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10 LAND, SOILS AND GEOLOGY

10.1 Introduction

This chapter assesses the effects of the Proposed Oatfield wind farm, which will be referred to as the 'Proposed Development', on the land, soils and geology environment of the Site. The Proposed Development includes all elements within the Red Line Boundary, the wind turbine generators with hardstands and blade lay down areas, substation, meteorological mast, temporary spoil repository areas, temporary contractors lay down area, site access tracks, and all ancillary electrical cabling and drainage. This chapter also provides a description of the work required along the proposed Grid Connection and the Turbine Delivery Route. Where adverse effects are predicted, the chapter identifies appropriate mitigation strategies therein. The assessment will consider the potential effects during the following phases of the Proposed Development:

- Construction Phase
- Operational Phase
- Decommissioning Phase (final phase)

This chapter of the EIAR is supported by figures listed below in **Appendix 10.5**:

- **Figure 10.1a**– Site Location and Layout Wind Farm
- **Figure 10.1b** – Site Location and Layout GCR and IPP Overview
- **Figure 10.1c** – Site Location and Layout Turbine Delivery Route Overview
- **Figure 10.2a** – Land Use Wind Farm
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- **Figure 10.2c** – Land Use Turbine Delivery
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This chapter of the EIAR is also supported by the following technical appendices provided in **Volume IV** of this EIAR:

- **Appendix 10.1** - Site Investigation & Peat Stability Risk Assessment
- **Appendix 10.1 - App A** - Peat Map
- **Appendix 10.1 - App B(a)** - Peat Database
- **Appendix 10.1 - App B(b)** - Risk Matrices
- **Appendix 10.1 - App C(a)** - Factor of Safety Map
- **Appendix 10.1 - App C(b)** - Risk Ranking Map
- **Appendix 10.2 –** Oatfield Grid Connection Route Assessment Database
- **Appendix 10.3 –** Oatfield Turbine Delivery Route Assessment Database
- **Appendix 10.4 –** Oatfield IPP Connection Route Assessment Database
- **Appendix 10.5 –** Figures

A Construction and Environmental Management Plan (CEMP) is appended to the EIAR in **Technical Appendix 5.1**. This document will be a key construction contract document, which will ensure that the mitigation measures, which are considered necessary to protect the environment are implemented. In the event that planning permission is granted for the development, any condition(s) relating to a CEMP which may be attached by the Local Authority to such a permission, will be implemented in accordance with the requirements of the condition.

10.1.1 Proposed Development Description

The Proposed Development comprises an 11-turbine wind farm on a site located within forested and agricultural lands. It also comprises a Grid Connection Route (GCR) for connection to the national grid, and temporary accommodating works along a Turbine Delivery Route (TDR) to the wind farm, to facilitate the delivery of large components from the port of delivery. The GCR and TDR are both assessed in this EIAR and form part of the planning application.

The key components that are described throughout the EIAR are listed below:

- The wind farm which consists of 11 wind turbines (4 turbines across the Eastern Development Area (Eastern DA) and 7 turbines across the Western Development Area (Western DA));
- The grid connection route and underground cables (also referred to as GCR and UGC); and,
- The turbine delivery route (TDR).

The term 'Proposed Development' collectively describes the above three components. Further information about the Proposed Development is presented in **EIAR Chapter 5: Description of the Proposed Development**.

10.1.2 Assessment Structure

In line with the EIA Directive (Directive 2014/52/EU) and current EPA guidelines on the information to be contained in Environmental Impact Assessment Reports (2022), the structure of this Land, Soils and Geology chapter is as follows:

- Assessment Methodology and Significance Criteria
- Description of baseline conditions at the Proposed Development
- Identification and assessment of effects 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 effects identified.
- Identification and assessment of residual effect of the development considering mitigation measures.
- Identification and assessment of cumulative effects if and where applicable.

10.1.3 Statement of Authority

RSK (Ireland) Ltd. (RSK), part of RSK Group, is a consultancy providing environmental services in the hydrological, hydrogeological and other environmental disciplines. The company and group provide consultancy to clients in both the public & private sectors. More information can be found at www.rskgroup.com. The principal members of the RSK EIA team involved in this assessment include the following persons;

- Project Manager & Lead Author: Sven Klinkenbergh – B.Sc. (Environmental Science), P.G.Dip. (Environmental Protection). Current Role: Principal Environmental Consultant. Experience c. 10 years
- Project Scientist: Deirdre Walsh – B.Sc. (Geology), M.Sc. (Geoscience), PhD (Geomodelling). Current Role: Environmental Consultant

10.2 Assessment Methodology and Significance Criteria

10.2.1 Assessment Methodology

The following assessments were undertaken in order to evaluate the potential effects of the Proposed 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.
- Undertake preliminary materials budget calculations in terms of subsoil excavation and removal associated with development design.
- Consider ground stability issues as a result of the Proposed 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.

10.2.2 Objective Led Approach

Direct impacts or effects on geological attributes or soils themselves are localised in the context of soils and geology (e.g., excavated soils from holes, stored and used as back fill). However, in many instances, these geological impacts give rise to the potential sources of contamination by water run off (i.e., indirect or secondary impacts) to ecological and hydrological receptors. For example: contamination of soils / peat by cementitious material is considered a localised impact, however if cementitious contamination is intercepted by surface water features or groundwater bodies the impact is potentially regional depending in the environmental circumstances. Therefore, throughout this report references will be made to EIAR **Chapter 9 Hydrology and Hydrogeology** for further detail and clarification on potential effects and mitigation measures of the Proposed Development.

The Soil Thematic Strategy and the Roadmap to a Resource Efficient Europe highlights the importance of sustainable use of soil and the need to tackle land take. In line with this proposal, it states

"*Public and private projects should therefore consider and limit their impact on land, particularly land take, and soil, including on organic matter, erosion, compaction and sealing. This should be facilitated through appropriate land use plans and policies at national, regional and local levels*" (EC, 2012).

10.2.3 Relevant Legislation and Guidance

This assessment complies with the European Directive 2014/52/EU 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 planning legislation, environmental legislation relevant to geological, geotechnical, hydrological, and hydrogeological aspects of the environment were referred to, such as:

- SI No. 30 of 2000: Planning and Development Act 2000 (e.g., Sections 212 (1) f; Part IV, 6; Fifth Schedule Condition 21).
- SI No. 600 of 2001: Planning and Development Regulations 2001,
- SI No. 4 of 1995: The Heritage Act 1995,
- SI No. 33 of 2000: The Wildlife (Amendment) Act, 2000.

The Clare County Development Plan (2017-2023) and current DRAFT (2023-2029) Country Development Plan- i.e., Clare Wind Energy Strategy, were also consulted 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:

- BSI (1999) Code of Practice for Site Investigations - BS 5930
- CIRIA (2006) Control of Water Pollution from Linear Construction Projects – Technical Guidance
- DHPLG (2017) Interim Guidelines for Planning Authorities on Statutory Plans, Renewable Energy and Climate Change and Wind Energy Development Guidelines 2006
- Department of Housing, Planning and Local Government (DEHLG) (2020) Draft Revised Wind Energy Guidelines
- Department of Housing, Planning, Community and Local Government (DHPLG) (2017) Interim Guidelines for Planning Authorities on Statutory Plans, Renewable Energy and Climate Change
- EPA (2022) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports
- Gharedaghloo, B. (2018) Characterizing the transport of hydrocarbon contaminants in peat soils and peatlands.
- 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
- NRA (2014) Guidelines for the Management of Waste from National Road Construction Projects
- National Parks and Wildlife Services (NPWS) (2015) National Peatlands Strategy
- NPWS (2017) Best practice in raised bog restoration in Ireland
- RSK (2022) Engineer's Quick Reference Guide for Ground Investigation
- Scottish Forestry Commission (2006) "Guidelines for the Risk Management of Peat Slips on the Construction of Low Volume / Low Cost Roads Over Peat"
- Scottish Government (2017) Peat Landslide Hazard and Risk Assessment: Best Practice Guide for Proposed Electricity Generation Developments
- Scottish National Heritage (SNH) (2013) A Handbook on Environmental Impact Assessment

10.2.4 Study Area

The study area or zone of influence is any land, soils and geology underlying the Proposed Development and its immediate surround. The study area extends to the wider area with consideration large-scale geological structures, karstic features and stability assessments.

The interconnection with hydrology, hydrogeology and other disciplines including ecology and their associated study areas are also considered as part of the assessment of potential effects and mitigation measures due to the potential secondary or indirect effects related to slope stability or runoff, to the surrounding surface water network and other sensitive receptors.

10.2.5 Desk Study

Desktop assessments were undertaken on the soils and geology aspects of the Proposed Development before and after field investigations. This involved the following components:

- Acquisition and compilation of all available and relevant maps of the Proposed Development.
- Study and assessment of the proposed locations of turbines and Site access roads tracks and Onsite Substation relative to available data on Site topography and slope gradients.
- Study and assessment of the proposed locations of turbines, Turbine Delivery Route, site access tracks, onsite substation and Grid Connection route connecting the Proposed Development to the national grid and associated infrastructure (e.g., typical drainage infrastructure) relative to available data on soils, subsoil and bedrock geology.
- Study of geospatial data obtained from various sources including; Environmental Protection Agency (EPA), Geological Survey Ireland (GSI), Teagasc, Ordinance Survey Ireland (OSi), National Parks and Wildlife (NPWS) overlain with the development plan drawings using a Geographic Information System (GIS). Data was assessed at a regional, local and site-specific scale.
- Additional data was obtained and assessed where relevant, for example, rain data obtained from Met Eireann, and river discharge rates and synoptic data sets obtained from the EPA.

10.2.6 Field Work

Field inspections were carried out at the site of the Proposed Development during August, September and October 2023. These works consisted of the following:

- Bedrock and mineral subsoil outcrop characterisation.
- Confirm if peat is present at or near any proposed Development locations.
- Peat depth probing if peat is present (depth to bedrock and/or competent subsoil).
- Slope measurements at proposed turbine locations to determine slope gradient.

- Recording of GPS co-ordinates for all investigation and monitoring points in the study.
- Digital photography of significant features.

Site walk overs were carried out to assess general ground conditions including topographical characteristics, potential for peat and to observe the existing site including visual assessment of the receiving environment in terms of impacts arising from the existing infrastructure and practices at the site.

10.2.7 Consultations

Information has been provided by a number of consultee organisations during the assessment, and this is summarised in **Table 10.1**. The response to each point raised by consultees is also presented within the table, demonstrating where the design of the Proposed Development has addressed responses to specific issues indicated by respective consultees.

Table 10.1: Responses / key issues raised during consultation and where they have been addressed

Consultee	Type and Date	Response received / key issues raised	Where the responses / key issues are addressed in the EIAR
Geological Survey Ireland	9th October 2023	Please find attached a list of our publicly available datasets that may be useful to the environmental assessment and planning process. We recommend that you review this list and refer to any datasets you consider relevant to your assessment. The remainder of this letter and following sections provide more detail on some of these datasets.	Each of these publicly available datasets was considered during the desk study and included in the Baseline Description Section 10.3 • Geoheritage, Section 10.3.9, • Geological Mapping: Bedrock, Section 10.3.4 Subsoils, Section 10.3.5, • Geohazards: Landslides susceptibility, Section 10.3.6, • Natural Resources, Section 10.3.8, • Guidelines, see Section 10.2.3

10.2.8 Evaluation of Potential Effects

In line with relevant guidelines (EPA, 2022[1]), and consideration of the criteria listed in Annex III of the Directive 2014/52/EU of the European Parliament and the council of April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private project on the environment, effects should be described by reference to the individual environmental factors and their sensitivities;

[1] Environmental Protection Agency (EPA) (2022) Guidelines on the information to be contained in Environmental Impact Assessment Reports

a) the **magnitude** and **spatial extent** of the effect (for example geographical area and size of the population likely to be affected);

b) the **nature** of the effect;

c) the transboundary nature of the effect;

d) the **intensity** and **complexity** of the effect;

e) the **probability** of the effect;

f) the expected onset, duration, frequency and reversibility of the effect;

g) the **cumulation** of the effect with the impact of other existing and/or approved projects;

h) the possibility of effectively reducing the impact.

10.2.8.1 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[2])

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 (**Table 10.2**) presents rated categories and criteria for rating site attributes (NRA, 2008[3]).

[2] Environmental Protection Agency (EPA) (2015) Advice Notes for Preparing Environmental Impact Statements DRAFT

[3] National Roads Authority (2008) Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes

Table 10.2: Criteria for rating site attributes – soils and geology specific

Importance	Criteria
Extremely High	Attribute has a high quality or value on an international scale.
Very High	Attribute has a high quality, significance or value on a regional or national scale.
High	Attribute has a high quality, significance or value on a local scale.
Medium	Attribute has a medium quality, significance or value on a local scale.
Low	Attribute has a low quality, significance or value on a local scale.

The sensitivity of the receiving geological environment is defined by the baseline quality, as well as its potential to absorb change or substitution. Considering the above categories of rating importance and associated criteria, the following table (**Table 10.3**) presents rated sensitivity categories (SNH, 2018[4]).

Table 10.3: Criteria for rating site sensitivity – landscape character specific

Importance	Criteria
High Sensitivity	Key characteristics and features which contribute significantly to the distinctiveness and character of the landscape character type. Designated landscapes e.g., National Parks, Natural Heritage Areas (NHAs) and Special Areas of Conservation (SACs) and landscapes identified as having low capacity to accommodate proposed form of change, that is, sites with attributes of **Very High Importance**.
Medium Sensitivity	Other characteristics or features of the landscape that contribute to the character of the landscape locally. Locally valued landscapes which are not designated. Landscapes identified as having some tolerance of the proposed change subject to design and mitigation etc., that is, sites with attributes of **Medium to High Importance**.
Low Sensitivity	Landscape characteristics and features that do not make a significant contribution to landscape character or distinctiveness locally, or which are untypical or uncharacteristic of the landscape type. Landscapes identified as being generally tolerant of the proposed change subject to design and mitigation etc, that is, sites with attributes of **Low Importance**.

10.2.8.2 Magnitude

The magnitude of potential effects arising as a product of the Development are defined in accordance with the criteria provided by the EPA, as presented in the following table (**Table 10.4**; EPA, 2022). These descriptive phrases are considered general terms for describing potential effects of the Development, and provide for considering baseline

[4] Scottish National Heritage (SNH) (2018) Environmental Impact Assessment Handbook V5

trends, for example, a *Moderate* effect is one which *is consistent with the existing or emerging trends*.

Table 10.4: Describing the magnitude of effects

Magnitude of Effect	Description
Imperceptible	An effect capable of measurement but without significant consequences.
Not Significant	An effect which causes noticeable changes in the character of the environment but without significant consequences.
Slight Effects	An effect which causes noticeable changes in the character of the environment without affecting its sensitivities.
Moderate Effects	An effect that alters the character of the environment in a manner that is consistent with existing and emerging baseline trends.
Significant Effects	An effect which, by its character, magnitude, duration or intensity, alters a sensitive aspect of the environment.
Very Significant	An effect which, by its character, magnitude, duration or intensity, significantly alters most of a sensitive aspect of the environment
Profound Effects	An effect which obliterates sensitive characteristics.

