GDG
GAVIN & DOHERTY
GEOSOLUTIONS

Illaunbaun Wind Farm - Environmental Impact Assessment Report

Chapter 9: Land, Soil, Geology and Hydrogeology

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

AA	Appropriate Assessment
CCG	Central Clare Group
CEMP	Construction Environmental Management Plan
CIRIA	Construction Industry Research and Information Association
CORINE	Coordination of Information on the Environment
DCENR	Department of Communications, Energy and Natural Resources
DEFRA	Department for Environment, Food and Rural Affairs
DHPLG	Department of Housing, Planning and Local Government
EC	European Commission
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EPA	Environmental Protection Agency
ESB	Electricity Supply Board
EU	European Union
FoS	Factor of Safety
GDG	Gavin and Doherty Geosolutions Ltd
GI	Ground Investigations
GIR	Ground Investigation Report
GPP	Guidance for Pollution Protection
GSI	Geological Survey Ireland
GWB	Groundwater Body
GWDTE	Groundwater Dependent Terrestrial Ecosystem
HSE	Health Service Executive
IGI	Institute of Geologists of Ireland
IWEA	Irish Wind Energy Association
Land Capability for Agriculture	Land Capability for Agriculture
LI	Locally Important (Aquifer)
MLURI	Macaulay Land Use Research Institute
mOD	Metres above Ordnance Datum
NDP	National Development Plan
NMS	National Monuments Service
NPWS	National Parks and Wildlife Service
NRA	National Roads Authority
NU	Namurian Undifferentiated
OSI	Ordnance Survey Ireland
PP	Poorly Productive
PSMP	Peat and Spoil Management Plan
PSR	Peat Stockpile Restriction
PSRA	Peat Stability Risk Assessment
PWS	Public Water Supply
RIGS	Regionally Important Geodiversity Site
RUG	Rock Unit Group
S.I.	Statutory Instrument

SAC	Special Area of Conservation
SBZ	Safety Buffer Zones
SEA	Strategic Environmental Assessment
SIS	Soil Information System
SOP	Standard Operating Procedure
SPA	Special Protection Area
SPT	Standard Penetration Tests
SSSI	Site of Special Scientific Interest
UCS	Uniaxial Compressive Strength
UNESCO	United Nations Educational, Scientific and Cultural Organization
WFD	Water Framework Directive
WMP	Waste Management Plan
WTG	Wind Turbine Generator
ZOC	Zones of Contribution
ZoI	Zone of Influence

GLOSSARY OF TERMS

Term	Description
Acrotelm	The upper, active layer of peat, typically aerated and fibrous, which is subject to seasonal wetting and drying. It plays a role in water movement and vegetation growth within peatlands.
Bedrock Aquifer	A water-bearing geological formation composed of rock (e.g., sandstone, mudstone, siltstone) through which groundwater can move.
Blanket Peat	A type of peatland that forms in areas with high rainfall and low temperatures. It "blankets" the landscape and is characterised by high water content, low strength, and high compressibility.
Central Clare Group	A geological formation of grey to dark grey mudstones, siltstones, and sandstones deposited in marine and fluvio-deltaic environments during the Carboniferous period.
Catotelm	The lower, permanently saturated and highly compressed layer of peat beneath the acrotelm, characterised by low permeability and limited decomposition.
Cross-Bedding	A sedimentary structure characterised by inclined layers within a rock, typically formed by the migration of ripples or dunes in environments like rivers, deserts, or coastal areas, indicating the direction of past flow or wind.
Cumulative Impacts	'The addition of many minor or significant effects, including effects of other projects, to create larger, more significant effects' (as per EPA, 2022).
Extreme Groundwater Vulnerability	A classification denoting area where groundwater is most at risk from surface contamination due to thin or absent overlying subsoil and rapid vertical travel time.
Glacial Till	An unsorted mixture of clay, sand, gravel, and boulders deposited by glacial ice. It can be dense and compact or loose depending on formation processes.
Groundwater Body	A defined volume of groundwater in aquifers that has coherent flow and quality characteristics. The Illaunbaun site lies within the Milltown Malbay GWB.
Groundwater-Dependent Terrestrial Ecosystem	Ecosystems that rely on groundwater to maintain their ecological structure and function.
Indirect Impact	'Impacts on the environment which are not a direct result of the project, often produced away from (the site) or as a result of a complex pathway' (as per EPA, 2022).

Karst	A landscape formed from the dissolution of soluble rocks, often characterised by sinkholes, caves, and underground drainage. No karst features are present within or near the site.
Lamination	Thin, parallel sedimentary layers less than one centimetre thick, often found in low-energy depositional environments such as marine basins.
Mitigation	Measure or action which would avoid, reduce, or remediate an impact.
Mudstone	A fine-grained sedimentary rock composed primarily of clay and silt-sized particles, typically formed in low-energy environments like deep marine settings, lakes, or floodplains.
Peat Stability Risk Assessment	An analysis used to determine the risk of peat movement or landslides under proposed development conditions, incorporating site-specific geotechnical data and best practice guidelines.
Receptor	A feature of the environment (e.g., water body, soil, habitat) that could be affected the Proposed Development.
Sandstone	A clastic sedimentary rock composed mainly of sand-sized mineral particles or rock fragments, typically formed in high-energy environments such as rivers, beaches, or deserts, and often cemented by silica, calcite, or iron oxides.
Siltstone	A sedimentary rock composed predominantly of silt-sized particles, typically finer than sandstone but coarser than claystone, and is often deposited in moderate-energy environments such as river deltas or shallow marine settings.
Source-Pathway-Receptor Model	An environmental risk assessment approach that evaluates potential impacts based on the existence of a contaminant source, a route for it to reach a receptor, and the receptor itself.
Water Framework Directive	EU legislation (2000/60/EC) requiring Member States to achieve good qualitative and quantitative status for all water bodies.
Water Body	A surface water body as defined under the Water Framework Directive (WFD) i.e., a river/stream, lake, transitional, coastal or groundwater body.

9 LAND, SOILS, GEOLOGY AND HYDROGEOLOGY

9.1 INTRODUCTION

Gavin and Doherty Geosolutions Ltd. (GDG) was commissioned by JC Mont Fort to undertake an Environmental Impact Assessment (EIA) of the proposed Illaunbaun Wind Farm, hereafter referred to as the Proposed Development. This chapter of the EIA Report evaluates the potential significant effects of the Proposed Development on land, soils, geology, hydrogeology, and potential contamination during the construction, operation, and decommissioning phases.

The assessment has been carried out in accordance with the Environmental Protection Agency (EPA) Guidelines on the information to be contained in Environmental Impact Assessment Reports (EPA, 2022) and is consistent with the requirements of the EIA Directive 2014/52/EU and Annexes I and II of the Planning and Development Regulations 2001 (as amended).

This chapter comprises of the following elements:

- Summary of relevant legislation, policy and guidance;
- Data sources used to characterise the baseline environment;
- Summary of consultations with stakeholders;
- Methodology followed in assessing the impacts of the Proposed Development (such as information of the receiving environment and the approach taken in assessing the potential impacts);
- Review of baseline conditions;
- Assessment of likely effects arising from the construction, operation and decommissioning of the Proposed Development;
- Identification of further mitigation measures and/or monitoring requirements (if any) in respect of any significant effects (following the 'mitigation hierarchy' of avoidance, minimisation, restoration and offsets in consecutive order); and
- Residual impact assessment determinations to consider the improvements associated with any additional mitigation measures identified during this process.

This chapter forms a critical part of the overall EIA process and provides the necessary technical evidence to support the planning and environmental decision-making for the Proposed Development.

9.1.1 RELEVANT LEGISLATION AND GUIDELINES

The assessment of likely significant environmental effects arising from the construction and operation stages of the Proposed Development, on soils, geology, hydrogeology and contamination, has been undertaken following guidance by the EPA (2022) and in line with the EIA Regulations.

9.1.1.1 NATIONAL AND INTERNATIONAL LEGISLATION

This chapter has been prepared in accordance with the relevant parts of the following national and international legislation:

International (European Union)

- Water Framework Directive (WFD) (2000/60/EC);
- European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2001 – 2018;
- Directives 2011/92/EU and 2014/52/EU on the assessment of the effects of certain public and private projects on the environment, including Circular Letter PL 1/2017: Implementation of Directive 2014/52/EU on the effects of certain public and private projects on the environment (EIA Directive);
- Groundwater Directives 80/68/EEC (Council of the European Union, 1979) and 2006/118/EC (Council of the European Union, 2006); and
- Council Directive 85/337/EEC of 27th June 1985 as amended by Directive 97/11/EC of 3rd March 1997, Directive 2003/35/EC of 26th May 2003 and Directive 2009/31/EC of 23rd April 2009.

National (Ireland)

- Planning and Development Act, 2000, as amended;
- Planning and Development Regulations 2001, as amended;
- Planning and Development Act 2000, as amended;
- Statutory Instrument (S.I.) No. 9 of 2010 European Communities Environmental Objectives (Groundwater) Regulations 2010 and amendments S.I. 389 of 2011, S.I. 149 of 2012, S.I. 149 of 2012 and S.I. 366 of 2016);
- S.I. No. 349 of 1989: European Communities (Environmental Impact Assessment) regulations and subsequent amendments (S.I. No. 84 of 1995, S.I. No. 352 of 1998, S.I. No. 93 of 1999; S.I. No. 450 of 2000; S.I No. 538 of 2001); S.I. No. 30 of 2000 the Planning and Development Act, 2000; and S.I 600 of 2001 Planning and Development Regulations and subsequent amendments, on the assessment of the effects of certain public and private projects on the environment;
- S.I. No. 4 of 1995: The Heritage Act 1995;
- Wildlife (Amendment) Act 2000; and
- European Commission (EC), (Birds and Natural Habitats) Regulations 2011, as amended.

9.1.1.2 RELEVANT POLICIES AND PLANS

The Proposed Development has been reviewed in relation to planning policy specific to the soils, geology, hydrogeology, and contamination. Statutory national and local planning policy frameworks, and associated supplementary guidelines pertinent to this chapter include:

- National Development Plan (NDP) (Department of Public Expenditure and Reform, 2021)

- Our Sustainable Future – A Framework for Sustainable Development for Ireland (Department of the Environment, Community and Local Government, 2012)
- Local Government (Water Pollution) Acts 1977 to 2007
- The Clare County Development Plan 2023-2029

9.1.1.3 GUIDANCE

The assessment is carried out in accordance with guidance listed below:

- Guidance on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU);
- Environmental Protection Agency (2022) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports;
- Institute of Geologists Ireland (2013): Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements;
- National Road's Authority (2008); Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- EPA (September 2015): Draft - Advice Notes on Current Practice (in the preparation of Environmental Impact Statements);
- EPA (September 2015): Draft – Revised Guidelines on the Information to be Contained in Environmental Impact Statements;
- EPA (2003): Advice Notes on Current Practice (in the Preparation on Environmental Impact Statements);
- CIRIA (2015) C741 - Environmental Good Practice On-Site;
- Department of Housing, Planning and Local Government, Wind Energy Development Guidelines (2006);
- Appropriate Assessment of Plans and Projects in Ireland - Guidance for Planning Authorities, DHPLG, 2010;
- Guidance on the Authorisation of Discharges to Groundwater. Environmental Protection Agency, 2011;
- European Communities (2021). Assessment of plans and projects in relation to Natura 2000 sites – Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC;
- Review of Wind Energy Development Guidelines "Preferred Draft Approach" (Department of Housing, Planning, Community and Local Government, 2017); and
- Peat Stability Risk Assessments, Best Practice Guide for Proposed Electricity Generation Developments - Second Edition (Natural Scotland and Scottish Executive, 2017).

9.2 ASSESSMENT METHODOLOGY

9.2.1 STATEMENT OF COMPETENCE

Gavin & Doherty Geosolutions Ltd (GDG) is a specialist engineering consultancy with a foundation in geoscience, environmental services and geotechnical engineering. The company was founded in 2011 and is committed to supporting projects which contribute to the global sustainability agenda, such as enhancing infrastructure, supporting onshore and offshore wind farm developments and general civil infrastructure design.

The members of the GDG EIA team involved in this assessment include:

- **Paul Stafford** is a Chartered Geologist with the Institute of Geologists of Ireland and holds the EurGeol title from the European Federation of Geologists. He has over 10 years of industry experience across the fields of petrophysics, sedimentology, structural geology, and geophysics. Paul has worked on several onshore and offshore renewable projects including Cummeennaboddoge Wind Farm, North Irish Sea Array Offshore Wind Farm and FEXCO Array Offshore Wind Farm.
- **Chris Engleman** is a Chartered Geologist with the Institute of Geologists of Ireland, working in the Onshore Renewables team at GDG. Chris has 5 years of experience in the onshore renewables sector and the field of geological mapping. He works on peat stability and management projects in advance of wind farm construction, ground investigation, rock and soil logging, GIS mapping and geotechnical design. Chris has worked on several onshore and offshore renewable projects including Yellow River Wind Farm, Cummeennaboddoge Wind Farm, Kilgarvan Wind Farm, Carrig Wind Farm, Dublin Array Offshore Wind Farm and Timahoe Solar PV Farm.
- **Roy Harrison** is a Chartered Geologist and Member of the Institution of Environmental Sciences with over 20 years' experience working in the sector, and has led the geoenvironmental EIA aspects of multiple large-scale developments, including wind farm projects (e.g. Middle Muir Wind Farm, Kype Muir Wind Farm, Kype Muir Extension Wind Farm), large-scale transportation projects (e.g. Clyde Waterfront, Renfrew Riverside and Glasgow Airport Investment Area Infrastructure Development Projects, Cross Tay Link Road, A96 Hardmuir to Fochabers) and urban redevelopments (e.g. Dublin Street North, Monaghan).

9.2.2 CONSULTATION

The assessment has been informed by consultation with statutory consultees, bodies with environmental responsibility and other interested parties. The Environmental Impact Assessment Scoping Report, 20136-R-002-00 EIA Scoping Report Illaunbaun Wind Farm, 12/12/2024, summarised the proposed scope of the EIA and was presented to a broad range of consultees. The received responses are reported in Chapter 6: Project Scoping & Consultation. Comments relevant to this chapter are summarised in Table 9-1.

Table 9-1: Consultation Responses

Consultee	Consultee Comments during EIA Scoping	Addressed within the Chapter
National Environment Health Service (HSE)	The EIAR should include a map and a description of the proposed location of each of the proposed wind turbines.	This information can be accessed in Section 2 of Chapter 5: Project Description.
National Environment Health Service (HSE)	The Proposed Development has the potential to have a significant impact on the quality of both surface and ground water. All drinking water sources, both surface and ground water, must be identified. Public and Group Water Scheme sources and supplies should be identified in addition to any private wells supplying potable water to houses in the vicinity of the Proposed Development. Measures to ensure that all sources and supplies are protected should be described. The National Environmental Health Service recommends that a walkover survey of the site is undertaken in addition to a desktop analysis of Geological Survey of Ireland data in order to identify the location of private wells used for drinking water purposes.	Groundwater abstraction points and private wells are detailed in Section 9.4.6.8 of this Chapter, while all surface water is identified in Section 1.3.1 of Chapter 10: Hydrology, Water Quality and Flood Risk. Walkover surveys were undertaken by GDG on several occasions and are discussed in both Technical Appendix A9-01 (Peat and Spoil Management Plan) and Technical Appendix A9-02 (Peat Stability Risk Assessment). Measures to ensure source protection of water supplies are outlined in Section 9.6 of this Chapter.
National Environment Health Service (HSE)	Any potential significant impacts to drinking water sources should be assessed. Details of bedrock, overburden, vulnerability, groundwater flows, aquifers and catchment areas should be considered when assessing potential impacts and any proposed mitigation measures.	Potential impacts are highlighted in Table 2-13 of this chapter, summarising the pre-mitigation impacts on sensitive receptors. Detailed information on the vulnerability and groundwater flows can be found under Section 9.4.6.5 of this Chapter.
National Environment Health Service (HSE)	Any impacts on surface water as a result of the construction of the underground cables should be identified and addressed in the EIAR.	This information can be found in Section 1.4.2 of Chapter 10: Hydrology, Water Quality and Flood Risk.
	A detailed assessment of the current ground stability of the site for the proposed windfarm development and all proposed mitigation measures should be detailed in the EIAR. The assessment should include the impact construction work may have on the future stability of	Ground stability is discussed in detail in both Technical Appendix A9-01 (Peat and Spoil Management Plan) and Technical Appendix A9-02 (Peat Stability Risk Assessment. The potential impacts associated with

Consultee	Consultee Comments during EIA Scoping	Addressed within the Chapter
	ground conditions, taking into consideration extreme weather events, site drainage and the potential for soil erosion.	construction are considered in Table 2-13.
National Environment Health Service (HSE)	Information should be provided on the make and model of the turbines and on construction details for the turbine foundations, including the depth and volume of concrete required. An accurate assessment of the potential impacts of the foundations on water quality and peat stability cannot be undertaken without this information.	This information can be found in Section 2.3.3 of Chapter 5: Project Description.
National Environment Health Service (HSE)	Reference is made to a peat slide which occurred near Ballybofey in Co. Donegal on 13th November 2020 which may have been linked to construction activity at Meenbog Wind Farm. Potential impacts on water supply associated with contamination following a peat slide include sedimentation and alteration of pH levels.	Potential contamination of surface water is discussed in Chapter 10: Hydrology, Water Quality and Flood Risk.
National Environment Health Service (HSE)	The National Environmental Health Service recommends that a detailed Peat Stability/Geotechnical Assessment should be undertaken to assess the suitability of the soil for the proposed development. The EIAR should include provision for a peat stability monitoring programme to identify early signs of potential bog slides ('pre-failure indicators' see the Scottish Government's 'Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Developments 2017)	Peat stability is discussed in great detail in both Technical Appendix A9-01 (Peat and Spoil Management Plan) and Technical Appendix A9-02 (Peat Stability Risk Assessment The potential impacts associated with construction are considered in Table 2-13. Provisions for monitoring of peat stability are outlined in Section 9.9 of this Chapter.
National Environment Health Service (HSE)	All existing or proposed wind farm developments in the vicinity should be clearly identified in the EIAR. The impact on sensitive receptors of the proposed development combined with any other wind farm/renewable energy developments in the vicinity should be considered. The EIAR should include a detailed assessment of any likely significant cumulative impacts of the proposed windfarm development.	Cumulative effects with regards to soils, geology, hydrogeology and contamination are discussed in Section 9.5.6 of this Chapter. A detailed assessment of all cumulative effects associated with the Proposed Development is outlined in Chapter 21 Interactive and Cumulative Effects.

Consultee	Consultee Comments during EIA Scoping	Addressed within the Chapter
Fáilte Ireland	The impact upon Geotourism related to geoheritage within the natural environment, e.g., any impacts on UNESCO Global Geoparks, of which we currently have three on the island of Ireland; Copper Coast in Co. Waterford, Burren and Cliffs of Moher in Co. Clare, and Cuilcagh Lakelands in Cavan and Fermanagh should be considered (where applicable) in this section.	The subject of Geological Heritage is covered in Section 9.4.7 of this chapter.
Fáilte Ireland	Indirect impacts such as material use for extensive landscaping and public realm should also be considered.	These impacts are considered in both technical appendices; Technical Appendix A9-01 (Peat and Spoil Management Plan) and Technical Appendix A9-02 (Peat Stability Risk Assessment.
Fáilte Ireland	Tourism uses can be water intense, depending on development type. Recreational use of a surface water feature, water-based leisure centres etc have different impacts to standard development.	Impacts on surface water features is discussed in Chapter 10 Hydrology, Water Quality and Flood Risk.
Geological Survey Ireland (GSI)	"We would recommend using our various data sets when conducting the EIAR, SEA, planning and scoping processes for developments, plans and policies."	GSI dataset have been implemented in 9.4.

9.2.3 DATA SOURCES

9.2.3.1 PUBLICLY AVAILABLE DATASETS

The comprehensive suite of publicly available datasets that were consulted to identify the baseline conditions at the Proposed Development are outlined in Table 9-2 below.

