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Part of the Breedon Group

216983-04/11/2021-EIAR Main Report Part 4 (Land, Soils & Geology, Water Part 1)

6. Land, Soils & Geology

6. Land, Soils & Geology

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INTRODUCTION

Background

6.1 This section of the Environmental Impact Assessment Report (EIAR) provides a description of the existing land, soils and geological setting at the regional and local scale, an assessment of the impact of the proposed development on the land, soils and geological features of the area and also other geological aspects of the development.

6.2 The proposed development consists of the deepening of the existing quarry extraction area by 2 no. 15 metre benches from -20m OD to -50m OD, along with minor amendments to the permitted quarry layout (Plan File ref. no's: S/02/5476 & ABP Ref. PL04.203762 and ABP Ref. 04.QD.0010) all within the existing permitted quarry footprint and the continued use of the existing water management system (settlement pond / infiltration pond system permitted under PL04.QD.0010) for the life of the proposed development. The application area is c. 12.6 Ha.

6.3 An extraction capacity of up to 375,000 tonnes per annum is sought to provide the applicant with the ability to respond to demand for aggregates for large infrastructure projects in the Region. A detailed project description is included in Chapter 2 of this EIAR.

6.4 The site consists of an existing quarry and associated ancillary activities; therefore, the soils and subsoils at the site have already been removed to facilitate the existing operations as part of the existing planning permission for the site.

Scope of Work / EIA Scoping

6.5 This EIAR is based on a desk study of the site / surrounding lands using published geological data, hydrogeological borehole drilling, photographs, and a recent site visit by SLR.

Author

6.6 This EIAR chapter relating to Land, Soils and Geology was prepared by Paul Gordon (EurGeol PGeo) of SLR Consulting. Paul has a BSc in Geology and an MSc in Environmental Management and has over 20 years' professional experience, primarily in the Irish minerals industry.

Limitations / Difficulties Encountered

6.7 No difficulties were encountered in the preparation of this chapter of the EIAR.

REGULATORY BACKGROUND

EU Directives

6.8 The following European Union (EU) Directive relate to Land, Soils and Geology at the site in this EIAR:

- Environmental Impact Assessment Directive (2011/92/EU);
- Environmental Impact Assessment Directive (2014/52/EU);

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

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

Irish Legislation

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

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

6.11 The above legislation regulates the information contained in an EIAR and planning at the site.

Planning Policy and Development Control

6.12 The following Planning Policy and Development Control relating to Land, Soils and Geology at the site in this EIAR is set out in the:

- Cork County Development Plan 2015-2021.
- Draft Cork County Development Plan 2022-2028.

6.13 The County Development Plan sets out conservation objectives in relation to soils, geology, geomorphology and geological heritage in the County.

Guidelines

6.14 This Land, Soils and Geology section of the EIAR has been prepared with regard to the following guidelines:

- Environmental Protection Agency (2017) *Guidelines on the Information to be Contained in Environmental Impact Assessment Reports. Draft dated May 2017.* Environmental Protection Agency, Johnstown Castle Estate, Co. Wexford
- DoEHLG (2010) Appropriate Assessment of Plans and Projects in Ireland - Guidance for Planning Authorities;
- Environmental Protection Agency (2002) Guidelines on the information to be contained in Environmental Impact Statements;
- Environmental Protection Agency (2003) Advice Notes on current practice (in the preparation of Environmental Impact Statements);

- 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 (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.
- National Roads Authority (2006) A Guide to Landscape Treatments for National Road Schemes in Ireland; and
- Transport Infrastructure Ireland (March, 2013). Specification for Road Works Series 600 – Earthworks.

Technical Standards

6.15 The following Technical Standard is used to describe subsoils and rock in this EIAR where required:

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

RECEIVING ENVIRONMENT

Study Area

6.16 The study area for this Land, Soils and Geology section of the EIAR comprises two principal geographic areas:

- the existing quarry at the site and ancillary working areas; and
- the immediate surrounding area within approximately 5km of the site.

Baseline Study Methodology

6.17 The baseline study undertaken for Land, Soils and Geology involves a review of published literature and information, the previous 2015 EIS (Chapter 7 – Soils & Geology), a site investigation carried out in 2012, a recent hydrogeological investigation and annual geological inspections of the quarry (carried out as part of the aggregate quality compliance programme).

6.18 This section describes the receiving environment at and in the immediate vicinity of the site using the available baseline information gathered, specifically the:

- **Context** of the receiving environment - location/ magnitude/ spatial extent and trends of the environmental factors;
- **Character** of the receiving environment - distinguishing aspects of the environment being considered here;
- **Significance** of the receiving environment - the quality, value or designation is assigned to the existing environment; and
- **Sensitivity** of the receiving environment - how sensitive is the aspect of the environment to change.

6.19 The baseline study is a qualitative assessment of the available information, based on professional experience.

Sources of Information

6.20 The following sources of information were consulted in the preparation of the receiving environment baseline study for Land, Soils and Geology:

- 2021 hydrogeological investigation, comprising three boreholes;
- 2015 EIS, including Site Investigation comprising (see Appendices 6-A & 6-B)
  - 19 No. boreholes
  - 2 No. cored drillholes
  - 8 No. Window sampler boreholes
  - 6 No. trial pits
- Geotechnical Assessment carried out in 2012 (refer to Appendix 6-C)
- Geological Survey of Ireland (www.gsi.ie);
- Teagasc soil and subsoil mapping for Irish Forestry Soils Project (www.epa.ie);
- Irish Soils Information System (www.teagasc.ie/soils);

- Irish Geological Heritage Programme (www.gsi.ie); and
- Ordnance Survey of Ireland (www.osi.ie).