In terms of soils and geology, magnitude is qualified in line with relevant guidance, as presented in the following table (**Table 10.5**; NRA, 2008). These descriptive phrases are considered development specific terms for describing potential effects of the Proposed Development, and do not provide for considering baseline trends and therefore are utilised to qualify effects in terms of weighting effects relative to site attribute importance, and scale where applicable.

Table 10.5: Qualifying the magnitude of effects on soil and geological attributes

Magnitude of Effect	Description	Example
Large Adverse	Results in a loss of attribute.	Removal of the majority (>50%) of geological heritage feature.
Moderate Adverse	Results in effect on integrity of attribute or loss of part of attribute.	Removal of part (15-50%) of geological heritage feature.
Small Adverse	Results in minor effect on integrity of attribute or loss of small part of attribute.	Removal of small part (<15%) of geological heritage feature.
Negligible	Results in an effect 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.

10.2.8.3 Significance criteria

Considering the above definitions and rating structures associated with sensitivity, attribute importance, and magnitude of potential effects, rating of significant environmental effects 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 10.4: Describing the magnitude of effects**) are linked directly with the development specific terms for qualifying potential effects (**Table 10.5: Qualifying the magnitude of effects on soil and geological attributes**) therefore, qualifying terms (**Table 10.6**) are used in determining the sensitivity of potential effects of the Proposed Development.

This is largely driven by the likely far-reaching characteristic of potential effects arising as a product of the Proposed Development in terms of soil and geology, and the separation of land areas based on baseline conditions (Section 10.4).

Table 10.6: Sensitivity (importance of attribute) & magnitude of effect matrix

Sensitivity (Importance of Attribute)	Magnitude of Effect			
	Negligible (Imperceptible)	**Small Adverse (Slight)**	**Moderate Adverse (Moderate)**	**Large Adverse (Significant to Profound)**
Extremely High	Imperceptible	Significant	Profound	Profound
Very High	Imperceptible	Significant / Moderate	Profound / Significant	Profound
High	Imperceptible	Moderate / Slight	Significant / Moderate	Profound / Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight / Moderate

10.3 Baseline Description

10.3.1 Introduction

An investigation of the existing land, soils and geology characteristics of the Proposed Development 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.

10.3.2 Wind Farm Site Description

The area of the proposed Wind Farm is characterised by relatively complex (hilly) topography with associated elevations ranging between c. 130 to 270 metres Above Ordnance Datum (mAOD). The Proposed Development comprises of two distinct areas; the Western Development Area (DA) and the Eastern DA, comprising of a total land area of approximately 296 hectares which principally consists of conifer plantation, transitional woodland scrub, mixed forest, pastures, agricultural lands and peat lands.

10.3.3 Land Use

Mapped land use is presented in **Figure 10.2 (a-c)**. Consultation with Corine (2018)[5] Land Use maps (EPA) indicates that the wind farm site is comprised mainly of *coniferous forest, transitional woodland-shrub, pastures, peat bogs*.

The Eastern DA is split between coniferous forest and transitional woodland-shrub with some peat bogs at the site entrance and access track.

The Western DA has a mix of coniferous forest, transitional woodland-shrub and pastures.

Along the Grid Connection route to the Loop in location, the land is predominantly pastures with a small area of coniferous forest.

Along the Turbine Delivery Route most of the land is used for pastures with some small areas of peat bogs, discontinuous urban fabric, mixed forest, land principally occupied by agriculture, with significant areas of natural vegetation, mineral extraction sites, road and rail networks and associated land, inland marshes, industrial or commercial units and transitional woodland-shrub along the route or directly adjacent to it.

10.3.4 Bedrock Geology

10.3.4.1 Wind Farm

There are a number of mapped geological formations underlying the wind farm element of the Proposed Development (GSI, Bedrock 100k[6], **Figure 10.3a**). The Old Red Sandstone is the most dominant bedrock and unconformably overlies the older inliers of Lower Palaeozoic mudstones and siltstones of the Broadford Formation and the Cornagnoe Formation:

- Cornagnoe Formation (CE) - The formation contains two principal lithologies, grey mudstones and mottled siltstones/mudstones. Both lithologies include thin beds of graptolitic mudstones from which graptolites of Llandovery age. Purple Grits (pg) are assigned here to the Cornagnoe Formation and underly T1 and T7.
- Broadford Formation (BF) - Dominated by grey banded mudstones but also contains abundant arenaceous horizons. This formation underlies T2 and T4.
- The Old Red Sandstone (ORS) - Red mudstones, siltstones and sandstones, and poorly sorted, polymict pebble conglomerates and breccias. This formation underlies T3, T4, T5, T6, T8, T9, T10, T11, both storage areas and the substation.

There are no mapped karst features located within or near the vicinity of the proposed development with the closest karst feature 4km north of the Eastern DA. This karst feature is associated with the limestone bedrock of the Ballysteen Formation (BA) and therefore it is unlikely that any unmapped karst features would be found at the Proposed Development.

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[5] CORINE Land Cover (2018). Online: https://land.copernicus.eu/pan-european/corine-land-cover/clc2018. [Accessed: August 2023]

[6] Geological Survey of Ireland (GSI) (ND) Geological Survey Ireland Spatial Resources [Online] - Available at: http://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228 [Accessed: October 2023]

There are a number of faults present including an east-west fault south of T1, proposed T1 hardstand and a north south orientated fault to the east side of T7, which are unlikely to affect or be affected by the Proposed Development.

10.3.4.2 Grid Connection Route

The mapped geological formations underlying the c. 3.88km Grid Connection Route Loop in to Ballycar (GSI, Bedrock 100k) are presented in **Figure 10.3b**. The proposed GCR is mainly within the Old Red Sandstone and partially in the Cratloes Formation (CR) laminated siltstone and sandstone. The Loop-in towers location is underlain by the Cratloes Formation.

10.3.4.3 Turbine Delivery Route

There are a number of mapped geological formations underlying the Option 3a TDR (GSI, Bedrock 100k, **Figure 10.3c**).

These include the Silurian siltstone and grits of the Hollyford Formation (HF) and purple grit in Cornagnoe Formation (pg). The laminated siltstone and sandstone of the Broadford and Cratloes Formations (BF and CR). The Devonian pale red sandstone of the Keeper Hill Formation (KH) and the Devonian-Carboniferous Old Red Sandstone (ORS). There are a number of Carboniferous units which are largely limestones with some mudstones and chert which include the Ballysteen Formation (BA) and its member the Ballynash Member (BAbn), the Lower Limestone Shale (LLS), the Rathkeal Formation (RK), the Shanagolden Formation (SG), the Parsonage and Corgrig Lodge Formation (PA), the Clare Shale Formation (CS), the Durnish Formation (DU), the Waulsortian Limestones (WA), the Lough Gur Formation (LR), the undifferentiated Visean Limestones (VIS) and Volcaniclastic Rocks (V).

10.3.5 Soils and Subsoils

10.3.5.1 Soils

Proposed Development Wind farm Areas

Consultation with available soil maps (GSI, EPA, Teagasc, **Figure 10.4a**) indicate a number of soil types at the wind farm site location including Blanket peat (BktPt) and ‘Acid Shallow, lithosolic or podzolic type soils potentially with peaty topsoil’ (AminSRPT) in the Eastern DA. The Western DA is a mix of ‘Acid Deep Poorly Drained Mineral’ (AminPD) soil covering large areas with smaller pockets of ‘Acid Poorly Drained Mineralsoils with Peaty Topsoil’ (AminPDPT), ‘Acid Deep Well Drained Mineral’ (AminDW), and ‘Acid Shallow Well Drained Mineral’ (AminSW) soil also mapped.

The soil types at each of the main infrastructure units are summarised in **Table 10.7**.

Table 10.7: Summary of soil types on site (GSI, Teagasc Soils, 2023)

Soil	Parent material	Description	Type	Turbines
AminSW	RckNCa	Acid Shallow Well Drained Mineral	Shallow well drained mineral - Derived from mainly non-calcareous parent materials	T1
AminPDPT	TDSs	Acid Poorly Drained Mineral Soils with Peaty Topsoil	Poorly drained mineral soils with peaty topsoil - Derived from mainly non-calcareous parent materials	T2 andT5
AminPD	TDSs	Acid Deep Poorly Drained Mineral	Deep poorly drained mineral - Derived from mainly non-calcareous parent materials	T3, T4, T5, T7, storage area A, met mast
AminSRPT	RckNCa	Acid Shallow, lithosolic or podzolic type soils potentially with peaty topsoil	Shallow, lithosolic or podzolic type soils potentially with peaty topsoil - Predominantly shallow soils derived from non-calcareous rock or gravels with/without peaty surface horizon	T6, T10 partially T1, T3
BktPt	BktPt	Blanket Peat	Peats	T8, T9,T11, storage area B
AminDW	TLPSsS	Acid Deep Well Drained Mineral	Deep well drained mineral - Derived from mainly non-calcareous parent materials	Substation

Grid Connection Route

Consultation with available soil maps (GSI, EPA, Teagasc, **Figure 10.4b**) indicate a number of soil types along the proposed grid connection route to Ballycar which is mainly within 'Acid Deep Poorly Drained Mineral' (AminPD) with smaller pockets of 'Acid Shallow Well Drained Mineral' (AminSW), 'Acid Shallow Poorly Drained Mineral' (AminSP), 'Mineral Alluviul' (AlluvMIN) and 'Blanket Peat' (BktPt).

The Loop-in towers location is underlain by 'Acid Poorly Drained Mineral Soils with Peaty Topsoil' (AminPDPT), 'Acid Deep well drained mineral' (AminDW), and 'Acid Deep Poorly Drained Mineral' (AminPD).

Turbine Delivery Route

Consultation with available soil maps (GSI, EPA, Teagasc, **Figure 10.4c**) indicate a number of soil types along the proposed Turbine Delivery Route (Option 3a). These include 'Acid Shallow Well Drained Mineral' (AminSW), 'Acid Shallow Poorly Drained Mineral' (AminSP), 'Acid Poorly Drained Mineral' (AminPD), 'Acid Poorly Drained Mineral Soils with Peaty Topsoil' (AminPDPT), 'Acid Deep well drained mineral' (AminDW), 'Acid

Shallow peaty poorly drained mineral' (AminSRPT), 'Basic Deep well drained mineral' (BminDW), 'Basic poorly drained mineral' (BminPD), 'Basic Shallow well drained mineral' (BminSW), 'Basic shallow poorly drained mineral' (BminSP), 'Basic Shallow, rocky, peaty/non peaty mineral' (BminSRPT), 'Cutover/cutaway peat' (Cut), 'Blanket Peat' (BktPt), 'Fen Peat' (FenPt), 'Marine/estuarine sediments' (MarSed), 'Lacustrine type soils' (Lac), 'Mineral Alluviul' (AlluvMIN), 'Marl Alluvial' (AlluvMRL), and 'Made ground' (Made).

10.3.5.2 Subsoils

Proposed Development Wind farm Areas

Consultation with available subsoil maps (EPA[7]) indicate that there is a variety of subsoil types across the wind farm site including peat (BktPt), TDSs sandstone till (Devonian) and TLPSsS, sandstone and shale till (Lower Paleozoic). The subsoil types at site are summarised in **Figure 10.5a** and **Table 10.8**.

Table 10.8: Summary of subsoil types on site (EPA, Subsoils, 2023)

Subsoil Class	Parent material	Description	Texture	Turbines
Bedrock at or close to surface	Rck	Bedrock at Surface	N/A	T1, T6, T10
Peat	BktPt	Blanket Peat	Peaty	T8, T9, T11, storage area B
Tills	TLPSsS	Sandstone and shale till (Lower Paleozoic)	Clayey	T2, T3, T4, T5, T7, met mast, storage area A, substation

According to the GSI Groundwater Body Description database, the subsoil thickness over most of the rest of the Lough Graney Groundwater Body[8] are shallower, generally in the range 2-15 m. According to the Newmarket-on-Fergus Groundwater Body description[9] subsoil thickness over the Devonian Old Red Sandstone and Silurian aquifers, varies from very thin to absent on ridges and local topographic highs, to between 6-20 m in valleys or local depressions.

Based on the GSI Groundwater Vulnerability map (GSI 2023; **Figure 9.10a**), the depth to bedrock or subsoil thickness can be inferred for each of the infrastructure units. Across

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[7] Environmental Protection Agency (EPA) (ND) EPA Map Viewer [Online] - Available at: https://gis.epa.ie/EPAMaps/ [Accessed: October 2023]

[8] Geological Survey of Ireland (GSI) (2003) Tulla – Lough Graney GWB: Summary of Initial Characterisation [Online] - Available at: https://gsi.geodata.gov.ie/downloads/Groundwater/Reports/GWB/LoughGraneyGWB.pdf [Accessed: October 2023]

[9] Geological Survey of Ireland (GSI) (2003) Tulla – Newmarket-on-Fergus GWB: Summary of Initial Characterisation [Online] - Available at: https://gsi.geodata.gov.ie/downloads/Groundwater/Reports/GWB/TullaNewmarketOnFergusGWB.pdf [Accessed: October 2023]

the site the groundwater vulnerability is mapped as 'Rock at or Near Surface' and 'Extreme' giving depth <1m and 1-3m respectively.

Grid Connection Route

Consultation with available subsoil maps (EPA; **Figure 10.5b**) indicate that the dominant subsoil underlying the proposed Grid Connection Route is 'Sandstone till' (TDSs), with some 'Rock at or near surface' (Rck), 'Blanket peat' (BktPt), 'Sandstone and shale till' (TLPSsS), and 'Alluvium' (A). GSI Groundwater Vulnerability (**Figure 9.10b**) indicates that most of the GCR has low groundwater vulnerability with small areas ranging from moderate to rock at or near surface. The areas with Extreme vulnerability to rock at or near surface are at, and to the southeast of the onsite substation, to the south of the R471 and at and to the north of the Loop-in area.

The Loop-in towers location is underlain by 'Sandstone till' (TDSs). The groundwater vulnerability is mapped as high giving an inferred depth to bedrock of 5-10m at the Loop-in towers location.

Turbine Delivery Route

Consultation with available subsoil maps (EPA; **Figure 10.5c**) indicate that there is a variety of subsoil underlying the proposed Turbine Deliver Route including 'Rock at or near surface' (Rck), 'Karstified limestone bedrock at surface' (KaRck), 'Sandstone till' (TDSs & TLPDSs), 'Sandstone and shale till' (TLPSsS), 'Limestone till' (TLs), 'Basic igneous till' (TBi), 'Sandstone and shale sands and gravels' (GLPSsS), 'Sandstone sands and gravels' (GLPDSs), 'Limestone sands and gravels' (GLs), 'Blanket peat' (BktPt), 'Cutover peat' (Cut), 'Fen peat' (FenPt), 'Lake sediments undifferntiated' (L), 'Estuarine sediments (silts/clays)' (Mesc), 'Marl shell' (Mrl), 'Alluvium' (A) and 'Made ground' (Made).

10.3.5.3 Peat depths

A total of 876 no. peat depths were recorded during site visits in September and October 2023 at the Eastern DA and Western DA. The peat depth distribution recorded on site is summarised in **Table 10.9**.

Table 10.9: Peat depth distribution by category

Peat depth category	Number of probes	Percentage of probes
Rock (0.00-0.01 m)	157	17.9%
Very Shallow (0.01-0.5 m)	547	62.4%
Shallow (0.5-2.0 m)	148	16.9%
Moderately Deep (2.0-3.5m)	21	2.4%
Deep (3.5-5.0 m)	3	0.3%
Very Deep (>5.0 m)	0	0.0%

A summary of the soils and subsoils at each turbine or infrastructure unit is outlined in the table below (**Table 10.10**).

