8 SOILS AND GEOLOGY

8.1 INTRODUCTION

This chapter assesses the impacts of the Development on the soils and geology of the Site. Where negative effects are predicted, the chapter identifies appropriate mitigation strategies therein. The assessment considers the potential effects during the following phases of the Development:

- Construction of the Development
- Operation of the Development
- Decommissioning of the Development (final phase)

The Development refers to all elements of the application for the construction and operation of the proposed Tullaghmore Wind Farm (**Chapter 2: Project Description**).

This chapter of the EIAR is supported by Figures provided in Volume III and by the following Technical Appendix document provided in Volume IV of this EIAR:

- **Technical Appendix 8.1** Peat Stability Risk Assessment. Andrew Garne Geotechnical Services.

A Construction Environmental Management Plan (CEMP) is appended to the EIAR in **Technical Appendix 2.1**. In the event permission is granted for the proposed development, the final CEMP will address the requirements of any relevant planning conditions, including any additional mitigation measures which are conditioned. It will include all of the mitigation prescribed within the EIAR. A summary of the mitigation measures is included in **Technical Appendix 16.1**.

8.1.1 Assessment Structure

In line with the Directive 2011/92/EU as amended (the EIA Directive as amended), and current EPA guidelines, the structure of this Soils and Geology chapter is as follows:

- Details of the assessment methodology utilised for desk and field studies.
- Description of baseline conditions at the Site.
- Identification and assessment of impacts to soils and geology associated with the Development, during the construction, operational and decommissioning phases of the Development.
- Mitigation measures to avoid or reduce the impacts identified.
- Identification and assessment of residual impact of the Development considering mitigation measures.
- Identification and assessment of cumulative impacts, if and where applicable.

This Chapter of the EIAR has been prepared by Andrew Garne B.Sc., M.Sc., MIGI, P.Geo. Andrew is a Registered Professional Geologist with over 30 years of relevant experience including over 20 years in Ireland where he has undertaken many Geology chapters and Peat Stability Assessments for numerous windfarms throughout Ireland.

8.2 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

8.2.1 Assessment Methodology

The following assessments were undertaken in order to evaluate the potential impacts of the Development on the soils, geology and ground stability aspects of the environment at the Site:

- Characterise the topographical, geological and geomorphological regime of the Site from the data acquired through desk study and onsite surveys.
- Consider ground stability issues as a result of the Development, its design and methodology of construction.
- Assess the combined data acquired and evaluate any likely impacts on the soils, geology and ground stability aspects of the environment.

- If impacts are identified, consider measures that would mitigate or reduce the identified impact.
- Present and report these findings in a clear and logical format that complies with EIAR reporting requirements.

8.2.2 Relevant Legislation and Guidance

This assessment complies with the EIA Directive as amended, which requires Environmental Impact Assessment for certain types of major development before development consent is granted. This assessment was undertaken in accordance with the following Irish legislation (transposition of the aforementioned directive):

- SI No. 296 of 2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018.

In addition to this legislation relevant to geological, geotechnical, hydrological and hydrogeological aspects of the environment were referred to, such as:

- Planning and Development Regulations 2001 as amended,
- The Heritage Act 1995 as amended,
- The Wildlife Acts 1976 – 2012 as amended.

The Galway County Development Plan (2015-2021) and the Adopted Galway County Development Plan (2022-2028) were also considered as part of the EIA process.

This assessment has been prepared using, inter alia, the following guidance documents, which take account of the aforementioned legislation and policy:

- Department of Housing, Planning and Local Government (2019) Draft Revised Wind Energy Guidelines
- EPA (2022) Guidelines on the information to be contained in Environmental Impact Assessment Reports – May 2022 (Supersedes 1997, 2002 and 2017 versions)
- Institute of Geologists of Ireland (IGI) (2002) Geology in Environmental Impact Statements – A Guide
- IGI (2013) Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements
- Irish Wind Energy Association (IWEA) (2012) Best Practice Guidelines for the Irish Wind Energy Industry
- National Roads Authority (NRA) (2008) Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes
- NRA (2008) Environmental Impact Assessment of National Road Schemes – A Practical Guide – Rev 1
- CIRIA (2006) Control of Water Pollution from Linear Construction Projects – Technical Guidance
- BSI (1999) Code of Practice for Site Investigations – BS 5930
- NPWS (2015) National Peatlands Strategy

8.2.3 Desk Study

A desk study consisting of a review of all available datasets, information, and literature resources relevant to the Site has been completed. The most current datasets and information maintained by the Environment Protection Agency (EPA), Geological Survey of Ireland (GSI), Ordnance Survey of Ireland (OSI) and the National Parks and Wildlife Service (NPWS) were reviewed to assist in

establishing the hydrological and hydrogeological characterisation of the Site. This involved the following components:

- Acquire and compile relevant available maps of the Development.
- Study and assess the proposed locations of turbines and Site tracks and 38kV Substation relative to available data on Site topography and slope gradients.
- Study and assess the proposed locations of turbines, Site Access Tracks and 38kV Substation relative to available data on Site soils, subsoil and bedrock geology.
- Study and assess the Peat Stability Risk Assessment (PSRA), (**Appendix 8.1**).
- Overlay Ordnance Survey of Ireland (OSI) 1:250,000, 1:50,000 and 1:10,560 (6") maps with AutoCAD plan drawings.
- Overlay Geological Survey of Ireland (GSI) Geology maps (1:100,000) to determine Site bedrock geology and the presence of any major faults or other anomalies.
- Overlay Geological Survey of Ireland (GSI) Landslide Susceptibility maps to determine Site landslide susceptibility risk classification.
- Overlay Environmental Protection Agency (EPA) and Teagasc (Agricultural Agriculture & Food Authority) Soils and Subsoil maps (1:50,000) to determine categories of soils and subsoil at the Site.
- Search of the GSI landslide database for records of landslide mass movement events at and near the Study Area.
- Search of National Parks and Wildlife Service designated Sites of Co. Galway.

8.2.4 Field Work

8.2.4.1 Geotechnical Investigations, Site Walk Over and Observations

An initial Site walkover survey was carried out by Andrew Garne Geotechnical Services and EcoQuest Environmental from 31st August to 3rd September 2020. Additional walkover surveys were made on 13th and 14th October 2020, 4th and 5th March 2021, 5th and 6th October 2021, 19th November 2021, 25th and 26th January 2022 and 18th August 2022, following layout design changes. The walkovers included peat gouge cores taken at both the turbine base, substation and peat storage locations.

A total of 389 peat probes, 7 gouge cores and 130 hand-held shear vane tests were undertaken within the EIAR red-line boundary, at turbine bases, at turbine hardstands, at the proposed substation location and along proposed access tracks at nominal 100m centres. A further 376 probes were undertaken outside the current EIAR boundary, within the Derroura Forest to the east, and along the proposed grid connection route to Screebe. An additional 54 peat probes, 54 shear vanes and 2 gouge cores were undertaken within the proposed peat storage and restoration (habitat enhancement) area near Maam Cross.

8.2.5 Evaluation of Potential Effects

8.2.5.1 Sensitivity

Sensitivity is defined as the potential for a receptor to be significantly affected by a proposed development (EPA, 2022). The EPA provides guidance on the assessment methodology, including defining general descriptive terms in relation to magnitude of impacts however, in terms of qualifying significance of the receiving environment the EPA guidance also states that:

"*The value of the superficial/ solid geology should be identified to allow an assessment of the impact of the proposed development to be considered adequately*" (EPA, 2015)

Potential effects arising from a proposed development in terms of soils and geology will be limited to a localised scale, and therefore in describing the sensitivity of soils and geology it is appropriate to rate such while considering the value of the receiving environment or Site attributes. To facilitate the qualification of geological attributes, guidance specific to land and soils as set out by National Roads Authority (NRA), and guidance specific to landscape as set out by Scottish National Heritage (SNH) has been used in conjunction with EPA guidance.

The following table presents rated categories and criteria for rating Site attributes (NRA, 2008).

