8.0 LAND, SOILS AND GEOLOGY

8.1 Introduction

This chapter of the EIAR assesses the effects of the proposed Castlebanny Wind Farm project as described in Chapter 2 (Description of the Proposed Development) on the land, soil and geological environment. Information on the existing soil and geological environment is presented as a baseline for the site. The potential effects of the development of the proposed wind farm and associated infrastructure are discussed along with recommended mitigation measures for each potential effect. Any residual and cumulative effects are also assessed.

8.1.1 Statement of Authority

TOBIN Consulting Engineers (TOBIN) have completed this chapter. TOBIN Hydrologists and Hydrogeologists are intimately familiar with the site characteristics for the Castlebanny Wind Farm, having worked on other wind farms including Lisheen, Bruckana and Derryadd set in various ground conditions and water environments. This chapter has been completed by John Dillon and Michelle Wong of TOBIN Consulting Engineers.

John Dillon (BSc., MSc., DIC, MCIWM, PGeo) is a hydrogeologist with 18 years' geological/hydrogeological experience in groundwater development, windfarm and major infrastructure developments. John has authored numerous Land, Soils and Geology chapters for EIARs for a range of projects.

Michelle Wong (BSc., MSc., EurGeol, PGeo) is a hydrogeologist with over 10 years' experience in both the public and private sectors. Michelle has a strong background in groundwater resource assessment and hydrogeological/ hydrological investigations in relation to developments such as quarries, utilities and wind farms. Michelle has authored numerous Land, Soils and Geology chapters for EIARs for a range of projects.

8.2 Methodology

The methodology used to produce this chapter included completing a desk study, site walkover, intrusive investigation in the form of trial pits, boreholes, and gouge augers, and non-intrusive investigation in the form of 2D geophysical resistivity testing.

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

- Examination of the Geological Survey of Ireland (GSI) datasets pertaining to geological and extractive industry data;
- Examination of Environmental Protection Agency (EPA) soil and subsoils datasets;
- Examination of National Parks and Wildlife Service (NPWS) nature conservation designations;
- Preparation of site maps and suitable field sheets for the site survey.

Site surveys relating to the land, soil and geological environment were undertaken over several days between February 2020 and August 2020. The site surveys included:

- A site walkover to review the ground conditions and assess the topography, geomorphology and requirements for further investigations;
- A trial pit located at or as close as possible to each proposed turbine location;
- Trial pits at each borrow pit;
- Trial pits at each potential substation;
- A trial pit at the grid connection;
- Laboratory tests on the material encountered in the trial pits;
- Logging of the soil layers;
- Sampling of each strata encountered;
- Laboratory analyses of the samples collected;
- Boreholes; and,
- 2D electrical resistivity testing.

The information obtained is referenced throughout Section 8.3. Following the desk top study and the site survey, geological maps were generated in GIS and are included in Figure 8-1 to Figure 8-4. Photographs of the trial pits are included in the Ground investigation report included within Appendix 8-1.

8.2.1 Relevant Guidance

This chapter has been prepared having regard to the following guidelines:

- Draft Guidelines on the Information to be contained in Environmental Impact Assessment Reports (Environmental Protection Agency, 2017);
- Revised Guidelines on the Information to be Contained in Environmental Impact Statements (Environmental Protection Agency, draft September 2015);
- Advice Notes for Preparing Environmental Impact Statements (Draft September 2015);
- Guidelines on the Information to be contained in Environmental Impact Statements (EPA 2002);
- Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (EPA 2003);
- Geology in Environmental Impact Statements – a Guide (Institute of Geologists of Ireland (IGI) 2002);
- Groundwater Directives (80/68/EEC) and (2006/118/EC);
- Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment Text with EEA relevance;
- Environmental Impact Assessment of National Road Schemes – A Practical Guide (NRA 2008a);
- Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (NRA 2008b);
- Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements (IGI 2013);
- Good practice guidelines on the control of water pollution from construction sites (Construction Industry Research and Information Association (CIRIA 2001);
- Guidelines for Planning Authorities on 'The Planning System and Flood Risk; Management' published in November 2009, jointly by the Office of Public Works (OPW) and the then Department of Environment, Heritage and Local Government (DEHLG);
- Guideline on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (NRA 2008c); and

- Peat Landslide Hazard and Risk Assessments, Best Practice Guide for Proposed Electricity Generation Developments, Natural Scotland Scottish Executive, 2nd Ed, 2017.

8.2.2 Consultation

As part of the study, TOBIN consulted with the following parties:

- Geological Survey of Ireland for details on background mapping and geological heritage; and
- Environmental Protection Agency.

8.2.3 Public information sources

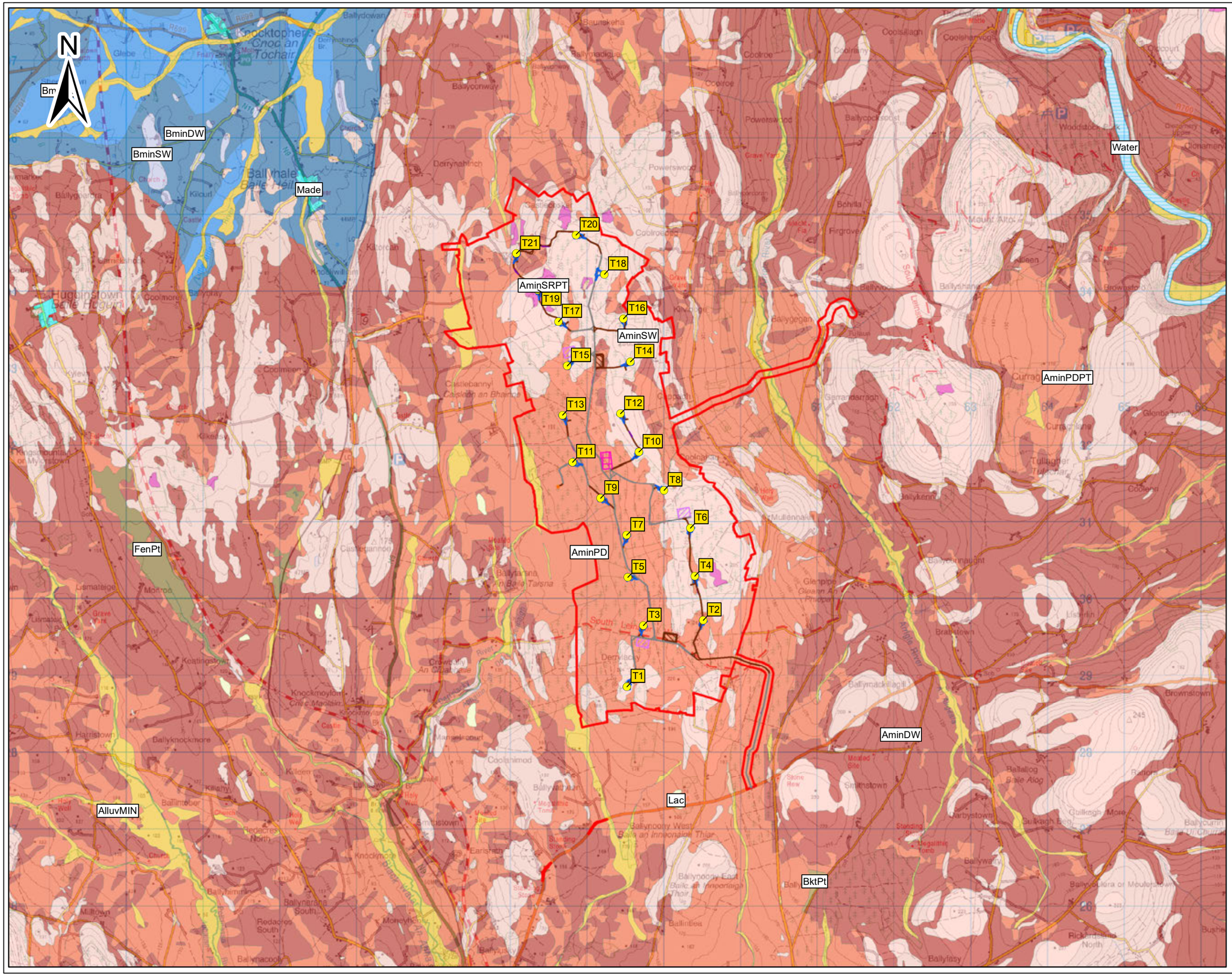
- Published geological, soil, groundwater, surface water, aquifer, recharge data obtained from the Geological Survey of Ireland (GSI);
- National Parks and Wildlife Service data of designated conservation areas;
- Waste and IPPC licensed facility data from EPA Geoportal;
- Irish Geological heritage site map from the GSI (www.gsi.ie);
- EPA online Envision Map Viewer (www.epa.ie);
- Flood history of site from OPW National Flood Hazard Mapping website (www.floodmaps.ie);
- Catchment flood risk assessment & management study (http://www.cfram.ie/pfra/); and,
- Aerial Photography from ESRI (ArcGIS).

8.3 Existing Environment

The existing environment is discussed in terms of geomorphology (landscape and topography), superficial, solid geology, and peat stability. The regional review of geological conditions covers a zone of 2 km from the site boundary, as suggested in the Institute of Geologists of Ireland (IGI) guidelines. The chapter also considers the turbine delivery route works and grid connection as described in Chapter 2 (Description of the Proposed Development).

8.3.1 Study Area

The study area for the purposes of the Soils and Geology chapter is shown in Figure 1-1 of this EIAR. The proposed wind farm site (as shown in Figure 1-2 of this EIAR) is located within an agricultural and forested landscape, between Mullinavat, Inistioge and Ballyhale, in Co. Kilkenny. The site of the proposed wind farm extends to approximately 1,434 ha, the majority (approximately 1,200 ha) of which is commercial forest owned by Coillte, while the remaining areas are third-party lands and comprise a mix of agricultural grassland, arable crops and forestry. Coillte forestry within the site comprises different stages of coniferous plantation forestry. The Arrigle River runs south-north to the east of the site area and the Derrylacky River runs to the west of the site. There are a number of residential properties near the boundary of the site. The entire proposed project is described in detail in Chapter 2 (Description of the Proposed Development) of this EIAR.



Legend

- Site Boundary
- Turbine Locations
- AminDW
- AminPD
- AminPDPT
- AminSW
- AminSRPT
- BminDW
- BminPD
- BminSW
- BktPt
- FenPt
- AlluvMIN
- Lac
- Made
- Water

Site Layout

- Borrow Pit Locations
- Compound 1
- Compound 2
- Improved Forest Roads
- Passing Bay
- Roads Proposed
- Substation
- Turbine Hardstand
- Wheelwash

Issue	Date	Description	By	Chkd.
D01	12/11/2020	Draft Issue	F.H.	M.W.

0 0.5 1
Kilometres

Client: COILLTE

Project: Castlebanny Wind Farm

Title: Regional Soils Map

Scale @ A3: 1:45,000

Prepared by:	Checked:	Date:
F. Healy	M.Wong	November 2020

Project Director: J.Staunton

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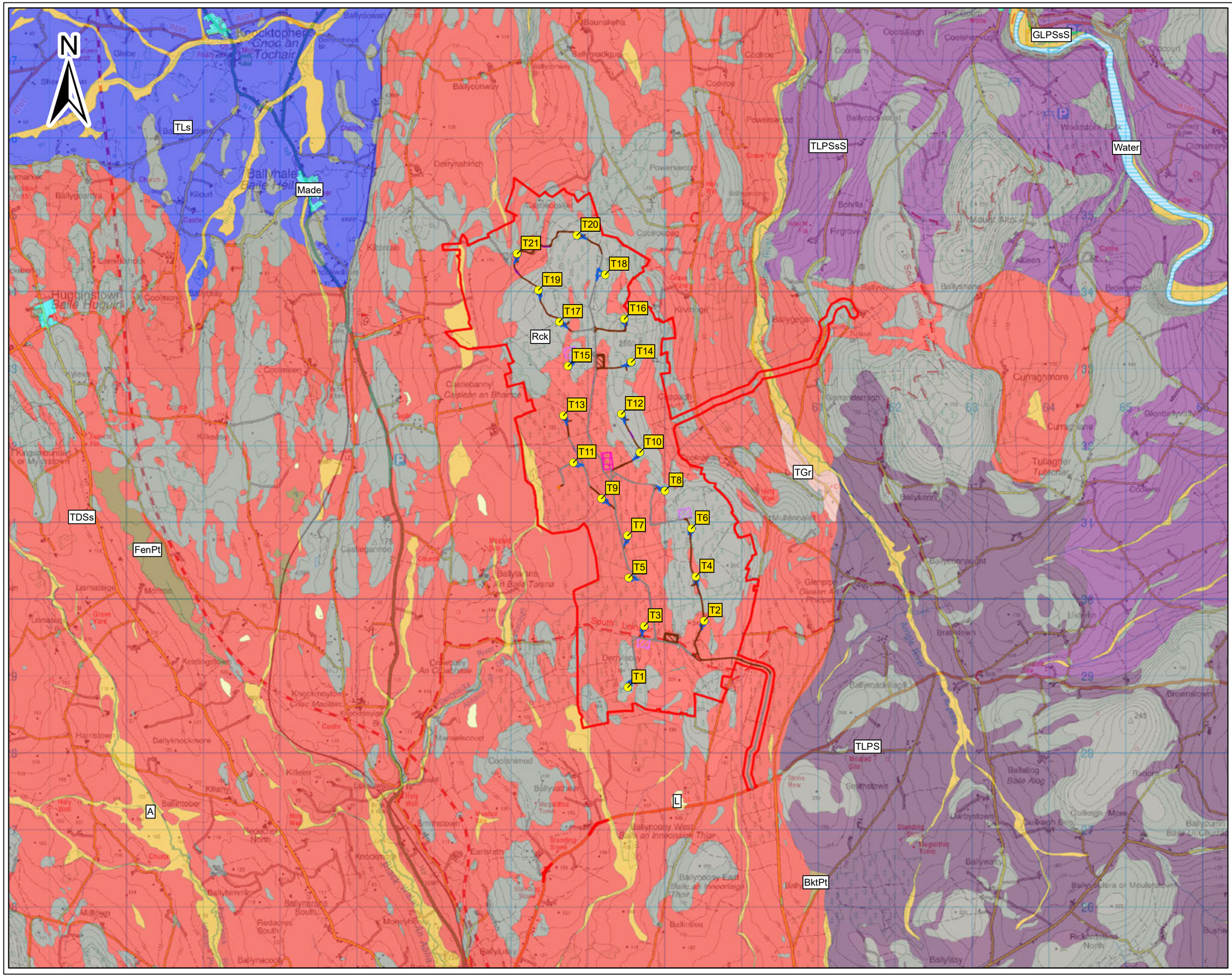
TOBIN CONSULTING ENGINEERS

Drawing No.: Figure 8.1

Draft: D01



Legend

- Site Boundary
- Turbine Locations
- TLPS
- TLPSsS
- TDSs
- TLs
- TGr
- GLPSsS
- L
- A
- BktPt
- FenPt
- Made
- Rck
- Water

Site Layout

- Borrow Pit Locations
- Compound 1
- Compound 2
- Improved Forest Roads
- Passing Bay
- Roads Proposed
- Substation
- Turbine Hardstand
- Wheelwash

Issue	Date	Description	By	Chkd.
D01	12/11/2020	Draft Issue	F.H.	M.W.