Table 9-2: Publicly Available Datasets

Source	Name	Description
Geological Survey Ireland (GSI)	Quaternary Mapping	Geological maps of the Proposed Development area produced by the GSI and available on the GSI online map viewer
	Bedrock Mapping	
	Aggregate Potential Mapping	
	Mineral Localities	
	Groundwater Aquifers	
	Groundwater Levels	

Source	Name	Description
	Wells and Springs Locations	
	Karst Database	
	Active Quarries and Pits	
	Subsoil Permeability Mapping	
	Landslide Events	
	Landslide Susceptibility	
	Geological Heritage Audited Sites	
	Groundwater Vulnerability Mapping	
Ordnance Survey Ireland (OSI)	Current and historical ordnance survey maps	Current and historical survey mas produced by the OSI
	Aerial photographs	
Teagasc	Teagasc Soils Data	Surface soil classification and description
Environmental Protection Agency (EPA)	Soil Information System (SIS) National soils	This dataset provides a variety of environmental information
	Corine land cover 2018	
	Waste facilities	
	Watercourses	
	WFD 3rd Cycle Status and Risk Assessments	
	EPA Catchments Unit	
National Parks and Wildlife Service (NPWS)	Mapping within the area of the Proposed Development	This dataset provides information on national parks, protected sites and nature reserves
National Monuments Service (NMS)	State Mining and Prospecting facilities	This dataset provides all recorded archaeological monuments
Department of Communications, Energy and Natural Resources (DCENR)	Minerals Ireland	A booklet containing a list of all current and prospecting mining facilities
	Historic Mine Sites – Inventory and Rosk Classification	An inventory of historic mines in Ireland
Source	Name	Description
Geological Survey Ireland (GSI)	Quaternary Mapping	Geological maps of the Proposed Development area produced by
	Bedrock Mapping	
	Aggregate Potential Mapping	

Source	Name	Description
	Mineral Localities	the GSI and available on the GSI online map viewer
	Groundwater Aquifers	
	Groundwater Levels	
	Wells and Springs Locations	
	Karst Database	
	Active Quarries and Pits	
	Subsoil Permeability Mapping	
	Landslide Events	
	Landslide Susceptibility	
	Geological Heritage Audited Sites	
	Groundwater Vulnerability Mapping	
Ordnance Survey Ireland (OSI)	Current and historical ordnance survey maps	Current and historical survey mas produced by the OSI
	Aerial photographs	
Teagasc	Teagasc Soils Data	Surface soil classification and description
Environmental Protection Agency (EPA)	Soil Information System (SIS) National soils	This dataset provides a variety of environmental information
	Corine land cover 2018	
	Waste facilities	
	Watercourses	
	WFD 3rd Cycle Status and Risk Assessments	
	EPA Catchments Unit	
National Parks and Wildlife Service (NPWS)	Mapping within the area of the Proposed Development	This dataset provides information on national parks, protected sites and nature reserves
National Monuments Service (NMS)	State Mining and Prospecting facilities	This dataset provides all recorded archaeological monuments
Department of Communications, Energy and Natural Resources (DCENR)	Minerals Ireland	A booklet containing a list of all current and prospecting mining facilities
	Historic Mine Sites – Inventory and Rosk Classification	An inventory of historic mines in Ireland

9.2.3.2 SITE WALKOVERS AND INTRUSIVE INVESTIGATIONS

A preliminary site walkover was conducted by a GDG engineer on 12th of April 2022. The purpose of this site visit was to inform the desk-based understanding of the baseline ground conditions and land uses at the Proposed Development. Peat probing was also carried out at this time, with a total of seven measurements taken.

A follow-up detailed peat probing campaign was conducted by GDG staff in April 2022. Further site walkovers, during which additional peat probe measurements were taken, were carried out in July 2023, September 2023, October 2023, and March 2024. The results of the peat probing and their interpretation will be further discussed in Section 9.4.5.2. A total of 422 probe measurements were recorded across the numerous site visits.

The findings of these ground investigations are summarised in the following technical appendices accompanying this Chapter:

- Technical Appendix A9-01: Peat and Spoil Management Plan; and
- Technical Appendix A9-02: Peat Stability and Risk Assessment.

9.2.4 ASSESSMENT OF EFFECTS

The baseline information gathered has been used to assess the value of each receptor relevant to this study (the 'baseline scenario') and its sensitivity to potential effects from the construction, operation and decommissioning of the Proposed Development. This assessment includes consideration of the likely Zone of Influence (ZoI) on soils, geology, hydrogeology, and contamination receptors, with due regard for the 'Do Nothing' scenario.

The impact assessment follows best-practice methodologies outlined in the *Guidelines on the Information to be Contained in Environmental Impact Assessment Reports* (EPA, 2022) and the *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology, and Hydrogeology for National Road Schemes* (National Road Authority, 2008).

A *source-pathway-receptor* model, defined as a connection between the source of impact and a sensitive receptor via an appropriate environmental pathway, has been applied to identify potential environmental impacts arising from project activities. These impacts have been systematically evaluated for their significance, both individually and in combination with other plans and projects. During construction, operational and decommissioning phases, various site activities may affect soils, geology, hydrogeology, and contamination within the Development area.

The importance and sensitivity of receptors in the ZoI have been determined using the criteria in Table 9-3. The magnitude of potential effects has been classified according to Table 9-4, and when combined with receptor sensitivity, this allows for an assessment of significance using the matrix in Figure 9-1.

The potential effects of the Proposed Development are discussed in Section 9.4, with appropriate mitigation measures detailed in Section 9.5. Residual effects are then considered in Section 9.6.

Table 9-3: Sensitivity Criteria (following EPA, 2022)

Importance (Sensitivity)	Definition and Examples
High Receptors with a high quality and/or rarity, local scale and limited potential for substitution/replacement or receptor with a medium quality and rarity, regional or national scale and limited potential for substitution/replacement.	**Geology:** Drift and solid geology underlying the Site is within a designated area (Site of Special Scientific Interest (SSSI) or Regionally Important Geodiversity Site (RIGS) and is of rare or of national importance. Geological resources (e.g. mineral reserves) within the Zone of Influence are of high value and importance.
	Soils: Soils are of very high value and importance, e.g. peat, very highly productive agricultural soils, superficial soils of very high value or geological importance. Land Capability for Agriculture Classes 1-3.
	Hydrogeology: Hydrogeological catchment area is of high value and importance i.e. provides baseflow to rivers, supports high potential Groundwater Dependent Terrestrial Ecosystem (GWDTEs) or used for local private water supplies, e.g. groundwater abstractions for private supply within 250m of the Site (greater than 1m depth excavations) or 0-100m (excavations less than 1m depth). Groundwater typically also has a vulnerability classification of High or Extreme.
	Contamination: Significant contamination of potential high risk to human health or sensitive water environment receptors.
Medium Receptors with a medium quality and/ or rarity, local scale and limited potential for substitution/ replacement or receptor with a low quality and rarity, regional or national scale and limited potential for substitution/ replacement.	**Geology:** Drift and solid geology underlying the Zone of Influence is not within a designated area (SSSI or RIGS) and deposits are of medium value and importance. Geological resources (e.g. mineral reserves) within the Zone of Influence are of medium value and importance.
	Soils: Soils are of medium value, e.g. productive agricultural soils. Capability for Agriculture Class 4.
	Hydrogeology: Hydrogeological catchment area is of medium value and importance and is not generally used for public or private water supplies. Groundwater supports medium potential GWDTE's. Groundwater typically also has a vulnerability classification of Moderate.
	Contamination: Contamination of potential low to moderate or moderate risk to human health or sensitive water environment receptors.
Low Receptors with a low quality and/ or rarity, local scale and limited potential for substitution/ replacement or receptor with a negligible quality and rarity, regional or	**Geology:** Drift and solid geology underlying the Site is not within a designated area (SSSI or RIGS), and deposits are of low value and importance. Geological resources (e.g. mineral reserves) on the Site are of low value and importance.
	Soils: Soils are of low value and importance, e.g. general superficial soils of low value or geological importance. Capability for Agriculture Classes 5-6.

Importance (Sensitivity)	Definition and Examples
national scale and limited potential for substitution/ replacement.	**Hydrogeology:** Hydrogeological catchment area is of low value and importance and is not used for public or private water supplies. Groundwater typically also has a vulnerability classification of Low.
	Contamination: Low levels of contamination unlikely to present a significant risk to human health or sensitive water environment receptors.
Negligible Receptors with a negligible quality and/ or rarity, local scale and potential for substitution/ replacement. Environmental equilibrium is stable and is resilient to changes that are greater than natural fluctuations, without detriment to its present character.	**Geology:** Drift and solid geology underlying the Proposed Development Boundary is not within a designated area, and deposits are of negligible value and importance. Geological resources (e.g. mineral reserves) on the Proposed Development Boundary are of negligible value and importance.
	Soils: Soils are of negligible value and importance, e.g. general superficial soils of negligible value or geological importance. Capability for Agriculture Class 7.
	Hydrogeology: Hydrogeological catchment area is of negligible value and importance and is not used for public or private water supplies. Groundwater typically also has a vulnerability classification of Low.
	Contamination: No identified contamination of potential risk to human health or sensitive water environment receptors.

Table 9-4: Criteria for Rating Magnitude of Effects (following EPA, 2022)

Magnitude of Impacts	Criteria
High Adverse	Results in loss of attribute, i.e. long term, permanent change to receptors resulting from activities associated with the Proposed Development, e.g. major changes to the hydrogeological regime or complete loss of soil / carbon resource.
Medium Adverse	Impacts integrity of attribute or results in loss of part of attribute, i.e. short to medium term change to receptors resulting from activities associated with the Proposed Development, e.g. non-significant alteration to the hydrogeological regime or substantial loss of soil / carbon resource.
Low Adverse	Results in minor impact on attribute, i.e. detectable but non-material and transitory changes to receptors resulting from activities associated with the Proposed Development, e.g. minor alteration to the hydrogeological regime or minor loss of soil / carbon resource.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect the use/integrity, i.e. negligible changes to receptors resulting from activities associated with the proposed development.

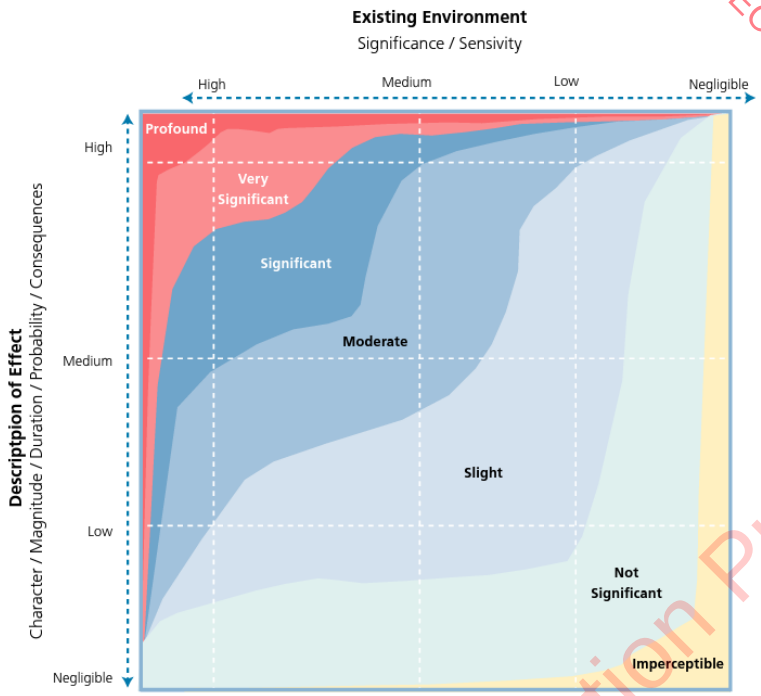


Figure 9-1: Criteria for Determining Significance (taken from EPA, 2022)

The sensitivity of the receiving environment, the magnitude of the potential impact and consideration of its likelihood of occurring, helps to evaluate the significance of the effect predicted prior to and after application of mitigation measures. The significance of effect has been defined using professional judgement, following the guide in Figure 9-1.

Effects can be beneficial (positive), neutral or adverse (negative) in nature. Significance of effects has been categorised as follows:

- *Imperceptible* – An effect capable of measurement but without significant consequences;
- *Not Significant* – An effect which causes noticeable changes in the character of the environment but without significant consequences;
- *Slight* – An effect which causes noticeable changes in the character of the environment without affecting its sensitivities;
- *Moderate* – An effect that alters the character of the environment in a manner that is consistent with existing and emerging baseline trends;
- *Significant effects* – An effect which, by its character, magnitude, duration or intensity, alters a sensitive aspect of the environment;
- *Very Significant* – An effect which, by its character, magnitude, duration or intensity, significantly alters most of a sensitive aspect of the environment; and
- *Profound Effects* – An effect which obliterates sensitive characteristics

Effects of Significant and above (adverse and beneficial) are considered 'significant' and mitigation measures have been considered to avoid, reduce or offset any predicted significant effects. Effects

of Moderate or below are not considered to be significant and therefore no mitigation measures are generally required, although may also be mitigated by design or proposed construction methodology.

The assessment described above includes consideration of integrated measures that are built into the project design (i.e. primary mitigation), and which are intended to prevent, reduce and where possible offset any significant adverse effects on the environment.

Where potentially significant adverse effects have not been eliminated by project design, further mitigation measures (i.e. secondary mitigation) have been proposed.

For each significant effect identified, appropriate secondary mitigation measures are prescribed. Secondary mitigation measures have been informed by stakeholder engagement and determined by the relevant technical experts.

Where relevant, residual effects have been determined for each significant effect, considering all proposed mitigation.

In cases where residual uncertainty of impact is identified within the EIAR, or the success of implemented mitigation measures requires validation, commitments have been made for the provision of monitoring.

9.2.5 LIMITATIONS OF ASSESSMENT

The information used for this assessment is suitable for Environmental Impact Assessment and planning purposes only.

Assumptions related to the assessment undertaken at this stage are as follows:

- All publicly available scientific information ascertained to inform this assessment is accurate and up to date, reflecting the current environment baseline.
- Limitations related to the assessment undertaken at this stage are as follows:
- Walkovers and peat probing conducted by GDG staff was limited in some areas of the site due to access issues, i.e., oversaturated ground conditions;
- Hydraulic properties of aquifers assessed in Section 9.4.6 are based on average properties across bedrock formations and will be subject to site-specific localised variability;
- The GSI Groundwater Wells and Abstraction database is not exhaustive. Whilst there are unlikely to be unlisted wells within the Proposed Development which have not been identified during site walkovers, the presence of additional wells in the ZoI cannot be ruled out; and
- GSI karst feature mapping is ongoing, and the presence of mapped features on the data viewer often reflects areas with greater field mapping coverage. It does not constitute a definitive representation of all karst features present within the ZoI.

9.3 GROUND INVESTIGATION

GDG were commissioned by JC Mont-Fort to prepare a planning-stage Ground Investigation Report (GIR) to support the geotechnical design of the Proposed Development. The objective of the GIR was to develop an engineering geological model of the site and to provide recommended characteristic geotechnical parameters for the preliminary design of the associated civil infrastructure.

The ground investigation, undertaken by Irish Drilling Limited in 2024, comprised the following activities:

- Four rotary core boreholes, including Standard Penetration Tests (SPT) in overburden materials;
- Seventeen machine-excavated trial pits;
- Forty-three hand shear vane tests;
- Eighty-eight peat probes to assess peat depth and distribution;
- Nine Russian core augers for peat profiling;
- A comprehensive suite of geotechnical soil and rock laboratory tests; and
- A suite of chemical and environmental laboratory analyses.

A detailed description of ground conditions can be found within the GIR *Illaunbaun Wind Farm – Ground Investigation Report* which accompanies this EIAR. In summary, the GIR includes the following elements:

- Desk Study: The desk study reviewed available information on site location and setting, topography, Quaternary and bedrock geology, and hydrogeological conditions;
- Ground Model Development: A stratigraphic model of the site was developed using data from borehole logs, trial pits, and Russian core auger logs. Peat thickness and extent were further refined using the results from the peat probing survey. This integrated model informed the geotechnical interpretation of the subsurface conditions;
- In-situ Testing: SPTs were conducted in overburden strata, and hand shear vane tests were performed to assess the undrained shear strength of near-surface cohesive soils such as peat; and
- Laboratory Testing: Laboratory testing included geotechnical analysis of soils through particle size distribution (using sieve and hydrometer methods), moisture content determination, and Atterberg limits to assess plasticity characteristics. Chemical testing assessed parameters such as pH, water-soluble and acid-soluble sulphates, and organic matter content. Rock strength was evaluated using Uniaxial Compressive Strength (UCS) and Point Load Strength Index tests.

The GIR provides a comprehensive understanding of the ground conditions at the site and establishes a preliminary geotechnical framework to inform the design of the wind farm. The relevant parts of the report have been used to inform the following EIAR assessment.

9.4 BASELINE: LAND, SOIL, GEOLOGY, AND HYDROGEOLOGY IN RECEIVING ENVIRONMENT

9.4.1 PROPOSED DEVELOPMENT AREA

The Proposed Development is located approximately 2.9km west coast of the Co. Clare coastline. The town of Milltown Malbay is located 4.2km to the southwest and the town of Lahinch is located 5.2km to the northwest. The proposed planning boundary encompasses the townlands of Toreen, Slievenalicka, Illaunbaun, Lackamore and Drumbaun, and is approximately 37ha in size.

Wind turbine generators (WTGs) are located in Drumbaun, Slievenalicka, Illaunbaun and Toreen townlands. Access roads out with the red line boundary are located in Illaunbaun, Slievenalicka and Toreen townlands. The proposed site entrance and access route from the southwest begins in Toreen townland. No site infrastructure is proposed within Lackamore townland.

The extent of the planning boundary for the Proposed Development is illustrated in Figure 9-2.

9.4.2 TOPOGRAPHY AND ENVIRONMENTAL SETTING

The undeveloped site currently consists of Coillte coniferous plantation, forestry tracks traversing the site and localised agricultural landowner plots.

The proposed main site access route extends from Toreen Road in the south-southwest of the Proposed Development. Proposed access roads between WTG infrastructure partially comprise existing Coillte forestry tracks. An initial site walkover conducted by GDG staff in April 2022 confirmed the presence of coniferous forestry and associated tracks.

There are a number of small surface watercourses within the Proposed Development. Headwaters of the River Cleedagh drain the west of the site and headwaters associated with the River Inagh (ID Inagh drain the eastern section. Two surface waterbodies, Lough Keagh and Lough Abullaunduff, are in the south and north of the site respectively. Lough Abullaunduff is categorised as a *Relict Lake with Marshy Characteristics.* This area represents a semi-closed former lake basin that has since been drained by field ditches for surrounding agriculture and now exhibits marshy conditions. Following intense rainfall, the area is prone to temporary flooding, suggesting a high-water table with species such as reeds and sedges observed during site walkovers. Surface water is discussed in further detail within Chapter 10: Hydrology, Water Quality and Flood Risk, of this EIAR.

The topography within the site boundary ranges from 120m above Ordnance Datum (mOD) in the east at Illaunbaun townland, rising to over 195mOD on the hill of Knockabullaunduff in the west and north where two hills are present in Drumbaun and Lackamore townlands. The access route from the northeast, through Illaunbaun townland, is steep and rises from 95mOD to 185mOD. Access routes from the south-southwest join the site at higher elevations, approximately 190mOD.

Several existing wind farms are located within 15km of the Proposed Development, to the south and southwest, including Booltiagh. Cahermuprphy, Kiltumper, Letteragh, Slievecallan and Sorrell Island wind farms. Cumulative effects associated with these developments with regards to soils, geology, hydrogeology and contamination are addressed in Section 9.5.5 of this Chapter.

A map showing contours, watercourses and other key features is shown in Figure 9-3.