Table 8.1: Criteria for Rating Site Attributes – Soils and Geology Specific

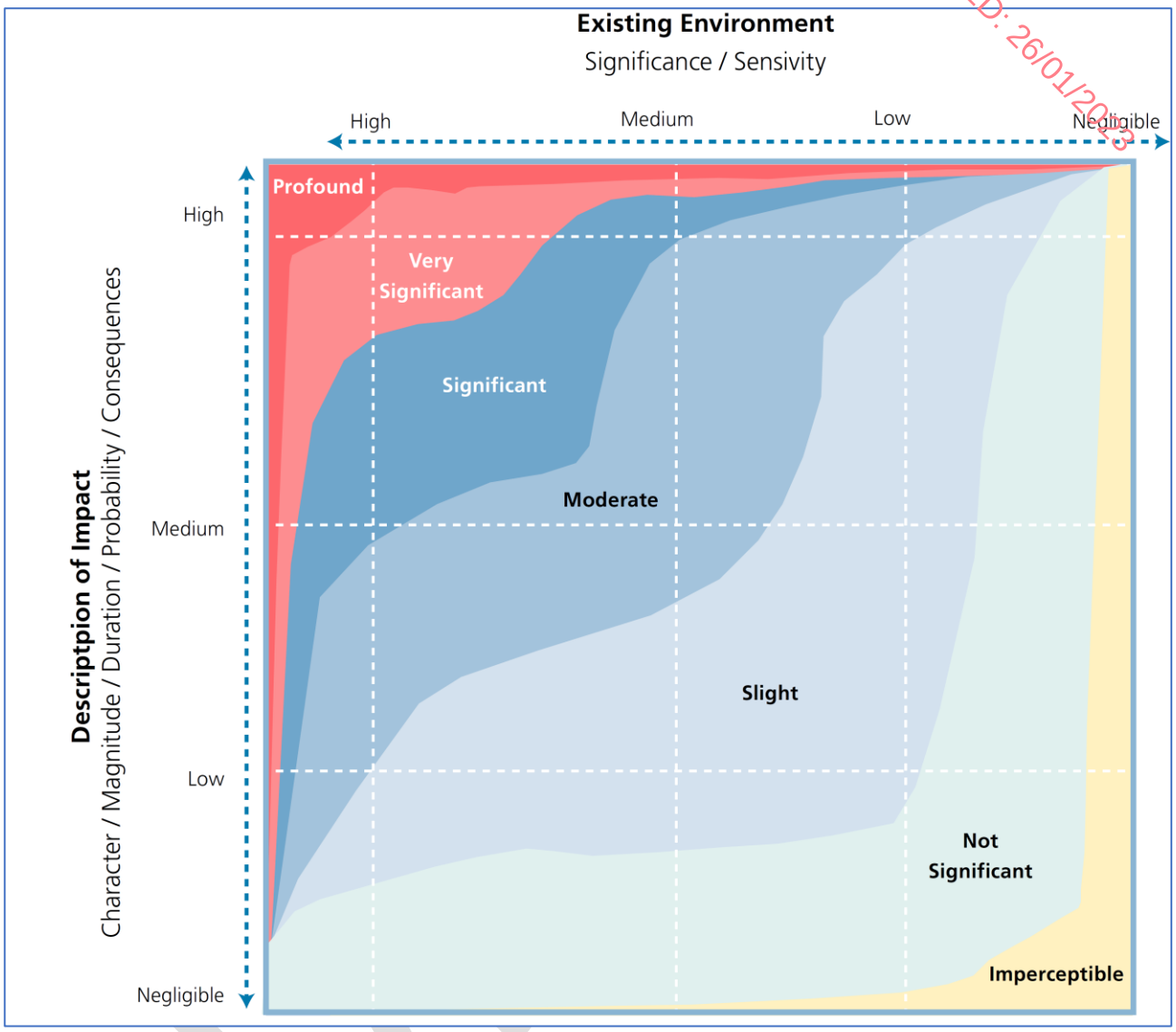
Importance	Criteria	Typical Examples
Very High	Attribute has a high quality, significance or value on a regional or national scale Degree or extent of soil contamination is significant on a national or regional scale Volume of peat and/or soft organic soil underlying route is significant on a national 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 route 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 route 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 route 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

*relative to the total volume of inert soil disposed of and/or recovered

The sensitivity of the receiving geological environment is defined by the baseline quality, as well as its potential to absorb change and for substitution.

The diagram shown in **Figure 8.1** presents how comparison of the character of the predicted impact to the sensitivity of the receiving environment can determine the significance of the impact (EPA, 2022).

Figure 8.1: Comparison of the Character of the Predicted Impact to the Sensitivity of the Receiving Environment (EPA, 2022)



8.2.5.2 Magnitude

The magnitude of potential impacts arising as a product of the Development are defined in accordance with the criteria provided by the EPA, as presented in the following table (EPA, 2022). These descriptive phrases are considered general terms for describing potential effects of the Development, and provide for considering baseline tends, for example; a *Moderate* impact is one which *is consistent with the existing or emerging trends*.

Table 8.2: Describing the Magnitude of Impacts

Magnitude of Impact	Description
Imperceptible	An impact capable of measurement but without noticeable consequences.
Slight	An impact that alters the character of the environment without affecting its sensitivities.
Moderate	An impact that alters the character of the environment in a manner that is consistent with the existing or emerging trends.
Significant	An impact, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.
Profound	An impact which obliterates all previous sensitive characteristics.

In terms of soils and geology, magnitude is qualified in line with relevant guidance, as presented in the following table (NRA, 2008). These descriptive phrases are considered development specific terms for describing potential effects of the Development, and do not provide for considering baseline trends and therefore are utilised to qualify impacts in terms of weighting impacts relative to Site attribute importance and scale.

Table 8.3: Qualifying the Magnitude of Impact on Soil and Geological Attributes

Magnitude of Impact	Description	Example
Large Adverse	Results in a loss of attribute.	Removal of the majority (>50%) of geological heritage feature.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute.	Removal of part (15-50%) of geological heritage feature.
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute.	Removal of small part (<15%) of geological heritage feature.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity.	No measurable changes in attributes.
Minor Beneficial	Results in minor improvement of attribute quality.	Minor enhancement of geological heritage feature.
Moderate Beneficial	Results in moderate improvement of attribute quality.	Moderate enhancement of geological heritage feature.
Major Beneficial	Results in major improvement of attribute quality.	Major enhancement of geological heritage feature.

8.2.5.3 Significance Criteria

Considering the above definitions and rating structures associated with sensitivity, attribute importance, and magnitude of potential impacts, rating of significant environmental impacts is done in accordance with relevant guidance, as presented in the table below which is, in effect, a risk matrix.

This matrix qualifies the magnitude of potential effects, based on the weighting of these effects in light of their importance and/or sensitivity of the receiving environment. In terms of Soils and Geology, the general terms for describing potential effects (**Table 8.3: Describing the Magnitude of Impacts**) are not linked directly with the Development specific terms for qualifying potential impacts (**Table 8.4: Qualifying the Magnitude of Impact on Soil and Geological Attributes)** therefore, both descriptive (**Table 8.3**) and qualifying (**Table 8.4**) terms are used in describing potential impacts of the Development. This is largely driven by the likely localised characteristic of potential effects arising as a product of the Development in terms of Soil and Geology, and the separation of land areas based on baseline conditions (**Section 8.4**).

Table 8.4: Weighted Rating of Significant Environmental Impacts

Sensitivity (Importance of Attribute)	Magnitude of Impact			
	Negligible (0-2%)	**Small (2-15%)**	**Moderate (15-50%)**	**Large (>50%)**
Extremely High	Slight / Moderate	Significant	Profound	Profound
Very High	Slight	Significant / Moderate	Profound / Significant	Profound
High	Slight / Imperceptible	Moderate / Slight	Significant / Moderate	Profound / Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight / Moderate

8.2.5.4 Scoping Responses and Consultation

Information has been provided by a number of consultee organisations during the assessment, and this is summarised in **Table 8.6**. The response to each point raised by consultees is also presented within the table, demonstrating where the design of the Development has addressed responses to specific issues indicated by respective consultees.

Table 8.6: Scoping Responses and Consultation

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
Irish Water	Letter in response to Scoping Report Received 31 October 2021	• *"Where the development proposal includes backfilling of materials, the waste sampling strategy for the proposed development to ensure the material is inert."*	• Only clean, inert fill will be used in the development. These issues are addressed in Sections 8.4.2.1.3 and 8.4.2.1.4.
Health Service Executive (HSE)	Letter in response to Scoping Report 5 November 2021	• *"A detailed assessment of the current ground stability of the Site for the proposed wind farm extension and all proposed mitigation measures should be detailed in the EIAR. The assessment should include the impact construction work may have on the future stability of ground conditions, taking into consideration extreme weather events, Site drainage and the potential for soil erosion.* • *Reference is made to a peat slide which occurred near Ballybofey in Co. Donegal on November 13th 2020 which may have been linked to construction activity at Meenbog Wind Farm. Potential impacts on water supply associated with contamination following the peat slide include sedimentation and alteration of pH levels.* • *The Environmental Health Service recommends that a detailed Peat Stability Assessment should be undertaken to assess the suitability of the soil for the proposed*	• Peat stability is addressed primarily in section 8.3.10 and within the Peat Stability Risk Assessment Report (PSRA) contained in **Technical Appendix 8.1**.

