Spink Quarry, Knockbaun, Abbeyleix, Co. Laois

Spink Quarry

Environmental Impact Assessment Report

Section 6

Land, Soils & Geology

2021

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6 LAND, SOILS & GEOLOGY

6.1 INTRODUCTION

This section of the EIAR describes the geological setting, in both a local and regional context, of the proposed development with respect to the land, soil, subsoil and geological bedrock environment. The potential impact on the geological environment resulting from the proposed continuance of quarry operations is assessed and possible mitigation measures proposed to reduce any significant impacts. It also provides an assessment of the impact of the quarry on the geological features of the site itself.

An assessment of the hydrological and hydrogeological impacts relating to the quarry is detailed in *Section 7* of the EIAR.

6.2 REGULATORY BACKGROUND

6.2.1 Introduction

There are two acts or regulations that are specific to this chapter, and these are:

- Mines and Quarries Act, 1965, (S.I. 7 of 1965); and
- The Safety, Health and Welfare at Work (Quarries) Regulations, 2008, (S.I. 28 of 2008), as amended.

Policies and plans that have a direct bearing on this chapter include the following:

- EMRA (2019). *Regional Spatial & Economic Strategy 2019-2031*. Eastern & Midland Regional Assembly (EMRA); and
- Laois County Council (2017). Laois County Development Plan 2017-2023.

Refer to Appendix 1 of this EIAR.

6.2.2 Guidance

This chapter of the EIAR has been prepared with regard to the following guidance:

- DoEHLG (2004). Quarries and Ancillary Activities – Guidelines for Planning Authorities. Department of the Environment, Heritage and Local Government (DoEHLG);
- EPA (1992). BATNEEC Guidance Notes for the Extraction of Minerals. Environmental Protection Agency (EPA);
- EPA (2006). Environmental Management in the Extractive Industry (Non-scheduled minerals). Environmental Protection Agency (EPA);
- EPA (2015). Draft Advice Notes for Preparing an Environmental Impact Statement. Environmental Protection Agency (EPA);

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- EPA (2017). Guidelines on the Information to be contained in an Environmental Impact Assessment Report, Draft, Environmental Protection Agency (EPA);
- GSI/ICF (2008). Geological Heritage Guidelines for the Extractive Industry. Geological Survey of Ireland (GSI) and Irish Concrete Federation (ICF);
- IGI (2007). Recommended Collection, Presentation and Interpretation of Geological and Hydrogeological Information for Quarry Development. Institute of Geologists of Ireland (IGI);
- IGI (2013). Guidelines for the preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements. Institute of Geologists of Ireland (IGI);
- NRA (2008). Environmental Impact Assessment of National Road Schemes - A Practical Guide National Roads Authority (NRA); and
- NRA (2009). Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes. National Roads Authority (NRA).

6.2.3 Technical Standards

This following technical standard was used in the field during the site visit:

- British Standards (2015). Code of Practice for Site Investigations BS5930:2015.

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6.3 METHODOLOGY

The section essentially describes the geological and soil environment at the site and wider vicinity and assesses the potential impacts on these as a result of the proposed development. The scope of works for the assessment undertaken comprised the following:

- Consultations;
- Desk Study;
  - Collation of existing regional information regarding the geology, soil and land use of the site and surrounding area.
  - Review of other available site information.
- Field Work;
  - Site walkover on 17th February 2021 and 31st June 2021
- Reporting.

6.3.1 Consultations

A response was received from Clare Glanville, Senior Geologist, GSI with respect to a request for pre-application consultation in relation to the proposed development (Refer to EIAR Section 6.6.2 below and Appendix 4 for details).

6.3.2 Desk Study

The desk study was undertaken to compile, review and interpret available information, data and literature pertaining principally to the geological and soil environment of the site, its immediate environs and regional setting.

All available regional and site-specific information was compiled, assessed and interpreted during the preparation of this geological assessment. The geological assessment of the site is considered sufficiently detailed to adequately characterise the geological setting of the site.

The evaluation consisted of an examination of relevant geological data from the Geological Survey of Ireland, the Irish Geological Heritage (IGH) Programme, and other geological references for the area, as well as data on soil and land use from the Environmental Protection Agency (McConnell & Philcox 1994; Parkes et al. 2016; Fealy & Green 2009). Available geological maps, surveys, literature, and reports relating to the site and the locality were examined as part of the baseline desk study. Site specific geological and geophysical data were acquired from reports by SLR (2020) and Apex (2021), respectively.

6.3.2.1 Sources of information

The assessment was carried out in general accordance with the above guidance documents. Also, data was sourced online from the following websites:

- http://gis.epa.ie/Envision Envision Geoportal, Environmental Protection Agency (EPA); and

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- http://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228 Public Data Viewer, Geological Survey of Ireland (GSI).

Refer also to References (EIAR Section 6.7 below).

6.3.2.2 Designations

The application site is not within any European Site, including Special Protection Area (SAC) and Special Protection Areas (SPA). Appropriate Assessment Screening has been carried out with respect to the proposed development (See Appendix 8).

The Irish Geological Heritage (IGH) Programme identifies a wide range of sites that represent Ireland's geological heritage. The programme is a partnership between the Geological Survey of Ireland (GSI) and the National Parks and Wildlife Service (NPWS), and sites identified as important for conservation are designated as Natural Heritage Areas (NHA).

In its 2017-2023 County Development Plan (CPD), Laois County Council (2017) recognises sites of geological interest, which include twenty five County Geological Sites (CGS). The site of the quarry is not designated as a CGS or a pNHA, while the nearest such site is Moyadd Stream, c. 2 km to the east.

6.3.2.3 Impact Assessment Methodology

The impact assessment methodology used in this EIAR is based on the criteria given in the EPA's Guidance EPA (2015; 2017) (Refer Appendix 3). The effects on land, soils and geology are assessed in terms of type (e.g., direct), quality (e.g., negative), significance (e.g., moderate), extent or context (e.g., area, conformance to baseline), probability (e.g., likely), and duration or frequency (e.g., short-term, momentary) of the impacts. The NRA (2008) provide an additional criterion for assessing soil and geology features that is based on its Importance from Very high to Low, which is also adopted in the EIAR (Refer Table 6.1). Thus, for example, the Importance of a designated County Geological Site (CGS) would be assessed as Very High, whereas that of an uneconomically extractable mineral resource would be assessed as Low.

6.3.3 Field Study

The field survey consisted of a site walkover on 17th February 2021 and 31st June 2021 to assess the geology of the site and record all significant geological features. The exposed sandstone/siltstone deposits in the quarry were examined during the site walkover and are described below. Aspects of the desk-based assessment were verified, and geological descriptions and photographs of the geological features were recorded. The site walkover included a visual examination of the quarry faces as part of this geological assessment.

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Table 6.1 Criteria for Estimation of Importance of Soil and Geology Attributes

Importance	Criteria	Typical Examples
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 route is significant on a national or regional scale*	Geological feature rare 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 route 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 highly 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 route 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 route 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 Uneconomically extractable mineral resource

* Relative to the total volume of inert soil disposed of and/or recovered. NRA (2008).

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6.4 BASELINE DESCRIPTION OF RECEIVING ENVIRONMENT

6.4.1 Land

Both the soils and bedrock geology have an important role in determining the environmental characteristics of the land. The underlying bedrock has a major influence on the landform that develops, and the constituent rocks provide the parent material from which the soils are derived. The natural characteristics of the rock help determine the nature of the derived soil, as well as the rate at which it forms, whilst the soil strongly affects both the natural vegetation that emerges, and the type of agriculture that can be sustained. The topography of the area is a reflection of the underlying geology, which is described in the succeeding subsections.

6.4.1.1 Site Location

The site is located within the Townland of Knockbaun, c. 4 km northwest of Swan, c. 7 km south of Timahoe, c. 9.5 km east of Abbeyleix, c. 10 km north of Castlecomer, c. 13.5 km southwest of Stradbally, c. 16 km south of Portlaoise, and c. 19.5 km northwest of Carlow Town (Refer EIAR Figures 1.1 and 1.2). The quarry is located on the southern side of Regional Road R430, which connects the town of Mountrath and Abbeyleix to the west with the village of Swan and Carlow Town to the southeast. The site is situated in a wide bow in the R430 as it swings around the hill into which the quarry has been excavated.

6.4.1.2 Topography

The topography of the region is that of rolling hilly landscape with the site situated on the northwestern margin of the Castlecomer Plateau, where elevations typically vary from 180 to 270 m Above Ordnance Datum (AOD). The site occurs at a maximum elevation of 261 m AOD along the southern boundary and a minimum elevation of 215 m AOD along the R430 Regional Road (northern boundary). The surrounding lands are largely agricultural with varying degrees of intensity, but with afforestation abutting the site to the south.

Topographically, the lands are within the watershed of the Nore River Basin. Hydraulically, however, there is a divide through the centre of the site with the subcatchments of the River Clogh to the east and the River Owenbeg to the west. The latter rises on-site close to the main entrance and flows to the southeast and subparallel to the R430 as a drainage ditch/stream, draining into the Clogh River, Dinin River and ultimately into the Nore River just north of Kilkenny City. Two tributaries of the Owenbeg River, the Knockbaun and Garrintaggart, rise south and north, respectively, of the quarry and flow to the northwest to drain into the mainstream of the River Owenbeg c. 500 m from the site. The Owenbeg River drains into the Nore River north of Ballyragget.

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6.4.1.3 Land Use & Land Cover

Outside of the immediate environs of the urban areas of Abbeyleix, Castlecomer and Carlow, and the nearby villages of Swan and Ballinakill, the settlement pattern in the area can be described as low to medium-intensity rural settlement. There are a significant number of detached residential dwellings located in the wider area, which typically occur as individual residences and diffuse ribbon development along the road network, while individual farmsteads generally occur at the end of lanes.

The land in the wider area surrounding the quarry is typically agricultural land and consists of a patchwork of generally medium to small agricultural fields, with typically poorly managed hedgerows. The Corine (CORINE: Co-ORdinated INformation on the Environment) land-use map (2018) shows that the land in the area is predominantly held in pasture (231), with significant areas of natural vegetation (243), coniferous forests (312), transitional woodland shrub (324), and minor areas of land principally occupied by agriculture (Refer Figure 11.6).

As stated above, the lands are bounded to the north by the R430 Regional Road, while it is bounded by farmland and afforestation along all other boundaries. There is a standoff of c. 300 m from the extraction area to the nearest residence, which is situated north of the site.

The applicant is full owner of the freehold interest in the site and full landholding, where the latter comprises c. 19.6 ha. To date, extraction has taken place in the northern and central sections of the quarry, and it is proposed that extraction will be confined to the existing permitted quarry area (P.A. Ref. 10/383) comprising an extraction area of c. 14.5 ha.

The northern and central area of the quarry site is largely dominated by bare, exposed ground, aggregate stockpiles, and infrastructure with areas of scrub and hedgerow on undeveloped lands around the perimeter. The southeasternmost section of the land holding (c. 4.7 ha), remains as undisturbed scrub and poor grazing land and will remain in place to form a natural screening barrier from views to the east and northeast. The adjacent land to the south is higher than the site and combined with a substantial number of hedgerows, native trees, and forestry along the boundaries, makes the site relatively secluded (Refer Figure 1.3).

The quarry is currently not in operation, and the asphalt plant has been removed from the site. The applicant does not intend to resume asphalt production at the site.

Quarry workings have been a feature of this site since before the 1970's.

