CHAPTER 7

LAND, SOILS AND GEOLOGY

QUARRY CONSULTING

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CHAPTER 7: Land, Soils and Geology

Introduction

7.1 This 'Land, Soils and Geology' (LSG) chapter of the Environmental Impact Assessment Report (EIAR) has been prepared for an extension in depth of a northern portion of an existing working quarry at Cregaree, Cong, Co. Mayo.

7.2 The existing operational limestone quarry extraction covers an area of approximately 62.45 hectares, with details of the site layout shown on EIAR Figure 1.2.

7.3 The lowest point on the existing permitted quarry floor is -5 mOD, which is in the southern section of the quarry (Pre-63). This area is permitted to -50m OD.

7.4 The development will consist of the deepening of 19 ha. of the northern portion of the existing permitted quarry extraction area (Plan File Ref. No. 20/77: ABP-308748-20 & Plan File Ref. No. PL16.SU0132: QD16.QD0009) from an elevation of +5 mOD to a proposed completion elevation of -12 mOD.

7.5 There is an east to west trending exposed wall of limestone, with no evidence of conduits, between the current floor elevation in the southern permitted area of the site and the proposed continued excavation area in the northern part of the site.

7.6 Haulage of material to existing static plant within the main quarry for processing. All associated ancillary facilities/works. Landscaping and restoration of the site. Further details on The Proposed Development were provided in Chapter 3.

7.7 This chapter of the EIAR presents the baseline land, soils and geological environment and then assesses potential impacts, assigns mitigation measures and then reassesses the potential residual impacts. Potential cumulative impacts are also addressed.

7.8 As stated throughout this EIAR, the assessments have been completed in accordance with the EU EIA Directive 2011/92/EU, as amended by EIA Directive 2014/52/EU and the European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018, in order to inform the consideration of the Application and provide the planning authority with the environmental information that must be considered when determining the Application.

7.9 Chapter 1 of the EIAR has confirmed that the Proposed Development, within the quarry, is entirely within the administrative boundary of Mayo County Council (MCC) and the EIAR is being provided to MCC as part of a planning application seeking full planning permission.

7.10 The applicant, McGraths Limestone, the application site, contributors to this EIAR and other pertinent details were previously presented in Chapter 1 and Chapter 3 of this chapter.

7.11 This Lands, Soils & Geology (LSG) assessment and chapter of the EIAR has been completed by Dr. Pamela Bartley (Hydro-G), who was also the field assessor and author of the Water Chapter of this, and previous, EIARs for the McGraths Cong quarry. The potential risk of groundwater interception in the areas of land surrounding the application site led to a strong hydrogeological, Water Chapter, focus for the Environmental Impact Assessment for the proposal to deepen the northern part of this quarry.

7.12 During previous planning authority determinations for the site, the Board granted permission in 2017 (QD16.QD0009) for a "Stage 1 to a depth of +5mOD" and advised that should the experience of the extraction concur with the Impact Assessments conclusions of No Potential for Impact, then the "Stage 2 to a depth of -12mOD" could be considered at a

later date, subject to the extraction of the first Stage proceeding as per the Impact Assessments presented.

7.13 This is now the later date and it is time to again present the Stage 2 part of the development because the progression to +5mOD progressed without incident. Almost ten years have passed since the commencement of extraction of the current permission. It is now time to secure resources for the region for the period 2027 and onwards. It takes time to progress through the planning process understanding that it takes years to progress through the evaluation process.

7.14 The important thing to note is that at the time of the 2017 Grant of planning the information presented to the competent planning authorities included the Site Investigations for the depth of rock excavation through the two Stages and to the elevation of -12m OD. Historic applications have been accompanied by an Environmental Impact Statement (EIS), Natura Impact Statement (NIS) and Further information in relation to European sites.

7.15 Therefore, the historic body of works informing previous Environmental Impact assessments and reporting contains the Site Investigation details and Impact Assessments for the proposal to bring the Floor to the final completion elevation of -12m OD.

7.16 The Impact Assessment presented here relies on historic intrusive Site Investigations, for drilling, coring, response tests and monitoring, and is updated with site monitoring data collected in the interim.

7.17 This LSG Impact Assessment has applied the most recent guidance from the EPA (2022) in the presentation of information in an EIAR and application of Impact Assessment.

Study Methodology

7.18 The objectives of this assessment, as per the EIA Directive (2014/52/EU) and EPA Guidance (2022), include as follows:

(i) Use publicly available resources and historical site-specific literature to characterise the baseline land, soils and geological conditions for the site.

(ii) Update this information using additional site investigation work (*e.g.,* drilling) and analysis.

(iii) Assess the potential impact of the proposed development on the LSG environment.

(iv) Specify appropriate mitigation measures for any identified potential impacts, as deemed necessary. The proposed development works, impacts and mitigation measures will then be reassessed, and residual impacts defined.

Statement of Expertise

7.19 The evaluation of the Water (hydrological and hydrogeological) environment and the assessment of Effects and Potential Impacts, with Mitigation Measures and Remedial Impacts, was completed by Dr. Pamela Bartley (Hydro-G) who is considered a karst groundwater specialist with quarry, Section 4 Discharge Licencing and Public Water Supply expertise.

7.20 Pamela Bartley's Statement of Expertise is presented as **Appendix 8.1, of the Water Chapter.**

7.21 This Lands, Soils & Geology Chapter and the Water Chapter were created by the same professional civil engineering hydrogeologist, who has soils, geology, hydrological and groundwater competency.

7.22 Hydro-G holds the required Professional Indemnity Insurances, Employers and Public Liability Insurances.

Legislative Instruments & Planning Guidance

7.23 This Lands, Soils and Geology assessment was prepared with consideration of European legislation, Irish Regulations and Guidance, listed as follows:

(i) Mines and Quarries Act (S.I. No. 7 of 1965).

(ii) S.I. 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).

(iii) The Planning and Development Acts, 2000, as amended.

(iv) 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. No. 685 of 2006.

(v) EIA Directive (2014/52/EU) of the European Parliament and of the Council of 16 April 2014, amending Directive 2011/92/EU, on the assessment of the effects of certain public and private projects on the environment.

(vi) S.I. No. 473 of 2011, European Union (Environmental Impact Assessment and Habitats) Regulations 2011 and S.I. No. 584 of 2011, European Union (Environmental Impact Assessment and Habitats) (No. 2) Regulations 2011.

(vii) Geology in Environmental Impact Statements. Institute of Geologists of Ireland (2002) & Guidelines for the Preparation of Soils, Geology & Hydrogeology Chapters of Environmental Impact Statements. Institute of Geologists of Ireland (2013).

(viii) Quarries and Ancillary Activities: Guidelines for Planning Authorities. Department of Environment, Heritage and Local Government (2004) & Environmental Management Guidelines for the Extractive Industry (Non-Scheduled Minerals). Environmental Protection Agency (2006).

(ix) Reclamation Planning in Hard Rock Quarries. Department of Civil & Structural Engineering, University of Sheffield and Edge Consultants, Mineral Industry Research Organisation (2004) & A Quarry Design Handbook. GWP Consultants and David Jarvis Associates Limited, UK (2014).

(x) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes. Transport Infrastructure Ireland (undated, c. 2009). https://www.tii.ie/technical-services/environment/planning/Guidelines-on-Procedures-for-Assessment-and-Treatment-of-Geology-Hydrology-and-Hydrogeology-for-National-Road-Schemes.pdf

(xi) Environmental Impact Assessment of Projects. Guidance on the preparation of the Environmental Impact Assessment Report (Directive 2011/92/EU, as amended by 2014/52/EU. European Union (2017).

(xii) Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment. Department of Housing, Planning and Local Government (2018).

(xiii) Guidelines on the Information to be contained in Environmental Impact Assessment Reports. Environmental Protection Agency (2022).

(xiv) Mayo County Development Plan 2022-2028.

Consultations

7.24 Quarry Consulting managed the Consultation process of this development proposal.

7.25 With respect to National Agency responses to consultation communication, the response from the GSI is of importance to the LSG assessment. The Geological Survey of Ireland (GSI) responded on the 5th of July 2024 (their Ref: 24/217) with a 5 page detailed cross referencing of important considerations and resources available to the applicant.

7.26 A full copy of the GSI's Response to Scoping is presented as **Appendix 7-1**.

7.27 Hydro-G hereby confirms that all data, maps and report GSI resources listed in the scoping response have been included in the assessment.

7.28 The GSI requested that the operator might assist the GSI's geological heritage goals with the following (and ideally this would be written into the restoration / closure plan) and be included as a condition of planning as deemed appropriate by the planning authority:

(1) Should development go ahead, all other factors considered, Geological Survey Ireland would much appreciate a copy of reports detailing any site investigations carried out. Should any significant bedrock cuttings be created, we would ask that they will be designed to remain visible as rock exposure rather than covered with soil and vegetated, in accordance with safety guidelines and engineering constraints.

(2) In areas where natural exposures are few, or deeply weathered, this measure would permit on-going improvement of geological knowledge of the subsurface and could be included as additional sites of the geoheritage dataset, if appropriate. Alternatively, we ask that a digital photographic record of significant new excavations could be provided. Potential visits from Geological Survey Ireland to personally document exposures could also be arranged.

Impact Assessment Methodology (EPA, 2022)

7.29 In addition to adhering to "Guidelines on the Information to be contained in Environmental Impact Statement Reports" (EPA, 2022), the Lands, Soils and Geology assessment was completed in accordance with "Geology in Environmental Impact Statements, a Guide" (IGI, 2002), and "Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements" (IGI, 2013). In addition, "Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes" (NRA, 2009) is referenced where the methodology for assessment of impact is appropriate.

7.30 The procedure for determination of potential impacts on the receiving land, soil and geological environment is to identify potential receptors within the site boundary and surrounding environment and use the information gathered during the desk study and field work to assess the degree to which these receptors will be impacted upon.

7.31 Criteria for assessing importance of site attributes and their magnitude of importance were taken from the NRA Guidelines (NRA, 2009) (as included in 'Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements' (IGI, 2013)).

7.32 The rating of potential environmental impacts on the land, soils and geology environment is based on the quality, significance, duration and type of impact characteristic identified. Consideration is given to both the importance of an attribute and the magnitude of the potential environmental impacts of the proposed activities on that cited attribute.

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

7.33 An impact rating has been developed for each of the phases of the proposed development based on the Institute for Geologists Ireland Guidance for the preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements (IGI, 2013).

7.34 In line with the IGI Guidance the receiving environment (Geological Features) was first identified.

7.35 The NRA rating criteria Tables of Appendix C of the IGI Guidance are presented as Appendix 7-2 to this assessment: the importance of the geological features Impact Table is followed by the Impact Table for estimation of the magnitude of the impact. This determines the significance of the impact prior to application of mitigation measures as set out in Table 7-3. Refer to Appendix 7-2 accompanying this assessment.

7.36 The assessments completed in this Section of the EIAR considered phases as follows:

(i) Construction Phase.

(ii) Operational Phase.

(iii) Landscaping, Restoration, Decommissioning & Aftercare.

Existing Environment

7.37 Desktop mapping and published information were employed to describe the land, soils, underlying quaternary and bedrock geology, areas of geological heritage, areas of economic interest with respect to geological resources and potential for soil contamination.

7.38 Desk study site information resources employed include, as follows:

- EPA mapping for land and geology https://gis.epa.ie/EPAMaps/.
- GSI On-line Groundwater database. Teagasc Soil, GSI Subsoils, Bedrock Classifications and Geoheritage Reporting https://dcenr.maps.arcgis.com/apps/MapSeries/.
- GSI (2003, 2005) Bedrock Geology Sheets 11, 14 & 15, 1:100,000 Map Series. Geological Survey of Ireland.
- Ordnance Survey of Ireland, 1:50,000 Discovery Map Series.
- Google Earth Pro Historic Photography series.
- EIA portal (https://housinggovie.maps.arcgis.com/).
- An Bord Pleanála files for the site.

- Previous EIARs created for applications for the site. Previous Permissions associated with the site are listed in the introductory sections of this EIAR.

7.39 In addition to national datasets and desktop available published information, this section also presents an overview of the significant body of historic site investigations at the site and the results of the current site investigation works, completed between 2015 to present in order to support the development of the baseline environment.

7.40 Desk study, historic and current site investigation results were then used to complete the Impact Assessment, identification of required mitigation measures and presentation of residual effects, if found.

7.41 There are many Geoheritage sites located in proximity to the development. They are all water related: Lough Mask, Lough Corrib, Cong Springs and Pigeon Hole and Curreighnabannow Spring.

7.42 The Geoheritage sites are of relevance to the Water Assessment rather than the LSG assessment. Therefore, the Water Chapter assesses those features.

Site Location & Topography

7.43 As described in more detail in Chapter 3 of this EIAR, the site is located within the townland of at Cregaree, Cong, Co. Mayo.

7.44 The centre of the application area is c. 2.5 km to the south west of Lough Mask and c. 2km to the north of Lough Corrib. The Cong Canal runs outside and along the quarry's eastern boundary. The water features are all described in the accompanying Water Chapter of this EIAR.

7.45 The quarry is located on the north-western outskirts of Cong village, north of the R345 road to Clonbur, and immediately west of the Cong Canal. Most of the quarry is in County Mayo.

7.46 A small part of the quarry, essentially its surface water discharge point, is in County Galway.

7.47 The site is located to the north of the R345 from which access is provided via a private access road, approximately 35m in length. Access to and from the quarry is via single site entrance.

7.48 The application site and regional topography are presented as **Figure 7-1**.

7.49 The application site and local topography are presented as **Figure 7-2**.

7.50 The natural land surface elevation of the entire quarry lands before excavations took place there was approximately 24m OD to ~20m OD. Indeed, the line of Longitude joining Lough Mask, the quarry and Lough Corrib has a land surface elevation of ~20m OD across the entire isthmus between Lough mask and Lough Corrib. There are a few small dips in the land immediately south of the quarry. There are a few small mounds north and west of the quarry but nothing significant. Land drops steeply south of Cong, in the vicinity of the shore of Lough Corrib. The pre-development elevation of the application site was c. 20m OD but it was granted in previous permissions to quarry to 5m OD (PL 16.SU0132; QD 16.QD0009; Mayo County Council Plan Ref. File No. 20/77; ABP Ref: ABP-308748-20).

7.51 The site sits on a land bridge, or isthmus, of limestone between two large lakes: Lough Mask to the north and Lough Corrib to the south.

7.52 The northern boundary of the quarry is 2.5 km south – southeast of Lough Mask's south eastern shores.

7.53 Cong village is 0.25km, approximately, to the south east of the quarry's southern boundary.

7.54 The centre of the quarry is 2km, approximately, north of Lough Corrib.

7.55 The land area focus of this application is the northern part of the quarry, which is part of the overall landholding of McGrath's quarry at Cregaree, Cong, Co Mayo. It is also a small part of the regional geological resource. Overall, the McGrath Quarry area is c. 64 hectares.

7.56 The application area is c. 19 ha. The 'isthmus' of limestone land between Lough Mask and Lough Corrib, in which the quarry is situated, has a total area of 8,000 hectares, approximately.

Land Use

7.57 As previously stated, according to the County Development Plan (refer to separate Planning Report submitted with the application) the site lies in an area which is zoned as a Rural General area and is not apparent within any designated scenic Views or Prospects.

7.58 There are no Prime Special Amenity or Secondary Special Amenity areas designated at the site. Agriculture and forestry are the land uses. There are a sparse number of one-off houses locally.

7.59 Land use in the vicinity of the site predominantly involves agriculture with interspersed forestry and one-off houses – refer to EIAR Chapter on Population and Human Health.

7.60 Agricultural land occurs to north and west of the site, and forestry occurs to the south. There are homes along the road the other side of the Cong Canal, to the east.

7.61 A recent history of activities on, and in the vicinity of, the application area was gained from aerial photography and historical mapping and is summarised in Table 7-4.

Table 7-4 Historical Land-Use at the Site and its Surroundings

Ordinance Survey Map Reference & / or dates	On Site	Immediate Surroundings
OS 6 inch colour (1837-1842)	The site is mapped as limestone pavement bare rock outcrop.	There are dwellings in the Cregaree area.
OS 6 inch Cassini (1845)	The site is mapped as limestone pavement bare rock outcrop.	There are dwellings in the Cregaree area. Royal Rock is mapped to the west.
OS 25 inch Historic (1888-1913)	No change from above	
Aerial Imagery 1995	The quarry has been well established in the southern part of the site.	New dwellings have been established around the site.
Aerial Imagery 2001	Perimeter access internal roads built	No obvious change in the vicinity of the site.
Aerial Imagery 2006	Substitute Consent Area Obvious.	No change in the vicinity of the site.
Aerial Imagery 2012 - 2024	Land reclamation to the north, expansion of quarrying activities.	No change in the vicinity of the site.