Table 10.10: Soils, subsoils and depth to bedrock summary for the main infrastructure units

DA	Turbine No. / Unit	Bedrock type	Soil	Subsoil	Peat depth (m)	Groundwater vulnerability	Depth to bedrock (m)
W	T1	Purple Grits (pg)	AminSW	Bedrock at or close to surface	0.01 - 1	Rock at or near surface	<1
W	T2	Banded mudstone (BF)	Amin PDPT	Till	0.01 - 1.5	Extreme	1-3
W	T3	Sandstone (ORS)	AminPD	Till	0.01 - 0.5	Extreme	1-3
W	T4	Banded mudstone (BF)	AminPD	Till	0.01 - 0.5	Extreme	1-3
W	T5	Sandstone (ORS)	AminPD	Till	0.01 - 0.5	Extreme	1-3
W	T6	Sandstone (ORS)	Amin SRPT	Bedrock at or close to surface	0.01 - 1.5	Rock at or near surface	<1
W	T7	Purple Grits (pg)	AminPD	Till	0.01 - 0.5	Extreme	1-3
E	T8	Sandstone (ORS)	BktPt	Peat	0.01 - 0.5	Extreme	1-3
E	T9	Sandstone (ORS)	BktPt	Peat	0.01 - 1.5	Extreme	1-3
E	T10	Sandstone (ORS)	Amin SRPT	Bedrock at or close to surface	0.01 - 1	Rock at or near surface	<1
E	T11	Sandstone (ORS)	BktPt	Peat	0.01 - 4	Extreme	1-3
W	Substation	Sandstone (ORS)	AminDW	Till	0.01 - 1	Extreme	1-3
W	Met Mast	Sandstone (ORS)	AminPD	Till	0.01 - 2*	Extreme	1-3
W	Compound/ Storage Area A	Sandstone (ORS)	AminPD	Till	0.01 - 0.5	Extreme	1-3
E	Compound/ Storage Area B	Sandstone (ORS)	BktPt	Peat	0.01 - 2	Extreme	1-3

*inferred from closest surveyed infrastructure unit (T2 track)

10.3.6 Landslide Susceptibility

The Geological Survey of Ireland (GSI) has developed a Landslide Susceptibility map[10] of Ireland. In consultation with this map (**Figure 10.6a**), the Proposed Development is considered to be of 'Low Risk' to 'Moderate Risk' in terms of landslide susceptibility. T6 and T10 are in areas which have been identified as 'moderately high' risk of landslide susceptibility. There is potential of 'High Risk' to landslide susceptibility to the north of the proposed T1 location (c. 75m).

The closest mapped Landslide Event (GSI, Landslide Events, 2023) recorded is c. 12km to the northeast which was described as a peat flow.

The Landslide Susceptibility along the Grid Connection Route (**Figure 10.6b**) is 'Low' Risk with some minor areas of 'Moderately Low' and 'Moderately High' Risk.

The Landslide Susceptibility along the Turbine Delivery Route (**Figure 10.6c**) is 'Low' Risk with some minor areas of 'Moderately Low' and 'Moderately High' Risk. The closest mapped Landslide Event (GSI, Landslide Events, 2023) recorded close to the TDR is c. 2.5km to the north at Killaloe which was described as a riverbank slide and occurred in 1948.

10.3.7 Peat Stability Risk Assessment

Peat depth across the wind farm site is generally very shallow to shallow (**Appendix 10.1– App A** and **App B**). The peat is shallower in the Western DA with some moderately deep peat In the Eastern DA. There is a small pocket of Moderately Deep to Deep peat to the north of T11.

The following table (**Table 10.11**) summarises the peat stability risk assessment data interpretation per major infrastructure unit. Note: results discussed are for FoS_{ADJ} Scenario B whereby 1.0m material surcharge is applied which allows for surcharges due to construction activity including stockpiled material to 1m. Aligned with Scottish Government Guidance, the Factor of Safety (FoS) values of 1.0 or greater are considered 'Acceptable' in terms of peat stability, whereas FoS ranges lower than 1.0 are deemed 'Unstable' and are classified as 'Unacceptable' (refer to **Table 9, Appendix 10.1**).

The Factor of Safety (Adjusted) (Conservative approach: Scenario B i.e. +1m surcharge relative to baseline conditions, or Scenario A) at peat probe locations is generally 'Acceptable' with 'Very Low' risk. This conservative approach uses conservative values for moisture content and shear strength instability risk assessment. The risk assessment itself is highly sensitive to and bias towards worst case environmental conditions in terms of peat or slope stability.

The Risk Ranking (Distance) Scenario B i.e., +1m surcharge) at peat probe locations is generally 'Very Low' to 'Low'.

Refer to **Appendix 10.1** Section 4 for full risk assessment results.

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[10] Geological Survey of Ireland (GSI) (ND) Geological Survey Ireland Spatial Resources [Online] - Available at: http://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228 [Accessed: October 2023]

Table 10.11: Peat stability risk assessment at main infrastructure units

DA	Turbine No. / Unit	Peat depth (m)	Slope (°)	FoS_{ADJ} (Factor of Safety adjusted considering site specific conditions)	RR_D (Ranked Risk considering Distance to Sensitive Receptors)	Receptor / Comment
W	T1	0.01 - 1	1.5 - 14	Acceptable	Very low	Risk of landslide to the north of the turbine
W	T2	0.01 - 1.5	1.5 - 14	Acceptable	Very low	
W	T3	0.01 - 0.5	3.5 - 6.5	Acceptable	Very low	
W	T4	0.01 - 0.5	6 - 8	Acceptable	Low	Close proximity to a surface water feature
W	T5	0.01 - 0.5	0.5 - 14	Acceptable	Very low	
W	T6	0.01 - 1.5	0.5 - 5.5	Acceptable	Very low	
W	T7	0.01 - 0.5	1 - 13	Acceptable	Low	
E	T8	0.01 - 0.5	0.5 - 6	Acceptable	Low	
E	T9	0.01 - 1.5	0.5 - 3	Acceptable	Very low	
E	T10	0.01 - 1	5 - 10	Acceptable	Very low	
E	T11	0.01 - 4	1 - 5	Acceptable	Very low	Some deeper peat to the north.
W	Substation	0.01 - 1	1 - 7	Acceptable	Very low	
W	Met Mast	0.01 - 2*	1.5	Acceptable	Very low / low	Inferred from data taken along the track to T2.

DA	Turbine No. / Unit	Peat depth (m)	Slope (°)	FoS_{ADJ} (Factor of Safety adjusted considering site specific conditions)	RR_D (Ranked Risk considering Distance to Sensitive Receptors)	Receptor / Comment
W	Storage Area A	0.01 - 0.5	1 - 12	Acceptable	Low	
E	Storage Area B	0.01 - 2	1 - 3	Acceptable	Very low	

With reference to **Appendix 10.1**, the risk of significant peat landslide events occurring at the Site is low given the nature, namely the relatively thin peat and where there are areas of thicker peat coincides with relatively flat topography at the Site.

10.3.8 Geological Resource Importance

The Geological Survey of Ireland (GSI) has areas mapped as Geological Resource Importance, such as active quarries and pits as well as mineral localities. Consultation with the GSI database shows mineral localities both metallic and non-metallic close to the site (<1km) and approximately 5km to the east is Ballyquin Pit (Sand and Gravel) and 6km to the south Ballycar Quarry (Crushed Rock and Dimension Stone).

10.3.9 Features of Geological Heritage

Consultation with the GSI database for known Geological Heritage Sites in Ireland indicates that there are no recorded 'Geoheritage' areas within the Proposed Development. The nearest Geological Heritage site is approximately 2km to the west is Ballyvorgal South [CE006][11] site, which is recommended for Geological NHA designation under the IGH 2 Precambrian to Devonian Palaeontology theme of the GSI's IGH Programme.

10.3.10 Designated & Protected Areas

A review of the NPWS mapping and website indicates that the Gortacullin Bog is an NHA which is adjacent the Proposed Development. It is to the north and west of T11 (c115m). This NHA is outside of the Blue Line Boundary with no infrastructure located in it.

The Proposed Development is not within any designated or protected areas (SAC / SPA). Any potential impacts to Soils or Geology are not considered to have direct impacts to downgradient designated sites, however entrainment of soils in runoff is a significant potential impact of the proposed development covered under EIAR **Chapter 9 Hydrology and Hydrogeology**. Therefore, impacts to soil have the potential to have secondary or indirect and impacts via hydrology in particular to down gradient receptors.

10.4 Assessment of Potential Effects

10.4.1 Significance Rating

Given the condition of the Proposed Development site in terms of land use practices, peat and soil quality, bedrock quality etc., Land, Soils and Geology as environmental attributes at the Site are considered to be of Medium Importance i.e., Attribute has a medium quality, significance or value on a local scale (Section 10.2.8).

With reference to Section 10.2.8 of this report and as summarised in **Table 10.12**, the geological attributes within the Development are considered to be of **Low to Medium Importance** and **Low to Medium Sensitivity**, and therefore classification of any

[11] Geological Survey of Ireland (GSI) (ND) CLARE - COUNTY GEOLOGICAL SITE REPORT [Online] - Available at: https://gsi.geodata.gov.ie/downloads/Geoheritage/Reports/CE006_Ballyvorgal_South.pdf [Accessed: October 2023]

potential impacts associated with the Development will be limited to Magnitudes associated with **Medium Importance**.

Table 10.12: Weighted rating of significant environmental effects – within the footprint of the site

Sensitivity (Importance of Attribute)	Magnitude of Effect			
	Negligible (Imperceptible)	**Small Adverse (Slight)**	**Moderate Adverse (Moderate)**	**Large Adverse (Significant to Profound)**
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight / Moderate

In terms of determining and assessing the magnitude of effects, categories of magnitude relate to the scale of the attribute, that is the attribute/s driving the classification of sensitivity is the area of the proposed site, and therefore scale is relative to the area of the proposed site itself. That is, the area of the site is approximately 418.58 ha (blue-line boundary area), and the area of the Proposed Development footprint is approximately 84.73 ha (red-line boundary area), therefore the area of the footprint of the Proposed Development equates to approximately 20.2 % of the blue-line boundary. This means that the land take associated with the Proposed Development is considered **adverse, moderate significance** (moderate (>15% area) effect on attribute with **Medium importance**), localised effect of the Proposed Development.

10.4.2 'Do-Nothing Impact'

The "Do Nothing Impact" is the effect should the Proposed Development not be constructed. Site investigations of the baseline geological and geotechnical conditions of the Site indicate the following:

- The site has already experienced impacts to baseline conditions due to the land use practices (**Figure 10.2a,** and **Appendix 9.2**) including agricultural (pastures, extensive drainage) and commercial afforestation activities (**Section 10.3.3**).
- There is no indication that current land use practices have had adverse impacts in terms of ground stability.
- The cumulative impact of afforestation on the proposed Site appears to be excavation of soil to construct drainage ditches and localised drainage of the soil, and varying degrees of soil erosion due to constructed roads and tracks, constructed drainage, vehicular movements, livestock movements etc.

Should the Proposed Development not proceed, the existing land-use practices at the proposed windfarm site will continue with associated modification of the existing environment.

If the Proposed Development were to not go ahead excavation along the grid connection route and IPP connection would not be required or any road widening and surface upgrading along the Turbine Delivery Route.

10.4.3 Construction Phase Potential Effects

The proposed Development is characterised by the subsequent subheadings.

10.4.3.1 Land take

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 generators with hardstands and blade lay down areas, substation, meteorological mast, temporary spoil repository areas, a temporary contractors lay down area and for temporary land take to facilitate the laying of grid connection cable ducting both on and off the site. Long-term land take associated with the Proposed Development is covered in Section 10.4.4 Operational Phase Potential Effects.

The effect of land take during construction is considered to be **small-scaled, direct**, **adverse, slight, localised**, and **permanent but reversible**.

Table 10.13 Land take quantities

Wind Farm Component	Land Take (ha)
Roads (including passing bays and reversing bays)	6.25
Compound	0.165
Hardstands	5.54
Turbine Foundations	0.49
Substation	2.73
OHL Mast	0.002
Meteorological Mast	0.005
Internal grid	0.44
IPP connection	0.636
Grid connection Option A - North OHL	0.23
Grid connection Option B - South OHL	0.25

Land take turbine delivery route

Land take is required for the Turbine Delivery Route (TDR), although the majority of the route will traverse already existing roadways (i.e., existing access tracks, public and local road networks) Therefore the land take along the turbine delivery route will be minimal.

One land take requirement along this route has been identified at the turn from R463 to the R471. This will involve the temporary loss of agricultural lands and some hedgerow (See EIAR **Chapter 5 Description of the Proposed Development, Figure 5.11**)

Excavation activities associated with land take required for the above temporary works will lead to disturbance of otherwise generally undisturbed, or bordering greenfield land, that is, the natural soil profile will potentially be disturbed. The area excavated will be reinstated following delivery of turbine components. The overall potential effect here is considered to be **not significant to slight** in terms of land, soils and geology, however it very important to consider proximity and impact to the existing receiving drainage network, as assessed under EIAR **Chapter 9** Hydrology and Hydrogeology.

Land take grid connection route

Minimal land take is required for the Grid Connection route considering the cable ducting will be buried in existing public roadways and verges and will be reinstated following laying of ducts. Temporary land take will be required to facilitate the HDD at the two locations along the GCR (**Table 5.8** EIAR **Chapter 5 Description of the Proposed Development**) one of which will result in excavation in adjacent farmland and temporary loss of hedgerow which will be reinstated post construction.

Any such impact is described similarly to general land take described above, however considering the small scale of disturbance, shallow cable trench (c. 1.2mbGL), the overall potential effect here is considered to be **not significant to slight** and **reversible**.

Land Take IPP cable route

The IPP cable route connecting the Eastern DA to the Western DA is 10.5km. Minimal land take is required for the IPP 33kV cable interconnector considering the line will principally be buried in or directly adjacent to existing roadways. Any such effect is described similarly to general land take described above, however considering the small scale of disturbance, shallow cable trench (c. 1.2mbGL), the effect is considered **negligible to slight, and reversible,** the trench will be backfilled and the surface of the road reinstated.

10.4.3.2 Clear fell of afforested areas

Felling of forest plantation at the proposed development will be necessary for areas of the Proposed Development in afforested sections within the Red Line Boundary. The proposed felled areas will consist of approximately 67ha of commercial conifer plantation to facilitate the Proposed Development.

This can lead to a slight increase in parameters such as phosphorous, nitrate, dissolved organic carbon and potassium in receiving waters flowing from the Proposed Development, which is considered to have an adverse effect on land and soils (this is discussed in greater detail in EIAR **Chapter 9 Hydrology and Hydrogeology**). If the Proposed Development does not take place, it is likely that the forest plantation at the Site will eventually either be clear felled or felled in larger volumes than the amount proposed as a function of this Proposed Development.

The overall potential effects here are considered to be of **moderate significance, permanent but reversible, and adverse**. With appropriate mitigation measures, planning and management, this impact can be reversed, and disturbance minimised. Vehicular movement associated with felling of afforested areas must also be considered here (Section 10.4.3.7).