There are no residences within or abutting the application site. The closest residential property is situated c. 175 m west of the northernmost corner of the application site and is one of a cluster of three residences at Larkin's Cross where the R430 intersects rural roads L7792 and L77921. Two further residences are situated nearby along rural road L77921, while a sixth residence is situated on the L77922 c. 240 m directly across from the site entrance. Because of the intervening hill into which the quarry was driven, the residence situated c. 240 m opposite the site entranceway is the only residence

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within 250 m that has views of the quarry workings (i.e., No. 4 in EIAR Figure 4.1). There has been a long historical association with quarrying at this location and consideration has been given to screening of the development, phasing and direction of working with respect to receptors to reduce visual impact, while impacts due to noise and dust are substantially attenuated.

The lands are bounded to the north by the R430, while it is bounded by farmland and afforestation along the other boundaries. Because the quarry has been developed by excavating into the northeastern flank of the hill, the latter screens all views of the workings in an arc from the northwest to west to south. Presently, there are limited views of the workings along the R430 east with most views of the current quarry workings screened by existing perimeter berms and screen planting along the roadside boundary. There are also middle-distance intermittent views from rural road L77922 and rural road L7792. These limited, intermittent views generally amount to views of the upper quarry face, against the coniferous forest forming the southern site boundary.

Overburden stripped to access the underlying resource has been used to construct peripheral screening berms and for restoration of completed sections of the excavation. An earthen berm with screening from mature planting of deciduous trees fringes the c. 700 m northern boundary of the quarry site with the R430, while the other boundaries are largely maintained with stock fencing and hedgerows.

Ultimately, the quarry site will be decommissioned and reinstated in accordance with the approved quarry restoration scheme. Thus, the quarry site will undergo a change of land use from mineral extraction to a secure wildlife refuge and will be integrated back into the surrounding landscape.

6.4.1.4 Land Take

The development will consist of the continued use and operation of the existing quarry within the currently permitted area (P.A. Ref. 10/383), including deepening of the quarry. Extraction will be confined to the existing permitted quarry area (P.A. Ref. 10/383) comprising c. 14.5 ha extraction area within the full landholding of c. 19.6 ha (Refer to EIAR Figures 1.2 and 1.3). The site is located on lands immediately southwest of Regional Road R430 and has c. 700 m of frontage onto the R430. The site is otherwise bound by agricultural and forested lands.

The northern and central area of the quarry site is largely dominated by bare, exposed ground, aggregate stockpiles, and infrastructure with areas of scrub and hedgerow on undeveloped lands around the perimeter. The southeasternmost section of the land holding (c. 4.7 ha), remains as undisturbed scrub and poor grazing land and will remain in place to form a natural screening barrier from views to the east and northeast. The adjacent land to the south is higher than the site and combined with a substantial number of hedgerows, native trees, and forestry along the boundaries, makes the site relatively secluded.

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6.4.2 Soils

Soil is an essential natural resource and is intrinsically valuable to the environment, and all life within it. Soil is the surface layer of the Earth's surface that is capable of supporting life, and encompasses topsoil and the upper, weathered portion of the subsoil. Soil varies from place to place, and may be mineral or organic, acid, or alkaline, deep, or shallow, and well drained or poorly drained. Soil generally derives from parent geological material and includes organic matter under the influence of numerous processes, unlike subsoil which has no organic matter within.

Soil provides for several important functions, including:

- Contributes to the hydrological cycle in the filtration/recharge, storage and discharge of rainwater;
- Supports all terrestrial ecology, including all flora and fauna; and
- Protects and enhances biodiversity;

Topsoil and subsoil may derive from parent geological material and organic matter under the influence of numerous processes, including weathering and erosion. In terms of subsoil, the profound influence of glaciation in Ireland is seen in the glacial till, which blankets much of the underlying rocks.

Visual assessment of the soils within the quarry site suggests that the soils are shallow, naturally well drained, with no indication of waterlogged soils.

6.4.2.1 Topsoil

The topsoil in the study area is typical of dry mineral soils found in rolling lowlands (Gardiner & Radford 1980). The 2nd Edition of the General Soil Map of Ireland, with accompanying Soil Survey Bulletin No. 36, was published by Gardiner and Radford (1980). The map has a publication scale of 1:575,000, which results in generalised soil regions that provide poor geographic resolution and reference to allow useful spatial data on the range of soil types to be expected at the scale of the property. Nonetheless, the topsoil in the wider area consists dominantly of Gleys (75%) with lesser associated Acid Brown Earths (15%) and Peats (10%), which are derived from parent materials of Upper Carboniferous shale glacial till and cover most of the Castlecomer Plateau.

The soil types occurring at the site and in the wider area were primarily assessed by reference to the Teagasc/EPA soil map (EPA 2018; Refer Figure 6.1). The dominant soil occurring in the wider area around the Spink Quarry is Surface Water Gleys and Ground Water Gleys (AminPD), which are derived from mainly non-calcareous parent material. There are several large patches of AminSW (Lithosols and Regosols), which are derived from mainly non-calcareous parent material, and cover most of the site at Knockbaun, with a minor tract of mostly Gleys (Refer Figure 6.1). Ribbons of Alluvmin (Mineral Alluvium) developed along river courses, and small pockets of AminSP (Peaty Podzols) also occur in the area.

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Lithosols and Regosols are azonal soils that are developed mostly from shallow stony deposits, and from the alluvial deposits of rivers, respectively (Gardiner & Radford 1980). Lithosols are skeletal stony soils that are predominantly shallow, well-drained soils derived from non-calcareous materials, and tend to be stony mineral soils. The profiles of Regosols show no distinct horizon development, and usually have a light-coloured A1 horizon directly overlying the C horizon. The texture of regosols varies between sands and clays, depending on the parent material. It is considered that the identification of Lithosols and Regosols in the Teasgasc/EPA maps is consistent with underlying non-calcareous parent material of Westphalian sandstones and shales (See EIAR Section 6.4.2.2 below).

Gleys are soils that have developed as a result of permanent or intermittent water logging and show the effects of poor drainage. This may be due to a high water table, a perched water table caused by the impervious nature of the soil, or to seepage of runoff from slopes. The name Gley is derived from the Russian words “glei”, meaning compact bluish-grey, as greyish, or bluey-grey colours and orange mottling are characteristic of gley soils. These soils occur at all elevations where the upper soil horizons are wet for much of the year and are generally rich in organic matter with intergrades to shallow peat (>50cm). The dominance of Gleys in the wider landscape indicate that the soil types in the Knockbaun locality are poorly drained.

6.4.2.2 Subsoil – Quaternary Geology

In terms of subsoil, the profound influence of glaciation in Ireland is seen in the deposits of glacial till and glaciofluvial sand and gravel that blanket much of the underlying rocks of the country. Geologically recent Quaternary sediments cover the rocks in most of Laois, and many are of glacial or glaciofluvial origin that were deposited within the last 2.6 million years (2.6 Ma).

The Quaternary Period itself spans from 2.6 Ma to present, and the sediments and features formed during glaciation, which is characteristic of the Period, are commonly treated under the general term Quaternary Geology. The last Ice Age, known as the Late Midlandian or Devensian, peaked at approximately 20-25,000 years before present (BP) in Ireland, with total deglaciation of Ireland by around 13,000 years BP. Soils would have begun to develop after deglaciation, around the beginning of Holocene epoch at 12,000 years BP. Thus, the origin of the subsoil is associated with deposition related to ice movement during glaciation, particularly during the glacial maxima, and later glacial retreat and melting during deglaciation. Ice sheets grind and pulverise the underlying bedrock, reducing it to fragments ranging from boulders to clay particles. Sediments and features formed during the glaciation are commonly treated under the general term Quaternary Geology. The two main types of Quaternary subsoils in Ireland are; (1) glacial till, largely deposited at the base of ice sheets; and (2) sand and gravel deposits associated with the melting of the ice sheets, and generally termed ‘glaciofluvial sands and gravels’.

The area of County Laois was overlain by a thick ice sheet at the glacial maxima, which moved in a general southeasterly direction. The powerful erosive force of the ice sheet

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is considered to have sculpted the landscape in the region, as evidenced by many preserved glacial features. Glacial till represents the most common and areally extensive glacial deposits and is comprised of poorly sorted boulder clay dumped in the zone of wastage beneath the glacier or ice sheet, which can be associated with one or more of the advancing ice sheets prior to the final Midlandian retreat. As ice sheets melt, the meltwaters sort and deposit fluvioglacial sands and gravels in the form of characteristic glacial features, such as eskers and moraines.

Teagasc and the EPA initiated a nationwide Soil and Subsoil Mapping Project, the final report for which was published by Fealy & Green (2009). The soil map of every county in Ireland were compiled by a remote sensing and GIS-based methodology. In order to map all the soil variants in a single national soil map, the classification system of soil types had to be simplified relative to previous soil surveys but retain a close relationship to the Great Soil Groups in Ireland. Although the maps have a maximum online scale of 1:2,000 (See EPA 2019), the nominal working scale of 1:100,000-150,000 was used during map preparation. The maps are categorically simplified, but are cartographically detailed, and thus offer superior spatial definition to the General Soil Map. The distribution of the soil types at Spink Quarry is assessed by reference to this Teagasc/EPA Soil/Subsoil Map, with supplementary interpretation based on the General Soil of Map of Ireland (Gardiner & Radford 1980). The Teagasc/EPA topsoil and subsoil maps of the Knockbaun area are shown in Figure 6.1 and Figure 6.2, respectively (Fealy & Green 2009; EPA 2020).

From groundwater data (GSI 2020), it is apparent that much of the Castlecomer Plateau is covered by relatively thin overburden thicknesses with vulnerability ratings of X and E, corresponding to overburden thicknesses of <1 m and <3 m, respectively. In the Knockbaun area, including the prominent hills to the north, the vulnerability rating is predominantly X and E, while the application site is almost entirely rated as X with a minor tract of E corresponding to the occurrence of Gley topsoil. On the Castlecomer Plateau, the overburden consists dominantly of glacial till (TNSSs), with lesser amounts of subcropping rock (Rck), minor glaciofluvial sands and gravels derived from limestone (GLs), and lesser discontinuous ribbons of undifferentiated alluvium (A) (Refer Figure 6.2). It is apparent from the latter Figure that the topsoil on-site is underlain by subcropping bedrock with negligible glacial overburden. A minor tract of till classified as TNSSs (Shales and sandstones till (Namurian)), which is the dominant subsoil type in the wider area, formerly extended from the near the site entrance to the processing area but has been stripped to access the underlying bedrock.

It is thus unsurprising that Spink Quarry was developed into a hill of subcropping Westphalian sandstones and shales, the Clay Gall Sandstone Fm. in particular, that were readily accessible from the R430 regional road in a rural area with low population density.

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6.4.3 Bedrock Geology

6.4.3.1 Regional Bedrock Geology

The application site lies on the extreme southwestern corner of Sheet 16, the Geology of Kildare-Wicklow (McConnell & Philcox 1994). Thus, this subsection is based largely on, but without explicit individual references in the text, the Geological Description to Accompany the Bedrock Geology 1:100,000 Scale Map Series, Sheet 16, Kildare-Wicklow (McConnell & Philcox 1994) and Sevastopulo (2009). The bedrock geology map available on the GSI online map viewer (GSI 2020) also confirms that all of the units within c. 3.5 km of the site are Carboniferous rocks of Pennsylvanian (i.e., formerly the Upper Carboniferous) age. These are shown in chronological order in Table 6.2.

Table 6.2 Bedrock Units of the Wider Knockbaun Area

Bedrock Unit	Epoch	Stage	Thickness
Coolbaun Formation	Pennsylvanian	Westphalian	c. 170 m
Clay Gall Sandstone Formation	Pennsylvanian	Westphalian	c. 30-50 m
Moyadd Coal Formation	Pennsylvanian	Westphalian	c. 400-500 m
Bregaun Flagstone Formation	Pennsylvanian	Namurian	c. 50 m

During the Ordovician and Silurian Periods (c. 490-415 Ma), the Iapetus Ocean closed bringing Laurentia (including northwest Ireland) and Avalonia (including southwest Ireland) into collision and culminating in the Caledonian Orogeny c. 425-395 Ma. During the Devonian Period (c. 417-354 Ma) Ireland was part of the Laurasian super continent, also known as the Old Red Sandstone continent. The latter underwent extensive subaerial erosion, whilst laying in arid southern subtropical latitudes, giving rise to the characteristic red coloured, continental facies sandstones. During the early Carboniferous (c. 354–327 Ma), a marine transgression advanced northward across the eroded and flat-lying continent (i.e., peneplained), and deposited a sequence of carbonate rocks that cover much of the Irish Midlands.

