CHAPTER 6

LAND, SOILS AND GEOLOGY

CONTENTS

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INTRODUCTION

Background

6.1 This chapter of the Environmental Impact Assessment Report (EIAR) evaluates the regional and local geological conditions at the application site at Aghamore Near, Aghamore Far and Carrownamaddoo townlands to accompany a Planning Application to Sligo County Council by Lagan Materials Ltd.

6.2 The proposed application area covers an area of c.22.5 ha. and comprises the proposed recommencement of activities at the existing limestone quarry and adjacent processing area at Aghamore Near, Aghamore Far and Carrownamaddoo townlands, Co. Sligo.

6.3 A description of the site and proposed development is outlined in Chapters 1 & 2 of this EIAR.

Scope of Work / EIA Scoping

6.4 This Chapter describes the local land, soil and geology at and around the application site based on the available information for the area. This assessment is based on a detailed examination of the existing quarry and a review of geological investigation works carried out in the surrounding area.

Consultations / Consultees

6.5 The Irish Geological Heritage (IGH) section of the Geological Survey of Ireland has been consulted in relation to this site.

Contributors / Author(s)

6.6 The information presented in this chapter is based on a detailed examination of the existing quarry at Aghamore and the surrounding area and was prepared by EurGeol Dr John Kelly PGeo, MIMMM, MIQ. Dr Kelly is a Professional Geologist with over 27 years professional experience.

Limitations / Difficulties Encountered

6.7 The assessment of the land, soils and geology presented in this chapter is based on visual observations from site visits, published information and available ground investigation records.

6.8 No specific limitations or difficulties were encountered in the preparation of this chapter of the EIAR.

REGULATORY BACKGROUND

Legislation

EU Directives

6.9 The following European Union (EU) Directives relate to Land, Soils and geology at the site in this EIAR:

- Environmental Impact Assessment Directive (2011/92/EU);
- The management of waste from extractive industries (2006/21/EC); and
- Environmental Liability Directive (2004/35/EC).

6.10 The EU EIA Directive regulates the information impact assessment process and information in this EIAR. The management of Waste Directive and the Environmental Liability Directive regulates the activities at the site.

Irish Legislation

6.11 The following legislation relating to Land, Soils and geology at the site in this EIAR:

- No. 349 of 1989, European Communities (Environmental Impact Assessment) Regulations, and subsequent amendments (S.I. No. 84 of 1994, S.I. No. 352 of 1998, S.I. No.; 93 of 1999, S.I. No. 450 of 2000 and S.I. No. 538 of 2001);
- S.I. No. 473 of 2011, European Union (Environmental Impact Assessment and Habitats) Regulations 2011;
- S.I. No. 584 of 2011, European Union (Environmental Impact Assessment and Habitats) (No.2) Regulations 2011;
- The Planning and Development Acts, 2000 to 2009; and
- The Planning and Development (Amendment) Act 2010, S.I. 600 of 2001 Planning and Development Regulations and subsequent amendments including, S.I. No. 364 of 2005 and S.I. 685 of 2006.

6.12 The above legislation regulates the information contained in an EIAR and planning application for the proposed development.

Planning Policy and Development Control

6.13 The following Planning Policy and Development Control relating to land, soils and geology at the site in this EIAR is set out in the:

- Sligo County Development Plan 2017-2023.

6.14 The county development plan sets out conservation objectives in relation to soils, geology, geomorphology and geological heritage in Sligo.

Guidelines

6.15 The following guidelines relating to Land, Soils and Geology and have been used in the preparation of this EIAR:

- DoEHLG, 2010. Appropriate Assessment of Plans and Projects in Ireland - Guidance for Planning Authorities;
- Environmental Protection Agency, 2002. Guidelines on the information to be contained in Environmental Impact Statements;
- Environmental Protection Agency, 2003. Advice Notes on current practice (in the preparation of Environmental Impact Statements);
- GSI, Irish Concrete Federation, 2008. Geological Heritage Guidelines for the Extractive Industry;
- Institute of Geologists of Ireland, 2002. Geology in Environmental Impact Statements, A Guide;
- Institute of Geologists of Ireland, 2007. Recommended collection, presentation and interpretation of geological and hydrogeological information for quarry developments;
- Institute of Geologists of Ireland, 2013. Guidelines for the preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements;
- National Roads Authority, 2008. Environmental Impact Assessment of National Road Schemes - A Practical Guide; and
- National Roads Authority, 2008. Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.

