9 LAND AND SOIL

9.1 INTRODUCTION

9.1.1 Scope of assessment

Hydro-Environmental Services (HES) was engaged by Malachy Walsh and Partners to undertake an assessment of the potential impacts of a proposed wind farm development at Carrownagowan, Co. Clare (the 'Proposed Development') on Land and Soils aspects (land, soils and geology) of the receiving environment. Other "Project" elements, including the grid connection and the replacement forestry lands, are also assessed. Please refer to section 2.3 of chapter 2 for a full description of the overall Project and the proposed development.

The objectives of the assessment are to:

- Produce a baseline study of the existing land and soil environment for the "Project";
- Identify likely significant positive and significant negative effects of the "Project" on land and soil during construction and operational phases;
- Identify mitigation measures to avoid, remedy or reduce significant negative direct and indirect effects; and,
- Assess significant residual effects, and cumulative effects of the "Project" along with other wind farm and infrastructural developments.

9.1.2 Methodology

A general walkover survey and initial baseline monitoring was undertaken by HES between August and December 2018, and further detailed site investigations works were undertaken during 2019. HES staff were on site on 20 man days (15 separate occasions: 18/06/2018, 19/06/2018, 30/08/2018, 24/09/2018, 19/10/2018, 19/11/2018, 26/11/2018, 12/12/2018, 31/01/2019, 01/02/2019, 14/02/2019, 28/03/2019, 13/06/2019, 14/06/2019, and 15/10/2019) during this period, and completed over 170 hours of site work. Data used in this assessment include the following:

- Geological desk study data from various on-line data sources;
- Logs of geological exposures were observed at existing borrow pits, outcrop faces and in stream beds across the site;
- Peat depth data (790 points) from across the site;
- A Peat Stability Risk Assessment (Appendix 9-2 has been prepared by MWP); and,
- Trial pit data (20 no trial pits excavated at turbine and infrastructure locations).

9.1.3 Assessment Criteria

9.1.3.1 *Impact Assessment Methodology*

Using information from the desk study and data from the site investigation, an estimation of the importance of the soil and geological environment within the study area is assessed using the criteria set out in Table 9.1 (NRA, 2008).

Table 9.1. Estimation of Importance of Soil and Geology Criteria (NRA, 2008).

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

The guideline criteria (EPA, 2017) for the assessment of impacts require that likely impacts are described with respect to their extent, magnitude, complexity, probability, duration, frequency, reversibility and transfrontier nature (if applicable). The descriptors used in this environmental impact assessment are those set out in EPA (2002) Glossary of Impacts as shown in Chapter 1 of this EIAR. In addition, the two impact characteristics proximity and probability are described for each impact and these are defined in Table 9.2.

In order to provide an understanding of this descriptive system in terms of the geological/hydrological environment, elements of this system of description of impacts are related to examples of potential impacts on the hydrology (water) and morphology (land, soils and geology) of the existing environment, as listed in Table 9.3.

Table 9.2. Additional Impact Characteristics.

Impact Characteristic	Degree/ Nature	Description
Proximity	Direct	An impact which occurs within the area of the proposed project, as a direct result of the proposed project.
	Indirect	An impact which is caused by the interaction of effects, or by off-site developments.
Probability	Low	A low likelihood of occurrence of the impact.
	Medium	A medium likelihood of occurrence of the impact.
	High	A high likelihood of occurrence of the impact.

Table 9.3. Impact descriptors related to the receiving environment.

Impact Characteristics		Potential Hydrological Impacts
Quality	**Significance**	
Negative only	Profound	Widespread permanent impact on: - The extent or morphology of a cSAC. - Regionally important aquifers. - Extents of floodplains. Mitigation measures are unlikely to remove such impacts.
Positive or Negative	Significant	Local or widespread time dependent impacts on: -The extent or morphology of a cSAC / ecologically important area. -A regionally important hydrogeological feature (or widespread effects to minor hydrogeological features). -Extent of floodplains. Widespread permanent impacts on the extent or morphology of an NHA/ecologically important area, Mitigation measures (to design) will reduce but not completely remove the impact – residual impacts will occur.
Positive or Negative	Moderate	Local time dependent impacts on: - The extent or morphology of a cSAC / NHA / ecologically important area. - A minor hydrogeological feature. - Extent of floodplains. Mitigation measures can mitigate the impact OR residual impacts occur, but these are consistent with existing or emerging trends
Positive, Negative or Neutral	Slight	Local perceptible time dependent impacts not requiring mitigation.
Neutral	Imperceptible	No impacts, or impacts which are beneath levels of perception, within normal bounds of variation, or within the bounds of measurement or forecasting error.

9.1.3.2 *Relevant Legislation*

The EIAR is prepared in accordance with the requirements of European Union Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (the 'EIA Directive') as amended by Directive 2014/52/EU. The requirements of the following legislation are complied with:

- the Planning and Development Act 2000 as amended, and the Planning and Development Regulations 2001 as amended.
- The Heritage Act 1995, as amended.

9.1.3.3 *Relevant Guidance*

The land, soils and geology section of this EIAR is carried out in accordance with the 'EIA Directive' as amended by Directive 2014/52/EU and having regard where relevant to guidance contained in the following documents:

- Environmental Protection Agency (2017): Draft Guidelines on the Information to be contained in Environmental Impact Assessment Reports;
- Environmental Protection Agency (2015): Draft - Advice Notes on Current Practice (in the preparation of Environmental Impact Statements;
- Environmental Protection Agency (2003): Advice Notes on Current Practice (in the Preparation on Environmental Impact Statements);
- Environmental Protection Agency (2002): Guidelines on the information to be contained in Environmental Impact Statements);
- Institute of Geologists Ireland (2013): Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements;
- COFORD (2004): Forest Road Manual – Guidelines for the Design, Construction and Management of Forest Roads;
- Forestry Commission (2004): Forests and Water Guidelines, Fourth Edition. Publ. Forestry Commission, Edinburgh;
- Coillte (2009): Forest Operations & Water Protection Guidelines;
- National Roads Authority (2005): Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (DoHPLG, 2018); and,
- Guidance on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU), (European Union, 2017).

9.1.4 Statement on Limitations and Difficulties Encountered

No difficulties were encountered during preparation of this Chapter of the EIAR.

9.2 EXISTING RECEIVING ENVIRONMENT

9.2.1 Site and Land Description

9.2.1.1 *Proposed Development*

The proposed development site (wind farm and turbine delivery route) as set out in Figure 1-1 of Chapter 1 and in section 2.3 of Chapter 2. The wind farm site is located approximately 9km northwest of Killaloe and ~3km southwest of the village of Bodyke, Co. Clare on the north-western slopes of Slieve Bernagh mountains. The total study area is approximately 749.69 hectares (~7.5 km^2). The site is roughly ovaloid in shape, ~ 4.7 km long along a northeast-southwest axis and approximately 2.2 km wide. A small spur ~ 1.2 km x 0.3 km juts out at the northern edge of the site. This spur meets an unnamed road which runs east-west through the townlands of Ballydonaghan and Caherhurly. Access to the site is along this road, via a smaller road which runs south from the crossroads at Caherhurly.

The southern half of the wind farm site slopes steeply in a north-westerly direction from the summit of Slieve Bernagh. Elevation ranges from 370m OD on the southern boundary of the site to 120m OD at its most northerly border. Two river valleys run in a north-westerly direction through the site, which provide the main drainage routes for site runoff. The majority of the site is covered in blanket bog which has been planted over with coniferous forests.

Proposed development works along the turbine delivery route involve third party lands (three areas) adjacent to the public road network required to accommodate the delivery of turbine components.

Works Area 1: 0.07ha to the northern side of the R352 in the townland of Coolready, Co. Clare approximately 1.1km southwest of Bodyke village.
Works Area 2: 0.4ha between the R352 and R465 in the townland of Coolready, Co. Clare approximately 450m south of Bodyke village.
Works Area 3: 0.5ha between the R464 and the L-8221 local road in the townland of Drummod, Co. Clare approximately 2.1km south of Bodyke village.
In addition, road widening works along a 2km section of the L-8221 local road, between the R465 and wind farm site entrance, will also be required.

A proposed development site location map is included in **Planning Drawing 19107-5001-A**.

9.2.1.2 *Grid Route*

The proposed grid route, which is approximately 25km in length, runs from the proposed Carrownagowan substation to Ardnacrusha. The route follows local roads through Kilbane town to the south of the site, then along the R446 and R471. From the R471 the route continues south along local roads towards the Ardnacrusha hydroelectric station. The location of the grid connection route is included in the drawing of the entire project in Appendix 2-1, Volume III.

9.2.1.3 *Replacement Forestry Lands (Ballard, Cooraclare & Trillickacurry)*

One of the 3 no. proposed replacement lands is situated at Cooraclare, Co. Clare. The site is located approximately 2.5 km west of Cooraclare town. The site comprises of two separate sections, with a total combined area of approximately 10.78 ha. The elevation at the site ranges between 18 and 22 m OD and slopes gently towards the Doonbeg river, along the southern boundary of the site. The site is accessible via an unnamed local road taken 3 km northwest of Coolaclare in the townland of Danganella West. The site is an area of previously cut bog, where all economic removal of peat has been completed. The site is drained to the south by the Doonbeg river (IE_SH_28D020725) which flows northwest towards Doonbeg. Within the western section of the site, a small drain ~150m long, constructed to drain the bog area, runs southwest into the Doonbeg river.

