6 LAND, SOILS AND GEOLOGY

6.1 Introduction

6.1.1 Background and Objectives

Hydro-Environmental Services (HES) was engaged by Milford Quarries Ltd to carry out an assessment of the potential effects of the proposed dimension stone quarry at Bannagagole, Old Leighlin, Co. Carlow on the land, soil, and geological environment.

The objectives of the assessment are:

- Produce a baseline study of the existing land, soils, and geological environment in the area of the Proposed Development site;
- Identify likely significant effects of the Proposed Development on land, soils, and geology during the construction and operation phases of the development;
- Identify mitigation measures to avoid, reduce or offset significant negative effects;
- Assess significant residual effects; and,
- Assess likely cumulative effects of the Proposed Development and other local developments.

6.1.2 Quality Assurance and Competence

Hydro-Environmental Services (HES) are a specialist geological, hydrological, hydrogeological, and environmental practice that delivers a range of water and environmental management consultancy services to the private and public sectors across Ireland and Northern Ireland. HES was established in 2005, and our office is located in Dungarvan, County Waterford.

Our core areas of expertise and experience include geology, hydrology, and hydrogeology. We routinely complete environmental impact assessments for land, soils and geology aspects for a variety of proposed extraction projects including bedrock quarries and sand and gravel pits.

This chapter of the EIAR was prepared by Michael Gill and Conor McGettigan.

Michael Gill (BA, BAI, Dip Geol., M.Sc., MIEI) is an Environmental Engineer and Hydrogeologist with over 22 years of environmental consultancy experience in Ireland. Michael has completed numerous geological, hydrological, and hydrogeological impact assessments for the extractive industry in Ireland. He has also managed EIAR assessments for infrastructure projects and private residential and commercial developments. In addition, he has substantial experience in wastewater engineering and site suitability assessments, wetland hydrology/hydrogeology, and water resource assessments. Michael has worked on over 100 quarry projects, including Ardfert quarry, Mallow quarry, and Bennettsbridge quarry.

Conor McGettigan (B.Sc., M.Sc.) is an Environmental Scientist with 3 years' of experience in environmental consultancy in Ireland. Conor holds an M.Sc. in Applied Environmental Science and a B.Sc. in Geology. Conor has prepared the Land, Soils and Geology chapters and Water (Hydrology and Hydrogeology) chapters for several quarry and wind farm EIAR projects (the wind farm projects would have included assessments of borrow pits). Conor also routinely prepares hydrological and hydrogeological impact assessment reports and flood risk assessment reports for a variety of proposed developments. Conor has recently worked on Bennettsbridge quarry and Kilmacow quarry.

6.1.3 Relevant Legislation

This EIAR is prepared in accordance with the requirement of the European Union Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (the 'EIA Directive') as amended by Directive 2014/52/EU.

The requirements of the following legislation are complied with:

- Planning and Development Acts, 2000-2021;
- Planning and Development Regulations, 2001 (as amended);
- Directives 2011/92/EU and 2014/52/EU on the assessment of the effects of certain public and private projects on the environment, including Circular Letter PL 1/2017: Implementation of Directive 2014/52/EU on the effects of certain public and private projects on the environment (EIA Directive);
- S.I. No. 296/2018 European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018;
- European Communities (Environmental Impact Assessment) Regulations 1989 to 2017; and,
- S.I. No. 4/1995: The Heritage Act 1995, as amended.

6.1.4 Relevant Guidance

The guidelines relevant to this assessment include:

- Environmental Protection Agency (May, 2022): Guidelines on the Information to be Contained in Environmental Impact Assessment Reports;
- Environmental Protection Agency (2006): Environmental Management in the Extractive Industry (Non-Scheduled Minerals);
- DoEHLG (2010) Appropriate Assessment of Plans and Projects in Ireland - Guidance for Planning Authorities;
- Geological Survey of Ireland, Irish Concrete Federation (2008) Geological Heritage Guidelines for the Extractive Industry;
- Institute of Geologists of Ireland (2002) Geology in Environmental Impact Statements, A Guide;
- Institute of Geologists of Ireland (2007) Recommended collection, presentation and interpretation of geological and hydrogeological information for quarry developments;
- Institute of Geologists of Ireland (2013) Guidelines for the preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements;
- National Roads Authority (2008) Environmental Impact Assessment of National Road Schemes - A Practical Guide;
- National Roads Authority (2008) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology, and Hydrogeology for National Road Schemes;
- Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (DoHPLG, 2018); and,
- Guidance on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU), (European Union, 2017).

6.2 Study Methodology

6.2.1 Desk Study

A desk study of the Proposed Development site and the surrounding area was completed prior to undertaking site investigations and site walkover assessments. The desk study involved collecting all relevant geological, hydrological, hydrogeological, and meteorological data for the area. This included consultation with the following sources:

- Environmental Protection Agency soils and subsoils mapping (www.epa.ie);
- Geological Survey of Ireland – Geological databases (www.gsi.ie);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 19 - Geology of Carlow - Wexford (GSI, 2003); and,
- Geological Survey of Ireland – 1:25,000 Field Mapping Sheets.

6.2.2 Baseline Monitoring and Site Investigations

An initial site visit and walkover survey was undertaken by Michael Gill of HES on 10th March 2022 with follow-up site investigation and baseline monitoring completed on site walkover surveys, including detailed drainage mapping and baseline monitoring/sampling, was undertaken by HES on 15th August, 17th August, 23rd August, 13th September, 10th October, 15th November and 19th December 2022.

In summary, the site investigations completed in order to address the land, soils and geology chapter of the EIAR included the following:

- Walkover surveys to assess the local ground conditions and layout of the Proposed Development site including surveys of the adjacent lands;
- Drilling and logging of 5 no. groundwater monitoring wells (BH1 – BH5) within the Proposed Development site in August 2022. Drilling was completed by Irish Drilling Ltd and the cores were logged by HES staff;
- The coreholes were converted to groundwater monitoring wells to allow monitoring of groundwater levels;
- 3 no. trial pits (TP1 – TP3) were excavated within the Proposed Development site on 15th August 2022;
- Mineral soils and subsoil were logged according to BS: 5930:2015 Code of Practice for Ground Investigations; and,
- 8 no. geophysical 2D resistivity profiles were completed with the site area. These surveys were undertaken by Minerex Geophysics Ltd in June & July 2022.

6.2.3 Impact Assessment Methodology

Using information from the desk study and data from the site investigations, an assessment of the importance of the soil and geological environment within the study area and proposed site is assessed using the criteria set out in Table 6-1 (NRA, 2008).

Table 6-1: Estimation of Importance of Soil and Geology Criteria (NRA, 2008)

Importance	Criteria	Typical Example
Very High	Attribute has a high quality, significance or value on a regional or national scale. Degree or extent of soil contamination is significant on a national or regional scale. Volume of peat and/or soft organic soil underlying 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 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 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 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 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. Uneconomically extractable mineral Resource.

