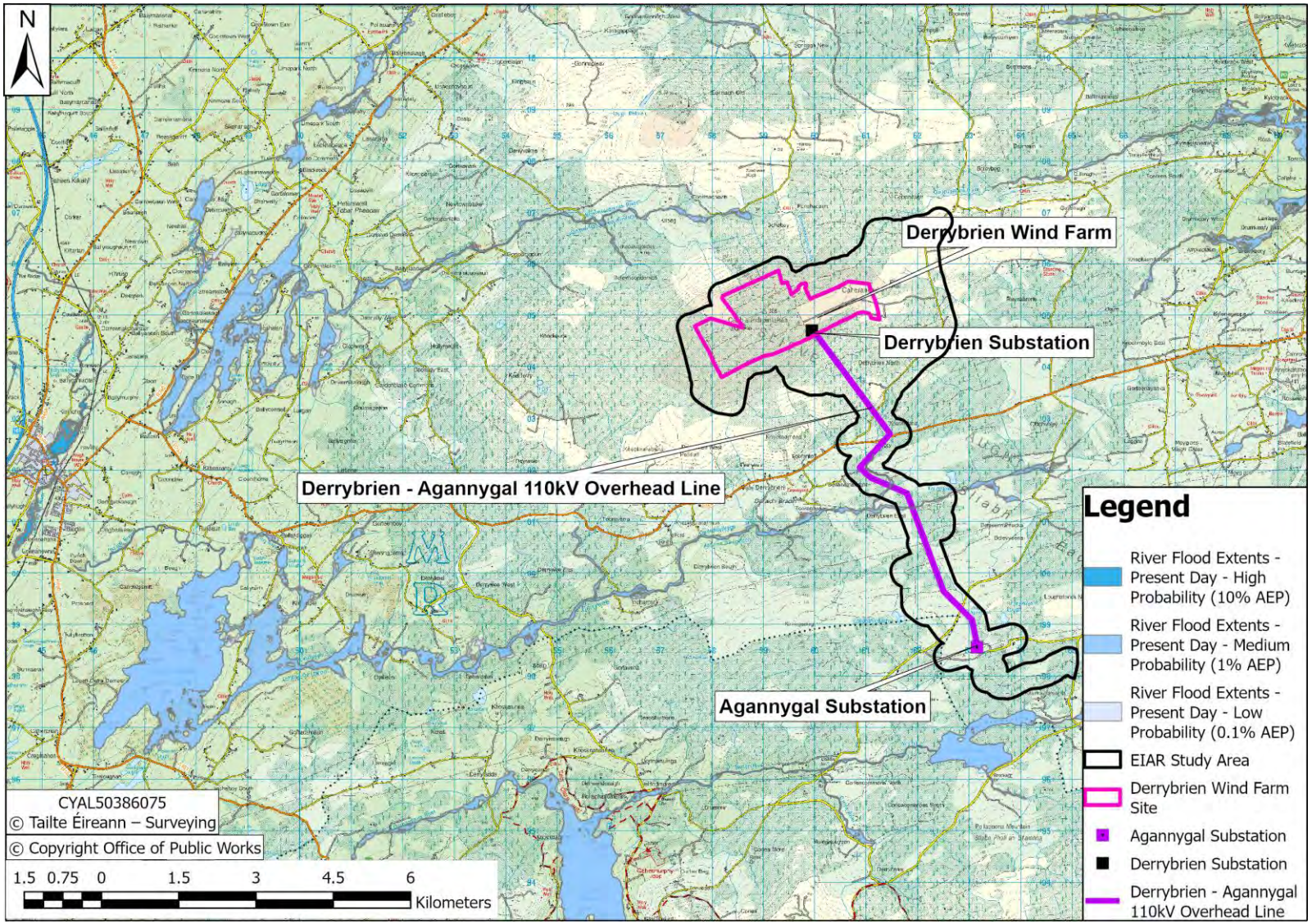

Figure 5 OPW CFRAMS Fluvial Flood Mapping

GSI Mapping

The predictive groundwater flood map produced by GSI presents the probabilistic flood extents for locations of recurrent karst groundwater flooding. It consists of a series of stacked polygons at each site representing the flood extent for specific AEP's mapping floods that are expected to occur every 10, 100 and 1000 years (AEP of 0.1, 0.01, and 0.001 respectively). The map is focussed primarily (but not entirely) on flooding at seasonally inundated wetlands known as turloughs. Sites were chosen for inclusion in the predictive map based on existing turlough databases as well as manual interpretation of SAR imagery.

The mapping process tied together the observed and remote sensing-derived hydrograph data, hydrological modelling, stochastic weather generation and extreme value analysis to generate predictive groundwater flood maps for over 400 qualifying sites. It should be noted that not all turloughs are included in the predictive map as some sites could not be successfully monitored with remote sensing technology and/or modelled. This mapping suggests the wind farm site, substations and OHL route all lie in Flood Zone C and are at low risk of groundwater flooding (Figure 6).

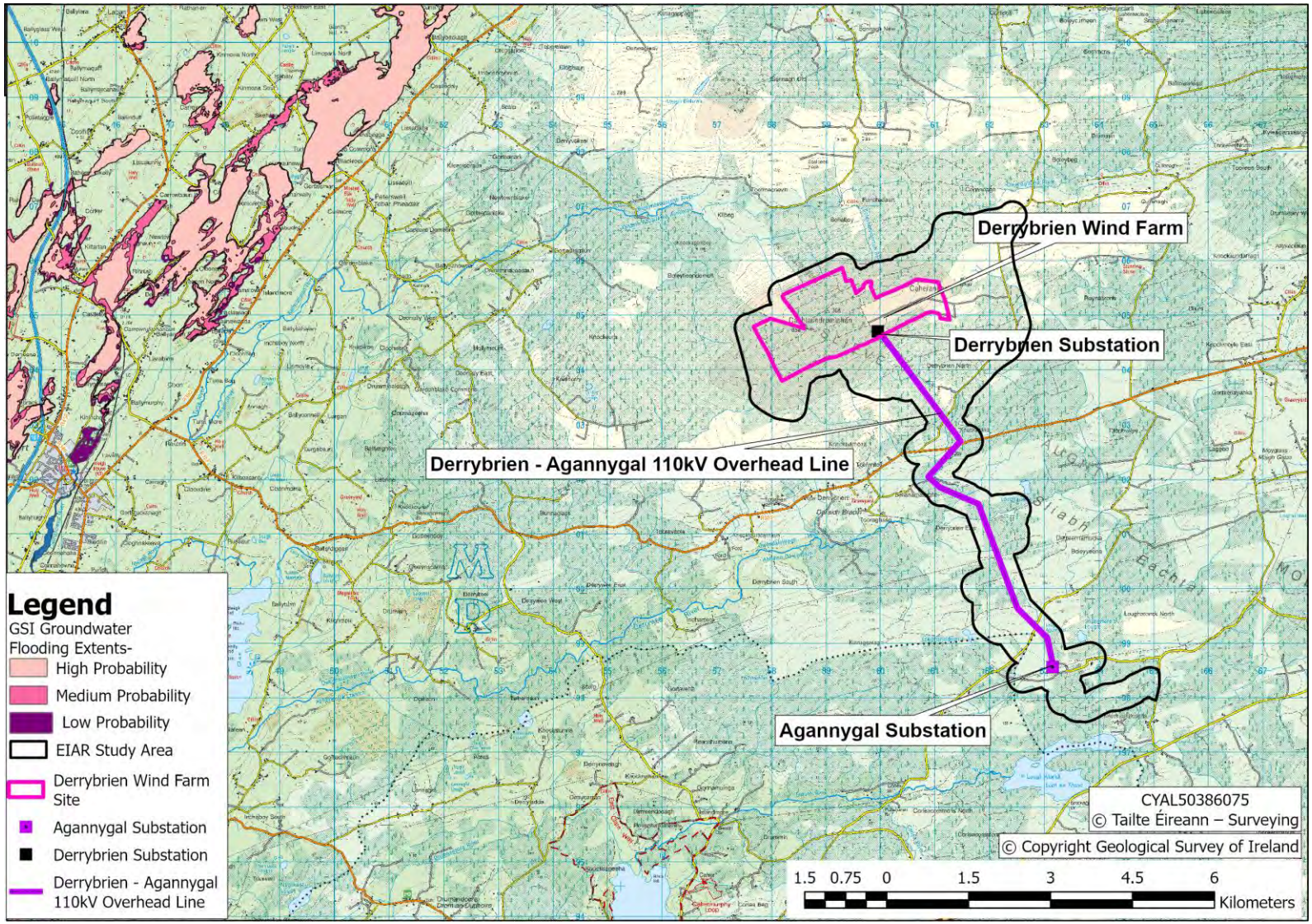

Figure 6 GSI Groundwater Flooding Probability Mapping

Derrybrien Wind Farm Development

Baseline Environment (2024)

The drainage system on the Derrybrien Wind Farm Development site (Figure 7) is by gravity flow following the natural gradient of the site, utilising a network of longitudinal drains and stream channels to discharge surface drainage waters off site to the local river systems. All of the drains and watercourses are narrow open channels, typically 1-2 m deep, with culverts under the site access tracks. Where the peat is shallow the drains penetrate into the underlying glacial till. However, in peat depths greater than 1-2 m deep the drains are only excavated into the peat layer. At the east end of the site the drainage network reflects the outline of the turbary plots. Slope angles in the drainage network vary from 2 to 5 degrees (i.e. gradients of 1:10 to 1:30), with the steepest channels draining toward the southeast.

Elevated blanket bogs such as the Derrybrien Wind Farm Development are wetlands that are fed directly by rainfall to give rise to their characteristic saturated and waterlogged surface conditions. The living surface peat layer (0.1 – 0.3 m thick), the acrotelm, can have a moisture content of 90 – 98% and features the peat-forming vegetation, i.e. sphagnum moss, cotton grass and other materials including purple moor grass, heather stems and roots. The acrotelm supplies plant material which then slowly forms peat in the underlying catotelm layer. Typically these active peat bogs grow slowly at 0.5 to 1.0 mm per annum. In active bogs sphagnum mosses form a protective carpet which is a mosaic of sphagnum species growing as dense hummocks, low growing lawns and as hollows that create the characteristically undulating bog surface. In these undrained conditions the saturated bog promotes increased surface ponding as pools and mires, also generating overland runoff as sheet flow across a wider surface of the bog. Active blanket bog generally remains close to saturation throughout the year and therefore has limited available flood storage except in depressions where larger pools can form before spilling overland.

In the case of the Derrybrien Wind Farm Development site, the land use represents a drained bog situation, representing a degraded bog condition. In damaged or degraded bogs because of drainage, burning, trampling / grazing, afforestation or agriculture (which includes fertiliser application as well as drainage) the surface the acrotelm can be lost resulting in the underlying catotelm layer being exposed to atmospheric conditions including surface water runoff, erosion, cracking, drying and wetting and the establishment of non-wetland vegetation, which accelerates the aeration, drying and shrinkage process referred to as primary consolidation. The loss of moisture and thus buoyancy in the upper layers further squeezes water from the catotelm layer giving rise to secondary compression.

Drainage of peat bogs is generally focused on lowering the perched / shallow water table in the peat through a network of deep connecting drains to provide an unsaturated soil root zone that enables plant growth to succeed. The construction of drainage ditches in a bog provides shorter pathways for surface water to run off and, depending on the density of the drainage network, will ultimately reduce waterlogging and over time, dry out the surface acrotelm layer and more gradually the upper layers of the catotelm. The acrotelm layer offers relatively low resistance to vertical and lateral water movement and, consequently, drainage tends to empty water reasonably readily from the acrotelm layer. However, given this layer is relatively thin, the drainage effects on the surrounding water table are minor. By contrast, due to its

compressed nature and very low permeability the catotelm layer drains very slowly (over many years to decades. Consequently, the drying process will over time alter the surface topography and increase the range in the water table between summer and winter levels.

Given the upland nature and gradients of the area, the nature of the quaternary and geology and shallow water table, the site on which the wind farm was developed represents high runoff category lands or conversely low winter rainfall acceptance potential based on the Flood Studies Report (NERC, 1975) classification.

Approximately 12 km of road drainage and turbine foundation drainage was constructed for the wind farm project (in addition to retaining c. 27 km of pre-existing drainage for turbary bog and forestry drainage), most of which connect the turbine foundation drainage to the pre-existing drains on site. Figure 7 shows the network of open drains on the site, both pre-existing former drainage in cyan and additional constructed collector drainage in magenta. The vast majority of the circa 27 km of pre-existing channels were left unchanged during construction except where there was a conflict with wind farm infrastructure. In areas where there were high concentrations of flow upstream of access tracks and / or close to turbine foundations, sections of drainage were re-aligned or deepened to reduce any risk of localised surface ponding and saturate conditions that could give rise to buoyancy issues in respect to the turbine structure. Some minor cleaning out and maintenance work took place as required.

Regular maintenance has been carried out as necessary since commissioning of the windfarm site. These included clearing out blocked drains at inlets or outlets, deepening or widening drains to increase capacity and flattening of side slopes along access tracks at the main watercourse crossings, regrading drains that were shown to have insufficient fall and repair or replacement of collapsed culverts. Drainage inspections are carried out monthly and following heavy rainfall or snow events. In addition to this, annual geotechnical inspections have identified drainage maintenance issues which generally involve localised clearing out and maintaining sections of site drains.

The use of floating roads, which accounts for 18.8 km out of 19.7 km of on-site access tracks (both pre-existing and constructed), facilitates rainwater infiltration into the peat layer beneath and as such does not require additional roadside drainage with rainwater falling onto the road allowed to spill over the edge into the undisturbed peat depending on local gradients. Floating roads are considered sympathetic to the natural drainage as they act neither as a barrier nor as a deep wide permeable drain that could dewater the adjacent saturated peat into its permeable formation layer and provide a drainage pathway convey drainage water elsewhere with the longitudinal gradient of the road. It should be noted that 2.24 km of tracks on the site prior to wind farm construction were floating roads. These allowed surface water to pass without issues or need for diversions. It is therefore with confidence that one can comment on the effect of floating roads on drainage at this wind farm site. The remaining 0.9 km of road which was non-floating were in small sections around Borrow Pit / Quarry 3 in the north-east corner of the site and at turbines T68 and T70 which were rebuilt with rockfill embankments following the peat slide in October 2003.

During storm events, runoff from hardstanding areas drain to the network of wind farm drains from which they eventually converge to reach the downstream watercourses. These drains

have been and continue to be inspected and maintained to ensure their integrity and provide for efficient drainage from the wind farm site before meeting with rivers downstream.

Culverts have been inserted at various wind farm access road crossings as necessary to maintain the conveyance path of the drains crossed and thus prevent excessive ponding of water on the uphill sides of these roads. The culverts installed are necessary to maintain the drainage runs and avoid unnecessary diversions of drainage on the site.

It should be noted that the extent of constructed wind farm drainage is, in comparison to similar developments of this type and scale, minor relative to the overall pre-existing drainage.

The wind farm site lies on relatively gently sloping ground surrounding the Peak of Cashlaundrumlahan Mountain which is the watershed to a number of small subcatchments that drain from this summit to eventually reach the downstream streams and rivers to the north and south of the wind farm site. As such there are no external surface water inflows and only the direct rainwater falling on the site contributes to increases in flows and water levels.

Given the minor nature of the drains and catchment area discharging from summit through the Windfarm, they represent ungauged catchments and require the application of ungauged flood estimation methods to determine the Greenfield runoff rates and the return period design flows for quantification of runoff rates and flooding.

Impact of Prospective Development on flood regime

The Prospective Development will entail dismantling of all turbines (blades, hub, nacelle and towers) and electrical disconnection. As no elements of the development are in operation, the wind farm development site can be considered as a Less Vulnerable Development for the duration of the decommissioning works as defined by Table 3.1 of the Planning Guidelines.

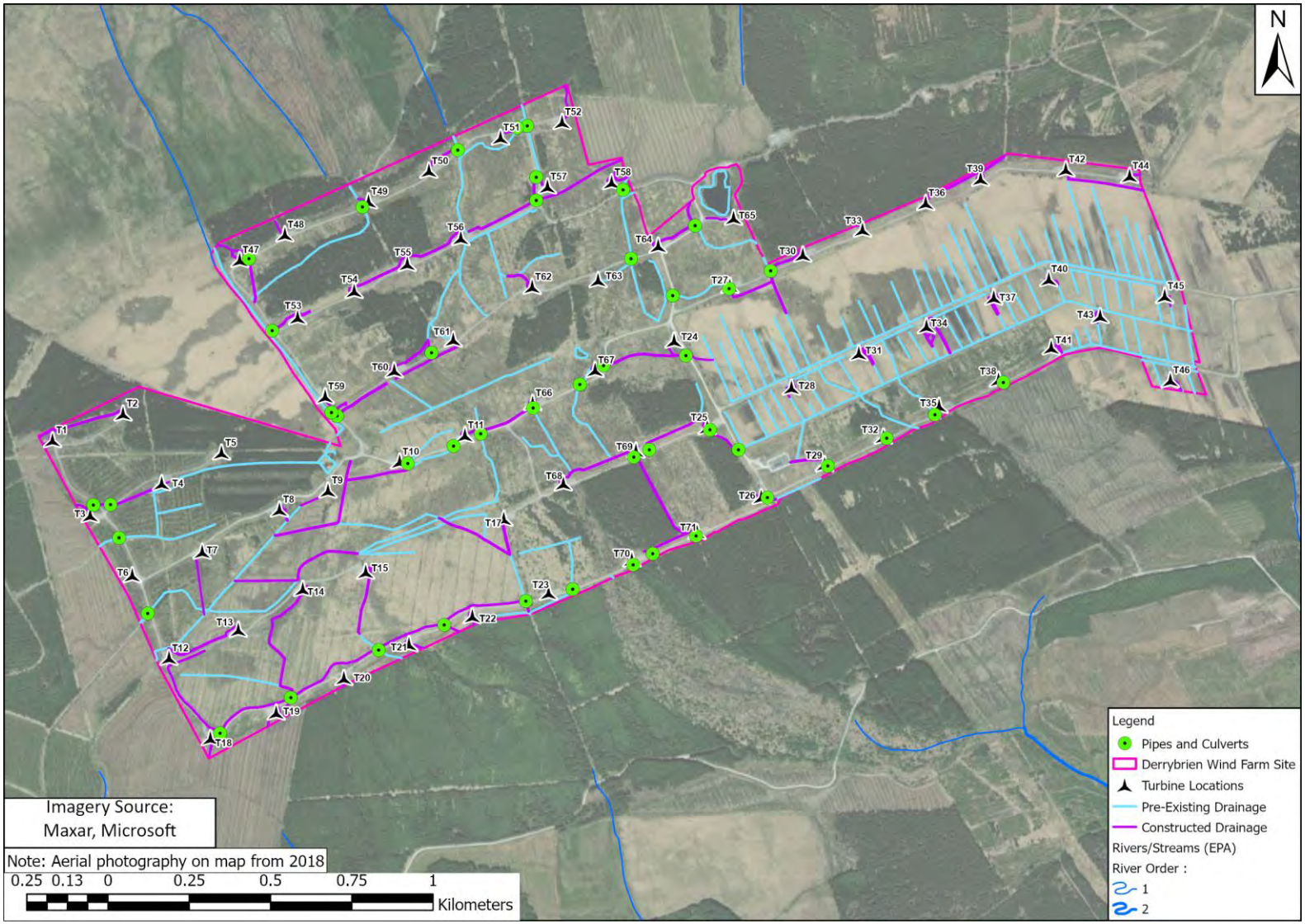

Figure 7 Derrybrien Wind Farm Development - Pre-existing and constructed drainage

Derrybrien 110 kV Substation

Baseline Environment

The 110-kV substation lies in an area with topography sloping generally from northwest to southeast. Any surface runoff affecting the substation area should constitute direct rainfall and / or overland flow from a small area of c. 0.05 km^2 (5 ha). The total fall between the top of this small catchment and the station is 17 m (347 mOD to 330 mOD) with an average gradient of 1:30 across the area.

The permeable area of substation compound constructed as part of the wind farm Project is finished on 50 mm single size clean compound stone. The permeable compound stone provides a means of attenuation for runoff and allows rainwater to infiltrate to ground similar to a Greenfield site. Rainwater from the roof of the control building connects via downpipes and drainage pipes away from the compound into the wind farm drainage system. The concrete access road within the compound is cambered to drain to the permeable compound stone. A deep drain to the southeast of the substation constructed as part of the Project conveys water using the natural steep gradient (approximately 1:10) via a culvert underneath the wind farm access track off-site to a pre-existing drain close to turbine T29 (Plate 3). This pre-existing drain then conveys water to the southeast passing through the steeply sloping Coillte forestry before joining the Derrybrien North River, a tributary of the Owendalulleegh River, just below the October 2003 slide area.

Impact of Prospective Development on flood regime

The high voltage equipment, the substation, and control building will be dismantled, and all equipment removed from site. The drainage channel running downstream from the substation will not be impacted by decommissioning activities. The hardstand area for the substation will be left in place after decommissioning. As no elements of the substation are in operation, the it can be considered as a Less Vulnerable Development as defined by Table 3.1 of the Planning Guidelines.

Agannygal Substation

Baseline Environment

The substation is elevated with respect to the surrounding area to the north, west and south. There is no record of pre-existing drainage or flooding issues on the site of the substation prior to construction and it is provisionally placed in Flood Zone C. The level of the station compound is 192.5 mOD.

The overall area of the compound is approximately 3,000 m^2, of which 350 m^2 or 12% is impermeable roof drainage. The permeable area of substation site constructed as part of the wind farm Project is finished on 50 mm single size clean compound stone. The permeable compound stone provides a means of attenuation of runoff and allows rainwater to infiltrate to ground as it would on a Greenfield for this portion of the site. A system of land drains installed around the substation collects additional surface water drainage, particularly overland flow to the higher eastern boundary of the substation. This water drains offsite as per Figure 8 where it leaves site with the land drainage. Runoff then flows down a steep vegetated shallow

channel next to the substation access road to where it joins with the local public road at an elevation of 181 m OD (Plate 4 and Plate 5).

Impact of Prospective Development on flood regime

The decommissioning of Agannygal Substation will involve the removal of the above ground elements of the substation and will entail de-energising of the electrical equipment in site and removal of the control building and equipment. The hardstand area for the substation and control building will be left in place after decommissioning as will the access road to the site. As no elements of the substation are in operation, it can be considered as a Less Vulnerable Development as defined by Table 3.1 of the Planning Guidelines. The designation of the decommissioned site is subject to a separate flood risk assessment as part of the rEIAR application.

It is reasonable to assume that there would be no increase in overall runoff rates associated with the decommissioning of the substation. Compared to the original Greenfield condition, there will be a small increase in runoff rates arising from the continued presence of hardstanding substation areas and its tarmac access road. Rather than rainfall runoff being dispersed over the area per its Greenfield condition, runoff from around the site is concentrated to a single flow path down a steep gradient to the local road. Based on the gradients on the access road (approximately 10% on average), in an extreme rainfall event flood waters would likely flow south across the road to the adjacent Coillte forestry ditch rather than ponding and blocking local road access.

Plate 3 Continuation of channel downstream of Derrybrien substation with small pipe culvert under access track

Plate 4 Looking north toward Agannygal substation

Plate 5 Channel downstream of Agannygal substation

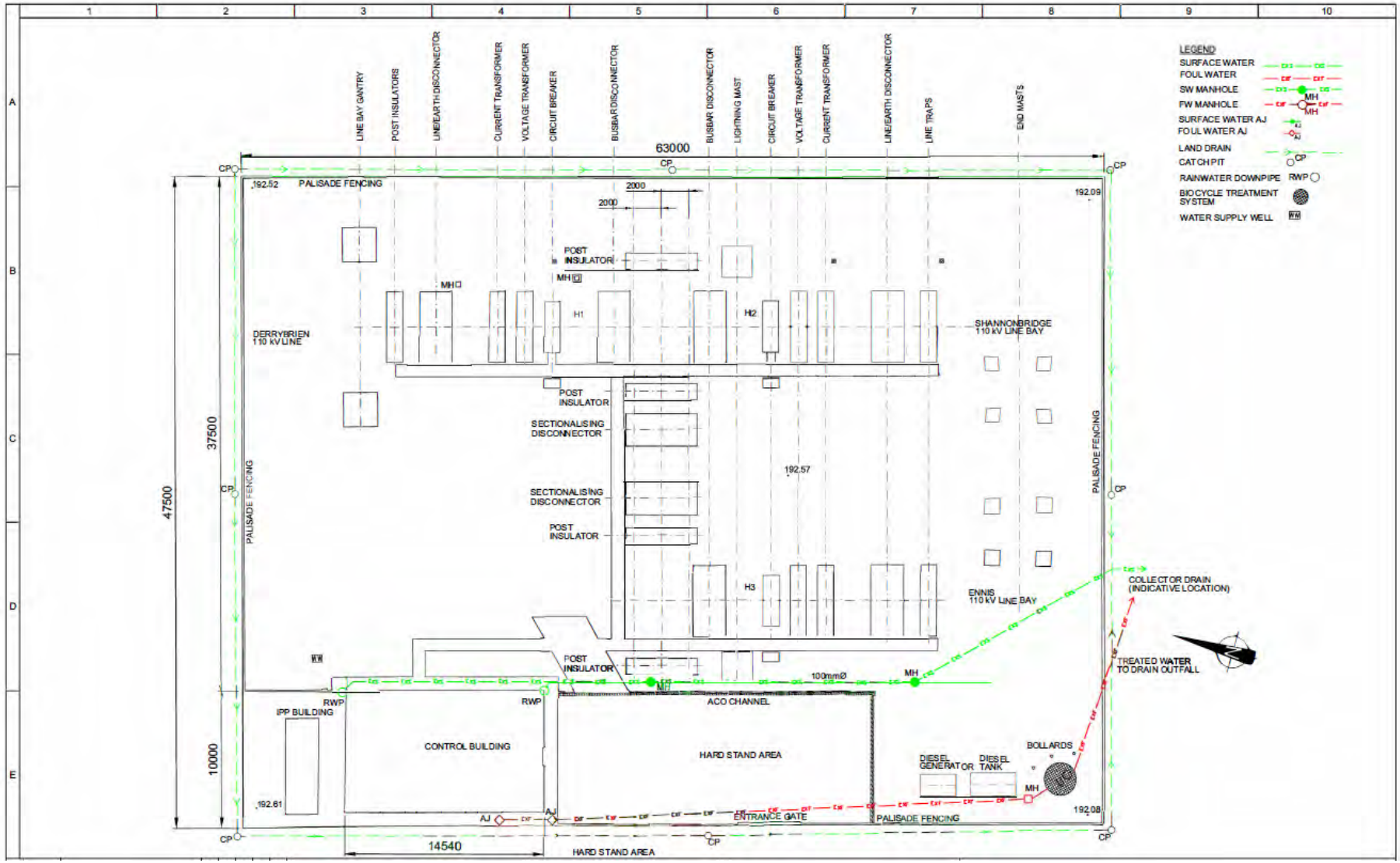

Figure 8 Agannygal Substation Drainage Infrastructure

OHL Route

Baseline Environment

Several watercourses exist within the footprint of the OHL route, the largest being the Owendalulleegh River, approximately 6.0 m wide, which passes beneath the OHL between pole sets 25 and 26. Major drainage features tend to run east to west in the OHL corridor, with minor tributary features aligned approximately north to south to tie into the major drainage features.

Impact of Prospective Development on Flood Regime

There are several flat areas where local ponding of surface water occurs, e.g. Lough Agannygal located between Polesets 37 and angle mast 38. The surrounding existing streams and ditches have not been interfered with as part of the wind farm development but typically have been regraded previously for use as forestry drainage where land use is commercial forestry. It is reported from Coillte data that this commercial forestry was established in the 1960s and 1970s. This is consistent with observations made on site that several areas have been clear felled and replanted over the years.

The polesets are considered to be water-compatible developments and as such, even in areas indicated as prone to flooding (Flood Zone A or B), carrying out the Justification Test is not required. According to NIFM mapping the indicative floodplains in the 100-year (1% AEP) event does not stretch far from the channel extents and as such does not reach the polesets on either side of any of the watercourses on the route.

V. Groundwater Flood Risk

Groundwater vulnerability represents the intrinsic geological and hydrogeological characteristics that determine how easily groundwater may be contaminated by activities at the surface. Vulnerability depends on the quantity of contaminants that can reach the groundwater, the time taken by water to infiltrate to the water table and the attenuating capacity of the geological deposits through which the water travels. The Geological Survey of Ireland (GSI) groundwater vulnerability rating of the aquifer underlying the site ranges from Moderate in the south-west corner of the site to High over most of the site. The High pollution vulnerability rating suggests that the general overburden, i.e., combined thickness of peat and mineral subsoils, at the site ranges from 3 – 5 m in these areas (Table 2). Ground investigation information showed the depth to the top of the rock was variable but typically ranged from 3.5 – 6.2 m, which generally reflects the GSI vulnerability classification of High and Moderate. However, the rock was shallower (between 1.3 m and 2.9 m) at the northern part of the site representing extreme vulnerability as per Table 2 and there were some locally deeper depths to rock (8 – 9.1 m) at the north-eastern and central parts of the site.

Sensitivity	**Hydrogeological Conditions**				
	Subsoil Permeability (Type) and Thickness			**Unsaturated Zone**	**Karst Features**
	High Permeability (Sand and Gravel)	**Medium Permeability (Sandy Subsoil)**	**Low Permeability (Clayey Subsoil/Peat)**	**Sand and Gravel aquifers only**	**<30 radius**
Extreme (E)	0 – 3.0 m	0 – 3.0 m	0 – 3.0 m	0 – 3.0 m	-
High (H)	>3.0 m	3.0 – 10.0 m	3.0 – 5.0 m	>3.0 m	N/A
Moderate (M)	N/A	>10.0 m	5.0 – 10.0 m	N/A	N/A
Low (L)	N/A	N/A	>10.0 m	N/A	N/A

Table 2 GSI Groundwater Vulnerability to Pollution Categories

The Ayle River Formation, comprising Devonian mudstones, siltstones and conglomerates, underlies most of the wind farm site. This bedrock formation is predominantly classified by the GSI (www.gsi.ie) as a poor bedrock aquifer (Pl), having bedrock that is generally unproductive except for local zones. This bedrock is a muddy impermeable bedrock that is not very conducive to transmitting and storing groundwater flow. There are no mapped fault lines traversing the site.

The upland areas comprise blanket peat, which underlies all the forestry in the area, with acid brown earths/brown podzolics and peaty gleys acidic underlying most of the agricultural lands farther down the valleys in both the Boleyneendorrish and Owendalulleegh catchments.

There are no mapped karst features associated with these Devonian Old red sandstones and conglomerates. The closest karst features to the Project area according to GSI mapping are a number of springs and depressions associated with the Ballysteen limestone formation near Ballynakill, approximately 5 km to the southeast of the wind farm site at its closest point (Figure

9). These springs are at the source of the Owendalulleegh River where the bedrock is a combination of dark muddy limestone / shale and massive unbedded lime-mudstone.

Groundwater on the wind farm can reasonably be expected to flow downslope through a network of natural open pipes within the peat as well as possibly through an open joint network in the underlying bedrock, particularly where it is weathered. Several springs have been identified on site in the past, particularly within scarp faces on the northern slopes, although these are not karst features. Linear tree patterns such as in the south-western corner of the site are possibly indicative of areas where subsurface flow has previously concentrated.

During construction, standpipes were installed by AGL Consulting Ltd. at 6 no. locations along a north-south axis from the centre to the south of the site in the vicinity of the peat slide to get a profile of the depth of groundwater down the slope. The readings that were taken from 17th November to 4th December 2003 indicated that the depth to groundwater ranged from 0.1 m to 1.1 m below ground level (BGL).

In addition to this, 12 no. electronic vibrating-wire piezometers were also installed to the base of the peat layer in clusters of three at 4 No. locations across the site to provide continuous readings of water levels in the peat. At each of these locations, newly constructed drainage could be expected to result in a fall in groundwater levels in the years following their excavation. The piezometers were installed adjacent to turbines T2 and T18 near the western boundary and near T34 in the middle of the former turbary land at the eastern end of the site (Figure 10). Piezometers installed at the northern end of the site at T49 / T50 malfunctioned and provided no useful measurements. The piezometers indicated that the depth to groundwater generally fluctuated between 0.3 and 1.1 mBGL at the end of construction in 2005, which was consistent with the pre-construction site investigation.

Piezometers / Turbine No.	Piezo Distance from Nearest Drain (m)	Drain depth (m)	Average fall in Groundwater Level 2005-2012 (m)(range)	Years of data
P1 – P3 / T2	4.5	0.85	0.7 (0.6 – 0.8)	Jan-05 to Nov-11
P4 – P6 / T18	13	1.4	0.4 (0.2 – 0.6)	Jan-05 to Nov-11
P7 – P9 / T34	5	1.3	0.6 (0.4 – 0.85)	Jan-05 to Feb-10

Table 3 Summary information of piezometers installed on site between 2005 and 2011

In the years following commissioning, groundwater levels in the peat at these piezometers gradually reduced by between 0.2 and 0.85 m (Figure 11). This gradual reduction is consistent with the very low permeability and correspondingly slow reaction time of groundwater levels in peat to newly excavated drainage lines. The ultimate reduction in groundwater levels was dependent on the depth to which the channels were excavated and the distance of measuring points from the channels (Table 3). For instance, piezometers 4 – 6 are further away from the nearest excavated drains and therefore have taken longer to reduce towards a final drawdown level. Piezometers 1 – 3, given their relative proximity to newly excavated drainage, should

stabilise at no lower than 0.85 mBGL. Given the baseline level in this area was close to the surface it was already close to stabilising by the end of 2011. At T34 the nearby drain was a pre-existing turbary drain which was likely cleaned out and was most likely deepened as part of the wind farm construction, resulting in the drawdown in groundwater levels.

As no further drainage has been installed on site and no measures have been taken to restore the baseline groundwater levels by blocking or infilling drains in the meantime, it is most likely that groundwater levels across the site have stabilised over the intervening years since 2012. In general, the vast majority of dewatering of the peat took place in the early years following construction, but the degree and rate of change would have varied significantly with the greatest changes most likely taking place in the southwest of the site where most of the new drainage channels were introduced while the relatively undisturbed areas such as the peatland and lake between T62 and T67 in the centre of the site undergoing little evident change and remaining largely intact.

The fall in groundwater levels was consistent and gradual at a rate of approximately 0.1 m/year (or 0.03 l/s per ha) across the site and would not have any significant impact on the downstream environment with respect to flood risk, given that falls in groundwater level are not correlated with periods of high surface water runoff. There is also no reason to believe that since the development of the wind farm the groundwater flood risk to the wind farm site given the general reduction in groundwater levels and the nature of the bedrock and quaternary geology and the topography of the site. In the long-term following decommissioning, with drains no longer maintained, locally the groundwater table will if anything increase very slowly but these local rises close to drains will not result in an increase in groundwater flooding on or off the site.

Derrybrien 110 kV Substation

The substation is located within the wind farm site. As discussed above there is no reason to believe groundwater poses a particular flood risk to the substation area.

Agannygal Substation

As with the wind farm development site, the Ayle River Formation comprising a muddy impermeable bedrock underlies the substation site. As with the wind farm, no mapped fault lines traverse the site. The GSI groundwater vulnerability rating of the underlying aquifer is classified as High suggesting that the total thickness of the soil is 3 – 5 m in this area. There are no mapped karst features and no mapped groundwater sources within the vicinity of the site. There is no reason to believe groundwater poses a flood risk to the site.

OHL Route

Based on information from the GSI database, the majority of the OHL route is underlain by rock which is considered a poor aquifer (bedrock which is generally unproductive except for local zones). However, the segment of the route underlain by Visean Limestone (between pole set 23 and 26 approximately) is considered a locally important aquifer (bedrock which is moderately productive only in local zones) although no evidence for groundwater usage from this aquifer has been found. Groundwater vulnerability ranges from low to extreme in pockets of the most low-lying areas across the OHL route due to the shallow depth to bedrock in these

areas. There are no mapped karst features in these areas. Groundwater poses no flood risk to this element of the Project.

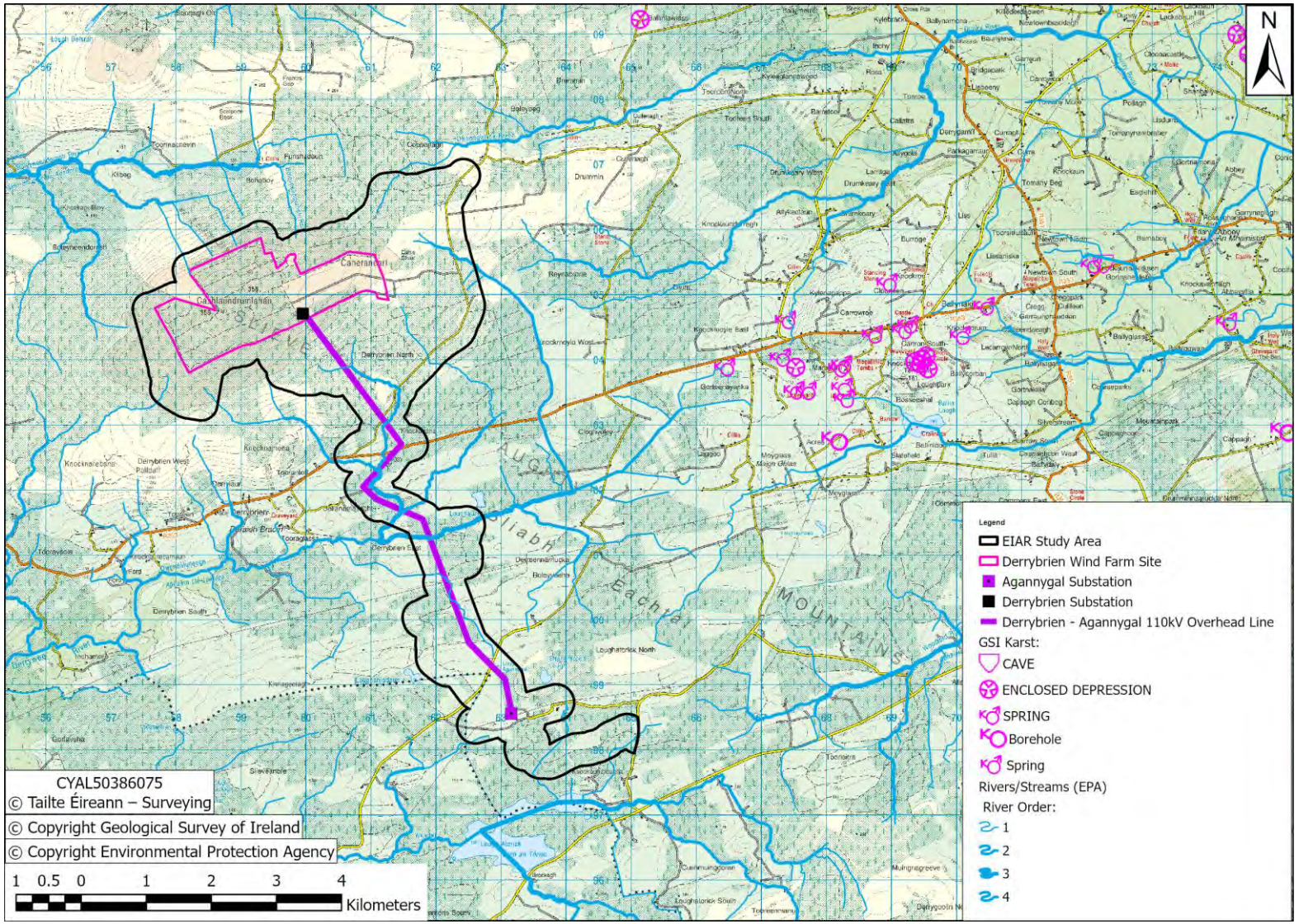

Figure 9 Karst features in relation to Derrybrien Wind Farm Development

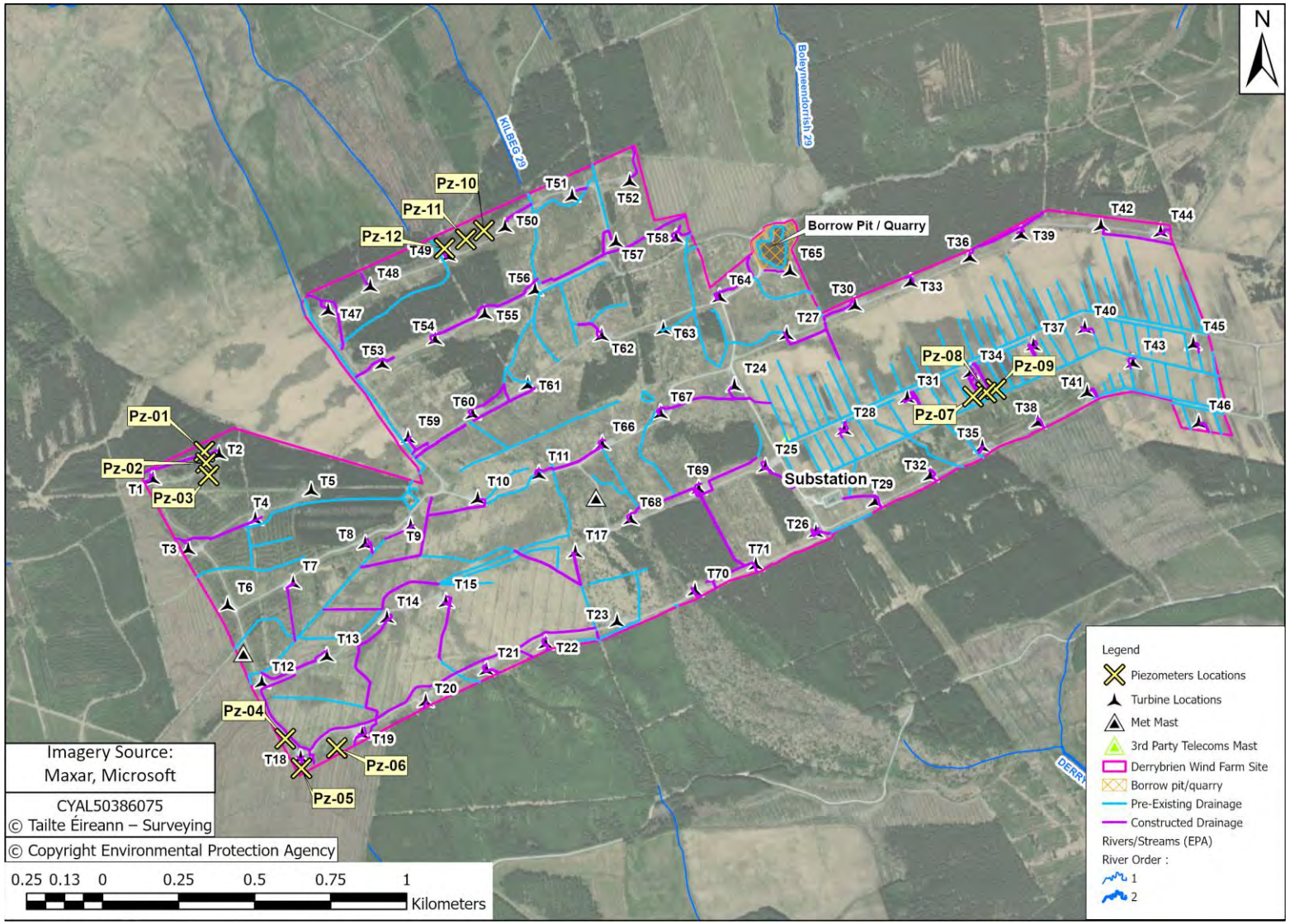

Figure 10 Approximate Location of Piezometers on site 2005-2011

Figure 11 Piezometer Data (2005-2011)

VI. Impact of Decommissioning Project on Current Flood Regime in Downstream Watercourses

There are three potential sources of change to the current flood regime emanating from the wind farm site during decommissioning to be considered –

1. Hardstanding - The Prospective Development will not result in any change in the impermeable area of the wind farm site as it is proposed that all hardstanding areas and roads will remain in place on the wind farm site post-decommissioning.
2. Drainage networks - The drains on the Derrybrien Wind Farm Development site will be cleared at decommissioning and based on operation and maintenance experience over the 20-year lifetime of the wind farm, if left undisturbed it shall continue to function for many years as it has since wind farm construction without blockages to interrupt flow routes.
3. Forestry - The Slieve Aughty Mountains has some of the largest concentrations of coniferous forest plantation in the country, most of which was originally planted in the 1960s and 1970s. The extent of forestry compartments has not changed appreciably since prior to project construction with forestry representing over 50% of land usage in the immediate vicinity of the wind farm. Due to its age profile, much of the forestry estate has over the last number of years and will over the next decade require felling. For example, between 2016 and 2018 a total of 2.57 km^2 of forestry was earmarked for felling on Coillte land in the catchments within which Derrybrien Wind Farm is located, similar to the amount felled for the wind farm Project between 2003 and 2005. It should be noted that for the purposes of this assessment, only the impact of felling associated with the wind farm decommissioning was considered and any other felling carried out following decommissioning is not relevant to this assessment. There will be minimal if any forestry clearing associated with the decommissioning and no new planting on the wind farm site is proposed.

Given there will be negligible change in land use and the effectiveness of the network draining the wind farm site, it can be reasonably concluded that Prospective Development will also have no impact on downstream watercourses.

Similarly, the decommissioning of the OHL route and Agannygal substation will not impact on downstream hydrology given there will be no change in land use associated with the works.

VII. Loss of Floodplain

No element of the Project is located within a fluvial floodplain with the exception of a short section of the OHL Route which is a water-compatible element of the development.

VIII. Conclusions

It is concluded that there will be no perceptible change in the risk of flooding arising from the Prospective Development given the size of the local downstream population and the proportion that could be affected in a flood event. On the broader regional scale, any changes in flood risk associated with the Derrybrien Wind Farm Development Decommissioning Project is deemed imperceptible given the broader extent of the Boleyneendorrish and Owendalulleegh catchments.

