Cush Wind Farm

Environmental Impact Assessment Report

Chapter 6: Land, Soils & Geology

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Contents

6.1 Introduction

6.1.1 Background & Objectives

This chapter provides an assessment of the likely and significant effects of the project on the land, soil and geological environment.

This chapter provides a baseline assessment of the environmental setting of the project (wind farm site, grid connection route and haul route) in terms of land, soils and geology and identifies the likely and significant effects that the construction, operation and decommissioning of the project will have on them, including an assessment of cumulative effects with other existing, permitted and proposed developments. Where required, appropriate mitigation measures to limit, reduce or avoid any identified likely significant adverse effects on land, soils and geology are recommended.

6.1.2 Description of the Project

In summary, the project comprises the following main components as described in **Chapter 3**:-

- 8 no. wind turbines with an overall tip height of 200m, and all associated ancillary infrastructure;
- All associated and ancillary site development, excavation, construction, landscaping and reinstatement works, including provision of site drainage infrastructure and forestry felling.
- Temporary alterations to the turbine component haul route; and,
- Construction of an electricity substation, Battery Electricity Storage System and installation of 5.6km of underground grid connection to facilitate connection of the proposed electricity substation to the existing 110kV substation at Clondallow, County Offaly;

The project site is located in rural County Offaly, approximately 4km north of the town of Birr and c. 28km south-west of Tullamore, County Offaly. Off-site and secondary developments; including the forestry replant lands and candidate quarries which may supply construction materials; also form part of the project.

The turbine component haul route, and associated temporary alterations works, are located within counties Galway, Roscommon, Westmeath, and Offaly. It is envisaged that the turbines will be transported from the Port of Galway, through the counties of Galway, Roscommon, Westmeath and Offaly, to the project site. However, as the route follows motorway and national roads through these counties, it is assessed that there is no likelihood of effects on land and soil and, therefore, these areas have been screened out from further assessment.

A full description of the project is presented in **Chapter 3**.

6.1.3 Statement of Authority

Hydro-Environmental Services (HES) are a specialist geological, hydrological, hydrogeological and environmental practice which delivers a range of geological/water and environmental management consultancy services to the private and public sectors across Ireland and Northern Ireland. HES was established in 2005, and our office is located in Dungarvan, County Waterford.

Our core areas of expertise and experience include water and geology. We routinely complete impact assessments for land soils and geology, hydrology and hydrogeology for a large variety of project types, including wind farms and associated grid connections.

This chapter was prepared by Michael Gill and David Broderick.

Michael Gill (P. Geo., B.A.I., MSc, Dip. Geol., MIEI) is an Environmental Engineer with over 22 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms in Ireland. He has also managed EIAR assessments for infrastructure projects and private residential and commercial developments. In addition, he has substantial experience in wastewater engineering and site suitability assessments, contaminated land investigation and assessment, wetland hydrology /hydrogeology, water resource assessments, surface water drainage design and SUDs design, and surface water/groundwater interactions. For example, Michael has worked on the EIS/EIAR for Oweninny WF, Cloncreen WF, and Derrinlough WF, and over 100 other wind farm-related projects.

David Broderick (P.Geo, BSc, H. Dip Env Eng, MSc.) is a hydrogeologist with over 17 years experience in both the public and private sectors. Having spent two years working in the Geological Survey of Ireland, working mainly on groundwater and source protection studies, David moved into the private sector. David has a strong background in groundwater resource assessment and hydrogeological/hydrological investigations in relation to developments such as quarries and wind farms. David has also completed numerous geology and water assessments for inclusion within EIARs for a range of commercial developments. David has worked on the EIS/EIAR for Oweninny WF, Cloncreen WF, Bracklyn WF, Arderroo WF and Yellow River WF, and over 80 other wind farm related projects across the country.

6.1.4 Relevant Legislation

This chapter has been prepared in accordance with the requirements of European Union Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (the 'EIA Directive') as amended by Directive 2014/52/EU.

Regard has also been had to the requirements of the following legislation:-

- S.I. No. 349/1989: European Communities (Environmental Impact Assessment) Regulations, and subsequent Amendments (S.I. No. 84/1995, S.I. No. 352/1998, S.I. No. 93/1999, S.I. No. 450/2000 and S.I. No. 538/2001), S.I. No. 30/2000, the Planning and Development Act, and S.I. 600/2001 Planning and Development Regulations and subsequent Amendments. These instruments implement EU Directive 85/373/EEC and subsequent amendments, on the assessment of the effects of certain public and private projects on the environment;
- Directives 2011/92/EU and 2014/52/EU on the assessment of the effects of certain public and private projects on the environment, including Circular Letter PL 1/2017: Implementation of Directive 2014/52/EU on the effects of certain public and private projects on the environment ('the EIA Directive');
- Planning and Development Act, 2000, as amended; and,
- S.I. No 296/2018: S.I. No. 296/2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 which transposes the provisions of Directive 2014/52/EU into Irish law.

6.1.5 Relevant Guidance

This chapter has been prepared having regard, where relevant, to the guidance contained in the following documents:-

- *Guidance Document on Wind Energy Developments and EU Nature Legislation* (European Commission, 2020);
- Environmental Protection Agency (2022) *Guidelines on the Information to be Contained in Environmental Impact Assessment Reports*;
- Institute of Geologists Ireland (2013) *Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements*;
- National Roads Authority (2008) *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*;
- Department of the Environment, Heritage, and Local Government (2006) *Wind Energy Development Guidelines for Planning Authorities 2006*;
- Forestry Commission (2004) *Forests and Water Guidelines, Fourth Edition. Publ. Forestry Commission, Edinburgh*;
- COFORD (2004) *Forest Road Manual – Guidelines for the Design, Construction and Management of Forest Roads*;
- Department of Housing, Planning & Local Government (2018) *Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment*;
- European Union (2017) Guidance *on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU);* and
- Institute of Environmental Management (IEMA) (2022) *A New Perspective on Land and Soil in Environmental Impact Assessment*.

6.2 Methodology

6.2.1 Desk Study

A desk study of the overall project areas and receiving environment (described below) was completed in advance of undertaking the walkover survey, visual assessments and site investigations. This involved collecting all relevant land, soil and geological information for the overall project area. Data sources included:-

- Environmental Protection Agency databases (www.epa.ie);
- Geological Survey of Ireland – Groundwater and Geological Database (www.gsi.ie);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 15 (Geology of Galway - Offaly). Geological Survey of Ireland (GSI, 1999);
- Geological Survey of Ireland – 1:25,000 Field Mapping Sheets;
- Ordnance Survey Ireland (OSI) – 6" and 1;5000 scale basemaps; and,
- Aerial photography (www.bing.com/maps; www.google.com/maps).

6.2.2 Baseline Monitoring & Site Investigations

An initial site walkover, geological mapping and soil probing exercise were undertaken by HES on 21 October 2022. Further site investigations including trial pits and gouge cores were undertaken on 5 December 2022 and 23 January 2023. Further surveys and baseline monitoring were completed on 25 January and 26 March 2023.

A geotechnical and peat stability assessment used to inform the assessment contained within this chapter was carried out by Fehily Timoney & Company (FT) and is enclosed in **Annex 6.1**. Separately, a Planning-Stage Peat and Spoil Management Plan has been prepared (see **Annex 3.4**) which details the handling, management and monitoring of material excavated during the construction phase and operational of the project.

In summary, site investigations to inform this assessment include the following:-

- Detailed site walkovers and visual inspections to assess ground conditions;
- Land and drainage surveys;
- A trial pit or soil gouge core was undertaken at each of the turbine locations, substation, construction compounds, spoil deposition areas and control building to investigate subsoil depth and lithology. A total of 7 no. trial pits were completed along with 4 no. soil gouge cores);
- 170 no. peat probe locations along with slope angle measurements were carried out by FT as part of the peat stability assessment;
- Logging, mapping of peat and subsoil exposures; and,
- Mineral subsoils were logged according to BS:5930.

6.2.3 Receptor Importance/Sensitivity Criteria

In addition to the utilisation of sensitivity and receptor importance criteria outlined within the above-mentioned EPA Guidance (EPA, 2022), this assessment, in accordance with National Roads Authority (NRA, 2008) guidance, quantifies the importance of the land, soil and geology environments at the project site by applying the criteria set out in **Table 6.1**, with the impact magnitude and impact rating subsequently assessed using **Table 6.2** and **Table 6.3.**

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

	is minor on a local scale. • Volume of peat and/or soft organic soil underlying site is small on a local scale.	site for construction and demolition wastes. • Poorly drained and/or low fertility soils. • Uneconomically extractable mineral resource.