The guideline criteria (EPA, 2022) for the assessment of likely significant effects require that likely effects are described with respect to their extent, magnitude, type (i.e., negative, positive or neutral) probability, duration, frequency, reversibility, and transfrontier nature (if applicable). The descriptors used in this environmental impact assessment report are those set out in the EPA (2022) Glossary of effects as shown in Chapter 1 of this EIAR. In addition, the two impact characteristics proximity and probability are described for each impact and these are defined in Table 6-2.

In order to provide an understanding of this descriptive system in terms of the geological/hydrological environment, elements of this system of description of effects are related to examples of potential likely significant effects on the geology and morphology of the existing environment, as listed in Table 6-3.

Table 6-2: Additional Impact Characteristics

Importance	Criteria	Typical Example
Proximity	Direct	An impact which occurs within the area of the proposed project, as a direct result of the proposed project.
	Indirect	An impact which is caused by the interaction of effects, or by off-site developments.
Probability	Low	A low likelihood of occurrence of the impact.
	Medium	A medium likelihood of occurrence of the impact.
	High	A high likelihood of occurrence of the impact.

Table 6-3: Impact Descriptors Related to the Receiving Environment

Impact Characteristic		Potential Geological and Hydrological Impacts
Quality	**Significance**	
Negative only	Profound	Widespread permanent impact on: • The extent or morphology of a cSAC. • Regionally important aquifers. • Extents of floodplains. Mitigation measures are unlikely to remove such impacts.
Positive or Negative	Significant	Local or widespread time-dependent impacts on: • The extent or morphology of a cSAC / ecologically important area. • A regionally important hydrogeological feature (or widespread effects to minor hydrogeological features). • Extent of floodplains. Widespread permanent impacts on the extent or morphology of an NHA/ecologically important area. Mitigation measures (to design) will reduce but not completely remove the impact – residual impacts will occur.
Positive or Negative	Moderate	Local time-dependent impacts on: • The extent or morphology of a cSAC / NHA / ecologically important area. • A minor hydrogeological feature. • Extent of floodplains. Mitigation measures can mitigate the impact OR residual impacts occur, but these are consistent with existing or emerging trends
Positive, Negative or Neutral	Slight	Local perceptible time-dependent impacts not requiring mitigation.

Impact Characteristic		Potential Geological and Hydrological Impacts
Quality	**Significance**	
Neutral	Imperceptible	No impacts, or impacts which are beneath levels of perception, within normal bounds of variation, or within the bounds of measurement or forecasting error.

6.3 The Existing and Receiving Environment (Baseline Situation)

6.3.1 Site Description and Topography

The Proposed Development site at Bannagagole, Old Leighlin Co. Carlow (the 'site'), occupies a total area of ~9.34hectares (ha) and forms part of the applicant's wider landholding of ~26ha. Regionally the site is situated ~17km south of Carlow Town and ~22km northeast of Kilkenny. On a more local scale, the site is located ~1.5km south of the village of Old Leighlin, ~5km southwest of Leighlinbridge and immediately south of the existing Old Leighlin Quarry.

The M9 motorway is located to the east of the site with the closest access point being located ~7km to the south at Junction 7. Junction 6 of the M9 motorway at Powerstown is located ~10km to the northeast.

The lands surrounding the site are largely agricultural in nature with several one-off houses located within a 1km radius. There is an equestrian centre located ~2km to the east. The site lies immediately to the south of an existing limestone bedrock quarry at Bannagagole (Old Leighlin Quarry) which is operated by Kilkenny Limestone Quarries Ltd. Rock extraction, processing, and surplus rock storage is carried out at the existing quarry.

The River Barrow is located ~4km to the east of the site, while the Madlin River, a tributary of the Barrow runs in a west to east direction ~1.5km north of the site.

The site is located to the east of the Castlecomer Plateau, with ground elevations within the site sloping to the east. Natural ground levels within the site range from ~75mOD in the east, adjacent to a local road (L3036), to a high of ~130mOD in the west. Topography to the west of the site rises steeply.

The site is accessed from the L3036 which connects to the village of Old Leighlin to the north and the R448 to the east. A small laneway extends westwards into the site from this local road. This laneway connects the road with a derelict farmhouse and associated derelict farm outbuildings (5 no.) which are located within the landholding.

6.3.2 Land and Landuse

According to Corine landcover mapping (2018), the site comprises agricultural pastures. No significant landuse changes are recorded by previous Corine land cover maps (1990 – 2018). Land use in the surrounding area is also mapped by Corine as agricultural pastures with some areas of coniferous forestry mapped further to the west of the site on higher ground associated with the Castlecomer Plateau.

Inspection of aerial photographs and follow-up site walkover surveys have provided greater detail regarding the landuse at the site at Bannagagole and the surrounding lands. The site is comprised of agricultural pastures and areas of coniferous forestry. An area in the east of the site contains agricultural grasslands, with much of the remainder of the site containing relatively young conifer plantations. Mature hedgerows are also present throughout the site, delineating local field boundaries. As stated above, the site contains a derelict house and 5 no. derelict farm outbuildings which are located towards the centre of the site. The site is accessed via a small laneway from the L3036 which extends into the site towards these derelict buildings.

Landuse in the surrounding lands is largely agricultural with isolated dwellings and farmhouses located along the local roads. The site also lies immediately to the south of the existing Old Leighlin Quarry.

6.3.3 Soils and Subsoils

The EPA soils map for the local area (www.epa.ie) shows that the soils overlying the site are predominantly acid poorly drained mineral soils (AminPD). The EPA map some acid deep well-drained mineral soil (AminDW) and basic shallow well-drained mineral soils (BminSW) in the west of the site. Soils in the surrounding lands are mapped as acidic shallow well-drained mineral soils (AminSW) to the west of the site and within the overall landholding. Soils to the east of the site are mapped as basic deep poorly drained mineral soils (BminPD). An area of made ground is also mapped to the northeast of the site within Old Leighlin Quarry. Soils to the south of the site and within the overall landholding are similar to those mapped within the site.

The GSI subsoil map for the local area (www.gsi.ie) shows that the site is predominantly underlain by till derived from Namurian sandstones and shales (TNSSs). A small area of bedrock outcrop/subcrop (Rck) is located on the higher ground in the northwest of the site. The GSI mapping also shows a small area of till derived from limestones (TLs) in the east of the site, adjacent to the L3036. Subsoils in the surrounding lands are mapped as bedrock outcrop/subcrop to the north in Old Leighlin Quarry and on the elevated ground to the west of the site. Subsoils to the east of the site are mapped as till derived from limestones. Subsoils within the overall landholding comprise largely of till derived from Namurian sandstones and shales with some bedrock outcrop in the west.

A local subsoils map is included below as Figure 6-1.

The nature and composition of the soils and subsoils present at the site have been verified during intrusive site investigations conducted by HES in August 2022. The intrusive site investigations comprised the excavation of 3 no. trial pits (TP1 – TP3) on 15th August 2022 and the drilling of 5 no. boreholes (BH1 – BH5) by Irish Drilling Ltd between 15th and 19th August 2022. The locations of the site investigation points are shown in Figure 6-2.