It can be concluded that most of the Project areas (with the exception of short sections of the OHL route) are not within floodplains and lie within Flood Zone C (Low risk of flooding) as defined by the guidance document to Planning Authorities in relation to Flood Risk Management. Furthermore, the existing flood risk in the downstream catchment has not to date and is not expected to be increased by any proposed decommissioning works at the wind farm.

The Derrybrien Wind Farm Decommissioning Project as a whole is therefore considered to be in overall compliance with the objectives of the Planning and Flood Risk Management Guidelines. The Project therefore has not and is not anticipated to give rise to any significant impacts related to flood risk within or downstream of the Project areas.

This flood risk assessment meets the requirements of the planning guidelines in respect to a site-specific FRA as the entire proposed decommissioned development falls under the category of water compatible type development and therefore suitable in all flood risk zones. The proposed decommissioned site will not impede access to watercourses nor does the project result in an increase in flood risk to third party lands locally or downstream.

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APPENDIX 9-2

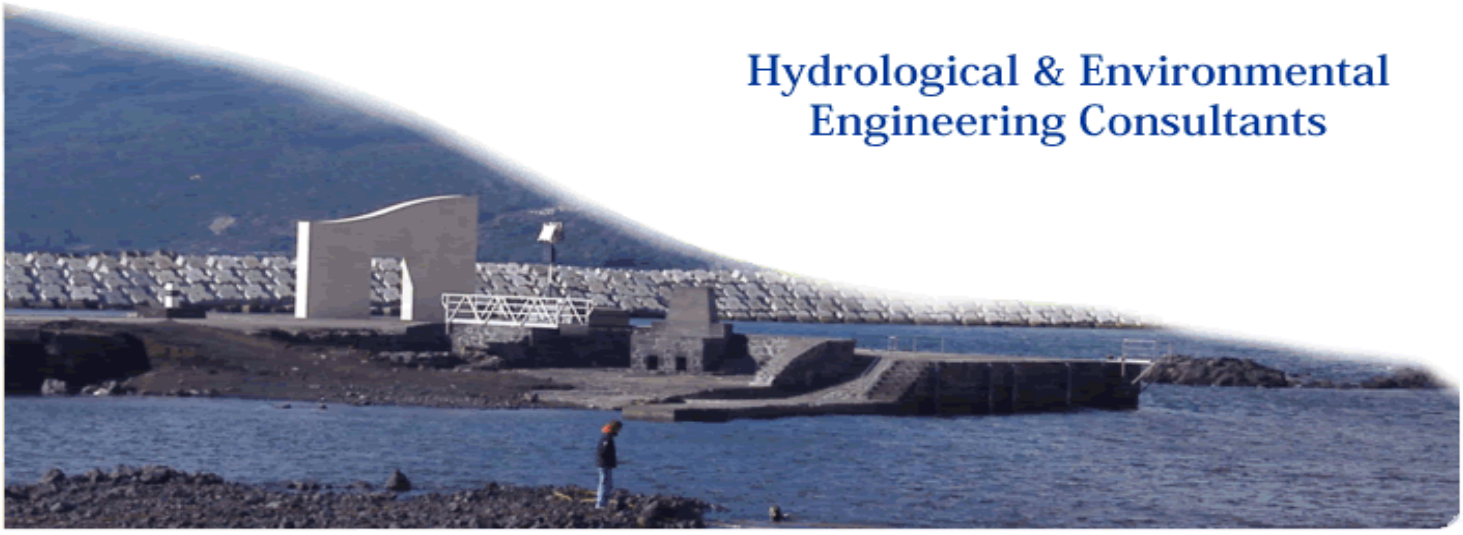
FLOOD REVIEW OF GORT LOWLANDS

Flooding Assessment of the Derrybrien Wind Farm Decommissioning Project on Downstream Flooding in the Gort Lowlands

On behalf of

ESB

January 2025



Hydrological & Environmental
Engineering Consultants

Flooding Assessment of the Derrybrien Wind Farm Decommissioning Project on Downstream Flooding in the Gort Lowlands

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1. Introduction

The scope of this report is to examine the downstream flooding of the Derrybrien Wind Farm Site, particularly in the Cutra and Gort lowlands area and the potential effect that the proposed decommissioning of the Derrybrien Wind Farm development, comprising decommissioning of the wind farm site, the overhead line and the Agannygal substation has on downstream flooding.

The Derrybrien Wind Farm site is located on the upper slopes of the Cashlaundrumlahan Mountain in Slieve Aughty mountain range in south County Galway. The total area of the Derrybrien Wind Farm site measures 3.44 km^2 (344 ha). The site and its drainage is located principally within two river systems – the Boleyneendorrish and Owendalulleegh catchments – which drain into the Gort Lowlands area and eventually by groundwater karst conduit flow, out to sea at Kinvarra (Hydrometric Area 29). A very small area of the Derrybrien site (< 1%), at the northeast corner of the site, drains eastward to the Duniry River, a tributary of the Kilcrow River in the Shannon catchment (Hydrometric area 25), which discharges into upper Lough Derg to the west of Portumna. Approximately 66% of the site drains through surface drains SSW to the Owendalulleegh River (flows into Lough Cutra) and 33% of the site drains NNW into the Boleyneendorrish (Ballycahalan R.) River. This represents drainage areas of 2.3 km^2 and 1.1 km^2 in the Owendalulleegh and Boleyneendorrish river catchments respectively. These rivers discharge into the Gort lowlands area, which is prone to turlough flooding at times of prolonged heavy winter rainfall. The flooding lasts over a period of many weeks. In addition to the wind farm site, the study area also comprises the corridor of the 7.7 km overhead line running southward from the wind farm site and the grid connection substation at Agannygal. The corridor is situated in two separate catchments, i.e., structure 1-39 in the Owendalulleegh catchment and 40-42 in the Bleach River catchment. The Agannygal Substation Site is located within the Bleach River Catchment. The Bleach River is a tributary of the Graney River and Lough Graney that discharges into Lough Derg near the village of Scarrif and is part of the Lower Shannon River System (Hydrometric Area 25).

2. Decommissioning Works

The demolition phase activities associated with the subject development are limited to the decommissioning of the 70-turbine wind farm and a grid connection, comprising c. 7.8km 110kV overhead line (OHL) connecting into the Ennis-Shannonbridge 110kV line, together with Derrybrien and Agannygal substations. Decommissioning will entail dismantling of all turbines (blades, hub, nacelle and towers) and electrical disconnection. The reinforced concrete turbine basses shall remain in place as well as the crane hardstand areas and the internal access roads. The OHL poles and mast elements will be removed from the corridor running between Derrybrien and Agannygal substation.

The high voltage equipment, the substation, and control building will be dismantled, and all such equipment removed from the site. All hardstanding areas for the substation, the turbine crane hardstanding and internal roads will be left in place after decommissioning.

The drainage system and much of the buried electrical cabling between the turbines bases and the Derrybrien Substation at the wind farm site will be left in place. The drainage system at decommissioning will be maintained and thereafter will not be maintained, so that over time these drains will naturally infill and become more vegetated and gradually less effective in respect to water table lowering. Similarly the pipe culverts under the access tracks will remain. Over time the drainage performance at the wind farm site is expected to gradually reduce resulting in slightly lower peak runoff rates and slightly higher groundwater levels on the site.

The four number rock barrages that were constructed as emergency works during the peat slippage in 2003 to stabilise the area and protect downstream lands and receiving watercourses are to be left in place as their retention does not result in any significant residual negative impact on the environment, whereas their removal could result in significant impact in respect to land disturbance and the potential for sediment and peat runoff into the downstream watercourses. The upper Barrages no's 1 and 2 are considered important for peat stability along this slip pathway.

3. Regional Hydrology

3.1 General Description

The basin area lying between the Dunkellin catchment to the north and the River Fergus Catchment to the south is referred to as the Gort Lowlands catchment. There is no direct river outlet to the sea and drainage from the 500km^2 catchment area discharges in underground conduits and caverns within the karst limestone bedrock to Galway Bay. The long-term annual average rainfall for the Gort Lowlands Catchment is measured to be 1140 mm (from the most recent Met Eireann (2020) Standard Annualised Average Rainfall (SAAR) map). The expected annual average groundwater flow rate discharging to the sea from this catchment is approximately 10 m^3/s based on an annual average evapotranspiration rate of 510 mm giving an effective rainfall (recharge) of 630mm per annum. The median annual maximum flow rate from this catchment is likely to be c. 50 m^3/s and the 100-year flow based on a national flood growth curve factor of 2 is of the order of 100 m^3/s. These are substantial flow rates for karst groundwater flow and result in substantial turlough flooding with overland flow cascading from one turlough to another.

The total drainage catchment to Kinvara sea outlets can be split between the impermeable catchment area to the east (including the Slieve Aughties to the south of Loughrea), of some 240km^2 in area that is underlain by muddy limestones, old sandstones, shales, mudstone and siltstone conglomerates and having generally low groundwater recharge rates and conversely naturally high surface runoff coefficients. The catchment area to the west is underlaid by

permeable pure limestones having an area of a further 260km^2 with moderate to high groundwater recharge rates and very low surface runoff rates. What is noticeable between east and west is the high density of stream and drainage channels in the east with the very sparse surface drainage features in the pure limestones due to the underground network of karst conduits. Higher annual rainfalls occur in the more elevated lands to the east with the highest annual rainfalls occurring in the Slieve Aughty uplands at on average 1430 mm per annum whereas in the lowlands area the annual rainfall is typically 1125 to 1175mm per annum.

3.2 Contributing upland Catchments

Three main upland rivers drain westwards into the Gort Lowlands area off the relatively impervious eastern section of the catchment which includes the Slieve Aughty uplands. These rivers from south to north are:

- the Owendalulleegh River that inflows to Lough Cutra and on to Gort Town as the Beagh / Cannahowna / Gort Rivers;
- the Boleyneendorrish (Ballycahalan) River to Ballylee; and
- the Owenshree River that discharges into Blackrock Turlough which overflows to Ballylee.

Refer to Figure 1 for the catchment extents of these rivers.

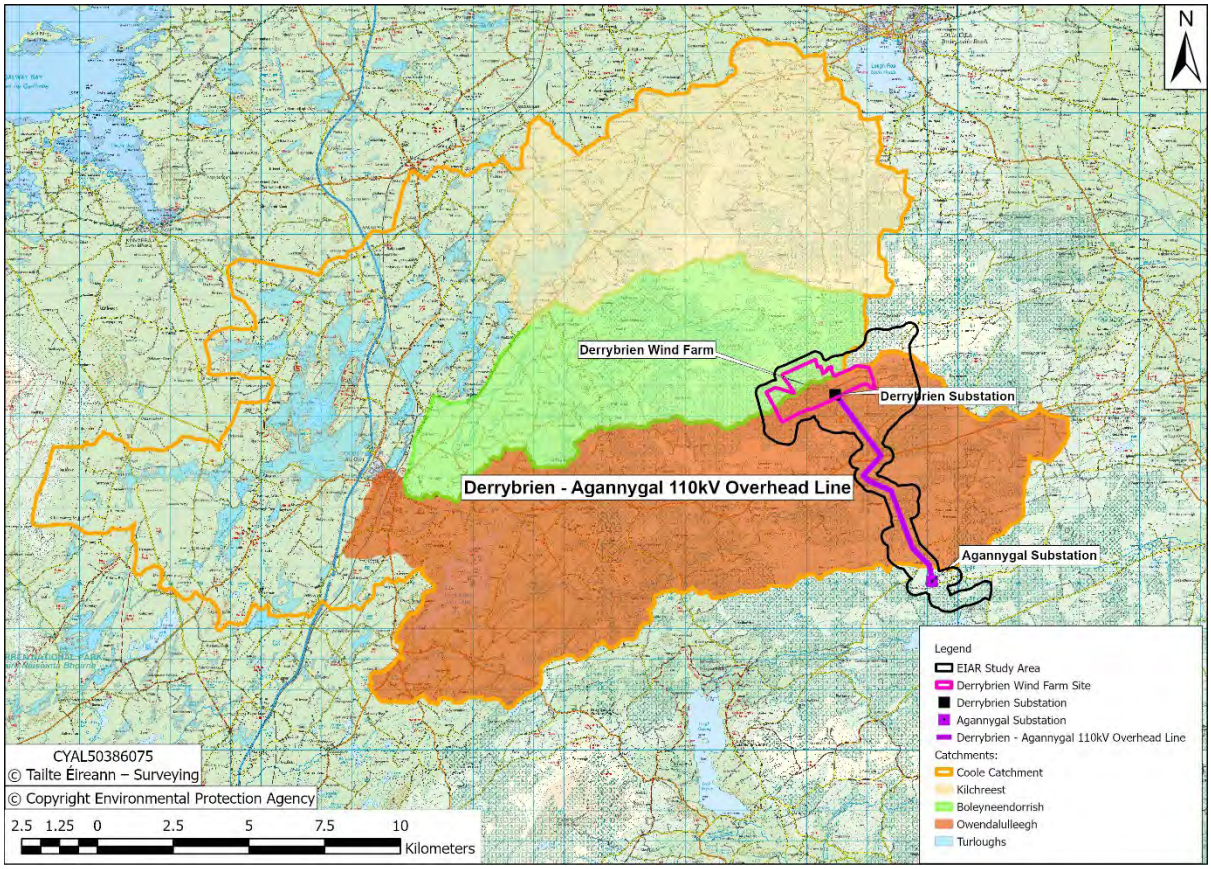

Figure 1 River catchments discharging to the Gort Lowlands

3.2.1 Owendalulleegh Catchment

The Owendalulleegh River rises in the townland of Gorteenayanka and flows westward to Lough Cutra. The catchment area of the Owendalulleegh River to Lough Cutra is 90 km^2 and to the Lough Cutra outflow (Beagh River) is 124 km^2 and to Gort Town (Gort River) is 134.6 km^2. Lough Cutra is a large lake with a permanent surface area of 3.8 km^2 which increases to c. 4.4 km^2 in flood periods. Lough Cutra provides important flood attenuation for the downstream river through Gort Town. Typical lake levels are 32.9 mOD Malin and the typical summer-winter lake level range is 1.2 m (EPA hydronet resource). This lake provides some attenuation to the Owendalulleegh River flood inflow which has a flashy flood hydrograph and to a certain extent protects downstream reaches through Gort Town. The outflow (Beagh River) from Lough Cutra sinks underground at the Punch Bowl, 2 km downstream of the lake and re-emerges as the Gort River at the Pollduagh Cave, south of Gort, and flows northwards through Gort Town before sinking again at the Castletown Swallow-holes (3 km north of Gort). There is a groundwater connection between the Castletown Swallow-holes and the Kiltartan spring risings. During large floods an overland flood route exists at Castletown, discharging northwards to Ballyloughan and Kiltartan floodplains before entering the Lough Coole and Garryland Turlough system.

The time to peak (t_p) for flood runoff to reach the inlet to Lough Cutra from the Owendalulleegh catchment is estimated to be 8 hours, which is relatively rapid given its steep upland catchment. The estimated median flood peak rate just upstream of Lough Cutra is 30.5 m^3/s from the Flood Studies Update (FSU) flood estimation method and the critical rainstorm duration for peak catchment runoff is 19 hours, which represents a reasonably flashy catchment that produces maximum flood rates during 1-day events. The maximum outflow rate and critical rainstorm duration depends on the level the lake is at and can typically delay the peak by between 12 to 24 hours through lake storage.

3.2.2 Boleyneendorrish Catchment

The Boleyneendorrish (Ballycahalan) River like the Owendalulleegh River has its headwaters in the Slieve Aughty uplands, located on the northern side, whereas the Owendalulleegh River is on the southern side of the mountain and wind farm. The Boleyneendorrish River conveys runoff in a westerly direction towards the N66 (Loughrea Road). Downstream (west) of the N66 it becomes the Streamstown River and the Turra River inflows to it before flowing northwards to Ballylee where it sinks at the Ballylee swallow holes. The total catchment area of this river to the Ballylee swallowholes is 61 km^2. Two large turloughs, Skehanagh and Newhall, form to the north and northeast of Ballylee. During extreme floods these turloughs become one and the entire Ballylee area floods out. Upstream of Ballylee on this river the Lough Coy and Peterswell Turloughs form. There is an overland flood route from Ballylee floodplain to Ballyloughaun Floodplain to the east of Kiltartan. The estimated catchment area to Ballyloughaun is c. 152 km^2, which also includes the Owenshree catchment. There is a groundwater connection between the sinks at Ballylee and the Kiltartan Springs. Downstream of Kiltartan the flow sinks underground and enters the Coole-Garryland Turlough complex. At times of large floods an important overland flow route is available from Kiltartan via the Corker Turlough and under the M18 at Raheen / Kilkelly to the Coole-Garryland Turlough. The time

to peak for flood runoff in the Boleyneendorrish catchment to reach the Streamstown Section at Thoor, Ballylee is 6 hours based on the Flood Study Report time to peak method using catchment characteristics (NERC 1997, Cawley and Cunnane 2003). The median flood peak rate is 16 m^3/s using the FSU method. Similarly to the Owendalulleegh catchment this represents a relatively flashy catchment that enters the Gort Lowland system.

3.2.3 Owenshree / Kilchreest Catchment

The Owenshree River has its headwaters in the northern extremity of the Slieve Aughty upland and flows south-westwards before terminating at the Blackrock Sinkhole near Peterswell. The Blackrock turlough swallow hole system is understood to drain to Lough Coy and the Polleelin / Pollanoween system at Ballylee. At times of large floods an overland flow path from Blackrock Turlough through to Skehanagh village towards Skehanagh Turlough and Ballylee becomes established. The catchment area of the Owenshree River to Blackrock Swallow-holes is 78.5 km^2. The time to peak for flood runoff to reach the Blackrock Turlough Swallow hole is estimated to be 7.5 hours. The estimated annual median flow rate in the upstream catchment to Blackrock Turlough is 16.35 m^3/s using the FSU flood estimation method.

3.2.4 Kiltartan Floodplain

The catchment area to Kiltartan Springs includes all of the above three river catchments and the local turlough basins and surrounding lands, which based on surface topography is c. 301 km^2 in area. It should be noted that the karst groundwater conduit flow system in the Gort Lowlands is complicated and has multiple connections between various sinks and springs with some groundwater connections bypassing the springs at Kiltartan and discharging directly to other more downstream turloughs and to the coastal springs near Kinvara (GSI, 2020). The flow rising from the springs at Kiltartan and its overland component discharges into the Coole-Garryland turlough complex via swallow holes and an overland flow route via Corker and Raheen. Past flood events have caused extensive flooding at Kiltartan Village with houses, roads (including the former N18) and the church at Kiltartan seriously flooded.

3.2.5 Lough Cutra

The EPA-gauged outflow from Lough Cutra gives a median flood (2-year return period) peak outflow rate of 19.15 m^3/s whereas the median flood inflow rate is 30.5 m^3/s . This suggests that Lough Cutra attenuates the flood peak by upto 30% for the median annual flood. The historical highest flooding recorded for Lough Cutra, since the EPA gauge record began in 1976, occurred on 19th – 20th November 2009. In a 48 hour period from 4:00am on the 18th November 2009 to 4:00am on the 20th, the lake level rose by 0.86 m to 34.67 mOD representing a flood storage volume of approximately 3.44 million m^3 based on a lake surface area of 4 km^2. To fill such a volume in a 48 hour period requires an inflow rate to be on average 20 m^3/s in excess of the outflow rate during that period. The gauged peak outflow from Lough Cutra gives a flow rate estimate of 55.6 m^3/s suggesting a peak inflow rate in excess of 75 m^3/s. The estimated peak outflow from Lough Cutra using the EPA rating curve involves considerable extrapolation beyond the gauged range of flows and is likely to be significantly overestimated being backwatered from downstream by the limited flow capacity

of the Punch Bowl Swallow-holes. It is more likely that the peak inflow and outflow were c. 60 and 40 m^3/s respectively. The flooding of the lands surrounding the downstream reach from Lough Cutra is caused by the throttle effect at the Punch Bowl swallow-hole and by the hydraulic capacity of the Beagh River outflow channel from the lake to the Punch Bowl. In 2009 the lake effectively delayed the flood peak by almost 24 hours between the inflow and outflow hydrograph peaks.

3.3 Land use

The general land use cover in the Gort Lowlands catchment and its 3 no. upland catchments is summarised below in Tables 1 to 4 and also shown in Figure 2. This land-use mapping is based on the latest available Corine land-use mapping (2018). This shows that forestry and wetlands / bogs make up a significant portion of the land use in these catchments at c. 46% for the overall Coole catchment of 388 km^2 and slightly over 50% is grassland / pasture. In the upland catchments of the Boleyneendorrish and Owendalulleegh River systems, forestry and peatlands represent 60 to 67% of the land use; refer to Tables 3 and 4.

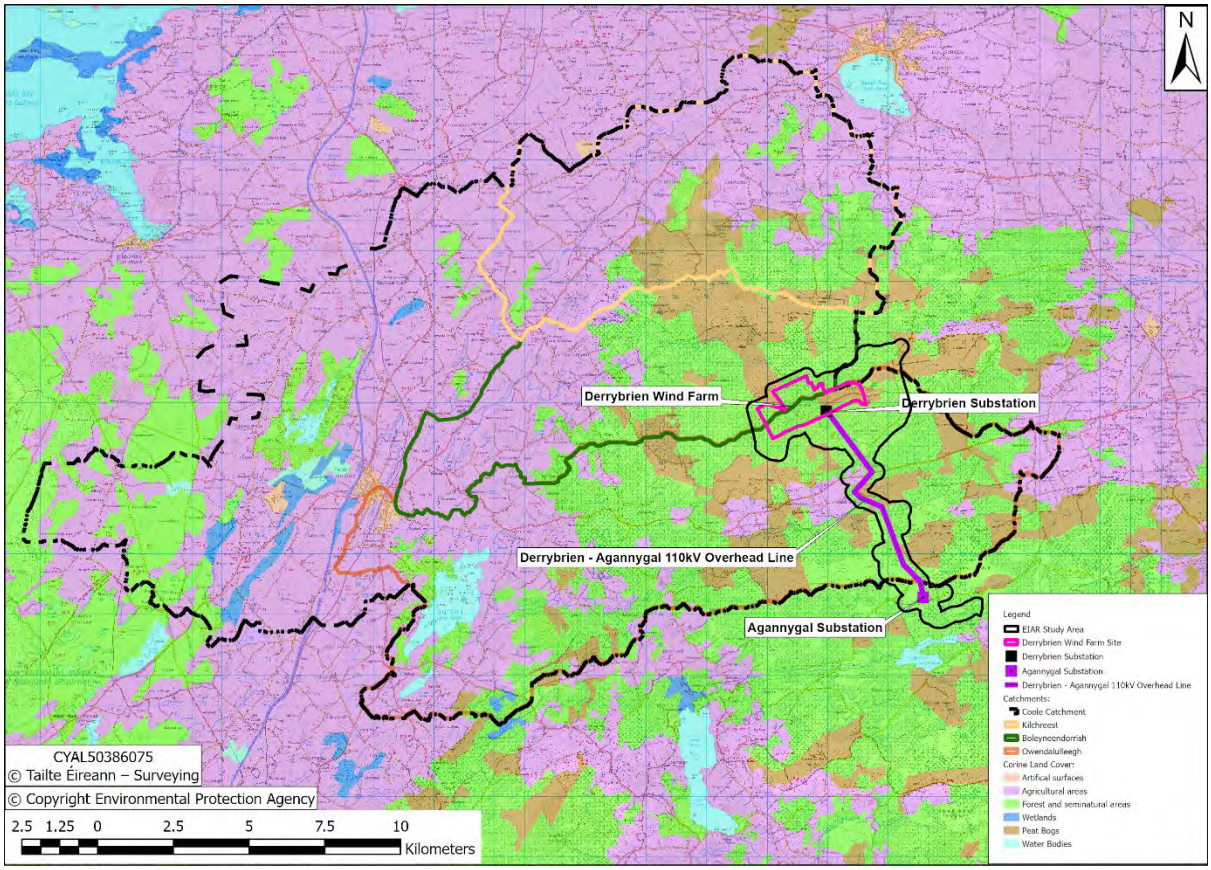

Figure 2 Corine Land use mapping

The Boleyneendorrish and Owendalulleegh catchments have significant fraction of their catchments associated with forestry at 41 and 50% respectively.

Table 1 Corine Landcover for the overall Coole Catchment

Class Description	Area (Ha)	Area (km^2)	Area (%)
Artificial surfaces	190.64	1.96	0.50%
Agricultural areas (grassland and pastures)	20155.50	201.56	51.90%
Forest and seminatural areas	12810.15	128.10	33.00%
Wetlands & Peat bogs	4982.23	49.82	12.80%
Water bodies	668.51	6.69	1.70%

Table 2 Corine Landcover for the Owenshree (Kilchreest) Catchment

Class Description	Area (Ha)	Area (km^2)	Area (%)
Artificial surfaces	0.045	0	0.00%
Agricultural areas (grassland and pastures)	5313.75	53.14	67.50%
Forest and seminatural areas	1519.40	15.19	19.30%
Wetlands & Peat bogs	1040.33	10.40	13.20%
Water bodies			

Table 3 Corine Landcover for the Boleyneendorrish Catchment

Class Description	Area (Ha)	Area (km^2)	Area (%)
Artificial surfaces	3.31	0.03	0.10%
Agricultural areas (grassland and pastures)	2424.00	24.24	39.50%
Forest and seminatural areas	2521.71	25.22	41.10%
Wetlands & Peat bogs	1179.96	11.80	19.20%
Water bodies			

Table 4 Corine Landcover for the Owendalulleegh Catchment

Class Description	Area (Ha)	Area (km^2)	Area (%)
Artificial surfaces	83.81	0.84	0.62%

Agricultural areas (grassland and pastures)	3978.43	39.70	29.46%
Forest and seminatural areas	6703.61	67.04	49.64%
Wetlands & Peat bogs	2317.72	23.18	17.16%
Water bodies	421.75	4.22	3.10%

4. Regional Hydrogeology

4.1 General Description

The outlet from the Gort Lowlands catchment to the sea is underground via karst groundwater flow from swallow-holes in the pure limestones within turlough-forming basins of the numerous turloughs in the Gort-Ardrahan area which includes some of the bigger turloughs at Blackrock, Ballylee, Kiltartan, Corker, Coole-Garryland, Caherglassaun and Cahermore. There is limited capacity in these underground conduit systems to discharge in flood conditions resulting in the groundwater table rising and the flooding out of the surrounding turlough basins until they reach their natural threshold levels and spill overland, flowing from one turlough area to another.

The catchment extents of the Gort Lowlands to the Cahermore Turlough 4 km southeast of Kinvara Village is presented in Figure 3. Also shown for reference on this figure is the Geological Survey of Ireland (GSI, 2019) maximum historical groundwater turlough flood extents and the 3.44 km^2 Derrybrien wind farm site in the Slieve Aughty Mountains to the east.

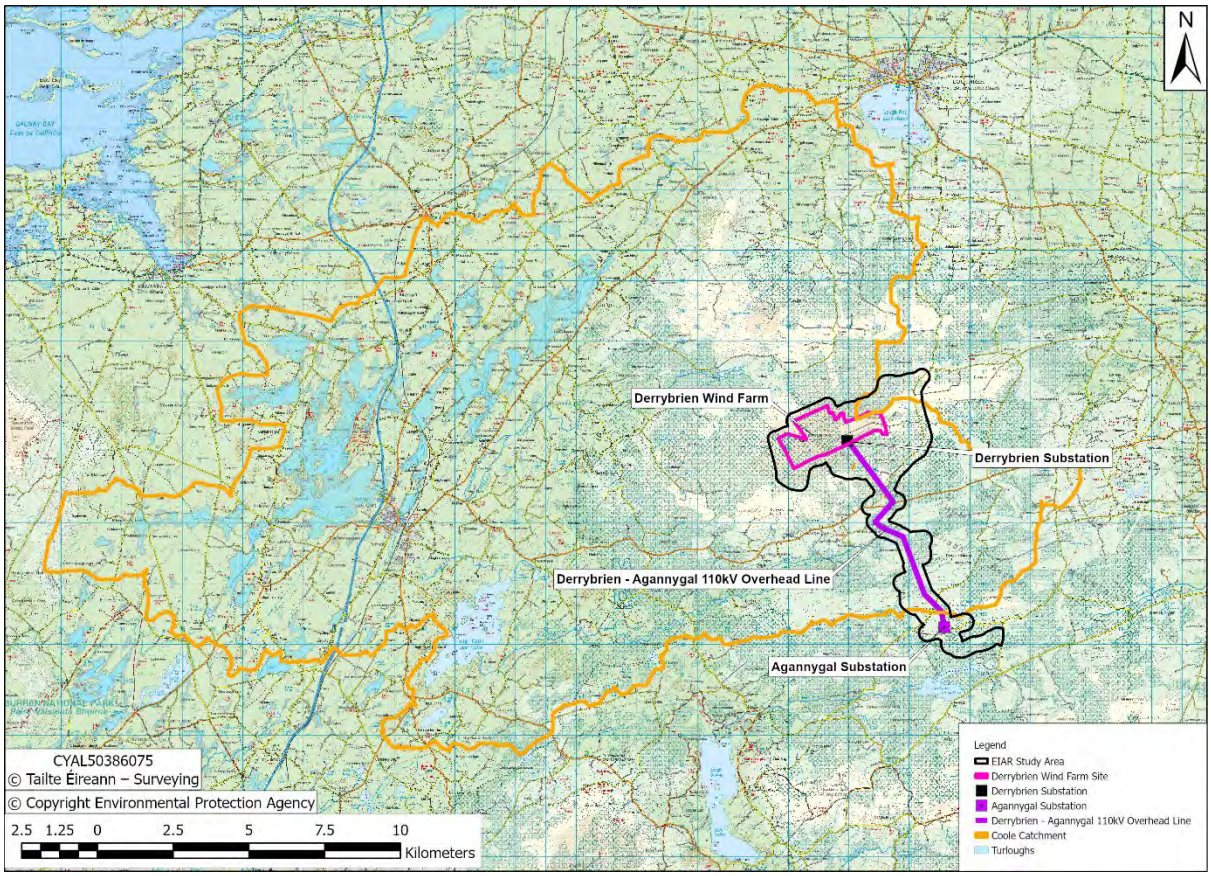

Figure 3 Catchment extents draining to the Coole – Garryland Turlough System showing maximum historical Flood Extents (GSI)

Groundwater and overland flow that enters the Coole and Garryland turlough system is stored until such time that it can discharge via its groundwater conduits. This can result in extensive overland flooding during large flood events when the groundwater outflow capacity is significantly exceeded. There are groundwater connections between Lough Coole and

Caherglassaun and Cahermore turloughs and the Kinvarra springs where it enters the sea. The entire Kinvara catchment to Slieve Aughty potentially drains an area of 500 km^2.

A line running southwest from Kilchreest to Peterswell to Gort and south to the west of Lough Cutra represents the divide between Pure Limestone Bedrock formations to the west of this line and the more impervious, muddy bedrocks that include conglomerates of Mudstone and Siltstone and Greywackes, Siltstones and Mudstones to the east. These conglomerates represent poorly productive bedrock aquifers (low storativity and transmissivity) and are overlaid by peats and silts resulting in low groundwater recharge rates, typically of less than 10%. The pure limestone formations with a free draining limestone till have groundwater recharge rates of c. 60% and the limestone outcrop areas have recharge rates of c. 85%. There is a contrasting picture in the density of surface drainage features between east and west of the catchment with a high density of surface drainage features in the muddy impervious bedrock areas and a near absence of surface drainage features in the highly karstified pure limestone formations to the west.

The pure limestones in the Gort Lowlands area to Kinvara are highly karstified and there are no surface flow outlets to the sea, with drainage outflow from the area entirely via groundwater flow in large conduits and caverns. Extensive dye tracing of the Gort Lowlands karst system has been conducted by David Drew, Trinity College, GSI and the Gort Lowlands Flood Study (Drew and Daly 1993, Southern Water Global 1997 and GSI 2020) to identify preferential pathways between sinks and springs. These investigations have shown widespread groundwater flow linkages between turloughs and inland and coastal springs at Kinvara and surrounding coastal areas. The Gort Lowlands system is completely dependent on groundwater flow for outflow. There are no watercourse channels present to convey runoff to the coast. Turloughs begin to fill with the rising regional groundwater table and fill further when the inflow to the turlough exceeds its limited outflow capacity.

The many large turloughs in the Gort Lowlands system are presented in Figure 4. The flooding of these turloughs is influenced by the inflow but also by downstream flood conditions in the interconnected turloughs and in extreme winter flooding events such as 2009 and 2015/2016 these turloughs rose significantly resulting in overland spills between turloughs in a cascade-like manner.

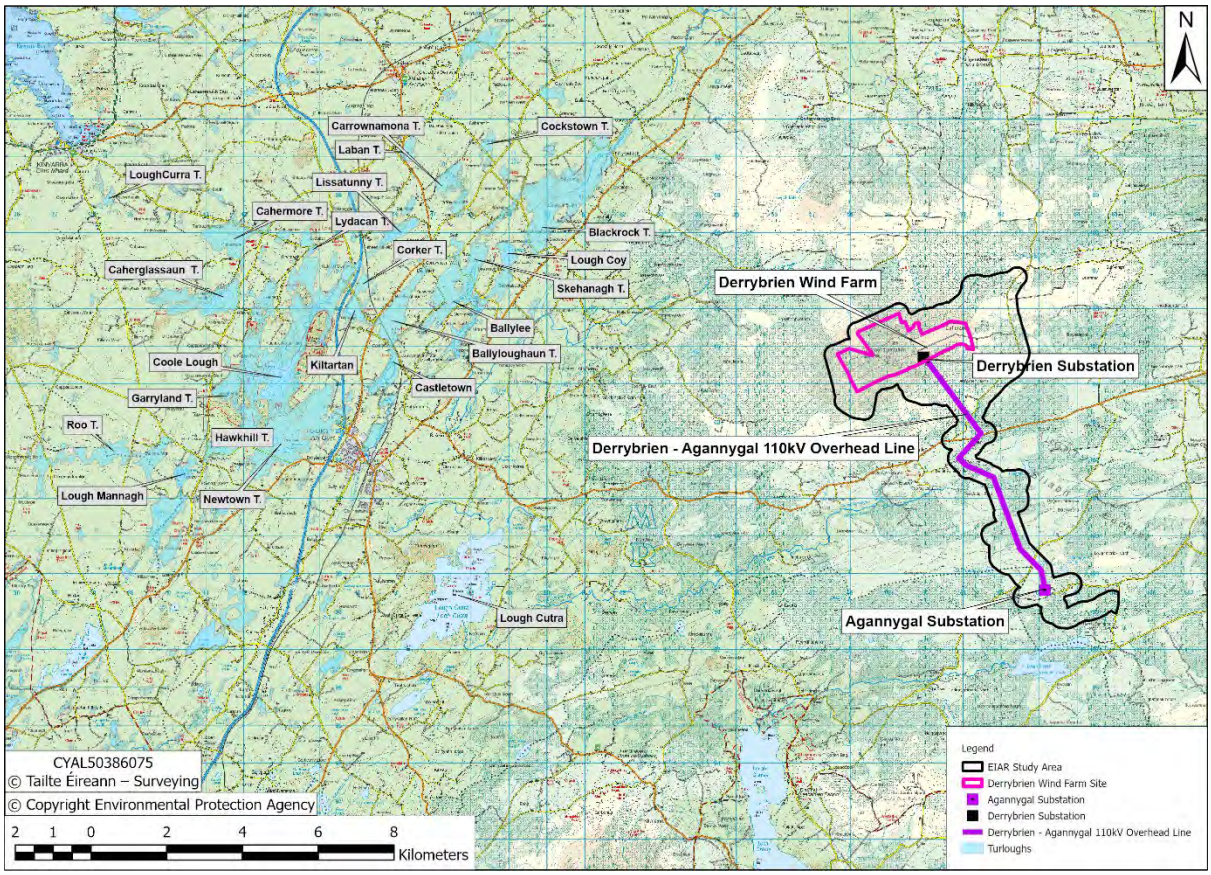

Figure 4 Main Turlough Flooding areas in the Gort Lowlands area (2009 groundwater flood extents, GSI)

5. Flooding

5.1 General

Flood prone areas downstream of the project windfarm site are associated with fluvial flooding in the river valleys of the Owendalulleegh and Boleyneendorrish Rivers and combined fluvial and groundwater flooding within the karst basins surrounding the numerous turloughs in the Gort Lowlands area. Flash flooding on the smaller mountain streams of the Slieve Aughties is associated with high intensity short duration rainfall events, with the sites of flooding occurring at road and land access culvert crossings either due to flow capacity restrictions or debris obstructions leading to flooding of local roads in the vicinity of the culvert crossings. Further downstream in the Gort lowlands area flooding is associated with much longer duration rainfall events (days and weeks), caused by the volume of floodwaters generated exceeding the flow capacity of the river reach or the flow capacity of the groundwater outlet from the Turlough basin.

The National Indictive Flood Mapping (NIFM) provides fluvial flood extents along the stream and river channel network for estimated 100year and 1000year flood events for all river reaches exceeding 5km^2 catchment area. It is a useful screening tool identifying potential flood prone areas. This mapping is based on fluvial sources for catchments in excess of 5km^2 and assumes within channel has capacity of 80% of the annual flood (QMED) and remainder floods its overbanks based on hydraulic modelling using a DTM ground level model, refer to Table 5 below. The QMED flow estimate is based on the FSU Physical Catchment Descriptors equation and the return period growth factors are based on the FSU pooled analysis of selected reliable gauged stations providing 500 station years of annual maximum flows. A full description of the methodology for the National Indictive Flood Mapping is available at https://www.floodinfo.ie/map/nifm_user_guidance_notes/ . This mapping is considered to be of moderate reliability.

Table 5 Channel Capacities modelled in the National Indicative Flood Mapping

Channel Type	Channel Capacity as % of Qmed
Rural area - shallow slope	100%
Rural area - moderate slope	80%
Rural area - steep slope	80%
Urban areas	100%
Arterial Drainage	135%

This mapping identifies the potential floodplains of the Owendalulleegh and Boleyneendorrish Rivers, whose floodplain extents only become more extensive downstream in the flatter gradients at Derreen townland upstream of Lough Cutra on the Owendalulleegh and in the turlough areas at Farnaun and Doonally West on the Boleyneendorrish, refer to Figure 5.

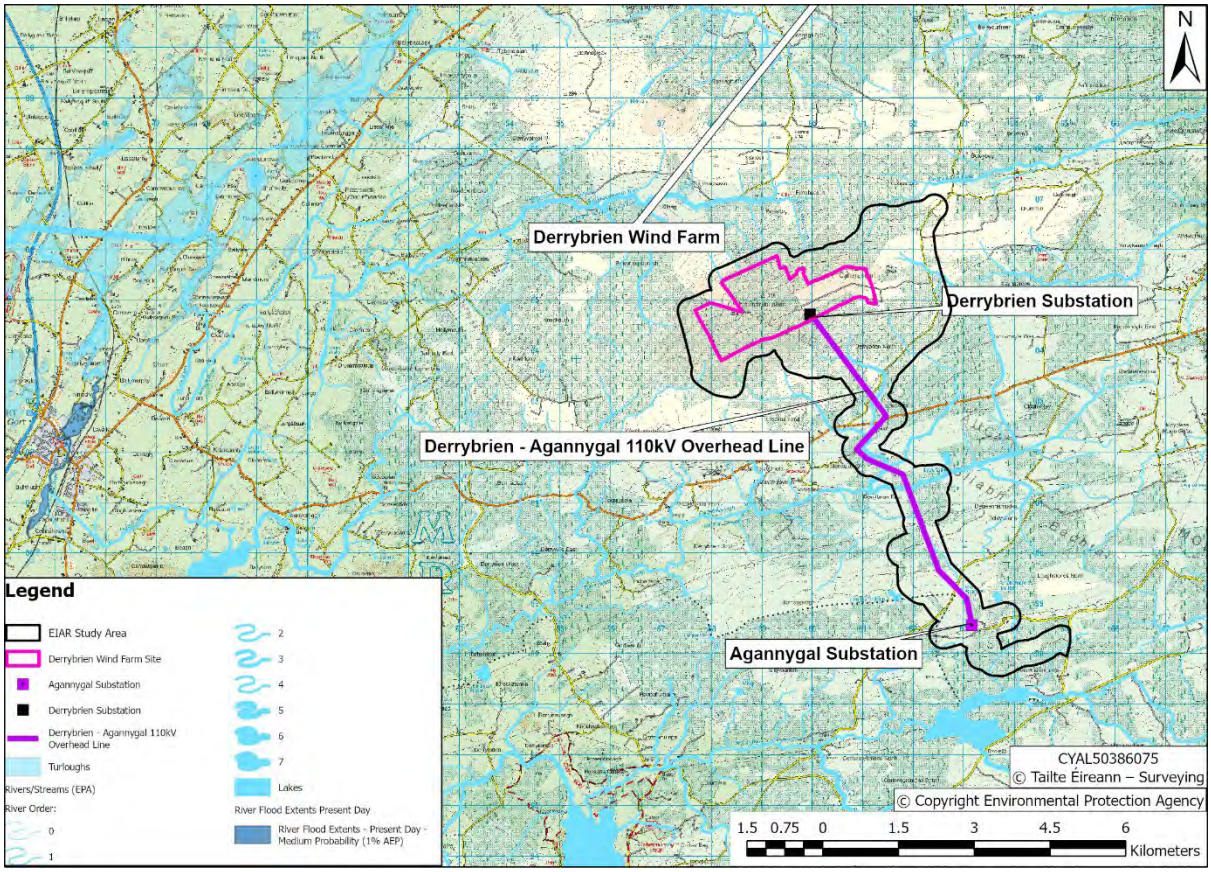

Figure 5 National Indicative 100-year Fluvial Flood Extents for the Boleyneendorrish and Owendalulleegh Rivers

Historical information on flooding events is available from the OPW Floodinfo Website (https://www.floodinfo.ie/), refer to Plate 3. This public resource does not represent an exhaustive list of historical events and is generally related to Local Authority information on flooding within their local areas. The majority of flood events shown are associated with the Turlough Flooding in the Gort Lowlands area. However a flood event was identified on the Owendalulleegh River at Drummin Townland associated with fluvial flooding of the floodplain area. Recurring flooding of floodplain lands by the Owendalulleegh River at Drummin and Derreen townlands occur. The catchment area of the Owendalulleegh to Drummin and Derreen c. 80km^2.

The Geological Survey of Ireland provide groundwater flood maps and groundwater level and turlough level gauging measurements principally for karst limestone areas including the Gort Lowlands and this information is relied upon in this report.

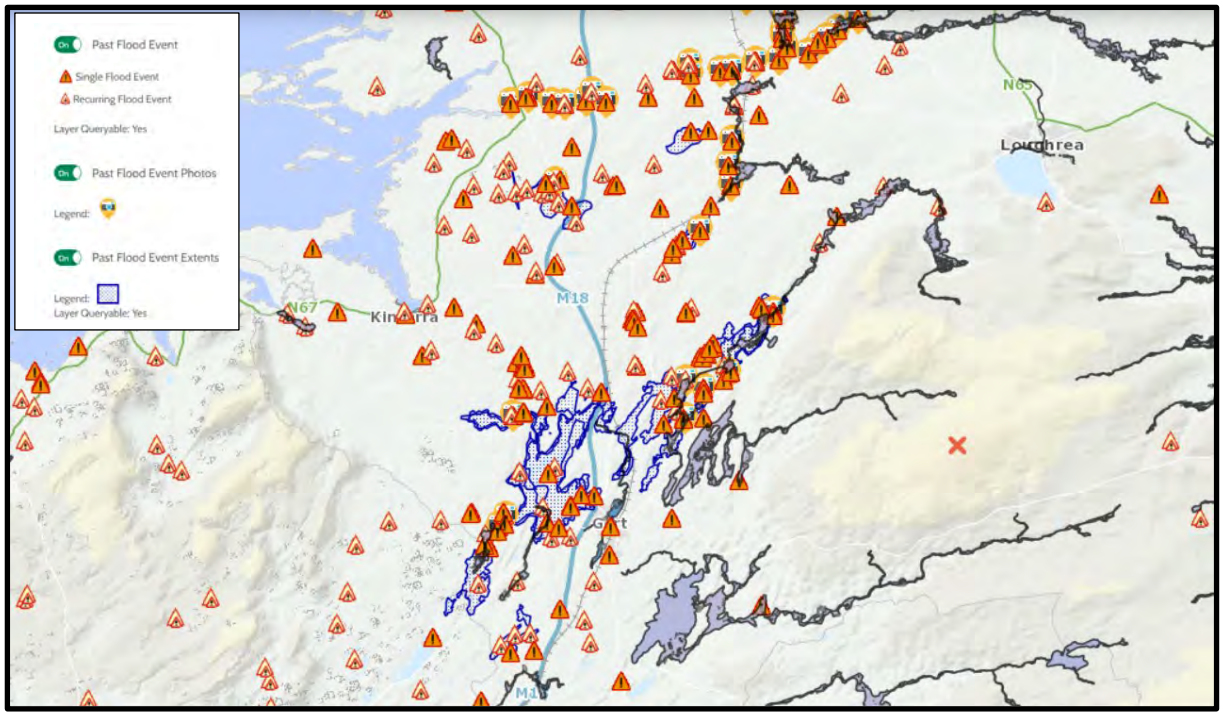

Plate 1 – Past Flood events from Floodinfo.ie

5.2 Historical Flooding

Severe turlough flooding in the Gort Lowlands system is associated with heavy prolonged winter rainfall events over many weeks and generally associated with sustained heavy rainfall between December and February (except for 2009 when extreme rainfall in November produced peak levels towards the end of November and early December).

Historically severe turlough flooding in the Gort Lowlands area occurred in

- 1989/1990
- 1993/1994
- 1994/1995
- 1999/2000
- 2009
- 2015/2016
- February-March 2020

Fluvial flooding in the Owendalulleegh and Boleyneendorrish Rivers and the Gort River were associated with December 1999, November 2009 and December 2015 events.