10.4.3.3 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. Compaction effects are considered to be **direct, likely, slight to moderate**, **permanent** and **adverse**.

Erosion and degradation of exposed soils will also occur, primarily during construction, which will potentially lead to loading of runoff with solids and other contaminants. Erosion effects are considered to be **direct, likely, moderate to significant, permanent** and **adverse**.

10.4.3.4 Ground or soil sealing

Ground or soil sealing is the covering of a soil with an impermeable material which in turn changes the geotechnical and hydrogeological attributes, for example, increased runoff. The use of impermeable material is an inevitable direct effect to some extent of most types of construction particularly in greenfield sites. The potential effects will be discussed further below.

Soil sealing effects are considered to be **direct, unavoidable, slight to moderate, long term / permanent** and **adverse**.

10.4.3.5 Subsoil and bedrock removal

Subsoil and bedrock removal will occur during construction excavations and is an unavoidable direct consequence of the development for turbine bases and other foundations and cable trenches along the Grid Connection route. 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.

The excavation and removal of soils and bedrock has the potential to result in the release of contaminants, particularly suspended solids to the receiving environment during the construction phase of the Proposed Development, and to a lesser extent during the operational phase relative to baseline conditions. No further subsoil or bedrock removal will be required during operation.

The amounts of subsoil and bedrock to be removed will depend on specific construction and excavation plans which are specified in **Table 10.14** below and in the EIAR **Chapter 5 Description of the Proposed Development**. The expected total volume of excavated material amounts to c.188,875m^3 or 190,843 m^3 for both Option A (North OHL) and B (South OHL) for the Grid Connection.

Table 10.14 Soil, subsoil and bedrock removal / excavation quantities

Wind Farm Component	OHL	Soil excavation (m^3)	Subsoil excavation (m^3)	Rock excavation (m^3)
Roads (including passing bays and reversing bays)	N	26,867.05	4,991.04	-
	S	26,733.82	5,153.72	
GCR and IPP	N	11,307.97	34,892.57	
	S	11,703.97	36,080.57	
Compound	Both	990.00	-	-
Drainage	Both	6,214.32	6,214.32	-
Hardstands	Both	22,251.70	-	-
Turbine Foundations	Both	2,187.43	10,207.99	9,478.85
Substation	Both	4,995.87	825.42	-
OHL Mast	Both	31.10	176.26	103.68
Meteorological mast	Both	11.52	65.28	19.20
Internal grid	Both	1,400.58	3,268.02	-

The overall potential effects for the removal and replacement of subsoil and bedrock for turbine and substation foundation construction is considered to be of **slight to moderate significance, adverse, localised, permanent but reversible** effect of the proposed development.

Although the effects on the local geology are **slight to moderate**, there are a number of indirect or secondary effects including the potential for entrainment of suspended solids in runoff and increasing groundwater vulnerability by decreasing the depth to water table. These effects are discussed further under EIAR **Chapter 9 Hydrology and Hydrogeology**.

Subsoils and weathered bedrock, when segregated and managed, can be reinstated similar to baseline conditions, and therefore effects are temporary, however breaking of competent bedrock cannot be reinstated to baseline conditions.

Worst case scenarios include the triggering of a significant localised peat-landslide or mass movement event, a potentially profound effect if in close proximity to receptors and permanent adverse effect, refer to **Appendix 10.1 – Site Investigation & Peat Stability Risk Assessment Report**.

The approach and methodology in which excavation of in-situ earth materials is undertaken is very important for ground stability in any environment. Excavation has the potential to cause slippage or mass failure under certain geotechnical and hydrological conditions, for example excavating in deep saturated peat on, above or below steep inclines in peatland areas during periods of extensive rainfall. It should be noted that the proposed location of turbines, avoid areas with steep to severe slopes (**Appendix 10.1 –**

App B(a)). Nonetheless, the degree of slope steepness will be considered when excavating material i.e., cut and fill, sidewalls of open excavations, movement and management of material etc.

Mitigative and reductive measures with regard to materials budget handling and potential indirect effect on water quality from mineral subsoil and bedrock excavation activities are outlined in the mitigation section of this report.

Excavations

Excavations will be required for most aspects of the development including for load bearing portions of turbine hardstands including turbine foundations, site access tracks, met mast and substation foundations, and works associated with the improvement or construction of watercourse crossings and culverts, temporary construction compounds, cable trenches and grid connection route. Estimates of excavation volumes are presented in **Table 10.14**. Therefore, volumes of peat and soils/subsoils to be excavated on the wind farm site is relatively low relative to the development footprint. Increased excavation and peat / soil / subsoil / bedrock removal activity will be concentrated to particular locations of the Proposed Development.

The approach and methodology in which excavation of in-situ earth materials is undertaken is very important for ground stability in any environment. Excavation has the potential to cause slippage or mass failure under certain geotechnical and hydrological conditions, for example excavating in deep saturated peat on, above or below steep inclines in peatland areas during periods of extensive rainfall[12].

The overall potential effects here are considered to be of **slight to moderate significance**, **permanent but reversible** and **adverse**, under the footprint of the development in greenfield or natural / peatland areas. In areas associated with existing infrastructure (turbine delivery route / grid connection), the effect will be **neutral to slight** including for adequate reinstatement. The excavation and removal of soils or bedrock is a direct effect of the Proposed Development. Subsoil excavation can be reversed during the decommissioning and reinstatement phase of the development whereas the removal of bedrock is a permanent effect.

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 (c. 8.63km) will be constructed using fill with a top surface dressing of hardcore and will not be tarmacadamed or have a wearing course. New access tracks will be c. 1.05m in width and 0.3m in depth.

The overall potential effects are considered to have a **slight, permanent** and **adverse** effect due to the relatively small footprint of infrastructure and its location.

[12] Feehan, J. and O'Donovan, G. (1996) "The bog of Ireland: an introduction to the natural, cultural and industrial heritage of Irish peatland" *University College Dublin – The Environmental Institute.*

Turbines and hardstand areas

The material encountered at each turbine and infrastructure location is considered to be mostly shallow peat overlying bedrock in the Eastern DA and shallow till overlying bedrock in the Western DA. Ground investigations in the form of peat probing has been carried out at and around the proposed turbine hardstand to inform the depth of excavation and upfill required.

Soil, subsoil and rock will be excavated at each turbine foundation location to a depth where the underlying soil or rock can bear the weight of the structure (**Table 10.15**). The depth of the excavation required for the turbine foundations is a maximum of approximately 3mbGL. The exact depth of excavation will be confirmed at detailed design stage dependant of the ground conditions at each turbine foundation location.

The hardstanding areas will require excavation of approximately 0.3mbGL.

Table 10.15: Excavation depth and volumes for turbine and substation foundations.

Hardstand	Depth of Excavation mbGL (approx.)	Data inferred from Geology		Excavated volume (m^3)		
		Topsoil mbGL (approx.)	Assumed Subsoil Depth mbGL	Topsoil	Subsoil	Rock
T1	3	0.3	0.9	198.86	397.71	1,392.00
T2	3	0.3	2	198.86	1,126.86	662.86
T3	3	0.3	2	198.86	1,126.86	662.86
T4	3	0.3	2	198.86	1,126.86	662.86
T5	3	0.3	2	198.86	1,126.86	662.86
T6	3	0.3	0.9	198.86	397.71	1,392.00
T7	3	0.3	2	198.86	1,126.86	662.86
T8	3	0.3	2	198.86	1,126.86	662.86
T9	3	0.3	2	198.86	1,126.86	662.86
T10	3	0.3	0.9	198.86	397.71	1,392.00
T11	3	0.3	2	198.86	1,126.86	662.86
Substation	1	0.3	2	5,309.25	825.42	-
Loop-in OHL	3	0.3	2	31.10	176.26	103.68
Total				7,527.78	11,209.66	9,582.53

The temporary construction compounds in both the Eastern DA and Western DA will require similar foundations to those of turbine hardstands.

The likely effects associated with excavations at hardstand areas are considered to be **slight to moderate adverse** (in terms of overall project scale), **permanent** (life of project) and **reversible** through reinstatement during the decommissioning phase of the Proposed Development.

Bedrock excavations

Bedrock excavations will be required at the proposed locations of turbine foundations, turbine hardstands, access tracks and the onsite substation.

Any excavated rock will be taken off site to be crushed and screened and then returned and reused on site as fill material.

The effects associated with bedrock excavations are considered to be **slight to moderate** and **adverse, permanent** and **irreversible**.

Site cable trenches

Cable trenches throughout the Site will be excavated to an anticipated depth of approximately 1.2m. Excavation of peat, till and bedrock will be required. Excavated material will be used to backfill the trench, and any surplus material will be used as berms along the access tracks or deposited in one of the designated storage locations. The retained topsoil will be used to reinstate vegetative cover immediately after the cables have been installed and the trench filled in.

The Eastern DA will be connected to the Western DA through an interconnecting 33kv IPP cable (**Figure 8.1**). The IPP cables will be installed within the body of the local public road network. Cable joint bays will be installed every 100m. Excess excavated material and the paved surface will be removed to a licensed waste facility.

The effects associated with excavations for site cable trenches and the interconnecting 33kv IPP cable are considered to be **slight** and **adverse, temporary** and **reversable**.

Turbine delivery route

The Turbine Delivery Route will use existing roadways and will require some temporary shallow excavations to accommodate the delivery of turbine components (EIAR **Chapter 16** and **Appendix 10.3**). It is anticipated that topsoil removal will occur at these locations to approximately 0.45m depending on the confirmatory detailed design and specific ground conditions.

The likely effects associated with excavations on the Turbine Delivery Route are considered to be **slight, adverse, long term to permanent** (life of project) and **reversible** through reinstatement after turbine delivery. Reuse of the Turbine Delivery Route during the operational phase of the development would only be necessary if heavy maintenance required replacement blades.

Grid connection route

The Proposed Development will be connected into either the existing Ardnacrusha to Ennis 110kV Overhead Line (Option A) or the existing Ardnacrusha to Drumline 110kV Overhead Line, (Option B) via a loop in 110kV double circuit underground cable to Loop-in masts at Ballycar North. The UGC works will be over approximately 3.83km or 4.16km (Option A or Option B respectively) via two 110kV cable trenches, which will be underground and constructed primarily within the existing road corridor to an anticipated depth of c.1.2m, and to a width of 0.6m.

Depending on the underlying subsoils and bedrock along the grid connection route excavation of road aggregates, peat, tills, and bedrock will be required (**Appendix 10.2**).

The trenches will be backfilled using a mixture of cement as a protection layer in which the cable and communication ducts will be embedded and with granular material. A top tarmacadam coat will be used to reinstate the roadways. The excavated material will be disposed of offsite as inert landfill at a licenced facility or recycled for use elsewhere.

Horizontal Directional Drilling (HDD) will be utilised at watercourse crossing and involves temporary construction of a launch and retrial pit either side of the watercourse and cable conduits are drilled beneath the watercourse from the launch pit to the retrieval pit (see Section 10.4.3.8 for potential effects associated with HDD.

The effects associated with excavations for cable trenches are considered to be **adverse, small (scale), slight significance, unavoidable** and **permanent**.

10.4.3.6 Storage and stockpiles

Overview

It is expected that the majority of spoil generated on site will be peat and subsoils with some rock excavated at turbine foundations and hardstands.

Material to be temporarily stored for a relatively long period during the construction phase will be stored in a designated area Storage Area A (close to T5) and Storage Area B (on the access track to T8) in both the Western DA and Eastern DA (6,000 m^2) and will be limited to 2m height. Short term temporary stockpiles elsewhere on the site will be limited to 1m and will be confined to the footprint of the development.

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.

The potential effect by construction works activity on water quality is discussed in EIAR **Chapter 9 Hydrology and Hydrogeology**.

Spoil management

Of significance, during the construction phase of the Proposed Development, is the management of excavated materials handling, storage and re-use. There is potential for **direct adverse effect** on localised ground stability, particularly in the vicinity of ongoing excavation works. For example, loading or surcharging of ground in proximity to open excavations is considered in good practices and health and safety procedures associated with excavation works, as presented in **Plate 10.1**. Direct and indirect adverse effects on surface water quality can also occur (EIAR **Chapter 9 Hydrology and Hydrogeology**). However, such impacts are considered **temporary** and **reversible**.

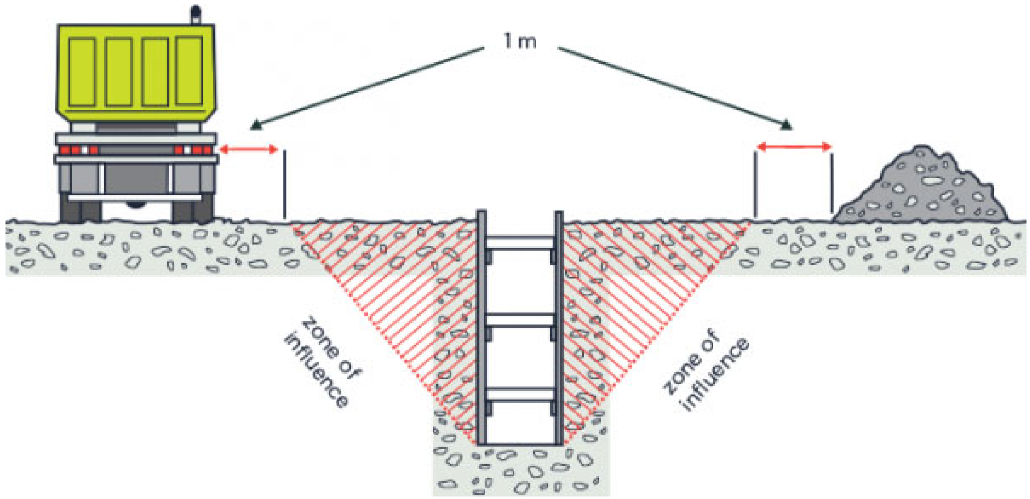

Plate 10.1: Example impact of loading or surcharge on ground in proximity to open excavations[13]

It is envisaged that excavated material (i.e. soils and subsoils) for turbine foundations will be used as back fill and for reinstatement purposes, that is reused on site as appropriate and any surplus material will be transported to spoil storage areas. Excavated material will arise from all infrastructure elements of the wind farm (foundations, tracks, hardstands etc).

There is potential for a **moderate** and **adverse** effects 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.

Organic matter loss can occur when wet peat is excavated and allowed to dry in the open air. 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). Furthermore, excavated forestry material can also contribute to Nutrient Enrichment from historical site practices, refer to Section 9.4.3.2 of EIAR **Chapter 9 Hydrology and Hydrogeology**.

The process of spoil management is expected to have a **slight** and **adverse** effect on the receiving environment.

Peat stability and slope failure

While the possibility of a peat slide is considered to be low (**Appendix 10.1**), poorly managed construction activities can increase the risk of stability issues arising including at a localised scale. Soil stability issues brought about by excavation or vehicular movement activities on site have the potential to lead to open excavation side wall collapse, or spilling of soil material etc., which in turn will potentially;

- Compromise ground stability in the vicinity of the works, thus increasing the effective footprint of the proposed Development.

[13] New Zealand Government (2016) Good Practice Guidelines – Excavation Safety

- Impact on the receiving surface water or drainage network. This is of particular concern in relation to portions of the development within surface water buffer zones or intercepting the existing drainage network

Worst case scenarios include significant movements of soils which are intercepted by surface water receptors, this is assessed further under EIAR **Chapter 9 Hydrology and Hydrogeology**.