Soils, Subsoils, Geological Mapping

7.62 Teagasc soil mapping is presented as **Figure 7-3**, which indicates that the application site used to be covered in 'BminSW' soils but Bedrock at surface-Calcareous exposed bedrock (RckCa) are now mapped by the GSI for the site.

7.63 GSI mapping for quaternary sediments (subsoils) is shown as **Figure 7-4**, which shows that 'KaRck' or 'karstified bedrock outcrop or subcrop' is mapped as the subsoil for the site.

7.64 GSI mapping for bedrock is shown as **Figure 7-5**. The Geological Survey of Ireland (www.gsi.ie) bedrock map of the region shows that the site is underlain by Dinantian Pure Bedded Limestones of the Carboniferous period. This type of limestone comprises the Cong Limestone Formation (CO) directly underneath the site BUT the Cong Canal Formation (NL) is in a 'C' shape around the CO formation of the site. The NL formation bounds the southern shores of Lough Mask, where all the swallow holes are, and also immediately south of the site and in the vicinity of Cong, where all the spring discharges and caves are mapped.

7.65 The GSI website mapping system shows the contact between two limestone formations, immediately south of the site and in the vicinity of Cong. The boundary between the two limestones is very significant because this boundary between the two limestones is the west to east orientated line along which there are many mapped karst features (caves) and springs discharging. This means that the limestone bedrock differentiation on the paper version of the GSI Sheet 11 1:100,000 scale map, immediately south of the site and in the vicinity of Cong, is validated by springs discharging on the ground. Refer to Plate 7-1.

7.66 The information presented in Plate 7-1 illustrates the differentiation between the Cong Formation (CO) limestone, which underlies the quarry, and the Cong Canal Formation (NL) that holds all the karst features: the swallow holes on the southern shores of Lough mask and the output points are all in the NL, rather than in the quarry's CO formation. Image taken from GSI, 2015 (www.online mapping) with annotations by added for purposes of clarity by the author of this chapter.

7.67 The type of Carboniferous Limestone bedrock underlying the quarry can therefore be confidently described as a virtually impermeable material, in its unfractured state, that is not as prone to karstification as the 'C' ring of the Cong canal (NL) limestone formation. The spring discharges line is along the point of contact with the two types of limestone and this suggests that most of the water flowing underground from Lough Mask's southern shore swallow holes to this line of springs and to Lough Corrib is part of a very deep groundwater system that is most probably 30 – 40m below sea level (Drew D., pers. Comm., 2015).

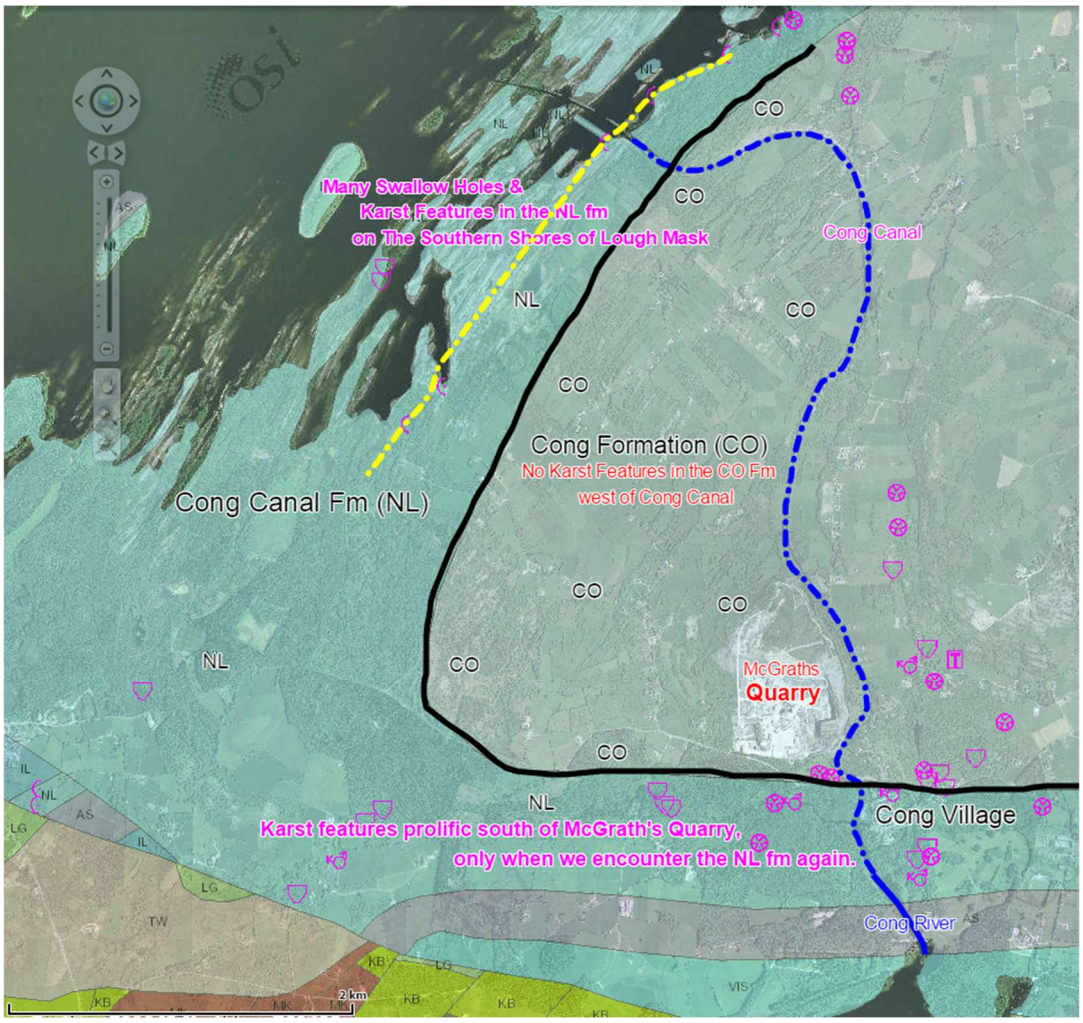

Plate 7-1 Geological Formations (annotated by Hydro-G)

7.68 As a result of the poor glacial cover in the general area of Cong, large areas of exposed limestone exist, especially moving to the north towards Lough Mask. The shallow limestones are karstified and shallow water flow occurs within the epi-karst. Regional groundwater flow (from north to south from Lough Mask to Lough Corrib) is controlled by karst conduits systems. Core hole data reported by Dr. John Colthurst (2014) for five deep cored holes at the quarry shows with certainty that site is underlain by pure bedded limestones to a depth of at least 180m below sea level (Core Hole A in the southern part of the quarry) and at least 50m below sea level at other core hole locations.

7.69 In the five core holes historically drilled across the entire site almost 100% Total Core recovery was achieved, which indicates no karst and no weathered zones. No significant karst water strikes were recorded by either core hole or other drilling explorations at the site. Epikarst water was encountered. The significance of this is that the bedrock is solid.

7.70 It has previously been reported by another hydrogeologist (Gill, 2014) working on the Ashford castle site, just south of this quarry and the village of Cong, that "*McGraths limestone quarry provides an excellent cross-section view of the limestone bedrock of the area. Of note from the quarry inspection is the following:*

- *There is no, or limited overlying soils or subsoils;*
- *The epi-karst is relatively shallow;*
- *The underlying limestone is massive, thickly bedded, and has limited seepages, and no significant evidence of conduit inflows, i.e. large block of solid limestone within the aquifer have no major fractures, fissures or joints systems that are capable of transmitting any groundwater;*
- *The beds are dipping to the north at a shallow angle of ~3°;*
- *There is a north-south nested vein structure to the east of the quarry but this does not appear to transmit groundwater in any quantity; and,*
- *The quarry floor is significantly below the invert of the Cong canal (which was transmitting surface water flow on the day of the inspection), but the intermediate massive limestone isolates the quarry from the canal flows. Again, this indicates a large block of solid limestone through which there is limited to no groundwater flow."*

Aggregate Potential

7.71 The GSI maps the site in the 'Very High' Potential for Crushed Rock Aggregate in County Mayo.

Geohazard Mapping

7.72 The site is mapped by the GSI as an Active Quarry.

7.73 No Landslides are mapped at or near the site.

7.74 The site is not mapped as having any landslide susceptibility.

Site Investigations - Drilling Results

7.75 All boreholes drilled on site are shown in Figure 7-6.

7.76 Five deep cored cores were completed at the site in 2014. The diameter of the drill cores were standard NQ size and continuous drill core were collected from sub-crop to the end of the drillhole. Details for the Core Holes are presented as Table 7-5.

Table 7-5 Deep Core Holes drilled across the application site and in the southern area.

Core Hole ID	Easting	Northing	2014 Ground Level (mOD)	Total Depth of BH (m bGL)	Exploration Depth Base Elevation (m OD)	Colthurst Notes on Drilling	Date Drilled	General Location Information
A	514033	756591	19.309	202	-182.691	The limestone is a solid mass of pure product with no weathered zones or water bearing routes.	May-14	In Southern Pre-63 Area
B	514280	755825	-5.525	85.2	-90.725		May-14	In Northern Application Area on on immediate boundary.
C	514324	756160	9.476	61.2	-51.724		May-14	
D	513945	756265	12.089	64.2	-52.111		May-14	
E	514259	756503	16.632	67.2	-50.568		May-14	

7.77 At five locations in the landholding the cores (B – E) were to a depth of 65 to 85 meters below ground level except one which was to a depth of 220 meters (Core Hole A). Four of these deep cored holes are in the current application area, or on its outer boundaries, and one of the cored holes is in the deepest part of the 'Pre-63' area of the quarry.

7.78 Examination of the descriptions of the deep cored holes that were drilled in and around the application area suggested that the limestone is a solid mass of pure product with no weathered zones or water bearing routes.

7.79 There was no change in bedrock formation that would suggest conduit connectivity between Lough Mask & Lough Corrib.

7.80 Additional drilling was conducted at many other locations across the entire site to thoroughly evaluate the potential for intersection with karst features in the subsurface within and on the peripheries of the application area. The deeper subsurface was explored for evidence of karst conduits that might be traversing underneath the entire site.

7.81 Locations chosen for drilling targeted routes mapped by the GSI as possible tracer line links between Lough Mask and the springs south of the quarry. It is understood that the conduits cannot be straight lines, as mapped by the GSI, who draws the lines indicatively straight between the point of tracer injection to the subsurface and the downstream point of detection at the surface. Therefore, the drilling programme also followed weathered zones in exposed faces down gradient of a drilling location, the obvious calcite veins throughout

the quarry floors and walls and the known north-south orientations of geological significance (Moore & Walsh, 2013).

7.82 Twenty Two Site Investigation boreholes were supervised by Hydro-G in the current application area. A summary record for the blast-rig probe holes are presented in Table 7-6.

Table 7-6 Hydro-G Application Area Drill Locations, Depths and Base of Hole Elevations

BH ID	Easting	Northing	2014 Ground Level (mOD)	Total Depth of BH (m bGL)	Exploration Depth Base Elevation (m OD)	Hydro-G Notes on Subsurface	Date Drilled
1	514071	756608	18.272	34	-15.728	Competent Bedrock, no cracks, no changes in drilling rig response, no moisture, no clays, no sands, no evidence of weathering or conduits, no water, Solid Pure Limestone DUST Returned.	06/08/2014
2	514129	756618	16.345	34	-17.655		06/08/2014
3	514152	756675	15.607	34	-18.393		06/08/2014
4	514161	756642	15.529	34	-18.471		07/08/2014
5	514159	756520	18.73	34	-15.27		07/08/2014
6	514062	756514	21.583	34	-12.417		07/08/2014
7	531963	756427	22.267	34	-11.733		07/08/2014
8	513951	756426	22.643	34	-11.357		07/08/2014
9	513982	756451	21.428	34	-12.572		07/08/2014
10	513922	756389	23.77	34	-10.23		07/08/2014
11	513974	756306	23.72	34	-10.28		07/08/2014
12	513980	756308	23.535	34	-10.465		07/08/2014
13	513981	756304	23.763	34	-10.237		08/08/2014
14	513982	756299	23.827	34	-10.173		08/08/2014
15	513983	756294	23.823	34	-10.177		08/08/2014
16	514112	756382	21.78	34	-12.22		08/08/2014
17	514135	756415	20.498	34	-13.502		08/08/2014
18	514117	756430	17.6	34	-16.4		08/08/2014
19	514306	756462	15.627	34	-18.373		08/08/2014
20	514353	756404	16.738	34	-17.262		08/08/2014
21	514353	756390	17.051	34	-16.949		08/08/2014
22	514369	756172	19.663	34	-14.337		01/09/2014

7.83 The significance of the closely spaced borehole site investigation drilling results for the application area is that there was no evidence of conduits in the entire profile drilled to base of holes a deepest elevation of -c. 18m OD.

7.84 In addition to 22 the Site Investigation Blast Hole drill rig probe holes within the application area, Hydro-G supervised a further 21 blast-rig probe holes in the wider quarry area. Details for these locations are shown in Table 7-7.

Table 7-7 Hydro-G Application Area Drill Locations to the south of the application area.

BH ID	Easting	Northing	2014 Ground Level (mOD)	Total Depth of BH (m bGL)	Exploration Depth Base Elevation (m OD)	Hydro-G Notes on Subsurface	Date Drilled
23	514459	755867	21.203	34	-12.797	Competent Bedrock, no cracks, no changes in drilling rig response, no moisture, no clays, no sands, no evidence of weathering or conduits, no water, Solid Pure Limestone DUST Returned.	01/09/2014
24	514285	755843	-5.713	34	-39.713		02/09/2014
25	514302	755876	1.602	34	-32.398		02/09/2014
26	514266	755907	-5.601	34	-39.601		02/09/2014
27	514287	755935	-5.878	34	-39.878		02/09/2014
28	514356	755950	-6.088	34	-40.088		02/09/2014
29	514353	755963	-5.642	34	-39.642		02/09/2014
30	514337	755964	-5.787	34	-39.787		02/09/2014
31	514233	756021	14.653	34	-19.347		03/09/2014
32	514227	756054	13.097	34	-20.903		03/09/2014
33	514212	756073	12.96	34	-21.04		03/09/2014
34	514234	756108	12.321	34	-21.679		03/09/2014
35	514314	756118	10.687	34	-23.313		03/09/2014
36	514321	756121	10.546	34	-23.454		03/09/2014
37	514298	756113	11.093	34	-22.907		03/09/2014
38	514199	756129	12.292	34	-21.708		03/09/2014
39	514185	756091	12.738	34	-21.262		03/09/2014
40	513995	756186	12.75	34	-21.25		04/09/2014
41	513985	756057	22	34	-12		04/09/2014
42	513866	755881	14.108	34	-19.892		04/09/2014
43	513906	755874	14.845	34	-19.155		04/09/2014

7.85 When the 5 core holes, 22 SI holes in the application area and the 21 more holes to the south of the application area are considered, information presented demonstrates that for 48 locations at the quarry, bedrock was explored to a depths of 5m to 175m below the -12m OD proposed depth of excavation. No evidence of any mechanism for weakness or groundwater flow was found.

7.86 In overall conclusion, drilling results suggest that the bedrock is spectacularly competent, pure and a high value resource that can safely be extracted without risk, as per the Objectives of the County Mayo Development Plan (2022 – 2028).

Cross Sections Arising from SI Drilling

7.87 'Section Lines' drawings are presented as A1 size paper printout drawings P1310-1 and P1310-2 in accompaniment to this EIAR, which is the appropriate scale for consideration, as are the actual cross sections generated which demonstrate justification for deepening the quarry. They provide the reference for the cross sections through the quarry for the DWG series P1310-3 to P1310-5.

7.88 For ease of textual reference in this report, Plate 7-2 reproduce the P1310-1 and P1310-2 schematics for Hydro-G's investigation locations.

Plate 7-2 Hydro-G's investigation locations and cross section line references for the A1 size DWG series P1310-3 to P1310-5.