The second of the proposed replacement lands is located at Ballard, Co. Wicklow. It comprises two individual land areas with a total combined area of 0.37 km^2(37 ha). The land areas are situated ~1.2 km west of Ballinaclash and approximately 4.4 km southwest of Rathdrum. These areas are accessible by following the R753 north to Ballinaclash, before turning left in Ballinaclash, heading west out a small Local road for ~1.5 km. The site is located on the north-eastern slope of Cushbawn hill, with elevation ranging from 160 mOD and the slope to the north / northwest to 220m OD. The lands are drained by a small stream which flows north-easterly close to the northern boundary of the site.

The third proposed replacement lands site is situated at Trillickacurry, Co. Longford. The site is located approximately 1 km southeast of Lisduff crossroads and approximately 3.5 km southeast of Longford town. The site comprises of three separate sections, with a total combined area of approximately 0.24km^2 (24ha). The elevation at the site ranges between 65-75 mOD and slopes gently in a south-easterly direction. The site is accessible via an unnamed road south at Lisduff crossroads. The site is an area of previously cut bog, where all economic removal of peat has been completed. The site is drained to the south by a small stream (Cloonkean stream, IE_SH_26C010900) which flows west along the southern boundary of the site.

Site location maps are included as Figures 1.3, 1.4 and 1.5 in Chapter 1 of the EIAR**.**

9.2.2 Soils and Subsoils

9.2.2.1 *Proposed Development*

The published soils map for the proposed development site is attached (www.epa.ie) as Figure 9.1. Blanket peat (BktPt) is the dominant soils type on the northern lower lying section of the site and also on the more elevated eastern and western sections of the site, along with pockets of deep poorly drained mineral soils derived from acidic parent material (AminPD). Poorly draining peaty soils are mapped in the central and south-central area of the site (towards the summit of Slieve Bernagh.

Mapped subsoils at the site are a mixture blanket peat (as described above) and Tills derived from Devonian Sandstone parent material (TDSs). The sandstone tills are mapped in the central southern area of the site. The published subsoils map for the proposed development site is attached as Figure 9.2. Areas of rock outcrop are mapped close to the Coumnagaun River channel, as well as at the western and northern edge of the site. Alluvium is also mapped along the route of the Coumnagaun River.

Along the turbine delivery route, soil and subsoil at the three sites is also mapped in Figures 9.1 and 9.2 (Volume III, Appendix 9-1) and predominentaly constitutes mineral soils over sandstone till / cutover peat.

Peat depths at the 19 no. turbine locations across the wind farm site have been investigated by HES during a site visits in October 2019. Information from these peat depth gauging works are included in Section 9.2.7. Depths will generally be shallower on the more elevated areas of the site and potentially deeper on lower lying flatters areas such as the north of the site. The blanket peat has been planted over with conifer trees throughout the site and there is little indication that the peat was cut for turf in the past. MWP completed 790 peat probes across the site with peat depths ranging from 0.05m to 4m. A peat depth map for the wind farm site is attached as Figure 9.3. Peat depth intervals recorded at the site (including all MWP and HES data) are shown on the histogram presented as Figure 9.4. Shear strengths were recorded at 489 data points and ranged between 4kPa to 62kPa.

20 no. trial pits have also been completed by MWP between 08th July 2019 – 21st August 2019. A summary of the trial pit information is contained below in Table 9.4. A trial pit location map is attached as Figure 9.5. The Ground Investigation Factual Report with the original trial pit logs is included as **Appendix 3-5**.

Table 9.4. Summary of trial pit logs from 20 no. trial pit locations

Trial Pit No.	Depth of TP (m)	Depth of PEAT	Subsoil Description
2	2.5	1	PEAT above grey/brown CLAY above Firm to stiff gravelly CLAY
3	2.2	1.2	PEAT above soft to firm silt, sandy, gravelly CLAY with cobbles and boulders. Possible bedrock at 2.2m.
4	2.5	1.8	PEAT above purple/brown silty, sandy gravelly CLAY
5	3.5	2.5	Peat above grey silty sandy gravelly CLAY
6	3.8	2.5	PEAT above blue/grey silty sandy CLAY above purple very sandy, very gravelly SILT/CLAY with cobbles and boulders
7	3.8	2	PEAT above firm purple/grey silty, sandy, gravelly CLAY with cobbles and boulders
8	2.6	0.4	PEAT above grey soft gravelly CLAY above purple firm silty, sandy, gravelly CLAY
10	4	1.3	PEAT above firm to stiff grey sandy, gravelly CLAY above stiff to very stiff brown grey sandy, gravelly CLAY
11	4	0.2	PEAT above grey/brown CLAY above firm to stiff grey/brown gravelly CLAY with frequent cobbles and boulders
12	3.2	1.8	PEAT above firm blue/grey sandy, gravelly CLAY
13	3.8	1.4	PEAT above soft grey sandy CLAY above brown/purple clayey GRAVEL
15	2.4	1.3	PEAT above firm grey gravelly CLAY above brown firm silty, sandy gravelly CLAY with cobbles and boulders
16	2.5	1.4	PEAT above grey/blue soft CLAY above firm purple sandy gravelly CLAY with cobbles and boulders
17	1.3	0.15	PEAT above sandy, gravelly CLAY above grey very clayey GRAVEL with cobbles and boulders. Possible bedrock at 1.3m.
18	1.7	1.6	PEAT above possible bedrock at 1.7m.
19	1	1	Poorly stable PEAT
20	2.5	1.4	PEAT above red/brown weathered SHALE.
21	2.5	1.5	PEAT above red/brown clayey sandy GRAVEL (possible weathered shale)
22	4.2	1.5	PEAT above brown silty SAND above grey/purple silty SAND with cobbles and boulders.
23	2.5	1	PEAT above red/brown sandy CLAY above weathered SHALE.

The summary trial pit information within Table 9.4 shows the site subsoil typically characterized by PEAT over CLAY which is generally silty and/or sandy and/or gravelly. The depth of the peat ranges from 0.15 to 2.5m. The CLAY below the peat is typically firm to stiff and purplish grey/brown in colour. Possible bedrock was encountered within TP3, TP17 and TP18. The bedrock was not described in the logs of these trial pits. Weathered bedrock, described as red shale, was encountered at TP20, TP21 and TP23.

In addition to trial pits, gouge augering was undertaken by HES in October 2019. Peat depth was gauged at the 19 no. turbine locations across the proposed development site. An assessment of the drainage regime was also undertaken at these sites. The results of the peat depth assessment are included below as Table 9.5.

Table 9.5. Peat depth gauge results from 19 no. turbine locations.

Turbine No.	Peat Depth (m)	Subsoil under Peat	Drainage observations
1	1.1	sandy gravelly till	Open area of peatland, surrounded by forestry plantations
2	0.95	sandy gravelly till/bedrock	Undulating, uneven, replanted forestry, dry hard well drained peat
3	~2.0	sandy gravelly till	Medium size trees, very soft sphagnum peat at ground level
4	1.08	till	Deep peat drains along cleared access path, sloping ground, proximity to SAC, but fire break in between
5	~2.4	rock/boulder	Rock outcrop to southwest, medium size trees
6	~2.1	till	Heavy trees at turbine location, with deep peat drains (~1.0m) with flowing water towards drain along forestry road to north
7	0.98	brown gravelly clay	Trial pit completed at T base
8	1.35-1.45	clay and rock	Slight deeper peat downhill to west-northwest
9	1.1	rock/boulder	Close to road junction, trial pit completed at junction, drainage to north, and east based on aerial photos
10	1.6	sandy gravelly till	Trial pit and auger location ~100m from Turbine location
11	1.75	brown clay/till	Fire break running north from turbine location towards forest road, deep drain running west along forest road.
12	2.2	sandy gravelly till	Trial pit completed at turbine base, wet area at edge of forest road where drainage is impeded
13	2.54	soft clay/till	North toward old forest road
14	2-2.3	sandy gravelly till	Stream emerging from forestry at 0563434, 0677482
15	1.8-2.1	sandy till	Auger locations ~20m from turbine base location
16	1.2	sandy till/boulders	Trial pit completed at turbine base
17	0.5	sandy till	Grassy virgin bog, no drains present
18	0.45	sandy gravelly clay	Young conifers, drains running adjacent to forestry road
19	0.8	sandy gravelly clay	Drains running north/northwest

Peat depths range from 0.4 – 2.4 m and are generally deepest towards the south of the site, which is topographically higher. The deepest peat is found near T12, T13 and T14 towards the southeast of the site, while the shallowest peat is found near T17, T18 and T19 towards the north of the site. The subsoil beneath the peat is typically a mixture of sandy gravelly till and sandy, sometimes gravelly clay.