6.16 The above guidelines are relevant to the preparation of a Land, Soils and Geology chapter of this EIAR.

Technical Standards

6.17 The following Technical Standard relating to Land, Soils and geology at the site in this EIAR:

- British Standards (2015). Code of Practice for Site Investigations BS5930:2015;
- British Standard (2001). Geotechnical investigation and testing – Identification and classification of soil BS EN ISO 14688-2:2004;
- British Standard (2003). Geotechnical investigation and testing – Identification and classification of rock BS EN ISO 14689-1:2003.

ADDITIONAL INFORMATION

6.18 As outlined in Chapter 1 a planning application was submitted to Sligo County Council (Plan File Ref. No. 18/345 / ABP Ref. 305821-19) in August 2018 for similar development to that proposed as part of this application. In October 2019 Sligo County Council granted planning permission for the development (subject to 23 no. conditions). 2 no. third party appeals of the decision by

Sligo County Council to grant permission for the proposed quarry development were made to An Bord Pleanala (ABP-305821-19). An Bord Pleanala refused permission for the proposed development on the 30th June 2020 for the 2 no. reasons – refer to Chapter 1 for further details.

6.19 In order to address the reasons for refusal, and further comments contained within the An Bord Pleanala Inspectors Report a number of additional surveys / site investigations, field work and assessments have been carried out.

6.20 This Chapter 6 of the EIAR has been updated as follows:

- Additional ground investigations have been undertaken at the application site, including boreholes and geophysical surveys;
- The assessment now includes the processing area on the Eastern side of the Local road.

RECEIVING ENVIRONMENT

Study Area

6.21 The study area for this Land, Soils and Geology section of the EIAR comprises the application area (c. 22.5 ha.) and surrounding lands.

Baseline Study Methodology

6.22 Existing information on the regional soils, superficial deposits and bedrock geology of the Aghamore area and its surrounds was collated and evaluated. Subsequent to this data compilation and review, site visits and inspections were undertaken to review the superficial deposits and bedrock geology at Aghamore Quarry and in the surrounding area.

Sources of Information

6.23 The following activities were undertaken as part of this geological assessment:

- Examination of GSI 1:100,000 geology map sheet 07 Geology of Sligo and Leitrim.
- Review of available geological information and literature.
- Review of previous rotary core borehole records and ground investigation reports.
- Site / quarry face inspections.
- Review of geophysical surveying investigations (APEX Geoservices report AGL17164_01, APEX Geophysics reports AGP19223_01 and AGP21007_01).
- Review of borehole logs from additional boreholes installed as part of the updated hydrogeological assessment for the proposed development (Boreholes MW12 to MW25, 2020).
- Review of previous geology and geotechnical assessments and aggregate testing results.

Regional Geology

Soil

6.24 Teagasc soil mapping, reproduced in **Figure 6-1**, indicates that the current extraction area and the aggregate processing area at the Aghamore site was originally underlain by renzinas and lithosols, with adjacent areas of lithosols and regosols and surface water gleys. Due to previous extraction, few areas of original, undisturbed soil remain across the application area.

Superficial Deposit Geology

6.25 Teagasc sub-soil (parent material) mapping, reproduced in **Figure 6-2**, shows that the lands that form part of the application are/were underlain by bedrock at, or close to, surface and glacial tills derived from metamorphic rocks. The eastern part of the application area (the processing area) is mapped by Teagasc as being composed of made ground or sands and gravels derived from Carboniferous limestones.

Bedrock Geology

6.26 The GSI 1:100,000 geology map Sheet 07 shows the existing extraction area to be developed within the Dartry Limestone Formation, refer to **Figure 6-3**.

Local Geology

Introduction

6.27 The quarry extraction area at the site is located to the south of the R287 road. The processing area is located to the east of a local road which separates the extraction area from the processing area.

Soil and Superficial Deposits

6.28 Soils and superficial deposits have been entirely stripped from the footprint of the current and previous extraction areas. A small amount of soils / subsoil material will be removed to construct the proposed settlement lagoon.

6.29 Previous drilling work in the unextracted areas indicates that the total thickness of soils and superficial deposits in this area varied from 3.0m to 6.0m. APEX Geophysics report AGP21007_01 indicates that the superficial deposits in the unextracted area (Area B) is between 0.0 – 2.0m thick, with small, localised pockets up to 5.0m in thickness. An area defined by APEX (Zone 1) defines an area of thick superficial deposits up to 15m in thickness.