6.21 Annual geological inspections of the quarry are carried out as part of the aggregate quality compliance programme.

Land Baseline

6.22 Within the EIA EU Directive (2014/52/EU) Land is recognised as a 'natural resource' and the Directive also refers to the importance of the sustainable use of soil and the need to address the unsustainable increase in settlement areas over time ('land take'). Therefore, the issues of land as both a natural resource and land take must be considered in an assessment.

6.23 The introduction section to the EIA EU Directive (2014/52/EU) notes that the:

'final document of the United Nations Conference on Sustainable Development held in Rio de Janeiro on 20-22 June 2012, which recognises the economic and social significance of good land management, including soil, and the need for urgent action to reverse land degradation. Public and private projects should therefore consider and limit their impact on land, particularly as regards land take, and on soil, including as regards organic matter, erosion, compaction and sealing; appropriate land use plans and policies at national, regional and local level are also relevant in this regard'.

6.24 Land can be considered to be a resource with a beneficial use to society, for example agricultural land use, extractive industry land use or urban residential land use; unnecessary land take may result in the loss of this resource which has the potential to have adverse social and economic consequences for society.

6.25 The site is an existing permitted quarry with associated ancillary facilities for asphalt production; therefore, the lands are already in use for extraction and associated production purposes.

6.26 The extraction of Limestone rock at the site is a tied resource land use activity, as it is dependent on the location and suitability of suitable materials for asphalt, readymix and ground limestone production, and therefore the Limestone material may be considered to be a natural resource.

6.27 The Cork County Development Plan (2015-2021) recognises that extractive industry is generally located in rural areas and can only be developed where the resources occurs.

6.28 The County Development Plan addresses mineral extraction in the county and sets out a number of objectives for the mineral industry related to the land use and resource nature of extractive industries in the County. The plan recognises that mineral extraction and the aggregate industry are important to the economy of the county in terms of employment generation and providing raw materials to the construction industry.

6.29 Development Plan Objective EE 12-1 is to safeguard mineral reserves states that it is an objective to:

- *Protect and safeguard the county's natural mineral resources from inappropriate development, by seeking to prevent incompatible land uses that could be located elsewhere, from being located in the vicinity of the resource, since the extraction of minerals and aggregates is resource based.*

6.30 Development Plan Objective EE 12-2 relates to a mineral strategy for the county Mineral Strategy and states that:

- *Consideration will be given to the desirability of preparing a Minerals Strategy to support a sustainable extractive industry during the life time of the plan.*

6.31 It is understood that no specific minerals strategy has been prepared for Cork County to date.

6.32 The development plan recognises that mineral extraction is an important part of the economy and that suitable mineral reserves are a natural resource-based material, are finite and are a tied landuse, depending on where they occur and that the material is a tied or resource-based land use.

6.33 The plan therefore seeks to protect and safeguard natural mineral resources from inappropriate development, by seeking to prevent incompatible land uses that could be located elsewhere.

6.34 In terms of land take, the proposed development does not require any additional land take as the deepening of the existing quarry will be within the existing permitted footprint of the quarry; however, the quarrying will result in a loss of the natural mineral resource at this location through its extraction.

6.35 The draft Cork County Development Plan 2022-2028 contains similar objectives to the current plan; including an objective to prepare a minerals strategy plan for the county. The draft plan also recognises that quarrying is essentially a rural activity which supports development within the county.

Soils Baseline

6.36 Soil is defined as the top layer of the earth's crust and is formed by mineral particles, organic matter, water, air and living organisms. Soil is an extremely complex, variable and living medium and its characteristics are a function of parent subsoil or bedrock materials, climate, relief and the actions of living organisms over time.

6.37 Soil formation is an extremely slow process and can take thousands of years to evolve; soil can be considered essentially as a non-renewable resource.

6.38 As the interface between the earth, the air and the water, soil performs many vital functions; it supports food and other biomass production (forestry, biofuels etc.) by providing anchorage for vegetation and storing water and nutrients long enough for plants to absorb them. Soil also stores, filters and transforms other substances including carbon and nitrogen, and has a role supporting habitats serving as a platform for human activity.

6.39 The current County Development Plan *'recognises the key role that soil plays in many areas including food production, surface water/flooding management and providing the key ingredient for supporting a wide range of ecosystem habitats and enhancing biodiversity. Therefore the need to conserve and manage the soils in the County is a key consideration.'*

6.40 The development plan also states that *'The Council will encourage the reuse of brownfield land where possible in preference to developing green field sites in order to reduce the loss of the county's more agriculturally productive soils. The protection of our natural assets as part of the County's Green Infrastructure resources will also assist in maintaining soil permeability levels which are important for drainage functions and ecosystem habitats.'*

6.41 Objective GI 9-1 of the County Development Plan relates to the Protection of Soils and states that it is an objective to

- *'Ensure the protection and conservation of the soils in County Cork by encouraging sustainable management practices and the reuse of brownfield lands'.*

National Soils

6.42 The Irish Soil Information System (ISIS) project was undertaken by the EPA and Teagasc, and has gathered together existing information and data from soil survey work in Ireland, which has been augmented with a new field data, leading to the production of a new national soil map at a scale of 1:250,000 (www.teagasc.ie/soils).