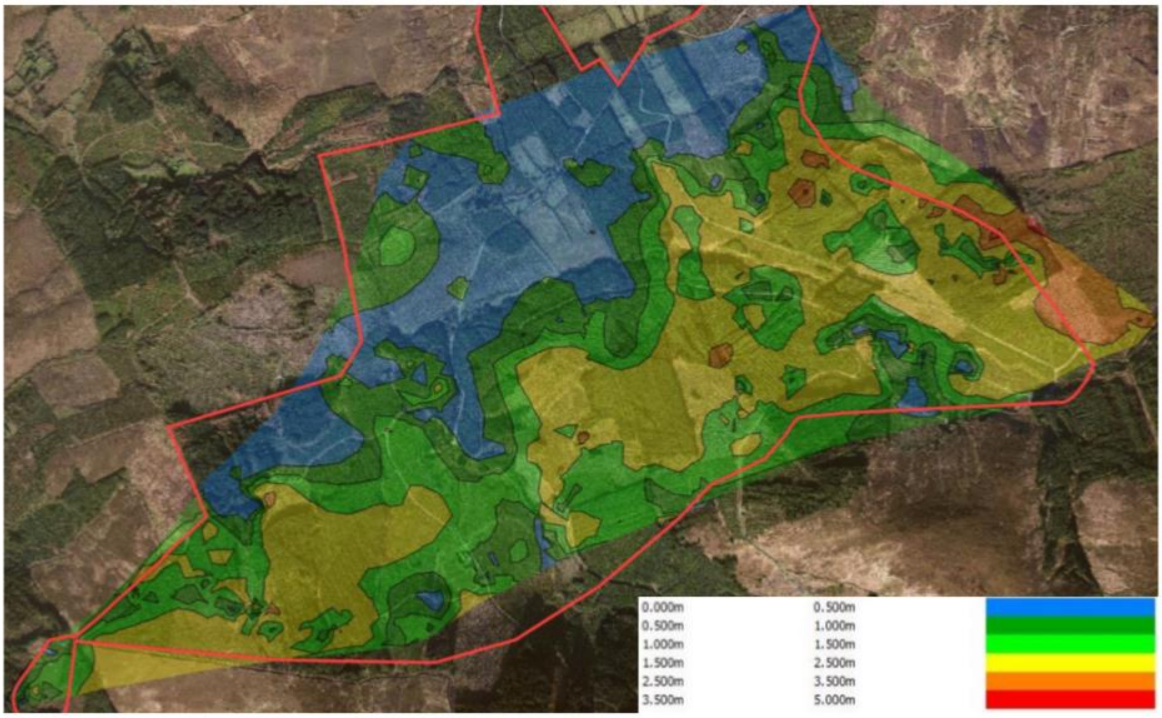

Figure 9.3: Peat Depth Map (Wind Farm)

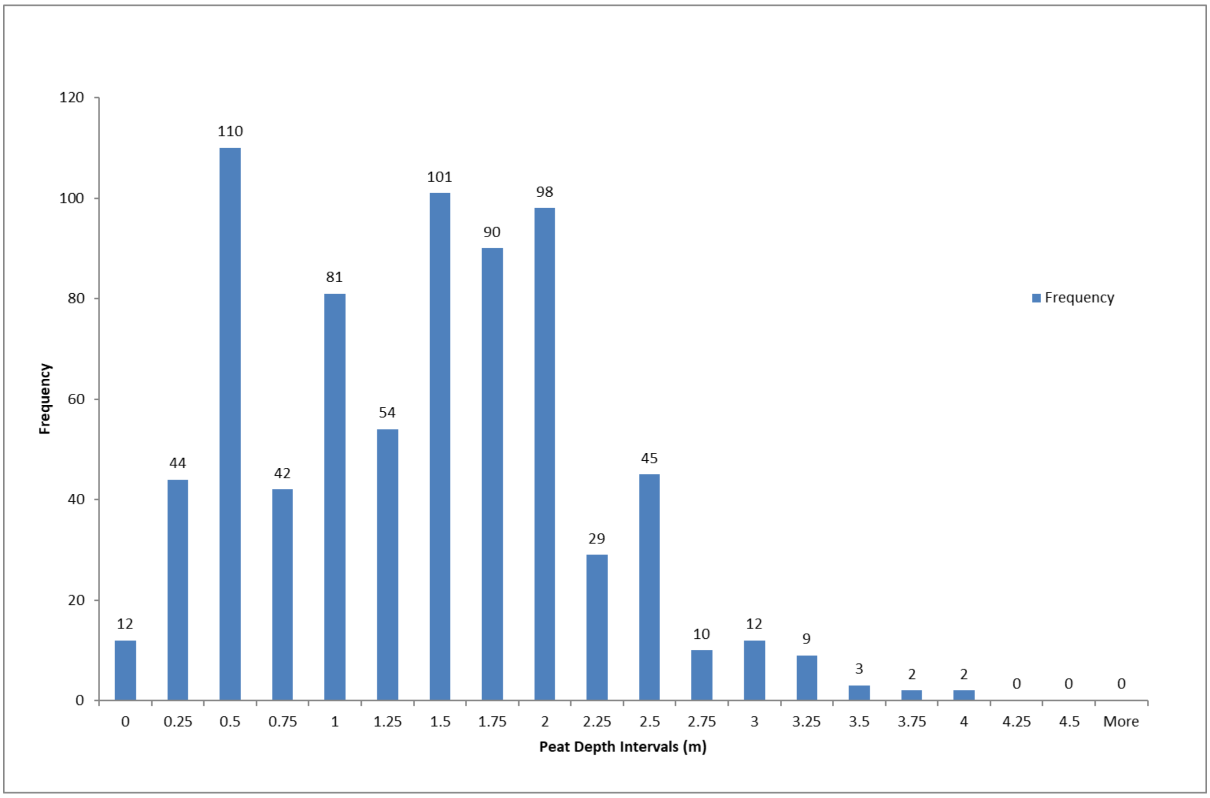

Figure 9.4: Peat depth frequency distribution plot

9.2.2.2 *Grid Route*

The grid route mainly runs along the carriageway of public roads and on access track within the proposed development site. Soils mapped locally along the grid route comprise mainly Acidic deep well drained mineral soils (AminDW) at the northern end of the route, transitioning to Acidic shallow well drained mineral soils (AminSW) through much of the middle section and finally Acidic deep poorly drained mineral soil (AminPD) and the southern end. Subsoils are mapped as mainly sandstone and sandstone/shale tills.

Published soils and subsoils maps for the proposed grid route are included as Figure 9.6 and 9.7.

9.2.2.3 *Replacement Forestry Lands (Ballard, Cooraclare & Trillickacurry)*

Soils are mapped at Cooraclare as generally cut peat along the western land area, transitioning to blanket peat near the local road to the north of this area. The soils along the eastern land are mapped as blanket peat (BkPt) with a small area of acidic, poorly drained mineral soil (AminPD) located to the south of the eastern land area.

Subsoils are mapped at Cooraclare as cut over raised peat and blanket peat, with a small area of Tills derived from Namurian shales (TNSSs) underlying the pocket of acidic mineral soil.

Soils are mapped at Ballard mainly as deep well-drained acidic mineral soils (AminDW), with a small area of poorly drained acidic mineral soils with peaty topsoil (AminPDPT). Subsoils are mapped at Ballard as Tills derived from Lower Palaeozoic sandstones and shales.

Subsoils are mapped at Trillickacurry as cutover over raised bog at the edges of the site, transitioning to Tills derived from Palaeozoic and Carboniferous sandstones and shales within the center of the site.

Published soils and subsoils maps for the Replacement Lands (Ballard, Cooraclare and Trillickacurry) are included on Figures 9.8, 9.9, 9.10 (soils) and Figures 9.11, 9.12, 9.13 (subsoils).

9.2.3 Bedrock Geology

9.2.3.1 *Proposed Development*

According to the GSI, the northern half of the Wind Farm site is mapped to be underlain by Devonian Old Red Sandstone (ORS) consisting of sandstone, conglomerate and siltstone. The southern half of the site is mapped to be underlain by Silurian meta-sediments which are compriseed locally of mainly greywacke. Outcrop is sparse throughout the site, given the cover of the blanket peat and mineral subsoils, but in general bedrock exposures at the site confirm the mapped geology. An exposure of bedrock is included below as **Plate 9-1**.

Plate 9-1: Bedrock exposure at disused borrow pit.

A regional northeast – southwest trending fault is mapped to intercept the eastern section of the site. A bedrock geology map for the proposed development site and grid route is included as Figure 9.14. The bedrock presented in Figure 9.14 shows the work areas along the turbine delivery route. While the proposed development site is predominantly underlain by sandstone, the works area in the foresty at Coolready is underlain by limestone.

9.2.3.2 *Grid Route*

The majority of the grid route is mapped to be underlain by similar bedrock to that of the windfarm which is a combination of ORS and Silurian meta-sediments. However, Dinantian sandstone, shales and (impure) limestones are mapped at the far southern end of the route.

