9.0 SOILS & GEOLOGY, GEOTECHNICS & GROUND STABILITY

9.1 INTRODUCTION

This chapter assesses the potential impact on land, soils and geology arising from the proposed Oweninny Wind Farm Phase 3 development and associated works project.

The proposed development site is located on Bord na Móna lands at Bellacorick, in North County Mayo, just north of the N59 national road. A full description of the Proposed Development is detailed in Chapter 3 Description of the development. Details of the existing site conditions are presented, potential impacts are assessed, and mitigation measures are recommended where required.

9.1.1 Statement of Authority

TOBIN Consulting Engineers have completed this chapter. TOBIN Hydrologists and Hydrogeologists are intimately familiar with the site characteristics for the Oweninny Wind Farm, having worked on wind farms at Lisheen, Ummeras, Derryadd and Bruckana set in similar ground conditions and water environment.

This chapter has been completed by Mr. John Dillon (BSc, MSc, MCIWM, PGeo), TOBIN Consulting Engineers. John has 18 years of experience in geological assessment for EIS/EIA. John also has experience in the assessment and supervision of renewable energy projects including Curragh wind farm, Castlebanny windfarm, Lisheen Phase III, Derryadd wind farm, Ummeras wind farm, Cloon – Lanesboro 110kv uprate, North South 400kV interconnector, Moneypoint substation, Clonymeath Solar Farm and Laois Kilkenny 400/110 kV substation.

Ciaran Reilly is a chartered geotechnical engineer, holding a PhD in geotechnical engineering from Trinity College Dublin and a BE in civil, structural & environmental engineering from National University of Ireland, Galway. He has strong specialist experience in geotechnical design and a wide range of experience in general civil engineering design and construction management, having worked with consultants, contractors, and clients in the design, checking, construction and project management of a range of geotechnical and civil engineering projects. Ciaran's project experience includes site investigation, landfill remediation, bridges, water and wastewater treatment schemes, flood relief schemes, road, rail, and cycleway/greenway infrastructure, reinforced soil, structural repair, offshore structures, and wind farms.

Joe Greene (BSc, MSc), is a geologist with eight years of experience in the environmental sector in Ireland and the UK. Joe has been involved in Environmental Impact Assessment Reports (EIARs) for grid connections, waste and quarry developments. Orlaith Tyrell (BSc, MSc), is a geologist with two years of experience in the environmental sector in Ireland. Orlaith has been involved in Environmental Impact Assessment Reports (EIARs) for wind farms, grid connections, waste and quarry developments.

9.2 METHODOLOGY

The methodology used to produce this chapter included a review of relevant legislation and guidance, a desktop study, a site walkover, an intrusive investigation, an evaluation of potential effects, an evaluation of the significance of the effects, and an identification of measures to avoid and mitigate effects.

The desktop assessment of the soils and geology included the following resources:

- Publicly available data from the Department of Communications, Energy and Natural Resources (accessed July 2022 and January 2023);
- 1992 Bellacorick wind farm application (Bord na Mona) – Planning references P90/1077 P92/355;
- 2013 Oweninny Wind Farm Application (Oweninny Power Ltd) Planning reference PA0029;
- EPA Environmental Data Maps (https://gis.epa.ie/EPAMaps/) (accessed July 2022 and January 2023);
- GeoHive online data maps (http://map.geohive.ie/)(accessed July 2022 and January 2023);;
- The Geological Survey of Ireland (GSI) website (www.gsi.ie) (accessed July 2022 and January 2023);;
- The GSI 1:100,000 Sheet No. 6 Geology of North Mayo;
- Irish Water – Water Supply Zone mapviewer (www.water.ie) (accessed January 2023);;
- EPA/WFD Water Environment Maps (www.catchments.ie/maps);(accessed July 2022 and January 2023);
- Waste and IPPC licensed facility data from EPA Geoportal; and(accessed July 2022 and January 2023);
- Aerial Photography from ESRI (ArcGIS).(accessed July 2022 and January 2023);

Guidelines and legislation used in the preparation of the report include the following:

- EPA document 'Guidelines on Information to be contained in Environmental Impact Statements' (2022)[1];
- CIRIA (Construction Industry Research and Information Association, UK) technical guidance on water pollution control and on current accepted best practice (CIRIA, 2001);
- Department of Housing, Planning and Local Government Wind Energy Development Guidelines (2006);

[1] http://www.epa.ie/pubs/advice/ea/guidelines/EPA_Guidelines_EIS_2022.pdf (Accessed June 2022)

- Groundwater Directives (80/68/EEC) and (2006/118/EC);
- Institute of Geologists of Ireland (IGI) publication 'Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements' (2013)[2];
- Irish Wind Energy Association (2012). Best Practice Guidelines for the Irish Wind Energy Industry;
- Enterprise Ireland - Best Practice Guide BPGCS005 Oil Storage Guidelines;
- Environment Agency for England and Wales 'Pollution Prevention Guideline (PPG6) Working at Construction and Demolition Sites' ;
- Peat Landslide Hazard and Risk Assessments, Best Practice Guide for Proposed Electricity Generation Developments - Second Edition (Natural Scotland Scottish Executive, 2017);
- Review of Wind Energy Development Guidelines "Preferred Draft Approach" (Department of Housing, Planning, Community and Local Government, 2019); and
- Scottish Natural Heritage (2013) Research and Guidance on Restoration and Decommissioning of Onshore Wind Farms Commissioned Report No. 591/ SNH, Stirling.

Mitigation measures are proposed, where required, to ensure that any proposed activities at the site will not adversely impact upon the geological and water environment outside of the site boundary.

Site surveys relating to the soil and geological environment and ground investigations were undertaken from Nov 2020 to August 2021 These included:

- A site walkover to review the ground conditions and assess the topography, geomorphology and requirements for further investigations was carried in November 2020 and February 2021;
- 101 No. trial pits at proposed turbine locations, potential substation location, along access tracks and potential construction compound;
- 200 No. Hand shear vane tests on the material encountered in the trial pits in 2020 and 2021;
- Geotechnical testing including PSDs, Atterberg Limits, Moisture, Shear Box test, CBRs and Compact tests;
- Peat probing was carried out in areas of peat and at the final proposed substation location in Nov 2020, April 2021, July and August 2021;
- Logging of the soil layers and sampling of each stratum encountered; and
- Laboratory analyses of the samples collected during the above investigations.

Ground investigation locations are provided in Figure 9-3 and within the ground investigation report presented in Appendix 9-1.

Consultation with various state agencies and environmental Non-Governmental Organisations (NGO's) was undertaken to inform the EIA. All project consultation is detailed in Chapter 1 of the EIAR and all responses received are summarised in Chapter 1 (Introduction) of this EIAR. Consultees were informed of updates to the site layout, as appropriate. Consultation letters

[2] http://www.igi.ie/news/updated-eis-guidelines.htm (Accessed June 2022)

were sent (as described in Chapter 1 (Introduction) to the following key parties relevant to this chapter:

- Geological Survey Ireland; and
- Environmental Protection Agency.

Table 9.1: Response to Consultation specific to Soils and Geology

Department	Comments and Recommendations	EIAR Chapter/Section
Geological Survey Ireland	• Geoheritage: Oweninny County Geological Sites (CGS) is present in the vicinity of the proposed development. • Geohazards: No recorded landslides in the area but a past event is recorded approximately 2 km west to the proposed development. • Groundwater • Geotechnical Database Resources	• Ch15 Cultural Heritage • Ch9 Land, Soils & Geology • Ch10 Hydrogeology • Ch11 Hydrology

9.2.1 Evaluation of Potential Effects

The stepped approach to impact assessment proposed in the IGI guidelines (2013) is adopted for the evaluation of potential effects. The baseline environment is assessed by characterising the site topographical, geological and geomorphologic regimes from the data acquired. Following on from the identification of the baseline environment, the available data is utilised to identify and categorise potential effects on the soils and geological environment as a result of the proposed development. These assessments are undertaken by:

- Undertaking preliminary materials calculations in terms of volumetric soil and subsoil excavation and reuse associated with development design;
- Assessing ground stability risks, in particular to peat stability;
- Assessing the combined data acquired and evaluating any likely effects on the soils, geology and ground stability; and
- Identifying effects and considering measures that would mitigate or reduce the identified effect.

Image 1 IGI Guidelines (2013) Stepped approach.

The significance of effects of the proposed development has been assessed in accordance with the EPA guidance document *Guidelines on the information to be contained in Environmental Impact Assessment Reports* (EIAR), April 2022. These are outlined in Chapter 1 (Introduction) of this EIAR. The effects associated with the proposed development are described with respect to the EPA guidance in the relevant sections of this chapter.

9.3 RECEIVING ENVIRONMENT

The existing environment is discussed in terms of geomorphology (landscape and topography), superficial and solid geology, and Peat stability. The regional review of geological conditions covered 2 km from the proposed development site, as suggested in the IGI guidelines. The study area has been defined using relevant guidance and professional judgement to identify potential source-pathway-receptor linkages and likely significant impacts associated with the construction, operation and decommissioning of the proposed wind farm.

9.3.1 Site Description

The proposed development site is located in North Mayo, west of Crossmolina and east of Bangor Erris, just north of the N59 road. Figure 9-1 below shows the site location with respect to the nearby towns and roads. The Phase 3 development will comprise a wind farm consisting of 18 wind turbines , with an overall maximum tip height of 200m within an overall site area of 2,282ha.

The installed turbines will have an individual installed capacity that will range from 4.5MW to 6.5MW. The proposed Oweninny Wind Farm Phase 3 ('the Project') will have a maximum export capacity of approximately 90MW wind energy (81MW to 117MW). Planning permission is sought for a period of 30 years from the date of commissioning. There are 7 proposed turbines to the west of Furnought Hill and 11 proposed turbines located to the north and east of Furnought Hill.

Phase 3 of the development will involve the construction of a 110 kV substation located near within the site bounds. The substation compound will occupy an area of 0.9ha.

Access tracks will also be constructed within the proposed site for Phase 3 of the development. Approximately 28km of access tracks are to be constructed. These will provide access to necessary locations within the site e.g., wind turbines and substation.

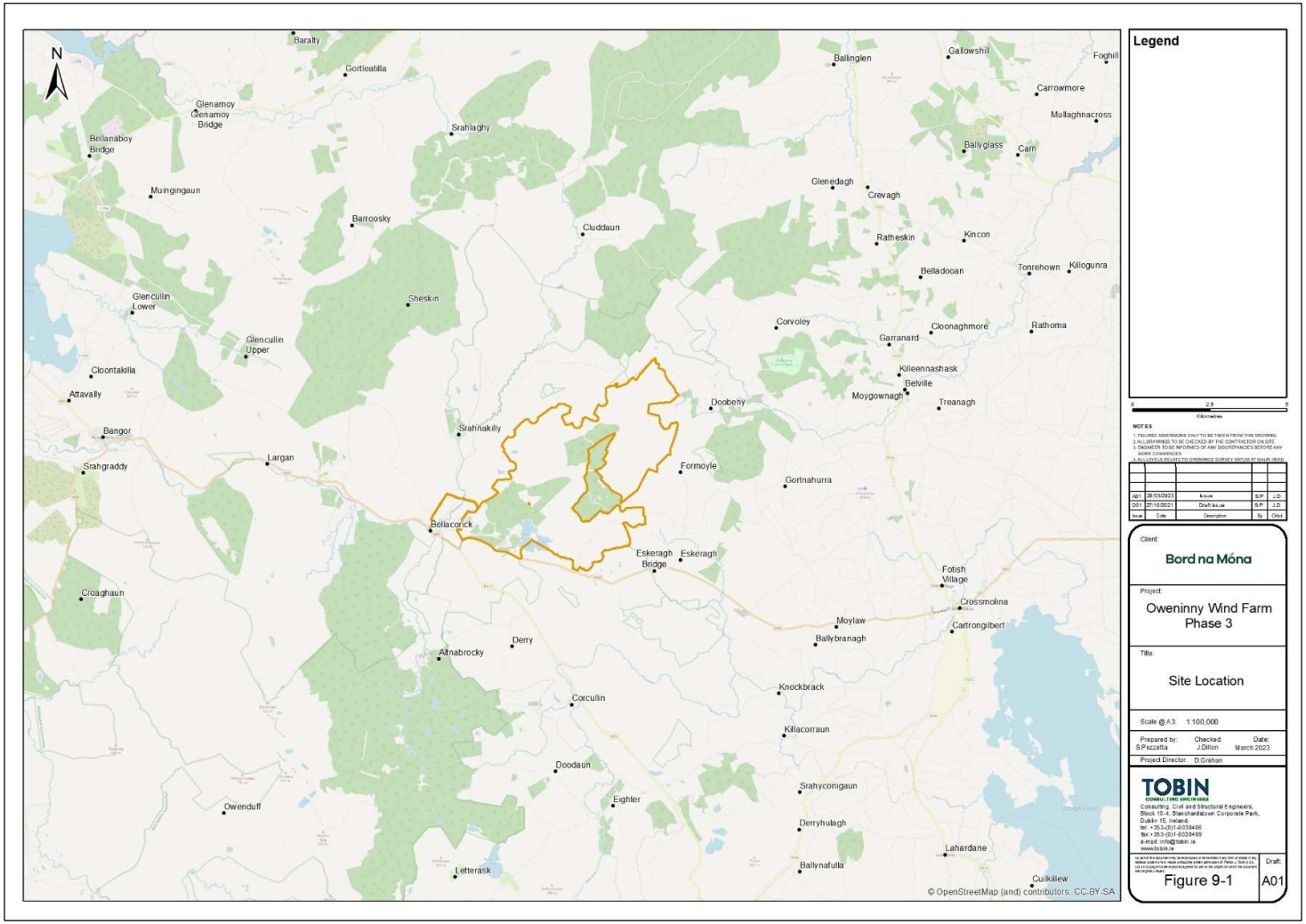

Figure 9-1: Oweninny Wind Farm Phase 3 Site Location Map

9.3.2 Topography and Geomorphology

Information on the topography and geomorphology of the area has been obtained from publicly available data on the GeoHive, GSI and EPA websites as well as Site Lidar data. The site is covered with thick glacial deposits with drumlins, hummocky sand and gravels and esker identified across the site resulting in local variations in topography. Post glacial Peat and alluvial deposits overlay the quaternary deposits.

The topographical elevations range from c.75 to 130 mAOD, with the majority of the site located on the lower and relatively flat-lying areas, currently overlain by cutover blanket peat bog. The proposed turbines are located between 80mOD and 100mOD.