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
		development. The EIAR should include provision for a peat stability monitoring programme to identify early signs of potential bog slides ('pre-failure indicator' see Scottish Governments 'Peat Landslide Hazard and Risk Assessment: Best Practice Guide for Proposed Electricity Development 2017')	
Inland Fisheries Ireland (IFI)	Letter in response to Scoping Report 12 November 2021	• *"4. We are concerned about soils, their structure and types around all the turbines, associated access roads and Site development. In particular we have concerns about the stability of the soils and the impact that works on both the turbines and access roads will have either directly or by vibration on the stability of the soils. IFI have serious concerns where it is proposed to construct wind turbines on peat soils especially if these peat soils are located on upland areas."* • *"5. IFI strongly recommends that specialist personnel are employed to assess soil strength and suitability of the ground at each Site and along any proposed access road. This is particularly important in relation to peat soils. From our experiences we will have serious difficulties with developments on peat soils where there is excessive slope and or where the peat depth exceeds one metre. Excessive slopes will be an issue with all wind farm proposals regardless of soil type. The potential for soil movement and landslides should be assessed fully within the EIS."* • *"9. Serious consideration must be given to the disposal of all waste materials such that they will not give rise to any risk. In terms of risk, the placing of soils on adjacent ground should not be permitted unless all the area has been the subject of an in-depth risk assessment. This is of particular concern where peat soils are encountered. Furthermore, drainage from disturbed and stockpiled soils will have to be considered in advance. It may be essential to carry out soil stockpiling operations in confined areas only and to ensure vegetation of the soils with suitable plants which will promote stability. Consideration must be given to runoff/leachate from any stockpiles.* • *11. The use of sedimentary rocks, such as shale, in road construction should be avoided. This type of material has poor tensile strength and is liable to be crushed by heavy vehicles thereby releasing fine sediment materials into the drainage*	• Peat stability is addressed primarily in section 8.3.10 and within the Peat Stability Risk Assessment Report (PSRA) contained in **Technical Appendix 8.1**. • There are no sedimentary rocks on Site and use of such rocks will not be permitted during construction. See

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
		system which are difficult to precipitate and may give rise to water pollution. We recommend that specialist expertise should advise on the type of material required for road construction bearing in mind the pressures that will arise during the construction phase and the necessity to avoid pollution due to fines washing out into the roadside drainage.	the CEMP for details (Technical Appendix 2.1). • A copy of detailed method statements and a Site-specific CEMP will be provided to IFI prior to the commencement of any approved works.
National Parks and Wildlife Services (NPWS)	Letter in response to Scoping Report 19 November 2021	• "1.2 Project Components In general, the EIAR should include sufficient project details so that the full nature and extent of the likely significant effects are clear and assessed fully in relation to, among other things, road design and construction methodology; Site drainage details, including settlement ponds; temporary and permanent storage or disposal areas for peat and other materials or wastes arising; extraction Sites/borrow pits; and any modifications to roads, bridges or culverts along the entire length of haul routes. Volumes of surplus material arising and of fill required should be calculated. Due consideration should also be given to the grid connection. The Department notes that the location map provided is for an area of peatland. The EIAR should give specific consideration to the mobilisation of silt and changes to the stability of peat. The proposed windfarm has the potential for significant changes in patterns of surface water flow and may desiccate the peat allowing pathways to open up resulting in subsurface water losses. It should be noted that in 2020 a number of major upland peatland (blanket bog) landslides occurred across Ireland, most notably on Shass Mountain near Drumkeeran in County Leitrim and Meenbog, near Ballybofey in County Donegal. The Peat Stability Risk Assessment must be considered in light of these occurrences with consideration of climate change predictions (e.g. rainfall level) in the hazard rating and should thoroughly assess risk with regard to change in weather patterns due to climate change such as more frequent and intense storms and rainfall events, increased likelihood and magnitude of river flooding, prolonged periods of dry conditions which may increase the likelihood of unstable peat. Detailed consideration should be given to the amount of peat to be excavated, stored, and disposed/recovered. A detailed plan for the safe storage, disposal and rehabilitation of	• Full details on the nature of the development are outlined in Section **Error! Reference source not found.**. The nature and extent of the likely significant effects are described in Section **Error! Reference source not found.**. • Site drainage details are addressed in the drainage design details outlined in **Chapter 9: Hydrology and Hydrogeology** • A detailed Peat Stability Risk Assessment Report (PSRA) is contained in **Technical Appendix 8.1**. The PSRA addresses all of the issues raise including the effects of climate change.

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
		excavated or disturbed peat should form part of the EIAR. The spreading or recovery of excavated peat on areas of intact bog, wet and revegetated areas of cutover bog or other habitats or vegetation of ecological value is unlikely to be acceptable. Excavated or exposed peat should not pose any threat to surface waters and water quality.	RECEIVED: 26/01/2023

8.3 BASELINE DESCRIPTION

8.3.1 Introduction

An investigation of the existing land, soils and geology characteristics of the study area was conducted by undertaking a desk study, consultation with relevant authorities and Site-based fieldwork surveys. All data collected has been interpreted to establish the baseline conditions within the study area and the significance of potential adverse effects have been assessed. These elements are discussed in detail in the following sections.

8.3.2 Site Description

The proposed windfarm development Site is located near the townland of Tullaghmore, approximately 9km west of Oughterard in County Galway. The main Site is located across 161.88 hectares of land which is predominantly bogland used for sheep grazing and is in the ownership of three local landowners. An additional area near Mam Cross is designated for peat storage and restoration (habitat enhancement) and extends to a further 29.86 hectares. The total site area is therefore 191.74 hectares. To the south of the Site is the N59 Road, Lough Bofin and the Connemara Bog Complex Special Area of Conservation (SAC). North of the Site there are additional areas of blanket bog, forestry, Curraun Lough, the Western Way long-distance walking trail and the Lough Corrib SAC. To the west/southwest of the Site flows the Owenwee River, Owenree River, Loughaunierin and Tawnaghbeg Lough.

The topography of the Site is such that it is broadly surrounded by or is partially overlapping three elevated areas. These include Knockbrack to the east of the Site (299m) near Lough Beg in the Derroura Forest and Cappanalaurabaun (273m) at the northern extent of the proposed Site. Further north beyond the Site boundary is Curraun Hill at 252m. Across the remainder of the Site, elevations typically range from between 100m and 200m.

8.3.3 Haul Route

It is proposed that the turbine nacelles, tower hubs and rotor blades will be landed in Galway Port. From there, they will be transported to the Site via the R336 to Maam Cross and then the N59 east to the upgraded site entrance. The proposed haul route is shown on Figure 2.4 in Section 2.

There are four areas on the haul route that will require works in third party lands. These are shown on Table 2.5 in Section 2.

8.3.4 Grid Route

The substation at Tullaghmore will connect via underground 38kV cable to the ESB 110kV Screebe substation. The overall length of the grid connection between the substation and the existing Screebe 110kV substation is 18.65km, of which, 1,450m is within the site of the Development with the remainder being located in the N59 and R336.The grid connection can be summarised as follows:

Underground Cable (UGC) from Screebe SS to Tullaghmore WF utilising sections of UGC in public road, primarily regional roads, and private lands. [18.65km]

The route of the above grid connection is provided in **Figure 2.10** in Volume III. The grid feasibility study carried out by TLI can be found in **Technical Appendix 2.2**.

8.3.5 Bedrock Geology

The GSI maps and website for this area show that the majority of the Site is underlain by Ordovician age igneous and metamorphic rocks as shown in **Plate 8.1**. It should be noted that some outcrops of bedrock are present throughout the Site, particularly within the upland (northern) parts of the Site.

The majority of the main Site is underlain by the Oughterard Granite formation which consists of two main bodies, the Oughterard mass in the east and the Tullaghmore mass in the west, which are linked by a narrow granite strip. The granite is non-porphyritic and medium to coarse grained, with pink or white K-feldspar but also includes areas of granodiorite, tonalite and dacite. The northern part of the main Site (between T3 and T2) is mainly underlain by the Bennabeola Quartzite Formation which comprises Proterozoic age pale quartzite (Argyl Group). A small part of the northeast corner of the Site is underlain by Proterozoic age Streamstown Schist Formation which comprises psammitic pelitic and semi-pelitic schists (Argyl Group).

Structurally, the Site is crossed by a northwest-southeast trending fault which runs close to the proposed locations of turbines T4 and T5. This fault is relict, not active, and will therefore not affect the structural stability of the site. Additionally, given the GSI mapped distance to the turbines (approximately 82m from T4 and 50m from T5), this fault is not expected to impact on any turbine base locations. An anticlinal fold axis trends east-west across the northern part of the Site which is not considered significant for design or structural stability.