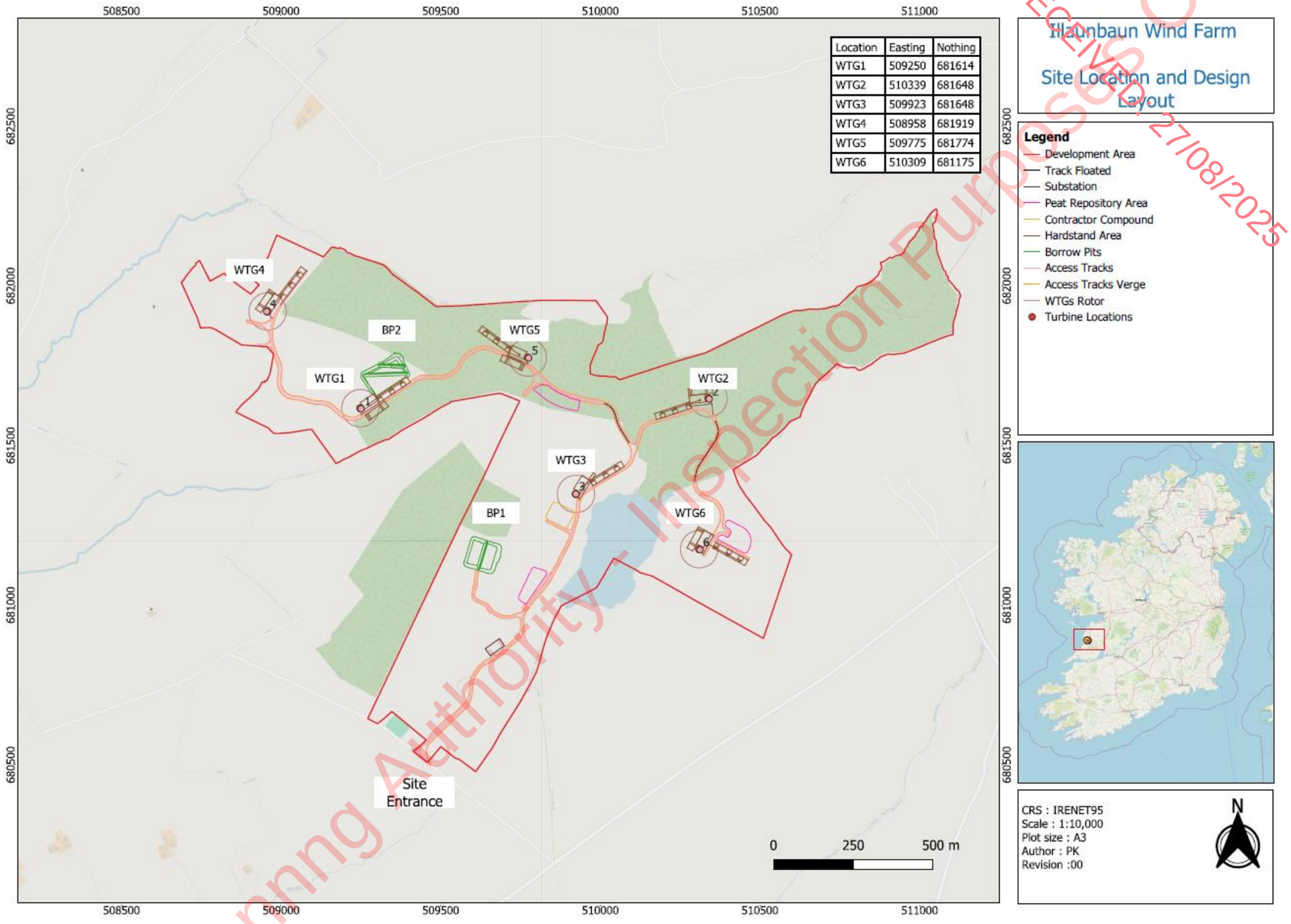


Figure 9-2: Site Location and Design Layout map

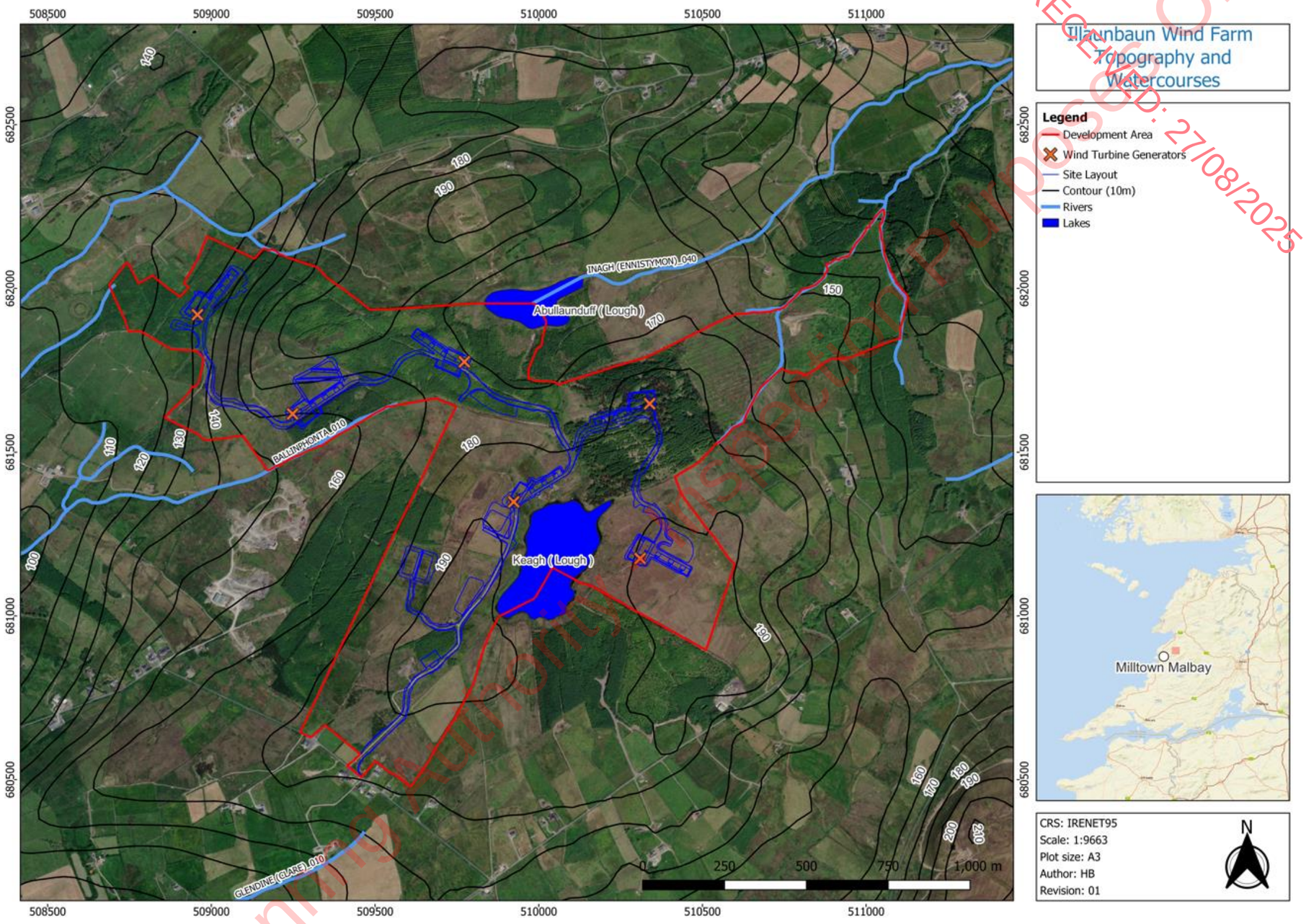


Figure 9-3 Detailed map of Proposed Development displaying the wind farm development area, WTG locations, elevation contours, and key water features

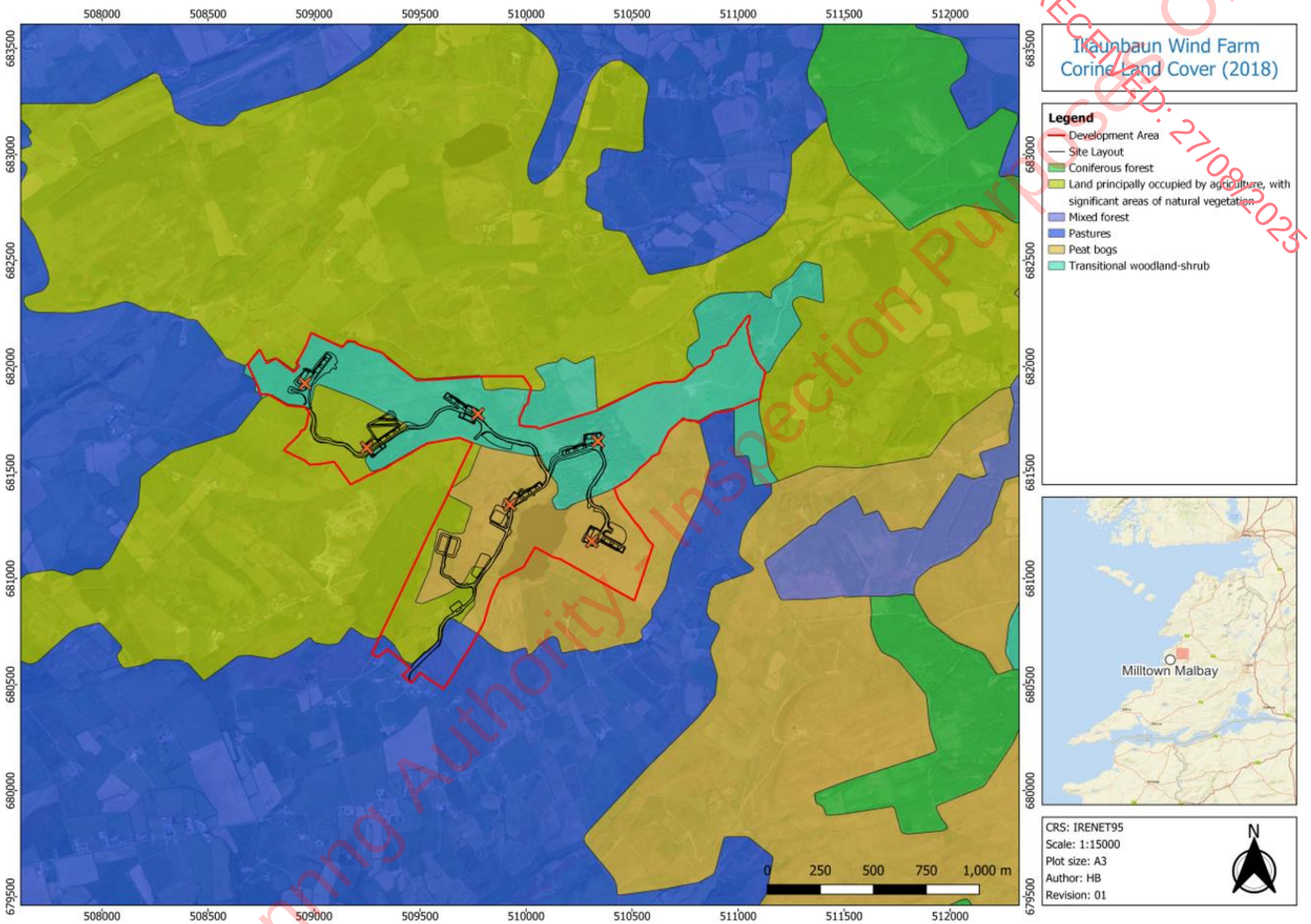


Figure 9-4: CORINE (2018) Land cover classification map of the Proposed Development

9.4.3 LAND USE AND CLASSIFICATION

CORINE (2018) land use mapping indicates mixed land uses comprising peat, pastures, transitional woodland scrub and land principally occupied by agriculture with significant areas of natural vegetation. Parts of the northeast of the site in the vicinity of T2 are covered by Coillte coniferous forestry plantation, with some areas of private coniferous plantation located in the vicinity of T5. Site walkovers indicate that some areas to the south of the proposed T3 location have been drained for coniferous plantation use but have not been planted. Site walkovers noted historical peat extraction to the west of T3 and in the vicinity of T6. No active peat extraction was observed at the Proposed Development.

A map displaying CORINE land use is shown in Figure 9-4.

The classification of agricultural land quality within the ZoI has been undertaken as per the Land Capability for Agriculture system developed by the Macaulay Land Use Research Institute, 1991 (MLURI, now part of the James Hutton Institute). This system is widely used in Scotland for evaluating land based on its potential for agricultural production, considering factors such as soil quality, drainage, climate, slope, and erosion risk. The Land Capability for Agriculture system categorises land into seven classes, ranging from Class 1 (land capable of producing a very wide range of crops) to Class 7 (land of very limited agricultural value). This classification provides a robust basis for assessing the impact of developments on agricultural land and helps inform the sensitivity of receptors in the assessment of effects in this Chapter.

The land within the Proposed Development has been classified as Class 6: Division 6.3. This classification indicates the land is only capable of use as rough grazing, with severe limitations that preclude arable or improved grassland use. Specifically, Division 6.3 is characterised by vegetation dominated by plant communities with low grazing value, including bog heather and blanket bog. These habitats typically offer limited nutritional value for livestock and are often associated with poor drainage and shallow soils.

9.4.4 SUPERFICIAL GEOLOGY

Superficial Geology refers to the layers of soil, rock, and other unconsolidated materials that lie above a targeted geological formation. These layers can consist of topsoil, sand, gravel, clay, and various types of sedimentary rock.

9.4.4.1 TOPSOIL

The main form of topsoil encountered is comprise of fine loamy drift with siliceous stones. This topsoil is designated as “Kilrush” on the Irish Soil Information System (SIS). The soil has poor drainage properties and can be greater than 80cm in thickness. Topsoil is discontinuous across the site with areas of exposed bedrock outcrop common.

9.4.4.2 QUATERNARY GEOLOGY

The Proposed Development contains soils classified as podzols (peaty), peat and gleys. Peaty soils and near-surface bedrock dominate most of the site with gleys located in the eastern and western peripheries. In general, soils within the Proposed Development are poorly draining and display acidic mineralisation due to prevalence of peat. The depth and extent of peat deposits may vary over short

distances as a function of local underlying geology, past and ongoing geomorphological progression and management history. Peat is discussed in further detail in Section 9.4.4.3.

According to the GSI Quaternary sediments map (1:50k), the majority of the Proposed Development is underlain by a mosaic of blanket peat and bedrock outcrop or sub crop, which indicates a combination of peat deposits interspersed between thin unsubstantial soils. Bedrock outcrop/sub crop are generally located in the upland areas and topographic highpoints within the north and west of the site but is spatially extent throughout. Tills derived from Namurian sandstones and shales are present at the boundaries of the Proposed Development, especially in Drumbaun and Illaunbaun townlands. Glacial till typically comprises a heterogenous mix of sand, gravel, cobbles, and boulders, usually held in an over consolidated clay matrix.

The prevalence of Quaternary sediments with respect to proposed site infrastructure is as follows:

- WTGs 1 and 2 (T1 and T1), in the west and east respectively, are underlain by bedrock outcrop/sub crop.
- WTGs 4 and 6 (T4 and T6) are underlain by peat in the south of the site. Associated peat depths will be discussed in further detail in Section 9.4.4.3.
- WTGs 3 and 5 (T3 and T5) are mapped at the interface of peat and bedrock outcrop/ sub crop.
- All proposed access roads traverse a mixture of peat, bedrock outcrop/sub crop and tills.

GSI Quaternary sediment mapping within the Proposed Development boundary and surrounding area is shown in Figure 9-5.

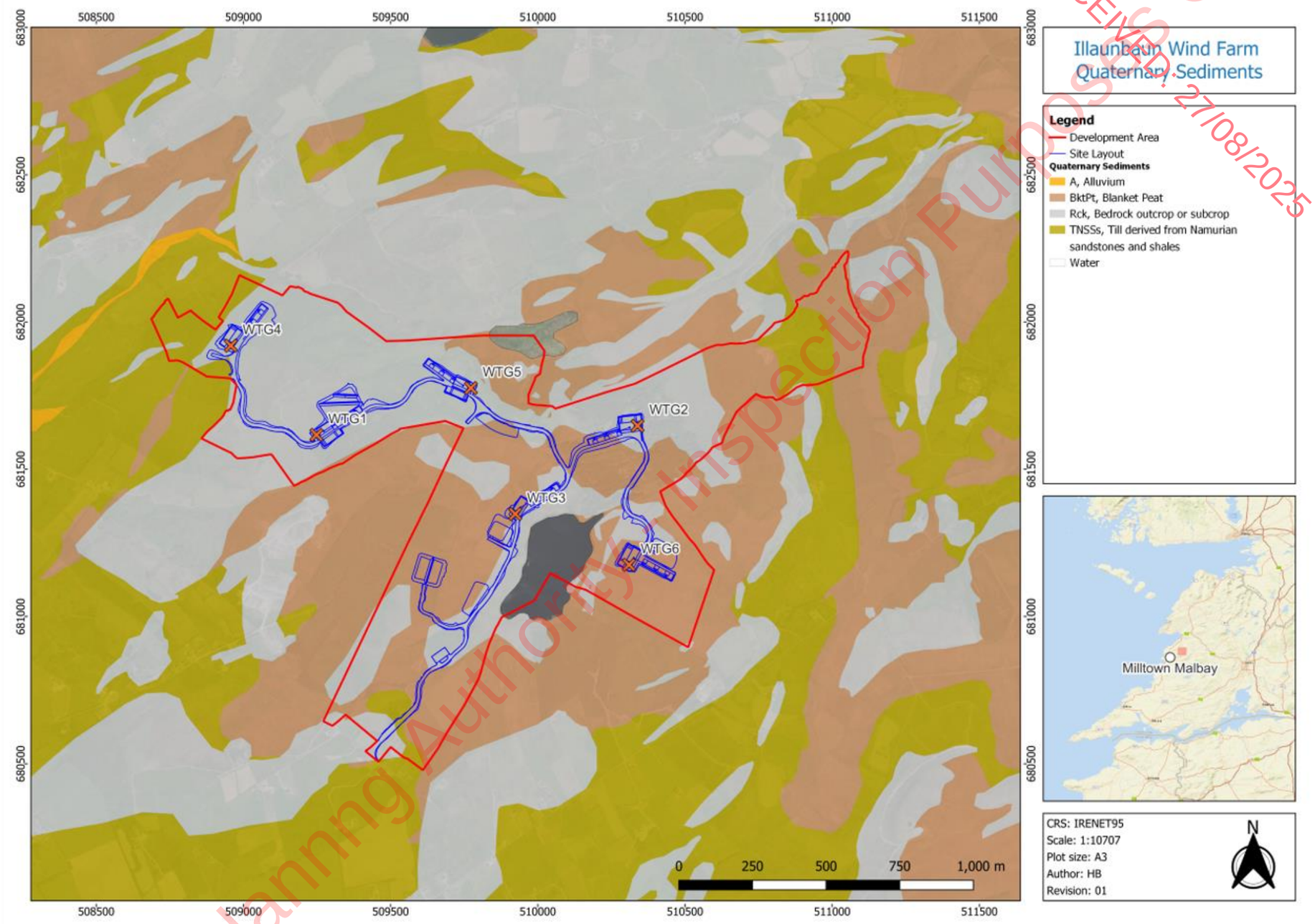


Figure 9-5: GSI Quaternary Sediments map of the Proposed Development

9.4.4.3 PEAT

This section on should be read in conjunction with the following Technical Appendices that accompany this Chapter:

- Technical Appendix A09-01: Peat and Spoil Management Plan; and
- Technical Appendix A09-02: Peat Stability Risk Assessment.

Characteristics

- As previously noted, extensive GI has been carried out across the site at a total of 422 locations, including 369 peat probes, 23 hand shear vanes, 9 Russian gouge cores, 4 rotary core boreholes and 17 trial pits undertaken by GDG and Irish Drilling Ltd between April 2022 to September 2024. The probe locations, measured depth, and interpolated peat depth map is provided in Figure 9-6.
- Site conditions range between open blanket peat, afforested blanket peat, cutaway peat and exposed bedrock.
- Peat thickness encountered during intrusive investigations ranged from 0 metres to a maximum of 4.80 metres, with a median thickness of 0.45m recorded. The frequency and variations of different peat thicknesses across the Proposed Development is shown in Figure 9-6.
- Trial pit investigations indicate that superficial deposits consist of peat overlying a silty, gravelly clay with inclusions of gravel and cobbles, extending to depths of up to 6 metres.
- The depths encountered are considered generally shallow areas of peat between bedrock and glacial till outcrop, with local moderate to deep areas where probes identified peat or very soft material thicknesses of up to 6.0m.
- In total, 82.7% of recorded peat thicknesses were under 1m, and 96.2% were under 2m. Peat depths of >2m in depth were encountered locally, particularly in the vicinity of T5 and underlying the proposed access road between T2 and T6.

Table 9-5 summarises the peat depth measured closest to the proposed WTG locations.

- Thicker deposits were measured at T5 and in the area north of T5, with a maximum of 6m measured. Peat in this area of the Proposed Development is likely associated with the nearby Lough Abullaunduff.
- Peat depths along proposed access tracks are generally less than 1m thick, with localised instances of thicker peat. For example, the track between T2 and T6 (up to 5.2m thick).
- The characteristics and interpreted engineering parameters of the peat material across the Proposed Development are detailed in *Technical Appendix A09-02: Peat Stability Risk Assessment*.

Table 9-5: Observed peat thicknesses at proposed WTG locations

WTG ID	Peat Thickness (m)
T1	0.73
T2	0.4
T3	0.9 – 1.55
T4	0.2 – 0.52
T5	1.12
T6	0.31 – 0.45

Stability

A detailed Peat Stability Risk Assessment (PRSA) is presented in *Technical Appendix A09-02* and assesses the risks posed by peat failures. This PRSA is based on the following steps:

- A desk study
- Site walkover and field work
- Stability analyses and a risk assessment
- Mitigation Measures
- Proposals for actions for the Proposed Development

The methodology followed the principles in the guidance document Peat Stability Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Scottish Executive, 2017). Full details of the process and findings are presented in the *Technical Appendix A9-02: Peat Stability and Risk Assessment* accompanying this Chapter

Overall, the PRSA concludes that significant peat slides are unlikely at the Proposed Development with diligent peat management and careful consideration of the peat conditions at the design and construction stage. The key findings of the PSRA are summarised as follows:

- A deterministic factor of safety value was calculated across the proposed element locations, along with other factors that could influence the stability of peat. The Proposed Development was found to have acceptable factors of safety and levels of risk against peat instability.
- The peat stability risk with regards the proposed infrastructure ranges between negligible and low.

However, the results of the factor of safety deterministic calculation and the site walkovers allowed for the identification of:

- 22no. Safety Buffer Zones (SBZ) that will have restricted construction activities and should not be used for the storage of peat or soils.
- 96no. Peat Stockpile Restriction areas (PSR) highlighted as not suitable for side casting or stockpiling of peat or soils.

A review of GSI Landslide Event mapping indicates there to be no known landslides mapped within the Proposed Development boundary. There are also no landslides mapped within a 15km radius of the Proposed Development. Furthermore, the development area is classified as low to moderately-low risk of landslide susceptibility by the GSI Landslide Susceptibility Map.

Overall, the PSRA concludes that significant peat slides are unlikely to have an impact on the site safety, and it is suitable for the proposed wind farm development.