6.43 The ISIS project has identified a number of Soil Associations across Ireland, which are each comprised of a range of soil types (or '*Series*'), each of them different in properties, with different environmental and agronomic responses. For each soil type, the properties have been recorded in a database maintained by Teagasc.

6.44 The soil association in the vicinity of the site is classified as the Clashmore Soil Association (1000n), see Figure 6.1, which is characterised by '*Coarse loamy drift with siliceous stones*'. The Clashmore Soil Association is described as comprising *'Brown Earths, Luvisols and Surface Water Gleys on drift with siliceous stones'*[1].

6.45 The Clashmore Soil Association is predominantly found in lowland areas and almost half of all soils found in this series are in Co. Cork (Creamer *et. al.*, 2018). The Brown Earths in this association are generally well drained.

6.46 The Clashmore Soil Association is comprised of a total of eight separate Soil Series which include soil series which have developed on glacial drift comprised predominantly of siliceous stones.

Site Soils

6.47 The Teagasc soil mapping for the Irish Forestry Soils (IFS) mapping project, indicates that the soils in the vicinity of the site are characterised by deep and well drained Acid Brown Earths and Brown Podzols, see Figure 6.2. There are smaller areas of peaty Lithosols along the foreshore and also areas of Rendzinas and Lithosols to the east of the site.

6.48 The soils mapping also indicates an extensive area of alluvial soils (fines) to the northwest of the site between Carrigtwohill and Fota Island, see Figure 6.2.

6.49 It is proposed to deepen the quarry void within the existing footprint and therefore the soils at the site have previously been removed. It is not proposed to remove any soils as part of this proposal to deepen the existing quarry.

Subsoils Baseline

Regional Subsoils

6.50 The Quaternary (Subsoil) deposits were deposited during the last 2 million years, and essentially comprise the unconsolidated materials overlying bedrock. The two main types of quaternary subsoils in Ireland are glacial till, deposited at the base of ice sheets, and Sand & Gravel deposits associated with the melting of the ice sheets which are generally termed glaciofluvial outwash sands and gravels. Other extensive quaternary subsoils in Ireland include peat, river alluvium and

[1] EPA Report No. 130 (2014), Irish Soil Information System: Synthesis Report Appendix 3 - Soil Association List

coastal process deposits. Most Quaternary subsoils in Ireland were deposited since the maximum of the last glaciation, the Midlandian, which occurred approximately 17,000 years ago.

6.51 The subsoils across Ireland have been mapped on a national basis by Teagasc as part of the EPA Soil and Subsoil Mapping Project for the Irish Forestry Soils (IFS) project. The subsoil mapping was undertaken at a national basis using existing Quaternary Geology maps, Publications, remote sensing, field mapping and sampling.

6.52 The subsoils in the vicinity of the site have been mapped under the IFS project as glacial till deposits which are comprised predominantly of Devonian Sandstone material, see Figure 6.3. Along the foreshore at the site the subsoils are thin or absent and rock is close to or at the surface. Alluvium has also been mapped in the vicinity of the site, between Carrigtwohill and Fota Island, see Figure 6.3.

6.53 Drilling to the north of the proposed site indicates a total soil plus subsoil thickness of 3.5-6.0m. Drilling to the south of the proposed site indicates a total soil plus subsoil thickness of 8.0-13.0m (see Appendix 6-A).

6.54 It is proposed to deepen the quarry void within the existing footprint and therefore the subsoils at the site have previously been removed. It is not proposed to remove any subsoils as part of this proposal to deepen of the existing quarry.

Bedrock Geology Baseline

6.55 The GSI geology map Sheet 22 (East Cork - Waterford) shows major geological faults running north south in the vicinity of the site, see Figure 6.4.

6.56 The southern part of the site is underlain by the Carboniferous Little Island Formation, comprised of massive and crinoidal fine Limestone, see Figure 6.4. The formation is described in the GSI Geological Memoirs (1995) as a 'uniform 500m thick succession of mudbank limestone'. The contact with the overlying formation is gradational.

6.57 The Little Island Formation is stratigraphically overlain in the northern part of the site by the Carboniferous Clashavodig Formation Limestone. The Clashavodig Formation is described in GSI Geological Memoir (1995) as a 'bedded sequence of calcilutite wackestones, skeletal, peloidal and oolitic grainstones and cherty calcilutites.'

6.58 The proposed development at the site involves the deepening of the existing quarry in both formations, from its existing floor level to a deeper floor level of -50 mOD. The Little Island Formation Limestone is the main geological unit which has been quarried at the site. Recent and previous wells (PW-3 Rossmore 2021, BH2 & BH3 – see **Table 6-1** and Appendix 6-A) indicate that the limestone extends to a depth of at least -75 mOD.

6.59 The geological structure in the area around the site is dominated by the Cork Syncline which runs in an east northeast to west southwest direction from Youghal Bay in the east to Cork City in the west (GSI, 1995). The site is at, or close to, the apex of the Cork Syncline, with the Clashavodig Formation being the youngest stratigraphic unit, at the core of the syncline.

6.60 There is a north-south fault with dextral offset c. 1.3km west of the site. No significant fault structures are observed at the site.

Table 6-1
Summary of boreholes drilled as part of 2021 hydrogeological assessment

Borehole No.	Easting (ITM)	Northing (ITM)	Collar Elevation (m)	Final Depth	Final Lithology
PW1	582363.3	570948.5	-0.4m OD	-54.0m OD	Sand
PW2	582402.1	571061.2	-18.5m OD	-53.0m OD	Soft limestone
PW3	582328.3	571275.8	0m OD	-75.0m OD	Solid limestone

Karst Baseline

6.61 According to the GSI, the bedrock in the vicinity of the site is classified as a Regionally Important Aquifer which is karstified. The quarry is located within the Midleton groundwater body (GWB) which includes the Regionally Important karstified Aquifer. The aquifer is mapped as 'Diffuse'; conduits are not expected.