Plate 8.1: Example Outcrop of Granite (Photo looking to the north)

Plate 8.2: Example Outcrop of Quartzite with regular fractures (Photo looking to the north-east)

8.3.6 Soils and Subsoils

The desk study on soils included a detailed review of published literature and datasets on soils, subsoils and minerals pertaining to the Site. From information obtained from the Geological Survey of Ireland (GSI) and Environmental Protection Agency (EPA) websites, the following soils are understood to exist on the Site.

- Blanket peat covers the majority of the Site to variable depths (based on the GSI Quaternary and Groundwater Vulnerability mapping). Although shallow peat and deeper pockets of peat occur, the peat is largely absent from some of the upland (northern) areas of the Site and parts of the lowland (southern) parts of the Site in addition to parts of the grid connection route to Screebe.
- Glacial till derived from the underlying granite bedrock and covering approximately 5% or less of the main Site area and minor parts of the grid connection route.

Approximately 20% or less of the main Site and less than 5% of the grid connection route has shallow/exposed bedrock and hence has no superficial geology cover. An overview of the bedrock geology for the main Site is shown in **Figure 8.1**. An overview of the quaternary geology for the main Site is shown in **Figure 8.2**, located in **Volume III**.

8.3.6.1 Peat Depths

Peat depths within the redline boundary of the main Site are given in **Table 8.7** below.

Table 8.7: Peat Depth Distribution by Category

Peat Depth Category	Number of Survey Points
A – Rock/Very Shallow Peat/Topsoil (0.0-0.5m)	163
B - Shallow (0.6-2.0m)	190
C - Moderately Deep (2.1-3.5m)	29
D - Deep (3.6-5.0m)	6
E - Extremely Deep (>5m)	1
Total	**389**

The table shows that the majority of the peat covering the redline boundary area of the main Site lies in the range of 0.5-2.0m depth. The maximum peat depth recorded was 5.5m, with an average depth over the main Site of 0.94m.

8.3.7 Geological Resource Importance

The Geological Survey of Ireland (GSI) website for this area shows that there are no active quarries close to the Site. The nearest active quarries are as follows:

- 12km north-east – A limestone quarry located at Lissoughter, Cong (Licence No. MO 005)
- 16km west – A green marble quarry located at Lissoughter, Recess (Licence No. G 016)
- 20km south-east – An unnamed stone quarry located at Ballinahallie, Moycullen (Licence No. G 001).

In addition, numerous mineral locations are listed within and around the Site which include recorded finds of copper, lead, gold and iron. The locations of the minerals are shown on **Figure 8.6**.

8.3.8 Features of Geological Heritage

The Geological Survey of Ireland (GSI) also maintains a database for known Geological Heritage Sites in Ireland. Two Geological Heritage Sites are located along the proposed Grid Connection Route and have the potential to be impacted by the Grid Connection Route as shown in **Figure 8.5**. Lough Nahasleam is located 2km south of Maam Cross and Loch na gClocha Ballagh is located 5km south of Maam Cross. Details of the Sites are taken from the GSI website and reproduced in **Tables 8.8** and **8.9** below.

Table 8.8: Audited Geological Site at Lough Nahasleam

Site Code	GY097
Site Name	Lough Nahasleam
IGH Theme 1	IGH5
IGH Theme 2	IGH11

County	Galway
Description	This Site comprises several large outcrops in a bog, close to the road
Designation	CGS
Geological	Coarse garnets formed during thermal metamorphism of the schists are well exposed
Report	Link
Coordinates (IG)	97553, 243788
Coordinates (ITM)	497525.90, 743813.41

Table 8.9: Audited Geological Site at Loch na gClocha Ballagh

Site Code	GY091
Site Name	Loch na gClocha Ballagh
IGH Theme 1	IGH11
County	Galway
Description	This Site consists of a large outcrop on the edge of a lake
Designation	CGS
Geological	The Site contains an excellent, readily accessible exposure of a composite dyke
Report	Link
Coordinates (IG)	97738, 241096
Coordinates (ITM)	497710.85, 741121.98

In addition, several other Sites are shown close to the Site and are also shown in **Figure 8.5**. These include Curraghduff Middle (a partly overgrown former mine Site, located 2.5km north-east of the Site), Lough Corrib (720m north of the Site), Oughteraard Granite (outcrops of granite located 1.7km north of Maam Cross), Lough Oorid Quarry (small abandoned quarry located 4.4km west of Maam Cross), Loch na hUileann - Lochan an Bhurca (rock outcrops adjacent to a lake, 3km southeast of Maam Cross) and Glentrasna Road (rock outcrops about 5km south of Maam Cross).

8.3.9 Landslide Susceptibility

The GSI maintains a Landslide Susceptibility Map for Ireland. Although some statistical approaches were also explored, the literature research and the requirement for a methodology that could be applied to Ireland as a whole coupled with the uncertainty as to how many additional landslides would be found by extending the inventory lead to a methodology known as the Unique Condition Unit (UCU) approach. As the name suggests, UCUs are parcels of terrain where a set of attributes are combined in a unique way. In the context of landslide susceptibility mapping, the attributes being considered are slope, soil type and an index which is a measure of overland flow concentration from intense rainfall events. The latter parameter has been called the Topographic Flow Index (TFI). As shown in **Figure 8.4**, the Landslide Susceptibility for the Site has been categorised by the GSI as Low to High.

The Geological Survey of Ireland (GSI) also maintains a database of known landslides in Ireland. The database records no landslides on or adjacent to the Site. The nearest recorded landslides are shown approximately 7km west of the Site where five landslides are recorded to the northwest of Maam Cross

as shown in **Figure 8.3**. The landslides are of unknown type but are recorded as having bedrock within 1m of the surface.

8.3.10 Peat Slide Risk Assessment

A Peat Stability Risk Assessment (PSRA) for the Site was carried out by Andrew Gaine Geotechnical Services. The details and conclusions of the PSRA are presented in the report dated 21st December 2022.

A qualitative slope stability assessment was carried out for the turbine and substation locations. This assessment showed that the risk of a peat slide occurring at the proposed locations of turbine T2, turbine T5 and the substation are considered to be "Low", while the risk of a peat slide occurring at the remaining four turbine locations is considered to be negligible due to a recoded peat depth of less than 0.5m. The risk of a slide occurring along the proposed grid route is also considered to be negligible due to a combination of low slopes and generally thin or absent peat in addition to the grid route being located within existing roads and pavements.

A quantitative slope stability assessment was also undertaken for the proposed turbine and substation locations and along the line of the proposed Site Access Tracks. This assessment calculated a "Safety Ratio" for 178 probe locations where peat depth, slope and shear strength were also measured. Figures 6 to 9 of the PSRA show the locations for each of the slope stability calculations. These calculations are based on the current ground and do not include any surcharge loadings. The results show only 3 locations of elevated risk in two areas, within the red line boundary, having a calculated "Safety Ratio" of greater than 1.0 (indicated on the Figures by red dots). The location of the two areas of elevated risk are approximately 80m northwest of turbine T03 and about 400m south of turbine T01.

Figures 10 to 13 of the PSRA show the locations for each of the slope stability calculations with the addition of a 20kPa surcharge. This load is equivalent of stockpiling approximately 2m depth of peat, or a typical loading from a "floating road" with construction traffic. The calculations now show 29 locations of elevated risk within the red line boundary (indicated by red dots), being located around turbines T02, T03 and T05, along the proposed access road to T02 and T03 (Figure 10), between turbines T01 and T06 (Figure 11), and along the access track to the south of turbine T01 (Figures 11 and 12).

8.3.11 Designated Sites

The following areas which lie close to the Site are designated according to the Government of Ireland's Geohive Map Viewer:

- Connemara Bog Complex SAC (Site Code 002034) and pNHA. This lies immediately south of the Site (to the south of the N59) and comprises "Lake Habitats, Woodland Habitats, Marine Community Types". It also partially overlaps with the Ballycuirke Lough Stream sub-catchment (Freshwater Pearl Mussel Catchment) (see below).

- Ballycuirke Lough Stream sub-catchment is a Margaritifera Sensitive Area in (Freshwater Pearl Mussel) in accordance with Annex II and Annex V of the EU Habitats Directive. This sub-catchment also lies immediately south of the Site but also extends to the east of the Site, cutting partially across the proposed temporary Site compound just north of the N59.

- Mamturk Mountains SAC (Site Code 002008). This extends northwest from approximately 700m northwest of the Site, immediately north of the peat storage and restoration (habitat enhancement) area and adjacent to the proposed grid connection route to Screebe.

- Lough Corrib SAC (Site Code 000297), SPA and pNHA. This lake lies approximately 720m north of the Site and comprises a freshwater aquatic habitat containing otter along with protected vegetation.

