# 8 SOILS AND GEOLOGY

## 8.1 INTRODUCTION

This chapter assesses the likely significant direct and indirect effects on the land, soils and geology environment of the proposed Moanmore Lower Wind Farm. The Development includes all elements within the Redline Boundary, the wind turbines, an electrical substation, site access tracks, turbine hardstands, Spoil Storage Area, Biodiversity Enhancement Areas, all site infrastructure, grid connection route (GCR), Blade Transfer Area and road vertical realignment. The Project includes all elements of Development and the temporary works along the Turbine Delivery Route (TDR) which are outside the redline boundary. Where significant effects are likely, the chapter identifies appropriate mitigation strategies therein. The assessment will consider the potential effects during the construction, operational, and decommissioning phases of the Project.

This chapter of the EIAR is supported by figures provided in **Volume III**:

- **Figure 8.1a –** Site location & layout wind farm
- **Figure 8.1b –** Site location & layout GCR
- **Figure 8.1c –** Site location & layout TDR works
- **Figure 8.2 –** Site topography
- **Figure 8.3 –** Land cover
- **Figure 8.4 –** Bedrock geology
- **Figure 8.5 –** Soils
- **Figure 8.6 –** Subsoils
- **Figure 8.7 –** Landslide risk & events
- **Figure 8.8 –** Land, soils and geology constraints

Technical Appendix document provided in **Volume IV** of this EIAR:

- **Appendix 8.1 –** Site Investigation & Stability Risk Assessment
- **Appendix 8.2 –** Land soils and geology potential effects table

A Construction Environmental Management Plan (CEMP) is appended to the EIAR in **Appendix 2.1**. This document will be a key construction contract document, which will ensure that the mitigation measures are implemented. In the event that planning permission is granted for the Project, the CEMP will be updated to include any condition(s) which may be attached to such a permission, and the measures will be implemented in accordance with the requirements of the condition.

### 8.1.1 Assessment structure

In line with the EIA Directive, EU guidelines and current EPA guidelines on the information to be contained in Environmental Impact Assessment Reports (EPA, 2022[1]), the structure of this Land, Soils and Geology chapter is as follows:

- Assessment Methodology and Significance Criteria
- Description of baseline conditions at the development
- Identification and assessment of effects to land, 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 effects of the development considering mitigation measures.
- Identification and assessment of cumulative effects if and where applicable.

### 8.1.2 Statement of authority

RSK (Ireland) Ltd. (RSK), part of RSK Group, is a consultancy providing environmental services in the soil and geology and other environmental disciplines including hydrology, hydrogeology. 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 EIA team involved in this assessment include the following:

- Project scientist: Deirdre Walsh – B.Sc. (Geology), M.Sc. (Geoscience), PhD (Geomodelling). Deirdre is an Environmental Consultant with over 10 years geoscience experience including exploration geology, geoscience research, and technical reporting.
- Technical Reviewer: Éilis Linehan B.Sc, M.Sc. (Environmental Science), H.Dip (Sustainability in Enterprise). Éilis is an Associate Director with RSK Ireland with over 12 years experience in environmental consultancy, environmental science and geo-environmental investigation.

Further details on the qualifications of each lead author can be found in **Appendix 1.1**.

### 8.1.3 Project description

A full project description can be found in **Chapter 2: Project Description**.

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

## 8.2 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

### 8.2.1 Assessment methodology





The stepped approach to impact assessment proposed in the Institute of Geologists of Ireland guidelines (IGI, 2013[2]), EIA Directive, EU guidelines and EPA guidelines (EPA, 2022) is adopted for the evaluation of potential effects on the receiving environment.

The following assessments were undertaken in order to evaluate the potential effects of the Project on the soils, geology and ground stability:

- Characterise the topographical, geological and geomorphological regime of the Project 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 Project, its design and methodology of construction.
- Assess the combined data acquired and evaluate any likely effects on the soils, geology, and ground stability aspects of the environment.
- If likely significant effects are identified, consider measures that would mitigate or reduce the identified impact.
- Present and report these findings in a clear and logical format that complies with EIAR reporting requirements.

### 8.2.2 Relevant legislation and guidance

This assessment was undertaken in accordance with the following Irish legislation (transposition of the EIA directives):

- SI No.600 of 2001 as amended: Planning and Development Regulations 2001-25.

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

- Planning and Development Regulations 2001-25 (as amended),
- The Heritage Act 1995 (as amended),
- The Wildlife Acts, 2000-2022.
- European Union (Invasive Alien Species) Regulations 2024
- Waste Management Acts 1996-2024
- European Communities (Waste Directive) Regulations 2011-2022

[2] Irish Geological Institute (2013) Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Effect Statements

- IEMA's latest Impact Assessment Guidance, 'A New Perspective on Land and Soil in Environmental Impact Assessment' (Feb 2022)

The Clare County Development Plan (2023-2029) - i.e., Clare Wind Energy Strategy, were also consulted as part of the EIA process.

This assessment has been prepared to the best scientific knowledge using, the following guidance documents,:

- BSI (2015) Code of Practice for Site Investigations - BS 5930
- Department of Housing, Planning, Community and Local Government (DHPLG) (2017) Interim Guidelines for Planning Authorities on Statutory Plans, Renewable Energy and Climate Change
- European Commission (EC) (2021) EU Soil Strategy for 2030
- EC (2017) Guidance on the preparation of the Environmental Impact Assessment Report
- EPA (2022) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports
- EU Biodiversity Strategy for 2030
- 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
- 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
- Teagasc (2022) Soil Map Viewer



### 8.2.3 Scoping responses and consultation

The scope for this assessment has been informed by consultation with statutory consultees, bodies with environmental responsibility and other interested parties. Consultation responses relating to the soils and geology are detailed in **Table 8.1**.



**Table 8.1: Scoping Responses and Consultation**

| Consultee | Summary of Consultee Response in relation to Hydrology / Hydrogeology |
|---|---|
| Department of Agriculture, Food and the Marine | "*If the proposed development will involve the felling or removal of any trees, the developer must obtain a Felling License from this Department before trees are felled or removed…..*"<br><br>"*……When the Forest Service is considering an application to fell trees, the following applies:*<br><br>*………The interaction of these proposed works with the environment locally and more widely, in addition to potential direct and indirect impacts on designated sites and water*"<br><br><u>Response:</u> provided in **Section 8.4.2.4** and **8.4.2.7** |
| Irish Peatland Conservation Council | "***Bogland***<br>*The IPCC would advise any developer planning construction in, or within close proximity to peatland habitat to be familiar with the Environmental Protection Agency funded project BOGLAND (www.ucd.ie/bogland). This project recommends the best practice guidelines to ensure no damaging development occurs on, or affects peat soils and peatlands of conservation value.*<br>***Nitrogen***<br>*"It has been highlighted to the Irish Peatland Conservation Council that nitrogen is becoming an issue for designated sites, halting many construction projects in the Netherlands and in 2018 in the UK 39 of 57 Special Areas of Conservation listed on the APIS website (http://www.apis.ac.uk) exceeded the Critical Load Threshold for nitrogen (some by over 300%). This is having negative impacts on the vegetation of the designated habitats and is working against the conservation objectives of the sites. There are various sources of excess nitrogen such as* |

| Consultee | Summary of Consultee Response in relation to Hydrology / Hydrogeology |
|---|---|
| | *construction (e.g.roads, traffic, developments), urban waste water (pollution) and agriculture (e.g. fertilizer/piggerys) and can enter a habitat via wet or dry deposition. The Irish Peatland Conservation Council ask that you assess the development in terms of its impact in regards to nitrogen and its affects on designated sites. We also ask that there is a long term monitoring agenda implemented to ascertain the long term emission rates/vectors which can be used to inform future projects. The impacts also need to be taken into account cumulatively along with other developments and projects as they may interact synergistically."*<br>Response: provided in **8.4.2.1** and **8.4.2.4** |
| Geological Survey of Ireland | The GSI provided a standard response which recommended the use of its publicly available data sources in the preparation of the EIAR.<br><br>Response: All available data sources with respect to soils and geology were used in the preparation of this EIAR (refer to **Section 8.2.5**). |
| Health Services Executive | " Geotechnical and Peat Stability Assessment<br>A detailed assessment of the current ground stability of the site for the proposed windfarm development and all proposed mitigation measures should be detailed in the EIAR. The assessment should include the impact construction work may have on the future stability of ground conditions, taking into consideration extreme weather events, site drainage and the potential for soil erosion….<br>Potential impacts of the foundations on water quality and peat stability cannot be undertaken without this information.<br>The National Environmental Health Service recommends that a detailed Peat Stability/Geotechnical Assessment should be undertaken to assess the suitability of the soil for the proposed development. The EIAR should include provision for a peat stability monitoring programme to identify early signs of potential bog slides ('pre-failure indicators' see the Scottish Government's 'Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Developments 2017) https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2017/04/peat-landslide-hazard-risk-assessments-best-practice-guide-proposed-electricity/documents/00517176-pdf/00517176-."<br><br>Response: The Peat Stability Risk Assessmnet is atatched as Appendix 8.1 and the assement of likely significant effects in relation to stability are discussed in Section **8.4.2.7**. |

### 8.2.4 Study area

The study area or zone of influence for soils and geology is typically localised to the redline boundary and its immediate surrounds (minimum 2km as outlined in the IGI guidelines (IGI, 2013)). The study area for the GCR and TDR extends 250m from the centre line of each route as per the NRA Guidance (NRA, 2008[3]).

The interconnection with hydrology, hydrogeology and other environmental factors (e.g., 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.

### 8.2.5 Desk study

A desk study was undertaken to collate and review background information in advance of the site survey and involved the following:

- Examination of the Geological Survey of Ireland (GSI) datasets pertaining to geological and extractive industry data.
- Examination of Environmental Protection Agency (EPA) soil, subsoils and Corine land cover datasets.
- Examination of National Parks and Wildlife Service (NPWS) nature conservation designations.
- Examination of historic 25-inch maps (GeoHive MapGenie 25 Inch).
- Preparation of site maps and suitable field sheets for the site survey.

### 8.2.6 Field work

Field inspections were carried out during June 2022, August 2023,March and December 2024 to assess general ground conditions including topographical characteristics, potential for peat and to observe the existing infrastructure and site practices.

Field works consisted of the following:

- Bedrock and mineral subsoil outcrop logging and characterisation.
- Peat depth probing where peat is present (depth to bedrock and/or competent subsoil).
- Gouge coring (peat and subsoil characterisation to BS 5930 and Von Post Humification scale).
- Site photography of significant features.

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

Field records, peat logs and photographs are presented in **Appendix 8.1**.



### 8.2.7 Evaluation of potential effects

In line with relevant guidelines (EPA, 2022), effects and consideration of the criteria listed in Annex III of the EIA Directive, effects should be described by reference to the individual environmental factors and their sensitivities.

#### *8.2.7.1 Sensitivity of attributes*

Sensitivity is defined as the potential for a receptor to be significantly affected by a proposed development (EPA, 2022).

To facilitate the qualification of geological attributes, as referenced in the IGI 2013 guidance, geological sensitivity criteria have been used as set out by the National Roads Authority (Box 4.1, NRA 2008), see **Table 8.2**.