0 0.5 1
Kilometres

Client: COILLTE

Project: Castlebanny Wind Farm

Title: Regional Subsoils Map

Scale @ A3: 1:45,000

Prepared by:	Checked:	Date:
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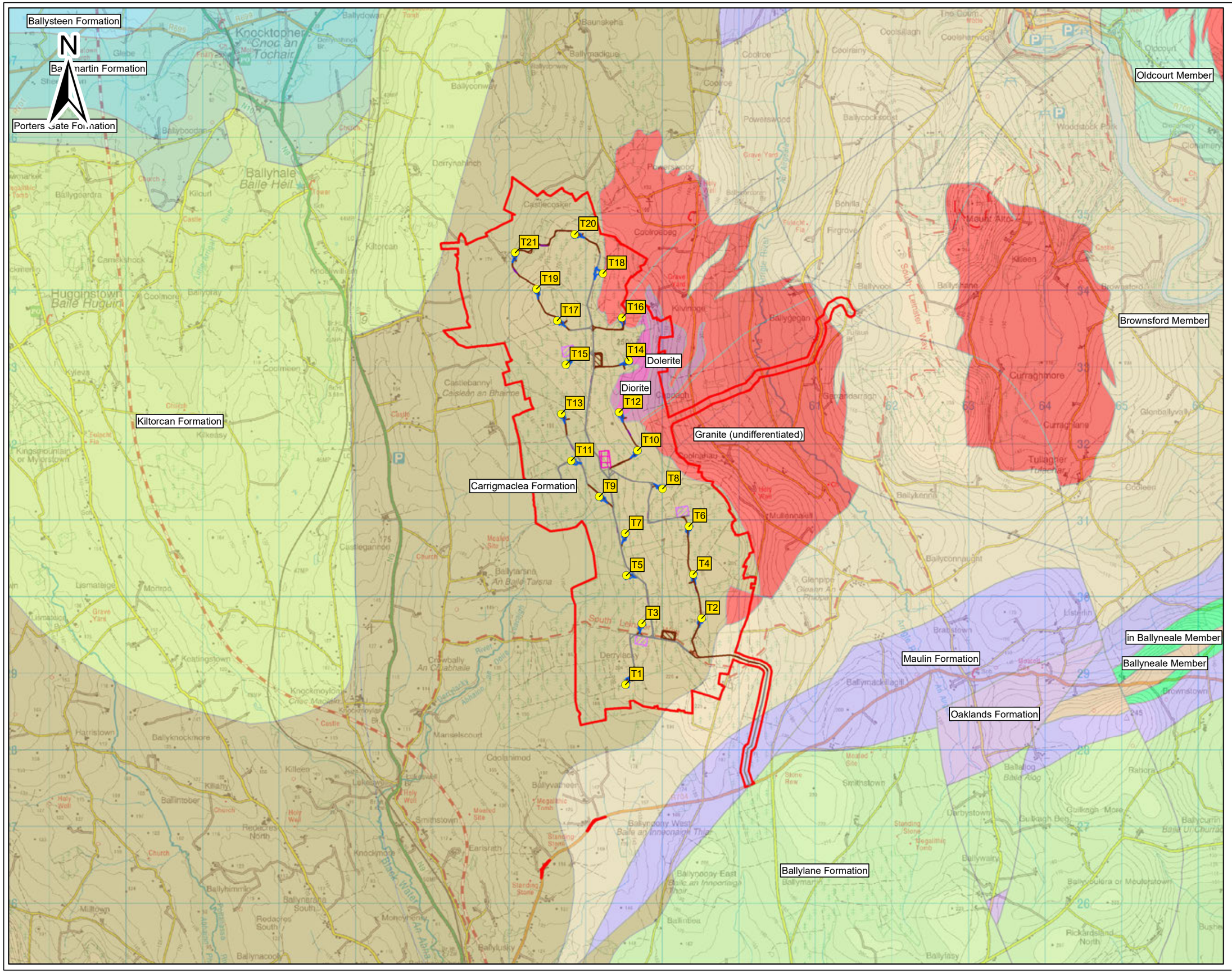
Drawing No.: Figure 8.2

Draft: D01



Legend

- Site Boundary
- Turbine Locations

Site Layout

- Borrow Pit Locations
- Compound 1
- Compound 2
- Improved Forest Roads
- Passing Bay
- Roads Proposed
- Substation
- Turbine Hardstand
- Wheelwash

Bedrock

- Ballysteen Formation
- Ballymartin Formation
- Porters Gate Formation
- Carrigmaclea Formation
- Kiltorcan Formation
- Dolerite
- Diorite
- Granite (undifferentiated)
- Ballylane Formation
- Oaklands Formation
- Maulin Formation
- Oldcourt Member
- Brownsford Member
- Ballyneale Member
- in Ballyneale Member

Issue	Date	Description	By	Chkd.
D01	12/11/2020	Draft Issue	F.H.	M.W.

0 0.5 1
Kilometres

Client: COILLTE

Project: Castlebanny Wind Farm

Title: Regional Bedrock Map

Scale @ A3: 1:45,000

Prepared by:	Checked:	Date:
F. Healy	M.Wong	November 2020

Project Director: J.Staunton

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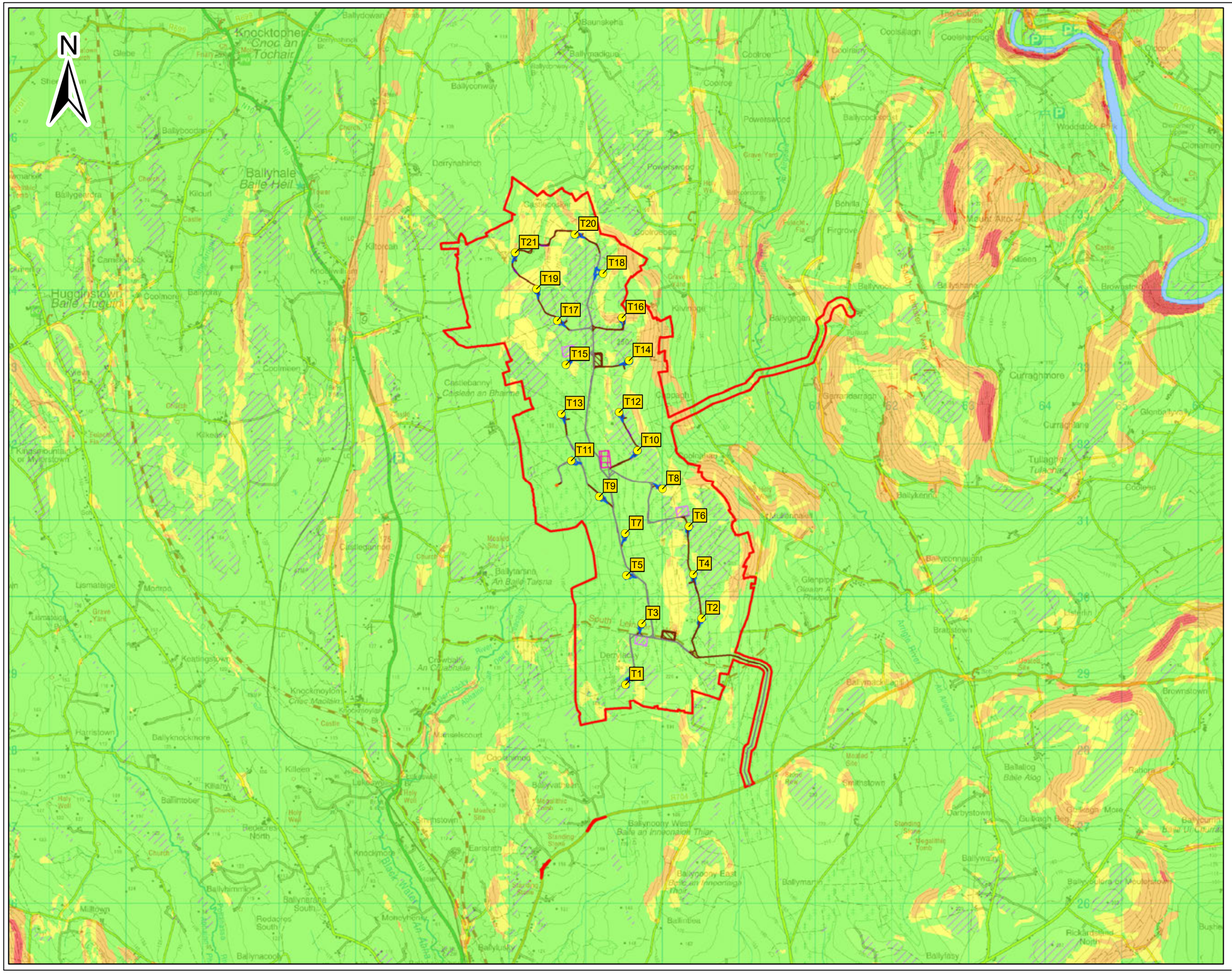
Drawing No.: Figure 8.3

Draft: D01



Legend

- Site Boundary
- Turbine Locations

Site Layout

- Borrow Pit Locations
- Compound 1
- Compound 2
- Improved Forest Roads
- Passing Bay
- Roads Proposed
- Substation
- Turbine Hardstand
- Wheelwash

Landslide Susceptibility

- Low
- Low (inferred)
- Moderately Low
- Moderately High
- High
- Water

Landslide Events were considered in the creation of this map. However, none appear within the visible area.

Issue	Date	Description	By	Chkd.
D01	12/11/2020	Draft Issue	F.H.	M.W.

0 0.5 1
Kilometres

Client: COILLTE

Project: Castlebanny Wind Farm

Title: Landslide Susceptibility Map

Scale @ A3: 1:45,000

Prepared by:	Checked:	Date:
F. Healy	M.Wong	November 2020

Project Director: J.Staunton

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TOBIN CONSULTING ENGINEERS

Drawing No.: Figure 8.4

Draft: D01

8.3.2 Site Topography and Geomorphology

The topography of the site can be described as gently sloping, rising from c. 145 mAOD to a high point of 250 mAOD in the north and 265 mAOD in the south. The proposed grid connection route drops to as low as c. 65 mAOD at one point. The site consists largely of resistant Devonian sandstone forming the higher ground with the eastern boundary tapering to lower elevations.

The GSI indicate glacial landforms orientated north-south across the site, subglacial streamlined bedrock further supported by glacial striae at St. Mullin's Cave, Co. Kilkenny. The nearby Arrigle River is a mapped meltwater channel. Two commissioned wind farms are located south/ southeast of the site, namely the Ballymartin and Rahora Windfarms.

8.3.3 Land Use

The overall wind farm site measures c. 1,434 ha and is predominantly covered in forestry plantation with agricultural land to the north of the site and forming the site boundaries. Forestry is comprised predominantly of coniferous with some broadleaf areas. Approximately 1,200 ha are in Coillte's ownership whilst the remaining comprise third-party owned areas of agricultural grassland, arable crops and commercial forest. There is an extensive network of existing internal access roads across the site to facilitate the ongoing forestry operations as well as local access to farmlands. The wind farm site is characterised by locally steep topography between 145 m and 265 m above ordnance datum (AOD). The grid connection is through forestry and agricultural lands. The TDR is along the main national and regional roads as shown on Figure 2-1.

8.3.4 Regional Soils

The regional soils in this area, including the northern part of the TDR and grid connection, are shown in Figure 8-1. Based on mapping by the Environmental Protection Agency (EPA) this indicates that this site consists of 6 no. types of soil, namely:

- AlluvMIN - Mineral alluvium;
- AminPD - Mineral poorly drained (Mainly acidic);
- AminSW - Shallow well drained mineral (Mainly acidic);
- AminSRPT - Shallow, rocky, peaty/non-peaty mineral complexes (Mainly acidic);
- AminDW - Deep well drained mineral (Mainly acidic); and,
- Lac – Lucustrine-type soils.