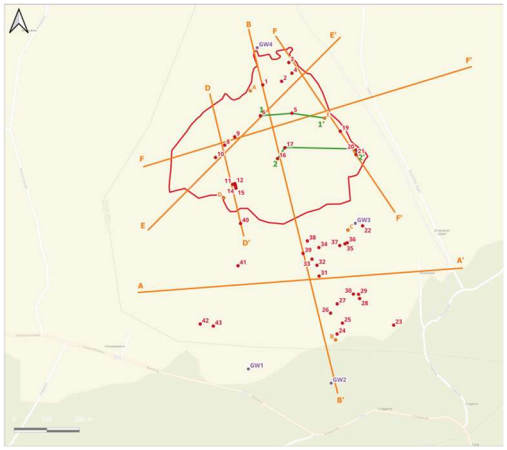	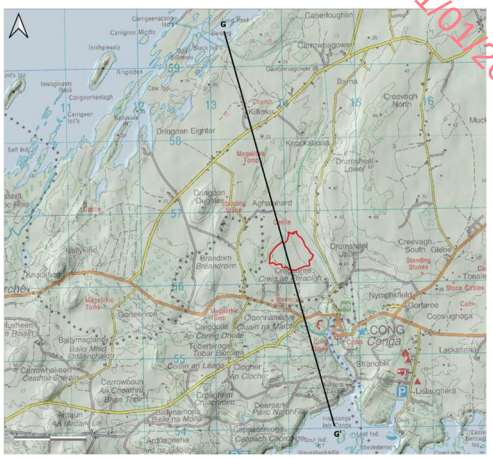
Plate A = On Site Section Lines, refer to Figure 8.10 (Water Chapter) and A1 drawing Figure No. P1310-1 for BH Locations in the context of Section Lines.	Plate B: Hydro-G's REGIONAL cross section line, refer to Figure 8.11 (Water Chapter) A1 drawing Figure No. P1310-2 for and P1310-5 for Cross Section.

7.89 Plate 7-2 presented schematics for investigation locations and cross section line references that are more clearly presented in the Water Chapter's Figures 8.10 and 8.11 and also in the A1 DWG Sheets Figures numbered P1310-1 & P1310-2 for the DWG series presenting the actual cross sections numbered Figures P1310-3, P1310-4 and P1310-5.

7.90 Section E-E1 covers a section of the quarry area presented for consideration for deepening. Figure No. P1310 – 4 (DWG No. P1310-1015-A1-104-00A). This cross section demonstrates that deepening the quarry in this area is likely to encounter only solid limestone.

7.91 Sections A-A1, B-B1, C-C1 & D-D1 are presented on Figure No. P1310 – 3 (DWG No. P1310-1015-A1-103-00A). These cross sections demonstrate that deepening the quarry in the application area is likely to encounter only solid limestone.

7.92 Specifically, Section D-D1 presented on Figure No. P1310 – 3 (DWG No. P1310-1015-A1-103-00A) shows that for 9 Blast Holes (ID'd as BL7 – BL15) and 'Core Hole D', only solid limestone was encountered. The target depth of exploration, base of hole depths range, achieved -10m OD to -50m OD, approximately. As previously stated, the proposal presented here is to excavate to -12m OD.

7.93 With Reference to Figure No. P1310-2 (reproduced as Plate 7-1B): The Regional cross section G-G1 demonstrates that the quarry has already excavated to below the elevations of Lough Mask and Lough Corrib – this has been completed in the 'Pre 63', 'Area A'. This area is hydrogeologically downgradient of the proposed area for deepening. Therefore, if deep conduits existed within the subsurface proposed for extraction under the 37L process then they might have appeared in the existing deep area but they did not.

Site Investigations - Bedrock Quality

7.94 The chemical characteristics of the bedrock at the site were evaluated and reported by Dr. John Colthurst in a 2014 report for the applicant (Colthurst, 2014). Refer to Appendix 7-3 for the entire Report.

7.95 Colthurst's (2014) report provides information on many aspects of the geology of the site. In particular, the following was presented:

- The limestone in the quarry appears to be very pure and there is no evidence of dolomitisation, silicification or mineralisation. No clays or shale are present in the succession and the overburden on top of the quarry has been stripped to avoid contamination. Petrological work (Jones in 2007) confirmed no visible silica in thin section and staining techniques did not show up any dolomite. Laboratory analysis confirmed the extremely pure CaCO3 nature of the limestone.
- From the limited analysis done in 2007 it is apparent that the Cong Quarry limestone is exceptionally pure and has the potential to be a source of chemical grade calcium carbonate. The limestone potentially has high value end uses including fillers and extenders in the manufacture of paper, paints and surface coatings, plastics, adhesives, mastics, sealants, fertilisers, animal feeding stuffs, pharmaceuticals, toiletries, carriers for insecticides and herbicides, cleaning products, glass, ceramics, desulphurisation of flue gas and water treatment. The limestone also appears to be suitable for the production of Precipitated Calcium Carbonate (PCC).
- While the work in 2007 was encouraging it is based on the analysis of only four randomly collected samples and a visual inspection of the quarry. McGraths decided that the resource needed to be defined in detail and that additional data should be collected on the overall quality of the limestone in and surrounding the quarry. To this purpose five diamond drillholes were completed in May/June 2014. The 2014 report presents Lithological Logs, Geotechnical Logs and a significant array of Laboratory Analyses for many parameters. A selection of chemical composition results are presented in Table 7-8 and it is clear that the CaCO3 increases in purity to 99.95% and other important attributes, such as MgO and Impurity contents improve with depth also. **This is a SIGNIFCANT reason for pursuing depth at the site.**

Table 7-8 Hydro-G Application Area Drill Locations to the south of the application area.

SAMPLE No.	Ground Level (mOD)	SiO2 %	$CaCO_3$ By Atomic Mass Conversion From CaO %	MgO %	MgCO3 %	Total Impurities %	CaCO3 By Difference %
964	17.315	0.7	90.95	3.51	7.34	8.50	91.50
966	13.315	0.47	94.84	1.72	3.60	4.45	95.55
903	7.806	0.12	94.33	2.32	4.85	5.19	94.81
934	7.486	0.11	96.04	3.17	6.63	6.95	93.05
936	3.486	0.19	96.48	2.18	4.56	5.01	94.99
938	-0.514	0.11	99.95	0.61	1.28	1.59	98.41
974	-2.685	0.11	97.43	1.17	2.45	2.77	97.23
941	-6.514	0.16	97.06	1.96	4.10	4.51	95.49
911	-8.194	0.07	99.52	0.65	1.36	1.59	98.41
944	-12.514	0.13	99.95	0.53	1.11	1.48	98.52

Site Investigations - Bedrock Permeability

7.96 The Carboniferous Limestone at this site is a virtually impermeable material in its unfractured state. Permeability of the rock matrix is generally low in the order of 10-15mls. However, it is commonly fractured and these fractures allow groundwater storage and flows. Groundwater movement is predominately along bedding planes although the main concentrations of flow appear to be controlled by the enlarged joints. From studies (ref Daly et al.) undertaken in the area the indications are that flow rates in the North- South Joints are twice as fast as the East-West trending joints.

7.97 Permeability testing by falling head and rising head methods has been undertaken in ESP (2006) reported drillholes present bedrock permeability as follows:

- BH A: K ranges from 4.08 x 10-7 to 7.98 x 10^{-8} m/s
- BH B: K ranges from 2.12 x 10-8 to 6.66 x 10^{-9} m/s
- BH C: K ranges from 4.54 x 10-9 to 5.99 x 10^{-10} m/s
- BH D: K ranges from 7.95 x 10-5 to 9.85 x 10^{-9} m/s

7.98 These results confirm that the bedrock mass is impermeable. The entire ESP Report (2006) is presented as Appendix 8.10, of the Water Chapter.

Impact Assessment

7.99 The proposal assessed for potential impact relates to the proposed extraction of bedrock over the course of a 25 year permission. Details for rates are presented in the opening chapters of the EIAR but no intensification is proposed.

7.100 The application of the framework and methodologies, as shown in Appendix 7-2, provides a general screening of the likely impact to the land, soils and geology environment.

7.101 The procedure for determination of more specific potential impacts to the receiving land, soils and geology environment is to use the information gathered, by desk study and field work, within the site boundary and surrounding landscapes and the assessment of potential impacts to these receptors are then described in terms of quality, significance, duration and type. This methodology adheres to the terminology provided by (EPA, 2022)'s Table 3.4 'Description of Effects', as provided in 'Guidelines on the information to be contained in Environmental Impact Assessment Reports'. Refer again to Appendix 7-2 of this Chapter.

Potential Impacts - Direct

7.102 Potential Impacts can arise from three project phases:

(i) Construction (enabling) phase.

(ii) Operational phase, and

(iii) Landscaping, restoration, decommissioning and aftercare phase.

7.103 Historical, permitted, development across the application area involved the stripping of soils and overburden followed by the extraction and breaking of rock. This has already taken place within the footprint of the current application area. The Construction Phase is already past. No enabling works are necessary. There are no Potential Impacts for the Construction (enabling) Phase.

7.104 With respect to the Operational Phase, further extraction of bedrock within the application site and associated activities, such as blasting and mechanical removal of rock, has the potential for direct impact on the geology of the limestone within the bedrock extraction area. This is therefore considered to be a direct and permanent impact to bedrock. This impact has occurred historically within the active quarry and it is considered appropriate in order to continue extraction of bedrock at this site. Operational Phase impacts require assessment.

7.105 Given the absence of soils/subsoils over the application area of already worked bedrock, the impact to the geological (soils/subsoils) attribute is deemed to be 'Negligible'.

7.106 Bedrock at the site is considered to be a geological attribute of High importance and the proposed works have a potential adverse impact of Moderate magnitude (Loss of a moderate proportion of future quarry or pit reserves). The impact to the geological (bedrock) attribute is deemed to be 'Significant/Moderate'.

7.107 The significance of the proposed 7 MT extraction of bedrock from this geological unit is considered to be significant/moderate. A quarry of this size would be considered to be at Moderate scale for quarry development.

7.108 It is proposed to develop one additional extractive bench of limestone below the current quarry floor of the application area to a final proposed floor elevation of -12m OD. Development of the quarry at depth below the current floor will result in the exact same rainfall runoff amount at the quarry and the drilling experience suggests potential for a small additional volume of water that will require management.

7.109 Water Management Systems are already in place to manage the waters that will arise on the floor during the excavation and breaking of bedrock proposed. In order to maintain a dry working environment on the floor of the quarry the floor sumps will evolve with progression into the bench being excavated. From the floor sump water will be sent to a series of four operational settlement lagoons elevated above the floor. Following treatment in the series of settlement lagoons, the waters arising from operation of the site will be discharged to surface water, under the Section 4 Discharge Licence for the site (W/391/05_R1, 2019 Galway County Council). Review of the information presented in the Water Chapter suggests that there is adequate capacity in the existing discharge licence and it will not need review or amendment in order to treat the proposed development's waters. Increases in rainfall amounts have already been accounted for in the climate change factors applied in the site's Emission Limit Value in the 2019 Licence.

7.110 By its nature, quarrying of the underlying rock will involve removal of an identified geological resource and therefore impact upon land, soils and geology must be expected. There will be

impact arising from removal of rock. There need not be negative impacts by virtue of correct design and mitigation measures.

7.111 There is potential for contamination of exposed overburden and bedrock as a result of spillages and leakages. Providing adequate mitigation control measures are in place, the risk of such is deemed to be negligible.

7.112 Quarrying presents a risk of potential impact on the stability of the bedrock environment. Subsidence, slope stability, compaction and slope failure are fully considered in the design of all extraction phases at this site, which ensures that these impacts will be prevented.

7.113 The restoration stage of the project describes the aftercare phase that follows the cessation of extractive activities. The decommissioning phase will provide a safer environment than is currently the case, with the removal of all plant and infrastructure, and creation of stable slopes in the interest of health & safety and long-term sustainability. The restoration plan will involve allowing water to accumulate in the quarry void. This confirms that the long-term land use will have changed from quarrying to biodiversity/amenity.

7.114 The site will be reinstated in accordance with the approved quarry restoration scheme, and thus integrated back into the surrounding landscape with the attendant improvement to the visual amenity of the area. This benefit is acknowledged in the Mayo County Development Plan (2022-2028).

7.115 With respect to Land, Soils & Geology or geological features, there are no Designated Sites with Conservation Objectives (SACs or SPAs), within the application area or within radius of influence of the proposed development.

7.116 On the basis of the foregoing, the Summary Table for Potential Impacts on Land, Soils and Geology is presented as Table 7-9.

Table 7-9 Summary of Potential Impacts on Land, Soils & Geology Environment

Scenarios where impacts may arise	Activity	Attribute	Importance of attribute	Nature and Description of the Effect	Quality of effect	Significance / magnitude of effect	Extent & Context of Effect	Probability of Effects (pre-mitigation)	Duration and Frequency	Type of effect
Enabling Phase	Not Applicable – Site is already enabled, application area is a hard rock floor of quarry, Water Management Systems are in place.									
Operational Phase	Extraction of bedrock	Bedrock	High	Loss of bedrock	Moderate / Adverse	Significant / Moderate	Removal of c. 7 MT over 25 years.	Likely	Permanent	Direct
	Extraction of bedrock	Bedrock	High	Raw material for use in construction industry	Positive	Significant/ Moderate	Local & Regional resource generation	Likely	Long-term	Direct
	Use and storage of fuel & hydrocarbon	Bedrock	High	Potential for contamination of underlying bedrock during refuelling or due to leakage	Adverse	Significant/ High	Within application boundary	Unlikely	Medium	Direct
Restoration Phase	Landscaping, movement of soils and stockpiles necessary to facilitate site restoration	Soil & Bedrock	High	Restoration of land to water-filled void	Positive	Significant/ Moderate	Application Area	Likely	Permanent	Direct
Unplanned Events	Fuel tank failure or large scale spillage	Exposed Bedrock	High	Hydrocarbon contamination	Negative	Significant/ High	Within application site boundary	Unlikely	Medium	Direct

Scenarios where impacts may arise	Activity	Attribute	Importance of attribute	Nature and Description of the Effect	Quality of effect	Significance / magnitude of effect	Extent & Context of Effect	Probability of Effects (pre-mitigation)	Duration and Frequency	Type of effect
	Face Collapse / Wall Stability	Exposed Bedrock	High	Rock Fall / Slump	Negative	Small / Adverse	Within application site boundary	Unlikely	Medium	Direct

Potential Impacts - Indirect

7.117 Indirect impacts (or secondary impacts) are those which are not a direct result of the proposed activity, often produced away from the project site or because of a complex pathway. The extraction of bedrock across the floor has already removed the capacity of these lands to provide agricultural production. The indirect impact on the soils may be considered to be of a medium to long-term nature because the soils have been reused elsewhere.

7.118 Activity at the proposed development site has the potential for the generation of dust, which could have an indirect, brief, imperceptible impact beyond the application boundary, without mitigation and monitoring methods already associated with the site.

Impacts – Transboundary

7.119 EIA Directive 2014-52-EU invokes the Espoo Convention on Environmental Impact Assessment in a Transboundary Context (1991) and applies its definition of transboundary impacts.

7.120 Given the location of the site at c.119 km, approximately, at its closest position to the border with Northern Ireland, which is to the north east of the site, the nature, size and scale of the proposed development, and the fact that water from the catchment flows in a southerly direction towards Lough Corrib, it is expected that the development will not have any significant transboundary effects with respect to land, soils and geology.

Impacts – Cumulative

7.121 The aim of the cumulative impact assessment is to examine whether any other proposed developments have the potential to act in-combination with the proposed application, subsequently giving rise to effects that would not otherwise be significant.

7.122 The cumulative impact assessment considered relevant activities within a 10 km radius. The cumulative impact Section of the Water Chapter has considered all potential for cumulative impact on the hydrogeological environment and the same targets are relevant for the geological environment. Given that the Water Chapter could conclude no potential for cumulative impact with other developments with respect to hydro and geology, the same conclusion is possible here in the LSG conclusions: No Potential for Cumulative Impact.

'Worst Case' Impacts

7.123 The 'worst case' impacts would involve a substantial fuel or other hydrocarbon spill on-site, resulting in localised contamination of the working bedrock environment, given that there are no soils or subsoils on the quarry floor. However, the settlement lagoon Water management system and mitigation measures associated with the Section 4 Discharge Licence (W/391/05_R1, 2019 Galway County Council) will ensure that there is no migration of contamination off site.

7.124 Additionally, lowering the quarry floor could increase the groundwater component in the sump, which will need to be dewatered. This could lead to increased discharge to external

surface watercourses and to lowering of the water table outside the quarry, with a possible attendant impact on nearby domestic wells. The quarry floor and its sump settlement system are to be adequately sized to handle the water volumes they will receive. Details are provided in the Water Chapter of this EIAR.

Mitigation Measures

7.125 Mitigation measures are set out in Table 7-10 and these will be adopted for the proposed extraction activities to reduce the potential impacts to the receiving land, soils and geology environment as identified in Table 7-9.

7.126 As a result of the mitigation measures implemented at the site, it is considered that any impacts associated with the quarrying related activities undertaken at the site will not contribute to cumulative impacts in combination with any developments in the surrounding area.

Residual Impacts

7.127 Residual impacts refer to the degree of environmental change that will occur after the proposed mitigation measures have taken effect. Residual Impacts are also shown with Mitigation Measures in Table 7-10.

7.128 As a result of the proposed mitigation and enhancement measures incorporated in the design, no significant, long-term, adverse residual impacts are predicted in terms of Land, Soils and Geology during the operational phase, other than the inevitable loss of mineral resources (i.e., Waulsortian limestone) due to quarrying.

