8 SOILS AND GEOLOGY

8.1 INTRODUCTION

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

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

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

This chapter of the EIAR is supported by Figures provided in **Volume III**.

A Construction Environmental Management Plan (CEMP) is appended to the EIAR in **Appendix 2.1**. In the event planning permission is granted for the proposed development, the CEMP will address the requirements of any relevant planning conditions, including any additional mitigation measures which are conditioned. It will include all of the mitigation prescribed within the EIAR. A summary of the mitigation measures is included in **Appendix 17.1**.

8.1.1 Assessment Structure

In line with Directive 2011/92/EU as amended (the EIA Directive as amended) and the EPA Guidelines on the information to be contained in Environmental Impact Assessment Reports (2022), the structure of this Soils and Geology chapter is as follows:

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

8.2 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

8.2.1 Assessment Methodology

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

- Characterisation of the topographical, geological and geomorphological regime of the Site from the data acquired through desk study and onsite surveys.
- Consideration of ground stability issues as a result of the Development, its design and methodology of construction.
- Assessment of the combined data acquired and evaluation of any likely impacts on the soils, geology and ground stability aspects of the environment.
- If impacts are identified, consideration of measures that would mitigate or reduce the identified impact.
- Presentation and reporting these findings in a clear and logical format that complies with EIAR reporting requirements.

8.2.2 Relevant Legislation and Guidance

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

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

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

- Planning and Development (Amendment) Regulations 2021
- The Heritage Act 1995, as amended
- The Wildlife 1976 - 2012, as amended.

The Waterford County Development Plan (2022-2028) was also considered as part of the EIA process.

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

- Department of Housing, Planning and Local Government (2019) Draft Revised Wind Energy Guidelines

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

8.2.3 Desk Study

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

- Acquire and compile relevant available maps of the Development.
- Study and assess the proposed locations of turbines and Site tracks relative to available data on Site topography and slope gradients.
- Study and assess the peat stability risk for the Site.
- Study and assess the proposed locations of turbines, Site access tracks and 110kV substation relative to available data on Site soils, subsoil and bedrock geology.
- Overlay Ordnance Survey of Ireland (OSI) 1:250,000, 1:50,000 and 1:10,560 (6") maps with AutoCAD plan drawings.
- Overlay Geological Survey of Ireland (GSI) Geology maps (1:100,000) to determine Site bedrock geology and the presence of any major faults or other anomalies.
- Overlay Geological Survey of Ireland (GSI) landslide susceptibility maps to determine Site landslide susceptibility risk classification.

- Overlay Environmental Protection Agency (EPA) and Teagasc (Agricultural Agriculture & Food Authority) soils and subsoil maps (1:50,000) to determine categories of soils and subsoil at the Site.
- Search of the GSI landslide database for records of landslide mass movement events at and near the study area (i.e. within c. 15km of the red line boundary).
- Search of the GSI geological heritage database for records of listed geological heritage sites at and near the study area (i.e. within c. 15km of the red line boundary).
- Search of the GSI geology database for listed mineral locations at and near the study area (i.e. within c. 15km of the red line boundary).
- Search of National Parks and Wildlife Service website.

8.2.4 Field Work

8.2.4.1 Geotechnical Investigations, Site Walk Over and Observations

An initial Site walkover survey was carried out by Andrew Garne Geotechnical Services on 17th June 2021. Additional walkover surveys were made on 3rd and 4th August 2022 and 24th August 2022. The walkovers included a number of peat probes taken at both the Turbine Base, Turbine Hardstands and Substation locations in addition to probes taken along the proposed access tracks.

A total of 347 peat probes were undertaken within the EIAR boundary. In addition, 15 trial pits were excavated on 1st and 2nd July 2022 in order to verify the underlying soils and geology profile at, or close to, the proposed turbines and substation. Additionally, 4 gouge cores were attempted at the proposed locations of 4 of the turbines in order to verify that no peat or soft soils were present at these locations. Due to the absence of peat or soft soils, these gouge cores did not penetrate deeper than the topsoil (c. 0.2m below ground level).

8.2.5 Evaluation of Potential Effects

8.2.5.1 Sensitivity

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

"*The value of the superficial/ solid geology should be identified to allow an assessment of the impact of the proposed development to be considered adequately*" (EPA, 2022)