The southern TDR locations, as mapped by the EPA indicate the following types of soil along the route:

- AlluvMIN - Alluvial (mineral)
- AminPD - Mineral poorly drained (Mainly acidic);
- AminDW - Deep well drained mineral (Mainly acidic);
- AminSW – Shallow well drained mineral (mainly acidic);
- Lac – Lucustrine type soils;
- BminSW - Shallow well drained mineral (Mainly basic);
- Cut- Cutover/cutaway peat; and,
- Made – Made ground.

Made Ground is encountered in urban areas. Alluvium deposits are encountered along the waterways.

8.3.5 Local Soils

The EPA databases indicate that the proposed windfarm project including site entrance and TDR is generally underlain by tills derived from mainly non-calcareous parent materials. The till, which is Quaternary in age, formed as an extensive envelope of the landscape in the area since deglaciation approximately 7,000 – 10,000 years ago. The bedrock outcrop or subcrop forms 40 to 50% of the windfarm project area.

8.3.6 Regional Subsoils

Figure 8-2 shows the regional subsoils in this area, including the northern part of the TDR and grid connection. The dominant subsoil occurring in the region is classified as till. The 4 no. subsoil types are characterised as follows:

- Alluvium (A);
- Bedrock outcrop or subcrop (Rck);
- Lacustrine sediments (L); and
- Till derived from Devonian sandstones (TDSs).

Bodies of till derived from sandstones are present across the project area. The bodies of till are related to the last deglaciation discussed previously in Section 8.3.2. Alluvium is also mapped within the study area and site boundary.

Based on mapping prepared by the EPA the southern portion of the TDR consists of the following soil types.:

- Made ground (Made);
- Alluvium (A);
- Cut over raised peat (cut);
- Lacustrine sediments (L);
- Bedrock outcrop or subcrop (Rck);
- Till derived from Devonian sandstones (TDSs); and
- Till derived from Lower Palaeozoic shales (TLPS).

8.3.7 Regional Bedrock

The bedrock geology on the 1:100 000 scale mapping from the GSI indicate that this site is characterised by 12 geological formations. The regional bedrock geology covering the windfarm, the northern part of the TDR and grid connection is shown in Figure 8-3 and a description of each formation is presented in Table 8-1.

The proposed TDR is underlain by a number of formations (marked with an asterisk) as described in Table 8-1.

The proposed grid connection is predominantly underlain by the Carrigmaclea Formation, Ballymartin Formation, Porters Gate Formation, Ross Member, Maulin Formation, Ballylane Formation and Ballysteen Formation.

Table 8-1: Regional Bedrock Geology Description

Formation (Era)	Description
Granite (Caledonian)	Granite - undifferentiated
Carrigmaclea Formation (Devonian)	Conglomerate and sandstone
Brownsford Member (Ordovician)*	Dark grey semi-pelitic, psammitic schist
Kiltorcan Formation (Devonian)*	Yellow & red sandstone & green mudstone
Dolerite (Tertiary)	Basalt & gabbro
Diorite (Caledonian)	Diorite
Ballymartin Formation (Carboniferous)*	Limestone & dark-grey calcareous shale
Porters Gate Formation (Carboniferous)*	Sandstone, shale & thin limestone
Ross Member (Ordovician)*	Dark grey slate with thin siltstone
Maulin Formation *	Dark blue-grey slate, phyllite & schist
Ballylane Formation (Ordovician)*	Green & grey slate with thin siltstone
Ballysteen Formation (Carboniferous)*	Dark muddy limestone, shale
Campile Formation (Ordovician)*	Rhyolitic volcanics
Waulsortian Limestones (Carboniferous)*	Massive unbedded lime-mudstone
Bullockpark Bay Member (Carboniferous)*	Oolitic limestone

* Outside wind farm site boundary

Figure 8-3 shows the local bedrock geology. The formations in the area are highlighted in Table 8-1 above.

The underlying bedrock for each proposed turbine location is presented in Table 8-2. This table shows three types of bedrock formation underlying the proposed turbine locations.

Table 8-2: Underlying bedrock formation for each proposed turbine location

Turbine Location	Bedrock Formation
1-11, 13, 15, 17, 19-21	Carrigmaclea Formation: Red, brown conglomerate & sandstone
12 and 14	Diorite
16 and 18	Granite (Undifferentiated)

8.3.8 Borehole Information

The GSI database contain records of verified borehole logs, groundwater wells and springs within and close to the development area. All of these boreholes are located within 1km of the development area. The information provided by the logs is limited as the logs were primarily used to determine rock head level. The findings of these logs are summarised in Table 8-3.

Table 8-3: GSI database groundwater and wells within 1km of site boundary

ID Borehole	Irish Grid Eastings	Irish Grid Northings	Usage	Depth to bedrock (m)	Yield (m^3/d)
2613SWW063	260310	131060	Agriculture & Domestic	1.2	n/a
2613SWW064	261150	130410	Unknown	9.1	n/a
2613SWW065	261160	130390	Unknown	7.3	n/a
2613SWW067	261520	130220	Agriculture & Domestic	2.1	4.4
2311NEW031	259820	128930	Unknown	1.5	n/a
2313SEW138	259610	131430	Unknown	3.0	n/a
2313SEW137	259590	131790	Unknown	2.0	n/a
2313SEW098	255680	135380	Industry	0.0	n/a
2313SEW099	255830	135570	Agriculture & Domestic	1.2	39.3
2313SEW100	258810	135240	Agriculture & Domestic	2.0	n/a

2313SEW101	258890	135260	Public Supply	3.0	n/a
2313SEW102	259440	135420	Unknown	n/a	32.7
2313SEW132	255510	132610	Agriculture & Domestic	3.0	5.5
2313SEW133	256160	130570	Agriculture & Domestic	1.0	65.5
2613SWW110	261300	131020	Unknown	11.9	n/a
2613SWW111	261370	130960	Unknown	7.6	n/a
2313SEW136	256840	132210	Unknown	12.0	n/a
2313SEW134	256620	130290	Agriculture & Domestic	4.0	n/a
2313SEW135	256780	130060	Agriculture & Domestic	12.0	n/a
2611NWW002	261270	129760	Agriculture & Domestic	19.8	32.7
2611NWW003	261290	129780	Agriculture & Domestic	3.7	32.7
2311NEW058	257820	126460	Agriculture & Domestic	11.6	21.8
1714-07	261299	130999	Unknown	11.9	n/a
1714-08	261349	130949	Unknown	7.6	n/a
1714-19	261049	130549	Unknown	9.1	n/a
1714-20	260999	130499	Unknown	7.3	n/a

8.3.9 Ground Investigation

An initial ground investigation (GI) of the development area was carried out in January and February 2020. All works were completed using Ground Investigation Ireland (GII) plant and logging was completed by GII engineering geologist. The following scope was completed as a part of the GI:

- 36 No. trial pits were carried out at each proposed turbine location, grid connection, substations and at the 2No. identified borrow pit locations;
- 4 No. Rotary core boreholes completed to a maximum depth of 20.2 mbgl at 2 No. Borrow Pits and 2 No. Arrigle River locations;
- 3 No. groundwater monitoring wells were installed; and
- Geotechnical laboratory testing.

The GI indicated that the site is generally covered by organic and gravelly clay, overlying sand and gravel which overlie weathered shale bedrock. No evidence of peat was encountered at any of the GI locations. Some shallow peaty soil and peat (<0.5m) occurs on site but has been avoided

by the proposed development. Locations of the trial pits are shown within the ground investigation report, presented in Appendix 8-1.

8.3.9.1 Trial Pit Summary

A summary of the ground conditions encountered during the ground investigation carried out as part of this report is given in Table 8-4. Turbine, substation, grid connection and borrow pit locations were investigated during this phase of GI. Where access was not possible, trial pits were undertaken as close as possible to the proposed location. In addition, sites were accessed on foot and probes were used to establish that no peat was present at these locations.

The purpose of trial pitting is to allow recovery of large bulk samples of soil and where visual examination of the strata is required. Although the method is relatively quick, a disadvantage is the level of surface disturbance. Trial pits are usually carried out when the ground is able to stand temporarily unsupported. Where water is present in the excavation, problems may be encountered due to instability of side walls. The unsupported sides of a trial pit can collapse. Soils on site are shallow, with the competent rock providing good bearing capacity.

The collapse of a trial pit is likely given the unsupported excavation and if the subsoils and sediment show no cohesive properties or it is saturated, however the collapse is very localised to the pit itself and does not have a bearing on the ground stability or suitability for windfarm infrastructure. Trial pitting facilitates a wide variety of in-situ tests such as plate load tests, particle size distribution and California Bearing Ratio (CBR) tests which inform accurate geotechnical information used for interpretation of soil properties and mechanics. All geotechnical laboratory testing has been included in Appendix 8-1.

Table 8-4: Ground profile for each turbine location and associated infrastructure

Turbine (Trial Pit No.)	Ground profile	Comments
Turbine 1 **(TP01)**	**0.00 – 0.50m**: Brown silty Topsoil **0.50 – 0.60m**: Grey/ pink clayey Gravel of shale	Trial pit stable, no groundwater encountered. Trial pit terminated on rock.
Turbine 2 **(TP02)**	**0.00 – 0.25m**: Brown organic Topsoil **0.25 – 0.75m**: Soft grey silty Clay **0.75 – 2.30m**: Pink clayey gravelly SAND **2.30 – 2.90m**: Purple sandy gravelly CLAY **2.90 – 3.00m**: SHALE	Trial pit collapse from 0.75 mBGL due to presence of sands (non-cohesive material) in trial pit. Groundwater encountered at 1.90 mBGL as moderate ingress. Trial pit terminated on rock.
Turbine 3 **(TP03)**	**0.00 – 0.30m**: Brown silty Topsoil **0.30 – 1.30m**: Soft grey mottled gravelly SILT	Trial pit collapse from 1.00 mBGL. No groundwater encountered. Trial pit terminated due to constant collapse.

Turbine (Trial Pit No.)	Ground profile	Comments
	1.30 – 2.70m: Soft grey/brown sandy gravelly SILT with occasional cobbles **2.70 – 3.00m**: Soft grey sandy gravelly SILT with occasional cobbles	
Turbine 4 **(TP04)**	**0.00 – 0.20m**: Brown silty Topsoil **0.20 – 0.60m**: Firm greyish sandy gravelly CLAY **0.60 – 0.65m**: SHALE	Trial pit stable, no groundwater encountered. Trial pit terminated on rock.
Turbine 5 **(TP05)**	**0.00 – 0.30m**: Brown silty Topsoil **0.30 – 1.30m**: Stiff grey gravelly clayey SILT with occasional cobbles **1.30 – 2.00m**: Soft pink sandy gravelly CLAY with occasional cobbles **2.00 – 2.65m**: Soft pink sandy gravelly CLAY with cobbles **2.65 – 2.70m**: SHALE	Trial pit collapse from 1.30 mBGL. Groundwater encountered at 1.30 mBGL as slow seepage. Trial pit terminated on rock.
Turbine 6 **(TP06)**	**0.00 – 0.45m**: Brown gravelly Topsoil **0.45 – 0.55m**: Grey/ pink clayey GRAVEL of shale	Trial pit stable, no groundwater encountered. Trial pit terminated on rock.
Turbine 7 **(TP07)**	**0.00 – 0.70m**: Brown clay Topsoil **0.70 – 1.20m**: Soft white sandy gravelly SILT with occasional cobbles **1.20 – 2.30m**: Soft pink sandy gravelly CLAY with occasional cobbles **2.30 – 4.20m**: Soft to firm brown sandy gravelly CLAY with occasional cobbles and boulders **4.20 – 4.30m**: Grey/ pink clayey GRAVEL of shale	Trial pit collapse from 0.70 mBGL. Groundwater encountered at 1.20 mBGL as slow seepage. Trial pit terminated on rock.
Turbine 8 **(TP08)**	**0.00 – 0.90m**: Brown gravelly Topsoil **0.90 – 1.00m**: Grey/ pink GRAVEL of shale	Trial pit stable, no groundwater encountered. Trial pit terminated on rock.

Turbine (Trial Pit No.)	Ground profile	Comments
Turbine 9 **(TP09)**	**0.00 – 0.20m**: Brown gravelly Topsoil **0.20 – 1.50m**: Soft to firm brown sandy gravelly SILT with occasional cobbles **1.50 – 1.90m**: Soft to firm pink sandy gravelly CLAY with occasional cobbles **1.90 – 2.00m**: Grey/ pink clayey GRAVEL with cobbles and boulders of shale	Trial pit collapse from 0.70 mBGL. Groundwater encountered at 0.60 mBGL as fast ingress. Trial pit terminated on rock.
Turbine 10 **(TP10)**	**0.00 – 0.20m**: Brown gravelly clay Topsoil **0.20 – 0.70m**: Grey/ brown clayey GRAVEL with occasional cobbles and boulders of shale **0.70 – 0.85m**: SHALE	Trial pit stable, no groundwater encountered. Trial pit terminated on rock.
Turbine 11 **(TP11)**	**0.00 – 0.10m**: Brown gravelly Topsoil **0.10 – 0.30m**: Soft grey sandy gravelly SILT **0.30 – 1.60m**: Soft pink/ brown sandy gravelly CLAY with occasional cobbles and boulders **1.60 – 3.00m**: Firm greyish brown sandy gravelly CLAY with occasional cobbles and boulders **3.00 – 4.20m**: Stiff brown sandy gravelly CLAY with occasional cobbles and boulders **4.20 – 4.30m**: Grey/ pink clayey GRAVEL with occasional cobbles and boulders of shale	Trial pit collapse from 0.50 mBGL. No groundwater encountered. Trial pit terminated on rock.
Turbine 12 **(TP12)**	**0.00 – 0.20m**: Brown gravelly clay Topsoil **0.20 – 0.90m**: Stiff red/ brown sandy gravelly CLAY with occasional cobbles **0.90 – 3.00m**: Yellow/ brown clayey gravelly fine SAND with occasional cobbles and boulders **3.00 – 4.10m**: Red/ brown clayey gravelly fine to coarse SAND with cobbles and boulders	Trial pit stable, no groundwater encountered.

