STATKRAFT

ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR) FOR THE PROPOSED DERNACART WIND FARM, COUNTY LAOIS

VOLUME 2 – MAIN REPORT

CHAPTER 13 - LAND, SOILS AND GEOLOGY

DECEMBER 2019

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13 LAND, SOILS AND GEOLOGY

13.1 Introduction

This chapter has been prepared to examine the potential impacts of the proposed Dernacart Wind Farm, and associated grid connection on existing land, soils and geology within the study area. The proposed development is defined in Chapter 1 - Introduction and a detailed description of the proposed development is set out in Chapter 4 - Description of the Proposed Development.

The potential impacts of the proposed development have been assessed, and mitigation measures proposed to eliminate or reduce any residual impacts on land, soils and geology. The assessment also considers the cumulative impacts of the project in combination with other nearby developments.

13.2 Assessment Methodology

The methodology adopted for this assessment includes:

- Review of appropriate guidance and legislation;
- Characterisation of the receiving environment;
- Review of the proposed development;
- Assessment of Potential Effects;
- Identification of Mitigation Measures; and
- Assessment of Residual Impacts.

13.2.1 Relevant Guidance and Legislation

The general EIA guidelines are listed in Chapter 1, other topic specific reference documents and legislation used in the preparation of this section include the following:

- NRA (2009), Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- IGI (2013), Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements;
- Scottish Executive (2017) Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments, 2nd Edition;
- European Union (2000/60/EC) Water Framework Directive;
- European Union (2006/188/EC) Groundwater Directive;
- Government of Ireland (2010) European Communities Environmental Objectives (Groundwater) Regulations (S.I. No. 9 of 2010);
- Government of Ireland (2003) European Communities (Water Policy) Regulations (S.I. No. 722 of 2003); and
- EPA (2003), Towards Setting Guideline Values for the Protection of Groundwater in Ireland.

13.2.2 Water Framework & Groundwater Directives, Status and Risk Assessment

The Water Framework Directive (WFD) provides for the protection, improvement and sustainable use of waters, including rivers, lakes, coastal waters, estuaries and groundwater within the EU Member States. It aims to prevent deterioration of these water bodies and enhance the status of aquatic ecosystems; promote sustainable water use; reduce pollution; and contribute to the mitigation of floods and droughts.

Under the Water Framework Directive large geographical areas of aquifer have been subdivided into smaller groundwater bodies (GWB) for them to be effectively managed.

The overriding purpose of the WFD is to achieve at least "good status" in all European waters and ensure that no further deterioration occurs in these waters.

European waters are classified as groundwaters, rivers, lakes, transitional and coastal waters. The first cycle of river basin management planning, which covered the period 2009-2015, developed plans and associated programmes of measures based on eight River Basin Districts (RBDs) within the island of Ireland. These plans set ambitious targets that envisaged that most water bodies would achieve good status by 2015.

The Groundwater Directive establishes a regime which sets groundwater quality standards and introduces measures to prevent or limit inputs of pollutants into groundwater. The directive establishes quality criteria that takes account local characteristics and allows for further improvements to be made based on monitoring data and new scientific knowledge. The directive thus represents a proportionate and scientifically sound response to the requirements of the Water Framework Directive (WFD) as it relates to assessments on chemical status of groundwater and the identification and reversal of significant and sustained upward trends in pollutant concentrations in groundwater.

13.2.3 Consultation

The scope for this assessment has been informed by consultation with statutory consultees, bodies with environmental responsibility and other interested parties as summarised in Chapter 5 – Scoping, Consultation and Key Issues.

13.2.4 Impact Appraisal Methodology

The following elements were examined to determine the potential impacts of the proposed development on Land, Soils and Geology within the study area:

- characterisation of the land, soils and geology underlying the study area; and
- evaluation of the potential impacts of the proposed development.

13.2.5 Evaluation Criteria

During each phase (construction, operation and decommissioning) of the proposed development, several activities will take place on site, some of which will have potential to cause impacts on the site's geological and hydrogeological regimes.

13.2.5.1 Assessment of Magnitude and Significance of Impact on Land, Soils and Geology

Impact ratings have been developed for each of the phases of the proposed development based on the Institute for Geologists Ireland (IGI) Guidance for the preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements. In line with the IGI Guidance the receiving environment (Geological Features) was first identified. Using the NRA rating criteria in Appendix C of the IGI Guidance the importance of the geological and hydrogeological features is rated (Tables 13-1 and 13-2) followed by an estimation of the magnitude of the impacts on geological and hydrogeological features (Tables 13-3 and 13-4).

This determines the significance of impact prior to application of mitigation measures as set out in Table 13-3 over.

Table 13-1: Criteria Rating Site Importance of Geological Features (NRA, 2009)

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

Table 13-2: Criteria Rating Site Importance of Hydrogeological Features (NRA, 2009)

Importance	Criteria	Typical Example
Extremely High	Attribute has a high quality or value on an international scale	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation e.g. SAC or SPA status
Very High	Attribute has a high quality or value on a regional or national scale	Regionally Important Aquifer with multiple wellfields. Groundwater supports river, wetland or surface water body ecosystem protected by national legislation – e.g. NHA status. Regionally important potable water source supplying >2500 homes Inner source protection area for regionally important water source.
High	Attribute has a high quality or value on a local scale	Regionally Important Aquifer. Groundwater provides large proportion of baseflow to local rivers. Locally important potable water source supplying >1000 homes. Outer source protection area for regionally important water source.

Importance	Criteria	Typical Example
		Inner source protection area for locally important water source.
Medium	Attribute has a medium quality or value on a local scale	Locally Important Aquifer Potable water source supplying >50 homes. Outer source protection area for locally important water source.
Low	Attribute has a low quality or value on a local scale	Poor Bedrock Aquifer. Potable water source supplying <50 homes.

The assessment of the magnitude of an impact incorporates the timing, scale, size and duration of the potential impact. The magnitude criteria for geological impacts are defined as set out in Table 13.2 over.

Table 13-3: Estimation of Magnitude of Impact on Geological Features (NRA, 2009)

Magnitude	Criterion	Description and Example
Large Adverse	Results in loss of attribute	• Loss of high proportion of future quarry or pit reserves • Irreversible loss of high proportion of local high fertility soils • Removal of entirety of geological heritage feature • Requirement to excavate / remediate entire waste site • Requirement to excavate and replace high proportion of peat, organic soils and/or soft mineral soils beneath alignment
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	• Loss of moderate proportion of future quarry or pit reserves • Removal of part of geological heritage feature • Irreversible loss of moderate proportion of local high fertility soils • Requirement to excavate / remediate significant proportion of waste site • Requirement to excavate and replace moderate proportion of peat, organic soils and/or soft mineral soils beneath alignment
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	• Loss of small proportion of future quarry or pit reserves • Removal of small part of geological heritage feature • Irreversible loss of small proportion of local high fertility soils and/or • high proportion of local low fertility soils • Requirement to excavate / remediate small proportion of waste site • Requirement to excavate and replace small proportion of peat, organic soils and/or soft mineral soils beneath alignment
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	No measurable changes in attributes

Magnitude	Criterion	Description and Example
Minor Beneficial	Results in minor improvement of attribute quality	Minor enhancement of geological heritage feature
Moderate Beneficial	Results in moderate improvement of attribute quality	Moderate enhancement of geological heritage feature
Major Beneficial	Results in major improvement of attribute quality	Major enhancement of geological heritage feature

Table 13-4: Estimation of Magnitude of Impact on Hydrogeological Features (NRA, 2009)

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute and /or quality and integrity of attribute	Removal of large proportion of aquifer. Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems. Potential high risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >2% annually.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Removal of moderate proportion of aquifer. Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or ecosystems. Potential medium risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >1% annually.
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Removal of small proportion of aquifer. Changes to aquifer or unsaturated zone resulting in minor change to water supply springs and wells, river baseflow or ecosystems. Potential low risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >0.5% annually.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Calculated risk of serious pollution incident <0.5% annually.

The matrix in Table 13-5 determines the significance of the impacts based on the importance and magnitude of the impacts as determined by Tables 13-1 to 13-4.

Table 13-5: Ratings of Significance of Impacts for Geology/Hydrogeology (NRA, 2009)

Importance of Attribute	Magnitude of Impact			
	Negligible	Small Adverse	Moderate Adverse	Large Adverse
Very High	Imperceptible	Significant/Moderate	Profound/Significant	Profound
High	Imperceptible	Moderate/Slight	Significant/Moderate	Profound/Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight/Moderate

The determination of the significance of each impact for this site is discussed in Section 13.4.

13.2.6 Desk Study

Prior to undertaking the site walkovers and intrusive site investigations, a desk study was undertaken to help determine the baseline conditions within the study area and planning boundary to provide relevant background information. The desk study involved an examination of the following sources of information:

- OSI (2019), Current and historic Ordnance Survey Ireland mapping and ortho-photography;
- Taluntais (1980), General Soil Map of Ireland;
- Geological Survey of Ireland (2019) GSI Public Data Viewer (www.spatial.dcenr.gov.ie);
- Environmental Protection Agency (2019) Review of the EPA online mapping (http://gis.epa.ie/Envision); and
- The proposed layout of the development.

To determine the existing hydrogeological regime within the study area the following EPA and GSI online datasets and mapping from the sources outlined above were reviewed:

- Catchment & Management Units;
- Groundwater Bodies Status and Risk;
- Drinking Water Protection Areas;
- Groundwater Resources (Aquifers);
- Groundwater Wells and Springs;
- Karst Features; and
- Groundwater Vulnerability

13.2.7 Field Assessments

Site walkovers were undertaken by an engineering geologist working for Fehily Timoney and Company (FT) during June and August 2019 to determine the baseline characteristics of the proposed development site.

The site assessment works undertaken comprised the following:

- Walk over inspections of the study area with recording of salient geomorphological features;
- Peat depth probing at 159 No. locations within the proposed development site; and
- Recording of GPS co-ordinates of site investigation locations.

13.3 Receiving Environment

The receiving environment is described hereunder. This includes descriptions of the underlying quaternary and bedrock geology, areas of geological heritage, areas of economic interest with respect to geological resources and potential for soil contamination. This section also includes a description of the existing hydrogeological regime. A summary of site-specific information obtained during site walkovers and site investigations undertaken as part of the baseline assessment works is also included.

13.3.1 Quaternary Deposits

13.3.1.1 Proposed Wind Farm Site

The Quaternary Geology underlying the proposed wind farm site, as taken from the GSI online mapping, comprise:

- Cut over raised peat (Cut)
- TILL derived from limestones (TLs)
- Gravels derived from Limestones (GLs)

The proposed wind farm site is predominantly underlain by cut over raised peat deposits. Areas of TILL derived from limestones and pockets of deposits of gravels derived from limestones are distributed throughout the central and southern portions of the proposed wind farm site.

13.3.1.2 Proposed Grid Connection

The Quaternary Geology underlying the proposed grid connection, as taken from the GSI online mapping, comprise:

- Cut over raised peat (Cut)
- TILL derived from limestones (TLs)
- Gravels derived from limestones (GLs)
- Alluvium
- Urban sediments

The future proposed Bracklone 110 kV cable route is predominately underlain by cut over raised peat, TILL derived from limestones, and gravels derived from limestones. The urban sediments are found at the eastern section of the grid connection at Portarlington. There are small sections of alluvium located adjacent to the River Barrow.

The Quaternary Geology of the proposed development site and its surrounds is presented in Figure 13-1.

13.3.2 Solid Geology

13.3.2.1 Proposed Wind Farm Site

The Geological Survey of Ireland (GSI) 1:100,000 scale bedrock geology map shows that the proposed wind farm site and associated access tracks are underlain by the Carboniferous Ballysteen Formation. The Ballysteen Formation is described as comprising bioclastic argillaceous limestone with oolitic limestones occurring through the formation.

13.3.2.2 Proposed Grid Connection

The future proposed Bracklone 110 kV cable route is predominately underlain by Carboniferous formations including:

- Ballysteen Formation
- Waulsortian Formation
- Allenwood Formation
- Lucan Formation

The Ballysteen Formation is described above.

The Waulsortian Limestone is described by the GSI as dominantly pale-grey, crudely bedded or massive Limestone.

The Allenwood Formation is described by the GSI as comprising pale-grey, generally massive shelf Limestones and their dolomitised equivalents.

According to the GSI, the Lucan Formation comprises dark-grey to black, fine-grained, occasionally cherty, micritic Limestones.

There are 2 No. unnamed faults underlying the route of the proposed grid connection, both trending northeast – southwest, and separating the Waulsortian and the Allenwood Formations.

However, it is considered these faults are no longer active and do not present a hazard for construction of the proposed wind farm or the associated grid connection.

The bedrock geology of the site and surrounding area is presented in Figure 13-2.

13.3.3 Geological Heritage

The GSI - Irish Geological Heritage Section (IGH) and the National Parks and Wildlife Service (NPWS) are undertaking a programme, – the Irish Geological Heritage Programme, to identify and select important geological and geomorphological sites throughout the country for designation as Natural Heritage Areas (NHAs). This is being addressed under 16 different geological themes. For each theme, a larger number of sites (from which to make the NHA selection) are being examined, to identify the most scientifically significant. The criterion of designating the minimum number of sites to exemplify the theme means that many sites of national importance are not selected as the very best examples. However, a second tier of County Geological Sites (CGS) (as per the National Heritage Plan) means that many of these can be included in County Development Plans and receive a measure of recognition and protection.