Plate 2 Flooding in the Kiltartan area on 26th February 2020

The most extensive flooding occurred in the Coole-Garryland Turlough in 2015/2016 (with the peak occurring in early January 2016). This event was followed in severity by the Nov/Dec 2009 flood (rainfall primarily fell in late October and November 2009) and the third ranked flood was the 1994/1995 flood that peaked at the end of January and early February1995. All flooding in the Gort Lowlands turloughs is winter-dominated flooding produced by prolonged rainfall events over many weeks as opposed to short duration flooding events over hours and days. The most recent event that peaked at the end of February / early March 2020 is ranked in terms of severity as the fourth worst event behind 2015/16, 2009 and 1994/95 events.

The observed peak flood levels in 2009 and 1994/1995 were similar at Blackrock and Thoor Ballylee Tower, but the 2009 flooding progressively exceeded 1994/95 in down-gradient turloughs, with flood levels in Caherglassaun approximately 0.7m higher in 2009. A comparison between 2009 and 2015/2016 showed that flood levels were higher in 2009 at Blackrock by c. 0.3 m but were surpassed by the 2015/16 event in the downstream turloughs at Kiltartan and Corker, Coole-Garryland, Caherglassaun and Cahermore Turloughs due to the greater volume and longer duration of the flooding event. In 2015/2016 the peak flood levels surpassed the 2009 event in the Caherglassaun Turlough by c. 0.8m and at Cahermore by over 1m. Table 6 below presents estimated historical maximum flood levels at the various Gort Lowlands turloughs.

Table 6 Historical maximum flood levels in a number of the turlough areas

Location	**Maximum Flood Level mOD**	**Year**
Blackrock Turlough	29.45 (29.15)	2009 (2015/16)
Lough Coy	19.3 (19.15)	2009 (2015/16)
Ballylee floodplain and Swallow hole area	19.15 to 19.4	2015/2016 and 2009

Ballyloughaun and lower Castletown Floodplains	18.0 to 18.2 (<16.5) **	2009 (2015/2016)
Kiltartan	14.9 – 15.2 (14.9 at Kiltartan Church)	2015/2016 (2009)
Coole Lough (Garyland)	14.65 (13.7)	2015/2016 (2009)
Hawkhill (Coole)	14.63 (13.75) (13.3)	2015/2016 (2009) (1994/1995)
Caherglassaun	14.5 (13.8)	2015/2016 (2009)
Cahermore	13.4 (12.5)	2015/2016 (94/95 and 2009)

** the flooding at Ballyloughaun floodplain in 2015/2016 was significantly reduced due to the replacement of undersized culverts beneath the former N18 road near Kiltartan, otherwise it would have been expected to be similar to 2009 max flood levels which had spilt across the road.

A review of long-term rainfall records in the earlier Gort Lowlands Flooding Study (Southern Global Water, 1997) concluded that in the 50 years preceding the first notable flood event in 1989/1990 that the prolonged rainfall events recorded, except for 1959, were not sufficient in rainfall amount to have produced severe turlough flooding in the Gort Lowlands compared to the more recent listed significant events in Section 4.1 above.

A review of the daily rainfall records from the Derrybrien II (St. No 2121) rain gauge (at altitude of 155 mOD) for the available record period 1st July 1982 to 31 August 2022 showed the following amounts in respect to the historical rainfall events:

- In 89/90 586 mm of rainfall fell in 3 months, namely December ' 89, January '90, February '90 having an average rate of 6.51 mm/day.
- In 93/94 646 mm of rainfall fell in a 3-month period from the 27th Nov 94 to 26th Feb 95 producing an average rate of 7.18 mm/day.
- In 94/95 820 mm of rainfall fell in 101 days from 2nd Dec 1994 to 10th Mar 1995 producing an average daily rate of 8.12 mm/day and this event followed a moderately wet November having a monthly total of 121 mm.
- In 99/00 631 mm rainfall fell in 102 days representing an average daily rate of 6.19 mm/day.
- In 2009 following a wet July (190 mm) and August (191 mm), a moderately dry September (58 mm) and a wet October (139.3 mm) 469 mm fell in a 29-day period from 30 October to 27 November producing an average daily rate of 16.2 mm/day.
- In 2015/16, similarly to 2009, a wet summer with 111 mm in July and 122 mm in August followed by moderate rainfall amounts in September and October of 75 mm and 66.6 mm respectively was followed by 708 mm from 4th Nov to 7th January (10.9 mm/day).

- In 2020 a record wet month in February recorded over three times its monthly average with the bulk of the rain falling in a 24-day period with an average in excess of 10 mm per day over the month of February.

Derrybrien II rain station is a point measurement at an altitude of c. 155 mOD and does not necessarily reflect the actual catchment-wide rainfall amounts as the lower altitudes within the Owendalulleegh catchment are likely to have had lower rainfall amounts, but the rainfall pattern from Derrybrien II represents well the prolonged nature of the rainfall that produced the significant downstream flooding in the Gort Lowlands turloughs. Figure 6 presents the location of the rain gauge network in the North Clare / South Galway area. There is not a complete record at all of these stations for the period of floods from 1989 onwards but a review of the available daily record shows similar trends to the Derrybrien II rain gauge.

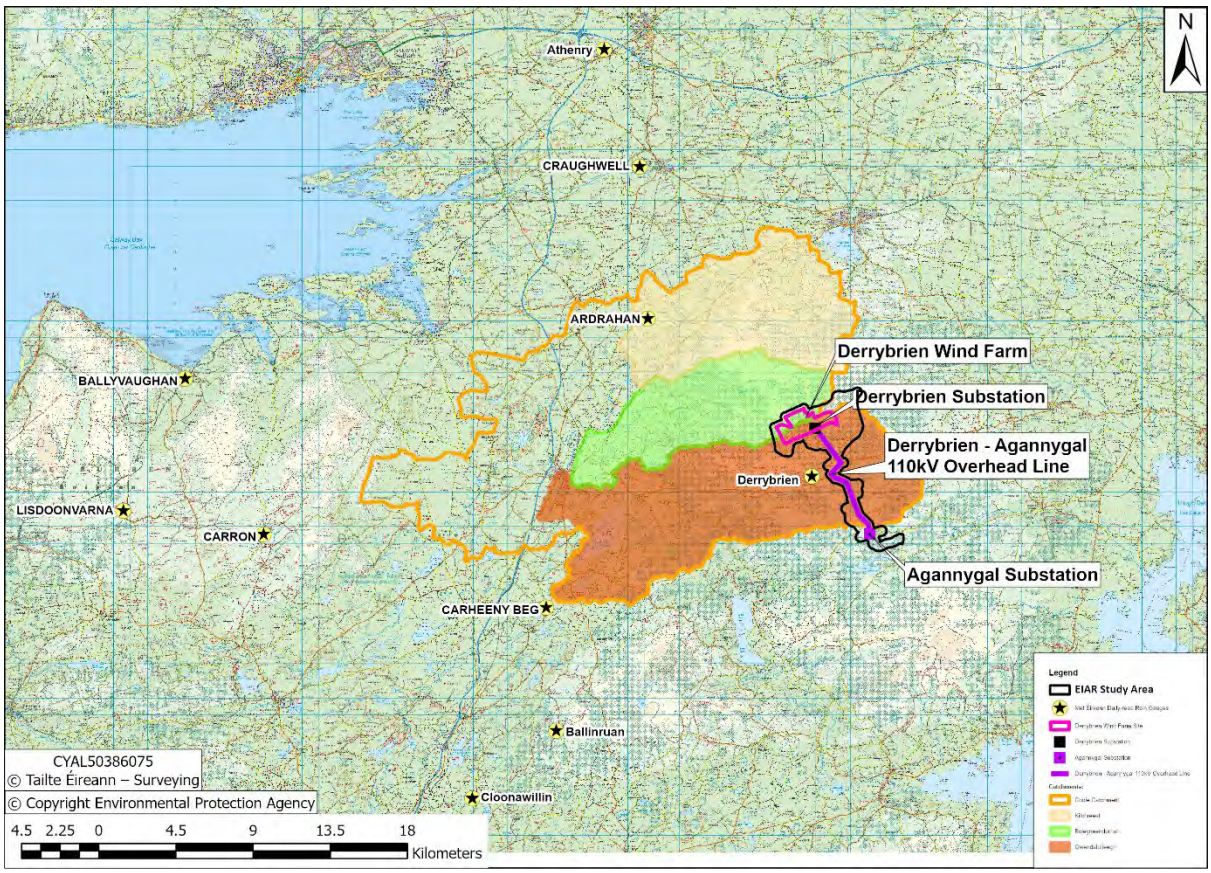

Figure 6 Location of Daily Read Rainfall Gauges in proximity to the Gort lowlands Catchment

The flood extents for the Gort Lowlands turloughs associated with the 2009 flood event that has been produced by the GSI is shown in Figure 4. The total surface area of turlough flood inundation in 2009 was 20.75 km^2. Based on these flood extents a 10 cm rise in flood level represents c. 2 million m^3 of flood storage which in terms of the contributing catchment area of 338 km^2 represents a rainfall depth of 5 mm. It should be noted that all the flood events listed above the prolonged rainfall depths over one or two months were well in excess of 5 mm/day. At a certain rainfall rate the groundwater outflow capacity of the turloughs (this will vary from turlough to turlough) is surpassed and the excess rainfall must store and eventually flood and spill overland. Essentially the turlough flooding in the lowlands area surrounding

Coole, Kiltartan and Ballylee is dominated by the flood volume entering over a prolonged period as opposed to high intensity short duration inflows that would be more critical to flooding in the upland valley sections of the catchment to the east and northeast of the Gort Lowlands area.

The 2015/2026 and 1% AEP flood extents were confirmed at Feasibility stage by Ryan Hanley Consulting Engineers on behalf of OPW/Galway Co. Council for the Gort Lowlands Flood Relief scheme. The maximum past flood extents and the 1% AEP flood extents were included in the Feasibility report and appendices (these reports and mapping can be downloaded from the following project website https://southgalwayfrs.ie/.

A paper by Naughton and McCormack (2016) of the GSI presented the flood extents for the winter 2015/2016 event, refer to Plate 3 below.

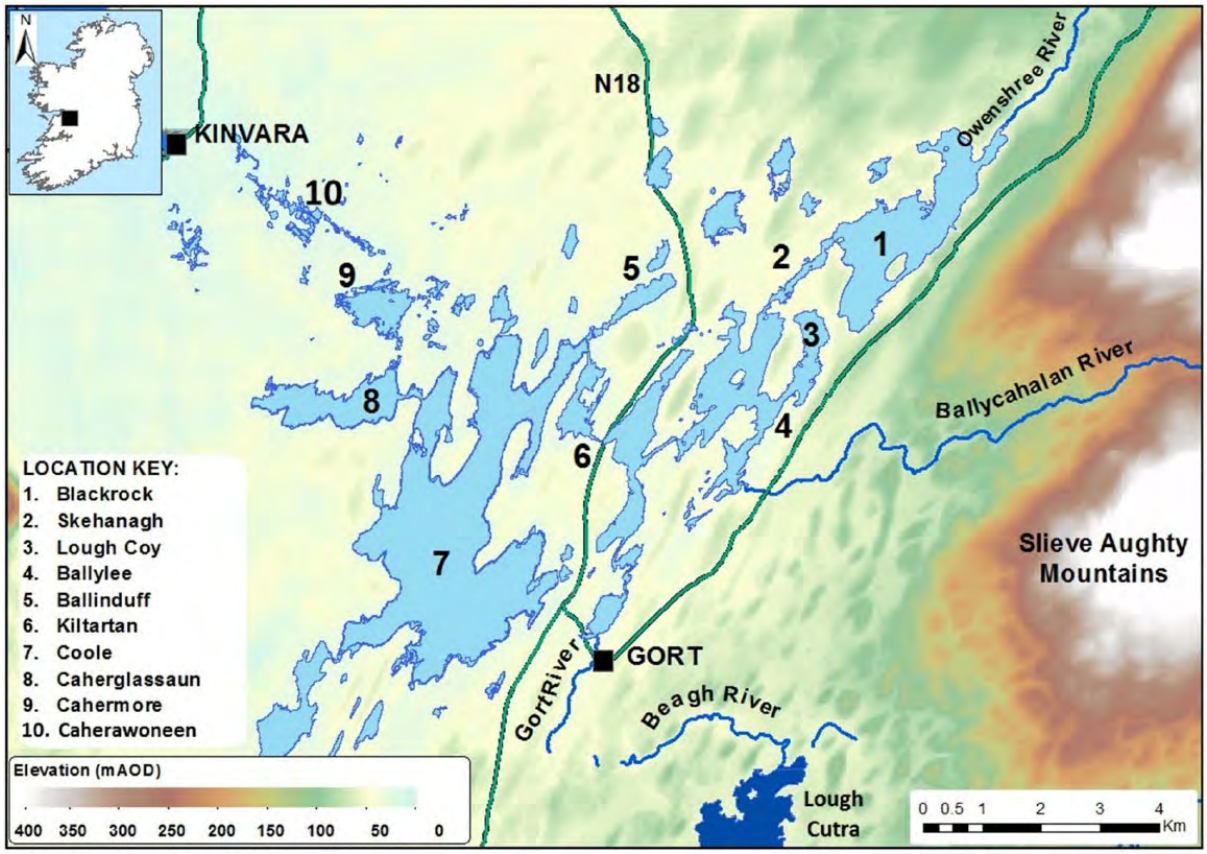

Plate 3 – Groundwater Flood extent map for the Gort Lowland, winter 2015-2016 (copied from McCormack and Naughton, 2016)

5.3 Turlough Flooding

Turlough flooding occurs when for a sustained period the inflow exceeds the capacity of groundwater outflow from the turlough basin via its karst conduit flow system. During prolonged and intense rainfall, the subterranean flow paths are unable to drain its catchment and the limited subsurface storage is quickly exhausted resulting in surface flooding in the low-lying topographical depression. Under normal flood conditions this inundation is necessary for the flood-dependent turlough habitat. The excess floodwater builds-up in the turlough basin which increases the hydraulic head available to drive increased groundwater outflow and / or continues to rise until it discharges as shallow groundwater flow within the epi-karst or overtops the basin crest and spills as overland flow. As water builds-up in the turlough basin, this does not always necessarily increase the head available for the groundwater flow, as the water level in the downstream receiving turlough basins may also be rising due to their limited outflow capacity causing a backwatering effect from restrictions further downstream. As the flood event proceeds and water levels continue to rise some of the turloughs become as one or become severely backwatered from the downstream turlough. Under normal flood conditions this inundation is necessary for the flood dependent turlough habitat. However, under extreme conditions, extensive surface flooding and overland flow can develop, posing a flood risk to surrounding properties, roads and agricultural land.

A review of water level records in the various monitored turloughs of the Gort Lowlands clearly indicates a highly damped attenuated system where flood levels gradually rise, producing a prolonged peak and receding slowly over many weeks. In these turloughs the change can be dramatic between summer low levels and max winter flood levels, for example Coole Lough summer level is c. 5.5 mOD and the maximum winter flood level observed is 14.7 mOD (c. 9.2m water depth difference).

The dye tracing carried out by David Drew (1994), GSI and the Gort Lowlands Flood Study (1997) shows multiple linkages to spring and turloughs from the various swallow-holes and turlough areas. These studies do not quantify the magnitude of these connections from these features only that there is a possible linkage. The main groundwater conduit flow linkages identified within the Gort Lowlands system are summarised as follows:

- Lough Bunny to Lough Skeardee and via Cloonteen River and swallow hole to Lough Mannagh and Hawkhill Turloughs
- Punch Bowl 2 km downstream of Lough Cutra, where the Beagh River from Lough Cutra sinks and rises at Pollduagh Cave in the townland of Cannahowna to becomethe Gort River.
- Blackrock Turlough to Lough Coy to Thor Ballylee Swallow-holes (Pollanoween and Pollaleen)
- Thoor-Ballylee Swallow-holes to Polldeelin Springs at Kiltartan and to the Lough Coole springs.

- The Gort River sinks at Pollatoophil swallow hole near Kiltartan castle and rises at Polldeelin Springs Kiltartan and to the Lough Coole Southern Springs
- Lough Coole-Garryland Turlough to Caherglassaun Turlough and also to the Kinvara springs
- Caherglassaun Turlough caves and swallow holes to Kinvara Springs (West, Central, and East)

5.4 Turlough overland spill pathways

As the inflow volume to the Gort Lowlands turlough basins exceeds the underground flow capacity of the karst conduit system the groundwater levels rise locally and the excess inflow volume is stored as standing water in the turlough basins. The turloughs continue to fill with the excess inflow until they spill overland or become joined with other nearby turloughs. The main overland flow spill pathways for the various Turloughs in the Gort Lowlands system are described as follows:

- Blackrock Turlough spills at Rahaly south in a southwest direction through Skehanagh to Carrowbaun East and onto the Ballylee floodplain at Newhall and Thoor Ballylee
- Overland flow from the Ballylee floodplain southwest via Rinrush and Deerpark to the Ballyloughaun Floodplain at the Athenry Rail line near the 44-mile post.
- The Castletown River at the Castletown Swallow-holes floods out and spills northwards to the Ballyloughaun floodplain crossing over the Castletown local road and the Galway-Ennis Railway line near the 44-mile post and joins with the Ballylee overflow in the Ballyloughlaun Floodplain.
- The Ballyloughaun floodplain spills westward across the R458 via the recently upgraded culvert crossing into the Kiltartan floodplain.
- The Kiltartan flood plain spills overland north to Corker turlough where it crosses west under the new M18 road to the Raheen turlough and south joining the Coole - Garryland Turlough
- To the south of Garryland-Coole Turlough the Cloonteen River drains Lough Mannagh to Hawkhill Turlough. Both Hawkhill and Newtown Turloughs all form part of the Garryland-Coole Turlough floodplain.
- The Garryland-Coole turlough spills northwards to Crannaghand then west into the Caherglassaun Turlough.
- Historically there is no overland spill from Caherblassaun Turlough to reach Cahermore Turlough located to the north.
- Cahermore Turlough spills northwards across the local Kinvara to Gort road c. 5km from Kinvara (southeast) and then spills overland northwest through Caherawoneen South and North to Shessaragh and eventually to Kinvara Bay to the northeast of Dungory Castle. This overland route was assisted by emergency flood relief works carried out by Galway Co. Co during the flood of 2015/2016.

5.5 Identified flood-prone areas requiring flood relief measures

A significant impact of flooding in the Gort Lowlands is the duration that areas are flooded or cut-off which extends to weeks and months during the most extreme events. The main flood-prone areas identified by the OPW PFRA (Preliminary Flood Risk Assessment) Groundwater and GSI flood risk mapping, the previous flooding studies and by the current Gort Lowlands Flood Relief Scheme carried out by Ryan Hanley Consulting Engineers (Ryan Hanley, 2018b) are summarised as follows:

Drummin and Derreen Townlands

- Extensive flood plan area due to flat nature of land with flooding associated with fluvial flows in the Owendalulleegh River. Catchment area is c. 80lkm2 with flood flows estimated to be at c. 2 cumec at the median annual flood and 56cumec at the 1000year flood. Channel gradient is flat with significant channel meandering present and extensive network of field drains within the floodplain lands. Local Road cut-off and flooded by the river.

Cahermore Turlough Area

- Cahermore Turlough peak flood level is 13.6 mOD (Dec 15/Jan 16 event) (overland spill prevented this level rising further). There are at least 10 houses and up to 5 farm sheds/slatted sheds at risk including cut-off and flooding of local roads.

Caherglassaun Turlough Area

- Caherglassaun Turlough reported historical maximum flood level reached 14.48 mOD during 2015/2016 event. 1 house and slatted shed and large sections of local road flooded.

Garryland – Coole Turlough Area

- At Garryland – Coole Turlough System the reported maximum flood level from the 2015/2016 is 14.74 mOD. In this area three houses, a farm yard, warehouse and interpretative centre along with slatted sheds and numerous local roads and farm access roads and potentially the new M18 road at the Gort Interchange (based on evidence from 2015/16 flood).

Lough Mannagh area

- At Lough Mannagh south of the Coole-Garryland turlough system the historical maximum flood level was reported to be 15.15 mOD in the lough and 14.9 mOD in the floodplain on the north side of the Poulataggle Road during the 2015/16 event. Lough Coole and Garryland turlough back up in Lough Mannagh during extreme flooding. In this area there are up to 7 houses, Tirneevin Church and three slatted sheds at risk of flooding and a number of local roads and farm accesses.

Kiltartan floodplain area

- At Kiltartan floodplain the maximum historical flood level is c. 14.9 to 15.0 mOD for the 2015/16 event with Coole-Garryland Turlough reaching 14.7 mOD. There is significant

flood risk at Kiltartan including the church (which has flooded on a number of occasions) and at least 5 houses classified and a number of farm sheds and a number of public local roads including private access roads.

Ballyloughaun and Castletown floodplains

- The Ballyloughaun and Castletown floodplains located to the east of the R458 (formerly the N18) at Kiltartan suffered its historical maximum flood level in the 2009 event when the R458 road flooded with a maximum flood level of 18 to 18.2 mOD. However during the 2015/16 flood event the maximum flood levels in the Ballyloughaun floodplain were between 16.2 and 16.5 mOD. This reduction in flood levels of 1.7 to 1.8 m was due substantially to the construction of a flood relief culvert under the R458 (former N18) road at Kiltartan (box culvert 2.9 m wide by 2.1 m in height) in the intervening years. Even at the much reduced flood levels in 2015/16 both the railway line and the Castletown road still flooded. No houses in the vicinity of this floodplain flooded or were at risk of flooding during either event. A number of local roads and the Limerick rail line (in excess of 400 m flooded) remain at significant flood risk.

Ballylee Floodplain Area

- At Thoor-Ballylee the peak flooding associated with the 2015/16 flood was of the order of 19.15 to 19.4 mOD. The main impact of flooding at Ballylee is flooding of the Thoor-Ballylee Yeats Centre, flooding of local roads leaving the Rinrush community cut-off and many houses stranded and access roads to farms and land cut-off.

Lough Coy

- The Ballylee floodplain backed up to Lough Coy in the 2015/16 flood event producing a maximum flood level of 19.5 mOD. At Lough Coy both 2009 and 2015/16 flood events produced similar maximum flood levels at Lough Coy. Such flood levels produce a flood risk to a number of slatted sheds and flood 350 m of the Dromorehill Road.

Blackrock Turlough

- The peak flood levels at Blackrock Turlough during the 2009 and the 2015/16 floods were surveyed at 29.45 and 29.15 mOD respectively. During the 2015/16 event at least 2 houses and 1 business flooded and almost 17 houses were cut-off. Flooding at Blackrock turlough produces a significant flood risk to 5 houses and 10 farm sheds in the vicinity of the turlough and many local roads and farm accesses may become submerged or cut-off.

6. Proposed Flood Relief Measures for Gort Lowlands

An extensive flood study of the Gort Lowlands catchment was carried out by Southern Global Water and Jennings's O Donovan in 1996/1997 (SGW/JOD, 1997). This study outlined various potential flood mitigation options which involved:

- Improving the conveyance (overland channel flow) for water from the Coole area to get to the sea at Kinvara
- Impounding water upstream of the major flooded areas (4 large impoundment (i.e. dam) locations on the principal rivers including the damming of Lough Cutra, and the Ballycahalan River).
- Diverting flow to other catchments upstream of the major flooded areas.

None of these options were considered to be viable and therefore were not progressed any further. It was found given the duration and flood volumes involved that the damming was not viable economically nor very effective in reducing flooding downstream in the Coole Area (Southern Global Water, 1997).

As a consequence of more extreme flooding, particularly the November 2009 and December/January2015/16 events, a review of the flood relief options for the Gort Lowlands was implemented by the OPW in association with Galway County Council and this culminated in the appointment of engineering consultants Ryan Hanley to bring forward a viable flood relief scheme for the Gort Lowlands area. Ryan Hanley have through extensive surveys and assessments including the involvement of Trinity College, who undertook the groundwater flood modelling, identified a preferred flood relief solution that involves overland flood conveyance between turloughs and eventually to the sea at Kinvarra Bay.

The preferred flood relief solution to the turlough flooding in the Gort Lowlands area is to lower the peak flood levels to prescribed target levels to protect, where feasible, properties that are at risk. These proposed reductions in flood level would typically be between 1 and 2 m at the 100-year design flood event. This solution would be in combination with raising local roads, the possible provision of alternative road access routes to cut-off communities, the possible relocation of some lower lying dwellings which cannot be feasibly protected and /or individual property defences (Ryan Hanley, 2019/2020). This approach of lowering only the top flood levels was adopted so as to protect the Annex I priority Turlough Habitats.

The mechanism for lowering the peak turlough levels is through enhancing the existing overland spill pathways between turloughs allowing them to spill earlier and at a lower level so as to cascade from one turlough to the next in controlled overland channels with suitably sized culverts under local roads and accesses until reaching the sea at Kinvara (i.e. Blackrock to Ballylee to Ballyloughaun to Kiltartan to Corker to Coole-Garryland to Caherglassaun to Cahermore and to the sea at Dungory, Kinvara). The scheme requires a continuous overland

pathway of spilling from one turlough to another to the sea and without such an integrated pathway to the sea, spilling from one turlough to another could potentially increase the flood risk in a given downstream turlough.

Other flood relief options were considered by the Consultants, such as upstream attenuation and land management on the inflowing tributaries of the Owenshree, Boleyneendorrish and Owendalulleegh Rivers as stand-alone measures or in combination with the above proposed overland turlough spill conveyance measures were found not to be very effective given the sheer flood volume involved and the long duration (typically two months) required to protect these downstream lowland areas. Such measures would have to involve damming of the river valleys for extended periods requiring the construction of major dams and the inundation of extensive area of upstream lands and only releasing a much smaller prescribed flow (i.e. 10 m^3/s from Lough Cutra and 4 m^3/s from Ballycahalan impoundments based on the Gort Lowlands Flood Study (Southern Global Water, 1997). It was also noted in this Study that the more serious turlough flooding of the lowlands areas occurred when prolonged winter rainfall over a 2-month period exceeded an average daily rainfall rate of 5 mm per day from the catchment. The total catchment area to Kiltartan is 301 km^2 and for the 2015/2016 flood event the average daily rainfall over a 66 day period was recorded at Derrybrien II to be 10.8 mm/day. Restricting runoff from the catchment to 5 mm/day (17.4 m^3/s) would have required the storage of 5.8 mm/day which represents a storage volume of 115 million m^3 of runoff. This is equivalent to a lake 11.5 km^2 in surface area and 10 m average depth which could only be emptied over many months.

Large scale land management changes of the entire Slieve Aughty Mountains in terms of returning the hill slopes and plateau (watershed) areas, which are predominantly commercial forestry, to undrained peatlands will not produce the desired effect of achieving any measurable flood reduction in the downstream Gort Lowlands area. The blocking of drains and generation of more saturated conditions on the bog surface will only, at most, slow the rapid runoff of surface water but will have minimal effect on altering the flood volume generated, particularly for the prolonged winter flood events critical to causing the flooding in the downstream Gort Lowlands basin.

Attenuation and land management measures (i.e. restoring undrained peatlands and reducing drainage affects in forestry) can be effective in reducing the flood runoff rates for short duration flood events. Such measures are not very effective for prolonged winter rainfall events where the flood volume as opposed to the flood rate is critical, and this applies in particular to the case of the Gort Lowlands turlough flooding situation. These attenuation and land management measures do not provide a sink or longer-term store for rainfall with the volume of rainfall becoming the runoff volume particularly on these elevated winter-saturated catchments which have low permeability sub-soils overlying a low permeability agrillaceous limestone bedrock.

It is important to note that the Derrybrien wind farm site of 3.44 km^2 is a relatively small section of the overall Slieve Aughty Mountain catchment and therefore land use changes there would have had no perceptible effect on flooding in the downstream Gort Lowlands catchment.

Currently the Gort Lowland Flood Relief Scheme is completing the environmental studies to support the preferred scheme of providing an overland spilling route to Kinvara, including Appropriate Assessments for the numerous SACs within the zone of influence of the Scheme. These Special Areas of Conservation (SAC) Natura Sites are listed as follows:

- East Burren Complex SAC
- Coole-Garryland Complex SAC and SPA (Special Protection Area)
- Carrowbaun, Newhall and Ballylee Turloughs SAC
- Peterswell Turlough SAC
- Cahermore Turlough SAC
- Caherglassaun Turlough SAC
- Inner Galway Bay SPA
- Galway Bay Complex SAC

7. Derrybrien Wind Farm Project Potential Flood Impact

This section examines the potential downstream flood impacts from the Derrybrien Wind Farm development on downstream flood receptors such as the Owendalulleegh and Boleyneendorrish Rivers, Lough Cutra and the turloughs and flood areas within the Gort Lowlands area. The Derrybrien site measures 3.44 km^2 in area of which 66.3% drains to the Owendalulleegh River (i.e. 2.28 km^2) and 33.1% to the Boleyneendorrish River (i.e. 1.15 km^2) and 0.6% to the Duniry River (which is part of the Shannon System). The lands within the wind farm site represent disturbed peat bog with 263ha formerly Coillte forestry plantation and 81 ha turbary bog lands. The peat slip area is 0.26 km^2 and the OHL corridor is 0.34 km^2, located in the Owendalulleegh Catchment and the southern end of the OHL in the neighbouring Bleach catchment draining to Lough Atorick and the River Fergus system. The OHL is almost entirely located in the former Coillte Forestry. The total combined site area within the Owendalulleegh catchment is 2.86 km^2.

The former (pre the wind farm development) turbary and forestry land uses introduced significant drainage of the mountain-side peatland giving rise to its disturbed and degraded peatland state at the site. The wind farm project cleared Coillte forestry (felling approximately 28 ha of forestry between the wind farm site, landslide and OHL route), introduced additional floating roads and hardcored areas, increased the drainage network to protect the turbine bases, peat deposit sites, site compound and substation sites and maintained and enhanced the existing drainage channels. The site was extensively drained prior to the wind farm project,

with 27 km out of 39 km of drains on the site pre-existing the wind farm project. The remaining almost 12 km of drains on the site were constructed for the wind farm project.

During the operation of the Windfarm these drains were inspected and where such inspections identified obstruction and peat build-up were locally cleaned.

The removal of trees from the site has enabled the peatland vegetation to re-establish in parts of the site and with some evidence of slow regeneration of blanket bog habitat on the site (refer to Chapter 6 – Biodiversity - Terrestrial). Overall it is considered that the wind farm project through its drainage has increased the rate (speed) of runoff from the site. The natural runoff characteristics of this upland site prior to the project would be classified as a high flood runoff site. The effect of the wind farm project, at a worst-case assessment, was to increase the runoff class of the site from high runoff to very high runoff. This effect would have increased the flood rate as opposed to the total flood volume, which will have remained relatively similar given the poor recharge rates associated with low permeability soils and sub-soils. The effect of this is more acute in the immediate locality of the site and rapidly diminishes downstream as the time to peak and the critical rainstorm duration increases with the increasing catchment area and travel distance involved. By the time the flood wave reaches the sensitive lower reaches of the Boleyneendorrish/Ballycahalan River upstream of the Thoor Ballylee turlough area (catchment 56 km^2) and the Owendalulleegh River upstream of Derreen and Lough Cutra (catchment area 80 and 90 km^2 respectively) the effect of increased runoff rates from the Derrybrien wind farm site are insignificant in respect to flows and flood levels at these downstream receptors.

The estimated change using the FSU Equation peak flow to Lough Cutra under an increase from high to very high runoff category lands achieved by reducing the BFI (baseflow index) in the FSU flood estimation equation is an increase of 0.58% in peak flood rate, increasing the annual maximum hydrograph peak (Qmed) from 31.07 m3/s to 31.25 m^3/s. In the Boleyneendorrish catchment the impact of the wind farm Project on peak downstream fluvial flood rate at Cloonbeg will be an increase of 0.28% in peak flood rate, increasing the annual maximum hydrograph peak (Qmed) from 16.14 m^3/s to 16.19 m^3/s. The estimated potential increases in flood flow peak of 0.58% and 0.28% in the downstream reaches of these catchments is considered minor in the context of downstream flooding and will have no perceptible impact on flood levels and duration of flooding. The Derrybrien Wind Farm does not change the overall flood volume discharging from the site which is the critical factor for flooding in the downstream Gort Lowlands area.

The decommissioning proposal for the Windfarm site is to retain the drainage network but not to maintain it post decommissioning, allowing it over time to naturally infill and become more vegetated and gradually less effective in respect to watertable lowering in the surrounding peat. Similarly the pipe culverts under the access tracks will remain. Over time the drainage performance at the wind farm site is expected to gradually reduce resulting in slightly lower peak runoff rates and slightly higher groundwater levels on the site.

The four number rock barrages that were constructed as emergency works during the peat slippage in 2003 to stabilise the area and protect downstream lands and receiving watercourses are to be left in place as their retention does not result in any significant residual negative impact on flooding, whereas their removal could result in significant impact in respect to land disturbance and the potential for sediment and peat runoff into the downstream watercourses. The upper Barrages no's 1 and 2 are considered important for peat stability along this slip pathway.

Options of attenuating and slowing the flow on the Derrybrien wind farm site through damming drains so as to achieve pre-existing greenfield runoff rates or lower will be of little benefit with respect to reducing downstream flooding at critical flood locations near Lough Cutra and in the downstream Gort Lowlands area. This measure would potentially only delay the onset of flooding by a matter of hours, whereas the downstream flooding occurs over days, weeks and months. Critical to the Gort Lowlands flooding is the total flood volume generated as opposed to the peak flow rates and as such the rainfall volume falling on the upland catchment will make its way to the Gort Lowlands area where it naturally stores until such time that it can empty to the sea via the groundwater system. The Gort Lowlands area acts as the natural floodplain and provides essential flood storage that protects surrounding and downstream lands from more serious flooding.

There is limited opportunity for flood risk management measures at the Derrybrien wind farm site. Such measures if applicable would involve slowing the flow through the provision of on-site flood storage attenuation through creating engineered attenuation reservoirs/dams and through damming drains. Such on-site attenuation measures would be ineffective given the nature of the flood risk in the downstream catchments which are caused by prolonged winter rainfall which is flood volume rather than flood rate sensitive. Attenuation is only effective for short duration events of hours as opposed to weeks. Over a prolonged flood period of weeks the same volume would be transmitted from the site with or without attenuation measures and therefore would have no perceptible effect on flooding in the critical Gort Lowlands area. Whether the site is a wind farm, forestry, cutaway bog or an upland blanket bog the same flood volume over a prolonged wet winter flood period would be generated and released downstream to Lough Cutra in the Owendalulleegh River and to Thoor Ballylee in the Ballycahalan. It also is important to note that construction of large reservoirs on the Derrybrien wind farm site or the blocking of the primary trunk drains could pose an unacceptable geotechnical peat stability risk with respect to future land slides.

The increased frequency of flooding in recent decades (i.e. commencing 1989/90 onwards) that has been witnessed in the downstream Gort Lowlands area is due to Meteorological factors of increased frequency and magnitude of prolonged winter rainfall events (critical duration four to eight weeks). Prior to the 1990s rainfall records show that the preceding decades of the 1960s, 1970s and 1980s were benign in comparison. There is no evidence to suggest that development of the wind farm in 2003 onwards is responsible for increased

flooding in the downstream Gort Lowlands areas. The scale of the Gort Lowlands catchment relative to the Derrybrien wind farm site at less than 1% logically suggests minimal impact this is further reinforced given that the site prior to the wind farm Project was already a drained site for forestry and turbary extraction.

8. Conclusions

The flooding in the downstream Gort Lowlands area and in the lower reaches of the Owendalulleegh and Boleyneendorrish Rivers is produced by extreme prolonged rainfall events being more a function of the flood volume generated by direct recharge to karst limestone basins and indirect fluvial flow off the upland impervious sandstone catchments of the Slieve Aughty Mountains. The flooding in these downstream reaches and the Gort Lowlands area is not overly sensitive to the speed of the runoff from the mountains as the turloughs and wide floodplain areas and Lough Cutra itself provide large natural flood storage that attenuate the runoff hydrograph over many days and weeks as opposed to hours.

It is clear from the flooding history that these lowland turlough areas have suffered more extreme flooding events from 1990 onwards with no significant flooding identified in the previous 50 years (rainfall analysis by Southern Global Water, 1997). The cause of this is meteorological with the recent three decades producing a number of extreme and prolonged winter rainfall events in comparison to a relatively benign rainfall/flood period in the 1950s, 1960s, 1970s and 1980s. In other large winter-flood dominated catchments such as the River Shannon, in which records go back to the 1930s, the same flood pattern can be observed with more extreme flood events favouring the more recent three decades. For instance, the largest inflows from Lough Derg to the Lower Shannon since the Shannon Scheme commenced operation in 1929 have occurred during the 2009, 2015/16 and 2020 floods.

Flood relief solutions for the Gort Lowlands are being progressed by OPW and Galway Co. Council through their consultants Ryan Hanley to protect vulnerable properties, farmyards, communities and roads in the Gort Lowlands area. The preferred flood relief options is to reduce turlough levels to specific target levels through engineering overland spill channels between turloughs until eventually reaching the sea at Dungory Kinvara. Currently the Gort Lowland Flood Relief Scheme is completing the environmental studies to support the preferred scheme of providing an overland flood relief spill route to Kinvara Bay, including Appropriate Assessments for the numerous SACs within the zone of influence of the Scheme.

In the case of Derrybrien, the former land use on the wind farm site was primarily commercial forestry and turbary which represents a drained bog situation and given it upland nature and gradients represents high flood runoff category land. The wind farm project introduced additional drainage and also maintained a number of the existing turbary drains. The drainage solution for the wind farm was not designed to extensively lower the water table level but

focused on collecting and conveying surface water runoff away from the turbine bases and therefore for the scale of the 344ha site the improved drainage does not represent a substantial network of drainage channels over its former forestry and turbary uses. The removal of trees from the site has enabled the peatland vegetation to re-establish throughout the site and with some evidence of slow regeneration of blanket bog habitat on the site, refer to ecology assessment. Overall it is considered that the wind farm Project through its drainage has increased the flood runoff rate over its former forestry and turbary uses from a high runoff category to a very high runoff category site. The effect of this on receiving surface water flood flows is assessed to be slight locally with the effect rapidly diminishing downgradient with increasing river catchment such that by the time it reaches flood affected areas at Derreen and Drummin, Lough Cutra and the Thoor Ballylee floodplain areas from the respective Owendalulleegh and Boleyneendorrish Rivers it is insignificant. The increased runoff rate by the Windfarm during its operation phase and pre-decommissioning is insignificant in respect to flooding and flood risk. The proposed decommissioning of the windfarm site, the OHL and the Agannygal Substation will not negatively impact flooding and flood risk in the downstream reaches.

The drainage network at the windfarm site is to be retained but not maintained post decommissioning and is expected over time (many years) to become less effective resulting in potential for slightly lower peak flood runoff rates from the 344ha site. The effect of this on downstream flooding in the lower reaches of the Owendalulleegh and Boleyneendorrish Rivers and the Gort Lowland area is expected to be imperceptible. The proposal to retain the rock barrages installed as emergency works in 2003 during the Derrybrien peat spill have no implications for causing any negative impact on downstream flooding or flood risk.

Attenuation at the site, located at the mountain top, through physical blockage of drains or the construction of pond areas etc. is not recommended given the limited effect it would have on downstream flooding and more critically due to the potential for increased peak stability risk and uncontrolled consequences by blocking such drains. The proposed decommissioning works for the OHL and Agannygal Substation will not impact flooding or flood risk locally or downstream.

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https://southgalwayfrs.ie/wp-content/uploads/2021/02/Feasibillity-Report-Appendix-C-Scheme-Drawings.pdf

https://southgalwayfrs.ie/wp-content/uploads/2021/02/FRA_CombinedFile-1.pdf

The preferred Flood Relief Scheme Mapping for the proposed South Galway (Gort Lowlands) Flood Relief Scheme

https://southgalwayfrs.ie/wp-content/uploads/2021/02/Emerging-Preferred-Scheme_Combined-1.pdf

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APPENDIX 12-1

ARCHEOLOGICAL SURVEY OF IRELAND RECORDS

Archaeological Survey of Ireland descriptions of archaeology sites in study area

Monument No.	Classification	Archaeological Survey of Ireland description
GA115-007----	Children's burial ground	On the crest of a locally prominent hill overlooking bogland and a small stream to the S. Marked on the 1920 edition of the OS 6-inch map as a subcircular unenclosed area (c. 12m N-S). It consists of an irregularly shaped unenclosed area (L 7.6m; Wth 4.3m) within which small set stones, projecting through the heather, indicate graves aligned N-S.
GA124-001----	Cashel	Located at the junction of four townlands, in an area of upland bog. Named 'Cashlaundrumlahan' on the OS 6-inch maps. According to local information, a 'double wall' once existed here but it was destroyed when the area was forested. No visible surface trace survives but a curving trackway may respect the circuit of the monument.
GA124-003----	Redundant record	This is a curving field wall. It is not an archaeological monument.
GA124-004----	Enclosure	On a S-facing slope in marshy grassland, overlooking the Owendalulleegh River. This poorly preserved oval enclosure (63m E-W; 42m N-S) is defined by a scarp. It is overlain by a field boundary at NW.
GA124-005----	Burial ground	On a S-facing slope in marshy grassland. This irregularly shaped burial ground (c. 55m E-W; c. 30m N-S) is enclosed by a stone wall and is accessed by a gateway at NW. It is still in use and all the headstones are modern. However, there is a bullaun stone (GA124-005001-) within it.
GA124-005001-	Bullaun stone	In pastureland sloping steeply to the S and overlooking woodland. Aspect is limited to the N. This bullaun lies the E end of a graveyard (GA124-005----). It is set in the ground and comprises an irregularly shaped, moss-covered boulder (1.2m N-S; 0.9m E-W; H 0.4m). Two bowls are visible: the N (diam. 0.4m; D 0.12m) bowl is circular in plan, while the S one (0.45m E-W; 0.35m N-S; D 0.18m), which is filled with water, is oval.
GA124-006----	Monumental structure	No published description
GA124-008----	Redundant record	This is a curving field boundary. It is not an archaeological monument.
GA124-009----	Boundary mound	No published description
GA124-010----	Boundary mound	No published description

Monument No.	Classification	Archaeological Survey of Ireland description
GA124-013----	Church	No published description
GA115-021----	Field boundary	On a N-facing slope in pastureland, overlooking the Owenglanna valley. Marked on the 1838 edition of the OS 6-inch map as subrectangular field and on the 1920 edition as a field boundary curving from SE through W to NE. On inspection in May 1984 it proved to be a subcircular drystone field wall (44.5m N-S), similar to others in the area. No trace of it survived from NE to SE where a low scarp indicated its outline. The current evidence is insufficient to warrant accepting this as an archaeological monument.