Table 6.1: Estimation of Importance of Soil and Geology Criteria (NRA, 2008)

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute	• Loss of high proportion of future quarry or pit reserves. • Irreversible loss of high proportion of local high fertility soils. • Removal of entirety of geological heritage feature. • Requirement to excavate / remediate entire waste site. • 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. • Removal of part of geological heritage feature. • Irreversible loss of moderate proportion of local high fertility soils. • Requirement to excavate / remediate significant proportion of waste site. • 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. • Removal of small part of geological heritage feature. • Irreversible loss of small proportion of local high fertility soils and/or High proportion of local low fertility soils. • Requirement to excavate / remediate small proportion of waste site. • 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 affect either use or integrity	• No measurable changes in attributes

Table 6.2: Estimation of Magnitude of Impact (NRA, 2008)

	Magnitude of Impact			
Importance of Tribute	Negligible	Small Adverse	Moderate Adverse	Large Adverse
Extremely High	Imperceptible	Significant	Profound	Profound

Very High	Imperceptible	Significant/ Moderate	Profound/ Significant	Profound
High	Imperceptible	Moderate/ Slight	Significant/ Moderate	Profound/ Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight/ Moderate

Table 6.3: Estimation of Rating of Impact (NRA, 2008)

6.2.4 Scoping & Consultation

The scope for this assessment has been informed by consultation with statutory consultees and other bodies with environmental responsibility.

This consultation process is outlined in **Chapter 1** of this EIAR. Matters raised and recommendations highlighted by the responses in relation to land, soils and geology are summarised in **Table 6.4** below. The full response from each of the below consultees are provided in **Annex 1.7.**

Consultee	Summary of Response	Addressed
Geological Survey of Ireland (GSI)	With the current plan, there may be potential impacts on the integrity of current County Geological Sites envisaged by the project, should these sites [i.e. Kilcormac Esker] not be assessed as constraints. Ideally, the sites should not be damaged or integrity impacted or reduced in any manner due to the project. However, this is not always possible, and in this situation appropriate mitigation measures should be put in place to minimize or mitigate potential impacts. We would recommend use of the Aggregate Potential Mapping viewer to identify areas of High to Very High source aggregate potential within the area. In keeping with a sustainable approach we would recommend use of our data and mapping viewers to identify and ensure that natural resources used in the proposed wind farm development are sustainably sourced from properly recognised and licensed facilities, and that consideration of future resource sterilization is considered.	**Sections 6.3.7 & 6.3.8**
Department of Agriculture, Food and the Marine (Forest Division)	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, is assessed. Consultation with relevant environmental and planning authorities may be required where specific sensitivities arise (e.g. local authorities, National Parks & Wildlife Service, Inland Fisheries Ireland, and the National Monuments Service)	**Section 6.3.8**

Table 6.4: Summary of Land and Soils Scoping Responses

6.2.5 Limitations and Difficulties Encountered

No limitations or difficulties were encountered during the preparation of the Land, Soils and Geology Chapter of the EIAR.

6.3 Description of the Existing Environment

6.3.1 Site Location & Description

The proposed project site, which has an area of approximately 290ha, is located c. 4km north of Birr, Co. Offaly. The N62 dissects the project site into an eastern portion and western portion. The project site setting is basin peat bogs fringed by other bogs, agricultural and forestry lands.

The western portion is mainly bordered by forestry with some agricultural land while the eastern portion its mainly agricultural land with some cutover peat bogs. Construction phase access to the project site from the N62 is via existing forestry/bog entrances whilst operational phase access is provided via private farm entrances off surrounding local roads.

Current land use within the project site is made up predominantly of peat bogs, agricultural pasture/grassland, and forestry, including commercial and woodland planting (of various species) and scrub.

2 no. turbines (T1 and T3) located towards the north of the project site are located on cutover bog and cutover bog mixed with scrub growth. The main proposed spoil deposition area (SDA1) along with the main construction compound (CC1) are also located on this type of landcover. T2 is located in an area of bog woodland (non-Annex I).

3 no. turbines (T4, T5 and T6) are located in mixed woodland/forestry which are also largely underlain by peat deposits at the proposed development areas. Turbines T5 and T6 are located in areas of commercial forestry (conifer plantation). There are also proposed spoil deposition areas around turbines T5 and T6.

The remaining 2 no. turbines (T7 and T8), substation, BESS, windfarm control building, met mast and construction compound no. 2 (CC2) are located on agricultural grassland.

The proposed project site is low lying with topography being slightly undulating to flat and with ground elevations ranging between 47 and 63m OD (Ordnance Datum). The overall slope is to the west.

The most elevated section of the proposed project site is found along the eastern fringes where agricultural grassland rises up to 63m OD (met mast location). The ground slopes in a general westerly direction from this eastern section to the lowest point on the far west of the project site which follows the valley of the Rapemills River.

The underground grid connection (5.6km) follows public roads for 4.7km with an off-road section through private lands for 0.65km. Approximately 200m of the route is in the project site itself. The off-road section of the grid connection is through rough grassland. The existing ESB owned Clondallow 110kV substation is located 1.7km to the southwest of the proposed project site.

The haul route works are predominately located within motorway and national roads. The majority of the works comprise the temporary removal of street furniture to accommodate the delivery of turbine components.

The temporary junction works at the N52/N62, located 1.7km to the southeast of the project site, will involve the temporary removal and replacement of a small section of tree lined hedgerow on the eastern side of the junction to make room for a turning area which is on a grassland area to the east of the N52.

The forestry replant lands in County Monaghan are mainly agricultural pasture, with fields bounded by hedgerows and treelines.

6.3.2 Land & Land Use

Based on the Corine (2018) mapping, 2 no. turbines (T1 and T3) located towards the north of the proposed project site are located on cutover bogs along with the main spoil deposition area (SDA1).

4 no. turbines are situated in heavily vegetated areas, mapped by Corine as mixed forests (T2 and T4) and transitional woodland (T5 and T6).

The remaining 2 no. turbines (T7 and T8), substation, BESS, construction compound no. 2 (CC2), control building are located on agricultural land.

The grid connection will be predominately located within the carriageway of the local road network, with a section through private lands via existing tracks and scrubland.

The replant lands in County Monaghan comprise a network of small-to-medium sized fields which are in agricultural pasture.

6.3.3 Superficial Geology

6.3.3.1 Mapped Soils & Subsoils

Based on the GSI/Teagasc soils mapping (www.gsi.ie) the project site is largely overlain by Cut Peat, with some basic shallow well-drained mineral soils (BminSW) located in the southeast of the project site at 2 no. proposed turbine locations (T7 and T8).

A small area of basic poorly drained mineral soil (BminPD) is mapped towards the centre of the project site along the N62. The grid connection route from the proposed project site pass through areas mapped predominantly as Cut Peat and BminSW. The mapped soil type at the N62/52 junction works along the haul route is Cut Peat.

GSI subsoils mapping (www.gsi.ie) show that the proposed project site is underlain predominantly by cutover raised peat (Cut) with Gravels derived from Limestones (GLs) mapped on the southeast and southwest of the project site and also underlying turbine locations T7 and T8. A small pocket of Till derived from Limestones (TLs) is mapped towards the centre of the proposed project site along the N62.

Gravels and eskers are mainly mapped along the grid connection route to the west of the project site. Esker ridges are mapped to coincide with the Gravel deposits at two locations along the proposed route. Area of Fen Peat are mapped in low-lying areas between the Esker ridges.

The proposed 110kV substation, BESS and control building location (grassland) are located where there is a mapped transition from peat (Cut) into Gravels. The subsoil type at the replanting lands is sandstone/shale tills.

A local subsoil geology map is shown in **Figure 6.1** below.