Turbine (Trial Pit No.)	Ground profile	Comments
	4.10 – 5.20m: Red/ brown fine to coarse SAND with cobbles of dense sand (possible weathered rock)	
Turbine 13 **(TP13)**	**0.00 – 0.20m**: Brown clay Topsoil **0.20 – 1.30m**: Soft red mottled sandy gravelly CLAY with occasional cobbles and boulders **1.30 – 2.00m**: Firm grey sandy gravelly CLAY with rounded cobbles and boulders **2.00 – 2.80m**: Firm to stiff red/ grey sandy gravelly CLAY with cobbles and boulders **2.80 – 3.20m**: Stiff red sandy gravelly CLAY with angular cobbles and boulders **3.20 – 3.30m**: Red clayey fine to coarse GRAVEL of shale	Trial pit collapse from 1.20 mBGL. No groundwater encountered. Trial pit terminated on rock.
Turbine 14 **(TP14)**	**0.00 – 0.20m**: Brown gravelly Topsoil **0.20 – 1.20m**: Soft red/ brown sandy gravelly CLAY **1.20 – 1.90m**: Pink sandy fine to coarse GRAVEL with abundant cobbles and boulders of shale **1.90 – 2.00m**: SHALE	Trial pit stable. No groundwater encountered. Trial pit terminated on rock.
Turbine 15 **(TP15)**	**0.00 – 0.50m**: Brown organic clay Topsoil **0.50 – 1.25m**: Soft to firm grey/ brown sandy gravelly CLAY **1.25 – 2.30m**: Soft pink sandy gravelly CLAY with occasional cobbles and boulders **2.30 – 2.50m**: Brown/ pink sandy clayey Gravel of shale	Trial pit collapse from 0.50 mBGL. Groundwater encountered at 0.60 mBGL as fast ingress. Trial pit terminated on rock.

Turbine (Trial Pit No.)	Ground profile	Comments
	2.50 – 3.10m: Brown/ red clayey GRAVEL with occasional angular cobbles and boulders of shale **3.10 – 3.20m**: SHALE	
Turbine 16 **(TP16)**	**0.00 – 0.40m**: Brown silty clay Topsoil **0.40 – 0.70m**: Soft to firm red/ brown silty gravelly CLAY with occasional cobbles **0.70 – 3.00m**: Firm pink brown sandy gravelly CLAY with occasional cobbles and boulders **3.00 – 4.30m**: Firm to stiff pink/ brown sandy gravelly CLAY with cobbles and boulders **4.30 – 4.50m**: White weathered SILTSTONE	Trial pit stable. No groundwater encountered. Trial pit terminated on rock.
Turbine 17 **(TP17)**	**0.00 – 0.40m**: Brown silty clay Topsoil **0.40 – 1.30m**: Red/ brown sandy SILT **1.30 – 2.30m**: Clay gravelly fine SAND with occasional angular cobbles and boulders **2.30 – 2.40m**: Red/ brown sandy angular GRAVEL with abundant cobbles and boulders of shale **2.40 – 2.50m**: SHALE	Trial pit stable. No groundwater encountered. Trial pit terminated on rock.
Turbine 18 **(TP18)**	**0.00 – 0.20m**: Brown organic clay Topsoil **0.20 – 1.00m**: Soft to firm red/ brown gravelly SILT **1.00 – 2.80m**: Grey fine to coarse SAND with occasional cobbles **2.80 – 2.90m**: SHALE	Trial pit stable. No groundwater encountered. Trial pit terminated on rock.

Turbine (Trial Pit No.)	Ground profile	Comments
Turbine 19 **(TP19A)**	**0.00 – 0.20m**: Brown organic clay Topsoil **0.20 – 0.55m**: Red/ brown sandy clayey fine to coarse GRAVEL with occasional cobbles and boulders of shale **0.55 – 0.65m**: SHALE	Trial pit stable. No groundwater encountered. Trial pit terminated on rock.
Turbine 19 **(TP19B)**	**0.00 – 0.20m**: Brown organic clay Topsoil **0.20 – 0.65m**: Red brown sandy clayey GRAVEL with occasional cobbles and boulders of shale **0.65 – 0.75m**: SHALE	Trial pit stable. No groundwater encountered. Trial pit terminated on rock.
Turbine 20 **(TP20)**	**0.00 – 0.40m**: Brown organic clay Topsoil **0.40 – 1.30m**: Soft brown mottled grey sandy gravelly SILT with angular cobbles and boulders **1.30 – 1.50m**: Brown mottled silty GRAVEL with occasional cobbles and boulders of shale **1.50 – 1.60m**: SHALE	Trial pit stable. No groundwater encountered. Trial pit terminated on rock.
Turbine 21 **(TP21)**	**0.00 – 0.30m**: Red silty clay Topsoil **0.30 – 0.90m**: Soft red/ brown gravelly silty CLAY with occasional subangular cobbles and boulders **0.90 – 1.80m**: Red brown clayey sandy fine to coarse GRAVEL with cobbles and boulders of shale **1.80 – 1.90m**: SHALE	Trial pit stable. No groundwater encountered. Trial pit terminated on rock.
Grid connection **(TPGRID)**	**0.00 – 0.30m**: Brown clay Topsoil **0.30 – 0.90m**: Soft to firm grey sandy gravelly SILT with occasional subangular cobbles and boulders	Trial pit collapse from 1.00 mBGL. Groundwater encountered at 0.90 mBGL as slow seepage.

Turbine (Trial Pit No.)	Ground profile	Comments
	0.90 – 2.40m: Stiff grey red sandy gravelly CLAY with occasional cobbles and boulders **2.40 – 3.50m**: Stiff red brown slightly sandy gravelly CLAY with occasional cobbles and boulders	
Substation **(TPSS1_1)**	**0.00 – 0.40m**: Brown gravelly clay Topsoil **0.40 – 0.80m**: Soft to firm grey sandy gravelly SILT **0.80 – 1.65m**: Soft to firm brown mottled pink CLAY with cobbles and boulders **1.65 – 2.70m**: Soft grey gravelly CLAY with cobbles and boulders **2.70 – 3.90m**: Firm grey brown sandy gravelly CLAY with occasional cobbles and boulders	Trial pit collapse from surface. No groundwater encountered. Trial pit terminated due to constant collapse.
Substation **(TPSS1 2)**	**0.00 – 0.40m**: Brown silty clay Topsoil **040 – 1.00m**: Soft grey sandy gravelly SILT with occasional cobbles **1.00 – 3.00m**: Soft bluish grey sandy gravelly CLAY with cobbles and boulders **3.00 – 4.30m**: Firm grey brown sandy gravelly CLAY with cobbles and boulders **4.30 – 4.50m**: Stiff grey brown sandy gravely CLAY	Trial pit collapse from surface. No groundwater encountered. Trial pit terminated due to rock.
Potential alternative substation location, since removed from proposed works **(TPSS2_1)**	**0.00 – 1.20m**: Soft grey sandy gravelly SILT with occasional sub-rounded cobbles and peaty lenses **.20 – 2.90m**: Soft to firm red brown sandy gravelly CLAY with occasional cobbles and boulders **2.90 – 3.50m**: Pink clayey sandy fine to coarse Gravel of shale **3.50 – 3.60m**: SHALE	Trial pit collapse from 1.00 mBGL. Groundwater encountered at 2.00 mBGL as moderate ingress. Trial pit terminated on rock.

Turbine (Trial Pit No.)	Ground profile	Comments
Potential alternative substation location, since removed from proposed works **(TPSS2_2)**	**0.00 – 0.30m**: Brown gravelly clay Topsoil **0.30 – 0.90m**: Firm red brown sandy gravelly CLAY with abundant cobbles and boulders **0.90 – 2.50m**: Firm grey sandy gravelly CLAY with abundant rounded cobbles and boulders **2.50 – 2.90m**: Pink clayey subangular GRAVEL of shale **2.90 – 3.00m**: SHALE	Trial pit collapse from surface. Groundwater encountered at 1.70 mBGL as fast ingress. Trial pit terminated on rock.
Borrow pit North **(BPN1_1)**	**0.00 – 0.40m**: Brown organic clay Topsoil **0.40 – 1.80m**: Red brown silty gravelly fine SAND with cobbles and boulders **1.80 – 1.90m**: SHALE/SANDSTONE	Trial pit stable. No groundwater encountered. Trial pit terminated on rock. Bore hole data indicates medium strong to strong graded red fine to medium grained SANDSTONE with occasional quartz grains.
Borrow pit North **(BPN1_2)**	**0.00 – 0.40m**: Brown organic clay Topsoil **0.40 – 1.30m**: MADE GROUND (access track) brown sandy gravelly clay **1.30 – 1.40m**: Rock or boulder pit base submerged	Trial pit stable. Groundwater encountered at 0.80 mBGL as very fast ingress. Trial pit terminated on rock/ boulder. Borehole data indicates Medium strong graded red medium to coarse grained SANDTONE with occasional quartz grains.
Borrow pit North **(BPN1_3)**	**0.00 – 0.10m**: Brown gravelly clay Topsoil **0.10 – 0.20m**: SHALE	Trial pit stable. No groundwater encountered. Trial pit terminated on rock. Borehole data indicates Medium strong graded red medium to coarse grained SANDTONE with occasional quartz grains.
Borrow pit North **(BPN2_1)**	**0.00 – 0.50m**: Brown clay Topsoil **0.50 – 0.70m**: Grey sandy gravelly CLAY with occasional cobbles **0.70 – 0.80m:** SHALE	Trial pit stable. No groundwater encountered. Trial pit terminated on rock.

Turbine (Trial Pit No.)	Ground profile	Comments
Borrow pit North (BPN2_2)	**0.00 – 0.30m**: Brown clay Topsoil **0.30 – 0.50m**: Grey sandy gravelly CLAY with occasional angular cobbles **0.50 – 0.70m:** SHALE	Trial pit stable. No groundwater encountered. Trial pit terminated on rock.
Borrow pit North (BPN2_3)	**0.00 – 0.25m**: Brown clay Topsoil **0.30 – 0.50m**: Soft grey sandy gravelly CLAY with occasional angular cobbles **0.50 – 0.70m:** SHALE	Trial pit stable. No groundwater encountered. Trial pit terminated on rock.
Central Borrow pit (BPS1)	**0.00 – 0.50m**: Brown gravelly clay Topsoil **0.50 – 0.70m**: Grey/ pink clayey GRAVEL of shale	Trial pit stable. No groundwater encountered. Trial pit terminated on rock.
Central Borrow pit (BPS2)	**0.00 – 0.50m**: Brown organic gravelly clay Topsoil **0.50 – 0.80m**: Firm grey sandy gravelly CLAY with occasional angular cobbles **0.80 – 0.90m**: Grey pink clayey Gravel of shale	Trial pit stable. No groundwater encountered. Trial pit terminated on rock.
Central Borrow pit (BPS3)	**0.00 – 0.50m**: Brown gravelly clay Topsoil **0.50 – 0.60m**: Grey pink clayey Gravel of shale	Trial pit stable. No groundwater encountered. Trial pit terminated on rock.

The requirement for a third borrow pit has since been identified by the applicant to minimise transport to the southern end of the site. The borrow pit will be labelled as Borrow Pit South (BPSouth herein) and will be located to the south of T3. Rock outcrops were noted to the south of BPSouth.

8.3.10 Laboratory Test Results

During the ground investigation, samples were taken for laboratory testing at each trial pit and borehole location. The tests carried out included:

- Moisture content
- Atterberg limits
- Particle size distribution by wet sieving
- Particle size distribution by hydrometer
- Organic Matter
- California Bearing Ratio (CBR)
- Moisture Condition Value (MCV)

Results are included in Appendix 8-1. The geotechnical testing confirms the descriptions of the trial pit logs as described in Section 8.3.9 with the primary constituent of the cohesive deposits found to be a clay of low to intermediate plasticity. The Particle Size Distribution tests confirm that generally the cohesive deposits are well-graded with percentages of sands and gravels ranging between 18 and 37% generally with fines contents of 30 to 45%. The Particle Size Distribution tests confirm that generally the granular deposits are well-graded with percentages of silt/clay typically between 0.40% and 21% with a gravel/sand content of typically 76% to 90%. The CBR testing on remoulded samples gave results ranging between 0.07% and 2.55% for the cohesive deposits.

8.3.11 Mineral / Aggregate Resources

There are no active quarries on the site. The GSI data indicate that one crushed rock aggregate potential location is present within the site area in proximity to turbine no.12, the site access track to the turbine and the turbine location overlie the dolerite, classified with a very high crushed rock aggregate potential. Site specific information at turbine no. 12 indicate subsoils are relatively deep at a minimum of 5.20 mBGL.

A historical (currently inactive) quarry lies approximately 0.6km to the north-west of the northern site boundary. No active mineral or aggregate sources have been identified by GSI data within 2km of the site boundary.

The GSI online Aggregate Potential Mapping Database shows that the Proposed Development site is located within an area mapped as being typically Moderate in terms of crushed rock aggregate potential, with some areas of low to high potential. There are no significant mapped areas of granular aggregate potential (i.e. potential for gravel reserves).

8.3.12 Geological Heritage

According to the Geological Survey of Ireland Spatial Resources, there are no Irish Geological Heritage sites inside the site boundary. The disused Kiltorcan Old Quarry is located c. 0.6km west of the north-western boundary of the site. The Kiltorcan New Quarry located 0.9km west of the north-western boundary of the site is the closest active shallow linear quarry excavation identified as a geological heritage site. No additional geological heritage sites have been identified within 2km of the site boundary.