Bedrock Geology

6.30 The bedrock geology at Aghamore Quarry is well understood from abundant quarry face exposures and rotary core drilling to the north, east and southeast of the existing extraction area.

6.31 The existing extraction area is developed within the Dartry Limestone Formation (see Table 6-1) located on the hangingwall (downthrown) side of a northwest downthrowing major fault, part of the Ox Mountains fault complex.

6.32 The information available indicates that the current and future extraction at the existing quarry is derived from strong, fresh, mid to dark-grey, fine-grained well bedded bioclastic cherty silicified and dolomitised limestones of the Dartry Limestone Formation.

6.33 Three sub-units have been identified within the Dartry Limestone at the site, as follows:

6.34 The lowermost unit is composed of dark grey, well-bedded poorly fossiliferous fine-grained cherty limestones. This unit lies below the quarry floor and is only known from drilling.

6.35 The middle unit is composed of dark grey, well-bedded (0.4m to 1.0m thick) fossiliferous cherty fine-grained limestone and dolomite with abundant calcite and dolomite infilled vugs.

6.36 The uppermost unit, only exposed in the northwest area of the quarry is composed of massive, pale-grey fine-grained (micrite) fossiliferous limestones.

6.37 Geophysical surveys by APEX (APEX Geoservices report AGL17164_01, APEX Geophysics reports AGP19223_01 and AGP21007_01) indicate that the bedrock under the existing quarry floor, in the lands immediately north of the existing quarry and to the west of the existing quarry are composed of clean, thin to medium bedded limestones. There are no indications of weathered zones or structural (fault, fissure) or karst features, with the exception of APEX Area B, which is interpreted as an area of clay-infilled fissures, that have no potential to be hydrologically active.

6.38 Due to the geological structure of the area and the proposed final depth of extraction, no geological units except the Dartry Limestone Formation will be extracted. The Dartry Limestone is underlain by the Glencar Limestone Formation, but the APEX geophysical surveying has not encountered values typical of he Glencar Limestone Formation, so it can be concluded that the Dartry Limestone / Glencar Limestone contact lies below the depth of the geophysical surveying.

Table 6-1
Lithological Sequence of Geological Units Present in the Existing Quarry Area (after MacDermot, 1996)

Formation	Estimated Thickness	Description
DARTRY LIMESTONE FORMATION	200m+	The dominant facies is a massive to thick-bedded, mostly very fine-grained and dark wackestone, locally rich in sponge spicules. Bedding is picked out by bands and nodules of irregular chert, sometimes forming 50% of the rock. There is pervasive dolomitization and silicification.
GLENCAR LIMESTONE FORMATION	UNKNOWN	Dark fine limestone & calcareous shale
OX MOUNTAINS FAULT COMPLEX		
OX MOUNTAIN METAMORPHIC COMPLEX SLISHWOOD DIVISION		Pelitic and semi-pelitic paragneiss, psammites, schists, gneisses and metabasites/serpentinite.

6.39 When operational, quarry aggregates produced at the site will be independently tested and geologically assessed on an annual basis to confirm that the aggregates are compliant with the requirements of the relevant aggregate quality standards and to ensure that the aggregates are of suitable quality and are fit for purpose including:

- NRA Series 500, 600 and 800 compliant aggregates.
- SR 21:2014 + A1:2016 Annex E. Guidance on the use of IS EN 13242:2002.
- SR 16:2016 Guidance on the use of IS EN 12620:2002 + A1:2008 - Aggregates For Concrete.
- SR 17:2004 Guidance on the use of IS EN 13043:2002 Aggregates for Bituminous Bound Aggregate Products.

Structure

6.40 The bedding thickness within the Dartry Limestone averages 1.0m and the rocks dip from 8° to 20° to the north or northwest.

6.41 One major fault has been identified at Aghamore, trending north-northwest and dipping steeply (80°) to 247° (north-northwest). The fault zone has been solutionally enlarged and is partially infilled with clays.

6.42 Analysis of joint sets exposed on quarry faces indicates that three main joint sets are present. Set one is sub-vertical and dips 76° to 344°, set two and three are almost vertical and dip 89° to 100° and 85° to 256° respectively.

6.43 All joints are typically tight with some having a calcite infill. Rock strength is strong to very strong and weathering is rarely present below the epikarst zone.