Localised anthropogenic changes to the topography in the form of areas of shallow excavation are also present due to the historic Peat cutting in the area as well as farming. Photo 1 below shows the general topography of the site. Note Furnought Hill which is the elevated area of forestry in the centre background of the photo.

Photo 1: Topography of Oweninny Phase 3 looking south-westwards from the north of the site – Oweninny Wind farm Phase 1 to the right of the photo.

9.3.3 Land Use

The Bellacorick area occupies an important place in the development of Ireland's renewable energy industry. In 1992, Bord na Móna Energy Limited established Ireland's first commercial wind farm on the cutover blanket bog at Bellacorick. In the past, the main activity on the site

was peat harvesting to supply the nearby power station at Bellacorick until peat harvesting operations ceased in 2003. Leave to apply for substitute consent (LS16.311862) was submitted to An Bord Pleanala in November 2021 in relation to previous peat harvesting activities. The peat-burning power station at Bellacorick burned milled Peat from the surrounding bog from 1962 until it was decommissioned in 2005 (the cooling tower was demolished in 2007). A Cutaway Rehabilitation plan was completed at the site between 2003 and 2007. The key purpose of the plan was to environmentally stabilise the site. An application for Leave for substitute consent for the historical peat extraction activity was submitted to An Bord Pleanala (ABP Ref -311862) on the 04/11/2021. No decision has been made on this application to date.

9.3.4 Soils and Subsoils

Reference to the Teagasc Soils Data maps (www.epa.ie) indicates that the site is predominantly covered by cutover peat (Figure 9-2), which was worked in the past by Bord na Móna, and is considered to generally be cut away peat bog. In addition, areas of alluvium have been identified along the western site boundary, along the Bellacorick River channel.

General information concerning the Quaternary geology was obtained from GSI online maps and database, which contain subsoil information from the Teagasc/EPA soil and subsoil mapping project. Glacial till, derived from Devonian and Carboniferous sandstones, is exposed in some areas where the Peat has been cutover. Other areas of gravels derived from similar material and from limestones have also been identified. Some areas of blanket bog are still in place including to the north east of Lough Dahybaun, along the site boundaries and near the afforrested areas of Furnought Hill.

The subsoil is described on the GSI database as having *'Moderate'* permeability and the soil has a '*WET*' drainage pattern across the area of the proposed site. Figure 9-3 below shows the subsoils map for the Phase 3 development site.

Previous site investigation work as part of the 2013 Oweninny Wind farm application, includes over 40 no. trial pits within the boundaries of the proposed Phase 3 site. Locations where site investigations were carried out are identified in Figure 9-4. Relevant information regarding Peat thicknesses extracted from these trial pit logs is summarised in Table 9.2 and Table 9.3 below. Areas where the Peat is noted to extend to a depth of 2m bgl or greater are highlighted. As such, these areas may prove to be less suitable for certain aspects of site development. Issues surrounding Peat thickness, slope and stability are later discussed in detail in Section 9.3.16 .

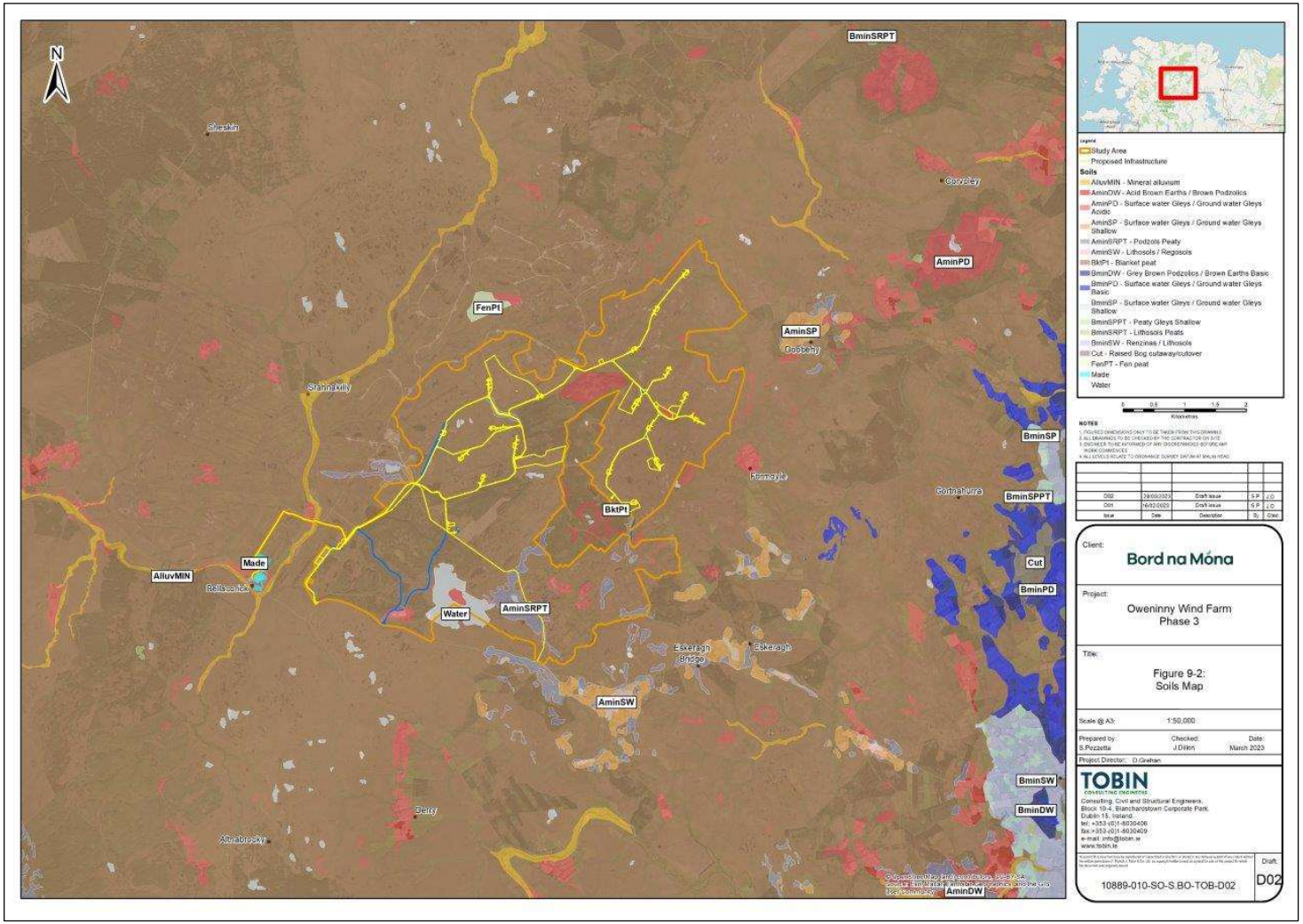

Figure 9-2: Soils Map

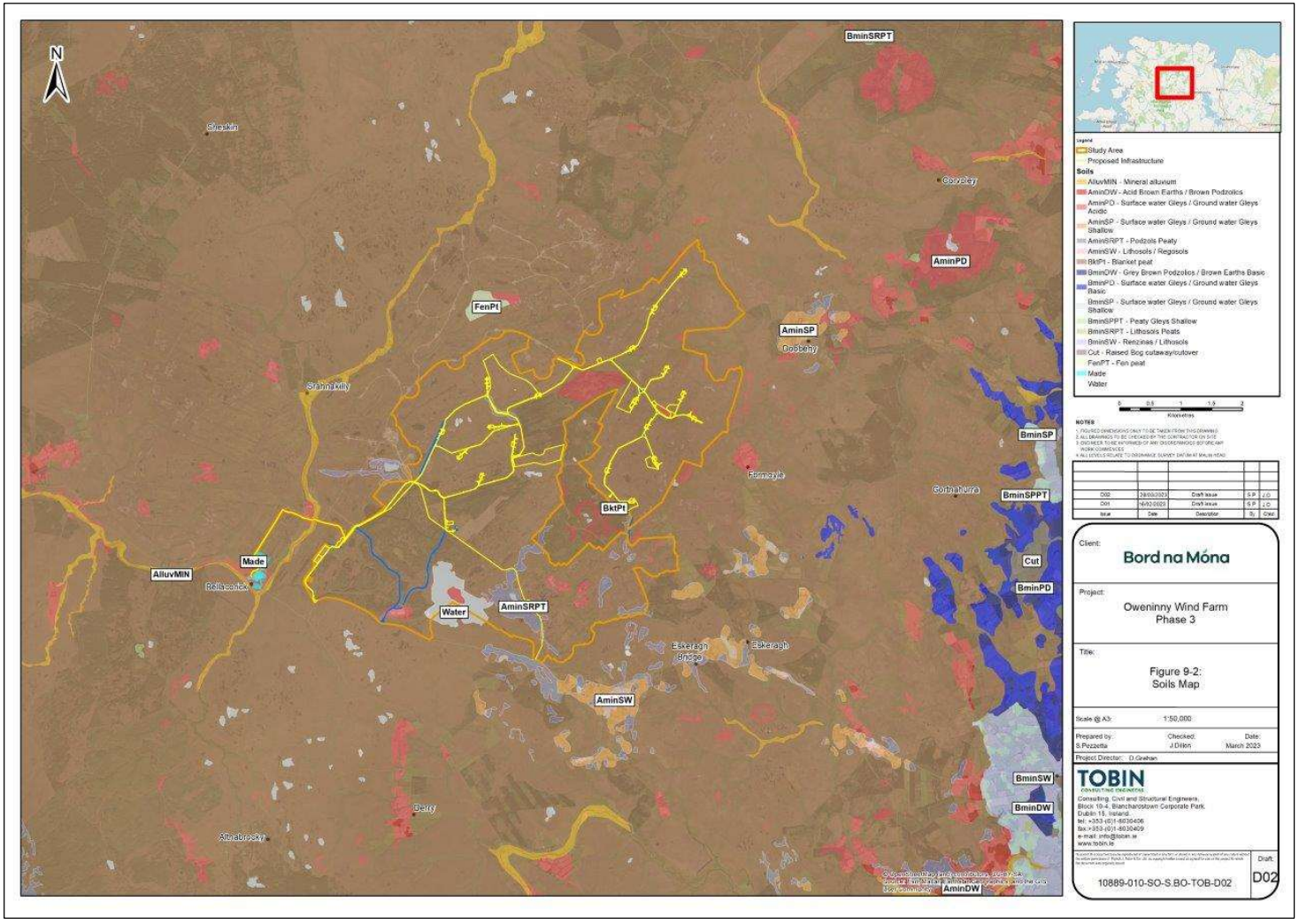

Figure 9-3: Subsoils Map

9.3.5 Site Investigations

A walkover survey was undertaken by TOBIN between the 12th Nov 2020 and the 20th February 2023. Previous Geotechnical ground investigations from 2013 were also used in the site assessment. Geotechnical ground investigations and a peat stability assessment were also undertaken by CRA and GII in 2021. The geological data collated by TOBIN has been used in the preparation of this EIAR Chapter.

A number of phases of ground investigation (GI) of the development area were carried out and are detailed in Table 9.2 and Table 9.3 respectively.

Table 9.2: Ground Investigation – 2013 Summary

Date	Investigation method	Logged by
2013	Trial pitting	ESBi
2013	Rotary Coring	IDL

Table 9.3: Ground Investigation – 2020-2021 Summary

Date	Investigation method	Logged by	Report Available in
November 2020	Trial pitting	Tobin/GII	Appendix 9.2
June 2021		GII	Appendix 9.2
August 2021		Tobin	Appendix 9.2
April 2021	Peat probing	IDL	Appendix 9.3
March 2021		Tobin	Appendix 9.3
December 2020– June 2021	Laboratory Testing	GII	Appendix 9.4

These investigations confirmed the general geology indicated in the geological mapping. The ground investigation indicated that the site is generally covered in peat which overlies soft to firm sandy tills or loose sand and gravels with occasional cobbles. The locations of the ground investigations are shown on Figures 9-4 and details of each investigation location is presented in Appendix 9.1 to 9.4. Mineral subsoils and peat were logged according to BS: 5930 and Von Post Scale respectively. Peat depths ranged from 0.1 to 3m at the proposed turbine locations.