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

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

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

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

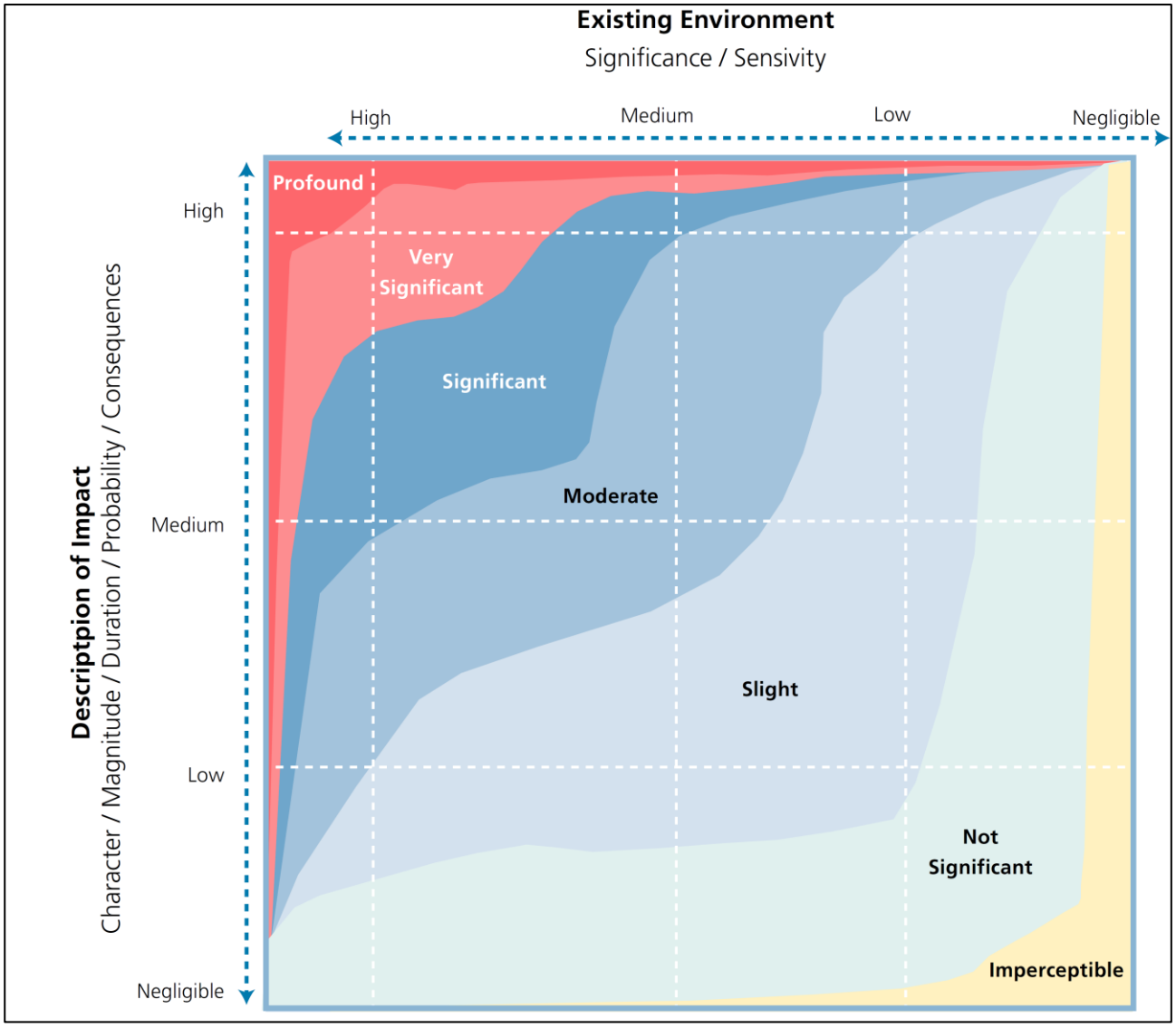
Importance	Criteria	Typical Examples
	Volume of peat and/or soft organic soil underlying route is moderate on a local scale*	
Low	Attribute has a low quality, significance or value on a local scale. Degree or extent of soil contamination is minor on a local scale. Volume of peat and/or soft organic soil underlying route is small on a local scale*	Large historical and/or recent site for construction and demolition wastes. Small historical and/or recent landfill site for construction and demolition wastes. Poorly drained and/or low fertility soils. Uneconomically extractable mineral resource.

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

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

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

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



8.2.5.2 Magnitude

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

Table 8.2: Describing the Magnitude of Impacts

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

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

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

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

8.2.5.3 Significance Criteria

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

This matrix qualifies the magnitude of potential effects, based on the weighting of these effects in light of their importance and/or sensitivity of the receiving environment. In terms of Soils and Geology, the general terms for describing potential effects (**Table 8.2: Describing the Magnitude of Impacts**) are not linked directly with the Development specific terms for qualifying potential impacts (**Table 8.3: Qualifying the Magnitude of Impact on Soil and Geological Attributes)** therefore, both descriptive (**Table 8.2**) and qualifying (**Table 8.3**) terms are used in describing potential impacts of the Development. This is largely driven by the likely localised characteristic of potential effects arising as a product of the Development in terms of Soil and Geology, and the separation of land areas based on baseline conditions (**Section 8.4**).

Table 8.4: Weighted Rating of Significant Environmental Impacts

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

8.2.5.4 Scoping Responses and Consultation

Information was received by a number of consultee organisations during the assessment as listed below:

- Irish Peatlands Conservation Council (IPPC)
- Geological Survey of Ireland (GSI)
- Dept. of Defence
- Dept. of Environment, Climate and Comms
- Dept. of Housing, Local Gov. and Heritage
- Dept. of Agriculture, Food and the Marine
- Waterford City & County Council

The only responses relevant to this Chapter of the EIAR were received by the IPPC and GSI, and these are summarised in **Table 8.5**. The table summarises where the response has been addresses within the EIAR.

Table 8.5: Scoping Responses and Consultation

Consultee	Type and Date of Response	Summary of Consultee Response with Relevance to This Chapter	Addressed
Irish Peatlands Conservation Council (IPPC)	Letter dated 18th July 2022	• ***Landslide Susceptibility*** *"Looking at the Geological Surveys of Ireland's Landslide Susceptibility Map shows that the locations for turbines 8 & 6 are in zones graded to be of a "High Landslide Susceptibility". The proposed turbine locations are a cause for concern and need to be extensively reviewed. It has come to IPCC's attention that current best-practice methods for assessing the probability and/or risk assessment for peat slippage and bog bursts/flows may not be fit for purpose. There has been a number of peat events in recent times, such as the Meenbog bog flow, Boleybrack Mountain peat slide and the Knockanefune Mountain bog slide and there is uncertainty over what caused them as there are confounding variables such as afforestation, developments (such as access roads), overgrazing, drainage, turbuary and rainfall. Peat has an exceptionally high water content, is a low density material with low compressive strength. Disturbed peat also has a low sheer strength. These parameters allow long runouts to develop when there is a peat failure with the potential to destroy aquatic wildlife directly and downstream. The possibility and extent of runouts could be examined further to ascertain where these might occur, what paths they would take and what would be at risk environmentally. This of course has to be dove-tailed with proper contingency and management plans in the event of an actual peat-slide. There is a high possibility that if there is a peat slide event it would affect neighbouring designated sites which would be unacceptable and disastrous. If there is a possibility of any more damage occurring to the designated sites and ANNEX I habitats as a result of this development then the project should not go ahead."*	• Landslide susceptibility is addressed 8.3.9 and 8.3.10. Due to the absence of any detected peat deposits on the site, the risks associated with peat instability are considered to be negligible.
Geological Survey Ireland	Letter dated 26th April 2022	*With reference to your email received on the 11 April 2022, concerning the Request for Scoping Opinion on EIA for Dyrick Hill Wind Farm, Ballinamult, Co Waterford, Geological Survey Ireland would encourage use of and reference to our datasets. Please find attached a list of our publicly available datasets that may be useful to the environmental assessment and planning process. We recommend that you review this list and refer to any datasets you consider relevant to your assessment.* *Geoheritage* *Groundwater*	• Geoheritage is addressed in **Section 8.3.8** of this Chapter. There are two known Geoheritage Sites within 10km of the site. • Groundwater is addressed in Chapter 9 of the EIAR. • Geological Mapping has been consulted as part of the Desk Study as referenced in **Section 8.2.3** and **Sections 8.3.5** and **8.3.6** of this Chapter.