6.62 No significant karst features have been encountered at the quarry. Some very minor karst-type fissures are visible in the upper bench at the existing quarry and no such features are visible in the lower bench.

6.63 Karstification most often occurs in the upper bedrock layers and along certain fractures, fissures and joints, at the expense of others; there are numerous surface karst features in the limestones in the east Cork Region (www.gsi.ie). However, Karst features such as cave systems, sinking streams, springs, swallow holes and other collapse features, common in the Midleton GWB, are known to extend below present sea levels and are estimated to extend to depths of up to 50m to 60m below O.D. Malin Head. Groundwater flows in these features will be through faults and joints formed by deformation that were subsequently enlarged by karstification.

6.64 There are no known geological faults at the site, and this has been confirmed during the site inspection.

6.65 The GSI database (www.gsi.ie) shows the closest karst features to the site are two landforms east of the quarry. Goat Hole cave is located approximately 1.0 km to the east, and a spring is located approximately 1.3 km east of the quarry; both karst features are in in Ballintubbrid West townland.

Geological Heritage Baseline

6.66 The current Cork County Development Plan lists sites of County geological importance. The plan recognises the importance of Geological Heritage and lists the important geological features within the County with the intention of maintaining their possible conservation value; the list of County Geological was produced by Cork Co. Council in consultation with the Geological Survey of Ireland and the Geology Department of the National University of Ireland, Cork.

6.67 Objective HE 2-6 of the County Development Plan states that the objective for Geological Sites is to *'Maintain the conservation value of those features or areas of geological interest that are listed in Volume 2, Chapter 3 Nature Conservation Areas, of the plan, and to protect them from inappropriate development.'*

6.68 There are no designated Irish Geological Heritage sites at Rossmore and there are no sites of County Geological Interest within or immediately adjacent to the development, as indicated in the current Cork County Development Plan.

Sensitive Receptors

6.69 In terms of land, soils and geology baseline considered here, the current landuse at the site is quarrying and both the soils and subsoils have been removed from the site previously to facilitate quarrying; therefore, no land use, land take, soil or subsoil sensitive receptors at the site have been identified from this baseline study.

6.70 The Limestone bedrock geology at the site is extensive in the east Cork area and is therefore not considered to be a sensitive receptor.

6.71 There are no geological heritage sites or sites of County Geological Interest present at the site.

IMPACT ASSESSMENT

Evaluation Methodology

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

Evaluation of Impacts

6.73 This assessment focuses on the potential impact of the deepening of the existing quarry on the land, soils and geology at the site. There are no site construction impacts associated with the deepening of the existing quarry and does not require any stripping of soils and subsoils across the lands.

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

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

Attribute	Status / Occurrence	Importance of attribute
Land	The land at the site comprises a working quarry and therefore has an existing industrial landuse. The land at present has no particular status in terms of its use or suitability for agriculture.	**Very High** - established landuse at the site based on a proven economic reserve of limestone resource. The industrial landuse at the site has a value in terms of its ability to provide employment, support the construction sector in the region and general economic growth, as well as maintaining competition in the marketplace.
Soils	There are no existing soils at the site. The soils at the site have been removed to	**None** - soils have been removed to facilitate extraction

	facilitate extraction, and are stored for use in future restoration or for screening the development.	
Subsoils	The glacial till subsoils at the site have been removed to facilitate the existing quarrying operations (apart from a small area in the northwest of the existing extraction area), and are stored for use in future restoration or for screening the development.	**None** – most of the subsoils have been removed to facilitate extraction
Geology	The limestone bedrock is currently quarried at the site. The Limestone is a finite resource within the east Cork and Waterford region which is resource tied.	**Very High** - the site has a proven economic limestone resource. The Limestone bedrock at the site provides employment, supports the construction sector in the region and general economic growth, as well as maintaining competition in the marketplace.

6.75 The magnitude of these impacts on the land, soils and geology attributes is assessed in **Table 6-3** below.

Table 6-3
Significance of Impacts on Land, Soil and Geology with no Mitigation

Attribute	Impact of Proposal on Land, Soil and Geology	Magnitude of potential impact
Land	No loss of existing industrial landuse	**Negligible** - no noticeable consequences with the continuance of an industrial landuse at the site.
Topsoil	No topsoil will be removed as part of the deepening of the existing quarry floor.	**Negligible** - no noticeable consequences as the topsoil has already been removed to facilitate extraction within the permitted extraction area.
Subsoils	Subsoils will be used in the restoration of the overall site.	**Moderate beneficial** - long term and positive with use of subsoils for restoration.
Geology	Limestone bedrock will be removed from the site	**Small Adverse** - Loss of a small part of the overall natural resource through its extraction and use in the construction / agriculture sector.

Indirect Impacts

6.76 There will be no indirect impacts on land, soils or geology as a result of the deepening of the existing quarry at the site.

Unplanned Events (i.e. Accidents)

6.77 Unplanned events within the application site, such as accidents, have the potential to impact on the land, soils and geology adjoining the site.

6.78 Ground instability, particularly the long-term stability of quarry faces, has the potential to impact on adjoining lands. Operations at the quarry will adhere to the Health and Safety Authority Safe Quarry Guidelines in relation to the Safety Health and Welfare at Work (Quarries) Regulations 2008-

2019 and this will limit the potential for unplanned events such as instability of quarry faces or instability in adjacent lands.