Geological Heritage

6.44 Review of available geological heritage literature (McAteer and Parkes 2004) does not list the application site as a Geological Heritage site.

6.45 Consultations were held with the Geological Heritage programme to ascertain if there was any geological heritage value of the rock exposures at Aghamore.

6.46 Arising from consultations, staff working on the IGH Programme have indicated that there may be some interest due to the good quality exposures of the Dartry Limestone and this would be considered when a review of the heritage audit is undertaken in the future. Consideration has been given to this in the proposed restoration plan for the quarry – refer to Figure 2.2.

Economic Geology

6.47 Crushed rock which is extracted from the application site is used to produce standards compliant aggregates which have a wide variety of construction and engineering end-uses including:-

- Structural backfills for specified engineering purposes and sub-concrete fills;
- Road sub-base, base and blacktop (tarmacadam) surfacing;
- General aggregate.

Karstification

6.48 The regional hydrogeological setting is detailed in Chapter 7 Water. This assessment of the presence of karst is based on site visits to examine the existing quarry faces, available public information from GSI, Teagasc etc., a review of the previous and recent APEX geophysical Surveys and the results from the 2020 drilling programme, detailed also in Chapter 7, Water.

6.49 Limestones with a high calcium carbonate ($CaCO_3$) content, are readily dissolved by weak acids such as carbonic acid in rainfall or humic acids derived from agricultural soils. The dissolution and enlargement of discontinuities in the limestone (such as joints, fractures, etc.) over geological time leads to the formation of rock dissolution landforms such as closed depressions (dolines), sinkholes, springs, turloughs and caves.

6.50 Strictly speaking, the term ‘karst’ is applied to areas where surface drainage has been disrupted by underground capture of surface streams by dissolution of the bedrock. A broader definition of the term however includes landscapes where distinctive karst landforms occur as a result of dissolution of the underlying bedrock.

6.51 Dissolution features in karst limestones, whether open or infilled with sediments present significant environmental challenges, particularly with respect to protection of groundwater quality and groundwater fed ecosystems. They also present unique engineering challenges, particularly with respect to slope stability, control of drainage or contamination of high-quality limestone resources.

6.52 A review of the GSI Karst Database (Quarter 2, 2016) indicates that there are no known karst related features in the vicinity of the application site.

6.53 A single spring has been recorded 800m northeast of the site – refer to Chapter 7 Hydrogeology.

6.54 The presence, nature and extent of any karstification at Aghamore Quarry has been separately assessed by inspection of existing quarry faces.

6.55 A clay-infilled solutionally enlarged fracture (fault) has been identified within the existing quarry void – refer to Figure 7.9 for location.

6.56 Examination of quarry faces and the results of the geophysical surveying by APEX indicate that the rockmass at Aghamore is composed of intact, unweathered limestones with no indication of significant karst features.

6.57 APEX Area B (defined in report AGP21007_01) is interpreted as being related to fossil karst, where pre-glacial karst features have been infilled with pre-glacial or glacial sediments and is now inactive.

6.58 Any potential karstic activity in the area is likely to be restricted to the contact between the Dartry Limestone and the underlying Glencar Limestone. This contact has not been located by the APEX surveying and clearly is located at a depth below the survey depth of the geophysical methods and will not be intersected by the proposed quarrying operations.

6.59 A review of the results of the 2020 additional boreholes indicates that all bedrock intervals intersected recorded Total Core Recoveries of 100%, confirming the absence of solution features or cavities in the areas drilled.

6.60 In summary, therefore, no active karst features are present within the existing quarry, geophysical surveying indicates an intact rock mass or the presence of minor inactive karst features and the 2020 drilling did not record any core loss indicating the presence of inactive or active karst in the areas drilled.

IMPACT ASSESSMENT

Evaluation Methodology

6.61 The evaluation of impacts of the of the proposed development is based on a methodology similar to that outlined in the 'Guidelines for the Assessment of Geology, Hydrology and Hydrogeology for National Road Schemes' published by the National Roads Authority (2009) and Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements published by the IGI (2013).