The rocks of the wider area belong to the Westphalian succession with ages between 313 and 304 Ma. At that time, Ireland lay south of the equator in tropical waters. The entire succession is approximately 300 m in thickness, and consists of a series of regressive cycles, each beginning with a marine phase that gradually shallowed resulting in subaerial emergence and deposition of plant material in a swampy environment, which would later become coal. The Westphalian succession lies conformably on top of the Bregaun Formation, which lies close to the top of the

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Namurian succession. The bedrock of the Knockbaun area, including Spink Quarry, is shown in Figure 6.4.

Bregaun Formation (BE)

The Bregaun Fm is approximately 50 m thick and consists of thick grey flaggy-bedded sandstones and siltstones with subordinate amounts of silty grey and often micaceous shales. The formation contains small sand volcanoes and slumps, which indicate a palaeoslope toward the north or northeast.

Moyadd Coal Formation (MC)

The Moyadd Coal Fm. conformably overlies the Bregaun Fm., and comprises the coal-bearing measures between the topmost Namurian No. 1 coal (Rockafoil Coal) and the Clay Gall Sandstone Formation. The formation is divided into two members, corresponding to two cycles—the Rockafoil Member of Yeadonian age (315.5–314.5 Ma) and Black Rock Siltstone Member of Langsettian age (314.5–313.4 Ma).

The Rockafoil Coal Member comprises 25 m of beds between the No. 1 Coal at the base and a distinctive marine faunal band with the ammonoid marker species *Gastioceras subcrenatum*. This band is known as the Fleck Rock, and comprises a bioturbated, grey, argillaceous siltstone, which is the international marker band for the base of the Westphalian Series. The upper part of the member comprises mainly silty shales, siltstones, thin sandstones and a second thin coal seam.

The succeeding cycle is known as the Black Rock and begins with approximately 15 m of marine shales and siltstones above the No. 2 coal seam. This uppermost 15 m of the Moyadd Formation is a distinctive unit of hard black siltstone, named the Black Rock Siltstone Member. The moderately thick Skehana and Marine Band coals formed in the conditions that succeeded the Fleck Rock, while the youngest widespread marine transgression is represented by dark shale.

Clay Gall Sandstone Formation (CG)

The Clay Gall Sandstone is named for the occurrence of "clay-galls", which are pebbles of mudstone or shale enclosed in the sandstone that probably correspond to clay rip-up clasts derived from underlying strata. The Clay Galls tend to characterize the lower part of the formation. The formation varies from 30 to 50 m in thickness, but is close to 50 m in the northern section of the Leinster Coalfield, and is the most widely known marker horizon across the coalfield. It is composed of medium- to fine-grained sand particles of quartz with minor feldspar, and is well cemented by silica generating an indurated, non-porous sandstone of quartzitic character. Interestingly, Sevastopula (2009) states that the sandstone is conspicuously coarse-grained and more felspathic than other sandstones deposited during the Pennsylvanian in southern Ireland. There are 3–6 m of siltstone above the sandstone before the top of the cycle at the No. 3 Coal Seam. Although marine bivalves and brachiopods were recorded near the base of the formation, most of the formation is likely of non-marine origin. The inclination of foresets in cross-stratified units of the formation suggests current directions were towards the north or northeast.

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Coolbaun Formation (CQ)

The Clay Gall Sandstone is succeeded by the overlying Coolbaun Formation, which includes the remainder of the succession and is c. 170 m in thickness. The formation begins with the No. 3 Coal Seam at the base. The seam is a shaly coal with a thickness of 0.2–0.3 m. This is succeeded by 25–45 m of argillaceous strata, mostly shales, which consists of both marine and non-marine units. This is followed by the Swan Sandstone Member (CQss), which is widespread across most of the Castlecomer Plateau. The member is a laminated, dark grey, fine-grained, siliceous sandstone that is up to 28 m in thickness and is lithologically similar to the Clay Gall Sandstone except for the lack of clay galls. It is used as a groundwater source for the nearby Swan Public Water Scheme. This is overlain by c. 15 m of shales and siltstone containing non-marine bivalves, which is in turn followed by the distinctive Double Fireclay Member comprising two 'seat earth' layers. This member consists of two thick beds of grey fireclay separated by c. 3.5 m of grey mudrock containing the Fairy Mount marine band with ammonoids and brachiopods. Above the fireclay, there are c. 65 m of dark shale containing non-marine bivalves, which is followed by siltstones and a few thin sandstones and coals.

Although no faults are identified as occurring in the site by GSI online mapping, several faults were identified within 5 km of the site (GSI 2020). The nearest fault is one of a series of near N-S oriented faults and offsets the Swan Sandstone Member northwards on the eastern side of the fault. The fault offset is significant, such that the Swan Sandstone Member is not in contact across the fault trace. A second set of faults with a Caledonian trend mostly lie south of the site and create a box-mesh of faults where these intersect with the N-S faults.

The spatial distribution of bedrock aquifers in the vicinity of the site is shown in Figures 6.5 and 6.6. Notably, there are no regionally important bedrock aquifers identified within 5 km of the site. The Clay Gall Sandstone Fm., which is the bedrock unit targeted for extraction, is identified as a Locally Important Aquifer which is Generally Moderately Productive (Lm). Both the Moyadd Coal and Coolbaun Fms. are identified as Poor Aquifers which are Generally Unproductive (Pu). However, the Swan Sandstone Member of the Coolbaun Fm. is identified as a Locally Important Aquifer which is Generally Moderately Productive (Lm), and a segment c. 3.75 km in length is identified as the Outer Source Area (SO) for the Swan Public Water Scheme. The Bregaun Fm. is identified as a Poor Aquifer which is Generally Unproductive except in Local Zones (Pl).

Because the Clay Gall Sandstone and Coolbaun each underlie roughly half of the site and are a locally important aquifer and a poor aquifer or aquitard, respectively, the sensitivity of the bedrock groundwater interest of the site is determined to be low. Although the proximity of the site to the Swan Public Water Scheme Outer Source Area, c. 1.25 km east of the site, is a potential concern given the proposed discharge of water to the tributary of the Clogh River, given the NE-SW regional groundwater

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flow, the site presents negligible risk to the Swan Public Water Scheme (See Section 7.5.11).

6.4.3.2 Site Bedrock Geology

The following is a synopsis of the findings of SLR Consulting's geological assessment (SLR 2020) and Apex Geoservices' geophysical investigation (Apex 2021) of the Spink Quarry (Refer to Appendices 6 and 7.3). The geophysical survey comprised of 9 electrical resistivity tomography (ERT) profiles. For further details on the hydrogeological assessment of the quarry, including drilling of 3 production wells, the reader is referred to the comprehensive analysis presented in Section 7, Water, of this EIAR.

SLR Consulting Ireland (SLR) were requested by Lagan Materials Ltd. (Lagan) to undertake a preliminary geological resource assessment of Spink Quarry and the lands immediately to the southeast of the current extraction area during February 2020. The assessment comprised a desktop review of previous exploration works, site inspection, rotary core drilling, petrographic analysis and chemical and physical testing. The geological assessment was primarily focused on confirming the quality and remaining extractable volumes of the Clay Gall Sandstone Formation and its likely potential for aggregate production. The assessment was also targeted at giving a preliminary assessment of the overlying and underlying formations for use in the manufacture of cement. Four boreholes (20-SP-01, 20-SP-02, 20-SP-03 and 20-SP-04) were drilled in lands of the Spink Quarry, totaling 220 m in length. Boreholes 20-SP-01, 20-SP-02, 20-SP-03 and 20-SP-04, with lengths of 30 m, 40 m, 60 m and 90 m, respectively, were targeted at identifying the underlying geology and any potentially high-quality aggregates. The locations of these boreholes are shown on Figure 6.7 below. The aim of these boreholes was to identify the aggregate extraction potential to extend the quarry.

The sequence exposed in the quarry comprises the underlying Moyadd Coal Formation exposed at the toe of the back face in the northwest, and the overlying Coolbaun Formation exposed at the crest of the face in the southeast (Refer to Plate 6.1 to Plate 6.3). The quarry has been developed almost entirely within the intervening Clay Gall Sandstone and consequently the entire sequence of the formation is exposed in the various quarry faces, as shown in Table 6.3 below. These reveal a massive thick uniform sandstone at the base of the formation with more variable interbedded sandstone and siltstone unit towards the top. The various lithologies have already been described under Section 6.4.3.1 Regional Bedrock Geology.

A total of four rotary cored boreholes (20-SP-01, 20-SP-01, 20-SP-03 and 20-SP-04) were drilled from northwest to southeast, perpendicular to strike, within the existing quarry and in the lands immediately to the southeast, see Figure 6.7 below. Boreholes 20-SP-01 and 20-SP-02 were drilled on the current quarry floor with a view to identifying the thickness of remaining Clay Gall Sandstone. The two boreholes further to the southeast were drilled in the lands above the quarry in order to identify the overburden thickness and thickness of Coolbaun Formation above the Clay Gall

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Sandstone. The investigation was also focused on a preliminary assessment of the suitability of the overlying and underlying formations for possible use in the manufacture of cement.

Three large diameter 'Production Wells' were drilled as part of the hydrogeological assessment of the site (Refer to EIAR Section 7). The large diameter boreholes were drilled to a target depth of c. 5 m below the proposed deepest part of the site's final floor level, which is proposed to be 200 m OD and 190 m AOD in the western and eastern zones, respectively, following the dip of the Clay Gall Sandstone Formation (Refer to Figures 3.1 and 3.3).

As expected for bedrock in Ireland, groundwater was primarily encountered in discrete zones. With the exception of ingress across a 5 m zone in PW1, all of the water strikes occurred along the interfaces between the different bedrock formations. It is clear that the largest water strikes were encountered at the interface where the Clay Gall Sandstones rest on the Moyadd Coal Formation.

The following table provides a summary of the bedrock units encountered across the site.

Table 6.3 Bedrock Units Exposed in the Spink Quarry

Bedrock Unit	Lithology	Thickness
Coolbaun Formation	Shale and sandstone with thin coal beds and a widespread sandstone, known as The Swan Sandstone Member.	≥ 26 m
Clay Gall Sandstone Formation	Medium and fine, feldspathic, quartzitic, well silica-cemented sandstone containing "clay-galls" (sandstone enclosing pebbles of shale).	c. 50 m
Moyadd Coal Formation	Coal-bearing marine shales, siltstones and minor sandstones.	≥ 18 m

Note: Max thicknesses from four rotary cored boreholes (SLR 2020).

SLR (2020) report that the bedding dips between <5° to 10° towards the southeast, with local steepening in the northwest due to the presence of a small fault.

The geophysical ERT survey returned findings showing the thickening of the Clay Gall sandstones from north to south beneath the quarry floor and that the beds dip at an apparent angle of approximately 10° to the southwest. An increase in thickness of the sandstone/siltstone to the southeast was also noted. The interpreted geology from the ERT profiles show good agreement with the adjacent boreholes and wells, which have been drawn on the sections in Appendix 7.3.

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The hydrogeologists do not consider the Rotary Core and Geophysics findings to be in conflict. The core boreholes were drilled in a straight line through the site almost NW-SE trending and therefore they did not have the opportunity to explore any dip in the N-S direction.