8.3.13 Soil Contamination

A review of the EPA website for both existing and historic licensed and illegal waste activities was carried out to identify any potential contamination sources present in the area and to identify any potential contaminating activities near the proposed development. The desk study indicated that no waste facilities, illegal waste activities, and licensed Integrated Pollution Prevention Control (IPPC) sites were present within a 2km radius of the proposed site.

8.3.14 Peat and Subsoils Stability

A review of the landslide information on the GSI Irish Landslides Database indicate that the nearest recorded landslide occurred approximately 5 km north-east of the development area (ID GSI_LS16-037). The event happened in January 2013. This event is characterised by “the Thomastown/ Inistioge Rd (R700) partially blocked at Brownsbarn Bridge following a landslide”

(GSI, 2013). The slide occurred at a road cutting. Figure 8-4 shows the regional Landslide Susceptibility. A number of vertical /near vertical excavations occur near LS16-037.

No peat deposits, which are frequently associated with instability, were noted on site. Minor areas of humic soils/ topsoil of less than 0.5m was noted in some areas including to the west of the existing access to T18 and east of Borrow Pit North. Peaty topsoil typically 0.15m deep was encountered near T20/T21.

An evaluation of the peat stability at Castlebanny Wind Farm site was undertaken. However there is limited peat/peaty soil as identified during the desk study and as supported by the GI. The GI identified that the shallow organic soils where present did not exceed 0.5 m in depth at any of the GI locations across the site.

During the geotechnical investigation by trial pits, the walls of 13 no. trial pits were unstable and collapsed during excavation. The material encountered was generally described as soft. Given that it was soft material encountered it is not surprising that the maximum depth of collapse occurred at 1.3 mBGL. Trial pit collapse is the result of unconsolidated subsoil material and is typical of the subsoils in the area. Due to the very limited depths and extents of "peaty" materials identified on the site, it is considered that the risk of peat instability is "negligible". Peaty materials were mostly identified within topsoil and may be decomposed forest floor materials and as such will be stripped during the topsoil stripping operations over the construction footprint and should be stockpiled for reuse.

All trial pits terminated upon meeting rock with the exception of turbine 3 and substation 1 (i.e. the proposed substation), where the trial pits were terminated due to collapse as a result of the presence of sandy gravelly silts at the turbine location and gravelly cobbles and boulders at substation 1. An additional trial pit was completed at substation 1. The areas of softer soil remain suitable for infrastructure construction by management of the stability of excavations described in Section 8.5 of this chapter.

8.3.15 Borrow Pits

Locations of borrow pits for extraction of construction aggregates for use on the scheme were initially identified by TOBIN and confirmed during the site walkover and GI. The areas were selected near Turbines 6 and 15 where known bedrock near to the surface exists. Initially, 2 No. borrow pits were selected where GI works were completed, namely the north and central borrow pits. A third borrow pit to cover the southern end of the site was selected after the GI was completed and is further discussed below. Based on the area of the three borrow pits (51,000m^2) and a maximum depth of 10m, the volume available in the borrow pits is approximately 510,000m^3. Based on the calculated volumes (see Table 8-5 below), the proposed borrow pits exceed the volume required for access tracks and hardstand and therefore the full depth of the borrow pits will not be required.

6 no. trial pits were excavated at the northern proposed borrow pit location. 3 no. trial pits were excavated at the central proposed borrow pit due to site access issues at the central location.

The depth to the shale bedrock at the north borrow pit ranged from 0.1 to 1.8 m BGL. The depth to shale bedrock in the central borrow pit ranged between 0.6 to 0.9 m BGL. Further information has been provided in Table 8-4. Bedrock in the borrow pits are moderately strong and provide

appropriate material for use in the access tracks and hardstand areas. The shallow soils overlying the bedrock will give rise to minimal potential for impacts when extracting.

Rotary cored boreholes were completed at two of the borrow pits. The cored boreholes at borrow pit north and central borrow pit were completed to a total depth of 20.20 m and 10.10 m respectively. The rotary core at borrow pit north recovered weak to medium-strong graded red sandstone, partially weathered in places with yellow staining and occasional quartz grains throughout, a number of fracture sets present. The rotary core at central borrow pit recovered medium-strong to strong graded red sandstone, partially weathered in places with yellow staining and significant quartz vein at 3.10 m and 5.40 m, a few fracture sets present.

The rock testing carried out on samples recovered from the boreholes reported Point Load (PL) Is50 values ranging between 0.90 and 9.76 MPa for the Sandstone. The Is50 results correlate to the UCS values using a factor of approximately 20, giving values of between 18.00 MPa and 195.2 MPa for the Sandstone. These results correlate to the strength descriptions for the Sandstone ranging between medium-strong to strong and confirming the variability of this stratum and the descriptions on the logs. The average of correlated values from the point loading suggest the Sandstone rock is typically on the border of medium-strong to strong. Borehole logs are presented in Appendix 8-1.

The testing completed on the cored borehole samples indicate the excavated material from both borrow pits is suitable to be used for construction in hardstand areas and access tracks.

A third borrow pit was identified after the GI to provide a local source of material for the southern end of the site. The nearest trial pit TP03 indicates silt and clay overlying weathered bedrock. Drilling was not completed at this location but the GSI maps indicate the bedrock to be similar to the cored boreholes completed i.e. medium-strong graded sandstone.

8.4 Potential Effects of the Development

The environmental effect of the development of the proposed project are discussed and assessed in the following sections. The 'do-nothing' scenario is reviewed and potential effects are assessed for three stages of the project life cycle; i.e. construction, operation and decommissioning.

8.4.1 Do-Nothing Scenario

The do-nothing situation relevant to soils and geology is where the proposed project does not proceed, the areas would remain as they currently are (i.e. predominantly areas of forestry and agriculture). Within the proposed wind farm site, forestry management, including thinning, felling, extraction and replanting, would continue as at present. Agricultural management would also continue as at present. This would result in no effect to the existing soils and geology conditions in the area.

8.4.2 Potential Effects During Construction

The proposed development is characterised by a number of main civil engineering works to provide the necessary infrastructure for completion. These include:

- Construction of access tracks and hardstands;

- Construction works at site entrance;
- Construction of temporary compounds, material storage areas, met mast, site offices and substation;
- Excavation for cable ducts, turbine foundations, substation foundations and met mast;
- Minor localised topsoil stripping at certain locations along the TDR
- Excavation of borrow pits, processing of materials and reinstatement;
- Management of excavated materials; and,
- Construction of surface water drainage system along the new access tracks;

The entire project as described in Chapter 2 of this EIAR (Description of the Proposed Development) has been considered in this impact assessment. The effects of the construction activities are discussed further in the following sections.

8.4.2.1 Land Use

The site of the proposed wind farm is predominantly covered in actively managed coniferous forestry plantations. There is an extensive network of existing access roads across the site to facilitate the ongoing forestry operations. Soils excavated will be reused within the site for landscaping purposes, therefore the potential impact on forestry/agricultural soils is negligible.

The permanent footprint of the proposed development measures approximately 36.3ha, representing approximately 2.5% of the site of the proposed wind farm. The proposed development makes use of existing access tracks thereby further minimising the potential for land use impacts. The proposed development will give rise to an increase in open area within the forestry. The proposed initial clearfelling of approximately 82.9 ha will be required at the onset of the construction phase, with approximately 7.9ha being replanted onsite at the end of the construction phase (at the northern construction compound and the reinstated borrow pits). Within the permanently felled area, there will be some windfarm infrastructure (i.e. the permanent footprint mentioned above) in addition to the regeneration of areas of low vegetation. Approximately 75ha of other offsite lands will be afforested within 2 years of clearfelling to ensure no net loss of forestry, as required under the Forestry Act 2014 (See Appendix 2-4 and 2-5 of this EIAR for further details). Potential impacts of forest felling include compaction and rutting of soils.

The main impact of the wind farm with regard to land and natural resources is the removal of vegetation and topsoil. It is anticipated that the removed vegetation would be transferred to stockpiles for re-use and any soils would be reused along the edges of the proposed development and in the borrow pits. Due to the land take for the proposed development and change in land use at the proposed site, it is considered that there will be a slight negative and permanent impact due to soil stripping and borrow pit reinstatement/landscaping works.

8.4.2.2 Construction of Access Tracks and Hardstands

Numerous onsite access tracks will be needed to accommodate the construction works and provide access to all infrastructure including turbine locations for the whole life cycle of the wind farm. The access tracks will be constructed using unbound crushed aggregates and incorporate drainage to maintain the performance of the pavement during wet weather. Material from the onsite borrow pits will be used for their construction, and any surplus excavated material will be used for borrow pit reinstatement. It is anticipated that the access tracks will be constructed using the founded/excavated method as no significant peat was

identified on site. Founded roads are excavated down to and constructed up from a competent geological stratum.

Soil sealing is the covering of a soil with an impermeable material; it often affects agricultural land as it changes the nature of the soil leading to impermeability, sealed areas are lost to agricultural or forestry uses while the ecological soil functions are impacted. Soil sealing also potentially increases the risk of flooding as surrounding soils may be influenced by change in water flow patterns. The proposed development will have limited soil sealing. Proposed access tracks will use gravel/permeable crushed rock /geotextile placed at the base of access tracks, as part of their typical design. The pre-mitigation construction potential impact is imperceptible, negative, and long-term due to the relatively small footprint of infrastructure and its location.

8.4.2.2.1 Material Calculations

Preliminary volume calculations provide an approximate estimation of stone fill required for all of the hardstanding foundations of 211,483m^3.

A summary table (Table 8-5 below) is provided with the volumes of stone material necessary for infrastructure.

Table 8-5: Construction Volume Summary

Area	Volume of Stone Fill Required (m^3)
Access tracks	50,325
Substation Compound Groundworks	14,174
Contractor's Compound	10,395
Turbine Hardstanding	64,449
Vehicle Turning, Laydown area and passing Areas	57,355
Turbine Foundation	14,785
Total	**211,483**

Approximately 510,000m^3 is available from on-site borrow pits. For the substation and construction compounds, all material will come from onsite borrow pits. In terms of material required from offsite sources, the following are the approximate estimates of the material requirements:

- Internal Access Tracks – 17,325 m^3 will come from off-site sources;
- Turbine Hardstand, Blade set-down area and vehicle turning area –15,100 m^3 will come from offsite sources. and

- Turbine Foundations – 14,785m^3 will come from offsite sources.

A summary balance of the material extraction and necessary for infrastructure is included below on Table 8-6.

Table 8-6: Volume Summary

Area	Volume (m^3)
Volume of stone fill material required for construction of access tracks, hardstanding, etc.	211,483
Stone material sourced from off-site quarries	47,210
Stone material sourced from on-site borrow pits	164,273
Total volume of excavated material from access tracks, hardstanding, etc. to be reinstated in on-site borrow pits and landscaping	211,483

Overall, the construction of the access tracks and hardstands for site infrastructure including temporary compounds, material storage areas, met mast, site offices and substation where the impact is considered to be similar, presents a not significant, long-term, negative effect.

8.4.2.3 Management of Excavated Materials

The handling, storage and re-use of excavated materials are of importance during the construction phase of the project. Stockpiles will be located 50m away from watercourses and drainage ditches. Topsoil and subsoils will be stored separately and used for landscaping and in the reinstatement of borrow pit areas. Topsoil will be stockpiled no higher than 2.5m and follow the recommendations set out in the NRA Guidelines for the Management of Waste from National Road Construction Projects (NRA, 2014). Trial pits completed to date suggest that stockpiles will need to be lower than this given the nature of the material encountered at selected sites. There is potential for a negative effect on water as a result of the erosion of soil and the inappropriate storage of excavated materials. However, any risk from the stockpiling of excavated materials can be managed through good site practice. The variable topography of the site requires a robust sediment and erosion plan to effectively reduce the risk of sediment release to surface waters.

It is intended that unsuitable founding soils (topsoil) and subsoils will be reused for site landscaping and used to reinstate the borrow pits. The borrow pit extraction area will be excavated as part of the construction works. Temporary stockpiling from excavations will be avoided near sensitive receptors such as watercourses. All of the excavated soils will be used for local landscaping or for borrow pit reinstatement. The potential impact is expected to be not significant, direct, short-term and negative to soils and bedrock.

For works along the grid connection and site entrance works, the excavated material will be cast to the side to be reused as backfilling material where appropriate. This material will not be stored in the vicinity of any watercourse. It will be cast on the upgradient side of the trench, so if any runoff did occur it would run into the downgradient trench. Excess material will be either transported within the proposed development site and used for borrow pit reinstatement or transported to a local appropriately licensed/permitted waste recovery facility. Examples of these facilities include Kilmacow Quarry, Kilmacow or CHI Environmental, Kilmacow. Some materials, subject to testing may be utilised under Article 27 of the European Communities (Waste Directive) Regulations 2011 for recycling. Where contaminants are found (or where bitumen-based materials are present) the material will be removed from site and disposed at an appropriately licenced/permitted facility. This action is expected to have a not significant, short-term negative effect.

Minimal excavations will be required for the TDR. At road/junction accommodation works along the TDR, the topsoil will be side-casted and smoothed off with the back of an excavator bucket, battered to minimise the potential for runoff. This soil will be used for reinstatement after the turbine delivery is complete. These works areas are minimally sized, and excavation depths are expected to be minimal. Where suitable conditions are not present to allow side-casting, the soils will be disposed of at a suitable licensed facility. This action is expected to have a not significant, short-term negative effect.