8.4 ASSESSMENT OF POTENTIAL IMPACTS

8.4.1 Do Nothing Impact

The "Do Nothing Impact" is the effect on the Site should the proposed wind farm not be constructed. In this case, it is envisaged that the current land use would remain as it is now, with continued low

intensity grazing for cattle and sheep. Given the nature of the land, being generally wet bog, it is unlikely that any substantial changes in this use will occur in the near future.

8.4.2 Construction Phase Potential Impacts

The proposed Development is characterised by the following civil engineering works to provide the necessary infrastructure to complete the wind farm as described in Chapter 2, Description of the Proposed Development:

- Erection of 6 no. wind turbines with an overall ground to blade tip height of 185m. The candidate wind turbine will have a rotor diameter of 162m and a hub height of 104m
- Construction of site access roads, crane hardstand areas and turbine foundations.
- Improvement of existing site entrance with access onto the N59
- Construction of one no. temporary construction compound with associated temporary site offices, parking areas and security fencing
- Installation of 1 no. permanent meteorological mast with a height of 104m
- Construction of new internal site access tracks and upgrade of existing Site track, to include all associated drainage
- Development of a site drainage network
- Construction of one no. permanent 38kV substation
- All associated underground electrical and communications cabling connecting the wind turbines to the wind farm substation
- All works associated with the connection of the wind farm to the national electricity grid, which will be via 38kV underground cable connection approximately 18.65km in length to the existing ESB Screebe 110kV GIS Substation.
- Biodiversity enhancement measures
- Peat storage and restoration (habitat enhancement) area

The EIA also assesses the Works at 4 no. locations along the proposed turbine delivery haul route from Galway Port and the proposed underground grid connection from the Site to Screebe 110kV Substation.

The direct and indirect effects of the construction activities, and their expected duration are discussed further in the following sections. The effect on use of land and on natural resources required to carry out the works which relate to soils and geology is also discussed.

8.4.2.1 Subsoil and Bedrock Removal

Subsoil and bedrock removal will occur during construction excavations and is an unavoidable consequence of the Development. Removal of the soil and bedrock is considered to be a permanent effect as it would not normally be reversed although some reinstatement of the soils is possible after decommissioning. No further subsoil or bedrock removal will be required during operation. The overall potential effects here are considered to be of **moderate** significance, **permanent** and **negative**.

8.4.2.1.1 Land Take

Some land take will be required during the construction and operation of the wind farm. This will be required for construction of Site Access Tracks, Turbine Foundations, 38kV Substation, Met Mast and for parts of the haul route which require temporary widening. Temporary land take will also be needed for construction of grid cables both on and off the Site.

8.4.2.1.2 Excavations

Excavations will be required for most aspects of the Development including for turbines, turbine hardstand areas, Site access tracks, haul route, Site compound, cable trenches and grid connection route. Estimates of excavation volumes are presented in Table 2.6.

8.4.2.1.3 Turbines and Hardstand areas

The material encountered at each turbine and infrastructure location is considered to be mostly shallow peat overlying bedrock. Minor areas of glacial till may also be encountered locally. It is expected that excavations for the majority of infrastructure will be taken down to bedrock. Due to the depth of the excavation required for the turbine foundations (maximum depth of 3m), some excavation of rock will also be required. The exact depth of excavation will be determined at detailed design stage.

Excavations will require imported granular fill material to upfill the excavation to the levels required for construction. This action is considered to have an insignificant, permanent, negative effect on the environment.

It is proposed that the structural granular fill material will be obtained from locally approved quarries (see **Table 2.4**) considering the onerous specification required for this type of material (the material has to conform to a regular suite of chemical and physical tests prior to use). The potential environmental effects of extracting material from off-site quarries has been discussed throughout Section 8.4.2.1.

The environmental effects of the construction of the hardstanding foundations are similar to that of the founded Site Access Tracks as discussed in **Section 8.4.2.1.4**. Ground investigations in the form of peat probing and gouge coring has been carried out along the proposed Turbine Hardstand locations to inform the depth of excavation and upfill required.

Similar to above, some of the material may be required from local quarries. The potential effect of extracting material from external quarries include extra pressure on transport routes and increased fuel consumption. This is discussed in **Chapter 14:Traffic and Transport**. Only licenced quarries will be used. All imported material will be fully tested in accordance with industry standards (TII Specification for Roadworks Series 800 and S.R.21 2014 + A1: 2016). Only verified clean, inert material will used.

8.4.2.1.4 Site Access Tracks

Site Access Tracks will be needed to accommodate the construction works and to provide access to the turbine locations for the whole life cycle of the wind farm. The tracks will be constructed using unbound crushed aggregates and incorporate drainage to maintain the performance of the pavement during wet weather.

The roads will be constructed predominantly as founded or occasionally as floating roads (in stable areas of deep peat only). Founded roads are excavated down to and constructed up from a competent geological stratum, whereas floated roads are built directly on top of the peat and soft soils. The roads shall be constructed to average heights of 0.5m or 1.0m above existing ground level.

Ground investigations in the form of peat probing has been carried out along the proposed Site Access Tracks to inform the depth of excavation and upfill required for the access tracks. The estimated volumes of excavated and imported materials are given in Chapter 2.

Soil sealing is the covering of a soil with an impermeable material; it often affects agricultural land, puts biodiversity at risk and increases the risk of flooding. The use of impermeable material is an inevitable direct effect to some extent of most types of construction. Permeable geotextile is usually placed at the base of access tracks, along with other infrastructure, as part of their design. However, this will have an **imperceptible**, **negative**, **permanent** effect due to the relatively small footprint of infrastructure and its location.

Similar to above, some of the material may be required from local quarries. The potential effect of extracting material from external quarries include for the extra pressure on transport routes and increased fuel consumption. This is discussed in **Chapter 14: Traffic and Transport**. Only licenced quarries will be used. All imported material will be fully tested in accordance with industry standards (TII Specification for Roadworks Series 800 and S.R.21 2014 + A1: 2016). Only verified clean, inert

material will used. The potential effects here are considered to be **not significant**, **permanent** and **negative**.

8.4.2.1.5 Site Haul Route

Haul Routes will generally use the existing public roads. However, some widening will be required at acute turns, within third party lands. Additionally, some minor land take may also be required through the centre of roundabouts. Details are presented in the Haul Route Selection Report in **Appendix 14.1**. Generally, the impacts associated with this will be as per the Site access track construction but on a very minor scale and reversible. The impacts are considered to be **not significant**, **temporary**, **negative** effects.

8.4.2.1.6 Bedrock Excavations

Due to the numerous areas of shallow bedrock encountered on the Site, it is likely that bedrock excavations will be required at some of the Turbine Foundations, Turbine Hardstands, Site Access Track excavations and possibly for substation excavations. A visual assessment or the exposed bedrock suggests that the excavated bedrock will predominantly comprise strong or very strong granite and quartzite. This material is likely to be suitable for re-use after crushing and screening, and would be of use as granular fill for Site Access Track construction.

The detailed ground investigations will confirm the quality and strength of the bedrock. It is likely that heavy breakers will be required in areas where deep or large excavations are required in very strong rock. Blasting will be not be undertaken. The long-term impacts of bedrock excavation are considered to be **not significant**, **permanent** and **negative**.

8.4.2.1.7 Site Cable Trenches

Cable trenches throughout the Site will be excavated to a maximum depth of 1.2m. Excavation of peat, bedrock and locally glacial till will be required. Imported granular fill will be used to surround the cables, however the majority of the excavated soils will be used for backfill with only minor amounts being removed and used elsewhere for berm landscaping. The impacts associated with excavations for cable trenches are considered to be **not significant**, **temporary** and **negative**.

8.4.2.1.8 Grid Connection Cable

Grid connection trenches will also be excavated along the grid connection route to Screebe. The trenches will be predominantly within roads and verges, to a maximum depth of 1.2m. Excavation of road aggregates, peat, bedrock and local glacial till will be required. The trenches will be backfilled using imported granular material. The excavated material will be disposed of offsite as inert landfill or recycled for use on site (topsoil and peat may be re-used for landscaping around the substation and turbines whilst subsoils and bedrock will be re-used for access track construction. The impacts associated with excavations for cable trenches are considered to be **not significant**, **permanent** and **negative**.

8.4.2.1.9 Borrow Pit

No borrow pit is proposed for the Site, however the importation of granular materials and concrete will have an **indirect, significant, negative, permanent** effect on the source quarry.

8.4.2.1.10 Temporary Construction Compound

It is proposed to construct a temporary Site construction compound just north of the N59 at the entrance to the Site. Construction will comprise the excavation and removal of peat and shallow bedrock and the importation of granular fill which will be placed and rolled. The area for the temporary Site construction compound was chosen in an area of cutaway bog in order to minimise the habitat impact. The impacts associated with construction of the compound are similar but less than for construction of the Site Access Tracks and are considered to be **not significant, temporary** and **negative**.