APPENDIX 12-2

SITE PHOTOGRAPHS

Plate 12- 1 View of wind farm from east

Plate 12- 2 View of wind farm from south

Plate 12- 3 View of wind farm entrance

Plate 12- 4 View of central area of wind farm from west

Plate 12- 5 View of north end of wind farm from west

Plate 12- 6 View of turbines in forestry from east

Plate 12- 7 View of turbines in peatland

Plate 12- 8 View of typical turbine base

Plate 12- 9 View of Derrybrien substation

Plate 12- 10 View of approx. recorded location of Cashel GA124-001----

Plate 12- 11 View of Borrow Pit 3 from north

Plate 12- 12 View of earth-cut drain within wind farm

Plate 12- 13 View of regrowth at location of peat slide

Plate 12- 14 View of overhead line looking north from Black Road

Plate 12- 15 View of Barrage 3 from north

Plate 12- 16 View of Black Road from north

Plate 12- 17 View of Black Road bridge from north

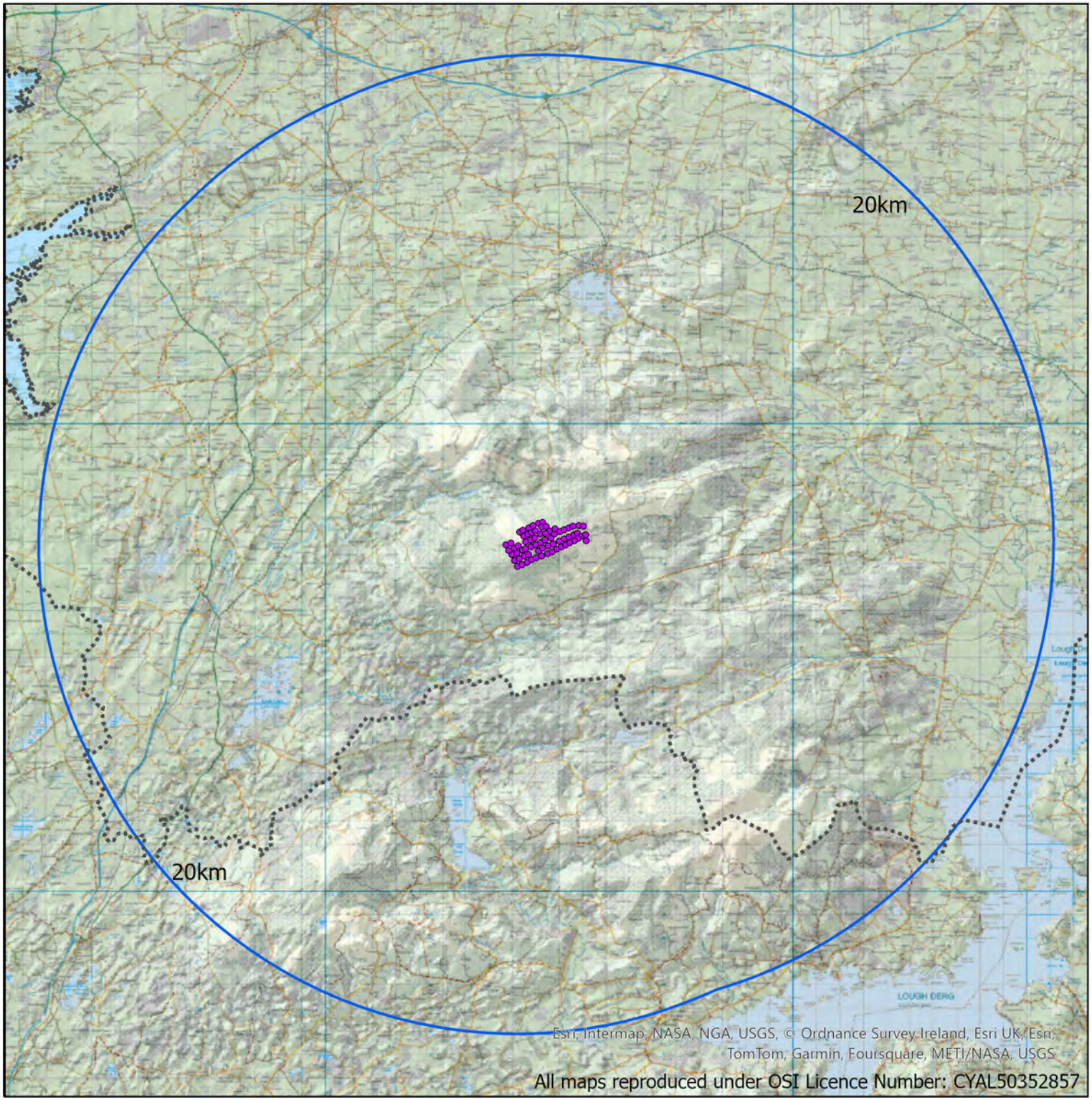
Plate 12- 18 View of Flaggy Bridge from northwest

Plate 12- 19 View of overhead line within forestry to south of R353 road

Plate 12- 20 View of overhead line entering Agannygal substation from north

APPENDIX 13-1

STUDY AREA MAP (A3)



All maps reproduced under OSI Licence Number: CYAL50352857

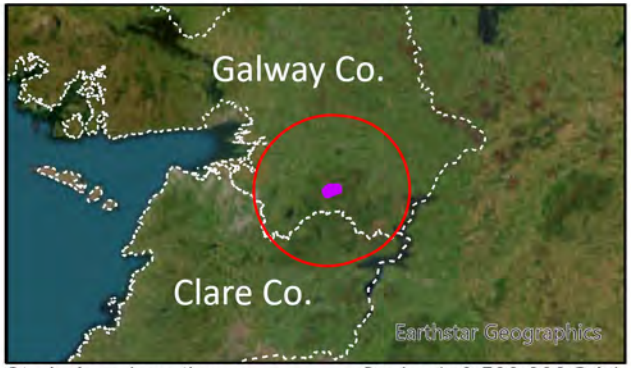
Legend

Galway County Boundary

Derrybrien Wind Farm Decommissioning Project

Study Area - 20Km

Existing Derrybrien Turbines



Study Area Location

Scale: 1: 3,500,000@A4

Site Location Map, Galway County
Derrybrien Wind Farm Decommissioning Project
Drawn: GN
Date: 10/2024

N

Scale 1:230.000@A4

CUNNANE STRATTON REYNOLDS
LAND PLANNING & DESIGN

APPENDIX 13-2

TOPOGRAPHIC MAP (A3)

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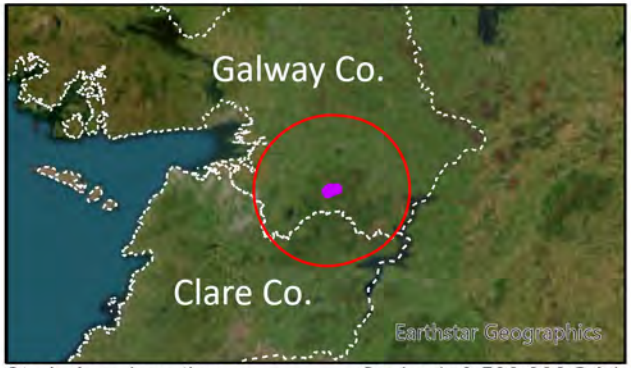
Legend

- △ Highest Elevations

Derrybrien Wind Farm Decommissioning Project

- 5km buffer
- Existing Derrybrien Turbines



Study Area Location

Scale: 1: 3,500,000@A4

Topographic Map
Derrybrien Wind Farm Decommissioning Project
Drawn: GN
Date: 10/2024

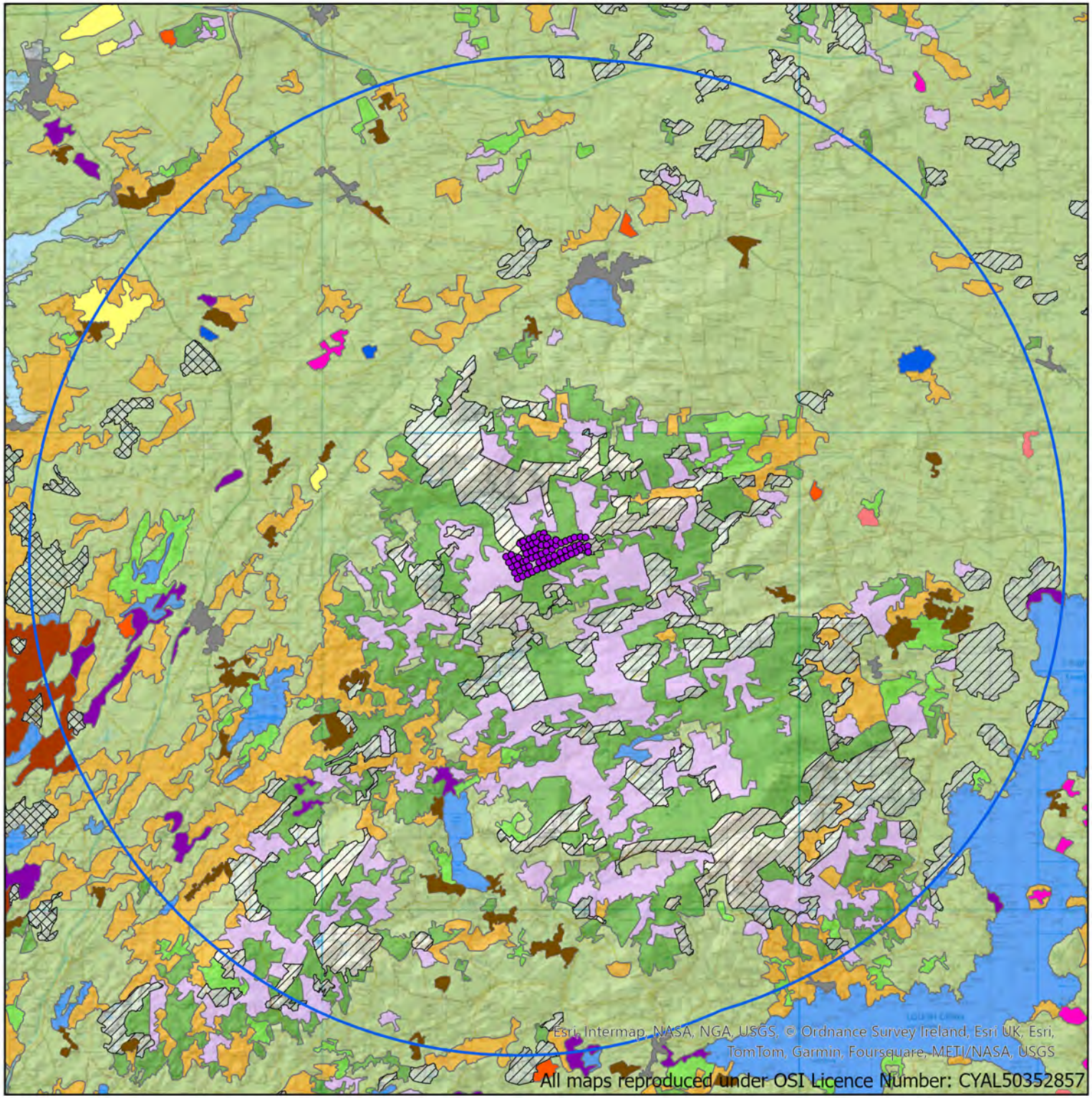
N

Scale 1:70.000@A4

CUNNANE STRATTON REYNOLDS
LAND PLANNING & DESIGN

APPENDIX 13-3

EPA CORINE LANDCOVER MAP - STUDY AREA



All maps reproduced under OSI Licence Number: CYAL50352857

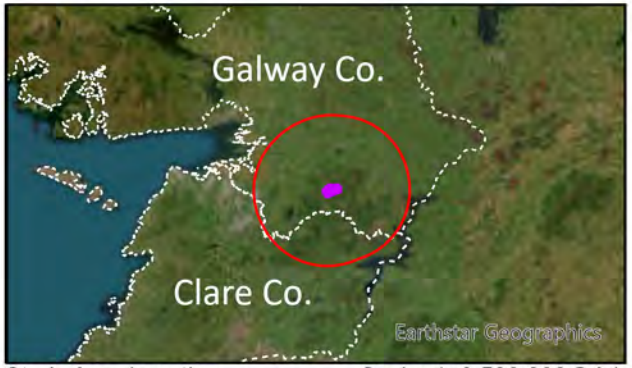
Legend

Derrybrien Wind Farm Decommissioning Project

- Study Area - 20Km
- Existing Derrybrien Turbines

CORINE Land Cover 2018

- Pastures
- Coniferous forest
- Mixed forest
- Transitional woodland-shrub
- Land principally occupied by agriculture, with significant areas of natural vegetation
- Non-irrigated arable
- Sport and leisure facilities
- Bare rocks
- Peat bogs
- Broad-leaved forest
- Complex cultivation patterns
- Discontinuous urban fabric
- Inland marshes
- Mineral extraction
- Natural grasslands
- Sparsely vegetated
- Water bodies



Study Area Location

Scale: 1: 3,500,000@A4

CORINE Land Cover 2018 Map
Derrybrien Wind Farm Decommissioning Project
Drawn: GN
Date: 10/2024

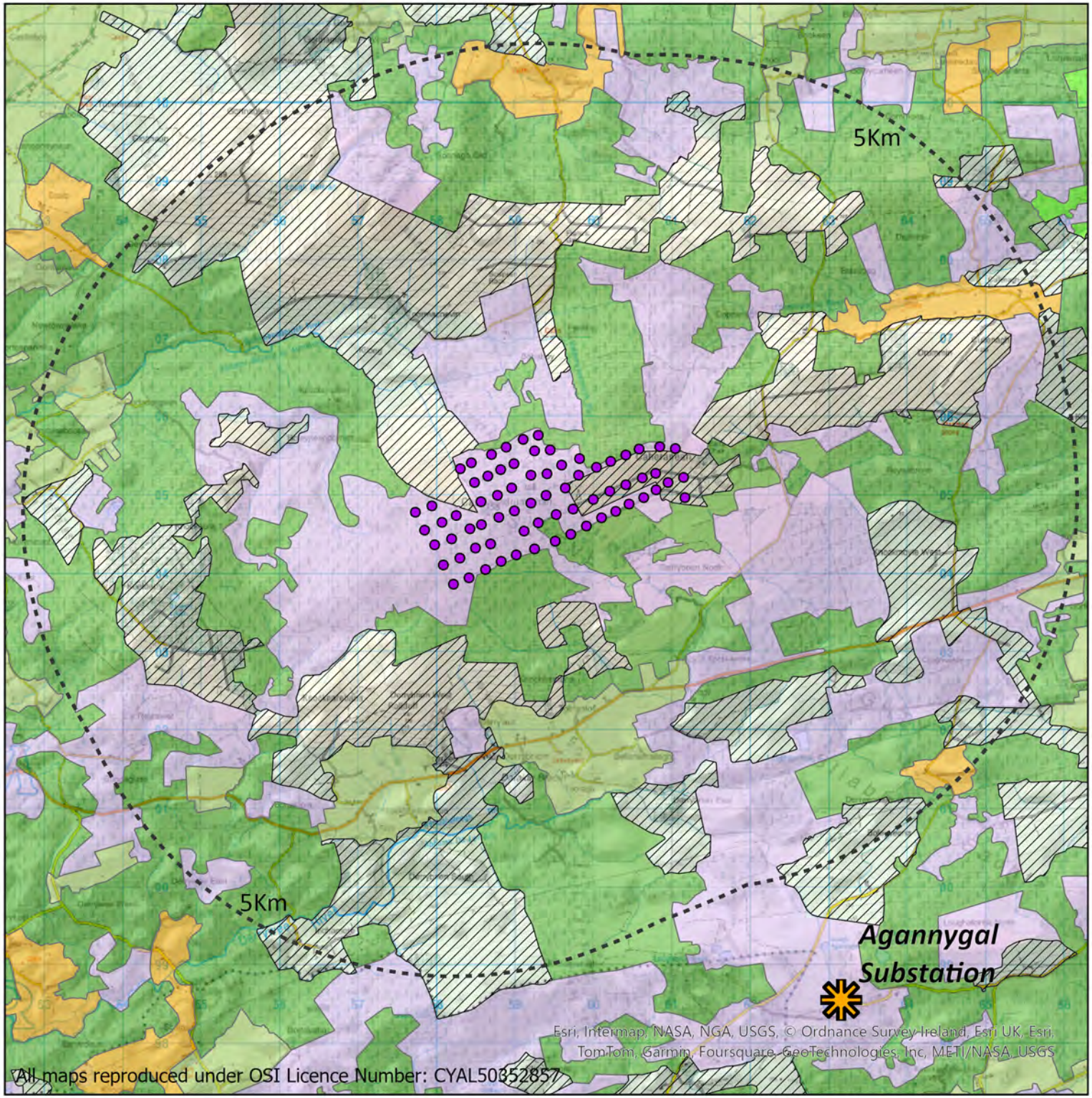
N

Scale 1:230.000@A4

CUNNANE STRATTON REYNOLDS
LAND PLANNING & DESIGN

APPENDIX 13-4

EPA CORINE LANDCOVER MAP - DETAILED



All maps reproduced under OSI Licence Number: CYAL50352857

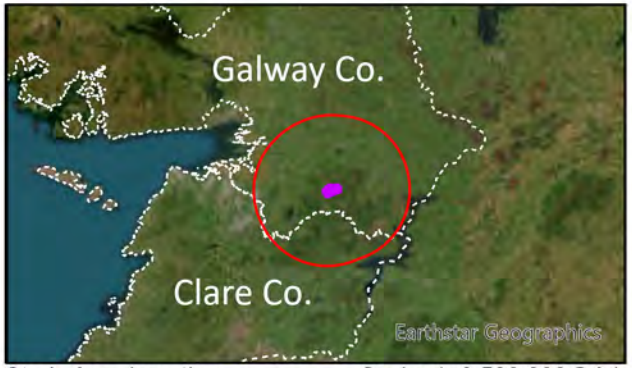
Legend

Derrybrien Wind Farm Decommissioning Project

- 5km buffer
- Existing Derrybrien Turbines
- Agannygal Substation

CORINE Land Cover 2018 (Adapted)

- Pastures
- Coniferous forest
- Mixed forest
- Transitional woodland-shrub
- Land principally occupied by agriculture, with significant areas of natural vegetation
- Peat bogs



Study Area Location

Scale: 1: 3,500,000@A4

CORINE Land Cover 2018 Map
Derrybrien Wind Farm Decommissioning Project
Drawn: GN
Date: 10/2024

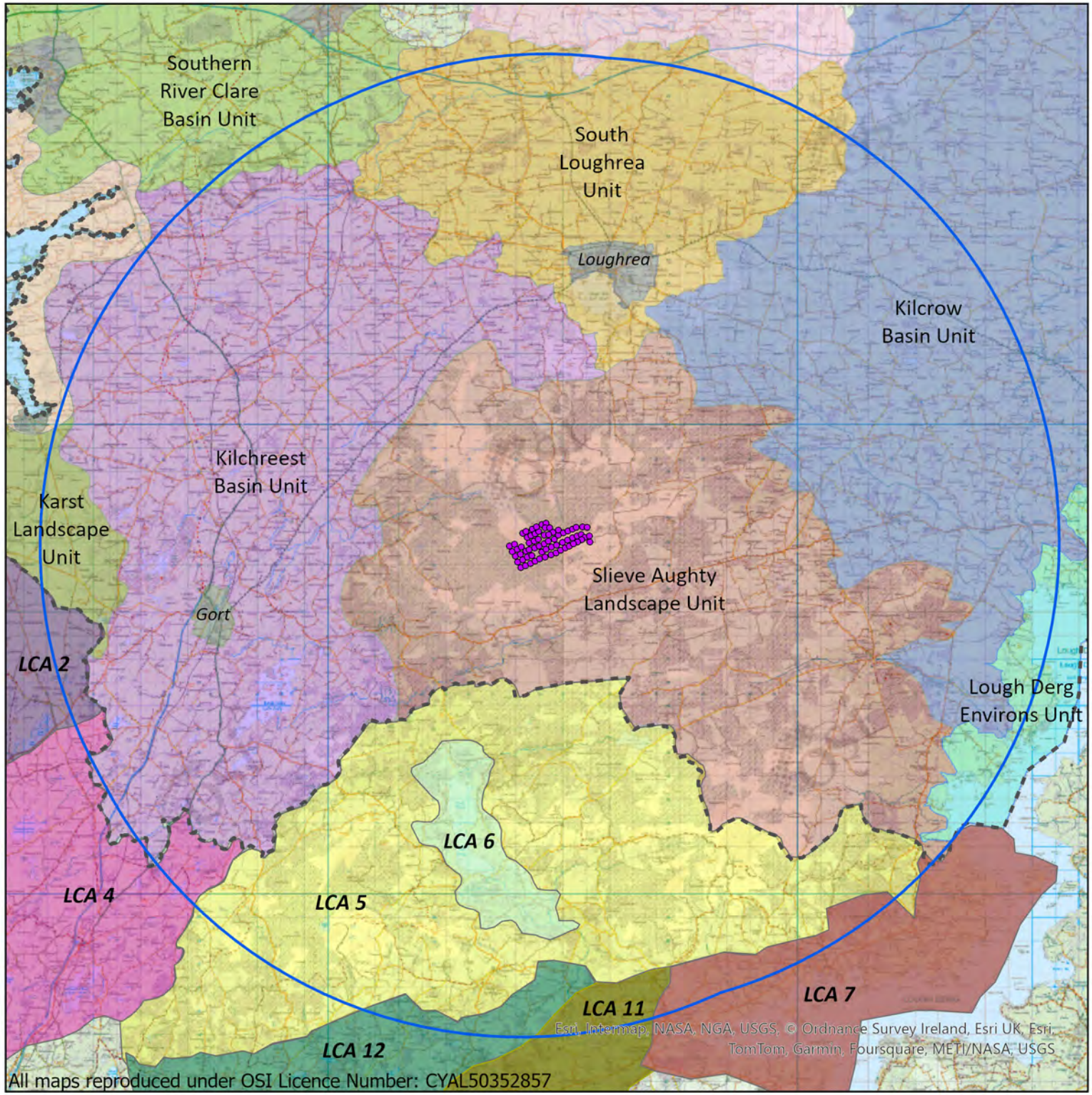
N

Scale 1:70.000@A4

CUNNANE STRATTON REYNOLDS
LAND PLANNING & DESIGN

APPENDIX 13-5

LANDSCAPE CHARACTER AREA MAP



All maps reproduced under OSI Licence Number: CYAL50352857

Legend

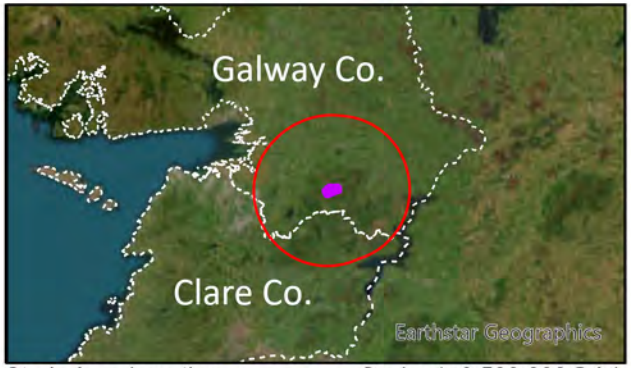
- Galway County Boundary
- Study Area - 20Km
- Existing Derrybrien Turbines

Landscape Character Units - Galway CDP 2022-2028

- Urban Environs Landscape
- Inner Galway Bay Unit
- Karst Landscape Unit
- Kilchreest Basin Unit
- Kilcrow Basin Unit
- Lough Derg Environs Unit
- Slieve Aughty Landscape Unit
- South Loughrea Unit
- Southern River Clare Basin Unit

Landscape Character Areas - Clare CDP 2023-2029

- LCA 2 Low Burren
- LCA 4 Fergus Loughlands
- LCA 5 Slieve Aughty Uplands
- LCA 6 Lough Graney
- LCA 7 Lough Derg Basin
- LCA 11 East Clare Loughlands
- LCA 12 Tulla Drumlin Farmland



Study Area Location

Scale: 1: 3,500,000@A4

Landscape Character Areas Map
Derrybrien Wind Farm Decommissioning Project
Drawn: GN
Date: 10/2024

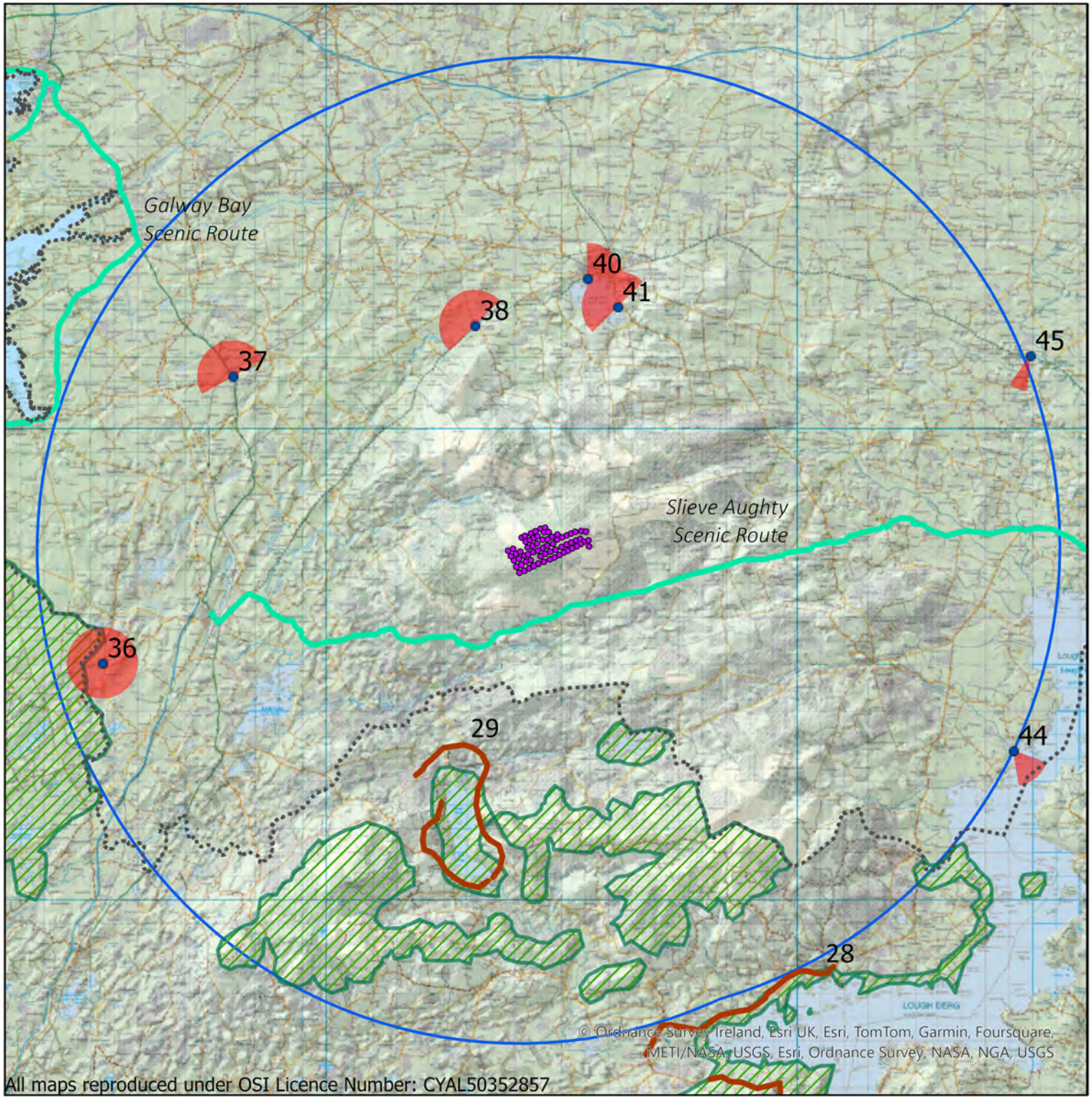
N

Scale 1:230.000@A4

CUNNANE STRATTON REYNOLDS
LAND PLANNING & DESIGN

APPENDIX 13-6

LANDSCAPE AND VISUAL DESIGNATIONS



All maps reproduced under OSI Licence Number: CYAL50352857

Legend

- Galway County Boundary

Derrybrien Wind Farm Decommissioning Project

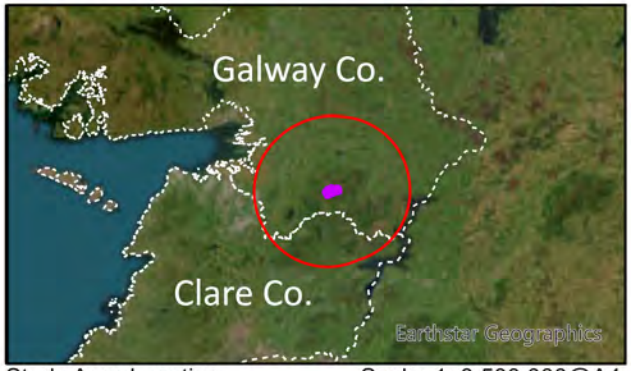
- Study Area - 20Km
- Existing Derrybrien Turbines

County Galway Protected Views - Galway CDP 2022-2028

- Scenic Routes
- Protected Views
- Angles of View

County Clare Landscape Designations - Clare CDP 2023-2029

- Clare Scenic Routes
- Clare Heritage Landscape



Study Area Location

Scale: 1: 3,500,000@A4

Landscape Designations Map
Derrybrien Wind Farm Decommissioning Project
Drawn: GN
Date: 10/2024

N

Scale 1:230.000@A4

CUNNANE STRATTON REYNOLDS
LAND PLANNING & DESIGN

APPENDIX 13-7

EXISTING ZTV MAP (A1)

Zone of Theoretical Visibility (ZTV) Map indicating areas with a theoretical view of the windfarm at Derrybrien, Co. Galway

Calculated to Hub Height (49m)

Derrybrien Turbine Locations

Number of Turbines Visible

3.6%	1 - 14
3.3%	15 - 28
5.2%	29 - 42
12.9%	43 - 56
37.7%	57 - 70

Photograph Location

Derrybrien 25km Extent

FINAL
Date: 8th April 2024
Scale when printed at A1 Size = 1:90,000 1 centimeter = 900 meters

Notes:

- *Theoretical visibility is based on an observer being able to see at least a full turbine blade (26m).*
- *Theoretical visibility is based on an observer eye level of 2m above ground level.*
- *Calculation does not account for screening due to vegetation, forestry, buildings or any other similar forms of screening.*
- *Calculation has been run using Ordnance Survey 10m DTM height data.*
- *Earth curvature and light refraction has been included in this calculation.*

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APPENDIX 13-8

VIEWPOINT MAP

VRP 1
VRP 17b
VRP 17
VRP 2
VRP 8
VRP 3
VRP 14
VRP 7
VRP 4
VRP 5
VRP 6
VRP 15
VRP 9
VRP 10
VRP 11
VRP 12
VRP 13
VRP 16

Esri, Intermap, NASA, NGA, USGS, © Ordnance Survey Ireland, Esri UK, Esri, TomTom, Garmin, Foursquare, METI/NASA, USGS

Legend

Galway County Boundary

Derrybrien Wind Farm Decommissioning Project

Study Area - 25km

Existing Derrybrien Turbines

Viewpoints

County Galway Protected Views - Galway CDP 2022-2028

Scenic Routes

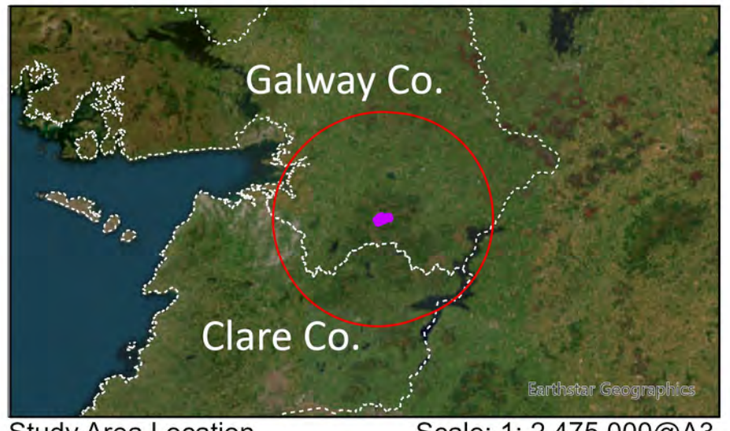
Protected Views

Angles of View

County Clare Landscape Designations - Clare CDP 2023-2029

Clare Scenic Routes

Clare Heritage Landscape



Study Area Location

Scale: 1: 2.475.000@A3

Viewpoint Map
Derrybrien Wind Farm Decommissioning Project
Drawn: GN
Date: 10/2024

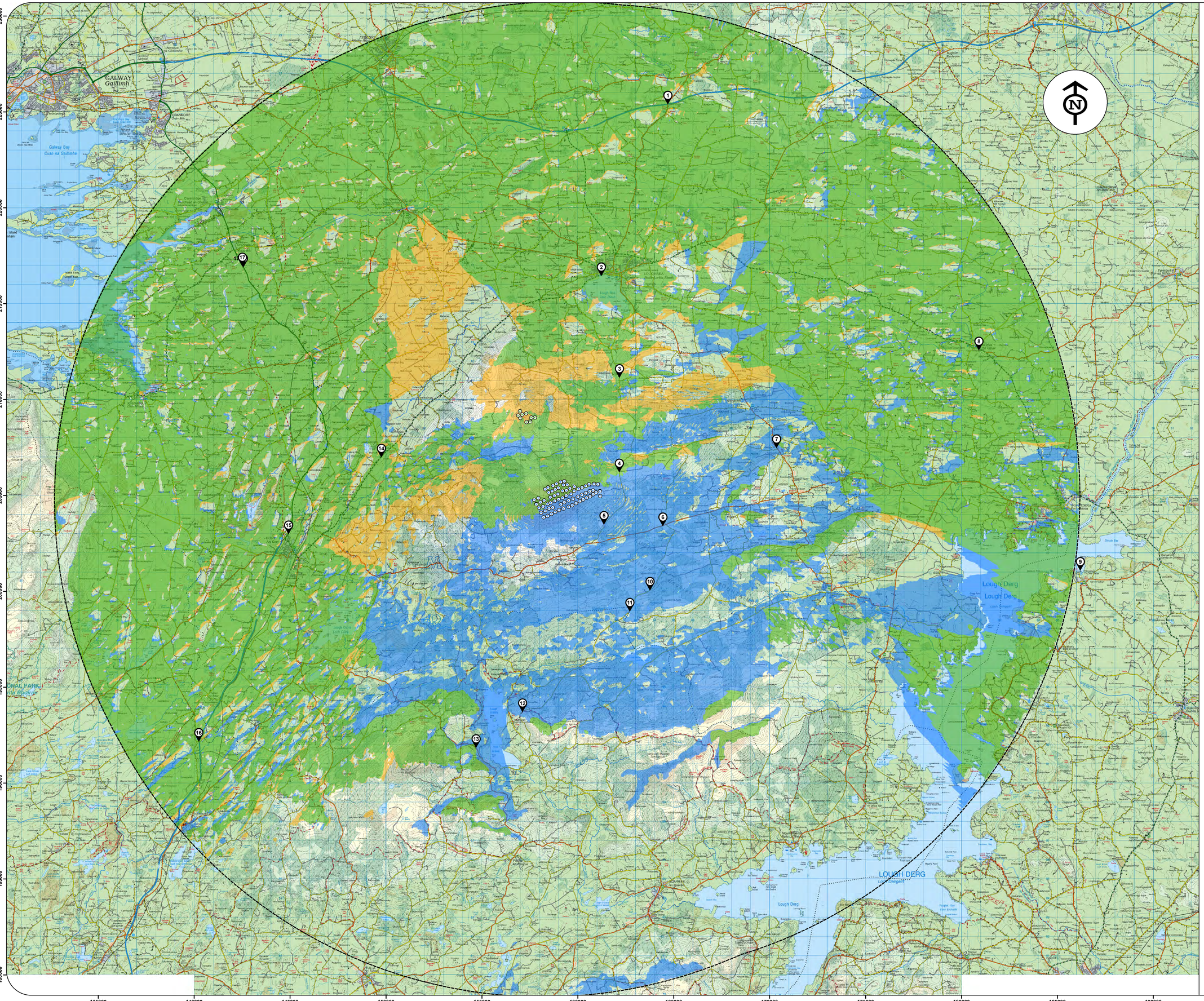
N

Scale 1:200.000@A3

CUNNANE STRATTON REYNOLDS
LAND PLANNING & DESIGN

APPENDIX 13-10

CUMULATIVE ZTV



Zone of Theoretical Visibility (ZTV) Map indicating areas with a theoretical view of the windfarm at Derrybrien, in combination with the existing Sonnagh Old windfarm

Derrybrien Turbine Locations

Sonnagh Old Turbine Locations

Wind Farms Visible

- *Derrybrien Only*
- *Both Windfarms Visible*
- *Sonnagh Old Only*

Photograph Location

Derrybrien 25km Extent

FINAL
Date: 8th April 2024
Scale when printed at A1 Size = 1:90,000 *1 centimeter = 900 meters*

Notes:

- *Theoretical visibility is based on an observer being able to see at least a full turbine blade (26m).*
- *Theoretical visibility is based on an observer eye level of 2m above ground level.*
- *Calculation does not account for screening due to vegetation, forestry, buildings or any other similar forms of screening.*
- *Calculation has been run using Ordnance Survey 10m DTM height data.*
- *Earth curvature and light refraction has been included in this calculation.*

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APPENDIX 14-1

TRAFFIC SURVEY DATA (BLACKS ROAD)

TRACSIS **TRAFFIC DATA**
Transport Data Collection and Analytics

Return To Dashboard

Convert to PCU

3784-IRE Derrybrien, Galway
Junction Turning Count
28/03/2023

Site 1 - Black Road / R353(E) / R353(W)

Origin Arm A Black Road

	Destination : Arm A Black Road								**Destination :** Arm B R353(E)								**Destination :** Arm C R353(W)								Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC	PC	Total	Car	LGV	OGV1	OGV2	PSV	MC	PC	Total	Car	LGV	OGV1	OGV2	PSV	MC	PC	Total	
07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
09:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
10:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
13:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
14:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
14:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
15:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TRACSIS **TRAFFIC DATA**
Transport Data Collection and Analytics

Return To Dashboard
Convert to PCU

3784-IRE Derrybrien, Galway
Junction Turning Count
28/03/2023

Site 1 - Black Road / R353(E) / R353(W)

15:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1					
16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2	2					
16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1					
16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	3	3					
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	6	6					
17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2	2					
17:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1					
17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1					
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0	0	0	3	4					
18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1					
18:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2	2					
18:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
18:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1					
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	4	4					
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	13	5	0	0	0	0	0	18	19					

Origin Arm B R353(E)

	Destination : Arm A Black Road							Total	**Destination :** Arm B R353(E)							Total	**Destination :** Arm C R353(W)							Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC	PC		Car	LGV	OGV1	OGV2	PSV	MC	PC		Car	LGV	OGV1	OGV2	PSV	MC	PC		
07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	2
07:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
07:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1	1	1	0	0	7	7
07:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	2	0	0	0	7	7
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	4	2	3	1	0	0	17	17
08:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	7	7
08:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	4	4
08:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	0	0	4	4
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	2	1	0	0	0	0	15	15
09:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	4	4
09:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2	2
09:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4	4
09:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	3	3
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	3	0	0	0	0	0	13	13
10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	3	3
10:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	3
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	1	0	0	0	0	6	6
11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	3
11:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
11:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1

TRACSIS **TRAFFIC DATA**
Transport Data Collection and Analytics

Return To Dashboard
Convert to PCU

3784-IRE Derrybrien, Galway
Junction Turning Count
28/03/2023

Site 1 - Black Road / R353(E) / R353(W)

Origin Arm C R353(W)

	Destination : Arm A Black Road							Total	Destination : Arm B R353(E)							Total	Destination : Arm C R353(W)							Total	Arm Totals
	Car	LGV	OGV1	OGV2	PSV	MC	PC		Car	LGV	OGV1	OGV2	PSV	MC	PC		Car	LGV	OGV1	OGV2	PSV	MC	PC		
11:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	6	6
12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	3	3
12:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
12:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	2
12:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	3	3
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	2	0	0	0	0	1	9	9
13:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	3
13:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2	2
13:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
13:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	2
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	1	0	0	0	0	0	8	8
14:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	3
14:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	3
14:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	6	6
14:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	3
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	3	0	0	0	0	0	15	15
15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	4	4
15:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
15:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	6	6
15:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	2	0	0	0	0	0	11	11
16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	3
16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	3	3
16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	3
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	2	0	0	0	0	9	9
17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
17:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	4	4
17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	4	4
17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	3	3
1 Hr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	3	0	0	0	0	0	12	12
18:00	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	5	6
18:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4	4
18:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	2
1 Hr	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	11	12
Total	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	99	22	6	3	1	0	1	132	133
07:00	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
07:15	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3
07:30	1	0	0	0	0	0	0	1	3	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	4

TRACSIS | TRAFFIC DATA
Transport Data Collection and Analytics

Return To Dashboard

Convert to PCU

3784-IRE Derrybrien, Galway
Junction Turning Count
28/03/2023

Site 1 - Black Road / R353(E) / R353(W)

07:45	0	0	0	0	0	0	0	0		1	2	0	0	0	0	0	3		0	0	0	0	0	0	0	0		3
1 Hr	1	1	0	0	0	0	0	2		8	2	0	0	0	0	0	10		0	0	0	0	0	0	0	0		12
08:00	2	1	0	0	0	0	0	3		5	1	0	0	0	0	0	6		0	0	0	0	0	0	0	0		9
08:15	2	0	0	0	0	0	0	2		3	1	0	0	0	0	0	4		0	0	0	0	0	0	0	0		6
08:30	1	0	0	0	0	0	0	1		4	0	0	0	0	0	0	4		0	0	0	0	0	0	0	0		5
08:45	0	0	0	0	0	0	0	0		3	1	0	0	0	0	0	4		0	0	0	0	0	0	0	0		4
1 Hr	5	1	0	0	0	0	0	6		15	3	0	0	0	0	0	18		0	0	0	0	0	0	0	0		24
09:00	0	1	0	0	0	0	0	1		0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0		1
09:15	1	0	0	0	0	0	0	1		1	0	1	0	0	0	0	2		0	0	0	0	0	0	0	0		3
09:30	0	0	0	0	0	0	0	0		2	0	0	0	0	0	0	2		0	0	0	0	0	0	0	0		2
09:45	0	0	0	0	0	0	0	0		2	0	0	0	0	0	0	2		0	0	0	0	0	0	0	0		2
1 Hr	1	1	0	0	0	0	0	2		5	0	1	0	0	0	0	6		0	0	0	0	0	0	0	0		8
10:00	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0		0
10:15	0	0	0	0	0	0	0	0		1	0	0	0	0	0	0	1		0	0	0	0	0	0	0	0		1
10:30	1	0	0	0	0	0	0	1		1	0	0	0	0	0	0	1		0	0	0	0	0	0	0	0		2
10:45	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0		0
1 Hr	1	0	0	0	0	0	0	1		2	0	0	0	0	0	0	2		0	0	0	0	0	0	0	0		3
11:00	1	0	0	0	0	0	0	1		0	1	0	0	0	0	0	1		0	0	0	0	0	0	0	0		2
11:15	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0		0
11:30	0	0	0	0	0	0	0	0		3	0	0	0	0	0	0	3		0	0	0	0	0	0	0	0		3
11:45	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0		0
1 Hr	1	0	0	0	0	0	0	1		3	1	0	0	0	0	0	4		0	0	0	0	0	0	0	0		5
12:00	2	0	0	0	0	0	0	2		3	0	0	0	0	0	0	3		0	0	0	0	0	0	0	0		5
12:15	0	0	0	0	0	0	0	0		1	0	0	0	0	0	0	1		0	0	0	0	0	0	0	0		1
12:30	0	0	0	0	0	0	0	0		1	0	1	0	0	0	0	2		0	0	0	0	0	0	0	0		2
12:45	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0		0
1 Hr	2	0	0	0	0	0	0	2		5	0	1	0	0	0	0	6		0	0	0	0	0	0	0	0		8
13:00	0	0	0	0	0	0	0	0		1	0	0	0	0	0	0	1		0	0	0	0	0	0	0	0		1
13:15	0	0	0	0	0	0	0	0		0	2	0	0	0	0	0	2		0	0	0	0	0	0	0	0		2
13:30	0	0	0	0	0	0	0	0		1	0	0	0	0	0	0	1		0	0	0	0	0	0	0	0		1
13:45	0	0	0	0	0	0	0	0		1	1	0	0	0	0	0	2		0	0	0	0	0	0	0	0		2
1 Hr	0	0	0	0	0	0	0	0		3	3	0	0	0	0	0	6		0	0	0	0	0	0	0	0		6
14:00	0	0	0	0	0	0	0	0		2	1	1	0	0	0	0	4		0	0	0	0	0	0	0	0		4
14:15	0	0	0	0	0	0	0	0		4	0	0	0	0	0	0	4		0	0	0	0	0	0	0	0		4
14:30	0	0	0	0	0	0	0	0		1	0	0	1	0	0	0	2		0	0	0	0	0	0	0	0		2
14:45	0	0	0	0	0	0	0	0		2	0	0	0	0	0	0	2		0	0	0	0	0	0	0	0		2
1 Hr	0	0	0	0	0	0	0	0		9	1	1	1	0	0	0	12		0	0	0	0	0	0	0	0		12
15:00	0	0	0	0	0	0	0	0		1	1	1	0	0	0	0	3		0	0	0	0	0	0	0	0		3
15:15	1	0	0	0	0	0	0	1		3	0	1	0	0	0	0	4		0	0	0	0	0	0	0	0		5
15:30	0	0	0	0	0	0	0	0		1	1	0	0	0	0	0	2		0	0	0	0	0	0	0	0		2
15:45	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0		0
1 Hr	1	0	0	0	0	0	0	1		5	2	2	0	0	0	0	9		0	0	0	0	0	0	0	0		10
16:00	0	0	0	0	0	0	0	0		2	1	0	0	0	0	0	3		0	0	0	0	0	0	0	0		3
16:15	0	1	0	0	0	0	0	1		1	0	0	0	0	0	0	1		0	0	0	0	0	0	0	0		2
16:30	0	0	0	0	0	0	0	0		1	0	0	0	0	0	0	1		0	0	0	0	0	0	0	0		1
16:45	0	0	0	0	0	0	0	0		1	1	0	0	0	0	0	2		0	0	0	0	0	0	0	0		2
1 Hr	0	1	0	0	0	0	0	1		5	2	0	0	0	0	0	7		0	0	0	0	0	0	0	0		8

TRACSIS | TRAFFIC DATA
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Convert to PCU

3784-IRE Derrybrien, Galway
Junction Turning Count
28/03/2023

Site 1 - Black Road / R353(E) / R353(W)

17:00	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	5	0	0	0	0	0	0	0	0	5
17:15	1	0	0	0	0	0	0	1	4	1	0	0	0	0	0	5	0	0	0	0	0	0	0	0	6
17:30	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	4	0	0	0	0	0	0	0	0	4
17:45	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	6	0	0	0	0	0	0	0	0	6
1 Hr	1	0	0	0	0	0	0	1	14	6	0	0	0	0	0	20	0	0	0	0	0	0	0	0	21
18:00	1	0	0	0	0	0	0	1	4	1	0	2	0	0	0	7	0	0	0	0	0	0	0	0	8
18:15	0	0	0	0	0	0	0	0	2	2	0	1	0	0	0	5	0	0	0	0	0	0	0	0	5
18:30	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	5
18:45	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
1 Hr	1	0	0	0	0	0	0	1	13	3	0	3	0	0	0	19	0	0	0	0	0	0	0	0	20
Total	14	4	0	0	0	0	0	18	87	23	5	4	0	0	0	119	0	0	0	0	0	0	0	0	137

ORIGIN SUMMARY

	Origin : Arm A Black Road							Total	**Origin :** Arm B R353(E)							Total	**Origin :** Arm C R353(W)							Total	Origin Totals
	Car	LGV	OGV1	OGV2	PSV	MC	PC		Car	LGV	OGV1	OGV2	PSV	MC	PC		Car	LGV	OGV1	OGV2	PSV	MC	PC		
07:00	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	1	1	0	0	0	0	0	2	4
07:15	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	3	0	0	0	0	0	0	3	4
07:30	0	0	0	0	0	0	0	0	4	0	1	1	1	0	0	7	4	0	0	0	0	0	0	4	11
07:45	0	0	0	0	0	0	0	0	1	4	0	2	0	0	0	7	1	2	0	0	0	0	0	3	10
1 Hr	0	0	0	0	0	0	0	0	7	4	2	3	1	0	0	17	9	3	0	0	0	0	0	12	29
08:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	2	0	0	0	0	0	9	9
08:15	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	7	5	1	0	0	0	0	0	6	13
08:30	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	4	5	0	0	0	0	0	0	5	9
08:45	1	0	0	0	0	0	0	1	2	1	1	0	0	0	0	4	3	1	0	0	0	0	0	4	9
1 Hr	1	0	0	0	0	0	0	1	12	2	1	0	0	0	0	15	20	4	0	0	0	0	0	24	40
09:00	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	4	0	1	0	0	0	0	0	1	5
09:15	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2	2	0	1	0	0	0	0	3	5
09:30	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4	2	0	0	0	0	0	0	2	6
09:45	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	3	2	0	0	0	0	0	0	2	5
1 Hr	0	0	0	0	0	0	0	0	10	3	0	0	0	0	0	13	6	1	1	0	0	0	0	8	21
10:00	1	0	0	0	0	0	0	1	0	2	1	0	0	0	0	3	0	0	0	0	0	0	0	0	4
10:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
10:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	2
10:45	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3
1 Hr	1	0	0	0	0	0	0	1	3	2	1	0	0	0	0	6	3	0	0	0	0	0	0	3	10
11:00	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	1	1	0	0	0	0	0	2	5
11:15	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
11:30	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	3	0	0	0	0	0	0	3	4
11:45	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
1 Hr	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	6	4	1	0	0	0	0	0	5	11
12:00	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	3	5	0	0	0	0	0	0	5	8
12:15	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	2
12:30	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	1	0	1	0	0	0	0	2	4
12:45	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	3
1 Hr	0	0	0	0	0	0	0	0	6	2	0	0	0	0	1	9	7	0	1	0	0	0	0	8	17