Any peat slide or slope failure which occurs will likely be localised due to the generally shallow peat and 'Acceptable' Factor of Safety rating for stability at the Site (**Appendix 10.1**). Potential indirect soil stability issues including downgradient of the Proposed Development footprint brought about by construction activities are considered to be **slight to moderate** (geology), **adverse**, **potentially permanent** effect but **reversible**. Risk of severe ground stability effects can be greatly minimised by applying mitigation measures, as described in following sections and in EIAR **Chapter 9 Hydrology and Hydrogeology**.

10.4.3.7 Vehicular movement

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) and forest felling (tracked harvester e.g.) and harvesting equipment, (wheeled forwarder and saw log transporters). During the operation phase, vehicles will be limited to occasional maintenance vehicles only.

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. Compaction effects are considered to be **slight to moderate**, **adverse** and **permanent**.

Erosion and degradation of exposed soils will also occur, primarily during construction, which will potentially lead to loading of runoff with solids and other contaminants. Entrainment of solids in storm or construction water runoff are assessed in EIAR **Chapter 9 Hydrology and Hydrogeology**.

Peat stability and slope failure

Vehicular movements on site have the potential to trigger soil or slope stability.

Turbine delivery route, grid connection route and site tracks

The delivery and connection routes will utilise existing roadways and infrastructure along the majority of the routes and therefore, the effects associated with vehicle movements along the Turbine Delivery Route is considered to be **not significant to slight, permanent** and **adverse**.

Vehicle movements along the Grid Connection Route and IPP 33kV connection will utilise existing roadways and infrastructure. In some places it may be necessary for construction vehicles to work off the existing infrastructure which may lead to a slight compaction of the underlying soils. The effects associated with vehicle movements during the construction of the Grid Connection Route are considered to be **slight, permanent** and **adverse**.

Vehicle movement along the site access tracks will result in a slight compaction of the underlying soils. The effects associated with vehicle movements along the site access tracks is considered to be **slight, permanent** and **adverse**.

10.4.3.8 Soil contamination

Overview

Construction activities associated with the Proposed Development have the potential to introduce a number of contaminants in a number of ways. Potential causing activities and associated contaminants include:

- Operation of plant vehicles and other petrol / diesel driven equipment - Hydrocarbons e.g., diesel, oil, grease.
- Wastewater sanitation – sewage
- Construction materials – e.g., concrete or cement, bentonite clay from horizontal direction drilling (HDD)
- General waste – e.g., plastic

Use of waste materials during construction, operation and decommissioning will be minimised by good site practices and waste management plans. The following sections present the possible effects primarily associated with the use of construction plant.

Hydrocarbons

Wherever there are vehicles and plant in use, there is the potential for a direct hydro-carbon release which has the capacity to contaminate soils and subsoils. Furthermore, a spill has the potential to indirectly pollute water, if the soil and subsoil act as a pathway from any source of pollution.

Hydrocarbon is a pollutant risk due to its toxicity to all flora and fauna organisms. Hydrocarbons adsorb (stick) onto the majority of natural solid objects it encounters, such as vegetation, animals, and earth materials such as peat. From a land and soils perspective, the naturally occurring chemical in crude oil and gasoline products-Polycyclic Aromatic Hydrocarbons or (PAHs), can burn most living organic tissue, such as vegetation, due to their volatile chemistry. It is also a nutrient supply for adapted micro-organisms, which can deplete dissolved oxygen at a rapid rate and thus kill off water based vertebrate and invertebrate life.

The hazard posed by hydrocarbon contamination to soil is significant in terms of adversely impacting on the health of the soils associated with the proposed site and the flora and fauna it supports, however the risk is considered limited considering the movement of same is limited. The more significant risk of hydrocarbons contamination of soils is the eventual and likely migration to surface water systems, a potentially significant negative impact - this is covered in EIAR **Chapter 9 Hydrology and Hydrogeology**.

Any accidental contaminant spillage of fuel or oil, depending on the volume, would potentially present a **moderate to significant**, **long term to permanent**, **adverse** effect on the soil and geological environment on the Site. However, this potential effect is considered to be localised (if contained, EIAR **Chapter 9 Hydrology and Hydrogeology**), naturally reversible (natural attenuation over a relatively medium to long term period of time), or immediately reversible (through remediation and restoration activities over a relatively short to medium term period of time). With appropriate environmental engineering controls and measures, this potential risk can be significantly reduced.

Horizontal Direction Drilling (HDD)

In terms of the HDD process, drilling will involve plant machinery which will be powered by hydrocarbons, therefore risk during the refuelling process as stated previously remains the same. HDD will be used for crossings along the GCR and are detailed in EIAR **Chapter 16 Traffic and Transport**. The risk of hydrocarbon spills stems primarily from broken hydraulic hoses used during the drilling/boring process. Small-scale quantities of greases known as 'drilling fluids' are also commonly used during the drilling process to keep components of the drill rig cool and lubricated. These drilling fluids are commonly composed of a mixture of bentonite clay, which can be harmful to the environment. Therefore, there is a risk of a potential oil leak from HDD along the grid connection route. It is unspecified at this time which drilling lubricant will be used during grid connection route works. Drilling fluids such as Clearbore, which is an environmentally friendly, High-Performance Water-Based Mud suitable for tunnelling and drilling operations (Drilling Supplies Europe14), or fluids with similar environmental properties will be used in drilling operations. Clearbore is a single component polymer-based product that is designed to instantly break down and become chemically destroyed in the presence of small quantities of calcium hypochlorite. The product is not toxic to aquatic organisms and is biodegradable (Global Seafood Alliance 2008[14]).

A worst-case scenario could possibly occur whereby the proposed works of HDD could result in a **direct, adverse, potentially significant, short term / reversible effect** of the development. This effect could result from any number of indirect anthropogenic sources, most commonly would be from: inadvertent drill returns containing bentonite clay, as mentioned above or by spillages of oil, fuel, or drilling fluid disposal. Such spillages could potentially affect the local land and soil environment, depending on the nature of the contamination issue, and to varying degrees depending on the characteristics of the site area. Considering the proximity to surface water associated with this type of infrastructure (i.e., directly below watercourses), the risk is elevated.

Further information and mitigation in relation to the management of potential contaminants is provided in EIAR **Chapter 9 Hydrology and Hydrogeology**.

Wastewater and sanitation

The Proposed Development includes for temporary sanitation facilities for site workers during the construction phase of development. The Proposed Development therefore has the potential to result in the accidental leakage of wastewater or chemicals associated

[14] Global Seafood Alliance (2008) Available at : https://www.globalseafood.org/advocate/chlorine-an-effective-disinfectant-in-aquaculture/).

with wastewater sanitation onto soils, and into the drainage network during the construction phase of the Proposed Development.

Wastewater and wastewater sanitation chemicals are pollutant risks due to their potential impact on the ecological productivity or chemical status of surface water systems, and toxicity to water-based flora and fauna.

The worst-case scenario/s associated with wastewater sanitation is the potential for sanitation chemical, particularly related to porta-loos, accidentally spilling or leaking and being intercepted by surface water drainage features and in turn surface water networks associated with the proposed development.

Potential incidents of release contaminants at the site will likely be short lived or temporary, however the potential impacts to downstream receptors can be **long lasting**, or **permanent**. With appropriate environmental engineering controls and mitigation measures these potential impacts can be significantly reduced. The impacts associated with wastewater and sewerage is considered to be **moderate to significant**, **temporary** and **adverse**.

Construction or cementitious materials

The Proposed Development will require concrete for the formation of turbine bases, including in locations which are in proximity to receptors e.g., drains and surface waterbodies. This gives rise to result in the accidental spillage or deposition of construction waste into soils and in turn impact on surface water runoff, or accidental spillages directly intercepted by drainage or surface water networks associated with the Proposed Development.

Depending on the chemistry of the material in question, the introduction of such materials can lead to a local change in hydrochemistry and impact on sensitive attributes e.g., ecology. For example, the introduction of cementitious material (concrete / cement / lean mix etc.) can lead to changes in soil and water pH, and increased concentrations of sulphates and other constituents of concrete can further impact water quality. Fresh or wet concrete is a much more significant hazard when compared to set or precast concrete which is considered inert in comparison, however it should also be noted that any construction materials or waste deposited, even if inert, is considered contamination.

Surface water runoff, or groundwater coming into contact with concrete will be impacted to a degree, however water percolating through lean mix concrete will be impacted significantly. Therefore, the production / acquisition, transport of material and management of plant machinery must also be considered.

The worst-case impacts associated with a release of wet or lean mix cementitious materials is considered to be potentially **adverse, direct, profound, likely, long-term to permanent**, particularly in terms of potential indirect or secondary effects on the receiving surface water system.

General waste

The construction phase of the Proposed Development has the potential to generate excess general wastes from construction personnel such as organic food waste, plastics (bottles and/or packaging), metals (aluminium cans and/or tins) and cardboard waste (Tetra Pak cartons, newspaper, wastepaper). This is an unavoidable impact of the

Proposed Development, but every effort will be made to ensure that every piece of general waste will be disposed of properly and removed from Site. The impacts associated with waste materials is considered to be **slight**, **permanent** and **adverse**.

10.4.4 Operational Phase Potential Effects

10.4.4.1 Land take

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, onsite substation and met mast. However, following the completion of construction the construction access tracks will be reinstated (temporary).

Once the wind farm becomes fully operational, no further construction other than minor landscaping and maintenance activities will be required, the footprint of the wind farm will remain in place, and this will continue to impact on land, soils and geology during the operational phase.

Land take wind farm

Land take relative to the scale of the site is a slight direct effect of the Proposed Development, that is land being used as forestry and agriculture pastures currently will be replaced by the Proposed Development. The extent of land take will correlate with the footprint of the Proposed Development with the exception of some existing track ways, however there is also additional land take considering required cut and fill, drainage and cable trench infrastructure, and the increased excavation footprint required for safe excavation practices.

Excavation, deposition and ground sealing activities associated with land take required for the Proposed Development will lead to disturbance of otherwise generally undisturbed, greenfield land, that is, the natural soil profile, important for the purpose of facilitating current land use practices, namely forestry and agriculture, will be directly affected under the footprint of the Proposed Development.

The overall potential effects here are considered to be of **slight to moderate** significance, **adverse**, **long term to permanent** (life of the project), but reversable through the decommissioning and restoration phase of the development. With appropriate mitigation measures, planning and management this effect can be reversed, and disturbance minimised.

Land take associated with the Turbine Delivery Route, Grid Connection Route and IPP 33kv cable interconnector will be limited to the Construction Phase of the Proposed Development.

10.4.4.2 Soil Compaction & Subsidence

The Proposed development will include access tracks on previously undisturbed land, which over time has the potential to compact underlying soils leading to subsidence and/or alteration of the natural attenuation of water. The overall potential effects here are considered to be of **slight to moderate significance, adverse, long term to permanent** (life of projects), but with appropriate monitoring, mitigation and maintenance these potential effects can be minimised.

10.4.5 Decommissioning Phase Potential Effects

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. The hardstands infrastructure will be reinstated following construction. A similar construction process will be required at decommissioning, i.e., rebuild hardstand and remove topsoil.

No new effects are anticipated during the Decommissioning Phase of the Proposed Development in comparison to the Construction Phase (removal of turbines and similar infrastructure on the geological, geomorphological and geotechnical environment), as stated above, therefore no new mitigation measures are required. However, the Decommissioning of major infrastructure including proposed turbines poses similar hazards and risks to the environment compared to that of the construction phase.

All waste materials removed from the Proposed Development will be sent to a licensed waste management firm and or recycling facility and disposed of in accordance with European Union (Waste Electrical and Electronic Equipment) Regulations 2014 and EU (Environmental Impact Assessment) Waste Regulations 2013 or other applicable legislation which may be in force at the time of decommissioning.

On the basis that a Decommissioning plan has been established, **Appendix 5.1**, and will be implemented during the Decommissioning works associated with the Development, potential issues arising giving cause to residual impacts are likely to be **infrequent**, **imperceptible to slight**, **localised and reversible**.

10.5 Mitigation Measures

10.5.1 Design Phase

10.5.1.1 Mitigation by avoidance

The opportunity to mitigate any effect is greatest at the design phase. In this respect, a detailed Site selection process was carried out by the Design Team. A process of "mitigation by avoidance" was undertaken by the EIA team during the design of the turbine and associated infrastructure layout. Arising from the results of this study, a constraints map was produced that identifies areas where geotechnical constraints (deep peat and shallow bedrock, steep slopes) could make parts of study area (blue-line boundary) less suitable for development without significant impact. Furthermore, within the study area, areas of deep peat and shallow bedrock, areas in near steep slopes and areas within buffers were identified, and the infrastructure design sought to avoid those areas as much as possible. The layout plan was reviewed and the best layout design available for protecting the Proposed Development's existing geotechnical (and hydrological) regime was identified, while also incorporating and overlaying landownership, engineering and avoiding other environmental constraints.

There remain some risks that cannot be mitigated through design and need to be managed during construction, including subsidence. Mitigation through design is especially applicable in the risk to human health during a project and this shall be exercised to minimise the negative risks present.

10.5.2 Construction Phase

10.5.2.1 Land take

Apart from the measures taken in the design phase of the development (avoiding the need for and reducing volumes of land take) there are no other reductive mitigation measures in terms of land take, that is the layout of the development minimises the effect of land take in so far as practical, without compromising or reducing the development itself.

10.5.2.2 Clear fell of afforested areas

Best practice working in specific environments such as forested areas will be adhered to including working outside of surface water or other buffer zones, and risk assessing on a case-by-case basis in terms of drainage intercepting run off, ecological and other sensitive environmental attributes. To mitigate against adverse effects associated will felling includes using a phased felling approach and minimising erosion of soils by using existing tracks.

While clear fell of afforested areas is unavoidable these mitigation measures can lessen effects of felling to the surrounding landscape and important surface water receptors by limiting the amount of exposed soil, vehicular movements, soil compaction, etc. introduced to the Proposed Development at one time.

10.5.2.3 Erosion and degradation

Erosion and degradation of exposed soils will occur primarily during construction. Considering the variability of metrological conditions and the potential for significant events to occur at any stage of the year, the construction phase will be limited to favourable meteorological conditions to avoid erosion and runoff from the site. Construction activities will not occur during periods of sustained significant rainfall events, or directly after such events (allowing time for work areas to drain excessive surface water loading and discharge rates reduce). These mitigation measures will help to avoid potential loading of runoff with solids and other contaminant into the receiving surface water network (EIAR **Chapter 9 Hydrology and Hydrogeology)**

10.5.2.4 Ground or soil sealing

Soil sealing will be mitigated by the use of a geotextile membrane on top of soils, this material will likely lead to a degree of subsidence with time. This will reduce the changes the geotechnical and hydrogeological attributes, for example, increased runoff. The use of impermeable material is an inevitable direct effect to some extent of most types of construction particularly in greenfield sites. However, this will be mitigated by reducing the area of sealed soil to a minimum.

10.5.2.5 Subsoil and bedrock removal

The removal of peat and mineral subsoil / bedrock is an unavoidable effect of the Proposed Development, but every effort will be made to ensure that the amount of earth materials excavated is kept to a minimum in order to limit the effect on the geotechnical and hydrological balance of the Site. The effects associated with this removal will be minimised using the following practices.