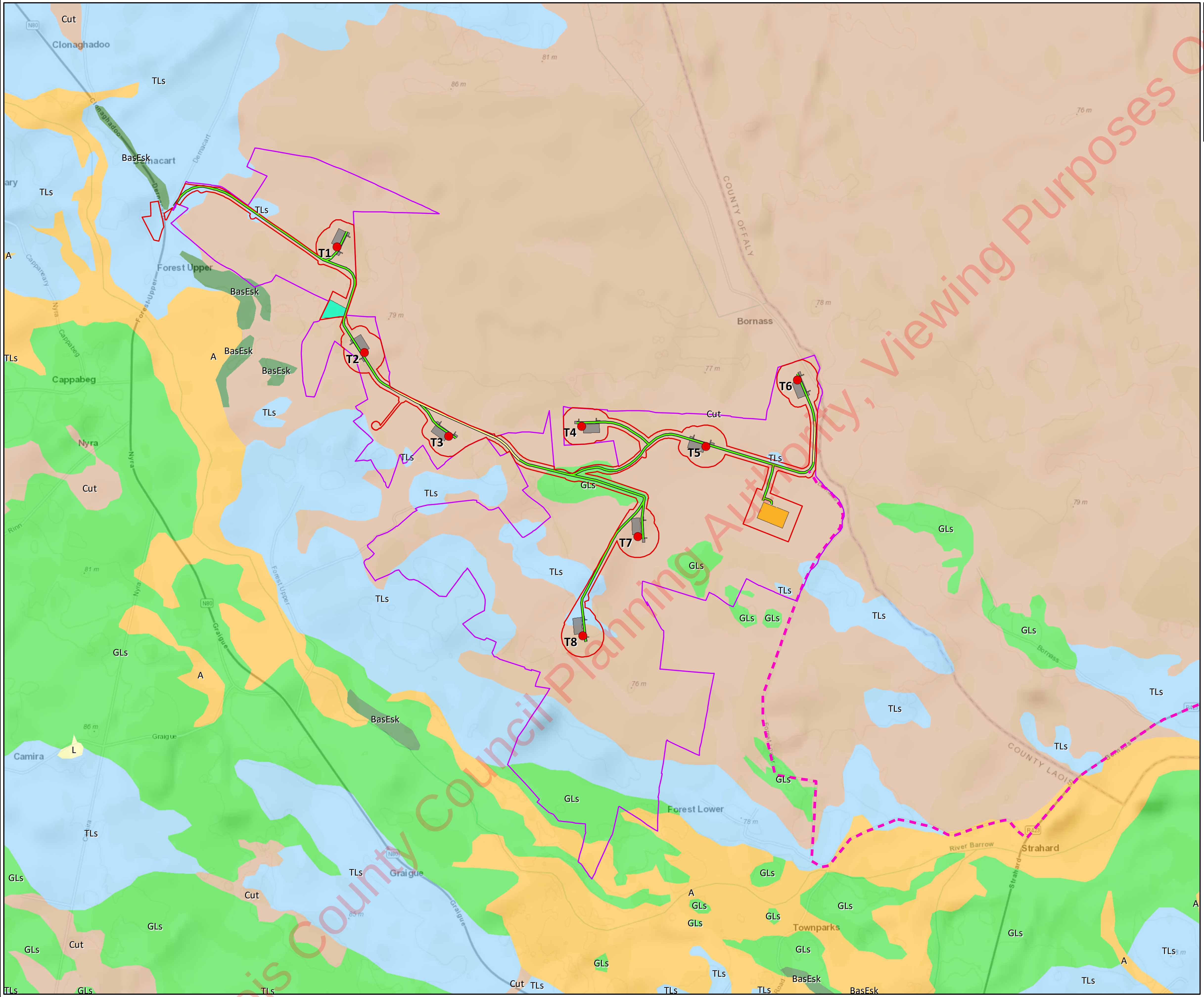
The GSI Online Irish Geological Heritage database indicates that the proposed wind farm study area is not located in an area of specific geological heritage interest. The closest area of Geological Heritage is Glenbarrow located approximately 7 km south-west of the site. According to the GSI, Glenbarrow is a good representative site in Laois to see the Devonian rocks of Slieve Bloom which are otherwise quite poorly exposed.

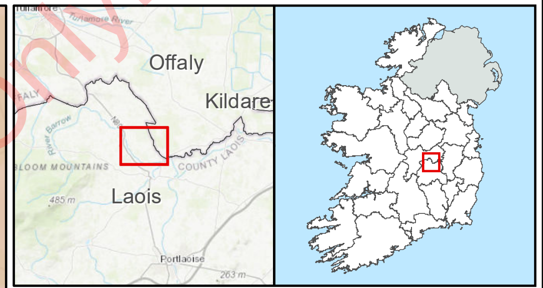
Figure 13-3 displays the areas of Geological Heritage within the wider study area.

13.3.4 Economic Geology

The GSI Online Minerals Database accessed via the Public Data Viewer shows a number of active and historic quarries and mineral occurrences surrounding the study area. These consist of rock and sand and gravel quarries none of which are located within the proposed development site boundary. The nearest active quarries are 2 No. sand and gravel workings identified as Seamus Gorman Sand & Gravel quarries situated south of the proposed development site.

Figure 13-4 displays the active quarries and mineral occurrences within the study area.





Proposed Turbines

Proposed Planning Boundary

Study Area Boundary

Proposed Cable Route

Proposed Turbine Hardstanding Areas

Proposed Substation

Proposed Temporary Compound

Proposed Access Tracks

Existing Track to be Upgraded

New Track

Quaternary Sediments

A, Alluvium

BasEsk, Eskers comprised of gravels of basic reaction

Cut, Cut over raised peat

GLs, Gravels derived from Limestones

L, Lacustrine sediments

TLs, Till derived from limestones

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PROJECT: Dernacart Wind Farm	
FIGURE NO: 13.1.1	
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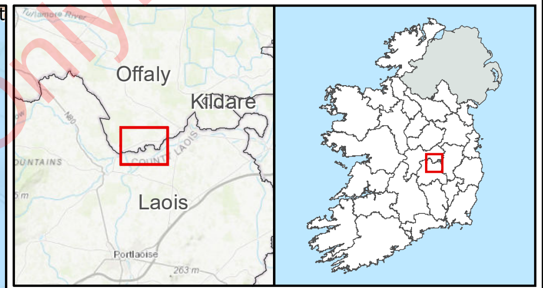

Proposed Cable Route

Quaternary Sediments

- A, Alluvium
- BasEsk, Eskers comprised of gravels of basic reaction
- Cut, Cut over raised peat
- GLs, Gravels derived from Limestones
- KaRck, Kartsified bedrock outcrop or subcrop
- L, Lacustrine sediments
- Rck, Bedrock outcrop or subcrop
- TLs, Till derived from limestones

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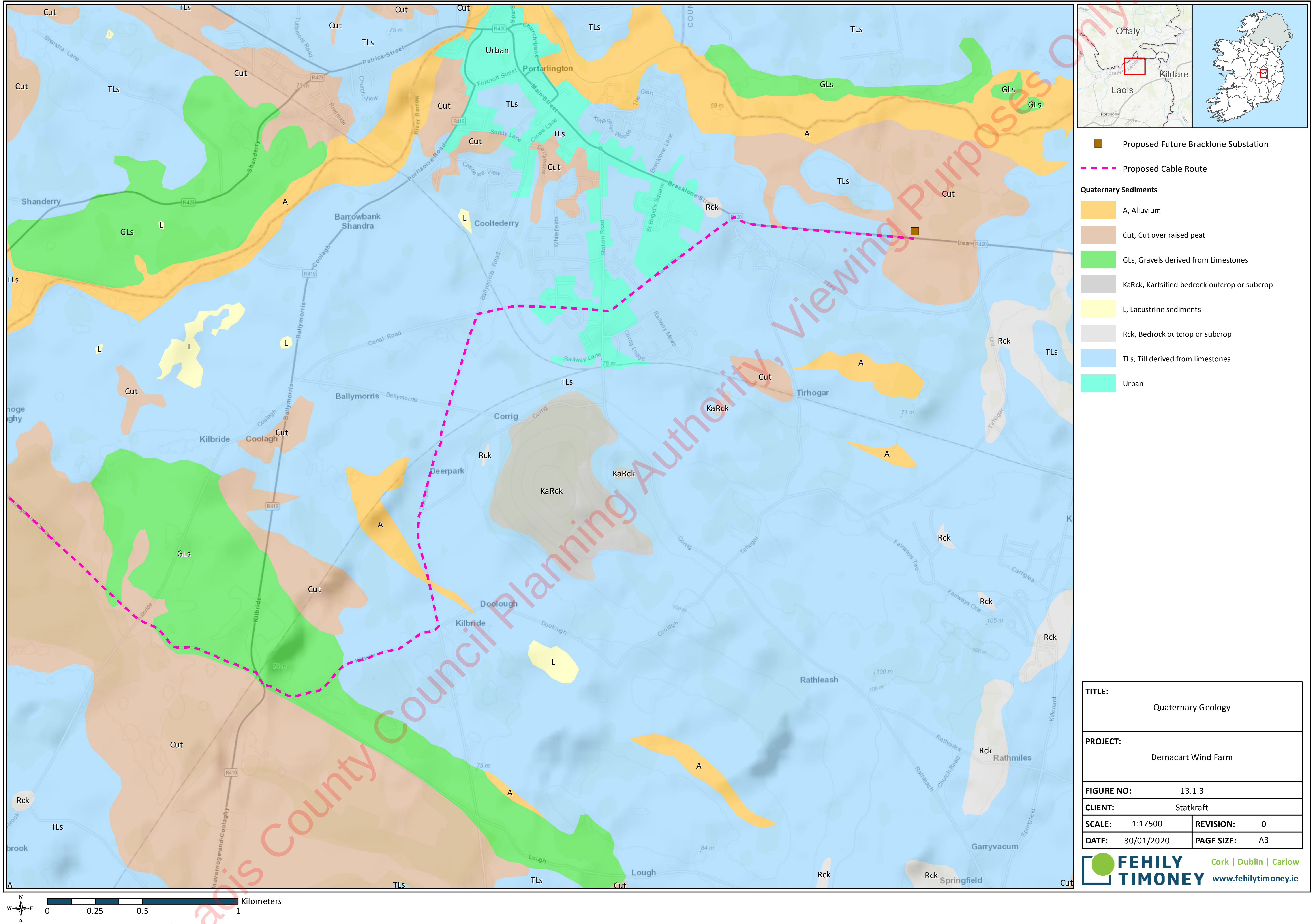

■ Proposed Future Bracklone Substation

- - - Proposed Cable Route

Quaternary Sediments

- A, Alluvium
- Cut, Cut over raised peat
- GLs, Gravels derived from Limestones
- KaRck, Kartsified bedrock outcrop or subcrop
- L, Lacustrine sediments
- Rck, Bedrock outcrop or subcrop
- TLs, Till derived from limestones
- Urban

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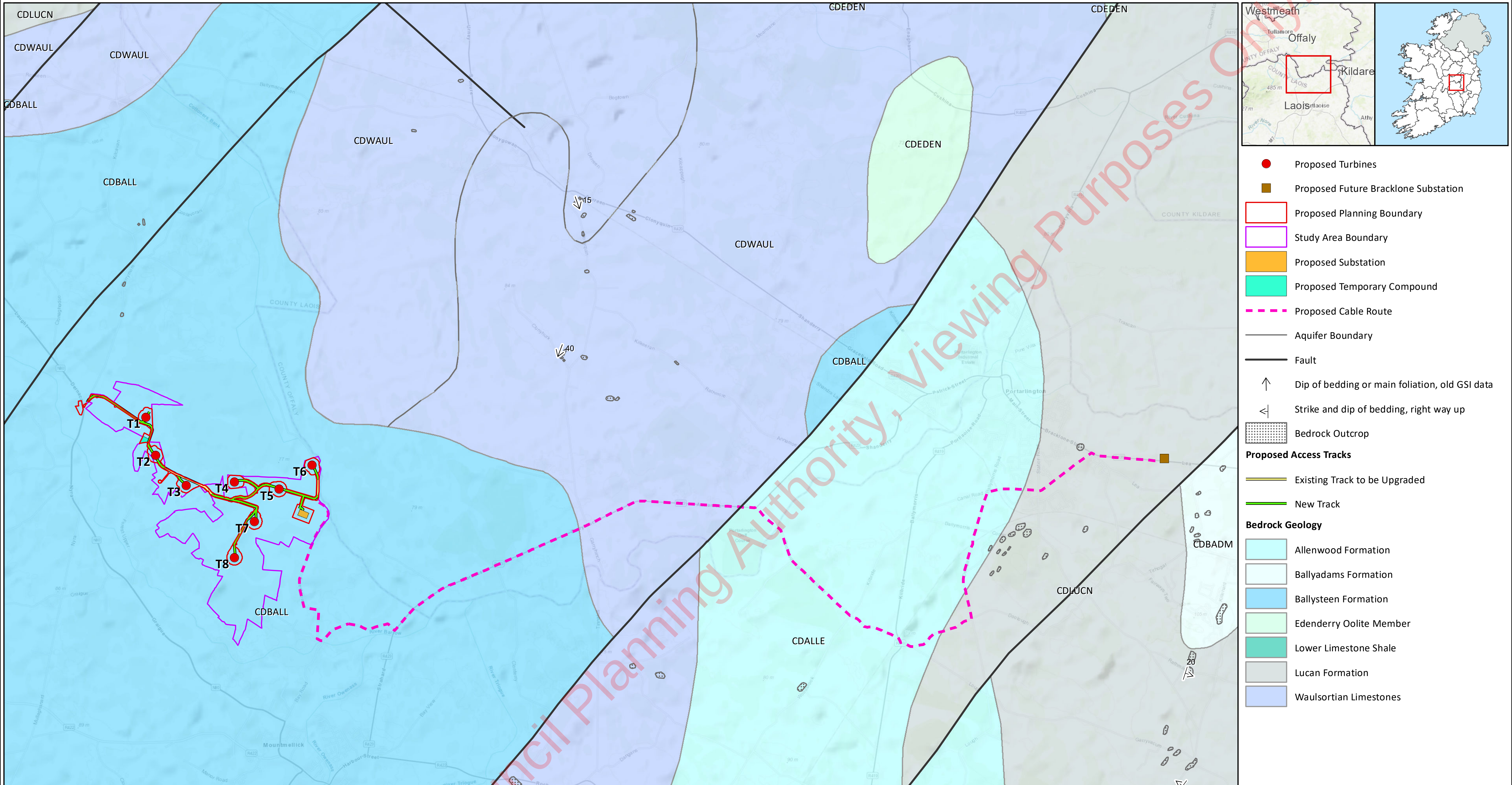

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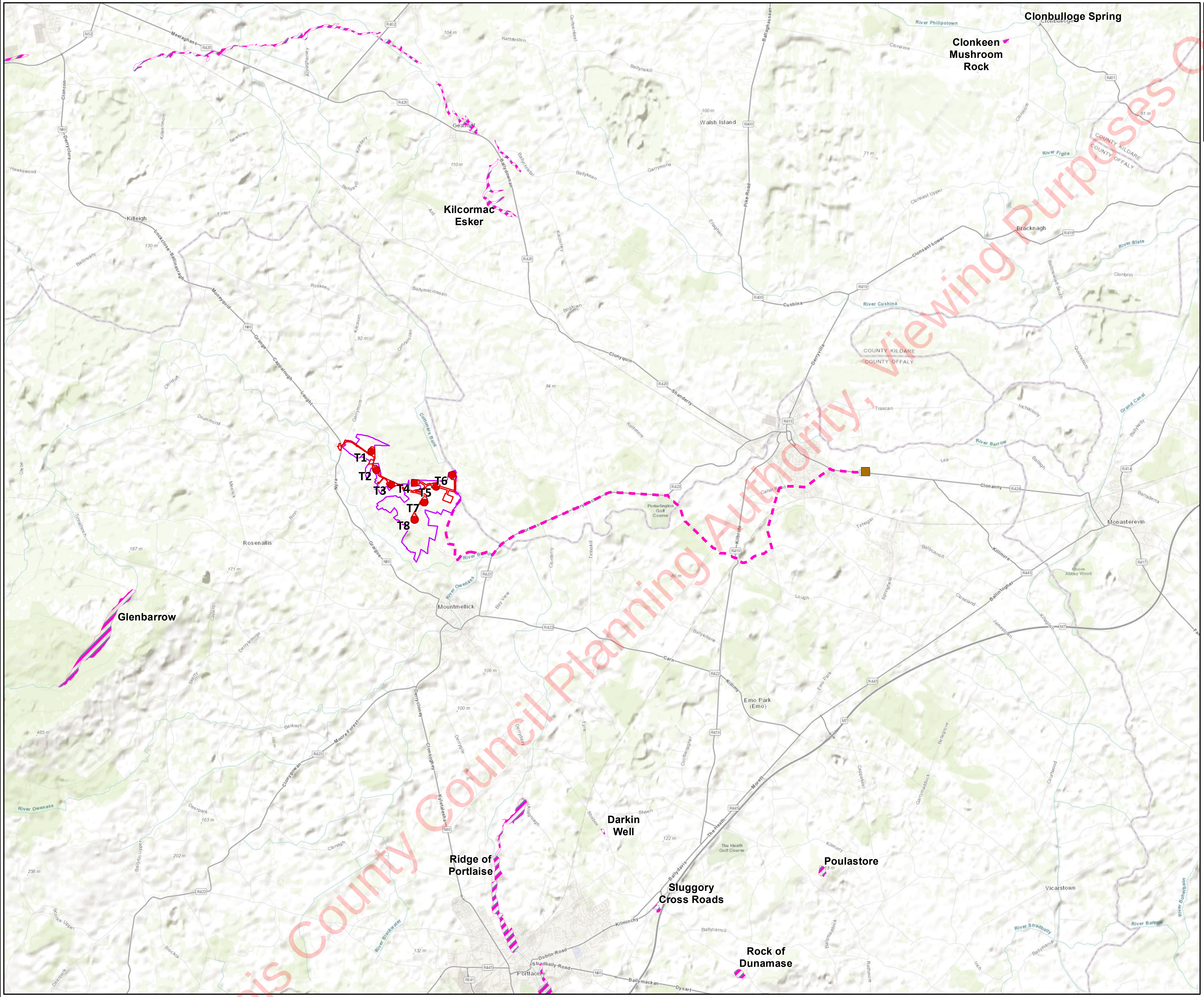