Consultee	Type and Date of Response	Summary of Consultee Response with Relevance to This Chapter	Addressed
		Geological Mapping *Geohazards* *Natural Resources (Minerals/Aggregates)* *Geochemistry of soils, surface waters and sediments* *Other Comments* *Should the development go ahead, all other factors considered, Geological Survey Ireland would much appreciate a copy of reports detailing any site investigations carried out. Should any significant bedrock cuttings be created, we would ask that they will be designed to remain visible as rock exposure rather than covered with soil and vegetated, in accordance with safety guidelines and engineering constraints. In areas where natural exposures are few, or deeply weathered, this measure would permit on-going improvement of geological knowledge of the subsurface and could be included as additional sites of the geoheritage dataset, if appropriate. Alternatively, we ask that a digital photographic record of significant new excavations could be provided. Potential visits from Geological Survey Ireland to personally document exposures could also be arranged*	• Geohazards (in particular Landslide Susceptibility) is referenced in the Desk Study in **Section 8.2.3** and 8.3.9 of this chapter. • Natural Resources are addressed within 8.3.7 of this Chapter. • Geochemistry of soils, surface waters and sediments are addressed in Chapter 9 of the EIAR.

8.3 BASELINE DESCRIPTION

8.3.1 Introduction

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

8.3.2 Site Description

The Site, as shown in **Figure 2.1** in **Volume III**, is located within an area of farmland, forestry and upland heath, and is located within the townlands of Ballynaguilkee Upper, Broemountain, Corradoon, Dyrick, Lickoran, Lickoranmountain, Lisleagh, Lisleaghmountain, Lyrattin and Scartmountain. The Site is located 43km west of Waterford City, 55km northeast of Cork City, and 12.9km northwest of Dungarvan.

The redline boundary extends to ~465ha, and comprises a mixture of farmland, forestry and upland heath. Much of the lands are in private, third-party ownership, while a portion of the site is shared land (commonage).

The topography of the site slopes gently downwards from a high point on Broemountain at the northwest corner of the site (maximum elevation 429mOD) down to a low point of approximately 150mOD in the southeast corner of the site. Dyrick Hill forms an elevated area close to the centre of the site which rises rapidly to an elevation of 286mOD.

8.3.3 Haul Route

It is proposed that the turbine nacelles, tower hubs and rotor blades will be landed in Waterford Port. From there, they will be transported to the Site via the N25 to Dungarvan, then north to the site. The proposed haul route is shown on **Figure 2.6** in **Volume III**.

Temporary works will be required to accommodate the delivery of the turbine components. These temporary works are included as part of this application and are assessed as part of this EIAR and are located in the townlands of Ballynaguilkee Lower, Kilcooney, Lisleagh, Gorteens, Kilmurry, Rathpatrick, Ballyduff East, Joulterspark and Burgery.

8.3.4 Grid Route

The substation at Dyrick Hill will connect via underground 110kV cable to the ESB 110kV Dungarvan substation. The overall length of the grid connection between the substation and the existing Dungarvan 110kV substation is 16.8km. The preferred grid connection route will comprise a 16.8km long underground cable from the Dyrick Hill Wind Farm to the Dungarvan substation. The route will include sections within public road, primarily regional roads and private lands.

The proposed grid connection passes through the townlands of Broemountain, Lyrattin, Farnane Lower, Farnane Upper, Castlequarter, Mountaincastle South, Carrigaun (Mansfield), Langanoran, Sleadycastle, Knockaunnaglokee, Garryduff, Colligan More, Garryclone, Colliganwood, Ballymacmague North, Ballymacmague South and Killadangan. The route of the above grid connection is provided in **Figure 2.1** in **Volume III**. The grid feasibility study carried out by TLI can be found in **Appendix 12.1**.

8.3.5 Bedrock Geology

The GSI maps and website for this area show that the majority of the Site is underlain by Devonian sedimentary "Old Red Sandstone Formation" as shown in **Plate 8.1**. It should be noted that some outcrops of bedrock are present within the upland (northwest) parts of the Site.

The bedrock comprises sandstone, mudstone, siltstone and conglomerate. The detailed geological mapping for the site shows that the bedrock within and to the north of Dyrick Hill comprises medium grained pink-purple sandstone and conglomerate of the Knockmealdown Sandstone Formation while the bedrock to the south of Dyrick Hill comprises Dusky-red to purple mudstones with subordinate pale-red sandstones of the Ballytrasna Formation.

Structurally, there are no known faults or folds affecting the site.