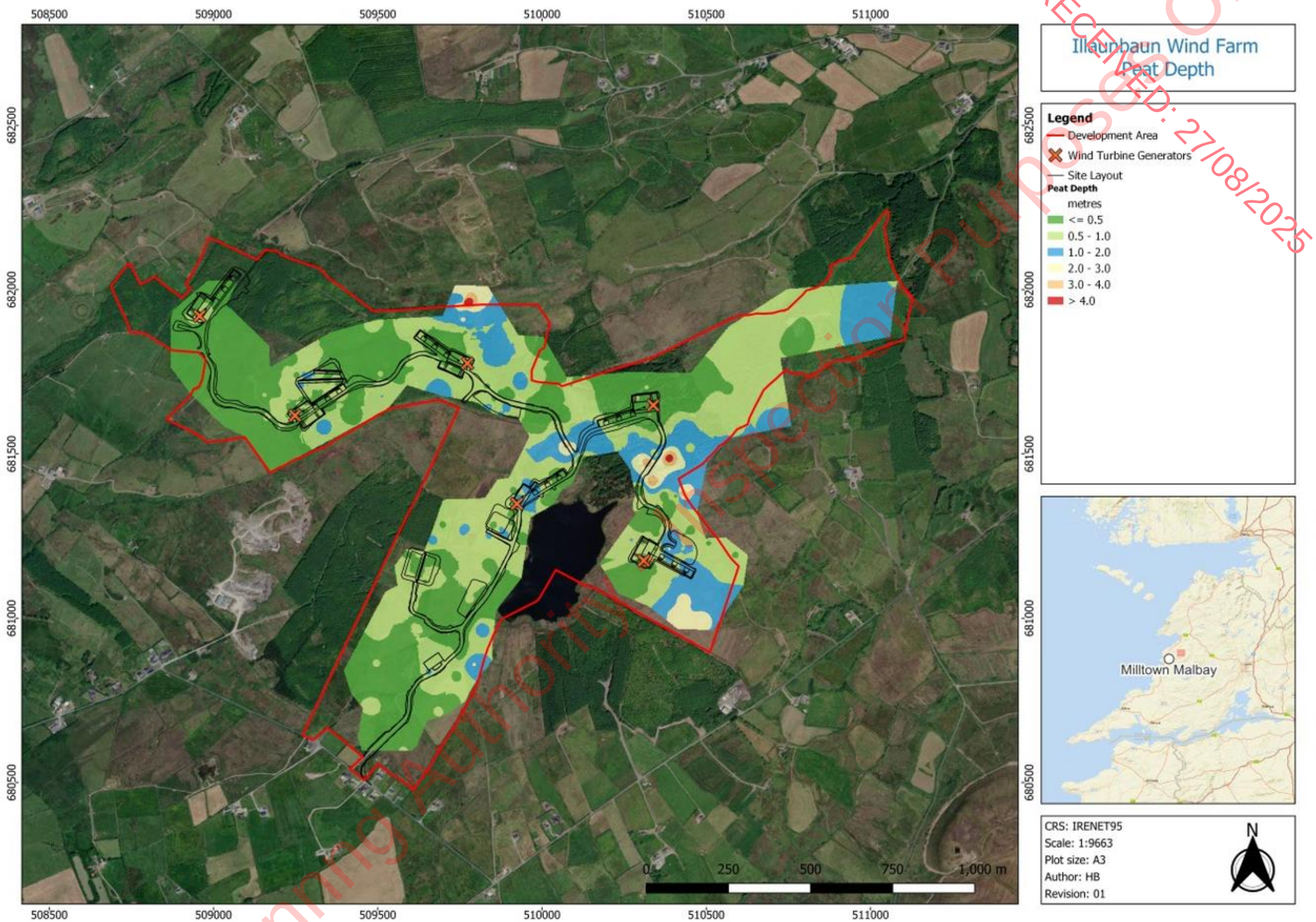


Figure 9-6: Interpolated peat depth plan of the Proposed Development

9.4.4.4 SOIL CONTAMINATION

Historical map data from GeoHive was used as part of a comprehensive desktop study to identify potential sources of legacy contamination across the Proposed Development and surrounding environs (Table 9-6). Mapping resources ranged from the 1830s to the present day and included various Ordnance Survey maps, aerial photographs, and satellite imagery.

The primary potential sources of contamination identified are associated with agricultural and Coillte forestry activities on-site. It is noted that site walkovers, peat probing surveys and ground investigations did not reveal any visible or olfactory evidence of contamination at the time of assessment, and made ground was not encountered.

Agricultural practices may have contributed to low levels of soil contamination through the use of fertilisers containing phosphates and nitrates. Similar compounds, along with potassium-based fertilisers, are also likely to have been used in the development and maintenance of the on-site Coillte tree nurseries and plantations. Additionally, there is potential for fuel (hydrocarbon) and chemical contamination from spillages and leaks associated with the use of plant machinery such as harvesters, forwarders, and skidders during forestry activities, although this would be expected to be small-scale and localised.

A further potential source of contamination in the surrounding environs is the adjacent Liscannor Stone Quarry, located along the western boundary of the Proposed Development. Leakage of fuel or chemicals from heavy machinery in this area could pose a risk to soil or groundwater quality, although again would be expected to be localised.

In general, contamination risk at the Proposed Development is judged to be **low.**

Table 9-6: Site land-use and development history.

Map Reference	On-Site Land Use	Surrounding Environs
Historic 6-inch Cassini Black and White (1837 - 1842)	Agriculture/greenfield. The majority of Proposed Development is characterised by rough pasture with “cropping rock”. Much of the Proposed Development is partitioned into unoccupied commonage land parcels. Quarry identified south of Lough Abullaunduff. Lough Abullaunduff also designated as marsh.	The surrounding environment is mainly comprised of unoccupied agricultural land. Dispersed settlements are located in the general area. There are also several small quarries, one bordering the southwest of the Proposed Development boundary.
Historic 25-inch map (1888-1913)	Agriculture/greenfield. During this period much of the northern and eastern site was designated as marsh with “green space and field” and “rough pasture” comprising the rest of the of Proposed Development. There are several small quarries across the Proposed Development area, with a prominent disused quarry on the northwestern	Rural, much of the surrounding environment is characterised by “rough pasture”. Low population density, sparse dwellings. Many small quarries can be identified outside of the Proposed Development boundaries.

Map Reference	On-Site Land Use	Surrounding Environs
	boundary of Lough Keagh. Other such quarries can be found south of Lough Abullaunduff and to the northeast of the Proposed Development.	
Aerial Photography (1995)	Agriculture/Forestry. Much of the northern area of the site is now assigned to forestry. Well defined nursery blocks along with older planted rows visible north of Lough Keagh. Additional rows of planted trees in the centre of the Proposed Development running parallel to Lough Keagh flanked to the east by agricultural land. The quarry located on the northern shore of Lough Keagh is potentially still operational. There are no dwellings within the Proposed Development boundaries.	The Proposed Development area is surrounded mainly by agricultural land and dispersed settlements. There is an increase on housing developments surrounding the Proposed Development. The quarry found on the southwestern boundary to the Proposed Development has expanded considerably.
Satellite Imagery (2001)	Agriculture/Forestry. The tree nursery to the northeast of Lough Keagh appears well-established, while the plantation to the northwest comprises relatively young trees. Centrally within the Proposed Development, additional rows of trees are evident alongside areas of agricultural land. Several of the smaller quarries now appear to be disused.	An increase in the development of detached houses is evident in the areas surrounding the Proposed Development, though agriculture remains the primary land use. Rockmount Primary School is clearly visible to the south of the Proposed Development. Liscannor Stone Quarry is located along the western boundary.
Satellite Imagery (2006)	Agriculture/Forestry. Imagery from 2006 indicates continued development of Coillte forestry. A new structure is also present on-site, located approximately 300 metres southwest of Lough Keagh. A radio tower is present in the western section of the Proposed Development, between T1 and T4.	Much of the surrounding land use remains unchanged, with no significant increase in housing observed. A new development is visible approximately 500 metres southeast of Lough Keagh.
Satellite Imagery (2013-2018)	Agriculture/Forestry. No significant changes are noted on-site. The Coillte plantation continues to mature, while the previously mentioned structure now appears abandoned and overgrown.	No major new developments are observed in the surrounding area. The Proposed Development remains characterised by single dwellings interspersed with

Map Reference	On-Site Land Use	Surrounding Environs
		agricultural land. The previously identified development has been confirmed as a storage area for box trailers.
Satellite Imagery (2025)	Agriculture/Forestry. No significant changes are noted on-site. A portion of the plantation to the northeast of Lough Keagh has been harvested. The previously discussed structure has since been cleared.	No major new developments are observed in the surrounding area.

9.4.5 BEDROCK GEOLOGY

9.4.5.1 BEDROCK UNITS

GSI 1:100k bedrock mapping identifies the Proposed Development as being entirely underlain by a single geological unit, the Central Clare Group (CCG). This formation is composed of grey to dark grey sequences of Carboniferous mudstone, siltstone, and sandstone. The lithology of the CCG can be characterised by its distinct stratigraphic features. At the base of the sequence lies a mudstone layer, typically 7 to 18 meters thick, which is often finely laminated. These basal mudstones are generally overlain by grey siltstones that range from laminated to massive in texture. Above the siltstones, the sequence transitions into thick layers of sandstone, which exhibit a variety of sedimentary structures, including lamination and cross-bedding, reflecting varying energy conditions during deposition.

Site walkovers confirmed that the CCG bedrock outcrops prominently in the topographic highs of the Proposed Development. These observations are consistent with the GSI's outcrop mapping.

The main bedrock unit and associated structural features at the Proposed Development and surrounding area is shown in (Figure 9-7.

9.4.5.2 STRUCTURAL GEOLOGY

The structural geology of the wider area is predominantly influenced by a dominant regional structural lineation in western Co. Clare, identified from the GSI 100k bedrock map. Within the Proposed Development boundary, no faults have been identified. The documented structural features in the ZoI are as follows:

- A pair of west/northwest-east/northeast trending faults are mapped at Slievecallan townland, approximately 450 m southeast of the Proposed Development.
- A further single fault, trending southeast-northwest, is located approximately 300 m southwest of the Proposed Development, at Drumbaun townland.
- Bedrock strata dips at right angles to the fold axes at angles of 10°, with wider CCG bedrock exhibiting a range from 10°-50° (GSI, 2017).

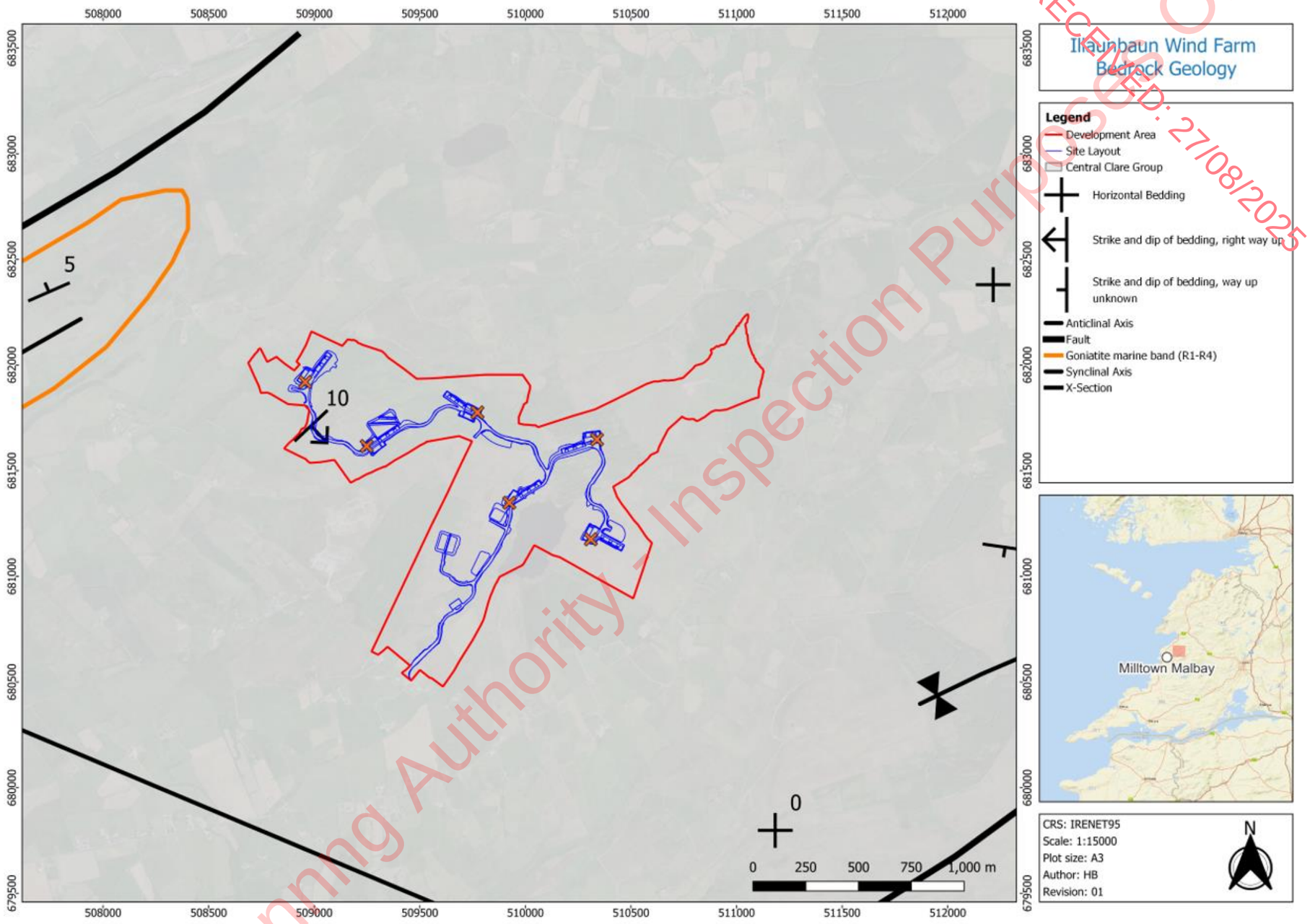


Figure 9-7: GSI bedrock geology and structural map of the Proposed Development

9.4.6 HYDROGEOLOGY

9.4.6.1 GROUNDWATER BODIES

According to GSI's groundwater map viewer, the Proposed Development is underlain by the Milltown Malbay groundwater body (GWB), (ID: IE_SH_G_167). The Milltown Malbay GWB covers much of western Co. Clare and comprises a total area of 766km^2. It is elongated north-south with elevations generally below 100mOD. The GWB is bound to the west by the coastline, the north by karstified Dinantian Pure Bedded Limestones of the Slieve Elva GWB and to the east/south by the Inagh River (GSI, 2003).

The GWB is characterised as having a 'PP' – poorly productive flow regime (GSI, 2000a). Transmissivities range from 2 - 20m^2/d and aquifer storativity is low. Groundwater flow is concentrated in the upper 10 – 15m bgl of the aquifer. Groundwater levels are often 0 - 8m bgl.

9.4.6.2 GROUNDWATER BODY WFD STATUS

Groundwater body status for 2016 – 2021 assessment period is designated as 'Good' overall, passing both quantitative and chemical status requirements under the Water Framework Directive (WFD) 3rd cycle assessment. Groundwater body risk status for the WFD 3rd Cycle risk assessment period is currently designated as under 'Review' with regards to meeting environmental objectives by 2027. It is not designated as a Groundwater-Dependent Terrestrial Ecosystem (GWDTE).

9.4.6.3 BEDROCK AQUIFERS

According to GSI's groundwater map viewer, bedrock directly underlying the site is categorised as a Locally Important (LI) Aquifer Bedrock (Figure 9-8). This is defined as "Bedrock which is Moderately Productive only in Local Zones". The bedrock aquifer has been categorised as a member of the 'Namurian Undifferentiated (NU)' Rock Unit Group (RUG).

Groundwater flow in this type of aquifer occurs predominantly through fractures, fissures and joints, giving a low fissure permeability which tends to decrease with depth. Flow paths are thought to be between 30 – 300m in length and locally important aquifers are generally capable of yielding enough water to supply single domestic wells only (10-20m^3/d), (GSI, 2017). The regional groundwater flow direction in the aquifer will be westwards towards the Atlantic Ocean (2000a).

Localised groundwater flow paths within the Proposed Development will follow the orientation of surface water subcatchments from topographic highs to lower elevation discharge points. Shallow groundwater in the south of the site will likely flow in the direction of Lough Keagh.

There are no superficial aquifers located within or adjacent to the Proposed Development boundary, although it is possible that localised perched groundwater is present at the base of peat deposits and within granular layers/ lenses within the glacial till matrix.

Hydraulic properties for the CCG are outlined in Table 9-7 and indicate the best estimate for transmissivity and storativity of the bedrock aquifer underlying the Proposed Development.

Table 9-7: Aquifer Bedrock Hydraulic Properties.

Bedrock unit name	Rock Unit Group	Aquifer type	From Kelly et al, 2015			
			Best estimate transmissivity (m2/d)	Transmissivity range (5th—95th%ile) (m2/d)	Geometric mean of Storativity (-)	Geometric mean of Specific yield (-)
Central Clare Group	NU	LI	7	0.5 - 152	0.00026	0.017

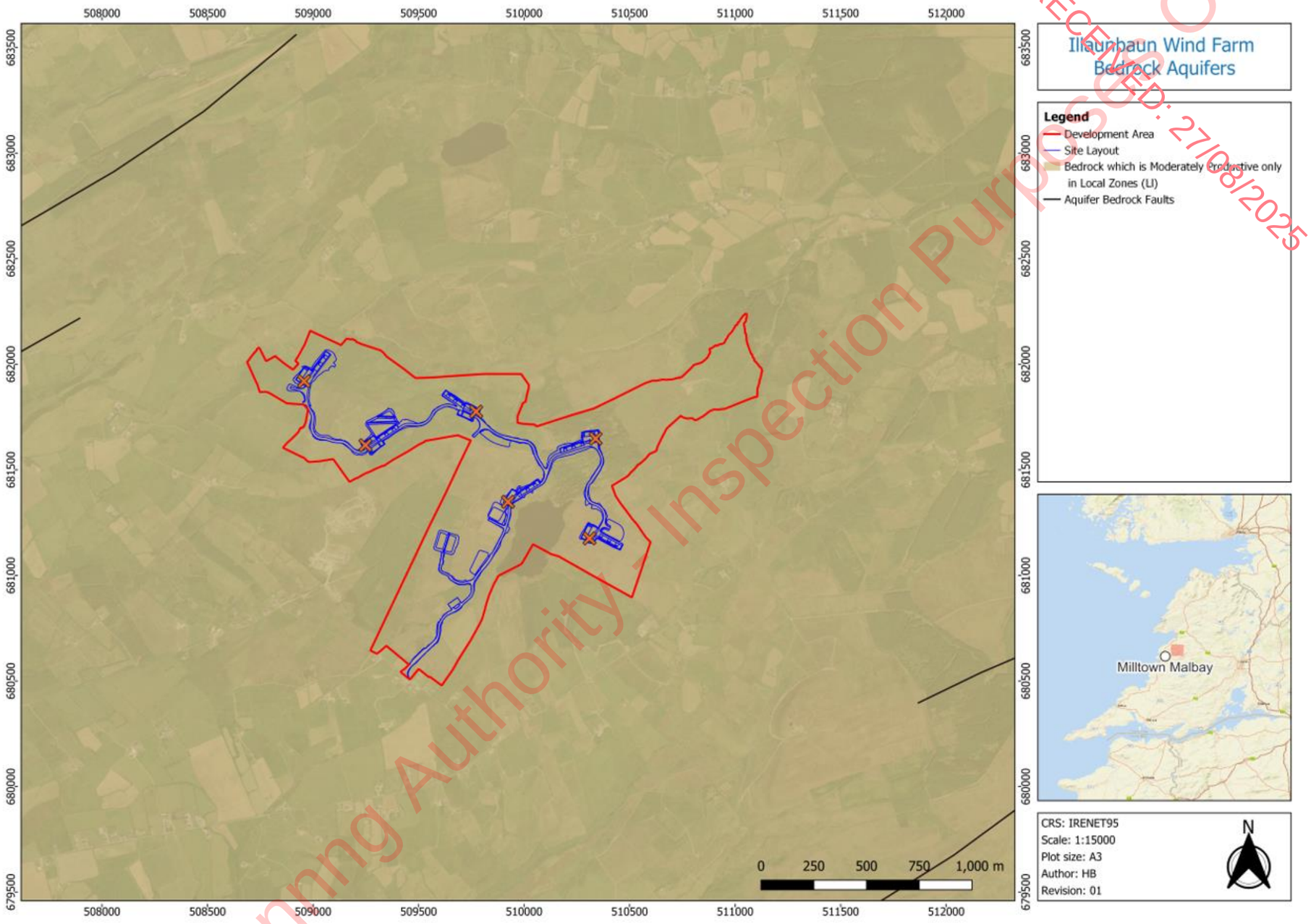


Figure 9-8: GSI aquifer map of bedrock productivity underlying the Proposed Development.

9.4.6.4 SUBSOIL PERMEABILITY

Subsoil permeability across the Proposed Development is categorised as 'N/A' due to thin superficial deposits, where depth to bedrock is less than 3m, including all WTG locations. Areas of 'Low' permeability, where superficial deposits are slightly thicker, surround the Proposed Development to the east, west, and south.

Subsoil permeability classifications within the Proposed Development boundary and surrounding area are presented in Figure 9-9.

9.4.6.5 GROUNDWATER VULNERABILITY

Groundwater vulnerability is a function of the thickness and permeability of the subsoil that overlies bedrock. These factors strongly influence the attenuation processes and the time it takes for contamination to be released into the subsurface.

The majority of the Proposed Development exhibits a mixture of 'Extreme' and 'X – Extreme' groundwater vulnerability, where bedrock is at or near surface. The easternmost area of the site borders a zone of 'High' vulnerability in Illaunbaun townland. Due to the localised variability on-site, pre-development vulnerability observed at individual WTGs and other infrastructure such as borrow pits, peat storage areas, site compounds and access roads will vary depending on location.

Groundwater vulnerability classifications within the Proposed Development boundary and surrounding area are presented in Figure 9-10

9.4.6.6 GROUNDWATER RECHARGE

Groundwater recharge is relatively low across much of the Proposed Development, between 150 - 200mm/yr. This is due to the limited storage capacity of the underlying 'Ll' aquifer type, with 200mm/yr representing the maximum amount of recharge that the aquifer can accept (GSI, 2017). An area of lower recharge, averaging 93mm/yr, is present to the east in Illaunbaun townland.