**Table 8.2: Criteria for Rating Site Sensitivity: Estimation of the Importance of Soil and Geological Attributes (from NRA 2008, Box 4.1)**

| Importance / Sensitivity | Criteria | Typical Example |
|---|---|---|
| Very High | Attribute has a high quality, significance or value on a regional or national scale.<br>Degree or extent of soil contamination is significant on a national or regional scale.<br>Volume of peat and / or soft organic soil underlying route is significant on a national or regional scale. | Geological feature rare on a regional or national scale (NHA).<br>Large existing quarry or pit.<br>Proven economically extractable mineral resource. |
| High | Attribute has a high quality, significance or value on a local scale.<br>Degree or extent of soil contamination is significant on a local scale. | Contaminated soil on site with previous heavy industrial usage (i.e., fuel farm).<br>Large recent landfill site for mixed wastes.<br>Geologically feature of high value on a local scale (County Geological Site).<br>Well drained and / or high fertility soils.<br>Moderately sized existing quarry or pit. |

| Importance / Sensitivity | Criteria | Typical Example |
|---|---|---|
| | Volume of peat and / or soft organic soil underlying site is significant on a local scale. | Marginally economic extractable mineral resource. |
| Medium | Attribute has a medium quality, significance or value on a local scale.<br>Degree or extent of soil contamination is moderate on a local scale.<br>Volume of peat and / or soft organic soil underlying site is moderate on a local scale. | Contaminated soil on site with previous light industrial usage.<br>Small recent landfill site for mixed wastes.<br>Moderately drained and / or moderate fertility soils.<br>Small existing quarry or pit.<br>Sub-economic extractable mineral resource. |
| Low | Attribute has a low quality, significance or value on a local scale.<br>Degree or extent of soil contamination is minor on a local scale.<br>Volume of peat and / or soft organic soil underlying site is small on a local scale. | Large historical and / or recent site for construction and demolition wastes.<br>Small historical and / or recent site for construction and demolition wastes.<br>Poorly drained and / or low fertility soils.<br>Uneconomically extractable mineral resource. |

#### *8.2.7.2 Magnitude of potential impacts*

The potential effects may have an adverse, negligible or beneficial effect on the land, soils and geology as set out by the National Roads Authority (Box 5.1, NRA 2008), see **Table 8.3**.

**Table 8.3: Qualifying the Magnitude of Impact on Soil and Geological Attributes (from NRA 2008, Box 5.1)**

| Magnitude of Effect | Description | Example |
|---|---|---|
| Large Adverse | Results in a loss of attribute. | Loss of high proportion of future quarry or pit reserves.<br>Irreversible loss of high proportion of local high fertility soils. |

| Magnitude of Effect | Description | Example |
|---|---|---|
| | | Removal of majority of geological heritage feature (>50%).<br>Requirement to excavate / remediate entire waste site.<br>Requirement to excavate and replace high proportion of peat, organic soils and/or soft mineral soils beneath alignment. |
| Moderate Adverse | Results in impact on integrity of attribute or loss of part of attribute. | Loss of moderate proportion of future quarry or pit reserves.<br>Removal of part of geological heritage feature (15-50%).<br>Irreversible loss of moderate proportion of local high fertility soils.<br>Requirement to excavate / remediate significant proportion of waste site.<br>Requirement to excavate and replace moderate proportion of peat, organic soils and/or soft mineral soils beneath alignment. |
| Small Adverse | Results in minor impact on integrity of attribute or loss of small part of attribute. | Loss of small proportion of future quarry or pit reserves.<br>Removal of small part of geological heritage feature (<15%).<br>Irreversible loss of small proportion of local high fertility soils and/or high proportion of local low fertility soils.<br>Requirement to excavate / remediate small proportion of waste site.<br>Requirement to excavate and replace small proportion of peat, organic soils and/or soft mineral soils beneath alignment. |
| Negligible | Results in an impact on attribute but of insufficient magnitude to | No measurable changes in attributes. |

| Magnitude of Effect | Description | Example |
|---|---|---|
| | affect either use or integrity. | |
| Minor Beneficial | Results in minor improvement of attribute quality. | Minor enhancement of geological heritage feature. Remediation of a small, contaminated site (<1ha) |
| Moderate Beneficial | Results in moderate improvement of attribute quality. | Moderate enhancement of geological heritage feature. Remediation of a medium, contaminated site (<2.5ha) |
| Major Beneficial | Results in major improvement of attribute quality. | Major enhancement of geological heritage feature. Remediation of a large, contaminated site (>2.5 ha) |

#### *8.2.7.3 The significance of potential effects*

The significance of potential effects arising as a result of the Project are defined in accordance with the criteria provided by the EPA (2022), as presented in the following **Table 8.4**. Likely effects are assessed.

**Table 8.4: Describing the Significance 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 | An effect which causes noticeable changes in the character of the environment without affecting its sensitivities. |
| Moderate | An effect that alters the character of the environment in a manner that is consistent with existing and emerging baseline trends. |
| Significant | 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 | An effect which obliterates sensitive characteristics. |

In line with IGI Guidance (2013), the significance of any potential effects on soils and geology will be determined based on the importance of the particular geological feature to be protected and the magnitude of the effect on that geological feature, as presented in **Table 8.5** below.



**Table 8.5: Rating of significant effects based on sensitivity and magnitude of effect (modified from NRA, 2008, Box 5.4)**

| Sensitivity (Importance of Attribute) | Magnitude of Effect | | | |
|---|---|---|---|---|
| | **Negligible (Imperceptible)** | **Small Adverse (Slight)** | **Moderate Adverse (Moderate)** | **Large Adverse (Significant to Profound)** |
| **Extremely High** | Imperceptible / Not Significant | Significant | Profound | Profound |
| **Very High** | Imperceptible / Not Significant | Significant / Moderate | Very Significant / Significant | Profound |
| **High** | Imperceptible / Not Significant | Moderate / Slight | Significant / Moderate | Very Significant / Significant |
| **Medium** | Imperceptible / Not Significant | Slight | Moderate | Significant |
| **Low** | Imperceptible | Imperceptible / Not Significant | Slight | Slight / Moderate |

### 8.2.7.4 Source-Pathway-Receptor

The Source-Pathway-Receptor (SPR) model is used in environmental risk assessment to identify potential pollution linkages. A source is a contaminant or pollutant present that has the potential to cause harm or pollution. A pathway is a route by which a receptor is or could be affected by a contaminant source. The receptor is something which can be adversely affected by a contaminant.

A risk is considered present only when there is an active linkage between a source, a pathway and a receptor.

Land, soils and geology can be a source, pathway and receptor for the potential release of contaminants. For example,

- Direct contamination from construction or operational activities can lead to the contamination of soil (the receptor).
- A potential contaminant can leach or migrate through soil (pathway) into another sensitive receptor such as groundwater.
- Potentially contaminated soil may be the source of contamination for previously uncontaminated soil, or any soil may be the source of contamination entrained in runoff and having effects to water quality.

### 8.2.8 Assumptions and limitations

No overarching assumptions or limitations have been identified that apply to the assessment for land, soils and geology. Where routine assumptions have been made in the course of undertaking the assessment, these are noted in the following sections.

## 8.3 BASELINE DESCRIPTION

### 8.3.1 Site description and topography

The Redline Boundary extends to 36.77ha, this includes the wind farm Site, a permanent Spoil Storage Area, the GCR, vertical alignment of the L6132 and a Blade Transfer Area.

The wind farm Site area is approximately 26.84ha and is located in south-west county Clare, 3km north-west of the town of Kilrush and 6.8km south-west of Cooraclare village. The wind farm Site is located within the townland Moanmore Lower. It is located within an area comprised of agricultural livestock grazing farmland, bog, and shrub land.

The Spoil Storage Area is located east of the wind Farm Site along the L2034. It is situated within the townland of Moanmore South and is comprised of agricultural livestock grazing farmland.

The Blade Transfer Area is located in the townland of Tullabrack East 5km north-east of the wind farm Site and is located within a mature conifer plantation.
The GCR will be located within the L2034 and L2036 carriage way and the vertical realignment will be within the L6132 carriageway.

Temporary verge strengthening and widening will be undertaken along the L6132 and widening works will be carried out along the L2034 and L2036.

The locations of different elements of the Project are shown in **Figure 8.1a-c**.

The wind farm Site is characterised by relatively flat lying topography with associated elevations ranging between 8 to 16mAOD. The Spoil Storage Area has a higher elevation than the wind farm Site. The wind farm Site and the Spoil Storage Area have an average slope of 2.5°, ranging from between 0.1 and 24.5° (**Figure 8.2**). The slope of the Blade Transfer Area ranges between 0.4 and 1.1°.

### 8.3.2 Land cover

Consultation with Corine (2018[4]) land cover maps (EPA, Corine 2018[5]) shows that the Site and Spoil Storage Area is comprised mainly of pastures (231), land principally occupied by agriculture with significant areas of natural vegetation (243) and peat bogs (412) (**Figure 8.3**). The wind farm site has been modified by agricultural practices including extensive land improvement works involving drainage and excavation of natural soil profiles or horizons. Historical peat cutting is also evident on the wind farm Site, see **Figure 6.4** the habitat map for the Site shows the location of cutover bog.

Along the GCR, the land is predominantly agricultural areas including pastures (231), land principally occupied by agriculture with significant areas of natural vegetation (243) with some very minor areas which are coniferous forests (312).

Land cover along the TDR where the road realignment and temporary works will take place is the same as the GCR. The Blade Transfer Area is mapped as transitional woodland-shrub (324).

### 8.3.3 Bedrock geology

The mapped geological formation (GSI, Bedrock 100k[6]) underlying most of the redline boundary including the Site and GCR is the Gull Island Formation (GI; **Figure 8.4**) which is a grey SILTSTONE with up to 20% sandstone towards the base decreasing upwards. The sandstones are usually exhibit flute casts at their base and ripple marks at the top.
Further east, the proposed Blade Transfer Area and vertical realignment area on the L6132 are underlain the Central Clare Group (CCG) which is interbedded mudstone, siltstone, sandstone of variable thicknesses. The group comprises five cyclothems (I to V), of mudstone, siltstone, and sandstone.

[4] CORINE Land Cover (2018). Online: https://land.copernicus.eu/pan-european/corine-land-cover/clc2018. [Accessed: June 2024]
[5] Environmental Protection Agency (EPA) (ND) EPA Map Viewer [Online], Layer Corine 2018 - Available at: https://gis.epa.ie/EPAMaps/ [Accessed: June 2024]
[6] Geological Survey of Ireland (GSI) (ND) Geology [Online] - Available at: https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=de7012a99d2748ea9106e7ee1b6ab8d5&scale=0 [Accessed: June 2024]

Consultation with GSI Geotechnical database indicates there is no available data for the underlying formations in the general area of these Namurian mudstone, sand and siltstones. There are no mapped outcrops or faults in the area. According to GSI mapping, there are no karst features located within or near the vicinity of any elements of the proposed Project. In addition, there was no evidence of karst features during the site surveys.



### 8.3.4 Soils and subsoils

#### *8.3.4.1 Soils*

Consultation with available soil maps (EPA, SIS National Soils[7]) indicate the dominant soil type at the wind farm Site is cut peat (Cut) with some surface water gleys, groundwater gleys (AminPD) and acid brown earths, brown podzolics (AminDW) to the east, peaty gleys (AminPDPT) to the south and lithosols, regosols (AminSW) to the east of T1 (**Figure 8.5**). The soil types at each of the main infrastructure units are summarised in **Table 8.6**. There is blanket peat (BktPt) underlying the Spoil Storage Area.

Along the GCR, the soil types are mapped as surface water gleys, groundwater gleys (AminPD) and cut peat (Cut). There is a small area of blanket peat (BktPt).

The soil types along the TDR where works are proposed are similar to those along the GCR and at the windfarm Site but also includes small pockets of shallow acid brown, earths/brown podzolics, lithosols, regosols, some outcropping rock (Amin SP).
The soil type at the Blade Transfer Area is cut peat (Cut).