Plate 8.1: Example of Fine Sandstone in old borrow pit (Photo looking to the north)

Plate 8.2: Example Outcrop of purple siltstone in borrow pit (Photo looking to the east)

8.3.6 Soils and Subsoils

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

- Glacial till underlies the majority of the site with minor areas of shallow bedrock in the west and northwest and minor areas of alluvium along the rivers between T03 and T05 and west of T09.
- No peat is shown to be present on the site.

An overview of the quaternary geology for the main Site is shown in **Figure 8.2**, located in **Volume III**.

8.3.6.1 Peat Depths

No areas of peat were identified during the fieldwork although shallow peaty topsoils were noted. Probe depths within the redline boundary are given in **Table 8.6** below.

Table 8.6: Probe Depth Distribution by Category

Peat Depth Category	Number of Survey Points
A – Rock/Very Shallow Peat/Topsoil (0.0-0.4m)	347
B - Shallow (0.5-2.0m)	0
C - Moderately Deep (2.1-3.5m)	0
D - Deep (3.6-5.0m)	0
E - Extremely Deep (>5m)	0
Total	**347**

The table shows that all probe depths were recorded as less than 0.5m. The maximum depth recorded was 0.4m.

8.3.6.2 Trial Pits and Gouge Cores

A total of 15 trial pits were excavated on 1/7/22 and 2/7/22 at the proposed locations of the turbines and the substation. Where excavator access to the turbine location was not possible (due to steep saturated slopes or trees), the trial pit was excavated at the nearest accessible location (T05, T08, T12, T13) and gouge cores were later attempted at the turbine locations on 3/8/22 and 4/8/22 in order to check for the presence of peat/soft soils.

No peat or soft soils were observed beneath the topsoil within any trial pits or gouge cores. A summary of the ground conditions observed within the trial pits and gouge cores are given below. Details of the trial pits are presented in **Appendix 8.1**.

Table 8.7: Trial Pit Summary

Location	Trial Pit	Topsoil	Firm-Stiff Sandy Gravelly Silt	Sand/Gravel (Weathered Rock)	Possible Bedrock
Turbine T01	T01	0 – 0.2m		0.2 – 1.7m	1.7m
Turbine T02	T02	0 – 0.3m	0.2 – 1.6m	0.3 – 1.1m	1.1m
Turbine T03	T03	0 – 0.3m			1.6m
Turbine T04	T04	0 – 0.3m		0.2 – 3.0m	3.0m
Turbine T05	T05	0 – 0.3m	0.3 – 2.5m	0.3 – 2.2m	2.2m
Turbine T06	T06	0 – 0.3m			2.5m
Turbine T06B*	T06B	0 – 0.3m		0.3 – 2.5m	2.5m
Turbine T07*	T07	0 – 0.3m	0.2 – 1.3m	0.3 – 2.1m	2.1m
Turbine T08	T08	0 – 0.3m		0.3 – 1.7m	2.1m
Turbine T09	T09	0 – 0.3m		0.3 – 2.0m	1.7m
Turbine T10	T10	0 – 0.3m	0.3 – 1.3m		2.0m
Turbine T11	T11	0 – 0.3m		0.3 – 1.8m	1.3m
Turbine T12	T12	0 – 0.3m			1.8m
Turbine T13	T13	0 – 0.3m	0.3 – 3.1m		3.1m
Substation	Substation	0 – 0.3m	0.4 – 2.0m		2.0m

*Note: Turbines T06B and T07 have been excluded from the development. This information is included for completeness only.

8.3.7 Geological Resource Importance

The Geological Survey of Ireland (GSI) website for this area shows that there are no registered active quarries close to the site. The nearest registered quarry is Cappagh Roadstone Quarry, located at Cappagh, some 10km south of the site.

Several mineral locations are listed within a few kilometres of the site boundary, to the north, south and east. These are listed as malachite and quartz mineral locations and are not expected to influence the site development (see **Figure 8.6**).

The GSI database shows that the land to the north of Dyrick Hill has a moderate to high aggregate potential from crushed rock, while the land to the south has a very low potential, possibly due to the presence of mudstone. Dyrick Hill itself has a very high aggregate potential.

8.3.8 Features of Geological Heritage

The Geological Survey of Ireland (GSI) also maintains a database for known Geological Heritage sites in Ireland. There are no known Geological Heritage areas close to the site or the grid connection route. The nearest Geological Heritage areas are located approximately 7km southwest (near Cappoquin) and approximately 7km west-northwest near the Knockmealdown Mountains. Details of the Sites are taken from the GSI website and reproduced in **Tables 8.8** and **8.9** below and are also shown on **Figure 8.5**.

Table 8.8: Audited Sites Information – Knockmealdown Gullies

Site Name	Knockmealdown Gullies
Site Code	WD042
IGH Theme 1	IGH14
County	Waterford
Description	Two deep gully channels formed by river incision since the last ice age
Designation	CGS
Geological	Though no dating has been completed on the features, they are considered to be Holocene in Age
Report	Link

Site Name	Knockmealdown Gullies
Coordinates (IG)	206883, 105971
Coordinates (ITM)	606831.763, 606025.583

Table 8.9: Audited Sites Information – Blackwater Bend

Site Name	Blackwater Bend
Site Code	WD011
IGH Theme 1	IGH14
County	Waterford
Description	A point in the river course where the flow direction changes ninety degrees, through gorges into high rock ridge
Designation	CGS, may be recommended for Geological NHA
Geological	Best example of river capture in Ireland; no other large river has a similar sized 90-degree bend
Report	Link
Coordinates (IG)	209749, 99454
Coordinates (ITM)	609697.522, 599510.524

8.3.9 Landslide Susceptibility

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

The GSI also maintains a database of known landslides in Ireland. The database records no landslides on or adjacent to the site. The nearest recorded landslides are shown approximately 8km west of the site within the Knockmealdown Mountains as illustrated on **Figure 8.3**.