The 3 no. trial pits did not encounter the full subsoil profile and extended to a maximum depth of 4.3mbgl (metres below ground level). The topsoil was typically described as comprising stiff, brown, slightly sandy, gravelly CLAY. The subsoils encountered during the trial pit excavations comprised Boulder Clay consisting of stiff, brown gravelly silty CLAY with angular and subangular gravels and cobbles of siltstone and mudstone. Geological logs for the trial pits are attached as Appendix C.

The full subsoil profile was encountered in the drilling of the 5 no. boreholes down into bedrock. These intrusive investigations found subsoil thicknesses within the site to range from 4.1 to 15.7m with an average depth to rock of 9.2m. Based on these site investigations, depth to bedrock is greatest in the south and west of the site, with depth to bedrock recorded as 15.7mbgl and 12.3mbgl in BH1 and BH5 respectively. Shallower bedrock was encountered toward the northeast of the site, with depth to bedrock recorded as 4.1mbgl and 4.3mbgl at BH3 and BH4 respectively. In terms of subsoil composition, the subsoils encountered during the drilling of these boreholes were typically described as firm, slightly silty occasionally gravelly CLAY (Boulder Clay).

The subsoils encountered during the site investigation works are therefore consistent with the till derived from Namurian sandstones and shales mapped in this area by the GSI.

8 no. geophysical surveys have also been completed at the site by Minerex Geophysical Ltd in June and July 2022. The interpretation of the geophysical surveys is consistent with the data obtained from the boreholes (refer to Geophysical Report attached as Appendix D). The boreholes carried out at the site generally match the depth to rock interpreted from the geophysical data.

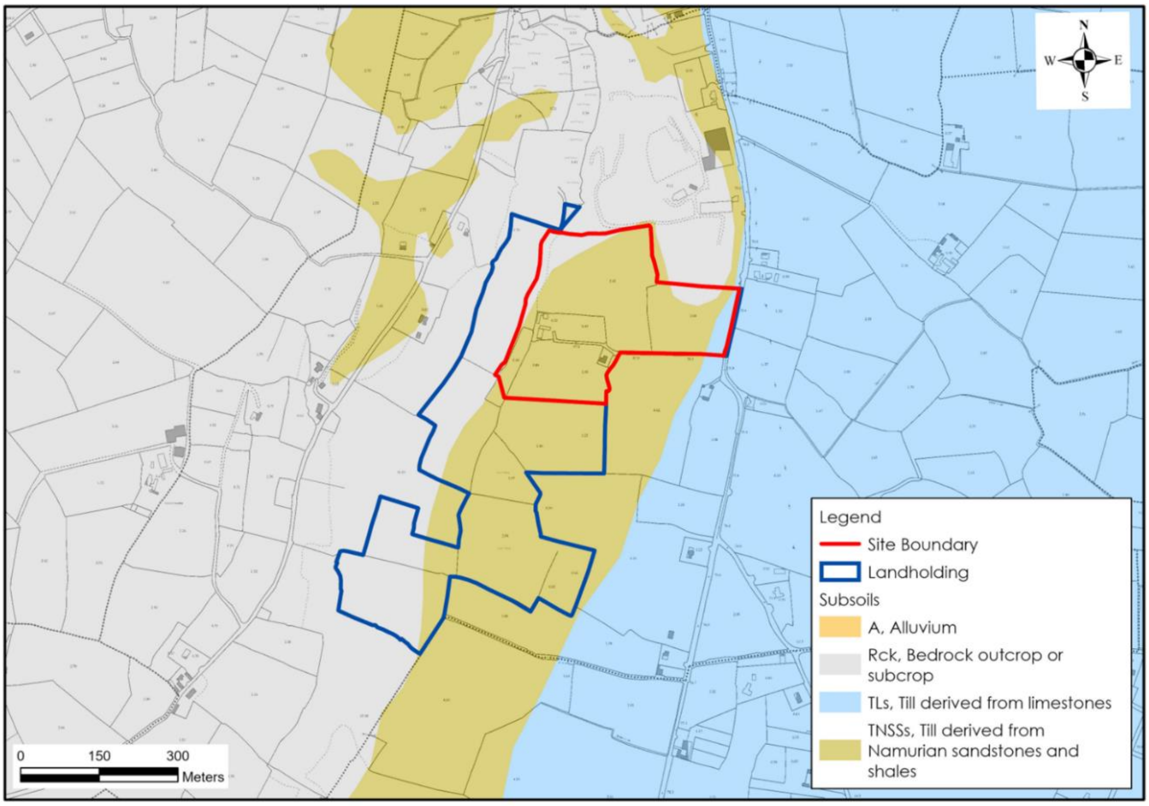

Figure 6-1: Local Subsoils Map (www.gsi.ie)

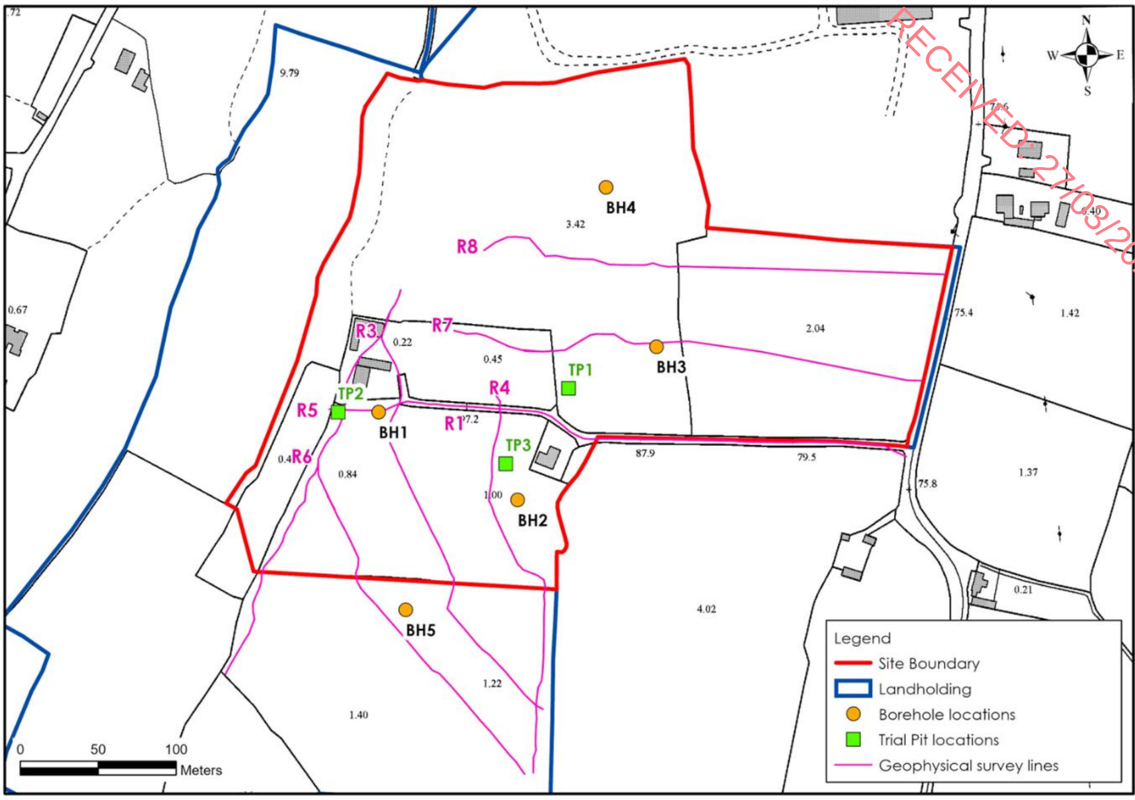

Figure 6-2: Map of Site Investigation Points

6.3.4 Bedrock Geology

The bedrock geology map for the local area (www.gsi.ie) shows that the site is underlain by 2 no. bedrock geological formations.