**Table 8.6: Summary of soil types on site (EPA, SIS National Soils)**

| Soil Code | Soil Group | Parent material | Description | Category | Location |
|---|---|---|---|---|---|
| Cut | Basin Peats, Blanket Peats (some) | Cut Peat | Cutaway/cutover peat | Cutover / cutaway peat | Turbines 1, 2, 3, GCR, TDR temporary works, Blade Transfer Area, vertical realignment, flood compensation, enhancement area |

[7] Environmental Protection Agency (EPA) (ND) EPA Map Viewer [Online], Layer SIS National Soils - Available at: https://gis.epa.ie/EPAMaps/ [Accessed: June 2024]

| Soil Code | Soil Group | Parent material | Description | Category | Location |
|---|---|---|---|---|---|
| AminPD | Surface water Gleys, Ground water Gleys | Till derived chiefly from Namurian rocks (TNSSs) | Derived from mainly non-calcareous parent materials | Mineral poorly drained (mainly acidic) | Along the access track and at the site entrance, GCR, TDR temporary works |
| AminDW | Acid Brown Earths, Brown Podzolics | TNSSs | Derived from mainly non-calcareous parent materials | Deep well drained mineral (mainly acidic) | Along the access track close to the entrance |
| AminPDPT | Peaty Gleys | TNSSs | Derived from mainly non-calcareous parent materials | Peaty poorly drained mineral (mainly acidic | Southeast of T3 |
| AminSW | Lithosols, Regosols | Esker Sands and Gravels (AcEsk) | Derived from mainly non-calcareous parent materials | Shallow well drained mineral (mainly acidic) | East of T1 along the access track, part of the flood compensation area |
| BktPt | Blanket Peats | BktPt | Blanket Peat | Blanket Peat | Proposed spoil area, GCR |
| AminSW | Lithosols, Regosols | Glaciofluvial sands and gravels (GNSSs) | Derived from mainly non-calcareous parent materials | Shallow well drained mineral (Mainly acidic) | TDR temporary works |



### *8.3.4.2 Subsoils*

Consultation with available subsoil map (EPA, Subsoils[8]; GSI Quaternary Sediments[9]) indicates that the main subsoil type at the site is cut over raised peat (Cut), there is till derived from Namurian sandstones and shales (TNSSs) to the east and south and eskers comprised of gravels of acidic reaction (AcEsk) to the east of T1 (**Figure 8.6**). This 'long bead' esker deposit is orientated north south and around 220m long. The location of the esker sands and gravels matches with the area mapped by the GSI as having high subsoil

[8] Environmental Protection Agency (EPA) (ND) EPA Map Viewer [Online], Layer Subsoils - Available at: https://gis.epa.ie/EPAMaps/ [Accessed: June 2024]
[9] Geological Survey of Ireland (GSI) (ND) Geology [Online] - Available at: https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=de7012a99d2748ea9106e7ee1b6ab8d5&scale=0 [Accessed: June 2024]

permeability, it also coincides with the location of a historic gravel pit. The remainder of the site is mapped as having low subsoil permeability.



Along the GCR the subsoil types are mapped as till derived from Namurian sandstones and shales (TNSSs) and cut over raised peat (Cut) with a small amount of blanket peat (BktPt). Subsoils underlying the TDR works are the same as those along the GCR and include a small pocket of esker sands and gravels (AcEsk) and minor glaciofluvial sands and gravels (GNSSs). The subsoil at the Blade Transfer Area is cut over peat (Cut).
The subsoil types for the Project are summarised in **Table 8.7**.

**Table 8.7: Summary of subsoil types underlying the Project (EPA, Subsoils)**

| Subsoil Class | Parent material | Description | Texture | Location |
|---|---|---|---|---|
| Peat | Cut | Cutover peat | Peaty | Turbines 1, 2 and 3, GCR, Blade Transfer Area, vertical realignment, TDR works, enhancement area, flood compensation areas |
| Tills (diamictons) | TNSSs | Shales and sandstones till (Namurian) | Clayey | East of the site, site entrance, GCR, TDR works |
| Esker sands and gravels | AcEsk | Acidic Esker sands and gravels | Gravelly | East of T1 along the access track, TDR works, eastern edge of the flood compensation area |
| Peat | BktPt | Blanket Peat | Peaty | Proposed spoil area |
| Glaciofluvial sands and gravels | GNSSs | Shales and sandstones sands and gravels (Namurian) | Gravelly | TDR works |



### *8.3.4.3 Peat depth*

The results of the peat surveys are presented in **Appendix 8.1**. Much of the wind farm Site is covered in peat, particularly to the west and at the turbine locations (**Figure 8.6a and 8.6b**). Peat depths at survey points (335 no.) range from 0.0m to 5.1m. The majority of the peat depths were generally very shallow to moderately deep (**Table 8.8** and **Appendix 8.1**).

South of T2 is deeper peat, associated with a raised bog. There is also deep peat to the south /southwest of T3, both of which are outside the working area. The peat depths in the Spoil Storage Area were very shallow to shallow ranging from 0.0m to 0.7m. The Blade Transfer Area peat depths ranged from 3.5m to 5.0m

No peat depths were recorded along the GCRand the TDR as these were located within existing road carriage ways.

**Table 8.8: Peat depth distribution by category**

| Peat Depth Category | Number of probes | Percentage of probes |
|---|---|---|
| A – Rock / no peat depth (0.00-0.01 m) | 23 | 7% |
| B – Very Shallow (0.01-0.5 m) | 117 | 35% |
| C – Shallow (0.5-2.0 m) | 126 | 38% |
| D – Moderately Deep (2.0-3.5m) | 49 | 15% |
| E – Deep (3.5-5.0 m) | 19 | 6% |
| F – Very Deep (>5.0 m) | 1 | <1% |
| **TOTAL** | 335 | 100% |

### *8.3.4.4 Subsoil permeability and groundwater vulnerability*

The GSI vulnerability mapping guidelines (**Table 8.9**) allow for the assignment of vulnerability ratings from "extreme" to "low", depending upon the subsoil type and thickness. An additional extreme "X" category is used to denote areas of bedrock outcrop or subcrop, or within 30m of a location of point recharge such as a karst feature.

**Table 8.9: Groundwater vulnerability mapping guidelines (Lee et al. 2008[10])**

| Depth to rock | Hydrogeological requirements for vulnerability categories | | | | |
|---|---|---|---|---|---|
| | Diffuse recharge | | | Point recharge | Unsaturated zone |
| | *high permeability (sand/gravel)* | *moderate permeability (sand subsoil)* | *low permeability (clayey subsoil, clay, peat)* | *(swallow holes, losing streams)* | *(sand & gravel aquifers only)* |
| 0-3m | Extreme | Extreme | Extreme | Extreme (30m radius) | Extreme |
| 3-5m | High | High | High | N/A | High |
| 5-10m | High | High | Moderate | N/A | High |

[10] Lee, M., Hunter Williams, N., Meehan, R., Kelly, R., Kabza, M., Murphy, O and Spillane, M (2008) Groundwater Vulnerability Mapping. Irish National Hydrology Conference.

| Depth to rock | Hydrogeological requirements for vulnerability categories | | | | |
|---|---|---|---|---|---|
| | Diffuse recharge | | | Point recharge | Unsaturated zone |
| | *high permeability (sand/gravel)* | *moderate permeability (sand subsoil)* | *low permeability (clayey subsoil, clay, peat)* | *(swallow holes, losing streams)* | *(sand & gravel aquifers only)* |
| >10m | High | Moderate | Low | N/A | High |

*i. N/A = not applicable*
*ii. Release point of contaminants is assumed to be 1-2m below ground surface.*
*iii. Permeability classifications relate to the engineering behaviours as described by BS5930.*
*iv. Outcrop and shallow subsoil (i.e. generally <1.0m) areas are shown as a sub-category of extreme vulnerability.*

*(amended from Deakin and Daly (1999) and DELG/EPA/GSI (1999))*

The subsoil permeability across the Site is low except in the area of the esker sands and gravels which has high subsoil permeability. The groundwater vulnerability across the much of the Site is mapped as Moderate "M" and Low "L", giving an inferred depth to rock of 5-10m. At the area underlain by esker sands and gravels, the inferred depth to rock is anywhere between 3-10m.

### *8.3.4.5 Summary*

Based on the findings of the desk study and field survey, aa summary of the soils and subsoils at each turbine or infrastructure unit is outlined in the table below (**Table 8.10**). The depth to bedrock is assumed based on the groundwater vulnerability mapping and subsoil permeability as outlined in **Table 8.9**. Based on desktop studies and site observations turbine foundations will be built within the glacial till subsoil and piling is not required.

**Table 8.10: Soils, subsoils and depth to bedrock summary for the main infrastructure units**

| Turbine / unit | Soil | Subsoil | Avg Peat depth (m) | Subsoil permeability | Groundwater vulnerability | Depth to bedrock (m) |
|---|---|---|---|---|---|---|
| T1 | Peat | Peat | 0.6 | Low | Moderate | 5-10m |
| T2 | Peat | Peat | 1.7 | Low | Moderate | 5-10m |
| T3 | Peat | Peat | 1.0 | Low | Moderate | 5-10m |
| Substation | AminPD | Till | 0.1 | Low | Moderate | 5-10m |
| Compound | AminPD | Till | 0.15 | Low | Moderate | 5-10m |
| Compensation area | Peat / AminSW | Peat / esker | 0.4 | Low / high | Moderate / high | 33-10m |

| Turbine / unit | Soil | Subsoil | Avg Peat depth (m) | Subsoil permeability | Groundwater vulnerability | Depth to bedrock (m) |
|---|---|---|---|---|---|---|
| Spoil area | Blanket peat | Blanket peat | 00.1 | Low | Moderate | 5-10m |
| Track 1 (entrance to T1) | Amin PD/ Peat/ AminSW | Peat / till / esker | 0.2 | Low / high | Moderate / high | 33-10m |
| Track 2 (entrance to substation) | AminPD /Peat | Peat / till | 0.1 | Low | Moderate | 5-10m |
| Track 3 (substation to T3) | AminPD/ Peat/ AminPDPT | Peat / till | 0.1 | Low | Moderate | 5-10m |
| Track 4 (T3 to T2) | Peat | Peat | 1.0 | Low | Moderate | 5-10m |
| Blade Transfer Area | Peat | Peat | 4.5 | Low | Moderate | 5-10m |





### 8.3.5 Economic geology

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 does not indicate mineral localities or quarries within the study area. The closest 'non-metallic' and 'metallic' localities are approximately 6km to the southeast. There are no quarries within or close to the study area according to the GSI mapping. However, according to the Cassini 6-inch historic maps there is a historic gravel pit just to the east of T1, this is in the same location as the glacial esker deposit. Evidence of a hollow in the area indicates the esker was used as a gravel pit in the past.

The Aggregate Potential Mapping (APM, GSI) shows the potential for crushed rocks and for sand and gravel which is very low potential at the site location the granular aggregate potential is very high at the esker location and not mapped across the rest of the site.

### 8.3.6 Geological heritage

Consultation with the GSI database for known Geological Heritage Sites in Ireland indicates that there are no Geological Heritage sites close to the Project. The closest geological heritage areas are Foohagh Point [CE021] approximately 11km to the northwest of the wind farm Site and Doonah [CE018] approximately 10km to the southwest. Both of these sites are County Geological Sites (CGS).

The Project is not expected to have any impact on any audited or unaudited geological heritage sites.

### 8.3.7 Designated sites

The Project is not within any designated or protected areas (Special Protection Area (SPA) / Special Area of Conservation (SAC) / Natural Heritage Area (NHA)). EIAR **Chapter 9: Hydrology and Hydrogeology** covers the potential secondary or indirect effects.