Evaluation of Impacts

Direct Impacts

6.62 The importance of existing land, soil and geology attributes identified at the application site is assessed in **Table 6-2** below:

Table 6-2
Importance of Geological Attributes in Vicinity of Application Site

Attribute	Status / Occurrence	Importance
Geohazards	None identified	Low
Geological Heritage	Excellent exposures of the bedrock sequence at Aghamore are present in the extraction area at Aghamore.	Medium
Economic Geology	The development involves extraction from an area within the existing quarry and deepening of the quarry within the existing quarry area.	Low
Agricultural Soil	The quarry is at its current maximum extent and no further agricultural soils will be removed.	Low

6.63 The magnitude of these impacts on the soil and geology attributes is assessed in **Table 6-3** overleaf:

Table 6-3
Significance of Impacts on Land, Soil and Geology

Attribute	Impact of Proposal on Land, Soil and Geology	Magnitude
Geohazards	n/a	n/a
Geological Heritage	No impact	None
Economic Geology	Direct impact on the existing in-situ bedrock within the proposed extraction area.	Small, negative
Agricultural Soil	Earlier restoration of landform and placement of topsoil / subsoil will restore part of the lands to basic agricultural use.	Small, positive

6.64 There will be no impact on geological heritage in the vicinity of the site.

Unplanned Events (i.e. Accidents)

6.65 It is highly unlikely that any unplanned events within the application site would result in a noticeable impact on the land, soils and geology.

6.66 Adhering to the HSA Safe Quarry Guidelines to the Safety Health and Welfare at Work (Quarries) Regulations 2008 should limit the potential for unplanned events in the form of instability in the quarry faces.

'Do-nothing Scenario' (esp. where deterioration will arise)

6.67 If the proposed recommencement and deepening of Aghamore Quarry is not permitted, the existing void would naturally recolonise with vegetation and water in the quarry void would rebound to its natural level.

MITIGATION MEASURES

6.68 There will be no lateral extension of the quarry and therefore no soil and subsoil is to be removed. The quarry area will be restored following completion of quarrying at the site, refer to Chapter 2 of this EIAR for details of the site restoration plan and on **Figures 2-3**.

6.69 A small area of soil / subsoil material will be removed to enable construction of the proposed settlement lagoon – refer to Figure 2.1. In order to limit the effects of erosion on any excavated soil material the following mitigation measures will be used on site during handling:

- Soil material will be placed in permanent or temporary locations at a safe angle of repose; and
- The re-handling of soil material will be minimised as much as possible in order to preserve the integrity of the soil material; this is also an economically prudent practice.

RESIDUAL IMPACT ASSESSMENT

6.70 Based on the impact assessment and existing mitigation measures described above, there will be no residual impact on land, soils or geology as a result of this proposed development.

REFERENCES

GSI, 2007, 1:100,000 Bedrock Geology of Ireland (Digital-Map).

Institute of Geologists of Ireland (2013) 'Guidelines for the preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements'.