8.4.2.1.11 Volumes of Material to be Excavated

Estimated total volumes of material to be excavated are presented in **Table 2.6**.

8.4.2.1.12 Summary of Impacts Due to Subsoil and Bedrock Removal

A general summary of the pre-mitigation impacts associated with subsoil and bedrock removal is presented in **Table 8.10.**

Table 8.10: Impact Summary – Subsoil and Bedrock Removal

Impact Description	Type	Quality	Significance	Weighted Significance	Extent	Context	Probability	Duration / Frequency
Subsoil and bedrock removal	Direct	Negative	Moderate	**Moderate**	Site	Conforms to baseline	Likely	Permanent

8.4.2.2 Storage and Stockpiles

8.4.2.2.1 Overview

It is expected that the majority of spoil generated on Site will be either peat or rock. It is expected that the majority of rock (and possibly minor quantities of glacial till) will be reused for the construction of Site Access Tracks. The peat will be used to restore an area of cutover bog within a designated area near Maam Cross. As a worst case, stockpiling of peat can give rise to increased pore pressures and the possibility of a bog burst or peat slide. Careful management of the spoil and ongoing landslide risk assessments will minimise the possibility of a landslide occurring. Due to the level nature of the ground in this area, this area has been assessed within the PSRA as being of very low risk of peat instability.

8.4.2.2.2 Spoil Management

The handling, management and re-use of excavated materials are of importance during the construction phase of the project. Excavated material will arise from all infrastructure elements of the windfarm (foundations, tracks, hardstands etc.). Peat should be stockpiled no higher than 1.5m and follow the recommendations set out in the NRA Guidelines for the Management of Waste from National Road Construction Projects (NRA, 2014).

There is potential for a moderate negative effect on soil due to erosion of inappropriately handled excavated materials. However, any effects from the handling of excavated materials will be managed through good Site practice (see Mitigation Measures in Section).

Organic matter loss can occur when wet peat is excavated and allowed to dry in the open air. For this reason, stockpiling of the peat will be avoided. Peat material is a major source of carbon and the loss of organic matter leads to an emission source of carbon dioxide (CO_2) and nitrogen dioxide (NO_2). A Carbon Calculator can be found in Chapter 15, Air Quality and Climate, which addresses the effect of loss of carbon to the atmosphere through the drying out of peat excavated as part of the proposed Development.

All excavated peat will be taken off the main Site and used to assist with regeneration of an area of cutover bog located near Maam Cross. The peat in this area is therefore expected to have a positive effect on the receiving environment. Excavated soil and bedrock will be re-used for the construction of Site access tracks. The process of spoil management on Site is expected to have a slight negative effect on the receiving environment.

8.4.2.2.3 Summary of Impacts Due to Storage and Stockpiles

A summary of the pre-mitigation potential impacts associated with soil/rock storage and stockpiles is given in **Table 8.11**.

Table 8.11: Impact Summary – Storage and Stockpiles

Impact Description	Type	Quality	Significance	Weighted Significance	Extent	Context	Probability	Duration / Frequency
Compaction, erosion and degradation of peat arising from vehicular movement	Direct	Negative	Moderate	Slight	Localised	Conforms to baseline Or Contrast to baseline	Likely	Long term / Permanent
Stability issues and slope failure arising from vehicular movement (Localised displacement)	Direct or Indirect / Secondary	Negative	Moderate	Slight	Localised / Potentially Regional	Contrast to baseline	Likely	Long term / Permanent
Stability issues and slope failure arising from vehicular movement (Landslide)	Indirect / Secondary	Negative	Significant	Moderate	Localised / Potentially Regional	Contrast to baseline	Unlikely	Permanent
Subsidence and settlement of newly established and upgraded Site tracks	Direct	Negative	Moderate	Slight	Localised	Conforms to baseline. Normal	Likely	Permanent
Compaction, erosion and degradation arising from vehicular movement (Localised displacement)	Direct or Indirect /Secondary	Negative	Moderate	Slight	Localised	Contrast to baseline	Likely	Long term / Permanent

8.4.2.3 Vehicular Movement

8.4.2.3.1 Overview

Vehicle movement will occur primarily during the construction phase of the wind farm. Construction vehicles will include cranes, excavators, dumper trucks, concrete trucks, private cars (construction personnel). During the operation phase, vehicles will generally be limited to occasional maintenance vehicles only. Additional vehicles including cranes will however be required in the event that any turbine requires replacement.

8.4.2.3.2 Compaction, Erosion and Degradation

Compaction of soils will occur during construction and to a limited extent during operation and decommissioning. In general, compacted soils will be excavated during construction, and access to soils away from hardstanding areas will be prevented. Ongoing compaction of soils will occur in areas of floated road construction, which will continue during operation and decommissioning. Compaction effects are considered to be insignificant, permanent and negative.

Erosion and degradation of exposed soils will also occur, primarily during construction. Erosion and degradation effects are also considered to be **not significant, permanent and negative**.

8.4.2.3.3 Peat Stability and Slope Failure

The effects of peat stability and slope failure are discussed in **Section 8.3.10** and in the PSRA in **Appendix 8.1**. Whilst the possibility of a peat slide is considered to be low, poorly managed construction activities (including traffic movement) can increase the risk. Any peat slide or slope failure which occurs will be localised due to the generally thin peat and the topography of the Site. However, given the proximity of several designated Sites, both to the north and south of the Site, any peat slide may result in some damage to nearby habitats and species. The effect of this is considered to be **significant, permanent** and **negative**.

8.4.2.3.4 Haul Route and Site Tracks

There will be no changes to the existing public roads with the exception of temporary widening at four locations on the haul route to allow a load bearing surface and temporary changes to two roundabouts along the haul route. Some compaction of the underlying soils may occur, although this will be slight. The impacts associated with vehicle movements along the haul route is considered to be **insignificant, permanent** and **negative**.

Vehicle movement along the Site Access Tracks will again result in a slight compaction of the underlying soils, particularly in areas where floated roads are constructed. The impacts associated with vehicle movements along the Site Access Tracks is considered to be **not significant, permanent** and **negative.**

8.4.2.3.5 Summary of Impacts Due to Vehicular Movement

A summary of the pre-mitigation impacts associated with vehicle movement is given in **Table 8.12**.

Table 8.12: Impact Summary – Vehicular Movement

Impact Description	Type	Quality	Significance	Weighted Significance	Extent	Context	Probability	Duration / Frequency
Compaction, erosion and degradation of peat arising from vehicular movement	Direct	Negative	Moderate	Slight	Localised	Conforms to baseline Or Contrast to baseline	Likely	Long term / Permanent
Stability issues and slope failure arising from vehicular movement (Localised displacement)	Direct or Indirect / Secondary	Negative	Moderate	Slight	Localised / Potentially Regional	Contrast to baseline	Likely	Long term / Permanent
Stability issues and slope failure arising from vehicular movement (Landslide)	Indirect / Secondary	Negative	Significant	Moderate	Localised / Potentially Regional	Contrast to baseline	Unlikely	Permanent
Subsidence and settlement of newly established and upgraded Site tracks	Direct	Negative	Moderate	Slight	Localised	Conforms to baseline. Normal	Likely	Permanent

8.4.2.4 Soil Contamination

8.4.2.4.1 Overview

Use of waste materials during construction, operation and decommissioning will be minimised by good site practices and waste management (see CEMP in **Technical Appendix 2.1**). The following sections present the possible impacts associated with the use of construction plant.

8.4.2.4.2 Hydrocarbons

Wherever there are vehicles and plant in use, there is the potential for a direct hydro-carbon release which may contaminate the soil and subsoil. A spill has the potential to indirectly pollute water if the soil and subsoil act as a pathway from any source of pollution. Any spill of fuel or oil would potentially present a moderate, long-term, negative effect on the soil and geological environment.

8.4.2.4.3 Wastewater and Sanitation

Wastewater/sewerage from the Temporary Construction Compound with be placed in a holding tank, which will be emptied periodically. Chemicals will be used to reduce odours. The waste will be taken to a local wastewater sanitation plant for treatment. Wastewater or sewerage leakage may occur but will be small, localised and short-term. The impacts associated with wastewater and sewerage is considered to be insignificant, permanent and negative.

8.4.2.4.4 Construction Materials

All construction materials will be stored in secure areas. Any hazardous materials will be correctly stored within properly bunded areas in accordance with good Site practice as described in the IWEA and Scottish Best Practice Guidelines and in accordance with the CEMP (**Technical Appendix 2.1**). The impacts associated with the construction materials is considered to be insignificant, permanent and negative.

8.4.2.4.5 General Waste

All construction and operation waste materials will be correctly sorted, recycled or disposed of practice as described in the IWEA and Scottish Best Practice Guidelines and in accordance with the CEMP (**Technical Appendix 2.1**). A policy of Reduce, Reuse and Recycle will apply. The impacts associated with waste materials is considered to be **insignificant, permanent** and **negative**.