### 8.3.8 Geohazards

#### *8.3.8.1 Seismic activity*

The island of Ireland does experience, monitor and record seismic activity, although the magnitude of such occurrences are generally low and do not generally pose a risk to infrastructure or human health. Earthquakes are considered a triggering mechanism for landslides. However, given the low magnitude experienced in Ireland, earthquakes are not considered an important triggering factor in terms of stability risks (Creighton et al, 2006[11]).

#### *8.3.8.2 Landslide susceptibility*

Landslide risk susceptibility (GSI Map Viewer; GSI 2016[12]) is 'low' at the wind farm Site, spoil storage, TDR and along the GCR **Figure 8.7**. No recorded landslide events are found within the redline boundary. The closest mapped landslide event is across the Shannon Estuary. It was recorded in 1997 and is located c. 25km to the southeast of the site (GSI_LS03-0050). The wind farm site is relatively low-lying, and the risk of slope stability issues is low.

Landslide risk susceptibility is 'low' along the TDR where works are due to take place including the blade set down.

#### *8.3.8.3 Peat stability risk assessment*

Peat depths of 2.0m or greater are considered 'moderately deep' to 'very deep' peat, and in extensive areas of peat >2.0m depth, excavation and construction activities become more complicated and present greater risk.

[11] Creighton, R., Doyle, A., Farrell, E. R., Fealy, R., Gavin, K., Henry, T., Johnston, T., Long, M., McKeown, C., Pellicer, X., Verbruggen, K. (2006) "Landslides in Ireland" Geological Survey Ireland: Irish Landslides Working Group.

[12] Geological Survey of Ireland (GSI) (2016) National Landslide Susceptibility Mapping Project Summary. Available at: https://gsi.geodata.gov.ie/downloads/Geohazards/Reports/IE_GSI_Landslide_Susceptibility_Mapping_Summary.pdf

Peat depth across the wind farm Site is generally very shallow to shallow with some 18% deeper (>2m). The deepest peat is located south of T2 (**Appendix 8.1**). There was 1 no. sampling point of very deep peat observed with in the Redline Boundary however, this are was avoided during the wind farm design.

With reference to **Appendix 8.1**, the risk of significant peat landslide events occurring at the Site is low given the nature, namely the shallow peat and generally flat topography at the Site. There was some evidence of localised peat collapse to the west of T2 and is likely related to cutting activities. However, there are no construction works proposed in this area. The risk assessment uses conservative values and in one scenario (Scenario B) applies a 3.5m surcharge to the infrastructure to model the worst case. The Factor of Safety (Adjusted) at peat probe locations is 'Acceptable' with 'Very Low' risk. The Risk Ranking (Distance to associated receptors) at peat probe locations is generally Low to Moderate due to the large number of drains on site.

The following tables (**Tables 8.11** and **8.12**) summarises the peat stability risk assessment data interpretation at the different infrastructure units and portions of track. See **Appendix 8.1** for the full risk assessment.

**Table 8.1: Peat Stability Risk Assessment – Factor of Safety (Adjusted)**

| Turbine No. / Unit | Peat depth avg (m) | Slope (deg) | $FoS_{ADJ}$ (Factor of Safety considering Distance to Sensitive Receptors) | | Geohazard / Comment |
|---|---|---|---|---|---|
| | | | A | B | |
| T1 | 0.6 | 0.7 | Acceptable | Acceptable | Some mapped drains close to T1. |
| T2 | 1.7 | 1.4 | Acceptable | Acceptable to unstable | The area to the west of T2 is saturated with areas of moderately deep peat. This area is associated with peat cutting and has unstable points associated with cut drainage. There are points which have an unstable factor when the worst-case scenario (B) is applied. These points are marginally stable without the application of a surcharge. |

| Turbine No. / Unit | Peat depth avg (m) | Slope (deg) | $FoS_{ADJ}$ (Factor of Safety considering Distance to Sensitive Receptors) | | Geohazard / Comment |
|---|---|---|---|---|---|
| | | | A | B | |
| T3 | 1.0 | 2.0 | Acceptable | Acceptable | Some mapped drains in close proximity to T3. |
| Substation | 0.1 | 2.4 | Acceptable | Acceptable | Close proximity to a primary drain |
| Temporary Compound | 0.15 | 2.8 | Acceptable | Acceptable | Close proximity to primary and secondary drains |
| Enhancement Areas | 0.4 | 1.0 | Acceptable | Acceptable | Drains around and between enhancement areas |
| Permanent Spoil Storage Area | 0.2 | 1.6 | Acceptable | Acceptable | Area very waterlogged. Drains around the edge of Spoil Storage Area flow west towards Moyasta. |
| Track 1 | 0.2 | 2.5 | Acceptable | Acceptable | A number of drains and close to the Moyasta River |
| Track 2 | 0.1 | 4.4 | Acceptable | Acceptable | Existing infrastructure |
| Track 3 | 0.1 | 2.5 | Acceptable | Acceptable | A number of drains in the area, existing infrastructure |
| Track 4 | 1.0 | 1.3 | Acceptable | Acceptable | A number of drains in the area, some moderately deep peat |
| Blade Transfer Area | 4.5 | 0.9 | Acceptable | Acceptable | Deep Peat |

**Table 8.12: Peat Stability Risk Assessment – Risk Ranking (Distance)**

| Turbine No. / Unit | Distance to Receptor | RRD (Ranked Risk Distance) | Receptor / Comment |
|---|---|---|---|
| T1 | <50m | Low to moderate | Some mapped drains close to T1. |
| T2 | <50m | Very low to high | The area to the west of T2 is saturated with areas of moderately deep peat. This area is associated with peat |

| Turbine No. / Unit | Distance to Receptor | RRD (Ranked Risk Distance) | Receptor / Comment |
|---|---|---|---|
| | | | cutting and has localised potentially unstable points associated with cut drainage. Note this area has been avoided by design. |
| T3 | <15m | Very low to moderate | Some mapped drains in close proximity to T3. |
| Substation | <50m | Very low to low | Close proximity to a primary drain |
| Biodiversity Enhancement Area | <15m | Very low to low | Close proximity to primary and secondary drains |
| Temporary Compound | <15m | Low to moderate | Close proximity to primary and secondary drains |
| Permanent Spoil Storage Area | <15m | Very low to moderate | Drains around the edge of Spoil Storage Area |
| Track 11 | <15m | Low to moderate | A number of drains and close to the Moyasta River |
| Track 22 | <15m | Generally, very low | Existing infrastructure |
| Track 33 | <15m | Low to moderate | A number of drains in the area, existing infrastructure |
| Track 4 | <15m | Low to moderate | A number of drains in the area, some moderately deep peat |
| Blade Transfer Area | >230m | Very low to low | Moyasta_010, surface water receptor |

#### 8.3.8.4 *Karst features*

Karst features form by the dissolution of rock. The GSI holds a database of mapped karst features. In Ireland most karst is found in Carboniferous Limestones. There was no evidence of karst features during the site surveys. Based on the bedrock type (siltstone) and interrogation of the karst database, there are no karst features in the area. There are no mapped karst features within 32km of the wind farm Site or the GCR. Similarly, all proposed works areas along the TDR are remote from these karstic aquifers and any mapped karst features. The proposed works areas along the TDR traverses land with groundwater vulnerability ratings ranging from 'Moderate Vulnerability' to 'Extreme Vulnerability' including 'X' which is described as "Rock at or near Surface or Karst". The Blade Transfer Area is mapped in an area of 'Moderate' vulnerability. It should be noted however that these works are predominantly located within the existing road network. No karst features are mapped in the vicinity of the proposed works.

#### 8.3.8.5 *Soil contamination*

The current land use is for agriculture and no evidence of on-site contamination was recorded during site surveys.

Consultation with waste and industry facilities mapping (EPA, 2024) indicates that there are no licenced waste facilities or IPC / IE licenced facilities on or within the immediate surrounds of the Site.

### 8.3.9 Receptor sensitivity

The importance / sensitivity of the geological receptors is assessed in **Table 8.13,** with reference to **Section 8.2.7.1.** Given the condition of the site in terms of land use practices, soil, subsoil, peat and bedrock quality, they are considered to be of low to high sensitivity.

**Table 8.13: Sensitivity of geological receptors / attributes**

| Attribute | Comment | Sensitivity |
|---|---|---|
| Land / land use | Agricultural land | Low (alone GCR & TDR) to medium (wind farm site) |
| Soil | Topsoil is a non-renewable resource | High |

| Attribute | Comment | Sensitivity |
|---|---|---|
| Subsoil | The subsoil on site is a mix of peat and till with a small area of esker sand and gavels. | Medium |
| Peat | Important habitat which is a carbon sink. Capacity to absorb and hold water. | High |
| Bedrock | No bedrock was mapped during the site visits, based on the groundwater vulnerability and subsoil permeability maps the bedrock on site is estimated to be >5m deep and therefore limited bedrock excavation is anticipated. | Low |
| Economic Geology | There are no quarries or areas of mineralisation within or close to the Project.<br>The crushed rock aggregate potential is very low. | Negligible |
| Heritage Areas | There are no heritage areas within or close to the Project. | Negligible |
| Geohazards | There is no mapped karst on site and the chance of karst in the underlying bedrock is very low.<br>The risk of tectonic activity is low.<br>The risk of a peat stability is generally low. There was evidence of peat stability issues related to peat cutting activities outside of the red line boundary, therefore the history of peat stability at the Site increases the sensitivity to high. However, the area classed as High has been avoided by design and is outside the construction footprint. | Low to High |

## 8.4 ASSESSMENT OF LIKELY SIGNIFICANT EFFECTS

The environmental effects of the Project are discussed and assessed in the following sections. The 'do-nothing' scenario is reviewed, and likely significant effects are assessed for three stages of the project life cycle (construction, operation, and decommissioning). The significance of potential effects is done in accordance with the methodology outlined in **Section 8.2.7**. A summary of the likely significant effects is provided in **Appendix 8.2**.

### 8.4.1 Do Nothing 'Scenario'

If the Project were not to proceed, the opportunity to generate renewable energy and electrical supply to the national grid would be lost, as would the opportunity to further contribute to meeting Government and EU targets for the production and consumption of electricity from renewable sources and the reduction of greenhouse gas emissions and compliance with the Climate Change and Low Carbon Emissions Act 2015-21 would be impeded.

Site investigations of the baseline geological and geotechnical conditions of the Site indicate the following:

- The site has already experienced impacts to natural baseline conditions due to the land use practices (**Figure 8.3**) including agricultural (pastures, extensive drainage) and peat cutting activities.

Should the Project not proceed, the existing land-use practices will continue with associated modification of the existing environment.

### 8.4.2 Construction phase likely significant effects

Consideration of likely significant effects includes:

- The activities likely to occur on-site during the construction phase of the Project.
- The potential likely impacts or changes resulting from the activity or action
- The potential likely effects which are the consequences of the potential impacts.

These are summarised in **Table 8.14** and discussed in the subsequent sections.

**Table 8.14: Summary of likely construction phase activities, potential impacts and effects**

| Activities | Potential likely impacts | Potential likely effects |
|---|---|---|
| Soil stripping<br>Clear felling (Blade Transfer Area) | Land take<br>Exposed soils<br>Compaction and subsidence | Loss of land / change of land use<br>Soil quality |

| Activities | Potential likely impacts | Potential likely effects |
|---|---|---|
| Excavation (foundations, cable trenching, flood compensation areas, drainage works)<br>Construction of infrastructure (temporary and permanent)<br>Construction / upgrade of watercrossings (drains)<br>Reuse / importation of materials<br>Vehicular movement<br>Storage / use of hydrocarbons / chemicals | Soil sealing<br>Erosion and degradation<br>Subsoil / bedrock removal<br>Hydrocarbon / chemical spill<br>Soil stability<br>Slope stability | Soil contamination<br>Loss of natural materials<br>Alteration of the natural soil profile |



#### 8.4.2.1 Land take

Land take is the loss of agricultural, forest and other semi-natural and natural land to urban and other artificial land development.