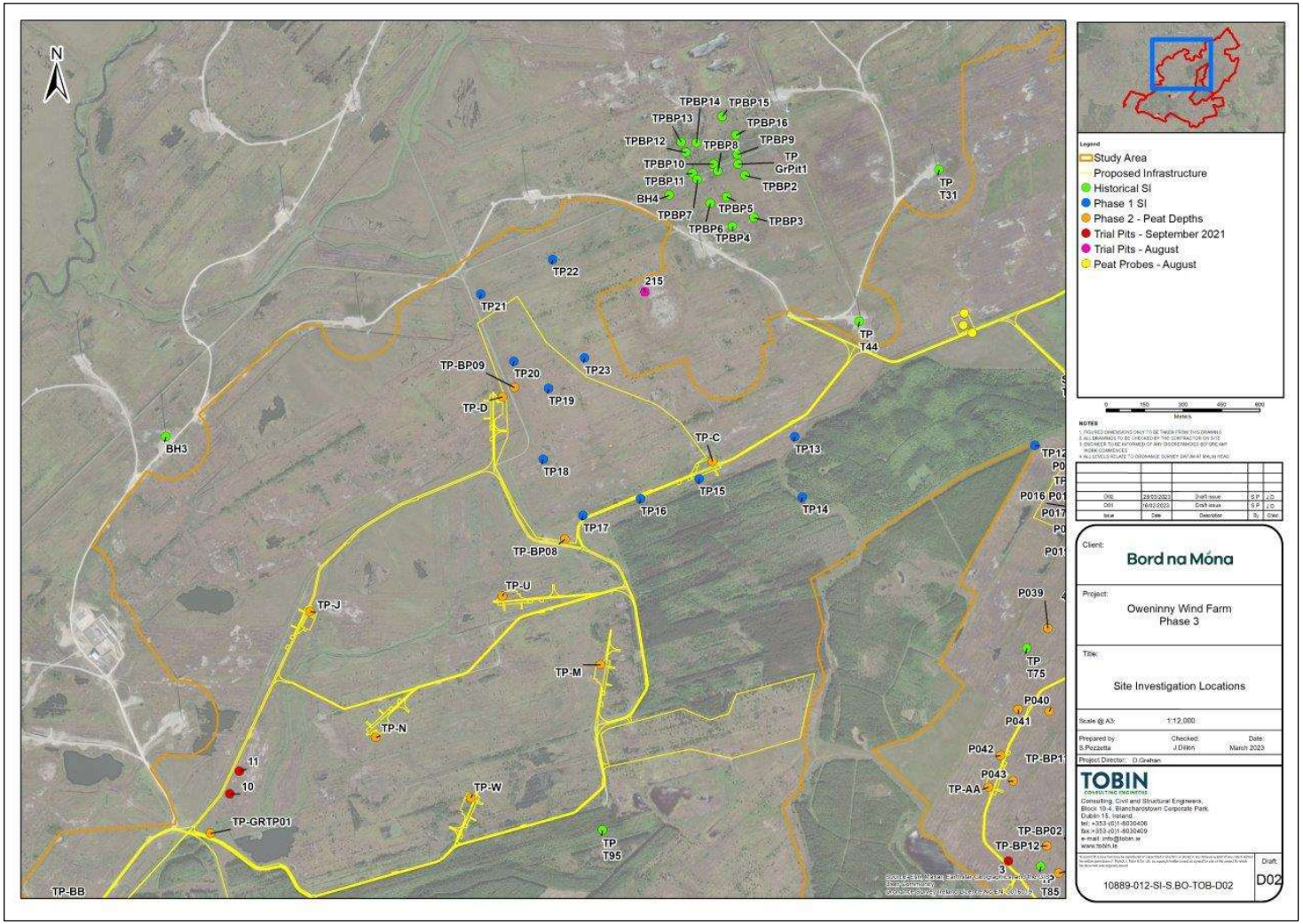

Figure 9-4A Site Investigation Locations Map

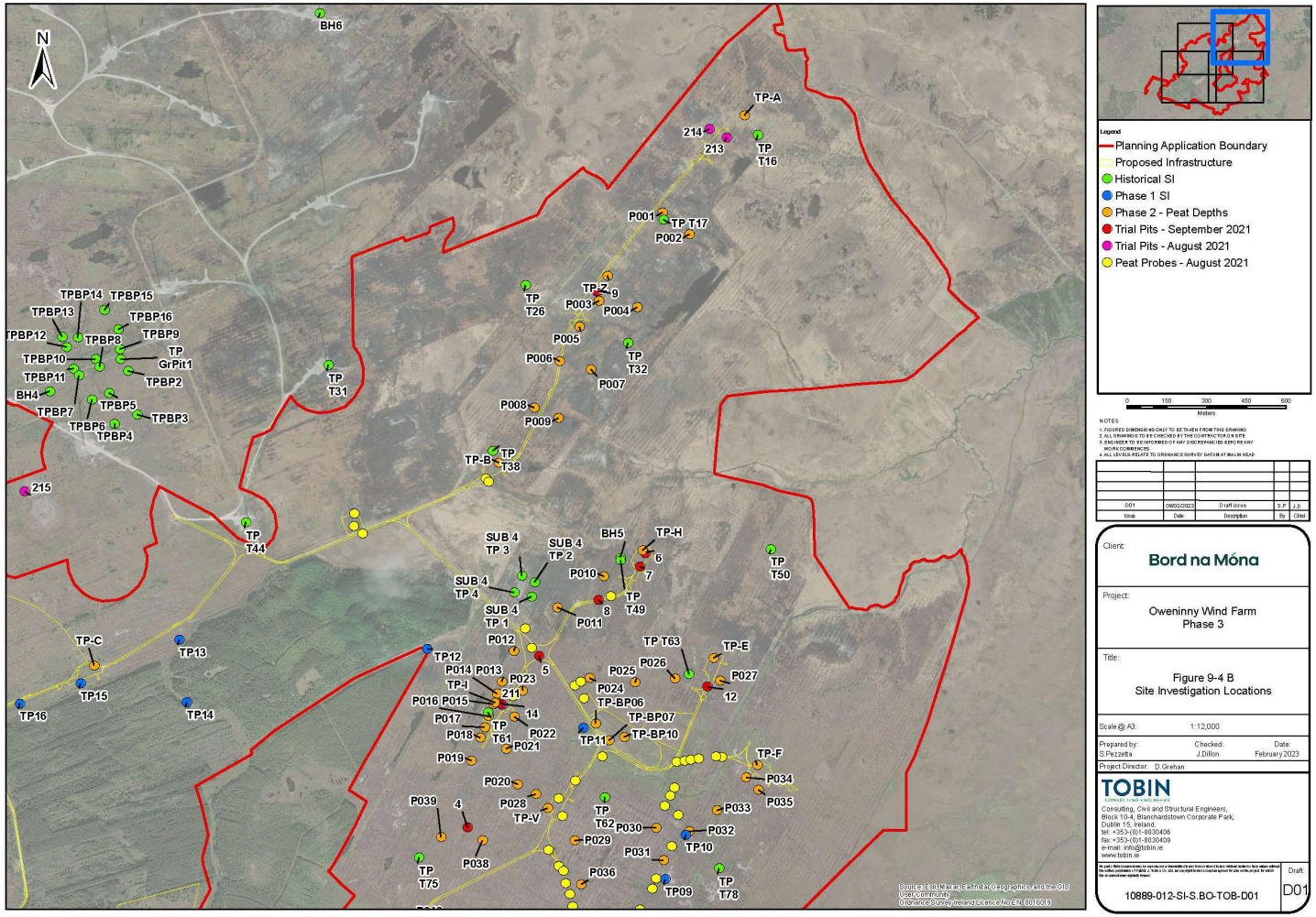

Figure 9-4B: Site Investigation Locations Map

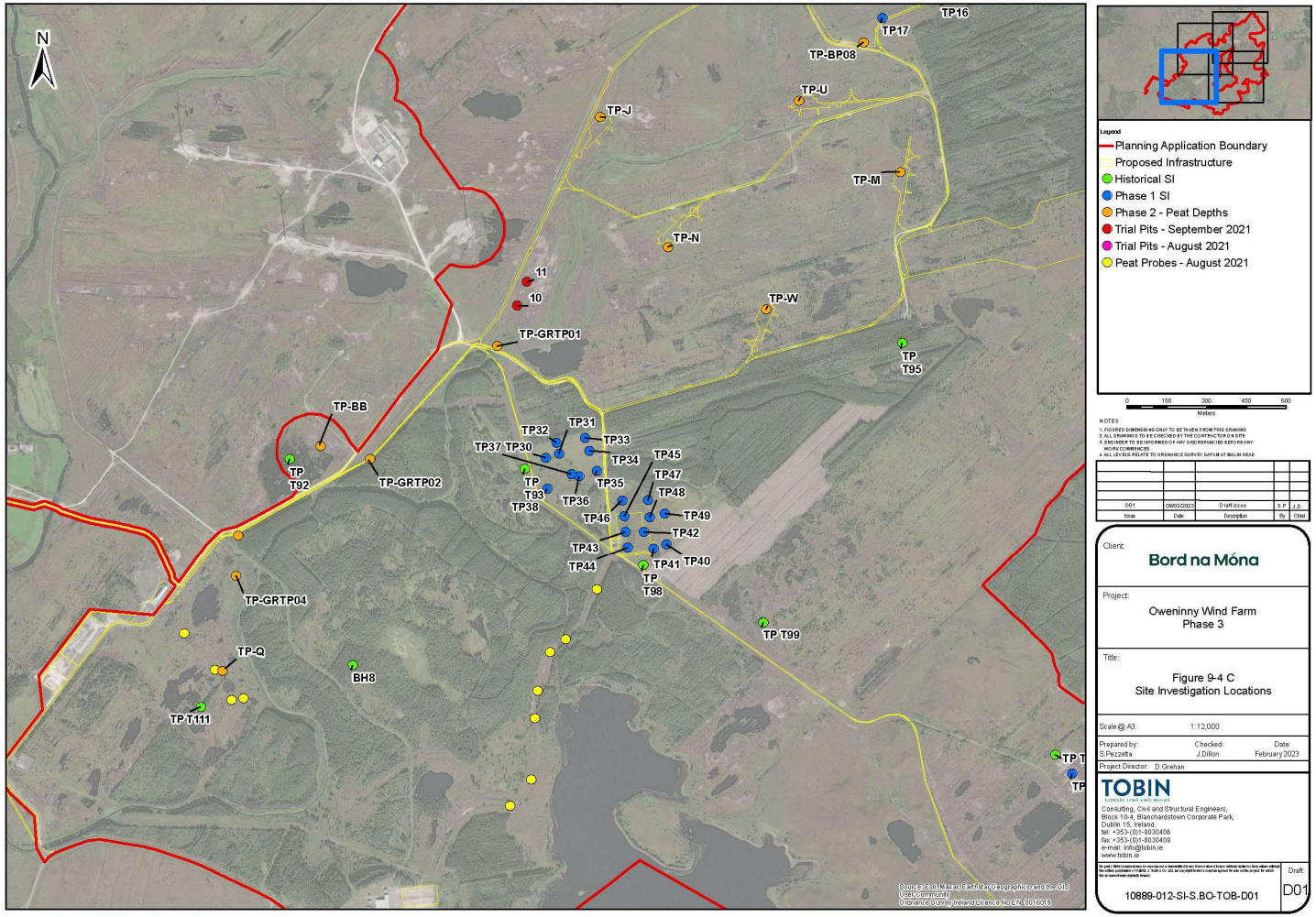

Figure 9-4C: Site Investigation Locations Map

Table 9.4: Turbine locations - Site Investigation

Trial Pit ID	Turbine	Horizon top	Horizon top	Description
TP-J	1	0	1.9	Soft dark brown slightly sandy slightly gravelly fibrous **PEAT** with a strong organic odour, rootlets and tree trunk fragments
TP-W	2	0	0.2	Soft dark brown slightly sandy slightly gravelly pseudo fibrous **PEAT** with moss.
TP-M[3]	3	0	0.1	Soft dark brown slightly sandy slightly gravelly **PEAT** with grass and rootlets.
		0.1	0.9	Soft dark brown slightly sandy slightly gravelly fibrous **PEAT** with tree trunk fragments.
TP-U	4	0	0.9	Soft brown slightly sandy slightly gravelly fibrous **PEAT** with tree trunk fragments.
TP-N	5	0	0.8	Soft dark brown slightly sandy slightly gravelly fibrous **PEAT** with rootlets.
TP-D	6	0	0.1	Soft dark brown slightly sandy slightly gravelly **PEAT** with grass and rootlets.
		0.1	0.9	Soft brown slightly sandy slightly gravelly **PEAT** with a strong organic odour
TP-C	7	0	0.2	Soft dark brown slightly sandy slightly gravelly **PEAT** with grass and rootlets
TP-B	8	0	1.8	Soft slightly sandy slightly gravelly **PEAT** with a strong organic odour.
TP-Z	9	0	1.2	Soft dark brown slightly sandy slightly gravelly fibrous **PEAT**.

[3] Note – More than one trial pit at a number of turbine locations.

Trial Pit ID	Turbine	Horizon top	Horizon top	Description
TP-A	10	0	0.4	Soft dark brown slightly sandy slightly gravelly pseudo fibrous **PEAT** with an organic odour.
TP-I	11	0	1.8	Soft brown slightly sandy slightly gravelly fibrous **PEAT** with a strong organic odour.
TP-AA	12	0	0.2	Soft dark brown slightly sandy slightly gravelly Peat TOPSOIL.
		0.2	2.7	Soft brown slightly sandy slightly gravelly fibrous **PEAT** with an organic odour and tree trunk fragments.
TP-L	13	0	0.8	Soft brown slightly sandy slightly gravelly pseudo fibrous **PEAT**.
		0.8	1.1	Soft light brown sandy gravelly SILT with rare cobbles.
TP-V	14	0	1.5	Soft brown slightly sandy slightly gravelly pseudo fibrous **PEAT**.
		1.5	3.1	Soft brown slightly sandy slightly gravelly fibrous **PEAT** with tree trunk fragments.
TP-G	15	0	0.4	Soft dark brown slightly sandy slightly gravelly pseudo fibrous **PEAT**
TP-F	16	0	0.6	Soft dark brown slightly sandy slightly gravelly pseudo fibrous **PEAT**.
TP-E	17	0	1.6	Soft brown slightly sandy slightly gravelly fibrous **PEAT**.
TP-H	18	0	3	Soft brown slightly sandy slightly gravelly fibrous **PEAT** with a strong organic odour.

Table 9.5: Subsoil Description at Turbine locations

Trial Pit ID[4]	Turbine	Horizon top	Horizon top	Description
TP-J	1	1.9	3.2	Firm grey very sandy slightly gravelly SILT with some subrounded cobbles. Gravel is subangular to subrounded fine to coarse
TP-W	2	0.2	0.6	Firm brownish grey sandy gravelly SILT with some organic matter. Gravel is subangular to subrounded fine to coarse
TP-W		0.6	2.2	Soft grey sandy slightly gravelly SILT with organic matter and some subrounded cobbles. Gravel is angular to subrounded fine to coarse
TP-M	3	0.9	2.2	Firm grey sandy gravelly SILT with occasional subrounded cobbles and rare subrounded boulders. Gravel is angular to subrounded fine to coarse
TP-M		2.2	2.6	Stiff grey sandy gravelly SILT with occasional subrounded cobbles and rare subrounded boulders. Gravel is angular to subrounded fine to coarse
TP-M		2.6	2.9	Grey sandy gravelly SILT with occasional subrounded cobbles and rare boulders. Gravel is angular to subrounded fine to coarse. High groundwater content
TP-U	4	0.9	1.2	Soft grey sandy gravelly SILT with some laminations and occasional subrounded cobbles and rare

4

Trial Pit ID[4]	Turbine	Horizon top	Horizon top	Description
				subrounded boulders. Gravel is subangular to subrounded fine to coarse
TP-U		1.2	2.6	Grey sandy gravelly SILT with occasional subangular to subrounded cobbles. Gravel is angular to subrounded fine to coarse. High groundwater content
TP-N	5	0.8	0.9	Soft brownish grey sandy gravelly SILT with occasional subangular to subrounded cobbles. Gravel is angular to subrounded fine to coarse
TP-N		0.9	2.8	Grey sandy gravelly SILT with some organic matter and sand lenses. High groundwater content
TP-D	6	0.9	1.3	Greyish light brown slightly silty gravelly fine to medium SAND with occasional subrounded cobbles. Gravel is subangular to rounded fine to coarse
TP-D		1.3	2.5	Grey silty gravelly fine to medium SAND with occasional subangular to rounded cobbles. Gravel is subangular to rounded fine to coarse
TP-C	7	0.2	1.1	Soft grey sandy gravelly SILT with occasional subrounded cobbles. Gravel is angular to subrounded fine to coarse
TP-C	7	1.1	3	Firm grey sandy gravelly SILT with occasional angular to subrounded cobbles and some subangular to rounded boulders. Gravel is