A small area in the east of the site, adjacent the L3036, is underlain by the Ballyadams Formation. The Ballyadams Formation comprises of medium to dark-grey thick-bedded to massive crinoidal calcarenite wackestones and packstones. Meanwhile, the remainder of the site is underlain by the Clongrenan Formation. The GSI state that this formation is characterised by typically medium-coarse grained thick limestones beds with variable presence of shales.

The GSI also map the presence of an additional 2 no. bedrock geological formations to the west of the site and within the overall landholding. The Luggacurren Shale Formation consists of mudstone and shale with chert and limestone. The Killeshin Siltstone Formation is composed of mainly grey argillaceous siltstones or silty mudstones with lesser amounts of sandstone and shale.

The GSI map the presence of a geological unconformity between the Clongrenan Formation and the Luggacurren Formation to the west of the site and within the overall landholding. According to the GSI the bedrock formations in the local area are noted to dip to the west/northwest. The GSI also record the occurrence of several bedrock outcrops in the north and northwest of the site, adjacent to the existing Old Leighlin Quarry. Further bedrock exposures are mapped in the south of the overall landholding.

The GSI do not map the occurrence of any faults or folds within the site. The closest mapped fault is a large north-south orientated fault that is mapped to ~1.3km to the west of the site.

A local bedrock geology map is included in Figure 6-3.

The nature and composition of the bedrock geology at the site has been verified by intrusive site investigations supervised by HES in August 2022. The locations of the site investigation points are shown in Figure 6-2.

Based on site-specific data the depth to bedrock at the site ranges from 4.1 to 15.7m (rock head between 84.2 and 88.9mOD) with an average depth to rock of 9.2m. Intrusive site investigations have revealed that the bedrock underlying the site comprises dark blue laminated and fossiliferous limestone which has been heavily dolomitised in places. The total drilling length of the 5 no. boreholes was 213.4m with ~54% of the returns consisting of dolomite and only 22.86% of the returns comprising intact, strong limestones. Geological logs for the boreholes are attached as Appendix C and are summarised in

Table 6-4.

8 no. geophysical surveys were completed by Minerex Geophysics Ltd in June/July 2022. The interpretation of the geophysical surveys are consistent with the data obtained from the boreholes (refer to Geophysical Report attached as Appendix 7.2). The resistivities are very varied with the main geological changes occurring from west to east across the site. The geophysics interpret a fault zone in the west of the survey area, close to the bottom of a steep hill. The zone to the east of the fault zone is interpreted as mudstone and is 5-25m thick. The mudstone is underlain by a weathered limestone layer which gives way to a muddy limestone in the east. The top of this limestone layer was noted to be at a depth of 5-10m on the east of the site and deepens to the west.

Figure 6-4 presents a schematic geological cross-section of the site. The cross-section is orientated east to west and is based on the available site investigation data including borehole logs and geophysical profiles. The main geological feature of note is a bedrock fault with mudstones and shales of the Luggacurren Formation to the west and muddy limestones of the Clogrenan Formation to the east. The Clongrenan Formation has been subject to dolomitisation, with the dolomite thinning to the east and away from the fault. To the east of the proposed extraction area, the geophysical surveys encountered strong and clean limestones of the Ballyadams Formation.

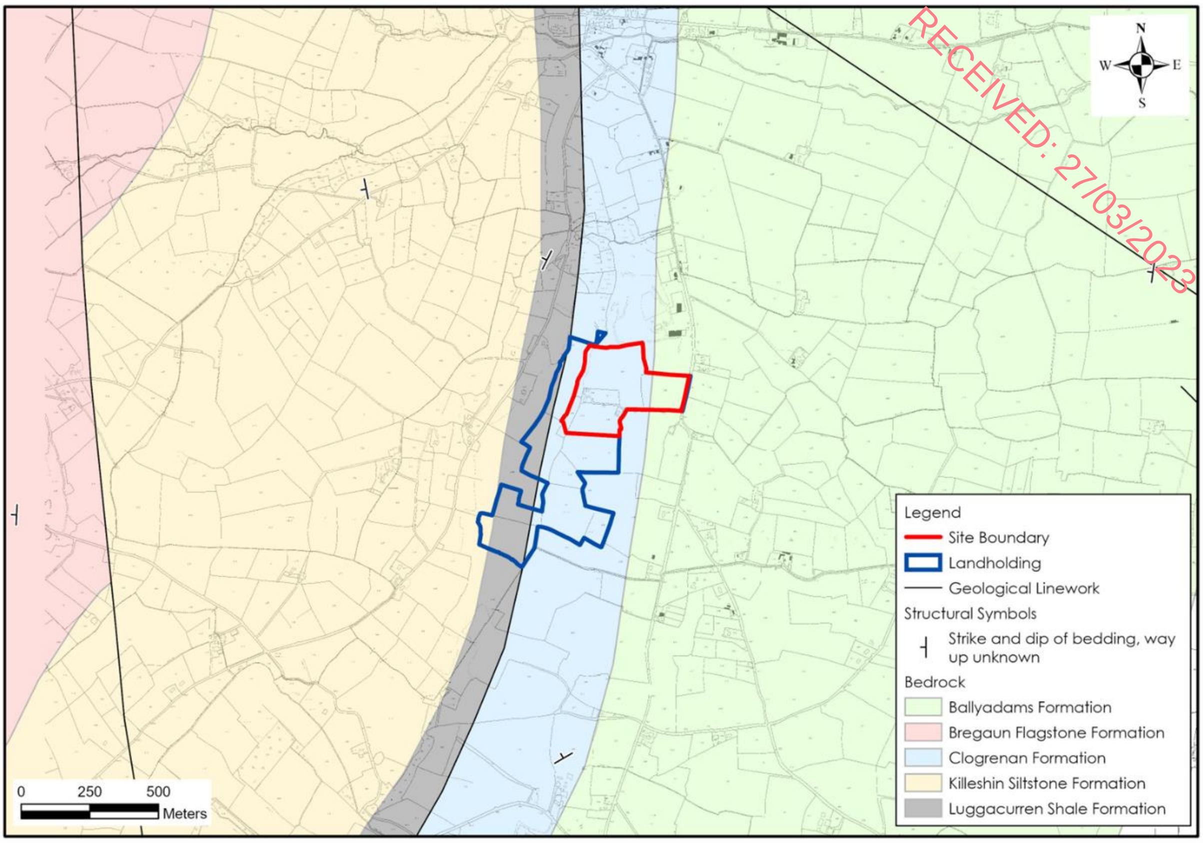

Figure 6-3: Bedrock Geology Map (www.gsi.ie)