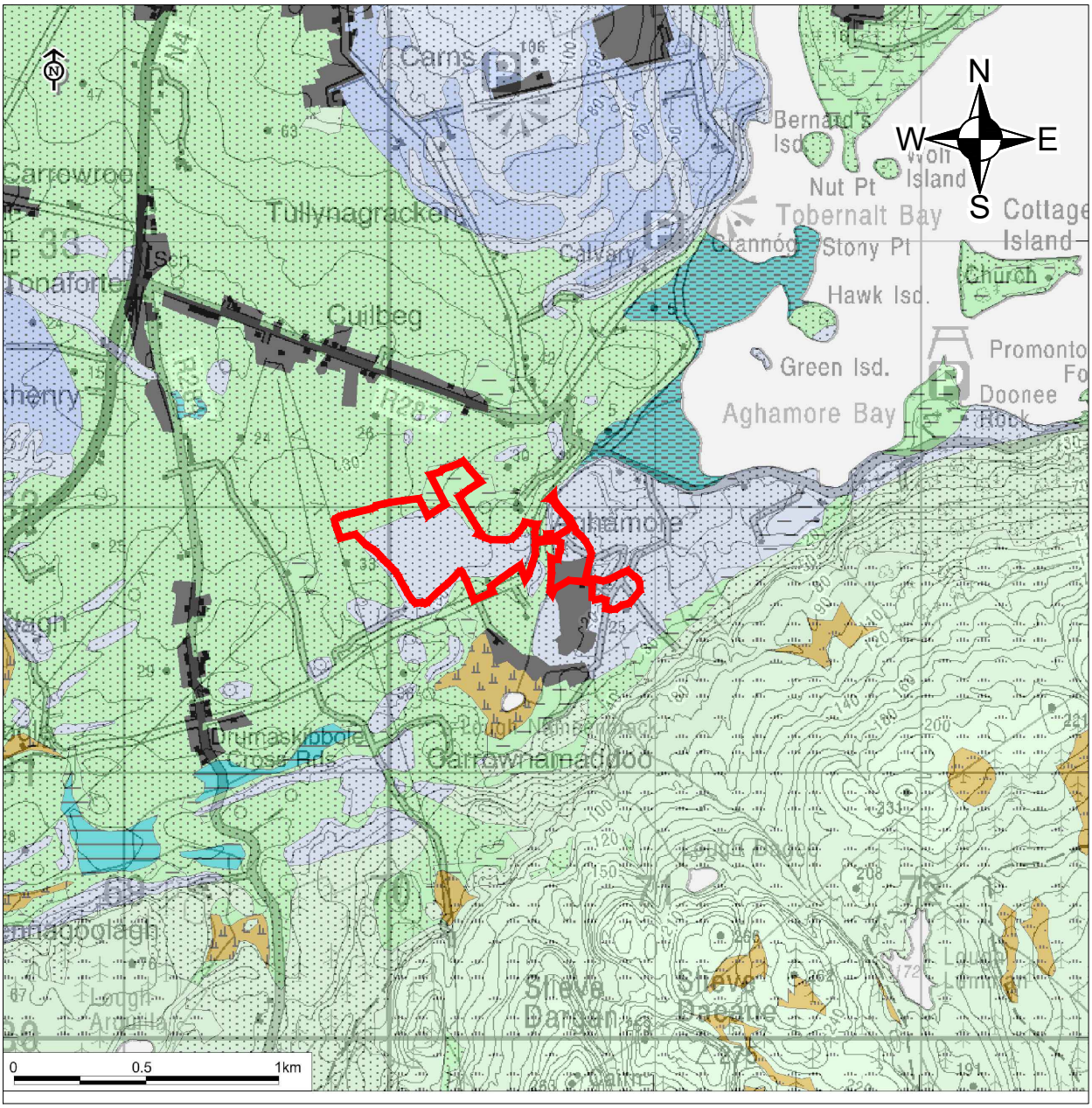
MacDermot, C.V., Long, C.B. and Harney, S.J. 1996. A geological description of Sligo, Leitrim, and adjoining parts of Cavan, Fermanagh, Mayo and Roscommon, to accompany the Bedrock Geology 1:100,000 Scale Map Series, sheet 7, Sligo-Leitrim, with contributions by K. Claringbold, D. Daly, R. Meehan and G. Stanley. GSI, 99pp.

McAteer, C. and Parkes, M. 2004 The Geological Heritage of Sligo. Geological Survey of Ireland Publication.

Teagasc, 2004, Ireland Subsoil Parent Materials Map (digital version).

Teagasc, 2007, Ireland Soils Map (digital version).

FIGURES



TEAGASC SOIL MAPPING

IFS SOIL TYPE

- Blanket Peats
- Cutaway and Cutover Peat
- Lacustrine Sediments
- Alluvium - Mineral
- Acid Brown Earths and Brown Podzolics
- Grey Brown Podzolics and Brown Earths
- Lithosols and Regosols
- Renzinas and Lithosols
- Surface Water Gleys derived from non-calcareous parent
- Surface Water Gleys derived from calcareous parent
- Peaty Podzols, Lithosols and Peats derived from non-calcareous parent
- Made Ground

PLANNING APPLICATION AREA

0 800m 2000

Metres 1:25,000

1. ORDNANCE SURVEY IRELAND LICENCE NO. CYAL50167032 (C) ORDNANCE SURVEY IRELAND / GOVERNMENT OF IRELAND
2. EXTRACT FROM TEAGASC SOILS MAPPING