Trial Pit ID[4]	Turbine	Horizon top	Horizon top	Description
				angular to subrounded fine to coarse
TP-B	8	1.8	2.5	Firm brownish grey sandy gravelly SILT with some laminations and occasional subangular to rounded cobbles. Gravel is subangular to rounded fine to coarse.
TP-B		2.5	3.2	Grey sandy gravelly SILT with some gravel lenses. Gravel is subangular to rounded fine to coarse. High groundwater content
TP-Z	9	1.2	2.7	Firm grey sandy gravelly SILT with some laminations and occasional subangular to rounded cobbles. Gravel is subangular to rounded fine to coarse
TP-Z		2.7	3.4	Firm to stiff grey sandy gravelly SILT with some laminations and occasional subangular to rounded cobbles. Gravel is subangular to rounded fine to coarse
TP-A	10	0.4	1.2	Firm brownish grey sandy gravelly SILT with some laminations. Gravel is subangular to subrounded fine to coarse
TP-A		1.2	2	Stiff grey sandy gravelly SILT with occasional subrounded to rounded cobbles and some subrounded to rounded boulders. Gravel is subangular to rounded fine to coarse
TP-A		2	3	Grey sandy gravelly SILT with occasional subangular to rounded cobbles and rare

Trial Pit ID[4]	Turbine	Horizon top	Horizon top	Description
				subrounded boulders. High groundwater content
TP-I	11	1.8	2.8	Grey silty slightly gravelly fine to medium SAND. Gravel is subangular to subrounded fine to coarse
TP-I		2.8	3.9	Soft bluish grey sandy gravelly SILT with occasional subrounded cobbles and rare subrounded boulders. Gravel is subangular to subrounded fine to coarse
TP-AA	12	2.7	3.8	Greyish brown silty gravelly fine to medium SAND with some subrounded cobbles. Gravel is angular to subrounded fine to coarse
TP-AA		3.8	4.3	Grey sandy gravelly SILT with some subrounded cobbles. Gravel is subangular to rounded fine to coarse. High groundwater content
TP-L	13	0.8	1.1	Soft light brown sandy gravelly SILT with rare cobbles. Gravel is subangular to subrounded fine to coarse
TP-L		1.1	2.1	Firm brownish grey sandy slightly gravelly SILT with some subrounded cobbles and some laminations. Gravel is subangular to subrounded fine to coarse
TP-L	13	2.1	2.8	Grey sandy gravelly SILT with occasional subrounded cobbles and some black gravel lenses. Gravel is subangular to

Trial Pit ID[4]	Turbine	Horizon top	Horizon top	Description
				subrounded fine to coarse. High groundwater content
TP-V	14	3.1	4.3	Firm grey sandy slightly gravelly SILT with occasional subrounded cobbles. Gravel is subangular to rounded fine to coarse
TP-G	15	0.4	0.6	Firm greyish brown sandy gravelly SILT with occasional subangular to rounded cobbles. Gravel is subangular to subrounded fine to coarse
TP-G		0.6	1.8	Soft grey sandy slightly gravelly SILT with occasional subrounded cobbles. Gravel is subangular to rounded fie to coarse
TP-G		1.8	2.2	Grey with blue lenses sandy gravelly SILT with occasional subrounded cobbles. Gravel is subangular to rounded fine to coarse. High groundwater content
TP-F	16	0.6	0.9	Soft grey sandy slightly gravelly SILT. Gravel is subangular to rounded fine to medium
TP-F		0.9	1.5	Orangey light brown slightly silty gravelly fine to medium SAND with some subrounded cobbles
TP-F		1.5	3.8	Light whitish brown slightly gravelly slightly silty fine to medium SAND with some subrounded cobbles. Gravel is subangular to rounded fine to coarse
TP-E	17	1.6	2.5	Soft grey sandy slightly gravelly SILT with some subrounded cobbles.

Trial Pit ID[4]	Turbine	Horizon top	Horizon top	Description
				Gravel is subangular to subrounded fine to coarse
TP-E		2.5	3.2	Blueish grey sandy gravelly SILT with occasional subrounded cobbles. Gravel is subangular to subrounded fine to coarse. High groundwater content
TP-H	18	3	3.1	Soft greyish brown sandy gravelly SILT . Gravel is subangular to subrounded fine to medium

9.3.6 Bedrock Geology

Information on the bedrock geology was obtained from the Geology of North Mayo, Sheet No. 6 (1:100,000) and accompanying booklet published by the Geological Survey of Ireland (GSI)[5].

The proposed site is underlain by the Downpatrick Formation which is comprised of Carboniferous cross-bedded sandstone and siltstone. The underlying bedrock geology is composed of a sequence of interbedded rock types comprising near shore marine mudstones and siltstones; alluvial and deltaic sandstones and siltstones; and fully marine bioclastic limestones interbedded with calcareous shales. Figure 9-5 below shows the underlying bedrock geology of the proposed site. There are no recorded exposures on the site as the formation is overlain by deep quaternary deposits (www.gsi.ie). The main exposure of the Downpatrick Formation is at Downpatrick head . The Downpatrick Formation comprises marine mudstone and siltstone; alluvial and deltaic sandstone and siltstone; and bioclastic (crinoidal) limestone which are interbedded with calcareous shale.

There are no mapped faults within the site boundary. Faults within the Downpatrick formation are present to the east and west, typically orientated in a northeast southwest direction.

The GSI database contain records of ground investigations carried out approximately 1 km west of the proposed site boundary, consisting of 16 no. boreholes at the site of the former Bellacorick Power Station.

[5] Long, C.B., MacDermott, C.V., Morris, J.H., Sleeman, A.G., & Tietzsch-Tyler, D. 1992. Geology of North Mayo: A Geological Description to accompany the Bedrock Geology 1:100,000 scale map series, Sheet 6, Mayo. Geological Survey or Ireland.

Previous site investigation work in 2013 includes 3 no. boreholes within the boundaries of the proposed Phase 3 site. Relevant information extracted from these borehole logs is summarised below.

Table 9.6:Depth to bedrock for boreholes within Phase 3 boundary

Borehole ID	Depth to Bedrock
BH5 (NE of Site)	8.30 (Obstruction – Rock or boulder)
BH7	15.15m (Moderately strong SANDSTONE)
BH8 (SW of Site)	23.10m (Strong SANDSTONE w/ thin MUDSTONE)

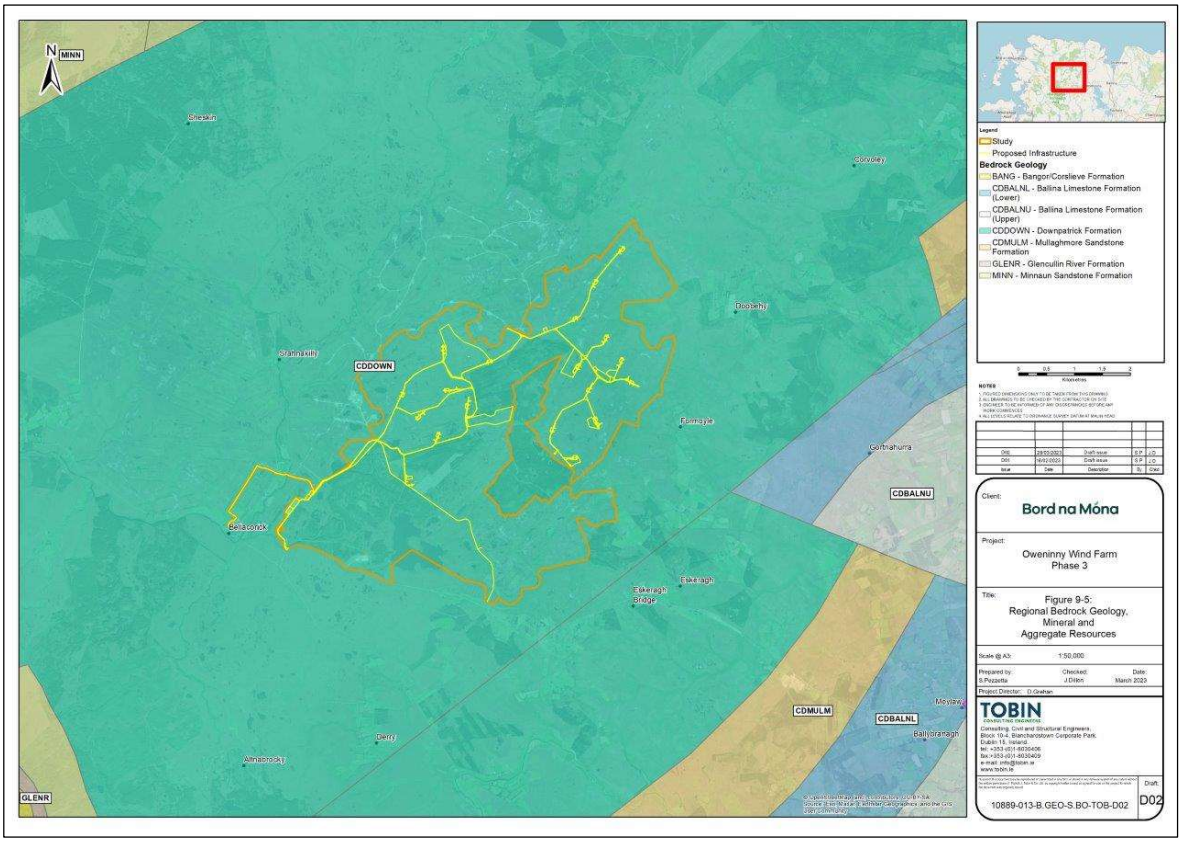

Figure 9-5: Underlying Bedrock Geology Map

9.3.7 Mineral/Aggregate Resources

The GSI database indicates that there are no active quarries, and no mineral locations present within the site boundary. There are 5 no. mineral and aggregate resources located in a zone of

approximately 2 km around the site and these are described as being non-metallic sand and gravel aggregates (Mineral IDs 1217 to 1221). Most of the mineral extraction relates to the extraction of sand and gravel deposits near the N59.

9.3.8 Geological Heritage

The GSI provides scientific appraisal and interpretative advice on geological and geomorphological sites, and is responsible for the identification of important sites that are capable of being conserved as Natural Heritage Areas (NHA).

One geological heritage site is recorded 0.5km to the south west of the nearest proposed turbine and is crossed by the cable route. This is the Bellacorick River (MO011), a meandering river channel within an extensive area of blanket bog. A detailed site report of the Bellacorick River is available through the GSI webite[6]. The geological system comprises Holocene age (post-Ice Age) river channels and Atlantic blanket bog, overlying glacial till (Quaternary) and calcareous sandstones of the Downpatrick Formation (Carboniferous Age).

The site is a Country Geological Site where the Altnabrocky River to the southeast of Bellacorick is within the Bellacorick Bog Complex SAC (001922). The Owenmore River catchment area (including the Oweninny and Altnabrocky catchment areas) is c.340km^2. Located some 7km north-east of Bellacorick at the headwaters of the Sruffaunnamuingabatia (EPA name - Knockmoyle a tributary of the Oweninny River) is the Bellacorick Iron Flush SAC (000466). Significant for the occurrence of Marsh Saxifrage, this site contains a small minerotrophic fen surrounded by drains and extensive areas of mechanically cut peat. No additional geological heritage sites have been identified within 2km of the site boundary.

9.3.9 Contaminated Land

An evaluation was undertaken to determine the presence and extent of potentially contaminated land in the study area. This evaluation is based on the identification of potential sources, pathways and receptors. As the site is predominently peatland, the potential for contamination is very low. No evidence of hydrocarbons was encountered during the site investigaiton works.

[6] GSI Geological Site Report of the Bellacorick River - https://secure.dccae.gov.ie/GSI_DOWNLOAD/Geoheritage/Reports/MO011_Bellacorick.pdf (Accessed June 2021)

A review of the EPA website for existing and historic licensed and illegal waste activities, mines and industries was carried out to identify any potential contamination sources present in the area and to identify any potential contaminating activities near the proposed development.

9.3.10 Waste and Industrial Emissions Facilities

No waste facility licences are recorded within the proposed site boundary. The EPA/WFD online water maps contain a point dataset of Industrial Emissions Licensing facilities. The EPA is the competent authority for granting and enforcing Industrial Emissions (IE) licences for specified industrial and agriculture activities listed in the First Schedule to the Environmental Protection Agency Act 1992 as amended. There is one IEL to the west of the proposed development (P0633).

Table 9.7: IPC Licence P0633

Industrial Emissions License P0633	
Registration No.	P0633-01
Name	Bellacorick Power Limited
Main Class of Activity	2.1: Energy
Licence Status	Ceased (Never Commenced)
Date from	2002
Category	Industry

9.3.11 Integrated Pollution Control (IPC) Sites

The EPA/WFD online water maps contain a points dataset of Integrated Pollution Control (IPC) sites. The EPA has been licensing certain activities since 1994. IPC licensing is governed by the Environmental Protection Agency Act 1992 as amended. Detailed procedures concerning the IPC licensing process are set out in the EPA Act 1992 as amended, and the associated licensing regulations.

IPC licences aim to prevent or reduce emissions to air, water and land, reduce waste and use energy/resources efficiently. An IPC licence is a single integrated licence which covers all emissions from the facility and its environmental management. All related operations that the licence holder carries in connection with the activity are controlled by this licence.

There are 1 no. IPC licenced sites within the proposed site boundary (P0505).

Table 9.8: IPC Licence P0505

Integrated Pollution Control Site P0505	
Registration No.	P0505-01
Name	Bord na Móna Energy Limited (Oweninny)
Main Class of Activity	1.4: Minerals and Other Materials
Licence Status	Licensed
Date from	1999
Category	Industry

This operation ceased activities in 2003. Between 2003 and 2007 , an on-going programme of decommissioning and rehabilitation was implemented. In relation to decommissioning, all production facilities have been decommissioned and removed. All waste materials including rail line, machines etc have been removed. There are no significant contamination present on the IPC site.