Consequently, the base of the Clay Gall Sandstone Formation is exposed in the north of the quarry, while the top of the formation is exposed in the south. The exposed quarry faces show a massive thick uniform sandstone at the base of the formation with a more variable interbedded sandstone and siltstone unit towards the top of the formation. Furthermore, a progressively thicker wedge of Coolbaun Formation overlies the Clay Gall further to the south.

SLR (2020) noted the occurrence of a small fault in outcrop at the extreme northwest of the quarry, while Apex recognised multiple faults from strong vertical dislocations in rock resistivity in the ERT profiles. These include several north-south faults and a possible east-west fault responsible for the local development of hydraulic head in groundwater just above the contact of the Clay Gall Sandstone-Moyadd formations, which is interpreted to have given rise to a highly productive water strike in Well PW2 in the northeast of the quarry.

It is notable that Apex (2021) report that Well PW2 encountered a sand filled cavity with a high-water yield of 900 m^3/d near the base of the Clay Gall Sandstone Formation. The ERT data confirm the thickening of the Clay Gall Sandstone Formation from north to south beneath the quarry floor and indicate that the beds dip at an apparent angle of approx. 10° to the southwest. The high yielding sand cavity in PW2 occurs near the base of the dipping sandstone beds of the Clay Gall Sandstone Formation. The data shows no indication that this is part of a localised fault or weathered zone.

The data suggest a permeable water-bearing zone of weak sandstone at the base of the sandstone/siltstone unit and dipping to the southwest and slightly to the east and terminated at the south of the quarry by an east-west vertical fault that places the sandstone/siltstone against lower permeability siltstone/sandstone. Such a model would have an increased head of groundwater as one moves to the southwest and may account for the water-bearing feature encountered near the base of the sandstone/siltstone in PW2 compared to the low or absent flow on PW3 further up dip to the northeast.

No excavations are planned at PW2, instead it is proposed that the settlement ponds will remain in-situ here. The water-bearing zone is also c. 16 m below the existing floor level in this area. This area of the site will not be worked. A buffer will be maintained around PW2 that will not be subject to blasting or excavation. Given the cavity was not detected in SP01, a buffer of 80 m to PW2 is considered reasonable.

The quarry design takes into account a requirement to maintain at least a 5 metre buffer above the contact between the Clay Gall Sandstone Formation and Moyadd Coal Formation. This will reduce the amount of water to be managed and discharged off-site (Refer to EIAR Section 7.5.8.4).

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From the geophysical and borehole data, the main water-bearing zone at the base of the sandstone should be below the proposed floor levels of 206 m AOD, 200 m AOD and 190 m AOD in the northwest, centre and southeast of the site, respectively.

The core recovered from beneath the quarry floor shows a thickly to massive bedded, medium- to coarse-grained sandstone.

SLR undertook a petrographic analysis of drill core sample No. 36063, to confirm the lithology and mineralogy of a representative Clay Gall Sandstone, which indicates a competent, fine- to coarse-grained, grey sandstone, with low apparent permeability, and massive to faintly laminated texture (Appendix 4 of SLR 2020).

Three >10.0 m drill core intervals selected to be representative of the main lithological types were sent for strength and durability testing including Los Angeles Value, Magnesium Sulfate Soundness, Polished Stone Value, Aggregate Abrasion Value, Water Absorption and Flakiness Index. These tests are designed to characterise the bulk strength and durability properties of the main lithologies and identify the aggregate potential of each.

The aggregate quality assessment carried out by SLR (Refer to Appendix 6) indicates that the sandstones of the Clay Gall Sandstone Formation are strong to very strong and are likely to be of high quality, similar or of even greater consistency to those previously worked in the quarry and should be capable of producing a surface dressing chip similar to that previously produced. These lithologies should be capable of producing aggregates in compliance with the specifications below:

- TII Series 500, 600 and 800 unbound fill materials;
- SR21: 2014 + A1: 2016 Annex E Guidance on the use of I.S. EN 13242 unbound fill materials; and
- S.R. 16 Guidance on the use of I.S. EN 12620:2002 Aggregates for concrete products.

The Coolbaun Formation (siltstones and mudstones with occasional sandstones) will likely be used more as a general fill material and/or for use in the manufacture of cement at Lagan's cement works at Killaskillen, Kinnegad, Co. Meath.

The underlying Moyadd Coal Formation is separated into two units based on the geochemical signature. The upper unit lying directly below the Clay Gall Sandstone and encountered in all four boreholes consists of a dark grey to black, thinly bedded Mudstone. The geochemical results from the underlying Moyadd Coal Formation suggest that the upper unit, although having a high alumina content, has an alkali content that may be unacceptable for use in the manufacture of cement. The lower unit has lower alkali levels, but it is not proposed to work the underlying Moyadd Coal Formation.

The quarry design takes into account a requirement to maintain at least a 5 metre buffer above the contact between the Clay Gall Sandstone Formation and Moyadd Coal Formation. This will reduce the amount of water to be managed and discharged off-site (Refer to EIAR Section 7.5.8.4).

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The saleable aggregate reserves within the proposed extraction area have been calculated following a detailed geological survey and drilling programme conducted by SLR Consulting (SLR 2020). Additional well drilling carried out as part of the hydrogeological assessment of the quarry (Refer to EIAR Section 7.5.4), a geophysical survey by Apex Geophysics (Refer to Appendix 7.3), and mapping of the quarry faces, were all used to refine the geological model for the site.

An aerial drone survey of the site was used to produce orthorectified images and a centimetre accurate Point Cloud for the existing topography of the site. Digital terrain modelling (DTM) software was then used to produce 3D models of the existing topography, geological formations, and quarry design.

Refer to EIAR Section 3.3.1.2 for details of the workable aggregate reserve assessment, including design constraints (i.e., standard criteria were adopted with regard to face heights, bench widths, haul road design, etc.).

It is proposed that the quarry will be worked in a series of benches (typically 10 to 20 m) down to a final depth of 200 m AOD in the western quarry area and 190 m AOD in the eastern quarry area (Refer to Figures 3.1 and 3.3). The development will see the extraction of both the Clay Gall Sandstone Formation and Coolbaun Formation, which overlies the Clay Gall sandstones to the east of the existing quarry sump. The measured resource has been calculated at c. 5.8 million tonnes.

It is proposed that the average output will be c. 200,000 tonnes per annum, giving an anticipated duration for the extraction of c. 29 years. A further 2 years will be required to implement and complete final restoration of the site to a secure wildlife refuge/ amenity use.

6.4.4 Geological Heritage

The Irish Geological Heritage (IGH) Programme identifies and selects a complete range of sites that represent Ireland’s geological heritage under sixteen themes ranging from Karst features to Hydrogeology. The IGH Programme is operated by a partnership between the GSI and the National Parks and Wildlife Service (NPWS), and sites identified as important for conservation are designated as Natural Heritage Areas (NHA). Datasets are now available online detailing sites of geological heritage.

A search of the GSI Geological Heritage Database indicates that there are no sites of geological heritage within the site of the quarry and only three sites within c. 5 km of the site. An audit of the Geological Heritage of County Laois was carried out in 2016, which identified 33 County Geological Sites (CGS) in the county. In its 2017-2023 County Development Plan (CPD), the Council recognizes these areas of conservation value, which include a number of geological and geomorphological sites (Laois County Council 2017).

Despite the profusion of CGS in southeast County Laois, there are only the three such sites of geological interest near Spink Quarry (<5 km). These sites are:

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Site Code	**LS025**
Site Name	Moyadd Stream
IGH-Theme-Primary	IGH 9
Location	ITM Coordinates: 655055; 683577
Site Description	A small river channel has exposed bedrock in the bed and banks for approximately 1 km
Geological Feature	The Moyadd Coal Formation is defined with this stream exposures defined as the type section
Designation	CGS, may be recommended for Geological NHA
Site Code	**LS007**
Site Name	Clogh River
IGH-Theme-Primary	IGH 14
Location	ITM Coordinates: 656298; 681998
Site Description	A meandering river with braided channels
Geological Feature	The feature exhibits well developed meanders and braided channels
Designation	CGS
Site Code	**LS012**
Site Name	Flemings Fireclay Quarries
IGH-Theme-Primary	IGH 9
Location	ITM Coordinates: 657542; 182206
Site Description	Extensive quarries worked for fireclay since 1935
Geological Feature	The quarries at Swan work the strata around a Double Fireclay within the Coolbaun Coal Formation
Designation	CGS , may be recommended for Geological NHA

6.4.5 Sensitive Receptors

The site is located in a sparsely populated rural area. The surrounding lands are largely agricultural, although a forestry plantation abuts the site to the south. The R430 Regional Road bounds the landholding to the north with c. 700 m of frontage.

In respect of Land, Soils and Geology, the land, soils and geological heritage in the area potentially represent sensitive receptors. No additional land take is envisaged as part of the proposed development, and thus no further lands will be directly impacted. The soils on-site have been stripped to gain access to the underlying

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sandstone/siltstones and have been used for perimeter screening berms or placed in long-term storage for subsequent use in restoration. Soil stripping was carried out in accordance with the principles of good soil handling. The storage areas and restoration areas have been vegetated to reduce both visual impact and erosion.

The geological bedrock exposures within the existing quarry previously were not considered of sufficient interest or importance to warrant designation or protection for earth science or geological heritage purposes. In addition, there are no geological sites of interest or proposed Geological National Heritage sites near the quarry at Knockbaun (Parkes et al. 2016). The nearest site, Moyadd Stream (IGH-9: Upper Carboniferous and Permian) is listed by GSI (2020) and Laois County Council (2017) as an area of Geological Interest or Heritage. It consists of a small river channel that has exposed bedrock in the bed and banks for approximately 1 km.

Notwithstanding the above, the impact of the development on the geological heritage of the site was assessed with reference to the consultation with GSI and to the "Geological Heritage Guidelines for the Extractive Industry" developed by the GSI and the Irish Concrete Federation (GSI/ICF 2008). These guidelines are intended for Irish Concrete Federation (ICF) members, in order that they may follow best practice and receive clear information concerning geological heritage in relation to any proposed quarry or related development or land purchase (Refer to EIAR Section6.6.2 below and Appendix 4).

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6.5 ASSESSMENT OF IMPACTS

The following Impact Assessment matrix provides an indication of the significance of potential effects arising during the life cycle of the development not accounting for any mitigation measures (Table 6.1). The quarry is a well-established operation such that there will be minimal additional construction works. As such, the impacts during the construction phase are not dealt with here.

Table 6.4 Land, Soil & Geology - Impact Matrix

‘Do Nothing’ Impacts	🟢		
Factors	**Construction**	**Operation**	**Decommissioning**
Direct Impacts		🟡	X
Indirect Impacts		X	X
Cumulative Impacts		X	X
Residual Impacts		🟡	🟢
`Worst Case’ Impacts		🔴	🔴

None/imperceptible: X; Slight: 🟢; Moderate: 🟡; Significant/Very significant: 🔴.
Refer to Appendix 3 for definition of Significance

6.5.1 ‘Do Nothing’ Impacts

If the development did not proceed, the aggregate resource would remain unused in situ, and the local supply of quality aggregates and concrete products would be more restricted. The existing site permitted under P.A. Ref. 10/383 comprises a moderate-sized (i.e., c. 19.6 ha), hardrock quarry that has been extensively worked, such that the lands represent a disturbed and degraded landscape with some remaining infrastructure and stockpiles on the quarry floor. Under the ‘Do Nothing’ scenario, all quarrying and ancillary activities would cease. The site would be restored to beneficial after-use as per the requirements of the existing planning permission (P.A. Ref. 10/383). However, the resources of the quarry would remain in situ and thus unutilised, and would possibly result in the requirement to develop a more remote greenfield site.