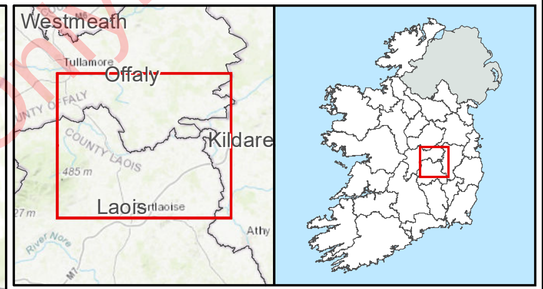

Proposed Turbines

Proposed Future Bracklone Substation

Proposed Planning Boundary

Study Area Boundary

Proposed Cable Route

Geological Heritage Sites

TITLE:	Geological Heritage
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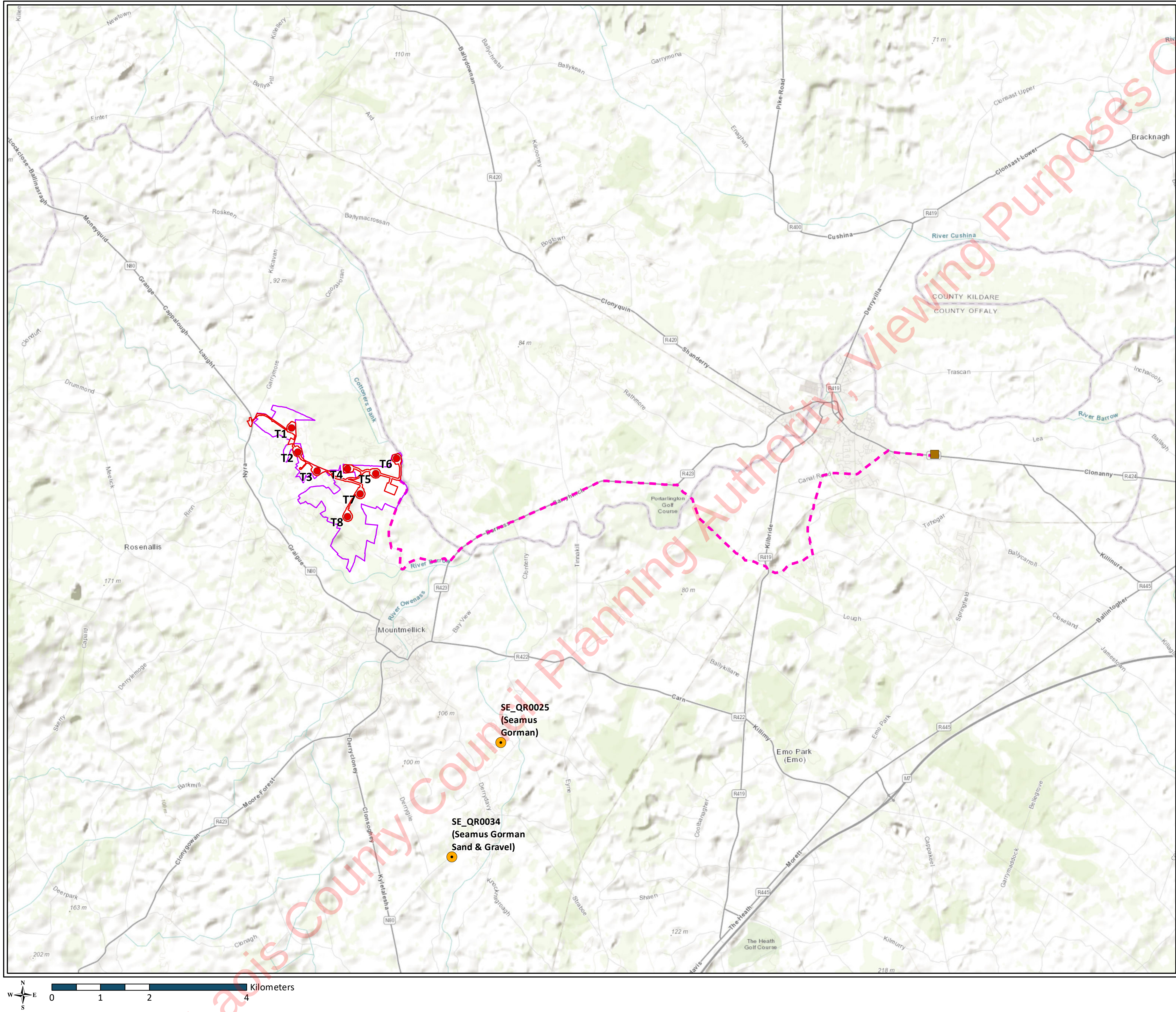

- Quarries
- Proposed Turbines
- Proposed Future Bracklone Substation
- Proposed Planning Boundary
- Study Area Boundary
- Proposed Cable Route

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PROJECT:	Dernacart Wind Farm
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DATE: 30/01/2020	**PAGE SIZE:** A3

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13.3.5 Hydrogeology

Groundwater Vulnerability

The Groundwater Vulnerability is classified by the GSI as being 'Moderate' across most of the proposed wind farm site becoming 'High' at the extreme east, west and south of the wind farm site. The extreme northern portion of the site is classified as being of 'Low' Groundwater Vulnerability.

All proposed turbine locations and the proposed temporary compound are located within areas mapped as being 'Moderate' vulnerability to groundwater pollution. The proposed substation at the eastern extent of the proposed wind farm site is located within an area of 'High' vulnerability to groundwater pollution.

The proposed grid connection route traverses areas of 'Moderate' to 'High' vulnerability along most of the proposed route. An area of 'Extreme' vulnerability is recorded at the eastern extent of the grid connection where overburden deposits are below 3m in thickness.

The GSI distribution of groundwater vulnerability for the site area is shown in Figure 13-7.

Based on the GSI aquifer vulnerability mapping (Figure 13-7), overburden deposits are generally between 5 and 10 m deep in the central portion of the proposed wind farm site; from 3 to 10 m deep in the east, west and south of the site; and more than 10m deep in the extreme northern portion of the site.

A summary of the groundwater vulnerability for the site is presented in Table 13-6. This table outlines the standard ratings of vulnerability used by the GSI, with the existing site conditions highlighted based on the findings of the site investigations.

Table 13-6: Groundwater Vulnerability

Vulnerability Rating	Hydrogeological Conditions		
	Subsoil Permeability (Type) and Thickness		
	High Permeability (sand/gravel)	Moderate Permeability (sandy soil)	Low Permeability (clayey subsoil, clay, peat)
extreme (E)	0 - 3.0 m	0 - 3.0 m	**0 - 3.0 m**
high (H)	**> 3.0 m**	3.0 -10.0 m	3.0 - 5.0 m
moderate (M)	N/A	>10.0 m	**5.0 - 10.0 m**
low (L)	N/A	N/A	**>10 m**

Groundwater Bodies Description

The study area is located within 3 No. groundwater bodies (GWBs). The proposed wind farm site is located within the Portlaoise GWB while the proposed grid connection traverses the Portlaoise, Bagnelstown Upper and the Cushina GWBs. For the purpose of this assessment, aquifer characteristics have been considered for each GWB within the study area. The descriptions have been taken from the 'Summary of Initial Characterisation' draft reports for each defined GWB published by the GSI in accordance with the Groundwater Working Group Publication: Guidance Document GW2 (2003). The GWB Characterisation Reports are available from the GSI Public Data Viewer. Site specific data including depth to bedrock and subsoil type encountered during intrusive investigations have been used to supplement and validate published information.

According to interim classification work carried out as part of the Water Framework Directive and published by the EPA, the Portlaoise, Bagnelstown Upper and Cushina GWBs are classified as having *'Good'* status in terms of quality and quantity. The overall risk result of *'Not At Risk'* is applied to the Portlaoise and Cushina GWBs while the Bagnelstown Upper GWB is under review with regards to risk status. The objective for these GWBs is to *Maintain* their good status. (EPA, 2019).

13.3.5.1Portlaoise GWB

The proposed wind farm site and the western extent of the proposed grid connection route is underlain by the Portlaoise GWB (Figure 13-5) which is classified by the GSI as being a Locally important aquifer – bedrock which is moderately productive only in local zones (Ll). The GWB extends north from the proposed development site to Geashill, Co. Offaly where typical elevations are low. The topography within the GWB rises to its highest elevations towards the south of the groundwater body.

The Portlaoise GWB comprises several bedrock aquifer lithologies as summarised below:

- BA – Ballysteen Formation – *Fossiliferous dark grey shaly limestone*.
- WA – Waulsortian Limestone – *Massive un-bedded limestone.*
- CD – Calp – *dark grey to black limestone and shale.*

According to the 'Summary of Initial Characterisation' report for the Portlaoise GWB (GSI, n.d.b), groundwater flows within this GWB are short and fracture controlled with limited dissolution of fractures within the Limestone units to shallow depths. It is not considered that the GWB has a regionally developed karstic flow system although recharge of acidic waters at the boundary between the underlying limestone unit and the adjacent sandstone units in the Slieve Bloom mountains are likely to enhance the development of karstic features in bedrock. There are no karst features recorded by the GSI within the study area.

There is the potential for 'point' recharge to the Portlaoise GWB along the boundary with Sandstone Units in the Slieve Bloom mountains and the limestones of this GWB from potential karstic features in bedrock. However, most recharge occurs via diffuse recharge where subsoils are thin or permeable. The main discharge mechanism from the Portlaoise GWB is to local rivers and to the Bagnelstown Upper GWB to the east.

13.3.5.2 Bagnelstown Upper

The central portion of the proposed grid connection is underlain by the Bagnelstown Upper GWB (Figure 13.5) which is classified by the GSI as being a Regionally Important Karstified Aquifer (Rk). The general topography of the GWB has higher elevation to the northeast and west with drainage southwards as represented by the River Barrow. To the east of the GWB are the Blackstairs Mountains with elevations of up to 800m with the Castlecomer Plateau to the west, which rises to 330m.

Within the study area the Bagnelstown GWB is predominantly underlain by the following aquifer lithologies as summarised below:

- WA – Waulsortian Limestone – *Massive un-bedded limestone.*
- AW – Allenwood Formation - *Mainly pale grey, pure massive limestone, commonly dolomitised.*

According to the 'Summary of Initial Characterisation' report for the Bagnelstown Upper GWB (GSI, n.d.b), groundwater flows within this GWB are restricted to the upper, near surface zone. This is due to the hydraulic connectivity between the Barrow Valley sand and gravel deposits and the underlying aquifer. As such, the flow regime within the aquifer is restricted with leakage occurring from the over lying sands and gravels directly into the bedrock aquifer.

The main recharge mechanism for the aquifer is along the slopes of the Castlecomer Plateau due to thin overburden deposits in this area. Where streams cross limestone lithologies surface water may enter the aquifer via swallow holes recorded in the west of the Barrow Valley. Most of the discharge from the GWB is to the River Barrow between Milford and Bagnelstown.

13.3.5.3 Cushina GWB

The eastern extent of the proposed grid connection is underlain by the Cushina GWB (Figure 13.5) which is classified by the GSI as being a Locally important aquifer – bedrock which is moderately productive only in local zones (Ll). The general topography of the GWB is low-lying particularly to the north with more undulating, hilly topography to the south.

Within the study area the Cushina GWB is predominantly underlain by the Lucan Formation which is described by the GSI as comprising *dark-grey to black, fine-grained, occasionally cherty, micritic Limestones.*

According to the 'Summary of Initial Characterisation' report for the Cushina GWB (GSI, n.d.b), groundwater flows within this GWB are fracture controlled given the absence of primary porosity within the aquifer lithologies. In such low permeability rocks, it is considered that the majority of groundwater flow will occur in the upper 3m of the aquifer. Below this depth, groundwater flow is through a connected network of fractures, some of which may become enlarged due to solution of the limestone bedrock.

The main recharge mechanism to the aquifer is from diffuse recharge via rainfall percolating through the subsoil. The proportion of the effective rainfall that recharges the aquifer is largely determined by the thickness and permeability of the soil and subsoil. Due to the generally low permeability of the aquifers within this GWB, a high proportion of the recharge will then discharge rapidly to surface watercourses via the upper layers of the aquifer, effectively reducing further the available groundwater resource in the aquifer.

Discharge from the Cushina aquifer is towards rivers which are in hydraulic continuity with the aquifer. Drainage density in the south of the GWB is quite low and this may indicate a higher permeability of the limestones here. Since there are an absence of streams in this area the aquifer discharges via springs with a number of karstic springs being recorded in the south of the GWB.

The GSI classifications for the GWBs in the study area, including the principle aquifer characteristics are summarised in Table 13-4, and shown on Figure 13-5. All aquifers in the study area are bedrock aquifers, there are no gravel aquifers within the study area (i.e. a gravel deposit of greater than 1 km^2 with a saturated thickness of greater than 5 m).

Table 13-4: Summary of Aquifer Classifications & Characteristics

Groundwater Body	European Code	Aquifer Name	GSI Aquifer Classification	Status	Transmissivity (m^2/day)
Portlaoise	IE_SE_G_107	Unnamed	Locally important aquifer – bedrock which is moderately productive only in local zones (LI)	Good	No published data
Bagnelstown Upper	IE_SE_G_153	Unnamed	Regionally important karstified aquifer (Rk)	Good	20 – 200m^2/day
Cushina	IE_SE_G_048	Unnamed	Locally important aquifer – bedrock which is moderately productive only in local zones (LI)	Good	No published data

Groundwater Supply Sources

A review of published information on groundwater supply sources within the study area was undertaken to identify potential groundwater dependant receptors at potential risk from the proposed development. These include group water schemes (GWS), source protection zones and private supply wells with information on these features obtained from the GSI Groundwater database.

Source Protection Zones

The GSI maintains a database of Public Supply Source Protection Areas. From a review of the database there are no Public Supply Source Protection Areas with the proposed development boundary.