The desk study indicated that no illegal waste activities were present within a 2km radius of the proposed area. No on-site evidence of contamination was detected. An application for substitute consent has been made under Section 177E of the Planning and Development Act 2000, as amended. The application for substitute consent relates to historic peat extraction activity within the Oweninny Bog. Peat harvesting operated under an Integrated Pollution Control Licence (IPC Reg. No. P0505-01) issued by the Environmental Protection Agency (EPA) in 2000. In accordance with this licence, a bog rehabilitation programme has been developed and implemented to enhance the rehabilitation of the site.

9.3.12 Aquifer Potential and Characteristics

The aquifer potential of a bedrock unit is determined by the groundwater productivity. The productivity is determined based on hydraulic characteristics compiled from borehole data throughout the county.

Reference to the GSI National Aquifer Map (www.GSI.ie) for the study area indicates that the underlying bedrock unit (Downpatrick Formation of Dinantian sandstones, shales and limestones) is classified as a *'Poor Aquifer – Bedrock which is Generally Unproductive except for Local Zones (Pl)'.*

Aquifer potential and characteristics are discussed further in Chapter 10 Hydrogeology (10.4.2).

9.3.13 Karst Features

The GSI Karst database was consulted for records of locations and types of reported karst features. There are no karst features reported to be located at the proposed wind farm site and no karst features were identified during the site visit. Due to the known geology, the potential to encounter unreported karst features is negligible.

9.3.14 EPA/GSI Source Protection Zones

As reported by the EPA and the GSI, groundwater sources, particularly public, group scheme and industrial supplies, are of critical importance in many regions. Consequently, the objective of Source Protection Zones is to provide protection by placing tighter controls on activities within all or part of the zone of contribution (ZOC) of the source.

According to the GSI/EPA Source Protection Zone Map (www.gsi.ie), there are no Source Protection Zones within the study area or in the surrounding region. Crossmolina Eskeragh Group Scheme source protection zone is c. 7 km south-east of the proposed site. The source is in a separate surface water and groundwater catchment.

9.3.15 Peat and Slope Stability

The GSI web resource indicates Peat related slope stability events on elevated sites to the north and west of the site but does not show any record of such events within 1km of the proposed development.

Ciaran Reilly & Associates carried out a peat stability risk assessment (PSRA) as part of the environmental impact assessment for the proposed Oweninny Phase 3 wind farm site The full report is outlined in Appendix 9.4.

The PSRA was carried out in accordance with Peat Landslide Hazard and Risk Assessments, Best Practice Guide for Proposed Electricity Generation Developments – Second edition (Scottish Government, 2017). The report sets out the methodology used to assess the peat stability risk, the activities undertaken, and the results of the peat stability assessment. The guidance gives four risk levels for Peat stability, which are: insignificant, significant, substantial and serious.

There are no turbines to be located along the northwest of Lough Dahybaun where Peat depths are commonly greater than 2m. However, it is worth noting that peat probing in this area has

found depths of greater than 2m in discreet areas to the east of Furnought Hill and the substation site.

A Peat Management Plan (PMP) has been prepared for the development. Recommendations made in this report and in the PMP will be taken into consideration during the design and construction stage of the proposed development. Best practice guidance regarding the management of Peat stability must be inherent in the construction phase of the project.

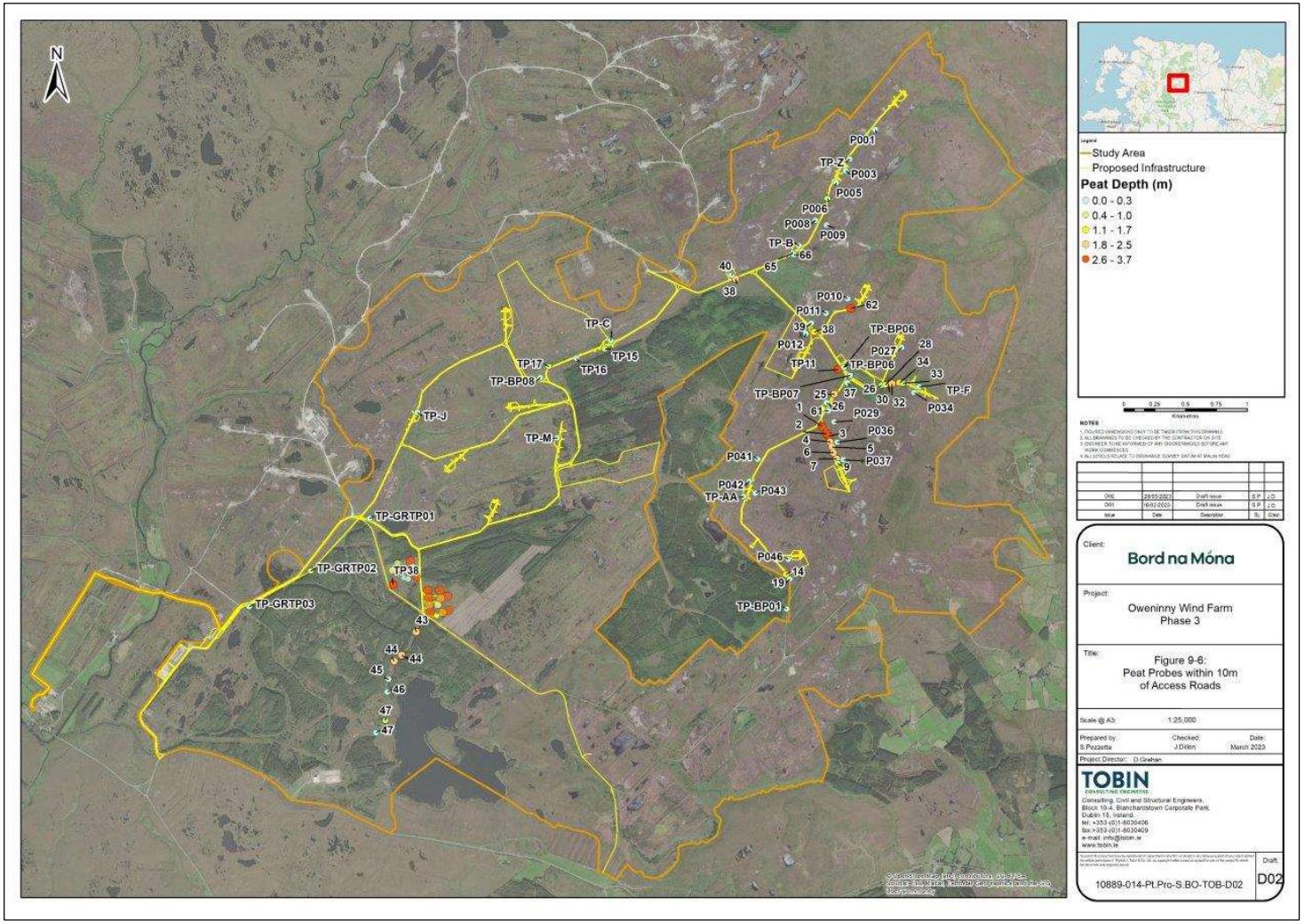

Figure 9-6: Peat Depths

9.3.16 Landslide Events

The GSI database provides information on locations, types, and frequencies of landslide events. On consultation of this database, no records of landslide events were found for the proposed site. The nearest recorded event is located on an elevated afforested site, approximately 2 km to the northeast of the site in 1988 (GSI_ LS05-0019). The landslide occurred within peat bog at an elevation of c.220 mAOD, along a slope gradient of >3˚, and at a northeast slope aspect. No apparent damage occurred. The underlying subsoils were gravels derived from limestone, with overlying blanket peat. The peat stability on site is discussed in greater detail in Section 3.14.

9.3.17 Borrow Pits

The borrow pit selection was based on the following factors:

- Avoidance of potential ecological receptors including intact blanket bog and fens/flushes;
- Avoidance of deeper peat;
- Location near areas of known sand and gravel deposits or gravelly till.

Based on the historical maps, previous and current site data, ground conditions generally consist of Peat cover sand/gravel or boulder clay over boulder clay/glacial gravels over sandstone/siltstone/bioclastic limestone bedrock (Downpatrick Formation).

The Peat at the site has been extensively harvested resulting in large areas of minimal (<0.5m) Peat in some areas. Some remnant undeveloped Peat areas remain on site and were avoided for consideration. Areas of deeper Peat were anticipated and not considered for borrow pit areas. Additionally, several areas of gravels, as delineated on the GSI mapping, were not considered due to ecological constraints such as the presence of intact blanket bog, in particular to the east and northeast of Lough Dahybaun.

Two areas were identified and are detailed below.

Area 1

Area 1 is a complex area overlain by c.0.5m Peat with an area of esker sand and gravels to the south. The esker bead is flanked by glaciofluvial outwash gravels and sands, deposited as fans and deltaic systems. Clean gravels were encountered in TP15, BP08, BP09, TP18, TP19, TP20, TP21 and TP22. Area 1 is located to the east of Oweninny Phase 1 outside of the Zone of contribution for the Bellacorick Iron Flush. There is no proposal to undertake any works within the Bellacorick Iron Flush surface water catchment or zone of contribution.

Peat depths in the area are shallow and underlain predominantly by slightly silty GRAVEL, gravelly SANDs, and some gravelly SILT. This area is also near the proposed borrow pit for Phase 1 of Oweninny Windfarm development. No bedrock was encountered on site. Based on previous SI, bedrock is >8m below ground level. While the overlying deposits are complex, available data indicates approximately 0.5m of Peat and 0.5m of gravelly SILT.

The site won material comprises surrounded sand and gravel. In general, there is a high percentage of sand. Stone is required for the final surface or capping layer will be sourced from off-site, appropriately authorised quarries. The stone material used will have an adequate tensile strength so as to accommodate the movement of heavy vehicles and plant used during the construction phase of the proposed development. The base layers of site won granular fill will not be tracked over by construction machinery until the capping layer has been applied. Geotextile or geogrid material will be placed between the layers of granular fill and surfacing material which will maintain the structural integrity of the upgraded and new roads throughout the construction and operational phases of the proposed development. Geogrids can significantly improve load distribution, minimising rutting and soil intermixing.

Area 2

Area 2 is a sand hill located to the east of Furnought Hill. The sand hill is predominantly comprised of light brown to whiteish gravelly SAND. Trial pits encountered dry gravelly SAND and are summarised below. In addition, Shear Box tests were undertaken at BP10 with results included in appendix A. The friction angle phi' varied between 32.7° and 39.6°. The sand material could be used with geotextiles for the base layers of the site roads. Stone is required for the final surface or capping layer and will be sourced from off-site, appropriately authorised quarries.

There was no bedrock encountered during the trial pitting undertaken at this location.

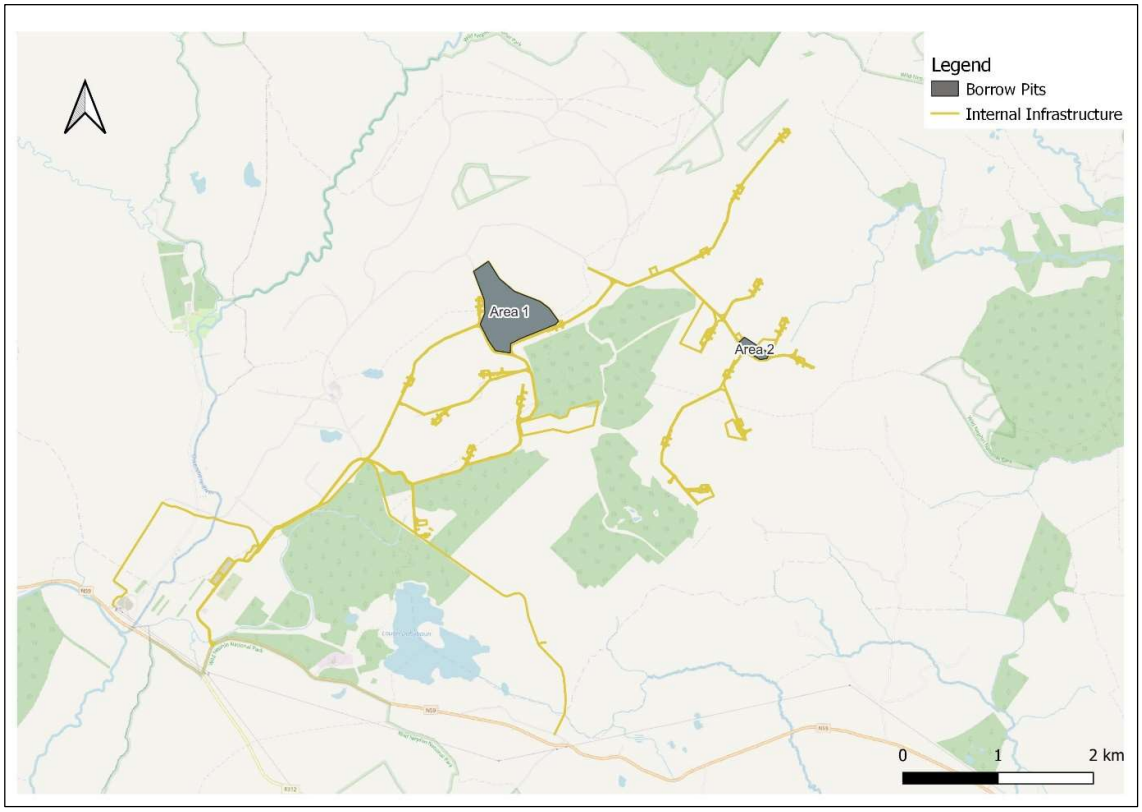

Image 2 Borrow pit locations.

9.3.18 Peat Deposition Areas

The peat deposition areas(PDAs) were based on the following factors:

- Avoidance of potential ecological receptors including intact blanket bog and fens/flushes;
- Location near the source excavation area.

Based on the historical maps, previous and current site data, ground conditions consist of shallow peat cover sand/gravel or boulder clay over boulder clay/glacial gravels over sandstone/siltstone/bioclastic limestone bedrock (Downpatrick Formation). The peat at the site has been extensively harvested resulting in large areas of minimal (<0.5m) peat in most areas. Areas of deeper peat were not considered for borrow pit areas.

Five areas were identified and are detailed below.

PDA 1

PDA 1 is the largest of the proposed peat deposition areas. The area is located to the south of coniferous forestry and to the south east of T3. PDA1 comprises a cutover peat area. Peat depths in the area are generally shallow to the centre of the area and underlain predominantly

by Grey silty slightly gravelly SAND and slightly sandy gravelly SILT. Peat is absent in a number of areas with exposures of the underlying subsoil.