8.4.2.4.6 Summary of Impacts Due to Soil Contamination

The Development has the potential to give rise to the following pre-mitigation soil contamination effects, shown in **Table 8.13** below:

Table 8.53: Impact Summary – Soil Contamination

Impact Description	Type	Quality	Significance	Weighted Significance	Extent	Context	Probability	Duration / Frequency
Hydrocarbon contamination	Direct	Negative	Moderate	Slight	Localised*	Contrast to baseline	Likely	Long term / Permanent
Wastewater Sanitation contamination – Waste	Direct	Negative	Small	Slight	Localised*	Contrast to baseline	Unlikely	Temporary
Wastewater Sanitation contamination – Chemicals	Direct	Negative	Moderate	Slight	Localised*	Contrast to baseline	Unlikely	Long term / Permanent
Construction Material contamination	Direct	Negative	Moderate	Slight	Localised*	Conforms to baseline	Likely	Long term / Permanent
General Waste contamination	Direct	Negative	Moderate	Slight	Localised*	Conforms to baseline	Likely	Long term / Permanent
* Contamination of soils / peat by hydrocarbons is considered a localised impact, however if hydrocarbon contamination is intercepted by surface water features the impact is potentially regional (**Chapter 9: Hydrology and Hydrogeology**)								

8.4.3 Decommissioning of the Wind Farm

In general, the potential effects associated with decommissioning will be similar to those associated with construction but of reduced magnitude because extensive excavation, and wet concrete handling will not be required. The potential environmental effect of soil storage and stockpiling and contamination by fuel leaks will remain during decommissioning.

8.4.4 Cumulative Effects

Cumulative effects of the Development with other developments in the region, as discussed in Chapter 4 -Policy, Planning and Development Context, relate to the indirect effects that may arise due to the use of public roads as haul routes to bring construction materials to Site and the cumulative effect on the use of natural resources. Chapter 14 - Traffic and Transport details the scenarios whereby the materials will be imported onto Site and assess the cumulative effects.

8.5 MITIGATION MEASURES AND RESIDUAL IMPACTS

This chapter outlines the main mitigation measures which will be applied to the wind farm in order to reduce the effects of the impacts outlined previously.

8.5.1 Design Phase

8.5.1.1.1 Mitigation by Avoidance

The opportunity to mitigate any effect is greatest at the design period. In this respect, a detailed Site selection process was carried out by the Developer. This process identified deep peat and shallow bedrock as specific geotechnical constraints. The detailed Site selection process is described in Chapter 3: Alternatives. Furthermore, within the chosen Site, areas of deep peat and shallow bedrock were identified, and the infrastructure design sought to avoid those areas as much as possible.

In order to mitigate against the risk of landslide associated with the construction and operation of floating roads, areas of deep peat have been avoided wherever possible. Floated roads will only be constructed in areas of deeper peat (>1.5m depth with a crossfall of less than 1 in 10). The floated roads will be laid directly on the existing peat using geogrid and crushed stone. Pipes will be installed at intervals to allow the existing runoff regime on the site to continue.

8.5.2 Construction Phase

8.5.2.1 Subsoil and Bedrock Removal

Subsoil and bedrock removal will occur throughout the construction of the wind farm and is unavoidable. However, the impacts associated with this removal will be minimised using the following practices.

8.5.2.1.1 Mitigation by Avoidance

As mentioned previously, areas of deep peat and shallow bedrock have been avoided during construction by careful design of the wind farm.

8.5.2.1.2 Mitigation by Good Practices

Best practice practice as described in the IWEA and Scottish Best Practice Guidelines will be applied during construction which will minimise the amount of soil and rock excavation. All works will be managed and carried out in accordance with the Construction Environmental Management Plan (CEMP) located in **Technical Appendix 2.1**, which will be updated by the civil engineering contractor and agreed prior to any works commencing on Site.

Excavated peat will mostly be taken off site and used in the restoration of an area of cutover bog located near Maam Cross. Localised areas of landscaping will be sealed and levelled using the back of an excavator bucket to prevent erosion.

8.5.2.1.3 Mitigation by Reduction

The disturbance of soil, subsoil and bedrock is an unavoidable effect of the Development, but careful design of the Wind Farm layout has been undertaken to ensure that the amount of earth materials excavated is kept to a minimum in order to limit the effect on the geological aspects of the Site (by avoiding areas of deep peat and shallow bedrock where possible and reducing the length of site

tracks). The management of geological materials is an important component of controlling dust and sediment and erosion control.

8.5.2.1.4 Mitigation by Reuse

Bedrock will be re-used for construction of Site Access Tracks wherever possible. The bedrock will comprise predominantly granite and quartzite which, when crushed and graded, will provide a good sub-base for Site Access Track construction. In addition, where excavated, glacial till and gravel will also be re-used for construction of access tracks.

Peat, overburden, and rock will be reused wherever possible on Site to reinstate excavated areas. Where possible, the upper vegetative layer will 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 landscaped peat. These measures will prevent the erosion of peat in the short and long term.

8.5.2.1.5 Mitigation by Remediation

On completion of the construction stage, any areas not required for operation will be reinstated. This will include the Temporary Construction Compound, turning areas and any materials storage areas. Granular material will be removed as required and reinstated with peat or other soils in keeping with the adjacent soils. Drainage will be reinstated, if required, in order to minimise future erosion of the soils and restore the pre-development state of the environment.

8.5.2.2 Storage and Stockpiles

8.5.2.2.1 Mitigation by Avoidance and Good Practice

As discussed previously, the opportunity to mitigate any effect is greatest at the design period. In this respect, a detailed Site selection process was carried out by the Developer. This process identified deep peat and shallow bedrock as specific geotechnical constraints. The detailed Site selection process is described in Chapter 3: Alternatives. Furthermore, within the chosen Site, areas of deep peat and shallow bedrock were identified, and the infrastructure design sought to avoid those areas where possible. In this respect, by minimising volumes of excavation, volumes for storage and stockpiles will also be reduced, thus reducing the impacts associated with them.

Best practice as described in the IWEA and Scottish Best Practice Guidelines will be applied during construction which will minimise the amount of soil and rock excavation and therefore also reduce storage and stockpile requirements. All works will be managed and carried out in accordance with the Construction and Environmental Management Plan (CEMP in **Technical Appendix 2.1**), which will be updated by the civil engineering contractor and agreed prior to any Site works commencing.

8.5.2.2.2 Mitigation by Reduction

Whenever possible, soil and rock will be re-used on the Site immediately, thereby reducing the need for double handling, which will also reduce the requirements to stockpile soils. Generally excavated rock will be used immediately for Site Access Track construction. Topsoil and peat will be transported to the designated storage area located near Maam Cross. Whenever possible stockpiles will be avoided. Stockpiles of rock on peat soils will be avoided to prevent instability. Peat will only be stockpiled temporarily in areas of thin or absent peat and only in areas which have been confirmed for stability by a suitably experienced geotechnical engineer.

8.5.2.2.3 Vehicular Movements

Vehicular movements will be restricted to the footprint of the proposed Development, particularly with respect to the newly constructed Site Access Tracks. This ensures that machinery must be kept on tracks and will not move onto areas that are not permitted for the Development.

Vehicular traffic on Site will be reduced through the re-use of excavated material on Site which will reduce the need to source material from external quarries.

8.5.2.2.4 Mitigation by Avoidance and Good Practice

As discussed previously, excavation volumes have been reduced during the design phase by avoiding areas of deep peat, shallow bedrock and by avoiding excessive cut and fill during construction. This will result in reduced excavation volumes and therefore reduced Site traffic.

Best practice as described in the IWEA and Scottish Best Practice Guidelines will be applied during construction which will minimise double handling, again reducing the Site traffic. All works will be managed and carried out in accordance with the Construction Environmental Management Plan

(CEMP in Technical Appendix 2.1), which will be updated by the civil engineering contractor and agreed prior to any Site works commencing.

Excavated peat will only be moved a short distance from the point of extraction to the restoration areas near Maam Cross and will be also be used locally for landscaping, thus again reducing the on-Site traffic. Excavated rock (and any glacial till) will be used for access track construction as close to the source of extraction as possible.

8.5.2.3 Ground Stability

8.5.2.3.1 Mitigation by Avoidance and Good Practice

As discussed previously, careful design of the wind farm has reduced the amount of construction required in areas of deep peat, high slopes and other areas of potential ground instability. Additionally, the following mitigation measures will also be applied as recommended in the PSRA (included as **Appendix 8.1**):

- Avoidance of stockpiling on the peat
- Avoidance of peat berms in areas of potential instability (highlighted by low safety ratios)
- Additional drainage will be provided in areas of construction
- Avoidance of drains discharging onto areas of weak or deep peat or areas of low safety ratios
- Avoidance of blasting

As noted in the PSRA, vehicular access to any areas of deep peat (>1m) during construction will be restricted to low ground pressure vehicles, with all construction vehicles travelling on existing access tracks whenever possible.