There are however 4 No. Source Protection Areas in the wider study area, and these are:

- Portlaoise, 8km south of the proposed wind farm site;
- Clonaslee, 6km west of the proposed wind farm site;
- Danganbeg / Meelaghans, 5.7km north-west of the proposed wind farm site; and
- Lough, 9km east of the proposed wind farm site.

These Public Supply Source Protection Areas are presented in Figure 13-6

Group Water Schemes

There are no Group Water Schemes (GWS) in the immediate vicinity of the proposed development. The nearest recorded GWS held within the GSI database is the Killenard GWS which are located approximately 0.75km east of the proposed grid connection route.

Groundwater Wells and Springs

Based on a review of the GSI Groundwater Wells and Springs database there are 28 No. Groundwater Wells and 1 No. spring recorded (10m to 1km accuracy) within 1km of the proposed development site. There are no groundwater wells or springs recorded by the GSI within the proposed wind farm site.

Figure 13-6 shows the location of groundwater wells included in the GSI dataset within the wider study area. The available details of groundwater wells and springs recorded by the GSI within 1km of the proposed development are included in below Table 13-5.

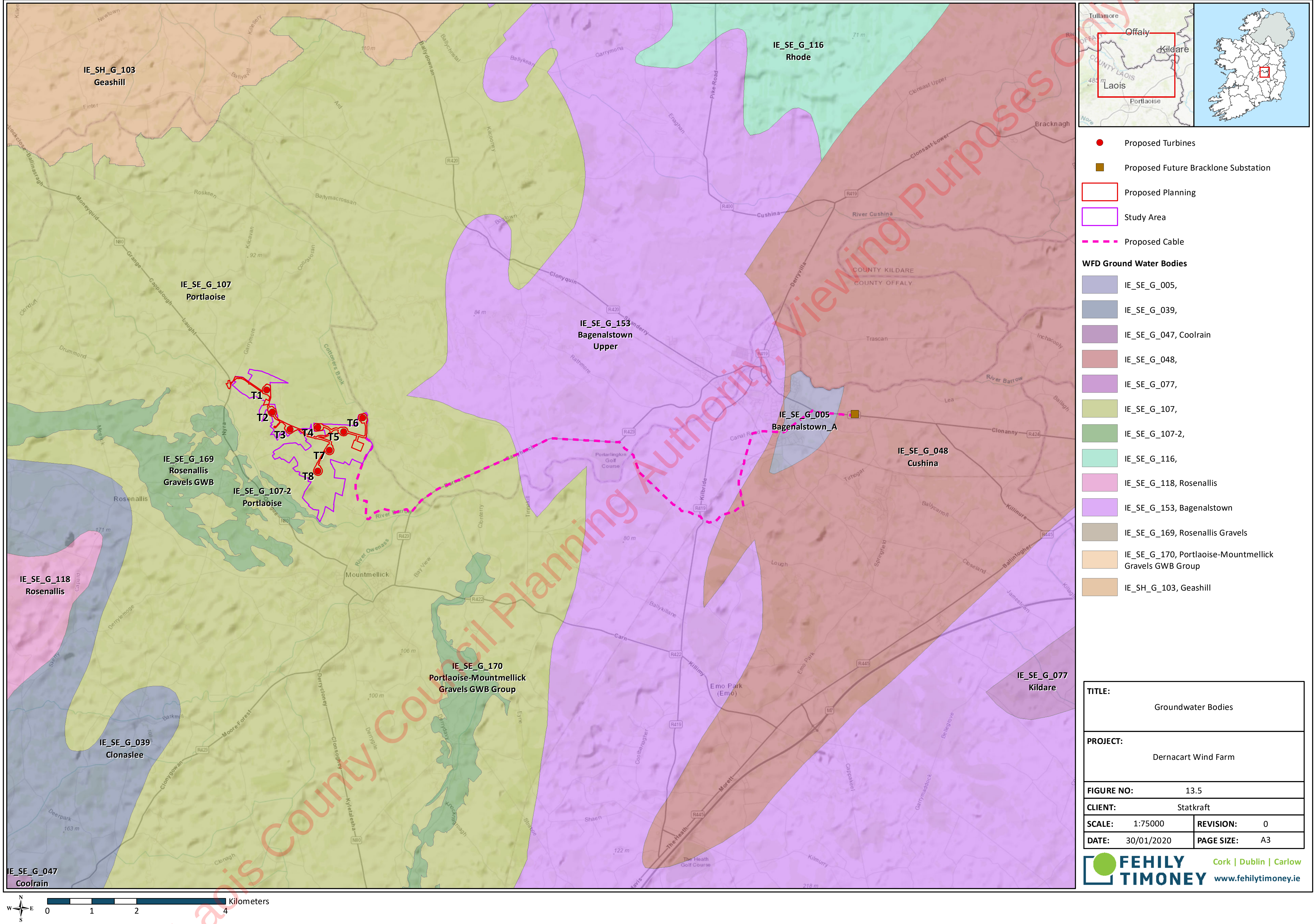
Table 13-5: Summary of Wells within the Study Area

GSI Location ID	Easting	Northing	Type	Total Depth	Current Use	Distance to Nearest Turbine (m)	Nearest Turbine ID
2319NEW144	254050	208600	Borehole	36.6	Public supply (Co Co)	9201	6
2319NEW145	254050	208600	Borehole	71.8	Group Scheme	9201	6
2321SEW041	254770	210840	Borehole	122	Unknown	9474	6
2321SEW042	254830	211280	Borehole	30.5	Industrial use	9514	6
2321SEW043	255600	211540	Borehole	49	Industrial use	10281	6
2321SEW044	255180	212520	Spring		Unknown	9913	6
2321SEW046	254900	210830	Borehole	183	Unknown	9605	6
2321SEW047	254630	210390	Borehole	84	Group Scheme	9377	6

GSI Location ID	Easting	Northing	Type	Total Depth	Current Use	Distance to Nearest Turbine (m)	Nearest Turbine ID
2321SEW048	254610	210150	Borehole	114.5	Group Scheme	9389	6
2321SEW049	254680	210500	Borehole	21	Unknown	9415	6
2321SEW050	254680	210550	Borehole		Group Scheme	9409	6
2321SEW051	254340	210520	Borehole	128	Group Scheme	9074	6
2321SWW037	242200	210770	Borehole	10.4	Unknown	886	2
2319NEW117	254420	209320	Borehole	68.2	Unknown	8859	6
2321SEW036	253980	212590	Borehole	85.3	Unknown	8230	6
2321SEW037	253920	212580	Borehole	65.8	Unknown	8169	6
2321SEW038	253980	212540	Borehole	61	Unknown	8223	6
2321SEW039	253980	212490	Borehole	7.9	Unknown	8218	6
2321SEW040	253980	212440	Borehole	7.9	Agri & domestic use	8212	6
2321SEW013	250750	210720	Dug well	4.3	Domestic use only	4988	6
2321SEW014	250150	211040	Dug well	3.2	Domestic use only	4354	6
2321SEW015	251360	211280	Dug well	2.1	Domestic use only	5546	6
2321SEW019	253770	212340	Dug well	4.9	Domestic use only	7993	6
2321SEW001	250680	211050	Borehole	2.5	Public supply (Co Co)	5331	6
2321SEW002	250780	211000	Borehole	84	Unknown	5435	6
2321SEW006	248850	211700	Dug well	5.8	Domestic use only	3488	6
2319NEW003	248920	209550	Borehole	11.3	Unknown	3847	6
2319NEW005	248920	209490	Dug well	4.6	Unknown	3876	6
2319NEW031	246730	208580	Dug well	3.7	Unknown	2480	8

13.3.5.4 Karst Features

According to the GSI datasets, there are no karst features recorded within the proposed development boundary. However, the Carboniferous bedrock underlying the site is prone to karstification with the GSI database recording a number of karst features within the wider study area. These generally comprise spring features to the south of the proposed development particularly to the south east of Emo. The location of recorded karst features is shown on Figure 13-8.



Proposed Turbines
Proposed Future Bracklone Substation
Proposed Planning
Study Area
Proposed Cable

WFD Ground Water Bodies

- IE_SE_G_005,
- IE_SE_G_039,
- IE_SE_G_047, Coolrain
- IE_SE_G_048,
- IE_SE_G_077,
- IE_SE_G_107,
- IE_SE_G_107-2,
- IE_SE_G_116,
- IE_SE_G_118, Rosenallis
- IE_SE_G_153, Bagenalstown
- IE_SE_G_169, Rosenallis Gravels
- IE_SE_G_170, Portlaoise-Mountmellick Gravels GWB Group
- IE_SH_G_103, Geashill

TITLE: Groundwater Bodies	
PROJECT: Dernacart Wind Farm	
FIGURE NO: 13.5	
CLIENT: Statkraft	
SCALE: 1:75000	**REVISION:** 0
DATE: 30/01/2020	**PAGE SIZE:** A3

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Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
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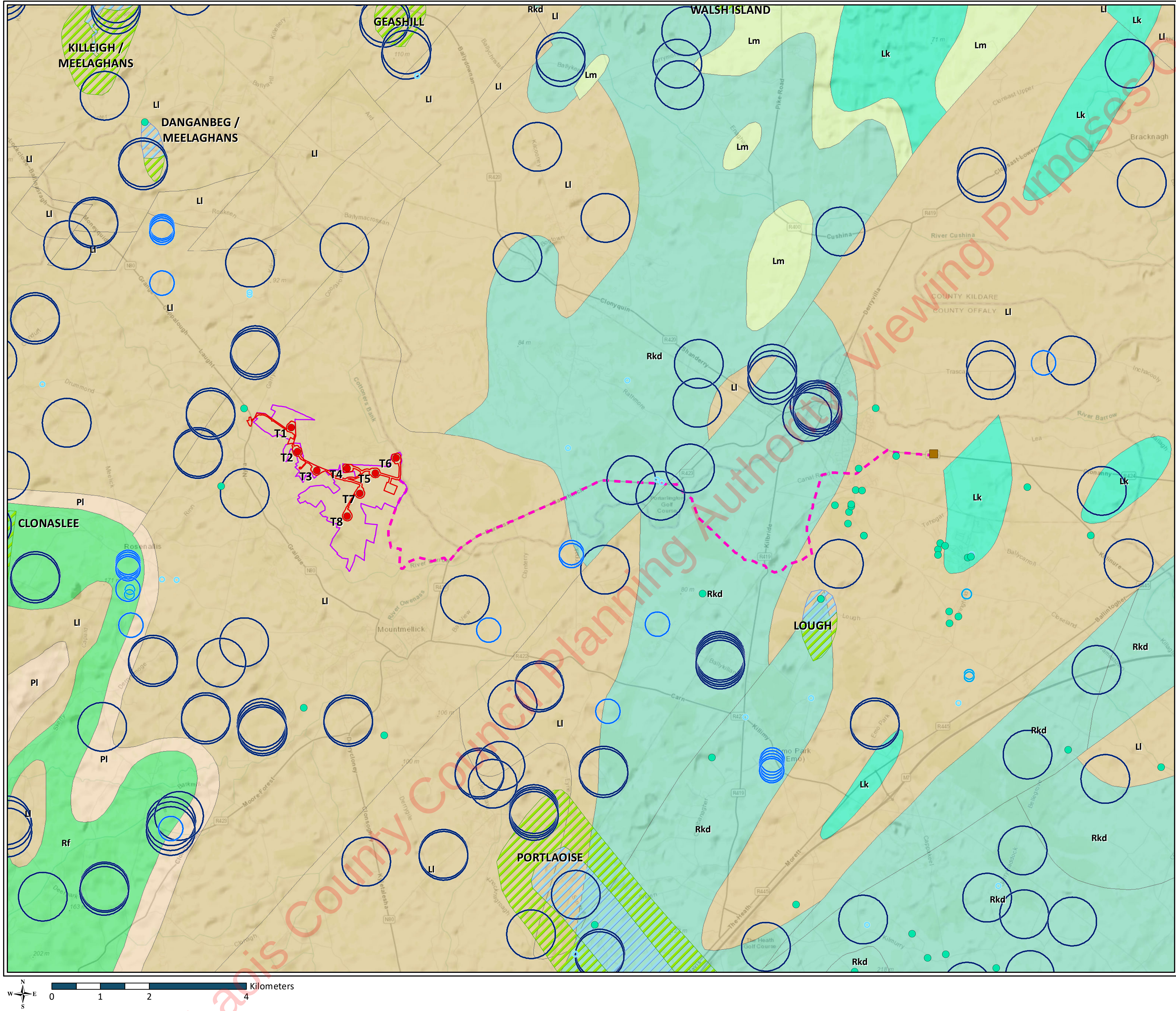

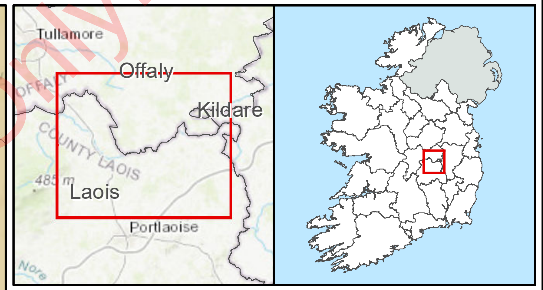

Proposed Turbines

Proposed Future Bracklone Substation

Proposed Planning Boundary

Study Area Boundary

Proposed Cable Route

Groundwater Well (10-50m Accuracy)

Groundwater Well (50-100m Accuracy)

Groundwater Well (100-200m Accuracy)

Groundwater Well (200-500m Accuracy)

Groundwater Well (500m-1km Accuracy)

Source Protection Area (Inner)

Source Protection Area (Outer)

Bedrock Aquifers

Lk: Locally Important Aquifer - Karstified

Ll: Locally Important Aquifer - Bedrock Mod Productive Locally

Lm: Locally Important Aquifer - Bedrock Generally Mod Productive

Pl: Poor Aquifer Bedrock Generally Unproductive Except Locally

Rf: Regionally Important Aquifer - Fissured Bedrock

Rkd: Regionally Important Aquifer - Karstified (diffuse)