9.2.3.3 *Replacement Forestry Lands (Ballard, Cooraclare & Trillickacurry)*

Bedrock is mapped at the Ballard site as Ordovician meta-sediments. Bedrock is mapped at the Cooraclare site as Gull Island Formation, grey siltstone and sandstone. Bedrock is mapped at the Trillickacurry site as Dinantian (Early Carboniferous) Impure Limestone. Bedrock geology maps for the replacement land sites are included as Figure 9.15, Figure 9.16 and Figure 9.17.

9.2.4 Geological Heritage

9.2.4.1 *Proposed Development*

There are no geological heritage sites locally at the proposed development site. The closest geological heritage site is located in small quarry at Ballymalone approximately ~3.1km northeast of the proposed development site (GSI Site Code: CE005). Graptolite fossils within an Ordovician bedrock formation were dated here to be of Caradoc age.

9.2.4.2 *Grid Route*

There are no mapped geological heritage sites along the proposed grid route. The geological heritage site at Ballymalone (as described above) is ~8km to northeast to the proposed grid connection route. Two additional geological heritage sites are located to the west of the grid route. These are Ballyvorgal South (GSI Site Code: CE006, 10.2km west), and Ballygar South (GSI Site Code: CE002, ~2.2km west). Ballyvorgal South is a streambank exposure with deep water fossil assembleges of Upper Ordovician Age, and Ballygar South is an agricultural grassland with underlying rock fossial assembleges of Silurain Age.

9.2.4.3 *Replacement Forestry Lands (Ballard, Cooraclare & Trillickacurry)*

There are no mapped geological heritage sites at any of the replacement land locations.

9.2.5 Soil Contamination

9.2.5.1 *Proposed Development*

There are no known areas of soil contamination on the site of the Proposed Development (wind farm and delivery route). During the preliminary and detailed site walkovers and site investigation works, no areas of contamination concern were identified.

According to the EPA online mapping (http://gis.epa.ie/Envision), there are no licenced waste facilities on or within the immediate environs of the site of the Proposed Development.

There are no historic mines at or in the immediate vicinity of the site of the Proposed Development that could potentially have contaminated tailings.

9.2.5.2 *Grid Route*

There are no reports of soil contamination along the grid route.

9.2.5.3 *Replacement Forestry Lands (Ballard, Cooraclare & Trillickacurry)*

There are no reports of soil contamination at the proposed replacement land sites.

9.2.6 Economic Geology

9.2.6.1 *Proposed Development*

According to the GSI (www.gsi.ie), the crushed rock aggregate potential in the area of the proposed development is Low to Moderate with some very low potential for granular aggregate.

There are no existing commercial quarries or pits in the locality of the proposed development site.

9.2.6.2 *Grid Route*

The crushed rock aggregate potential and the granular aggregate potential along the grid route is Low to Moderate and similar to the area of the proposed development site.

9.2.6.3 *Replacement Forestry Lands (Ballard, Cooraclare, & Trillickacurry)*

The crushed rock aggregate potential at the replacement land sites vary from Low to High with Low granular aggregate potential.

9.2.7 Peat Stability Risk Assessment

9.2.7.1 *Proposed Development Site*

A peat stability assessment has been undertaken by MWP for the proposed development. While the proposed development includes the wind farm and the turbine delivery route, no peat stability assessment was required at the works areas on the delivery route as there are no steep slopes, no areas of deep peat or no rivers present. Therefore the peat stability assessment, attached as **Appendix 9-2,** refers to the wind farm infrastructure.

The Carrownagowan wind farm was designed from the outset with a constraints-driven approach to place turbines in low risk areas. MWP completed extensive walkovers and surveys of the site between May 2018 and November 2019 and completed 790 peat probes across the site with peat depths ranging from 0.05m to 4m. Shear strengths were recorded ranging from 4kPa to 62kPa. Initial constraints were defined by housing setback, watercourse buffering, buffering of designated areas and areas of high conservation forestry, and buffering of areas of ecological interest. MWP then employed high resolution LiDAR data to create an accurate Digital Elevation Model (DEM) of the site and then used ground slope as a primary design constraint to place infrastructure in areas of the site with low ground slope. MWP then completed a Risk Assessment using the Peatslide Hazard Rating System (PHRS) (Nichol, 2006).

The PHRS is a step in the process of peat stability risk assessment (Refer to **Volume III, Appendix 9-2** for full assessment). The findings of the PHRS at 24 no. infrastructure locations were that the risk ranged from Negligible (Substation, PMM (Proposed Met Mast), T18, BP1, BP3) through Very Low for the majority of the site to Low (T5 and T14). Results are presented in Table 9.6. The recommended Engineering Response to a finding of a Low Hazard rating is that Further investigation of the peat slide hazard may be required and this has been done as part of this assessment as discussed below.

Table 9.6. Peat Hazard Rating System Score.

Peatslide Hazard Rating Score	Area of Infrastructure	Engineering Response
Negligible	T17, BP1, BP3, PMM, Substation	Do nothing. Acceptable.
Very Low	T1, T2, BP2, T3, T4, T6, T7, T8, T9, T10, T11, T12, T13, T15, T16, T18, T19	Monitor and review. Manage by normal slope maintenance procedures (i.e. visual weekly monitoring).
Low	T5, T14	Further investigation of the peat slide hazard may be required. Manage by normal slope maintenance procedures (i.e. visual weekly monitoring).
Low-Moderate	None	Peatslide stabilisation works may be required.
Moderate	None	Peatslide stabilisation works may be required. Further studies required to refine judgements.
High	None	Peatslide stabilisation works likely to be required. Further investigations will be

		required, including a comprehensive assessment of risks.
Very High	None	Large scale mitigation works will be required. Urgent requirements for further investigations, including a comprehensive assessment of risks.

Following on from the PHRS above in Table 9.6, further investigation of the hazard was carried out by MWP which included an Infinite Slope Stability Analysis (ISSA) for the entire site using the peat probe data and slope data from the LiDAR DEM to calculate the Factor of Safety (FoS) against peatslide for each location probed. ISSA analysis was completed at 790 locations.

The ISSA output was that the majority of the site had a FoS against peatslide in excess of 4 with no infrastructure placed in areas with a FoS less than 2. This is illustrated in Table 9.7 where FoS outputs for baseline condition, and a surcharged condition, which considers a worst-case-scenario of additional loading of 1m of stockpiled peat, are presented for the 24 no. infrastructure locations used in Table 9.6 above.

Table 9.7. ISSA FoS Results.

Infrastructure Location	Easting	Northing	Factor of Safety for Load Condition	
			Baseline (Load Condition 1)	Surcharged (Load Condition 2)
T1	559385	675575	27.99	11.03
T2	559850	676030	11.90	6.49
T3	560484	675908	7.26	3.80
T4	561137	675897	8.68	4.73
T5	560394	676494	12.47	8.69
T6	561109	676437	21.71	14.71
T7	561881	676649	18.21	9.11
T8	562533	676815	9.45	5.51
T9	561098	676928	26.36	14.38
T10	561800	677115	20.79	13.09
T11	562539	677308	8.51	5.57
T12	563149	677146	5.22	3.68
T13	563650	677042	46.01	26.01
T14	563431	677641	12.47	8.80
T15	562982	677858	40.47	13.49
T16	562556	678103	20.78	10.39

Infrastructure Location	Easting	Northing	Factor of Safety for Load Condition	
			Baseline (Load Condition 1)	Surcharged (Load Condition 2)
T17	561903	677741	262.09	43.68
T18	561234	677472	23.14	6.61
T19	561435	678011	95.51	52.10
PMM	561144	677998	859.61	143.27
BP1	560270	676570	115.43	32.98
BP2	561098	676928	45.19	18.61
BP3	562640	678660	66.88	19.11
Substation	561890	678280	287.41	26.13

For the stability analysis two load conditions were examined, namely

Condition (1): no surcharge loading

Condition (2): surcharge of 10 kPa, equivalent to 1 m of stockpiled peat assumed as a worst case.

MWP completed assessments of the risk presented using the industry best practice guidance of the Scottish Executive (2006) and the revised 2017 Scottish Government guidelines for 'Peat Landslide Hazard and Risk Assessments'. The outcome of the risk assessment was that landslide presented a Negligible to Low Level of risk to the Wind Farm Infrastructure.

In summary, the peat stability risk assessment completed by MWP was undertaken in a two-step fashion. The initial Peatslide Hazard Rating System was used to define hazard ranking for all elements of the proposed wind farm development. The output of this method of analysis was that the area represented a **Negligible** to **Low** Hazard Rating for peatslide. The findings reflect the mitigation by design philosophy adopted in designing the wind farm infrastructure of avoiding areas of steeper slopes from the outset. The Engineering Design Response for a Low PHRS score is to complete "*Further investigation of the peat slide hazard may be required. Manage by normal slope maintenance procedures*." Further investigations were completed and as such MWP completed ISSA across the whole site, using 790 analysis points, combining peat depth and slope to complete the computational slope stability assessment. The output of the ISSA was that peat landslide presented a **Negligible Risk** to the infrastructure of the Wind Farm. The two-step approach taken is conservative and gives added confidence by way of parallel outputs.