8.3.10 Peat Stability Risk Assessment

No peat was encountered on the site although peaty topsoil (peaty podzols and peaty gleys) were observed within the upland areas to a maximum depth of 0.4m. In accordance with the Scottish Executive Guidelines, a Peat Stability Risk Assessment (PSRA) is not required for sites where peat depths do not exceed 0.5m. In these cases, the risk of a peat slide occurring is considered to be negligible. Should any areas of peat thickness greater than 0.5m be encountered on the site before or during the works, a full PSRA will be undertaken in order to minimise the risks associated with the peat.

8.3.11 Designated Sites

The following areas are designated according to the EPA's Map Viewer:

- Blackwater River SAC (Site Code 002170) and pNHA. The Farnane River flows north to south along the western boundary of the site and into the Finisk River which flows north to south, approximately 1km east of the site. Both rivers are part of the Blackwater River SAC. The site is also dissected by the Lisleagh Stream which also flows southeast into the Finisk River at Millstreet. Further details on the surface waters are presented in Chapter 9 of the EIAR.

8.4 ASSESSMENT OF POTENTIAL IMPACTS

8.4.1 Do Nothing Impact

The "Do Nothing Impact" is the effect on the Site should the proposed wind farm not be constructed. In this case, it is envisaged that the current land use would remain as it is now, with continued low intensity grazing for cattle and sheep. Given the nature of the land, being predominantly farmland and open heath (rough grazing), it is unlikely that any substantial changes in this use will occur in the near future.

8.4.2 Construction Phase Potential Impacts

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

The Project will comprise of the following main components:

- Erection of 12 no. 6.0-7.2 MW wind turbines (Note* this is the current output available for the turbine of this size. It is possible that, with improvements in technology, the output may increase at the time of construction.) with an overall ground tip height of 185m. The candidate wind turbines will have a 162m rotor diameter and a hub height of 104m.

- Construction of Crane Hardstand areas and Turbine Foundations.
- Construction of new internal Site Access Tracks and upgrade of existing Site roads, to include passing bays and all associated drainage.
- Construction of a new wind farm Site entrance with access onto the R671 regional road in the townlands of Lickoran.
- Improvement of existing Site entrances with access onto local roads in the townlands of Broemountain.
- Improvements and temporary modifications to existing public road infrastructure to facilitate delivery of abnormal loads and turbine delivery.
- Construction of one Temporary Construction Compound with associated temporary site offices, parking area and security fencing.
- Development of on-site Borrow Pit.
- Installation of one Permanent Meteorological Mast up to a height of 110m.
- Development of a Site drainage network.
- Construction of one permanent 110 kV Substation.
- All associated Wind Farm Internal Cabling connecting the wind turbines to the Onsite Substation.
- All works associated with the connection of the wind turbines to the national electricity grid, which will be via 110 kV underground cable connection approximately 16.1km in length to the existing Dungarvan 110 kV Substation.
- Upgrade works on the Turbine Delivery Route from Waterford Port.
- Ancillary forestry felling to facilitate construction and operation of the Development.

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

8.4.2.1 Subsoil and Bedrock Removal

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

8.4.2.1.1 Land Take

Some land take will be required during the construction and operation of the wind farm. This will be required for construction of Site Access Tracks, Turbine Foundations, 110V Substation, Met Mast and for parts of the haul route which require temporary widening. Temporary land take will also be needed for construction of grid cables both on and off the Site.

8.4.2.1.2 Excavations

Excavations will be required for most aspects of the Development including for Turbines, Turbine Hardstand areas, Site access tracks, haul route, Site compound, cable trenches and grid connection route. Estimates of excavation and reinstatement volumes are presented in **Table 2.5** of **Chapter 2** and **Table 8.10** of this Chapter.

8.4.2.1.3 Turbines and Hardstand areas

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

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

The environmental effects of the construction of the hardstanding foundations are similar to that of the founded Site Access Tracks as discussed in **Section 8.4.2.1.4**. Ground investigations in the form of trial pits, peat probes and gouge cores have taken place at the proposed Turbine Hardstand locations to inform the depth of excavation and upfill required. Some of the material for the construction of the Turbine Hardstands will be imported from local quarries. The potential effect of extracting material from external quarries include the extra pressure on transport routes and increased fuel consumption. This is discussed in **Chapter 14 "Traffic and Transport"**. Only licenced quarries will be used. All imported material will be fully tested in accordance with industry standards (TII Specification for Roadworks Series 800 and S.R.21 2014 + A1: 2016). Only verified clean, inert material will be used.

8.4.2.1.4 Site Access Tracks

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

The roads will be constructed as founded roads only. Founded roads are excavated down to and constructed up from a competent geological stratum. The roads shall be constructed to average heights of 0.5m to 1.0m above existing ground level.

Ground investigations in the form of peat probing have been carried out along the proposed Site Access Tracks to check for the presence of peat or soft soils which would require excavation. The estimated volumes of excavated and imported materials are given in **Chapter 2**.

Soil sealing is the covering of a soil with an impermeable material; it often affects agricultural land, puts biodiversity at risk and increases the risk of flooding. The use of impermeable material is an inevitable direct effect, to some extent, of most types of construction. Permeable geotextile will be placed at the base of access tracks, along with other infrastructure, as part of their design. However, due to the relatively small footprint of infrastructure and its location, this will have an **imperceptible**, **negative**, **permanent** effect. Similar to above, some of the material may be required from local quarries. The potential effect of extracting material from external quarries include the extra pressure on transport routes and increased fuel consumption. This is discussed in **Chapter 14: Traffic and Transport**. Only licenced quarries will be used. All imported material will be fully tested in accordance with industry standards (TII Specification for Roadworks Series 800 and S.R.21 2014 + A1: 2016). Only verified clean, inert material will used. The potential effects here are considered to be **not significant**, **permanent** and **negative**.