PDA 2

PDA 2 is located to the west of T11 and the east of a coniferous forestry planation. PDA1 comprises a cutover peat area with a former peat railway running southwest to northeast thought the area. Peat depths in the area are generally shallow and underlain predominantly by very silty sandy SAND and slightly sandy gravelly SILT. Peat is absent to the centre of the site with exposures of the underlying subsoil. Peat depths increase to the east and along the headlands.

PDA 3

PDA 3 is located to the north of Borrow Pit B and to the south of T17. PDA3 comprises a cutover peat area. Peat depths in the area are generally shallow and underlain predominantly by very silty SAND and sandy SILT. Peat is absent in a number of areas with exposures of the underlying subsoil.

PDA 4

PDA 4 is located to the south of coniferous forestry and to the south west of T15. PDA4 comprises a cutover peat area. Peat depths in the area are generally shallow and underlain predominantly by greyish brown sandy gravelly SILT. Peat is absent in a number of areas with exposures of the underlying subsoil to the east of the PDA.

PDA 5

PDA 5 is located to the north of coniferous forestry and to the south east of T13. PDA5 comprises a cutover peat area. Peat depths in the area are generally shallow and underlain predominantly by very silty sandy GRAVEL and slightly sandy gravelly SILT. Peat is absent in a number of areas with exposures of the underlying subsoil.

9.4 POTENTIAL IMPACT

The environmental effects 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.

9.4.1 Do-Nothing Scenario

The do-nothing situation relevant to soils and geology is one where the proposed project does not proceed and Bord na Móna continues to manage the site through the surrender of the EPA licence and beyond. Arising from of the rehabilitation plan many areas are slowly revegetating on the site with the formation of a number of surface water ponds. Overall, the bog is showing good signs of recovery. Rehabilitation will continue regardless of wind farm development. In a do-nothing situation, land-use would remain the same. Within the proposed wind farm site, forestry management, including thinning, felling, extraction and replanting, would continue as at present. Agricultural management in the wider area would also continue as at present. This would result in no significant effect to the existing soils and geology conditions in the area.

9.4.2 Potential Effects - Constructions Phase

The proposed development is characterised by the following civil engineering works to provide the necessary infrastructure to complete the wind farm as described in Chapter 3, Description of the Proposed Development:

- Construction of access tracks (permanent and temporary) to the wind turbines, construction compound, met mast and substation;
- Construction of temporary compounds including hard stands, construction material storage areas and site offices;
- Management of excavated materials;
- Excavation for turbine foundations, hardstanding foundations, substation foundations and met masts;
- Excavation of borrow pits, processing of materials and reinstatement;
- Excavation for cable ducts (both onsite and the grid connection); and
- Construction of surface water drainage system along the new internal access tracks.

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

9.4.2.1 Geological Heritage Sites

One geological heritage feature is located within the environs of the site – Bellacorick CGS. One cable crossing is proposed of the Oweninny River. No works are proposed on the Bellacorick CGS riverbanks. It is not anticipated that this upgrade will affect the riverbank beyond the extent of the existing crossing. The potential impact on the Bellacorrick CGS is temporary, direct, slight to imperceptible and likely. No other potential impacts were identified on CGS.

9.4.2.2 Land Use

The site of the proposed wind farm is predominantly covered in bogland that was previously drained for extensive peat harvesting by Bord na Móna. The bog has undergone a rehabilitation phase and is currently showing good signs of recovery (Photo 2). There are some areas of managed coniferous plantations located within the site boundary. There is a network of existing roads/tracks facilitating previous wind farm developments, forestry, agriculture and peat extraction. Soil excavated will be reused within the site for landscaping purposes, therefore the potential impact on forestry/agricultural soils is negligible.

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 will be utilised in the peat deposition areas. Bord na Móna has considerable experience in the moving and storage of peat, both during peat production operations and during the rehabilitation phase associated with its cutaway bogs. All excavated peat and non-peat will be placed/spread locally alongside the proposed infrastructure elements on site, where possible. The peat and soil placed adjacent to the proposed infrastructure elements will be restricted to a depth of 1m over a 10m wide corridor on both sides of the proposed infrastructure elements. Peat will only be reused in stretches of low longitudinal track gradient and in the PDAs.

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, certain and permanent impact due to soil stripping and borrow pit reinstatement/landscaping works.

Photo 2: Aerial Evidence of Bog Rehabilitation

Photo 3: Photo showing the different land-uses at Oweninny; Wind Farms, Agriculture and Forestry

9.4.2.3 Contamination

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. A spill of fuel or oil would

potentially present a slight to moderate, direct, long-term negative effect on the soil and geological environment.

9.4.2.4 Mineral/Aggregate Resources

The ground conditions generally consist of Peat cover sand/gravel or boulder clay over boulder clay/glacial gravels over sandstone/siltstone/bioclastic limestone bedrock (Downpatrick Formation). It is proposed to utilise two borrow pits are proposed for the Oweninny III Windfarm. This action is expected to have a negligible, long-term effect.

9.4.2.5 Management of Excavated Materials

The handling, management and re-use of excavated materials are of importance during the construction phase of the project. Excavated material will arise from all infrastructure elements of the windfarm (bases, access tracks, hardstanding etc.). There is potential for a moderate negative effect on soil due to erosion of inappropriately handled excavated materials. The relatively flat topography of the site reduces the risk of erosion or sediment release to surface waters.

It is intended that unsuitable founding soils and peat will be side casted, bermed and profiled i.e., placed adjacent to works locations. Considering the topography, it should be appropriate to do this across most of the site. It is anticipated that the height of berms and thickness of peat and unsuitably found soils that are side cast will not be greater than 1m. Peat and soils will be stored and used for backfill. Where necessary soils will be transported elsewhere around the site for landscaping, such as near watercourses (to avoid stockpiling there). For the proposed substation, approximately 27,000 m^3 of peat will be excavated and placed in a peat deposition area. This action is expected to have a not significant, short-term negative effect.

For works along the grid connection, 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 used on the site of the proposed development for landscaping and reinstatement, Where contaminants are found the material will be removed from site using an appropriate permitted contractor and disposed at an appropriately licenced facility. This action is expected to have a not significant, short-term negative effect.

Minimal excavations will be required for the Turbine Delivery Route TDR. At road/junction accommodation works along the TDR, the topsoil will be side-cast 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. Hardcore will also be placed directly on the topsoil at works areas of the TDR, no excavated material will be generated however the soil properties will differ from its natural state. Potential effects are negative, slight, direct, long-term, certain effect on peat and soils.

Table 9.9 below provides a summary of the excavation volumes necessary for infrastructure.

Table 9.9: Volume Summary

Area	Peat Volume (m^3)
Hardstanding Foundations	121,000
Turbine Foundations	19,100
Substation and Compounds	27,700
Met Mast	2,300
Underground Cables	12,100
Access Tracks	252,000
Total	363,000

9.4.2.5.1 Construction of Access tracks (Permanent and Temporary) to the Wind Turbines, Construction Compound, Met Mast and Substation

Access tracks will be needed to accommodate the construction works and provide access to turbine locations for the whole life cycle of the wind farm. The access tracks will be constructed mainly using site won material as subbase and unbound crushed aggregates and incorporate drainage to maintain the performance of the pavement during wet weather. The access tracks will be constructed as founded or floating roads. Founded roads are excavated down to and constructed up from a competent geological stratum, whereas floated roads are built directly on top of the peat and soft soils. Where peat is deeper than 1m, floating roads will be used. The access tracks shall be constructed to average heights of 0.5m above existing ground level.

Ground investigation in the form of trial pitting and peat probing have been carried out along the proposed access routes to inform the depth of excavation and upfill required for the access tracks. Volume calculations provide an approximate estimation of fill required for the roads. It is estimated as 121,000 m^3 of material, to be moved to the reuse location.

Material will be imported from locally approved quarries. The potential effect of extracting additional volumes of material from external quarries include additional pressure on transport routes and more fuel consumption. This is discussed in Chapter 17 - Traffic and Transport.

Soil sealing is the covering of a soil with an impermeable material; it often affects agricultural land, puts biodiversity at risk and increases the risk of flooding. This is an inevitable direct effect to some extent of most types of construction. Permeable geotextile is placed at the base of access tracks, along with other infrastructure, as part of their typical design. However, this will have an imperceptible, negative, permanent effect due to the relatively small footprint of infrastructure and its location.

Overall, the construction of the temporary and permanent roads presents a slight, certain permanent, negative effect.

9.4.2.5.2 Construction of Temporary Construction Compounds including Hardstanding, Construction Material Storage Areas and Site Offices

At the commencement of the construction phase a construction compound will be constructed to provide office space, welfare facilities, concrete wash out areas, hardstands for storing materials and hazardous materials. The hardstanding shall be constructed to average heights of 0.5 m above existing ground level.

Volume calculations provide a rough estimation of fill required for the temporary compound area. It is likely that this material volume will be imported from locally approved quarries. As discussed previously, there are potential effects to extraction of materials on site and also from local quarries.

The construction of the temporary compounds presents a not significant, permanent, negative effect. There is a potential for effects on groundwater as a result of washing out of concrete (see Chapter 10 - Hydrogeology).

9.4.2.5.3 Excavation for Turbine Foundations

As a part of the ground investigation , the material encountered at the trial pit locations generally consisted of grey to light brown, soft to firm sandy tills and silty SANDS. The soft peat conditions, require removal for the wind turbine foundations. Deeper excavations to more competent material may be required to construct the turbine foundations. Based on the ground investigation the proposed foundations will be both piled and gravity foundations. As a worst-case design scenario (regarding soils and geology) it is assumed that the foundations will be

gravity bases which require additional excavations and material. For the piled turbine foundations, a driven piling type and configuration could be up to 70 no. 300mm square concrete driven piles. For the bored pile turbine foundations, a driven piling type and configuration is 16 no. 1600mm cylindrical piles. A similar type of pile and configuration was used for the turbine foundations on the Phase 1 and 2 of the Oweninny wind farm. For gravity type turbine foundations, unsuitable material will be excavated and replaced by granular fill (6N) and excavated material will be placed in the peat deposition areas or utilised near the proposed turbines. .

Under the peat and soft soil stability assessment within the PSRA, the results were found to be the same for most turbines as soft ground was encountered in all of these trial pits without confirmation of depth of a competent layer. The risk rating relates to a depth of Peat or Soft sediments identified in these areas. While in the absence of mitigation, areas are rated as *"medium"* risk, it is noted that in all cases a *"low"* risk rating is achieved by the implementation of suitable and common-place mitigation measures (See Appendix 9-2).

Volume calculations provide an estimation of fill required for all the turbine foundations on the assumption piling of the turbine locations are required. It is estimated as35,000 m^3 is required. Material for the construction works will be sourced from site and locally approved quarries.

The potential effect on soils and geology is considered to be not significant, permanent and negative.

9.4.2.5.4 Excavation for Hardstanding Foundations

The environmental effects of the construction of the hardstanding foundations are similar to that of the founded access tracks as discussed above. Ground investigation in the form of trial pitting has been carried out along the proposed hardstanding locations to inform the depth of excavation and upfill required. Volume calculations provide an approximate estimation of fill required for all of the hardstanding foundations.

Similar to the above, the material will be sourced from local quarries. These effects are considered to be negligible, certain, permanent and negative.

9.4.2.5.5 Excavation for Substation Foundation

The construction of the substation foundation will require removal of peat and soil to a competent founding layer and upfilling with concrete or structural fill to the required finished

floor level. Ground investigations at the substation location has been undertaken for the purposes of the EIAR and have been used to inform the depth of excavation and upfill required. Peat/peaty soil is present on the site (2m on average).

Volume calculations provide an estimation of fill required for the foundations for the substation assuming spread foundations are used where they are founded on competent material.

The construction of the substation is anticipated to have negative effects due to the need for extracting material from local quarries. These effects are considered to be slight, certain, permanent and negative.

9.4.2.5.6 Excavation for Met Masts

The construction of met masts will require removal of topsoil and subsoil to a competent founding layer and upfilling with concrete or structural fill to the required foundation formation level. A crane hardstanding will also be required to install the met mast. This will be similar but smaller than those constructed at the turbines. Ground investigations at potential locations have only been undertaken for the purposes of the EIAR and have been used to inform the depth of excavation and upfill required.

Volume calculations provide a rough estimation of fill required for the foundations and crane pad for the met mast, assuming spread foundations are used where it is founded on competent material. The volume of material required for the met mast is minimal (2,800 m^3 material). These effects are considered to be negligible, certain, permanent and negative.

9.4.2.5.7 Grid Connection

Each turbine will connect by underground cable to the onsite substation and from there to the EirGrid Bellacorick 110kV Substation. All cable laying works will be carried out as Drawings 10889-2070 to 2073, It is assumed that initially the contractor will excavate cable trenches and then lay high density polyethylene (HDPE) ducting in the trench in a surround of CBM (cement bound material). A rope will be inserted into the ducts to facilitate cable-pulling later. The as-constructed detail of the cable duct locations will be carefully recorded. Cable marker strips will be placed 75mm above the ducts with two communication ducts also laid.

A layer of cable marker strips will be laid above the communication ducts and the trench backfilled. There is no proposed infrastructure within the public road. Directional drilling is proposed under the local road.

A similar construction methodology will apply for cable trenches laid adjacent to site access tracks. In this case the cable-ducts will generally be laid after the track has been constructed and will be adjacent to the site access tracks. The trenches within these locations will generally be backfilled using the excavated material.

9.4.2.5.8 Borrow Pits

Underlying the peat, slightly silty sand and gravel is present along with silty till and gravelly till. Bedrock is greater than 8m deep across the site so the borrow pits will comprise of sand and gravel deposits and gravelly till.

An initial site walkover was undertaken, and a review of the previous site investigations have been carried out. The borrow pit selection was based on the following factors:

- Avoidance of potential ecological receptors including intact blanket bog and fens
- Avoidance of deeper peat where possible
- Location near areas of known sand and gravel deposits or gravelly till.

Remnant undeveloped peat areas on site are avoided. Areas of deeper peat were anticipated and not considered for borrow pit areas. Additionally, several areas of gravels, as delineated on the GSI mapping, were not considered due to ecological constraints such as the presence of intact blanket bog.

There are three areas considered for the borrow pit location. Area 1 is located to the northwest of Furnought Hill. Area 2 is located to the northeast of Furnought Hill.

With a shallow excavation in the area, material up to 4m bgl or 2.5 m below the water table are accessible with conventional excavators or if required long reach excavators. Wet working can help to limit the impact on local groundwater resources. See Table 9.10 below for dewatering options of the various borrow pit locations. Potential effects for dry working or wet working is negative, slight, direct, long-term, certain effect on peat and soils.