TRACSIS | **TRAFFIC DATA**
Transport Data Collection and Analytics

Return To Dashboard

Convert to PCU

3784-IRE Derrybrien, Galway
Junction Turning Count
28/03/2023

Site 1 - Black Road / R353(E) / R353(W)

13:00	1	0	0	0	0	0	0	1	3	0	0	0	0	0	0	3	1	0	0	0	0	0	0	1	5
13:15	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2	0	2	0	0	0	0	0	2	4
13:30	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	2
13:45	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	1	1	0	0	0	0	0	2	4
1 Hr	1	0	0	0	0	0	0	1	7	1	0	0	0	0	0	8	3	3	0	0	0	0	0	6	15
14:00	1	0	0	0	0	0	0	1	3	0	0	0	0	0	0	3	2	1	1	0	0	0	0	4	8
14:15	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	4	0	0	0	0	0	0	4	7
14:30	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	6	1	0	0	1	0	0	0	2	8
14:45	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	2	0	0	0	0	0	0	2	5
1 Hr	1	0	0	0	0	0	0	1	12	3	0	0	0	0	0	15	9	1	1	1	0	0	0	12	28
15:00	1	0	0	0	0	0	0	1	2	2	0	0	0	0	0	4	1	1	1	0	0	0	0	3	8
15:15	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	4	0	1	0	0	0	0	5	6
15:30	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	6	1	1	0	0	0	0	0	2	8
15:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Hr	1	0	0	0	0	0	0	1	9	2	0	0	0	0	0	11	6	2	2	0	0	0	0	10	22
16:00	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	2	1	0	0	0	0	0	3	6
16:15	1	1	0	0	0	0	0	2	1	0	2	0	0	0	0	3	1	1	0	0	0	0	0	2	7
16:30	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	2
16:45	2	1	0	0	0	0	0	3	3	0	0	0	0	0	0	3	1	1	0	0	0	0	0	2	8
1 Hr	3	3	0	0	0	0	0	6	7	0	2	0	0	0	0	9	5	3	0	0	0	0	0	8	23
17:00	1	1	0	0	0	0	0	2	1	0	0	0	0	0	0	1	3	2	0	0	0	0	0	5	8
17:15	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	4	5	1	0	0	0	0	0	6	10
17:30	1	0	0	0	0	0	0	1	3	1	0	0	0	0	0	4	3	1	0	0	0	0	0	4	9
17:45	0	0	0	0	0	0	1	1	2	1	0	0	0	0	0	3	4	2	0	0	0	0	0	6	10
1 Hr	2	1	0	0	0	0	1	4	9	3	0	0	0	0	0	12	15	6	0	0	0	0	0	21	37
18:00	1	0	0	0	0	0	0	1	5	0	0	0	0	0	1	6	5	1	0	2	0	0	0	8	15
18:15	1	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	2	0	1	0	0	0	5	7
18:30	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4	5	0	0	0	0	0	0	5	9
18:45	1	0	0	0	0	0	0	1	2	0	0	0	0	0	0	2	2	0	0	0	0	0	0	2	5
1 Hr	3	1	0	0	0	0	0	4	11	0	0	0	0	0	1	12	14	3	0	3	0	0	0	20	36
Total	13	5	0	0	0	0	1	19	99	22	6	3	1	0	2	133	101	27	5	4	0	0	0	137	289

DESTINATION SUMMARY

	Destination : Arm A Black Road							Total	**Destination :** Arm B R353(E)							Total	**Destination :** Arm C R353(W)							Total	Dest Totals
	Car	LGV	OGV1	OGV2	PSV	MC	PC		Car	LGV	OGV1	OGV2	PSV	MC	PC		Car	LGV	OGV1	OGV2	PSV	MC	PC		
07:00	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	2	0	0	0	0	0	0	2	4
07:15	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	1	0	0	0	0	1	4
07:30	1	0	0	0	0	0	0	1	3	0	0	0	0	0	0	3	4	0	1	1	1	0	0	7	11
07:45	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	3	1	4	0	2	0	0	0	7	10
1 Hr	1	1	0	0	0	0	0	2	8	2	0	0	0	0	0	10	7	4	2	3	1	0	0	17	29
08:00	2	1	0	0	0	0	0	3	5	1	0	0	0	0	0	6	0	0	0	0	0	0	0	0	9
08:15	2	0	0	0	0	0	0	2	3	1	0	0	0	0	0	4	7	0	0	0	0	0	0	7	13
08:30	1	0	0	0	0	0	0	1	4	0	0	0	0	0	0	4	3	1	0	0	0	0	0	4	9
08:45	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	4	3	1	1	0	0	0	0	5	9
1 Hr	5	1	0	0	0	0	0	6	15	3	0	0	0	0	0	18	13	2	1	0	0	0	0	16	40

TRACSIS | TRAFFIC DATA
Transport Data Collection and Analytics

Return To Dashboard

Convert to PCU

3784-IRE Derrybrien, Galway
Junction Turning Count
28/03/2023

Site 1 - Black Road / R353(E) / R353(W)

09:00	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	4	5
09:15	1	0	0	0	0	0	0	1	1	0	1	0	0	0	0	2	1	1	0	0	0	0	0	2	5
09:30	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	4	0	0	0	0	0	0	4	6
09:45	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	2	1	0	0	0	0	0	3	5
1 Hr	1	1	0	0	0	0	0	2	5	0	1	0	0	0	0	6	10	3	0	0	0	0	0	13	21
10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0	0	4	4
10:15	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
10:30	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
10:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	3
1 Hr	1	0	0	0	0	0	0	1	2	0	0	0	0	0	0	2	4	2	1	0	0	0	0	7	10
11:00	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	3	0	0	0	0	0	0	3	5
11:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
11:30	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	1	0	0	0	0	0	0	1	4
11:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
1 Hr	1	0	0	0	0	0	0	1	3	1	0	0	0	0	0	4	6	0	0	0	0	0	0	6	11
12:00	2	0	0	0	0	0	0	2	3	0	0	0	0	0	0	3	1	2	0	0	0	0	0	3	8
12:15	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	2
12:30	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	2	2	0	0	0	0	0	0	2	4
12:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	3	3
1 Hr	2	0	0	0	0	0	0	2	5	0	1	0	0	0	0	6	6	2	0	0	0	0	1	9	17
13:00	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	4	0	0	0	0	0	0	4	5
13:15	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	1	1	0	0	0	0	0	2	4
13:30	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	2
13:45	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2	2	0	0	0	0	0	0	2	4
1 Hr	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	6	8	1	0	0	0	0	0	9	15
14:00	0	0	0	0	0	0	0	0	2	1	1	0	0	0	0	4	4	0	0	0	0	0	0	4	8
14:15	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4	3	0	0	0	0	0	0	3	7
14:30	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	2	3	3	0	0	0	0	0	6	8
14:45	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	3	0	0	0	0	0	0	3	5
1 Hr	0	0	0	0	0	0	0	0	9	1	1	1	0	0	0	12	13	3	0	0	0	0	0	16	28
15:00	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	3	3	2	0	0	0	0	0	5	8
15:15	1	0	0	0	0	0	0	1	3	0	1	0	0	0	0	4	1	0	0	0	0	0	0	1	6
15:30	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2	6	0	0	0	0	0	0	6	8
15:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Hr	1	0	0	0	0	0	0	1	5	2	2	0	0	0	0	9	10	2	0	0	0	0	0	12	22
16:00	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	3	3	0	0	0	0	0	0	3	6
16:15	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	2	1	2	0	0	0	0	5	7
16:30	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	2
16:45	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2	5	1	0	0	0	0	0	6	8
1 Hr	0	1	0	0	0	0	0	1	5	2	0	0	0	0	0	7	10	3	2	0	0	0	0	15	23
17:00	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	5	2	1	0	0	0	0	0	3	8
17:15	1	0	0	0	0	0	0	1	4	1	0	0	0	0	0	5	3	1	0	0	0	0	0	4	10
17:30	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	4	4	1	0	0	0	0	0	5	9
17:45	0	0	0	0	0	0	0	0	4	2	0	0	0	0	1	7	2	1	0	0	0	0	0	3	10
1 Hr	1	0	0	0	0	0	0	1	14	6	0	0	0	0	1	21	11	4	0	0	0	0	0	15	37
18:00	1	0	0	0	0	0	1	2	4	1	0	2	0	0	0	7	6	0	0	0	0	0	0	6	15
18:15	0	0	0	0	0	0	0	0	2	2	0	1	0	0	0	5	1	1	0	0	0	0	0	2	7

TRACSIS | TRAFFIC DATA
Transport Data Collection and Analytics

Return To Dashboard

Convert to PCU

3784-IRE Derrybrien, Galway
Junction Turning Count
28/03/2023

Site 1 - Black Road / R353(E) / R353(W)

18:30	0	0	0	0	0	0	0	0		5	0	0	0	0	0	0	5		4	0	0	0	0	0	0	4		9
18:45	0	0	0	0	0	0	0	0		2	0	0	0	0	0	0	2		3	0	0	0	0	0	0	3		5
1 Hr	1	0	0	0	0	0	1	2		13	3	0	3	0	0	0	19		14	1	0	0	0	0	0	15		36
Total	14	4	0	0	0	0	1	19		87	23	5	4	0	0	1	120		112	27	6	3	1	0	1	150		289

APPENDIX 14-2

PICADY 10 ANALYSIS REPORT FOR R353 (BLACKS ROAD)

Junctions 10

PICADY 10 - Priority Intersection Module

Version: 10.0.4.1693
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The users of this computer program for the solution of an engineering problem are in no way relieved of their responsibility for the correctness of the solution

Filename: 11482 T Junction Rev C.j10
Path: \\fserver4-gal\tobin\Projects\11482 - Derrybrien Wand Farm Decommissioning\05-Design\01-Calculations
Report generation date: 10/07/2023 12:46:31

»Base Year 2023, AM
»Base Year 2023, PM
»No Dev - Year of Opening [2025], AM
»No Dev - Year of Opening [2025], PM
»With Dev - Year of Opening [2025], AM
»With Dev - Year of Opening [2025], PM

Summary of junction performance

	AM					PM				
	Queue (Veh)	Delay (s)	RFC	LOS	Junction Delay (s)	Queue (Veh)	Delay (s)	RFC	LOS	Junction Delay (s)
	Base Year 2023									
Stream B-AC	0.0	0.00	0.00	A	0.00	0.0	0.00	0.00	A	0.00
Stream C-AB	0.0	0.00	0.00	A		0.0	0.00	0.00	A	
	No Dev - Year of Opening [2025]									
Stream B-AC	0.0	0.00	0.00	A	0.00	0.0	0.00	0.00	A	0.00
Stream C-AB	0.0	0.00	0.00	A		0.0	0.00	0.00	A	
	With Dev - Year of Opening [2025]									
Stream B-AC	0.0	0.00	0.00	A	0.00	0.3	14.64	0.25	B	8.40
Stream C-AB	0.0	0.00	0.00	A		0.0	0.00	0.00	A	

There are warnings associated with one or more model runs - see the 'Data Errors and Warnings' tables for each Analysis or Demand Set.

Values shown are the highest values encountered over all time segments. Delay is the maximum value of average delay per arriving vehicle. Junction LOS and Junction Delay are demand-weighted averages.

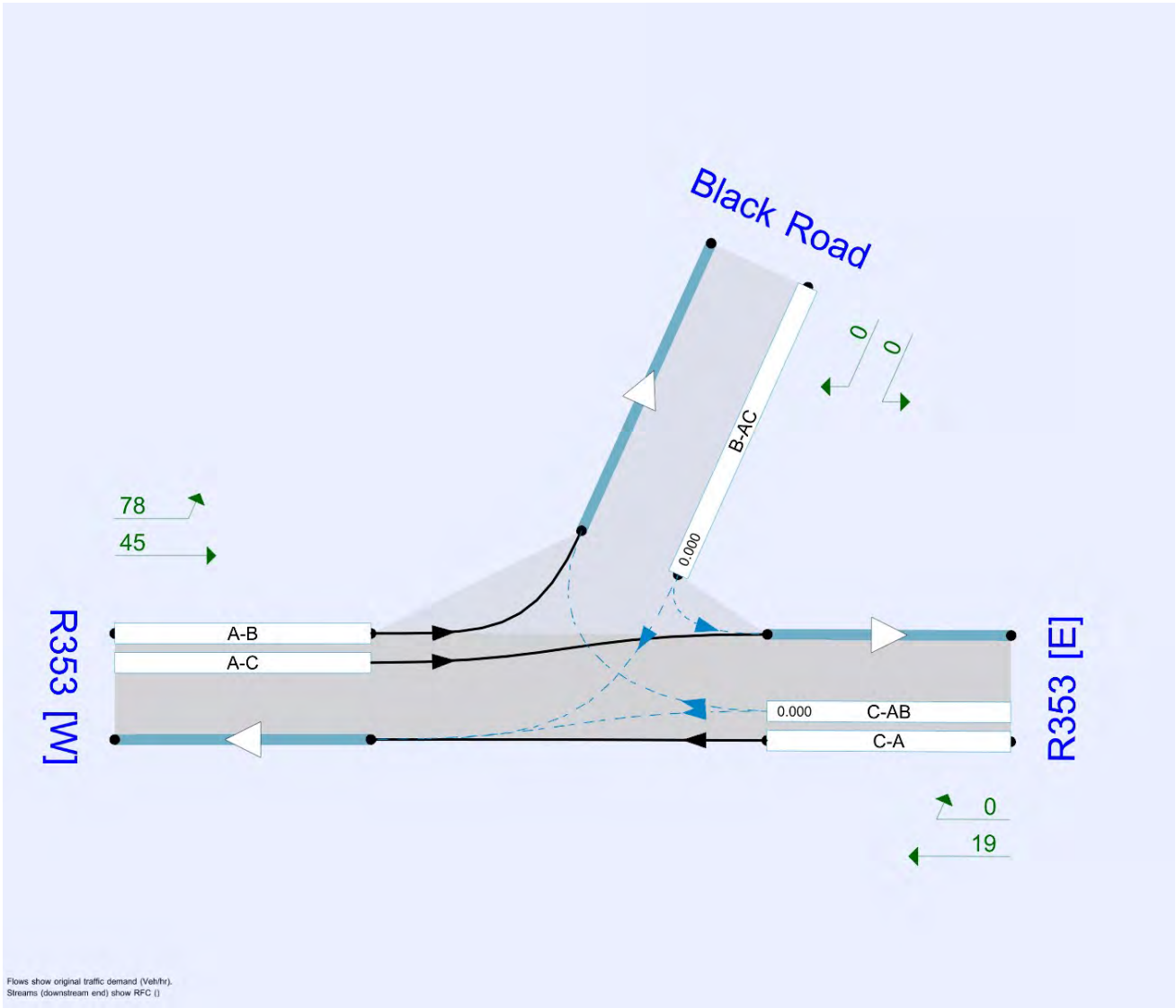
File summary

File Description

Title	
Location	
Site number	
Date	23/03/2023
Version	
Status	(new file)
Identifier	
Client	
Jobnumber	
Enumerator	TOBIN\Gabriela.Iha
Description	

Units

Distance units	Speed units	Traffic units input	Traffic units results	Flow units	Average delay units	Total delay units	Rate of delay units
m	kph	Veh	Veh	perHour	s	-Min	perMin



The junction diagram reflects the last run of Junctions.

Analysis Options

Vehicle length (m)	Calculate Queue Percentiles	Calculate detailed queueing delay	Show lane queues in feet / metres	Show all PICADY stream intercepts	Calculate residual capacity	RFC Threshold	Average Delay threshold (s)	Queue threshold (PCU)	Use iterations with HCM roundabouts	Max number of iterations for roundabouts
5.75	✓					0.85	36.00	20.00		500

Demand Set Summary

ID	Scenario name	Time Period name	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D1	Base Year 2023	AM	ONE HOUR	07:30	09:00	15	✓
D2	Base Year 2023	PM	ONE HOUR	17:00	18:30	15	✓
D3	No Dev - Year of Opening [2025]	AM	ONE HOUR	07:30	09:00	15	✓
D4	No Dev - Year of Opening [2025]	PM	ONE HOUR	17:00	18:30	15	✓
D5	With Dev - Year of Opening [2025]	AM	ONE HOUR	07:30	09:00	15	✓
D6	With Dev - Year of Opening [2025]	PM	ONE HOUR	17:00	18:30	15	✓

Analysis Set Details

ID	Include in report	Network flow scaling factor (%)	Network capacity scaling factor (%)
A1	✓	100.000	100.000

Base Year 2023, AM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Major arm width	R353 [E] - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
1	R353/ Black Road	T-Junction	Two-way	Two-way	Two-way		0.00	A

Junction Network

Driving side	Lighting	Network delay (s)	Network LOS
Left	Normal/unknown	0.00	A

Arms

Arms

Arm	Name	Description	Arm type
A	R353 [W]		Major
B	Black Road		Minor
C	R353 [E]		Major

Major Arm Geometry

Arm	Width of carriageway (m)	Has kerbed central reserve	Has right-turn storage	Visibility for right turn (m)	Blocks?	Blocking queue (PCU)
R353 [E]	4.40			250.0	✓	0.00

Geometries for Arm C are measured opposite Arm B. Geometries for Arm A (if relevant) are measured opposite Arm D.

Minor Arm Geometry

Arm	Minor arm type	Lane width (m)	Visibility to left (m)	Visibility to right (m)
Black Road	One lane	3.88	34	14

Slope / Intercept / Capacity

Priority Intersection Slopes and Intercepts

Stream	Intercept (Veh/hr)	Slope for A-B	Slope for A-C	Slope for C-A	Slope for C-B
B-A	539	0.105	0.265	0.167	0.379
B-C	688	0.113	0.285	-	-
C-B	719	0.298	0.298	-	-

The slopes and intercepts shown above include custom intercept adjustments only.

Streams may be combined, in which case capacity will be adjusted.

Values are shown for the first time segment only; they may differ for subsequent time segments.

Traffic Demand

Demand Set Details

ID	Scenario name	Time Period name	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D1	Base Year 2023	AM	ONE HOUR	07:30	09:00	15	✓

Vehicle mix varies over turn	Vehicle mix varies over entry	Vehicle mix source	PCU Factor for a HV (PCU)
✓	✓	HV Percentages	2.00

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (Veh/hr)	Scaling Factor (%)
R353 [W]		ONE HOUR	✓	23	100.000
Black Road		ONE HOUR	✓	0	100.000
R353 [E]		ONE HOUR	✓	18	100.000

Origin-Destination Data

Demand (Veh/hr)

		To		
		R353 [W]	Black Road	R353 [E]
From	R353 [W]	0	6	17
	Black Road	0	0	0
	R353 [E]	18	0	0

Vehicle Mix

Heavy Vehicle Percentages

		To		
		R353 [W]	Black Road	R353 [E]
From	R353 [W]	0	0	0
	Black Road	0	0	0
	R353 [E]	11	0	0

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (Veh)	Max 95th percentile Queue (Veh)	Max LOS	Average Demand (Veh/hr)	Total Junction Arrivals (Veh)
B-AC	0.00	0.00	0.0	~1	A	0	0
C-AB	0.00	0.00	0.0	~1	A	0	0
C-A						17	25
A-B						6	8
A-C						16	23

Main Results for each time segment

07:30 - 07:45

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	599	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	676	0.000	0	0.0	0.0	0.000	A
C-A	14	3			14				
A-B	5	1			5				
A-C	13	3			13				

07:45 - 08:00

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	598	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	675	0.000	0	0.0	0.0	0.000	A
C-A	16	4			16				
A-B	5	1			5				
A-C	15	4			15				

08:00 - 08:15

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	596	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	674	0.000	0	0.0	0.0	0.000	A
C-A	20	5			20				
A-B	7	2			7				
A-C	19	5			19				

08:15 - 08:30

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	596	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	674	0.000	0	0.0	0.0	0.000	A
C-A	20	5			20				
A-B	7	2			7				
A-C	19	5			19				

08:30 - 08:45

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	598	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	675	0.000	0	0.0	0.0	0.000	A
C-A	16	4			16				
A-B	5	1			5				
A-C	15	4			15				

08:45 - 09:00

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	599	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	676	0.000	0	0.0	0.0	0.000	A
C-A	14	3			14				
A-B	5	1			5				
A-C	13	3			13				

Queue Variation Results for each time segment

07:30 - 07:45

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

07:45 - 08:00

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

08:00 - 08:15

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

08:15 - 08:30

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

08:30 - 08:45

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

08:45 - 09:00

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

Base Year 2023, PM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Major arm width	R353 [E] - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
1	R353/ Black Road	T-Junction	Two-way	Two-way	Two-way		0.00	A

Junction Network

Driving side	Lighting	Network delay (s)	Network LOS
Left	Normal/unknown	0.00	A

Traffic Demand

Demand Set Details

ID	Scenario name	Time Period name	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D2	Base Year 2023	PM	ONE HOUR	17:00	18:30	15	✓

Vehicle mix varies over turn	Vehicle mix varies over entry	Vehicle mix source	PCU Factor for a HV (PCU)
✓	✓	HV Percentages	2.00

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (Veh/hr)	Scaling Factor (%)
R353 [W]		ONE HOUR	✓	24	100.000
Black Road		ONE HOUR	✓	2	100.000
R353 [E]		ONE HOUR	✓	16	100.000

Origin-Destination Data

Demand (Veh/hr)

		To		
		R353 [W]	Black Road	R353 [E]
From	R353 [W]	0	2	22
	Black Road	2	0	0
	R353 [E]	16	0	0

Vehicle Mix

Heavy Vehicle Percentages

		To		
		R353 [W]	Black Road	R353 [E]
From	R353 [W]	0	0	9
	Black Road	0	0	0
	R353 [E]	0	0	0

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (Veh)	Max 95th percentile Queue (Veh)	Max LOS	Average Demand (Veh/hr)	Total Junction Arrivals (Veh)
B-AC	0.00	0.00	0.0	~1	A	0	0
C-AB	0.00	0.00	0.0	~1	A	0	0
C-A						15	22
A-B						2	3
A-C						20	30

Main Results for each time segment

17:00 - 17:15

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	598	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	713	0.000	0	0.0	0.0	0.000	A
C-A	12	3			12				
A-B	2	0.38			2				
A-C	17	4			17				

17:15 - 17:30

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	597	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	712	0.000	0	0.0	0.0	0.000	A
C-A	14	4			14				
A-B	2	0.45			2				
A-C	20	5			20				

17:30 - 17:45

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	595	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	710	0.000	0	0.0	0.0	0.000	A
C-A	18	4			18				
A-B	2	0.55			2				
A-C	24	6			24				

17:45 - 18:00

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	595	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	710	0.000	0	0.0	0.0	0.000	A
C-A	18	4			18				
A-B	2	0.55			2				
A-C	24	6			24				

18:00 - 18:15

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	597	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	712	0.000	0	0.0	0.0	0.000	A
C-A	14	4			14				
A-B	2	0.45			2				
A-C	20	5			20				

18:15 - 18:30

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	598	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	713	0.000	0	0.0	0.0	0.000	A
C-A	12	3			12				
A-B	2	0.38			2				
A-C	17	4			17				

Queue Variation Results for each time segment

17:00 - 17:15

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

17:15 - 17:30

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

17:30 - 17:45

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

17:45 - 18:00

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

18:00 - 18:15

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

18:15 - 18:30

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

No Dev - Year of Opening [2025], AM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Major arm width	R353 [E] - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
1	R353/ Black Road	T-Junction	Two-way	Two-way	Two-way		0.00	A

Junction Network

Driving side	Lighting	Network delay (s)	Network LOS
Left	Normal/unknown	0.00	A

Traffic Demand

Demand Set Details

ID	Scenario name	Time Period name	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D3	No Dev - Year of Opening [2025]	AM	ONE HOUR	07:30	09:00	15	✓

Vehicle mix varies over turn	Vehicle mix varies over entry	Vehicle mix source	PCU Factor for a HV (PCU)
✓	✓	HV Percentages	2.00

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (Veh/hr)	Scaling Factor (%)
R353 [W]		ONE HOUR	✓	24	100.000
Black Road		ONE HOUR	✓	0	100.000
R353 [E]		ONE HOUR	✓	19	100.000

Origin-Destination Data

Demand (Veh/hr)

		To		
		R353 [W]	Black Road	R353 [E]
From	R353 [W]	0	6	18
	Black Road	0	0	0
	R353 [E]	19	0	0

Vehicle Mix

Heavy Vehicle Percentages

		To		
		R353 [W]	Black Road	R353 [E]
From	R353 [W]	0	0	0
	Black Road	0	0	0
	R353 [E]	11	0	0

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (Veh)	Max 95th percentile Queue (Veh)	Max LOS	Average Demand (Veh/hr)	Total Junction Arrivals (Veh)
B-AC	0.00	0.00	0.0	~1	A	0	0
C-AB	0.00	0.00	0.0	~1	A	0	0
C-A						17	26
A-B						6	8
A-C						17	25

Main Results for each time segment

07:30 - 07:45

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	599	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	676	0.000	0	0.0	0.0	0.000	A
C-A	14	4			14				
A-B	5	1			5				
A-C	14	3			14				

07:45 - 08:00

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	598	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	675	0.000	0	0.0	0.0	0.000	A
C-A	17	4			17				
A-B	5	1			5				
A-C	16	4			16				

08:00 - 08:15

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	596	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	674	0.000	0	0.0	0.0	0.000	A
C-A	21	5			21				
A-B	7	2			7				
A-C	20	5			20				

08:15 - 08:30

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	596	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	674	0.000	0	0.0	0.0	0.000	A
C-A	21	5			21				
A-B	7	2			7				
A-C	20	5			20				

08:30 - 08:45

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	598	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	675	0.000	0	0.0	0.0	0.000	A
C-A	17	4			17				
A-B	5	1			5				
A-C	16	4			16				

08:45 - 09:00

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	599	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	676	0.000	0	0.0	0.0	0.000	A
C-A	14	4			14				
A-B	5	1			5				
A-C	14	3			14				

Queue Variation Results for each time segment

07:30 - 07:45

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

07:45 - 08:00

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

08:00 - 08:15

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

08:15 - 08:30

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

08:30 - 08:45

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

08:45 - 09:00

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

No Dev - Year of Opening [2025], PM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Major arm width	R353 [E] - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
1	R353/ Black Road	T-Junction	Two-way	Two-way	Two-way		0.00	A

Junction Network

Driving side	Lighting	Network delay (s)	Network LOS
Left	Normal/unknown	0.00	A

Traffic Demand

Demand Set Details

ID	Scenario name	Time Period name	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D4	No Dev - Year of Opening [2025]	PM	ONE HOUR	17:00	18:30	15	✓

Vehicle mix varies over turn	Vehicle mix varies over entry	Vehicle mix source	PCU Factor for a HV (PCU)
✓	✓	HV Percentages	2.00

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (Veh/hr)	Scaling Factor (%)
R353 [W]		ONE HOUR	✓	25	100.000
Black Road		ONE HOUR	✓	2	100.000
R353 [E]		ONE HOUR	✓	17	100.000

Origin-Destination Data

Demand (Veh/hr)

		To		
		R353 [W]	Black Road	R353 [E]
From	R353 [W]	0	2	23
	Black Road	2	0	0
	R353 [E]	17	0	0

Vehicle Mix

Heavy Vehicle Percentages

		To		
		R353 [W]	Black Road	R353 [E]
From	R353 [W]	0	0	9
	Black Road	0	0	0
	R353 [E]	0	0	0

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (Veh)	Max 95th percentile Queue (Veh)	Max LOS	Average Demand (Veh/hr)	Total Junction Arrivals (Veh)
B-AC	0.00	0.00	0.0	~1	A	0	0
C-AB	0.00	0.00	0.0	~1	A	0	0
C-A						16	23
A-B						2	3
A-C						21	32

Main Results for each time segment

17:00 - 17:15

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	598	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	713	0.000	0	0.0	0.0	0.000	A
C-A	13	3			13				
A-B	2	0.38			2				
A-C	17	4			17				

17:15 - 17:30

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	597	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	711	0.000	0	0.0	0.0	0.000	A
C-A	15	4			15				
A-B	2	0.45			2				
A-C	21	5			21				

17:30 - 17:45

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	595	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	710	0.000	0	0.0	0.0	0.000	A
C-A	19	5			19				
A-B	2	0.55			2				
A-C	25	6			25				

17:45 - 18:00

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	595	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	710	0.000	0	0.0	0.0	0.000	A
C-A	19	5			19				
A-B	2	0.55			2				
A-C	25	6			25				

18:00 - 18:15

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	597	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	711	0.000	0	0.0	0.0	0.000	A
C-A	15	4			15				
A-B	2	0.45			2				
A-C	21	5			21				

18:15 - 18:30

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	598	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	713	0.000	0	0.0	0.0	0.000	A
C-A	13	3			13				
A-B	2	0.38			2				
A-C	17	4			17				

Queue Variation Results for each time segment

17:00 - 17:15

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

17:15 - 17:30

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

17:30 - 17:45

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

17:45 - 18:00

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

18:00 - 18:15

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

18:15 - 18:30

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

With Dev - Year of Opening [2025], AM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Major arm width	R353 [E] - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
1	R353/ Black Road	T-Junction	Two-way	Two-way	Two-way		0.00	A

Junction Network

Driving side	Lighting	Network delay (s)	Network LOS
Left	Normal/unknown	0.00	A

Traffic Demand

Demand Set Details

ID	Scenario name	Time Period name	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D5	With Dev - Year of Opening [2025]	AM	ONE HOUR	07:30	09:00	15	✓

Vehicle mix varies over turn	Vehicle mix varies over entry	Vehicle mix source	PCU Factor for a HV (PCU)
✓	✓	HV Percentages	2.00

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (Veh/hr)	Scaling Factor (%)
R353 [W]		ONE HOUR	✓	123	100.000
Black Road		ONE HOUR	✓	0	100.000
R353 [E]		ONE HOUR	✓	19	100.000

Origin-Destination Data

Demand (Veh/hr)

		To		
		R353 [W]	Black Road	R353 [E]
From	R353 [W]	0	78	45
	Black Road	0	0	0
	R353 [E]	19	0	0

Vehicle Mix

Heavy Vehicle Percentages

		To		
		R353 [W]	Black Road	R353 [E]
From	R353 [W]	0	56	36
	Black Road	0	0	0
	R353 [E]	11	0	0

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (Veh)	Max 95th percentile Queue (Veh)	Max LOS	Average Demand (Veh/hr)	Total Junction Arrivals (Veh)
B-AC	0.00	0.00	0.0	~1	A	0	0
C-AB	0.00	0.00	0.0	~1	A	0	0
C-A						17	26
A-B						72	107
A-C						41	62

Main Results for each time segment

07:30 - 07:45

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	580	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	642	0.000	0	0.0	0.0	0.000	A
C-A	14	4			14				
A-B	59	15			59				
A-C	34	8			34				

07:45 - 08:00

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	575	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	635	0.000	0	0.0	0.0	0.000	A
C-A	17	4			17				
A-B	70	18			70				
A-C	40	10			40				

08:00 - 08:15

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	569	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	624	0.000	0	0.0	0.0	0.000	A
C-A	21	5			21				
A-B	86	21			86				
A-C	50	12			50				

08:15 - 08:30

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	569	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	624	0.000	0	0.0	0.0	0.000	A
C-A	21	5			21				
A-B	86	21			86				
A-C	50	12			50				

08:30 - 08:45

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	575	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	635	0.000	0	0.0	0.0	0.000	A
C-A	17	4			17				
A-B	70	18			70				
A-C	40	10			40				

08:45 - 09:00

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	0	0	580	0.000	0	0.0	0.0	0.000	A
C-AB	0	0	642	0.000	0	0.0	0.0	0.000	A
C-A	14	4			14				
A-B	59	15			59				
A-C	34	8			34				

Queue Variation Results for each time segment

07:30 - 07:45

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

07:45 - 08:00

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

08:00 - 08:15

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

08:15 - 08:30

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

08:30 - 08:45

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

08:45 - 09:00

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.00	0.00	0.00	0.00	0.00			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

With Dev - Year of Opening [2025], PM

Data Errors and Warnings

Severity	Area	Item	Description
Warning	Major arm width	R353 [E] - Major arm geometry	For two-way major roads, please interpret results with caution if the total major carriageway width is less than 6m.
Warning	Queue variations	Analysis Options	Queue percentiles may be unreliable if the mean queue in any time segment is very low or very high.

Junction Network

Junctions

Junction	Name	Junction type	Arm A Direction	Arm B Direction	Arm C Direction	Use circulating lanes	Junction Delay (s)	Junction LOS
1	R353/ Black Road	T-Junction	Two-way	Two-way	Two-way		8.40	A

Junction Network

Driving side	Lighting	Network delay (s)	Network LOS
Left	Normal/unknown	8.40	A

Traffic Demand

Demand Set Details

ID	Scenario name	Time Period name	Traffic profile type	Start time (HH:mm)	Finish time (HH:mm)	Time segment length (min)	Run automatically
D6	With Dev - Year of Opening [2025]	PM	ONE HOUR	17:00	18:30	15	✓

Vehicle mix varies over turn	Vehicle mix varies over entry	Vehicle mix source	PCU Factor for a HV (PCU)
✓	✓	HV Percentages	2.00

Demand overview (Traffic)

Arm	Linked arm	Profile type	Use O-D data	Average Demand (Veh/hr)	Scaling Factor (%)
R353 [W]		ONE HOUR	✓	25	100.000
Black Road		ONE HOUR	✓	74	100.000
R353 [E]		ONE HOUR	✓	44	100.000

Origin-Destination Data

Demand (Veh/hr)

		To		
		R353 [W]	Black Road	R353 [E]
From	R353 [W]	0	2	23
	Black Road	74	0	0
	R353 [E]	44	0	0

Vehicle Mix

Heavy Vehicle Percentages

		To		
		R353 [W]	Black Road	R353 [E]
From	R353 [W]	0	0	9
	Black Road	59	0	0
	R353 [E]	37	0	0

Results

Results Summary for whole modelled period

Stream	Max RFC	Max Delay (s)	Max Queue (Veh)	Max 95th percentile Queue (Veh)	Max LOS	Average Demand (Veh/hr)	Total Junction Arrivals (Veh)
B-AC	0.25	14.64	0.3	1.1	B	68	102
C-AB	0.00	0.00	0.0	~1	A	0	0
C-A						40	61
A-B						2	3
A-C						21	32

Main Results for each time segment

17:00 - 17:15

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	56	14	331	0.168	55	0.0	0.2	13.002	B
C-AB	0	0	601	0.000	0	0.0	0.0	0.000	A
C-A	33	8			33				
A-B	2	0.38			2				
A-C	17	4			17				

17:15 - 17:30

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	67	17	329	0.202	66	0.2	0.2	13.667	B
C-AB	0	0	600	0.000	0	0.0	0.0	0.000	A
C-A	40	10			40				
A-B	2	0.45			2				
A-C	21	5			21				

17:30 - 17:45

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	81	20	327	0.249	81	0.2	0.3	14.603	B
C-AB	0	0	599	0.000	0	0.0	0.0	0.000	A
C-A	48	12			48				
A-B	2	0.55			2				
A-C	25	6			25				

17:45 - 18:00

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	81	20	327	0.249	81	0.3	0.3	14.638	B
C-AB	0	0	599	0.000	0	0.0	0.0	0.000	A
C-A	48	12			48				
A-B	2	0.55			2				
A-C	25	6			25				

18:00 - 18:15

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	67	17	329	0.202	67	0.3	0.3	13.719	B
C-AB	0	0	600	0.000	0	0.0	0.0	0.000	A
C-A	40	10			40				
A-B	2	0.45			2				
A-C	21	5			21				

18:15 - 18:30

Stream	Total Demand (Veh/hr)	Junction Arrivals (Veh)	Capacity (Veh/hr)	RFC	Throughput (Veh/hr)	Start queue (Veh)	End queue (Veh)	Delay (s)	Unsignalised level of service
B-AC	56	14	331	0.168	56	0.3	0.2	13.094	B
C-AB	0	0	601	0.000	0	0.0	0.0	0.000	A
C-A	33	8			33				
A-B	2	0.38			2				
A-C	17	4			17				

Queue Variation Results for each time segment

17:00 - 17:15

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.20	0.00	0.00	0.20	0.20			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

17:15 - 17:30

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.25	0.00	0.00	0.25	0.25			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

17:30 - 17:45

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.32	0.03	0.26	0.46	0.49			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

17:45 - 18:00

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.33	0.03	0.31	1.10	1.10			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

18:00 - 18:15

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.26	0.00	0.00	0.26	0.26			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

18:15 - 18:30

Stream	Mean (Veh)	Q05 (Veh)	Q50 (Veh)	Q90 (Veh)	Q95 (Veh)	Percentile message	Marker message	Probability of reaching or exceeding marker	Probability of exactly reaching marker
B-AC	0.21	0.00	0.00	0.21	0.21			N/A	N/A
C-AB	0.00	0.00	0.00	0.00	0.00			N/A	N/A

APPENDIX 14-3

TRAFFIC MANAGEMENT PLAN

TOBIN

Derrybrien Wind Farm Decommissioning Project

Traffic Management Plan (TMP)

BUILT ON KNOWLEDGE

Document Control Sheet	
Document Reference	Traffic Management Plan (TMP)
Client:	Galway County Council
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Rev	Description	Author	Date	Reviewer	Date	Approval	Date
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1. INTRODUCTION

1.1 INTRODUCTION

This Traffic Management Plan (TMP) was prepared as requested by Galway County Council's Roads Department. The TMP is a "living document" that describes the management of the existing road network in the Derrybrien Wind Farm area. Therefore, any changes which may occur in the planning process and in the detailed decommissioning programme can be incorporated, as can inputs from the Contractor, the detailed design team, and Client. The commitments included within the Environmental Impact Assessment Report (EIAR) are the minimum commitments that the Contractor shall follow, and others will be developed during the Decommissioning Phase in consultation with the various stakeholders, including the Local Authority.

1.2 OBJECTIVES

This Traffic Management Plan (TMP) has been prepared prior to the appointment of a Contractor, material suppliers and final Decommissioning Phase programme. It will be updated following grant of planning permission and prior to commencement of any construction works.

The primary objectives of this TMP are to:

- Outline minimum road safety measures to be undertaken at site access/egress locations during the Decommissioning Phase, including approaches to such access/egress locations, and
- Demonstrate to the developer, contractor, and suppliers the need to adhere to the relevant guidance documentation for such works.

The TMP shall address the following issues which are explained in detail in this report:

- Consent, Licenses, Notifications and Permissions,
- General Provisions,
- Site Access and Egress,
- Routing of Construction Traffic,
- Site Specific Temporary Traffic Measure,
- Enforcement of Traffic Management Plan, and
- Emergency Procedures During the Construction.

1.3 IMPLEMENTATION AND MONITORING

The principal Contractor shall agree and implement measures to monitor the effectiveness of the TMP, in conjunction with the Local Authority and Client. On finalisation of the TMP, the Contractor shall adopt the plan and associated monitoring measures.

In order to ensure that environmental awareness and compliance is communicated effectively at the start and throughout the decommissioning works, this TMP will be communicated to all site personnel, including management staff, operatives, and sub-contractors. The key elements of this TMP will form part of the site induction which will be mandatory for all employees, contractors and visitors attending the site.

2. THE PROJECT

2.1 PROJECT LOCATION

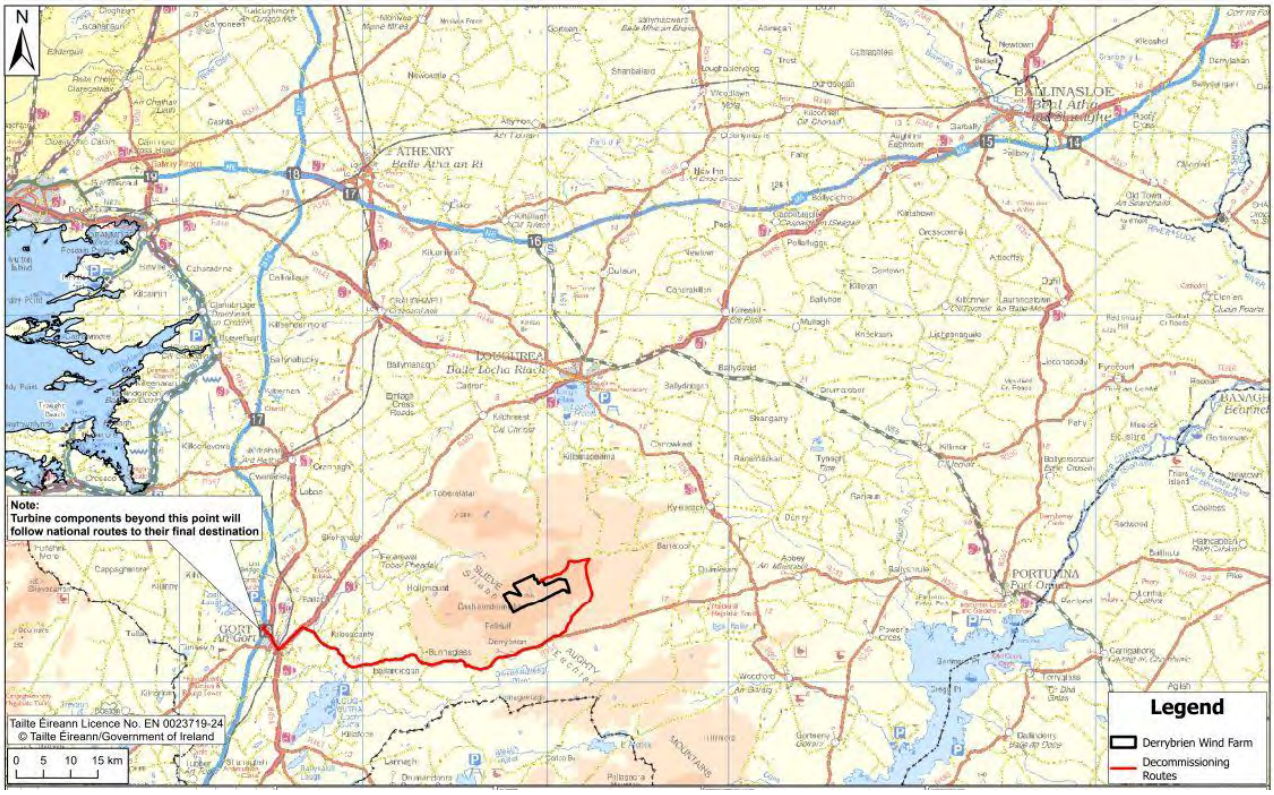
Derrybrien Wind Farm is in County Galway in the northern part of the Slieve Aughty Mountains approximately 11 km due south of Loughrea, 12.7 km northeast of Gort and 24 km west of Portumna, Galway City lies some 35 km to the northwest of the wind farm site. The wind farm site is in the south of the county approximately 4.6 km from the border with County Clare and 21 km from the border with County Tipperary in the southeast.

The wind farm site is located within the townlands of Coppanagh, Boleyneendorrish, Kilbeg, Toormacnevin, Funshadaun, Bohaboy, Derrybrien North and Derrybrien West. The postal address is Derrybrien North, Kylebrack, Loughrea, County Galway, Eircode H62 PE08. The approximate centre of the wind farm site is at Irish Transverse Mercator (ITM) co-ordinates 559572E, 705010N

The closest settlement to the wind farm site is the village of Derrybrien some 2 km to the south. The village of Peterswell is approximately 7.5 km west of the site. The nearest occupied houses are located approximately 2 km from the wind farm site.

Access to the site is via the Turbary Road. Figure 2.1 presents the project site location.

Figure 2.1: Site Location Map (Source: ESB)



2.2 PROJECT DESCRIPTION

The decommissioning works will involve the removal of the above ground elements of the wind farm and will entail:

- De-energising of the site which will involve initially high voltage (HV) disconnection followed by low voltage (LV) disconnection of turbines.
- Controlled dismantling of 70no. turbines (blades, nacelle, and tower) and 2no. anemometer lattice masts.
- Controlled removal of electrical equipment from Derrybrien substation and demolition of substation building.
- Removal of de-energised underground LV cables, electrical control systems and ducts, where possible.

The decommissioning and removal of the Derrybrien Wind Farm Grid Connection is anticipated to take approximately 12-14 weeks. The decommissioning works will include:

- Destringing of the Overhead Line Conductor
- Removal of the Overhead Line Infrastructure
- Decommissioning of the Agannygal Substation.
- Reinstatement of the Ennis-Shannonbridge 110kV Line

2.3 Proposed Site Access and Egress

The site access is existing and operational for the Derrybrien Wind Farm and Coillte operations, as no changes or modifications are proposed to the existing access it was agreed that a Road Safety Audit (RSA) is not required.

3. DECOMMISSIONING PHASE TRAFFIC GENERATION

3.1 DERRYBRIEN WIND FARM

During the decommissioning a wide range of mechanical plant will be mobilised to the wind farm site. This plant will be generally kept on the site and not removed from the site until it has fulfilled its purpose. The amount and type of plant on site will vary in accordance with the level and type of activity on site over the period of decommissioning.