6.79 With the implementation of the Quarry Regulations 2008-2019, it is considered unlikely that instability of quarry faces would result in an impact on the land, soils and geology at the site.

Human Health

6.80 From a land, soils and geology perspective, any potential impacts on human health from the excavation and processing of the Limestone rock at the site would not be via the landuse, soils and geology pathways but via other pathways such as air and water, which are addressed in the relevant chapters of this EIAR.

Cumulative Impacts

6.81 There are other permitted quarries in the vicinity, including one immediately adjacent to the site. Permission has also been granted for a solar voltaic panel array to the northwest. No cumulative impacts have been identified on land, soil or geology associated with the proposed development at the site.

Interaction with Other Impacts

6.82 No interactions with other impacts have been identified for the land, soils or geology attributes associated with the proposed development.

'Do-nothing Scenario'

6.83 Under the 'do nothing scenario' there will be no additional impact on the land, soils and geology, over and above that from the existing quarry. The existing Limestone material in the proposed development area will remain in place.

MITIGATION MEASURES

6.84 Soil management measures are already in place at the site for the existing quarrying operation, and will remain in place during the lifetime of the proposed deepening of the existing quarry. There is a restoration scheme in place for the quarry for the post-operational afteruse of the land, refer to EIAR chapter 2.

6.85 The construction stage has been completed for the existing quarrying operations at the site. The operational stage of the quarry is the further extraction of the Limestone material within the permitted quarry footprint, over the proposed lifetime of the deepening of the existing quarry.

Construction Stage

6.86 The site preparation stage has been completed for the existing quarrying operations at the site and therefore no mitigation measures are required for this stage. This application relates to the deepening of the existing quarry.

Operational Stage

6.87 During the operational stage the Limestone rock will be quarried and processed at the site.

6.88 Operations at the quarry will adhere to the Health and Safety Authority Safe Quarry Guidelines in relation to the Safety Health and Welfare at Work (Quarries) Regulations 2008-2019 and this will limit the potential for unplanned events such as instability of quarry faces or instability in adjacent lands.

6.89 No other specific mitigation measures are required at the site in terms of land, soil and geology at this stage.

RESIDUAL IMPACT ASSESSMENT

6.90 The residual impacts on land, soil and geology are those impacts which remain following the implementation of the mitigation measures outlined above.

Construction Stage

6.91 As the proposed development is a deepening of the quarry within the existing quarry footprint, there are no residual impacts associated with this stage.

Operational Stage

6.92 The operation of the quarry in line with the Health and Safety Authority Safe Quarry Guidelines in relation to the Safety Health and Welfare at Work (Quarries) Regulations 2008-2019, will limit the potential for unplanned events such as instability of quarry face or instability in adjacent lands. Therefore, it is considered that the residual impact of the proposed continued extraction within the permitted extraction area will be low to imperceptible.

Restoration Stage

6.93 The planning application area will be restored to natural habitat afteruse, which is one of the beneficial after uses listed in the EPA Guidelines: 'Environmental Management in the Extractive Industry' (2006). This restoration scheme will assist in enhancing the biodiversity of the site and local area. The restoration will be achieved by implementation of the following measures:

- Creating a water body within the final quarry void as the groundwater level rebounds to its natural level, on permanent cessation of extraction operations.
- Retaining existing vegetation and provision of woodland and barrier mix planting around the perimeter of the quarry void; [Check for consistency with final Restoration drawing]
- Leaving some areas for natural re-colonisation;

6.94 The restoration of the application area to natural habitat afteruse will have a positive impact on the biodiversity of the site and local area.

REFERENCES

Cork County Development Plan, 2015 - 2021.