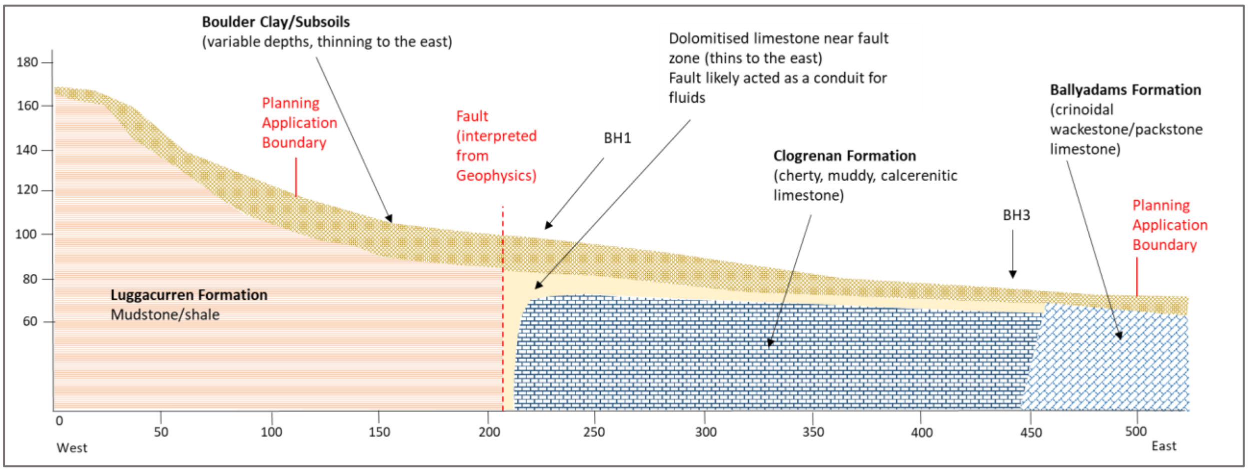

Figure 6-4: Schematic Geological Cross-Section based on SI data

Table 6-4: Summary Borehole Information

Borehole Number	Easting	Northing	Depth to Bedrock (m)	Rockhead (mOD)	Summary Geology (mbgl)
BH1	665914.03	664072.34	15.7	88.0	0 – 15.7: Overburden 15.7 – 16.5: Strong dark blue fine grained limestone 16.5 – 24.5: Strong creamy dolomite limestone

Borehole Number	Easting	Northing	Depth to Bedrock (m)	Rockhead (mOD)	Summary Geology (mbgl)
					24.5 – 27.5: Strong blue laminated dolomite limestone 27.5 – 40.2: Strong pale grey dolomite limestone
BH2	666003.53	664015.54	9.0	84.8	0 – 9.0: Overburden 9.0 – 17.3: Fragmented pale grey dolomite limestone 17.3 – 20.3: Clay 20.3 – 34.7: Pale grey dolomite 34.7 – 40.3: Strong blue limestone
BH3	666092.20	664114.54	4.1	84.2	0 – 4.1: Overburden 4.1 – 7.9: Pale pink dolomite 7.9 – 20.0: Strong dark blue limestone 20.0 – 21.2: Weak black fine-grained mudstone 21.2 – 40.3: Strong dark blue limestone
BH4	666059.71	664216.69	4.3	88.9	0 – 4.3: Overburden 4.3-31.5: Strong pale grey dolomite 31.5 – 39.4: Strong blue bioclastic limestone 39.4 – 40.3: White coarse-grained limestone
BH5	665931.37	663945.57	12.3	85.1	0 – 12.3: Overburden 12.3 – 40.5: Moderately strong pale grey dolomite 40.5 – 50.5: Strong pale blue limestones 50.5 – 52.3: Strong dark blue bioclastic limestone

6.3.5 Geological Resource Importance

The GSI database[3] (www.gsi.ie) shows that the site is located in an area of High to Very High Potential for crushed rock aggregate (i.e., potential for a bedrock quarry). The bedrock underlying the site could be classified as being of “High” importance. The existing Old Leighlin Quarry located immediately to the north of the site is an active limestone quarry which produces stone for monumental and architectural use. Therefore the bedrock underlying the proposed site is of similar economic use (proven by drilling investigations and geophysical surveys) and importance.

In terms of the local soils and subsoils, the site is not mapped by the GSI (www.gsi.ie) as an area with granular aggregate potential. The glacial till deposits at the site can be classified as being of “Low” Importance.

The GSI Online Minerals Database (www.gsi.ie) records the presence of Old Leighlin Quarry immediately to the north of the site. This quarry is operated by Kilkenny Limestone Quarries

[3] *Source: GSI online Aggregate Potential Mapping Database*

Ltd and, as stated above, is a limestone quarry for dimension stone. A second active quarry is located at Knockadeen, ~6km southwest of the site, and is underlain by the Killeshin Siltstone Formation. Another quarry is mapped to the southeast of the site near Bagenalstown and is underlain by the Ballyadams Formation.

In terms of the recorded occurrence of minerals, a mineral locality is mapped by the GSI (www.gsi.ie) at Old Leighlin Quarry where the key mineral is listed as limestone (Mineral Location Ref: 3035). Additional comments provided by the GSI state that this is an active quarry with coarse calcarenite and comprises ~40% micrite and 30% sparite. Several mineral localities are also mapped to the southwest of the site in the townlands of Coolreagh and Kellymount Co. Kilkenny. An active quarry produces limestone at Kellymount (Mineral Location Ref: 739) while large disused sandstone quarries also occur in this area (Mineral Location Ref: 5084 and 5085). The occurrence of sand and gravel deposits overlying limestone with black marble beds is recorded near Bagenalstown to the southeast of the site (Mineral Location Ref: 699).

The location of mapped active quarries and mineral locations as recorded by the GSI are shown in Figure 6-5.

6.3.6 Geological Heritage and Designated Sites

Bannagagole Quarry (*i.e.* Old Leighlin Quarry) immediately to the north of the site is designated as a County Geological Site (CGS) and is recommended for designation as a National Geological Heritage Area (Site Code: CW004). This quarry is described as a very large and deep working quarry hosted in the limestones of the Ballyadams Formation. It has been noted to host many interesting fossils including corals and brachiopods.

There are no other geological heritage areas located within 5km of the site. Geological heritage areas within 10km of the site are listed in

Table 6-5.