Mitigation by avoidance

The proposed turbines and infrastructure layout was dictated to a large degree by the existing infrastructure, peat depth and the topography, locating turbines in areas where the existing infrastructure is utilised, peat is shallow, and the topography is favourable. Similarly, engineered cut and fill extents which have been designed will minimise the volumes of subsoils to be removed either directly by excavation (turbine foundations) or as a function of cut and fill requirements (hardstands).

Mitigation by good practices

Best practice 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), which will be updated by the civil engineering contractor and agreed prior to any works commencing on Site.

Excavation of peat in areas where there is >1.0m in peat depth will follow appropriate engineering controls (Section 9.5.2.3**,** EIAR **Chapter 9 Hydrology and Hydrogeology**), such as the drainage of the peat along the proposed Site tracks in advance of excavation activity (1 month in advance where possible) to reduce pore water content and thus instability of the peat substrate prior to excavation. Such drains will be positioned at an oblique angle to slope contours to ensure ground stability. Drains will not be positioned parallel to slope contours, that is, a gradient more than zero. It is noted that some drains will be close to parallel with elevation contours. This drainage will be attenuated prior to outfall (EIAR **Chapter 9 Hydrology and Hydrogeology** and the Surface Water Management Plan, **Appendix 5.1**). It is noted that peat depth at the Site is generally very shallow to shallow, and management of saturated peat will be required at relatively few locations.

In those parts of the Site where excavation may intercept areas of peat that are >1.0m depth, a geotechnical engineer/engineering geologist will be onsite to supervise and manage the excavation works and confirm the necessity for supporting newly excavated peat exposures or redirect initial construction phase drainage to maintain ground stability.

Mitigation by reduction

Apart from the measures taken in the design phase of the Proposed Development (avoiding the need for and reducing volumes of subsoils to be removed) there are no other reductive mitigation measures in terms of subsoil and bedrock removal. That is, the layout of the Proposed Development minimises the impact of subsoil and bedrock removal in so far as practical, without compromising or reducing the Proposed Development itself.

Mitigation by reuse

Bedrock will be re-used for construction of site access tracks and/or turbine hardstands wherever possible. The bedrock will comprise predominantly sandstone which when crushed and graded should provide a good sub-base for site access track construction. However, the rock type is considered relatively weak and will be prone to degrading over time under loading and plant movements, in turn potentially leading to the generation of dust and / or increased entrainment of solids in storm runoff. A more suitable, stronger rock type, Type 1, will be imported to the site for use as track topping.

Peat, overburden, and rock will be reused where possible on Site to reinstate excavated areas where appropriate. 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.

Subsoil and bedrock which are excavated as part of the initial construction (and potential Decommissioning) phase(s) will be reused onsite where possible.

Excess bedrock will be reused as backfill in areas previously excavated, or as backfill in cut and fill operations, for example; site access tracks and turbine hardstands. Using the local bedrock as fill will ensure that effects to hydrochemistry are minimised.

Geotechnical testing on imported material to site will be carried out prior to its use onsite particularly for use as a running or load bearing surface and will only be used for those purposes if the suitability of same conforms to relevant standards.

Peat material excavated will be reused as backfill in areas previously excavated as much as possible, and/or for reinstatement works elsewhere on the Site. To facilitate this the acrotelm (living layer) and the catotelm (lower layer) will be treated as two separate materials. Catotelm peat will be used to backfill, for example around Turbine Foundations once established. Acrotelm peat will be used as a dressing on top of deposited catotelm peat in order to promote and re-establish flora and ensure the acrotelm layer becomes relatively cohesive in terms of localised peat stability (vegetated), refer to the CEMP, **Appendix 5.1**.

Similarly, all soil and subsoil types or horizons which will be identified during intrusive ground investigations and during actual construction, will be treated as separate materials and arisings separated accordingly. This includes, for example Acrotelm peat, catotelm peat, clays, subsoils (TILLS), weathered rock.

With relation to excavated material removed during the Grid Connection network installation, any earthen (sod) banks to be excavated will be carefully removed and stored separately, maintained and used during reinstatement. Any surplus excavated material from roadways will be disposed of to the licenced facility.

The management, movement, and temporary stockpiling of material on Site, including a materials balance assessment and plan is detailed in the CEMP, this will include identification of suitable temporary set down areas which will be located within the Development footprint and will consider and avoid geo-constraints identified in this report (**Appendix 10.1**). Temporary set down / stockpile areas will be considered similarly to active excavation areas in terms of applying precautionary measures and good practices, and mitigation measures, including those relating to control of runoff and entrapment of suspended solids (EIAR **Chapter 9 Hydrology and Hydrogeology**).

Mitigation by remediation

On completion of the construction stage, any areas not required for operation will be reinstated. This may include the temporary construction compounds, turning areas, and materials storage areas. Granular material will be removed as required and reinstated with peat or other soils in keeping with the adjacent soils. Drainage measures will be reinstated as required in order to minimise future erosion of the soils. The mitigation measures listed above, namely backfilling with peat in layers, are in effect remediation measures, whereby the impact of required excavation works are remediated and limited to the extent of the actual proposed infrastructure. This will be carried out at the designated reinstatement locations, infilling with material in identified soil horizons as mentioned above to revert these areas to baseline levels.

Excess subsoils and bedrock will be used for remediation and reinstatement purposes elsewhere on the Site, including areas already impacted by agricultural activities (forestry) and eroded or degraded areas.

Mitigation measures outlined here as well as in the Peat and Spoil Management Plan of **Appendix 5.1** of the CEMP will ensure the impacts arising from excavation activities are minimised to the footprint of the Proposed Development and improve some other degraded areas of the Site, thus offsetting the adverse impacts of the Proposed Development.

Mitigation by engineering controls

Considering the variability of subsoil and bedrock depths further intrusive ground investigation must be carried out prior to construction in line with infrastructure manufacturer specification in order to confirm the specific ground conditions at each of the infrastructure units. Geotechnical testing is required for turbine and substation foundations as well as anywhere engineering controls are being used as a mitigation measure such as the potential requirement for a retaining wall at T4.

10.5.2.6 Storage and stockpiles

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 specific geotechnical constraints.

Excavation of materials is unavoidable however the impacts of same can be minimised if managed appropriately. Similarly, given that excavations are unavoidable, so too are temporary stockpiles. Best practice 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 CEMP, which will be updated by the civil engineering contractor and agreed prior to any Site works commencing.

It is expected that during excavation, arisings will be segregated and stored locally before being transported directly to a backfill / deposit area or to a dedicated temporary stockpile area as necessary. Material stored in temporary storage areas will be reused elsewhere on site as backfill, berms, landscaping and reinstatement of construction areas. No permanent stockpiles will remain on site. Surplus material following the completion of the construction phase will be transported offsite and reused as a by-product (through Regulation 27 of the European Communities (Waste Directive) Regulations 2011), or as a waste to a licenced facility.

Management of excavations arising will be carried out in a phased approach (**Appendix 9.5 Tile 30 – Tile 34**);

1. Excavate to competent ground in areas to facilitate access to temporary storage locations. Excavation arisings will be managed within the infrastructure layout and temporary storage locations.
2. Construct initial sections of access track including deposit of engineering fill / crushed rock arising at turbine locations.
3. Excavate and prepare first turbine hardstand area to competent ground. Material arising will be managed within the infrastructure outline, reused directly where possible, and thereafter within temporary storage areas as necessary.
4. Excavate and prepare next turbine hardstand area to competent ground. Material arising will be managed within the infrastructure outline, reused directly where possible including previously excavated hardstand areas, and thereafter within temporary storage areas as necessary.
5. Complete hardstand areas, backfill / landscaping etc using materials in temporary storage.

Temporary stockpile locations are identified and will be used to avoid the temporary placement of any excavation arisings outside of the footprint of the development. Temporary stockpile areas will be managed to facilitate the orderly segregation of material types, be isolated from the receiving surface water network (EIAR **Chapter 9 Hydrology and Hydrogeology**) by the use of silt screens etc., are limited in height, and are covered in plastic sheeting during extended temporary periods and ahead of storm alerts. No temporary stockpiles will be positioned or placed on areas of peat which have not been assessed or are indicated as being geo-hazards, particularly in areas of unacceptable factor of safety / stability (**Appendix 10.1**). All temporary stockpiles will be positioned on established and existing hardstand areas or in designated areas which are appropriate for short term storage.

Temporary storage locations have been identified in the CEMP (**Appendix 5.1**), and these areas will also be managed in terms of potential for solids entrainment by runoff (EIAR **Chapter 9 Hydrology and Hydrogeology**). No temporary stockpile placed on established hardstands in areas of deeper peat (**Appendix 10.1 App- B**) will be in excess of 1m in height. This is due to potential localised stability and subsidence issues in relation to the peat under and in vicinity of the hardstand and stockpile.

Two storage areas one in each of the DAs (Storage Area A and B) will be managed in a similar manner to that described above and will be allowed stabilise for a period during the construction phase, following which the material will be vegetated and managed in line with other improvement works on site. Promoting the vegetating of the material will aid in binding the material and minimising erosion.

As discussed in EIAR **Chapter 9 Hydrology and Hydrogeology**, stockpiling of material will invariably lead to the entrainment of solids in surface water runoff. Mitigation measures to address same are detailed in EIAR **Chapter 9 Hydrology and**

Hydrogeology, and in **Appendix 5.1**, Peat and Spoil Management Plan which facilitates the near immediate reuse of material in so far as practical, thus reducing the potential for temporary stockpiles in general. For example, the material arising from the first excavation is deposited in areas identified as having potential for restoration or requiring fill, the material arising from the second excavation is used as fill and reinstatement material in the first excavation location, etc.

Mitigation by reduction

The volume of material to be managed including temporary stockpiling is directly proportional to the volumes of material required to be excavated, in total the volume of material is large, however when managed appropriately (ongoing reinstatement) the volume of material to be managed at any one time will be minimised. Whenever possible, soil will be re-used on the Wind Farm immediately, thereby reducing the need for double handling, reducing the requirements of stockpiles. The excavated rock will be taken to a plant off-site, where it will be crushed and screened. The processed rock material will then be returned to site and used as fill material. Topsoil and peat will be transported to the designated spoil storage areas. Peat will only be stockpiled temporarily in areas of thin or absent peat and only in areas which have been assessed for stability by a suitably experienced geotechnical engineer. Peat should be stockpiled no higher than 2m and follow the recommendations set out in the (NRA, 2014, Section 8.2).

The Peat and Spoil Management Plan, **Appendix 5.1** forming part of the CEMP, identifies volumes and types of materials arising, temporary stockpiling locations, routes for reuse and remediation, requirements in terms of logistics and considerations in terms of timing and planning of movements of material. The Peat and Spoil Management Plan will ensure that the material arising from any excavation will have a predetermined plan and route for re-use / remediation, or disposal if all potential for reuse / remediation have been exhausted.

Mitigation measures for stockpiles related to the Grid Connection Route, IPP connection route and Turbine delivery route include restricting stockpiles to less than 1.5m in height and will be subject to approval by the Site Manager and Project Ecological Clerk of Works (ECoW). Additionally, any excavated material will be later used to backfill the trench where appropriate, any surplus material will be transported to a licensed facility.

Residual effects post mitigation

10.5.2.7 Vehicular movements

Vehicular movements will be restricted to the footprint of the Proposed Development and advancing ahead of any constructed hardstand will be minimised in so far as practical to reduce the compaction of soils. For example, excavation ahead of established hardstands will be in line with expected phases of turbine hardstand and site access track construction in terms of both delivery of and installation of material and site activity periods whereby excavations will not be opened ahead of site shut down periods. This will be done with a view to minimising soils / subsoils exposure to rain and runoff.

Ancillary machinery will be kept on established turbine hardstands, and no vehicles will be permitted outside of the footprint of the Proposed Development (including both areas of the windfarm and the Loop in tower) and will not move onto land that is not proposed for the Proposed Development if it can be avoided.

Where vehicular movements are necessary outside of the Proposed Development, ground conditions will be maintained as well as possible. This includes for example replacing sods, smoothing over with excavator bucket etc. Vehicular traffic on Site is reduced through the re-use of excavated material on Site.

For the Grid Connection route and IPP 33kV interconnector, before starting construction, the area around the edge of each joint bay which will be used by heavy vehicles will be surfaced with a terram cover (if required) and stone aggregate to minimise ground damage.

Adequate employment of mitigation measures described will minimise the adverse impacts posed by vehicular movements, and any localised unforeseen impacts will trigger escalation of response ensuring locations are restored and any potential pathways to receptors are isolated.

Mitigation by avoidance and good practice

As discussed previously, excavation volumes have been reduced during the design phase, and also 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 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), which will be updated by the civil engineering contractor and agreed prior to any Site works commencing.

Excavated peat will only be moved short distances from the point of extraction and will be used locally for reinstatement, landscaping of improvement areas, 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.

Vehicular movements are restricted to the footprint of the development as far as practical in order to reduce the potential for additional compaction.

10.5.2.8 Ground stability

Mitigation by avoidance and good practice

Peat and slope stability investigations at the Proposed Development indicate that the area has a generally low risk probability with respect to peat slippage and slope failure under the footprint of the Proposed Development. Nonetheless, the following mitigation measures will also be applied as recommended in the PSRA (included as **Appendix 10.1**):

- Short term temporary stockpiles will be limited to 1m height and removed for reuse/remediation purposes or transported to the designated Spoil Storage Areas where the height will be 2m. It is envisaged that all material will be reused on Site, unless contaminated (for example, due to accidental hydrocarbon/fuel spill). Therefore, the risk posed by the management of material in terms of peat and slope stability is dramatically reduced.

Furthermore, with a view to applying the precautionary principle, the following procedures will be adopted as best practice mitigation measures at the Site.

All excavations and construction will be supervised by a geotechnical engineer/ engineering geologist.

- The Contractor's * methodology statement and risk assessment will be in line with the Construction Environmental Management Plan and will be reviewed and approved by a suitably qualified geotechnical engineer/engineering geologist prior to Site operations. (*Contractor here refers to the chosen or contracted construction company at the commencement stage of the proposed Development).
- Particular attention and pre-construction assessment (developer / sub-contractor site specific risk assessment and method statement (RAMS) and on-site toolbox talks etc.) and mitigation planning will be given to any new infrastructure, for example, the proposed site access tracks, culverted watercourse crossings and associated hardstand / access track.
- Groundwater level (pore water pressure) will be kept low at all times (excavation dewatering) to avoid ground stability risks (subsidence) associated with peat and careful attention will be given to the existing drainage and how structures might affect it. Draining water from the construction area will be done through advanced dewatering techniques. In particular, ponding of water will not be allowed to occur in recent excavations, particularly in any areas encountered where peat is >1m. All deliberate or incidental sumps will be drained to carry water away from the sump following rainfall. Otherwise, this water will increase hydraulic heads locally (or increased bog water or groundwater levels), increase pore water pressure and can potentially lead to instability.
- In areas of saturated peatlands, prior to excavation, drains will be established to effectively drain grounds prior to earthworks. Such drains will be positioned at an oblique angle to slope contours to ensure ground stability. Drains on areas of the Site with minimal risk of bog failure as identified by Site Investigations will be positioned at a more acute angle to the slope contour in order to reduce the velocity of surface water drainage. It is noted that deeper (>2.0 m) peat at the Site is generally confined to isolated pockets and the need for measures such as sheet piling is very low.
- Peat will be carefully managed particularly when in temporary storage. Temporary storage areas will be isolated from the receiving environment by means of temporary infrastructure such as boundary berms comprised of subsoils sourced at the Site, or similar material. There is potential for large volumes of bog water draining from new stockpiles which will also be managed. Mitigation will include removal of gross solids from runoff prior to bog water intercepting the wind farm drainage network. Temporary measures such as dewatering and pumping through silt bags will be employed to assist this process. Draining of stockpiled peat, in a controlled manner is recommended, (**Appendix 5.1**), with a view to reducing the weight and mobility of the material, therefore reducing risk in terms of localised stability. Similar measures will be applied to the management of subsoil arisings at the Site.