8.4.2.1.5 Site Haul Route

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

8.4.2.1.6 Bedrock Excavations

Due to the numerous areas of shallow bedrock encountered on the Site, it is likely that bedrock excavations will be required at some of the Turbine Foundations, Turbine Hardstands, Site Access Track excavations and possibly for substation excavations, in addition to the Borrow Pit excavation (see **Section 8.4.2.1.9**). The initial visual assessment of rock outcrops and rock recovered from the trial pits on the site suggests that the bedrock will predominantly comprise moderately strong and highly fractured siltstone and fine sandstone. This material is likely to be suitable for re-use after crushing and screening, and would be of use as granular fill for Site Access Track construction. The GSI online aggregate potential maps also indicate a high to very high crushed stone aggregate potential within the site.

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

8.4.2.1.7 Site Cable Trenches

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

8.4.2.1.8 Grid Connection Cable

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

8.4.2.1.9 Borrow Pit

A borrow pit is proposed for the Site and will be located between turbines T09 and T10 (see **Figure 8.7**). The area of the borrow pit will be approximately 127m x 127m with a depth of approximately 2m. This will have a **direct, significant, negative, permanent** effect on the Site. Some importation of granular materials and concrete will also occur and will also have an **indirect, significant, negative, permanent** effect on the source quarry.

8.4.2.1.10 Temporary Construction Compound

It is proposed to construct a temporary Site construction compound on the Site. Construction will comprise the excavation and removal of topsoil and shallow bedrock and the importation of granular fill which will be placed and rolled. The impacts associated with construction of the compound are similar but less than for construction of the Site Access Tracks and are considered to be **not significant, temporary** and **negative**.

8.4.2.1.11 Volumes of Material to be Excavated

A summary of the estimated total volumes of material to be excavated, filled and imported are presented in **Table 8.10**.

8.4.2.1.12 Summary of Impacts Due to Subsoil and Bedrock Removal

A general summary of the pre-mitigation potential impacts associated with subsoil and bedrock removal is presented in **Table 8.11.**

Table 8.10: Summary of Excavation Volumes (m^3)

Topsoil Excavation	Topsoil Embankment Construction	Subsoil/Rock Excavation	Fill to Formation Level	General Fill / Capping	Clause 804 Surfacing	Berm Construction	Surplus to Borrow Pit
76,825	73,325	333,375	186,180	55,745	21,745	15,000	**Topsoil 3,500 Soils/Rock 55,000**

Table 8.11: Impact Summary – Subsoil and Bedrock Removal

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

8.4.2.2 Storage and Stockpiles

8.4.2.2.1 Overview

It is expected that the majority of spoil generated on Site will be either gravel or rock. It is expected that all of the gravel and rock (and minor quantities of glacial till) will be reused for the construction of Site Access Tracks, hardstandings and general fill. Careful management of the spoil/stockpiles and ongoing risk assessments will minimise the risk of ground instability to an acceptable (negligible) level.

8.4.2.2.2 Spoil Management

The handling, management and re-use of excavated materials are of importance during the construction phase of the project. Excavated material will arise from all infrastructure elements of the windfarm (foundations, tracks, hardstands etc.). Soil and rock should be stockpiled no higher than 2m and follow the recommendations set out in the NRA Guidelines for the Management of Waste from National Road Construction Projects (NRA, 2014).

There is potential for a moderate negative effect on soil due to erosion of inappropriately handled excavated materials. However, any effects from the handling of excavated materials will be managed through good Site practice as defines by the IWEA's "*Best Practice Guidelines for the Irish Wind Energy Association".*

All excavated materials will be re-used on site for construction of Site Access Tracks, turbine bases, substation and construction compound. **Table 8.10** shows that a surplus volume of approximately 55,000m^3 of subsoil/rock and 3,500m^3 of topsoil will be generated. This surplus will be used for reinstatement of the borrow pit. A temporary spoil storage area is located approximately 200m east of turbine T09 (adjacent to the T09 access track – see **Figure 8.7**). The process of spoil management is expected to have a **slight negative** effect on the receiving environment.

8.4.2.2.3 Summary of Impacts Due to Storage and Stockpiles

A summary of the pre-mitigation potential impacts associated with soil/rock storage and stockpiles is given in **Table 8.12**.

Table 8.12: Impact Summary – Storage and Stockpiles

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

8.4.2.3 Vehicular Movement

8.4.2.3.1 Overview

Vehicle movement will occur primarily during the construction phase of the wind farm. Construction vehicles will include cranes, excavators, dumper trucks, concrete trucks, private cars (construction personnel). During the operation phase, vehicles will be limited

to occasional maintenance vehicles only. Additional vehicles including cranes will however be required in the unlikely event that any turbine requires replacement.

8.4.2.3.2 Compaction, Erosion and Degradation

Compaction of soils will occur during construction and to a limited extent during operation and decommissioning. In general, compacted soils will be excavated during construction, and access to soils adjacent to the hardstanding areas will be prevented. Compaction effects are considered to be **insignificant, permanent** and **negative.**

Erosion and degradation of exposed soils will also occur, primarily during construction. Erosion and degradation effects are also considered to be **insignificant, permanent** and **negative**.

8.4.2.3.3 Peat Stability and Slope Failure

The effects of peat stability and slope failure are discussed in **Section 8.3.10**. Due to the absence of peat found during surveys, the possibility of a peat slide is considered to be negligible. Any slide or slope failure which does occur would be small and localised due to the absence of peat and the topography of the Site. However, given the proximity of the designated Sites, both to the east and west of the Site, any ground instability which did occur could potentially result in some minor damage to nearby aquatic habitats and aquatic species. Due to the absence of peat however, the effect of this is considered to be **insignificant, permanent** and **negative**.