Furthermore, the site is not located within any designated European Site (i.e. Special Area of Conservation (SAC) or Special Protected Area (SPA)). The nearest designated site is the River Barrow and River Nore SAC (Site Code: 002162), located ~1km northeast of the site along the Madlin River. This SAC is located downstream of the site and a full assessment of potential impacts resulting from the Proposed Development on this designated site is included in Chapter 8: Hydrology.

Table 6-5: Geological Heritage Sites (www.gsi.ie)

Site	Site Code	Designation	Distance from Site (km)	Description
Bannagagole Quarry	CW004	CGS	Immediately to the north	Very large and deep working quarry
Ballymoon Esker, Bagenalstown	CW003	CGS	~5.8km to the southeast	An esker ridge of sands and gravels
Morrisey's Quarry	CW006	CGS	~8km to the northeast	A large working quarry with extensive overburden of glacial till

Site	Site Code	Designation	Distance from Site (km)	Description
Clongrenan Quarry	CW005	CGS	~8.1km to the northeast	A large and deep working quarry
Old Rossmore	LS026	CGS	~9.5km to the north	An abandoned coal mine and quarry with several large open pits, waste heaps and derelict plant
Ballyellin Quarry	CW001	CGS	~9km to the southeast	A large working quarry

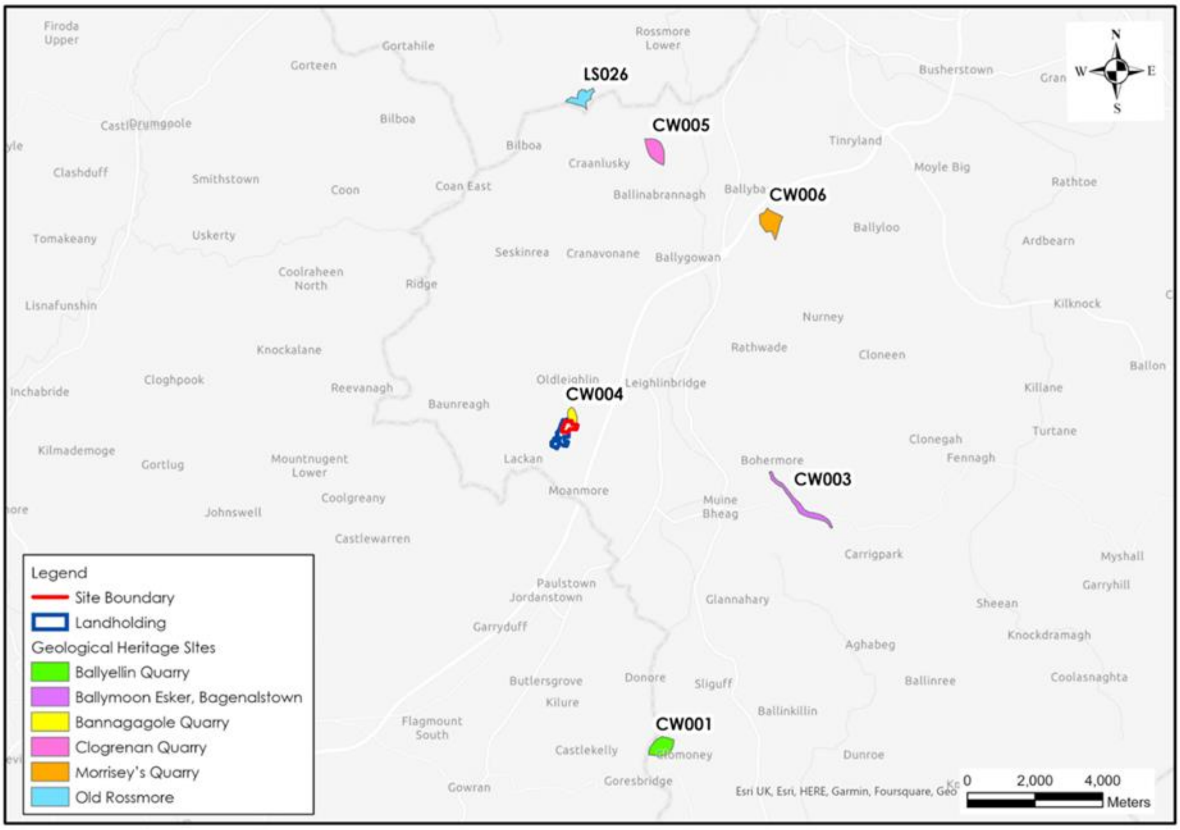

Figure 6-5: Geological Heritage Areas, Active Quarries and Mineral Locations (www.gsi.ie)

6.3.7 Soil Contamination

During site walkover surveys and site investigations, no evidence of soil contamination was recorded at this site.

According to the EPA online mapping database (www.epa.ie), there are no licenced waste facilities or dump sites within the site or in the surrounding lands. The closest mapped waste facility is the Powerstown Landfill Site, located just south of Exit 6 off the M9.

Furthermore, there are no IEL/IPC Licence facilities in the immediate area of the site. The closest mapped IEL licence occurs ~1.5km south of the site at Moanmore and relates to pig farming (P0825-01).

The GSI online database (www.gsi.ie) records the presence of several historic quarries in the Bannagagole area. These historic quarries typically date from the early to mid-20^{th} century. These historic quarries correspond to the existing location of the operational Old Leighlin Quarry. A quarry dating from the early to mid-20^{th} century is also mapped in the northwest of the site. This has been digitised by the GSI from OSI maps of the local area.

6.3.8 Receptor Sensitivity

Based on Table 6-1, the soils and subsoils at the site can be classified as being of Low Importance due to the moderate volumes of soils and subsoils and the nature of these deposits which do not have any granular aggregate potential.

The bedrock underlying the site can be classified as being of Very High Importance as the bedrock in this area has a high value on a regional scale with the designation of Bannagagole Quarry (Old Leighlin Quarry) as a County Geological Heritage Area. This large existing quarry indicates that there is an economically extractable mineral resource in this area. Furthermore, the bedrock underlying the site is mapped as having High to Very High potential for crushed rock aggregate.

6.4 Characteristics of the Proposed Development

The Proposed Development comprises the development of a bedrock quarry proposed for a period of 12 to 13 years followed by the implementation of a restoration plan.

Extraction is proposed over a total area of 2.44ha and will involve the extraction of ~84,000 tonnes (30,000m^3) of material annually from the site. The proposed quarry void will be extracted to a depth of 2 no. benches of ~10m each from the top of the bedrock, with a final floor level of ~56.5mOD.

Extraction will be preceded by site preparation which will involve stripping soils and subsoils from the proposed extraction area. The volume of overburden to be removed is estimated to be ~122,345m^3. The stripped overburden will be utilised in the construction of berms surrounding the extraction area while it is proposed to store the remainder in a soil storage area (~3.1ha) which will have an average fill depth of ~4m.

Site investigations have revealed that the usable dimension limestone at the site is at a depth of ~10m below ground level and a layer of unusable dimension stone will require extraction prior to reaching the quality limestone bedrock. The Proposed Development includes a working area (~1.2ha) to the south of the extraction area which will provide for the crushing and processing of the unusable stone and storage of the dimension stone. The working area will also include parking, a staff canteen, a weighbridge and a stockpile area.