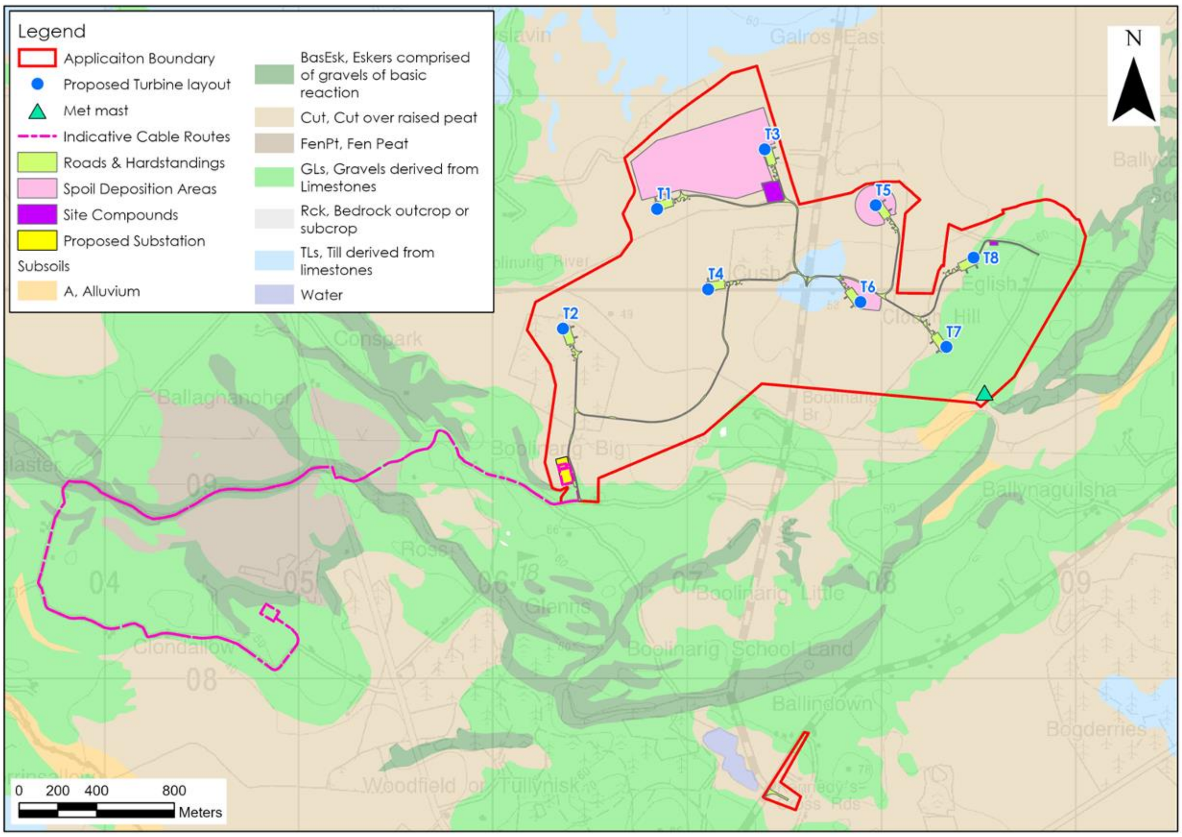

Figure 6.1: Local Subsoils Geology Mapping

6.3.3.2 Site Investigations

A total of 170 no. peat probes were carried out by FT at the project site between 26th and 28th September 2022.

Peat depths recorded from peat probing across the project site ranged from 0 to 5.0m with an average depth of 2.1m. Approximately 90 percent of peat depth probes recorded peat depths of less than 4.0m. A number of localised readings were recorded where peat depths were between 4.0 and 5.0m.

Peat depths recorded at the turbine locations varied from 0 to 4.3m with an average depth of 2.8m. Turbines T7 and T8 are the only turbines not located on cutover bogs, albeit shallow peaty soil (0.4m) was recorded at T8 (refer to **Table 6.5** below for summary peat depths).

With respect to the new proposed access roads, peat depths are typically less than 3.0m with localised depths of up to 5m recorded. The peat depths at spoil deposition area no. 1 ranged from 1 to 4m. Peat depths at the construction compounds ranged between 0 and 2m. No peat is present along the grid connection or at the proposed substation location.

Trial pits were excavated at all accessible turbine locations T1, T2, T3, T6, T7 and T8. Peat probes and soil gouge cores were carried out at inaccessible turbines T4 and T5 as an alternative to trial pits due to their location in forestry.

Table 6.5 includes a summary of peat depths and the mineral subsoil lithology. Trial pits and gouge core logs and photographs are provided at **Annex 6.2**.

The overburden geology profile at the turbine locations on bogs typically has the following sequence – peat, shell marl and lacustrine clay. The depth to the base of the lacustrine clay exceeds 5m (maximum depth of trial pit) at all turbine locations on bogs.

Subsoils at turbines T7 and T8 are glacial till dominated (i.e. SILT/CLAY and SAND/GRAVELS) as they are located outside of the cutover raised bog areas.

Mineral subsoils (SILT/CLAY) are present at the substation, BESS and control building location which is a grassland area.

Trial pit, peat probe and soil gouge core locations are illustrated in **Figure 6.2** below.

Location	Peat Depth Range (m)[1]	Depth to Base of Lac/Clay (m)	Summary of Subsoil Lithology
T1	1.5 – 3.3	>5	Shell MARL above lacustrine CLAY
T2	0.5 – 4	>5	Shell MARL above lacustrine CLAY
T3	2 – 3.8	>5	Shell MARL above lacustrine CLAY
T4	1 - 4.3	n/d	Shell MARL
T5	1.4 – 2.1	n/d	Shell MARL
T6	2 – 2.5	>5	Shell MARL above lacustrine CLAY
T7	0	>5	Gravelly SILT over lacustrine CLAY
T8	0.1 – 0.4	n/a	Silt over silt sandy GRAVEL
Substation	0	n/a	SILT/CLAY
Control Building	0	n/a	SILT/CLAY
Construction Compound 1	0 - 2	n/d	Shell MARL
Construction Compound 2	0 - 1	n/a	SILT/CLAY
Spoil Deposition Area 1	1 – 4.0	n/d	Shell MARL

n/d – Not determined as only the shell marl layer was confirmed by soil coring

n/a – Not applicable as no lacustrine clay layer present

Table 6.5: Summary of Trial Pit, Soil Probes & Gouge Core Investigations

Based on the criteria in **Table 6.1** above, local soils and subsoils are assessed to be of Low-to-Medium importance. This is largely due to the cutover and heavily drained nature of the peat bogs (Low) and the Medium importance of agricultural land.

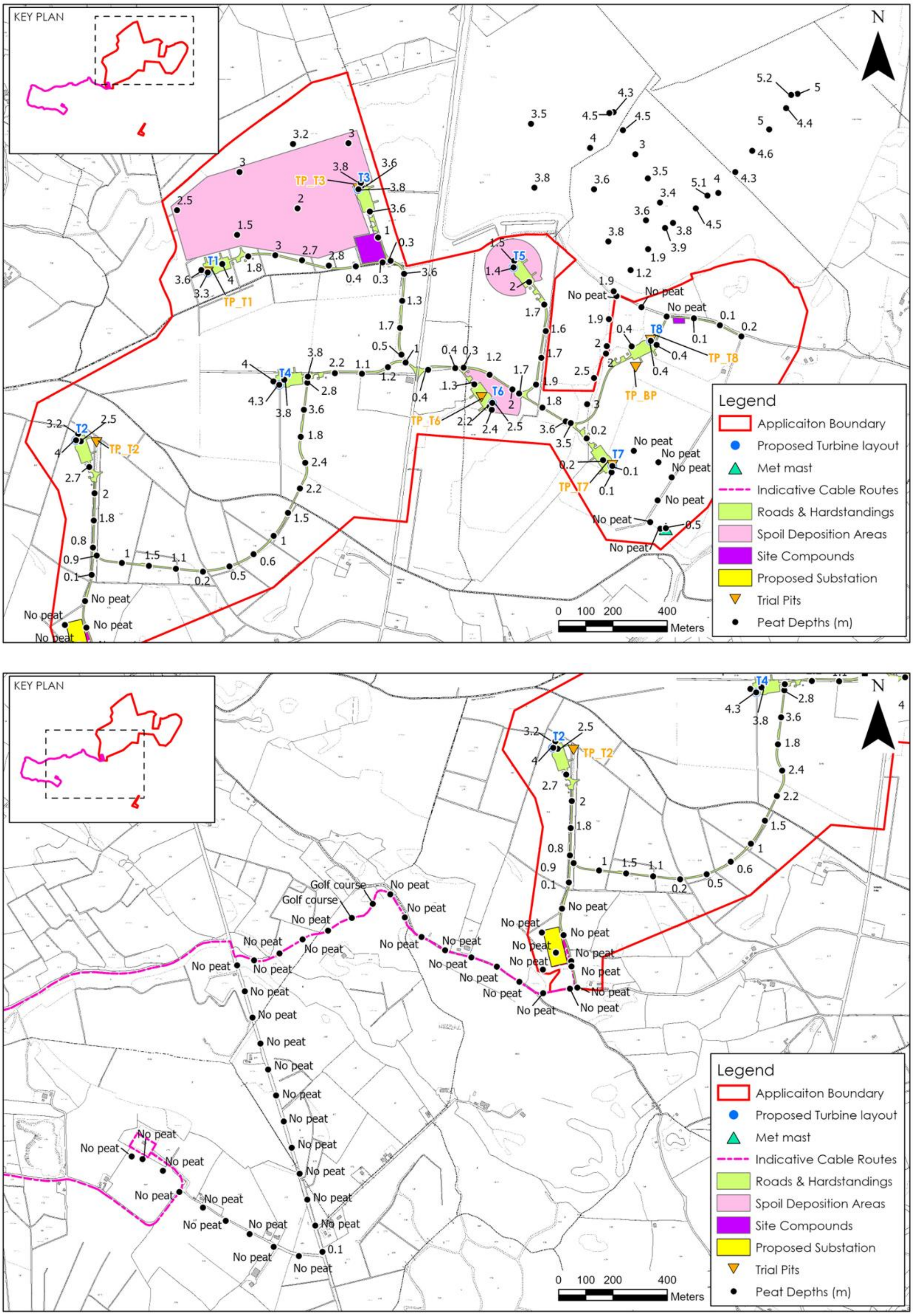

Figure 6.2: Site Investigation Maps

6.3.3.3 Soil Contamination

There are no known areas of soil contamination within the project site or in its immediate environs. During the site walkovers and intrusive site investigations, no areas of contamination concern were identified.