The primary recharge mechanisms at the Proposed Development will be a combination of diffuse flow through subsoils and direct recharge of the aquifer unit where bedrock outcrops are exposed.

Groundwater recharge for the Proposed Development and surrounding area is shown in Figure 9-11.

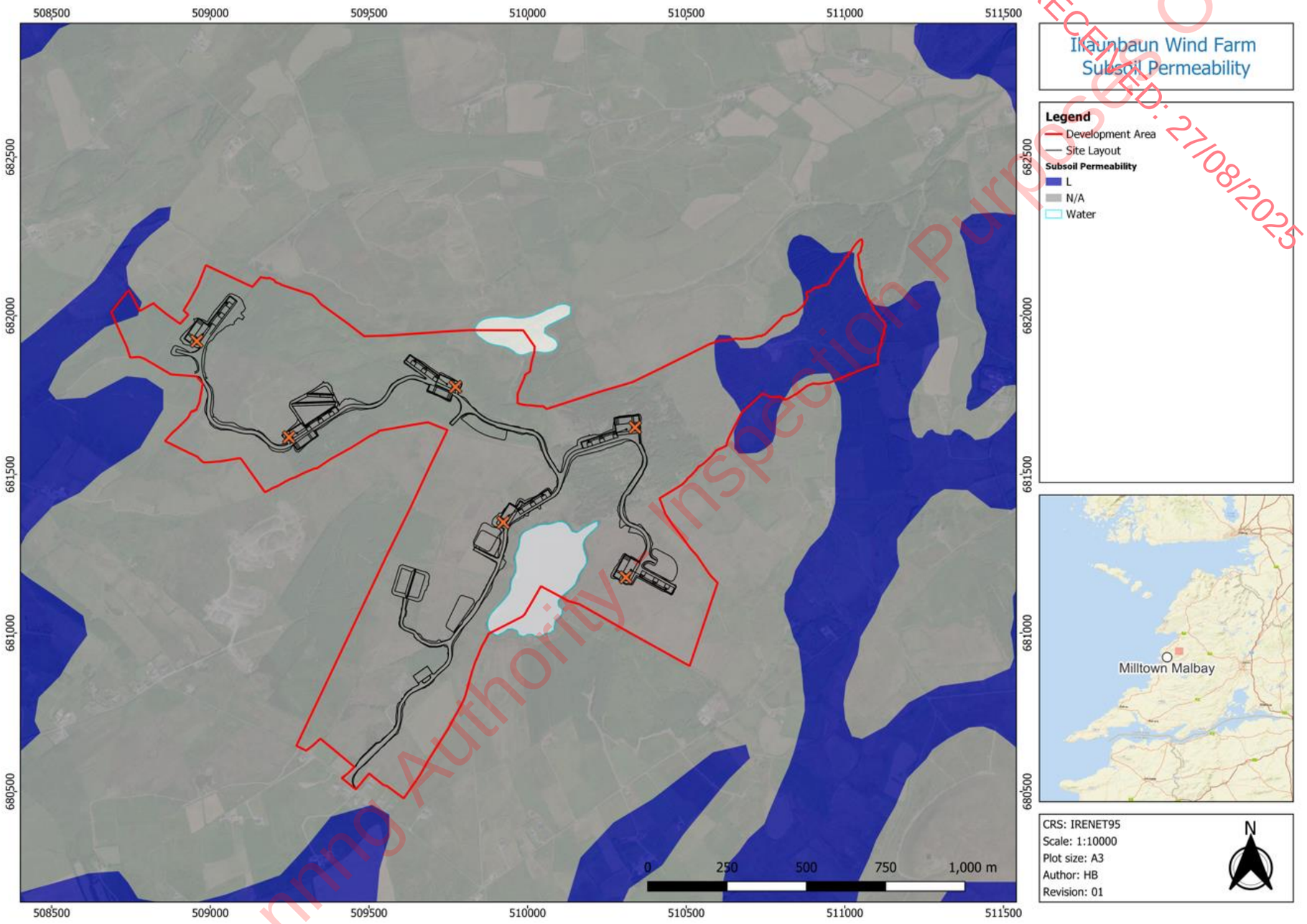


Figure 9-9: GSI subsoil permeability classifications for the Proposed Development

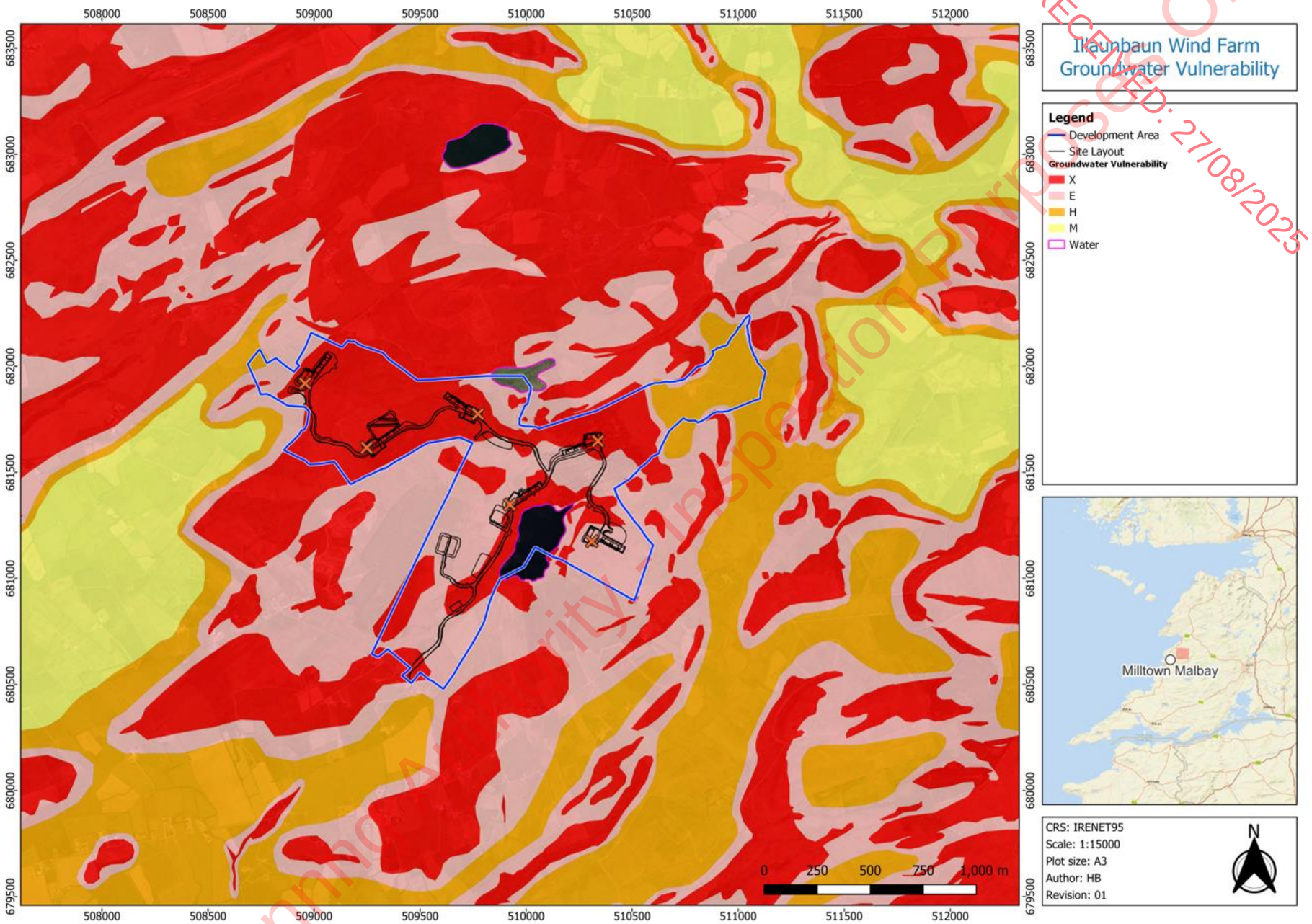


Figure 9-10: GSI groundwater vulnerability classifications for the Proposed Development

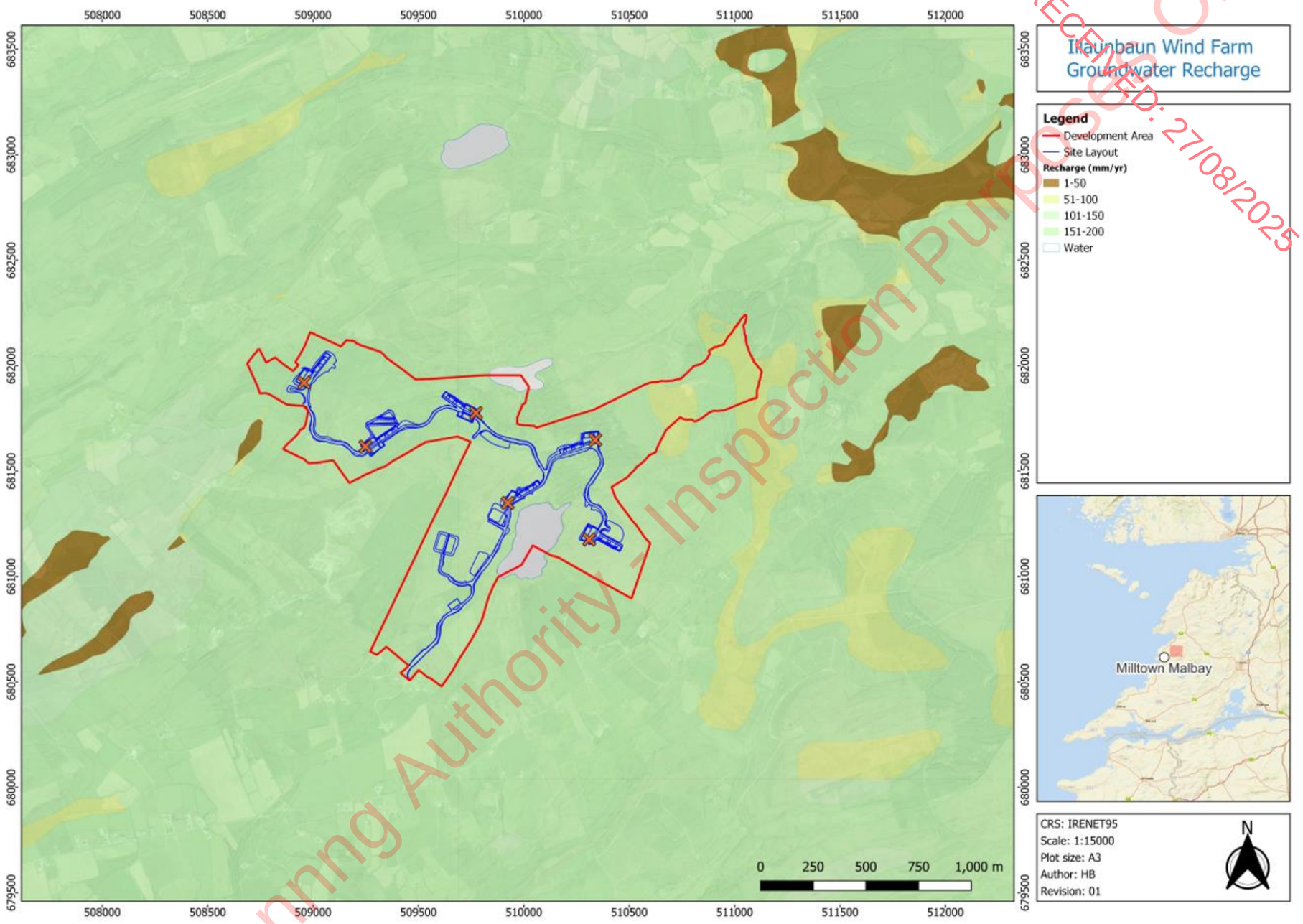


Figure 9-11: GSI groundwater recharge rates for the Proposed Development

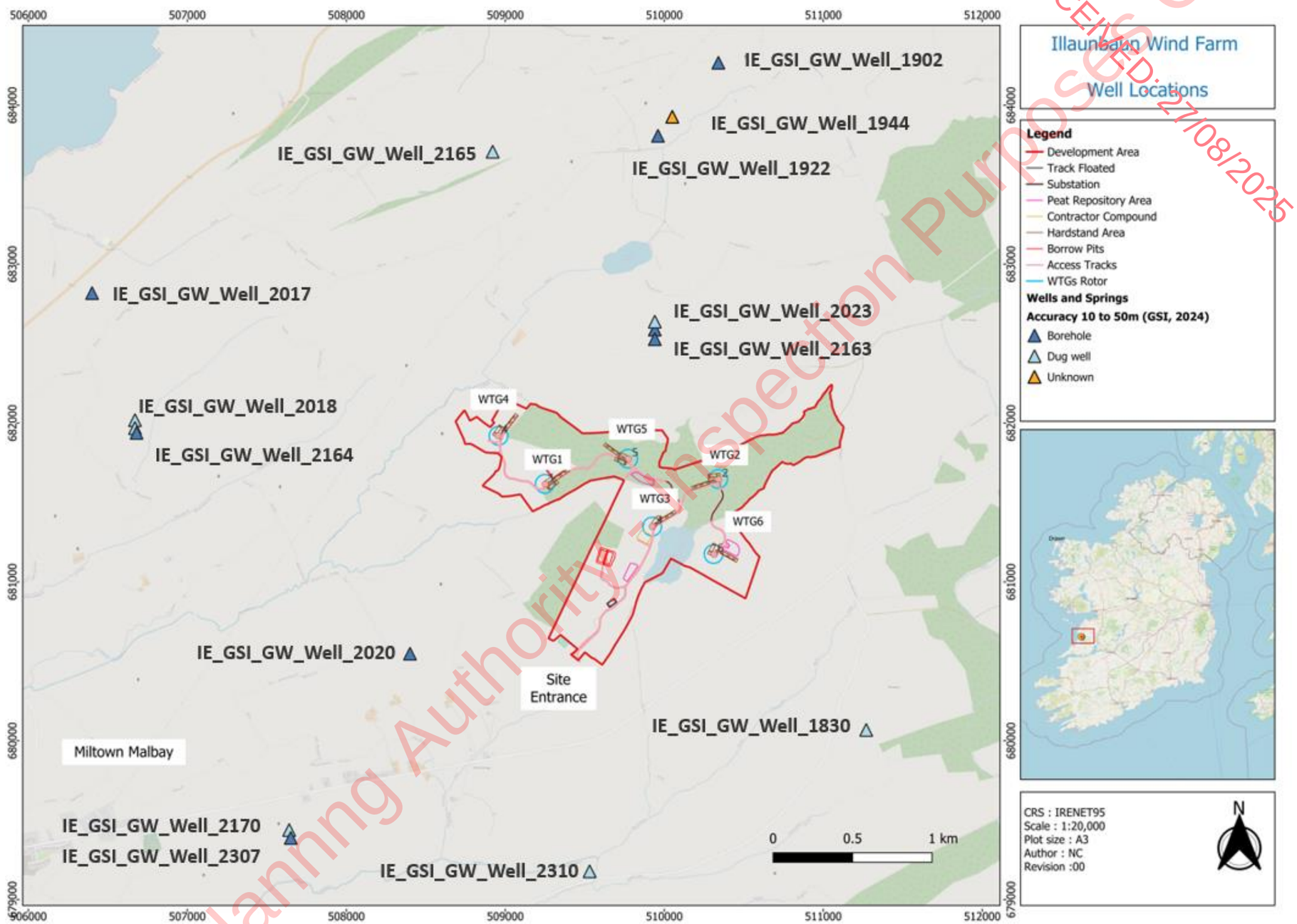


Figure 9-12: Map showing wells and abstractions recorded by GSI in proximity of the Proposed Development

9.4.6.7 KARST RISK ASSESSMENT

There is no evidence of karst bedrock features within the Proposed Development boundary. This reflects the dominance of sandstone, siltstone & mudstone lithology comprising the CCG and the absence of bedrock comprising calcium carbonate beneath the Proposed Development. This is supported by a lack of karst features observed within the wider CCG bedrock. As such, there is assessed to be low likelihood of bedrock karstification present on-site.

The closest karst feature is over 15km to the east of the Proposed Development, near Kilnamona. This is a groundwater spring located in the separate Gull Island Formation.

9.4.6.8 GROUNDWATER WELLS AND SPRINGS

There are no known private wells, PWS or Group Water Scheme (GWS) abstraction points located within the Proposed Development boundary. As a result, there are also no Source Protection Areas (SPAs) or Zones of Contribution (ZOCs) which intersect the Proposed Development boundary.

The closest SPA is Drumcliff Springs PWS which is located over 10km to the east, near Ennis town. Total current abstraction from the spring is 12,000 m^3/d (GSI, 2000). There is no known hydraulic connection between the Proposed Development area and the Drumcliff Springs PWS.

A review of the GSI Groundwater Wells and Abstraction database indicates there are a total 33 groundwater wells recorded within 5km of the Proposed Development boundary. The closest three wells are approximately 550m to the north of the Proposed Development, in Lackamore townland (Table 9-8). These wells are of very low yield, less than 10 m^3/day. One moderate yield well, 440m^3/day, is located approximately 4.8km southeast at Carrowduff. The abstraction at Carrowduff is separated from the site topographically and by large watercourses such as the Inagh River, consequently is not likely to be in hydraulic continuity with groundwater beneath the Proposed Development. No wells within 5km record yields above 40 m^3/day and are therefore not judged to have a significant impact on the groundwater flow regime (Table 9-8).

The GSI Ground water Wells and abstraction database is not exhaustive. Whilst there are unlikely to be unlisted wells within the ZoI which have not been identified during site walkovers, the presence of additional wells cannot be ruled out. However, if present, any yields would likely be low given the hydraulic properties of the Ll bedrock aquifer outlined in Section 9.4.6.3.

Table 9-8: Key groundwater wells within the surrounding area.

Well ID	Distance to Site (m)	Depth of Hole (m)	Depth to Bedrock (m)	GSI Yield Class	Source Yield (m3/day)
IE_GSI_GW_Well_2163	550	22.9	4.6	Poor	8.70
IE_GSI_GW_Well_2023	550	6.0	1.8	n/a	n/a
IE_GSI_GW_Well_2164	2250	16.5	1.5	Poor	16.40
IE_GSI_GW_Well_2020	1000	6	3.4	Poor	n/a
IE_GSI_GW_Well_2165	1750	27.1	3.7	n/a	16.4
IE_GSI_GW_Well_1830	1875	42.7	n/a	n/a	32.7

Well ID	Distance to Site (m)	Depth of Hole (m)	Depth to Bedrock (m)	GSI Yield Class	Source Yield (m3/day)
IE_GSI_GW_Well_2310	1500	15.2	1.5	n/a	32.7
IE_GSI_GW_Well_2170	2500	27.4	2.1	n/a	n/a

9.4.7 GEOLOGICAL HERITAGE

The GSI Geological Heritage database shows that there are currently no areas of geological heritage situated within 5km of the Proposed Development boundary.

The closest (audited) Geological Heritage site is located approximately 6.5km to the southwest of the Proposed Development. It is recorded as a foreshore exposure at the coastal section of Spanish Point and is described as “well-bedded sandstones, siltstones and mudstones of the Upper Carboniferous (Namurian) Central Clare Group”. It is designated within the County Geological Sites for Co. Clare.

9.4.8 ECONOMIC GEOLOGY

According to the GSI online minerals data viewer, there are no active quarries or mineral occurrences within the Proposed Development boundary. However, an active stone quarry is currently located to the immediate southwest of the Proposed Development, within Slievenalicka townland. This quarry is operated by Liscannor Flagstone Quarries.

The GSI Aggregate Potential map indicates the Proposed Development is located within an area of ‘High’ to ‘Very High’ potential for crushed rock aggregate (Figure 9-13). Small sections of ‘Moderate’ potential border the site in Illaunbaun and Drumbaun townlands. This may reflect areas where greater peat thicknesses inhibit extraction of materials.

There is no potential indicated for granular aggregates within the Proposed Development boundary. A small section of ‘Very Low’ potential granular aggregate is present to the immediate northwest of the site, in Drumbaun townland.

A review of satellite imagery does not show any commercial peat harvesting within the Proposed Development boundary or surrounding area.