7.129 It is considered that following full restoration and closure of the site that there will be no significant, long-term, adverse impacts in terms of Land, Soils and Geology, again other than the permanent, significant negative impact due to extraction of the mineral resources. The restored quarry will provide a more manageable environment, than is currently the case, but with a change in land-use from Mineral extraction to the future beneficial future land-use as wildlife amenity.

7.130 The primary mitigating factor is that the overall regional and national scale of this type of bedrock is large. The impact of the extraction of the proposed footprint of limestone bedrock is small relative to the volume of this type of this rock in the region. A large area of Galway and Mayo is underlain by Waulsortian Limestone.

Table 7-10 Mitigation Measures and Residual Impacts

	POTENTIAL IMPACT			MITITGATION MEASURES	RESIDUAL EFFECT FOLLOWING MITIGATION	
Phase where impacts may arise	**Activity**	**Attribute**	**Character of Potential Impact**	**Description of Mitigation**	**Significance or quality of Effect**	**Probability**
Construction	Not applicable as explained in Potential Impact Table, above.					
Operational	Extraction of bedrock	Bedrock	Local & Regional Resource Generation	No mitigation required for the supply of materials because it is the planned, positive activity for the development.	Positive, Significant	Likely
	Extraction of bedrock	Bedrock	Long-term stability	A detailed working scheme/ restoration plan has been prepared. In preparing the design, standard criteria were adopted with regard to face slopes, standoffs to site boundaries, etc. The final quarry face angles will be assessed by a geotechnical engineer to ensure long-term stability after completion of extraction operations. The stability of restored faces observed in the existing quarry indicates that the long-term stability of the final quarry faces will be satisfactory in this geological environment.	Negative, Not significant	Likely
	Extraction of bedrock	Bedrock	Geological Heritage	Allowing access to quarry faces by appropriate scientists (upon request and with due regards to Health and Safety requirements) during quarrying to check for interesting new stratigraphies / relationships as they might become exposed and to establish if the quarry site is worthy of recognition post extraction and through aftercare/restoration planning. Leaving a representative section of the quarry face at the end of the quarry's life or inclusion of information panels to promote the geology to the public	Positive, Significant	Likely

	POTENTIAL IMPACT			MITITGATION MEASURES	RESIDUAL EFFECT FOLLOWING MITIGATION	
Phase where impacts may arise	Activity	Attribute	Character of Potential Impact	Description of Mitigation	Significance or quality of Effect	Probability
				or develop tourism or educational resources if appropriate depending on the future use of the site. Should any significant bedrock exposures of importance be identified, McGraths will work with the GSI to find a mutually beneficial arrangement on how best they can be designed to remain visible as rock exposure rather than covered with soil and vegetated, in accordance with safety guidelines and engineering constraints. This measure would permit on-going improvement of geological knowledge of the subsurface and could be included as additional sites of the Geoheritage dataset, if appropriate. The final land restoration scheme will ultimately allow the site to be returned to a condition whereby there will be negligible residual impact on the geological heritage of the site and surrounding environment due to the excavation and removal of bedrock underlying the site. It is planned to minimise, eliminate or decrease long-term ecological and visual impacts on the environment through the implementation of the final restoration scheme.		
	Landscaping. Restoration of Residual faces, movement of berms and stockpiles necessary to facilitate site restoration	Soils, subsoils & Bedrock	Restoration of land to water filled void	No mitigation is required for restoration as it is a planned part of the development. It is anticipated that final restoration will be achieved within 2 years of completion of extraction operations. Final restoration will be to a beneficial after-use as a secure wildlife refuge/ amenity with water feature. The intention is to create a habitat suitable for aquatic life and birds, such that the disused workings will eventually become of considerable amenity value. A detailed Restoration and landscaping plan has been prepared as part of the application. A well-coordinated restoration process will ensure that representative areas of quarry faces are left unvegetated. Parts of the upper benches will also be seeded with suitable species of shrubs and climbers to create vegetated	Positive, Moderate	Likely

	POTENTIAL IMPACT			MITITGATION MEASURES	RESIDUAL EFFECT FOLLOWING MITIGATION	
Phase where impacts may arise	Activity	Attribute	Character of Potential Impact	Description of Mitigation	Significance or quality of Effect	Probability
				ledges. Vegetation and natural colonisation on these benches will encourage growth on the faces and will subsequently break up the natural harshness of the exposed rock face. This will occur in a progressive manner as quarrying progresses.		
Restoration Phase	Fuel tank failure or large-scale spillage	Exposed Bedrock	Potential for contamination of exposed bedrock as a result of spillages/leakages.	Fuels are stored with bunds. Refueling and lubrication of semi-mobile plant and haulage vehicles is carried out by a trained and dedicated operative. Control measures exist as standard operating procedures in the overall quarry.	Neutral	Unlikely
Unplanned Events	As above.					

Interaction with other Impacts

7.131 The EIAR guidelines (EPA, 2022) highlight that the interaction of impacts to the land, soils and geological environment, arising from proposed activities, must be given due consideration alongside potential receptors identified in other EIAR sections. The likely interactions have been identified as follows:

(i) The movement of bedrock by blasting and mechanical means can give rise to increased dust emissions.
(ii) The operation of plant associated with extraction and haulage can give rise to increased traffic movements.
(iii) The operation of plant associated with extraction and haulage can give rise to increased noise emissions.
(iv) The extraction of bedrock can impact upon surface and groundwater quality and flow patterns.
(v) The extraction of bedrock can impact upon biodiversity and cause disturbance to habitats in the area.

7.132 Each of these issues and the mitigation measures proposed are addressed in detail in the relevant sections of this EIAR & the 'Interactions of the Foregoing'. These impacts are considered to be negative but with suitable measures in place, their significance can be mitigated, with the exception of the extraction of bedrock, the removal of which is permanent. However, this is an inevitable consequence of quarrying and extractive activities that is deemed essential to development of society.

Do-Nothing Scenario

7.133 The 'Do Nothing Scenario' evaluation requires consideration of the effect on the environment as it would be in the future should the proposed works not be carried out.

7.134 If the development did not proceed, the aggregate resource would remain unused in situ, and the local supply of quality aggregates would be more restricted.

7.135 The lands represent a disturbed and degraded landscape with infrastructure and stockpiles on the quarry floor. Under the 'Do Nothing' scenario, all quarrying activities would cease. The site would be restored to beneficial after-use as per the requirements of the existing planning permission. However, the potential future resources of the quarry would remain in situ, unutilised, and would possibly result in the requirement to develop a more remote greenfield site in a different part of the landscape, whether that is near Cong or another part of County Mayo.

7.136 As the proposed activities are an extension of activities at an established extraction site, it is envisaged that no new or different potential impacts shall be introduced when compared to the current operational phase.

7.137 It is considered more appropriate to continue activities at an existing active quarry as opposed to opening a new quarry on a greenfield site. The extractive industry is necessary in order to meet the needs of society for homes, transport networks, places of work and recreational areas. Quarrying is an established land use at this site and it has been integrated into the local environment. As it is a continuation of existing activities, there will be effectively no construction or enabling phase with respect to access to the extraction area.

7.138 Extraction capacity is sought to provide the applicant with the ability to respond to demand for aggregates in the region. Permission is sought for a period of 25 years.

7.139 Whilst machinery will be replaced as necessary, there will be no increase in site infrastructure associated with ongoing extraction, internal haulage and processing of raw material.

7.140 Sourcing of bedrock at a greenfield site at a further remove would significantly increase impacts linked to traffic such as increased combustion of fossil fuels.

Monitoring

7.141 As no significant impacts are expected other than the loss of the mineral resource, no specific monitoring with respect to the land, soil or geological environment is likely envisaged.

7.142 The detailed procedures to be followed, in respect of monitoring for the purpose of demonstrating compliance with Permissions and Licences etc., are understood by site workers, operators and management. Operation of the quarry already includes monitoring activities (e.g., Water, Blasting, Noise and Dust) to demonstrate that the development is not having an adverse impact on the surrounding environment.

7.143 Future environmental monitoring reports for the site will continue to be submitted to Mayo County Council for their approval prior to the commencement of quarry activities.

7.144 New monitoring programs will be compiled to comply with any new Conditions attached to any decision to grant planning permission, and also to ensure that the development is not having an adverse impact on the surrounding environment.

Close

7.145 The Mayo County Development Plan (2022 – 2028) acknowledges quarrying as an important source of employment and that the continual supply of aggregates is necessary for future growth. In addition, MCC acknowledges the need for environmental protection and that extractive industry guidelines must be adhered to. The field works and application of EPA (2022), NRA (2009) and IGI (2013) Guidelines for assessment enable a conclusion that the quarry can continue to supply rock, with the application of mitigation measures and that there will be no residual effects. It is respectively requested that the site has been assessed in accordance with the EU EIA Directive 2011/92/EU, as amended by EIA Directive 2014/52/EU and the European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018.