According to the EPA online mapping database (http://gis.epa.ie/Envision), there are no licensed waste facilities within or in the immediate environs of the project site.

There are no historic mines within or in the immediate vicinity of the project site which are likely to have contaminated tailings and could give rise to adverse environmental effects.

6.3.4 Bedrock Geology

Based on the GSI bedrock mapping (www.gsi.ie), Dinantian Pure Unbedded Limestones (Waulsortion Limestone) underlie the middle section of the proposed project site, Dinantian Lower Impure Limestones (Ballysteen Formation) are mapped on the west, while Dinantian Pure Bedded Limestones (Visean Limestones) are mapped on the far east of the proposed project site.

The Waulsortion Limestone are reported dominantly grey, crudely bedded or massive limestones. The Ballysteen Formation is described as dark muddy limestone and shale. The Visean Limestones are undifferentiated.

The grid connection route is mapped to be underlain by the Waulsortion Limestone and Ballysteen formation, with the latter also being mapped at the proposed 110kV substation, BESS and control building location.

The bedrock underlying the proposed project site is not exposed due to the presence of peat bogs and sand and gravel deposits. Also, bedrock was not encountered at any of the trial pit locations.

The Visean Limestones, which are mapped to underlie the far east of the project site, are potentially prone to karstification. The Visean Limestones do not underlie any of the proposed project infrastructure.

The Waulsortion Limestone and Ballysteen formation do not typically dispose themselves to significant karstification as they are generally impure or massive. The GSI do not map any karst features within the proposed project site, however a spring is mapped close to the south-eastern site boundary where Waulsortion Limestones are mapped.

A NW-SE orientated fault is mapped in the southwestern corner of the project site. However, this bedrock fault will have no consequence for the proposed project due to the shallow nature of the works.

Bedrock at the replant lands is mapped as Silurian metasediments and volcanics.

A bedrock geology map for the area is shown in **Figure 6.3** below.

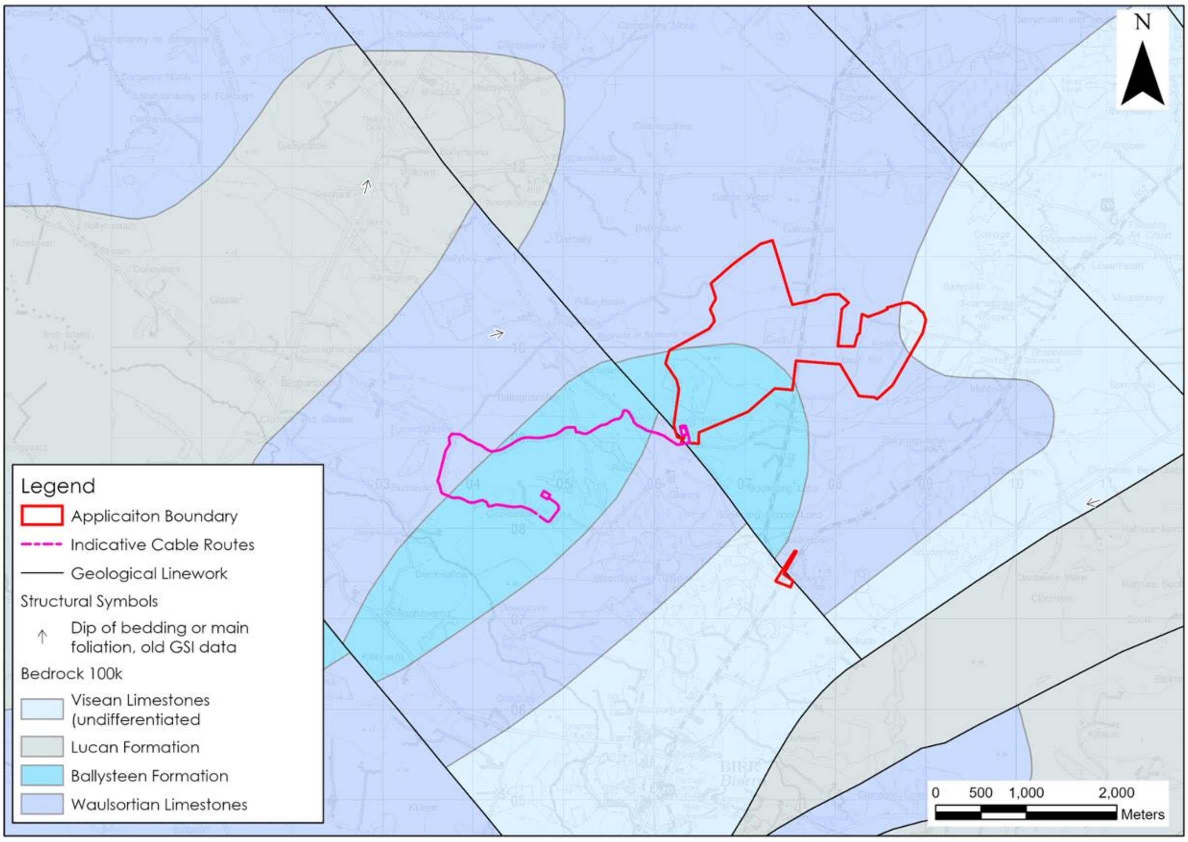

Figure 6.3: Local Bedrock Geology Mapping

6.3.5 Peat Stability Analysis Introduction

An analysis of peat stability was carried out at all the main infrastructure locations where peat was identified. The purpose of the analysis was to determine the Factor of Safety (FoS) of the peat slopes. The minimum required Factor of Safety (FoS) is 1.3 based on *BS6031:1981: Code of Practice for Earthworks* (BSI, 2009). The assigned probability of instability associated with a given FoS value is described in **Table 6.6** below. Hydrological and hydrogeological factors were also assessed in the Geotechnical and Peat Stability Assessment Report (**Annex 6.1**).

No peat failures/landslides are recorded at the project site which suggests that conditions do not pre-dispose themselves to failures/landslides. The flat topography/nature of the terrain on site reflects the low risk of peat failure.

The landslide susceptibility at the project site was classified by the GSI (2022) as low susceptibility, which is expected given the flat terrain present.

There is no peat present along the grid connection route and haul route work areas and therefore there was no requirement to carry out the detailed analysis as described below for the wind farm site.

The hand vane results indicate undrained shear strengths in the range 18 to 65kPa, with an average value of about 44kPa. The strengths recorded would be typical of well drained peat as is present on the Cush site.

The recorded undrained strength at the wind farm site is significantly greater than the lower bound values for Derrybrien Wind Farm, for example, indicating that there is no close correlation to the peat conditions at the Derrybrien Wind Farm site and that there is significantly less likelihood of failure on the project site[1].

Scale	Factor of Safety	Probability
1	1.30 or greater	Negligible/None
2	1.29 to 1.20	Unlikely
3	1.19 to 1.11	Likely
4	1.01 to 1.10	Probable
5	<1.0	Very Likely

Table 6.6: Probability Scale for Factor of Safety

6.3.6 Peat Stability Results

Stability of a peat slope is dependent on several factors. The main factors that influence peat stability are slope angle, shear strength of peat, depth of peat, pore water pressure and loading conditions.

An adverse combination of factors could potentially result in peat sliding. An adverse condition of one of the above-mentioned factors alone is unlikely to result in peat failure. The infinite slope model (Skempton and DeLory, 1957) is used to combine these factors to determine a factor of safety for peat sliding. This model is based on a translational slide, which is a reasonable representation of the dominant mode of movement for peat failures.

To assess the factor of safety for a peat slide, an undrained[2] (short-term stability) and drained (long-term stability) analysis has been undertaken to determine the stability of the peat slopes on site:-

- The undrained loading condition applies in the short-term during construction and until construction induced pore water pressures dissipate; and
- The drained loading condition applies in the long-term. The condition examines the effect of in particular, the change in groundwater level as a result of rainfall on the existing stability of the natural peat slopes.