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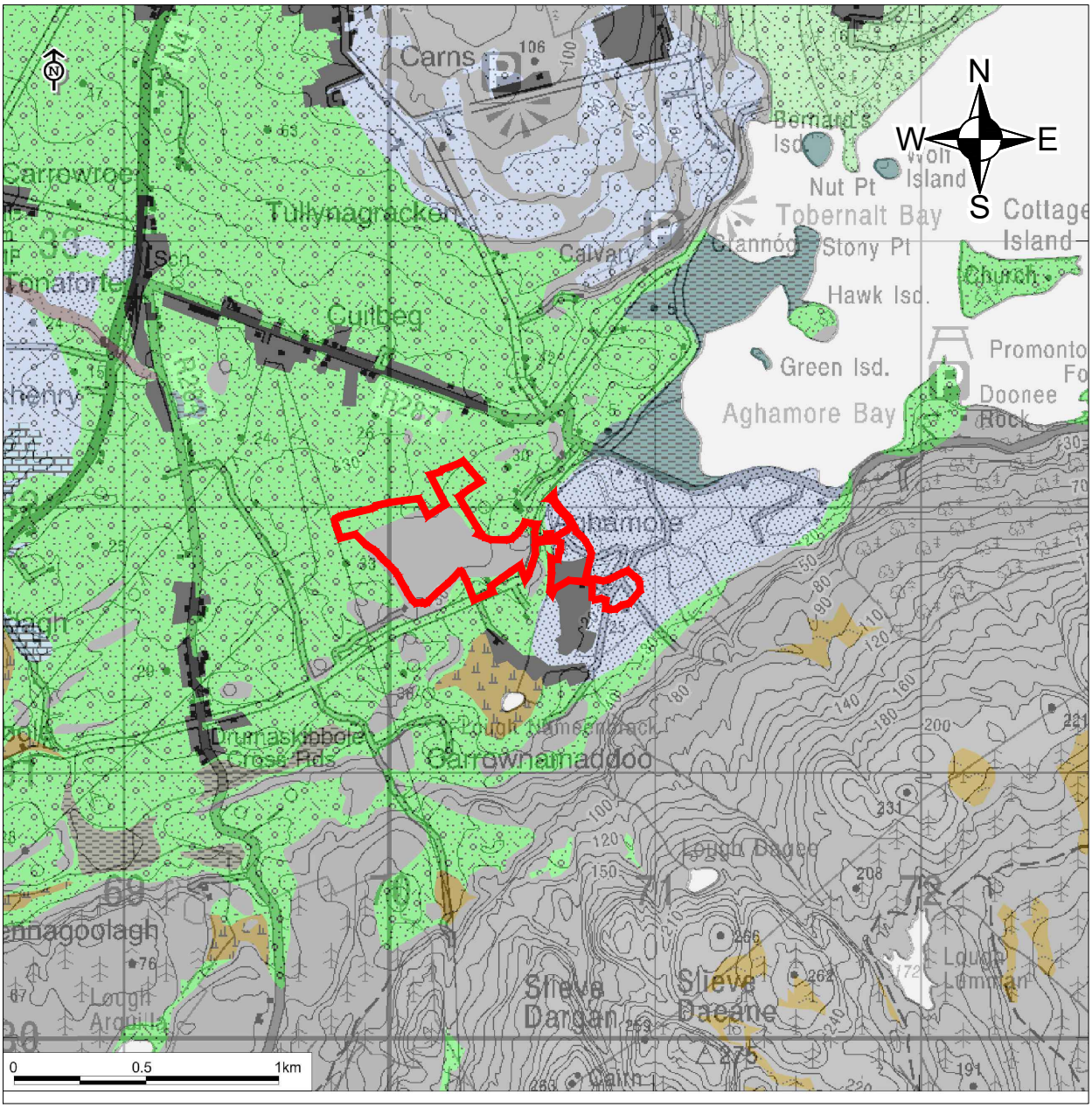
SOILS MAPPING

FIGURE 6.1

Scale	Date
1:25,000 @ A4	MAY 2021

501.00584.00019.EIAR Figure 6.1 SOILS.Rev.0.dwg



Teagasc Subsoil Mapping
Parent Material Type

- Blanket Peat
- Cutover Peat
- Alluvium
- Lacustrine Sediments
- Sand and Gravel - Carboniferous Limestones
- Till - Namurian Clasts
- Till - Carboniferous Limestone
- Till - Metamorphics
- Limestone Bedrock
- Outcrop & Subcrop
- Made Ground

PLANNING APPLICATION AREA

1. ORDNANCE SURVEY IRELAND LICENCE NO. CYAL50167032 (C) ORDNANCE SURVEY IRELAND / GOVERNMENT OF IRELAND
2. EXTRACT FROM TEAGASC SUBSOILS MAPPING