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6.5.2 Direct Impacts

Rock quarrying has occurred within the application site, and as such, there has been an impact on the bedrock geology as a result of this prior development.

As described, the site is an existing quarry in which much of the development works and site infrastructure is in place. The extraction area has largely been stripped of soils for use in the construction of perimeter screening berms and for restoration of the upper quarry faces along the southern boundary. In general, bedrock is close to or at surface with less than 0.5 m of soils to be removed.

Soil stripping will be undertaken in a progressive manner as new extraction areas are required and will be on-going throughout much of the life of the operation.

Topsoil and overburden, stripped to obtain access to the underlying bedrock, will be used in restoration or placed in temporary overburden storage areas for use in future restoration. The storage areas and restoration areas will be vegetated as soon as is possible, to reduce both visual impact and erosion of overburden.

A 50 m standoff from the extraction area to the R430 Regional Road will continue to be maintained. This standoff area includes the existing site access, wheel wash, weighbridge, refuelling hard stand, storeroom, water settlement pond system, perimeter screening berms, and other ancillaries. The standoff also includes the constructed pond/wetland at the site entrance that feeds the headwaters of the Clogh Stream. The rising of the Clogh River is in this zone and is thereby protected. This bank also acts to screen the development from views to the north.

It is proposed that the quarry will be worked in a series of benches (typically 10 to 20 m) down to a final depth of 200 m AOD in the western quarry area and 190 m AOD in the eastern quarry area. The development will see the extraction of both the Clay Gall Sandstone and Coolbaun formations, where the latter overlies the Clay Gall to the east of the existing quarry sump. The workable reserves have been calculated at c. 5.8 million tonnes (Refer to EIAR Table 3.2).

The site will be worked from the existing quarry area in a westerly direction in a series of benches to between 206 and 200 m AOD. The quarry design takes into account a requirement identified in the hydrogeological study of the EIAR (Refer to Section 7) to maintain at least a 5 metre buffer above the contact between the Clay Gall Sandstone Formation and Moyadd Coal Formation. This will reduce the amount of water to be managed and discharged offsite (Refer to EIAR Section 7.5.8.4). The western quarry area has already been developed to c. 225 m AOD. The material to be worked in this area comprises the high-quality Clay Gall sandstones.

At the same time, the quarry will be pushed in an easterly direction with removal of the overlying Coolbaun Formation to expose the underlying Clay Gall Sandstone Formation. The eastern quarry area will be developed in a series of typically 10 m benches down to c. 190 m AOD (Refer to Figures 3.1 to 3.3).

The aggregate quality assessment carried out by SLR (Refer to Appendix 6) indicates that the sandstones of the Clay Gall Sandstone Formation are strong to very strong and

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are likely to be of high quality, similar or of even greater consistency to those previously worked in the quarry and should be capable of producing a surface dressing chip similar to that previously produced. These lithologies should be capable of producing aggregates in compliance with the specifications below:

- TII Series 500, 600 and 800 unbound fill materials;
- SR21: 2014 + A1: 2016 Annex E Guidance on the use of I.S. EN 13242 unbound fill materials; and
- S.R. 16 Guidance on the use of I.S. EN 12620:2002 Aggregates for concrete products.

The Coolbaun Formation (siltstones and mudstones with occasional sandstones) will likely be used more as a general fill material and / or for use in the manufacture of cement at Lagan's cement works at Killaskillen, Kinnegad, Co. Meath.

By its nature, quarrying of the underlying rock would involve removal of an identified geological resource and therefore some impact upon land, soils and geology must be expected (Table 6.1). It is considered that the operation and restoration would provide employment opportunities and raw material to help meet the needs of a growing population.

There is a moderate, but controlled impact due to the removal of raw material during the operation. Excavations in bedrock to date involved excavations in a delineated benched area. The impact of excavations to date at the quarry would be considered as negative with moderate significance and of permanent nature.

Table 6.5 Direct Impacts by Stage of Development

Direct Impact	Construction Stage	Operational Stage	Decommissioning Stage
Land Use	None—no new land take.	None—no new land take	Moderate, long-term, positive due to return to beneficial after-use.
Soils	Significant, medium-term, negative impact as soil is stripped from southernmost section of proposed extraction area.	None—soil will already have been stripped from proposed extraction area.	Significant, long-term, positive due to restoration of site to wildlife amenity through promotion of natural colonization of restored quarry faces.
Geological Bedrock	None.	Moderate, long-term, negative impact due to removal of mineral resources.	Moderate, long-term, positive impacts if site restoration includes provision for preservation, promotion and access to designated geoheritage features of high to very high importance.
Sensitive Receptors: Geological Heritage	None.	Significant, long-term, positive impact if fresh exposures due to excavation are of geological/ scientific interest and of high to very high importance.	

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The decommissioning phase will provide for a safer environment on-site, with the removal of all plant and infrastructure, and the creation of stable slopes that are in the interest of health & safety and long-term sustainability.

Sevastopolu (2009) noted that there were no detailed studies of the sedimentology of the Clay Gall Sandstone, which is poorly exposed. Thus, the increased exposure of a complete section of the Clay Gall Sandstone Formation at Knockbaun would enable a greater understanding of this important bedrock unit, and would probably represent a direct positive impact of the development.

6.5.3 Indirect Impacts

There is a considerable history of quarrying on-site, which began prior to the 1970s, and which has had no identifiable indirect impact on the geology of the area. The development will have no indirect impact on the local or regional geology, as no contaminants will be released onto the lands, and dust emissions will be tightly controlled.

6.5.4 Cumulative Impacts

There are no nearby mineral extraction or industrial developments, such that it is unlikely that the current development will lead to significant adverse impacts in combination with other developments—the nearest being the Lagan Clay Products Facility at Swan. Thus, no negative cumulative impacts on the geological environment were identified.

6.5.5 Transboundary Impacts

The 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. Given the location (c. 135 km from the border with N. Ireland), nature, size and scale of the proposed development, it is expected that the impacts of the development would not have any significant transboundary effects on land, soils or geology.

6.5.6 Residual Impacts

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.

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, other than the development of the in-situ mineral resource. The restored quarry will provide a more manageable environment than is currently the case, but with a change in land-use from the original agricultural use to the future beneficial use as a wildlife amenity.

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6.5.7 'Worst Case' Impacts

Excavation works will result in the same level of vulnerability of groundwater at the site as is now experienced by the same area of open bedrock. The 'worst case' impacts would involve a substantial hydrocarbon spill on-site, resulting in significant contamination of the groundwater in this locally important bedrock aquifer, i.e., 'Clay Gall Sandstone (Lm)'. However, the extensive mitigation measures implemented in the design and operation of the development will mitigate this scenario to the largest degree possible (Refer to EIAR Section 7.7).

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 an attendant impact on domestic wells.

The quarry floor and its sump settlement system are to be adequately sized to handle the water volumes they will receive. The volume of discharge has been calculated to equate to an intercept of < 0.1 % of the regional groundwater flow volume. Water management and discharge have been designed in cognisance of enacted Irish Regulations concerning Groundwater, Surface Water, Birds, Habitats and Pearl Mussels. There will be no significant net loss or gain in the GWB system because the volume intercepted and managed at the site represents, by calculated water balance, <0.1 % of the regional groundwater flow volume. Hydraulic response testing of the bedrock suggests that the radial effect will not impact the local wells.

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6.6 MITIGATION & MONITORING

The removal of the in-situ mineral resources represents a moderate long-term, negative impact on the bedrock geology, albeit an inevitable outcome of extractive operations. The development is not expected to have any significant negative impact on the surficial geology of the site or surrounding area, and thus it is proposed that only standard soil handling measures will be implemented as mitigation measures with respect to the surficial geology. Ultimately, after final land reclamation of the enclosing quarry site, with the land restored to a wildlife amenity, there will be no adverse residual impact on the surrounding environment from the development.

Environmental monitoring, including local groundwater and surface water monitoring will be implement during the operational, closure and decommissioning phases of the development.

6.6.1 Soils

Consideration has been given to soil and subsoil management. Importantly, the EPA/Teagasc subsoil map clearly shows the dominance of subcropping bedrock and the almost complete lack of subsoil deposits underlying the topsoil across the site.

The extraction area has largely been stripped of soils for use in the construction of perimeter screening berms and for restoration of the upper quarry faces along the southern boundary. In general, bedrock is close to or at surface with less than 0.5 m of soils to be removed.

Topsoil and overburden stripping will be undertaken in a progressive manner as new extraction areas are required and will be on-going throughout much of the life of the operation.

Topsoil and overburden, stripped to obtain access to the underlying bedrock, will be used in restoration or placed in temporary overburden storage areas for use in future restoration. The storage areas and restoration areas will be vegetated as soon as is possible, to reduce both visual impact and erosion of overburden.

Stripping of soils will be carried out in accordance with the principles of good soil handling. These principles are aimed at reducing possible adverse effects such as smearing and compaction of the soil. Measures that are to be incorporated to achieve this aim include:

- Within soil stripping areas, topsoil will be stripped with excavator and dumper trucks working from the haulage track;
- For the replacement of subsoil and topsoil, the machinery will work from the haulage track or the exposed subsoil surface and away from the reinstated part of the site;
- Soils will only be handled in dry weather conditions;
- Soils will not be stripped or placed when the moisture content is high, i.e., after heavy rainfall;
- Soils will not be moved in unusually dry and windy weather conditions;

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- Soils will be stored within perimeter security/ screening embankments of the site. This is to allow the vegetation of these screening embankments to develop as soon as possible;
- All temporary storage mounds will have slope angles not greater than 1:1.5 and will be re-vegetated as quickly as possible to avoid soil erosion by air and water; and
- Topsoil shall be stored to a height not exceeding 3 metres to preserve the organic constituents.

Further details with respect to the management of topsoil and overburden soils are outlined in EIAR Section 3.3.3.4.

6.6.2 Bedrock Geology

The removal of the in-situ mineral resources represents a moderate, long-term, negative impact on the bedrock geology, albeit an inevitable outcome of extractive operations. The geological bedrock exposures within the existing quarry were not previously considered of sufficient interest or importance to warrant designation or protection for earth science or geological heritage purposes. In addition, there are no geological sites of interest or proposed Geological National Heritage sites near the site of the quarry at Knockbaun (Parkes et al. 2016). However, if fresh exposures due to excavation are of geological/ scientific interest, and hence of high to very high importance, incorporation of such exposures in the restoration scheme would represent a moderate, long-term, positive impact. Provision for preservation, promotion and access to designated geoheritage features would further mitigate the loss of the primary resource, in a manner not too different from the preservation of features by record or in-situ as practiced in Archaeology.

Notwithstanding the above, the impact of the development on the geological heritage of the site was assessed with reference to the consultation with the GSI and to the "Geological Heritage Guidelines for the Extractive Industry" developed by the GSI and the Irish Concrete Federation (GSI/ICF 2008). These guidelines are intended for Irish Concrete Federation (ICF) members so that they may follow best practice and receive clear information concerning geological heritage in relation to any proposed quarry or related development or land purchase.

In response to a request for pre-application consultation, the GSI requested that the operator might incorporate two commitments into the restoration/ closure plan, and these might also be made conditions of planning as appropriate by the planning authority (Refer Appendix 4). These are:

1. Allowing access to quarry faces by appropriate scientists (upon request and with due regards to Health and Safety requirements) during quarrying to record any new or significant stratigraphies / relationships as they might become exposed and to establish if the quarry site is worthy of geoheritage 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

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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.