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

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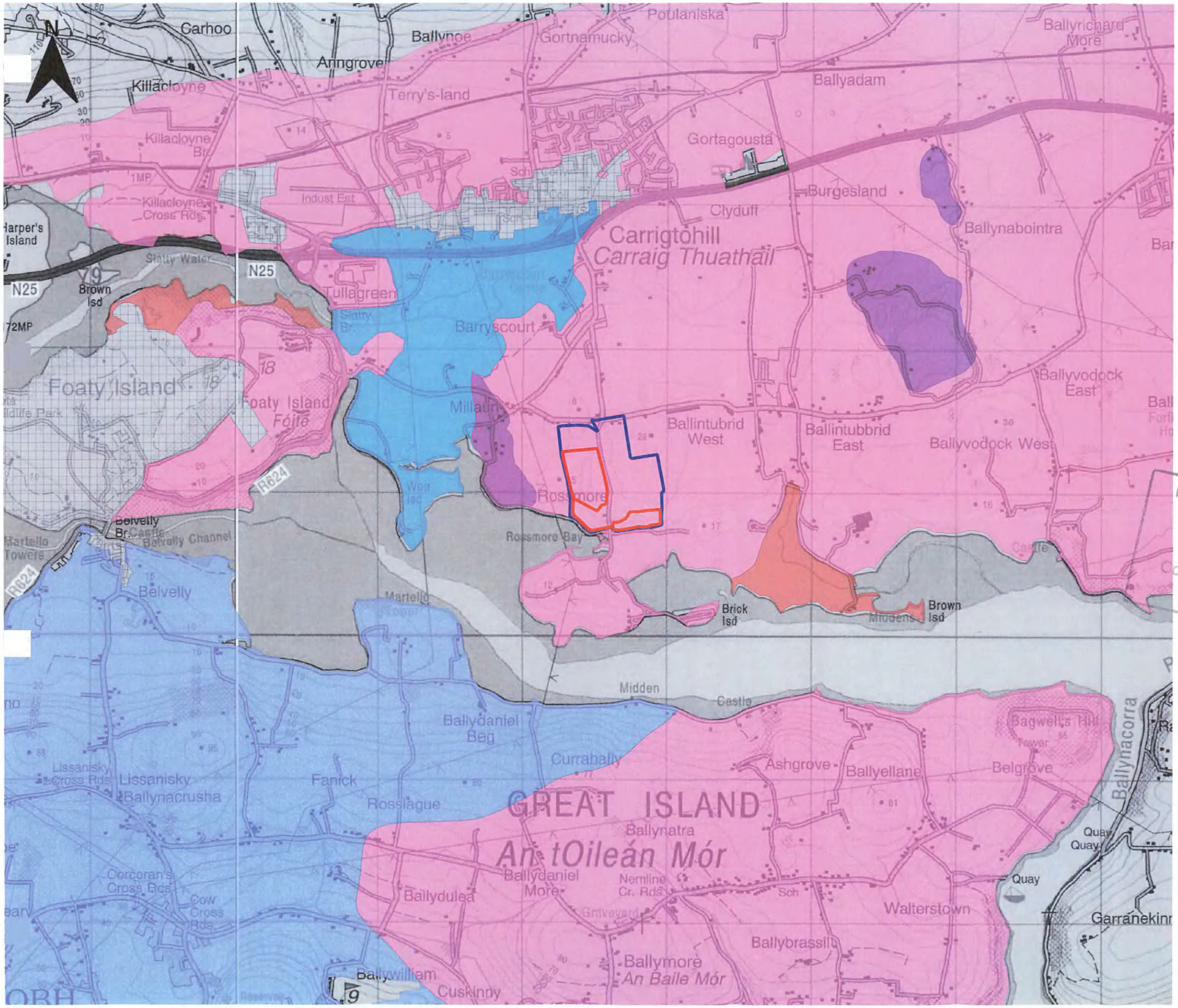
FIGURES

Figure 6.1 - Soil Association Map

Figure 6.2 - National Soils Map

Figure 6.3 - National Subsoils Map

Figure 6.4 - Geology Map



NOTES

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LEGEND

- APPLICANT'S LAND INTEREST
- PLANNING APPLICATION AREA (c. 12.6 ha)

Soil Association

- Clashmore
- Marine
- Rock
- Ross Carbery
- Tidal marsh
- Urban

0 0.5 1 km

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ENVIRONMENTAL IMPACT ASSESSMENT REPORT

ROSSMORE QUARRY
CARRIGTOHILL, CO. CORK

SOIL ASSOCIATION MAP

FIGURE 6-1

Scale: 1:25,000 @ A3

Date: SEPT 2021

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LEGEND

APPLICANT'S LAND INTEREST

PLANNING APPLICATION AREA
(c. 12.6 ha)

Rossmore Soils

- Mineral Alluvium
- Acid Brown Earths & Brown Podzols
- Peaty Lithosols
- Rendzinas and Lithosols
- Made Ground
- Marine Sands
- Marine Sediments

0 0.5 1 km

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SOILS MAP

FIGURE 6-2

Scale: 1:25,000 @ A3

Date: SEPT 2021

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2. Subsoils Mapping © Teagasc

LEGEND

- APPLICANT'S LAND INTEREST
- PLANNING APPLICATION AREA (c. 12.6 ha)

Rossmore Subsoils

- Alluvium
- Made Ground
- Estuarine Silts and Clays
- Marine Gravels
- Outcrop/Subcrop
- Till - Devonian Sandstone Clasts
- Till - Carboniferous Limestone Clasts