- Peat is required for reinstatement, therefore acrotelm peat (top living layer, c. 0.5m) will be stripped off the surface of the bog and placed carefully at the margins of the Development along the access track and hardstand margins
- Relatively high impact construction activities (e.g., excavations, movement of soils / subsoils / rock) are acceptable to be carried out throughout the year, when taking into account the various restrictions of the Development, (for example, breeding bird seasons). However, considering the variability of metrological conditions and the potential for significant events to occur at any stage of the year, the construction phase will be limited to favourable meteorological conditions. In order to mitigate for particular earth works tasks and suitable meteorological conditions, construction activities will not occur during periods of sustained significant rainfall events, or directly after such events (allowing time for work areas to drain excessive surface water loading and discharge rates reduce).
- From examination of factual evidence to date, the majority of landslides occur after an intense period of rainfall. Stability issues at a localised scale will be similarly impacted by rainfall events, particularly when dealing with exposed soils or open excavations. An emergency response system will be developed for the construction phase of the Proposed Development, particularly during the early excavation phase. This, at a minimum, will involve 24-hour advance meteorological forecasting (Met Éireann download) linked to a trigger-response system. When a pre-determined rainfall trigger level is exceeded (e.g., one in a 100-year storm event or very heavy rainfall at >25mm/hr), planned responses will be undertaken. These responses will include cessation of construction until the storm event including storm runoff has passed over. Following heavy rainfall events, and before construction works recommence, the Site will be inspected and corrective measures implemented to ensure safe working conditions, for example dewatering of standing water in open excavations, etc.

Vehicular movements will be restricted to the footprint of the Proposed Development, and advancing ahead of any constructed hardstand will be minimised in so far as practical, for example; excavation ahead of established hardstands will be in line with expected phases of hardstand and track construction in terms of both delivery of and installation of material and site activity periods whereby excavations will not be opened ahead of site shut down periods. This will be done with a view to minimising soils / subsoils exposure to rain and runoff.

Ancillary machinery will be kept on established hardstands, no vehicles will be permitted outside of the footprint of the Proposed Development and will not move onto land that is not proposed for the Proposed Development if it can be avoided. 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 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 **Appendix 5.1**), 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 to continuously monitor areas of peat. Ongoing physical stability checks and calculations will be undertaken to verify that safety standards are being met.

Adhering to the mitigation measures described herewith will minimise the adverse impacts posed by vehicular movements, and ultimately any impacts arising will be temporary considering the initial decommissioning and construction of the Proposed Development will in effect reverse any impact by vehicular movement within the footprint of the Proposed Development.

Mitigation by reduction

The temporary storage of construction materials, equipment, and earth materials will be kept to an absolute minimum during the construction phase of the Proposed Development. This will be achieved by means of appropriate planning and logistical considerations forming part of the CEMP (**Appendix 5.1**), similar to the measures set out in relation to the management of spoil on the Site.

For example, the excavation material for the construction of access track will not progress ahead of actual track construction (as discussed under mitigation addressing vehicular movements), therefore minimising the volume of arisings to be managed. Areas for permanent deposit of material e.g., backfill adjacent to constructed infrastructure, will be identified and suitable material deposited as it becomes available. These efficiencies will be designed into the detailed CEMP (**Appendix 5.1**).

Emergency response

Mitigation measures as outlined in the previous sections will reduce the potential for stability issues arising during the construction phase of the Proposed Development. However, there remains a low risk of stability issues arising, particularly at a localised scale.

Emergency responses to potential stability incidents have been assessed and established to form part of the CEMP, Emergency Response Plan before construction works initiate. The following are potential emergencies and respective emergency responses to be followed in the event of an incident in:

- Peat stability issues at a localised scale during excavation works – In the event that soil stability issues arise during construction activities, all ongoing construction activities at the particular area of the Site will cease immediately, the assigned geotechnical supervisor will inspect and characterise the issue at hand, corrective measures will be prescribed. Localised stability issues will likely occur with a broad range in severity including minor side wall collapse with no significant effect, to relatively significant areas of peat being impacted by excavation activities, or in worst case scenarios localised stability at one location triggering a chain of events leading to significant peat or slope stability issue arising, including localised stability in close proximity to receptors. The assigned geotechnical engineer will assess each scenario and will escalate to the following mitigation scope as the need arises.
- Provision for a peat stability monitoring programme to identify early signs of potential bog slides (pre-failure indicators, for example cracks forming). This will

be done in line with Scottish Governments' "Peat Landslide Hazard and Risk Assessments".

- Significant peat or slope stability issues during construction activities – In the unlikely event that soil and slope stability issues arise during construction activities, all ongoing activities in the vicinity will cease immediately, all operators will evacuate the area by foot, if safe to do so, until the area is assessed by competent person/s, the assigned geotechnical supervisor will inspect and characterise the issue at hand, corrective measures will be prescribed. The area impacted will be characterised fully and risk assessments completed prior to any further works commencing at or near the location. This assessment will be phased including initial rapid response Phase 1 Assessment which will include at a minimum the prescription of exclusion zones and preliminary mitigation steps to be taken, for example; the management of runoff in or from the affected area.

Considering the highly dynamic nature of peat or soil stability issues at any particular site, it is important to establish an equally dynamic yet robust framework to follow in the event of an incident. Establishment of an emergency framework will follow relevant guidance to initially qualify any incident (by on site competent geotechnical engineer) and risk assess the area, and to then apply initial measures and design a complete emergency / contingency plan in line with an established structured emergency response. Relevant guidance includes as presented in Section 10.2.3 will be adhered to.

Emergency response will prioritise isolating and containing any materials which is being or will be intercepted by the established drainage network or receiving surface water network. Emergency materials and equipment requirements will be identified, incorporated in the CEMP, and will be managed on Site with a view to be being easily accessible and readily available.

Onsite training and toolbox talks will ensure any response to any potential incident is mobilised quickly and efficiently.

This is in combination with mitigation measures as described under EIAR **Chapter 9 Hydrology and Hydrogeology** whereby precautionary measures e.g., silt screen fencing etc. will be in place. Emergency response above existing or in place measures might include crudely building dams with an excavator to attenuate or direct flow until conditions stabilise, depositing subsoil or crushed rock material to dam drainage channels, and reactionary dewatering through silt bags to appropriate areas of the Site i.e., vegetated area and without impacting on problem area in terms of stability.

10.5.2.9 Soil contamination

Soil contamination, or the potential for contamination, is an inherent risk associated with any development. As such, good practice during construction activities, as detailed in the CEMP (**Appendix 5.1**), will address and minimise the potential for soil contamination to occur. The CEMP will be developed to include the scheduled checks of assets (plant, vehicles, fuel bowsers) on a regular basis during the construction phase of the Proposed 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. In addition, all such management plans will be revised as 'live' documents, so that lessons learned, and improvements will be made over course of the Development.

Contaminants which pose the most significant risk to soils, namely hydrocarbons and construction materials such as cement / concrete, pose an even greater risk to surface waters and groundwaters. In the event an accidental discharge was to occur without mitigation, contaminates will likely leak or be spilled on soils initially. Protecting soils from such will in turn mitigate against the potential for contaminates reaching the hydrological network associated with the Site, however given that such features are fundamental to the potential effect of contaminants down gradient of surface water receptors, mitigation measures for contaminants are presented in detail in EIAR **Chapter 9 Hydrology and Hydrogeology**.

Mitigation by avoidance and good practice

Release of hydrocarbons

To control and contain any potential hydrocarbon or other harmful substance spillages by vehicles during construction, it is recommended where possible to refuel plant equipment off the development site, thus mitigating this potential impact by avoidance.

Where fuelling offsite is impractical (e.g., bulldozers, cranes, etc.) and fuelling must occur on Site, all oil and chemical storage facilities will be bunded to 110% volume capacity of fuels stored at the site. A bunded refuelling area (with a Class 1 full retention oil interceptor) will be designated for the purpose of safe fuel storage and fuel transfer to vehicles, located at the Temporary Contractor's Compound near T5. Only designated trained operators will be authorised to refuel plant on Site. Furthermore, an Emergency Response Plan will be in place as part of the CEMP before consented works are carried out.

As discussed, construction activities will be restricted to the footprint of the Proposed Development, therefore the potential for contaminants reaching soils is likely limited to these areas or specific construction area. There remains the potential for contaminant migration through soils however, scope for migration is limited considering the site geology i.e., peat / loamy soil with low permeability and transmissivity rates, and similarly poorly productive bedrock aquifers with only localised connectivity. The highest permeability and transmissivity rates at the Site are attributed to the underlying till / gravels. It is also noted that the scale of any potential contamination impact will likely be minor in scale, for example, plant machinery leak (on exposed ground), as opposed to a fuel tank rupture (in bunded structure).

In order to mitigate against possible fuel spills the following elements are to be included:

- 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.

In the event of an accidental spill during the construction, operational or decommissioning phase of the Proposed Development, contamination occurrences will be addressed immediately, this includes the cessation of works in the area of the spillage until the issue is resolved. In this regard, appropriate spill kits must be provided across the site to deal with the event of a spillage and made available at all times. Spill kits will contain a minimum of; oil absorbent granules, oil absorbent pads, oil absorbent booms, and heavy-duty refuse bags (for collection and appropriate disposal of contaminated matter). Onsite contractors will be trained in their use. The CEMP (**Appendix 5.1**) will reflect the location and type of spill kits. No materials contaminated or otherwise will be left on the Site. Suitable receptacles for hydrocarbon contaminated materials will also be at hand. Upon usage, spill kits will be promptly replaced.

Release of wastewater sanitation contaminants

During the construction phase sanitation will consist of temporary welfare unit(s) that are self-contained and will be serviced regularly. Chemicals are likely to be used to reduce odours. Temporary compound areas will be constructed on a base of geo-textile matting laid at ground level. This will be stabilized with the laying of hardcore material on top.

All wastewaters will be collected in an enclosed holding tank and removed from site on a regular basis for final wastewater treatment by a licensed contractor. There will be no onsite treatment of wastewater. A wastewater or sewerage leakage is not anticipated in a properly managed Site.

Release of construction and cementitious materials

In order to mitigate the potential impact posed by the use of concrete and the associated effects on surface water in the receiving environment, the following precautions and mitigation measures are recommended as outlined in the CEMP (**Appendix 5.1**):

Precast concrete will be used wherever possible i.e., formed offsite. Elements of the proposed development where the use of precast concrete is not possible includes turbine foundations. Where the use of precast concrete is not possible the following mitigation measures will apply:

- Lean mix concrete, often used to provide protection to main foundations of infrastructure from soil biome, will be minimized, limited to the requirement of turbine foundations if necessary. Lean mix concrete can alter the pH of water if introduced, which would then require the treatment of acid before being discharged to the surrounding environment. The risk of runoff will be minimal, as concrete will be contained in an enclosed, excavated area.
- The acquisition, transport and use of any cement or concrete on site will be planned fully in advance of commencing works by the Contractor's Environmental Manager and supervised at all times by the Developer appointed Ecological Clerk of Works (ECoW).
- There will be no excess cementitious material on the vehicle which could be deposited on trackways or anywhere else on site. To this end, delivery trucks, tools and equipment will be cleaned at designated washout areas located conveniently and within a controlled area of the Site. Vehicles will undergo a

visual inspection prior to being permitted to drive onto the proposed site or progress beyond the contractor's yard.

In addition, the following drainage measures will apply;

- Any shuttering installed to contain the concrete during pouring will be installed to a high standard with minimal potential for leaks. Additional measures could be taken to ensure this, for example the use of plastic sheeting or other sealing products at joints.
- Concrete will be poured during periods of minimal precipitation. This will reduce the potential for surface water run off being significantly affected by freshly poured concrete. This will require limiting these works to dry meteorological conditions i.e., avoid foreseen sustained rainfall (any foreseen rainfall event longer than 4-hour duration) and/or any foreseen intense rainfall event (>3mm/hour). This also will avoid such conditions while concrete is curing, in so far as practical.
- Ground crew will have a spill kit readily available, and any spillages or deposits will be cleaned/removed as soon as possible and disposed of appropriately.
- Pouring of concrete into standing water within excavations will not be undertaken. Excavations will be prepared before pouring of concrete by pumping standing water out of excavations to the buffered surface water discharge systems in place.
- No surplus concrete will be stored or deposited anywhere on site. Such material will be returned to the source location or disposed of off-site appropriately.

Elements of the Proposed Development where precast concrete will be used will be identified by the construction contractor in the updated CEMP, e.g., structural elements of watercourse crossings (single span / closed culverts) as well as cable joint bay structures.

Supplementary mitigation measures outlined in EIAR **Chapter 9 Hydrology and Hydrogeology** to surface water receptors will also apply.

General waste

All construction and operation waste materials will be correctly sorted, recycled or disposed of accordance with good site practice and in accordance with the Site Management Plan (**Appendix 5.1**). A policy of Reduce, Reuse and Recycle will apply. The mitigated impacts associated with general waste is considered to be **slight**, **temporary** and **neutral**.

Mitigation by reduction

As discussed previously, careful design of the wind farm has reduced the amount of Site traffic required on Site by reducing site access track lengths, excavation volumes and double handling. Similarly, good site practice and a robust CEMP will also result in less traffic and a lower potential for fuel spills and leakages. Any vehicles coming onto the Site will be required to be inspected and cleaned before leaving the Temporary Construction Compound before advancing to the destined construction area.

Emergency response

Mitigation measures as outlined in the previous sections will reduce the potential for soil contamination during the construction phase of the Proposed Development. However, there remains the risk of accidental spillages and or leaks of contaminants onto soils.

Emergency responses to potential contamination incidents have been assessed (EIAR **Chapter 6 Population and Human Health**), and form part of the Emergency Response Plan which is part of the CEMP, **Appendix 5.1** before construction works initiate.

Potential emergencies and respective emergency responses include hydrocarbon spills or leaks, cement / concrete contamination.

In the event of a significant contamination or pollution incident e.g., discharge or accidental release of hydrocarbons / fuel to surface water systems, contamination occurrences will be addressed immediately, this includes the cessation of works in the area of the spillage until the issue is resolved. The relevant authorities listed in the Emergency Response Plan and stakeholders will also be promptly informed.

Refer to EIAR **Chapter 9 Hydrology and Hydrogeology** for further information.

10.5.2.10 Material and waste management

A Waste Management Plan has been prepared as part of the CEMP in **Appendix 5.1**. All excavated earth materials, wherever possible, will either be re-used in an environmentally appropriate and safe manner e.g., landscaping and bog restoration or removed from the Site at the end of the construction phase. No permeant stockpiles will be left on the Site.