Design measures in the form of a peat stability monitoring programme during construction has been proposed in order to mitigate this low level of risk. These monitoring proposals are presented in Section 9.5.1.5.1.

9.2.7.2 *Grid Route*

The route of the grid connection is mainly along the route of existing roads and no peat is mapped locally. The Peat Stability Risk Assessment is not required on the grid route as there are no steep slopes or no deep peat along the grid route.

9.2.7.3 *Replacement Forestry Lands (Ballard, Cooraclare & Trillickacurry)*

There is some cutover peat mapped at the replacement sites. However, the replanting works do not require a peat stability assessment as there are no steep slopes or no deep peat, and no civil works are proposed.

9.2.8 Do-Nothing Scenario

Surface water drainage in areas of existing access roads and coniferous plantations will continue to function and may be extended in the case of coniferous plantation. Coniferous forestry will be felled as forestry compartments reach maturity. Re-planting of these areas with more coniferous trees is predicted. Ground Preparation including mounding and wind rowing will take place to facilitate afforestation. This will be carried out in accordance with The Department of Agriculture , Food and the Marine - Environmental Guidance for Afforestation Dec 2016 :

https://www.agriculture.gov.ie/media/migration/forestry/grantandpremiumschemes/2016/EnvironmentalRequirementsAfforestationDecember121216.pdf

The land, soils and geology will remain largely unaltered in the Do-Nothing Scenario.

9.3 CHARACTERISTICS OF THE PROJECT

The proposed development will involve removal of peat, subsoil and bedrock for additional access road and hardstanding emplacement. Bedrock for construction will be sourced from 3 no. proposed borrow pits. It is proposed that these borrow pits will be used as peat and subsoil (spoil) disposal areas. A further 30,933 m^3 of stone (aggregate and capping) will be imported from local approved quarries for construction of access roads, hardstands and compounds.

Estimated volumes of peat and spoil are presented in Table 9.8. Not all of the peat and soil excavated will be sent to the peat disposal areas, a portion will be used for reinstatement and landscaping works around the site (~43,715m^3). Bedrock excavated during cut and fill works will be used for filling along the development footprint. Peat and spoil storage volumes are presented in Table 2.4 of the EIAR. Further details are provided in Chapter 2, Section 2.3.3.15 of the EIAR.

Table 9.8. Estimated Peat, Mineral Soil and Bedrock Excavation Volumes

Development Component	Peat (m^3)	Rock/Mineral Soil (m^3)	Total (m^3)
19 No. Turbines & Hardstands	80,847	34,729	115,576
Substation Compound	2,108	38,296	40,404
Access Roads	47,175	42,393	89,568
2 no. Construction Compounds	1,670	9,231	10,901
Permanent Met Mast Hardstand	37	250	287
Total	**131,837**	**124,899**	**256,736**

9.4 LIKELY SIGNIFICANT EFFECTS

The assessment of the likely significant effects is outlined below. As the bulk of the earthworks and excavations will be at the proposed development lands, where the wind farm will be constructed, this is the main focus of the assessment. The grid route, turbine delivery route and the replacement lands are all included where relevant.

9.4.1 Construction Phase

9.4.1.1 *Land & Land Use*

Topography will be altered slightly by excavation works and access road creation within the proposed development site, but these small changes will be imperceptible on a wider land/landscape scale. There will be no significant change to the forestry elements within the proposed wind farm site.

Similarly along the grid connection route, and turbine delivery route there are only very small proposed changes to land, and imperceptible changes to topography. Along the grid connection route all excavations will be reinstated to existing ground/road level.

The proposed wind farm development lands are located predominately within existing commercial conifer forestry that is owned and managed by Coillte, for timber production. The surrounding land use, outside the proposed development site, is a mixture of rural farm land and low density residential settlement. The area is well served by a network of local roads and there is already a substantial network of existing forestry roads providing access in and around the Coillte site. A section of public road, the L-8218 Local road, provides access the forestry site.

There are currently no defined recreational land-uses within or associated with the proposed development site. Coillte do however grant limited recreational permits/licences for seasonal hunting activities within the plantation and has an open forestry policy, which facilitates pedestrian access over the forest roads.

The nearest forestry lands offering general public recreational amenities are situated on Crag Hill on the lower slopes of the Slieve Bernagh Mountains over looking Lough Derg. There are 3 way marked trails in this forest – one is a moderate looped walk called the Crag Wood Walk and this trailhead also gives access onto the East Clare Way. A new trail was constructed in 2016 which allows visitors to access Moylussa, the highest point in county Clare.

The land-use along the grid connection comprises mainly transport, and surrounding land use is mainly agriculture and residential.

All new development proposals have the potential to effect the local area character and human environment by introducing a new incompatible land use activity which could result in physical disruption, severance or exclusion of users ability to continue existing activities or the sterilisation of lands thus preventing any additional further land-use potential.

During construction there will be a level of effect on existing land-uses within the development site. Existing forestry activities and harvesting within the plantation will cease for the duration of the construction works. Hunting and public access within the plantation will also be prohibited during construction and decommissioning. Usage of the section of public road, the L-8218 Local road, which passes through the site will be restricted during construction. Similarly during decommissioning there will be restrictions on public access within the site. Outside of the development footprint it is not envisioned that land use activities will be adversely impacted.

Once the wind farm is operational conventional felling and forestry activities will resume and continue to take place at the site independent of the wind farm development. Only a relatively small area of commercial forestry, approximately 10% of the proposed development site, will be permanently displaced in the footprint of the wind farm infrastructure. This loss of land use will not be significant.

Also there will be no severance, loss of rights of way or public amenities during the operational phase. It is likely that the improvements to the on-site forestry tracks would provide opportunities for further development and use of some of the forest areas for recreation. Therefore no significant negative effects are predicted on the potential recreational use.

In terms of impacts to neighbouring lands and land-uses it is considered that the wind farm developments do not pose a significant risk to either existing or future land-uses. All existing land-use practices can co-exist with the proposed wind farm.

The land-use along the grid connection comprises mainly transport, and surrounding land use is mainly agriculture and residential. The grid connection construction works, estimated to be 10 months in duration, would require a road opening licence and temporary traffic management measures along the grid route, including alternating one-way stop/go traffic and temporary road closures with local diversion routes. This will result in disruption to existing traffic and access for local land owners and property owners/residents in the vicinity of the route.

The active construction area for the grid connection will be small, ranging from 100 to 200 metres in length at any one time, and it will be transient in nature as it moves along the route. The grid connection construction works will therefore have a temporary moderate short-term negative impact for road users and local land owners and property owners/residents in the vicinity of the route. Once in place, the grid connection will not affect existing or further land uses.

Overall it is considered that during the construction phase there is likely to be a slight to moderate negative impact on land use within the wind farm site and along the grid connection route. Similarly during decommissioning there is likely to be temporary disruptions to land-uses and access. Impacts would be temporary and not significant. During operation it is considered that the wind farm development would have a neutral impact on land-uses.

There are no construction works associated with the replacement forestry lands.

Pathway: extraction/excavation of the substrate and landscaping.

Receptor: The receptor is the land and land use.

Pre-Mitigation Potential Impact: Negative, slight, temporary impact on land and land use at the wind farm site during construction phase.

Negative, moderate, short term impact on land and land use along the grid route during construction phase.

9.4.1.2 *Peat, Subsoil and bedrock excavation*

Excavation of peat, subsoil and bedrock will be required for site levelling, construction of the wind farm site infrastructure, *i.e.* gravity foundations for turbine bases, crane hardstands, met masts, substation, internal cable network and turbine delivery route accommodation works. This will result in a permanent removal of peat, subsoil and bedrock at excavation locations. Estimated volumes of peat and bedrock to be removed are shown in Table 9.8 and Table 2.4 above. The total volume of peat to be excavated is 131,837m^3, and the total volume of spoil is 124,899m^3. ~35% or 43,715m^3 of the excavated spoil material will be reused as site won aggregate. The remainder of peat and spoil will be used in landscaping (88,264m^3), roadside berms (9,714m^3), and placement in deposition areas at the 3 no. borrow pits (114,083m^3). There is no loss/export of peat or subsoil/spoil, it will just be relocated within the site.

Pathway: The mechanism for this impact will be extraction/excavation of the substrate.

Receptor: The receptor is the peat, soil and bedrock at the site.

Pre-Mitigation Potential Impact: Negative, slight/moderate, direct, likely, permanent impact on peat, subsoil and bedrock.

9.4.1.3 *Potential Contamination of soil through leakages/spillages and alteration of peat/soil geochemistry.*

Accidental spillage during refuelling of construction plant with petroleum hydrocarbons is a pollution risk. The accumulation of small spills of fuels and lubricants during routine plant use can also be a significant pollution risk. Hydrocarbon has a high toxicity to humans, and all flora and fauna, including fish, and is persistent in the environment. Large spills or leaks have the potential to result in significant effects (i.e. potential contamination of peat, subsoils and pollution of the underlying aquifer) on the geological and water environment.

Pathway: The pathway for this impact is through infiltration through pore space in the soil/bedrock.

Receptor: The receptor is the peat, soil, subsoil and bedrock.