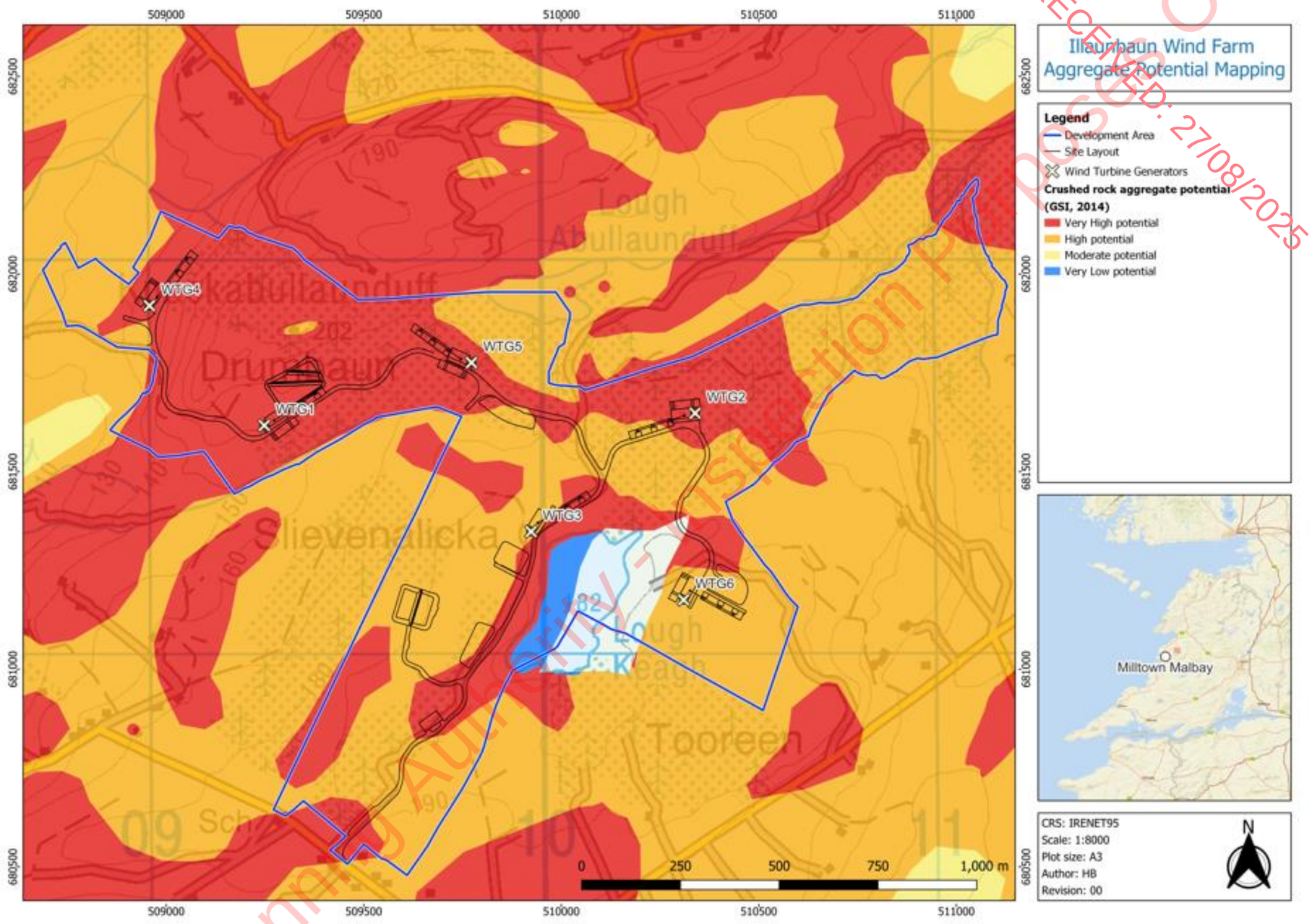


Figure 9-13: Map highlighting the potential for crushed rock aggregate across the site

9.4.9 SUMMARY OF BASELINE CONDITIONS

A review of desk study information on the Proposed Development indicates most of the Proposed Development exhibits a mixture of topsoil, blanket peat and bedrock outcrop at topographic highs. The glacial till typically comprises a heterogenous mix of sand, gravel, cobbles, and boulders, held in an over consolidated clay matrix. The land is of limited agricultural value, noted to be generally suitable only for rough grazing.

The thickness of peat encountered during intrusive investigations ranges from 0m to a maximum of 4.80m with the distribution of peat depth across the site ranging from 82.7% <1m and 96.2% <2m. Overall, the PSRA concludes that significant peat slides are unlikely to have an impact on the site safety, and it is suitable for the proposed wind farm development. Peat stability risk ranges between negligible and low.

Bedrock comprises sequences of Carboniferous mudstone, siltstone, and sandstone associated with the CCG, which is classified as a Locally Important 'Ll' aquifer and is contemporaneous with the Miltown Malbay GWB. Subsoil permeability across the Proposed Development is categorised as 'N/A' due to thin superficial deposits and thus groundwater vulnerability is generally categorised as a mixture of 'Extreme' and 'X – Extreme' at all WTG locations and access tracks. Vertical groundwater migration is likely to occur via diffuse and direct recharge, and groundwater flowpaths will follow typically follow topographic orientation, for example directed towards Lough Keagh in the south of the site. Groundwater recharge is limited within the aquifer, to between 150 – 200mm/yr. This is as a result of limited storage capacity. There are private groundwater abstractions within proximity to the site, although these are of very low yield and more than 500m from the site.

There are no recorded geological heritage sites in the site and no karst features are present. There is high potential for crushed rock aggregate extraction on-site, and a small active quarry borders the southwest of the site boundary. Presence of peat on site may limit extraction in some areas.

It is considered unlikely that there are any sensitive Groundwater Dependent Terrestrial Ecosystems (GWDTEs) within the vicinity of the Proposed Development.

The primary potential sources of contamination identified are associated with agricultural and Coillte forestry activities on-site, although these would be expected to be small-scale and localised. In general, contamination risk at the Proposed Development is judged to be low**.**

9.4.10 SUMMARY OF RECEPTOR SENSITIVITIES

Table 9-9 shows the receptors outlined in this section and applies the criteria from Section 9.3 to give each a sensitivity score from negligible to very high.

Table 9-9: Receptor sensitivity

Receptor	Sensitivity	Discussion
Soils (excluding peat)	Low	Soil cover is variable with bedrock outcrop common on-site. Peat soils expected to be underlain by glacial till. These deposits are of low agricultural value and geological importance and therefore overall sensitivity is low.

Receptor	Sensitivity	Discussion
Peat (storage)	High	Peat is present across large parts of the site at thicknesses of up to 6m, with more than half of the investigation locations recording thick peat (i.e. greater than 1.0m).
Peat (landslide)	High	The risk of peat stability in relation to the proposed infrastructure is assessed as negligible to low. However, the risk assessment has identified multiple 'safety buffer' zones where construction activities will be restricted, and the storage of peat or soils is not permitted, so consequently the sensitivity has been assessed as high for the purposes of this EIAR. Additionally, several peat stockpile restriction areas have been designated as unsuitable for side casting or stockpiling of peat or soils.
Geology	Low	Carboniferous mudstone, siltstone, and sandstone associated with the CCG. Considered to be of low geological value. No designated geological heritage sites or karst features within Proposed Development. Economic geological resources designated as high potential for crushed rock aggregate, However, there will be limited impact on the overall resource as the majority of the surrounding area is deemed to have high to very high potential for crushed rock aggregate, and the proposed development site's footprint is relatively small-scale by comparison.
Groundwater body	High	Bedrock aquifer is characterised as 'Bedrock which is Moderately Productive only in Local Zones'. There are substantial areas of the site where the groundwater vulnerability is 'Extreme' to 'X-Extreme'. Exposed bedrock outcrop/sub crop provides potential direct entry to groundwater via diffuse flow during site works. It is considered unlikely that there are any sensitive Groundwater Dependent Terrestrial Ecosystems on or in the vicinity of the Proposed Development. There are no public groundwater abstractions in hydrological continuity. However, there are a number of private abstractions nearby, which may be impacted despite low yields.
Contamination	Low	There are no likely historical sources of significant contamination within the Proposed Development, although localised and small-scale contamination is possible associated with the possible use of fertilisers from forestry use and hydrocarbons/chemical spills or leakages from plant or machinery. No made ground or other evidence of contamination was recorded during the walkover or intrusive investigation and consequently the sensitivity associated with contamination in relation to soils, geology and hydrogeology is considered to be low.

9.5 ASSESSMENT OF EFFECTS

During each phase of the Proposed Development (construction, operation, and decommissioning), activities on-site will have the potential to impact the soils, geological and hydrogeological receiving

environment at the Proposed Development and surrounding area. Specific effects related to each phase of wind farm development are considered in this Section.

A detailed description of the Proposed Development infrastructure is provided in Chapter 5: Project Description. In summary, the Proposed Development will consist of six wind WTGs with a maximum blade tip height of 150m, rotor diameter of 117m and a hub height of 91.5m. It will include a 38kV substation with a control building, security fencing, and associated electrical infrastructure. The development will require underground cabling to connect the WTGs to the substation and onward connection to the national grid. Site works will involve upgrading existing roads, constructing new access tracks, junction improvements, and establishing hardstand areas. Additional elements include two borrow pits, three peat repository areas, a temporary construction compound, site drainage, forestry felling, and signage, along with all necessary ancillary works. Sediment controls, temporary construction compounds, tree felling of existing forestry and all other associated works will also be included.

9.5.1 "DO-NOTHING" SCENARIO

Should the Proposed Development not be constructed then there would be no changes made to existing land-use. The land, soils, geology and hydrogeology would remain unchanged as a result of this 'Do-Nothing' scenario.

Forestry and agricultural activities would continue undisturbed. Forestry would continue on the Coillte land with the felling of sub compartments once mature and subsequent re-planting of coniferous tree nurseries. Coillte plantations may also be reploughed and fertilised with phosphates where necessary to facilitate the afforestation process.

9.5.2 CONSTRUCTION ACTIVITIES

The construction phase of the Proposed Development is anticipated to take 12-18 months. Potential impacts during this phase include activities such as temporary and permanent excavation and the storage of peat. These activities may cause disturbance to the local environment and require careful management to mitigate impacts.

Activities associated with the construction phase which could give rise to potential impacts on the receiving environment are as follows:

- Excavation and construction of approximately 3.5km of new access tracks, 2-5m wide;
- Upgrade of 880m of existing access track;
- Excavation and construction of six WTG foundations;
- Excavation and construction of six permanent crane hardstandings;
- Cable laying within track verges;
- Cable laying along grid connection route;
- Use of 1 construction compound, storage and use of oils and fuels;
- Extraction of aggregate via 2 borrow pits;

- Backfilling of borrow pits with excavated peat;
- Stockpiling of excavated soils and peat, including up to 3 permanent peat storage areas;
- Side casting of excavated peat along access tracks;
- Tree felling to create access track corridors and space for WTGs and additional structures;
- Installation of cut-off drains;
- Installation of drains, both temporary and permanent;
- Dewatering of excavations and trenches;
- Discharge of surface water and groundwater from excavations;
- Temporary watercourse diversions;
- Concrete mixing and pouring; and
- Site reinstatement.

9.5.2.1 ESTIMATIONS OF PEAT EXCAVATION VOLUMES

The peat depths assessed during the ground investigation (GI) were examined at key infrastructural elements of the Proposed Development, including each WTG location, crane hardstand, borrow pit site, and access tracks. The volume of peat material excavated has been estimated using the average peat depth calculated across the footprint of the structure to define the basal surface of the peat.

Table 9-10: Summary of preliminary excavation volumes

Infrastructure	Excavated peat volume (m3)	Excavated spoil volume (m3)
Floated Access Roads - New	0	0
Founded Access Roads - Existing Roads	6,680	0
Founded Access Roads - New Roads (Including widening)	22,260	14,010
Temporary Compound	0	0
WTG foundations	2,670	1,110
WTG Hardstands	19,390	48,760
Substation	1,340	50,110
Borrow Pit	7,100	0
Total	59,440	113,990

Several key considerations have been made in estimating peat reinstatement volumes:

- A conservative reinstatement volume of 2m³ per linear meter (lin.m) has been applied for new access roads, with 1m³ placed on each side of the trackway. This may be increased to 4m³ per lin.m during detailed design, subject to stability considerations.

- For existing access road widenings, a reinstatement volume of 1m³ per lin.m has been allocated, assuming placement on one side only of the proposed widened trackway.
- For upgrades to existing access roads, a reinstatement volume of 1m³ per lin.m has been allocated, with 0.5m³ placed on each side of the upgraded road.
- Hardstand areas, including crane hardstands and temporary construction compounds, are estimated to accommodate 3m³ of reinstated peat per external lin.m of their perimeter.
- A conservative estimate of 20% of the total cohesive spoil volume has been designated for reuse in the construction of safety berms across the Proposed Development.
- Three peat repository areas have been identified for the permanent placement of peat and spoil material, along with borrow-pit reinstatement.

These measures ensure that peat management within the development is efficient, environmentally responsible, and aligned with best practices for site restoration and stability.

Table 9-11: Summary of preliminary peat reinstatement volumes

Infrastructure	Peat Reinstatement volume (m3)	Comments
Floated Access Roads - New	16,140	Placement of arisings 2m3/lin.m alongside existing and new founded roads, where topography allows.
Founded Access Roads - Existing Roads	2,200	
Founded Access Roads -New Roads (Including widening)	4,210	Placement of arisings 1m3/lin.m alongside upgraded roads, where topography allows.
Temporary Compound	600	
WTG foundations	720	Placement of arisings 3m3/lin.m of external hardstand perimeter, where topography allows.
WTG Hardstands	10,030	Placement of arisings 3m3/lin.m of external compound perimeter, where topography allows.
Substation	270	Placement of arisings 3m3/lin.m of external substation perimeter, where topography allows.
Borrow Pit	28,980	1m peat placement within peat repository areas, with a reduction to account for constructing a 3m cell berm.
Total	63,150	

Table 9-12: Summary of preliminary spoil reinstatement volumes

Comment	Spoil Reinstatement volume (m3)
20% Reinstatement of Total Volume	6,740
Spoil Stockpile Areas	31,530
Total	**38,270**

The volumes presented in Table 9-11 and Table 9-12 are based on standard earthworks practice, where cut and fill volumes are evaluated on a 1m³ cut to 1m³ fill basis. It is recognised that bulking may occur, as excavated soils can occupy a greater volume due to a reduction in density. However, this effect is expected to be significantly offset by compaction during placement and natural settlement, ensuring that the outlined volumes remain accurate.

9.5.2.2 WTG FOUNDATIONS

Excavations will be undertaken to reach a suitable bearing stratum for the WTGs. It will be ensured that all peat is removed from the footprint of the WTG foundation.

Exact design and construction methodology of the WTG foundations can only be determined at the detailed design stage. However, for the purposes of this EIAR, it is assumed foundations will comprise mass reinforced concrete bases which will be backfilled upon completion. Dewatering may be required depending on the groundwater levels across the site. Existing site investigation information considers there to be potential for shallow groundwater in some areas of the site where surface waterbodies are present.

It is envisaged that the potential impacts on the land, soils, geology and hydrogeology will be the same regardless of WTG selection. The following potential impacts are flagged for WTG foundation construction:

- Increased erosion and sediment run-off due to soils exposure during excavations;
- Loss of peat resources due to excavation and compaction;
- Subsequent loss of soils, peat or solid geology due to erosion during excavations;
- Temporary exposure of bedrock resulting in increased groundwater vulnerability during excavations;
- Localised alteration of the groundwater flow directions during excavation and construction of the WTG base structures; and
- Potential contamination of soils and groundwater via leaks and spillages of concrete or unset cement during excavation and construction.

9.5.2.3 ACCESS TRACKS, PASSING BAYS AND EXISTING ROAD UPGRADES

Excavations will be undertaken for infrastructure such as access tracks and passing bays, whilst upgrades will be made to existing road networks in order to accommodate WTG delivery. These will generate direct impacts such as:

- Increased erosion and sediment run-off due to soils exposure during excavations;

- Loss of peat resources due to excavation and compaction;
- Subsequent loss of soils, peat or solid geology due to erosion during excavations;
- Temporary exposure of bedrock resulting in increased groundwater vulnerability during excavations; and
- Potential contamination of soils and groundwater via leaks and spillages from plant machinery.

9.5.2.4 SUBSTATION, CABLE TRENCHING AND GRID CONNECTIONS

- Increased erosion and sediment run-off due to soils exposure during excavations;
- Loss of peat resources due to excavation and compaction;
- Subsequent loss of soils, peat or solid geology due to erosion during excavations;
- Temporary exposure of bedrock resulting in increased groundwater vulnerability during excavations;
- Potential contamination of soils and groundwater via leaks and spillages of concrete or unset cement during excavation and construction of the substation; and
- Potential contamination of soils and groundwater via leaks and spillages from fuels and oils associated with the grid transformer during the operational phase of wind farm.

9.5.2.5 BORROW PITS

Borrow pits will be excavated during the construction phase to provide aggregate material for works including access tracks, WTG/crane/met mast hardstandings, upfill for WTG foundations and temporary compounds.

The following potential impacts are flagged for borrow pit excavation works on-Site:

- Increased erosion and sediment run-off due to soils exposure during excavations;
- Loss of peat resources due to excavation and compaction;
- Subsequent loss of soils, peat or solid geology due to erosion during excavations;
- Temporary exposure of bedrock resulting in increased groundwater vulnerability during excavations;
- Localised alteration of the groundwater flow directions during excavation; and
- Increased landslide and/or peat stability risk due to blasting. This is only the case for extreme events.

Excavation of borrow pits will also involve the generation of dust and potential wastewater with high suspended solids content. Potential for release of suspended solids to surface watercourses will be discussed further in Chapter 10: Hydrology, Water Quality and Flood Risk.

9.5.2.6 PEAT REPOSITORIES AND MATERIALS STORAGE

Three permanent peat storage areas have been designated within the Proposed Development. Temporary stockpiling of materials will be required between excavation, transportation and/or reuse.

The following potential impacts are flagged for peat repositories and material storage on-Site:

- Potential for collapse/landslide due to incorrect storage of peat and/or storage of peat in the wrong areas on-Site;
- Potential for increased sediment in runoff from excavated peat if appropriate peat storage design measures and drainage controls are not implemented;
- Potential for increased sediment in runoff from other stored materials if appropriate storage design measures and drainage controls are not implemented; and
- Peat degradation due to drying out if appropriate peat storage design measures are not implemented.

9.5.2.7 SLOPE STABILITY

Peat stability has been discussed in Section 9.4.4.3 and in *Technical Appendix A09-02*. The following potential risk factors for slope stability are flagged:

- Potential impacts of cutting of peat at the toe of slopes creating an unloading of peat mass;
- Potential impacts of compaction and loading of peat mass via heavy machinery and structures;
- Potential impacts of changes to vegetation and tree cover which reduces the tensile strength slopes;
- Potential impacts of deforestation and removal of binding root structures to facilitate construction of the Proposed Development;
- Potential impacts of mechanical vibrations or vibrations from blasting during borrow pit excavation causing an increase in shear stresses in peat;
- Potential impacts of an artificial drainage regime on changes in pore water pressures of peat along slip surfaces; and
- Potential impacts of excavated peat and soil if appropriate storage design measures are not implemented.

9.5.2.8 TREE FELLING

- Potential erosion of soils and sediment run-off from increased exposure to weathering and removal of root structures;
- Potential impact on peat stability due to risk factor of removing stabilising influence of existing vegetation; and
- Mobilisation of phosphate fertilisers from disturbed soils into groundwater.

- It is noted that the likelihood of impacts from phosphates will be spatially variable across the site depending on the presence of peat and bedrock outcrop.
- There is also understood to be a lack of shallow groundwater within, and recharge capacity to the underlying Ll bedrock aquifer.

Further consideration on potential effects from overland sediment and phosphate release to surface waters is given in Chapter 10: Hydrology, Water Quality and Flood Risk.

9.5.2.9 CONSTRUCTION AND PLANT EQUIPMENT

- Compaction of peat due to construction machinery, equipment and vehicle movement;
- Potential for accidental contamination of soils and groundwater via leaks and spillages from fuels and/or chemical compounds from plant machinery; and
- Potential for accidental contamination of soils and groundwater via leaks and spillages from poor practice regarding storage of oil, chemical, fuel storage and wastewater handling.

9.5.3 OPERATIONAL ACTIVITIES

The operational phase of the Proposed Development is projected to have a duration of 30 years. While the majority of construction-related activities will have ceased, some overlap in impacts, particularly those related to permanent peat storage and land use, will continue into the operational phase. Ongoing monitoring and maintenance will be necessary to ensure long-term environmental and structural integrity.

Activities associated with the operational phase which could give rise to potential impacts on the receiving environment are as follows:

- Ongoing use of substation, access tracks and permanent compound with fuels and hydrocarbons;
- Maintenance of WTGs, access tracks and cables; and
- Vehicular use.

The operational activities associated with the Proposed Development which could give rise to potential effects on soils, geology, hydrogeology and contamination are summarised as follows:

- Vehicle movement and storage of materials which may cause pollution from accidental fuel or chemical compound leakages; and
- Accidental release or leakage of other liquids on-site such as wastewater associated with site facilities.
- These activities are outlined in greater detail within Chapter 5: Project Description.

9.5.4 DECOMMISSIONING ACTIVITIES

The decommissioning phase and the activities associated with the Proposed Development could give rise to potential effects on the land, soils, geology and hydrogeology of the receiving environment. In

general, potential impacts encountered during the decommissioning phase of the wind farm will be like those associated with the construction phase, but of a lesser magnitude.

Activities associated with the decommissioning phase of the Proposed Development which could give rise to potential effects are summarised as follows:

- Removal of all major equipment and structures, or replacement with new;
- Substation to remain in place as it will be under Electricity Supply Board (ESB) ownership;
- On-site access tracks will be left in-situ for use by landowners;
- Removal of underground cables, with ducting to remain in portions where cables are located beneath roads;
- Removal of crane hardstanding adjacent to WTGs;
- Reinstatement of ground at former structures, i.e. crane hardstanding;
- Stockpiling of soils and peat;
- Sections of drainage will remain;
- Use of reactivated temporary compounds, storage and use of oils and fuels; and
- Vehicular use.
- In light of the above activities, the following potential effects have been identified for the decommissioning phase of the Proposed Development:
- Compaction and temporary excavations during decommissioning of wind farm infrastructure resulting in adverse effects on soils, including peat, and superficial geology;
- Increased erosion of superficial soils due to temporary exposure of ground during removal of infrastructure and prior to restoration;
- Accidental release, leakage or spillage of hydrocarbons, fuel or oils from storage tanks/ plant causing contamination of groundwater; and
- Localised and temporary alteration of the groundwater regime of WTG base structures and windfarm infrastructure.