TITLE: Aquifer Classification

PROJECT: Dernacart Wind Farm

FIGURE NO:	13.6		
CLIENT:	Statkraft		
SCALE:	1:75000	**REVISION:**	0
DATE:	30/01/2020	**PAGE SIZE:**	A3

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Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
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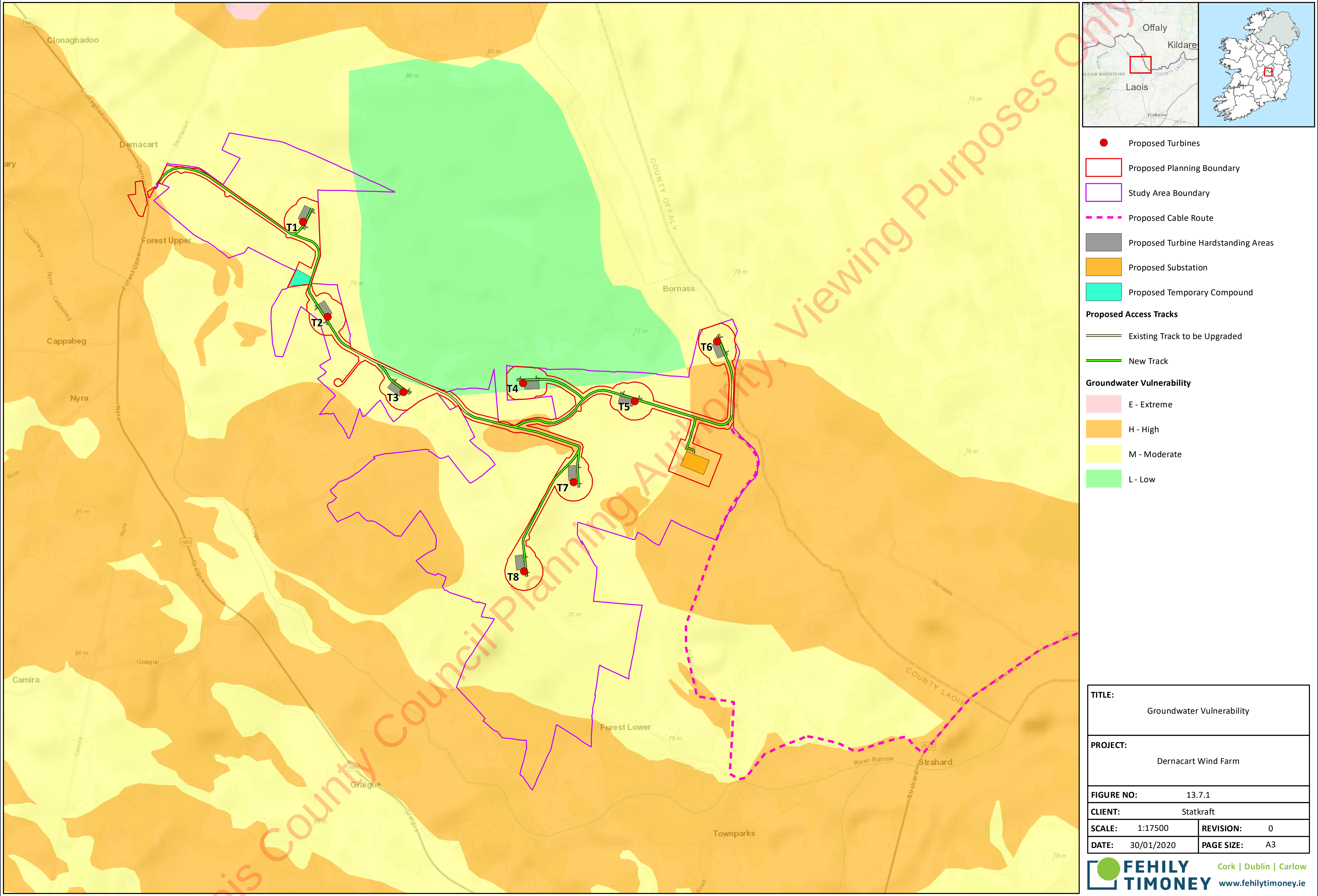

- Proposed Turbines
- Proposed Planning Boundary
- Study Area Boundary
- Proposed Cable Route
- Proposed Turbine Hardstanding Areas
- Proposed Substation
- Proposed Temporary Compound

Proposed Access Tracks

- Existing Track to be Upgraded
- New Track

Groundwater Vulnerability

- E - Extreme
- H - High
- M - Moderate
- L - Low

Kilometers: 0, 0.25, 0.5, 1

TITLE: Groundwater Vulnerability	
PROJECT: Dernacart Wind Farm	
FIGURE NO: 13.7.1	
CLIENT: Statkraft	
SCALE: 1:17500	**REVISION:** 0
DATE: 30/01/2020	**PAGE SIZE:** A3

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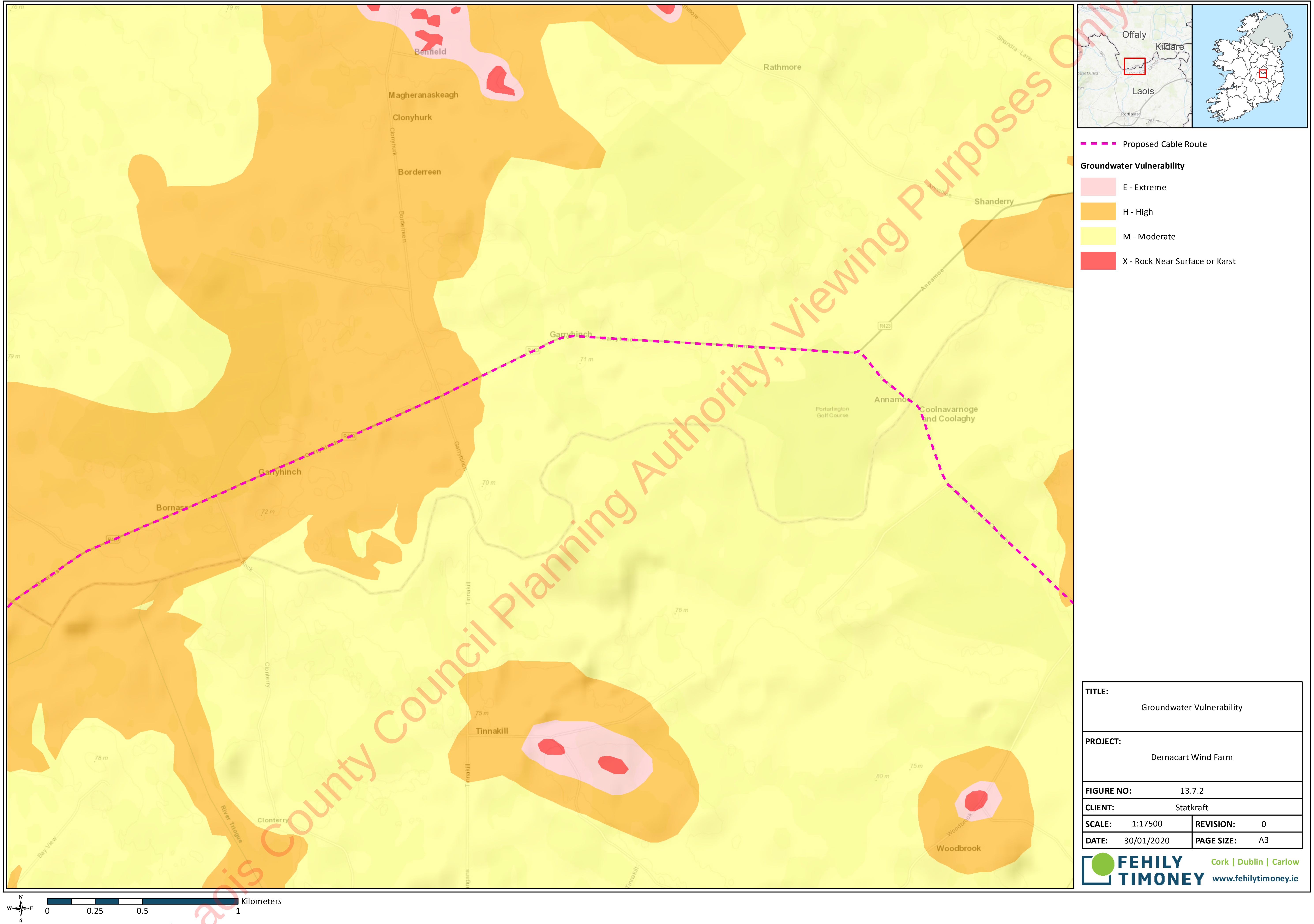

TITLE: Groundwater Vulnerability

PROJECT: Dernacart Wind Farm

FIGURE NO:	13.7.2
CLIENT:	Statkraft
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DATE: 30/01/2020	PAGE SIZE: A3

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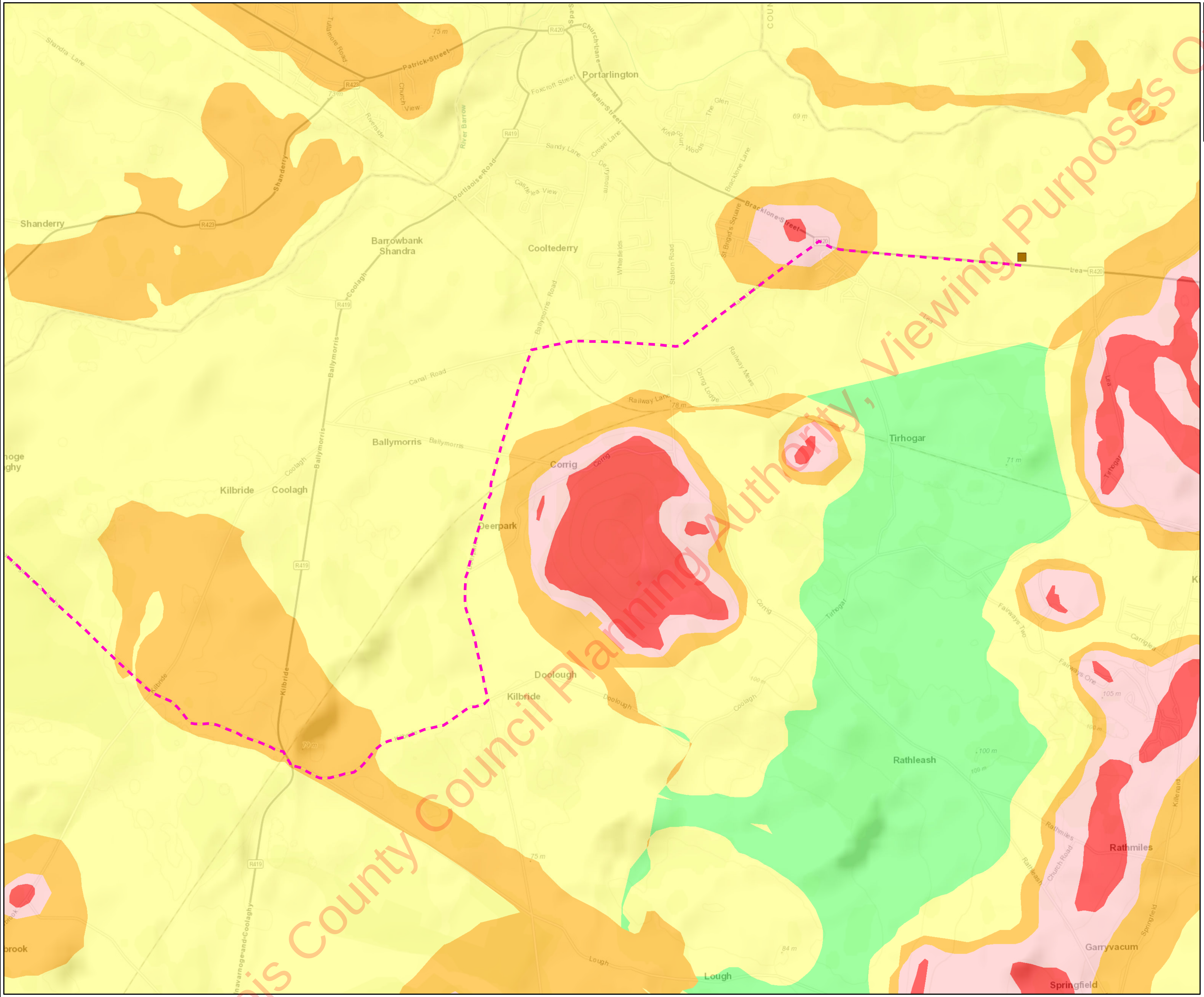

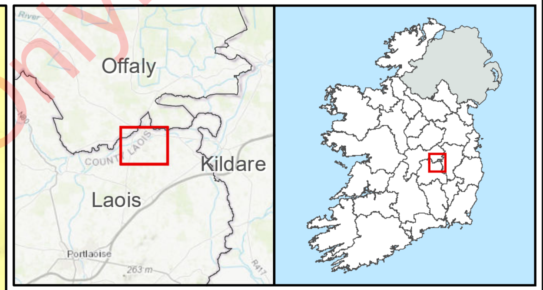

Proposed Future Bracklone Substation

Proposed Cable Route

Groundwater Vulnerability

- E - Extreme
- H - High
- M - Moderate
- L - Low
- X - Rock Near Surface or Karst

TITLE:	Groundwater Vulnerability
PROJECT:	Dernacart Wind Farm
FIGURE NO:	13.7.3
CLIENT:	Statkraft
SCALE:	1:17500
REVISION:	0
DATE:	30/01/2020
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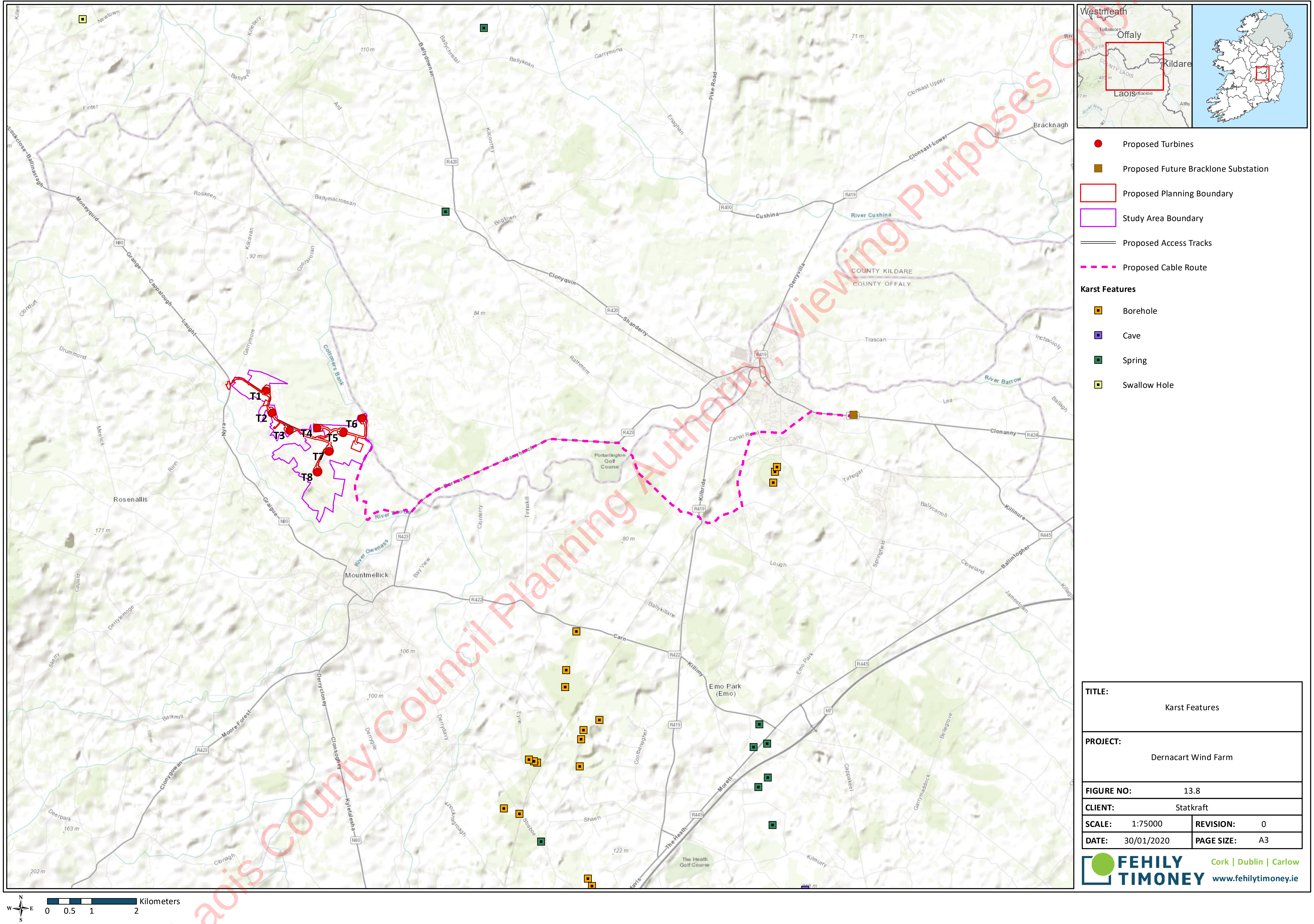
0 0.25 0.5 1 Kilometers



TITLE: Karst Features

PROJECT: Dernacart Wind Farm

FIGURE NO:	13.8		
CLIENT:	Statkraft		
SCALE:	1:75000	REVISION:	0
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13.3.6 Existing Slope Stability

During the site walkovers a series of hand-held probes were undertaken to determine the presence/depth of peat and/or soft soils within the site.