8.4.2.4 Hydrocarbon Release

Wherever there are vehicles and plant in use, there is the potential for hydro-carbon release which may contaminate the soil and subsoil. A spill has the potential to indirectly pollute water, if the soil and subsoil act as a pathway from any source of pollution. Any spill of fuel or oil would potentially present a moderate, long-term negative effect on the soil and geological environment. Good site practice can mitigate any effect (Refer to Section 8.5 Mitigation Measures).

8.4.2.5 Excavations

The material encountered in the trial pits excavated at each turbine location was relatively stable with a few locations of soft ground conditions, such as Turbine 3. Areas of shallow soft ground will be removed for turbine construction on founded competent ground/bedrock. Deep excavations to more competent material will be required to construct the turbine foundations at Turbine 3. Additional fill material will be needed to upfill the excavation to the levels required for the wind turbine at Turbine 3.

The construction of the substation compound will require removal of topsoil and subsoil to a competent founding layer and upfilling with structural fill and/or concrete (concrete only proposed for the substation buildings and associated structures) to the required finished floor level. Ground investigation has been carried out in the area of the proposed substation location, the initial trial pits at substation one (TPSS1_1) encountered soft to firm ground between 0.4 to 3.0 mbgl.

Up to 510,000m^3 is available from on-site borrow pits which will provide the majority of the required construction material (see Table 8-5 and Table 8-6 for material balance information). Where excavations extend into competent rock in borrow pits for example, it is likely to require very heavy ripping and may even require blasting methods to extract the stronger rock. The

depth of competent rock varies across each borrow pit. There is potential that blasting may be required in all borrow pits and may cause a negative short-term effect. The potential effects of blasting have been assessed and are addressed in Chapter 12, Noise and Vibration.

The borrow pits will be reinstated using two material sources (a) overburden from the opening of the borrow pits, and (b) mineral soils excavated elsewhere on the site that cannot be reused in construction.

Materials required for the construction works will be sourced locally. Borrow pits from within the site will be used for access track and hardstand base layers. Some material importation to site will be required such as ready mixed concrete, road surface, etc. The use of on-site borrow pits will reduce the environmental effect of other aspects of the development by reducing the need to transport material to site. On-site extraction and processing (rock breaking and crushing) of rock materials can produce dust and noise during construction. This is outlined in Chapter 14, Air Quality and Climate and Chapter 12 Noise and Vibration. Similarly, water may be generated from any groundwater pumping at borrow pits (refer to Chapter 8 - Hydrology and Hydrogeology). The deep temporary excavations into bedrock will create a temporary exposure of bedrock which will provide additional in-situ information of the soils and geology in the area. Overall, the excavation of on-site borrow pits will have a neutral environmental effect.

Grid Connection

Each turbine will connect by underground cable to the onsite substation and from there to the existing overhead 110kV line at Ballyvool. All grid-connection cable laying works will be carried out as per EirGrid requirements, which have been described in Chapter 2 (Description of the Proposed Development) and in accordance with the Typical Trench Bedding Details provided in Appendix 2-1 of this EIAR.

The grid connection will be laid beneath the ground surface and/or public road. The area where excavations are planned will be the subject of a confirmatory survey, prior to the commencement of works. A verification condition survey will be carried out for all parts of the route within the public road. A trench will be opened using an excavator to accommodate the formation. The excavated material will be cast to the side to be reused as backfilling material where appropriate. This material will not be stored in the vicinity of any watercourse and will be smoothed with the back of an excavator bucket to minimise runoff. It will be cast on the upgradient side of the trench, so if any runoff did occur it will run into the downgradient trench. Excess material will be used on the site of the proposed development for local landscaping and borrow pit reinstatement, further detail is provided in Chapter 2 (Description of Proposed Development,) Section 2.10.5.

Overall, the excavation required for the grid connection will have an imperceptible, temporary and neutral environmental effect on soils and geology.

Turbine Delivery Route

Temporary accommodation works are required along the turbine delivery route such as hedge or tree cutting, temporary relocation of poles, lampposts, signage and local road widening. Some areas of temporary surfacing will also be required.

Where a temporary surface is needed for the turbine delivery route, works will start with the clearing of any vegetation, and the topsoil will be stripped and either used locally for landscaping purposes, used for borrow pit reinstatement onsite or disposed of at a permitted/licensed facility. Where local use for landscaping does occur, it will be smoothed off with the back of a bucket and seeded with a suitable grass seed mix. Silt control curtains will also be employed if required. Material will not be stockpiled within 50m of a watercourse. It is anticipated that the volume of excess material generated will be relatively small and the majority of excavated topsoil will be used locally for landscaping. Any excess excavated material which needs to be taken off site will be taken to a licensed/permitted waste facility. Suitable fill material (broken stone and clause 804) will be used to create a firm running area for the passage of turbine delivery vehicles. The areas will be fenced off when the delivery is not occurring. After the delivery of turbines to site, a stock proof fence will be erected between the hardstand surface and the road, or the site will be re-instated to the original condition, and any removed vegetation will be reseeded/replanted with a similar native species composition.

Any upgrades to the road will be carried out in advance of turbine deliveries and will be subject to further consents and agreements. The impact mechanisms include excavation and vehicle movements which has the potential to affect the subsoil and surface water environments.

The potential impact on soils and geology is negative, direct, not significant and short term.

Peat and Soil Stability

As discussed in Section 8.3.13, peat was not identified as a significant issue on the development site given the GI did not encounter any peat deposits which are frequently associated with instability in upland areas. A peat stability assessment is included in Appendix 8-2. A soil stability assessment is included in Appendix 8-3. The ground investigation completed in 2020 identified a number of trial pit locations with soft ground conditions to a relatively shallow depth of up to 3 m below ground. Organic subsoils were encountered at 4 no. trial pit locations which did not exceed 0.5m in thickness. Minor areas of peat identified in the site were avoided as part of the site design. There was very limited evidence of peat at the site.

The walkover study as part of the Peat Stability Risk Assessment (See Appendix 8-2) carried out in August 2020 found limited evidence of peaty and organic topsoil within the site boundary, particularly to the north of the scheme. It is considered that some of this material identified as “peaty” may be recent decomposed forest floor material. The depth of this peaty or organic topsoil was less than 500mm in all cases encountered during the walkover and mostly less than 150mm.

The local subsoil data has been reviewed together with the GSI landslide susceptibility classification. Minor areas of peaty soil are also encountered near Borrow Pit North and T15. There is one area where “moderately high” landslide susceptibility was identified in conjunction with peaty topsoil, between Turbine 20 and Turbine 21, however the walkover study found less than 0.15m of peaty topsoil in this location and hence it is considered that the risk of peat instability is “negligible” at this location.

Soils encountered at T16 comprised of firm till overlying bedrock. No areas of potential instability were identified during the site walkovers. No significant soil stability risk occurs

as a result of the soil stability analyses carried out. All soil parameters and loadings are factored in accordance with Eurocode 7 Design Approach. Further details on soil stability are included in Appendix 8-3.

Mitigation measures to address localised stability issues such as battering of excavations are outlined in Section 8.5.

8.4.3 Potential Effects During Operation

During the operational phase of the project, no new impacts on the soil and geological environment will arise. A few direct impacts are possible during the operational phase of the proposed development. These may include:

- Some construction traffic may be necessary for maintenance of the site (access tracks, substations and turbines) which could result in minor accidental leaks or spills of fuels/ oils affecting the ground and water;
- The transformer in the substation and transformers in each turbine are oil cooled. There is potential for spills and leaks of oils from this equipment resulting in contamination of soils and water.

The direct operational impacts has the potential to negatively affect the ground or water directly. However, mitigation measures and management controls will negate this risk (refer to Section 8.5.2).

In relation to indirect impacts, small volumes of additional unbound crushed aggregate material may be required during the operation phase where tracks have settled on the subsoil, to resurface unbound onsite tracks and for the maintenance of the amenity trackway surface. This will be sourced from site material or from local licenced quarries which will place intermittent minor demand on local resources. It is expected that only small quantities of unbound crushed aggregates may be needed. The resurfacing of onsite and amenity tracks will therefore present an imperceptible negative short-term or long-term effect.

No cumulative impacts on the soils and geology environment are envisaged during the operational stage, as there will be no significant movement of soils/subsoils, or construction works, during this period.

The effects of operation on natural resources such as land, soils and geology will be imperceptible and long-term.

8.4.4 Potential Effects During Decommissioning

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

Turbine foundations and the grid connection infrastructure will remain in place underground and would be covered with earth and allowed to revegetate or reseed as appropriate. The site access tracks will be in use for additional purposes to the operation of the wind farm (e.g. for

forestry access and recreational use) by the time the decommissioning of the project is to be considered, and therefore will remain in-situ for future use.

In most cases, and certainly for granular based tracks (but also concrete and asphalt) these materials are mostly inert and stable over the long-term, so will not pose a contamination risk if left in-situ.

The substation will be retained as a permanent structure and will not be decommissioned.

The replanted forestry lands will not be decommissioned as they will continue as forestry.

8.4.5 Summary of Potential impacts

A summary of the significance criteria is outlined below for the construction, operational and decommissioning phase in Tables 8-7 to 8-9.

Table 8-7: Significance of Land and Soils Criteria – Construction Phase (Pre-mitigation)

Environmental Attribute (Land, Soil and Geology)	Turbines	Borrow Pits	Cable Route and substation	Access tracks and Construction compounds
Geological heritage sites – County Geological Sites	No IGH sites at proposed site. -Imperceptible			
Contaminated sites	No contaminated sites identified - Imperceptible			
Contamination of soil by potential pollutants/hydrocarbons	Slight - unlikely, direct and short term on localised soils and bedrock within the site boundary	Slight - unlikely, direct and short term on localised soils and bedrock within the site boundary	Slight - unlikely, direct and short term on localised soils and bedrock within the site boundary	Slight - unlikely, direct and short term on localised soils and bedrock within the site boundary
Identification of karst features	No Karst features - Imperceptible			
Mineral resources and Mines	None identified, imperceptible	None identified - on site borrow pits to be used thereby	None identified, imperceptible	None identified, imperceptible

Environmental Attribute (Land, Soil and Geology)	Turbines	Borrow Pits	Cable Route and substation	Access tracks and Construction compounds
		reducing demand on external sites - Not significant		
Peat stability	No significant peat deposits encountered Not significant	No significant peat deposits encountered Not significant	No significant peat deposits encountered Not significant	No significant peat deposits encountered Not significant
Soil Stability	Not significant, certain and permanent	Not significant, certain and permanent	Not significant, certain and permanent	Not significant, certain and permanent
Land and Soils (Natural resources)	Slight - certain and permanent due to relocation of soils and bedrock within the site boundary	Slight - certain and permanent due to relocation of soils and bedrock within the site boundary	Slight - certain and permanent due to relocation of soils within the site boundary	Slight - certain and permanent due to relocation of soils within the site boundary

Table 8-8: Significance of Land and Soils Criteria – Operational Phase (Pre-mitigation)

Environmental Attribute (Land, Soil and Geology)	Turbines	Borrow Pits	Cable Route and substation	Access tracks and Construction compounds
Geological heritage sites – County Geological Sites	No IGH sites at proposed site. -Imperceptible			

Contaminated sites	No contaminated sites identified - Imperceptible			
Contamination of soil by potential pollutants/hydrocarbons	Slight to Not Significant - unlikely, direct and short term	Imperceptible - area to be reinstated	Slight - unlikely, direct and short term	Slight to Not significant- unlikely, direct and short term
Identification of karst features	No Karst features- Imperceptible			
Mineral resources and Mines	None identified, imperceptible			
Peat stability	No significant peat deposits encountered Imperceptible			
Soil Stability	No significant excavations - Imperceptible			
Land and Soils (Natural resources)	Not significant no excavations during operational phase- Imperceptible			

Table 8-9: Significance of Land and Soils Criteria – Decommissioning Phase (Pre-mitigation)

Environmental Attribute (Land, Soil and Geology)	Turbines	Borrow Pits	Cable Route and substation	Access tracks and Construction compounds
Geological heritage sites– **County Geological Sites**	No IGH sites at proposed site. -Imperceptible			
Contaminated sites	No contaminated sites identified - Imperceptible			
Contamination of soil by potential pollutants/hydrocarbons	Slight - unlikely, direct and short term due to relocation of soils and bedrock within the site	Slight - unlikely, direct and short term due to relocation of soils and bedrock within the site boundary	Slight - unlikely, direct and short term due to relocation of soils and bedrock within the site	Slight - unlikely, direct and short term due to relocation of soils and bedrock within the site boundary

Environmental Attribute (Land, Soil and Geology)	Turbines	Borrow Pits	Cable Route and substation	Access tracks and Construction compounds
	boundary		boundary	
Identification of hydrogeological features from the GSI karst database	No Karst features Imperceptible			
Mineral resources and Mines	None identified, imperceptible	None identified, imperceptible	None identified, imperceptible	None identified, imperceptible
Peat stability	No significant peat deposits encountered Not significant	No significant peat deposits encountered Not significant	No significant peat deposits encountered Not significant	No significant peat deposits encountered Not significant
Soil Stability	Not significant, certain and permanent	Not significant, certain and permanent	Not significant, certain and permanent	Not significant, certain and permanent
Land and Soils (Natural resources)	Slight - certain and permanent due to relocation of soils and bedrock within the site boundary	Slight - certain and permanent due to relocation of soils and bedrock within the site boundary	Slight - certain and permanent due to relocation of soils within the site boundary	Slight - certain and permanent due to relocation of soils within the site boundary

Overall, the potential impacts are slight/not significant. Mitigation measures are identified in section 8.5 to address these impacts.

8.4.6 Major Accidents

As part of the requirements of the new EIA Directive, the applicant is requested to consider the "Expected Significant Adverse Effects of the project on the environment deriving from the

vulnerability of the project to risks of major accidents and/or disasters which are relevant to the project concerned."