During the construction phase, land take will include all temporary and permanent land take. The activities associated with land take include soil stripping, construction of hardstands, access tracks and temporary infrastructure, excavation of the onsite drainage and the temporary storage of excavated materials.

Temporary land take is reversible following reinstatement works on completion of construction. Permanent land take will remain in place throughout the operational phase of the Project. Proposed temporary and permanent land take is detailed in **Chapter 2: Project Description – Section 2.5.14.**

Excavated material will be reused on Site where possible. Removed soils will be treated as a byproduct and used for land reclamation or beneficial use elsewhere.

##### 8.4.2.1.1 Land take wind farm

The area within the Redline Boundary is approximately 36.77ha, and the area of the Project footprint during construction (both temporary and permanent) is approximately 8.48ha. This is approximately 23% of the area of the proposed site and therefore considered to have a **moderate adverse** effect (**Table 8.3**) on a geological attribute of medium sensitivity (**Table 8.2**).

**Pre-mitigation likely effects of wind farm land take during construction phase are described as direct, adverse, of moderate significance and short to long-term** (temporary or permanent land take).There is no likely significant effect to temporary or permanent land take on the wind farm site.

#### 8.4.2.1.2 Land take GCR

Localised temporary land take is required to lay cables along the GCR which runs along or directly adjacent existing roadways. A small portion of the GCR will traverse greenfield / green verge areas in private lands. Trenches will be reinstated following excavation and laying of cables with no permanent changes in land use practices or character at ground level. GCR works are considered to have a **small adverse** effect (**Table 8.3**) on a geological attribute of **low** sensitivity (**Table 8.2**).

**Likely effects of GCR land take during construction phase are described as direct, adverse, imperceptible / not significant and temporary.** There is no likely significant effect to temporary or permanent land take on the GCR.

#### 8.4.2.1.3 Land take TDR

The TDR options will require minimal land take, considering that the majority of the route will traverse already existing roadways (i.e., existing public road networks). Localised road widening, verge strengthening and vertical realignment of the L6132 along its length up to the junction with the N68 road at Derreen cross is required to facilitate the delivery of turbine components. A temporary Blade Transfer Area will also be required during the construction phase. Following the delivery of turbine components, reinstatement of temporary accommodation will occur. Planned TDR works are considered to have a **small adverse** effect (**Table 8.3**) on a geological attribute of **low** sensitivity (**Table 8.2**).

**Likely effects of TDR land take during construction phase are described as direct, adverse, imperceptible / not significant and temporary.** There is no likely significant effect to temporary or permanent land take on the TDR

### *8.4.2.2 Soil compaction and subsidence*

Compaction of soil by on-site plant during construction of infrastructure.

Compaction of soil leads to a reduction of pore spaces and soil degradation. The rate of compaction or subsidence in subsoils is dependent on the soil/subsoil geotechnical properties. Subsoils at the wind farm site are predominantly a mixture of peat and till. Peat is a very compressible soil whereas till is likely to have varying degrees of load bearing capacity.

Compaction or subsidence of soils as a result of construction of the wind farm and GCR or for temporary works along the TDR is **small adverse** (**Table 8.3**) in magnitude but can lead to reduction in soil quality, an attribute with **medium to high** sensitivity (**Table 8.2**).

**Pre-mitigation likely effect of compaction on soil quality is localised, direct, adverse, of slight to moderate significance and irreversible. There is no likely significant effect of compaction on soil quality.**

### *8.4.2.3 Soil sealing*

Soil sealing is the covering of a soil with an impermeable material or structure and is an inevitable direct effect to some extent of most types of construction particularly in greenfield sites.

Soil sealing creates an impervious layer (prevents fluid from passing through), which damages the natural soil structure and compromises its ability to function. Soil sealing can lead to degradation of soil which can affect the physical, chemical and biological properties. While the use of impermeable materials or structures are limited to very few areas at the temporary construction compound (<1% of the total Project area), soil sealing can have **small adverse** (**Table 8.3**) effects on soil quality and function, an attribute of **medium** sensitivity (**Table 8.2**).

**Pre-mitigation likely effects are localised, direct, of slight significance and long-term. There is no likely significant effect of soil sealing.**

### *8.4.2.4 Soil erosion and degradation*

Activities including soils stripping, clear felling, excavation and the management of excavated materials can result in the exposure of soils and is unavoidable for the construction of the wind farm.

Erosion of exposed soils, leading to a loss of a natural resource and a reduction in the quality of soil, will occur primarily during construction. Unmitigated stockpiling or inappropriately handled excavated materials have the potential to lead to soil erosion. 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 ($NO_2$).

The potential for soil erosion to arise during the construction phase of the Project is largely dependent on the site design, site management, vehicular movement and operation during excavation works, and weather conditions. Erosion of the exposed or stockpiled soils may result in the generation of dust and or the increase in sediment laden run off (interactions with Air Quality (**Chapter 12: Air Quality and Climate**) and **Chapter 9: Hydrology and Hydrogeology**). Poorly designed drainage can result in additional erosion of soil.

The effect of soil erosion is the loss of subsoil or topsoil as a resource and the reduction in soil quality, an attribute with medium to high sensitivity. In the absence of proper management, the effects of soil erosion are considered to be **small adverse** in magnitude (**Table 8.3**) on a geological attribute of **high** sensitivity (**Table 8.2**).

**Pre-mitigation likely effects of erosion on the land and soils are considered to be direct, adverse, of slight to moderate significance and irreversible. There is no likely significant effect of erosion on the land and soils.**

### *8.4.2.5 Soil and bedrock removal*

Excavation and removal of soils or bedrock for the construction of the wind farm will alter the natural soil profile which can be partially reversed during the decommissioning and reinstatement phase of the Project should the materials be appropriately managed.
The total volume of excavated material amounts 52,847m$^3$ as detailed in the Peat Spoil Management Plan – **Appendix 2.1 – CEMP – Appendix C**.

Most of the excavations are shallow (<1m) including excavation works for access tracks, hardstands, temporary compounds, drainage works and for the TDR works. The extent of shallow excavation activities and soil stripping is considered moderate in scale. Deeper excavations (>(>2m) are limited to turbine and substation foundations and therefore the extent of deeper excavation activities is considered small in scale. Excavation works for cable trenches and along the GCR are 1 and 1.22m deep respectively, these works are small in scale.

#### 8.4.2.5.1 Removal of soils

As topsoil is non-renewable, the damage or loss of topsoil (an attribute with high importance)) can potentially lead to a reduction in agricultural yield. Peat is an important habitat which captures carbon from the atmosphere and is capable of storing water.

Removal of soil, an attribute with **medium to high** importance (**Table 8.2**) will be **small adverse** in scale (**Table 8.3**). When segregated and managed, topsoil, subsoil and peat can be reinstated similar to baseline conditions.

**Pre-mitigation likely effects of removal and replacement of topsoil, subsoil and peat is considered, localised, direct, adverse, of moderate significance and short to long-term** (temporary or permanent land take). These effects are reversible through reinstatement.

#### 8.4.2.5.2 Soil removal along existing infrastructure

In areas associated with excavation along existing infrastructure (TDR/GCR) the sensitivity is **low**, and the effect is localised and therefore considered **small adverse** in magnitude. **Likely effects will be direct, adverse, not significant / imperceptible and temporary**. The likely effects are reversible through reinstatement.

### *8.4.2.6 Soil contamination*

There is the potential for soil to be contaminated during the construction phase of the Project. Potential sources of contamination include:

- Hydrocarbons
- Imported soils or aggregate

#### 8.4.2.6.1 Hydrocarbons

Wherever there are vehicles and plant in use, there is the potential for a direct hydrocarbon release which has the capacity to contaminate soils and subsoils.

Hydrocarbon contamination can affect the health of the soils and therefore effect the environment they support. Hydrocarbon pollution events can affect the soil microorganisms (such as bacteria and fungi), reducing the number, diversity and activity. The soil microbial community are the nutrients which are available to support plant life.

Should a hydrocarbon pollution event occur and reach the underlying soils these soils can act as a pathway for the hydrocarbon contamination to reach sensitive receptors including groundwater or surface water.

Soil is an attribute with **medium to high** importance and depending on the scale of the hydrocarbon spill, the magnitude may vary between **small and moderate adverse**. **Pre-mitigation likely effects to soil quality from an accidental spillage would be localised, direct, adverse, of moderate significance to significant and long-term. There would be potential significant effect on downstream surface water. There would be no significant effect on local groundwater quality.**

However, this likely effect is considered to be naturally reversible (natural attenuation over a relatively medium to long term period of time), or reversible (through remediation and reinstatement activities over a relatively short to medium term period of time).

#### 8.4.2.6.2 Imported soil or aggregate

There is potential risk that if contaminated or unsuitable material is brought to site and used as fill, it could contaminate previously uncontaminated material. This is an unlikely potential effect as any imported material will be fully tested in accordance with industry standards and subject to Article 27/28. Only verified clean, inert material will be used.

**While unlikely, pre-mitigation effects to soil quality, an attribute with medium to high importance, from contamination by imported aggregates would be described as direct, adverse, of moderate significance and short to long-term. There is no likely significant effects of contamination by imported aggregates.** These effects are reversible through remediation.

### *8.4.2.7 Stability*

A number of construction activities have the potential to cause a stability issue on site. These include excavation activities, storage of excavated material both temporarily on site and at the permanent Spoil Storage Area, clear felling, and vehicular movements.

The likelihood of a slope stability issue arising is dependent on the site topography, the presence of peat, the underlying substrate topology and the site. The risk of slope, ground and geological stability issues arising at the wind farm site is low as detailed in **Section 8.3.8.**

There remains a risk of localised soil stability issues as a result of excavation activities and stockpiling of excavated material, which have the potential to lead to open excavation side wall collapse or spilling of soil material, increasing the effective footprint of the Development. This would lead to additional erosion and effect the soil quality or potentially lead to the permanent loss of soil from the wind farm. Vehicular movements on site have the potential to trigger soil stability.

Small scale soil stability issues are associated with a geological attribute with **medium** importance.

**Pre-mitigation likely effects are localised, direct or indirect, adverse, of slight significance, short-term and reversible through remediation.**

**In the absence of mitigation, a worst-case stability issue, while unlikely, could affect geological attributes of high importance. The effects would be considered direct or indirect, adverse, moderate to very significant and potentially permanent.**

### 8.4.3 Operational phase likely significant effects

#### *8.4.3.1 Land take*

Land take will be required during the operation of the wind farm for permanent access tracks, permanent hardstand areas, substation and turbine foundations. Once the wind farm becomes fully operational, no further construction other than minor landscaping and maintenance activities will be required. The permanent footprint of the wind farm will remain in place. Reinstatement works following construction will reduce the operational land take to approximately 5.29ha around 14% of the Redline Boundary (36.77ha) and therefore the magnitude of effects on the land, attribute has **medium** importance, is considered **moderate adverse**

**Likely effect of permanent land take associated with Project is the loss of agricultural land and is considered to be localised, direct, of moderate significance and long-term. Land take effects are reversible after decommissioning.**

#### *8.4.3.2 Soil compaction and subsidence*

Soils under the permanent footprint of the wind farm, over time have the potential to be compacted, leading to subsidence. Soil quality is considered to have **medium to high** importance and the magnitude of potential compaction is considered **small adverse**.