As part of the Irish Geological Heritage (IGH) Programme, consultees are requested to assist with developing work on Irish geological heritage by following the guidelines/mitigation measures below:

Quarry Operation Stage

- Facilitate periodic visits from IGH during the quarry operation, to advise on future geo-conservation issues, e.g., preserving a representative section of the geology; Permit access for research by bona fide geologists, which may include recording new data and sample collecting, and for educational purposes - health and safety considerations permitting. Off-track parking areas would be ideal for examination of sections.
- Notify IGH about any significant new section or feature, temporary or permanent, that may become exposed by quarrying, e.g., after blasting (or send a digital photograph that can be quickly assessed). New faces can be examined by IGH or other relevant expert, with minimal interruption to the quarrying operation, and may facilitate optimum extraction as well as enhance geological understanding of the area. Discuss with IGH how new features can be accommodated in closure plans;
- Monitor and, ideally, maintain a digital photographic record of the extraction process, so that new faces are documented, as well as any new or significant feature flagged to IGH. These can be examined if needed, adding to GSI's knowledge base and facilitating a smooth quarrying operation; IGH can advise on ideal monitoring and photographic methods. Forward any annual reporting groundwater monitoring data digitally to the GSI Groundwater Programme (as submitted to the EPA and local authorities as per the EU Water Framework Directive or planning condition).

End operation stage

- Finalise restoration plans in consultation with IGH, ideally having designed the operation of the quarry to consider end use. Plan for maximum geodiversity on closure, if appropriate. In particular, leave rock faces visible as exposure rather than covered with soil, vegetation or rock debris); make rock faces safely available to geologists, and to the public if possible, by creating public pathways and viewing areas with furniture and information panels (IGH can advise on interpretative materials).
- Maintaining access to the geological heritage interest promotes geoconservation in the community. There are more imaginative, and economical, end uses for quarries than the backfilling method that obliterates existing and newly created geodiversity and biodiversity, such as their modification as open-air amphitheatres

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or rock-climbing facilities. Even if converted to light industrial use, the quarry walls can be retained for geodiversity interest.

As statutory consultees a copy of this EIAR, including site specific geological and geophysical reports by SLR (2020) and Apex (2021), will be made available to the GSI (Refer to Appendices 6 and 7.3 respectively).

Lagan recognises the importance of the Geological Survey of Ireland as Irelands public earth science knowledge centre. In order to facilitate the aims of the GSI to provide free, open and accurate data and maps on Irelands subsurface to landowners, the public, industry and all other stakeholders within Ireland and internationally Lagan will work with the GSI wherever possible following any request made by the GSI to Lagan. Lagan is also amenable to working with the GSI with a view to providing a copy of any future reports detailing any site investigations carried out together with a digital photographic record of significant new excavations. Furthermore, should Lagan receive a request from the GSI to visit site to collect any geological data or personally document exposures for example, arrangements will be made to facilitate a mutually convenient time. The data would be added to Geological Survey of Ireland's national database of site investigation boreholes, implemented to provide a better service to the civil engineering sector. This information would facilitate the GSI to further our understanding of the underlying geology and the geological history of this part of Ireland.

Should any significant bedrock exposures of importance be identified, Lagan 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.

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 (Refer to Figure 3.2).

A well-coordinated restoration process (in consultation with the IGH) 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

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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.

Site restoration allows vegetation to become established during the course of the development, thereby reducing the overall impact of the development (i.e., visual impact, dust impact, flora and fauna impact, etc.). It also has the added benefit to the operator of spreading out the cost of restoration over the life of the development.

Grading and planting on completed sections of the upper quarry face will be carried out as shown in Figures 3.1 to 3.3. The upper benches will be seeded with suitable species of shrubs and climbers to create vegetated 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.

A detailed working scheme/ restoration plan has been prepared (Refer to Figures 3.1 to 3.3). In preparing the design, standard criteria were adopted with regard to face slopes, standoffs to site boundaries, etc. The final quarry face angles have been 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.

The client will ensure that there is a periodic examination of new faces and any new features revealed, by a visiting GSI geologist or consultant.

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 surrounding environment due to the extraction and removal of the sandstone/siltstone 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 landscaping & restoration scheme.

It is considered that the exact detail with respect to final treatment of quarry should be left to at least 6 months prior to final restoration to facilitate future beneficial end use. A typical planning condition to this effect could be *"The developer shall confirm in writing with the planning authority within 6 months of the cessation of operations, the details of, and programme for, implementation of the restoration scheme upon permanent cessation of quarrying activity at the site*". Further information on the restoration scheme is given in Section 3.4 – Site Restoration and Section 11 – Landscape.

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6.8 FIGURES & PLATES

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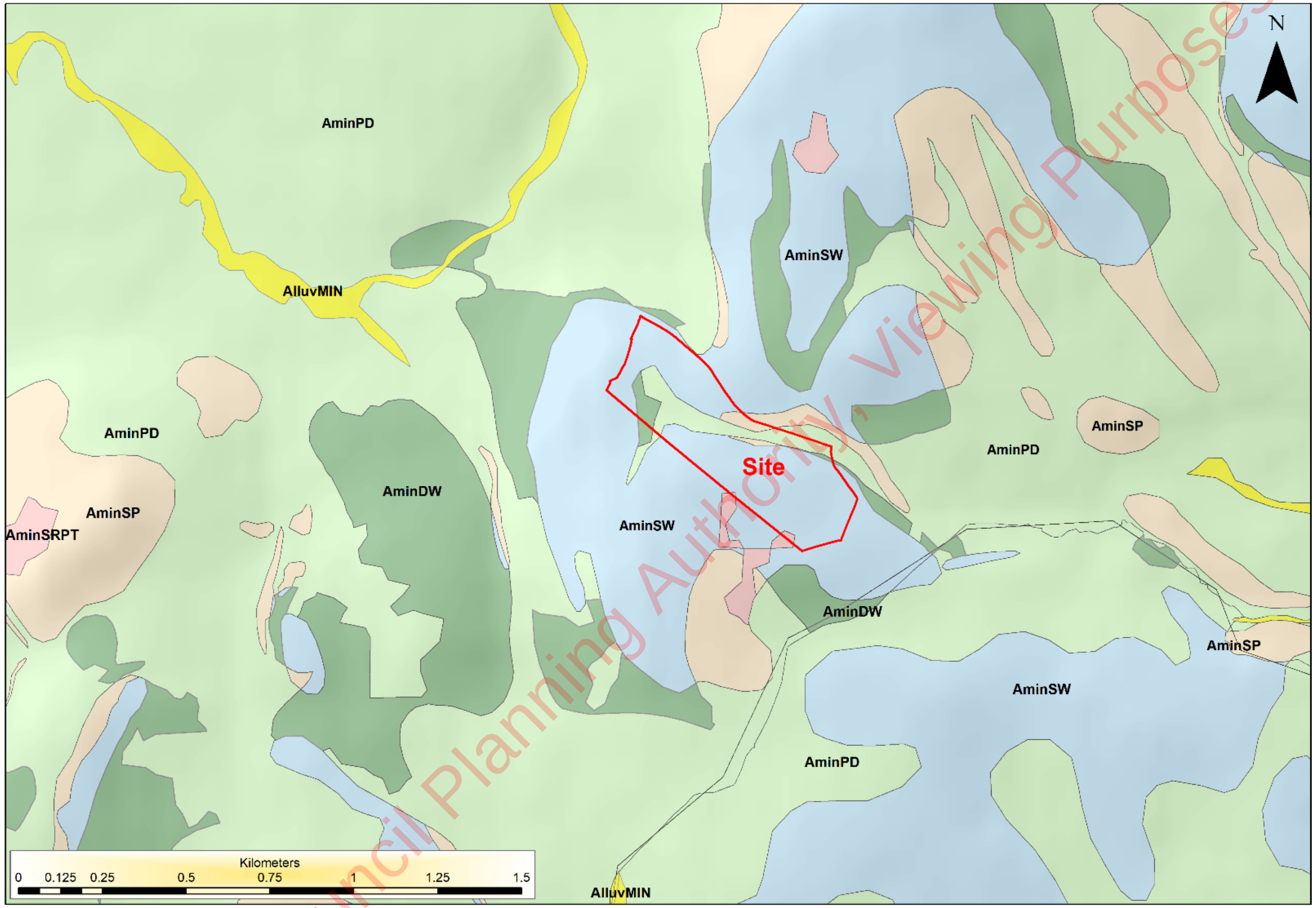

Figure 6.1 Map showing topsoil of wider area around Knockbaun.

Note dominance of large swathes of AminPD (Surface Water and Groundwater Gleys: light green) in the wider area. AminSW (Lithosols / Regosols: light Blue) occurs in several large patches and dominates the site, while there are lesser amounts of AminDW (Acid Brown Earths / Brown Podzolics: dark green), AminSP (Shallow Surface Water and Groundwater Gleys: Light brown) and AminSRPT (Peaty Podzols: Pink) and Alluvmin (Mineral Alluvium: Yellow). Rendered with ArcGIS 10.3.1 using data from EPA (2020)

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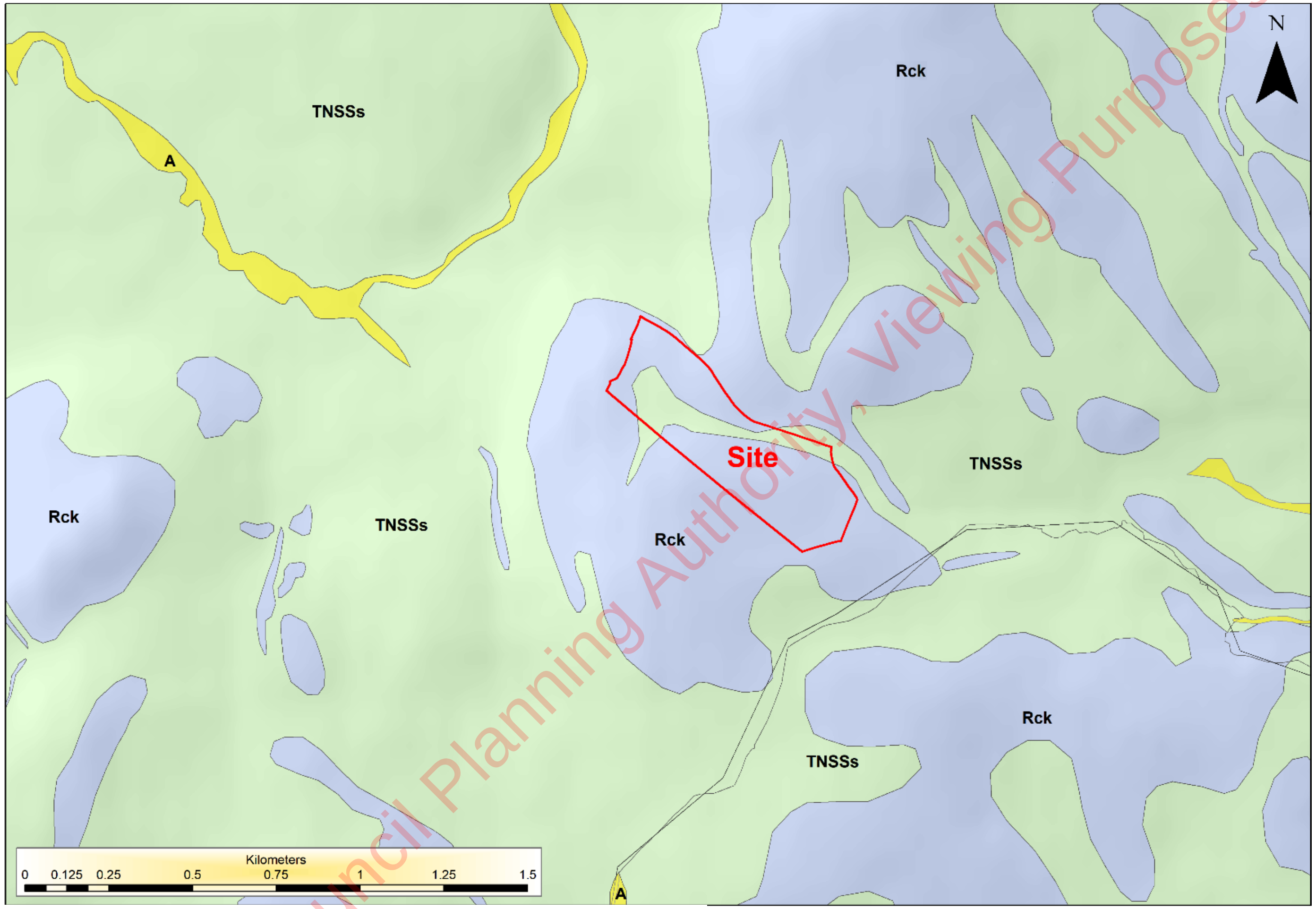

Figure 6.2 Map showing topsoil of wider area around Knockbaun

Note dominance of large swathes of TNSSs (Shales and sandstones till (Namurian): light green) including part of the quarry site and Rck (subcropping bedrock: light blue). Note also ribbon of A (Alluvium undifferentiated: Yellow) tracing the Owenbeg River. Note slight disparity/ overlap between boundaries for Laois and Kilkenny soils data at lower right. Rendered with ArcGIS 10.3.1 using data from EPA (2020).