A summary of the 'undrained analysis' is presented in **Table 6.7** and the 'drained analysis' in **Table 6.8**; while full results can be found in **Annex 6.1**.

In summary, the findings demonstrate that the project site has an acceptable margin of safety, is suitable for wind farm development and is considered to be at low risk of peat failure or ground instability. The findings include recommendations and control measures for construction work in peat lands to ensure that all works adhere to an acceptable standard of safety.

Infrastructure ID	Factor of Safety for Load Condition	
	Condition 1	Condition 2
T1	5.55	4.20
T2	5.06	3.91

[1] Derrybrien Wind Farm is located in County Galway and was the subject of a significant peat slide in 2003.
[2] For the stability analysis two load conditions were examined; namely, Condition 1: no surcharge loading, and Condition 2: surcharge of 10 kPa, equivalent to 1 m of stockpiled peat assumed as a worst case.

Infrastructure ID	Factor of Safety for Load Condition	
	Condition 1	Condition 2
T3	5.06	3.91
T4	4.65	3.66
T5	14.34	7.82
T6	5.22	3.59
T7	114.8	10.44
T8	28.86	4.81
Substation, BESS & Control Building	No Peat	
Construction Compound 1	16.28	5.16
Construction Compound 2	43.11	7.19
Met Mast	22.96	7.65
Spoil Deposition Area 1	4.59	3.28

Table 6.7: Factor of Safety Results (Undrained Condition)

Infrastructure ID	Factor of Safety for Load Condition	
	Condition 1	Condition 2
T1	17.05	16.15
T2	16.73	15.96
T3	16.73	15.96
T4	16.45	15.79
T5	22.91	18.57
T6	12.38	11.29
T7	85.43	15.86
T8	23.68	7.64
Substation, BESS & Control Building	No Peat	
Construction Compound 1	17.53	10.12
Construction Compound 2	70.70	22.91
Met Mast	24.2	14.0
Spoil Deposition Area 1	11.96	11.08

Table 6.8: Factor of Safety Results (Drained Condition)

6.3.7 Geological Resource Importance

According to the GSI natural resource mapping, the area of the proposed project has a very low to high crushed rock aggregate potential. The high potential area corresponds to the mapped extent of the Dinantian Pure Unbedded Limestones. Meanwhile, the majority of the project site has moderate potential with the southwest of the site mapped as having very low potential.

Those areas to the east and west of the proposed project site which are underlain by gravels have moderate to high potential for granular aggregates. The proposed 110kV sub-station location is mapped in an area of high potential. The granular aggregate potential along the grid route range from no potential to very high potential. The very high potential for granular aggregate corresponds to the mapped extent of the esker deposits.

Based on the criteria in **Table 6.1** and the GSI aggregate potential above, the local bedrock sand and gravels underlying the project site has a Low to High Importance.

6.3.8 Geological Heritage & Designated Sites

Kilcormac Esker Geological Heritage Area (GHA) (Site Code: OY018), which forms part of the much larger Killimor-Birr-Fivealley-Kilcormac Esker System, is mapped to the southeast and southwest of the proposed project site. This GHA is described as a good example of a deglacial, meltwater-deposited complex. Refer to **Figure 6.4** below.

In terms of the project infrastructure, the proposed grid connection route intercepts the Kilcormac Esker for approximately 1.5km, but the route is along a public road at this location. Therefore, effects on the Kilcormac Esker have been scoped out for further assessment.

Further afield, Annagh Mushroom Rock (Site code: TY001) and the Little Brosna Callows (Site Code: TY046) are located approximately 4km west of the proposed project site.

Based on the criteria in **Table 6.1** above, geological heritage sites have a High Importance.

Designated sites include Natural Heritage Areas (NHAs), proposed Natural Heritage Areas (pNHAs), candidate Special Areas of Conservation (cSAC), Special Areas of Conservation (SAC) and Special Protection Areas (SPAs). There are no designated sites within the project site or adjacent to it, which can be directly affected (from a land, soil and geology perspective) by the construction, operation or decommissioning of the project.

Designated sites in close proximity to the proposed project site and grid connection include Woodville Woods pNHA (Site Code: 000927), Ross and Glens Eskers pNHA and Ridge Road, SW of Rapemills SAC/pNHA (Site Code:000919). The temporary junction works at the N52/N62 are located close to the Woodville Woods pNHA.

The proposed grid connection runs adjacent to Ridge Road, SW of Rapemills SAC for approximately 1km where it follows the public road. Ridge Road, SW of Rapemills SAC consists of steep-sided, twin esker ridges formed from glacial gravels.

Further details of the assessment of potential hydrological effects on downstream designated sites, including the River Shannon Calllows SAC, can be found in **Chapter 7**. Based on the criteria in **Table 6.1** above, designated sites have a Very High Importance.

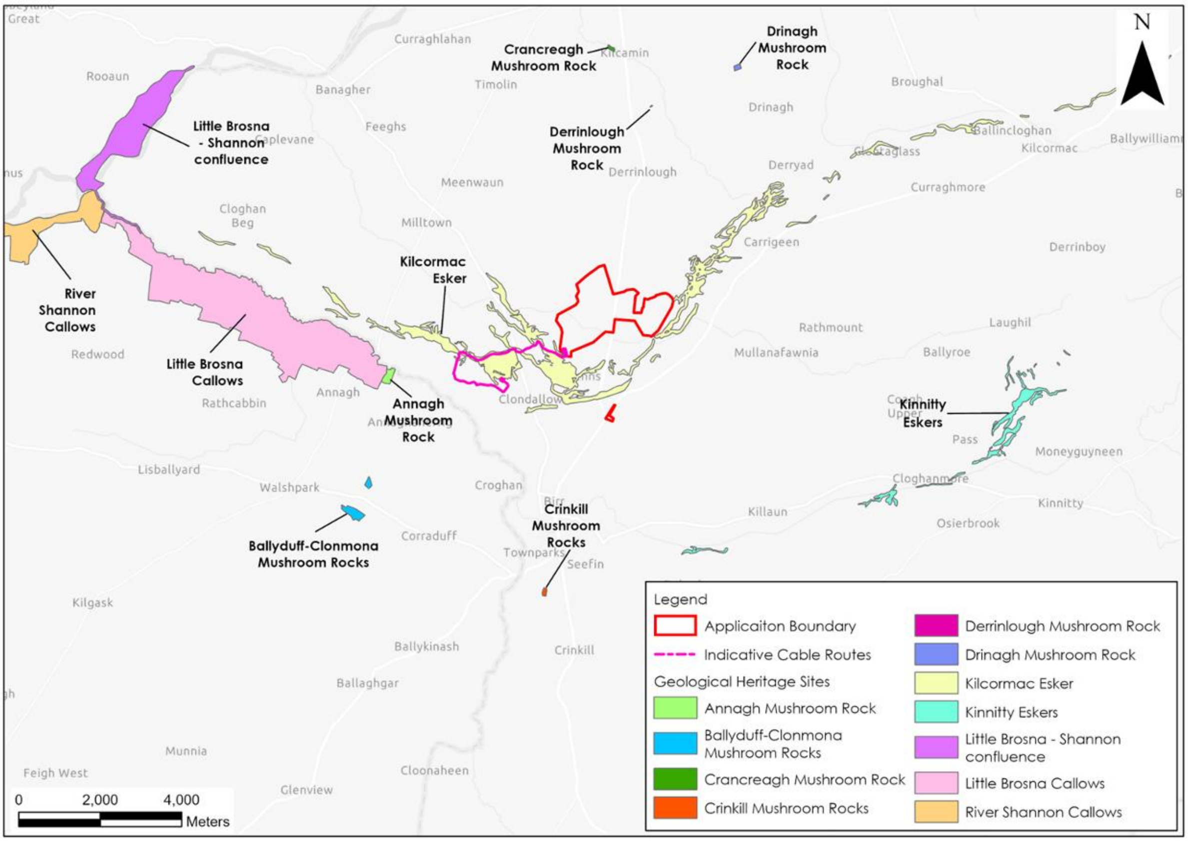

Figure 6.4: Designated Sites & Geological Heritage Sites

6.4 Assessment of Likely Effects

6.4.1 Characteristics of the Project

The project will typically involve the removal of peat, soil, subsoil and possibly bedrock (if foundation piling is required) to facilitate the emplacement of access tracks, turbine foundations, crane hardstands, substation and control building area foundations, meteorological mast foundation, and underground electrical cabling.

The turbine foundations will either be gravity design or piled foundation depending on more detailed site investigations. The excavations volumes calculated in **Table 6.9** below assume a gravity design as this is the worst case scenario because excavation volumes and spoil volumes will be higher.