**The overall likely effects are considered to be localised, direct, of slight to moderate significance and permanent**.

#### *8.4.3.3 Soil contamination*

Occasional access necessary for maintenance of the wind farm (access tracks, substations and turbines) during the operational phase could result in minor accidental leaks or spills of fuels/ oils adversely affecting the underlying soil. The bunded transformer in the substation and transformers in each turbine are oil cooled. There is potential for spills and leaks of oils from this equipment resulting in contamination of soils. The effect of a hydrocarbon spill is to reduce the soil quality (**Section 8.4.2.6.1**).

Likewise, the importation of materials from off-site will be closely monitored to ensure that no contamination, either by way of chemical and other contaminants or invasive species, is brought onto the Site from external sources. Importation of materials such as aggregates and other forms of construction materials will be monitored, documented, certified, sampled and tested as per the requirements of the **CEMP** (**Appendix 2.1**).

Soil is considered to have **medium to high** importance and the magnitude of potential contamination is **small adverse** as most of the onsite subsoils have low permeabilities reducing potential for contamination to spread.

**Pre-mitigation likely effects of minor soil contamination incidents during the operational phase of the Project is considered to be localised, direct, adverse, of slight to moderate significance, but reversible through remediation. There is no likely significant effect of soil contamination incidents during the operational phase of the Project.**

### 8.4.4 Decommissioning phase potential effects

In general, the potential effects associated with the decommissioning phase will be similar to those associated with the construction phase but of reduced magnitude because there will be no excavation. The potential environmental effects of soil storage and contamination by fuel leaks will remain during the decommissioning phase.
The material required to reinstate any areas where infrastructure is removed will need to be sourced from elsewhere on the site. A similar construction process will be required at decommissioning (i.e., rebuild hardstand and remove topsoil) given that the condition of the environment will likely change over the course of the operational phase of the Project. Turbine foundations and access tracks will be left in-situ.

The land and soils are considered to be **medium to high** importance and the magnitude of change is anticipated to be similar to that of the construction phase and therefore **moderate adverse**.
**Likely effects to the land, soils and geology during the decommissioning phase are considered to be localised, direct adverse of slight to moderate significance and short-term.**

## 8.5 MITIGATION MEASURES

### 8.5.1 Design phase mitigation measures

#### *8.5.1.1 Mitigation by avoidance*

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 (**Figure 8.8**) was produced that identifies areas where geotechnical constraints (deep peat and saturated areas) could make parts of the study area less suitable for the Project. 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 existing geotechnical, geological (and hydrological) regime was identified, while also incorporating engineering constraints and avoiding other environmental and ecological constraints.



#### *8.5.1.2 Engineering controls*

Following mitigation by avoidance where areas of peat were unavoidable engineering controls were used for the design of access tracks. Newly constructed site access tracks in areas with peat greater than 1m deep will be of a floating road construction type, using layers of geosynthetic materials and aggregates. Site access tracks on peat less than 1m deep will generally be constructed using traditional cut and fill methodology.

Floating roads can help to reduce the impact of the construction phase on the underlying peat by reducing the amount of peat excavated and reducing the quantities of imported aggregate. The floating tracks will be monitored by a civil/geotechnical engineer at a reasonable frequency during the construction, operation and decommissioning of the wind farm.

### 8.5.2 Construction phase mitigation measures

#### *8.5.2.1 The Construction Environmental Management Plan (CEMP)*

All works will be managed and carried out in accordance with the Construction Environmental Management Plan (CEMP; **Appendix 2.1**), which will be updated by the civil engineering contractor to include any conditions specified by the planning authority on grant of planning permission and agreed prior to any works commencing on Site.

#### *8.5.2.2 Land take*

The turbines and other infrastructure are located in areas where the existing track infrastructure is utilised, and the topography and geology are favourable. Similarly, infrastructure has been designed such that the areas of land take are to be located outside of buffer zones for sensitive receptors and constraints areas.

Land take along the TDR will be reinstated following the delivery of the components. Works along the GCR will be reinstated following the laying of route. Following construction, temporary construction areas will be reinstated reducing the land take during the operational phase.

#### *8.5.2.3 Soil compaction and subsidence*

By design, the development footprint utilises any existing infrastructure, avoids areas of deep peat and the footprint has been limited as far as practicable. This helps to reduce the overall area of potential soil compaction and subsidence.

to increase load bearing capacity of the underlying soil prior to constructing the edge berms which will be brought down to competent ground. A rock berm and silt fencing will be installed around the spoil storage area. The runoff from the spoil area, will directed to an appropriately sized settlement pond before being discharged to an existing drain that flows for 640m before entering the Order 1 Durha stream.

Vehicular movement will be limited to the development footprint as far as practicable to prevent the damage and compaction of soils outside of the construction area.
Excavation volumes have been minimised through the design phase by avoiding excessive cut and fill during construction and by the orderly management of materials. This will result in reduced site traffic and a reduction in the potential for additional compaction.

#### 8.5.2.4 Soil sealing

There is potential for soil sealing at some locations at the wind farm site due to the use of impermeable material, typical of most types of construction particularly in greenfield sites.
The effect of soil sealing will be mitigated by reducing the area where impermeable material is used and using semi permeable material where possible, to allow water to pass through and preserve the health of the underlying soil. Site access tracks across peat greater than 1m deep will be floated using layers of geosynthetic materials and aggregates. The use of semi permeable material will reduce changes to the geotechnical and hydrogeological attributes compared to impermeable material.

#### 8.5.2.5 Soil erosion and degradation

Erosion and degradation of exposed soils will occur primarily during the construction phase. Mitigation against the potential effects, includes:

- Limiting the amount of exposed soil at any one time.
- Limiting vehicular movement to the development footprint as far as practicable.
- Ceasing construction activities during periods of sustained significant rainfall events, or directly after such events.
- Covering exposed temporary stockpiles with plastic sheeting during periods where works have temporarily ceased (e.g., weekends / overnight) and ahead of heavy rainfall / storm alerts.
- Where possible when excavating peat, the upper vegetative layer will be stored separately from subsoil and with the vegetation part of the sod facing upwards 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.

- Reusing soils and subsoils as quickly as possible.
- Any areas not required for operation will be reinstated, including drainage, to minimise future erosion of the soils.
- Following the construction phase, temporary areas and drainage will be reinstated and revegetated so as to minimise future erosion of the soils.
- No stockpiles will remain on site following the construction phase of the Project.
- Peat on site will be managed as per the Peat Spoil Management Plan (**Appendix 2.1 CEMP – Appendix C**).

### *8.5.2.6 Subsoil and bedrock removal*

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. Engineered cut and fill extents which have been designed to 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 measures to reduce the effects to the natural soil profile from excavation activities include minimising excavation, appropriate storage for reinstatement or reuse on site where possible. Soils and excavated material that cannot be used on site will be moved to a licensed facility will be treated as an Article 27 by-product where possible. Peat Spoil will be will Be used as backfill or reinstatement where possible.

The designated Spoil Storage Area has a capacity of 44,928m$^3$ for the estimated excavation quantities (**Table 2.7**, **Appendix 2.1 CEMP – Appendix C**). Refer to The Peat Spoil Management Plan (**Appendix 2.1** CEMP – Appendix C) for additional detail on the management of peat.

- All soil and subsoil types or horizons identified construction, will be treated as separate materials and arisings separated accordingly. This includes, for example acrotelm peat, catotelm peat, topsoil, clays, subsoils, weathered rock. Therefore, during reinstatement works, the soil profile can be returned to as close to baseline as possible with material in identified soil horizons.
- 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. These areas include exposed areas around infrastructure such as slopes or graded ground around Site access tracks, turbine hardstands and foundations. Excavated peat will also be reinstated in degraded cutaway bog. 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 in the working space around turbine foundations. 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).

- While excavated bedrock is not expected on site, if it is encountered it will be re-used on site wherever possible for construction of site access tracks and/or turbine hardstands or as ballast on top of turbine foundations. Using the local bedrock as fill will ensure that effects to hydrochemistry are minimised.

### 8.5.2.7 Soil contamination

Soil contamination, or the potential for contamination, is an inherent risk associated with any development. Protecting soils from contamination from construction materials such as hydrocarbons, drilling fluids and other contaminants will, in turn, mitigate against the potential for contaminants reaching the hydrological network associated with the site and therefore additional sensitive receptors.

- As discussed, construction activities will be restricted to the footprint of the development, therefore the potential for contaminants reaching soils is likely limited to the footprint of the development or construction area.
- Dedicated, bunded storage areas will be used for all fuels or hazardous substances.
- Any and all contaminants including any contaminated soil will be removed from the site in an appropriate manner if and when they should be produced or observed, and suitable remediation work undertaken.
- A suitably qualified Resident Engineer will be present on site to supervise construction activities.
- In the event of a significant contamination or pollution incident e.g., discharge or accidental release of hydrocarbons / fuel, contamination occurrences will be addressed immediately, this includes the cessation of works in the area of the spillage until the issue is resolved. If necessary, the relevant authorities will be notified, and stakeholders will also be promptly informed.

#### 8.5.2.7.1 Release of hydrocarbons

- Any vehicles coming onto the site will be required to be inspected and cleaned before leaving the temporary construction compound and advancing to the construction area. Machines will be inspected twice a day during the day to check for leaks.
- Onsite re-fuelling of plant and machinery will be carried out using a mobile double skinned fuel bowser:

- The fuel bowser, a double-axel custom-built refuelling trailer will be re-filled off site, and will be towed around the site by a 4x4 jeep to where machinery is located;
- The 4x4 jeep will also carry fuel absorbent material and pads in the event of any accidental spillages.
- The fuel bowser will be parked on a level area in the construction compound when not in use and only designated trained and competent operatives will be authorised to refuel plant on site.
- All machinery will carry a spill kit.

In the event of an accidental spill of hydrocarbons, contamination occurrences will be addressed immediately (as outlined in the CEMP). This includes the cessation of works in the area of the spillage until the issue is resolved. No materials contaminated including soils will be left on the site.

With appropriate environmental engineering controls and measures, this potential risk can be significantly reduced.

##### 8.5.2.7.2 Imported aggregate

To mitigate against the potential effects of importing contaminated aggregate to the land and soils, only verified clean, inert material with an Article 27 declaration will be used. A list of local quarries is provided in **Table 2.5, Chapter 2: Project Description** as indicative of where the material may come from.

Imported rock will be locally sourced and conform to relevant standards, it will not change the baseline conditions.

#### *8.5.2.8 Stability*

Peat and slope stability investigations at the wind farm Site indicate that the area has a low risk probability with respect to peat slippage and slope failure under the footprint of the development.

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

#### 8.5.2.8.1 General stability

An experienced civil engineer / geotechnical engineer / engineering geologist will be employed during the construction phase to monitor excavation activities, to verify that safety standards are being met and monitor for any potential stability issues, particularly in areas of deep peat or where there are deeper excavations.

Emergency responses to potential stability incidents have been assessed and established to form part of the CEMP, Emergency Response Plan.

Construction activities will not occur during periods of sustained significant rainfall events, or directly after such events. Vehicular movements will be restricted to the footprint of the development.

#### 8.5.2.8.2 Stockpile stability

- Short term stockpilings will be limited to the footprint of the development, outside of any sensitive buffers, slopes or areas which are indicated as high risk. Stockpiling will only in areas which have been risk assessed.
- No stockpiles will be placed in the area to the west and south of T2.
- Short term temporary stockpiles will be limited to 1m height and removed for reuse/remediation purposes or transported to the designated Spoil Storage Area where the height will be 2m for peat and 3.5m for soil.
- Stockpiles will have side slopes battered back to a safe angle of repose.
- Exposed temporary stockpiles will be covered in plastic sheeting during periods where works have temporarily ceased (e.g., weekends / overnight) and ahead of heavy rainfall / storm alerts.