The slopes of the site are characterised by gentle slopes of between 1° and 3°. No evidence of slope instability was observed at the site and there are no historical records of landslide activity within or close to the site, on the GSI (n.d) database.

The nearest landslide event recorded by the GSI was at Chapel Hill (location Easting: 638,997, Northing: 708,004) which occurred 5 km west of the proposed wind farm site in the Clarnahinch mountains and was related to a slope failure in Glacial TILL. The event occurred on agricultural land with no impacts recorded.

Following the site walkover, a review of the published checklist for peat landslide hazard and risk assessment was carried out, as outlined in Figure 1.1 of the Scottish Executive – Peat Landslide Hazard and Risk Assessments (2017).

The potential for a landslide risk is defined in the Scottish Executive "Peat Landslide Hazard and Risk Assessments, Best Practice Guide for Proposed Electricity Generation Developments" (2017) as the following:

- *Peat is present at the development site in excess of 0.5 m depth, and;*
- *There is evidence of current or historical landslide activity at the site, or;*
- *Slopes > 2° are present on-site, or;*
- *The works will impinge on the peat covered areas and cannot be relocated to avoid peat covered areas.*

A Peat Stability Assessment was carried out by an engineering geologist from FT during July and August 2019. The assessment included the advancement of a total of 100 No. peat probes and 32 No. hand shear vanes across the site to confirm the depth, shear strength and classification of peat deposits within the proposed site boundary.

During the assessment, records were made of the land use, peat depth, drainage features, geomorphology, slope and any other features that could affect slope stability, such as streams, flushes etc. The site is characterised by gentle slopes and contains moderately to well drained ground. The site is predominantly underlain by cutover raised peat with smaller areas of TILL and gravels derived from limestones present in the southern parts.

During the site assessment, hand-held probes were taken at and around proposed turbine locations, along the access tracks and at the proposed substation locations to determine the depth of the peat deposits across the site. The site assessment works identified extensive cut peat deposits across the site with an average depth of 1.2m. The maximum peat depth recorded was 1.6m but the extent of this area of deeper peat was limited.

The finding of the Peat Stability Assessment is included in Appendix 13-1, Volume 3 of the EIAR.

The key findings of the site walkover survey and peat stability assessment are presented below:

- The site geology comprises limestone bedrock overlain by glacial TILL and cutover peat;
- The Peat Stability Assessment identified an average peat depth of 1.2m;
- The peat encountered during the site assessment was found to be slightly decomposed to moderately decomposed with a low to moderate moisture content;
- No evidence of existing ground instability was noted at the site with areas of peat generally being moderately to well drained with well-developed vegetation coverage across the peat; and
- Slope stability analysis shows that the safety values across the study area are well above the minimum safety factor required for both short- and long-term stability.

13.3.7 Soil Contamination

There are no known areas of soil contamination within the proposed development site. No evidence of soil contamination was noted during site walkovers. As agricultural/ forestry equipment is used across much of the proposed development site it is possible that minor fuel spills and leaks have occurred locally in the past.

According to the EPA online mapping (https://gis.epa.ie/EPAMaps/), there are no licenced waste facilities or IPPC licenced facilities on or within the immediate environs of the proposed wind farm or the future proposed Bracklone grid connection route. The nearest EPA Licensed Waste Facility is the Kyletalesha Landfill (EPA Licence W0026-03), located approximately 6.5 km south of the study area.

13.3.8 Materials Balance and Storage

The quantities of imported material required for the construction of proposed development and quantities of material to be excavated during the construction phase are presented below in Table 13-6.
The quantities have been estimated based on the planning stage design and the findings of preliminary site assessments.

Table 13-6: Aggregate and Extraction Volumes

Item	Approximate Surplus Quantity Extracted (m³)	Approximate Quantity Imported (m³)
Access Tracks		
New Track Construction	15,109	18,150
Existing Track Upgrade	1,110	1,110
Track-side Drainage	3,720	
Settlement Ponds	2,000	400
Turbine Delivery Route Upgrades	1,500	1,500
Sub-Total:	**23,438**	**21,160**
Hardstandings and Compounds		
Crane Platforms	24,640	24,640
Sub-station Platform	11,036	11,036
Construction Compound	500	500
Sub-Total:	**36,176**	**36,176**
Turbine Foundations		
Turbine Foundation Construction	5,027	5,027
Sub-Total:	**5,027**	**5,027**
Cable Trenching and Cable Routes		
Cable Trenching Works	1,416	665
Cable Route Construction	1,122	1,961
Sub-Total:	**2,538**	**2,626**
TOTAL:	**67,179**	**64,989**

Preliminary calculations show that the amount of imported aggregate required during construction will be of the order 65,000m^3 as shown in Table 13.6.

The total quantity of surplus soils arising from the excavation of roads, hardstands, turbine bases, compounds, the substation, cable trenches, drainage ponds and swales is estimated to be approximately 67,179 m^3.

Surplus glacial TILL recovered from excavations will, where deemed suitable be used as general fill for the construction of new access roads and as ballast fill to turbine foundations. It is anticipated that 50% of the material excavated from the internal and external grid connection trenches will be reused in the reinstatement works with the remainder of the excavated volume replaced by imported fill.

Surplus topsoil and peat recovered from excavations deemed not suitable for use as general fill will be used for landscaping berms along existing and new access tracks and for reinstatement purposes around turbine bases and hardstands.

These berms will be created from suitable excavated material and will be located on the opposite side of infrastructure to any interceptor drains. The berms will therefore not obstruct flow or risk siltation to interceptor drains. Berms will be placed outside the roadside drains which drain the new access tracks. The location of berms are illustrated on the accompanying planning drawings.

13.3.9 Site Assessment Results

As outlined in Section 13.2.3 site assessments were carried out by a geologist from FT between June and August 2019. The site assessments included a series of hand-held probes and hand shear vanes at proposed infrastructure locations to determine the presence/depth of peat and/or soft soils within the proposed development site. Visual observations were also made to assess the stability of other soil slopes and rock exposures across the site. A summary of the information obtained during the field assessments is provided below in Table 13-7:

Table 13-7: Site Assessment Summary

Proposed Infrastructure	Land use	Quaternary Deposits (GSI Online Mapping)	Peat Present	Average Peat Depth (m)	Groundwater Vulnerability (GSI Online Mapping	Aquifer Classification (GSI Online Mapping)
T1	Mature Forestry	Cutover Raised Peat	Yes	0.8m	Moderate	Locally important aquifer – bedrock which is moderately productive only in local zones (LI).
T2	Agricultural Land (Grassland)			0.2m		
T3	Edge of Mature Forestry			1.0m		
T4	Mature Forestry			1.0m	Low	
T5	Mature Forestry			1.0m	Moderate	
T6	Mature Forestry			1.2m		
T7	Agricultural Land (Grassland)			0.2m		
T8	Agricultural Land (Grassland) – Peaty Topsoil			0.2m		
Substation	Immature Forestry			0.2m	High	
Temporary Site Compound	Agricultural Land (Grassland) – Peaty Topsoil			0.2m	Moderate	

13.4 Potential Effects

The potential effects on the underlying land, soils and geology at the site are assessed in the following sections for the activities associated within each phase (construction, operation and decommissioning) for the proposed development as described in Chapter 4.

The potential impacts are assessed in accordance with the evaluation criteria outlined in Section 13.2. The unmitigated potential impacts are summarised in Tables 13-8 and 13-9. The proposed mitigation measures are then considered to eliminate or reduce potential impacts.

13.4.1 Do Nothing Impact

If the proposed Dernacart Wind Farm were not constructed, it is likely that the current land uses will continue for the foreseeable future, i.e. grazing, arable, forestry and cut peat bog. The impact on the Land, Soils and Geology would remain largely unaltered as a result.

13.4.2 Construction Phase

The following on-site activities have been identified as the sources of potential impacts on the existing geological and hydrogeological conditions from the construction of the proposed development:

Tree Felling

An area of the proposed development site comprises of commercial coniferous forestry. Felling of approximately 18ha of coniferous forestry is required within and around the wind farm infrastructure to accommodate the construction of some turbines, hardstands, crane pads, access tracks and the proposed onsite substation. Of the eight proposed turbines, five turbines T1, T3, T4, T5 and T6 are located within forestry and consequently tree felling will be required as part of the project.

These works will be the subject of a Felling Licence Application to the Forest Service prior to construction as per the Forest Service's policy on granting felling licences for wind farm developments. The proposed areas to be felled are illustrated on Figure 4-8 in Chapter 4, Description of the Proposed Development.

Earthworks

The proposed development will require construction phase earthworks associated with the excavation of turbine bases, removal of overburden deposits for the construction of site compound, sub-station, grid connection trenches and internal access roads. As such there is the potential for impact to land, soils and geology from the excavation and movement of existing peat and glacial TILL deposits during the construction phase of the proposed development.

The following earthworks excavations will be required:

- Removal of eat deposits
- Excavation of glacial TILL

The following filling and material deposition operations will be required:

- Deposition of surplus peat and glacial TILL deposits berms along existing and new access tracks and for reinstatement proposes around turbine bases and hardstands
- Importation and filling of site won and imported fill and engineering aggregates

Some temporary stockpiles of material may be necessary prior to reinstatement; however, no permanent stockpiles of material will remain after construction. It is proposed that all onsite materials excavated shall be retained on site and re-used where suitable as part of the construction phase to minimise the import materials requirements.

Given the presence of cut away peat deposits across the proposed development site it will be necessary, prior to the construction of the proposed development to remove existing peat deposits from the proposed infrastructure and turbine locations. Peat depths across the site vary from 0.2m to 1.6 m averaging approximately 1.2 m. The methodology for the proposed peat stripping and spreading activities is outlined below.

Surplus peat and glacial TILL recovered from excavations will be used for landscaping berms along proposed internal access tracks and for reinstatement proposes around turbine bases and hardstands. These berms will be created from suitable excavated material and are located on the opposite side of infrastructure to any interceptor drains. The berms will therefore not obstruct flow or risk siltation to interceptor drains. Berms will be placed outside the roadside drains which drain the new access tracks. The location of berms are illustrated on the accompanying planning drawings.

Slope Stability

Following the site walkover, a review of the published checklist for peat landslide hazard and risk assessment was carried out, as outlined in Figure 1.1 of the Scottish Executive – Peat Landslide Hazard and Risk Assessments (2017).

The results of the peat stability assessment recorded Factor of Safety (FoS) results for existing in-situ peat stability ranging from 18.2 to 306.9 with factored surcharged FoS results of between 7.4 to 49.6 recorded. Based on the analyses presented, the development areas are considered stable since no data points were recorded to have a FoS of less than 1.0.

In summary, the results give rise to in-situ safety ratios for translational slides which are above the minimum required value for all locations analysed across the study area. Calculated safety ratios when an additional surcharge is included in the analysis give rise to lower safety ratios with no FoS results falling below 1.0. Based on the findings of the Peat Stability Assessment Report it is considered that there is a Low Risk of peat stability hazard at the proposed development.

The complete findings of the landslide risk assessment are provided in the Peat Stability Assessment Report in Appendix 13-1 of Volume 3 of this EIAR.

Internal Access Roads and Hardstands

There will be approximately 6 km of internal access tracks associated with the proposed wind farm development. This will be a combination of existing track upgrade and construction of new tracks; approximately 5.5 km of new track construction and approximately 0.88 km of existing track upgrade. Tracks will preferentially be constructed using conventional construction methods. Hardstand areas will be provided at each turbine location.

The internal access tracks will permit access for construction vehicles and for maintenance vehicles during the operational phase. The tracks will be approximately 4.5 -5 m wide (usable carriageway) along straight sections and wider at bends. The tracks will not be surfaced; however, they will be well drained and culverted. Drainage is discussed in more detail in Chapter 14, Hydrology and Water Quality of this EIAR.

During the earthworks, topsoil, peat and soft soils will be excavated for tracks and hardstand construction. Where shallow, all peat will be excavated for track construction unless floating road construction is undertaken. It is envisaged that the track construction will consist of up to 500 mm hardcore on geogrid after removal of peat and / or soft soils. The construction methodology for new tracks and hardstand will generally be as follows:

- Peat/topsoil will be excavated and locally placed and graded to one or both sides of the track / hardstand
- Formation will be prepared to receive geogrid
- Granular Fill will be placed and compacted in layers to approximately 500 mm depth (or competent material for founded road)
- A drainage ditch will be formed, within the excavated width, along the sides of the tracks / hardstand, Surplus peat/clay excavated shall be used as impermeable layer and ditch shaping.

- Surplus excavated material will be placed along each side of the track / hardstand and dressed to blend in with surrounding landscaping and to provide screening.
- Where suitable, surplus excavated material will also be used for reinstatement purposes around turbine bases and hardstands.

Floating roads may be required if the necessary excavation to competent ground is deeper than expected. Floating roads are constructed without excavating the existing ground and shall only be used where site conditions allow. The construction methodology for floating roads will generally be as follows:

- A layer of combined geotextile will be laid directly on the existing surface.
- Granular Fill will be placed on the geotextile and compacted in layers to the required depth with additional geogrid reinforcement as required.
- A 300mm layer of compacted Type B material (Clause 804) will be placed on top to provide a suitable surfacing layer.

Turbine Foundation Construction

Turbines of the size proposed for the Dernacart Wind Farm typically have foundations heights in the order of 2 m and diameters in the order of 20 m, depending on the manufacturer and ground conditions. Ideally, a suitable bearing stratum is encountered within 3 m from ground surface so that the turbine foundation can be finished at / near existing ground level. Where deeper excavations are required to reach a suitable bearing stratum, soil replacement (engineered fill) is used to bring up the excavation so that the turbine foundation is finished at or near existing ground level. Flexibility of $^{+}/_{-}$ 1.5 m in the finished levels is required to allow for sloping topography and ground conditions.

Where excavations beyond 5m below ground level are required to reach a suitable bearing stratum, piled foundations may be required. Piles used for turbine foundations are either pre-cast driven piles or bored piles. Pile length is site-specific but tends to be approximately 12 m to 20 m long. The turbine foundation requirements will be determined following the detailed site investigation at pre-construction stage.