0 0.5 1 km

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ROSSMORE QUARRY
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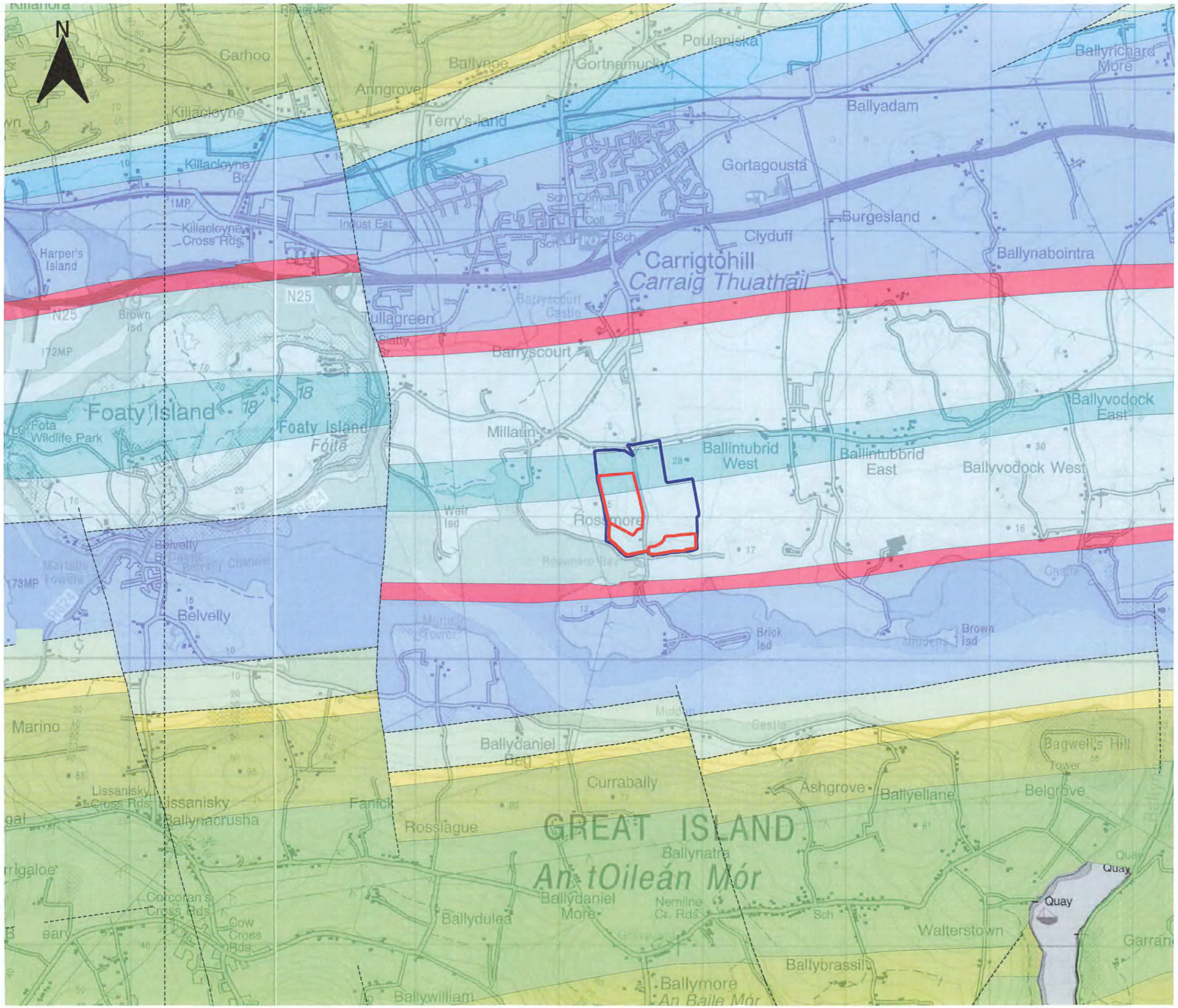
TEAGASC SUBSOIL MAP

FIGURE 6-3

Scale
1:25,000 @ A3

Date
SEPT 2021



NOTES

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LEGEND

- APPLICANT'S LAND INTEREST
- PLANNING APPLICATION AREA (c. 12.6 ha)

Bedrock Geology

- Ballysteen Formation
- Ballytrasna Formation
- Clashavodig Formation
- Cork Red Marble Formation
- Cuskinny Member
- Gyleen Formation
- Little Island Formation
- Old Head Sandstone Formation
- Waulsortian Limestones
- ----- Fault

0 0.5 1 km

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ENVIRONMENTAL IMPACT ASSESSMENT REPORT

ROSSMORE QUARRY
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BEDROCK GEOLOGY

FIGURE 6-4

Scale	Date
1:25,000 @ A3	SEPT 2021

7. Water

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Appendices

Appendix 7.1 Discharge Licences: Lagan [WP(W)08/18(R)] with the Compliance Engineering Report for Installed Systems and the adjacent Kilsaran Site's Licence [WP(W)10/18].

Appendix 7.2 Historical Site Investigations, Borehole Logs & Geotechnical Review Report

Appendix 7.3 Recorded discharge volumes

Appendix 7.4 Hydrochemical monitoring and laboratory result reports for the site (2018 to 2021) (Included on CD EIAR Digital Copy)

Appendix 7.5 Wastewater Treatment & Discharge Details

Appendix 7.6 Water Management Systems & Designs (2015)

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Appendix 7.8 2021 Production Well Drilling Logs

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7.0 WATER

7.1 Introduction

This Water Assessment is to form part of an EIAR for Lagan Materials Ltd. site at Rossmore, Carrigtwohill, Co. Cork. The site and regional context are shown in Figure 7.1. The centre of the site has the following ITM Grid References: ITM Easting 182448; ITM Northing 71056. The quarry's application has been described in Chapter 2 of the EIAR and from here on in it will be referred to as "the site" for ease of reference throughout this chapter in which the hydrological and hydrogeological environment at and surrounding the proposed development are now described.

The site is an operational quarry previously granted permission under An Bord Pleanála reference number 04.QD.0010. SLR detailed the planning history in the Pre-Planning consultation document (February 2021, SLR Ref: 501.00584.00024). In summary, the site's planning history spans from 2004 (S/02/5476, ABP Ref. PL 04.203762) to 2020 (20/06709) and concerns differing granted applications for quarrying, an asphalt plant, readymix concrete batching plant, ground limestone storage building, extension of permission duration and varying operational hours.

The site lies within the Lee, Cork Harbour and Youghal Bay catchment, the Tibbotstown_SC_010 surface water sub-catchment and is underlain by the Midleton Groundwater Body (GWB). The quarry is in a coastal setting and is adjacent to the Great Island Channel SAC (Site Code 001058), Great Island Channel pNHA (Site Code 001058) and Cork Harbour SPA (Site Code 004030).