Pre-Mitigation Potential Impact: Negative, direct, slight, short term, unlikely impact on peat, soil, subsoil and bedrock.

9.4.1.4 *Erosion of exposed subsoils and peat during tree felling and infrastructure construction work*

Exposed subsoils and peat may become eroded through interaction with surface water and winds, as well as from vehicle movement over the exposed surfaces.

Pathway: Movement of vehicles, surface water and wind interaction

Receptor: The receptor is the peat, subsoil and weathered bedrock.

Pre-Mitigation Potential Impact: Negative, direct, slight, likely impact on peat, subsoil and bedrock.

9.4.1.5 *Peat instability and failure*

A slope failure involves a mass movement of earth material (including peat material) under shear stress along one or several surfaces. The movement may be rotational or planar (Landslides in Ireland, (GSI, 2006)). Peat instability or failure (peat slides) refers to a significant mass movement of a body of peat that would have an adverse impact on the Proposed Development site, proposed construction access road and the surrounding environment. Peat failure excludes localised movement of peat that could occur below an access road, creep movement or erosion type events. The consequence of peat failure at the proposed development site may result in:

- Death or injury to site personnel;
- Damage to machinery;
- Damage or loss of infrastructure;
- Drainage disruption by blockage of drainage pathway by relocated peat and spoil;
- Site works damaged or unstable;
- Potential contamination of watercourses, water supplies by particulates; and,
- Degradation of the peat environment by relocation of peat and spoil.

Pathway: Vehicle movement and excavations

Receptor: Peat subsoils

Pre-Mitigation Potential Impact: Negative, significant, direct, low probability permanent effect on peat and subsoils. The findings of the peat stability assessment showed that the proposed development site at Carrownagowan has an acceptable margin of safety, is suitable for the proposed wind farm development and is considered to be negligible to low risk of peat failure (*c.f.* Section 9.2.7). The findings of the PSRA will be adopted and include recommendations for monitoring and control measures for construction work in peatlands.

9.4.1.6 *Replacement Forestry Lands - Replanting Sites*

At the 3 no. replanting sites, soils and peats can be disturbed during mounding and replanting works. Disturbance will be small scale and temporary in nature.

Pathway: Vehicle movement, mounding works and planting.

Receptor: Peat and subsoils

Pre-Mitigation Potential Impact: Negative, slight, direct, high probability permanent effect on peat and subsoils.

9.4.1.7 *Grid Connection*

Excavation of soils, subsoils and bedrock will be required along the grid route. These works will result in temporary and transient disturbance of road surfaces, subsoil and bedrock. The majority of subsoil excavated along the grid cable connection will however be reinstated back within the trench.

Pathway: Excavation/trenching works.

Receptor: Soils, subsoils and bedrock.

Pre-Mitigation Potential Impact: Negative, slight/moderate, direct, high probability permanent effect on soils, subsoils and bedrock.

9.4.1.8 *Turbine Delivery Route*

Excavation of soils, subsoils will be required along the turbine delivery route at 3 no. locations (as described in Section 3.3). These works will result in temporary and transient disturbance of road surfaces and soil/subsoils. The soil/subsoil excavated along the turbine delivery route will be used locally for landscaping at the 3 no locations where works are required.

Pathway: Excavation/landscaping works.

Receptor: Soils and subsoils (no bedrock excavation required).

Pre-Mitigation Potential Impact: Negative, slight, direct, high probability permanent effect on soils and subsoils, with no impact on bedrock.

9.4.2 Operational Phase

9.4.2.1 *Land & Land Use*

All potential impacts to land and land use will occur during the proposed development construction phase. No additional impacts to Land and Land use will occur during the Operational phase, as no further works are proposed.

Pathway: excavation works.

Receptor: Soils, subsoils and bedrock.

Pre-Mitigation Potential Impact: No impact, as no works proposed.

9.4.2.2 *Forestry Replanting Sites*

At the 3 no. replanting sites, soils and peats could be disturbed during thinning and felling works which occur during the lifetime of a forest. Disturbance is likely to be small scale and temporary in nature.

Pathway: thinning/harvesting forestry.

Receptor: Soils, subsoils and bedrock.

Pre-Mitigation Potential Impact: Negative, slight, direct, high probability permanent effect on peat and subsoils.

9.4.2.3 *Grid Connection*

Minor excavations of replaced soils, subsoils, trench backfill material could be required along the grid route if a fault occurred during the operational phase. These works would be temporary and short duration. Any material excavated during such works would however be reinstated back within the trench.

Pathway: Excavation/trenching works.

Receptor: Soils, subsoils and bedrock.

Pre-Mitigation Potential Impact: Negative, imperceptible, direct, low probability temporary effect on soils, subsoils and bedrock.

9.4.2.4 *Fuel/Oil spillage from Operational Stage Vehicles*

Some construction vehicles or plant may be necessary for maintenance of turbines which could result in minor accidental leaks or spills of fuel/oil.

Pathway: The pathway for this impact is through infiltration through pore space in the soil/bedrock.

Receptor: The receptor is the underlying peat, soil, subsoil and bedrock.

Pre-Mitigation Potential Impact: Negative, imperceptible, direct, long term, unlikely impact on peat, soil, subsoil and bedrock.

9.4.2.5 *Transformer Oil leakage*

The transformer in the substation and transformers in each turbine are oil cooled. There is potential for spills / leaks of oils from this equipment resulting in contamination of soils and groundwater.

Pathway: The pathway for this impact is through infiltration through pore space in the soil/bedrock.

Receptor: The receptor is the underlying peat, soil, subsoil and bedrock.

Pre-Mitigation Potential Impact: Negative, imperceptible, direct, long term, unlikely impact on peat, soil, subsoil and bedrock.

9.4.3 Decommissioning Phase

The potential impacts associated with decommissioning of the proposed development will be similar to those associated with construction (*i.e.* peat, subsoils and bedrock excavation, potential contamination by leaks and spills, erosion of exposed subsoils, and peat instability and failure), but of reduced magnitude.

During decommissioning, it may be possible to reverse or at least reduce some of the potential impacts caused during construction by rehabilitating construction areas such as turbine bases, hard standing areas. This will be done by covering with peatland vegetation/scraw or poorly humified peat to encourage vegetation growth and reduce run-off and sedimentation. Other impacts such as possible soil compaction and potential contamination by fuel leaks will remain but will be of reduced magnitude. However, as noted in the Scottish Natural Heritage report (SNH) Research and Guidance on Restoration and Decommissioning of Onshore Wind Farms (SNH, 2013) reinstatement proposals for a wind farm are made approximately 30 years in advance, so within the lifespan of the wind farm, technological advances and preferred approaches to reinstatement are likely to change. According to the SNH guidance, it is therefore:

"best practice not to limit options too far in advance of actual decommissioning but to maintain informed flexibility until close to the end-of-life of the wind farm".

Some of the impacts will be avoided by leaving elements of the proposed development in place where appropriate. The substation will remain in-situ and will be retained by EirGrid/ESB. The turbine bases will be rehabilitated by covering with local topsoil/peat in order to regenerate vegetation which will reduce runoff and sedimentation effects. Internal roads will remain as forest roads.

9.4.4 Assessment of Health Effects

Potential health effects arise mainly through the potential for soil and ground contamination. A wind farm is not a recognized source of pollution and so the potential for effects during the operational phase are negligible. Hydrocarbons will be used onsite during construction however the volumes will be small in the context of the scale of the Proposed Development Site and will be handled and stored in accordance with best practice mitigation measures (as outlined in Section 9.5.1.3). The potential residual impacts associated with soil or ground contamination and subsequent health effects are negligible.

9.4.5 Cumulative effects

Due to the localised nature of the proposed construction works which will be kept within the proposed development site boundary, there is no potential for significant cumulative effects in-combination with any other local developments (refer to Chapter 2) on the land, soils and geology environment. The only way the proposed development can have in combination effects with other off site projects and plans is via the drainage and off site surface water network, and this hydrological pathway is assessed in Chapter 8.

The construction of the grid connection works will only require relatively localised excavation works, will be short duration, and will be linear and transient in nature and therefore will not contribute to any significant cumulative effects.

9.4.6 Risk of major Accidents and Disasters

The potential for a landslide has been avoided through the detailed design process and the peat investigation. The proposed development is not located in areas of high risk of peatslide. Refer to Volume III, Appendix 9-2 for the Peat Stability Risk Assessment.

9.5 MITIGATION

9.5.1 Construction Phase

9.5.1.1 *Land & Land Use*

9.5.1.1.1 Mitigation Measures

- Where possible, use of the existing forestry access road network to reduce overall footprint of new development.

9.5.1.2 *Peat, Subsoil and Bedrock Excavation*

9.5.1.2.1 Mitigation Measures

- Placement of turbines and associated infrastructure in areas with shallow peat where possible;
- Where possible, use of the existing forestry access road network to reduce peat excavation and borrow pit volumes;
- Use of floating roads (where acceptable to do so) to reduce peat excavation volumes;
- The peat and subsoil which will be removed during the construction phase will be localised to the turbine location and access roads;
- No turbines or related infrastructure will be constructed near or on any designated sites such as NHAs or SACs; and,
- A minimal volume of peat and subsoil will be removed to allow for infrastructural work to take place in comparison to the total volume present on the site due to optimisation of the layout by mitigation by design.