References

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Figures

Figure 7-1 Site Location and Topography

Figure 7-2 General Soils

Figure 7-3 Quaternary Geology

Figure 7-4 Bedrock and Structural Geology

Figure 7-5 Geoheritage Areas

Figure 7-6 Boreholes

Figure 7-1 Site Location and Topography

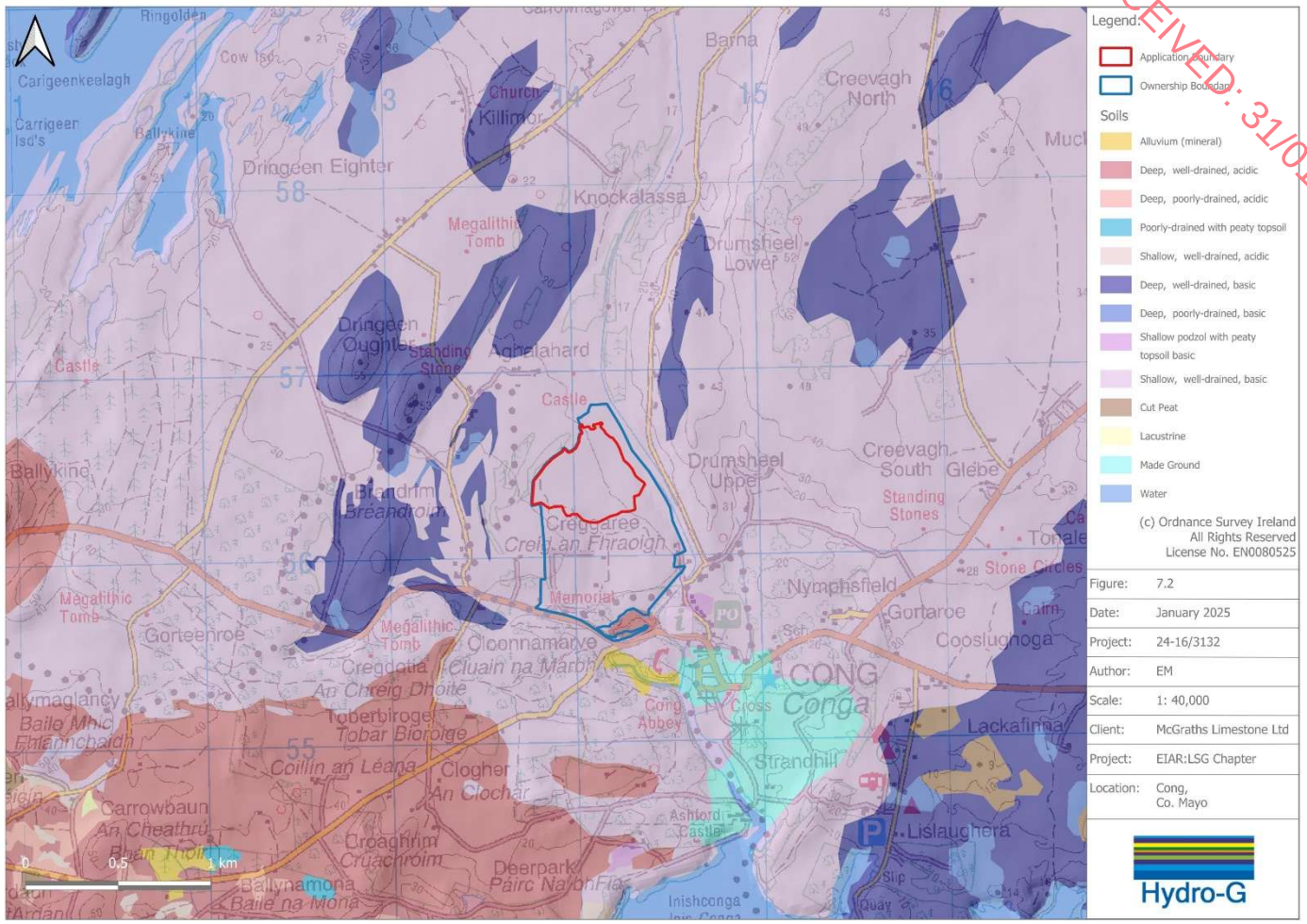

Figure 7-2 General Soils

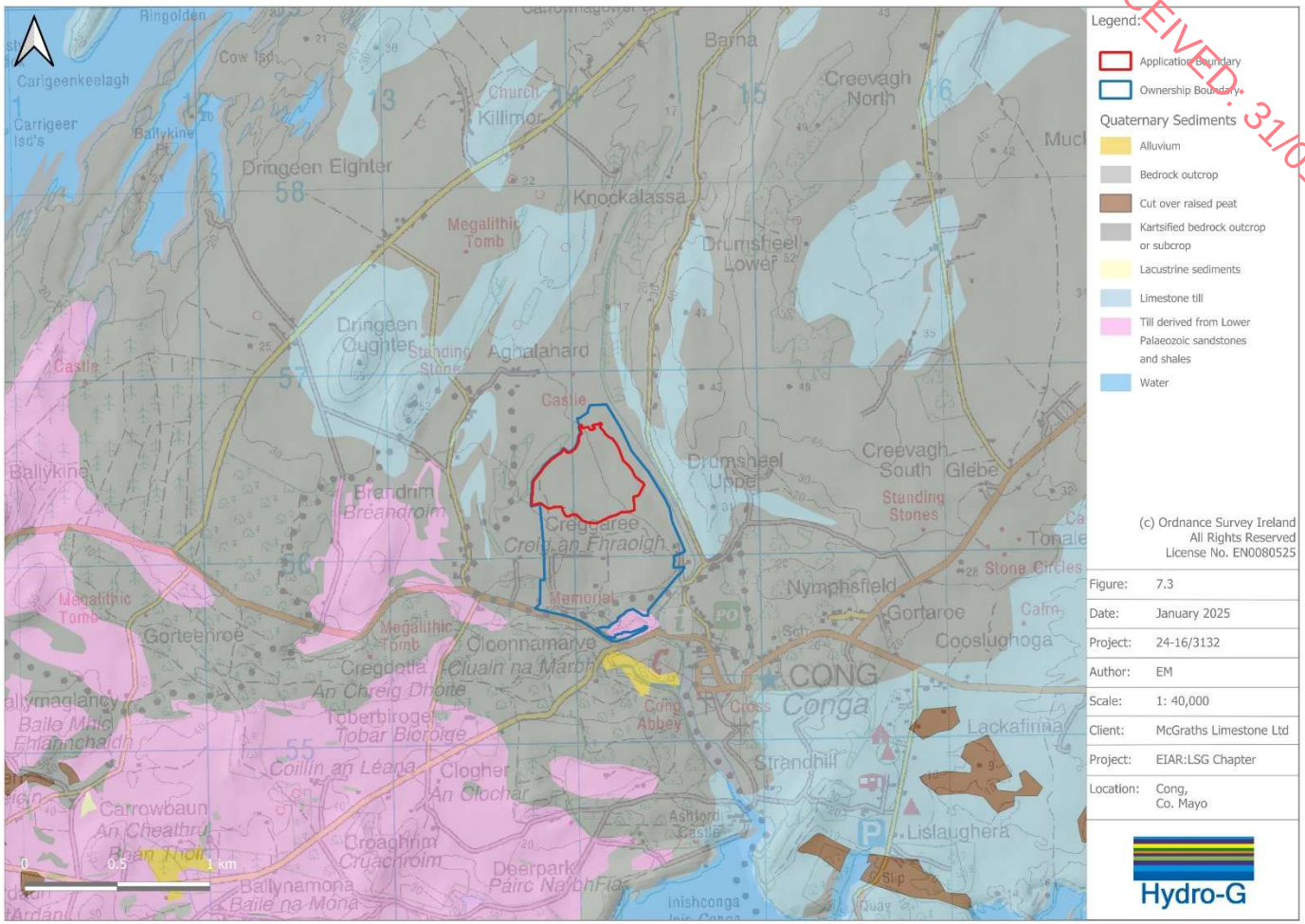

Figure 7-3 Quaternary Geology

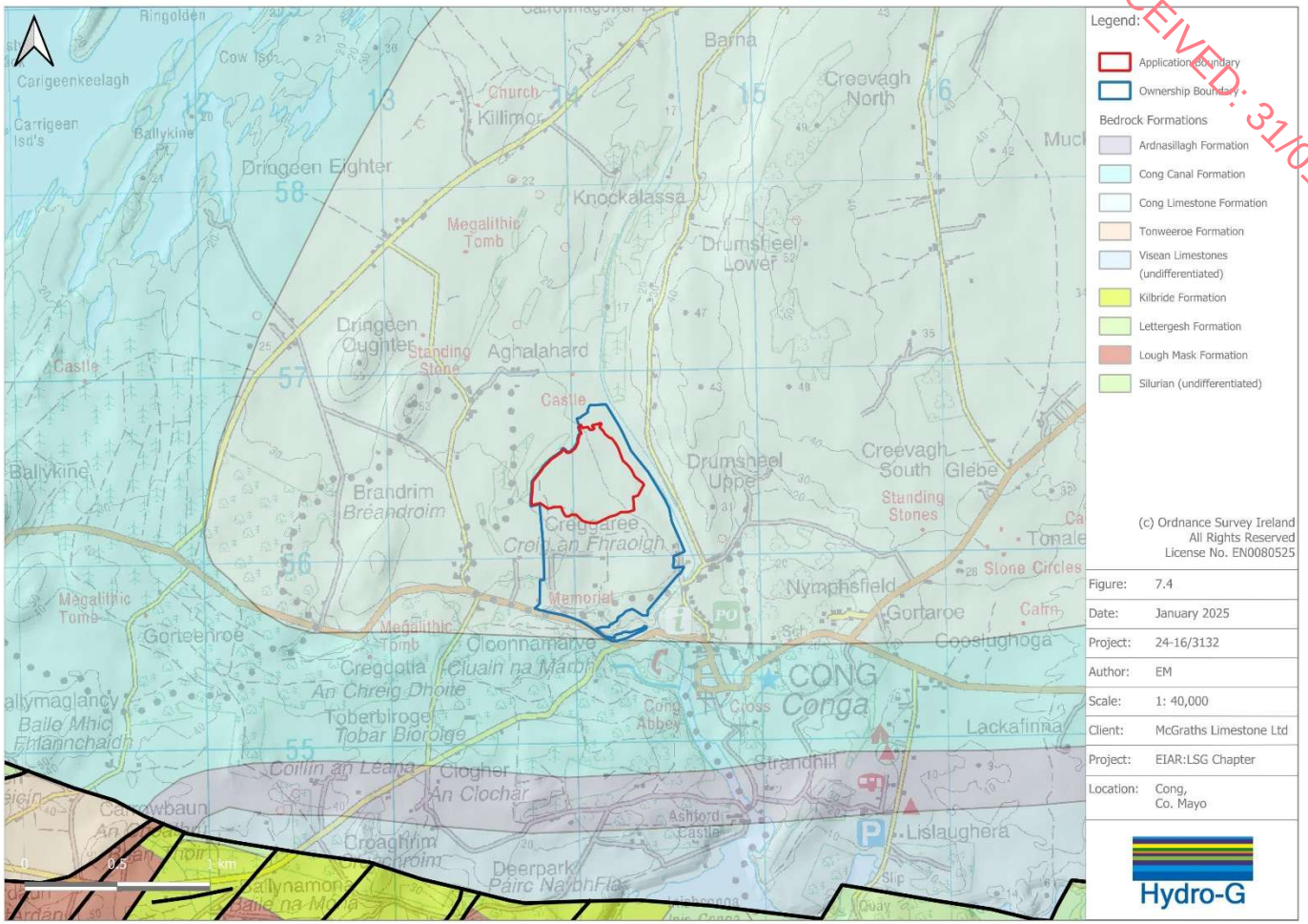

Figure 7-4 Bedrock and Structural Geology

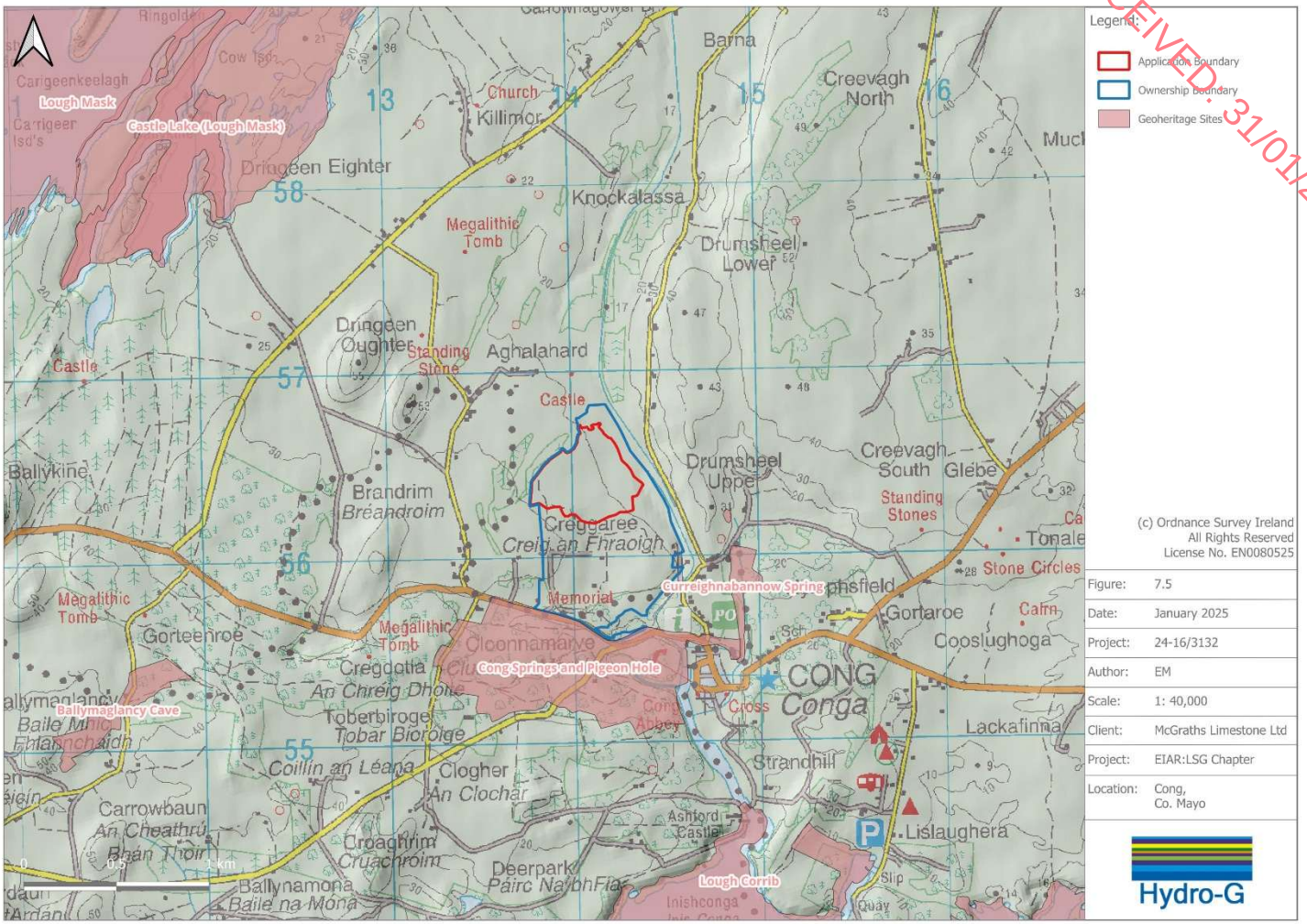

Figure 7-5 Geoheritage Areas

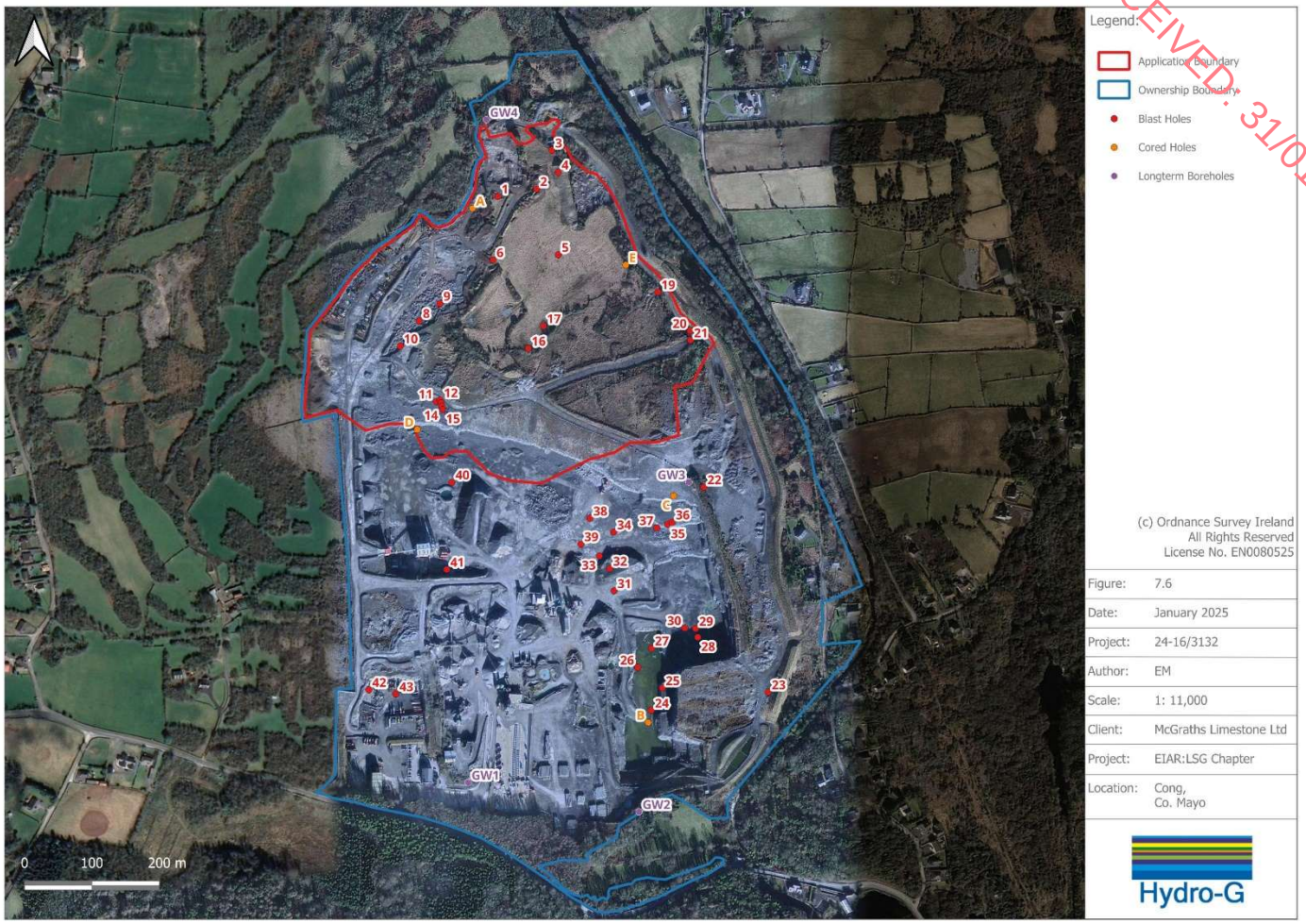

Figure 7-6 Boreholes

Appendix 7-1 GSI Scoping Response

An Roinn Comhshaoil,
Aeráide agus Cumarsáide
Department of the Environment,
Climate and Communications

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

Rory Brickenden
Quarry Consulting
Cedar Park
Westport
Co. Mayo, F28 PN47

05 June 2024

Re: Deepening of part of the existing permitted limestone quarry at Cregaree, Cong, Co Mayo
Your Ref: 65.01
Our Ref: 24/217

Dear Rory,

Geological Survey Ireland is the national earth science agency and is a division of the Department of the Environment, Climate and Communications. We provide independent geological information and gather various data for that purpose. Please see our website for data availability. We recommend using these various data sets, when conducting the EIAR, SEA, planning and scoping processes. Use of our data or maps should be attributed correctly to 'Geological Survey Ireland'.

The publicly available data referenced/presented here, should in no way be construed as Geological Survey Ireland support for or objection to the proposed development or plan. The data is made freely available to all and can be used as independent scientific data in assessments, plans or policies. It should be noted that in many cases this data is a baseline or starting point for further site specific assessments.

With reference to your email received on the 29 May 2024, concerning the eepening of part of the existing permitted limestone quarry at Cregaree, Cong, Co Mayo, Geological Survey Ireland would encourage use of and reference to our datasets. This data can add to the content and robustness of the SEA process. With this in mind, please find attached a list of our publicly available datasets that may be useful to the environmental assessment and planning process. We recommend that you review this list and refer to any datasets you consider relevant to your assessment. The remainder of this letter and following sections provide more detail on some of these datasets.

Geoheritage

Geological Survey Ireland is in partnership with the National Parks and Wildlife Service (NPWS, Department of Housing, Local Government and Heritage), to identify and select important geological and geomorphological sites throughout the country for designation as geological NHAs (Natural Heritage Areas). This is addressed by the Geoheritage Programme of Geological Survey Ireland, under 16 different geological themes, in which the minimum number of scientifically significant sites that best represent the theme are rigorously selected by a panel of theme experts.

County Geological Sites (CGSs), as adopted under the National Heritage Plan, include additional sites that may also be of national importance, but which were not selected as the very best examples for NHA designation. All geological heritage sites identified by Geological Survey Ireland are categorised as CGS pending any further NHA designation by NPWS. CGSs are now routinely included in County Development Plans and in the GIS of planning departments, to ensure the recognition and appropriate protection of geological heritage within the planning system. CGSs can be viewed online under the Geological Heritage tab on the online Map Viewer.

The audit of County Geological Sites of County Mayo and County Galway were published in 2020 and 2019 respectively. The full report details can be found here and here. **Our records show that there are CGSs adjacent to the limestone quarry.**

> **Cong Springs and Pigeon Hole**, Co. Galway (GR 114001, 255389), under IGH themes: IGH1 Karst, IGH16 Hydrogeology. A number of complex karst features; caves, springs, dolines, epikarst outcrop & limestone pavement. The springs are some of the largest worldwide and the area is an intricate and complex karst system. Link to Site Report: GW036.
>
> **Curreighnabannow Spring**, Co. Mayo (GR 114944, 255827), under IGH theme: IGH1 Karst, IGH16 Hydrogeology. A major spring of the extensive underground drainage system between Lough Mask and Lough Corrib. The spring is the highest of the Cong springs and is one that operates at successively higher levels as stage levels rise. The site contributes to a major water supply source and it is one of the most important karst sites in County Mayo and County Galway. Link to Site Report: MO040.

With the current plan, there are no envisaged impacts on the integrity of current CGSs by the proposed development. However, if the proposed development plan is altered, please contact Clare Glanville (Clare.Glanville@gsi.ie) for further information and possible mitigation measures if applicable.

Geological Survey Ireland would request that the operator might assist our geological heritage goals with the following (and ideally this would be written into the restoration / closure plan) and be included as a condition of planning as deemed appropriate by the planning authority:

1. Allowing access to quarry faces by appropriate scientists (upon request and with due regards to Health and Safety requirements) during quarrying to check for interesting new stratigraphies / relationships as they might become exposed and to establish if the quarry site is worthy of recognition post extraction and through aftercare/restoration planning.

2. If deemed appropriate in (1) above, leaving a representative section of the quarry face at the end of the quarry life or inclusion of information panels to promote the geology to the public or develop tourism or educational resources if appropriate depending on the future use of the site. Natural exposures are few, or deeply weathered, this measure would permit on-going improvement of geological knowledge of the subsurface.

The Geoheritage Programme tries to promote a partnership between geological heritage and active quarrying, with such measures as those outlined in the 'Geological Heritage Guidelines for the Extractive Industry', which can be downloaded here. This document, written in association with Irish Concrete Federation, acts as a comprehensive guide in the sustainable extraction of natural resources while preserving the geological heritage of Ireland.

Groundwater

Geological Survey Ireland's Groundwater and Geothermal Unit, provides advice, data and maps relating to groundwater distribution, quality and use, which is especially relevant for safe and secure drinking water supplies and healthy ecosystems. Proposed developments need to consider any potential impact on specific groundwater abstractions and on groundwater resources in general. We recommend using the groundwater maps on our Map viewer which should include: wells; drinking water source protection areas; the national map suite - aquifer, groundwater vulnerability, groundwater recharge and subsoil permeability maps**.**

For areas underlain by limestone, please refer to the karst specific data layers (karst features, tracer test database; turlough water levels (gwlevel.ie). Background information is also provided in the Groundwater Body Descriptions. Please read all disclaimers carefully when using Geological Survey Ireland data.