The type and number of Light Vehicles (LV) at the Derrybrien Wind Farm site during the peak decommissioning works will comprise of the vehicles as identified in Table 3.1 below:

Table 3.1: Type and number of LV vehicles during decommissioning phase for Derrybrien Wind Farm Site

Type of Vehicle (LV) at Derrybrien Wind Farm Site	Number of LV during decommissioning phase at Derrybrien Wind Farm Site
Personnel 4X4 vehicles	3-40
Total	40 (per day)

The type and number of Heavy Goods Vehicles (HGV) at the Derrybrien Wind Farm site during the peak decommissioning works will comprise of the vehicles as identified in Table 3.2 below:

Table 3.2: Type and number of LV vehicles during decommissioning phase for Derrybrien Wind Farm Site

Type of Vehicle (HGV) at Derrybrien Wind Farm Site	Number of HGV during decommissioning phase at Derrybrien Wind Farm site
Excavators	2
Dumpers	2
Roller	1
Tractor and diesel bowser	1
Tractor and trailer	1
JCB	1
Mobile task lighting generator	2
Mobile pumps	1
Water bowser	1
Mobile Crane 60 ton for dismantling wind turbines	2
Mobile Crane (50 ton (2)) and ancillary support vehicles	3

Type of Vehicle (HGV) at Derrybrien Wind Farm Site	Number of HGV during decommissioning phase at Derrybrien Wind Farm site
Mobile Crane (300 ton (2)) and ancillary support vehicles	5
3 & 4 axle lorries	2
HGV vehicles to take waste, containers, skips, materials etc.	10
HGV with imported stone for potholes	2
HGV with imported stone to widen the turbary road	25
Total	61 (per day)

HGVs will access to and egress from the wind farm site entrance via Black Road from the R353. Empty HGVs will be permitted to travel either south or north of the wind farm site entrance, to avoid congestion.

During the construction of the wind farm, a number of road and junction improvements were completed to provide access to the site during turbine delivery. All these accommodation areas remain in place for use during decommissioning and turbine component removal. No additional works are required.

3.2 DERRYBRIEN SUBSTATION

During the decommissioning a range of mechanical plant will be mobilised to the wind farm substation site. This plant will be generally kept on the site and not removed from the site until it has fulfilled its purpose. The amount and type of plant on site will vary in accordance with the level and type of activity over the period of decommissioning. The type and number of Light Vehicles at the Derrybrien substation during the peak decommissioning works will comprise of the vehicles as identified in Table 3.3 below:

Table 3.3: Type and number of LV vehicles during decommissioning phase for Derrybrien Substation

Type of Vehicle (LV) at Derrybrien Wind Farm Site	Number of LV during decommissioning phase at Derrybrien Wind Farm Site
Personnel vehicles	16
Total	16 (per day)

The type and number of Heavy Goods Vehicles (HGV) at the Derrybrien Substation during the peak decommissioning works will comprise of the vehicles as identified in Table 3.4 below:

Table 3.4: Type and number of HGV vehicles during decommissioning phase for Derrybrien Substation

Type of Vehicle (HGV) at Derrybrien Substation	Number of HGV during decommissioning phase at Derrybrien Substation
Mobile task lighting generator	2
MEWPS	2
Forklifts/Teleporters	1
Hi ab	2
Cherry pickers	2
HGV vehicles to take waste, containers, skips, materials etc.	10
Mobile Crane (800 ton (1)) and ancillary support vehicles	5
Mobile Crane (50 ton (1)) and ancillary support vehicles	3
Excavator	1
Total	28 (per day)

3.3 OHL Decommissioning

During the decommissioning a small range of mechanical plant will be mobilised to the works location when it is required. This plant will be generally kept on the site, moved from location to location and not removed from the site until it had fulfilled its purpose. The amount and type of plant on site will vary in accordance with the level and type of activity over the period of decommissioning. The type and number of Light Vehicles at the OHL decommissioning site during the peak decommissioning works will comprise of the vehicles as identified in Table 3.5 below:

Table 3.5: Type and number of LV vehicles during decommissioning phase for OHL

Type of Vehicle (LV) at OHL Decommissioning	Number of LV during decommissioning phase at OHL
Personnel vehicles	16
Total	6 (per day)

The type and number of Heavy Goods Vehicles (HGV) at the OHL during the peak decommissioning works will comprise of the vehicles as identified in Table 3.6 below:

Table 3.6: Type and number of HGV vehicles during decommissioning phase for OHL

Type of Vehicle (HGV) at OHL Decommissioning	Number of HGV during decommissioning phase at OHL site
Tracked excavator	2
Tracked dumpers	2
Tractor and diesel bowser	1
Tractor and trailer	1
3 & 4 axle lorries	2
Mobile task lighting generator	2
Total	10 (per day)

Access to the overhead line structures is from nearby roads and forestry tracks.

3.4 AGANNYGAL SUBSTATION DECOMMISSIONING

During the decommissioning a wide range of mechanical plant will be mobilised to the Agannygal substation site. This plant will be generally kept on the site and not removed from the site until it had fulfilled its purpose. The amount and type of plant on site will vary in accordance with the level and type of activity on site over the period of decommissioning. The type and number of Light Vehicles (LV) at the Agannygal substation during the peak decommissioning works will comprise of the vehicles as identified in Table 3.7 below:

Table 3.7: Type and number of LV vehicles during decommissioning phase Agannygal Substation

Type of Vehicle (LV) at Agannygal Substation	Number of LV during decommissioning phase at Agannygal Substation
Personnel 4-wheel drive vehicles	16
Total	16 (per day)

The type and number of Heavy Goods Vehicles (HGV) at the Agannygal Substation during the peak decommissioning works will comprise of the vehicles as identified in Table 3.8 below:

Table 3.8: Type and number of LV vehicles during decommissioning phase Agannygal Substation

Type of Vehicle (LV) at Agannygal Substation	Number of LV during decommissioning phase at Agannygal Substation
Mobile task lighting generator	2
MEWPS	2

Forklifts/Teleporters	1
Hi ab	2
Cherry pickers	2
Mobile Crane (60 ton (1)) and ancillary support vehicles	2
HGV vehicles to take waste, containers, skips, materials etc.	10
Excavator	1
Total	22 (per day)

The AM and PM peak vehicles (LV and HGV) passing through R353 and Black Road junction to access Derrybrien wind farm site, Derrybrien substation, Agannygal substation and OHL decommissioning site during decommissioning phase are provided in Table 3.9 below:

Table 3.9: AM & PM Peak Vehicles (LV & HGV) passing through R353 at Black Road Junction

Works Zone	Classification	AM Peak	PM Peak
Derrybrien Wind Farm Site, Derrybrien substation, Agannygal substation & OHL	LV	39	39
	HGV	60	60

3.5 WORKING HOURS

The duration of the decommissioning phase is expected to be approximately 24 months. Decommission activities will occur between the hours of 07:00 and 19:00 on Monday to Friday, between 08:00 and 13:00 on Saturdays and there will be no activity on Sundays or Bank Holidays. Due to the nature of the works, there will be occasions during deconstruction of the project where extended working hours will be required. In particular, during the transport of the turbine components.

Where additional or alternative working hours are required, these will be agreed in advance with Galway County Council.

4. DECOMMISSIONING PHASE TRAFFIC MANAGEMENT PLAN

The Contractor shall develop and take account of the commitments imposed within this TMP. The following are the commitments made at the planning stage of the project, which shall be further developed by the Contractor and agreed upon with the Roads Authorities, prior to works commencing on site:

- General Provisions,
- Site Access and Egress,
- Routing of Decommissioning Phase Traffic,
- Site Specific Temporary Traffic Measures,
  - Traffic Management Logistics,
  - Traffic Management Speed Limits,
  - Traffic Management Signage,
  - Road Closures,
  - Timings of Material Deliveries to Site,
  - Abnormal Load,
  - Road Cleaning,
- Enforcement of Traffic Management Plan, and
- Emergency Procedures During the Decommissioning

4.1 CONSENTS, LICENCES, NOTIFICATIONS AND PERMISSIONS

The key consents, licences, notifications, and permissions likely to be required for the project with regards to traffic and roads are summarised as:

- Planning permission and associated planning compliance.
- Abnormal loads – it is envisaged that permits will be required for the abnormal loads that will be required for the transporting turbine components from the site.
- Road opening licences for underground cable works, junction upgrade works, foundations in the public roadway, etc.
- Approval of temporary traffic management plans.
- Road closures and diversions.
- Permission for works outside of standard construction operation hours agreed upon with the Galway County Council.
- Permission from the Motorway Maintenance and Renewal Contractor (MMaRC)/Public Private Partnership Contractor (PPP) on the relevant national roads.

The above list is non-exhaustive but identifies the key consents, licenses, notifications, and permissions required for the project. This list will be further populated as required through

planning compliance and stakeholder engagement to ensure that any further consents are identified as early as possible and do not impact on the decommissioning programme.

4.2 General Provisions

The decommissioning phase traffic impacts of the proposed project have been identified as being minimum during both peak hours and temporary in nature. It is important that any impact caused by the proposed project is minimised as far as possible, and, considering this, the following mitigation measures shall be included in future developments of this TMP:

- Traffic movements will be limited to 07:00 - 19:00 Monday to Friday and 07:00 – 14:00 Saturday, unless otherwise agreed in writing with Galway County Council.
- HGV movements will be restricted during peak road network hours (including school hours) from 08:00 – 09:00 and 17:00 – 18:00 Monday to Friday, unless otherwise agreed in writing with Galway County Council.
- HGV movements for the proposed project shall be directed away from sensitive areas (i.e., schools, urban centres).
- No parking shall be permitted along the access route for unloading or activities that result in blockages of access routes. Such vehicles will be immediately requested to move to avoid impeding the works and traffic on the road network.
- Measures to remove queuing of construction traffic on the adjoining road network, including turning space and queuing of convoy HGVs will be provided within the sites.
- Wheel wash equipment will be used on site to prevent mud and stones from being transferred from the site to the public road network.
- Activities generating dust will be minimised where practical during windy conditions. Loads will be covered on arrival and departure from the site, where required.
- Clear warning signs will be placed on the public road network to provide advance warning to road users of the presence of the decommissioning site and slower-moving vehicles making turning manoeuvres.
- Access to the decommissioning site will be controlled by onsite personnel and all visitors will be asked to sign in and out of the site by security/site personnel, and site visitors will all receive a suitable Health and Safety site induction.
- Security gates will be sufficiently set back from the public road, so that vehicles entering the site will stop well clear of the public road.
- The final TMP will also include provisions by the appointed Contractor, for details of the intended construction practice for the development, including:
- Traffic Management Co-ordinator – a competent traffic management co-ordinator will be appointed for the duration of the project and this person will be the main point of contact for all matters relating to traffic management,

- Decommission Programme – a programme of decommission will be submitted to Galway County Council in advance of the removal of the turbine components from the site,
- Information to locals – residents in the area will be informed of any upcoming traffic related matters, e.g., temporary lane/road closures (if required) or any night movement of turbine components, via posters in public places. Information will include the contact details of the Developer's representative, who will be the main point of contact for all queries from the public or local authority during normal working hours. An "out of hours" emergency number will also be provided,
- Pre and Post Decommissioning Condition Survey – a pre-condition survey of roads on approach to the site will be carried out prior to decommission commencement to record the condition of the road. A post decommission survey will be carried out after the works are completed. The timing of these surveys will be agreed with Galway County Council;
- Liaison with Local Authorities – liaison with Galway CC, including the roads and transport section, through which the decommission route traverses, and An Garda Siochána, during the decommission phase of the AILs, wherein an escort for all convoys may be required;
- Temporary Alterations – implementation of temporary alterations to road network at critical junctions,
- Travel plan for workers – a travel plan for staff and sub-contractor staff,
- Temporary traffic signs – As part of the traffic management measures, temporary traffic signs will be put in place.
- Traffic Management Operatives (TMOs) will be present at site access point during peak delivery times, and
- Transport of Large Turbine Components – The management plan will include the option to transport the large wind turbine plant components at night in order to minimise disruption to general traffic during the decommission stage.

The Traffic Management Plan (TMP) will be updated by the principal Contractor and agreed with the Planning Authorities prior to the commencement of development in the event of a grant of permission.

4.3 Site Access and Egress

At the proposed access point to the proposed wind farm, visibility splays shall be provided and maintained in accordance with the Galway CC and County Development Plan 2022-2028. To ensure safe working access for all vehicles on the Wind Farm, these works will be required to be undertaken in advance of all other activities on the site utilising this access.

The Contractor shall be required to utilise a safe system of traffic management, potentially including the use of Traffic Management Operatives (TMOs) for the control of traffic during access/egress operations at the site access location during peak decommissioning activities.

4.4 Routing of Decommission Phase Traffic

During deconstruction all the vehicles will use the same roadway network that was used during construction phase. The haul routes utilise the national and regional road network as much as feasible, with only localised use of the local road network. Traffic will depart the Wind Farm site via the Turbary Road and Black Road.

Project HGV traffic will be directed away from communities and sensitive receptors (i.e., schools, dense residential areas, urban centres) where possible to minimise the effect on these communities.

4.5 Site Specific Temporary Traffic Measures

The specific details of each temporary traffic measure shall be developed by the Contractor(s) for site access in consultation with the Roads Authority, An Garda Síochána and other Emergency services, before being submitted to the Roads Authority for formal approval prior to any works taking place.

The maximum length of the active traffic management area (i.e., including taper lengths) shall be no more than 500 metres in length for any proposed shuttle system. In order to minimise traffic delays, it may be necessary to limit the works site to shorter lengths if queuing delays are encountered.

Any requirement for a traffic lane closure will be controlled by an active traffic management system (i.e., temporary traffic signals or Stop & Go/Téigh discs). An Garda Síochána shall be consulted prior to the implementation of the active traffic management system. The operation of a manual 'Stop & Go/Téigh' system will be undertaken by trained personnel, wearing suitable high visibility garments. The operators of this type of system will be in verbal contact (i.e., radio) and preferably inter-visible. At these locations queue lengths will be estimated initially with onsite measurements to determine the necessary warning distance for approaching drivers. The signage shall be adjusted as necessary when the actual impact on traffic flows is established.

Where roadworks impede dwelling access onto the road network, the residents shall be instructed on how to egress the property at times when a shuttle system is in operation. The Contractor shall provide a TMO where the motorist is having difficulty following the instructions.

Where reasonably practicable, consideration will be given to the possibility of removing the traffic management measures in order to deal with:

- Particularly high traffic volumes due to sporting or other events,
- Adverse weather conditions,
- Emergency access, or
- Times when work is not in progress.

If the night-time or weekend Temporary Traffic Management (TTM) measures vary from the daytime plan, a separate TTM will be prepared to be approved by the Roads Authority.

On completion of the works, the traffic management measures are to be removed when the road is safe and free from obstructions, all reinstatement of road surfacing is completed, and all permanent signs, road markings, and other items are in place.

4.5.1 Traffic Management Systems/Logistics

The Principal Contractor as a minimum shall employ the following traffic management systems and logistics to facilitate the safe transport of materials to and from the proposed project.

4.5.2 Traffic Management Operatives (TMOs)

During peak decommissioning activities, with a higher number of HGV movements to and from the site, a TTM (i.e., stop/go system) at the site access may be required to facilitate the movement of HGV vehicles.

Also, during peak decommissioning activities, TMOs may be required within the site to manage the movement of HGVs within the internal layout.

TTM for the decommissioning will be developed by the appointed Contractor in consultation with the specialised haulage provider, An Garda Síochána, and the Local Authority.

4.5.3 Convoy System

A convoy system shall be employed by the principal Contractor, applied to HGVs departing the site, involving:

- Traffic management operatives at the proposed wind farm access/egress point to facilitate movement of construction vehicles in a convoy system (maximum 4 no. HGVs),
- Suitable spaces shall be made available within the site for queuing of HGVs (i.e., passing bays and at site access),
- Traffic management operatives shall be stationed at the site access T-junction with a suitable intercommunication system (i.e., radio) to control the release of the convoy system,
- The convoy shall have separation between convoys to facilitate use of the public road network in the absence of HGV movements.

4.5.4 Traffic Management Speed Limits

Once a temporary speed limit is deemed appropriate by the Contractor to facilitate the decommissioning phase activities along the public roads serving the proposed project, it shall be required for the appointed Contractor to liaise with the relevant Roads Authority for obtaining a temporary speed limit.

Adherence to posted/legal speed limits will be emphasised to all staff, suppliers, and contractors. In speed zones greater than 60 km/h, drivers of HGVs will be instructed that vehicular movements in sensitive locations, such as schools and local community areas, shall be restricted to 60 km/h. Such advisory speed limits will only apply to decommissioning phase haulage traffic and shall not apply to general traffic. It is not proposed to signpost such speed limits in the interest of clarity for local road users.

4.5.5 Traffic Management Signage

Signage for temporary traffic measures shall be provided in accordance with the Department of Transport, Tourism and Sport - Chapter 8 – Temporary Traffic Measures and Signs for Roadworks – August 2019.

Advanced warning signs will be used to alert drivers to the unexpected road layout. Clear warning signs shall be placed at adjacent roads and the entrances, to advise the general public of the presence of construction sites and activities. All permanent road signs contrary to the proposed roadworks will be covered for the duration of the works and uncovered on removal of the temporary traffic management measures.

The duration of the decommissioning phase is expected to be approximately 24 months. Decommission activities will occur between the hours of 07:00 and 19:00 on Monday to Friday, between 08:00 and 13:00 on Saturdays and there will be no activity on Sundays or Bank Holidays. Due to the nature of the works, there will be occasions during deconstruction of the project where extended working hours will be required. In particular, during the transport of the turbine components.

Where additional or alternative working hours are required, these will be agreed in advance with Galway County Council.

4.5.6 Timing of Material Movements

With the aim of reduce impacts on local communities and residents adjacent to the proposed sites, it is planned that:

- Decommissioning activities will be undertaken based on a six-day working week, with deliveries between 07:00 - 19:00 on weekdays and 08:00 - 13:00 on Saturdays and there will be no activity on Sundays and Bank Holidays.
- Activities outside these hours shall be agreed with the Local Authority in advance.
- Due to the nature of the works, there will be occasions during deconstruction of the project where extended working hours will be required. In particular, during the transport of the turbine components. Where additional or alternative working hours are required, these will be agreed in advance with Galway County Council.
- The Contractor shall liaise with the management of other construction projects and the local authority to co-ordinate transport of turbine components from site.
- HGV movements from the site will be suspended on the days of any major events (i.e., sporting, agricultural etc), that have the potential to increase traffic volumes on the existing road network in the vicinity.
- A convoy system shall be employed for HGVs departing the wind farm site to reduce the frequency of isolated HGV movements on the public road network as much as practicable.

4.5.7 Abnormal Indivisible Load

The principal Contractor shall ensure that the haulage of these AILs is done in conjunction with an Gardaí Síochána and the Roads Authorities. The principal appointed Contractor and their haulage provider will be responsible for obtaining all necessary permissions and licences from the local authorities and Gardaí.

4.5.8 Road Cleaning

Regular visual surveys of the road network in the vicinity of the sites will be carried out. Where identified/required, the Contractor shall carry out road sweeping operations, employing a suction sweeper to remove any project related dirt and material deposited on the road network by construction/delivery vehicles. It shall be a requirement of the works contract that the Contractor(s) will be required to provide wheel cleaning facilities, and any other necessary measures to remove mud and organic material from vehicles as outlined in the CEMP.

4.5.9 Enforcement of Traffic Management Plan

The appointed Contractor will further develop this Traffic Management Plan in consultation with the Road's Authority Galway County Council. The Contractor will agree and implement an appropriate way of monitoring the effectiveness of the plan.

All project staff and material suppliers will be required to adhere to the TMP. Inspections/spot checks will also be carried out by the Contractor to ensure that all project staff and material supplies follow the agreed measures adopted in the TMP.

4.5.10 Emergency Procedures During the Construction

In case of emergency, the following procedures shall be implemented:

- Emergency Services will be contacted immediately by dialling 112,
- Exact details of the emergency/ incident will be given by the caller to the emergency line operator to allow them to assess the situation and respond in an adequate manner,
- Follow the instructions of the Local Authorities and An Garda Síochána,
- Emergency will be reported to the Site Team Supervisor and the Safety Officer,
- Where required, site first aiders will attend the emergency immediately, and
- The Safety Officer will ensure that the emergency services are enroute.

It is important that during the Decommissioning Phase, emergency services can gain ready access to any property along the Haul Road or in the vicinity of any of the infrastructure sites, or indeed can gain priority usage of any Haul Road. Emergency procedures will be agreed, and contact numbers provided to the local Emergency Services. On being notified of a priority condition, all construction vehicles will be directed to give right of way to the emergency vehicles until the need for priority access has passed.

With respect to an emergency condition arising on any of the sites, priority access to and from these sites will be given to ambulance or fire tenders.

4.5.11 Decommission Phase

Turbine design renders the decommissioning process as a straightforward process. In the decommissioning phase, cranes disassemble each turbine section and remove from the site. The upper sections of the foundations projecting above ground will be removed, and the remainder of the foundations will be covered by soils typical of the surrounding environment and then re-seeded or left to re-vegetate according to ecological requirements. Underground cables will be cut back at the turbine termination points and will either be recycled or left buried in situ (de-energised). It is proposed that site routes would remain to allow access through the site either

for further alternative development of the site, for ongoing forestry operations and/or for amenity purposes, as considered appropriate at the time.

The traffic management of the decommissioning phase will be advised by the road conditions at the time of decommissioning. It is envisaged that a Traffic Management Plan shall be developed for the decommission phase.

5. CONCLUSION

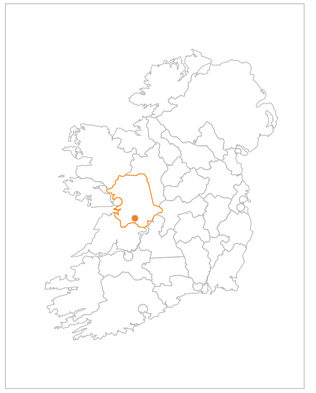
The Traffic Management Plan is a living document and shall be developed through the decommission phase with ongoing consultation with the Local Authority, An Garda Síochána, Emergency Services and other stakeholders.

This TMP has thus far been developed to the Planning Stage, so that the necessary steps are taken throughout the planning proposals to support an efficient, safe transportation operation, with the least possible impact upon vulnerable road users and traffic along the haul roads or close to the proposed project.

Appendix A TRAFFIC MANAGEMENT PLAN

WK 052

Temporary Traffic Signs



LEGEND:

SITE BOUNDARY

TEMPORARY TRAFFIC SIGN

NOTES:

1. FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING.
2. ALL DRAWINGS TO BE CHECKED BY THE CONTRACTOR ON SITE.
3. ENGINEER/EMPLOYERS REPRESENTATIVE, AS APPROPRIATE, TO BE INFORMED BY THE CONTRACTOR OF ANY DISCREPANCIES BEFORE ANY WORK COMMENCES.
4. THE CONTRACTOR SHALL UNDERTAKE A THOROUGH CHECK FOR THE ACTUAL LOCATION OF ALL SERVICES/UTILITIES, ABOVE AND BELOW GROUND, BEFORE ANY WORK COMMENCES.
5. ALL LEVELS SHOWN RELATE TO ORDNANCE SURVEY DATUM AT MALIN HEAD.

Rev	Date	Description	By	Chkd.
D02	04/12/2023	Planning issue	NN	JOF
D01	21/06/2023	Planning issue	NN	JOF

Client: ESB Energy for generations

Project: Derrybrien Wind Farm

Title: Traffic Management Plan Temporary Signage

Scale @ A1: NA

Prepared by:	Checked by:	Date:
NN	JOF	December 2023

Drawing Status: Planning issue

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Drawing No.: 11482

Revision: D02

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APPENDIX 16-1

TURBINE RECYCLABILITY REPORT

RE:WIND VESTAS V52

Turbine Recyclability Assessment

ESB Renewables O&M

Date: 22/11/2022

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1 EXECUTIVE SUMMARY

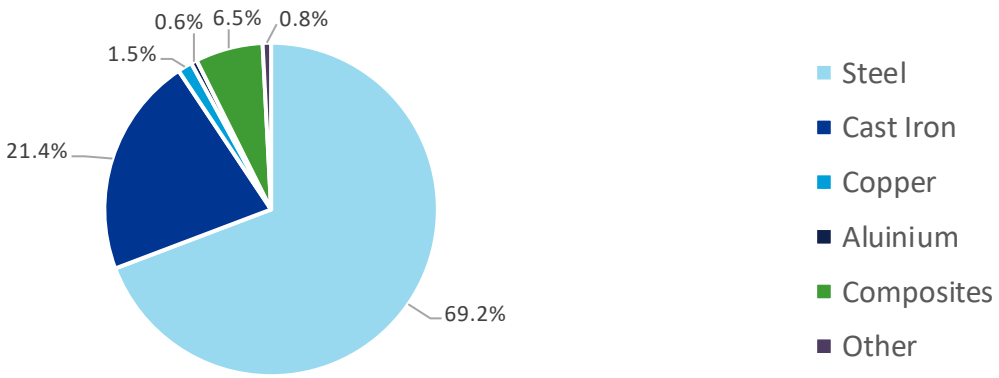
DNV has conducted an assessment of the recyclability of a Vestas V52 MW wind turbine located at the Derrybrien Wind Farm in the Republic of Ireland. The material composition and weights of the major components have been modelled, and appropriate recycling methods, facilities and providers are presented in this report. Results and highlights of the assessment are shown below.

Table 1-1: Recyclability summary for the Vestas V52 wind turbine

Turbine Recyclability[1]	
Steel	59.2 t (69.2% of total mass)
Cast Iron	18.3 t (21.4% of total mass)
Copper	1.2 t (1.5% of total mass)
Aluminium	0.5 t (0.6% of total mass)
Composites	5.6 t (6.5% of total mass)
Other (hydraulics, coolants, etc.)	0.7 t (0.8% of total mass)
Overall turbine weight	85.5 t
Overall turbine recyclability[2]	88%

1 – Of note, the weights are based off the technical specification for the Vestas V52 850 kW
2 – Recyclability is defined as the ratio of the mass of metal to overall turbine mass including an assumed recycling rate of 95%. See Section 2.1 for more details.

Figure 1-1: Vestas V52 wind turbine material composition weighting



2 TURBINE RECYCLABILITY

The Vestas V52 850 kW turbine is an adaptable wind turbine appropriate for a broad spectrum and medium and high winds. The size of the turbine and sound profile means it can be found in both populated and remote locations, using its variable pitch and variable speed technologies to optimise the power output of the turbine.

Mass values of the major components give an insight into the overall recyclability of the turbine. It is important to measure the proportion of the turbine that can be recycled past the end-of-life as it provides a 'usable' business measure to drive up the total recyclability of wind turbines across the market.

2.1 Turbine composition

A summary of the general turbine characteristics as well as the material breakdown and weights of each of the major components is presented in Table 2-1 below. Where weight and material information were not provided by the manufacturer, DNV has modelled the turbine's characteristics using DNV's advanced concept design model library Renewables.Architect (RA). RA uses a mixture of load analysis, geometry optimisation and scaling law models to design and optimise a representative turbine according to the input specifications. The software is heavily benchmarked against DNV's expansive expertise within wind turbine design. Various assumptions have been made on the design decisions of the turbine that have led to conservative estimates of the masses that can be expected from a V52 wind turbine. The masses stated should be used as a guideline to give insight into the quantity and proportions of material that may constitute each turbine as contain a level of uncertainty.

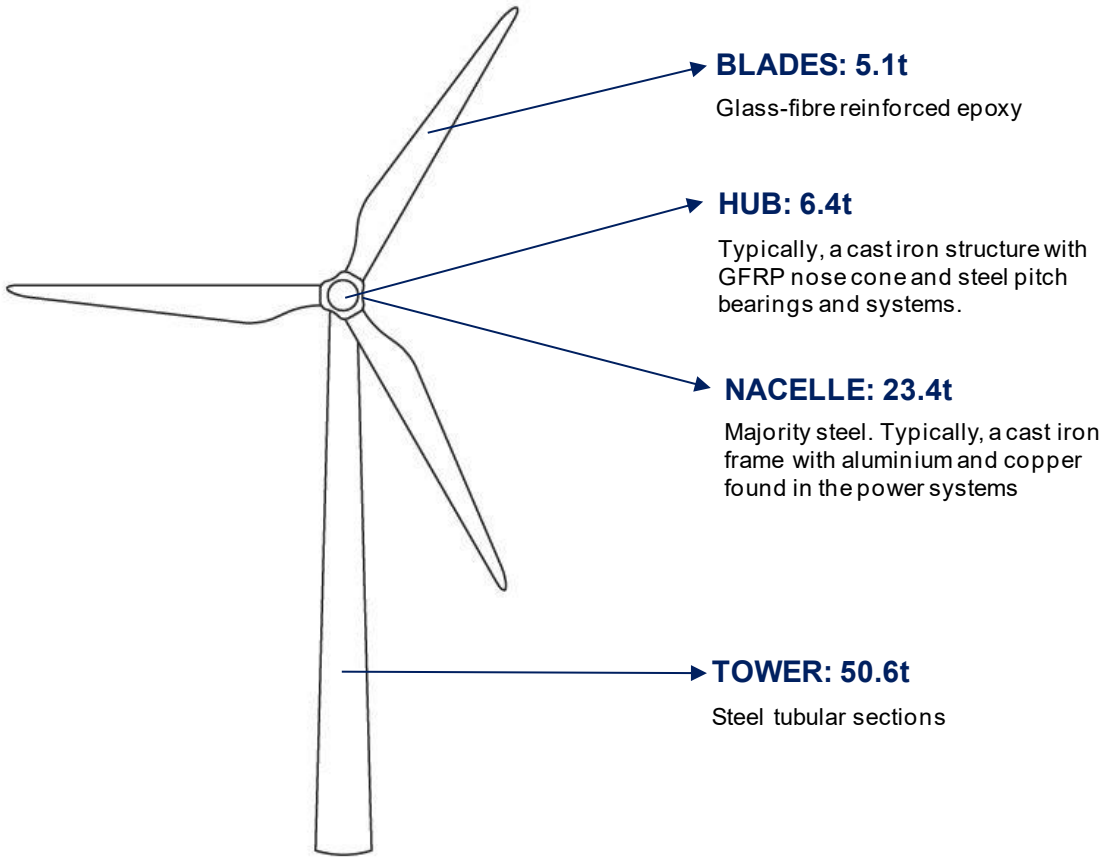
Table 2-1: Material and mass break down of major turbine components

Characteristics	Description	
Turbine model	Vestas V52	
Nominal power	850 kW	
Wind class (IEC)	IA	
Rotor diameter	52 m	
Hub height	49 m (other models available: 40, 44, 55, 60, 65 m)	
Control	Variable speed pitch regulation	
Powertrain	Gearbox	
Tower	Materials	Tubular Steel sections
	Tower	50 t
	Tower internals[1]	0.6 t
	Total mass	50.6 t
Blades	Materials	Glass fiber reinforced epoxy
	Total mass	1.7 t (each)
Hub	Hub structure	2.8 t Cast iron and glass reinforced polyester coated with gelcoat

	Pitch bearings and systems	3.6 t Cast iron, steel, and polyester
	Total mass	6.4 t
Nacelle	Cover	1.0 t Fiberglass
	Hydraulics[2]	0.2 t Lubrication and power systems
	Yaw bearing and system	2.2 t Cast iron, steel, and polyester
	Mainframe and bedplate	1.0 t Cast iron and girder structure
	Generator	3.8 t Steel, cast iron, and copper
	Gearbox	5.5 t Steel
	Power circuit	0.8 t Steel, copper, aluminium, and resin
	Main shaft and bearings	5.5 t Cast iron and Steel
	Contingency	3.4 t non-modelled components such as cooling systems, rotor lock, bolts, safety/communication equipment, sensors, etc.)
	Total mass	23.4 t

1-Tower internals include the ladder, ground controller, and transport frame
2 -The hydraulic systems in the nacelle are not considered to be recyclable

Figure 2-1: Overview of modelled component mass for the Vestas V52 turbine



All turbine major components have been modelled using DNV's advanced concept design model library Renewables.Architect. The US National Renewable Energy Laboratory (NREL) [1] have put together research that describes the typical bill of materials for wind turbines, which is used in this report and shown below in Table 2-2.

Table 2-2: Indicative expected composition in the Vestas V52 turbine

Material	Steel	Cast iron	Copper	Aluminium	Composites	Other
Percentage by mass	69.2%	21.4%	1.5%	0.6%	6.5%	0.8%

There are a number of uncertainty sources when predicting the masses of the components within the existing turbines. Renewable.Architect focuses on the major components and uses simple assumptions to calculate the masses of less significant components such as internal tower parts, contingencies, cables, electronic systems, etc. In mixed metal components (gearbox, generator, etc.), Renewable.Architect simply calculates the overall mass, thereby assuming them to be mono-material.

Calculating the recyclability of a product gives a measure of the proportion of the turbine that can be usefully recycled at the end-of-life. It is calculated using the following equation, where it accounts for the recycling rates of each component and produces a result that is measured as a percentage of the total turbine mass [2]. In this case, the components that have been considered non-recyclable are the blades and hydraulic systems.

$$Recyclability = \sum_{i=1}^{all\ metal\ components} \frac{\text{metal recycling rate} \times \text{metal component mass } (kg)}{total\ component\ mass\ (kg)} \quad (1)$$

It is assumed that significant components listed in the above tables are primarily mono-material with up to 95% recyclability rate [3]. This then yields a total recyclability of 88% for the modelled V52 wind turbine.

2.2 Non-recyclable and materials of concern

As described above, 88% of the turbine's mass is metallic and recyclable. These materials are easy to process and can offset the decommissioning costs. However, a great area of concern is what can be done with materials that are not recyclable or that are not cost effective to manage. When considering non-recyclable materials, the best practice is summarised through the waste hierarchy shown below. For example, when considering the most sustainable solution is to extend the life of the materials as long as possible which could be done through the refurbishing and sale of components to a second hand market.

Figure 2-2: The waste hierarchy

2.2.1 Blades

The V52 blades are made from pre-impregnated glass fibre reinforced epoxy to make up the blade spar, and steel for the root attachment, with an epoxy gelcoat surface. The exact material composition of the remaining blade is unknown. Blades are difficult to recycle due to the combination of glass fibers with epoxy which cannot be easily separated from the other materials. Some modern blades utilise balsa wood in the construction of the supporting beam. Although DNV is not aware of the use of balsa wood in this specific blade design it is possible that it is used as Vestas has not published which models use this material. Further details on balsa wood are discussed in Section 2.2.1.1 below.

Recycling of glass fibres is a difficult and costly process but it is possible, and there are a number of technologies which have been trialled and are in development to meet this growing demand. Figure 2-3 shows the various different fibre recycling technologies, their technology readiness level, and associated cost. Further details on the full blade recycling is discussed in Section 4.1.

Table 2-2:Technology readiness level (TRL) of blade recycling technologies [4]

Material	Type	TRL	Cost
Glass fibre	Cement co-processing	9	Low
	Mechanical	9	Low
	Electro-mechanical	6	High investment and running costs

At this point in time, many recycling methods which create new material for the manufacturing of new products are still under development and have not yet been fully commercialised. The recovery of material and energy through cement co-processing is becoming widely used throughout the industry to handle this composite waste. This process involves the mechanical grinding of blade sections such that they can be used as a fuel feedstock replacing coal in the cement kiln.

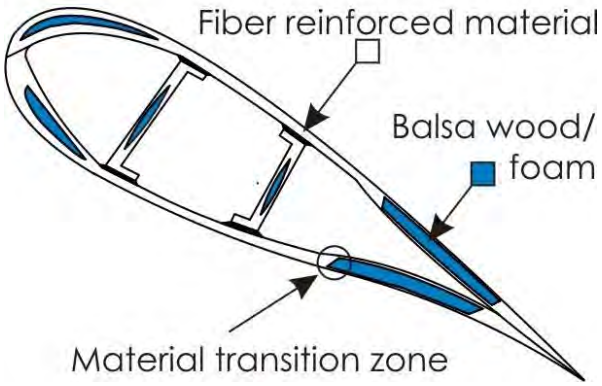
Through this process energy is recovered for the production of cement and can reduce the CO_2 emission intensity by as much as 27% [5].

2.2.1.1 Balsa wood

Balsa wood is a material commonly found in wind turbine blades which is used to provide support to the blade structure. It is ideal for wind turbine applications due to its light weight, toughness, and having a high stiffness-to-weight ratio. It is typically incorporated into blades by being sandwiched between the outer and inner layer of fibreglass in sections which run the entire length of the blade as in Figure 2-4; Approximately 150 m^3 is required in order to produce a blade with a 100m length [6]. Despite its beneficial material properties, the use of balsa in wind turbine blade production has been criticised due to ethical concerns in its sourcing.

Over 95% of the world's balsa wood comes from Ecuador, where it is farmed in large plantations [7]. In 2018, a change in European legislation to promote renewable energy combined with a high demand caused by China's "wind rush" caused a dramatic increase in the global demand for this material. This resulted in increased deforestation and illegal logging, which causes a loss of rainforest habitat, and affects local ecosystems and indigenous communities. Consequently, this culminative effect has been labelled as the "Green Power Paradox".

Figure 2-4: Generic blade cross section [8]



To counteract this paradox and deal with supply issues, efforts have been made by the wind community to reduce their reliance on balsa wood by using alternative materials that are less environmentally and socially damaging. As part of this effort, Vestas has been able to produce the first full scale turbine blade made using PET (Polyethylene Terephthalate), a plastic polymer that substitutes balsa. This material is cheaper to produce, has a much lower ecological impact, is lighter, and can be made from recycled plastic bottles. As the production and incorporation of PET in turbines is scaled up, the forecast shows a use increase from 20% in 2019 to more than 55% by 2023, while the demand for balsa will remain stable [9]. In trend with this demand, Vestas appears to be committed in reducing their dependence on balsa through substitution with PET. Even though it is known that balsa is present in Vestas' new and existing turbine blades, they have not released any public data on which or how many of their turbine models contain this material [10]. However, reasonable assumptions reveal the likelihood of balsa being present in a Vestas' turbine blade tends to increase with the age of the asset.

2.2.2 Lubricants and oils

Operating fluids or lubricants are used in wind turbines in the generator, converter, gearbox, hydraulic system, rotor bearings and in the transformer. These liquids are harmful to the environment and must be handled with care during decommissioning. The following specific lubricants are expected to be encountered during the decommissioning process:

- Anti-freeze in the generator to help prevent the cooling system from freezing;
- Gear oil in the gearbox;
- Grease on all bearings;

- Resin cover coating in generator or transformer.
- Various cleaning agents and chemicals for maintenance of the turbine;
- Oil in the transformer.

Oils and lubricants should be handled carefully and where feasible, different fluids should not be mixed to ensure efficient recycling. There exists a significant risk of soil contamination during the decommissioning process if these fluids are not handled properly and it is recommended that specialist contractors are used when extracting these substances. If correctly handled oils and lubricants can be recycled through refining and processing into fuel oils and raw materials in the petrochemicals industry. DNV recommends contracting a specialist company to remove all oils and hydraulic fluids from the turbine prior to dismantling during the decommissioning process.

2.3 Non-turbine materials

This study focuses on the turbine itself although during the decommissioning other site elements will need to be removed and processed. Items such as roads and foundations can make up a significant portion of the site waste, considerations for these materials are shown below.

2.3.1 Turbine Foundations

Turbine foundations vary but typically consist of concrete reinforced with steel rebar. Foundations may either be rock anchored or gravity based (buoyant or non-buoyant) and the quantity of concrete and rebar will vary significantly for each. In order to recycle foundation material, the rebar and concrete must be separated which can be a difficult and costly process.

Like steel and aluminium, concrete can be repeatedly recycled (or re-recycled). The recycled concrete product is commonly crushed into aggregate and can be re-used in many ways e.g. cement replacement, concrete levees for flood protection, backfilling and filler. Recycled concrete has several benefits:

- It replaces other materials such as gravel that must otherwise be mined and transported for use.
- It reduces waste in landfills and avoids disposal or tipping fees.

Rebar can be recycled as scrap metal in the same way as any other metal as long as the concrete can be separated from the material.

2.3.2 Electric Cables

Polymers are used together with aluminium, copper and steel in the production of cables for the plant. Separately, electric and electronic components incorporated in the turbine make up around 1% of its mass [1]. The conduction material of electric cables, usually aluminium and/or copper is inherently valuable and recyclable however the separation of the insulating material from cables to facilitate recycling is difficult and expensive. Best practice is considered to be the re-use of cables in new applications.

3 REGULATIONS AND SUPPLY CHAIN

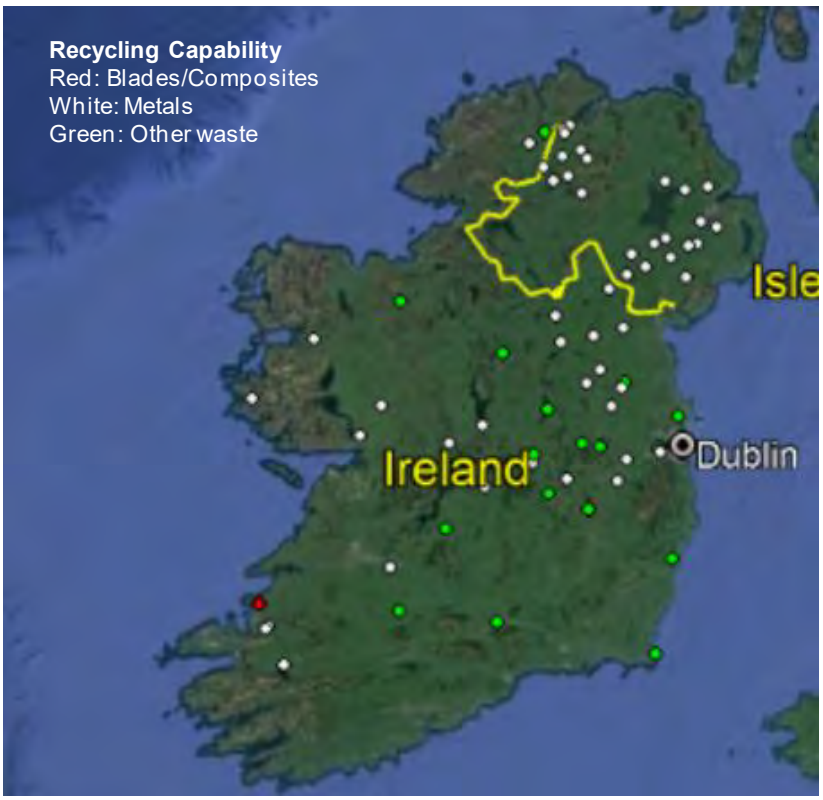
Decommissioning and recycling wind turbines is dependent on the applicable legislation, and the available recycling techniques and facilities in the given location. This section provides an overview of the relevant regulations that need to be taken into account with regards to material management, the recycling techniques in Republic of Ireland, and the actual decommissioning process, where the options are described as well as their advantages and disadvantages.

3.1 Decommissioning legislation and guidelines

In the Republic of Ireland, decommissioning requirements for onshore wind farms are enclosed within the development of the project as part of the permitting process. Projects go through an environmental impact assessment that involves a high level analysis of the decommissioning phase as well issuing a 'decommissioning bond' in place with the local permitting authority to cover some of the future decommissioning costs. Depending on the materials that need to be disposed of, different legislation apply.

In addition, the decommissioning requirements imposed by the permit conditions must comply with several EU directives. EU directives set goals for member states which are to be included in local law. A summary of the EU and local waste regulations is presented in Appendix A.

Figure 2-2: Potential recycling facilities Ireland



A list of potentially suitable recycling facilities on the island of Ireland is presented in Appendix B, although DNV has not confirmed that these are fully equipped to process wind turbine components and recommends contacting the facilities directly to confirm this during the contracting phase.

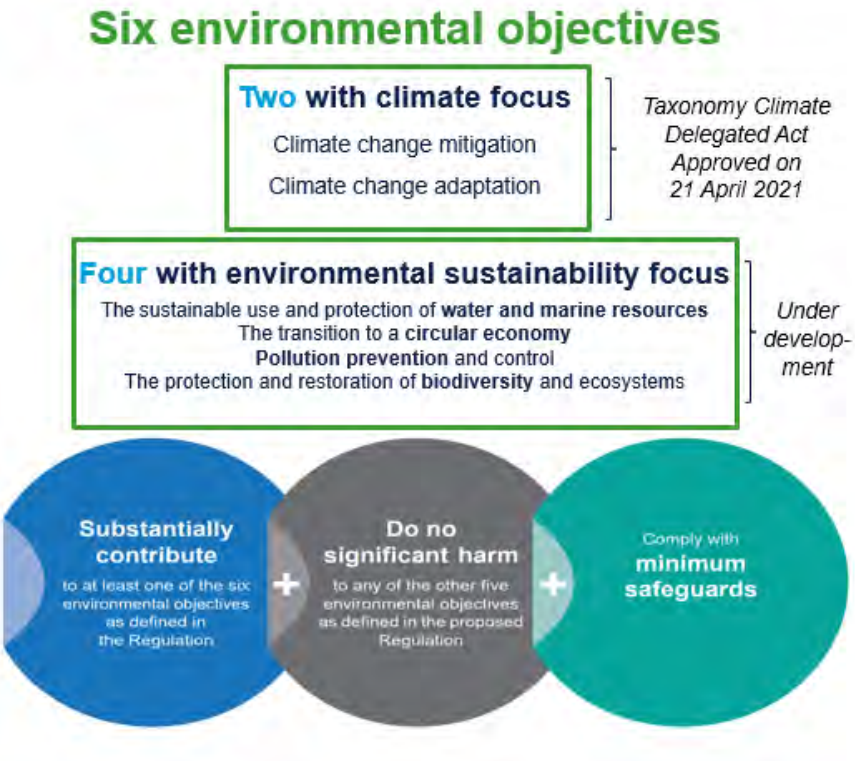
Across Europe, a number of guidelines have been created in the recent years which are specific to wind farm decommissioning. These mainly relate to the German DIN standard [10] and Wind Europe's guidelines. DNV recommends these are consulted and followed [3].