#### 8.5.2.8.3 Designated Spoil Storage Area

Surplus excavated peat will be stored in the designated Spoil Storage Area to the east of the windfarm site. Prior to construction, this area will be drained with new drainage constructed.

- Retention berms will be used at the edge of the permanent storage location to prevent any movement of material from the storage location and mitigate against high organic material entering the surrounding surface water network. Silt fencing will surround the berms. This a specific and appropriate measure for peat storage.
- The stone retention berm will be brought down to firm ground, with peat and soft waterlogged soil removed.

- This permanent storage area will be topped with the excavated top surface layer of acrotelm peat and topsoil excavated from that area to encourage rapid revegetation.
- The Spoil Storage Area will be monitored daily during the construction phase.
- The Spoil Storage Arae will drain to an appropriately sized settlement pond before discharging to an existing drain as detailed in the Surface Water Management Plan – **Appendix 2.1 -CEMP** – **Appendix B** and shown on **Drawing No. 6778-JOD-MM-XX-DR-C-1401**.





### *8.5.2.9 Peat stability*

It is noted that peat depth at the wind farm site is very shallow to moderately deep, 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, particularly around T2.
- 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 will be stockpiled no higher than 2m and will follow the recommendations set out in the (NRA, 2014[13]).
- No temporary stockpiles will be positioned or placed on areas of peat which have not been assessed or are indicated as high risk, including to the south and west of T2.
- 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.
- 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 deep. All deliberate or incidental sumps will be drained to carry water away from the sump following rainfall to the nearest stilling pond via the constructed drainage network.
- Groundwater level (pore water pressure) will be kept low at all times (excavation dewatering) to avoid ground stability risks (subsidence) associated with peat and

[13] National Roads Authority (2014), Guidelines for the Management of Waste from National Road Construction Projects

careful attention will be given to the existing drainage and how structures might affect it.

- Vehicular access to any areas of deep peat (>1m) during construction will be restricted to low ground pressure vehicles, with all construction vehicles traveling on existing access tracks whenever possible.
- In the unlikely event of a peat stability issue, all ongoing construction activities at the particular area of the Site and all ongoing activities in the vicinity will cease immediately. The assigned geotechnical supervisor will inspect and characterise the issue at hand, before advising on the corrective measures to be implemented.
- 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' Guidance (2017[14]).

Adhering to the mitigation measures described will minimise the adverse impacts posed by excavation activities, vehicular movements, storage of material and the potential for stability issues arising or affecting the Project will be reduced.





### 8.5.3 Operational phase mitigation measures

No new effects are anticipated during the operational phase of the Project on the geological, geomorphological and geotechnical environment therefore no additional mitigation measures are required.

Maintenance and monitoring during the operational phase of the Project pose similar potential effects to those associated with the construction phase but to a far lesser extent. The operational team will carry out maintenance works (to site 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 wind farm. Any vehicles utilised during the operational phase will be maintained on a weekly basis and checked daily to ensure any damage or leakages are corrected.

The likely significant effects on the land, soil and geology during the operational phase of the Project will be mitigated through good site practice, management of vehicular movements, hydrocarbon controls.

#### *8.5.3.1 Monitoring*

The spoil material at the permanent storage area will need to dry out over a number of years to increase the shear strength. Therefore, the permanent Spoil Storage Area will require

[14] Scottish Government (2017) Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments

additional monitoring during the operational phase, including restricted access following the construction phase until the storage area is deemed to be stable. The drainage of the Spoil Storage Area will remain for the operational phase.

### 8.5.4 Decommissioning phase mitigation measures

Following the permitted lifespan of the wind farm, decommissioning of the infrastructure will occur, or the wind farm may be repowered with more modern turbines, subject to a separate planning application.

The towers, blades and all components will be removed from Site and reused, recycled, or disposed of in a suitably licensed facility. The turbine transformers will also be removed from Site. Underground cables will be removed while the ducting will be left in-situ. The foundations will remain in-situ, apart from the above ground sections. Hardstand areas will be remediated to match the existing landscape as closely as possible. Access tracks will be left in-situ.

No new adverse effects are anticipated during the decommissioning phase of the Project. 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 wind farm.

Mitigation measures for the decommissioning phase are the same as those outlined for the construction phase (**Section 8.5.2**).

## 8.6 RESIDUAL EFFECTS

The unavoidable residual effects on the soils and geology environment as a function of the Project is that there will be localised changes in ground conditions at the wind farm site and GCR with natural materials such as peat, subsoil and bedrock being replaced by concrete, subgrade and surfacing materials.

**Likely residual effects are localised, direct, adverse, of moderate significance at a local scale, permanent change to the materials composition underlying the development footprint. There is no significant effects to the materials composition underlying the development footprint.**

### 8.6.1 Construction phase residual effects

Mitigation measures outlined in this report lay down the framework to reduce potential effects of the Development on geological receptors. The residual effects after implementation of all mitigation measures for the construction phase of the Project are summarised below.

#### 8.6.1.1 Land take

Following the mitigation measures outlined in **Section 8.5.2.2** the residual effects of land take on the land during the construction phase have a significance level of **beneficial to slight**. **There will be no significant effect on land take**.

#### 8.6.1.2 Soil compaction and subsidence

Following the mitigation measures outlined in **Section 8.5.2.3** the residual effects of soil compaction and subsidence on the soils have a significance level of **slight**. **There is no significant effects of soil compaction and subsidence on the soils.**

#### 8.6.1.3 Soil sealing

Following the mitigation measures outlined in **Section 8.5.2.4**. the residual effects associated with soil sealing on the underlying soils have a significance level of **slight**. **There is no significant effects associated with soil sealing on the underlying soils.**

#### 8.6.1.4 Soil erosion and degradation

Following the mitigation measures outlined in **Section 8.5.2.5**, the residual effects associated with erosion and degradation of soils during construction have a significance level of **slight**. **There is no significant effects associated with erosion and degradation of soils during construction.**

#### 8.6.1.5 Soil and bedrock removal

Following the mitigation measures outline in **Section 8.5.2.6**, the residual effects associated with subsoil and bedrock removal are considered to have a significance level of **slight**. **There is no significant effects associated with subsoil and bedrock removal.**

#### 8.6.1.6 Soil contamination

Following the mitigation measures outlined in **Section 8.5.2.7**, the residual effects associated with soil contamination are considered to have a significance level of **slight**. **There is no significant effects associated with soil contamination.**

#### 8.6.1.7 Stability

Following the mitigation measures outlined in **Section 8.5.2.8** the residual effects associated with ground stability on the land, soils and geology are considered to have a significance level of **slight**. **There is no significant effects associated with stability on lands, soils and geology.**

#### *8.6.1.8 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 improved where possible. It is expected that the residual effects associated with the construction phase of the Project on the land soils and geology will have a significance level of **beneficial to slight with no significant adverse effects identified**. **There is no significant effects associated with erosion and degradation of soils during construction.**

### 8.6.2 Operational phase residual effects

The mitigated residual effects from the operational phase are considered to have a significance level of **slight with no significant adverse effects identified**. **There is no significant effects from the operational phase.**

### 8.6.3 Decommissioning phase residual effects

The mitigated residual effects associated with decommissioning includes waste generation, potential hydrocarbon leakage and erosion of soil and rock. In general, effects will be similar to those at construction and operational phases, but of a greatly reduced magnitude and are therefore considered to have a significance level of slight.

Managed appropriately, the restoration of the Site following the decommissioning phase will have **neutral to beneficial effects** relative to baseline conditions. **There is no significant effects associated with the decommissioning phase.**

## 8.7 CUMULATIVE EFFECTS

Cumulative effects as defined by the EPA (2022), is the addition of many minor or insignificant effects, including effects of other projects, to create larger, more significant effects. **Tables 2.1** and **2.2** (**Chapter 2: Project Description**) highlight the other developments or proposed developments in the vicinity of this Project.

### 8.7.1 Potential Cumulative Effects with Forestry

Due to the localised nature of the proposed construction works which will be kept within the Redline Boundary, there is no potential for significant cumulative effects in-combination with other local developments on the land, soils and geology environment. The only way the Proposed Project can have in combination effects with other off site projects and plans is via drainage and off site surface water network, and this hydrological pathway is assessed in **Chapter 9: Hydrology and Hydrogeology**.

### 8.7.2 Potential Cumulative Effects with Other Wind Farms

Impacts on land, soil and geology will not extend beyond the immediate vicinity of the Project. The greatest potential for cumulative effects associated with these wind farms would be during the construction of the Project and the construction phases of these wind farms. The proposed Ballykett Wind is considered for cumulative effects as it has not been constructed. The other wind farm developments are operational and the construction phase of these development cannot overlap with that of the Project.

The EIAR for Ballykett Wind Farm and the EIAR for the Project detail strict mitigation measures for the protection of soils and geology during all phases of this proposed development.

Therefore, with the implementation of the proposed mitigation measures (both for the Project and for the other wind farms) there will be no cumulative effects associated with the construction, operational or decommissioning phases of the Project and other wind farms within the cumulative study area.

### 8.7.3 Potential Cumulative Effects with Grid Connection Route

A study was completed to identify any grid connection routes associated with other proposed wind farm development which overlap with the GCR. The greatest potential for cumulative effect to occur would be if the construction phase of the underground grid connection routes overlapped with each other.

No significant overlap occurs between the GCR and the proposed grid options for Ballykett Wind Farm. Whilst Grid Route Option 1 for Ballykett Wind Farm joins the existing Tullabrack 110kV Substation, this route approaches the substation from the east. Therefore, the only overlap with the GCR will occur within the Tullabrack 110kV Substation compound. Practicalities will make it highly unlikely that the construction phase of the grid connections in the vicinity of Tullabrack 110kV Substation would occur at the same time as this would result in road closures (two trenches being excavated at the same time).

Furthermore, the EIARs for Ballykett Wind Farm and the EIAR for the Project detail strict mitigation measures for the protection of soils and geology during the construction of the grid connections. Therefore, with the implementation of the prescribed mitigation measures there will be no cumulative effects on soils and geology.

An overlap of ~570m was identified between the GCR and the proposed onshore grid connection route for the proposed Sceirde Rocks Offshore Wind Farm along the L2034 to the east of the Site. Similarly, practicalities (and road safety issues) will make it highly unlikely that the construction phase of the overlapping sections of the grid connections would occur at the same time as this would result in road closures (two trenches being excavated at the same time). Furthermore, the EIARs for onshore elements of Sceirde Rocks Wind Farm and the EIAR for the Project detail strict mitigation measures for the protection of soils and geology during the construction of the grid connections. Therefore, with the implementation of the prescribed mitigation measures there will be no cumulative effects.

### 8.7.4 Potential Cumulative Effects with Other Developments

A detailed cumulative assessment has been carried out for all planning applications (granted and awaiting decisions) within the cumulative study area.

The planning applications identified within the study area are for new dwellings or renovations of existing dwellings, as well as for the erection of farm buildings (refer to **Chapter 2: Project Description**). Based on the small scale of the works and the temporal period of likely works, combined with the mitigation measures prescribed in this report for protection of soils and geology, no cumulative effects will occur as a result of the Project (construction, operation and decommissioning phases) and other developments.

In summary there are **no significant cumulative effects** anticipated from other projects during the construction, operation and decommissioning phases of the Project.