8.4.2.3.4 Haul Route and Site Tracks.

There will be few changes to the existing public roads, with the exception of temporary widening at some locations on the haul route to allow a load bearing surface and temporary changes to some roundabouts along the haul route as detailed in the Turbine Haul Route Selection Report (**Appendix 14.1**). Some compaction of the underlying soils may occur, although this will be slight. The impacts associated with vehicle movements along the haul route is considered to be **insignificant, permanent** and **negative**.

8.4.2.3.5 Summary of Impacts Due to Vehicular Movement

A summary of the pre-mitigation potential impacts associated with vehicle movement is given in **Table 8.13**.

Table 8.13: Impact Summary – Vehicular Movement

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

8.4.2.4 Soil Contamination

8.4.2.4.1 Overview

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

8.4.2.4.2 Hydrocarbons

Wherever there are vehicles and plant in use, there is the potential for a direct hydrocarbon release which may contaminate the soil and subsoil. A spill has the potential to indirectly pollute water, if the soil and subsoil act as a pathway from any source of pollution. Any spill of fuel or oil would potentially present a **moderate, long-term negative** effect on the soil and geological environment. Good Site practice will mitigate any effect in the short-term and long-term (refer to **Section 8.5.2.5**).

8.4.2.4.3 Wastewater and Sanitation

Wastewater/sewerage from the Temporary Construction Compound and 110kV substation compound will be placed in a holding tank, which will be emptied periodically. Chemicals will be used to reduce odours. The waste will be taken to a local wastewater sanitation plant for treatment. Wastewater or sewerage leakage is not anticipated in a properly managed Site (in accordance with IWEA and Scottish Best Practice Guidelines). The impacts associated with wastewater and sewerage is considered to be **insignificant, permanent and negative**.

8.4.2.4.4 Construction Materials

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

8.4.2.4.5 General Waste

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

8.4.2.4.6 Summary of Impacts Due to Soil Contamination

The Development has the potential to give rise to the following pre-mitigation soil contamination impacts, shown in **Table 8.14** below:

Table 8.24: Impact Summary – Soil Contamination

Impact Description	Type	Quality	Significance	Weighted Significance	Extent	Context	Probability	Duration / Frequency
Hydrocarbon contamination	Direct	Negative	Moderate	Moderate	Localised	Contrast to Baseline	Likely	Long term/ Permanent

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

8.4.3 Decommissioning of the Wind Farm

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

8.4.4 Cumulative Effects

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

8.5 MITIGATION MEASURES AND RESIDUAL IMPACTS

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

8.5.1 Design Phase

8.5.1.1 Mitigation by Avoidance

The opportunity to mitigate any effect is greatest at the design period. In this respect, a detailed Site selection process was carried out by the Developer. This process identified steep slopes and shallow bedrock as specific geotechnical constraints. The detailed Site selection process is described in **Chapter 3: Alternatives**. Furthermore, within the chosen Site, areas of shallow bedrock were identified, and the infrastructure design sought to avoid those areas as much as possible. Mitigation through design is especially applicable in the risk to human health during a project due to the risk of landslips or ground instability and this shall be exercised to minimise the negative risks present.

8.5.2 Construction Phase

8.5.2.1 Subsoil and Bedrock Removal

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

8.5.2.1.1 Mitigation by Avoidance

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

8.5.2.1.2 Mitigation by Good Practices

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

Excavated soil and rock will only be moved short distances from the point of extraction and will be used locally for Site Access Track construction or landscaping. Landscaping areas will be sealed and levelled using the back of an excavator bucket to prevent erosion.

In order to reduce the impacts associated with the use of off-site quarries, an on-site borrow pit will be developed which will reduce transport distances in addition to noise and dust hazards associated with off-site quarries. In order to reduce the impacts associated with the on-site borrow pit, rock use will be reduced and re-used wherever possible (see **Sections 8.5.2.1.3** and **8.5.2.1.4**). On completion of the construction phase, the borrow pit

will be backfilled and returned, as close as possible, to its pre-development state (see **Section 8.5.3.4**).

8.5.2.1.3 Mitigation by Reduction

The disturbance of soil, subsoil and bedrock is an unavoidable effect of the Development. However, adherence to the CEMP and IWEA/Scottish Best Practice Guidelines will ensure that the amount of earth materials excavated is kept to a minimum in order to limit the effect on the geological aspects of the Site. The management of geological materials is an important component of controlling dust and sediment and erosion control.

8.5.2.1.4 Mitigation by Reuse

Soil and rock will be re-used for construction of Site Access Tracks wherever possible. The bedrock will comprise predominantly sandstone and siltstone which, when crushed and graded, should provide a good sub-base for Site Access Track construction.

The topsoil will be reused on Site for landscaping purposes around infrastructure and adjacent to access tracks. These measures will prevent the erosion of exposed areas of overburden in the short and long term.

Volumes of soil/rock and topsoil are shown in **Table 8.10**. The calculated surplus (approximately 55,000m^3 of subsoil/rock and 3,500m^3 of topsoil will be used for reinstatement of the borrow pit (approximate dimensions 127m x 127m x 2m deep).

8.5.2.1.5 Mitigation by Remediation

On completion of the construction stage, any areas not required for operation will be reinstated. This will include the Temporary Construction Compound, turning areas and materials storage areas. Granular material will be removed as required and reinstated with topsoil in keeping with the adjacent soils. As shown above and in **Table 8.9**, the surplus volumes of subsoil/rock and topsoil will be used for reinstatement of the borrow pit. Drainage will be reinstated in order to minimise future erosion of the soils and restore the pre-development state of the environment (see **Surface Water Management Plan** in **Appendix 2.1**).