Best practice practice as described in the IWEA and Scottish Best Practice Guidelines will be applied during construction which will minimise the risk of ground instability. All works will be managed and carried out in accordance with the Construction Environmental Management Plan (CEMP in **Technical Appendix 2.1**), which will be updated by the civil engineering contractor and agreed prior to any Site works commencing.

A Geotechnical Clerk of Works will be employed during the construction phase in order to continuously monitor areas of peat, in particular areas of deep peat and the areas of potential instability highlighted in the PSRA. Ongoing physical stability checks and calculations will be undertaken in order to verify that safety standards are being met. In particular, construction areas will be checked for signs of cracking, movement, bulking or subsidence which may give rise to subsequent instability. Any areas identified will require a detailed peat stability risk assessment and ongoing monitoring which will include sighting poles and lines to be set-up across slopes in addition to ground surveying to check for any signs of ground movement.

8.5.2.3.2 Emergency Response

The Construction Environmental Management Plan (CEMP in **Technical Appendix 2.1**) includes an emergency response to be applied in the event of a landslide or ground instability. In particular, catch fences and other physical barriers (i.e. concrete blocks) will be on Site and available in sufficient quantities to be used in the event of ground instability.

8.5.2.4 Soil Contamination

The CEMP (**Technical Appendix 2.1**) includes provision for the checking of assets (plant, vehicles, fuel bowsers) on a regular basis during the construction phase of the Development. The purpose of this management control is to ensure that the measures in place are operating effectively, prevent accidental leakages, and identify potential breaches in the protective retention and attenuation network during earthworks operations.

8.5.2.4.1 Mitigation by Avoidance and Good Practice

A fuel management plan is included in the CEMP (**Technical Appendix 2.1**) and includes the following elements:

- Mobile bowsers, tanks and drums will be stored in secure, impermeable storage area, away from drains and open water;

- Fuel containers will be stored within a secondary containment system e.g. bund for static tanks or a drip tray for mobile stores;
- Ancillary equipment such as hoses, pipes will be contained within the bund;
- Taps, nozzles or valves will be fitted with a lock system;
- Fuel and oil stores including tanks and drums will be regularly inspected for leaks and signs of damage;
- Only designated trained operators will be authorised to refuel plant on Site.

8.5.2.4.2 Mitigation by Reduction

As discussed previously, careful design of the wind farm has reduced the amount of Site traffic required on Site by reducing access tracks lengths, excavation volumes and double handling. Similarly, good Site practice and a robust CEMP (**Technical Appendix 2.1**) will also result in less traffic and a lower potential for fuel spills and leakages.

8.5.2.4.3 Emergency Response

Procedures and contingency plans are proposed to deal with any emergency accidents or spills. In particular an emergency spill kit with oil boom and absorbers will be kept on Site in the event of an accidental spill. All Site operatives will be trained in its use. In addition, all vehicles will also contain emergency spill kits.

8.5.2.5 Material and Waste Management

All materials used on Site and wastes generated on Site will be reduced by good Site practice and attention to the CEMP (**Technical Appendix 2.1**). A policy of reduce, re-use and recycle will apply. All waste will be segregated and re-used where possible or removed from Site for recycling. Any waste which is not recyclable or compostable will be properly disposed to landfill. Whenever possible, excavated materials will be re-used close to the area of excavation. The careful design which has been achieved will result in minimal excess soil and rock.

8.5.2.6 Construction Phase Residual Impacts

The residual impacts after implementation of all mitigation measures for the construction phase of the development are presented in **Table 8.13**.

Table 8.13: Residual Impact Summary

Impact Description	Type	Quality	Significance	Weighted Significance	Extent	Context	Probability	Duration / Frequency
Subsoil and bedrock removal	Direct	Negative	Moderate	Moderate	Localised	Conforms to baseline	Unavoidable	Permanent
Storage of stockpiles (general)	Direct	Negative	Small	Slight	Localised	Conforms to baseline	Likely	Temporary
Compaction, erosion and degradation of peat arising from vehicular movement	Direct	Negative	Small	Slight	Localised	Conforms to baseline Or Contrast to baseline	Avoidable	Long term / permanent
Stability issues and slope failure arising from vehicular movement (Localised/ regional displacement)	Direct or Indirect / Secondary	Negative	Moderate	Moderate	Localised / Potentially Regional	Contrast to baseline	Avoidable	Long term / permanent
Subsidence and settlement of newly established and enhanced Site tracks	Direct	Neutral	Small	Slight	Localised	Conforms to baseline.	Likely	Permanent
Localised stability issues arising during construction activities (Localised displacement)	Direct or Indirect / Secondary	Negative	Small	Slight	Localised	Conforms to baseline	Avoidable	Long term / Permanent
Hydrocarbon contamination	Direct	Negative	Small	Slight	Localised*	Contrast to baseline	Avoidable	Long term / Permanent
Construction Material contamination	Direct	Negative	Small	Slight	Localised*	Conforms to baseline	Avoidable	Long term / Permanent
General Waste contamination	Direct	Negative	Small	Slight	Localised*	Conforms to baseline	Avoidable	Long term / Permanent

Note:

* Contamination of soils / peat by hydrocarbons is considered a localised impact, however if hydrocarbon contamination is intercepted by surface water features the impact is potentially regional (**Chapter 9 – Hydrology and Hydrogeology**)

8.5.2.7 Operational Phase

All wastes from the control building and ancillary facilities will be removed by the appropriate contractor. The operational team will carry out maintenance works (to Site Access Tracks, 38kV Substation and turbines) and will put in place control measures to mitigate the risk of hydrocarbon or oil spills during the operational phase of the windfarm. Any vehicles utilised during the operational

phase will be maintained on a weekly basis and checked daily to ensure any damage or leakages are corrected.

The potential effects are limited by the size of the fuel tank of vehicles used on the Site. Additional potential impacts will occur in the event that a turbine needs replacement. The impacts associated with this will be similar to those involved for vehicles movements during construction but much reduced.

There are no other impacts relating to soils and geology during the operational phase of the Development.

8.5.2.8 Operational Phase Residual Impacts

The potential effects on the soil and geological environment during the operational phase of the work will be mitigated through good Site practice as described in the IWEA and Scottish Best Practice Guidelines as detailed in the CEMP (**Technical Appendix 2.1**); vehicular movements, hydrocarbon controls, sustainable use of natural resources, human health etc. as discussed previously. Overall, the residual effects from these aspects will have a not significant, permanent, negative effect on the Site.

8.5.3 Development Decommissioning and Restoration Phases

8.5.3.1 Decommissioning of Infrastructure

Following the permitted lifespan of the wind farm, decommissioning of the infrastructure will occur or the Site may be repowered with more modern turbines, subject to a separate planning application. All physical infrastructure (turbines, mast etc.) will be removed, re-used or recycled as appropriate or upgraded if the Site is to be repowered.

8.5.3.2 Decommissioning Phase Residual Impacts

The residual impacts associated with decommissioning includes waste generation, hydrocarbon leakage and erosion of soil and rock. In general, impacts will be similar to those at construction, but of a greatly reduced magnitude.

8.5.3.3 Reinstatement of Redundant Access Track and Hardstand Areas

Redundant access tracks, turbine bases and hardstand areas will be reinstated post construction. Some of the Site Access Tracks and hardstanding areas, if not required during operation, will also be reinstated (these areas will be identified at operation stage depending on operational requirements). Areas of excess soil and rock will be reused in order to match the surrounding land as near as possible. Drainage and slopes will be restored as close to the original ground as possible.

After decommissioning of the wind farm, all Site Access Tracks and areas of hardstanding will be returned to as close to their natural state as possible.

8.5.3.4 Reinstatement Phase Residual Impacts

On completion of reinstatement works, it is expected that the wind farm will be returned as close to its present condition as possible. In particular, areas of peat and current drainage regimes will be reinstated. It is expected that the long-term residual impacts associated with the wind farm development will therefore be negligible.

8.6 SUMMARY OF SIGNIFICANT IMPACTS

Providing the mitigation measures outlined in this report are fully implemented and best practice as described in the IWEA and Scottish Best Practice Guidelines is followed on Site, it is expected that impacts associated with the development of the wind farm will not be significant. The CEMP (**Technical Appendix 2.1**) also includes a suitable monitoring programme which will ensure that there is rigid adherence both to the CEMP and to the mitigation measures outlined here during construction, operation and decommissioning of the wind farm.

8.7 REFERENCES

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