Gravity foundations depths are expected to be between 3m and 5m deep, depending on ground conditions at each turbine location, with an approximate diameter of 22m. For the piled turbine foundations, a typical piling type and configuration could be up to 16 no. 900mm rotary bored piles down to suitable weight bearing substrate. The turbine hardstands will require to be founded on competent material underlying the peat deposits.

Floating access roads are the predominant road construction type proposed for the project site which given the ground conditions and type of terrain present is deemed an appropriate construction approach. Where shallow peat is present (<1m), excavate and replace (founded) type construction.

Overburden/spoil will be utilised for reinstatement of excavated areas etc. and for landscaping purposes. Excess material, or material which cannot be used for reinstatement, will be stored, permanently, at 3 no. dedicated spoil deposition areas or, where appropriate, will be spread across areas where felling has occurred.

The designated 3 no. spoil deposition areas can accommodate up to c. 86,500m^3 of material. It is proposed the stored spoil will be spread at shallow depths (up to a maximum depth of 310mm) across the dedicated areas to avoid potential stability issues.

To maintain the geological integrity of the project site, it is proposed that generated spoil will firstly be deposited locally to its point of origin or at a location of similar geological characteristics.

Following the completion of the spoil deposition process, the dedicated spoil storage areas also be graded to match existing profiles and reseeded.

It is, therefore, predicted that all spoil generated, which is suitable for storage via this method, will be stored permanently within the project site. However, certain materials (e.g. tarmac/road cuttings from haul route works and grid connection works) will be removed from site and disposed of at a licensed waste facility. As waste license permits are subject to renewal, it is not currently possible to confirm the precise location for the disposal of excess spoil; however, having reviewed the National Waste Collection Permit Office (NWCPO) database, there are a number of facilities within County Offaly which currently accept soil, rock and other materials arising from construction projects.

The trench, within which the underground electricity line (grid connection) will be placed, will be typically 0.6m wide by 1.2m deep. The trench will be located predominately within the carriageway of public roads. It is predicted that c. 9,528m^3 of spoil will be generated during trench excavation with the majority being removed and stored at the permanent spoil deposition areas. It is estimated that only c. 146m^3 will be re-used in the reinstatement process. The trench will be backfilled and reinstated to the required specifications, and finished as appropriate to the satisfaction of the respective landowners or local authority.

The haul route works will largely involve road furniture alteration, however temporary hedgerow removal will be required for a turning area at the N52/N62 junction.

The forestry replanting will be carried out by hand or by using light machinery. Therefore, due to the very minor and localised nature of the groundworks associated with the haul route and replanting works, they have been scoped out from further assessment.

Estimated volumes of spoil (including topsoil, subsoil, peat, and tar) to be removed for each element of the proposal are indicated in **Table 6.9**, **Table 6.10** and **Table 6.11** below.

Please refer to the Spoil and Peat Management Plan (**Annex 3.4**) prepared by Galetech Energy Services for further details on the management and storage of spoil.

Project Item	Total Excavated Material (m³)	Peat for Spoil Deposition Areas (m³)	Peat for use in Reinstatement/Landscaping (m³)	Topsoil & Subsoil for Spoil Deposition Areas (m³)	Topsoil & Subsoil for use in Reinstatement/ Landscaping (m³)
8 no. turbines (Access, hardstand, and foundation)	91,189	52,205	27,800	6,495	4,689
Access tracks & entrances	2,293	0	0	0	2,293
Construction Compounds 2 no.	900	0	0	700	200
Control Building	160	0	0	160	0
Meteorologic-al Mast	60	30	0	30	0
Drainage	8,700	8,700	0	0	0
Underground Cables	8,678	4,339	0	0	4,339
Totals	**111,980**	**65,274**	**27,800**	**7,385**	**11,521**

Table 6.9: Summary of Estimated Excavation Volumes at Project site

Project Item	Total Excavated Material (m³)	Peat for Spoil Deposition Areas (m³)	Peat for use in Reinstatement/Landscaping (m³)	Topsoil & Subsoil for Spoil Deposition Areas (m³)	Topsoil & Subsoil for use in Reinstatement / Landscaping (m³)	Tar
Substation Compound	6,708	0	0	4,238	2,471	0
Grid Connection	9,528	0	0	8,835	146	547

Table 6.10: Estimated Spoil Volumes at Electrical Substation & Grid Connection Route

Project Item	Total Excavated Material (m³)	Peat for Spoil Deposition Areas (m³)	Peat for use in Reinstatement/Landscaping (m³)	Topsoil & Subsoil for Spoil Deposition Areas (m³)	Topsoil & Subsoil for use in Reinstatement/ Landscaping (m³)	Tar
Alteration Works	1,599	0	0	0	1,593	6

Table 6.11: Estimated Spoil Volumes at Haul Route Alteration Locations

6.4.2 'Do-Nothing' Impact

In the event that the project is not progressed, existing land uses will continue and there will be no alteration to the land, soil or geological environment.

6.4.3 Construction Phase

6.4.3.1 Soil, Subsoil & Bedrock Excavation

The excavation of peat, soil, subsoil and possibly bedrock (where present) will be required for all groundworks; including site levelling, the installation of infrastructure (e.g. turbine foundations, substation foundation, hardstands and electrical cabling) and for access track formation and will, therefore, give rise to direct effects on these receptors. The excavation of soils and subsoils will also be required along the grid connection route; while minor levels of excavation are predicted at haul route works locations.

Bedrock is likely only to be encountered if piling is carried out, as evidenced by the results of the preliminary site investigations undertaken.

Due to the shallow nature of the works along the grid connection (c. 1.2m) and the fact the cable will largely be placed within the carriageway of public roads effects on soils, subsoil and bedrock will not likely be significant.

These works will result in a direct, permanent loss of soil, subsoil and bedrock at excavated locations. The estimated excavation volumes are detailed in **Table 6.9** above.

The overall effect is determined not to be significant due to the following:-

- The peat, soils and subsoils and bedrock at the project site are generally classified as 'low to medium' importance;
- A minimal volume of peat, soil, subsoil and bedrock; in comparison to the total resource present on the site; will be removed to allow for the construction of the project;
- The peat, soil, subsoil, and bedrock which will be removed during the construction phase will be localised to the footprint of infrastructure only; and,
- No turbines or related infrastructure will be constructed within or near any designated sites for the protection of ecological features or geological heritage.

The excavation and relocation of material is an inevitable part of the project and no mitigation is required. The excavation of materials will be completed in accordance with best practice for the management and treatment of such materials. The overall effect of the excavation of peat, soil, subsoil and bedrock is summarised in **Table 6.12** below.

Attribute	Description
Receptor	Peat, soils, subsoils and bedrock
Pathway/Mechanism	Excavations
Overall Effect	Negative, direct, moderate, likely, permanent effect on peat, soil, subsoil and bedrock

Table 6.12: Peat, Soil & Subsoil Excavation Effect

6.4.3.2 Erosion of Exposed Peat, Soil & Subsoil at Excavation & Storage Areas

The exposure of peat, soil and subsoils at locations of excavation and of spoil storage can increase the likelihood of soil erosion resulting in a direct physical effect on land and soil. However, given the small footprint of the proposed excavation (including the haul route temporary alteration works, grid connection works, and forestry replanting) and spoil storage areas in the context of the overall project site, the pre-mitigation effect will not be significant.

The pre-mitigation effects of peat, soil and subsoil erosion are summarised in **Table 6.13** below.

Attribute	Description
Receptor	Peat, Soils and subsoils
Pathway/Mechanism	Vehicle movement, surface water erosion, and wind action.
Pre-Mitigation Effect	Negative, direct, slight, likely effect on peat, soil and subsoils.

Table 6.13: Peat, Soil & Subsoil Erosion Effect

6.4.3.3 Contamination of Peat, Soils & Subsoils by Leakages or Spillages of Hydrocarbons or Other Chemicals

The contamination of peat, soils and subsoils presents a direct effect on the geology of the project site. Accidental spillage during refuelling of construction plant with petroleum hydrocarbons is a pollution risk. The accumulation of small spills of fuels and lubricants during routine plant use can also be a significant pollution risk. Hydrocarbon has a high toxicity to humans and all flora and fauna, including fish, and is persistent in the environment. Large spills or leaks are likely to result in significant effects (i.e. contamination of soils and subsoil on the geological environment. The likely pre-mitigation effect is assessed to be not significant due to the relatively low volumes of fuels/chemicals that will be kept on-site (including along the grid connection route and forestry replant lands) at any one time.

The pre-mitigation effect of soil contamination is summarised in **Table 6.14** below.