The Groundwater Data Viewer indicates an aquifer classed as a 'Regionally Important Aquifer - Karstified (conduit)' underlies the proposed development.

The Groundwater Vulnerability map indicates the range of groundwater vulnerabilities within the area covered is variable. We would therefore recommend use of the Groundwater Viewer to identify areas of High to Extreme Vulnerability and 'Rock at or near surface' in your assessments, as any groundwater-surface water interactions that might occur would be greatest in these areas.

The Karst Viewer indicates numerous karst features in the vicinity including karst springs, enclosed depressions, turlough and caves.

GWClimate is a groundwater monitoring and modelling project that aims to investigate the impact of climate change on groundwater in Ireland. This is a follow on from a previous project (GWFlood) and the data may be useful in relation to Flood Risk Assessment (FRA) and management plans. Maps and data are available on the Map viewer.

Geological Survey Ireland has completed Groundwater Protection Schemes (GWPSs) in partnership with Local Authorities, and there is now national coverage of GWPS mapping. A Groundwater Protection Scheme provides guidelines for the planning and licensing authorities in carrying out their functions, and a framework to assist in decision-making on the location, nature and control of developments and activities in order to protect groundwater.

The Groundwater Protection Response overview and link to the main reports is here: https://www.gsi.ie/en-ie/programmes-and-projects/groundwater/projects/protecting-drinking-water/what-is-drinking-water-protection/county-groundwater-protection-schemes/Pages/default.aspx

Geological Mapping

Geological Survey Ireland maintains online datasets of bedrock and subsoils geological mapping that are reliable and accessible. We would encourage you to use these data which can be found here, in your future assessments.

Please note we have recently launched QGIS compatible bedrock (100K) and Quaternary geology map data, with instructional manuals and videos. This makes our data more accessible to general public and external stakeholders. QGIS compatible data can be found in our downloadable bedrock 100k .zip file on the Data & Maps section of our website.

Geohazards

Geohazards can cause widespread damage to landscapes, wildlife, human property and human life. In Ireland, landslides, flooding and coastal erosion are the most prevalent of these hazards. We recommend that geohazards be taken into consideration, especially when developing areas where these risks are prevalent, and we encourage the use of our data when doing so.

Geological Survey Ireland has information available on landslides in Ireland via the National Landslide Database and Landslide Susceptibility Map both of which are available for viewing on our dedicated Map Viewer. Associated guidance documentation relating to the National Landslide Susceptibility Map is also available.

Geological Survey Ireland also engaged in a national project on Groundwater Flooding. The data from this project may be useful in relation to Flood Risk Assessment (FRA) and management plans, and is described in more detail under 'Groundwater' above.

Geochemistry of soils, surface waters and sediments

Geological Survey Ireland provides baseline geochemistry data for Ireland as part of the Tellus programme. Baseline geochemistry data can be used to assess the chemical status of soil and water at a regional scale and to support the assessment of existing or potential impacts of human activity on environmental chemical quality. Tellus is a national-scale mapping programme which provides multi-element data for shallow soil, stream sediment and stream water in Ireland. At present, mapping consists of the border, western and midland regions. Data is available at https://www.gsi.ie/en-ie/data-and-maps/Pages/Geochemistry.aspx.

Geophysical data

Geological Survey Ireland produces high-resolution geophysical data (Magnetic field, electrical conductivity, natural gamma-ray radiation) of soils & rocks as part of the Tellus programme. These data currently cover approximately 75% of the country and provide supporting geological information on a regional scale useful for assessing environmental impact and risk. The Tellus programme provides expertise to the Environmental Protection Agency (EPA) for the determination of radon risk. The data is used in mineral exploration or is useful in aiding site investigation works for large scale projects.

Guidelines

The following guidelines may also be of assistance:

- Institute of Geologists of Ireland, 2013. Guidelines for the Preparation of the Soils, Geology and Hydrogeology Chapters of Geology in Environmental Impact Statements.
- EPA, 2022. Guidelines on the information to be contained in Environmental Impact Assessment Reports (EIAR)

- Department of Environment, Heritage and Local Government, 2004. Quarries and Ancillary Activities, Guidelines for Planning Authorities.
- Environmental Protection Agency, 2006. Environmental Management in the Extractive Industry: Non-Scheduled Minerals.
- Geological Survey of Ireland - Irish Concrete Federation, 2008. Geological Heritage Guidelines for the Extractive Industry.

Other Comments

Should development go ahead, all other factors considered, Geological Survey Ireland would much appreciate a copy of reports detailing any site investigations carried out. Should any significant bedrock cuttings be created, we would ask that they will be designed to remain visible as rock exposure rather than covered with soil and vegetated, in accordance with safety guidelines and engineering constraints. In areas where natural exposures are few, or deeply weathered, this measure would permit on-going improvement of geological knowledge of the subsurface and could be included as additional sites of the geoheritage dataset, if appropriate. Alternatively, we ask that a digital photographic record of significant new excavations could be provided. Potential visits from Geological Survey Ireland to personally document exposures could also be arranged.

The data would be added to Geological Survey Ireland's national database of site investigation boreholes, implemented to provide a better service to the civil engineering sector. Data can be sent to the Geological Mapping Unit, at mailto:GeologicalMappingInfo@gsi.ie, 01-678 2795.

I hope that these comments are of assistance, and if we can be of any further help, please do not hesitate to the Geological Survey Ireland Planning Team at GSIPlanning@gsi.ie.

Yours sincerely,

Geoheritage and Planning Programme

Enc: Table - Geological Survey Ireland's Publicly Available Datasets Relevant to Planning, EIA and SEA processes.

Geological Survey Ireland's Publicly Available Datasets Relevant to Planning, EIA and SEA processes

following European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018

(S.I. No. 296 of 2018)

Geological Survey Ireland Programme	Dataset	Relevant EIA Topic	Coverage	Description / Notes / Limitations	Link to Geological Survey Ireland map viewer
Geohazards	Landslide: National landslide database and landslide susceptibility map	Land & Soil/Climate/Landscape	National	Associated guidance documentation relating to the National Landslide Susceptibility Map is also available.	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=b68cf1e4a9044a5981f950e9b9c5625c
Geohazards	Groundwater Flooding (Historic)	Water	Regional	Provide information of historic flooding, both surface water and groundwater. [A lack of flooding presented in any specific location of the map only indicates that a flood has not been detected. It does not indicate that a flood cannot occur in that location at present or in the future]	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=848f83c85799436b808652f9c735b1cc
Geohazards	Groundwater Flooding (Predictive)	Water	Regional	Provides information on the probability of future karst groundwater flooding (where available). [The maps do not, and are not intended to, constitute advice. Professional or specialist advice should be sought before taking, or refraining from, any action on the basis of the flood maps]	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=848f83c85799436b808652f9c735b1cc
Geohazards	Radon Map	Land & Soils/Air	National		http://www.epa.ie/radiation/radonmap/
Geoheritage	County Geological Sites as adopted by National Heritage Plan and listed in County Development Pla	Land & Soils/Landscape	Regional	All geological heritage sites identified by Geological Survey Ireland are categorised as CGS pending any further NHA designation by NPWS.	https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228
Geological Mapping	Bedrock geology:	Land & Soils	National	1:100,000 scale and associated memoirs.	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=de7012a99d2748ea9106e7ee1b6ab8d5&scale=0
Geological Mapping	Bedrock geology:	Land & Soils	Regional	1:50,000 scale	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=de7012a99d2748ea9106e7ee1b6ab8d5&scale=0
Geological Mapping	Quaternary geology: Sediments	Land & Soils	National	1:50,000 scale	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=de7012a99d2748ea9106e7ee1b6ab8d5&scale=0
Geological Mapping	Quaternary geology: Geomorphology	Land & Soils	National	1:50,000 scale	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=de7012a99d2748ea9106e7ee1b6ab8d5&scale=0
Geological Mapping	Physiographic units:	Land & Soils	National	Broad-scale physical landscape units mapped at 1:100,000 scale in order to be represented as a cartographic digital map at 1:250,000 scale	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=afa76a420fc54877843aca1bc075c62b
Geological Mapping	GeoUrban: Spatial geological data for the greater Dublin and Cork areas	Land & Soils	Regional	includes 3D models	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=9768f4818b79416093b6b2212a850ce6&scale=0
Geological Mapping	Geotechnical database	Land & Soils	National	Digitised geotechnical and Site Investigation Reports and boreholes which can be accessed through online downloads	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=a2718be1873d47a585a3f0415b4a724c
Goldmine	Historical data sets including geological memoirs and 6" to 1 mile geological mapping records	land & Soils/Water	National	available online	https://secure.dccae.gov.ie/goldmine/index.html
Groundwater & Geothermal	Groundwater resources (aquifers)	Water	National	Data limited to 1:100,000 scale; sites should be investigated at local scale	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=7e8a202301594687ab14629a10b748ef
Groundwater & Geothermal	Groundwater recharge.	Water	National	Data limited to 1:40,000 scale; sites should be investigated at local scale; long term annual average recharge	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=7e8a202301594687ab14629a10b748ef
Groundwater & Geothermal	Groundwater vulnerability.	Water	National	Data limited to 1:40,000 scale; sites should be investigated at local scale	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=7e8a202301594687ab14629a10b748ef
Groundwater & Geothermal	Group scheme and public supply source protection areas.	Water	National	Not all PWS / GWS have SPZ / ZOC. Check with IW / coco / NFGWS for private supplies.	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=7e8a202301594687ab14629a10b748ef
Groundwater & Geothermal	Groundwater Protection Schemes	Water	National	Data is limited to scale of 1:40,000. Data does not include all of the source protections areas	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=7e8a202301594687ab14629a10b748ef
Groundwater & Geothermal	Catchment and WFD management units.	Water	National		https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=7e8a202301594687ab14629a10b748ef
Groundwater & Geothermal	karst specific data layers	water	National	For areas underlain by limestone, includes karst features, tracer test database; turlough water levels (gwlevel.ie).	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=7e8a202301594687ab14629a10b748ef
Groundwater & Geothermal	Wells and Springs	Water	National	Not comprehensive, there may be unrecorded wells and springs	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=7e8a202301594687ab14629a10b748ef
Groundwater & Geothermal	Groundwater body Descriptions	Water	National	Not exhaustive; only those in designated SACs; could be other GWDTEs; for more information contact NPWS / EPA / site investigations	https://www.gsi.ie/en-ie/programmes-and-projects/groundwater-and-geothermal-unit/activities/understanding-ireland-groundwater/Pages/Groundwater-bodies.aspx
Groundwater & Geothermal	Geothermal Suitability maps	land & Soils/Water	National	Also, Roadmap for a Policy and Regulatory Framework for Geothermal Energy, November 2020	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=9ee46bee08de41278b90a991d60c0b9e
Marine & Coastal Unit	INFOMAR - Ireland's national marine mapping programme; providing key baseline data for Ireland's	Water	National		https://secure.dccae.gov.ie/GSI/INFOMAR_VIEWER/
Marine & Coastal Unit	CHERISH - Coastal change project (Climate, Heritage and Environments of Reefs, Islands, and Headla	Water	Regional		http://www.cherishproject.eu/en/
Marine & Coastal Unit	Coastal Vulnerability Index (CVI).	water /Land & Soils	Regional	Currently the project is being carried out on the east coast and will be rolled out nationally	https://www.gsi.ie/en-ie/programmes-and-projects/marine-and-coastal-unit/projects/Pages/Coastal-Vulnerability-Index.aspx
Minerals	Aggregate potential	Land & Soils/Material Assets	National	Consideration of mineral resources and potential resources as a material asset which should be explicitly recognised within the environmental assessment process	https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=ee8c4c285a49413aa6f1344416dc9956
Minerals	Active quarries	Land & Soils	National		https://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=ee8c4c285a49413aa6f1344416dc9956
Minerals	Historic mines	Land & Soils/Cultural Heritage	National	Inventory and Risk Classification 2009. Environmental Protection Agency, Economic Minerals Division and Geological Survey Ireland (DECC).	https://gis.epa.ie/EPAMaps/default?easting=?&northing=?&lid=EPA:LEMA_Facilties_Extractive_Facilities https://www.epa.ie/enforcement/mines/
Tellus	Geochemical data: multi-element data for shallow soil, stream sediment and stream water	Land & Soils	Regional	A national mapping programme	https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=6304e122b733498b99642707ff72f754
Tellus	Airborne geophysical data including radiometrics, electromagnetics and magnetics	Land & Soils	Regional	A national mapping programme	https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=6304e122b733498b99642707ff72f754
Tellus	urban geochemistry mapping (Dublin SURGE project),	Land & Soils	Regional		https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=6304e122b733498b99642707ff72f754

Notes:

1. The maps and data listed above are available on the Geological Survey Ireland map viewer https://www.gsi.ie/en-ie/data-and-maps/Pages/default.aspx

2. Please read all disclaimers carefully when using Geological Survey Ireland data

3. Geological Survey Ireland and Irish Concrete Federation published guidelines for the treatment of geological heritage in the extractive industry in 2008.

Appendix 7-2 NRA rating criteria Tables of Appendix C of IGI (2013) Guidance

Table 7-1 Criteria for Rating Site Importance of Geological Features (NRA, 2009)

Magnitude	Criterion	Description & 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

The assessment of the magnitude of an impact incorporates the timing, scale, size and duration of the impact. The magnitude criteria for geological impacts are defined in Table 7-2.

Table 7-2 Criteria for Estimating Magnitude of Impact on Geology Attribute (NRA, 2009)

Magnitude	Criterion	Description & 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
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

The matrix in Table 7-3 determines the significance of the impacts based on the site importance and magnitude of the impacts as determined by and Table 7-2.

Table 7-3 Criteria for Rating of Significant Environmental Impacts (NRA, 2009; IGI, 2013)

Importance of Attribute	Magnitude of Impact			
	Negligible	**Small**	**Moderate**	**Large**
Extremely High	Imperceptible	Significant	Profound	Profound
Very High	Imperceptible	Significant/moderate	Profound/significant	Profound
High	Imperceptible	Moderate/slight	**Significant/moderate**	Severe/significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight/moderate

Appendix 7-3 Colthurst (2014)

Report for: McGrath Quarry Group Ltd

McGrath Quarry Group Ltd

Quarry at Cregaree, Cong, County Mayo

Prepared by:

Eur Geol. John Colthurst Ph.D, P Geo **12th August 2014**

Introduction

McGrath Quarry Group is quarrying limestone at Cregaree about 0.75 kilometres west-northwest of the village of Cong, County Galway. The quarry is accessed from the main Cong to Clonbur road.

Quarrying started at this location in 1952, initially on a seasonal basis to produce ground limestone for agricultural purposes. The quarry was purchased by the present owners, the McGrath family in the early 1960s. The quarry began producing stone for building and road construction in the 1980s and a readymix plant was added in 1985. The quarry has continued to expand both its production and its range of products and a tarmacadam plant was added in 1988. It also produces weathered limestone for the garden design industry and is a source of building stone for limestone walls.

The quarry site now encompasses an area of about 67 hectares.