0 800m 2000

Metres 1:25,000

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SUBSOILS MAPPING

FIGURE 6.2

Scale	Date
1:25,000 @ A4	MAY 2021

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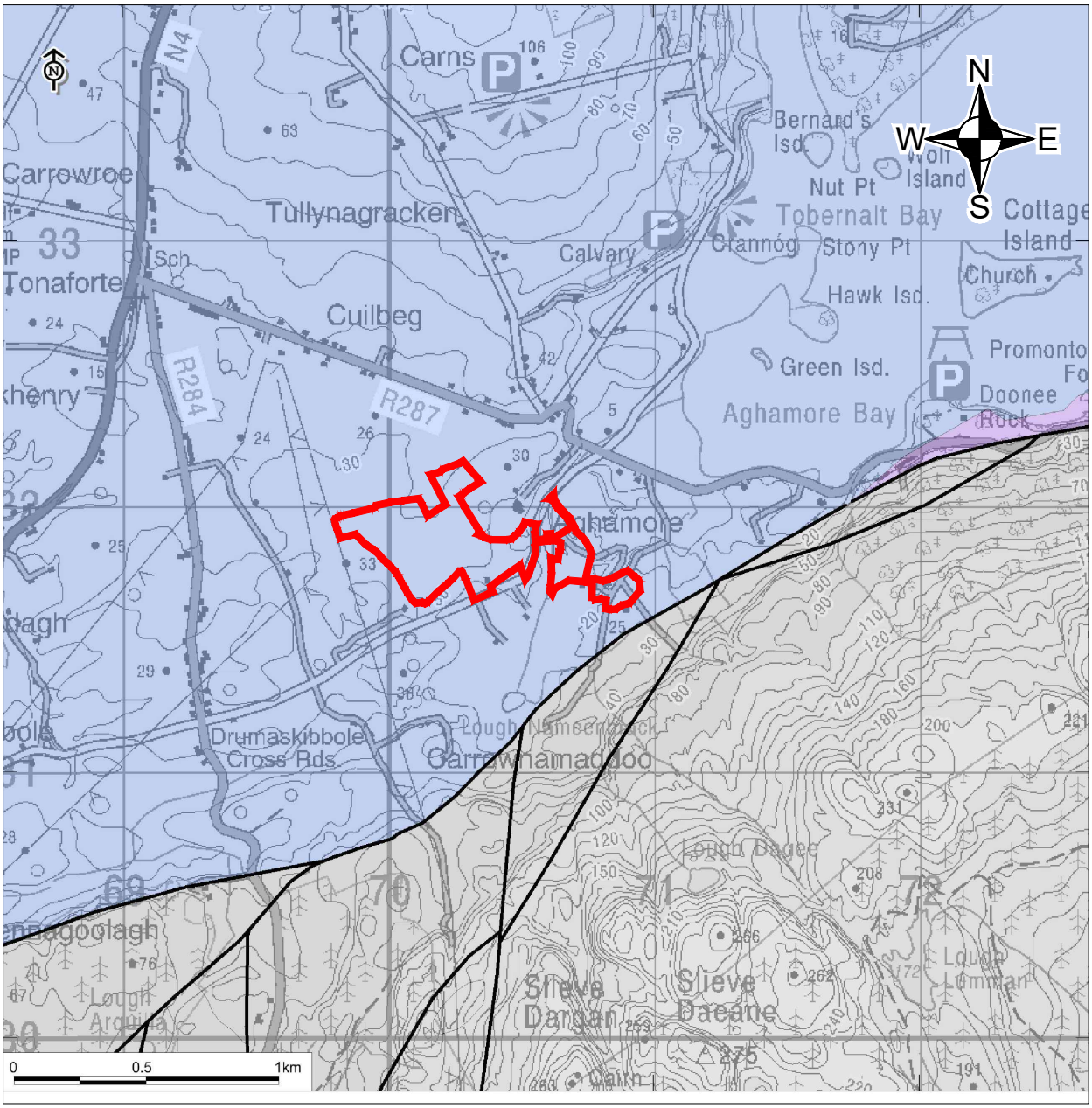

Aghamore Area
Bedrock Geology Units

- Dartry Limestone Formation
- Mudbank limestone
- Ox Mountain Metamorphic Complex

PLANNING APPLICATION AREA

1. ORDNANCE SURVEY IRELAND LICENCE NO. CYAL50167032 (C) ORDNANCE SURVEY IRELAND / GOVERNMENT OF IRELAND
2. EXTRACT FROM GSI BEDROCK GEOLOGY MAPPING

0 800m 2000

Metres 1:25,000

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BEDROCK GEOLOGY

FIGURE 6.3

Scale	Date
1:25,000 @ A4	MAY 2021

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