Once the quality dimension stone is exposed in the extraction area, the stone will be cut into blocks using a diamond tipped chain or diamond wire saws. The blocks of dimension stone will be lifted by an excavator and immediately transported off-site for sale/processing elsewhere.

Access to the Proposed Development will be facilitated by a HGV site entrance from the local road to the east of the site.

The Proposed Development will also include a wheel wash facility, storage shed (240m^3), the installation of surface water attenuation and settlement ponds on the quarry floor and all other associated siteworks including the final quarry restoration.

6.5 Potential Impact of the Proposed Development

6.5.1 Construction Phase

In the context of the Proposed Development the construction stage is taken to be the preparation of the proposed extraction area of 2.49ha. As the proposed extraction area is currently a greenfield site, the Proposed Development will involve vegetation removal and soil/subsoil stripping. It is calculated that 122,345m^3 of overburden will require removal. This material will be used in the construction of berms surrounding the extraction area, with excess material stored in a dedicated soil storage area. This phase of the development will be completed using earth moving machinery (i.e., excavators and dump trucks).

The construction phase also includes the construction of site access roads, the site entrance and the proposed compound area. The existing onsite building will be demolished during this phase of the Proposed Development.

6.5.1.1 Effect on Land and Landuse

The construction of the Proposed Development will result in the loss of approximately 2.06ha of agricultural land and 4.49ha of commercial forestry. The extraction will result in local topographic changes with the removal of till overburden from the site. The depth to bedrock at the site is ~5mbgl, therefore the proposed 2.49ha extraction area will see a lowering of ~5m in its surface topography during this phase of the Proposed Development.

The impacts on land use will be localised to within the Proposed Development footprint (i.e., the extraction area, the soil storage area, and the setdown area). This Proposed Development area comprises ~35.9% of the total landholding.

There will be no effects on the lands adjoining the site.

The pre-mitigation potential effect will be negative, moderate, direct, likely, long-term, effect on land and landuse.

6.5.1.2 Excavation of Soil and Subsoils

The Proposed Development will involve the movement of approximately 122,345m^3 of overburden within the site in order to expose the underlying limestone bedrock.

In order to proceed with extraction, a portion of this stripped overburden will be used to construct temporary berms around the proposed extraction area. The remainder of the material will be stored in the proposed soil storage area to the south of the extraction area. The stripped soil and subsoils will ultimately be used in the restoration of the site post-extraction.

Earthworks and soil/subsoil disturbance will also be required for the construction of the site entrance, site access roads and the proposed compound area.

The pre-mitigation potential effect will be negative, reversible, moderate, direct, likely, permanent effect on soil and subsoils.

6.5.1.3 Contamination of Soil, Subsoils and Bedrock by Oil/Fuel Spillages and Leaks

Construction phase activities at the site including the stripping of vegetation, soil removal, demolition of existing buildings and the construction of the site entrance, compound area and access roads will be completed using machinery. Such machinery are powered by diesel engines and operated using hydraulics. Unless carefully managed such plant and machinery have the potential to leak hydraulic oils or cause fuel leaks during refueling operations.

Only small volumes of fuel/oils will be present on-site and therefore no significant effects are expected.

The pre-mitigation potential effect will be negative, reversible, slight, direct/indirect, unlikely, medium-term effect on soil and subsoils.

6.5.1.4 Erosion of Exposed Soils and Subsoils

There is a high likelihood of erosion of soil and subsoil during its excavation and during extraction works. The main impacts associated with this aspect is towards the water environment, and therefore this aspect is further assessed in detail in Chapter 8.

The pre-mitigation potential effect will be negative, slight, direct, short-term, likely effect on soil and subsoils by erosion.

6.5.2 Operational Phase

In the context of the Proposed Development the operational phase is taken to be the extraction of limestone bedrock to a final proposed depth of ~56.5mOD. This phase of the Proposed Development will firstly involve the extraction of limestone which will be crushed and processed in the proposed working area to the south of the extraction area. Once the usable dimension stone is at the surface it will be extracted and transported off-site for processing.

6.5.2.1 Excavation of Bedrock

The Proposed Development will involve the extraction of approximately 30,000m^3 per year (~84,000tpa) of bedrock down to a final floor level of 56.5mOD (2 no. benches of ~10m each from the top of the bedrock).

In order to extract the usable dimension stone, ~10m depth of unusable stone will be extracted, crushed and processed on site.

The pre-mitigation potential impact will be negative, irreversible, moderate, direct, likely, and permanent effect on bedrock.

6.5.2.2 Contamination of Bedrock by Oil/Fuel Spillages and Leaks

Plant and site vehicles will be present throughout the operational phase of the Proposed Development. Accidental spillage of fuels and hydraulic oils during operations can be a pollution risk to land, soils and associated ecosystems. Hydrocarbons have a high toxicity to humans, and all flora and fauna, and is persistent in the environment.

Only small volumes of fuel/oils will be present on-site and therefore no significant effects are expected.

The pre-mitigation potential impact will be negative, reversible, slight, direct/indirect, unlikely, medium-term effect on bedrock.

6.5.2.3 Impact on Geological Heritage Sites

The site is mapped immediately to the south of Bannagagole Quarry which has been designated as a County Geological Site (CGS) and is recommended for designation as a National Geological Heritage Area (Site Code: CW004). This quarry is described as a very large and deep working quarry hosted in the limestones of the Ballyadams Formation. It has been noted to host many interesting fossils including coral and brachiopods.

The Proposed Development has no potential to impact on this CGS as all impacts associated with the land, soils and geological environment will be contained within the proposed site boundary.

Indeed, the Proposed Development will result in further exposure of the local bedrock geology, providing greater bedrock exposures and increased opportunities for geologists to study the local bedrock geology formations.

The Proposed Development has no potential to impact any geological heritage sites.

6.5.3 Potential Cumulative Impacts

Whilst the other land use activities in the surrounding area are mainly agricultural, the site is located immediately to the south of the existing Old Leighlin Quarry.

Due to the lack of any significant residual impacts from the development that would affect the wider geological environment, there will be no significant cumulative impacts to land, soils and geology resulting from the Proposed Development, and other local existing developments, projects and plans. All impacts on land, soils and geology relating to the Proposed Development will be localised and contained within the development footprint.

6.5.4 Restoration Phase

The restoration plan includes allowing the quarry void to naturally fill with water with some of the void backfilled with spoil from the surrounding berms. The void will be surrounded by a secure post and wire fence. The proposed soil storage areas will be seeded and allowed to revert to scrubland. Meanwhile, the proposed setdown area and shed will be cleared and restored to scrubland. The remainder of the site will be planted with trees. No negative impacts on the land, soil and geological environments will occur during the restoration or post-restoration phase. The restoration phase will have a positive effect in terms of land, by returning most of the site back to scrubland.