Regional Geology

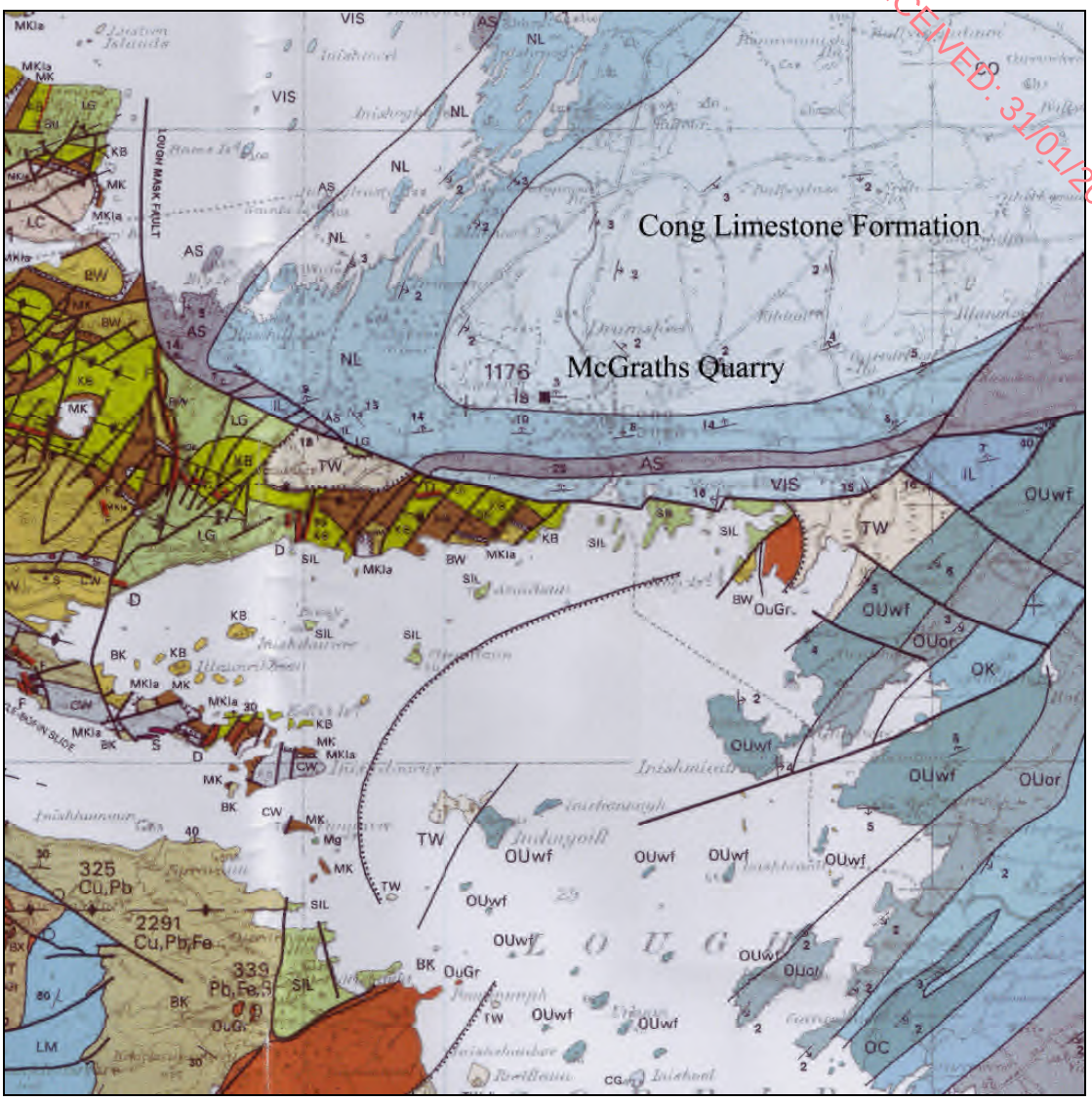

Figure 1.The geology of the area is documented in Geology of South Mayo Sheet 11, published on a Scale of 1:100,000 by the Geological Survey of Ireland, 2002.

The Carboniferous limestone on the eastern side of Lough Mask and Lough Corrib rests unconformably on Lower Palaeozoic and Dalradian rocks which are exposed on the western side of the lakes and which also form the mountainous terrain of Connemara and Murrisk. Lower Palaeozoic rocks are exposed on the southern shore of the isthmus between Mask and Corrib but a major fault separates these from the Carboniferous limestone which outcrops around Cong and extends north-eastwards towards Ballinrobe.

The most recent published work on the area is the Geological Society Special Report, Number 26, 2011. This report considerably updates the information previously available.

The Cong Canal Formation and the Cong Formation are now renamed the Corranellistrum and Knockmaa Formations.

Code	Formation Name	Thickness	Lithology
	Two Mile Ditch Mb	30m	Like Knockmaa Fm but with clay wayboards
	Knockmaa Formation	c400m	Similar to the underlying formation but with ceroid Lithostrotion.
	Corranellistrum Formation	c110m	Thick bedded medium grey, clean, fine- to medium-grained calcarenite.
	Aughnanure Oolite Formation	33m	Cross-bedded ooidal, skeletal and coated grainstone
AS	Ardnasillagh Formation	66m	Dark cherty limestone, thin shales
OC	Oldchapel Lst Formation	64m	Dark fine limestone and calcareous shale
CG	Cregg Lst Formation	157m	Coarse sandy limestone and oolite
OUor	Oughterard Lst Formation	46m	Dark limestone with thin shales
OUwf	Oughterard Lst Formation	112m	Dolomitic limestone and shale
TW	Tonweeroe Formation	C 105m	Red and grey sandstone siltstone and shale
	Unconformity	VVVVVV	
	Lower Palaeozoic		Greywackes and volcanic rocks

Only the Ardnasillagh Formation and the Corranellistrum Formation are exposed at surface around Cong as the underlying units are faulted out between Cong and the northern shore of Lough Corrib. The older Carboniferous units are exposed on the eastern shore of Lough Corrib south of Cross.

Work done for Cong Quarry by Gareth Jones of Conodate, in 2007, identified a Holkerian Cf5 microfauna in samples collected from the quarry. This firmly places the quarry in the Corranellistrum Formation, although it probably extends upwards into the Knockmaa Formation.

Jones prepared thin sections of both the samples he received and he describes both samples as being medium to coarse grainstone with abundant bioclasts and with a matrix of sparry calcite. No sulphides were seen and no quartz was visible in the thin sections. Staining with Potassium Fericyanide and Alizarin Red indicated that both sections were composed of calcite and that no dolomite was present.

Visual Inspection

The quarry was first visited in July 2007 and some time was spent examining the workings. The quarry was again visited in May 2014, prior to a diamond drilling programme.

The overburden in the area is very thin to absent but whatever overburden there is has been stripped back to expose the epikarsted top of the limestones (Plates 1 and 2). These karsted limestones are relatively thin, circa 2 metres, but the joint planes have been opened up by weathering. The weathered joints have been infilled with brown clay (Plate 3). This weathered limestone is extracted separately and is sold to the landscaping industry. The main quarry material below the epikarst consists of fresh or very slightly weathered limestone.

The quarry is worked in medium to dark grey, fresh, sparry limestones, with a variable bioclastic component. Bioclastic components include large brachiopods, corals, and crinoids. The limestones are well bedded and individual beds range in thickness from less than 1 metre up to 3 metres. Bedding planes are flat to slightly undulose but there are no clay seams present between beds and individual beds are lithologically indistinguishable from the overlying and underlying beds.

Plate 1. Bedding stripped off at the top of the quarry. Bedding planes are slightly undulating but there are no shale interbeds.

Plate 2. Epikarst limestone on western side of quarry. Face is developed along a north / south vertical joint.

Plate 3. Epikarst fissure infilled with brown clays. Face is approximately 2 metres high.

Plate 4. Quarry face on the Upper Bench. Note the obvious almost flat bedding in the limestone and the well developed set of vertical joints trending almost north/south (trend 178°).

Structure

As mentioned previously the limestone is almost flat lying and the dip measured across the quarry varies between 2 and 5° always towards the north or north-north-west. The published GSI map for the area (see Figure 1) indicates a dip of the 3° for the limestone in the vicinity of the quarry. Apart from the bedding the other obvious structural feature present is the vertical jointing. The most prominent joint set trends between 178 and 180°, that is almost north/south. A second less prominent set is orthogonal to the first set and trends east/west.

These joints are planar sided and do not show any evidence of vertical or lateral movement along them. Some of the joints, especially the north/south ones have opened slightly and the voids thus created are filled with white calcite. The very prominent joint illustrated in Plate 4 also contains purple fluorite (CaF_2)

Plate 5. North/south calcite vein visible on the floor of the quarry. This vein is 2 cm wide and is filled with white calcite.

Plate 6. The same calcite vein as in plate 5 but now controlling a vertical face in the quarry.

These joints are important in that they directly influence the faces of the quarry as blasting tends to fracture material which then fails along a prominent joint.

There is no evidence of displacement along these joints but joints are more closely spaced in some areas and the smooth vertical face on one side of the sump bench is controlled by closely spaced joints.

Weathering

The limestone is very fresh, except for the first couple of metres. Slight brownish discolouration is noticeable on some joint faces but this does not penetrate into the rock.

Water

On the days that the quarry was visited very little water was entering the quarry. There were minor seepages along bedding planes and along some of the joints but there were no significant fissures making large amounts of water.

Dolomitisation and Silicifacation

There is no visible evidence of dolomitisation anywhere in the quarry. No chert horizons are seen and there is no evidence of silicification.

Mineralisation

The only mineralisation present apart from the calcite veins is the fluorite which is present in a least one of the wider calcite veins shown in plate 4.

Plate 7. Purple fluorite in 2 cm wide calcite vein.

Chemistry of the Limestone

The limestone in the quarry appears to be very pure and there is no evidence of dolomitisation, silicification or mineralisation. No clays or shale are present in the succession and the overburden on top of the quarry has been stripped to avoid contamination. Petrological work done by Jones in 2007 confirmed that the samples provided to him contained no visible silica in thin section and staining techniques did not show up any dolomite.

McGraths Quarry completed some analysis of the limestone in 2007 and the results confirmed the extremely pure CaCO3 nature of the limestone.

From the limited analysis done in 2007 it is apparent that the Cong Quarry limestone is exceptionally pure and has the potential to be a source of chemical grade calcium carbonate. The limestone potentially has high value end uses including fillers and extenders in the manufacture of paper, paints and surface coatings, plastics, adhesives, mastics, sealants, fertilisers, animal feeding stuffs, pharmaceuticals, toiletries, carriers for insecticides and herbicides, cleaning products, glass, ceramics, desulphurisation of flue gas and water treatment. The limestone also appears to be suitable for the production of Precipitated Calcium Carbonate (PCC).

Further Work carried out in 2014

While the work in 2007 was encouraging it is based on the analysis of only four randomly collected samples and a visual inspection of the quarry. McGraths decided that the resource needed to be defined in detail and that additional data should be collected on the overall quality of the limestone in and surrounding the quarry.

To this purpose five diamond drillholes were completed in May/June 2014.

The drillholes were drilled using a standard wireline diamond drilling rig and the drilling contractor was Drilling 2000. The driller who carried out the work in the quarry was John Taylor. All of the drillcore is NQ size and continuous drillcore was collected from sub-crop to the end of the drillhole. The drillcore is stored in 1.5m long wooden core-boxes with two 1.5m runs in each box. The driller used a 3m core barrel and placed core tags in the boxes on completion of each 3m run. The drillcore was retained on site and the core boxes are stored on racks in a water tight container.

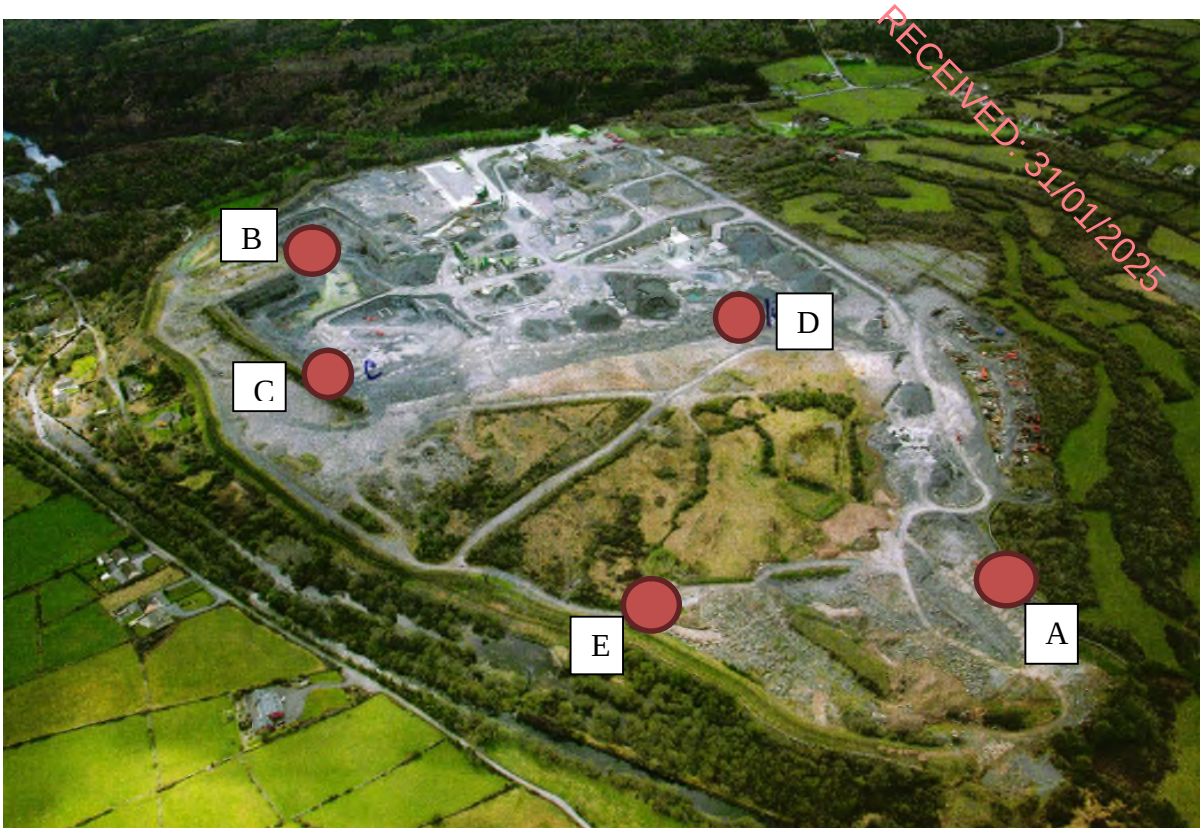

Plate 8. Drillhole locations for drillholes Cong A, B, C, D and E drilled in June 2014

	ITM co-ordinates		Metres OD		
Drillhole	Easting	Northing	Collar Elevation/ Ground Level	Final Depth	Elevation end of hole
Cong A	514033.3	756591.1	19.315	202	-182.685
Cong B	514279.8	755825	-5.444	85.2	-90.64
Cong C	514324	756159.8	9.486	61.2	-51.714
Cong D	513949.4	756269.9	11.806	64.2	-52.394
Cong E	514259.5	756502.1	16.577	67.2	-50.623
Total				479.8m	

It was originally planned to drill a maximum of 440m but Cong A was continued on to a final depth of 202m to provide a fuller geological understanding of the area.

Core Logging and Interpretation

Consultant Geologist John Colthurst logged all of the drillholes on site.

- The numbering of the core boxes was checked and all boxes numbered with permanent tape.
- The marker tags were checked to ensure that they were present, in their correct places and were legible.
- The drillcore was washed, if necessary, to remove and clay adhering to it.
- The geologist checked and condensed the core prior to geotechnical logging. Any broken core was pieced back together to allow accurate core recovery estimations.
- The drillcore was photographed.
- The drillcore was logged. Both a geotechnical log and a lithologic log were completed.
- Unusual features, dolomitised intervals, significant fossils were photographed separately.
- After logging, the entire core, with the exception of the bottom 130m of drillhole Cong A, was marked up in two metre intervals for sampling. Two metre intervals, every ten metres, were also marked up from 80m to the end of drillhole Cong A.
- A geological technician used a diamond saw to half the drillcore longitudinally. One half of the core was retained in the core box and the other half, in 2m intervals, was placed in heavy gauge plastic bags which were then sealed.
- A triplicate tag numbering system was used to identify the samples. One numbered tag was placed in the bag with the sample, the second section of the tag was placed in the core box and the third section remained in the tag book.
- The samples were then dispatched to ALS Chemex in Loughrea for analysis.

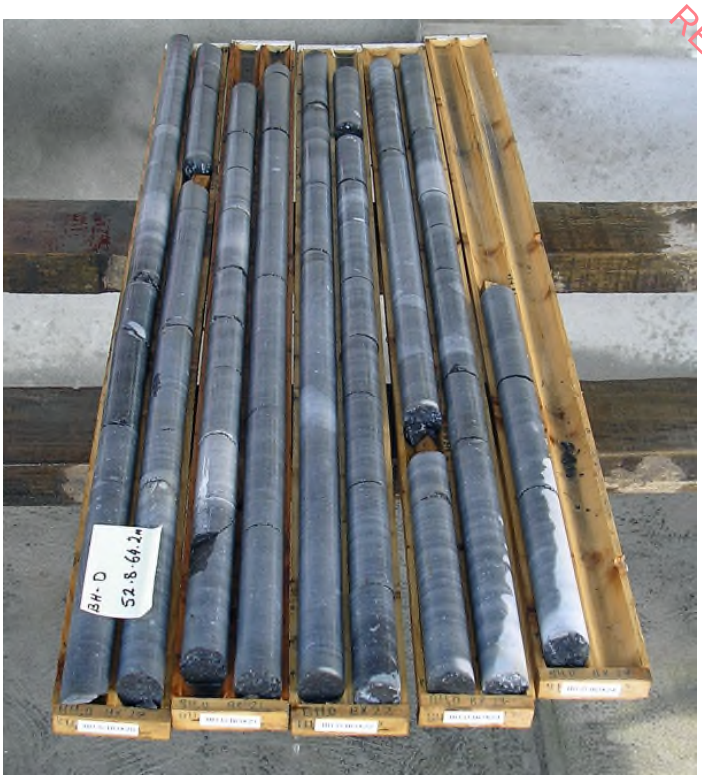

Plate 9. Typical photograph of drillcore, Cong D 52.8 to 64.2m. All drillhole photographs are included in the Appendix.