Where suitable, surplus excavated material will be used for reinstatement purposes around turbine bases and hardstands.

Internal Cabling and Grid Connection

Each turbine will connect by underground cable to the next turbine and eventually to both substations - the on-site substation and the future proposed Bracklone substation. All cable laying works will be carried out as per EirGrid/ESB requirements, but it is assumed that initially the contractor will excavate cable trenches and then lay high density polyethylene (HDPE) ducting in the trench in a surround of CBM (cement bound material). A rope will be inserted into the ducts to facilitate cable-pulling later. The as-constructed detail of the cable duct locations will be carefully recorded.

Cable marker strips will be placed 75mm above the ducts with two communication ducts also laid. An additional layer of cable marker strips will be laid above the communication ducts and the trench back-filled. Back-filling and reinstatement in public roads will be to a specification to be agreed with the road authority.

A similar construction methodology will apply for cable trenches laid within site access tracks. In this case the cable-ducts will generally be laid when the track is being constructed and will follow the edge of the site access tracks. The trenches within these locations will generally be backfilled using the excavated material.

13.4.2.1 Summary Potential Direct Impacts

Land, Soils and Geology

Direct impacts to the existing geological regime associated with the construction phase of the proposed development are:

- Soil compaction may occur due to movement of construction vehicles, plant and machinery. This will occur particularly within areas of highly compressible soft deposits which are left in-situ during the construction phase. This could lead to an increase in surface water runoff due to reduced infiltration of rainfall and subsequently to an increase in erosion of overburden deposits left in-situ.
- The use of plant and machinery during construction will require the storage and use of Fuels, lubricants and hydraulic fluids . Their storage and use present potential for spills and leaks which could contaminate underlying exposed soils.
- Concrete works required for the turbine foundations will typically require excavations and concrete pours requiring placement of blinding, shutters, reinforcement for final concrete pour.
- During construction, imported engineering fill and excavated soils will be exposed in excavations and in temporary stockpiles. These soils will be subject to erosion by wind and rain which could deposit silt in streams with an indirect impact on water quality.
- Parts of the site are used for commercial forestry, 18 ha of which will be felled for the construction of the wind farm. Felling will involve the use of heavy felling machinery, which could result in soil erosion. These activities are carried out under a licencing and approval system administered by the Department of Agriculture, Food and the Marine (Forest Service), which include conditions requiring environmental controls.

The overall magnitude of these potential impacts associated with the construction phase of the proposed development, prior to mitigation given the limited time scale for the works, is considered to be a Short Term, Negative Impact of **Slight to Moderate Significance.**

Hydrogeology

Direct impacts to the existing hydrogeological regime associated with the construction phase of the proposed development are:

- Potential for groundwater pollution from the removal of overburden (peat and glacial TILL) deposits. The aquifer underlying the study area is rated as having 'Moderate' to 'High' vulnerability to groundwater pollution within the proposed wind farm site. The proposed grid connection route traverses' areas of 'Moderate' to 'High' vulnerability with an area of 'Extreme' vulnerability is recorded at the eastern extent of the grid connection. It is proposed to remove the overlying peat and glacial TILL deposits as outlined in the proposed design. The vulnerability of the aquifer to groundwater pollution particularly during construction stage will be increased as overburden is removed thus reducing the level of protection from groundwater pollution.
- Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Soil erosion as a result of exposure of soils in open excavations and temporary storage of excavated materials represents a potential impact to the underlying groundwater aquifer. From the removal of additional aquifer material during construction stage it is considered the risk posed to groundwater quality is increased from the infiltration of silt laden surface water runoff run-off during construction phase earthworks.
- Potential for contamination to groundwater from spills/leakages during construction phase earthworks. The use of construction plant and associated refuelling and storage of fuels and hydrocarbons with potential for spills or leaks could result in contamination of the underlying aquifers.
- Reduction in groundwater levels from dewatering of excavations as required during the construction stage if high groundwater is encountered. This impact is most likely during the excavation of deeper turbine foundations at the proposed development. There are no groundwater supply wells recorded in the vicinity of proposed turbine locations. It is considered that other excavations associated with the substation, temporary compound and grid connection trenches will not extend into the underlying bedrock aquifers.

Upon completion of the construction phase, it is considered that groundwater levels will revert to the pre-construction situation when there is no longer a requirement to control groundwater levels.

The overall magnitude of these potential impacts associated with the construction phase of the proposed development, prior to mitigation given the limited time scale for the works, is considered to be a Short Term, Negative Impact of **Moderate/Slight** to **Moderate Significance.**

13.4.2.2 Potential Indirect Impacts

Quantities of granular material will be required for the proposed development. This will place a demand on local aggregate extraction facilities.

Where the material excavated from the proposed development is not suitable for reuse as backfill or deposition on site this material will be disposed of at a facility licensed (subject to environmental testing and classification) to accept this waste type. This will take up available void space at licensed facilities if not recycled.

The proposed grid connection and associated trenches may present a preferential pathway for the movement of groundwater and/or contamination in the subsurface. However, the subsoil is glacial TILL which is predominantly cohesive and therefore has a low permeability throughout most of the proposed grid connection route.

13.4.3 Operational Phase

The potential impacts on land, soils and geology from the operation of the proposed development are outlined hereunder.

13.4.3.1 Potential Direct Impacts

Very few potential direct impacts are envisaged during the operational phase of the wind farm. These include:

- Some construction traffic may be necessary for the maintenance of turbines which could result in minor accidental leaks or spills of fuels, lubricants or hydraulic fluids; and
- The grid transformer in the substation and transformers in each turbine may be oil cooled. There is potential for spills / leaks of oils from this equipment resulting in contamination of soils and groundwater.

The magnitude of these potential impacts, prior to mitigation, is considered to be of **Slight Significance.**

13.4.3.2 Potential Indirect Impacts

A small amount of granular material may be required to maintain access tracks during operation which will place intermittent minor demand on local quarries.

The magnitude of these potential impacts, prior to mitigation, is considered to be of **Slight Significance.**

13.4.4 Potential Impacts during Decommissioning

The potential impacts associated with decommissioning will be similar to those associated with construction but of reduced magnitude.

During decommissioning, it may be possible to reverse or at least reduce some of the impacts caused during construction by rehabilitating construction areas such as turbine bases, hardstanding areas, the substation and site compound. This will be done by covering with topsoil to encourage vegetation growth and reduce run-off and sedimentation.

Other impacts such as possible soil compaction and contamination by fuel leaks will remain but will be of reduced magnitude. Nevertheless, as noted in the Scottish Natural Heritage guidance on restoration and decommissioning of onshore wind farms (SNH, 2013) reinstatement proposals for a wind farm are made approximately 30 years in advance, so within the lifespan of the wind farm, technological advances and preferred approaches to reinstatement are likely to change. It is therefore '*best practice not to limit options too far in advance of actual decommissioning but to maintain informed flexibility until close to the end-of-life of the wind farm*'.

13.4.5 Potential Cumulative Impacts

The nearest existing and permitted wind farm developments in the vicinity of the Dernacart Wind Farm include the existing Mount Lucas Wind Farm, 13 km to the north-northeast and the permitted Moanvane Wind Farm 8km north of the proposed development.

It is considered, given the distances to the existing Mount Lucas Wind Farm, permitted Moanvane Wind Farm and the localised land take with regard to the proposed development the potential cumulative impact on the receiving environment is considered to be **Negligible.**

The proposed grid connection route for the Dernacart Wind Farm will eventually connect to the future proposed Bracklone substation at Portarlington, County Laois. Given the limited extent of the development footprint for the substation developments and the distance from the main wind farm site the potential cumulative impact on the receiving environment is considered to be **Negligible.**

The following neighbouring proposed permitted developments were also examined for potential cumulative impacts on soils and geology. The relevant permitted projects and the distance from the development are listed in Table 13-8 below:

Table 13-8: Potential Cumulative Impact from Permitted Developments

	Development	Distance to Dernacart	Status
1	Solar Farm at Ballyduff	10km	Permitted
2	Solar Farm at Shanderry	8.5km	Permitted
3	Wind Farm at Stonestown	33km	Permitted
4	Energy Storage Facility at Lumcloon	18km	Permitted
5	Solar Farm at Derrymore	21km	Permitted
6	Cheese Manufacturing Facility at Togher, Portlaoise.	17km	Permitted

It is considered that the permitted developments outlined above are located far enough from the proposed development at Dernacart, that the potential cumulative impact on the receiving environmental is considered to be **Negligible.**

During the construction of the proposed development there will be a requirement for the importation of engineered fill from source quarries and potential for disposal of materials unsuitable for reuse at licensed facilities. Should any of the proposed or permitted developments outlined above and proposed Dernacart Wind Farm be constructed at the same time it is considered there will be a **Slight** cumulative impact in terms of demands placed on local quarries for aggregate and available void space at licensed facilities during the construction phase of these developments.

13.4.6 Summary of Potential Impacts

A summary of unmitigated potential impacts on land, soils and geology attributes from the proposed development is provided in Table 13-8 with the potential impacts on hydrogeological attributes provided in Table 13-9.

Table 13-9: Summary of Potential Unmitigated Impact Significance on Land, Soils and Geology Attributes

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Construction Phase					
Earthworks	Removal of overburden material, open excavations and subsequent exposure underlying overburden and bedrock leading to increased erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils.	Local peat deposits, organic soils and glacial TILL deposits. Bedrock	Medium	Moderate	Moderate
Felling Activities	Exposure of underlying overburden leading to increased erosion. Felling machinery resulting soil compaction of soft deposits and an increase in surface water runoff resulting in increased erosion of exposed soils.	Local peat deposits, organic soils and glacial TILL deposits.	Medium	Moderate	Moderate
Construction of Internal Site Access Tracks, Hardstands and Temporary Compound	Open excavations, increased runoff causing erosion of underlying overburden and bedrock. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill.	Local peat deposits, organic soils and glacial TILL deposits. Bedrock Local quarries	Medium	Moderate	Moderate
Construction of Turbine and Substation Foundations	Open excavations, increased runoff causing erosion of underlying overburden and bedrock. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill and concrete products.	Local peat deposits, organic soils and glacial TILL deposits. Bedrock Local quarries	Medium	Moderate	Moderate
Construction of the Grid Connection and Internal Cabling	Removal of overburden material and exposure underlying Clay and Bedrock to erosion.	Local peat deposits, organic soils and glacial TILL deposits.	Medium	Small Adverse	Slight

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
	Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill and concrete products. Disposal of surplus excavated material to licenced facility.	Bedrock Local quarries Licenced Waste Facilities			
Earthworks associated with the construction of the proposed development and associated infrastructure	Slope Failure.	Local peat deposits, organic soils and glacial TILL deposits.	Medium	Small Adverse	Slight
Operational Phase					
Maintenance Traffic, Substation	Release of hydrocarbons or fuel spill.	Local peat deposits, organic soils and glacial TILL deposits. Bedrock	Medium	Small Adverse	Slight
Maintenance of access tracks	Importation of engineering fill.	Local quarries	Medium	Small Adverse	Slight
Cumulative Impacts					
Construction of the proposed development and associated infrastructure	Cumulative impacts on local quarries from extraction of fill for proposed development. Disposal of surplus excavated material to licenced facility.	Local quarries Licensed Waste Facilities	Medium	Small Adverse	Slight

Table 13-10: Summary of Potential Unmitigated Impact Significance on Hydrogeology

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
Construction Phase					
Earthworks	Potential for ground water pollution from the removal of overburden (peat and glacial TILL) deposits. Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during construction phase earthworks.	Portlaoise GWB Locally Important Bedrock Aquifer	Medium	Moderate	Moderate
Felling Activities	Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages from felling machinery.	Portlaoise GWB Locally Important Bedrock Aquifer	Medium	Moderate	Moderate
Construction of Internal Site Access Tracks, Hardstands and Temporary Compound	Potential for ground water pollution from the removal of overburden (peat and glacial TILL) deposits. Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer. Potential for contamination to groundwater from spills/leakages during construction phase earthworks. Potential for ground water pollution from the use of cement-based compounds during the construction phase.	Portlaoise GWB Locally Important Bedrock Aquifer	Medium	Moderate	Moderate
Construction of Turbine and Substation Foundations	Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer.	Portlaoise GWB Locally Important Bedrock Aquifer	Medium	Medium	Moderate

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation	
				Magnitude	Significance
	Potential for contamination to groundwater from spills/leakages during construction phase earthworks. Potential for ground water pollution from the use of cement-based compounds during the construction phase.				
Construction of the Grid Connection and Internal Cabling	Potential for ground water pollution from the removal of overburden (peat and glacial TILL) deposits. Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer Potential for contamination to groundwater from spills/leakages during construction phase earthworks.	Portlaoise, Bagnelstown & Cushina GWBs Locally and Regionally Important Bedrock Aquifers	High	Small Adverse	Moderate/Slight
Dewatering activities during excavation works	Reduction in groundwater levels from dewatering of excavation as required during the construction phase	Portlaoise, Bagnelstown & Cushina GWBs Locally and Regionally Important Bedrock Aquifers Groundwater Wells & Springs	High	Negligible	Imperceptible
Operation					
Operational traffic, refuelling of vehicles	Some operational traffic will be necessary for maintenance plus normal operational traffic which could result in minor accidental leaks or spills of fuel/oil.	Portlaoise GWB Bedrock Aquifer	Medium	Small Adverse	Slight

13.5 Mitigation Measures

The following section outlines appropriate mitigation measures to by design and best practice to avoid or reduce the potential impact of the proposed development.

13.5.1 Mitigation by Design and Best Practice

With regard to the proposed development, detailed design and best practice will be implemented as follows:

- The proposed development will be designed in accordance with best practice
- The works will be designed and checked by geotechnical and civil engineers, suitably qualified and experienced in excavation and earthworks design and construction methodologies.
- Any excavation and construction related works will be subject to a design risk assessment at detailed design stage to evaluate risk levels for the construction, operation and maintenance of the works. Identified impacts will be minimised by the application of principles of avoidance, prevention and protection. Information on residual impacts will be recorded and relayed to appropriate parties
- A method statement for each element of the works will be prepared by the Contractor prior to any element of the work being carried out.
- Given that the works comprise a significant proportion of excavation and earthworks, suitably qualified and experienced geotechnical personnel will be required on site to supervise the works.
- The Contract will require planning of the works such that earthworks are not scheduled during severe weather conditions. Where such weather is forecast, suitable measures will be taken to secure the works.

13.5.2 Construction Phase

The following sections outline appropriate mitigation measures to avoid or reduce the potential impact of the proposed development.

13.5.2.1 Construction Environmental Management Plan

A Construction Environmental Management Plan (CEMP) has been prepared for the proposed development and is included in Volume 3, Appendices. The CEMP defines the work practices, environmental management procedures and management responsibilities relating to the construction phase of the proposed development. The CEMP describes how the contractor for the main construction works will implement a site Environmental Management System (EMS) to meet the specified contractual, regulatory and statutory requirements including the requirements identified as part of the environmental impact assessment process.

The CEMP will be updated prior to construction to take account of any amendments arising during the consenting process and relevant conditions attached to the planning permission and will be implemented for the duration of the construction phase of the project. The CEMP will be a live document and will be reviewed and updated as required.