9.5.5 CUMULATIVE EFFECTS AND OTHER INTERACTIONS

9.5.5.1 OTHER RENEWABLE ENERGY PROJECTS

Cumulative effects refer to changes in the environment that result from a proposed development when considered in combination with other past, present, or reasonably foreseeable future activities. Potential cumulative effects may arise from the Proposed Development when considered in combination with other existing, permitted, or proposed projects in the wider area, particularly where their respective zones of influence overlap. In line with the EPA Guidelines (2022), a review of such projects has been undertaken, and developments with potential for cumulative interaction, based on location, scale, and environmental sensitivity, have been identified.

A detailed assessment outlining the scale, type, and proximity of these projects is provided in Chapter 21: Interactive and Cumulative Effects.

This assessment specifically considers potential cumulative effects in combination with the nearby Slievecallan Wind Farm, located approximately 3.5 km to the southeast. While the Proposed Development does not directly share any infrastructure components with neighbouring developments, proximity and similar construction practices have been taken into account. In addition, several other wind farms are located within a 10 -15 km radius to the south-southeast of the Proposed Development, including Booltiagh, Glenmore, Boolynagleragh, Sorrell Island, Lissycasey, Kiltumper, and Cahermurphy Wind Farms.

Each of these developments has been considered within the cumulative effects assessment. Notably, respective EIARs for these developments report no significant residual impacts following mitigation, and it is expected that any negative impacts associated with these schemes would be localised and minor in nature. As such, these projects are considered to be at a sufficient distance from the Proposed Development to avoid meaningful cumulative interactions on soils, geology, hydrogeology and contamination receptors.

9.5.5.2 CUMULATIVE EFFECTS

Considering the generally low sensitivity of the superficial soils and underlying solid geology across the site, no significant construction or operational cumulative effects are anticipated in relation to these receptors from the Proposed Development and other identified developments in the surrounding area.

Geology as a receptor is not considered sensitive in the context of the Proposed Development, and no significant cumulative effects on the geological environment are predicted during either the construction or operational phases.

Given the low sensitivity and limited presence of contamination within the site, no notable cumulative effects related to contamination are expected to arise from the Proposed Development in combination with other nearby projects.

Potential adverse effects on groundwater and PWSs are possible through the accidental releases, leakages or spillages of hydrocarbons, fuels or oils from storage tanks/plant during operation, along with other potential impacts such as alteration of groundwater flowpaths. These effects are considered to be localised short-term construction issues which are unlikely to have a measurable cumulative adverse effect following implementation of appropriate mitigation measures.

- Potential adverse effects on on-site peat through loss of peat soils due to temporary excavations for windfarm infrastructure, and potential landslide risk of peat caused by risk factors such as cutting, loading, vibration, alterations to surface water drainage, vegetation removal, or inappropriate storage of peat, leading to potential effects on surface water, infrastructure and people. As above, these effects are considered to be localised issues which will be managed through mitigation and are unlikely to have a measurable adverse cumulative effect.

9.5.6 SUMMARY OF POTENTIAL EFFECTS

Potential effects specific to the construction, operation and decommissioning phases operation of the Proposed Development on the receiving geological and hydrogeological environment are discussed in Section 9.5.1 to 9.5.5. Each effect has been assigned a ranking of Importance and Magnitude based on the respective receptor sensitivity and criteria for assessing magnitude given in Table 9-3 and Table 9-4. Significance has been assessed using the methodology described in Section 9.2, whereby the significance of the effect is determined by comparing the character of the predicted effect to the sensitivity of the receiving environment, as outlined in Figure 9-1. A summary table of the potential effects is displayed in Table 9-13.

Table 9-13: Summary of pre-mitigation effects on the receiving geological environment during the construction, operation and decommissioning phases of the Proposed Development.

Receptor	Potential Impacts	Importance (sensitivity)	Magnitude	Significance
Construction Phase				
Soils (excluding peat)	Potential loss of / adverse effects on the superficial geology (soils) due to temporary excavations and tree felling for wind farm infrastructure.	Low	Low Adverse	Slight
	Potential increased erosion of superficial soils due to tree felling and loss of surface vegetation.	Low	Low Adverse	Slight
Peat (storage)	Potential loss of / adverse effects on the peat soils due to temporary excavations for windfarm infrastructure.	High	Medium Adverse	Significant
	Peat compaction associated with construction traffic may reduce soil permeability and increase surface runoff.	High	Medium Adverse	Significant
	Potential increased erosion of superficial soils due to construction phase tree felling and loss of surface vegetation.	High	Medim Adverse	Significant
Peat (landslide)	Potential landslide of peat caused by risk factors such as cutting, loading, vibration, alterations to surface water drainage, vegetation removal, or inappropriate storage of peat, leading to effects on surface water, infrastructure and people.	High	High Adverse	Very Significant
Geology	Potential loss of / adverse effects on the bedrock geology beneath temporary excavations for wind farm infrastructure.	Low	Low Adverse	Not Significant
Groundwater bodies	Potential localised increase in alkalinity from spillages of concrete or unset cement causing pollution of groundwater.	High	Medium Adverse	Significant

	Potential risk of contamination to abstractions from accidental spillages of hazardous substances during construction activities within source protection zones or groundwater catchment areas.	High	Medium Adverse	Significant
	Potential for accidental releases, leakages or spillages of hydrocarbons, fuels or oils from storage tanks/construction plant during construction causing contamination of groundwater.	High	Medium Adverse	Significant
	Potential localised alteration of the groundwater flowpaths during construction of the WTG base structures and windfarm infrastructure.	High	Low Adverse	Slight
	Potential exposure of bedrock and increase in groundwater vulnerability.	High	Medium Adverse	Significant
	Potential mobilisation of phosphate fertilisers associated with forestry into groundwater.	High	Medium Adverse	Significant
Contamination	Potential impacts on human health from site soils (on construction staff and future site users).	Low	Negligible	Imperceptible
	Potential impacts on human health from imported and site-won contaminated soils.	Low	Negligible	Imperceptible
	Potential wider environmental impacts from contamination associated with incorrect disposal of site soils.	Low	Negligible	Imperceptible
	Potential for contamination present in soils to have increased mobility and cause further impact, due to construction activities, on both human health and the wider environment.	Low	Negligible	Imperceptible
	Mobilisation of contamination in soils because of additional sediment loading or leaching.	Low	Negligible	Imperceptible

Operational Phase				
Soils (excluding peat)	Potential loss of / adverse effects on the superficial geology (soils) due to permanent excavations for wind farm infrastructure.	Low	Low Adverse	Slight
Peat (storage)	Potential loss of / adverse effects on the peat soils due to permanent excavations for wind farm infrastructure.	High	Medium Adverse	Significant
	Ongoing potential increased erosion of superficial soils due to tree felling and loss of surface vegetation.	High	Medium Adverse	Significant
Peat (landslide)	Ongoing potential landslide of peat caused by risk factors during the construction phase such as cutting, loading, vibration, alterations to surface water drainage, vegetation removal, leading to effects on surface water, infrastructure and people.	High	High Adverse	Very Significant
Geology	Potential loss of / adverse effects on the solid geological resource beneath permanent excavations for wind farm infrastructure.	Low	Low adverse	Not Significant
Groundwater bodies	Potential for accidental releases, leakages or spillages of hydrocarbons, fuels or oils from storage tanks/plant during operation causing contamination of groundwater.	High	Medium Adverse	Significant
	Potential risk to abstractions from long-term changes in groundwater quality or flow resulting from hardstanding cover or leaching of contaminants from operational infrastructure within sensitive source protection areas.	High	Medium Adverse	Significant
	Potential localised alteration of the groundwater flowpaths due to WTG base structures and wind farm infrastructure.	High	Low Adverse	Slight
	Potential contamination of groundwater by leachable contamination from imported fill materials.	High	Medium Adverse	Significant
	Reduction in infiltration/recharge caused by increased hardstanding cover or compaction of soils, resulting in impacts on groundwater.	High	Medium Adverse	Significant

Contamination	Ongoing potential impacts on human health from site soils (on site users).	Low	Negligible	Imperceptible
	Ongoing potential impacts on human health from imported and site-won contaminated soils.	Low	Negligible	Imperceptible
	Ongoing potential for contamination present in soils to have increased mobility and cause further impact, due to construction activities, on both human health and the wider environment.	Low	Negligible	Imperceptible
Decommissioning Phase				
Soils (excluding peat)	Potential increased erosion of superficial geology (soils) during the decommissioning process due to temporary exposure of ground during removal of infrastructure and prior to restoration.	Low	Low Adverse	Slight
Peat (storage)	Potential loss of / adverse effects on the peat soils during any excavations necessary for decommissioning.	High	Low Adverse	Moderate
Peat (landslide)	Potential landslide of peat caused by risk factors such as cutting, loading, vibration, alterations to surface water drainage, vegetation removal, or inappropriate storage of peat, leading to effects on surface water, infrastructure and people.	High	High Adverse	Very Significant
Geology	Potential loss of / adverse effects on the solid geological resource beneath permanent excavations during removal of wind farm infrastructure.	Low	Low Adverse	Slight
Groundwater bodies	Potential for accidental release, leakage or spillage of hydrocarbons, fuel or oils from storage tanks/construction plant during decommissioning causing contamination of groundwater.	High	Medium Adverse	Significant
	Potential risk to abstractions from accidental spillages or mobilisation of residual contaminants during decommissioning works, particularly where activities occur within groundwater source protection zones.	High	Medium Adverse	Significant

	Potential localised alteration of the groundwater flow paths due to removal of WTG base structures and wind farm infrastructure.	High	Low Adverse	Slight
	Changes to infiltration/recharge caused by reduced hardstanding cover or compaction of soils.	High	Low Adverse	Slight
Contamination	Potential impacts on human health from site soils (on site workers).	Low	Negligible	Imperceptible
	Potential impacts on human health from imported and site-won contaminated soils.	Low	Negligible	Imperceptible
	Potential wider environmental impacts from contamination associated with incorrect disposal of site soils	Low	Negligible	Imperceptible
	Potential for contamination present in soils to have increased mobility and cause further impact, due to construction activities, on both human health and the wider environment.	Low	Negligible	Imperceptible
	Mobilisation of contamination in soils because of additional sediment loading or leaching.	Low	Negligible	Imperceptible

9.6 MITIGATION MEASURES

As noted in Section 9.2.4, effects of Significant and above (adverse and beneficial) are considered 'significant' and mitigation measures have been considered to avoid, reduce or offset any predicted significant effects. Those effects which have been identified as Moderate significance or below are not considered to be significant and therefore no mitigation measures are required, however, it is considered that the mitigation measures detailed below will also reduce the likely impact of these effects to an even lower magnitude. In some cases, the identified effects have already been reduced in significance through integration of measures built into the Project design.

9.6.1 EMBEDDED MITIGATION

With reference to the baseline assessments and EIAR Scoping Report, the design of the Proposed Development has followed an iterative process which best accounts for the sensitivity of key geological and hydrogeological receptors. As a result, where possible, sensitive receptors have been avoided during the design of infrastructure components to minimise any potential impact which may arise from works associated with the construction, operational and decommission phases of wind farm development.

Specific embedded or designed-in mitigation measures which have dictated infrastructure design, and which the developer has committed to implement in full, are outlined in Chapter 4 of this EIAR. Those activities that still have the potential to cause potential impacts on the sensitive receptors after embedded mitigation has been accounted for are outlined in Section 9.6.2.

9.6.1.1 GENERAL

- Infrastructure has been strategically positioned to minimise cut and fill requirements throughout the Proposed Development. This will reduce impact on the geological environment and minimise changes to sensitive receptors such as peat deposits.

9.6.1.2 WIND TURBINES

- Sizing of hardstanding areas have been minimised to limit the spatial area affected by works at each WTG location.
- WTGs are located close to access tracks to minimise the total track length required and therefore limit damage to the geological environment.
- Where possible, WTGs have been strategically positioned to target areas of shallow peat. This will avoid areas of deeper peat cover and areas noted to be unstable, as per *Technical Appendix A9-01* and *Technical Appendix A9-02*.

9.6.1.3 ACCESS TRACKS

- Design of proposed access tracks comprise existing Coillte forestry tracks and site entry points, where possible, within the Proposed Development.
- Design of proposed access tracks will use floating track, where feasible, to minimise intrusive works on the geological environment.

- Where possible, proposed access tracks target areas of shallow peat. This will avoid increasing existing peat instability across the Proposed Development.
- Where possible, proposed access tracks have been positioned to maintain a minimum distance of 50m from surface watercourses.
- Where possible, proposed access tracks have been positioned to minimise the number of water crossings across the Proposed Development.
- Proposed access track lengths between WTGs have been minimised to limit damage to the geological environment.

9.6.2 CONSTRUCTION MITIGATION

The following mitigation measures will be implemented in full to reduce or avoid the potential impacts associated with the construction phase of wind farm development, as outlined in Section 9.5.

9.6.2.1 TURBINE FOUNDATIONS

- All works undertaken at the WTGs location will be undertaken in accordance with the Construction Environmental Management Plan (CEMP) accompanying this EIAR.

9.6.2.2 ACCESS TRACKS

- All works undertaken during construction/extension of access tracks will be undertaken in accordance with the CEMP.
- Earthworks will be conducted from designated work corridors to minimise the spatial area impacted during the construction phase.
- Erosion and sediment control measures, including silt fences, sediment traps, and buffer zones, will prevent sediment-laden runoff from infiltrating the ground, protecting groundwater quality and maintaining natural recharge conditions.
- Restoration and landscape integration will include the decommissioning of temporary access tracks and the re-establishment of vegetation using native species to promote soil stability, reduce erosion, and support natural infiltration, minimising any potential long-term impacts on soils and groundwater.

9.6.2.3 BORROW PIT EXCAVATIONS

- All excavation works undertaken at the borrow pit locations will be undertaken in accordance with the Construction Environmental Management Plan (CEMP) accompanying this EIAR.
- Dust suppression techniques will be used during excavation works in accordance with the measures outlined in the CEMP.
- Temporary pumping of groundwater may be required to facilitate excavation and remove wastewater with high concentrations of suspended soils. This will be carried out in accordance with the measures outlined in the CEMP.

- Excavations will not be undertaken during periods of severe weather where there is a risk to either the stability of materials and/or management, transport and storage of said materials.
- Excavation works will be monitored by a qualified geotechnical engineer.

9.6.2.4 SLOPE STABILITY

- Mitigation measures are proposed to limit the potential for peat stability issues and slope failure at the Proposed Development. These measures are derived from the findings of the Peat Stability Risk Assessment and best-practice guidance outlined within the Peat Management Plan outlined in technical appendices which accompany this Chapter.

During the construction stage, the peat stability risk assessment will be updated to account for any variations in the layout that may arise. This reassessment will ensure that peat stability and landslide risks are appropriately managed as construction progresses.

A preliminary assessment of peat and spoil material placement and reinstatement has already been conducted, indicating that stability is acceptable. To further mitigate against any potential peat failure, the design also incorporates the use of safety buffer areas and designated peat stockpile restriction zones to manage loading and maintain slope integrity. Furthermore, a detailed stability assessment will be carried out as part of the design process, once specific locations are confirmed, and additional GI data becomes available.

The Contractor will be responsible for conducting a confirmatory construction-stage Peat Stability Risk Assessment, which will evaluate the peat stability and landslide risks associated with any layout modifications that may arise during the detailed design and/or construction phase. This will ensure that all necessary mitigation measures are implemented to maintain safe and stable site conditions.

The following additional mitigation measures are proposed to reduce, offset and avoid peat disturbance which may incur stability issues:

- Proposed peat repositories are in areas with low risk of peat instability, in accordance with *Technical Appendix A9-02: Peat Stability Risk Assessment*.
- The application of Safety Buffer Areas. Designated areas where no development or construction activities will be carried out, including plant movements, peat or overburden excavation or reinstatement or placement of peat or any overburden materials.
- Further quantitative assessments carried out in the construction PSRA; such as the Factor of Safety (FoS) analysis. The FoS calculations will provide a direct measure of the degree of stability of a slope by the ratio of the shear resistance along a potential surface of failure and the landslide driving forces acting on such a surface.
- Peat related works will be subject to additional detailed design and thoroughly checked by a suitably qualified geotechnical engineer, hydrologist, and/or drainage engineer.
- Peat generated during construction can be reused or reinstated across the Proposed Development to minimise waste and support environmental restoration. To ensure seamless integration with the surrounding topography, peat should be placed as soon as reasonably

practical after construction, contributing to landscape enhancement, reducing visual impacts, and aiding in habitat restoration.

- Detailed method statements will be prepared for all elements of the construction phase and will be outlined accordingly in the CEMP.
- Risk characterisation for slope stability will be outlined in the CEMP. Any risk identified during the construction phase will be minimised by following the principles of avoidance, prevention and protection.
- Transportation distances of excavated peat will be minimised from the point of extraction. For example, initially side cast and then transported to the nearest designated borrow pit or peat storage area.
- Excavation works will be monitored by a qualified geotechnical engineer.
- Vibration monitoring will be undertaken throughout the construction phase to assess and minimise the disturbance.
- Frequent monitoring of slopes will be undertaken during the construction phase, including additional monitoring follow periods of intense or prolonged rainfall. Monitoring will be conducted by a qualified geotechnical engineer.

9.6.2.5 TREE FELLING

- Machine combinations (i.e. handheld or mechanical) will be chosen which are most suitable for ground conditions and which will minimise soils disturbance.
- Tree felling will only be undertaken in areas of proposed infrastructure that have low risk of peat instability. Areas of deeper peat will be avoided to minimise risks to slope stability.
- Tree felling buffers have been minimised to ensure health and safety concerns are addressed with regards wind-blow during the construction phase.
- Where possible, retention of trees will ensure that slope stability is not adversely impacted, and the risk of surface run off is minimised.

9.6.2.6 SOIL EROSION

The following precautionary measures shall be undertaken to minimise the risk of impacting on soil within the receiving environment:

- Sound design principles will be followed to adhere to relevant Irish guidelines and recognised international guidelines for best practice.
- Whilst a major incident is highly unlikely to occur in circumstances where the mitigation measures are fully implemented, a major incident response plan will be detailed by the contractor in the detailed CEMP.
- Excavations will be constructed and backfilled as quickly as possible to minimise risk of soil erosion.

- Excavations will be stopped immediately during periods of intense rainfall due to the potential for sediment mobilisation and risk to materials management.
- Excavated materials will be stored appropriately in accordance with the measures outlined in the CEMP.
- Where possible, silt traps and bunding will be used to minimise the mobilisation of suspended sediments in run off.
- With the exception of designated peat storage areas outlined in the CEMP, no material stockpiles will be left on-Site after the construction phase.

9.6.2.7 SOIL COMPACTION

- A designated work corridor will be delineated prior to commencement of earthworks. Plant machinery will be required to operate within this boundary to limit the damage to the geological environment.
- Where possible, excavations of soils/peat will be conducted from the access tracks to minimise the impacted spatial area during the construction phase.

9.6.2.8 OIL, FUEL AND CHEMICAL LEAKAGES/SPILLAGES AND WASTEWATER

General effects on soil contamination may arise associated with works machinery and the temporary storage of construction materials, oils, fuels and chemicals. As such the potential for spillage or release of fuel oil and other dangerous substances will be mitigated through the following measures:

- The risk of soil quality effects associated with works machinery and leakages/spillages of fuels, oils, other chemicals will be controlled through good site management and the adherence to codes and practices outlined by the main contractor in the detailed CEMP.
    - This includes management and auditing procedures such as toolbox talks, and adherence to permits, licences, certificates and planning permissions
- All potentially polluting liquids will be sited on an impervious base and stored within containers and/or fully bunded and designated areas which are secured
    - The control measures in Guidance for Pollution Prevention - GPP2: Above Ground Oil Storage Tanks (DEFRA, 2017) and GPP26 “Safe storage – drums and intermediate bulk containers” (DEFRA, 2021), shall be implemented to ensure safe storage of oils and chemicals
    - The base and bund walls must be impermeable to the material stored and of adequate capacity.
    - This will be conducted using the necessary equipment in accordance with the CEMP.
- Plant machinery will be confined to allocated areas of the Proposed Development during the construction phase. Safe operation of refuelling activities shall be in accordance with GPP 7 *Safe Storage – The safe operation of refuelling facilities* (DEFRA, 2011). Refuelling of plant machinery will be conducted at designated refuelling points.

- Emergency spill kits will be readily available to protect against accidental release, leakage or spillage of potentially polluting substances.
- All plant and equipment will be regularly inspected for any signs of damage leaks. A checklist must be present to make sure that the checks have been carried out.
- A spillage control procedure and project specific Pollution Incident Response Plan will be in place and all staff should be trained on how to deal with spillages. This procedure is outlined in the CEMP.
- The following mitigation measures are proposed to reduce or offset potential adverse effects on water quality due to accidental release or leakage of wastewater associated with temporary site facilities:
- Wastewater will be collected in containerised welfare units at designated points and removed off-site by a permitted waste contractor.
- Existing and proposed surface water drainage and discharge points will be mapped on a drainage layout. These will be noted on construction site plans and protected accordingly to ensure water bodies are not impacted from sediment and other pollutants using measures to intercept the pathway for such pollutants. Such measures will be outlined in greater detail by the main contractor within the detailed CEMP.