Geotechnical Logs

The geotechnical logs are provided as an appendix to this report. The core is examined 3m interval by 3m interval.

Definitions

Core Run: The core run is the length of core drilled between each pull of the core tube. In theory this is always 3m but in reality it will vary slightly depending on where the core breaks.

Total Core Recovery: The recovery is measured by the geologist, who first pieces the core together. Because the core can not be totally pieced back together the core recovery is often slightly greater than the actual core run. The total core recovery (TCR) is the measured core recovered expressed as a percentage of the core run.

Recovery >100mm: The geologist measures all pieces of core which are greater than 100mm in length and are complete in the round. These are expressed as a percentage of the Core Run in the Rock Quality Designation (RQD). High % RQDs indicate strong fresh competent unfractured rock.

Joint Frequency: The geologist counts the number of joints over a 3m interval. For this purpose bedding planes are counted as joints but artificial bedding breaks, created

by the driller, are discounted. The higher the frequency the more thinly bedded or fractured the rock.

Number of Joints: This is a measure of the number of types of joint present. A value of 1 indicates that only the bedding is present. A value of 2 indicates the presence of a joint system. In Cong Quarry a value of 2 almost always reflects the presence of vertical joints.

Weathering: There is a system of codes in place to designate the level of weathering of rock. Codes cover everything from totally weathered rock to fresh completely unaffected rock. Almost all of the Cong rocks are coded as F (fresh). A few sections are classified as FW (faintly weathered). In faintly weathered sections there is slightly staining on joints and bedding planes but the weathering does not penetrate into the rock.

Vuggy: Limestone can be massive and dense or it can on occasion be vuggy and porous. Almost all of the Cong rocks are non vuggy. Any vuggyness is normally associated with dolomitisation.

Roughness: There is a coding system in place for the roughness of joints. This is important in engineering applications because the smoother the joint the more likely it is to fail. Because the main joint identified in Cong quarry is the bedding and this is almost flat-lying the smoothness or otherwise of the joints is not very important but in any case the joints are rough and sometimes they are even stylolitic.

Infill: This is a category to describe the material infilling joints. In Cong the joints are either tight with no infill or they contain white calcite.

The geotechnical logs of the Cong drillholes are summarised in the table following:

Drillhole	From-To metres	Core Recovery	RQD	Joint frequency per metre
Cong A	0 - 202	100.3%	97.5%	1.8
Cong B	0 - 85.2	100%	90.4%	1.7
Cong C	0 - 61.2	100.3%	98.7%	1.4
Cong D*	4.2 - 64.2	100.6%	91.4%	1.9
Cong E*	1.1 - 67.2	102%	99.9%	1.2

* *Short interval at start of these holes not included in statistics because ground was broken by blasting.*

In all five drillholes the core recovery is 100% are greater. These core recoveries show that no cavities were intersected in any of the drillholes. RQDs range between 91.4% and 99.9% and these very high RQDs demonstrate the highly competent fresh unfractured nature of the rock. The slightly lower, but still high, RQDs in Cong B and Cong D are because these drillholes intersected sub-vertical to steeply dipping joints.

The joint frequency per metre is also low and is associated with the thickly bedded or massive nature of the limestone.

With the exception of a very small number of intervals, mostly at the start of drillholes, the rock is classified as F (Fresh). This means that there is no detectable sign of weathering. Intervals at the top of drillholes A, B, D, and E are classified as FW (Faintly Weathered).

A couple of short vuggy intervals are recorded, 105.5 – 107.29m in Cong A and 84.8 – 85.2m in Cong B. Both of these intervals are associated with dolomitisation.

Plate 10. Vuggy dolomitised interval at 27.4m in Cong A. Note the dolomite crystals lining the vug.

Lithologic Logs

Lithologic logs were also prepared for all of the drillholes. The lithologic logs subdivide the units within the drillholes. However all of the drillholes are very similar and even the deep hole, Cong A does not differ much.

- Almost all of the core consists of clean medium to fine grained biosparites and grainstones
- There are no mudstones present

- Some intervals look to be pellety or oolitic for example 20.8 – 22.8m in Cong A

- Cong A becomes very slightly darker and muddier below 144.4m. This interval is not intersected in the other drillholes

- Cong A however finishes in very clean pale grey biosparite

- All of the holes are fossiliferous with well developed patches of colonial coral. These corals are prominent from 40.2m downwards in Cong A, from 9m in Cong B, from 34.2m in Cong C, from 28.2m in Cong D and from 28.2m in Cong E and it is possible to suggest a rough correlation from hole to hole.

	Collar Elevation OD	First Colonial Coral (metres down hole)	Elevation OD of first Colonial Coral horizon
Cong A	19.315	40.2	-20.885
Cong B	-5.444	9	-14.444
Cong C	9.486	34.2	-24.7
Cong D	11.806	28.2	-16.34
Cong E	16.577	28.2	-11.623

The beds dip to the north or northwest, as a result this horizon will be deepest in Cong A, shallowest in Cong B and at intermediate depths in the other three holes.

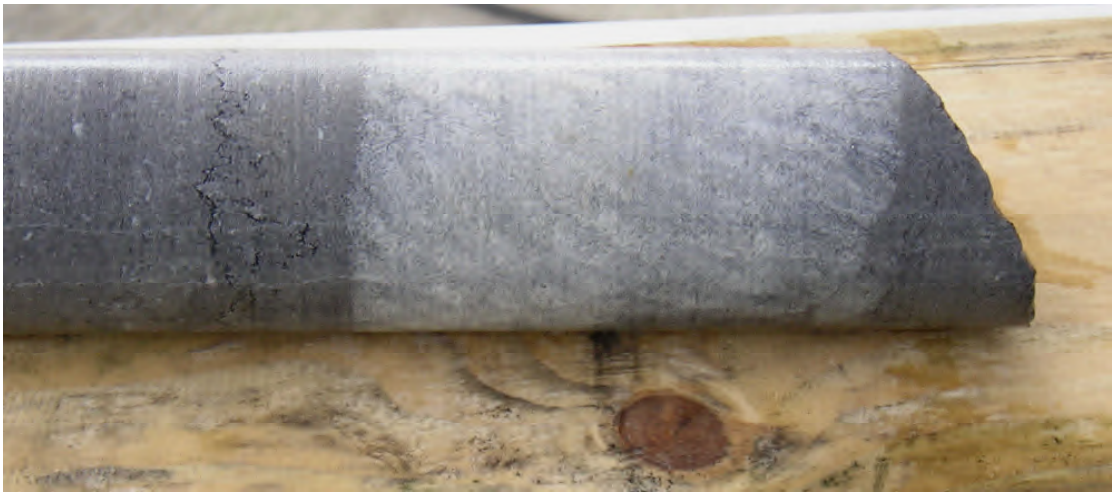

Plate 11. Typical Colonial Coral, probably Lithostrotion verticale. This specimen is from Cong A.

Other macro-fossils present include solitary corals, brachiopods, gastropods, and crinoids. The micropalaeontology done by Jones in 2007 also identified a diverse micro fauna which could be used for detailed correlation if required.

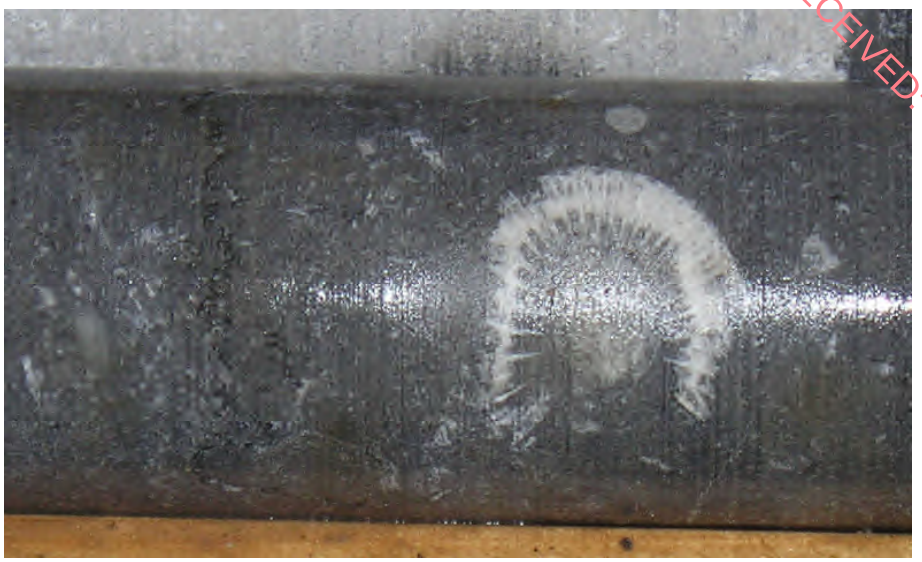

Plate 11. Solitary coral, Cong A

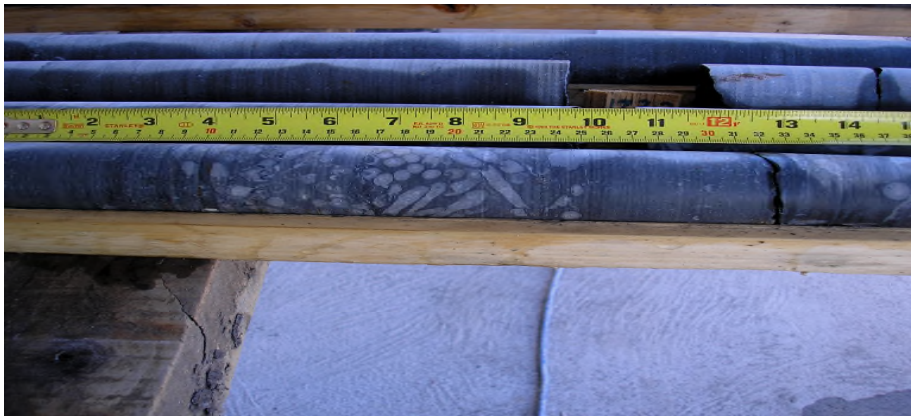

Plate 12. Colonial coral, probably Syringapora, Cong A

Plate 13. Solitary coral, Cong A

Chemical Analysis

All of drillholes Cong B, C, D and E were sawn, halved and bagged in 2m intervals for chemical analysis. The top 70m of drillhole A was sampled in the same manner. The remainder of Cong A was also sampled but a two metre half-core sample was taken every 10m.

The samples were sent to ALS in Loughrea for analysis.

ME-XRF26 was selected for Total Whole Rock Analysis and ME-ICP61 was used to look at a wider range of trace elements. Sulphur was analysed using S-IR08. ALS had some difficulties with ME-XRF26 and instead used ME-XRF06. Fact sheets outlining each of these methods are included in the Appendix.

The results received from ALS are in the form of EXCEL spreadsheets. These are difficult to print due to their length and they are supplied digitally with this report.

In the main spreadsheets the blue columns have been added. In the XRF results the CaO and MgO have been converted to $CaCO_3$ and $MgCO_3$. The $CaCO_3$ and $MgCO_3$ have been added together to measure total carbonate.

The two tables below have converted the XRF results for CaO and MgO to $CaCO_3$ and $MgCO_3$ by atomic mass. The top table uses cut core assays to a final depth of -50m OD and the bottom table uses all of the assays including the assays taken every 10m to the bottom of Cong A.

The tables also show $CaCO_3$ calculated by difference. All of the components with the exception of $CaCO_3$ are added up and subtracted from 100%. The two methods differ by 0.5%. The main impurity is $MgCO_3$ and this is most prevalent in Cong A where the top part of the hole is slightly dolomitised.

Carbonate content in Cong Drillholes, to depth of -50m OD

	From metres	To metres	$CaCO_3$	$MgCO_3$	$MgCO_3$+$CaCO_3$	$CaCO_3$ by difference
Cong A	0	70	95.94	4.11	100.05	95.360
Cong B	0	46	98.47	1.37	99.85	98.188
Cong C	0	60	99.09	2.16	101.25	97.397
Cong D	0	62	98.08	2.37	100.45	97.249
Cong E	0	64	96.13	2.89	99.02	96.628
Average			97.54	2.58	100.12	96.964

Carbonate content in Cong Drillholes, full depth for all drillholes

	From metres	To metres	$CaCO_3$	$MgCO_3$	$MgCO_3$+$CaCO_3$	$CaCO_3$ by difference
Cong A	0	202	95.64	4.14	99.77	95.192
Cong B	0	85.2	97.20	2.18	99.39	97.369
Cong C	0	60	99.09	2.16	101.25	97.397
Cong D	0	64.2	98.12	2.23	100.35	97.287
Cong E	0	66	96.13	2.89	99.02	96.666
Average			97.24	2.72	99.96	96.78

Conclusions drawn from the Chemical Analysis

- % Al (Aluminium) by ICP ranges between 0.038% and 0.049% with an average value of 0.043%. The bottom part of Cong A is slightly higher at 0.068% and this is as expected because the logging indicates that this section is slightly argillaceous. Overall the values are very low and the argillite content is negligible.

- Cr (Chromium) values are between 2.9 and 4.7ppm

- Fe (Iron) values by ICP range between 0.018 and 0.037% with an average value of 0.025%. The bottom part of Cong A is slightly higher at 0.049%

- Mg (Magnesium) values by ICP range between 0.351 and 1.102% with an average of 0.668%. The bottom part of Cong A is higher at 1.078%. The upper part of Cong A is higher in Mg that the upper parts of the other holes. Most of the higher Mg values are within the top 30m of this hole and the highest value is in the interval 26 to 28m. This is the same interval where the vuggy dolomite, in Plate 10, was observed.

  Cong A is the furthest north of the drillholes and collared highest in the succession. Most of the higher Magnesium values are in rocks towards the top of the succession and they are also in evidence in drillholes C and D.

- Mn (Manganese) values range between 20.06 and 60.03ppm with an average of 32.74ppm. The bottom part of Cong A is slightly higher than average but lower than the upper part of Cong A

- P (Phosphorus) values range between 25.714 and 30.476ppm with an average of 28.151ppm.

- Sulphur values where detected average 0.025% except in the bottom part of Cong A where they are 0.05%

- Calcium Carbonate values by XRF range between 95.42% and 98.49% with an average of 96.95%. The bottom part of Cong A is lower at 94.16%.

- Total Carbonate, which includes Magnesium Carbonate, ranges from 98.44% to 100.50% with an average of 99.47%. The bottom part of Cong A is slightly lower with an average value of 98.35%.

- SiO_2 values by XRF range between 0.135 and 0.194% with an average of 0.168%. The bottom part of Cong A is considerably higher at 0.67%. The Jones petrographic report (2007) mentions the presence of fossil sponge spicules and these rather than terrigenous debris possibly account for the low levels of silica present.

- Sr (Strontium) values by ICP are extremely consistent across all of the drillholes. The average strontium value is 337.78ppm. Small quantities of Strontium replace Calcium in Calcium Carbonate.

Mineralisation and Alteration in drillcore

A vuggy dolomitised zone is present from 27.23 to 27.6m in Cong A. This is illustrated in Plate 10. Analysis of the limestone above this interval in Cong A suggests the presence of some Magnesium but no obvious dolomite is visible in the core and there is no vuggy porosity.

Occasional fresh brassy cubic pyrite crystals are present and these are always associated with brachiopod fossil moulds. A typical example is shown in Plate 14. This type of pyrite is generally considered to be largely unreactive.

Plate 14. Cubic pyrite in a brachiopod mould.

S. R. 21:2014 Compliance

S.R. 21 deals with Guidance on the use of I.S.13242:2002+A1:2007 – Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction. Section E.2.4 of S.R.21 requires a geological, chemical and petrographic assessment of a quarry and the end products. The Professional Geologist as part of his study investigated whether Cragree Quarry is fully compliant with S.R.21. The S.R.21 document is a separate report but the Professional Geologist is

satisfied that Cragree is fully compliant and that aggregate from the quarry is suitable for use under concrete floors and footpaths.

Prepared by:

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Appendices:

Geotechnical Drill-logs for Drillholes Cong A to E

Lithological Drill-logs for Drillholes Cong A to E

Photographs of Drillholes Cong A to E

List of all drillcore cut and sampled with sampling intervals and sample numbers

Sulphur Analysis Methods – Speciality Assay Procedure provided by ALS Minerals

Whole Rock Geochemistry ME-XRF-06 – Procedure provided by ALS Minerals

Geochemical Procedure ME-ICP61 – Procedure provided by ALS Minerals

Geochemical results, from ALS, provided digitally