9.5.1.3 *Potential Contamination of soil through leakages/spillages and alteration of peat/soil geochemistry*

9.5.1.3.1 Mitigation Measures

- Minimal refuelling or maintenance of construction vehicles or plant will take place on site. Off-site refuelling will occur at a controlled fuelling station;

- On site re-fuelling will be undertaken using a double skinned bowser with spill kits on the ready for accidental leakages or spillages;
- Fuels stored on site will be minimised. Storage areas where required will be bunded appropriately for the fuel storage volume for the time period of the construction and fitted with a storm drainage system and an appropriate oil interceptor;
- The electrical control building will be bunded appropriately to the volume of oils likely to be stored, and to prevent leakage of any associated chemicals to groundwater or surface water. The bunded area will be fitted with a storm drainage system and an appropriate oil interceptor;
- The plant used will be regularly inspected for leaks and fitness for purpose; and,
- An emergency plan for the construction phase to deal with accidental spillages will be contained within the Construction Environmental Management Plan (refer to **Appendix 3-1**). Spill kits will be available to deal with any accidental spillage in and outside the re-fuelling area.

9.5.1.4 *Erosion of exposed subsoils and peat during tree felling and infrastructure construction work.*

9.5.1.4.1 Mitigation Measures

Peat removed from turbine locations and access roads will be used for landscaping, cast aside along designated access roads and deposited on-site in the 3 no. proposed borrow pits. Where possible, the vegetative layer shall be stored with the vegetation part of the sod facing the right way up to encourage growth of plants and vegetation at the surface of the stored peat within the peat storage areas (i.e. Borrow pits, or along roadside Berms along Internal Floated Access Roads). Re-seeding and spreading/planting of heather and moss cuttings will also be carried out in these areas. These measures will prevent erosion of stored peat in the long term.

Any excess temporary mounded peat in storage for long periods will be surrounded with silt fencing and sealed using the bucket of an excavator to minimise erosion. The use of bunds around earthworks and mounds will prevent egress of water from the works.

In order to minimize erosion of mineral subsoils stripping of peat will not take place during extremely wet periods (to prevent increased silt rich runoff). Temporary drainage systems will be implemented to limit runoff impacts during the construction phase.

Brash mats will be used to support vehicles on soft ground, reducing peat and mineral soils erosion and avoiding the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal will take place when they become heavily used and worn. Provision will be made for brash mats along all off-road routes, to protect the soil from compaction and rutting.

9.5.1.5 *Peat instability and failure*

9.5.1.5.1 Mitigation Measures

The findings of the Peat Stability Risk Assessment is that there is a Negligible to Low Risk to the project therefore no further design measures are considered necessary (Volume III, Appendix 9-2).

The level of peat monitoring which will be implemented for the site reflects the strategy of placing infrastructure in low risk areas of the site. With the systematic siting of infrastructure using mitigation by avoidance ensuring that deep peat has been avoided, peat stability monitoring methodology can best be achieved using Sightline Monitoring.

Monitoring by sightlines entails driving a series of posts at ~5m centres, exactly aligned, across the section of bog being monitored. Any signs of distress or deformation in the bog will quickly manifest itself by some of the posts moving out of alignment. Early discovery of stress in the peat will give the developer a chance to implement emergency procedures to prevent the onset of a bog burst or localised peat slide. While the risk of such occurrence is low in this instance, the precautionary principle dictates that monitoring posts will be installed in work areas where there are areas of lower Factor of Safety adjacent to the works areas, as defined above.

The Construction Manager for the project will impart the philosophy that everyone on the site is aware of peat stability and report any sign of misalignment in monitoring posts. Vigilance is a fundamental requirement when working on peat where inappropriate construction methodology can cause instability in otherwise benign conditions. A geotechnical engineer experienced in working in the upland peat environment will be employed full time to ensure the implementation of best practice in this environment. The methodology of all civil works will be reviewed by this engineer and the monitoring posts will be the subject of a dedicated inspection on a weekly basis by the geotechnical engineer.

The following general measures incorporated into the construction phase of the project will assist in the management of the risks for this site:

- Appointment of experienced and competent contractors;
- The site will be supervised by experienced and qualified personnel;
- Ensure construction method statements are followed or where agreed modified/ developed.
- Allocate sufficient time for the project (be aware that decreasing the construction time has the potential to increase the risk of initiating a peat movement);
- Set up, maintain and report findings from monitoring systems, including sightline monitoring;
- Maintain vigilance and awareness through Tool-Box-Talks (TBTs) on peat stability;
- Prevent undercutting of slopes and unsupported excavations;
- Prevent placement of loads/overburden on marginal ground; and,
- Maintain a managed robust drainage system.

9.5.1.6 *Forestry Replanting Sites*

9.5.1.6.1 Mitigation Measures

In forestry areas brash mats will be used to support vehicles on soft ground, reducing peat and mineral soils erosion and avoiding the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal will take place when they become heavily used and worn. Provision will be made for brash mats along all off-road routes, to protect the soil from compaction and rutting.

All works will be completed to standard forestry guidelines (Department of Agriculture, Food and the Marine, 2019, Standards for Felling and Reforestation), and in accordance with licence conditions issued by the Forest Service.

https://www.agriculture.gov.ie/media/migration/forestry/grantandpremiumschemes/schemecirculars/2019/InterimStandardsforFellingandReforestation071019.pdf

9.5.1.7 *Grid Connection*

9.5.1.7.1 Mitigation Measures

- Use of the existing road network to reduce subsoil and bedrock excavation volumes;
- The subsoil and bedrock which will be excavated during the construction phase will be localised to the proposed grid connection route alignment;
- A minimal volume of subsoil and bedrock will be removed to allow for grid connection works, and suitable material will be reused in trench backfilling where possible; and,
- Excess excavated material will be removed off site to a suitably licenced waste facility.

9.5.1.8 *Turbine Delivery Route*

9.5.1.8.1 Mitigation Measures

- Use of the existing road network to reduce soil/subsoil excavation volumes;
- The soil/subsoil which will be excavated during the construction phase will be localised to the proposed 3 no. locations along the turbine delivery route;
- A minimal volume of soil/subsoil will be excavated/landscaped and the areas of ground where works will occur is small; and,
- Excess excavated material will be used for local landscaping.

9.5.2 Operational Phase

9.5.2.1 *Forestry Replanting Sites*

9.5.2.1.1 Mitigation Measures

Compliance with Forestry Guidelines (Department of Agriculture , Food and the Marine, 2016, Environmental Guidance for Afforestation) and licences issued by the Forestry Service.

9.5.2.2 *Grid Connection*

None required, unless repair works are undertaken, then mitigation will include:

- Use of temporary excavations over the shortest distances possible;
- All excavated material will stored and reused during reinstatement; and,
- The works are likely to be completed over short periods of 1 to 2 days.

9.5.2.3 *Fuel/Oil spillage from operational stage vehicles*

9.5.2.3.1 Mitigation Measures

- Minimal refuelling or maintenance of operational vehicles or plant will take place on site. Off-site refuelling will occur at a controlled fuelling station;
- On site re-fuelling will be undertaken using a double skinned bowser with spill kits on the ready for accidental leakages or spillages;
- A minimal amount of fuels will be stored on site. Storage areas where required will be bunded appropriately for the fuel storage volume for the time period of the construction and fitted with a storm drainage system and an appropriate oil interceptor;
- The plant used will be regularly inspected for leaks and fitness for purpose; and,
- An emergency plan for the operational phase to deal with accidental spillages will be prepared and will be communicated to plant operatives. Spill kits will be available to deal with and accidental spillage in and outside the re-fuelling area.

9.5.2.4 *Transformer Oil leakage*

9.5.2.4.1 Mitigation Measures

The substation transformer, oil storage tanks, will be in a concrete bund capable of holding 110% of the oil in the transformer and storage tanks.

Turbine transformers are predominantly located within the turbines, so any leaks would be contained within or adjacent to the turbine. These measures will be sufficient to reduce risk to ground/peat/soils and subsoils, and groundwater and surface water quality.

9.5.3 Decommissioning Phase

9.5.3.1 *Mitigation Measures*

Mitigation measures that are likely to be applied during decommissioning activities will be similar to those applied during construction where relevant. Some of the impacts will be avoided by leaving elements of the development in place where appropriate. The bases will be rehabilitated by covering with local topsoil/peat in order to regenerate vegetation which will reduce runoff and sedimentation effects. Access tracks which are not required for farm use or forestry will also be left to vegetate naturally. All materials and equipment that form part of the wind farm will be removed from site and disposed of or recycled in an environmentally sustainable manner. Mitigation measures to avoid potential contamination by accidental fuel leakage and compaction of soil by on-site plant will be implemented as per the construction phase mitigation measures in Section 9.5.1.3.1.