3.2 The EU taxonomy for sustainable activities

The transition to a circular economy is one of the European Union's six environmental goals as defined in the EU Taxonomy directive [12]. Circularity in the wind industry has become a topic of interest and an increasing number of stakeholders are questioning what happens at the end of a wind farm's life. In addition, many of the first wind farms constructed in Europe are now reaching the end of their designed life. Many will be repowered although this still involves the dismantling and disposal of the old turbines. In Europe alone, there are more than 34,000 turbines with over15 years that expect to generate 25,000 tonnes of waste per year by 2025, and up to 52,000 tonnes by 2030 [12].

Figure 3-1 below shows the six environmental objectives of the EU taxonomy [11]. From 2022, all large enterprises are required to report on the alignment of their investments with this taxonomy framework. In order to be compliant, it must be shown that the investment substantially contributes to at least one area and does no significant harm in all others. Renewables by definition contribute to climate change mitigation. Through the environmental impact assessment which is commonly prepared during the project development, the "do no significant harm" in all other areas can be proven, with the exception of the transition to a circular economy. Therefore, to be fully aligned it is imperative that end of life solutions are contemplated.

Figure 3-1: The six environmental objectives of the EU taxonomy



3.3 The decommissioning process

A successful partial or full decommissioning of a wind farm requires engagement from a number of parties as stakeholders in the project, namely:

- The owner of the wind farm
- The company that operates the wind farm
- The decommissioning provider
- The waste management company

- The local authorities

Each have their own unique responsibilities which are essential to accomplish the dismantling of the project.

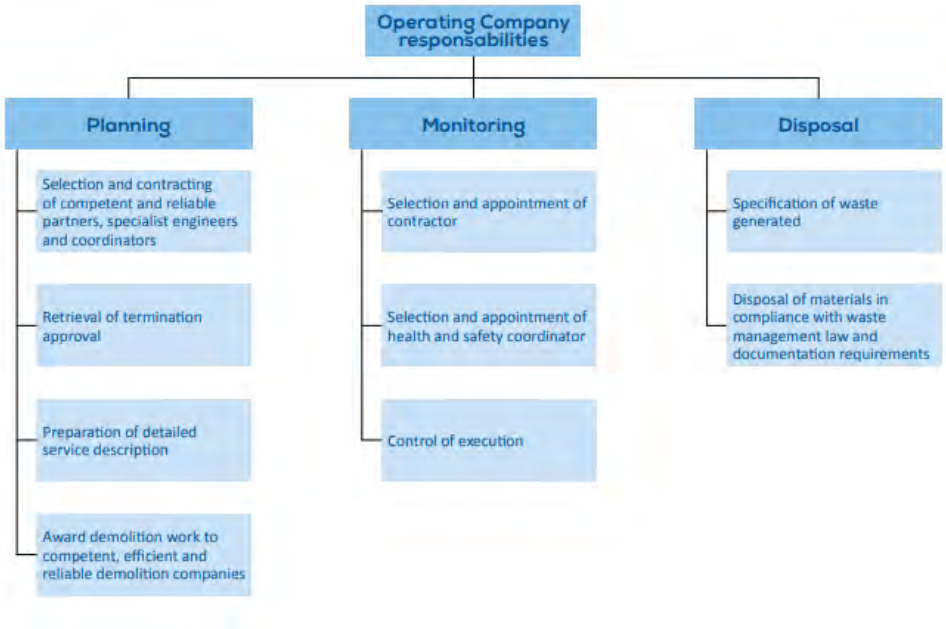
The owner

The owner of the wind farm bears overall liability for the project and is the most exposed to any reputational impact that may arise as a result of the actions of the other parties. The owner is responsible for obtaining the necessary permits and licences but in reality, the majority of the responsibility for the project lies with the operating company.

The operating company

The operating company bears the overall responsibility for the execution of the decommissioning process. In many cases, the operating company may be a subsidiary of the wind farm owner or the wind farm owner itself. In line with Wind Europe's best practice guidelines, the operating company is responsible for the planning, monitoring and disposal of materials during the decommissioning phase. A breakdown of these responsibilities can be seen in Figure 3-2 below.

Figure 3-2: Operating company decommissioning responsibilities [1]



The decommissioning provider

The decommissioning provider must be appointed by the wind farm operator as their contractor for the execution of the dismantling procedure. This may be done through a tender process similar to the turbine supply. The dismantling company is responsible for checking removal instructions on the construction site, fulfilling health and safety regulations, compliance verification with prescribed measures, supervision, coordination and control of proper execution. At the dismantling site, extensive waste categorisation should be in place in order to ensure the highest possible recycling quality of the respective categories, and to prevent pollutants accumulation in the material cycle. In accordance with the tender for the dismantling process, the decommissioning provider will implement the agreed turbine removal methodology which mainly consists using cranes, felling, or controlled explosions. .

Recently, DNV has observed a growth in the number of EPC (Engineering, Procurement, Construction) contract style offered for the decommissioning services. To reduce time and effort during the decommissioning planning process, DNV presents a list of the known active companies in Appendix C to this report.

The waste management company

The waste management company is responsible for the disposal of materials, waste disposal logistics, compliance with requirements to complete removal, and issuance of disposal proof. The waste management company and the decommissioning provider are usually partnered companies and should be appropriately monitored by the wind farm operating company.

The local authority

The local authority role is to supervise and check that the public-law provisions of the decommissioning measures have been accomplished. Authorities may require the former operating company to submit appropriate documents to prove that the waste was disposed of properly.

4 EXISTING ALTERNATIVES TO LANDFILL

Given the current outlook on the number of wind turbines that are expected to be decommissioned in the coming years, there has been an acceleration in the number of companies, industry groups, academic initiatives and projects aiming to improve circularity and sustainability in the wind industry. Nevertheless, many of these technologies are not yet at a Technology Readiness Level (TRL) where they could manage the volume of waste expected. Those having a suitable TRL are often too expensive to yet be commercially viable options. The European Union ranks TRL on a scale of 1 to 9 based on the following definitions:

- TRL 1 – basic principles observed
- TRL 2 – technology concept formulated
- TRL 3 – experimental proof of concept
- TRL 4 – technology validated in lab
- TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 7 – system prototype demonstration in operational environment
- TRL 8 – system complete and qualified
- TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies)

Most innovations in this space are in relation to the recycling of blades as these are the single largest obstacle to the achievement of full circularity in the wind industry. There are also a number of other ongoing initiatives relating to circularity such as the processing of rare earth metals found in turbines.

DNV has presented a list of sample initiatives that are ongoing in the wind industry, along with a short description of the project and a link to the website. For each initiative, and if applicable, DNV has assessed the expected TRL based on the published progress to date.

4.1 Re-use and re-sale

DNV has observed a growth in the demand from the industry to reuse/resale major components and even complete turbines once these are decommissioned. The main platforms being used have been listed in the table below.

Table 4-1: Second hand market platforms

Name	Link
BayWa r.e. (Germany)	https://www.baywa-re.de/en/wind/additional-topics/pre-owned-wind-turbines
Dutchwind (Netherlands)	https://dutchwind.com/
Gutinvest (Spain)	https://www.gutinvest.es/es/pagina/servicios
Hitwind (UK)	https://www.hitwind.com/
MKWind (Poland)	https://en.mkwind.pl/

MWPS (UK)	https://www.mwps.world/
Recircular (Spain)	https://recircular.net/
Renewable Parts Ltd	https://www.renewable-parts.com/services/turbines
Repowering (Spain)	https://repoweringsolutions.com/english/products/used_wind_turbine/index.htm
RES-ELITE (Germany)	https://en.reselite.de/
wind-turbine.com (Germany)	https://windturbines-marketplace.com/

4.2 Refurbishment

To help the increasing reuse and resale demand, DNV has also identified a number of options that reinsert decommissioned refurbished components and turbines in to the market.

Table 4-2: Existing refurbishment initiatives

Company	Description of service	Link
Renewable Parts (UK)	Focusing on circular economy best practices, Renewable Parts is a supply chain and refurbishment specialist formed in with a philosophy of continuous improvement, with an innovation centre located in Lochgilphead (UK). It applies the latest techniques to restore unserviceable parts to their original "as new" condition and helps customers reduce their carbon footprint and become greener businesses. Its R&D underpins that all refurbished or remanufactured components meet or exceed performance levels by those attained from new, and carry a full warranty.	https://www.renewable-parts.com/services/refurbishment
BayWa r.e. (Germany)	Option for nacelle and rotor blade reconditioning at their plan in Basdahl (Germany) according to DNV guideline specifications.	https://www.baywa-re.de/en/wind/additional-topics/pre-owned-wind-turbines#our-services
GIRA Wind (Spain)	The objective is to refurbish and give value to the largest volume of equipment, components, materials and complete turbines for its subsequent marketing. Among other processes, the recovery of fiberglass from blades, hub covers and hoods will be carried out to reincorporate this material into the market. Plant to be operational by 2025.	https://www.naturgy.com/sala_de_prensa/notas_de_prensa/2s2022/naturgy_y_ruralia_crean_la_primera_empresa_espanola_para__el_reciclaje_integral_de_parques_eolicos

4.3 Blades

The following companies, projects and initiatives are aiming to improve or help with the recyclability of the existing fleet of wind turbine blades.

Table 4-1: Existing blade pre-processing initiatives

Company	Description of service	TRL	Link
HJHansen Recycling (Denmark)	HJHansen Recycling pre-processes the blades through cutting to ensure it is possible to transport them to recycling facilities in an economically viable way.	9	https://www.hjhansen.dk/windde com/
Veolia (US)	Our Repurposed Engineered Material (REM) solutions begin with profiling, assessing, and certifying the material. The wind turbine blades are shredded, contaminants are removed, and are blended to create an engineered product ready for transport to cement and lime plants where it is utilized as a raw material substitute to replace fossil fuels that power the manufacturing process. REM from wind generation contains biogenic carbon which burns cleaner than coal and thereby, reduces greenhouse gas emissions.	9	https://info.veolianorthamerica.com/repurposed-engineered-material-brochure

Table 4-3: Existing blade recycling alternatives

Company	Description of service	TRL	Link
Geocycle (Switzerland)	The process consists of 100% recovery of energy from blades in cement co-processing.	9	Waste management for a better world (geocycle.com)
Global Fibreglass Solutions (US)	A patented process to recycle fibreglass and turn it into raw material for multiple products that they manufacture such as EcoPoly Pellets (EP Pellets) which are used in a wide variety of applications in the production of plastics and injection moulds.	9	Fiberglass Recycling | Global Fiberglass Solutions (globalfiberglassinc.com)
GP Reblade (Poland, France, Germany, Brazil)	Different options provided for recycling blades such as geotechnical blocks to strengthen slopes, wharfs and port entrances; OSB & chipboards; and small architecture for public and office spaces such as educational parks, bridges or furniture.	9	https://gp-renewables.energy/gp-reblade/
NeoComp (Germany)	The company offers a 100% recovery guarantee where the fibreglass waste becomes a high-quality substitute fuel and recycled fibres. The	9	neocomp GmbH

Company	Description of service	TRL	Link
	solution is implemented in the cement industry for supplying both energy and raw materials		
Neowa (Germany)	In the sector since 2015 with an innovative recycling process that processes GRP waste into a high-quality substitute for the cement industry where no residue is left. Besides, this recycling process guarantees a 100 percent use of GRP waste.	9	https://www.fibreglass-recycling.eu/england-1/
Bcircular (Spain)	Spin-off of the Spanish National Research Council (CSIC), aiming to recycle wind turbine blades, and other composites. The process is an energy-efficient, closed process obtaining reusable glass and carbon fibres.	7	BCIRCULAR - Allows applying circular economy
Composite Recycling (Switzerland)	A proprietary pyrolysis technology and process that reclaims the fibres in a way that preserves them largely intact, maintaining most of their structural and functional properties and therefore, their reusability.	7	Composite Recycling | Composite Recycling (composite-recycling.ch)
Reciclalia (Spain)	Composite recycling system with the use of by-products, eliminating almost 100% of the resin present in the materials. Also provides a mobile system for chopping wind turbine blades and other large pieces.	7	Reciclalia Composite
Gjenkraft (Norway)	The company is to provide composite waste recycling services and later sales of the recovered raw materials. The technology is based on a variation of the pyrolysis process which enables the recovery of glass and carbon fibres, synthetic fuels and carbon from the waste.	6	https://www.gjenkraft.com/
TEC Production & Services GmbH (Germany, Austria)	TEC Production, a cement production company with an envisioned mechanical grinding and centrifuge system. The goal is to create clean, long strand fibres that can be reused as virgin material in composite production.	5	Home - A TEC - Innovative Technologies for Tailor-made Solutions (atec) (atec-ltd.com)
Blades2Build (Spain)	Consortium led by PreZero and Endesa, with other important companies such as GE, LM Wind Power and Reciclaclia. The aim is to recycle over 6k tonnes per annum of glass and carbon fibres but to also try to reuse and reincorporate the fibres into other sectors. The recovered fiberglass can be used, among other applications, in sectors such as the automotive,	Unknown	https://www.endesa.com/es/prensa/sala-de-prensa/noticias/informacion-economica/endesa-y-prezero-recibe-reconocimiento-union-europea-por-planta-de-palas-eolicas

Company	Description of service	TRL	Link
	construction or ceramics, thus creating a circular economy in the Spanish wind business. The facility will be operational by 2024.		
EnergyLoop (Spain)	Aims to respond to the challenges of the wind energy industry by promoting the circular economy through the recovery of wind turbine blade components and reuse in sectors such as energy, aerospace, automobile, textile, chemical or construction.	Unknown	https://energyloop.info/
FLSmidth	FLSmidth investigates the possibilities of using shredded blade material and ashes from the pyrolysis process in the cement production process on a global scale.	Unknown	https://www.flsmidth.com/en-gb/company/sustainability
Makeen Power (Denmark)	Plant to break down materials in wind turbine blades by exposing them to extreme heat through pyrolysis.	Unknown	http://www.makeenpower.com/home/news/decomblades/

4.4 Rare earth metals

Rare earth materials are mainly found in direct drive turbines, although are also present in smaller quantities in turbines with gearboxes. Special consideration in the decommissioning process should be given to these materials and so several initiatives have been listed to improve the circularity in this space.

Table 4-4: Rare earth material recycling initiatives

Name	Description of service	TRL	Link
Solvay (France)	A mining and raw material company which also creates and recycles rare earth materials.	9	Rare earths | Solvay
REE4EU (EU)	Developed, validated and demonstrated in 2 industrially relevant pilots, an innovative Rare Earth Alloys (REA) production route from permanent magnets (PM) and Ni Metal Hydride (NiMH) battery waste.	4	REE4EU
EIT Raw Materials (EU)	An initiative supported by the European Union focused on improving production of raw materials in the EU, and processing of recycled rare earth materials without exporting to China.	N/A	EIT RawMaterials

A list of other decommissioning initiatives focused on improving the circularity of the wind industry is shown in Appendix D to this report.

5 RECOMMENDED ACTIONS

As a stakeholder in a wind farm, there are a number of actions that can be taken through the life of a project to ensure that waste and circularity are efficiently managed at the end of a project's life. By taking these simple actions, the overall sustainability and environmental impact of the project can be improved. A list of recommended actions is presented below, broken down into different measures that can be taken at the start of a project's life, during operation, and at the end of life.

5.1 Before commissioning

The following list of recommended actions can be taken prior to construction and completion of the wind farm.

Table 5-1: Recommended actions to improve circularity pre-COD

Recommended action	Impact/Benefit
Request turbine material composition and weights from manufacturer (OEM) during the tendering process.	Facilitates enhanced estimation of decommissioning costs and ensures relevant data is available for designing the decommissioning process.
Include requirement for a suitable level of recyclability or use of recycled materials in turbine supply contracts.	Ensures the most recyclable product is procured and creates transparency.
Include a decommissioning cost estimate in the project financial model.	Ensures sufficient funds are available for decommissioning and recycling components.
Assess alignment of new projects with the EU Taxonomy Directive*.	The Taxonomy Framework is a useful tool for ensuring the project is contributing to climate action goals.
Report on scope 3 emissions to the Carbon Disclosure Project (CDP) or similar initiative*.	Places pressure to reduce emissions and improve circularity throughout the entire supply chain.

*These actions should be taken throughout the life of the project and for all the projects and investments made by the organisation.

5.2 During operation

The following actions should be taken throughout the operational life of the project to maximise efficiency during decommissioning.

Table 5-2: Recommended actions to improve circularity during operations

Recommended action	Impact/Benefit
The planned operational life should be evaluated at regular intervals throughout its performance, considering the individual components and varying factors such as support schemes.	To know when to expect decommissioning, it is essential to understand how long the project will last. Any potential life extensions and planned component exchanges can be arranged.
Design the end of life strategy and decommissioning plan as early as possible, having at least 5 years margin.	Efficient decommissioning procedures can be established, recycling facilities and decommissioning partners can be identified, project management time can be minimised.

Maximising the component life through proactive preventive maintenance while minimising the number of components used.	The best way to minimise the waste impact is to avoid the need for disposal.

5.3 At end of life

The following actions can be taken while organising the decommissioning process at the end of life and also during the decommissioning process itself.

Table 5-3: Recommended actions to improve circularity at end of life

Recommended action	Impact/Benefit
Engage the manufacturer (OEM) to establish if there is potential for resale or second life utilisation of any major components.	The sale on second hand markets can offset decommissioning costs and reduce the number of new parts manufactured for other sites. This is a more sustainable solution than recycling and sits higher in the waste hierarchy as discussed in Section 3.2.
Choose a reputable decommissioning provider who commits to compliance with WindEurope and other best practices when decommissioning.	Goal of decommissioning should not be to achieve a least cost solution but to minimise environmental impact and this should be considered in the tendering process.
Impose a traceability requirement in decommissioning contracts.	Ensures components are recycled as required and relevant waste regulations are complied. Also prevents negative reputational damage due to poor handling of materials.
Aim to process materials locally.	Decreases emissions due to transporting components and can improve the local economy and perception of wind farms.
Adopt new and innovative recycling methods for components such as blades and rare earth metals.	Demonstrator projects facilitate the scaling up of new recycling technologies which benefit the whole industry and also creates positive press for the project and its stakeholders.

Finally, DNV also recommends participation in joint industry projects and working groups that focus on improving sustainability and increasing circularity at the end of life.

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APPENDIX A APPLICABLE WASTE REGULATIONS

Overview of EU Directives and Local Law on decommissioning and waste treatment in the Republic of Ireland

Material	Relevant Legislation	Highlight from legislation	Best Practice	Type of recycling facility
Concrete	EU Directive: EU Waste Framework Directive (2008/98/EC) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008L0098 National law: No specific law on concrete from foundations in the Republic of Ireland, but concrete waste is a waste source in the EU's construction and demolition waste category with code 17 01 01.	EU Directive: At least 70% of the weight of non-hazardous construction and demolition waste (CDW) must be reused or recycled by 2020. EU Waste code: 17 01 01 Republic of Ireland: It is required to dispose concrete waste at a registered waste carrier.	Netherlands, where all lap 3 concrete from renovation or demolition of buildings, roads and other infrastructure must be recycled or reused. https://lap3.nl/sectorplannen/sectorplannen/metalen/	Licensed facility.

Material	Relevant Legislation	Highlight from legislation	Best Practice	Type of recycling facility
Metals	EU Directive: EU Waste Framework Directive (2008/98/EC), article 11 Entire document: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008L0098 Relevant article in English: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32008L0098&from=EN#d1e1203-3-1	EU Directive: Member states shall take measures to promote high-quality recycling and, to this end, shall set up separate collections of waste where technically, environmentally and economically practicable and appropriate to meet the necessary quality standards for the relevant recycling sectors. Republic of Ireland: The Republic of Ireland follows the EU directives.	Netherlands, where the minimal standard for permitting is recycling. https://lap3.nl/sectorplannen/sectorplannen/metalen/	Licensed facility

Material	Relevant Legislation	Highlight from legislation	Best Practice	Type of recycling facility
Composites from blades	No specific EU Directive but the EU pushes on circular economy which is part of the European Green Deal European Strategy for Plastics in a Circular Economy (2018). https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1516265440535&uri=COM:2018:28:FIN EU Circular Economy Action Plan (2020) https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1583933814386&uri=COM:2020:98:FIN	Composite blade waste is most often categorised as plastic waste from construction and demolition with the code 17 02 03. The EU strives to circularity with the EU Circular Economy Action plan (2020) and European Strategy for Plastics in a Circular Economy (2018).	Germany, Austria, Netherlands, Sweden and Finland have banned composites from being landfilled or incinerated.	Licensed facility
Rare earth metals	-	Rare earth metals are listed as non-hazardous in the EU Waste Framework Directive (2008/98/EC). Therefore, no special European or national law is in place.	-	-

Material	Relevant Legislation	Highlight from legislation	Best Practice	Type of recycling facility
Electric cables	EU Directive EU Waste Framework Directive (2008/98/EC) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008L0098 WEEE Directive 2012/19/EU https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32012L0019 National law S.I. No. 149/2014 – European Union (Waste Electrical and Electronic Equipment) Regulations 2014 https://www.irishstatutebook.ie/eli/2014/si/149/made/en/print	External electric cables have to be removed from any separaPhoney collected WEEE and be disposed of or recovered in compliance with the Waste Frame Work Directive (2008/98/EC) Republic of Ireland: The Republic of Ireland has implemented the EU directive.	-	Licensed facility

Material	Relevant Legislation	Highlight from legislation	Best Practice	Type of recycling facility
Oils	EU Directive EU Waste Framework Directive (2008/98/EC) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008L0098 National law S.I. No. 399/1992 – The European Communities (Waste Oils) Regulations, 1992 S.I. No. 399/1992 - The European Communities (Waste Oils) Regulations, 1992. (irishstatutebook.ie)	Waste oils must be collected separaPhoney (when this is technically feasible) and treated per the waste hierarchy. Furthermore, no harm should be done during the process to human health and the environment. Moreover, waste oils of different characteristics should not be mixed to simplify treatment. Republic of Ireland: The Republic of Ireland follows the European Directives	-	Licensed facility

Material	Relevant Legislation	Highlight from legislation	Best Practice	Type of recycling facility
Site restoration	EU Directive: Site restoration is not included in the EU Directive. It is handled by local law. National law: Part of planning conditions and permitting. So this can differ for each project.	The consenting authority can include requirements for restoration of land to an acceptable condition as part of the planning approval process. But this depends on the consenting authority. Republic of Ireland: On full or partial decommissioning of the wind turbine, or if it ceases operation for more than a year, the turbine shall be removed and ground reinstated within 3 months.	France and Germany. In France the current legal framework will require total excavation of foundations at the end of life except if an environmental impact assessment recommends not to do it. In Germany, the operator has to issue a declaration of commitment to dismantle the installation and remove all soil sealing when permanently abandoning the site.	-

European Waste Codes for turbine components

Component	EU waste code
Tower	Steel: 17 04 05 Concrete: 17 01 01
Nacelle and components	Steel/ferrous materials: 17 04 05 Plastics/ plastic-composite materials: 17 02 03 Mixed materials: 17 09 04
Hazardous liquids	Oils: 13 01 10*, 13 02 04*, 13 02 05*, 13 02 08*, 13 08 01 Others: 13 01 10* Insulating and heat transfer oils: 13 03 07*, 13 03 08*, 13 03 10*
Generator/transformers	16 02 14, 16 02 13*
Batteries	16 06 01* (lead), 16 06 02* (NiCd), 16 06 03* (mercury), 16 06 04 (alkali), 16 06 05 (other)
Gearbox	17 04 05 / 17 04 07
Spinner/hub	Steel/ferrous metals: 17 04 05 Plastics/plastic-composite materials: 17 02 03 Mixed materials: 17 09 04
Rotor blades	17 02 03, 17 09 04, 10 11 03
Cables in tower	17 04 11
Switchgears, transformer, other electrotechnical components	16 02 14, 16 02 13*

Foundation/ concrete fraction	17 01 01
Foundation/reinforcement steel	17 04 05/19 12 02
Routes/crane platforms	17 01 07

*As hazardous waste classified waste fractions.

APPENDIX B WASTE DISPOSAL FACILITIES

Overview of Licensed Waste Carriers/ Recycling facilities in the Republic of Ireland

Name of facility	Location	Capability	Link / Contact information
Irish Waste	HQ: The Sweepstakes Ballbridge Dublin 4 Yard: Irish Waste Services 116 Duncrue Street Belfast BT3 9AR	WEEE, Contaminated soil, oil spillage clean up, oil collection, Recycling and total waste management	https://www.irishwaste.net/ Phone: +353 (1) 664 1798
Recycled Aggregates Ireland: Skips R Us Ltd	Office 1: Skips R Us (Ireland) Ltd Third Floor Elgee Building Market Square Dundalk Louth A91 YR9X Office 2: Skips R Us (Ireland) Ltd Coliemore House Coliemore Road Dalkey Co. Dublin	Disposal of broken concrete including EWC 17 01 01 to a licensed facility	https://www.skipsrus.com/ Email: info@skipsrus.com Phone: +353 (0) 42961 1235
Fitzpatrick Recycling	Peter Fitzpatrick Ltd. Leod Quarries Leode Hilltown Newry Northern Ireland BT34 5TJ	Recycling of construction waste in a quarry facility. Construction waste includes concrete	https://www.pfitzpatrick.com/ Email: info@pfitzpatrick.com Phone: +44 (0) 28 4063 0690

Name of facility	Location	Capability	Link / Contact information
Clearway Metal Recycling	HQ: 41 Dobbin Road Portadown Co. Armagh BT62 4EY Dublin Office: Pigeon House Road Ringsend Co. Dublin Dublin 4	Purchases and transports scrap metal. Includes Ferrous and Non-Ferrous metals	https://clearway-group.co.uk/ Phone: +353 (0) 1667 5335
KMK Metals Recycling Ltd.	Cappincur Industrial Estate Daingean Road Tullamore Offaly R35 NY29	Collection of WEEE and metals (ferrous, non-ferrous and rare earth) for recycling	https://www.kmk.ie Email: info@kmk.ie Phone: +353 (0) 5793 41634
Wilton Recycling	Kiffa Crosserlough Ballyjamesduff Co. Cavan Ireland A82 F4W2	Collection of WEEE and metals (ferrous and non-ferrous) for recycling	https://www.wilton-recycling.ie/ Email: info@wilton-recycling.com Phone: +353 (0) 49437 4825
Oran Metal Group	Limerick: Limerick Metal Recycling Company Ltd Ballysimon Road Limerick Galway: Galway Metal Company Ltd Oranmore Business Park Oranmore Co Galway Laois: A1 Metals Recycling Ltd Acragar Mountmellick Co Laois	Collection of ferrous and non-ferrous metals for recycling	http://www.oranmetalgroup.com/ Email: info@oranmetal.ie Phone: 1800 110 220, +353 (0) 9179 4358

Name of facility	Location	Capability	Link / Contact information
Enva	HQ: Clominam Industrial Estate Portlaoise Co. Laois R32 XD95	Disposal of concrete & construction material; contaminated soil and land remediation; Oil waste recycling; Metal recycling including ferrous and non-ferrous; WEEE. In addition, they handle Hazardous Waste	https://enva.com/ Phone: +353 (0) 57867 8600, 1800 504 504
ACW	Ardinagh Construction Waste Ardinagh Taghmon Co. Wexford	Collection and disposal of construction waste including metals and concrete	http://www.constructionwaste.ie Email: Infor@constructionwaste.ie Phone: +353 (0) 86838 2196
Total Waste Management	Total Waste Management Fassaroe Bray Co Wicklow	Total waste management services including non-hazardous and hazardous materials and contaminated soils	https://www.twm.ie Email: Hazardous.Waste@greenstar.ie Phone: +353 (0) 1274 6224
AES/Bord na Móna	Silliot Hill Recycling Centre & Civic Amenity Silliot Hill, Kilcullen, Co.Kildare.	Scrap Metal, Waste Oil, Bulky Waste, Polystyrene. Custom-built centre where householders can bring a wide range of materials for recycling or disposal where necessary	https://www.bnmrecycling.ie/civic-amenities/silliot-hill-recycling-centre-civic-amenity/ Phone: 045 913080
AES/Bord na Móna	Athy Recycling Centre Gallows Hill, Athy, Co. Kildare	Scrap Metal, Waste Oil, Bulky Waste, Polystyrene	https://www.bnmrecycling.ie/civic-amenities/athy-recycling-centre/ Phone: 059 8640657
AES/Bord na Móna	Portarlington Civic Amenity Lea Road, Portarlington, Co. Laois	Metal, electrical items -Large & small, polystyrene	https://www.bnmrecycling.ie/civic-amenities/portarlington-civic-amenity/
AES/Bord na Móna	Nenagh Civic Amenity Springfort Cross, Nenagh, Co. Tipperary	Electrical, commercial recycling. Waste transfer station licensed to accept and process up to 24,750	https://www.bnmrecycling.ie/civic-amenities/nenagh-civic-amenity/

Name of facility	Location	Capability	Link / Contact information
		tonne per annum of household, commercial & industrial, and construction & demolition waste	Phone: 059 8640657
AES/Bord na Móna	AES Portlaoise / Bord na Móna Recycling Portlaoise Kyletalesha, Co. Laois	Waste transfer station licensed to accept and process for recovery up to 40,000 tonnes per annum of household, commercial & industrial, construction & demolition waste, as well as timber shredding	https://www.bnmrecycling.ie/business/our-business/areas-of-operation/ Phone: 0578662268
AES/Bord na Móna	Bord na Móna Recycling Tullamore/ Aes Ireland Limited Spollanstown Industrial Estate, Tullamore, Co. Offaly	Waste transfer station licensed to accept and process up to 60,000 tonnes per annum of household, commercial & industrial, and construction & demolition waste	https://www.bnmrecycling.ie/business/our-business/areas-of-operation/ Phone: 057 9321755
AES/Bord na Móna	Bord na Móna Recycling Navan/ AES Navan Address: Clonmagadden, Proudstown Road, Navan, Co. Meath	Waste transfer station licensed to accept and process up to 95,000 tonne per annum of commercial & industrial, construction & demolition waste, as well as timber shredding	https://www.bnmrecycling.ie/ Phone: 046 9022222
AES/Bord na Móna	Bord na Móna Recycling Lusk/ AES Lusk Address: Coldwinters, Blakescross, Lusk, Co. Dublin	Bord na Móna Recycling recently acquired this waste transfer station, which is licensed to accept and process up to 95,000 tonnes per annum of household, commercial & industrial, and construction & demolition waste	https://www.bnmrecycling.ie/ Phone: 01 5331860
AES/Bord na Móna	Bord na Móna Recycling Rosslare/ AES Rosslare Address: Riscrann, Co. Wexford	Waste transfer station licensed to accept and process up to 23,000 tonnes per annum of household, commercial & industrial, and construction & demolition waste	https://www.bnmrecycling.ie/ Phone: +35345580060

Name of facility	Location	Capability	Link / Contact information
AES/Bord na Móna	Drehid Landfill/Composting/Landfill Gas Facility Address: Killinagh Upper, Carbury, Co. Kildare	This engineered landfill commenced operations in 2008 and is currently licensed to accept 120,000 tonnes per annum of household, commercial & industrial waste	https://www.bnmrecycling.ie/ Phone: +353 45439472
AES/Bord na Móna	Athy Civic Amenity Centre Address: Gallows Hill, Athy, Co.Kildare	Custom-built centre where householders can bring a wide range of materials for recycling or disposal where necessary	https://www.bnmrecycling.ie/ Phone: 059 8640657
Clonmel Waste	Location 1: Ard Gaoithe Business Park, Clonmel. Co. Tipperary E91 HW20 Location 2: Lawlesstown, Clonmel, Co. Tipperary, E91 K526	Metal, Soil & Stone, Timber, Builders/DIY waste, Electrical Items	https://clonmelwaste.ie/ Email: info@clonmelwaste.ie Phone: (052) 6124509
Barna	Barna Recycling Civic Amenity Site, Carrowbrowne Carrowbrowne, Headford Road Co. Galway	Scrap Metal, WEEE, General non-recyclable waste	https://www.barnarecycling.com/wp-content/uploads/2013/10/Carrowbrowne_Amenity_Centre2.pdf Phone :091 771619
Barna	Barna Recycling Tuam Civic Amenity Site Rinkippeen, Co. Galway	Scrap Metal, WEEE, General non-recyclable waste	https://www.barnarecycling.com/wp-content/uploads/2021/12/Barna-Waste-Civic-Amenity-Sites-Tuam-New-Dec-2021.pdf Phone: +3539326438
Barna	Barna Recycling Ballinasloe Civic Amenity Site Beechlawn Heights, Pollboy, Ballinasloe, Co. Galway	Scrap Metal, WEEE, General non-recyclable waste	https://www.barnarecycling.com/wp-content/uploads/2021/12/Barna-Waste-Civic-Amenity-Sites-Ballinasloe-New-Dec-2021.pdf

Name of facility	Location	Capability	Link / Contact information
			Phone: 091 771619
Barna	Barna Recycling Civic Amenity Site, Tubbercurry Connolly Park, Tobercurry, Co. Sligo	WEEE	https://www.barnarecycling.com/wp-content/uploads/2020/12/Tubbercurry-Amenity-Centre-2020.pdf Phone: 071 9186869
Barna	Barna Recycling Golden Island Athlone Golden Island, Golden Island (Kilmaine), Athlone, Co. Westmeath	Aluminum and steel, WEEE, Scrap metal, Polystyrene	https://www.barnarecycling.com/wp-content/uploads/2017/06/Golden-Island-Athlone.pdf Phone: 090 6477397
Dillon Waste	Dillon Waste Spa Rd, Knockanacuig, Tralee, Co. Kerry	Scrap Metal, Rubble, Batteries.	https://www.dillonrecycling.ie/page/civic-amenity
Dillon Waste	Monavalley Industrial Estate, Tralee, Co. Kerry, V92 PCA2	Scrap Metal, Rubble, Batteries.	https://www.dillonrecycling.ie/page/civic-amenity
Panda / Greenstar	HQ: Ballymount Rd Upper, Ballymount, Dublin		https://www.panda.ie/ Phone: +353 1 829 8992
Panda / Greenstar	Ballymount Civic Amenity Ballymount Ave, Greenhills, Dublin 24	WEEE, Scrap Metal	https://www.sdcc.ie/en/services/environment/recycling-and-waste/recycling-centres/ Phone: +353 01 829 8992
Panda / Greenstar	North Strand Recycling Centre North Strand, Dublin 1	WEEE, Scrap Metal	https://www.dublincity.ie/residential/environment/waste-and-recycling/recycling-information/bring-centres-dublin-city-council Phone: +35318364716
Panda / Greenstar	Greenstar, Ringsend Recycling Centre Ringsend, Pigeon House Rd, Dublin 4	WEEE, Steel	https://www.dublincity.ie/sites/default/files/2021-09/ringsend-info-leaflet-sept-2021-.pdf Phone:+353 16144750

Name of facility	Location	Capability	Link / Contact information
Panda / Greenstar	Kilmallock Civic Amenity Centre Shannon Developments Ind. Estate, Bruree Road, Limerick	WEEE, Scrap Metal	https://www.limerickrecyclingcentres.ie/materials-accepted Phone:+353 6398836
Panda / Greenstar	Mungret Civic Amenity Centre Bunlicky, Mungret, Limerick	Concrete, Scrap metal, WEE, All Batteries, hard plastics, Polystyrene, engine oils	https://www.limerickrecyclingcentres.ie/materials-accepted Phone: +35361305720
Killarney Waste	KWD Recycling, Aughacureen, Killarney, Co. Kerry	Scrap Metal, construction waste	https://kwd.ie/ Email: info@kwd.ie Phone: 0818 37 37 37
Patrick Logan & Sons	Castleforward, Newtowncunningham, Co. Donegal	Construction waste	https://www.loganwaste.com/ Email: info@loganwaste.com Phone: 074 9108111
Mulleadys	Mulleady's Ltd. Cloonaugh, Drumlish, Co. Longford, N39 E4F4	Mixed site Waste, Rubble, Soil, Plastic	https://mulleadys.com/waste_consultancy.html Email: info@mulleadys.com Phone: (043)3324128
Mulleadys	Mulleadys Ltd. Cloonaugh, Drumlish Co. Longford, N39 E4F4	Mixed site Waste, Rubble, Soil, Plastic	https://mulleadys.com/civic_amenity.html https://mulleadys.com/waste_consultancy.html Phone: (043) 3324128
Mulleadys	Mulleady Ltd. Mullingar Civic Amenity Unit 16/17 Mullingar Business Park, N91 HE2F	Mixed site Waste, Rubble, Soil, Plastic	https://mulleadys.com/civic_amenity.html https://mulleadys.com/waste_consultancy.html Phone: (044) 934 7177
McElvaney Waste	McElvaney's Waste & Recycling Scotch Corner Recycling Centre, Letterbane, Annyalla, Castleblayney, Co. Monaghan, A75 P267	Scrap Metal,Polystyrene, Used Engine Oil, Hard Plastic	https://www.mcelvaneywaste.com/household-customers/recycling-centres/centre-

Name of facility	Location	Capability	Link / Contact information
			locations/scotch-corner-recycling-centre.html Phone:+353 429744230
McElvaney Waste	McElvaney's Waste & Recycling - Bailieborough Recycling Centre Shercock Road, Beckscourt, Bailieborough, Co. Cavan, A82 FX64	Scrap Metal , WEE, Polystyrene, Used Engine Oil, Hard Plastic	https://www.mcelvaneywaste.com/household-customers/recycling-centres/centre-locations/bailieborough-recycling-centre.html Phone:+353 429666892
McElvaney Waste	McElvaney's Waste & Recycling - Corranure Recycling Centre Corranure, Co. Cavan, H12 DK61	Scrap Metal, WEEE, Polystyrene, Used Engine Oil, Hard Plastic	https://www.mcelvaneywaste.com/household-customers/recycling-centres/centre-locations/corranure-recycling-centre.html Phone: +353494327658
McElvaney Waste	McElvaney's Waste & Recycling - Carrickmacross Recycling Centre Magheross, Convent Lands, Co. Monaghan, A81 YT50	Scrap Metal, WEEE, Building Rubble (Tiles, Ceramics, Bricks), Polystyrene, Used Engine Oil, Hard Plastic	https://www.mcelvaneywaste.com/household-customers/recycling-centres/centre-locations/carrickmacross-recycling-centre.html Phone: +353429661500
Allied Recycling	Clonmellon Industrial Estate, Clonmellon, Co. Westmeath, C15 HN81	Scrap Metal, Road sweeper, plastic removal.	https://www.alliedrecycling.ie//commercial/#services-we-offer Email: info@alliedrecycling.ie Phone:+353 469433366
Allied Recycling	Allied Recycling Unit 74, Naas Industrial Estate, Naas, W91 T259, Co. Kildare	Scrap Metal, Road sweeper, plastic removal	https://www.alliedrecycling.ie//commercial/#services-we-offer Email: info@alliedrecycling.ie
Oxigen	Mullaghboy Industrial Estate, Athboy Road, Navan, Co.Meath	Scrap Metal, WEEE, Rubble	https://oxigen.ie/company/civic-amenity-sites

Name of facility	Location	Capability	Link / Contact information
			Phone: 046 9293436, 0860200826
Oxigen	Trim Recycling Centre Manorlands Summerhill Road, Trim, Co.Meath	Scrap Metal, WEEE, Rubble	https://oxigen.ie/company/civic-amenity-sites Phone: 046 9293436, 0860200826
Oxigen	Kells Recycling Centre Lloyd Business Park, Cavan Road, Kells, Co.Meath	Scrap Metal, WEEE, Rubble	https://oxigen.ie/company/civic-amenity-sites Phone: 046 9293436, 0860200826
Oxigen	Oxigen Environmental Civic Amenity Site Merrywell Business Park, Ballymount Road Lower, Dublin 12, D12 HY65	Scrap Metal,Polystyrene, Rubble	https://oxigen.ie/company/civic-amenity-sites Phone: 01 426 3126
Oxigen	Derryclure recycling centre Derryclure, Killeigh, Co. Offaly, R35 FT53	Scrap Metal, WEEE, Rubble	https://oxigen.ie/company/civic-amenity-sites Phone: 057 9344893
Oxigen	Edenderry recycling centre Dublin Rd, Edenderry, Co. Offaly	WEEE	https://oxigen.ie/company/civic-amenity-sites
Oxigen	Birr recycling centre Syngefield Industrial Estate, Kinitty Road, Birr, Co. Offaly..	Scrap Metal, WEEE	https://oxigen.ie/company/civic-amenity-sites Phone: 057 9125905.
Bourke Waste	Clogher, Westport, Co. Mayo	Scrap Metal, WEEE	https://bourkewaste.ie/our-services/ Phone: +3539826882
Thorntons	Thorntons Recycling, Unit S3B Henry Road, Parkwest Business Park, Dublin 12, D12 AC2X	Construction waste	https://www.thorntons-recycling.ie/commercial Email: info@thorntons-recycling.ie Phone:(01) 623 5133
Wilton Waste	Kiffa, Crosserlough, Ballyjamesduff, Co. Cavan, A82 F4W2	Ferrous and non-ferrous metals recycle, plastic recycle	https://www.wilton-recycling.ie/

Name of facility	Location	Capability	Link / Contact information
			Email: info@wilton-recycling.com Phone: 049 437 4825
DM Waste	Address:Labbadish Manorcunningham, Letterkenny, Co. Donegal	Metals Construction material	https://www.dmwaste.com/page/skips Email: info@dmwaste.com Phone:353749157189
AWD Group	AWD Group, Glanbia House, Arklow Road, Inch, Co Wexford	Construction waste, plastic	https://www.awdgroup.ie/business?id=92 Phone: 0402 36161
New Line Recycling Centre	New Line Tandragee Rd, Lurgan, BT66 8QS	Scrap metal, engine oil, WEEE	https://www.armaghbanbridgecraigavon.gov.uk/resident/recycling-centres/
Craigavon Borough Council Civic Amenity Site	Duke St Portadown, Craigavon, BT62 3EX	Scrap metal, engine oil, WEEE	https://www.armaghbanbridgecraigavon.gov.uk/resident/recycling-centres/ Phone:+442838350629
Banbridge Recycling Centre	Scarva Road, Banbridge, BT32 3QD	Scrap metal, engine oil, WEEE	https://www.armaghbanbridgecraigavon.gov.uk/resident/recycling-centres/ Phone:+443000300900
Dromore Amenity Site	Mossvale Road, Dromore, BT25 1DG	Scrap metal, engine oil, WEEE	https://www.armaghbanbridgecraigavon.gov.uk/resident/recycling-centres/ Phone:+442892698022
Rathfriland Amenity Site	Iveagh Park Road, Rathfriland, BT34 5DZ	Scrap metal, engine oil, WEEE	https://www.armaghbanbridgecraigavon.gov.uk/resident/recycling-centres/ Phone:+442840631075
Armagh Recycling Centre	Station Road, Armagh, BT61 7NP	Scrap metal, engine oil, WEEE	https://www.armaghbanbridgecraigavon.gov.uk/resident/recycling-centres/ Phone: +442837510245

Name of facility	Location	Capability	Link / Contact information
Keady Recycling Centre	Keady Business Centre, Annavale Road, Keady, BT60 2RP	Scrap metal, engine oil, WEEE	https://www.armaghbanbridgecraigavon.gov.uk/resident/recycling-centres/ Phone: +442837539131
Market Hill Recycling Centre	Markethill Business Centre, Fairgreen Road, Markethill, BT60 1PW	Scrap metal, engine oil, WEEE	https://www.armaghbanbridgecraigavon.gov.uk/resident/recycling-centres/
Carryduff Household Recycling Centre	8 Comber Road, Co Down BT8 8AN	Scrap metal, Rubble, Non-recyclable plastics, engine oil, WEEE	https://www.lisburncastlereagh.gov.uk/resident/bins-and-recycling/recycling-locations Phone: +442892509453
Drumlough Household Recycling Centre	Dromara Road, Hillsborough, Co Down BT26 6QA	Scrap metal, Rubble, Hard plastics, engine oil, WEEE	https://www.lisburncastlereagh.gov.uk/resident/bins-and-recycling/recycling-locations Phone: +442892509453
The Cutts Household Recycling Centre	Derriaghy, Co Antrim BT17 9HN	Scrap metal, Rubble, Hard plastics, engine oil, WEEE	https://www.lisburncastlereagh.gov.uk/resident/bins-and-recycling/recycling-locations
Glendermott Road Recycling Centre	37 Glendermott Road, BT47 6BG	Scrap metal, Rubble, Hard plastics, engine oil, WEEE. No access for trailers at this site.	https://recycling.derrystrabane.com/recycling-centres/what-we-accept/ Phone: +442871376590
Pennyburn Recycling Centre	7 Pennyburn Ind Estate, BT48 0LU.	Scrap metal, Rubble, Hard plastics, engine oil, WEEE	https://recycling.derrystrabane.com/recycling-centres/what-we-accept/ Phone: 02871376600
Strahans Road Recycling Centre	Strahans Rd, Strabane, BT82 9SG.	Scrap metal, Rubble, Hard plastics, engine oil, WEEE	https://recycling.derrystrabane.com/recycling-centres/what-we-accept/ Phone:+442871253253
Strathfoyle Recycling Centre	Temple Road, BT47 6TW.	Scrap metal, Rubble, Hard plastics, engine oil, WEEE	https://recycling.derrystrabane.com/recycling-centres/what-we-accept/ Phone: 02871863303