This section describes the expected significant effects on the environment arising from the vulnerability of the proposed development to risks of major accidents and/or natural disasters which are relevant to the project.

As set out in the EIA guidance there are two main considerations:

- The potential of the project to cause accidents and/or disasters, including implications for human health, cultural heritage, and the environment;
- The vulnerability of the project to potential disasters/accidents, including the risk to the project of both natural disasters (e.g. flooding) and man-made disasters (e.g. technological disasters).

Low consequence events, such as minor spills, have been scoped out as these events are unlikely to result in significant adverse effects as they do not fall into the definition of a Major Accidents and Disasters. The proposed development (and associated works) to natural disasters. In this regard, the most likely major accidents that could occur as a result of the proposed development (and its associated works) include:

- Significant hydrocarbon spillage;
- Turbine collapse; and
- Turbine or substation fire.

The most likely natural disasters that might occur and potentially impact the proposed development (and its associated works) include:

- Fire; and
- Landslide.

In relation to major accidents, the following geological hazards do not occur on the site:

- Earthquakes do not occur in a sufficient intensity at the site;
- No karst risk occurs on the site due to the underlying geology; and
- There are no significant deposits in the proposed footprint that give rise to a major accident or disaster (e.g. landslide).

No significant peat stability issues arise on the site due to the lack of peat soils in the proposed footprint. No significant soil stability issues arise on the site. The potential for a significant spillage of hydrocarbons is negligible because there will be no significant stores of such materials and therefore does not give rise to a major accident or disaster.

Due to the felling of trees around the substation and turbine locations, in the unlikely event of a fire there is no significant risk of additional fire risk due to separation distances. Gravel and hardstand areas surround the substations and turbine areas which further limits fire risk potential. Additionally, in the event of substation fire there is minimal potential for fire spread due to construction of the substation elements and minimal storage of flammable material. Based on the limited fuels at the turbine and substations, there is no significant impact from fire on the land and soils environment as a result of the proposed development.

In relation to land, soils and geology, it can be concluded that the risk of accidents associated with this development is very low and would not cause unusual, significant or adverse effects on land and soils environment during the construction, operational and decommissioning phase.

8.5 Mitigation Measures

Mitigation measures for the construction, operation and decommissioning of Castlebanny Wind Farm to avoid or reduce the potential effect of the proposed development are presented below. A number of mitigation measures considered for soil and geology are similar to those relating to hydrology and hydrogeology, further detail can be found in Chapter 9 'Hydrology and Hydrogeology'.

8.5.1 Mitigation Measures During Construction Phase

The construction of the development has the potential (with no mitigation) to cause "not significant" to "moderate" short-term to long-term effects to the soil and geology of the proposed development site. Implementing mitigation measures detailed below will reduce the significance of the effects. The mitigation measures have been based on CIRIA (Construction Industry Research and Information Association, UK) technical guidance on water pollution control and on current accepted best practice (CIRIA, 2001). Good site practice will be applied to ensure no fuels, oils, wastes or any other substances are stored in a manner on site in which they may spill and enter the ground. Dedicated, bunded storage areas will be used for all fuels or hazardous substances.

The materials encountered in the trial pits are likely to be relatively stable during the excavation for the turbine bases. A physical barrier will be installed between the excavations and the potentially unstable material at unstable conditions, in the form of a granular berm or sheet piles. The long-term stability of the area around the wind turbine foundations will be achieved by filling the area back up to existing ground level following installation of the foundation.

Excavation works will be monitored by a suitably qualified and experienced geotechnical engineer or engineering geologist. The earthworks will not be scheduled to be carried out during severe weather conditions.

All works will be managed and carried out in accordance with the Construction and Environmental Management Plan (CEMP) which is included in Appendix 2-7. In the event An Bord Pleanála decides to grant permission for the proposed development, the final CEMP will address the requirements of any relevant planning conditions, including any additional mitigation measures. In addition, all works will be managed and carried out in accordance with the Forestry Report (Appendix 2-4 of this EIAR).

8.5.1.1 Management of Excavated Materials

The disturbance and excavation of soil, subsoil and bedrock is an unavoidable effect of the development, but every effort will be made to ensure that the amount of earth materials excavated is kept to a minimum in order to limit the effect on the geological aspects of the site. The management of geological materials and spoil is an important component of controlling dust and sediment and erosion control. Excavated soils and bedrock 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. The upper

vegetative layer will be stored with the vegetation part of the sod facing the right way up to encourage growth of plants and vegetation at the surface of the landscaped soils.

These measures will prevent the erosion of soil in the short and long term. Soils, overburden, and rock will be reused on site to reinstate any excavations where appropriate.

To ensure slope stability, excavations will be battered back (sloped) to between 1:1.5 and 1:2 depending on depth and type of material. Permanent slopes will generally be less than 1:3. The works programme for the construction stage of the proposed development will also take account of weather forecasts, and predicted rainfall in particular. Large excavations and movements of subsoil or vegetation stripping will be suspended or scaled back if heavy rain is forecasted. Works should be suspended if forecasting suggests any of the following is likely to occur:

- >10 mm/hr (i.e. high intensity local rainfall events);
- >25 mm in a 24 hour period (heavy frontal rainfall lasting most of the day); or,
- >half monthly average rainfall in any 7 days.

Prior to works being suspended the following control measures should be completed:

- Secure all open excavations;
- Provide temporary or emergency drainage to prevent back-up of surface runoff; and,
- Avoid working during heavy rainfall and for up to 24 hours after heavy events to ensure drainage systems are not overloaded.

All excavation works during the construction stage will be monitored by an experienced engineer.

Mitigation measures will be put in place during the construction of the scheme to reduce the likelihood of an excavation collapsing. Mitigation measures include construction of a granular berm or temporary sheet pile wall to support the soft clays during construction. Based on the GI undertaken, together with information obtained from other sources, provides necessary information to assess the suitability of the ground to support the proposed development. There is a very low risk of landslide (high factor of safety) which is further reduced by implementation of the mitigation measures.

8.5.1.2 Vehicular Movement

Access tracks will be constructed first to allow for access on the site. Vehicular movements will be restricted to the footprint of the permitted development, particularly with respect to the newly constructed access tracks. This means that machinery must be kept on tracks and aside from advancing excavations do not move onto areas that are not permitted for the development, such as areas which have not been designated for access or infrastructure.

8.5.1.3 Waste Management

A construction phase Waste Management Plan (WMP) is included in the CEMP which controls the management of all site-generated construction waste and the storage and disposal of the waste. Waste streams (including material-related streams such as soils, stone, metals, paper and cardboard, plastics, wood, rubber, textiles, bio-waste and product-related streams such as packaging, electronic waste, batteries, accumulators and construction waste) will be managed,

collected, segregated and stored in separate areas at the temporary compound and removed off site by a licensed waste management contractor at regular intervals during the works. Appropriated facilities are included in the CEMP, Appendix 2-7.

A wastewater holding tank (twin-hulled) will be used for the temporary welfare facilities and managed by a licensed contractor. The concrete wash-out areas will be bunded, controlled and emptied by a licensed waste collector as required. Any excess building materials (PVC piping, cement materials, electrical wiring, etc.) will be taken off site at the end of the construction phase.

8.5.1.4 General Site Management

The CEMP (Appendix 2-7 of this EIAR) has been developed to include the checking of equipment (plant, vehicles, fuel bowsers) on a regular basis during the construction phase of the project. The purpose of the CEMP 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.

Management of Fuel and Oil

The CEMP (Appendix 2-7 of this EIAR) provides details on measures and mitigation in relation to the management of fuels and oils on site. These include:

- Minimal refuelling or maintenance of construction vehicles or plant will take place on site. Off-site refuelling will occur at a controlled fuelling station;
- Mobile bowsers, tanks and drums will be stored in secure, bunded, 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;
- An emergency plan for the construction phase to deal with emergency accidents or spills is contained within the CEMP (Appendix 2-7 of this EIAR); and
- An emergency spill kit with oil boom and absorbers will be kept on site in the event of an accidental spill. All site operatives will be trained in its use.

Drainage and the Management of Sediment and Geological Spoil

The internal access tracks will require a drainage network to be in place for the construction and operation phases of the site. Fundamental to any construction phase is the need to keep clean water (i.e. runoff from adjacent ground upslope of the permitted development footprint) separate from construction area runoff and manage all other run off and water from construction in an appropriate manner. This will necessitate the implementation of the measures in the CEMP to mitigate against sediment loss and erosion, with associated settlement ponds and silt traps. The Sediment and Erosion Plan forms part of the CEMP (Appendix 2-7 of this EIAR) for the site. The Sediment and Erosion Plan is included as a design feature thereby

applying mitigation by design. The good management of material on site will reduce any indirect risk to water.

The handling, storage and re-use of excavated materials are of importance during the construction phase of the project. Excavated topsoil will not be stored in excessive mounds on the site. Excavated and affected areas will be left to naturally revegetate. If revegetation of the upper layer is unsuccessful, the area will be seeded with indigenous species. The re-vegetation of these areas promotes stability, reduces desiccation, run-off erosion and susceptibility to freeze/thaw action.

8.5.1.5 Excavations

The materials encountered in the trial pits are likely to be relatively stable during the excavation for the turbine bases. A physical barrier can be implemented between the excavations and the potentially unstable material at unstable conditions, in the form of a granular berm or sheet piles. The long-term stability of the area around the wind turbine foundations will be achieved by filling the area back up to existing ground level following installation of the foundation.

Excavation works will be monitored by a suitably qualified and experienced geotechnical engineer or engineering geologist. The earthworks will not be scheduled to be carried out during severe weather conditions. Subject to landowner permission, selected private water supply wells at representative locations closest to turbine and borrow pit locations around the site will be monitored for water level and quality pre-construction and during the construction phase.

Following these mitigation measures, the resultant effect will be not significant, permanent and negative.

8.5.2 Mitigation Measures During Operational Phase

Similar to the construction phase, a twin-hulled wastewater holding tank will be provided and will need to be periodically emptied by a permitted contractor. Likewise, any oil spill related to the equipment or their maintenance will be cleaned and 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 access tracks, substation and turbines) and will put in place mitigation measures to reduce the risk of hydrocarbon or oil spills during the operational phase of the windfarm. The potential effects are limited by the size of the fuel tank of vehicles used on the site.

The proposed mitigation measures during the operational phase are as follows:

- Minimal refuelling or maintenance of operational vehicles or plant will take place on site. Off-site refuelling will occur at a controlled fuelling station;
- On site re-fuelling will be undertaken using a double skinned bowser with spill kits on the ready for accidental leakages or spillages;
- Re-fuelling will be undertaken by suitably trained personnel only;
- Fuels stored on site will be minimised. Storage areas where required will be bunded appropriately for the fuel storage volume for the time period of the operation and fitted with a storm drainage system and an appropriate oil interceptor;

8.5.2.1 Land Use

It is intended that unsuitable founding soils (topsoil) and subsoils will be reused for site landscaping and used to reinstate the borrow pits. Temporary stockpiling from excavations will be avoided near sensitive receptors such as watercourses. All of the excavated soils will be used for local landscaping or for borrow pit reinstatement. Approximately 2.5% of the site will be altered as a result of the proposed development.

In order to minimise the potential impacts to Land Use, the following mitigation measures are proposed:

- Minimising areas for earthworks thereby reducing land take requirements;
- Restricting areas for construction works and temporary storage to a minimum;
- Retention of all existing perimeter planting and re-generating vegetation where possible and sufficiently protect in areas close to construction works as described in BS 5837:2005;
- Disturbance of existing vegetation will be minimised where possible and proposed planting will help integrate the proposed development into the current land use;
- The handling, storage and re-use of excavated materials are of importance during the construction phase of the project. Stockpiles will be located away from the watercourses and drainage ditches. Topsoil and subsoils will be stored near the landscaping and in the reinstatement of borrow pit areas. Topsoil will be stockpiled no higher than 2.5m and follow the recommendations set out in the NRA Guidelines for the Management of Waste from National Road Construction Projects (NRA, 2014);
- Turves will be stored turf side up and must not be allowed to dry out;
- No permanent spoil or stockpiles will be left on site;
- The method for restoration of excavated or disturbed areas is to encourage stabilisation and early establishment of vegetation cover, where available, vegetative sods/turves or other topsoil in keeping with the surrounding vegetation type will be used to provide a dressing for the final surface; and
- To prevent erosion and run-off and to facilitate vegetation reinstatement, any sloped embankment will be graded such that the slope angle is not too steep and that embankments match the surrounding ground profile.

8.5.3 Mitigation Measures During Decommissioning Phase

Decommissioning will comprise the removal of all over ground elements of the wind farm.

The site roadways may be in use for additional purposes to the operation of the wind farm (e.g. for forest/agricultural and recreational access) by the time the decommissioning of the project is to be considered, and therefore the site roads will remain in-situ for future use. Some of the hardstand material will be removed where required, and along with the turbine foundations, covered in topsoil and revegetated. The substation and grid connection infrastructure will form part of the permanent national grid network.

The risks associated with leaving tracks in-situ are relatively low. The decommissioning phase will not require any significant works that will impact the land and soils environment.

A fuel management plan to avoid contamination by fuel leakage during decommissioning works will be implemented as per the construction phase mitigation measures.

Mitigation measures applied during decommissioning activities will be similar to those applied during construction where relevant. Some of the impacts will be avoided by leaving elements of the Proposed Development in place where appropriate. The bases will be rehabilitated by covering with local topsoil in order to regenerate vegetation which will reduce runoff and sedimentation effects. Access tracks which are not required for farm use or forestry will also be left to vegetate naturally. Mitigation measures to avoid contamination by accidental fuel leakage and compaction of soil by on-site plant will be implemented as per the construction phase mitigation measures in Section 8.5.1.