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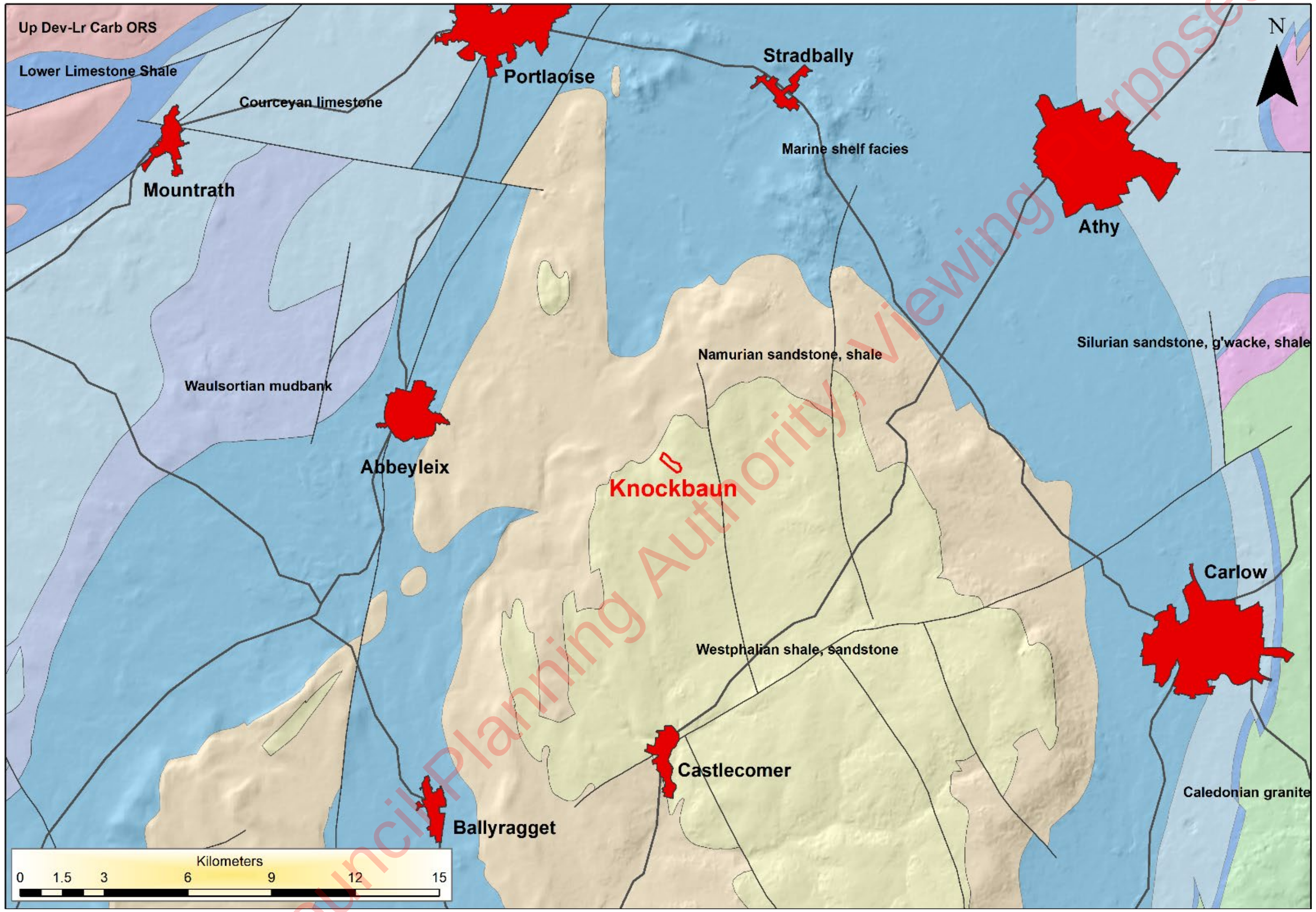

Figure 6.3 Map showing Regional Bedrock Geology

GSI's 1:500,000 scale bedrock geological data. Note site lies at northwestern extent of Westphalian sandstones and shales on the Castlecomer Plateau. Rendered with ArcGIS 10.3.1 using data from GSI (2020).

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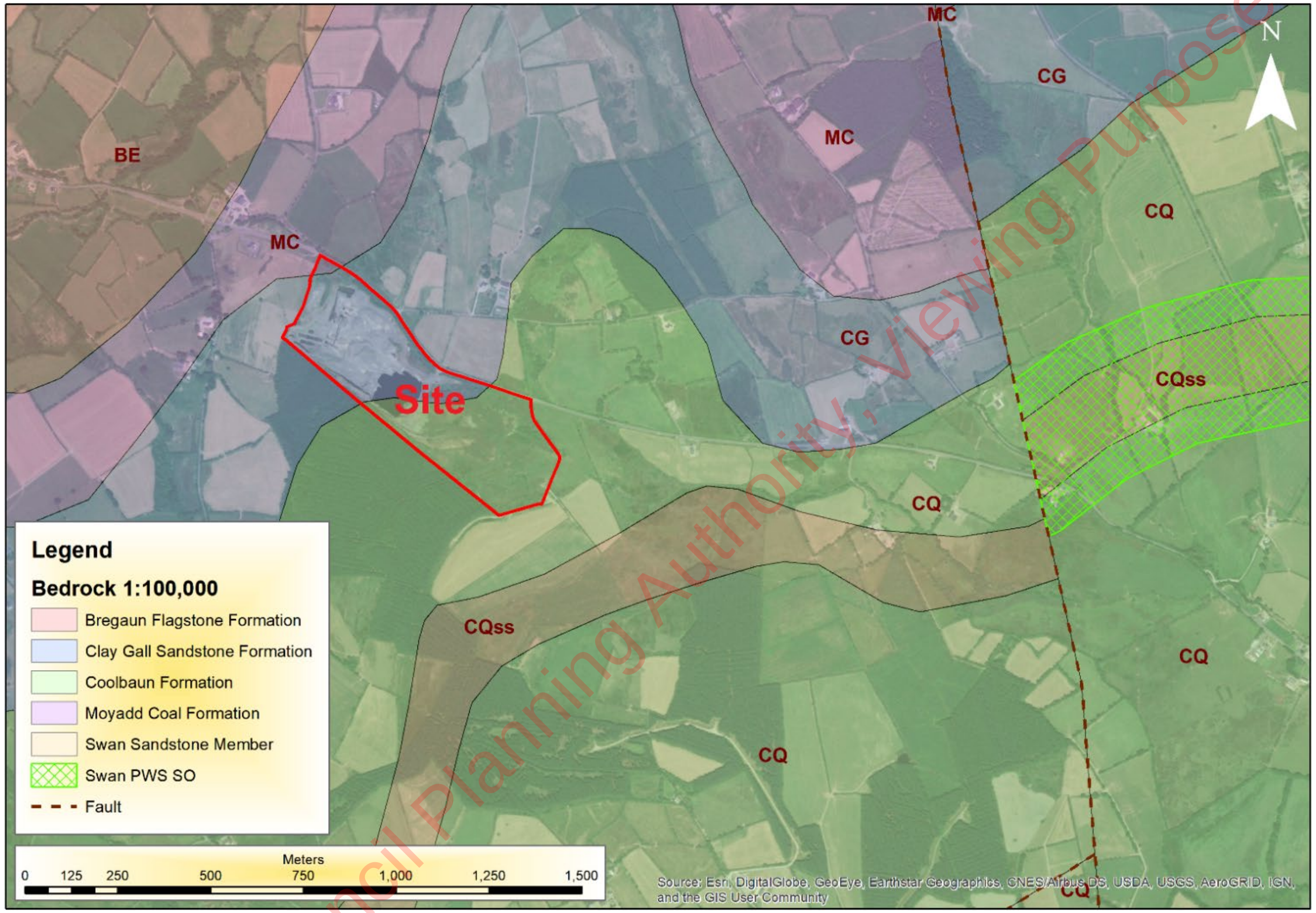

Figure 6.4 Map showing bedrock geology of area around Knockbaun

The Clay Gall Sandstone Fm. underlies the northern half of site while the Coolbaun Fm. underlies the southern half of site. The Coolbaun Fm. overlies the Clay Gall Fm., and becomes progressively thicker to the southeast due to c. 5–10° dip to southeast. Rendered with ArcGIS 10.3.1 using data from GSI (2020).

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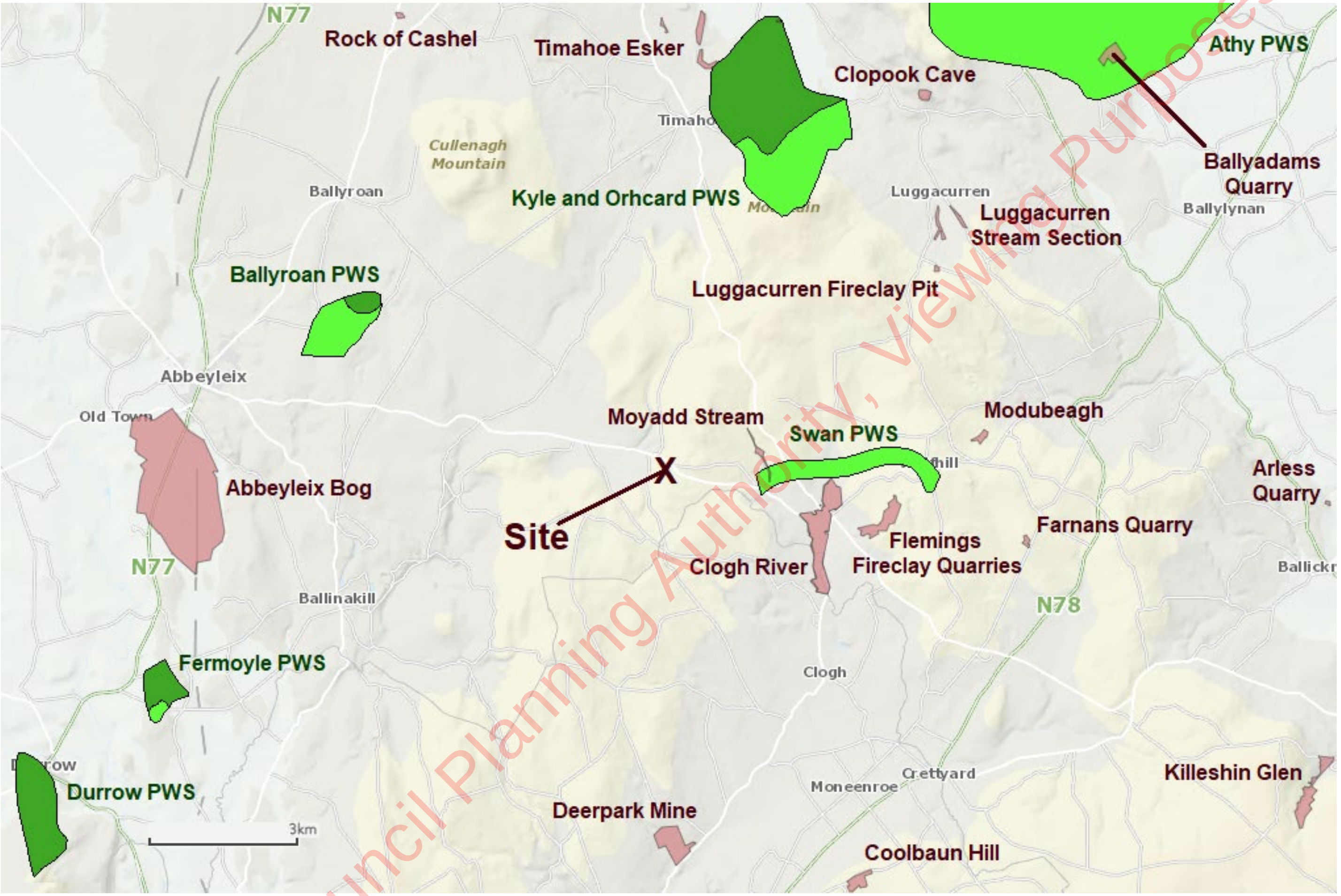