Table 9.10: Dewatering Options for Borrow Pit Areas

Area	Peat Depth	Groundwater Level	Dewatering Options
1	<0.5m	1-2m bgl	Moderate to rapid groundwater inflows encountered in gravels. Dewatering limited by the limited gravel extents. Potential dewatering options include dewatering or dredging.
2	<0.3m	Not Encountered	No significant groundwater encountered. No dewatering required.

A summary of the potential volumes is included in Table 9.11 below. In terms of suitability, Area 2 is the most suitable for material.

Table 9.11: Borrow Pit - Potential Material Volumes and Summary of the Area Characteristics

Area	Peat Depth	Soil Type	Area (ha)	Potential Volume (m^3)	Ecological/Other Constraints
1	<0.5m	Slightly silty gravelly SANDs. No bedrock encountered	43ha-Assume 10 ha for optimum extraction relating to areas of gravel eskers and fans beneath the shallow peat	>400,000 t >200,000 m^3 2.5 m x 100,000 m^2 250,000m^3 x 1.6t/m^3 Overburden 50,000m^3	No significant lakes/former lakes on site, no archaeological features encountered
2	<0.3m	Slightly gravelly SAND with some gravel lenses. No bedrock encountered	3.3 ha	>160,000 t 100,000 m^3 3m x 33,000 m^2 100,000m^3 x 1.6t/m^3	No significant lakes/former lakes on site, no archaeological features encountered

9.4.2.5.9 Peat Deposition Areas

Due to the nature of the development, i.e., deposition of soil and peat, there is the potential for impacting the shallow soil and geology environment. Excavation of peat and subsoil will be required for construction of works for the installation of access roads. This will result in a permanent removal and relocation of cutover peat and subsoil. Estimated volumes of peat and subsoils to be relocated are summarised above. There is no loss of peat or subsoil, as it will all be relocated within the proposed development.

The amount of peat and soil excavated from tracks depends on the final design i.e., cut or floating. Worse case scenarios (all cut roads) were utilised in the excavation calculations. Peat depth information (both probed and extrapolated depths) was used to determine the preliminary estimates of excavation volumes for each of the main infrastructure elements.

The design aimed to minimise further the amount of peat excavated by proposing floating tracks wherever possible. The significance and magnitude of the impact of the use of the peat deposition area is considered slight, direct, certain, permanent effect on peat and subsoil. The assessment of the magnitude has taken account of the deposition of peat on previously harvested areas. The deposition of peat will not significantly impact the geological environment, other than to raise the topographic elevation. Revegetation and rewetting of the peat deposition area may promote to expansion of wetland/peatland habitat. The potential impact on soils and geology is negative, certain, direct, not significant and long term.

9.4.2.5.10 Turbine Delivery Route

In some cases, temporary accommodation works are required along the turbine delivery route such as hedge or tree cutting, temporary relocation of powerlines/poles, lampposts, signage and local road widening. The potential for impacts is limited due to the existing TDR works for Oweninny Phase 1 and Phase 2. Any upgrades to the identified haul route options (including the existing Oweninny phase 1 and 2 TDR – See Chapter 15 Traffic and Transport)) will be carried out in advance of turbine deliveries and following consultation and agreement with Mayo County Council. The potential impact on soils and geology is negative, certain, direct, not significant and short term.

9.4.2.6 Peat and Soil Stability

The peat stability assessment is carried out to determine the stability of peat slopes and to identify areas of peatland that are suitable for development. The findings of the assessment discriminate between areas of stable and unstable peat, and areas of marginal stability where restrictions may apply.

The site is relatively flat lying (0 to 2 degrees) and peat at the site has been drained previously. As part of the PSRA, both Quantitative and Deterministic Assessment was undertaken. A Quantitative Assessment including a review of slope and peat stability risks at Phase 3 was carried out in order to identify more accurate location specific risk. The site is found to comprise the following areas of Peat risk: 40% insignificant risk, 40% significant risk, 20% substantial risk and 0% serious risk.

The findings of the Quantitative assessment indicates a “medium” to “low” hazard ranking for instability related to the requirement for excavations on the site. Any potential collapse will be localised to each individual excavation as opposed to having an effect on the whole project.

A deterministic assessment requires geotechnical information and site characteristics which are obtained from desk study and site walkover, e.g., properties of peat/soil/rock, slope geometry, depth of peat, underlying strata, groundwater, etc. An adverse combination of the factors listed above could potentially result in instability. Using the information above, a factor of safety/overdesign factor is calculated for the stability of individual parcels of peatland on a site. Deterministic stability assessments indicate that the materials are considered to be stable in the short (undrained) and long (drained) term, hence justifying the “low” hazard ranking assigned.

Potential effects are long term, negative, significant, direct and indirect, very low probability effect on peat and subsoils. The findings of the peat stability assessment showed that the proposed Oweninny wind farm site has an acceptable factor of safety, is suitable for the proposed wind farm development and is considered to be at low risk of peat failure.

A Peat Management Plan (PMP) has been prepared for the development. Recommendations made in this report and in the PMP will be updated during the design and construction stage of the proposed development. Guidance regarding the management of Peat stability will be inherent at every stage of the construction phase of the project.

9.4.2.7 Human Health

There are a number of potential negative effects on human health relating to soils, geology and earthworks operations during the construction phase of this project. The most apparent is dust from material extraction and transport of soils and excavated rock which is discussed in Chapter 10- Air Quality.

Other negative effects include the risks to construction personnel associated with earthworks and large excavations such as falling from heights, engulfment, drowning, etc. Potential human health effects will only be present during construction. The effects of the proposed development on human health are discussed in Chapter 6 - Population and Human Health.

9.4.2.8 Accidents/Disasters

Soil erosion due to flooding may be considered another accident or disaster; a site-specific flood assessment is discussed further in the Chapter 10 – Hydrology and Hydrogeology. There is no significant risk of flooding of the critical infrastructure the proposed development.

9.4.3 Potential Effects – Operation

During the operation phase of the project, no significant effects on the soil and geological environment will arise due to the good stability. Any hydrocarbon or oil spills related to the maintenance of the site (access tracks, substation, and turbines) has the potential to negatively affect the ground directly.

Potential effects during the operational phase of the proposed development include:

- Low levels of traffic are 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 have the potential to negatively affect the ground or water directly.

In relation to indirect impacts, small volumes of additional unbound crushed aggregate material may be required during the operation phase where roads/tracks have settled on the subsoil and to resurface unbound roads. Aggregate required will only be sourced from quarries which are listed on the register maintained by the local authority. This 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 roads will therefore pose an imperceptible negative short-term or long-term effect.

The effects of operation on natural resources such as land, soils and geology will be imperceptible and long-term. Peatland rehabilitation in accordance with the EPA IPC Licence will continue during the operation of the wind farm.

9.4.4 Potential Effects – 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 effects in removal of all ground elements

will involve civil works, management of excavated material and accidents and disasters, see sections 9.5 for the potential environmental effects.

Turbine foundations would remain in place underground and would be covered with earth and allowed to revegetate or reseed as appropriate. The site access tracks may be in use for additional purposes to the operation of the wind farm (e.g., amenity access) by the time the decommissioning of the project is to be considered, and therefore it will likely be more appropriate to leave the site access tracks 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.

9.4.5 Summary of Potential impacts

A summary of the significance criteria is outlined below for the construction, operational and decommissioning phase in Tables 9.4 to 9.6.

Table 9.12: 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
Land and Soils (Natural resources)	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	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
Geological heritage sites – County Geological Sites	No IGH sites at proposed site. - Imperceptible	No IGH sites at proposed site. - Imperceptible	No alteration to the CGS - Slight/Imperceptible		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 within the site boundary		Slight - unlikely, direct and short term on localised soils within the	Slight to moderate- unlikely, direct and short term on localised	Slight - unlikely, direct and short term on localised

Environmental Attribute (Land, Soil and Geology)	Turbines	Borrow Pits	Cable Route and substation	Access tracks and Construction compounds
		site boundary	soils within the site boundary	soils within the site boundary
Mineral resources and Mines	None identified, imperceptible	None identified - on site borrow pits to be used thereby reducing demand on external sites - Not significant	None identified, imperceptible	None identified, imperceptible
Peat and soil stability	Not significant, certain and permanent	Not significant, certain and permanent	Not significant, certain and permanent	Not significant, certain and permanent

Table 9.13: 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
Land and Soils (Natural resources)	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	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
Geological heritage sites –County Geological Sites	Imperceptible	Imperceptible	Imperceptible	Imperceptible
Contaminated sites	No contaminated sites identified - Imperceptible			
Contamination of soil by potential pollutants/hydrocarbons	Slight - unlikely, direct and short term on localised soils within the site boundary	Slight - unlikely, direct and short term on localised soils within the site boundary	Imperceptible	Slight - unlikely, direct and short term on localised soils within the site boundary
Mineral resources and Mines	Imperceptible	Imperceptible	Imperceptible	Imperceptible
Peat and soil stability	Not significant, certain and permanent	Not significant, certain and permanent	Not significant, certain and permanent	Not significant, certain and permanent

Table 9.14: 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
Land and Soils (Natural resources)	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	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
Geological heritage sites –County Geological Sites	Imperceptible	Imperceptible	Imperceptible	Imperceptible
Contaminated sites	No contaminated sites identified - Imperceptible			
Contamination of soil by potential pollutants/hydrocarbons	Slight - unlikely, direct and short term on localised soils within the site boundary	Slight - unlikely, direct and short term on localised soils within the site boundary	Imperceptible	Slight - unlikely, direct and short term on localised soils within the site boundary
Mineral resources and Mines	Imperceptible	Imperceptible	Imperceptible	Imperceptible
Peat and soil stability	Not significant, certain and permanent	Not significant, certain and permanent	Not significant, certain and permanent	Not significant, certain and permanent

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

9.5 MITIGATION MEASURES

Mitigation measures for the construction, operation and decommissioning of the proposed Oweninny Phase 3 wind farm to avoid or reduce the potential effect of the proposed development are presented below.

9.5.1 Mitigation by Avoidance

The opportunity to mitigate any effect is greatest at the design period. In this respect Bord na Móna carried out a detailed site evaluation process. This process identified deep peat as a specific constraint. Existing access tracks were utilised where possible (57% of roads or 15.6km out of 28.3km) and areas of remnant bog were avoided.

Furthermore, within the chosen site, those areas of deep peat were identified, and the internal road design sought to avoid those areas where possible. Finally, although it is expected that founded roads will constitute the majority of the site, floating roads will also be considered where suitable. However, there are some risks that cannot be mitigated through design and need to be managed during construction. Mitigation through design is especially applicable in the risk to human health during a project and shall be exercised to minimise the any negative risks present.

9.5.2 Construction Phase

A Construction Environment Management Plan (CEMP) has been developed and can be viewed in appendix 3.1.

Compliance with good construction practice, will be a key requirement for all contractors and it is proposed that the general guidance provided by

- Environment Agency for England and Wales 'Pollution Prevention Guideline (PPG6) Working at Construction and Demolition Sites' , and
- 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 earthworks will not be scheduled to be carried out during severe weather conditions.

9.5.2.1 Geological Heritage

There are no significant works proposed along the Bellacorrick CGS. No works are intended to be required on the Bellacorick CGS as part of the development, except the laying of cables within an existing bridge over the Oweninny.

9.5.2.2 Land-Use

The site of the proposed wind farm is predominantly covered in actively managed rough grassland and bog. There is an extensive network of existing access roads across the site will be used to facilitate the proposed development. Soils excavated will be reused within the site for landscaping purposes and borrow pit reinstatement, therefore the potential impact on is a negative, slight, direct, likely, permanent effect on land use.

9.5.2.3 Contamination

Concrete and cement products may give rise to alkali effluents that may impact on receiving waters.

The following measures are proposed in terms of concrete/cement management:

- Contractors will be required to provide a designated bin for washing down the chutes of concrete lorries on site;
- Wash down and washout of concrete transporting vehicles will take place at a the source site to prevent cementitious material and water entering the surface water network;
- Waste material will be removed from site to an appropriate waste permit facility; and
- Disposal of excess concrete on any part of the construction site will be prohibited.

The following measures are proposed in terms of fuel management:

- Fuel storage and fuelling facilities will be required at several fixed locations and at mobile locations around the site, given the size of the project site it is impractical to track large plant to a single fixed facility.
- Fuel storage and any oil storage will be carried out in accordance with the Enterprise Ireland Best Practice Guide BPGCS005 Oil Storage Guidelines.
- Fuel and oil storage at fixed locations will be in a fixed tank, undercover and within a steel or concrete bund.
- A dedicated impermeable bunded refuelling area will be constructed adjacent to the fixed fuel storage areas.
- Double skinned plastic tanks will not be acceptable at the site for any purpose unless they are placed within fixed concrete or steel external bunds.
- Each fixed fuel and oil storage bunds shall be sized to hold 110 % of the oil volume of the largest tank therein. The fixed fuel and oil storage bunds shall be blind sumped. The rainwater pumped from each bund shall be discharged to the surface water drainage system via an oil interceptor.
- In the event of a spill, the liquid contained in the bund shall be removed by a liquid waste tanker, as will be the contents of the surface water drainage system and oil interceptor. Where refuelling is required on site away from fixed storage locations this will only be

carried out utilising steel intrinsically bunded mobile fuel bowsers. At site refuelling locations, refuelling will take place within mobile bunds, but at a minimum fuel line from the bowser to the plant being fuelled will be contained by drip trays.

- Generators and associated fuel tanks to be used at the site shall either be placed within bunds as per fuel storage tanks or shall be integrated units (i.e., fuel tank and generator in one unit) that are intrinsically bunded. No external tanks and associated fuel lines shall be permitted on site unless these are housed within a fixed bund with the generator.

The contractor's yard/maintenance yard shall incorporate a bund for the storage of small vehicles and oil filled equipment, such as hand portable generators, pumps, etc. Storage of small volume oils or chemicals, in barrels, IBCs, etc, will be stored in a covered bunded area. Where barrels or other containers are required at work locations these shall be stored in enclosed bunded cabinets, and drip trays shall be used where distribution of the material is required.

The main storage areas for oil filled equipment, vehicles, plant, etc, shall be impermeably surface and the discharge of surface water from these areas will be via oil interceptors. An oil spill response plan will be developed for the construction works and appropriate containment equipment will be available at work locations in the event of a spillage. Oil spill response will form part of site personnel induction and training at the site.