9.6.2.9 GROUNDWATER

- A site-specific CEMP will be prepared and implemented by the appointed contractor. This will include spill response protocols, surface water and groundwater protection measures, pollution control procedures, and emergency response measures.
- All fuels, oils, and chemicals will be stored in double-bunded, lockable tanks located in designated, impermeable refuelling and storage areas, away from drainage paths or watercourses. Storage areas will be regularly inspected and maintained to prevent leaks or failures.
- Construction plant and vehicles will undergo routine inspection and maintenance to avoid leakage of hydrocarbons.
- WTG bases, access roads, and associated infrastructure will be designed to minimise disruption to natural groundwater flow paths. This includes avoiding interception of shallow flow systems and maintaining natural surface and subsurface drainage patterns.
- In areas classified as highly vulnerable, ground disturbance will be minimised, and protective measures such as temporary ground protection, geotextile barriers, and infiltration control will be implemented.
- Baseline monitoring of water quality and quantity will be conducted for PWS sources within the zone of influence prior to construction. Monitoring will continue throughout construction and post-completion to detect any changes attributable to site activities. The installation of dedicated groundwater monitoring boreholes may be required near sensitive abstraction zones.

9.6.2.10 CONTAMINATED SOILS

- The following precautionary measures shall be undertaken to minimise the risk of impacting on soil contamination at the Proposed Development:
- Contamination will be considered as part of the earthworks specification to confirm the material suitability for re-use within the Site, including with respect to marine criteria. This will be outlined within the detailed CEMP.
- Any imported soils required for construction purposes will be subject to chemical analysis and assessed against relevant screening values to demonstrate their suitability for use (with respect to risks to both human health and the water environment).
- Materials which are temporarily stored on-Site will be stored in accordance with the measures outlined in the CEMP, for example using covers to prevent air-blown transportation and surface run-off.
- Concrete wash water handling will be carried out at designated areas and suitably managed in accordance with the CEMP.
- In the event of any unexpected contamination, assessment will be undertaken to understand the nature and extent of the contamination. Any soils that subsequently need to be removed from site will be stored, removed, and treated/disposed of in accordance with guidance on managing contamination and waste management legislation. This will include the use of appropriate PPE, and measures to mitigate the generation of dust, such as damping down during dry periods. Classification and assessment of waste materials will be conducted as quickly as possible to ensure minimal exposure time to the receiving environment. Soils which are temporarily stored on-site will be stored appropriately, separate to clean materials, with covers and bunding as necessary.

A Waste Management Plan (WMP) will be outlined by the main contractor within the detailed CEMP and will detail the control of all site-generated construction waste and the storage and disposal of the waste.

- Soils will be stored, removed, and disposed of in accordance with the relevant waste management legislation.
- Classification and assessment of waste materials will be conducted as quickly as possible to ensure minimal exposure time to the receiving environment.
- Soils which are temporarily stored on-site will be stored appropriately, separate to clean materials, with covers and bunding as necessary.

9.6.3 OPERATIONAL MITIGATION

The following mitigation measures will be implemented in full to reduce or avoid the potential impacts associated with the operational phase of wind farm development, as outlined in Section 9.4.

9.6.3.1 OIL, FUEL AND CHEMICAL LEAKAGES/SPILLAGES

- The substation will be situated on an area of hardstand in order to minimise the downward migration of contaminants from stored materials into subsoils and groundwater.
- Potentially hazardous contaminants, such as hydrocarbons, fuels or oils will be stored in suitable containers and/or fully-bunded designated areas.
- Emergency spill kits will be made readily available on-Site to minimise the impact of any accidental releases, leakages or spillages of potentially contaminating materials.

9.6.3.2 GROUNDWATER

- Potential effects on groundwater during the operational period of the Proposed Development will be mitigated through the following measures:
- Substations, transformers, and cable joints will be regularly inspected and maintained to prevent leakage of oils or other hazardous substances. Any incidents will be managed under a site-specific environmental response plan.
- Infrastructure layout and design will maintain the integrity of identified groundwater flow paths and recharge zones. Should any unforeseen redirection of groundwater be detected post-construction, corrective measures such as local regrading or drainage adjustment will be considered.
- Continued monitoring of any identified PWS sources will be carried out to detect any changes in water quality or yield during operation. Results will be reviewed regularly and inform ongoing environmental management.

9.6.3.3 SLOPE STABILITY

- Visual inspections of areas of stored peat and peat slopes adjacent to wind farm components will be undertaken annually. Inspections will be undertaken by a qualified geotechnical engineer.
- Photographic surveys will be used to document and track any visual changes to materials. Inspections will be undertaken by a qualified engineering geologist/ geologist/ geotechnical engineer/ civil engineer.
- Engineered solutions will be designed and implemented for areas of suspected instability as and when required. Design will be undertaken by a qualified engineering geologist/ geologist/ geotechnical engineer /civil engineer.

9.6.3.4 SOIL EROSION

- Engineered solutions will be designed and implemented for areas of visible erosion, as and when required. Design will be undertaken by a qualified geotechnical engineer.

9.6.4 DECOMMISSIONING MITIGATION

As above, mitigation measures outlined in the construction phase will be followed as appropriate to the decommissioning of the wind farm.

The Irish Wind Energy Association (IWEA) states that when decommissioning a wind farm "the concrete bases could be removed, but it may be better to leave them under the ground, as this causes less disturbance". As a result, WTG foundations, hardstanding, access tracks and associated infrastructure may be left in-situ, due to a greater amount of environmental damage being caused during the removal process.

Decommissioning also provides an opportunity to either reduce or reverse impacts generated during the construction phase. The following is proposed to best achieve this:

- Rehabilitation of construction areas including WTG bases, hardstanding, substation, and site compounds. This will be achieved by covering areas with topsoil/peat to encourage vegetation growth which will in turn reduce surface water run-off and potential sedimentation processes post-decommissioning.
- Access tracks will be retained to aid forestry activities and for legacy monitoring purposes.
- All decommissioning works will follow an updated CEMP, including strict controls on fuel storage, machinery operation, and removal of infrastructure. Waste will be disposed of at licensed facilities.
- Decommissioning-related plant and equipment will be managed using the same containment and spill prevention protocols employed during construction. Temporary bunding and spill kits will be deployed on-site.

9.7 SUMMARY OF RESIDUAL EFFECTS

A summary of the potential effects on the receiving environment during the construction, operational and decommissioning phases of development following mitigation measures, is provided below in Table 9-14.

Table 9-14: Summary of post-mitigation effects on the receiving geological environment during the construction, operational and decommissioning phases of Proposed Development

Receptor	Potential Effects	Importance (sensitivity)	Magnitude (pre-mitigation)	Significance (pre-mitigation)	Magnitude (post-mitigation)	Significance (post-mitigation)
Construction Phase						
Peat (storage)	Potential loss of / adverse effects on the peat soils due to temporary excavations for windfarm infrastructure.	High	Medium Adverse	Significant	Low Adverse	Slight
	Peat compaction associated with construction traffic may reduce soil permeability and increase surface runoff.	High	Medium Adverse	Significant	Low Adverse	Slight
	Potential increased erosion of superficial soils due to construction phase tree felling and loss of surface vegetation.	High	Medium Adverse	Significant	Low Adverse	Slight
Peat (landslide)	Potential landslide of peat caused by risk factors such as cutting, loading, vibration, alterations to surface water drainage, vegetation removal, or inappropriate storage of peat, leading to effects on surface water, infrastructure and people.	High	High Adverse	Very Significant	Low Adverse	Slight
Groundwater bodies	Potential localised increase in alkalinity from spillages of concrete or unset cement causing pollution of groundwater.	High	Medium Adverse	Significant	Low Adverse	Slight

	Potential risk of contamination to abstractions from accidental spillages of hazardous substances during construction activities within source protection zones or groundwater catchment areas.	High	Medium Adverse	Significant	Low Adverse	Slight
	Potential for accidental releases, leakages or spillages of hydrocarbons, fuels or oils from storage tanks/construction plant during construction causing contamination of groundwater.	High	Medium Adverse	Significant	Low Adverse	Slight
	Potential mobilisation of phosphate fertilisers associated with forestry into groundwater.	High	Medium Adverse	Significant	Low Adverse	Slight
	Potential exposure of bedrock and increase in groundwater vulnerability.	High	Medium Adverse	Significant	Low Adverse	Slight
Operational Phase						
Peat (storage)	Potential loss of / adverse effects on the peat soils due to permanent excavations for wind farm infrastructure.	High	Medium Adverse	Significant	Low Adverse	Slight
	Ongoing potential increased erosion of superficial soils due to construction phase tree felling and loss of surface vegetation.	High	Medium Adverse	Significant	Low Adverse	Slight
Peat (landslide)	Ongoing potential landslide of peat caused by risk factors during the construction phase such as cutting, loading, vibration, alterations to surface water drainage, vegetation removal, leading to effects on surface water, infrastructure and people.	High	High Adverse	Very Significant	Low Adverse	Slight

Groundwater bodies	Potential for accidental releases, leakages or spillages of hydrocarbons, fuels or oils from storage tanks/plant during operation causing contamination of groundwater.	High	Medium Adverse	Significant	Low Adverse	Slight
	Potential risk to abstractions from long-term changes in groundwater quality or flow resulting from hardstanding cover or leaching of contaminants from operational infrastructure within sensitive source protection areas.	High	Medium Adverse	Significant	Low Adverse	Slight
	Potential contamination of groundwater by leachable contamination from imported fill materials.	High	Medium Adverse	Significant	Low Adverse	Slight
	Reduction in infiltration/recharge caused by increased hardstanding cover or compaction of soils, resulting in impacts on groundwater.	High	Medium Adverse	Significant	Low Adverse	Slight
Decommissioning Phase						
Peat (storage)	Potential loss of / adverse effects on the peat soils during any excavations necessary for decommissioning	High	Medium Adverse	Significant	Low Adverse	Slight
Peat (landslide)	Potential landslide of peat caused by risk factors such as cutting, loading, vibration, alterations to surface water drainage, vegetation removal, or inappropriate storage of peat, leading to effects on surface water, infrastructure and people.	High	High Adverse	Very Significant	Low Adverse	Slight
Groundwater bodies	Potential for accidental release, leakage or spillage of hydrocarbons, fuel or oils from storage tanks/construction plant during decommissioning causing contamination of groundwater.	High	Medium Adverse	Significant	Low Adverse	Slight

	Potential risk to abstractions from accidental spillages or mobilisation of residual contaminants during decommissioning works, particularly where activities occur within groundwater source protection zones.	High	Medium Adverse	Significant	Low Adverse	Slight

As indicated in Table 9-14, the final assessment of potential effects associated with the construction, operational and decommissioning phases of the Proposed Development, following implementation of mitigation measures outlined in Section 9.6, concludes that the overall effects on soils, geology, hydrogeology and contamination will be *slight adverse or less*.

9.8 MONITORING

The mitigation measures proposed in Section 2.6 will be subject to ongoing monitoring to ensure their effectiveness throughout the lifecycle of the project.

A water quality monitoring system will be implemented throughout the construction phase of the Proposed Development to ensure continued protection of groundwater resources and downgradient receptors, such as private water supplies.

As outlined in *Technical Appendix A9-02: Peat Stability and Risk Assessment*, the following recommendations have been made for monitoring peat in areas where construction activities are proposed on or adjacent to peat deposits exceeding 2m in depth.

It is recommended that movement monitoring posts be installed upslope and downslope of the works areas. These posts will be 1.0m to 1.5m in length and spaced at 5m intervals, with a minimum of seven posts per monitoring line (covering approximately 30m). A string line will be tensioned between the first and last posts, with all intermediate posts in contact with the same side of the string to facilitate visual detection of movement. Each post will be uniquely numbered, and a record of the numbering system will be maintained.

Monitoring posts will be checked at least once daily, with increased inspection frequency during adjacent construction activity. All inspections will be documented, including date, time, and any observed relative movement between posts, referenced by post number.

In addition to post monitoring, the contractor will carry out routine inspections of all peatland areas surrounding the works. These inspections will assess ground stability and drainage, and identify any signs of surface cracking, deformation, excessive settlement of structures, blocked drains, or emergent springs.

A comprehensive suite of Standard Operating Procedures (SOPs) will be provided for mitigation of all environmental aspects identified ad mechanisms to ensure effective implementation.

If any unforeseen contamination is identified during construction (e.g., hydrocarbon impacted soils, etc.), then work in such areas will be halted until a suitably qualified professional has been consulted to assess the situation and provide advice.

Any imported soils or fill materials required for construction purposes will be subject to assessment to demonstrate their suitability for use, which may need to include chemical analysis and assessment against relevant screening values, depending on their source.

9.9 CONCLUSION

A comprehensive assessment has been undertaken to evaluate the potential environmental effects of the Illaunbaun Wind Farm during the construction, operational, and decommissioning phases, with a focus on land, soils, geology, and hydrogeology within the receiving environment. This assessment draws on baseline site investigations, desk-based studies, and a suite of technical

appendices, including the *Peat and Spoil Management Plan (Technical Appendix A9-01)* and the *Peat Stability Risk Assessment (Technical Appendix A9-02).*

Peat on site presents the primary risk, including the potential for landslides, erosion, and soil compaction from construction activities. Mitigation processes include peat repositories that will be located in low-risk areas, Safety Buffer Zones and Peat Stockpile Restriction areas that will be established, and quantitative assessments such as Factor of Safety analyses will be applied. Peat excavation, handling, and reinstatement will be overseen by qualified professionals, with an emphasis on reusing peat to support habitat restoration and landscape integration. These measures will be set out in the Construction and Environmental Management Plan, along with detailed method statements. Ongoing monitoring will include regular inspections and professional oversight to ensure effectiveness. These actions are expected to reduce residual peat-related impacts to only slight significant level post-mitigation.

Groundwater also poses several risks on-site, including contamination from accidental spillages of fuels, oils, concrete, and other hazardous substances during construction, operation, and decommissioning, particularly within sensitive groundwater source protection zones. There is also potential for localised alteration of groundwater flow paths due to excavation and infrastructure, increased vulnerability from bedrock exposure, reduced recharge from hardstanding or soil compaction, and potential mobilisation of contaminants such as phosphates. To manage these risks, the CEMP will incorporate groundwater protection measures. Ground disturbance will be minimised in areas classified as “highly vulnerable”, fuel storage will follow best practices, including use of double-bunded, lockable tanks located on impermeable surfaces. Infrastructure will be designed to maintain natural groundwater flow and infiltration, with permeable surfaces used where feasible. Monitoring of groundwater quality in nearby abstraction and monitoring wells will be carried out before, during, and after construction.

No significant risks have been identified in relation to other environmental receptors such as soils, geology, or contamination. There is no evidence of existing soil contamination, and development activities are not anticipated to introduce any new significant contamination sources. Minor risks that may arise will be managed through adherence to the CEMP and standard best-practice construction methods, ensuring the continued integrity of soil and geological resources and avoiding any significant environmental impacts.

9.10 REFERENCES

Bibby, J.S., Douglas, H.A., Thomasson, A.J., & Robertson, J.S. (1991). Land Capability Classification for Agriculture. Macaulay Land Use Research Institute, Aberdeen.

Construction Industry Research and Information Association (CIRIA), 2015. *Environmental Good Practice On-Site Guide (C741)*.

Council of the European Communities, 1985. *Council Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment*.

Amended by: Directive 97/11/EC, Directive 2003/35/EC, and Directive 2009/31/EC.

Department of Communications, Energy and Natural Resources (DCENR), n.d. *Minerals Ireland database and Historic Mine Site Inventory*. Available at: https://www.mineralsireland.ie

Department of Housing, Planning and Local Government (DHPLG), 2006. *Wind Energy Development Guidelines*.

Department of the Environment, Heritage and Local Government (DoEHLG), 2010. Appropriate Assessment of Plans and Projects in Ireland: Guidance for Planning Authorities.

Environmental Protection Agency (EPA), 2015. Draft Advice Notes on Current Practice (in the preparation of Environmental Impact Statements). EPA, Wexford, Ireland.

Environmental Protection Agency (EPA), 2022. Guidelines on the Information to be Contained in Environmental Impact Assessment Reports. EPA, Wexford, Ireland.

Environmental Protection Agency (EPA), n.d. Water Framework Directive (WFD) 3rd Cycle status and risk assessments, Soil Information System (SIS), waste facilities, Catchments.ie datasets. Available at: https://www.epa.ie

European Commission, 2000. Directive 2000/60/EC establishing a framework for Community action in the field of water policy (Water Framework Directive). Official Journal of the European Communities, L327, pp.1–73.

European Commission, 2011. Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (codification). Official Journal of the European Union, L26, pp.1–21. Amended by: European Commission, 2014. Directive 2014/52/EU. Official Journal of the European Union, L124, pp.1–18.

European Commission, 2021. Article 6 of the Habitats Directive – Methodological Guidance on the Provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC.

Geological Survey Ireland (2000). Ennis Public Supply, Drumcliff Spring Co. Clare, Groundwater Source Protection, February 2000. Available at: https://www.gsi.ie

Geological Survey Ireland (GSI), n.d. Bedrock and Quaternary geology maps, aquifer classifications, groundwater vulnerability and recharge maps, wells and abstractions, karst features, geological heritage sites, landslide susceptibility mapping. Available at: https://www.gsi.ie

Government of Ireland, 1977–2007. Local Government (Water Pollution) Acts 1977 to 2007.

Government of Ireland, 2000. Planning and Development Act 2000 (No. 30 of 2000), as amended.

Government of Ireland, 2001. Planning and Development Regulations 2001 (S.I. No. 600 of 2001), as amended.

Government of Ireland, 2010. *European Communities Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010)*, as amended by S.I. No. 389/2011, S.I. No. 149/2012, and S.I. No. 366/2016.

Institute of Geologists of Ireland (IGI), 2013. Guidelines for Preparation of Soils, Geology and Hydrogeology Chapters in Environmental Impact Statements.

National Monuments Service (NMS), n.d. *Archaeological Survey of Ireland – Sites and Monuments Record*. Available at: https://www.archaeology.ie

National Parks and Wildlife Service (NPWS), n.d. *Designated sites and natural heritage data*. Available at: https://www.npws.ie

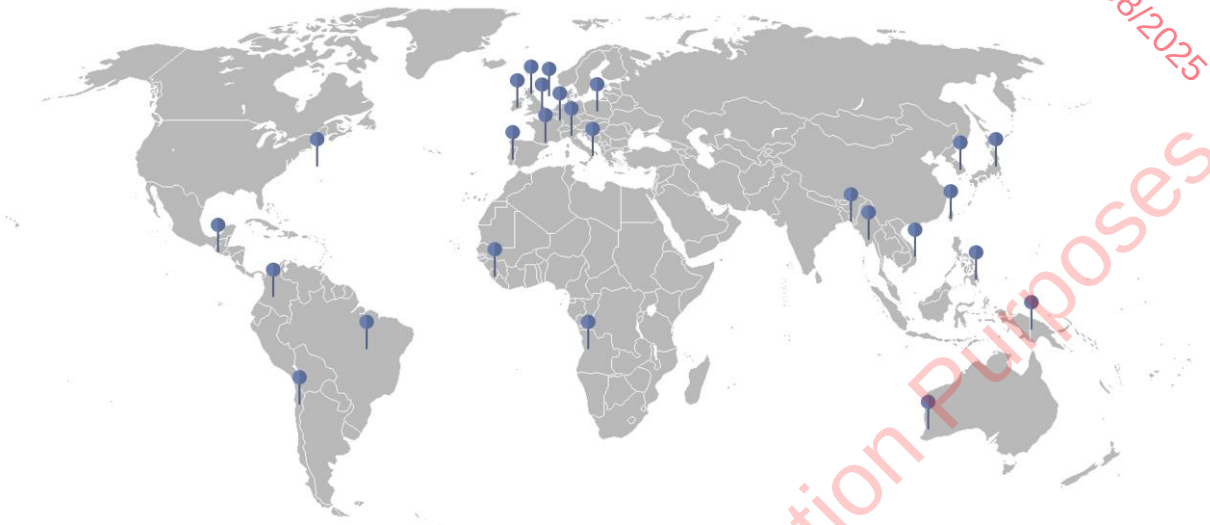
National Roads Authority (NRA), 2008. Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.

Ordnance Survey Ireland (OSI), n.d. *Historical and current mapping, aerial photography*. Available at: https://www.osi.ie

Scottish Government, 2017. Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments.

Teagasc, n.d. *National Soil Maps*. Available at: https://www.teagasc.ie

GLOBAL PROJECT REACH



Offices

Dublin (Head Office)
Gavin & Doherty Geosolutions
Unit A2, Nutgrove Office Park
Rathfarnham
Dublin 14, D14 X627
Phone: +353 1 207 1000

Cork
Gavin & Doherty Geosolutions
First Floor, 12 South Mall
Cork
T12 RD43

London
Gavin & Doherty Geosolutions (UK) Limited
85 Great Portland Street, First Floor
London
W1W 7LT

Utrecht
Gavin & Doherty Geosolutions
WTC Utrecht, Stadsplateau 7
3521 AZ Utrecht
The Netherlands

Belfast
Gavin & Doherty Geosolutions (UK) Limited
Scottish Provident Building
7 Donegall Square West
Belfast
BT1 6JH

Edinburgh
Gavin & Doherty Geosolutions (UK) Limited
22 Northumberland Street SW Lane
Edinburgh
EH3 6JD

Rhode Island
Gavin & Doherty Geosolutions Inc.
225 Dyer St, 2nd Floor
Providence, RI 02903
USA

GDG
GAVIN & DOHERTY
GEOSOLUTIONS

Website: www.gdgeo.com
Email: info@gdgeo.com

A Venterra Group Plc
Member Company