Name of facility	Location	Capability	Link / Contact information
Claudy Recycling Centre	Learmount Road, BT47 4AQ	Scrap metal, Rubble, Hard plastics, engine oil, WEEE	https://recycling.derrystrabane.com/recycling-centres/what-we-accept/ Phone: 02871338054
Donemana Recycling Centre	226 Berryhill Rd, Donemana, Strabane, BT82 0NB	Scrap metal, Rubble, Hard plastics, engine oil, WEEE	https://recycling.derrystrabane.com/recycling-centres/what-we-accept/
Newtownstewart Recycling Centre	Douglas Rd, Newtownstewart, Omagh, BT78 4NE	Scrap metal, Rubble, Hard plastics, engine oil, WEEE	https://recycling.derrystrabane.com/recycling-centres/what-we-accept/
Park Recycling Centre	Learmount Road, Derry, BT47 4AL	Scrap metal, Rubble, Hard plastics, engine oil, WEEE	https://recycling.derrystrabane.com/recycling-centres/what-we-accept/ Phone: +442877780062
Plumbridge Recycling Centre	37 Ligford Rd, Omagh, BT79 8DL	Scrap metal, Rubble, Hard plastics, engine oil, WEEE	https://recycling.derrystrabane.com/recycling-centres/what-we-accept/
RecycoWaste	89 Barony Rd, Omagh, BT79 7QG	Scrap metal, plastic including hard plastics or baled plastic film	https://www.recycowaste.com/
Newpark HRC (Household Recycling Centre)	Orchard Way, Antrim BT41 2RU	Scrap metal, Hardcore and rubble, Used engine oil, WEEE	https://antrimandnewtownabbey.gov.uk/residents/bins-recycling/recycle-centres/newpark-antrim-(1)/ Phone:+442894428107
Bruslee Household Recycling Centre	Belfast Rd, Ballyclare, BT39 9LS, UK	Commercial waste, Scrap metal, Hardcore and rubble, Used engine oil, WEEE	https://antrimandnewtownabbey.gov.uk/residents/bins-recycling/recycle-centres/bruslee/ Phone:+442893352122
Craigmore Household Recycling Centre	Craigmore Rd, Clonkeen Rd, Randalstown, Antrim, BT41 3JL, UK	Scrap metal, Hardcore and rubble, Used engine oil, WEEE, Soil	https://antrimandnewtownabbey.gov.uk/residents/bins-recycling/recycle-centres/randalstown/ Phone: +442894473813

APPENDIX C DECOMMISSIONING PROVIDERS

Overview of EPC style decommissioning providers active in the Republic of Ireland

Company	Location	Capability	Link / Contact information
Antro Group	39 Avenue Joseph Jongen, 1180 Brussels, Belgium	Offer trade of MW class Wind turbines, Turnkey decommissioning services and trade of energy equipment	https://antrogroup.com/ Email: info@antrogroup.com Phone: + 32 487 504 267
Business in Wind	Hanzeweg 45, 3771 NG Barneveld, The Netherlands	Professional solution for dismantling of wind turbines. Offer inspection, purchasing and sales of old turbines, disassembly and transport, warehousing, refurbishment and transport and installation	https://businessinwind.com/ Email: info@businessinwind.com Phone: +31 85 071 82 00
F&B group	OosPhoneijke Industrieweg 54, 8801JW Franeker, Netherlands	Decommissioning, project management, repowering, warehouse, maintenance and buy and sell of old wind turbines	https://www.fenbgroup.nl/en/ Email: info@fenbgroup.nl Phone: +31 517 23 40 03
HJHansen Wind Decom	Havnegade 110, 5000 Odense, Denmark	All-in-one solution for decommissioning and recycling wind projects. The aim is to establish an efficient and sustainable treatment within the circular economy. The business structure enables provide experts from the dismantling process to selling each scrap fraction and recycling.	https://www.hjhansen.dk/winddecom/processen/ Email: info@hjhansen.dk Phone: +45 63 10 91 00
Lezama Demoliciones	Trapaga Elkartegia, Bº Ugarte s/n- MOD 17-21, 48510	Partnered with all the necessary services, Lezama Demoliciones provide turnkey decommissioning services to meet the client's requirements.	https://lezama.es/ Email: info@lezama.es Phone: +34 946 71 31 44

Company	Location	Capability	Link / Contact information
	Bilbao, Spain		
REMO	Not specified on website	Specialists in decommissioning services. The offer services regarding installation and commissioning, inspections maintenance and repairs, decommissioning, main component exchange, manpower, access and blades	https://remoglobal.com/services/decommissioning/ Email: russel.bell@remoglobal.com
WindTurbine	Salomėjos Nėries str. 87-56, LT-06331 Vilnius, Lithuania	Specialized in the installation and dismantling servicing of wind turbines	https://www.windturbine.lt/ Email: buywindturbine@gmail.com Phone: +370 65911707
Windtranz	Ballyronan, Ballyheigue, Tralee, Co. Kerry, V92 AKV4, Republic of Ireland	Windtranz, together with is its industry partner Enva, dismantles, transports & recycles wind farms through the cement kiln process and the energy from waste.	https://www.windtranz.com/ Email: info@windtranz.com Phone: • Ireland: +353 66 7133769, +353 87 2221755 • UK: +44 7551 006 998, +44 7501 775 939

APPENDIX D DECOMMISSIONING INITIATIVES

Ongoing decommissioning initiatives identified

Name	Description of service	Link
Asociación española de demolición, decontaminación, corte y reciclaje (Spain)	The Association was created in order to promote the work within the sector of decommissioning, cutting and waste management, and includes a support platform for such companies.	https://www.aeded.org/
AIRPOXY (Spain)	Introducing a novel family of ground-breaking thermoset composites that preserve all the advantages of the conventional, with the capacity to be easily processed, repaired and even recycled.	https://www.airpoxy.eu/
Carbo4Power (EU)	Development of a new generation of lightweight, high strength, multifunctional, recyclable materials for offshore wind and tidal turbine rotor blades that will increase their operational performance and durability while reducing the cost of energy production.	https://www.carbo4power.net/
CETEC (Denmark)	Circular Economy for Thermosets Epoxy Composites (CETEC) is an led by Vestas and involves both industrial and academic partners that have developed to accelerate the production and commercialisation of their first fully recyclable wind turbine blade.	https://epoxy-europe.eu/spotlight/new-project-to-enable-full-recyclability-of-wind-turbine-blades/
CEWS: Circular Economy for the Wind Sector (UK)	ORE Catapult has established CEWS to investigate new solutions for the bulk recycling of wind turbine blades, and the use of techno-economic analysis to assess suitability of large-scale redeployment and reduce the environmental and ecological impacts.	https://ore.catapult.org.uk/stories/cews/
DecomBlades (Denmark)	DecomBlades is an initiative that aims to establish a functional, sustainable value chain for the handling of end of life wind turbine blades including decommissioning, re-processing and recycling.	https://decomblades.dk/
Decom Tools (EU)	The objective of the project is to develop eco-innovative concepts and sustainable approaches for the end of lifecycle of offshore wind farms. The target is to reduce the offshore wind decommissioning costs by 20% and the environmental footprint by 25%, while increasing the know-how and expertise of the North Sea Region stakeholders in this sector.	https://northsearegion.eu/decomtools/
HiPerDiF (UK)	High Performance Discontinues Fibre (HiPerDiF) produces highly aligned discontinuous fibre composites with the goal of addressing the issues of	http://www.bristol.ac.uk/composites/research/hiperdif/

	the composite industry with regards to the manufacturing and recycling.	
IEA Wind Task 45 (EU)	Identify and mitigate the barriers to the recycling of wind turbine blades. The task focuses on the technical aspects of recycling, the blade life cycle and value chain, and expects to produce recommended practices and guidelines that can be used by practitioners.	https://iea-wind.org/task45/
Miljoskarm (Denmark)	Repurpose of second hand wind turbine blades as bike shelters, sound barriers and other installations which benefit from the light weight and sound insulation properties.	https://miljoskarm.dk/en/
ReDisCoveR (UK)	Transform the UK's wolrd leading composite end-of-life academic and commercial capabilities into a fully functioning and interconnected supply chain as the fledging market expands exponentionally.	https://www.nccuk.com/work-with-us/cross-catapult-projects/rediscover-composites/?popupclosed=true
R3FIBER (Spain)	Thermal recycling process: technical and economic feasibility of R3FIBER process, obtaining high quality glass and carbon fibres in a self-sustained process.	https://www.bcircular.com/r3fiber/
REVYTA (Italy)	Even though more focused on the ship and railway indiustry, the project allows recycling of FRP waste as an alternative to landfill disposal, thus supporting circular economy development.	https://www.interregeurope.eu/good-practices/revyta-recupero-vetroresina-yacht-treni-camper https://www.dife.it/progetto-revyta
Re-Wind Network (Ireland, UK, US)	The Re-Wind Network provides architectural design, structural engineering analysis and design, and construction management and logistics services to those wishing to repurpose the end-of-Life wind turbine blades.	https://www.re-wind.info/
The Circular Wind Hub (EU)	Overall goal to improve the circularity of materials in the wind industry, as well as keeping these materials in Europe while retaining strong business cases.	https://www.echt.community/the-circular-wind-hub/
Superuse Studios (Netherlands)	A company turning decommissioned wind turbine blades into playgrounds.	https://www.superuse-studios.com/
SusWIND (UK)	SusWIND will discover and demonstrate viable ways to recycle composite wind turbine blades, to explore the use of sustainable materials and processes in developing composites for blades, and to innovate in design to future-proof the turbine blades of tomorrow.	https://www.nccuk.com/what-we-do/sustainability/suswind/

ZEBRA (France)	Zero wastE Blade ReseArch (ZEBRA), led by French research center IRT Jules Verne brings together industrial companies and technical centers which aim to develop sustainable material and production processes for the manufacturing of wind energy blades. The project will determine the feasibility of recycling composite wind turbine blade components fabricated with glass fiber reinforced Elium® thermoplastic resin.	https://www.lmwindpower.com/en/stories-and-press/stories/news-from-lm-places/zebra-project-launched

Table 4-5 Other interesting although expired decommissioning initiatives

Name	Description of service	Link
ECOBULK (EU), 2017-2021	Large-scale European initiative to demonstrate that re-using, upgrading, refurbishing, and recycling composite products is possible, profitable, sustainable and appealing.	https://www.ecobulk.eu/
FiberEuse (EU), 2017-2021	An industry group aiming at bringing together and integrating various different composite recycling projects and promote scaling up of technologies.	http://fibereuse.eu/
ReRoBalsa (Germany), 2017-2019	Recycling of rotor blades in order to recover balsa wood/foam for the production of insulation materials.	https://www.wki.fraunhofer.de/en/research-projects/2017/ReRoBalsa_rotor-blades-recycling-balsa-wood-plastic-foam-for-insulation-materials.html
Developing a concept and measures for resource saving dismantling of wind turbines (Germany), 2017-2019	Aim to develop a circular economy approach for end-of-life onshore wind turbines.	https://ramboll.com/media/environ/supporting-a-major-circular-economy-project-in-the-german-wind-energy-sector
Dreamwind (Denmark), 2016-2020	Investigating new ways to recycle and manufacture reusable composite materials for wind turbine blades via bio-based resources and stimuli-responsive materials.	http://www.dreamwind.dk/en/
NANOLEAP (EU), 2015-2018	Developing demonstrators and business cases for new applications of secondary raw materials stemming from composite waste streams.	https://cordis.europa.eu/project/id/646397

WaliD (EU), 2015-2017	Wind blade using cost-effective advanced lightweight design, part of the project has been designing approaches for recyclable rotor blades.	https://cordis.europa.eu/project/id/309985
LIFE BRIO Project (EU), 2014-2017	Optimising procedures for the dismantling of wind farms, considering proper composite waste management from blades, as well as developing policy and legislative recommendations to the European Commission.	http://www.lifebrio.eu/index.php/en/
ForCycle (Germany), 2014-2016	Recycling of composite parts from plastics with matrix materials.	https://www.ivv.fraunhofer.de/en/recycling-environment/recycling-of-plastic-composites/forcycle.html
EXHUME (UK), 2013-2016	Development of new and resource efficient composite recycling and re-manufacturing processes in collaboration with industry.	https://www.cranfield.ac.uk/case-studies/exhume
Genvind Innovation Consortium (Denmark), 2012-2016	Demonstrated how composite waste can be applied in different products, components and structures which were based on cradle-to-cradle philosophies.	https://www.dti.dk/genvind/35154
SELFRAG CFRP (EU), 2012-2014	Development of a high voltage pulse fragmentation process for the recycling of thermoset composite materials.	https://cordis.europa.eu/project/rcn/106311/reporting/en
SUSRAC (EU), 2011-2013	Mechanical recycling of aircraft composites using grinding and identification of novel applications.	https://cordis.europa.eu/project/rcn/101279/reporting/en
Recycling of Waste Glass Fibre Reinforced Plastic with Microwave Pyrolysis (EU), 2011-2012	Recycling FRP thermosets via microwave pyrolysis.	https://webgate.ec.europa.eu/life/publicWebsite/project/details/2834
EURECOMP (Recycling Thermoset Composites of the SST) (EU), 2009-2012	Recycling FRP thermosets via solvolysis.	http://cordis.europa.eu/result/rcn/54152_en.html

REACT (Re-use of Glass Fibre Reinforced Plastics by Selective Shredding and Re-activating the Recyclate) (EU), 2003-2005	Recycling FRP thermosets via mechanical processes.	http://cordis.europa.eu/project/rcn/68366_en.html

About DNV

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Driven by its purpose, to safeguard life, property, and the environment, DNV helps tackle the challenges and global transformations facing its customers and the world today and is a trusted voice for many of the world's most successful and forward-thinking companies.

APPENDIX 16-2

OUTLINE RESOURCE AND WASTE MANAGEMENT PLAN

Planning and Environmental Consultants

Outline Resource and Waste Management Plan

Derrybrien Wind Farm Development Decommissioning Project – Prospective Development

DOCUMENT DETAILS

Client:	**Gort Windfarms Ltd**
Project Title:	**Derrybrien Wind Farm Development Decommissioning Project – Prospective Development**
Project Number:	**220437**
Document Title:	**Outline Resource and Waste Management Plan**
Document File Name:	**Outline Resource and Waste Management Plan F 2024.12.23**
Prepared By:	**MKO** **Tuam Road** **Galway** **Ireland** **H91 VW84**

Planning and Environmental Consultants

Rev	Status	Date	Author(s)	Approved By
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1. INTRODUCTION

1.1 Purpose and Objectives of the RWMP

This Resource and Waste Management Plan (RWMP) has been developed by MKO on behalf of Gort Windfarms Ltd who intend to apply to An Bord Pleanála for planning permission for the "Derrybrien Windfarm Decommissioning Project" which comprises two elements: (1) the carrying out of physical works to decommission specific features of the existing Derrybrien Wind Farm (the Prospective Development); and (2) the proposed 'retention' in situ of other specific features of the existing development (i.e. the Retained Development). The project site is located in the townlands of Boyaboy, Bolenyneendorrish, Coppanagh, Derreennamucka, Derrybrien East, Derrybrien North, Derrybrien West, Funshadaun, Kilbeg, Loughatorick North, Loughstorick South and Toormacnevin, County Galway.

This RWMP provides an outline for the Prospective Development and the works involved. It incorporates the mitigating principles to ensure that the proposed works are carried out in a way that minimises the potential for any environmental impacts as a result of demolition and decommissioning activities associated with the proposed works and the wastes which will be generated during the project in accordance with the European waste hierarchy and relevant waste legislation.

Among the measures set out in the Waste Action Plan for a Circular Economy, a commitment to revise the 2006 guidance on '*Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Waste in Developments'*. Following this commitment, the EPA have published *Draft Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Waste in Developments* in April 2021 and is currently undergoing public consultation on the guidance. The RWMP has been prepared in line with the draft guidelines set out by the EPA.

This RWMP identifies for the incoming contractor, the key planning and waste management considerations that must be adhered to during decommissioning and demolition works. This report is intended as a single, amalgamated document that can be used during any potential phases of the project, as a single consolidated point of reference relating to all demolition and wastes management requirements for the Planning Authority, developer and contractors alike.

This report has been prepared by Tom Madden BSc. (Env) and reviewed by Thomas Blackwell BSc. MSc (Env)

1.2 Potential Amendment Scenarios

This RWMP will require further updating and final agreement with the various stakeholders should the project secure Planning Permission, in line with all conditions which apply and in order to identify, assess and satisfy the contract performance criteria. The final RWMP will also require updating by the selected contractor. Therefore, this is a working document and will be developed further prior to decommissioning commencing.

Triggers for amendments to the RWMP will include:

- When there is a need to improve performance in an area of environmental impact;
- As a result of changes in environmental legislation applicable and relevant to the project;
- Where the outcomes from auditing establish a need for change;
- Where Work Method Statements identify changes to a methodology to address high environmental risk;
- As a result of an incident or complaint occurring that necessitates an amendment

1.3 Background to the Prospective Development

The site of the development is currently occupied by the existing Derrybrien Wind Farm Development. The site includes turbines, associated buildings, cables, overhead lines and their respective support structures and access tracks.

The development and evolution of the Derrybrien Wind Farm Development Decommissioning Project has been informed by the outcome of the Substitute Consent Application to An Bord Pleanála (Inspectors Report ABP-308019-20). Noting An Bord Pleanála's reasons for refusal of substitute consent and Galway County Council's comments on the need to manage works near watercourses, the Derrybrien Wind Farm Development Decommissioning Project was scoped to include:

- Works that could definitively and demonstrably not pose any risk, or perceived risk, to the environment that may be considered unacceptable by a Planning Authority; and
- Works that could be completed (i.e. works that Gort Wind Farms Ltd could submit for planning permission).

The evolution of the Derrybrien Wind Farm Development Decommissioning Project has been documented previously in Chapter 3 Assessment of Alternatives of the EIAR.

2. WASTE MANAGEMENT POLICY AND LEGISLATIVE CONTEXT

2.1 Wast Management Policy

2.1.1 National Level

2.1.1.1 'Changing Our Ways', Policy Statement 1998

The Irish Government issued a policy statement in September 1998, '*Changing Our Ways*', which identified objectives for the prevention, minimisation, reuse, recycling, recovery and disposal of waste in Ireland. The target for construction and demolition (C&D) waste in this report was to recycle at least 50% of C&D waste within a five-year period (by 2003), with a progressive increase to at least 85% over fifteen years (i.e. 2013).

In response to the Changing Our Ways report, a task force (Task Force B4) representing the waste sector of the already established Forum for the Construction Industry, released a report entitled *'Recycling of Construction and Demolition Waste*' concerning the development and implementation of a voluntary construction industry programme to meet the Government's objectives for the recovery of C&D waste.

2.1.1.2 A Waste Action Plan for a Circular Economy, 2020

In September 2020, the Irish Government published a policy document outlining a new action plan for Ireland to cover the period of 2020-2025. This plan, '*A Waste Action Plan for a Circular Economy*' (WAPCE), replaces the previous national waste management plan, '*A Resource Opportunity*' (2012), and was prepared in response to the 'European Green Deal' which sets a roadmap for a transition to an altered economical model, where climate and environmental challenges are turned into opportunities.

The WAPCE sets the direction for waste planning and management in Ireland up to 2025. This reorientates policy from a focus on managing waste to a much greater focus on creating circular patterns of production and consumption. Other policy statements of a number of public bodies already acknowledge the circular economy as a national policy priority.

The policy document contains over 200 measures across various waste areas including circular economy, municipal waste, consumer protection and citizen engagement, plastics and packaging, construction and demolition, textiles, green public procurement and waste enforcement.

One of the first actions to be taken was the development of the Whole of Government Circular Economy Strategy 2022-2023 '*Living More, Using Less'* (2021) to set a course for Ireland to transition across all sectors and at all levels of Government toward circularity and was issued in December 2021. It is anticipated that the Strategy will be updated in full every 18 months to 2 years.

2.1.1.3 Circular Economy and Miscellaneous Provisions Act 2022

The Circular Economy and Miscellaneous Provisions Act 2022 was signed into law in July 2022. The Act underpins Ireland's shift from a "take-make-waste" linear model to a more sustainable pattern of production and consumption, that retains the value of resources in our economy for as long as possible and that will to significantly reduce our greenhouse gas emissions. The Act defines Circular Economy for the first time in Irish law, incentivises the use of recycled and reusable alternatives to wasteful, single-use disposable packaging, introduces a mandatory segregation and incentivised charging regime

for commercial waste, streamlines the national processes for End-of-Waste and By-Products decisions, tackling the delays which can be encountered by industry, and supporting the availability of recycled secondary raw materials in the Irish market, and tackles illegal fly-tipping and littering.

2.1.2 Regional Level - Connacht-Ulster Waste Management Plan 2015 – 2021

The Project is located in the Local Authority area of Galway County Council (GCC). The Connacht-Ulster Waste Management Plan 2015 – 2021, published in May 2015, is the current regional waste management plan for the GCC area. This plan replaces the previous Connacht region plan due to changing National policy and changes being enacted by the Waste Framework Directive (2008/98/EC).

The Regional Plan sets out the strategic targets for waste management in the region and sets a specific target for C&D waste of "70% preparing for reuse, recycling and other recovery of construction and demolition waste" (excluding natural soils and stones and hazardous wastes) to be achieved by 2020.

The Galway County Development Plan 2022 – 2028 sets out a number of policies for Galway County in line with the objectives of the regional waste management plan. The plan identifies supporting the implementation of the regional waste management plan as one of the Council's policies. Other waste policy which is relevant to the Project are included in Table 16-1, below.

Table 2-1 Waste Management Policy Objectives from Galway County Development Plan 2022 – 2028

Policy Objectives Waste Management	
WM 1	**Connacht and Ulster Waste Management Plan 2015-2021**
Support the implementation of the Connacht and Ulster Waste Management Plan 2015-2021 or any updated version of this document within the lifetime of the plan.	
WM 2	**Requirements for Waste Management**
Support and promote the circular economy principles, prioritising prevention, reuse, recycling and recovery, and to sustainably manage residual waste. New developments will be expected to take account of the provisions of the Waste Management Plan for the Region and observe those elements of it that relate to waste prevention and minimisation, waste recycling facilities, and the capacity for source segregation.	
WM 3	**Waste Recovery and Disposal Facilities**
Support and facilitate the provision of adequate waste recovery and disposal facilities for the county.	
WM 4	**Waste Legalisation**
To require that all waste disposal shall be undertaken in compliance with the requirements of the Environmental Protection Agency and relevant Waste Management Legislation.	
WM 5	**Construction and Environmental Management Plans**
Construction Environment Management Plans (CEMP) shall be prepared in advance of the construction of relevant projects and implemented throughout. Such plans shall incorporate relevant mitigation measures which have been integrated into the Plan and any lower tier Environmental	

Policy Objectives Waste Management
Impact Statement or Appropriate Assessment. CEMPs typically provide details of intended construction practice for the proposed development, including: (a) location of the sites and materials compound(s) including area(s) identified for the storage of construction refuse; (b) location of areas for construction site offices and staff facilities; (c) details of site security fencing and hoardings; (d) details of on-site car parking facilities for site workers during the course of construction; (e) details of the timing and routing of construction traffic to and from the construction site and associated directional signage; (f) measures to obviate queuing of construction traffic on the adjoining road network; (g) measures to prevent the spillage or deposit of clay, rubble or other debris; (h) alternative arrangements to be put in place for pedestrians and vehicles in the case of the closure of any public right of way during the course of site development works; (i) details of appropriate mitigation measures for noise, dust and vibration, and monitoring of such levels; (j) containment of all construction-related fuel and oil within specially constructed bunds to ensure that fuel spillages are fully contained (such bunds shall be roofed to exclude rainwater); (k) disposal of construction/demolition waste and details of how it is proposed to manage excavated soil, including compliance with 2006 Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects, Department of the Environment, Heritage and Local Government; (l) a water and sediment management plan, providing for means to ensure that surface water runoff is controlled such that no silt or other pollutants enter local water courses or drains;
WM 6 Waste Management
To continue to meet the duties under the Waste Management (certification of historic unlicensed waste disposal and recovery activity) Regulations 2008, including those in relation to the identification and registration of closed landfills.
WM7 Recycling Infrastructure
To provide for the provision of recycling infrastructure throughout the county where it is considered necessary and support the provision of additional recycling infrastructure throughout the county.
WM 8 Sustainable Waste Management Practices
Promote and facilitate communities to become involved in environmental awareness activities and community based recycling initiatives or environmental management initiatives that will lead to local sustainable waste management practices.

Policy Objectives Waste Management	
WM 9	**Separate Collection of Waste**
Encourage and support the provision of separate collection of waste in accordance with the requirements of the Waste Management (Food Waste) Regulations 2009, the Waste Framework Directive Regulations, 2011 and other relevant legislation.	
WM10	**Landfill Sites**
a) Galway County Council will put in place a plan during the lifetime of the 2022- 2028 Galway County Development Plan for Poolboy Landfill in Ballinasloe to deal with remediation of the Poolboy Landfill site to a standard consistent with the end use of Poolboy Landfill and adjacent lands to open space/ park amenity area for community use including community sustainable energy/ climate action measures. b) Galway County Council will put in place a plan during the lifetime of 2022-2028 Galway County Development Plan for Kilconnell Landfill to deal with the remediation of the Kilconnell Landfill site to a standard consistent with the end use of Kilconnell Landfill to open space / park amenity area for community use including community sustainable energy/ climate action measures.	

2.2 Relevant Legislation

The primary legislative instruments that govern waste management in Ireland and applicable to the Prospective Development are:

- Waste Management Act 1996 as amended.
- Environmental Protection Agency Act 1992 as amended.
- Litter Pollution Act 1997 as amended.
- Planning and Development Act 2000 (as amended)

One of the guiding principles of European waste legislation, which has in turn been incorporated into the Waste Management Act 1996 as amended and subsequent Irish legislation, is the principle of "Duty of Care". This implies that the waste producer is responsible for waste from the time it is generated through until its legal recycling, recovery or disposal (including its method of disposal). As it is not practical in most cases for the waste producer to physically transfer all waste from where it is produced to the final destination, waste contractors will be employed to physically transport waste to the final destination. Following on from this is the concept of "Polluter Pays" whereby the waste producer is liable to be prosecuted for pollution incidents, which may arise from the incorrect management of waste produced, including the actions of any contractors engaged (e.g. for transportation and disposal/recovery/recycling of waste).

It is therefore imperative that the Developer ensures that the waste contractors engaged by demolition and construction contractors are legally compliant with respect to waste transportation, recycling, recovery and disposal. This includes the requirement that a contractor handle, transport and recycle/recover/dispose of waste in a manner that ensures that no adverse environmental impacts occur as a result of any of these activities.

A collection permit to transport waste must be held by each waste contractor which is issued by the National Waste Collection Permit Office (NWCPO). Waste receiving facilities must also be appropriately permitted or licensed. Operators of such facilities cannot receive any waste, unless in possession of a Certificate of Registration (COR) or waste permit granted by the relevant Local Authority under the Waste Management (Facility Permit & Registration) Regulations 2007 and Amendments or a Waste or Industrial Emissions Licence granted by the EPA. The COR / permit /

licence held will specify the type and quantity of waste able to be received, stored, sorted, recycled, recovered and/or disposed of at the specified site.

3. RELEVANT GUIDANCE

The Environmental Protection Agency (EPA) of Ireland issued *'Best Practice Guidelines for the Preparation of Resource & Waste Management Plans for Construction & Demolition Projects'* (the guidelines) in November 2021. These guidelines replace the previous 2006 guidelines issued by The National Construction and Demolition Waste Council (NCDWC) and the Department of the Environment, Heritage and Local Government (DoEHLG) in 2006. The guidelines provide a practical approach which is informed by best practice in the prevention and management of C&D wastes and resources from design to construction of a project, including consideration of the decommissioning of a project. These guidelines have been followed in the preparation of the resource and waste management plan (RWMP) for the Project and include the following elements:

- Predicted C&D wastes and procedures to prevent, minimise, recycle and reuse wastes;
- Roles and Responsibilities;
- Relevant EU, national and local waste policy, legislation and guidelines;
- Waste disposal/recycling of C&D wastes at the site;
- Provision of training for Resource Waste Manager (RM) and site crew;
- Details of proposed record keeping system;
- Details of waste audit procedures and plan; and
- Details of consultation with relevant bodies i.e. waste recycling companies, Local Authority, etc.

Section 3 of the guidelines identifies thresholds above which there is a requirement for the preparation of a bespoke RWMP for developments. The new guidance classifies developments on a two-tiered system. Developments which do not exceed any of the following thresholds may be classed as Tier 1 development, which require a simplified RWMP:

- New residential development of less than 10 dwellings.
- Retrofit of 20 dwellings or less.
- New commercial, industrial, infrastructural, institutional, educational, health and other developments with an aggregate floor area less than 1,250m^2.
- Retrofit of commercial, industrial, infrastructural, institutional, educational, health and other developments with an aggregate floor area less than 2,000m^2; and
- Demolition projects generating in total less than 100m^3 in volume of C&D waste.
- A development which exceeds one or more of these thresholds is classed as Tier-2 projects.

This development requires a RWMP as a Tier 2 development as it is above following criterion:

- Demolition projects generating in total less than 100m^3 in volume of C&D waste.

The decommissioning of the Derrybrien Wind Farm Development, including the demolition of the Derrybrien and Agannygal Substations will likely generate in excess of 100m^3 of C&D waste. Therefore, a bespoke RWMP is required for the project.

Other guidelines followed in the preparation of the RWMP include *'Construction and Demolition Waste Management – a handbook for Contractors and Site Managers'*, published by FÁS and the Construction Industry Federation in 2002 and the previous guidelines, *'Best Practice Guidelines for the Preparation of Waste Management Plans for Construction and Demolition Projects'* (2006).

These guidance documents are considered to define best practice for C&D projects in Ireland and describe how C&D projects are to be undertaken such that environmental impacts and risks are minimised and maximum levels of waste recycling are achieved.

4. SITE AND PROJECT DETAILS

4.1 Site Location and Development Description

The site is located approximately 11 kilometres (km) due south of Loughrea, 13km northeast of Gort and 24km west of Portumna, Co. Galway. The approximate location for the centre of the site in Irish Transverse Mercator (ITM) is X 559599, Y 705169. The site covers an area of approximately 344.5 hectares in total.

The Prospective Development comprises of the decommissioning, dismantling, and removal of 70 No. wind turbines (existing), 2 No. anemometer lattice masts, removal of electrical equipment from Derrybrien substation and demolition of substation building and wind farm control building, decommissioning and removal of the Derrybrien Wind Farm grid connection comprising Derrybrien-Agannygal 110 kV Overhead Line (7.8 km) and 110kV Agannygal Substation connecting into the Ennis-Shannonbridge 110 kV Overhead Line, and reconnection of the existing Ennis-Shannonbridge 110 kV Overhead Line. It is proposed that turbine foundation and site roads will remain in-situ.

Access to the site for site traffic and for the removal of turbine components will be via the current existing entrance from the Coillte access road in the townlands of Bohaboy, Funshadaun and Coppanagh, via a minor public road known as the Black Road (approximately 3.1 km from the wind farm to the Black Road/Coillte junction). Access to the Black Road is via the R353 Regional Road, which originates near Portumna, passes over Flaggy Bridge before passing through the village of Derrybrien to join the N66 Loughrea - Gort National Secondary Road near Gort. From Gort the Black Road is accessed via the N66 for a distance of 1.7 km and the R353 for a distance of 14km. Alternatively, the Black Road /Coillte access road can be accessed via minor public roads from Loughrea a distance of approximately 10km.

4.2 Targets and Objectives

The key site targets are as follows:

- Ensure works and activities are completed in accordance with mitigation and best practice approach presented in this RWMP and associated planning documentation.
- Ensure works and activities are completed in accordance with all planning conditions for the development and in accordance with all relevant waste legislation.
- Ensure the management of waste materials has minimal impact/disturbance to local landowners and the local community.
- Ensure that the waste produced on site during the decommissioning works is managed in a way to ensure minimal impact on the Natural Environment.
- Adopt a sustainable approach to the works; and
- Provide adequate waste management training and awareness for all project personnel.

The key site objectives are as follows:

- Good waste management and housekeeping to be implemented.
- Work Methods and designs will be altered where it is found the volume of waste has been enhanced.
- Comply with all relevant waste and environmental legislation.

5. ROLES AND RESPONSIBILITIES

5.1 Role of the Client (Gort Wind Farms Ltd.)

- The Client has commissioned the preparation and submission of a preliminary RWMP as part of the design and planning submission
- The Client will require the preparation and submission of an updated RWMP as part of the construction tendering process.
- The client will ensure that the RWMP is agreed on and submitted to the local authority prior to commencement of works on site.
- The Client will request the end-of-project RWMP from the Contractor.

5.2 Role of the Client Advisory Team

The Client Advisory Team (engineers, architects, consultants, etc.) is procured by the Client and is responsible for the following::

- Drafting and maintaining the RWMP through the design, planning and procurement phases of the project;
- Appointing a Resource Manager (RM) to track and document the design process, inform the Design Team and prepare the RWMP.
- Including details and estimated quantities of all projected waste streams with the support of environmental consultants/scientists. This should also include data on waste types (e.g. waste characterisation data, contaminated land assessments, site investigation information) and prevention mechanisms (such as by-products) to illustrate the positive circular economy principles applied by the Design Team;
- Managing and valuing the demolition work with the support of quantity surveyors;
- Handing over of the RWMP to the selected Contractor upon commencement of decommissioning of the Project, in a similar fashion to how the safety file is handed over to the Contractor;
- Working with the Contractor as required to meet the performance targets for the project.

5.3 Future Role of the Contractor

The principal Contractor procured by the Client to undertake the construction operations is responsible for the following:

- Preparing, implementing and reviewing the RWMP through decommissioning (including the management of all suppliers and sub-contractors) as per the requirements of these guidelines.
- Identifying a designated and suitably qualified Resource Manager (RM) who will be responsible for implementing the RWMP.
- Identifying all hauliers to be engaged to transport each of the resources / wastes off-site. Note that any resource that is legally a 'waste' must only be transported by a haulier with a valid Waste Collection Permit.
- Please note that the movement of hazardous waste material off-site falls under the European Communities (Shipments of Hazardous Waste exclusively within Ireland) Regulations 2011. Each shipment of hazardous waste material off-site is to be legally accompanied by a Waste Transfer Form. Hazardous wase such as asbestos should only be handled by competent persons with appropriate training and expertise. More information on handling of asbestos-containing material is available from the Health and Safety Authority.

- Implementing waste management policies whereby waste material generated on site are to be segregated as far as practicable.
- Identifying all destinations for resources taken off-site. As above, any resource that is legally a 'waste' must only be transported to an authorised waste facility.
- End-of-waste and by-product notifications addressed with EPA where required.
- Clarification of any other statutory waste management obligations, which could include on-site processing.
- Full records of all resources (both wastes and other resources) should be maintained for the duration of the project.
- Preparing a RWMP Implementation Review Report at project handover.

5.4 Local Authority

The Local Authority as the planning regulator is responsible for the following tasks:

- Ensure that the requirement for an RWMP for C&D Projects is required for all planning applications (through setting this requirement as an objective of the County Development Plan or local planning policy) for development where construction or demolition is proposed.
- Ensuring that any RWMP submitted with planning complies with the requirements of the EPA guidelines.
- Setting appropriate planning conditions as required in line with the requirements of Section 34(4)(l) of the Planning and Development Acts, as amended.
- Ongoing enforcement of these conditions through the Prospective Development.

6. DECOMMISSIONING & DEMOLITION WASTE MANAGEMENT

6.1 Introduction

The generation of waste as a result of decommissioning related activity will provide the majority of on-site wastes which will need to be managed under guidelines set out in this document. This section of the RWMP provides a Waste Management Plan which outlines the best practice procedures during the Prospective Development.

The plan is based on the European waste hierarchy which sets out the most to least preferred options for waste management. Waste prevention and re-use are viewed as the most desirable options for managing wastes with the least desirable option considered being landfill.

This plan has a number of key objectives as outlined below:

- To set out management prescriptions that adhere to the waste management hierarchy.
- To outline the roles and responsibilities of the Waste Manager

6.1.1 Legislation

The Waste Management Act 1996 and its subsequent amendments provide for measures to improve performance in relation to waste management, recycling and recovery. The Act also provides a regulatory framework for meeting higher environmental standards set out by other national and EU legislation.

The Act requires that any waste related activity has to have all necessary licenses and authorisations. It will be the duty of the Waste Manager on the site of the Prospective Development to ensure that all contractors hired to remove waste from the site have valid Waste Collection Permits. It will then be necessary to ensure that the waste is delivered to a licensed or permitted waste facility. The hired waste contractors and subsequent receiving facilities must adhere to the conditions set out in their respective permits and authorisations.

6.1.2 Waste Management Hierarchy

The waste management hierarchy sets out the most efficient way of managing in the following order:

Prevention and Minimisation:

The primary aim of the RWMP will be to prevent and thereby reduce the amount of waste generated at each stage of the project. The prevention and minimisation of waste of this project will be developed by implementing effective on-site materials management in terms of both material acquisition and storage on site.

Reuse of Waste:

Reusing as much of the waste generated on site as possible will reduce the quantities of waste that will have to be transported off site to recovery facilities or landfill. Site management will be required to encourage the appropriate reuse of materials where possible as well as identify re-use opportunities to achieve ultimate goal of waste reduction.

The potential for re-use of materials on the site during the works will be minimal however clean inert concrete, rubble and stones may have a re-use potential for landscaping and site restoration.

Recycling of Waste:

There are a number of established markets available for the beneficial use of demolition waste such as using waste concrete as fill for new roads. A designated Waste Storage Area (WSA) will be maintained on site which will cater for segregation and recycling of various waste streams

At all times during the implementation of the RWMP, disposal of waste to landfill will be considered only as a last resort.

6.2 Demolition Activities

A number of minor demolition works will be carried out at the site, primarily on the substation buildings. The works will involve the removal of these structures and associated infrastructure. The sequencing of the demolition works will be decided by the main contractor following detailed site survey of the buildings and surrounding area. Such a survey will provide detail on the:

- The condition of the building (which will determine the potential re-use of site options)
- The demolition methods recommended.
- The location and removal methods for any toxic or hazardous materials.
- The type and location of adjoining and surrounding areas which may be affected by noise, vibration, dust and removal of the building structure

The demolition process of the substations and associated components will generally follow the sequencing shown in Table 6.1 below.

Table 6-1 Typical Demolition Sequencing

Demolition Sequence	General Description
Services Disconnection	Shut of electricity and remove all electrical equipment. Disconnection of wells, capping and sealing and removal of pumps from site.
Inventory of Hazardous Wastes	e.g. Oil separator to be emptied prior to being backfilled with stone. Emptying of sewage treatment plant prior to being backfilled with stone
Removal of furniture/Equipment	Furniture
Removal of fixtures	Fixtures & fittings
Removal of timber	Floors, trusses, rafters
Removal of Fencing	Palisade fencing to be removed
Demolition of Structures Shells	Manual or mechanical demolition
Source segregation of material fractions	C&D waste recovery
Transport of materials to authorised facilities	Authorised Waste Collection Permit holders and Waste Facility or Licence holders
Site restoration/landscaping/ security	Landscaping, hoarding etc.

Typical description of works for the demolition of the control building is as follows:

- The roof will be removed with the slates and trusses segregated.
- The concrete roof/ceiling slabs will be lifted and moved to ground level before being broken up.
- External blockwork will be removed, and cavity insulation segregated from concrete blocks, before demolishing the internal leaf.

6.3 Decommissioning and Demolition Waste Management

Prior to the commencement of any demolition works at the site a full audit of waste that will be generated on site will be carried out. For the purposes of this RWMP a list of expected waste types that may be generated has been drawn up and the anticipated quantity of each waste category as well as the List of Waste Catalogue Codes pertaining to each waste type is included in Table 6-2. The list has been prepared following a review of the application of the proposed decommissioning and demolition and all available design documents and does not constitute a full waste audit.

Table 6-2 Expected waste types arising during the Prospective Development

Material Type	Example	LOW Code
Cables	Electrical wiring	17 04 11
Metals	Copper, aluminium, lead, iron and steel	17 04 07
Inert materials	Sand, stones, plaster, rock, blocks	17 01 07
Mixed municipal waste	Daily canteen waste from workers, miscellaneous	20 03 01
Plastic	PVC frames, electrical fittings	17 02 03
Plastic packaging	Packaging with new materials	15 01 02
Mixed materials	Nacelle and components	17 09 04
Tiles and ceramics	Slates and tiles	17 01 03
Resins	Turbine blades and components	20 01 27
Wood	Roof trusses	15 01 03
Concrete	Surfacing, Flooring material	17 01 01
Hazardous liquids	Oils, insulating and heat transfer oils, others	13 01 10*, 13 02 04*, 13 02 05*, 13 02 08*, 13 08 01,13 01 10*, 13 03 07*, 13 03 08*, 13 03 10*

The associated components will be removed from site for re-use, recycling or waste disposal. Any structural elements that are not suitable for recycling will be disposed of in an appropriate manner. All lubrication fluids will be drained down and put aside for appropriate collection, storage, transport and disposal. Any materials which cannot be re-used or recycled will be disposed of by an appropriately licenced contractor.

Hazardous wastes that may occur on site during the Prospective Development may include oil, diesel fuel, chemicals, paints, preservatives etc. All hazardous wastes will be stored in bunded containers/areas before being collected by an authorised waste contractor and brought to an EPA licensed waste facility. Sulphur hexafluoride (SF6) switchgear from the substation and any oil containing equipment will be carefully removed in compliance with applicable legislation and disposed of appropriately. As mentioned above, hazardous wastes will be kept separate from non-hazardous wastes so that contamination does not occur. Further details on how hazardous wastes and oils will be dealt with during decommissioning are outlined in the accompanying Decommissioning Management Plan.

The majority of the waste generated by the demolition works at the Derrybrien Substation will consist of concrete rubble, metal cladding, the existing wall structures (internal and external), doors, windows (glass) and other associated support components (steel beams/bracing). These materials will be segregated from all other waste components and sent by an authorised waste collector to an authorised waste recovery facility. The remaining volume of waste material will not be large enough to warrant any further segregation, therefore, this waste generated during the demolition of the building will be deposited into a single skip. This waste material will be transferred to a Materials Recovery Facility (MRF) by a fully licensed waste contractor where the waste will be sorted into individual waste streams for recycling, recovery or disposal.

6.4 Implementation

6.4.1 Roles and Responsibilities for Waste Management

Prior to the commencement of the Prospective Development, a Waste Manager will be appointed by the project team. The Waste Manager will be responsible for the implementation of the objectives of this plan, ensuring that all hired waste contractors have the necessary authorisations and that the waste management hierarchy is adhered to. The person nominated must have sufficient authority so that they can ensure everyone working on the proposed project adheres to the management plan. The waste manager will also be required to conducted regular waste audits throughout the site to ensure that the waste management plan is operating effectively.

6.4.2 Training

It is important for the Resource Manager to communicate effectively with colleagues in relation to the aims and objectives of the waste management plan. All employees working on site during the Prospective Development will be trained in materials management and thereby, should be able to:

- Distinguish reusable materials from those suitable for recycling;
- Ensure maximum segregation at source;
- Co-operate with site manager on the best locations for stockpiling reusable materials;
- Separate materials for recovery; and
- Identify and liaise with waste contractors and waste facility operators.

6.4.3 Record Keeping

The RWMP will provide systems that will enable all arisings, movements and treatments of waste to be recorded. This system will enable the contractor to measure and record the quantity of waste being generated. It will highlight the areas from which most waste occurs and allows the measurement of arisings against performance targets. The RWMP can then be adapted with changes that are seen through record keeping.

The fully licensed waste contractor employed to remove waste from the site will be required to provide documented records for all waste dispatches leaving the site. Each record will contain the following:

- Consignment Reference Number
- Material Type(s) and LOW Code(s)
- Company Name and Address of Site of Origin
- Trade Name and Collection Permit Ref. of Waste Carrier
- Trade Name and Licence Ref. of Destination Facility
- Date and Time of Waste Dispatch
- Registration no. of Waste Carrier vehicle
- Weight of Material
- Signature of Confirmation of Dispatch detail
- Date and Time of Waste Arrival at Destination
- Site Address of Destination Facility

6.5 Waste Management Plan Conclusion

The WMP will be properly adhered to by all staff involved in the project which will be outlined within the induction process for all site personnel. The waste hierarchy will always be employed to ensure that the least possible amount of waste is produced during the Prospective Development. Reuse of certain

types of decommissioning wastes will cut down on the cost and requirement of raw materials therefore further minimising waste levels.

7. OUTLINE WASTE AUDIT PROCEEDURE

7.1 Responsibility for Waste Audit

The appointed RM will be responsible for conducting a waste audit at the site during the Prospective Development. Contact details for the nominated RM will be provided to the GCC Waste Regulation Unit after the main contractor is appointed and prior to any material being removed from site.

7.2 Review of Records and Identification of Corrective Actions

A review of all waste management costs and the records for the waste generated and transported off-site should be undertaken mid-way through the demolition and construction phase of the Prospective Development.

If waste movements are not accounted for, the reasons for this should be established in order to see if and why the record keeping system has not been maintained. The waste records will be compared with the established recovery / reuse / recycling targets for the site. Each material type will be examined, in order to see where the largest percentage waste generation is occurring. The waste management methods for each material type will be reviewed in order to highlight how the targets can be achieved.

Upon completion of the Prospective Development, a final report will be prepared, summarising the outcomes of waste management processes adopted and the total recycling / reuse / recovery figures for the project.

8. DECOMMISIONING ENVIRONMENTAL MITIGATION MEASURES

During the decommissioning works, the Construction Environmental Management Plan (CEMP) will be followed in regard to implementing and managing all environmental management requirements.

This CEMP explains the construction techniques and methodologies which will be implemented during the Prospective Development.

The CEMP mitigation measures will be implemented to ensure that pollution and nuisances arising from demolition and decommissioning activities is prevented where possible and managed in accordance with best practice environmental protection.

The CEMP will be implemented and adhered to by the demolition and decommissioning contractors and will be overseen and updated as required if site conditions change by the Project Manager, Environmental Manager, RM and Ecological Clerk of Works where relevant. All personnel working on the site will be trained in the implementation of the procedures.

9. CONSULTATION

9.1 Local Authority

Once decommissioning/demolition contractors have been appointed and have appointed waste contractors, and prior to removal of any C&D waste materials off-site, details of the proposed destination of each waste stream will be provided to the Galway County Council (GCC) Waste Regulation Unit.

GCC will also be consulted, as required, throughout the demolition, excavation and construction phases in order to ensure that all available waste reduction, reuse and recycling opportunities are identified and utilised and that compliant waste management practices are carried out.

9.2 Recycling/Salvage Companies

The appointed waste contractor for the main waste streams managed by the demolition contractors will be audited in order to ensure that relevant and up-to-date waste collection permits and facility registrations / permits / licences are held. In addition, information will be obtained regarding the feasibility of recycling each material, the costs of recycling / reclamation, the means by which the wastes will be collected and transported off-site, and the recycling / reclamation process each material will undergo off-site.