The replanted forestry lands will continue as commercial forestry where the forestry cycle of felling and replanting occurs.

8.6 Cumulative Impacts

Cumulative effects of this project with other developments in the region, as discussed in Chapter 4 - Policy, Planning and Development Context, relate to the effects on soils and geology. Due to the use of on-site borrow pits, the demand for external aggregate (natural resources) for roads is greatly reduced, therefore limiting the potential for cumulative impacts.

It is not envisioned that there will be any significant effects in relation to soils and geology during the construction phase given efficient design along with material management such as using onsite borrow pits for the construction phase will ensure optimisation of the volume of materials required to be imported to site. This will mitigate any cumulative effects relating to importing of material and use of public roads as haul roads.

The replanted forestry has been assessed in terms of cumulative impact with the windfarm site, grid connection and TDR works. Due to the remote location of the replanted lands, lying in excess of 50 km from the Proposed Development, there is no cumulative geological or hydrogeological impact with the Proposed Development anticipated.

A review of the Local Authority Planning Register shows that the following 'other developments' as described below are relevant planning applications in terms of the 10km zone of influence radius surrounding the proposed development site.

Pl. Ref. 10/103 – Planning application in 2010 by ESB for the development at this site at Kilkenny 110kV electrical transformer station. The development will consist of Amendment to previously approved application Reg. Ref: 08/404. Permission was granted 22/02/2010.

Pl. Ref. 16/14 - Planning permission for the permission of a period of 15 years and the retention of existing quarry with an extraction area of approximately 1.20 ha. At Castlegannon, Ballyhale. Planning permission was granted 24/10/2016

Pl. Ref. 16/445 – Highfield Solar Limited application for a 10 year permission for the construction of a Solar PV Energy development at Derrynahinch, Knocktopher, within a total site area of up to 10.6ha, to include one, single-storey electrical substation building, electrical transformer/inverter station modules, solar PV panels ground mounted on steel support structures. Granted by Council 17/01/2017.

Pl Ref: 16/778 - ART Generation Ltd application for a solar farm at Tullaroan, Callan, consisting of PV arrays for the generation of electricity of up to 5MW for export to the national grid on

land covering an area of approximately 10.6 hectares (approximately 9.8 hectares for the solar arrays and 0.8 for the existing site entrance and access road) with associated infrastructure. Granted by Council 25/04/2017.

Pl Ref: 16/592- Solar Sense SPV3 Limited applied for permission for a solar photovoltaic installation comprising up to 26,100m2 of solar panels on ground mounted frames, 4 no. inverters housed in 2 units, 1 no.20kV substation, security fencing, new entrance onto public road, access tracks, CCTV; underground cable and ducts including underground cable and ducts along the public road to the entrance of the existing Ballyhale substation within the townland of Kiltorcan, Co. Kilkenny. Kilkenny County Council refused permission but the decision was over turned by ABP and they granted permission 13/02/2018.

Pl Ref: 18/573 – EirGrid plc application for proposed uprate works on the existing 110kV line between Great Island substation, Co. Wexford and Kilkenny substation, Co. Kilkenny, Permission was granted 08/03/2019.

Pl Ref: 19/538 – Solar Sense SPV 3 Ltd applied for permission for the provision of 4 no battery storage container required by the previously granted solar farm in Ballyhale and Kiltorcan, (Reg Ref: 16/592). Permission was granted 25/10/2019.

Ongoing forestry and agricultural activities in the area are also considered. Based on a review of the projects within 10km of the site there are no projects which give rise to significant cumulative impacts on land, soils and geology.

No cumulative impacts on the soils and geology environment are envisaged during the construction, operational and decommissioning stage. Pre mitigation, there will be a slight risk of pollution from hydrocarbons or other leakage from machinery but with mitigation, this is not likely to add to a significant cumulative effect.

8.7 Residual Impacts

The replacement of topsoil, subsoils and rock, with gravels and concrete for the construction of the infrastructure (temporary and permanent) will result in a change in ground conditions within the proposed development site. Overall, this residual effect is permanent but not significant.

Deposits of soft clay and silt were noted in trial pit logs. However, it is considered that these risks can be managed effectively through normal design and construction mitigations and controls to secure the short- and long-term stability of the proposed earthworks including turbine and substation foundations and access roads.

Based on the GI undertaken, together with information obtained from other sources, provides necessary information to assess the suitability of the ground to support the proposed development. There is a very low risk of landslide (high factor of safety) which is further reduced by implementation of the mitigation measures.

All other potential effects on the soil and geological environment will be mitigated through good site practice on vehicular movements, management of pollutant fluids, sustainable use of soils etc. Overall, the residual effects from these aspects will be not significant to imperceptible, temporary and negative.

8.7.1 Summary of Residual impacts

A summary of the significance criteria is outlined below for the construction, operational and decommissioning phase in Tables 8-10 to 8-12.

Table 8-10: Significance of Land and Soils Criteria – Construction Phase (Post-mitigation)

Environmental Attribute (Land, Soil and Geology)	Turbines	Borrow Pits	Cable Route and substation	Access tracks and Construction compounds
Geological heritage sites – County Geological Sites	No IGH sites at proposed site. -Imperceptible			
Contaminated sites	No contaminated sites identified - Imperceptible			
Contamination of soil by potential pollutants/hydrocarbons	Not significant - unlikely, direct and short term on localised soils and bedrock within the site boundary	Not significant - unlikely, direct and short term on localised soils and bedrock within the site boundary	Not significant - unlikely, direct and short term on localised soils and bedrock within the site boundary	Not significant - unlikely, direct and short term on localised soils and bedrock within the site boundary
Identification of karst features	No Karst features - Imperceptible			
Mineral resources and Mines	Not applicable, imperceptible			
Peat stability	No significant peat deposits encountered. Unlikely Imperceptible to Not significant	No significant peat deposits encountered. Unlikely Imperceptible to Not significant	No significant peat deposits encountered. Unlikely Imperceptible to Not significant	No significant peat deposits encountered. Unlikely Imperceptible to Not significant
Soil Stability	No significant peat deposits encountered. Unlikely Imperceptible	No significant peat deposits encountered. Unlikely Imperceptible	No significant peat deposits encountered. Unlikely Imperceptible	No significant peat deposits encountered. Unlikely Imperceptible

Environmental Attribute (Land, Soil and Geology)	Turbines	Borrow Pits	Cable Route and substation	Access tracks and Construction compounds
	to Not significant	to Not significant	to Not significant	to Not significant
Land and Soils (Natural resources)	Not significant - certain and permanent due to relocation of soils and bedrock within the site boundary. Soils to be reused within the site for the restoration of borrow pits and landscaping.	Not significant - certain and permanent due to relocation of soils and bedrock within the site boundary. Soils to be reused within the site for the restoration of borrow pits and landscaping.	Not significant - certain and permanent due to relocation of soils and bedrock within the site boundary. Soils to be reused within the site for the restoration of borrow pits and landscaping.	Not significant - certain and permanent due to relocation of soils and bedrock within the site boundary. Soils to be reused within the site for the restoration of borrow pits and landscaping.

Table 8-11: Significance of Land and Soils Criteria – Operational Phase (Post-mitigation)

Environmental Attribute (Land, Soil and Geology)	Turbines	Borrow Pits	Cable Route and substation	Access tracks and Construction compounds
Geological heritage sites – County Geological Sites	No IGH sites at proposed site. -Imperceptible			
Contaminated sites	No contaminated sites identified – Imperceptible			
Contamination of soil by potential pollutants/hydrocarbons	Not Significant - unlikely, direct and short term due to relocation of soils and bedrock within the site boundary	Not Significant - unlikely, direct and short term due to relocation of soils and bedrock within the site boundary	Not Significant - unlikely, direct and short term due to relocation of soils and bedrock within the site boundary	Not Significant - unlikely, direct and short term due to relocation of soils and bedrock within the site boundary

Environmental Attribute (Land, Soil and Geology)	Turbines	Borrow Pits	Cable Route and substation	Access tracks and Construction compounds
Identification of karst features	No Karst features- Imperceptible			
Mineral resources and Mines	None identified, imperceptible			
Peat stability	No significant peat deposits encountered Imperceptible	No significant peat deposits encountered Imperceptible	No significant peat deposits encountered Imperceptible	No significant peat deposits encountered Imperceptible
Soil Stability	No significant excavations - Imperceptible	No significant excavations - Imperceptible	No significant excavations - Imperceptible	No significant excavations - Imperceptible
Land and Soils (Natural resources)	No significant excavations - Imperceptible	No significant excavations - Imperceptible	No significant excavations - Imperceptible	No significant excavations - Imperceptible

Table 8-12: Significance of Land and Soils Criteria – Decommissioning Phase (Post-mitigation)

Environmental Attribute (Land, Soil and Geology)	Turbines	Borrow Pits	Cable Route and substation	Access tracks and Construction compounds
Geological heritage sites – County Geological Sites	No IGH sites at proposed site. -Imperceptible			
Contaminated sites	No contaminated sites identified - Imperceptible			
Contamination of soil by potential pollutants/hydrocarbons	Not Significant - unlikely, direct and short term due to relocation of soils and	Not Significant - unlikely, direct and short term due to relocation of soils and bedrock within	Not Significant - unlikely, direct and short term due to relocation of soils and bedrock within the site	Not Significant - unlikely, direct and short term due to relocation of soils and bedrock within

Environmental Attribute (Land, Soil and Geology)	Turbines	Borrow Pits	Cable Route and substation	Access tracks and Construction compounds
	bedrock within the site boundary	the site boundary	boundary	the site boundary
Identification of hydrogeological features from the GSI karst database	No Karst features Imperceptible			
Mineral resources and Mines	None identified, imperceptible	None identified, imperceptible	None identified, imperceptible	None identified, imperceptible
Peat stability	No significant peat deposits encountered Not significant	No significant peat deposits encountered Not significant	No significant peat deposits encountered Not significant	No significant peat deposits encountered Not significant
Soil Stability	Not significant, certain and permanent	Not significant, certain and permanent	Not significant, certain and permanent	Not significant, certain and permanent
Land and Soils (Natural resources)	Not significant - certain and permanent due to relocation of soils within the site boundary	Not significant - certain and permanent due to relocation of soils within the site boundary	Imperceptible - No changes to substation and cables as a result of decommissioning	Not Significant - certain and permanent due to relocation of soils within the site boundary

Overall, the potential impacts are of imperceptible/not significant with the implementation of the mitigation measures.

8.8 Conclusion

Overall, the development of a wind farm at Castlebanny, Co. Kilkenny will not have a significant negative impact on the soil and geological environment based on the mitigations measures that will be put in place and managed appropriately throughout the life cycle of the wind farm.

No significant peat deposits are encountered on site which would give rise to peat stability concerns. As detailed in the stability assessment - Appendix 8-2 of the EIAR, due to the very limited depths and extents of peaty soil material identified on the site, the risk of peat instability is negligible in accordance with the Energy Consents Unit Scottish Government (2017) Peat

Landslide Hazard and Risk Assessments, Best Practice Guide for Proposed Electricity Generation Developments – Second edition. No significant soil stability issue occurs on the proposed site.

Results from the GI undertaken, together with information obtained from other sources, provides necessary information to assess the suitability of the ground to support the proposed development. There is a very low risk of landslide due to the lack of peat. The stability risk is further reduced by implementation of the proposed mitigation measures.

Castlebanny Wind Farm is not a sensitive site in terms of the soils and geological environment. This is primarily due to commercial forestry, greenfield status and the sites relatively low geological value. In terms of the soil and geological environment, the proposed project is not expected to contribute to any significant, negative cumulative effects on other existing developments in the vicinity.

8.9 References

- Revised Guidelines on the Information to be Contained in Environmental Impact Statements (Environmental Protection Agency, draft September 2015);
- Advice Notes for Preparing Environmental Impact Statements (Draft September 2015);
- Construction Industry Research and Information Association (CIRIA) 2001, Control of water pollution from construction sites, Guidance for consultants and contractors.
- Construction Industry Research and Information Association (CIRIA) 2015, c750 Groundwater control: design and practice.
- Guidelines on the Information to be contained in Environmental Impact Statements (EPA 2002);
- Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (EPA 2003);
- Geology in Environmental Impact Statements – a Guide (Institute of Geologists of Ireland (IGI) 2002);
- Groundwater Directives (80/68/EEC) and (2006/118/EC);
- Environmental Impact Assessment of National Road Schemes – A Practical Guide (NRA 2008a);
- Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (NRA 2008b);
- Guidelines for the Management of Waste from National Road Construction Projects (Revision 1, NRA 2014);
- Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements (IGI 2013);
- Good practice guidelines on the control of water pollution from construction sites (Construction Industry Research and Information Association (CIRIA 2001);
- Guidelines for Planning Authorities on 'The Planning System and Flood Risk; Management' published in November 2009, jointly by the Office of Public Works (OPW) and the then Department of Environment, Heritage and Local Government (DEHLG);
- Guideline on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (NRA 2008c);
- Guidelines for Planning Authorities on 'The Planning System and Flood Risk Management published in November 2009, jointly by the Office of Public Works (OPW) and the then Department of Environment, Heritage and Local Government (DEHLG); and
- Peat Landslide Hazard and Risk Assessments, Best Practice Guide for Proposed Electricity Generation Developments, Natural Scotland Scottish Executive, 2017, 2nd Ed.
- Environmental Protection Agency., 2020. EPA Map Viewer. http://gis.epa.ie/Envision
- Geological Survey of Ireland., 2016. Department of Communication, Energy and Natural Resources: Online Mapping. https://www.gsi.ie/Mapping.htm
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