Figure 6.5 Map of wider area around Knockbaun showing sites of Geological Heritage and Groundwater Protection Zones

Note proximity of the Swan PWS SO and the Moyadd Stream and Clogh River sites to the application site at Knockbaun. Rendered with ArcGIS 10.3.1 using data from GSI (2020).

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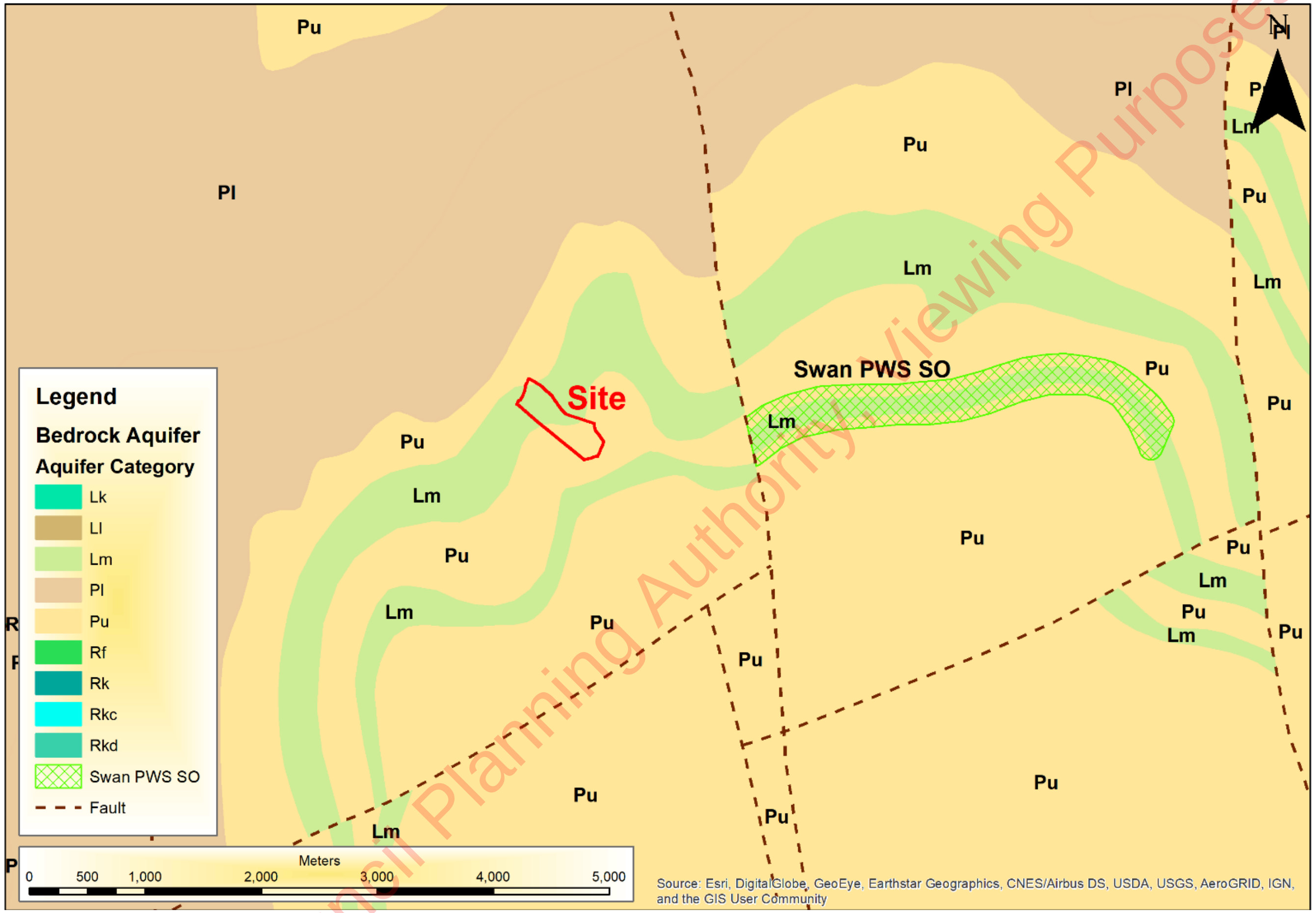

Figure 6.6 Aquifer map of wider area around Knockbaun

Note that bedrock underlying the northern half of the site is classified as Lm, which denotes “Locally Important Bedrock Aquifer, Generally Moderately Productive”, while bedrock underlying the southern half of the site is classified as Pu, which denotes “Poor Aquifer, which is Generally Unproductive. Rendered with ArcGIS 10.3.1 using data from GSI (2020).

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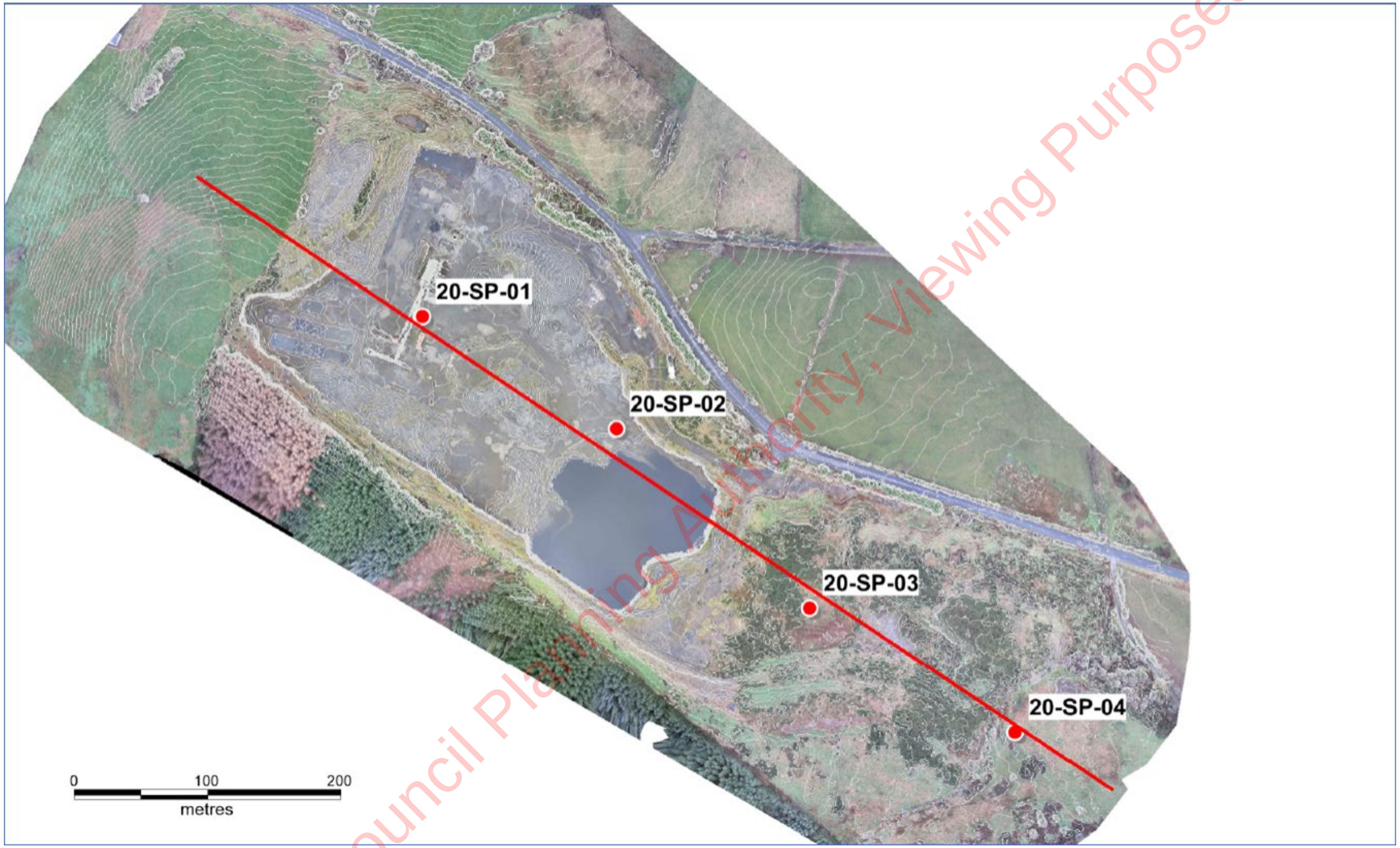

Figure 6.7 Aerial image of application site at Knockbaun showing location of Boreholes 20-SP-01 to 20-SP-04

Modified from SLR (2020).

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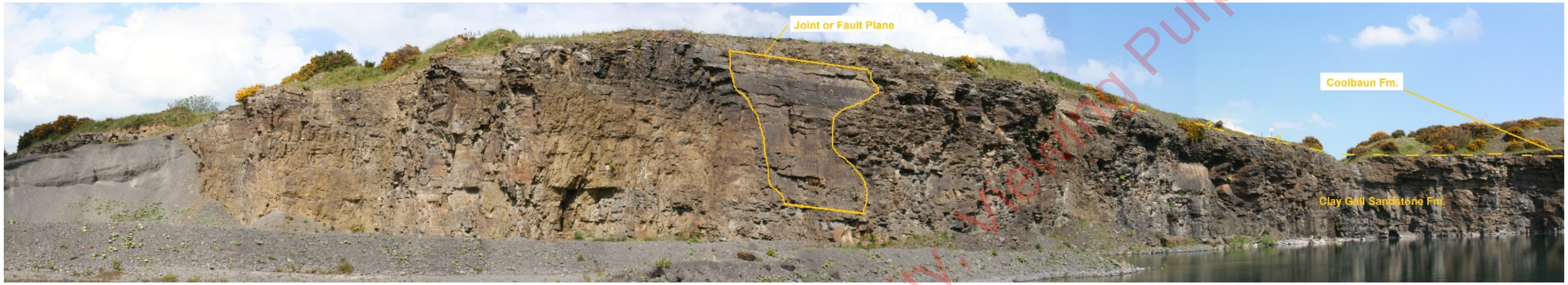

Plate 6.1 Panoramic View of North Face of Quarry

Note Coolbaun Fm. pinches out at right.

Plate 6.2 Panoramic View of East Face of Quarry

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Plate 6.3 Panoramic View of South Face of Quarry

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