Any surplus of natural materials (e.g., peat) to be used as backfill or deposited elsewhere in the Site will not be deposited to above existing / original ground level for the area in question. This ensures that peat used as backfill around newly established turbine foundations will not exceed local ground level, and any peat or natural materials deposited elsewhere, for example peat cutting areas, will not exceed original ground level. In essence, no permanent peat stockpiles will be established as a product of the construction phase of the Proposed Development, or associated restoration activities as all materials will be re-used as much as possible on-site.

Excavated materials onsite will be reused and recycled according to the Waste Hierarchy as much as possible. Where it is not possible to do so, any excess materials (road building materials) or artificial (PVC piping, cement materials, electrical wiring etc.) will be taken offsite and disposed of at a licensed facility at the end of the construction phase, refer to **Appendix 5.1**. In the event of waste arising at the Site, management of waste arising from the construction phase of the Development will require classification, appropriate transfer, and appropriate disposal. Waste streams will vary and will include the following potential categories:

- Inert / Non-Hazardous Soils & Stones (EWC Code: 17 05 04) – greenfield subsoils and bedrock is likely to be Inert. This could include surplus coarse / hardcore aggregate contaminated with soils remaining at the end of the construction phase of the development.
- Hazardous Soils & Stones (EWC Code: 17 05 03*) or oily waste (spill kit consumables) – Soils or any materials with significant hydrocarbon contamination

will likely be hazardous due to Total Petroleum Hydrocarbon concentrations. Soils impacted by significantly by cementitious material contamination will likely be hazardous due to elevated pH concentrations.

Careful design will result in minimal excess soil and rock encountered during the construction phase.

All materials used on Site and wastes generated on Site will be reduced by good Site practice and attention to the CEMP. Mitigation by remediation, for example, housekeeping, maintenance etc., in terms of waste or contaminants will be an ongoing measure throughout the construction phase of the Development, that is any and all contaminants will be removed from the Site in an appropriate manner when ever produced or observed.

Waste management measures to avoid site pollution are specified in the CEMP, **Appendix 5.1**. 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 of landfill.

10.5.3 Operational Phase

No new effects are anticipated during the operational phase of the Proposed Development on the geological, geomorphological and geotechnical environment therefore no additional mitigation measures are required. Similar hazards are identified when comparing the construction and operational phases of the Proposed Development, however considering that works will be far less intensive during the operational phase, the likelihood of effects is low, thus the risk is low.

Maintenance and monitoring during the operational phase of the Proposed Development pose similar hazards and risks associated with the construction phase but to a far lesser extent, for example, the potential for fuel spills from vehicles, etc. The mitigation measures described in this EIAR chapter will be adopted and implemented. 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, onsite 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. Vehicular movement will be confined to the footprint of the development in order to minimise the compaction, erosion and degradation of soils.

Regular monitoring, similar to the construction phase but on a less frequent basis will be required. For example, the Proposed Development will be inspected on a routine quarterly basis and following storm events. Any potential issues arising will be noted and remedial action taken in line with construction phase mitigation.

The potential effects on the soil and geological environment during the operational phase of the work will be mitigated through good site practice; vehicular movements, hydrocarbon controls, sustainable use of natural resources, human health etc. as discussed previously.

10.5.4 Decommissioning Phase

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

No new adverse effects are anticipated during the decommissioning phase of the Proposed Development however the phase will be considered similar in nature to the construction phase in terms of hazards and application of mitigation measures. Baseline conditions will be qualified again towards the end of the lifetime of the Proposed Development (c. 35 years). Managed appropriately, the restoration of the Site following the Decommissioning phase will have **neutral to beneficial** effects relative to baseline conditions.

10.6 Residual Effects

The unavoidable residual effects on the soils and geology environment as a function of the Proposed Development is that there will be a change in ground conditions at the Site with natural materials such as peat, subsoil and bedrock being replaced by concrete, subgrade and surfacing materials. This is a **direct, localised, adverse, moderate significance at a local scale, direct permanent** change to the materials composition at the Proposed Development.

10.6.1 Construction Phase

Mitigation measures outlined in this report lay down the framework to reduce all potential effects of the Proposed Development on geological receptors. It is noted that geological mitigation measures and effects are strongly connected to those related to Hydrology and Hydrogeology. Furthermore, the mitigation laid out in this chapter provides mitigation by avoidance measures for hydrology and hydrogeology effects. The mitigated potential effects lay down the achievable benchmarks provided measures are considered and implemented adequately.

The residual effects after implementation of all mitigation measures for the construction phase of the development are presented in **Table 10.16** and summarised below.

10.6.1.1 Land take

The residual effects associated with land take following mitigation (Section 10.5.2.1) is considered to be **slight** and **temporary** to **long-term**. Land take along the TDR, GCR and IPP will be reinstated following construction. Temporary infrastructure associated with the windfarm will also be reinstated following the Construction Phase.

10.6.1.2 Clear fell of afforested areas

Following the mitigation measure outlined in Section 10.5.2.2 the residual effects on the soils and geology associated with felling are **slight to beneficial** and **permanent / reversible**.

10.6.1.3 Erosion and degradation

Following the mitigation measure outlined in Section 10.5.2.3, the residual effects associated with erosion and degradation of soils is **not significant** and **permanent**.

10.6.1.4 Ground or soil sealing

The residual effects associated with ground or soil sealing following mitigation (Section 10.5.2.4) is considered to be **slight to moderate** and **permanent / long term**.

10.6.1.5 Subsoil and bedrock removal

Mitigation measures outline here as well as in the CEMP (**Appendix 5.1**) will ensure that the effects arising from excavation activities are minimised to the footprint of the Proposed Development. The mitigated effects (Section 10.5.2.5) associated with subsoil and bedrock removal are considered to be **not significant** and **permanent.**

10.6.1.6 Storage and stockpiles

The mitigated effects (Section 10.5.2.6) associated with storage and stockpiles are considered to be **not significant** and **temporary.**

10.6.1.7 Vehicular movements

The residual effects following mitigation (Section 10.5.2.7) associated with vehicular movement are considered to be **not significant** and **long term to permanent.**

10.6.1.8 Ground stability

The residual effects associated with ground stability following mitigation (Section 10.5.2.8) are considered to be **negligible/neutral** and **permanent / reversable.**

10.6.1.9 Soil contamination

The mitigated effects (Section 10.5.2.9) associated with soil contamination are considered to be **slight to negligible/neutral** and **temporary to long term.**

10.6.1.10 Material and waste management

The mitigated effects (Section 10.5.2.10) associated with material and waste management are considered to be **not significant to slight** and **long term to permanent.**

10.6.1.11 Construction phase residual effects

On completion of reinstatement works, following the construction phase, 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 and left to revegetate naturally with the passage of time and the Site will revert over time to a more natural drainage regime. It is expected that the long-term residual effects associated with the wind farm Proposed Development will therefore be **insignificant, adverse** and **permanent** effect on the soils and geology**.**

10.6.2 Operational Phase

Overall, the residual effects associated with the Operational Phase of the Proposed Development following mitigation measures including good site practice; vehicular movements, hydrocarbon controls will have a **slight**, **permanent**, **adverse** effect on the soils and geology of the Proposed Development.

10.6.3 Decommissioning Phase

Residual effects after the Decommissioning phase are complete include all effects classified as being long-term to permanent effects of the Proposed Development, that is, there will remain a change in ground conditions under the footprint of the development with the replacement of natural materials such as peat, subsoil and bedrock by concrete, subgrade and surfacing materials. This is a **localised, adverse, significant / moderate** weighted significance, **direct permanent** change to the materials composition at the Proposed Development.

The residual effects associated with Decommissioning includes waste generation, hydrocarbon leakage and erosion of soil and rock. The carefully managed reintroduction and/or reuse of soils and peat at the Proposed Development in place of turbine hardstand areas, and successful habitat management, revegetating and rewilding of those areas will have **beneficial effects**, or **revert to baseline conditions** of the preconstruction phase.

10.7 Cumulative Effects

Cumulative effects as defined by the EPA (2022[15]), is the addition of many minor or insignificant effects, including effects of other projects, to create larger, more significant effects. Considering the discipline under investigation, soils and geology, and the fact that potential effects of the development on same are generally localised, the cumulative effects of the development are not considered to vary dramatically or behave synergistically when considering the site as a unit, or indeed when considering in conjunction with other developments in the vicinity or downgradient of the site.

On a national scale the importance of land and soils (i.e., habitat in general), in terms of ecological value must be considered. Aim and objectives for soil quality and soil health have been outlined in the *EU Soil Strategy* (EC, 2021). To name a few.

- All EU soil ecosystems are healthy and more resilient and can therefore continue to provide their crucial services.
- No net land take and reduction in soil pollution.
- Protecting and reducing degradation of soils, as well as sustainable management practices.

These will be implemented by means of several key actions. Although this is not yet transposed, the development in question would aid some of the actions by 'limiting drainage of wetlands and organic soils and to restore managed and drained peatlands to

[15] Environmental Protection Agency (EPA) (2022) Guidelines on the information to be contained in Environmental Effect Assessment Reports

mitigate and adapt to climate change'. Mitigation measures installed on site would also 'restore degraded soils' and 'reduce erosion'.

10.7.1 Construction Phase

There are **no significant cumulative effects** anticipated from other projects during the construction phase of the Proposed Development. The residual effects from other construction projects would be similar to this development i.e., would lead to **slight** residual effects on the soils and geological environment with the replacement of natural materials such as peat and soil with construction materials such as concrete.

10.7.2 Operational Phase

Residual cumulative effects from other nearby wind farms in terms of land take which is generally localised and is expected to have a **not significant to slight residual effect** provided mitigation measures are implemented and monitored in line with the relevant guidelines and legislation.

10.7.3 Decommissioning Phase

There are **no significant cumulative effects** anticipated from other projects during the Decommissioning Phase of the Proposed Development.

Table 10.16: Summary of assessment of effects – Soils and Geology

Potential Effect	Beneficial / Adverse / Neutral	Extent (Site / Local / National / Transboundary)	Short term/ Long term	Direct / Indirect	Permanent / Temporary	Reversible / Irreversible	Significance of Effects (according to defined criteria)	Proposed Mitigation	Residual Effects (according to defined criteria)
Construction Phase									
Land Take Wind Farm	Adverse	Development Footprint	Long term	Direct	Permanent	Reversible after Decommissioning / Restoration	Slight	Section 10.5.2.1	Slight
Land Take Grid Connection Route	Adverse	Localised	Short term	Direct	Temporary	Reversible	Slight	Section 10.5.2.1	Slight
Land Take IPP cable interconnector	Adverse	Localised	Short term	Direct	Temporary	Reversible	Slight	Section 10.5.2.1	Slight
Land Take Turbine Delivery Route	Adverse	Localised	Short term	Direct	Temporary	Reversible	Slight	Section 10.5.2.1	Slight
Clear felling of afforested areas	Adverse to beneficial	Development Footprint and turbine buffer zones	Long term	Direct	Permanent	Reversible	Moderate	Section 10.5.2.2	Slight
Erosion and degradation	Adverse	Development Footprint	Long term	Direct	Permanent	Irreversible	Slight to Moderate	Section 10.5.2.3	Not significant
Ground or soil sealing	Adverse	Development Footprint	Long term	Direct	Permanent	Reversible	Slight to Moderate	Section 10.5.2.4	Slight to Moderate
Subsoil and Bedrock Removal – Site Access Tracks	Adverse	Development Footprint	Long term	Direct	Permanent	Reversible	Slight	Section 10.5.2.5	Slight to Moderate
Subsoil and Bedrock Removal – Hardstand and Foundation Areas	Adverse	Development Footprint	Long term	Direct	Permanent	Reversible for subsoil irreversible for bedrock	Slight to Moderate	Section 10.5.2.5	Slight to Moderate
Subsoil and Bedrock Removal – Site Cable Trenches	Adverse	Development Footprint	Long term	Direct	Permanent	Reversible for subsoil irreversible for bedrock	Slight	Section 10.5.2.5	Not significant to slight
Subsoil and Bedrock Removal – Turbine Delivery Route	Adverse	Localised	Long term	Direct	Permanent	Reversible for subsoil irreversible for bedrock	Slight	Section 10.5.2.5	Not significant
Subsoil and Bedrock Removal – Grid Connection Route / IPP connection	Adverse	Localised	Long term	Direct	Permanent	Reversible for subsoil irreversible for bedrock	Slight	Section 10.5.2.5	Not significant
Spoil Management	Adverse	Development Footprint and localised (GCR/IPP)	Short term	Direct	Temporary	Reversible	Moderate	Section 10.5.2.6	Not significant
Peat Stability	Adverse	Localised / potentially regional	Long term	Direct	Permanent	Reversible	Slight to Moderate	Section 10.5.2.8	Not significant
Compaction, erosion and degradation arising from vehicular movement (localised displacement)	Adverse	Development Footprint	Long term	Direct	Permanent	Irreversible	Slight to Moderate	Section 10.5.2.7	Not significant

Potential Effect	Beneficial / Adverse / Neutral	Extent (Site / Local / National / Transboundary)	Short term/ Long term	Direct / Indirect	Permanent / Temporary	Reversible / Irreversible	Significance of Effects (according to defined criteria)	Proposed Mitigation	Residual Effects (according to defined criteria)
Stability issues and slope failure arising from vehicular movement (localised displacement)	Adverse	Localised / potentially regional	Long term	Direct or Indirect / Secondary	Permanent	Irreversible	Slight (to Profound)	Section 10.5.2.7	Slight
Stability issues and slope failure arising from vehicular movement (Landslide – worst case)	Adverse	Localised / potentially regional	Long term	Indirect / Secondary	Permanent	Irreversible	Significant (to Profound)	Section 10.5.2.7	Not significant
Subsidence and settlement of newly established and upgraded site tracks	Adverse	Development Footprint	Long term	Direct	Permanent	Irreversible	Slight	Section 10.5.2.8	Not significant
Hydrocarbon contamination	Adverse	Localised*	Long term	Direct	Permanent	Reversible	Moderate to Significant	Section 10.5.2.9	Not significant to slight
HDD contamination	Adverse	Localised*	Short term	Direct	Temporary	Reversible	Moderate to Significant	Section 10.5.2.9	Not significant to slight
Wastewater sanitation contamination – waste	Adverse	Localised*	Long term	Direct	Temporary	Reversible	Moderate to Significant	Section 10.5.2.9	Not significant to slight
Wastewater sanitation contamination – chemicals	Adverse	Localised*	Long term	Direct	Temporary	Reversible	Moderate to Significant	Section 10.5.2.9	Not significant to slight
Construction material contamination	Adverse	Localised*	Long term	Direct	Permanent	Reversible	Slight to Significant	Section 10.5.2.9	Not significant to slight
General Waste contamination	Adverse	Development Footprint	Long term	Direct	Permanent	Reversible	Slight	Section 10.5.2.9	Not significant
Operational Phase									
Land take wind farm	Adverse	Development Footprint	Long term	Direct	Permanent	Reversible after Decommissioning / Restoration	Slight	Section 10.5.1 and 10.5.2.1	Slight
Soil compaction and subsidence	Adverse	Development Footprint	Long term	Direct	Permanent	Irreversible	Slight to Moderate	Section 10.5.2.7 and 10.5.3	Not significant to slight

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