All wastes generated on site will be segregated so that where possible and appropriate materials are re-used on site. Residual materials will be collected by licensed waste haulier for appropriate sorting, recycling and disposal.

9.5.2.4 Management of Excavated Materials

The disturbance 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 is an important component of controlling dust and sediment and erosion control. Excavated peat will only be moved short distances from the point of extraction and will be used locally for landscaping or reused in the peat deposition areas. Landscaping areas will be sealed and levelled using the back of an excavator bucket to prevent erosion. Where possible, the upper vegetative layer will be stored with the vegetation part of the sod facing the right way up to encourage growth of plants and vegetation at the surface of the landscaped peat. These measures will prevent the erosion of peat in the short and long term. Peat, overburden, and rock will be reused where possible on site to reinstate borrow pits and other excavations where appropriate.

Peat soils will be either side cast on to the existing cutover bog or placed in the Peat Deposition Areas. Where side casting occurs, it is expected that the existing vegetation extensive area and existing drainage system will remove any risk from generation of silt to surface water bodies. At the large excavation locations, such as turbine bases and substations, silt control measures will be incorporated into work area drainage with the discharge onto cutover bog rather than directly to surface water, which will provide additional silt control.

The PDAs are located in a flat area away from sensitive receptors; the deposition area will be designed to be completed in phases and will include specific drainage and silt controls. On completion the peat deposition area surfaces will be stabilised by the establishment of natural peat land vegetation. Peat deposition area areas (PDA1 to PDA5) are located throughout the development and provide an opportunity for peatland restoration of shallow peat areas and areas where peat is absent.

A key project goal is to incorporate sustainability into the design and construction of the project as is practical. Where mineral soils are encountered in the excavation and construction of site roads, bases, etc, this material will be stockpiled for assessment and subsequent re-use. Where mineral soil is not directly suitable for construction it will be used for reinstatement works and will be geo-engineered as necessary.

Exposed soils can lead to the generation of dust in dry windy conditions or silty run-off in wet conditions. Dust generation will be controlled by wetting soil surface in dry conditions or by covering soil stockpiles with geomembrane. If long term storage is required for reusable soil, particularly where such storage will span spring and summer periods consideration will be given to vegetating the stockpile. To control generation of silt run off soil stockpiles will be surrounded by either silt fencing or toe drain or will be covered. Surface run off from across the construction site will be directed to surface water control areas that may include siltation ponds or similar.

As part of the proposed works two borrow pits are proposed to obtain materials suitable for construction, the purposes of which is to minimise the need for import of aggregates from elsewhere, reducing the project's environmental footprint. The borrow pit will be operated wet through the water table to minimise any impact on groundwater flows beneath the site. It is not intended that the borrow pit be fully reinstated, although it is expected that the borrow pit may be partially reinstated using suitable excess materials arising from the site works. The flooded borrow pit area remaining post reinstatement will be established as a wet land area to maintain and enhance biodiversity.

The site construction traffic will utilise the permanent access track network for access and egress, and this access will be constructed in advance of other ground works in a sequential manner. Where access is required off the permanent road network, access will be made by the placement of bog mats or similar and bridging of drainage channels, the purpose of which is to minimise soil compaction and avoid break up and erosion of the soil.

A Peat Management Plan (PMP) was developed as part of the planning application – See Appendix 9-2. This plan documents how Peat will be managed on site for re-use of materials, the design for on-site re-use and disposal options, and a scheme for the tracking and recording of soil movements.

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.

A physical barrier will 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 carried out during severe weather conditions.

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

9.5.2.4.1 Borrow Pits

All overburden materials to be stripped will be used on site for re-use during the restoration stages. There is no requirement for any peat/silt materials to be removed from the site.

9.5.2.4.2 Grid Connection and cables

All overburden materials to be stripped will be used on site for re-use during the restoration stages. There is no requirement for any peat/silt materials to be removed from the site.

Construction of internal electricity transmission cables will present similar, but lower-level risks, to the construction risks outlined above, and the same mitigation measures will be adopted as above.

9.5.2.4.3 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.

9.5.2.5 Geohazard/Peat and Soil Stability

Mitigation measures will be put in place during the detailed design and construction of the scheme to reduce the likelihood of an individual excavation collapsing.

The risk of peat stability has and will be further minimised and mitigated by optimising the design of the wind farm, by choosing a safe and controlled construction methodology, by having a rigorous documentation and quality control system during construction and by controlling construction activities carefully.

Given the scale of the project a major consideration for the development at this site is the management of the materials excavated as part of the construction works. To this end and in order to further mitigate against any risk of peat instability, it is proposed to remove peat from areas of substantial risk and place this material in areas of insignificant risk upslope of a designed berm or solid road. Side casting of peat in areas of higher risk will not take place unless retained

by a designed structure. Peat deposition areas will also form part of the Peat management solution, and this will be located on low-risk areas of cutover bog. A full material management plan for the various phases of the development will be designed and maintained over the course of the project.

Mitigation measures include stepping or battering back of excavations to a safe angle (as determined through a detailed slope stability assessment by a competent temporary works designer) or construction of a temporary sheet pile wall to support the peat and soft clays during construction. Following mitigation, the hazard ranking of the development is considered to be "low" for all areas. It is concluded that the site is suitable for the proposed development.

The management of peat stability will be ongoing throughout the construction and operational stages of the project and will be managed through the use of a geotechnical risk register.

9.5.3 Operational Phase

Operational activities at the site will focus on the maintenance of wind turbines and associated infrastructure. Oil filled components of the wind turbines will be periodically refurbished and replaced.

Fuel and oil storage and handling requirements will be as detailed for construction, with permanent fuel and oil storage located within permanent covered bunds.

Electrical apparatus, such as transformers, will be required within the substations, all such oil containing electrical apparatus shall be constructed within permanent concrete bunds that shall have been constructed and tested to provide containment. Each bund shall be sized to hold 110 % of the oil volume within the electrical apparatus it encloses. The bunds shall be blind sumped and alarmed to allow the regular removal of clean rainwater by means of a pump. In the event of a spill, the liquid contained in the bund shall be removed by liquid waste tanker, as will be the contents of the surface water drainage system and oil interceptor.

Surface water discharges from permanent storage areas and substation bunds shall be to surface water via an oil interceptor. The oil interceptors at the site shall be subject to a regular inspection and de-sludging to ensure that they retain full operational efficiency.

Site operatives shall receive appropriate training and materials shall be available on site to immediately respond to any fuel or oil spill.

Welfare facilities will be provided at the substation location. These welfare facilities will produce foul effluent and these effluents will be stored in a holding tank prior to removal to an approved treatment facility.

9.5.4 Decommissioning Phase

Decommissioning will comprise the removal of power generation devices and infrastructure to ground level, it is assumed that below ground cabling, etc, would be abandoned in-situ.

Internal access roads could be removed although the Irish Wind Energy Association (IWEA) suggest there may be benefits to leaving them in place (IWEA, 2012). Furthermore, in the context that almost all of the internal roads will have a dual function of providing access to the turbines and amenity trackways it is intended that all of the roadways will be retained.

Concrete bases will be left in the ground, covered with topsoil, and allowed to naturally re-seed in line with IWEA best practises (IWEA, 2017). The area around the bases will be rehabilitated by covering it with locally sourced soil in order to regenerate the vegetation. This will also reduce run-off and sedimentation effects.

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

The risks arising from the decommissioning of the site would be less than those for construction, but mitigation measures for decommissioning would conform to those given for construction and would be anticipated to be fully protective of the environment.

9.6 CUMULATIVE IMPACT

Cumulative effects of this project with other developments in the region, as discussed in Chapter 5 - Policy, Planning and Development Context. Efficient design along with material management 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.

Cumulative effects of this project with other developments in the region, relate to the effects on Hydrology. These developments include other existing or planned developments in the environs of Oweninny Bog and/or developments with the potential to interface with the bog in terms of environmental effects. Key developments in the area include:

- Sheskin Wind Farm;

- Doonleg Wind Turbine;
- Oweninny Bog Substitute Consent; and
- Green Hydrogen Plant (Planning Phase).

Sheskin Wind Farm

Sheskin Wind Farm (Mayo Co. Co. Planning reference: 15825) is comprised of 8 wind turbines and associated works, is located approximately 150 metres from the proposed development. Each turbine will have a maximum overall height of 150 metres. It was granted conditional planning permission 2016 and started construction in 2022. The proposed windfarm will be completed in 2024, prior to the construction of Oweninny Phase 3. An EIAR for this development concluded the implementation of appropriate mitigation measures, the proposed wind farm at Sheskin will have no potential for cumulative impacts with other known projects.

Dooleeg Wind Turbine

Permission for a single wind turbine generator (Mayo Co. Co. Planning Reference: 20467), with an overall max height of 180 metres and 20kV grid connection to Bellacorick 110kV substation. It is located approximately 300m from the proposed development site and was granted conditional permission in 2021. The Wind Turbine is located in the An EIAR and NIS have been produced for this proposed development. The application concluded that this project alone or in-combination with other plans or projects, will not result in significant adverse effects to any European sites.

Oweninny Wind Farm Phase 1 and 2

Oweninny Bog is currently subject to ongoing wind farm development. Construction of Oweninny Wind Farm Phase 1 has been completed and the project is in the operational phase. Oweninny Wind Farm Phase 2 is currently in the construction phase where there is the greatest potential for impact.

The bog remnant and bog rehabilitation areas will not be significantly affected by the wind farm development and the overall site development will be carried out in a manner that integrates with the bog rehabilitation programme. The criteria defining successful rehabilitation are the same with or without the windfarm; Stabilisation of peat through revegetation, mitigation of silt run-off and establishment of wetland communities where possible.

The bog is relatively flat lying, with cutover blanket peat overlying glacial till that in turn overly sedimentary bedrock of mixed lithology. No significant groundwater resources are present at the site, although localised perched groundwater may be associated with areas of granular

overburden. No significant geological resources are known at the site and geological heritage is limited to the banks of the Oweninny/Owenmore River.

Permission for a single wind turbine generator (Mayo Co. Co. Planning Reference: 20467), with an overall max height of 180 metres and 20kV grid connection to Bellacorick 110kV substation. It is located approximately 300m from the proposed development site and was granted conditional permission in 2021. An EIAR have been produced for this proposed development. The EIAR concluded that this project alone or in-combination with other plans or projects, will not result in significant adverse effects to any European sites.

Oweninny Bog Substitute Consent

TOBIN have been commissioned to submit a substitute consent application on behalf of Bord na Mona for the historic peat extraction at Oweninny Bog. Within this application an assessment was carried out on of any likely significant effects on geology as a result of this peat extraction. The proposed development site is located within Oweninny Bog.

A remedial EIAR has been developed (unpublished TOBIN reports) for the Oweninny Bog, which included an assessment on any likely significant effects from the historic peat extraction within the receiving soils and geology environment.

Mayo Green Hydrogen Production Plant

The development of a hydrogen plant (Mayo Co. Co. Planning Reference: 22502) that will produce hydrogen by the electrolysis of water, is proposed at a site approx. 1km from the Oweninny Phase 3 site boundary. The hydrogen produced will be stored on site and available for Injection into the transmission gas network or the removal off site by trucks with tube trailers.

In terms of the potential effects of the Mayo Green Hydrogen Plant development, the biggest risk is during the construction phase of the development as this is the phase when earthworks and excavations will be undertaken at the sites.

The implementation of the proposed mitigation measures will ensure there will be no cumulative significant adverse effects on the soils and geology environment from the proposed hydrogen plant in combination with other relevant developments.

Other Smaller Developments

A review of the Mayo County Council planning portals revealed a number of small scale residential and rural developments (e.g., residential one-off housing and agriculturally based developments) proposed in areas between Crossmolina, Bellacorick and Bangor-Erris in proximity to the proposed development site. Considering the small scale residential and rural developments, there is no potential for significant adverse effects on soils and geology. A full list of planning applications within the wider area of the site are provided in Chapter 5 (Policy, Planning & Development Context) Appendix 5-1 of this EIAR.

9.6.1 Cumulative Assessment

No significant residual effects on any ecological receptor have been identified from the sections above. No significant residual effects were reported for any receptors within any of the nearby wind farm/other assessment reviewed. Taking into consideration other plans or projects no residual cumulative effects are anticipated.

Due to the localised nature of the proposed works within the site boundary, there is no potential for significant, negative cumulative effects in-combination with other local developments on the groundwater environment.

9.7 RESIDUAL IMPACT

The replacement of natural peat, 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, due the relatively low sensitivity of the site and the implementation of the mitigation measures, the residual effect is insignificant and neither permanent nor negative.

Following mitigation procedures, the residual effect in relation to peat stability will be not significant, short-term, negative effect and will be localised to excavations carried out during in construction phase.

All other potential effects on the soil and geological environment will be mitigated through good site practice; vehicular movements, hydrocarbon release, sustainable use of natural resources, human health etc. as discussed previously. Overall, the residual effects, long term and insignificant on the site.

Environmental Attribute	Potential Impact – Construction	Potential Impact – Construction
Geological heritage sites – CGSs	One IGH site crossed with cable route. Slight, short term	Negligible
Land Use	Temporary loss of soils – slight, temporary impacts	Negligible, certain, direct and long term.
Contaminated sites/Contamination	Potential minor contamination, slight to moderate localised, short term	Negligible, certain, direct and long term.
Mineral resources and mines	Negligible, long term effect	Negligible, certain, direct and long term.
Management of excavations Soil Compaction/excavation management	The potential impact on soils and geology is negative, certain, direct, not significant and long term.	Negligible, certain, direct and long term.
Geohazards, GSI karst database, Peat	No karst feature. Peat and soft sediments present and assessed via PSRA. Potential effects are long term, negative, significant, direct and indirect, very low probability effect on peat and subsoils.	Potential effects are long term, negative, significant, direct and indirect, very low probability effect on peat and subsoils.

9.8 SUMMARY

The project site is relatively flat lying, with cutover blanket peat overlying glacial till that in turn overly sedimentary bedrock of mixed lithology. No significant geological resources are known at the site and geological heritage is limited to the banks of the Bellacorick River.

Due to the relatively flat, drained and cutaway nature of the site, Peat stability risk is limited to localised construction areas at the site.

The principal risks associated with soil and geology at the site are the management of soils. It is expected that these risks can be fully mitigated through the implementation of the identified mitigation measures.

Hence, it is not expected that the project will give rise to any significant residual impacts with regard to soil and geology.