8.5.2.2 Storage and Stockpiles

8.5.2.2.1 Mitigation by Avoidance and Good Practice

As discussed previously, the opportunity to mitigate any effect is greatest at the design period. In this respect, a detailed Site selection process was carried out by the Developer.

This process identified steep slopes and shallow bedrock as specific geotechnical constraints. The detailed Site selection process is described in **Chapter 3: Alternatives**. Furthermore, within the chosen Site, the infrastructure design sought to avoid those areas where possible. In this respect, by minimising volumes of excavation, volumes for storage and stockpiles will also be reduced, thus reducing the impacts associated with them.

Best practice as described in the IWEA and Scottish Best Practice Guidelines will be applied during construction which will minimise the amount of soil and rock excavation and therefore also reduce storage and stockpile requirements. A temporary spoil stockpile will be located adjacent to the T09 access track, approximately 200m east of turbine T09. All works will be managed and carried out in accordance with the Construction and Environmental Management Plan (CEMP in **Appendix 2.1**), which will be updated by the civil engineering contractor and agreed prior to any Site works commencing. Topsoil will only be moved short distances from the point of extraction and will be used locally for landscaping. Landscaping areas will be sealed and levelled using the back of an excavator bucket to prevent erosion.

8.5.2.2.2 Mitigation by Reduction

Whenever possible, soil and rock will be re-used on the Site immediately, thereby reducing the need for double handling, which will also reduce the requirement to stockpile soils. Excavated soil and rock will be used immediately for Site Access Track construction. Whenever possible stockpiles will be avoided to prevent instability.

8.5.2.3 Vehicular Movements

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

Vehicular traffic on Site will be reduced through the re-use of excavated material on Site which will reduce the need to source material from external quarries. Any vehicles utilised during the construction phase will be maintained on a weekly basis and checked daily to ensure any damage or leakages are corrected.

8.5.2.3.1 Mitigation by Avoidance and Good Practice

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

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

Excavated topsoil will only be moved short distances from the point of extraction and will be used locally for landscaping, thus again reducing the on-Site traffic. Excavated soil and rock will be used for Site Access Track construction as close to the source of extraction as possible.

8.5.2.4 Ground Stability

8.5.2.4.1 Mitigation by Avoidance and Good Practice

As discussed previously, careful design of the wind farm has reduced the amount of construction required in areas of steep slopes and other areas of potential ground instability. Best practice as described in the IWEA and Scottish Best Practice Guidelines will be applied during construction which will minimise the risk of ground instability. All works will be managed and carried out in accordance with the Construction Environmental Management Plan (CEMP in **Appendix 2.1**), which will be updated by the civil engineering contractor and agreed prior to any Site works commencing.

8.5.2.4.2 Emergency Response

The Construction Environmental Management Plan (CEMP in **Appendix 2.1**) will include an emergency response to be applied in the event of a landslide or ground instability. In particular, catch fences and other physical barriers (i.e. concrete blocks) will be on Site and available in sufficient quantities to be used in the event of ground instability. A plan will be made to prevent or divert any landslide away from protected areas (NHA, SPA and/or SAC).

8.5.2.5 Soil Contamination

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

8.5.2.5.1 Mitigation by Avoidance and Good Practice

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

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

8.5.2.5.2 Mitigation by Reduction

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

8.5.2.5.3 Emergency Response

Procedures and contingency plans will be set up to deal with emergency accidents or spills. In particular, an emergency spill kit with oil boom and absorbers will be kept in Site vehicles in the event of an accidental spill. All Site operatives will be trained in its use.

8.5.2.6 Material and Waste Management

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

8.5.2.7 Construction Phase Residual Impacts

The residual impacts after implementation of all mitigation measures for the construction phase of the development are presented in **Table 8.15**.

Table 8.15: Residual Impact Summary

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

Note:

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

8.5.2.8 Operational Phase

All wastes from the control building and ancillary facilities will be removed by the appropriate contractor. The operational team will carry out maintenance works (to Site Access Tracks, 110kV Substation and turbines) and will put in place control measures to mitigate the risk of hydrocarbon or oil spills during the operational phase of the windfarm. Any vehicles utilised during the operational phase will be maintained on a weekly basis and checked daily to ensure any damage or leakages are corrected.

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

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

8.5.2.9 Operational Phase Residual Impacts

The potential effects on the soil and geological environment during the operational phase of the work will be mitigated through good Site practice as described in the IWEA and Scottish Best Practice Guidelines as detailed in the CEMP (**Appendix 2.1**); vehicular movements, hydrocarbon controls etc. as discussed previously. Overall, the residual effects from these aspects will have an **insignificant, permanent, negative** effect on the Site.

8.5.3 Development Decommissioning and Restoration Phases

8.5.3.1 Decommissioning of Infrastructure

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

8.5.3.2 Decommissioning Phase Residual Impacts

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

8.5.3.3 Reinstatement of Redundant Access Track and Hardstand Areas

Redundant Site Access Tracks, turbine bases and hardstand areas will be reinstated post construction. Some of the Site Access Tracks and hardstanding areas, if not required during operation, will also be reinstated post–construction stage (these areas will be identified at operation stage depending on operational requirements). Drainage and slopes will be restored to as close to the original ground as possible.

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

8.5.3.4 Reinstatement of Borrow Pit

Redundant Borrow Pits will be backfilled with surplus excavated soil and rock from the site. Drainage and slopes will be restored to as close to the original ground as possible. Once backfilling of the Borrow Pit is close to completion, the surface will be covered by a layer of topsoil in order to encourage re-growth of native vegetation.

After decommissioning of the Wind Farm, all Site Borrow Pits will be returned to as close to their pre-development state as possible.

8.5.3.5 Reinstatement Phase Residual Impacts

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

8.6 SUMMARY OF SIGNIFICANT IMPACTS

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

8.7 REFERENCES

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