The on-site substation will remain in place as it will be under the ownership of the ESB/EirGrid. Underground cables, including grid connection, will be cut back and left underground, and the ducting left in place. The cables will not be removed if the Environmental Assessment of the decommissioning operation demonstrates that this would do more harm than leaving them in situ.

9.6 RESIDUAL IMPACTS

9.6.1 Construction Phase

9.6.1.1 *Land & Land Use*

Residual Effect Assessment: The land take over all elements of the project is relatively small. The topography at each project elements will not be altered in any significant way. Land use effects will be temporary during the construction phase. The residual effect on land and land use are - Negative, imperceptible, permanent effect on Land and topography, and temporary effects on Land use across the proposed windfarm development and the grid route.

Significance of Effects: For the reasons outlined above, no significant effects on land and land use will occur as a result of the proposed windfarm development and the grid route or the replacement forestry lands.

9.6.1.2 *Peat, Subsoil and bedrock excavation*

Residual Effect Assessment: The granular soil at the site can be classified as of “Low to Medium” importance and the peat deposits at the site can be classified as of “Low” importance as the blanket bog is already degraded by historical forestry and drainage works. The impact is the disturbance and relocation of c256,736m^3 of peat and spoil during construction. The design measures incorporated into the project as described above (section 9.5.1.1), in particular the avoidance of deeper peat areas combined with the 'Medium' and 'low' importance of the deposits means that the residual effect is considered - Negative, slight, direct, high probability, permanent effect on peat and subsoils due to disturbance and relocation within the site.

Significance of Effects: For the reasons outlined above, no significant effects on soils and subsoils will occur as a result of peat, subsoil and bedrock excavation.

9.6.1.3 *Potential Contamination of soil through leakages/spillages and alteration of peat/soil geochemistry.*

Residual Effect Assessment: The use and storage of hydrocarbons and small volumes of chemicals is a standard risk associated with all construction sites. Proven and effective measures to mitigate the risk of spills and leaks have been proposed above and will break the pathway between the potential source and the receptor. The residual effect is considered to be - Negative, imperceptible, direct, short-term, low probability effect on peat and subsoils and bedrock.

Significance of Effects: For the reasons outlined above, no significant effects on peat, subsoils and bedrock will occur as a result of potential contamination of soil through leakages/spillages and alteration of peat/soil geochemistry.

9.6.1.4 *Erosion of exposed subsoils and peat during tree felling and infrastructure construction work.*

Residual Effect Assessment: Peat soils and spoil can be eroded by vehicle movements, wind action and by water movement. To prevent this all excavation works will be completed in accordance with a detailed Peat and Spoil Management Plan (refer to **Appendix 3-3**), material will be moved the least possible distance, and reseeding and planting will be completed to bind landscaped peat and spoil together. Following implementation of these measures the residual effected is considered - Negative, slight, direct, short-term, medium probability effect on peat and subsoils by erosion and wind action (erosion by water is assessed in Chapter 8 of the EIAR).

Significance of Effects: No significant effects on soils, subsoils or bedrock will occur as a result of erosion of exposed subsoils and peat during tree felling and access road/turbine base construction work.

9.6.1.5 *Peat instability and failure*

Residual Effect Assessment: A detailed Peat Stability Risk Assessment has been completed for the development proposal. The findings of that assessment have demonstrated that there is a low risk of peat failure (at the site) as a result of the proposed development. With the implementation of the control measures outlined above the residual effect is considered - Negative, imperceptible, direct, low probability, permanent effect on peat and subsoils.

Significance of Effects: For the reasons outlined above, no significant effects on soils and subsoils will occur from peat instability and failure.

9.6.1.6 *Forestry Replanting Sites*

Residual Effect Assessment: All works at forestry replanting sites will be completed in line with best practice forestry guidelines (Department of Agriculture, Food and the Marine, 2016, Environmental Guidance for Afforestation)and in accordance with a licence issued by the Forest Service. The residual effect will be: Negative, slight, indirect, temporary, likely impact on the soils and geological environment.

Significance of Effects: For the reasons outlined above, no significant effects on soils and subsoils will occur during the construction phase from the proposed forestry replanting works.

9.6.1.7 *Grid Connection*

Residual Effect Assessment: The design measures incorporated into the project as described above (Section 9.4.1.1 and Section 9.4.2.3) combined with the 'Low to Moderate' importance of the geological deposits along the grid route means that the residual effect is considered to be **-** Negative, direct, slight, unlikely, permanent impact on soils and subsoils. Negative, direct, slight, likely, permanent impact on bedrock.

Significance of Effects: For the reasons outlined above, no significant effects on soils/subsoils and bedrock will occur during the construction phase of the proposed grid connection works.

9.6.1.8 *Turbine Delivery Route*

Residual Effect Assessment: The areas of land take and works for the turbine delivery route works are small and occur at 3 no. junctions. Proposed works will be temporary and short duration. The residual effect is considered to be **-** Negative, direct, imperceptible, likely, permanent impact on soils and subsoils.

Significance of Effects: For the reasons outlined above, no significant effects on soils/subsoils will occur during the construction phase of the proposed turbine delivery route.

9.6.2 Operational Phase

9.6.2.1 *Forestry Replanting Sites*

Residual Effect Assessment: All works at forestry replanting sites will be completed in line with best practice forestry guidelines and in accordance with a licence from the Forest Service. The residual effect will be: Negative, slight, indirect, temporary, likely impact on the soils and geological environment.

Significance of Effects: For the reasons outlined above, no significant effects on soils and subsoils will occur during the construction phase from the Forestry Replanting works.

9.6.2.2 *Grid Connection*

Residual Effect Assessment: The design measures incorporated into the project as described above (Section 9.4.1.1 and Section 9.4.2.2) will be implemented for any required emergency repair works on the grid connection route during the operational phase. The residual effect is considered to be - Negative, direct, imperceptible, unlikely, permanent impact on soils and subsoils. Negative, direct, imperceptible, unlikely, permanent impact on bedrock.

Significance of Effects: For the reasons outlined above, no significant effects on soils and subsoils will occur during the operational phase from grid connection works.

9.6.2.3 *Fuel/Oil spillage from Operational Stage Vehicles*

Residual Effect Assessment: There are no residual impacts on the land, soils and geological environment following implementation of the mitigation measures outlined in Section 9.5.2.1.

Significance of Effects: For the reasons outlined above, no significant effects on soils and subsoils will occur from Fuel/Oil spillage from Operational Stage Vehicles.

9.6.2.4 *Transformer Oil leakage*

Residual Effect Assessment: There are no residual impacts on the land, soils and geological environment following implementation of the mitigation measures outlined in Section 9.5.2.2.

Significance of Effects: For the reasons outlined above, no significant effects on soils and subsoils will occur from transformer oil leakage.

9.6.3 Decommissioning Phase

Residual Effect Assessment: As outlined in Chapter 2, elements of the wind farm development and grid connection will be left in-situ. The bases/hardstands will be rehabilitated by covering with local topsoil/peat in order to regenerate vegetation which will reduce runoff and sedimentation effects. Access tracks which are not required for farm use or forestry will also be left to vegetate naturally. All materials and equipment that form part of the wind farm will be removed from site and disposed of or recycled in an environmentally sustainable manner. The replanted forestry lands will not be decommissioned as they will continue as forestry. Residual effects as assessed to be: Negative, slight, direct, likely, permanent impact on peat, soils, subsoils and bedrock.

Significance of Effects: For the reasons outlined above, no significant effects on soils and subsoils will occur during the decommissioning phase of the development.

9.7 CONCLUSIONS

HES have completed a thorough assessment of the project in respect of the land, soil and geological environment.

9.7.1 Summary of Effects – Land, Soils and Geological Environment

We have concluded that no significant impacts on the land, soil and geology of the site of Proposed Development or along the grid route or at the location of the replacement forestry lands will occur during construction, operation, or during decommissioning phases of the wind farm, the haul route, the grid connection, and the forestry replanting works.

Our assessment also confirms that there will be no cumulative effects on land soil and geology environment as a result of the proposed development and other proposed projects.

References

British Standards Institution (BSI). (2015) BS5930 - Code of Practice for Site Investigations.

Department of Housing, Planning and local Government, 2018: Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment.

Environmental Protection Agency (2017): Draft Guidelines on the Information to be contained in Environmental Impact Assessment Reports.

Environmental Protection Agency (September 2015): Draft - Advice Notes on Current Practice (in the preparation of Environmental Impact Statements.

Environmental Protection Agency (2003): Advice Notes on Current Practice (in the Preparation on Environmental Impact Statements).

European Union, 2017: Guidance on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU).

Geological Survey of Ireland (GSI). (1996) Geology of the Shannon Estuary, 1:100,000 scale Bedrock Geology Series, Sheet 17.

Institute of Geologists Ireland (2013): Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements.

National Roads Authority (2008): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.

Nichol, D. (2006). Peatslide hazard rating system for wind farm development purposes. Proceedings of the 28th Annual Conference of the British Wind Energy Association (BWEA28).

Scottish Natural Heritage report (SNH) Research and Guidance on Restoration and Decommissioning of Onshore Wind Farms (SNH, 2013).