6.5.5 "Do Nothing" Impact

If the Proposed Development were not to proceed, the proposed site would remain as a greenfield site, continuing to be used for agriculture and commercial forestry.

6.6 Avoidance, Remedial & Mitigation Measures

6.6.1 Construction Phase

6.6.1.1 Effect on Land and Landuse

The loss of agricultural land and forestry resulting from the Proposed Development on a local or regional scale is minimal and therefore the effects of actual agricultural/forestry land loss is not significant.

Given the local topography of the site, any change in topography is likely to be minimal in the overall landscape. The stripped overburden will be used in the construction of berms surrounding the extraction area.

Mitigation will include a restoration plan which will return the some of the proposed site to scrubland and will comprise planting of trees within the site. An area of the quarry void will be backfilled with topsoil and overburden which was previously stripped while some of the quarry void will be allowed to fill with water.

6.6.1.2 Excavation of Soil and Subsoils

Site earthworks and the stripping of soil and subsoils will result in a direct impact on the local geological environment.

The impacts will be localised (i.e., only within the proposed extraction area) and will be mostly mitigated through the adoption of a suitable landscape and restoration plan which will be undertaken on completion of the extraction works. The stripped topsoil will be used to form a berm around the extraction area and/or stored within a proposed soil storage area and will ultimately be used in the restoration of the site.

Furthermore, the glacial till subsoils at the site are considered to be of low importance.

Any impacts are considered an acceptable and unavoidable part of the Proposed Development as the soils and subsoils must be removed in order to expose the underlying bedrock which will be extracted for economic purposes.

6.6.1.3 Contamination of Soil, Subsoils and Bedrock by Oil/Fuel Spillages and Leaks

The following mitigation measures are proposed:

- All plant and machinery will be serviced before being mobilised to application site;
- Refuelling will be completed in a controlled manner using drip trays (bunded container trays) at all times;
- Drip-trays will be used for fixed or mobile plant in order to retain oil leaks and spills;
- Adoption of fuel interceptors;
- Only designated trained operators will be authorised to refuel plant on site;
- Procedures and contingency plans will be set up to deal with emergency accidents and spills;

- An emergency spill kit with oil boom, absorbers etc. will be kept on site for use in the event of an accidental spillage; and
- All activities will operate under an Environmental Management Plan.

6.6.1.4 Erosion of Exposed Soils and Subsoils

The following mitigation measures will be used:

- Soil removed from extraction area will be used to create a boundary berm around the extraction site;
- Any excess soil/subsoil not required in the construction of the berms will be stored at the proposed soil storage area;
- Where possible, the upper vegetative layer (where still present) will be stored with the vegetation part of the sod facing the right way up to encourage growth of plants and vegetation at the surface of the stored soil within the soil storage areas; and,
- Re-seeding and spreading/planting will also be carried out in these areas.

6.6.2 Operational Phase

6.6.2.1 Excavation of Bedrock

Bedrock extraction will result in a direct impact on the local geological environment.

The bedrock in this area is of High Importance and has a high potential for the development of a quarry. The presence of Old Leighlin Quarry immediately to the north of the site indicates the economic suitability of this area for the development of a dimension stone quarry.

The proposed bedrock extraction is considered to be an acceptable and unavoidable part of the Proposed Development. The impacts however will be localised within the proposed extraction area of ~2.49ha. This proposed extraction area comprises ~26.6% of the application area and ~9.6% of the overall landholding.

Therefore, no specific mitigation measures are required.

6.6.2.2 Contamination of Bedrock by Oil/Fuel Spillages and Leaks

Same as during the construction phase as outlined in **Section 6.6.1.3**.

6.6.2.3 Impact on Geological Heritage Sites

No mitigation measures are required as the Proposed Development has no potential to impact on any geological heritage site.

6.7 Residual Impacts

6.7.1 Construction Phase

6.7.1.1 Effect on Land and Landuse

Agricultural land used for grazing is the dominant land use in the area of the Proposed Development. Due to the relatively small footprint of the Proposed Development on a local scale along with the proposed restoration plan the residual effect will be negative, direct, slight, likely, medium-term effect on land and landuse.

6.7.1.2 Excavation of Soil and Subsoils

The soils and subsoils present at the site will require removal in order to expose the underlying bedrock which will be extracted for economic purposes. This removal of overburden is considered an acceptable impact associated with the Proposed Development. The residual effect will be a negative, irreversible, slight, direct, likely, and permanent effect on soils and subsoils.

6.7.1.3 Contamination of Soil, Subsoils and Bedrock by Oil/Fuel Spillages and Leaks

The use and storage of hydrocarbons and small volumes of chemicals is a standard risk associated with all quarry sites. Proven and effective measures to mitigate the risk of spills and leaks, such as fuel interceptors, have been proposed above and will break the pathway between the potential source and the receptor. The residual effect will be negative, reversible, imperceptible, direct, medium-term, unlikely effect on soils, subsoils and bedrock.

6.7.1.4 Erosion of Exposed Soils and Subsoils

Soils and spoil can be eroded by vehicle movements and by water movement. To prevent this all-excavation works will be completed in accordance with a Spoil Management Plan, material will be moved the least possible distance, and reseeding and planting will be completed. Following implementation of these measures the residual effect will be negative, slight, direct, short-term, likely effect on subsoils by erosion.

6.7.2 Operational Phase

6.7.2.1 Excavation of Bedrock

While the bedrock which will be removed are considered to be of High Importance, these bedrock formations are also present outside of the site within the local area.

The residual effect is considered to be negative, irreversible, slight, direct, likely, permanent effect on bedrock.

6.7.2.2 Contamination of Bedrock by Oil/Fuel Spillages and Leaks

The use and storage of hydrocarbons and small volumes of chemicals is a standard risk associated with all quarry sites. Proven and effective measures to mitigate the risk of spills and leaks have been proposed above and will break the pathway between the potential source and the receptor. The residual effect will be negative, reversible, imperceptible, direct, short-term, unlikely effect on soils, subsoils and bedrock.

6.7.2.3 Impact on Geological Heritage Sites

The Proposed Development has no potential to impact any geological heritage sites.

6.8 Restoration Phase

The potential impacts associated with the restoration phase are similar to those outlined during the construction phase. The mitigation measures outlined for the construction phase in order to protect against contamination of soils and bedrock will be implemented throughout the restoration phase.

With the implementation of the mitigation measures no negative impacts on the land, soil and geological environments are expected during the restoration or post restoration phase. The restoration will have a positive effect in terms of returning the site back to scrubland.

6.9 Monitoring

6.9.1 Construction Phase

No monitoring is required in terms of the land, soils and geological environment.

6.9.2 Operational Phase

No monitoring is required in terms of the land, soils and geological environment.

6.9.3 Restoration Phase

No monitoring is required in terms of the land, soils and geological environment.

6.10 Interactions

Interactions with the water environment can potentially occur through erosion of soils/subsoils. This is discussed and assessed in Chapter 8.

6.11 Difficulties Encountered When Compiling

No difficulties were encountered during the preparation of this chapter of the EIAR.

6.12 References

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