Attribute	Description
Receptor	Peat, soil and subsoils
Pathway	Peat, soil and subsoil pore space.
Pre-Mitigation Effect	Negative, direct, moderate, short-term, likely effect on, peat, soils and subsoils.

Table 6.14: Peat, Soil & Subsoil Contamination Effect

6.4.3.4 Effects on Land & Land Use

The total permanent development footprint amounts to c. 8.65ha.

The construction of the project will result in the land use change of c. 1.8ha of agricultural land, 1.6ha of cutover bogs and c. 23ha of forestry. The change of land use of c. 1.8ha of agricultural land is not significant as it constitutes a very small area of the overall project site and will not materially affect land use within the project site. Existing agricultural operations can readily co-exist and there will be no perceptible effect on these activities.

The construction of the project will result in the felling of c. 23ha of existing forestry. This amounts to c. 17% of the existing forestry currently present at the site (i.e. 135ha).

This forestry will be felled to accommodate the construction of the project (i.e. physical placement of infrastructure) and to facilitate its effective and efficient operation of this infrastructure (i.e. wind turbines). It is not, therefore, proposed to replace this forestry on-site but to replant same (like for like) off-site.

The replanting of forestry is subject to a separate licensing and consenting process which incorporates an environmental assessment of the subject replant lands. While it is not possible, at this point, to specify a particular parcel of land where replanting will take place; a parcel of land has been identified in County Monaghan where replanting is likely to be undertaken (see **Chapter 3**).

Given the relatively small area of the wind farm site which will be subject to felling (c. 6%) and, separately, planting; the methodologies involved in the felling and replanting processes; and the characteristics of the replant lands; it is assessed that there will be no likely significant effect on land or on land-use.

It is similarly assessed that, through adherence to best practice techniques and methodologies, and the appropriate implementation of environmental control measures where necessary, during the felling and replanting activities; significant adverse effects on soils are unlikely to arise.

The presence of the grid connection will not, being entirely sub-surface, result in any alteration to land or land-use. Similarly, the characteristics of the temporary haul route alteration works will not result in any effect on land or land-use.

The pre-mitigation effect on land and land-use is summarised in **Table 6.15** below.

Attribute	Description
Receptor	Land & Land Use
Pathway	Excavation and infrastructure construction
Pre-Mitigation Effect	Negative, slight, direct, likely, permanent effect on land and land use.

Table 6.15: Land & Land Use Effect

6.4.3.5 Peat Instability & Failure

A peat stability risk assessment was carried out for the main infrastructure elements at the wind farm. This approach takes into account guidelines for geotechnical/peat stability risk assessments as given in PLHRA (2017) and MacCulloch (2005).

Peat instability or failure refers to a significant mass movement of a body of peat that would have an adverse impact on the proposed wind farm development and the surrounding environment. The potential significant effects of peat failure at the study area may result in:

- Death or injury to site personnel;

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

However, the findings of the peat assessment, which involved analysis of 170 no. locations, showed that the project development areas have an acceptable margin of safety and that the site is suitable for the project. Notwithstanding the above, the management of peat stability and appropriate construction practices will be inherent in the construction phase to ensure peat failures do not occur on site.

The pre-mitigation effect on land and land-use is summarised in **Table 6.16** below.

Attribute	Description
Receptor	Peat Stability
Pathway	Excavation and infrastructure construction
Pre-Mitigation Effect	Negative, moderate, direct, unlikely effect on peat stability

Table 6.16: Peat Stability & Failure

6.4.4 Operation Phase

Following the completion of the construction phase, including the appropriate reinstatement and landscaping of the project site which will avoid the likelihood of erosion effects, very few (if any) effects on land and soils are likely during the operational phase of the project. These may include:-

- Minor accidental leaks or spills of fuel/oil from vehicles associated with the occasional maintenance of the wind farm; and,
- The transformer in the substation and transformers in each turbine will be oil-cooled. There is a risk of spills/leaks of oils from this equipment resulting in contamination of soils.

6.4.5 Decommissioning Phase

The likely effects associated with decommissioning of the project will be similar to those associated with construction but of a substantially reduced magnitude (i.e. imperceptible to slight). Activities which are likely to affect land & soil include the removal and reinstatement of turbine hardstand areas and access tracks (where not retained); while some sub-surface elements will be left *in situ* to reduce effects.

6.4.6 Assessment of Cumulative Effects

The land and soil impact assessment concludes that, in relation to the wind farm development, significant effects are unlikely to arise predominately due to the localised and near surface nature of the construction works and the absence of likely significant effects during the operation and decommissioning phases.

Similarly, and given the small construction footprint and shallow earthworks proposed at the electricity substation and grid connection infrastructure; it is assessed that significant cumulative effects on land, soils and geology are unlikely to arise in-combination with the wind farm as a result of this secondary/off-site development and any effects are assessed to be not significant. It is also assessed that other secondary/off-site works; including haul route temporary alteration works and forestry replanting; are unlikely to be of a sufficient scale such that significant effects could occur in cumulation with the wind farm and grid connection. Overall, therefore, it is assessed that there is no likelihood of the overall project giving rise to likely significant effects on land & soil.

Given that all likely effects relating to the project are assessed to be direct, contained within the immediate vicinity of the project, and unlikely to extend beyond the project site; it is assessed that there is no pathway for the project to act in combination with other existing, permitted and proposed developments.

All known existing, permitted and proposed developments (as listed in **Chapter 1**) in the vicinity of the project have been assessed to determine the likelihood of cumulative effects arising. The majority of other developments are assessed to be of an insufficient scale such that significant cumulative effects could not arise or there is a substantial separation distances between the respective projects and, therefore, an absence of connectivity.

6.4.7 Assessment of Likely Health Effects

The possibility of health effects, albeit unlikely, arises mainly from the potential for soil and ground contamination during construction. A type of development, such as the project proposed, is not a recognised source of land or soil pollution and therefore the potential for effects during the construction, operational or decommissioning phases is unlikely.

Hydrocarbons will be used onsite during construction; however, the volumes will be small and will be handled and stored in accordance with best practice mitigation measures. As a result, it is assessed that the likely residual effects associated with soil or ground contamination and subsequent health effects will be imperceptible.

6.4.8 Risk of Major Accidents & Disasters

Due to the nature of the project site, i.e. soft peat deposits, there is a risk of peat movement occurring. However, due to the flat nature of the site, the risk is low.

A comprehensive peat stability risk assessment (FT, 2023) has been undertaken for all proposed infrastructure locations, and it concludes that with the implementation of the proposed control (mitigation) measures. The residual risk of a landslide occurring is determined to be negligible/none.

6.5 Mitigation & Monitoring

6.5.1 Construction Phase

6.5.1.1 Peat, Soil, Subsoil & Bedrock Excavation

The excavation of peat, soil, subsoil and bedrock will have a direct effect on the geological environment and no specific mitigation measures are proposed. The excavation and long term storage of materials will be completed in accordance with best practice for the management and treatment of such materials.

6.5.1.2 Erosion of Exposed Peat, Soil & Subsoil at Excavation & Storage Areas

The following avoidance and design measures are proposed to reduce erosion effects at excavation and spoil storage areas:-

- Mats will be used, as necessary, to support construction plant and machinery on soft ground, thus reducing the likelihood of soil and subsoil erosion and avoiding the formation of rutted areas. This will substantially reduce the likelihood for surface water ponding to occur;
- Excavated material will be side cast and stored temporarily adjacent to excavation areas for use during reinstatement and landscaping. Where material is not required for reinstatement or landscaping, it shall be immediately transported to the spoil deposition areas;
- Silt fences, and all necessary surface water management measures (including upslope interceptor drains), will be installed around all temporary stockpiles to limit movement of entrained sediment in surface water runoff. All slopes will be sealed with the bucket of an excavator;
- In order to minimise erosion during the construction phase, works will not take place during periods of intense or prolonged rainfall (to prevent increased silt laden runoff). Drainage systems, as outlined in **Chapter 7**, will be implemented to limit runoff effects during the construction phase;
- At the designated spoil deposition areas, material will be placed in layers to ensure stability is maintained and works will be undertaken in accordance with best practice construction methodologies. Works at the spoil deposition areas will be monitored, on a weekly basis during the construction phase and monthly for a 6 no. month period thereafter, by an appropriately qualified Geotechnical Engineer. In the event that any ground stability issues arise, the Engineer will have the power to cease works until such time as remedial works have been completed to his/her satisfaction;
- Permanently mounded spoil; for example, berms surrounding turbines and hardstands, berms located along access tracks and at the spoil deposition areas; will be seeded and grassed over at the earliest opportunity to prevent erosion; and,
- The electricity line (grid connection) trench will be reinstated to the required specification and in accordance with landowner requirements and will be reseeded or allowed to vegetate naturally (on agricultural land) or topped with tarmacadam (or similar along public roads) at the earliest opportunity to prevent erosion.