Reference to relevant sections of the CEMP with respect to the mitigation of potential impacts to Land, Soils and Geology from the proposed development are outlined below.

13.5.2.2 Earthworks

The development will be constructed in a phased manner to reduce the potential impacts of the development on the land, soils and geology at the site. Phased construction reduces the amount of open, exposed excavations at any one time. Details of the proposed methodology and mitigation measures are summarised below and are also outlined in the CEMP in Appendix 4.2 of Volume 3.

One of the primary mitigation measures employed at the preliminary design stage is the minimisation of volumes of excavated peat and glacial TILL deposits to be exported off site. Excavated overburden peat and glacial TILL will be retained for site and reused as far as possible.

This will include:

- Use of suitable site won material (glacial TILL) general fill in the construction of access tracks, hardstands and in reinstatement around turbine foundations; and
- Surplus peat and glacial TILL will be re-used on site in the form of landscaping and berms.

Surplus glacial TILL deposits excavated during the course of the works will be temporarily stored in a level area adjacent to the construction phase excavations prior to reuse.

Some temporary stockpiles (not exceeding 2 m in height) of material will be necessary adjacent to the excavation areas prior to reinstatement, however no long-term stockpiles of material will remain after construction and no surplus/waste soil or rock will be removed from the proposed development site.

To mitigate against the compaction of soil at the site, prior to the commencement of any earthworks, the work corridor will be pegged, and machinery will stay within this corridor so that peatland / soils outside the work area is not damaged. Excavations will then be carried out from access tracks, where possible, as they are constructed in order to reduce the compaction of soft ground. Where works are undertaken on existing peat deposits low ground pressure or wide tracked excavators will be used to strip the peat.

To mitigate against erosion of the exposed soil or rock, all excavations will be constructed and backfilled as quickly as possible. Excavations will stop during or prior to heavy rainfall events. To mitigate against possible contamination of the exposed soils and bedrock, refueling of machinery and plant will only occur at designated refueling areas.

Soil excavated from trenches along the proposed grid connection route will be taken to a licenced facility for disposal or recycling where required. If feasible, the upper layers of tarmac and asphalt will be excavated separately to the lower engineered fill layers. The lower engineered fill layers will be reused. The tarmac / asphalt layers will be taken to a licenced facility for disposal or recycling.

All temporary cuts/excavations will be carried out such that they are stable or adequately supported. Gravel fill will be used to provide additional support to temporary cuts/excavations where appropriate. Unstable temporary cuts/excavations will not be left unsupported. Where appropriate and necessary, temporary cuts and excavations will be protected against the ingress of water or erosion.

Peat stability monitoring program and appropriate instrumentation may be required where deeper in-situ peat deposits occur. The requirement and proposed location of monitoring instrumentation will be identified prior to construction works commencing on site.

Interceptor drains will be installed prior to any construction works commencing. Temporary settlement ponds and silt management measures will be installed to mitigate against sediment run-off as required. Further assessment of potential impacts to surface water discharges during the construction phase are discussed in Chapter 14, Hydrology and Water Quality of this EIAR.

13.5.2.3Control of Sediment Laden Runoff

The potential impact from silt laden surface water runoff from increased erosion of exposed overburden deposits will be assessed at site-specific locations particularly at new and existing drainage locations where earthworks are proposed.

Details of the proposed Surface Water Management System and mitigation measures is summarised below and are also outlined in the CEMP in Appendix 4.2 of Volume 3.

Best practices will be employed in the prevention of silt laden run-off from entering watercourses as discussed below.

To minimise the impact to surface water quality, existing peat bog drainage will be maintained outside the immediate site area, and where appropriate additional site drainage and settlement ponds will be installed as required prior to construction activities. Silt fencing will be installed in new and existing drainage and monitoring of water quality undertaken during the construction phase.

Final drainage will be constructed following the completion of these activities with silt fencing maintained until such time as a vegetation cover has become established. Chapter 14, Hydrology and Water Quality of this EIAR discusses surface water issues in more detail.

13.5.2.4 Measures for Spills

Details of oil spill protection measures adjacent to sensitive receptors and emergency spill response procedures are outlined in the CEMP contained in Appendix 4.2 of Volume 3.

Storage tanks, used to store fuel for the various items of machinery, will be self-contained and double-walled. Refuelling of construction vehicles will be carried out from these tanks or from delivery vehicles at designated refuelling areas. Specific mitigation measures relating to the management of hydrocarbons are as follows:

- Fuels, lubricants and hydraulic fluids for equipment used on the construction site will be carefully handled to avoid spillage;
- Any spillage of fuels, lubricants or hydraulic oils will be immediately contained, and the contaminated soil removed from the site and properly disposed of;
- Waste oils and hydraulic fluids will be collected in leak-proof containers and removed from the site for disposal or re-cycling; and
- Appropriate spill control equipment, such as oil soakage pads, will be kept within the construction area and in each item of plant to deal with any accidental spillage.

13.5.2.5 Slope Stability

With regard to slope stability issues, detailed design best practice will be implemented as follows:

- The works will be designed and supervised by a suitably qualified and experienced geotechnical engineer or engineering geologist, and hydrologist or drainage engineer;
- Peat stability monitoring program and appropriate instrumentation may be required where deeper in-situ peat deposits occur. The requirement and proposed location of monitoring instrumentation will be identified prior to construction works commencing on site. Excavation works will be monitored by suitably qualified and experienced geotechnical engineer;
- The programming of the works (by the Contractor) will be such that earthworks are not scheduled to be carried out during severe weather conditions. Where such weather is forecast, suitable measures will be taken to secure the works;
- Prior to the placement of peat in the proposed berms the existing ground conditions will be inspected by a suitably qualified and experienced geotechnical engineer or engineering geologist to ensure there is no potential for ground instability from the peat placement activities; and
- All temporary cuts/excavations will be carried out such that they are stable or adequately supported. Gravel fill will be used to provide additional support to drains where appropriate. Unstable temporary cuts/excavations will not be left unsupported. Where appropriate and necessary, temporary cuts and excavations will be protected against the ingress of water or erosion.

13.5.2.6 Groundwater

To mitigate against the increased vulnerability of the underlying aquifer to groundwater pollution, all excavations will be constructed and backfilled as quickly as possible. Excavations will stop during or prior to heavy rainfall events. To mitigate against possible contamination of the underlying, refuelling of machinery and plant will only occur at designated refuelling areas. Details of mitigation measures related to spills and fuel storage are outlined above in Section 13.4.1.4.

The dewatering of the foundation excavations is not expected to cause interference with domestic wells in the area, due to large offset distances to known wells, relatively shallow depths of excavation and temporary short-term nature of dewatering, if required.

The GSI database is however not complete; it is possible that there are other wells in addition to those in the GSI databases, but are generally associated with houses, the offset to which from the turbines is a minimum of 740m from non-involved landowners. In the unlikely event of a domestic well being impacted by the wind farm development, an alternative supply will be provided – either in the form of a connection to mains water or a replacement well.

The GSI holds records of groundwater wells in the vicinity of the proposed grid connection route. However, trenches are shallow (1.2 m deep) and will only be open for a short period. Depending on the ground conditions, presence of services, traffic management required, weather conditions, etc., the rate of installation of cable ducting would vary between 50 m and 100 m per day. Dewatering is therefore unlikely to be required and no impacts on wells is envisaged.

Cable trenches could provide preferential pathways for groundwater and contaminant movement. To avoid the cable trenches becoming preferential pathways, clay plugs (or other low permeability material) will be installed at intervals along the trench to stop / inhibit water movement.

13.5.3 Mitigation Measures during Operation

It is not envisaged that the operation of the proposed development will result in significant impacts on the geological and hydrogeological regimes within the study area, as there will be no further disturbance of overburden post-construction.

The main potential residual impact during the operation phase would be the risk of contamination of groundwater from spills. Due to the reduced magnitude of the impacts, no additional mitigation measures are required for the maintenance and operation of the wind farm, over and above those incorporated into the design of the substation transformer, which will be bunded to protect soils against accidental leakages of oil.

13.5.4 Mitigation Measures during Decommissioning

Mitigation measures applied during decommissioning activities will be similar to those applied during construction where relevant.

Some of the impacts associated with reinstatement of the site (excavation of turbine bases, access tracks etc.) will be avoided by leaving these in place where possible. The Irish Wind Energy Association (IWEA) (11) 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*". It is proposed to leave the access tracks in-situ at the decommissioning stage. IWEA also state that "*it may be best*" to leave site tracks in-situ depending on the size and geography of the development.

It is considered that leaving the turbine foundations, access tracks and hardstanding areas in-situ will cause less environmental damage than removing and recycling them. Removal of this infrastructure would result in considerable disruption to the local environment in terms of increased sedimentation, erosion, dust, noise, traffic and an increased possibility of contamination of the local water table. However, if removal is deemed to be required by the respective local authority all infrastructure will be removed with mitigation measures similar to those during construction being employed.

Mitigation measures to avoid contamination by accidental fuel leakage and compaction of soil by on-site plant will be implemented as per the construction phase mitigation measures outlined in Section 13.5.2.4.

13.5.5 Cumulative

During the construction of the proposed development there will be a requirement for the importation of engineered fill from source quarries and potential for disposal of materials unsuitable for reuse at licensed facilities. Should any of the permitted developments outlined above and proposed Dernacart Wind Farm be constructed at the same time it is considered there will be a **Slight** cumulative impact in terms of demands placed on local quarries for aggregate and available void space at licensed facilities during the construction phase of these developments.

No significant, direct negative cumulative effects are envisaged during the operation or decommissioning phase of the proposed development. As such no mitigation measures are required with respect to potential cumulative impacts of the proposed development.

13.6 Residual Impacts

It can be observed from Tables 13-10 and 13-11 that, following the implementation of mitigation measures, the residual impact significance to the receiving environment would be imperceptible during the construction period and imperceptible during the operation of the proposed development. The implementation of mitigation measures will be monitored throughout the construction and operational phases by a suitably qualified person.

The proposed development is not expected to contribute to any significant, negative cumulative effects of other existing developments in the vicinity. Slight residual cumulative effects from the excavation of fill material from local quarries and disposal of material deemed unsuitable for reuse are considered result from the proposed development by placing demand on existing quarries and available void space at licensed facilities during the construction phase of the development.

Table 13-11: Residual Impact Significance for Sensitive Geological Attributes

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction Phase							
Earthworks	Removal of overburden material, open excavations and subsequent exposure underlying overburden and bedrock leading to increased erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils.	Local peat deposits, organic soils and glacial TILL deposits. Bedrock	Medium	Moderate	Moderate	Negligible	Imperceptible
Felling Activities	Exposure of underlying overburden leading to increased erosion. Felling machinery resulting soil compaction of soft deposits and an increase in surface water runoff resulting in increased erosion of exposed soils.	Local peat deposits, organic soils and glacial TILL deposits.	Medium	Moderate	Moderate	Negligible	Imperceptible
Construction of Internal Site Access Tracks, Hardstands and Temporary Compound	Open excavations, increased runoff causing erosion of underlying overburden and bedrock. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill	Local peat deposits, organic soils and glacial TILL deposits. Bedrock Local quarries	Medium	Moderate	Moderate	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction of Turbine and Substation Foundations	Open excavations, increased runoff causing erosion of underlying overburden and bedrock. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill and concrete products	Local peat deposits, organic soils and glacial TILL deposits. Bedrock Local quarries	Medium	Moderate	Moderate	Negligible	Imperceptible
Construction of the Grid Connection and Internal Cabling	Removal of overburden material and exposure underlying Clay and Bedrock to erosion. Construction traffic resulting soil compaction and increase in surface water runoff resulting in increased erosion of exposed soils. Importation of engineering fill and concrete products Disposal of surplus excavated material to licenced facility	Local peat deposits, organic soils and glacial TILL deposits. Bedrock Local quarries Licenced Waste Facilities	Medium	Small Adverse	Slight	Small Adverse	Imperceptible
Earthworks associated with the construction of the proposed development and associated infrastructure	Slope Failure	Local peat deposits, organic soils and glacial TILL deposits.	Medium	Small Adverse	Slight	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Operational Phase							
Maintenance Traffic	Release of hydrocarbons or fuel spill	Local peat deposits, organic soils and glacial TILL deposits. Bedrock	Medium	Small Adverse	Slight		
Maintenance of access tracks	Importation of engineering fill	Local quarries	Medium	Small Adverse	Slight	Small Adverse	Imperceptible
Cumulative Impacts							
Construction of the proposed development and associated infrastructure	Cumulative impacts on local quarries from extraction of fill for proposed development Disposal of surplus excavated material to licenced facility	Local quarries Licensed Waste Facilities	Medium	Small Adverse	Slight	Small Adverse	Slight

Table 13-12: Residual Impact Significance for Sensitive Hydrogeological Attributes

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction Phase							
Earthworks	Potential for ground water pollution from the removal of overburden (Peat and Glacial TILL) deposits. Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer Potential for contamination to groundwater from spills/leakages during construction phase earthworks.	Portlaoise GWB Locally Important Bedrock Aquifer	Medium	Moderate	Moderate	Negligible	Imperceptible
Felling Activities	Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer Potential for contamination to groundwater from spills/leakages from felling machinery	Portlaoise GWB Locally Important Bedrock Aquifer	Medium	Moderate	Moderate	Negligible	Imperceptible
Construction of Internal Site Access Tracks, Hardstands and Temporary Compound	Potential for ground water pollution from the removal of overburden (Peat and Glacial TILL) deposits. Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer Potential for contamination to groundwater from spills/leakages during construction phase earthworks. Potential for ground water pollution from the use of cement-based compounds during the construction phase	Portlaoise GWB Locally Important Bedrock Aquifer	Medium	Moderate	Moderate	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Construction of Turbine and Substation Foundations	Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer Potential for contamination to groundwater from spills/leakages during construction phase earthworks. Potential for ground water pollution from the use of cement-based compounds during the construction phase	Portlaoise GWB Locally Important Bedrock Aquifer	Medium	Medium	Moderate	Negligible	Imperceptible
Construction of the Grid Connection and Internal Cabling	Potential for ground water pollution from the removal of overburden (Peat and Glacial TILL) deposits. Potential for silt infiltration to groundwater as a result of increased surface runoff and reduced protection of the aquifer Potential for contamination to groundwater from spills/leakages during construction phase earthworks.	Portlaoise, Bagnelstown & Cushina GWBs Locally and Regionally Important Bedrock Aquifers	High	Small Adverse	Moderate/Slight	Negligible	Imperceptible
Dewatering activities during excavation works	Reduction in groundwater levels from dewatering of excavation as required during the construction phase	Portlaoise, Bagnelstown & Cushina GWBs Locally and Regionally Important Bedrock Aquifers Groundwater Wells & Springs	High	Negligible	Imperceptible	Negligible	Imperceptible

Activity	Potential Impact	Receptor	Sensitivity	Prior to Mitigation		Post Mitigation	
				Magnitude	Significance	Magnitude	Significance
Operation							
Maintenance Traffic	Some operational traffic will be necessary for maintenance plus normal operational traffic which could result in minor accidental leaks or spills of fuel/oil.	Portlaoise GWB Bedrock Aquifer Groundwater Wells and Springs	Medium	Small Adverse	Slight	Negligible	Imperceptible

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