## 8.8 SUMMARY OF SIGNIFICANT EFFECTS

This chapter comprehensively assesses all elements of the Project. The likely significant effects that could arise from the Project during the construction, operational and decommissioning phases relate to the soil quality, soil contamination, change of land use, loss of natural materials and alteration of the natural soil profile (**Table 8.15**).



Unmitigated effects can potentially be long term to permanent and range in significance from slight to significant. Many of the effects are temporary and, following remediation works, these are reversible. While these effects are generally localised when considering the land, soil and geological environmental receptors, there is the potential for secondary and indirect effect on other sensitive receptors including surface water and habitats.

Providing the prescribed mitigation measures outlined in this report are fully implemented and best practice is followed on Site, the risk of such potential effects will be significantly reduced or avoided.

In summary, no likely significant residual effects on the land, soils and geology environment have been identified.

**Table 8.15: Summary of assessment of effects – land, soils and geology**

| Action | Impact (changes resulting from action) | Effect (consequences of impacts) | Receptor | Sensitivity of receptor (Table 8.2) | Probability | Extent | Duration | Reversible | Magnitude of effect (Table 8.3) | Significance of unmitigated likely effects (Table 8.4 and Table 8.5) | Summary of proposed mitigation | Significance of residual effects (Table 8.4 and Table 8.5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction phase** | | | | | | | | | | | | |
| Construction of WF | Land take | Loss of agricultural land | Land | Medium | Likely | Development footprint | Short to long-term | Reversible through reinstatement | Moderate adverse | Moderate | Design, minimise footprint, reinstate following construction | Beneficial to Slight **Not Significant** |
| Construction of GCR | Land take | Temporary loss of land | Land | Medium | Likely | Localised | Temporary | Reversible through reinstatement | Small adverse | Slight | Design, minimise footprint, reinstate following construction | Slight **Not Significant** |
| Road widening TDR | Land take | Temporary loss of land | Land | Medium | Likely | Localised | Temporary | Reversible through reinstatement | Small adverse | Slight | Design, minimise footprint, reinstate following construction | Slight **Not Significant** |
| Use of impermeable materials | Ground or soil Sealing | Soil quality | Topsoil / Subsoil | Medium | Likely | Localised | Long-term | Irreversible | Small adverse | Slight | Design, minimise footprint | Slight **Not Significant** |
| Construction of new tracks / infrastructure, vehicle movement | Compaction | Soil quality | Topsoil / Subsoil / Agricultural land | Medium / High | Likely | Development footprint; localised | Permanent | Irreversible | Small adverse | Slight | Design, minimise footprint, vehicle movement restricted to development footprint | Slight **Not Significant** |
| Floating tracks | Subsidence | Increase the density of peat, peat soil quality, peat hydrology | Peat | Medium / High | Likely | Development footprint; localised | Long-term | Irreversible | Small adverse | Slight | Design, minimise footprint | Slight **Not Significant** |
| Soil stripping | Erosion and degradation | Soil quality | Topsoil | High | Likely | Development footprint; localised | Permanent | Irreversible | Small adverse | Slight / moderate | Limit soil exposure, limit vehicular movement, cover exposed soils, cease activity during weather, reuse as quick as possible, reinstate following construction | Slight **Not Significant** |

| Action | Impact (changes resulting from action) | Effect (consequences of impacts) | Receptor | Sensitivity of receptor (Table 8.2) | Probability | Extent | Duration | Reversible | Magnitude of effect (Table 8.3) | Significance of unmitigated likely effects (Table 8.4 and Table 8.5) | Summary of proposed mitigation | Significance of residual effects (Table 8.4 and Table 8.5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Exposure of soils | Erosion and degradation | Soil quality | Subsoil | Medium | Likely | Development footprint; localised | Permanent | Irreversible | Small adverse | Slight | Limit soil exposure, limit vehicular movement, cover exposed soils, cease activity during weather, reuse as quick as possible, reinstate following construction | Slight **Not Significant** |
| Exposure of soils | Erosion and degradation | Peat soil quality | Peat soils | High | Likely | Development footprint; localised | Permanent | Irreversible | Small adverse | Slight / moderate | Limit soil exposure, limit vehicular movement, cover exposed soils, cease activity during weather, reuse as quick as possible, reinstate following construction | Slight **Not Significant** |
| Excavation WF | Topsoil removal | Alter the natural profile | Topsoil | High | Likely | Development footprint | Short to long-term | Reversible through reinstatement | Small adverse | Slight / moderate | Reuse, reinstatement, correct storage to separate soil horizons | Slight **Not Significant** **Not Significant** |
| Excavation WF | Subsoil removal | Alter the natural profile | Subsoil | Medium | Likely | Development footprint | Short to long-term | Reversible through reinstatement | Small adverse | Slight | Reuse, reinstatement, correct storage to separate soil horizons | **Not Significant** |
| Excavation WF | Peat removal | Alter the natural profile | Peat soils | High | Likely | Development footprint | Short to long-term | Reversible through reinstatement, remediation or natural attenuation | Small adverse | Slight / moderate | Reuse, reinstatement, correct storage to separate soil horizons, use of floating tracks in areas of peat >1m deep. Peat Spoil Management Plan (**Appendix 2.1 CEMP – Appendix C**) | Slight **Not Significant** |
| Excavation GCR / TDR | Subsoil removal | Alter the natural profile | Subsoil | Medium | Likely | Localised | Temporary | Reversible through reinstatement | Small adverse | Slight | Reuse to backfill trenches | **Not Significant** |

| Action | Impact (changes resulting from action) | Effect (consequences of impacts) | Receptor | Sensitivity of receptor (Table 8.2) | Probability | Extent | Duration | Reversible | Magnitude of effect (Table 8.3) | Significance of unmitigated likely effects (Table 8.4 and Table 8.5) | Summary of proposed mitigation | Significance of residual effects (Table 8.4 and Table 8.5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| Temporary storages of stockpiles | Exposure of topsoil / soil / bedrock | Soil quality | Topsoil / Subsoil | Medium / High | Likely | Development footprint; localised | Short-term | Reversible through reinstatement | Small adverse | Slight | Storage within development footprint / designated area, limit height, battered back to a safe angle of repose / cover overnight and ahead of weather / reuse as soon as possible. Monitor stockpiles | **Not Significant** |
| Long term storages of stockpiles | Exposure of topsoil / soil / bedrock | Soil quality | Peat / Subsoil | Medium | Likely | Permanent Spoil Storage Area | Permanent | Reversible through remediation | Small adverse | Slight | Retention berms, limit height, restrict access, top with acrotelm peat to encourage rapid revegetation, monitoring | **Not Significant** |
| Storage of stockpiles | Unmitigated waste management | Soil quality, additional land take, potential for contamination | Topsoil / Subsoil / Agricultural land | Medium | Likely | Localised | Short-term | Reversible through remediation | Small adverse | Slight | Waste management plan, any surplus material will be classified and appropriately transported / disposed of at a licenced facility | **Not Significant** |
| Hydrocarbon spill | Soil contamination -hydrocarbons | Soil quality | Topsoil / Subsoil | Medium / High | Likely | Localised | Short to long-term | Reversible through remediation or natural attenuation | Moderate adverse | Moderate / Significant | Dedicated bunded storage areas for hydrocarbons and other chemicals, inspect vehicles, designated refuelling area at compound, spill kits, receptacles for contaminated materials, removal of | Slight **Not Significant** |

| Action | Impact (changes resulting from action) | Effect (consequences of impacts) | Receptor | Sensitivity of receptor (Table 8.2) | Probability | Extent | Duration | Reversible | Magnitude of effect (Table 8.3) | Significance of unmitigated likely effects (Table 8.4 and Table 8.5) | Summary of proposed mitigation | Significance of residual effects (Table 8.4 and Table 8.5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | contaminated material, emergency response plan | |
| Importing aggregate | Soil contamination -imported aggregate | Soil quality | Topsoil / Subsoil | Medium / High | Possible | Development footprint; localised | Short to long-term | Reversible through remediation | Small adverse | Slight | Only verified clean, inert material will be used | **Not Significant** |
| Storage of material, vehicular movement, clear felling, construction activities | Ground stability - small scale | Increased land take | Topsoil / Subsoil / Peat | Medium | Likely | Localised | Short to long-term | Reversible through remediation | Small adverse | Slight | Geotechnical engineer / geologist, appropriate monitoring, emergency response plan, appropriate storage of material, restrict vehicular movement, weather monitoring, restrict access to permanent storage area, retention berms used at the edge of the permanent storage area to prevent any movement | Slight **Not Significant** |
| Storage of material, vehicular movement, clear felling, construction activities | Ground stability - peat | Increased land take, potential sensitive receptors downstream, sensitive habitat | Peat | Medium / High | Likely | Localised | Short to long-term | Reversible through remediation | Small adverse | Slight | Geotechnical engineer / geologist, appropriate monitoring, emergency response plan, appropriate storage of material, restrict vehicular movement, weather monitoring, restrict access to permanent storage area, retention berms used at the edge of the | Slight **Not Significant** |

| Action | Impact (changes resulting from action) | Effect (consequences of impacts) | Receptor | Sensitivity of receptor (Table 8.2) | Probability | Extent | Duration | Reversible | Magnitude of effect (Table 8.3) | Significance of unmitigated likely effects (Table 8.4 and Table 8.5) | Summary of proposed mitigation | Significance of residual effects (Table 8.4 and Table 8.5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | permanent storage area to prevent any movement | |
| Construction of turbines | Ground stability - large scale - worst case | Increased land take, | Topsoil / Subsoil / Bedrock | High / Very High | Possible | Localised | Potentially Permanent | Potentially irreversible | Small adverse | Moderate / Significant | Geotechnical investigation at all infrastructure locations, mitigation by engineering if required, supervision by a geotechnical engineer / geologist, emergency response plan, appropriate storage of material, restrict vehicular movement, weather monitoring | Slight **Not Significant** |
| **Operational phase** | | | | | | | | | | | | |
| Wind farm | Land take | Loss of agricultural land | Agricultural Land | Medium | Likely | Permanent infrastructure | Long-term | Reversible after decommissioning | Small adverse | Slight | Design, minimise footprint, reinstate temporary infrastructure, enhancement area adjacent to the windfarm | Beneficial to Slight **Not Significant** |
| Establishment of permanent infrastructure, vehicular movement | Soil compaction and subsidence | Soil quality | Topsoil / Subsoil / Land | Medium / High | Likely | Permanent infrastructure | Permanent | Irreversible | Small adverse | Slight | Design, minimise footprint, reinstate temporary infrastructure | Slight **Not Significant** |
| Fuel spill from maintenance vehicle or oil | Soil contamination | Soil quality | Topsoil / Subsoil | High | Likely | Localised | Short to long-term | Reversible through remediation or natural attenuation | Small adverse | Slight / moderate | Dedicated bunded storage areas for hydrocarbons and other | Slight **Not Significant** |

| Action | Impact (changes resulting from action) | Effect (consequences of impacts) | Receptor | Sensitivity of receptor (Table 8.2) | Probability | Extent | Duration | Reversible | Magnitude of effect (Table 8.3) | Significance of unmitigated likely effects (Table 8.4 and Table 8.5) | Summary of proposed mitigation | Significance of residual effects (Table 8.4 and Table 8.5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| from transformers | | | | | | | | | | | chemicals, inspect vehicles, spill kits, receptacles for contaminated materials, removal of contaminated material, emergency response plan, bunded transformers | |
| Permanent storage of material | Ground stability - peat | Increased land take, potential sensitive receptors downstream, sensitive habitat | Peat | Medium / High | Possible | Localised | Short to long-term | Reversible through remediation | Small adverse | Slight | Operational phase monitoring, retention berms used at the edge of the permanent storage area to prevent any movement. | Slight **Not Significant** |