6.5.1.3 Contamination of Soils & Subsoils by Leakages, Spillages of Hydrocarbons or Other Chemicals

The following measures are proposed to specifically prevent contamination of soils and subsoils:-

- The volume of fuels or oils stored on site will be minimised. All fuel and oil will be stored in an appropriately bunded area within the temporary construction compound. Only an appropriate volume of fuel will be stored at any given time. The bunded area will be roofed to avoid the ingress of rainfall and will be fitted with a storm drainage system and an appropriate oil interceptor;
- All bunded areas will have 110% capacity of the volume to be stored;
- On site re-fuelling of 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 at the temporary compound and will be towed around the site by a 4x4 jeep to where plant and machinery is located. The 4x4 jeep will also be fully stocked with 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. Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations to avoid any accidental leakages;

- All plant and machinery used during construction will be regularly inspected for leaks and fitness for purpose;
- Spill kits will be available to deal with any accidental spillages within the temporary construction compound and during re-fuelling;
- All waste tar material arising from road cuttings (from trenching in public roads and haul route temporary alteration works) will be removed off-site and disposed of at a licensed waste facility. Due to the potential for contamination of soils and subsoils, it is not proposed to utilise this material for any reinstatement works or to store it within the spoil deposition areas; and
- An emergency plan for the construction phase to deal with accidental spillages is contained within the Planning-Stage Construction and Environmental Management Plan (**Annex 3.4**). This emergency plan will be further developed by the contractor prior to the commencement of construction.

6.5.1.4 Land & Land Use

The change in land use of 1.8ha agricultural land within the project site is minimal (0.6% coverage at the site) and therefore the effects of are assessed to be not significant. The change in land use away from agricultural production is assessed to be an acceptable part of the project and therefore no mitigation is proposed.

23ha of forestry will be felled to accommodate wind farm infrastructure. However, all tree coverage felled will be replaced at a replanting site which will be subject to technical approval through a separate consenting process. No specific measures, other than best-practice felling and replanting methodologies are proposed and the efficacy and appropriateness of these measures will be assessed, separately, through the felling and replanting licensing process. However, subject to the adherence to standard methodologies, no significant effects are assessed as likely.

Approximately 1.6ha of cutover bog surface will be developed on, however given the already cutover, drained and degraded nature of the bog surface at the project development areas, the effects are considered to be imperceptible.

Silt fencing be installed around the area of levelled soil while it naturally revegetated to prevent soil loss into the drains.

6.5.1.5 Peat Stability & Failure

Firstly, the key mitigation with regard peat stability risk at the project site was the carrying out of a robust, multidisciplinary site investigation and peat stability risk assessment carried out in accordance with best practice guidance (PLHRAG, Scottish Government, 2017).

The findings of the peat assessment, which involved analysis of 170 no. locations, showed that the proposed development areas have an acceptable margin of safety and that the site is suitable for the proposed wind farm development.

The peat stability risk assessment report provides a number of mitigation/control measures to reduce the potential risk of peat failure at each infrastructure location. Sections of access roads to the nearest infrastructure element will be subject to the same mitigation/control measures that apply to the nearest infrastructure element. The required mitigation/control measures are shown below:

The following control measures incorporated into the construction phase of the project will ensure the management of the risks for this site:

- Appointment of experienced and competent contractors;
- The site will be supervised by experienced and qualified personnel;
- Allocate sufficient time for the project (be aware that decreasing the construction time has the potential to increase the risk of initiating a localised peat movement);
- Prevent undercutting of slopes and unsupported excavations;
- Maintain a managed robust drainage system;
- Prevent placement of loads/overburden on marginal ground;
- Implementation of safety buffers around deep peat areas;
- Adhere to the spoil and peat storage restriction areas detailed in the Geotechnical and Peat Stability Risk Assessment (GDG, 2023);
- Set up, maintain and report findings from monitoring systems as outlined in the Geotechnical and Peat Stability Assessment (FT, 2023);
- Ensure construction method statements are developed and agreed before commencement of construction and are followed by the contractor; and,
- Revise and amend the Construction Risk Register as construction progresses to ensure that risks are managed and controlled for the duration of construction.

6.5.2 Operational Phase

Following the completion of construction activities and the reseeding of exposed soil as a result of excavations and spoil storage, it is assessed that due to the absence of likely soil erosion effects, no mitigation measures are required.

Oil used in transformers (at the substation and within each turbine) and storage of oils at the substation could leak during the operational phase and result in effects on soil and subsoils. The substation transformer and oil storage tanks will be located in a roofed concrete bund capable of holding 110% of the stored oil volume. Turbine transformers will be located within the turbines, and any leaks will be fully contained within the turbine thus eliminating any pathway for leakages to affect land and soil.

6.5.3 Decommissioning Phase

During decommissioning, it may be possible to reverse or at least reduce some of the likely effects caused during construction by rehabilitating construction areas such as turbine foundations and hardstanding areas. This will be done by removing wind farm infrastructure and restoring disturbed ground with previously excavated material where possible.

Other effects such as possible soil compaction and any contamination by fuel leaks will remain but will be of a substantially reduced magnitude. However, as noted in the Scottish Natural Heritage report (SNH) *Research and Guidance on Restoration and Decommissioning of Onshore Wind Farms* (SNH, 2013) reinstatement proposals for a wind farm are made approximately 30-years in advance and within the lifespan of the wind farm, technological advances and preferred approaches to reinstatement are likely to change. According to the SNH guidance, it is therefore:-

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

Mitigation measures applied during decommissioning activities will be similar to those applied during construction where relevant. Some of the effects will be avoided by retaining some elements of the project in place where appropriate; for example, access tracks within the site may be retained for agricultural and forestry uses. Mitigation measures, to avoid contamination by accidental fuel leakage and compaction of soil by on-site plant and machinery, will be implemented as per the construction phase mitigation measures.

No significant effects on the land, soils and geology environment are likely during the decommissioning stage of the project.

6.5.4 Monitoring Measures

There is no proposed monitoring programme for land and soils. However, during and post-construction all excavated or raised areas (i.e. cut and fill) and reinstated/landscaped ground, including the spoil deposition areas, will be inspected for signs of erosion and instability by the Geotechnical Engineer appointed by the Developer. These inspections will be undertaken on a weekly basis during the construction phase and monthly, for a six-month period, post-construction.

6.6 Residual Effects

6.6.1 Construction Phase

The loss of land/land-use from agricultural production, and the excavation and relocation of soil, subsoil and bedrock is an inevitable part of the development works and therefore no mitigation measures, other than standard construction best practices, are proposed. As a result, the likely residual effect with respect to soil, subsoil, and bedrock excavation and loss of land/land use is assessed to be the same as the pre-mitigation effects, which is Slight.

The residual effects with respect to soil/subsoil erosion and contamination effects are assessed to be imperceptible.

A detailed geotechnical and peat stability assessment (FT, 2023) has been completed for the development proposal. The findings of that assessment have demonstrated that there is a low risk of peat failure at the site as a result of the proposed project. With the implementation of the control measures outlined above the residual effect is negative, imperceptible, direct, permanent, unlikely effect on peat stability.

6.6.2 Operational Phase

No significant residual effects are assessed as likely to occur during the operational phase.

6.6.3 Decommissioning Phase

No significant residual effects are assessed as likely to occur during the decommissioning phase.

6.7 Summary

Excavations will be required for site levelling and for the installation of turbine foundations, crane hardstands, access tracks, electrical cabling, electricity substation and grid connection infrastructure. This will result in the permanent removal of soil, subsoil and bedrock (where present) at excavation locations. Excavated soil and subsoil will be used for reinstatement and landscaping, where appropriate; while excavated bedrock will be used in the construction of crane hardstandings and access tracks (where possible); and where excess material arises, this will be disposed of at the dedicated spoil disposal areas.

Due to the geographically spread out and transient nature of the grid connection works and haul route temporary alteration works, these are not anticipated to result in a likely cumulative effect with the wind farm development. Furthermore, all other existing, permitted and proposed developments in the vicinity of the project have been assessed to determine their likelihood to act cumulatively with the project; however, it is concluded that there is no likelihood of significant cumulative impacts.

In conclusion, this assessment has determined that the project (including grid connection, haul route works and forestry replanting), will not result in any likely significant effects on land, soils and the geological environment. Where effects are likely to occur, such as soil erosion or contamination, the implementation of best-practice construction techniques and appropriate mitigation measures will ensure that any residual effects are imperceptible. Where it is not possible to implement mitigation measures, such as in respect of the direct excavation of soil and subsoil, the level of effect is considered to be slight and will not likely be significant.