The quarry is permitted to operate below sea level, to a permitted depth of -20m OD, and therefore has a discharge licence [WP(W)08/18(R)] issued by Cork County Council in February 2019 (Appendix 7.1). The discharge licence permits a daily volume of 12,000 m3/d or 500m3/hr. The site has an established and operational Water Management System constructed to treat and infiltrate the WP(W)08/18(R) licensed 12,000m3/d. The water management system is located to the east of the quarry working site. The water management system was designed to accommodate the 1:100 year storm event, the combined effect of the adjacent working quarry (operated by Kilsaran), potential recirculating groundwater from the infiltration pond and also made provision for a future potential scenario for the cessation of the adjacent Kilsaran quarry. In the event that the neighbouring quarry operation ceased, Lagan would have to dewater both quarries and this treatment capacity is built into the lagoon systems.

The proposed development concerns the extraction of rock in the established quarry footprint over an area of 9.5ha, approximately, within the existing, permitted, working quarry at Rossmore, Carrigtwohill, Co. Cork. The proposal is to deepen the quarry void's footprint by a further 2 benches thereby bringing the floor from its current, permitted, elevation of -20m OD to a proposed depth of -50 m OD. As part of

previous permissions, the area has already been stripped of overburden. No further stripping of topsoil or overburden materials will be carried out within the application area.

7.1.1 Objectives

The objectives of this assessment are to:

- Provide information for the status and baseline hydrogeological and hydrological conditions for the site and the region.
- Assess the potential impact of the proposed development on the underlying groundwater body and associated surface and coastal water bodies.
- Evaluate the current discharge licence WP(W)08/18(R) and potential requirement for review of the licence considering field investigations conducted for this 2021 EIAR.
- Identify receptors, present sensitivities, assess potential risks and impacts and provide appropriate mitigation measures, as deemed necessary.
- Consider & address hydrological & hydrogeological issues raised, for the site or other developments in the area, in previous planning determinations returned by Cork County Council and previous items identified in An Bord Pleanála considerations.

7.2 Study Methodology

Overall, the study components comprised as follows:

i. A desk study including mapping of hydrogeological characteristics, water features and WFD Reports for the area (www.epa.maps). The site has the benefit of a substantial body of work completed for the Water chapter relating to the 2015 EIS, prepared by Craig O'Connor (BSc., MSc Hydrogeology, P Geo, Eur Geol, C Geol., FGS) of TMS Environment Ltd., with specialist inputs by Minerex Environmental Ltd (Dr. Conor Quinlan and Cecil Shine Eur Geol, M.Sc. PGeo) and by Minerex Geophysics Ltd (Hartmut Krahn), which provided detail on previous Site Investigations, modelling and consequent designs supporting previous grants of permission and a successful grant of a discharge licence for the site (2019). Characterisation information also exists on the Cork County Council Planning web portal for the adjacent Kilsaran site (namely in Planning Ref Files 215965, 034570 and 186465).

ii. Visual examination of the walls of the excavated areas at the site in many recharge scenarios: wet periods and dry periods. The purpose of this was to evaluate the rock exposed in the walls from natural ground level to the current deepest floor levels, which are at 19m below sea level. The unsaturated depth of wall available is therefore >25m in some areas of the site. The wall area available for observations provides great insight for the potential for groundwater at the site.

iii. Borehole drilling at Production Well diameters to facilitate pumping tests through the profile to the proposed excavation depth of -50m OD.

iv. Pump tests on three Production Wells to test the potential for increases in dewatering requirements.

v. Evaluation of the site's sequential water quality results for groundwater collected in the sump of the quarry, the established monitoring boreholes and discharge from the quarry to the operational water management lagoons and infiltration area.

vi. Evaluation of the site's long term datalogger records for groundwater levels at the site itself, neighbouring domestic wells and other off site monitoring boreholes.

vii. Assessment of potential for impact.

Ultimately, each of the study components fed information to create Hydro-G's Conceptual Site Model for the hydrogeological system at the site and the local surrounding area's hydrology and hydrogeology. The Conceptual Site Model for the hydrogeological system was then used to populate a hydrogeological Risk Assessment Framework. The Water Chapter of the 2015 EIS for the site contributed substantially to the assessment.

The assessment of impacts within this chapter is carried out with respect to the hydrogeological and hydrological environment. Within this chapter, potential impacts are effects of the proposed development's resultant changes to the environment. Impacts are assessed in terms of scale, *i.e.* imperceptible, not significant, slight, moderate etc. and mitigation measures proposed, if necessary. As required by the Planning and Development Regulations 2001-2021, the assessment presented in this chapter considers Impact Assessment under the headings of Do Nothing, Transboundary, Direct, Indirect, Cumulative, Residual & Worst Case. Impacts are also assessed in relation to construction, operational and decommissioning stages.

The significance of potential impacts on geological, hydrogeological and hydrological sensitive receptors was estimated, as is EIAR convention in Ireland, by implementing an assessment as per the Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes, NRA (2008) and the Guidelines for the Preparation of Soils, Geology & Hydrogeology Chapters of Environmental Impact Statements, IGI (2013). Those assessment frameworks require input of the project's groundwater and geological type attributes and measures to determine the magnitude of the impact on the attribute.

In addition to the application of the Irish NRA Impact assessment methodology, Hydro-G applies practical guidance specifically relating to quarries and dewatering as published by the UK Environment Agency (*i.e.* the public body equivalent of the Irish EPA): that Guidance Document is cited as Boak, R. et. al. (2007) Using Science to create a better place: hydrogeological impact appraisal for dewatering abstractions. (Environment Agency, Science Report – SC40020/SR1) and the approach is succinctly outlined by the EA (2007) as follows:

> *"The methodology for Hydro-Geological impact appraisal (HIA) is designed to fit into the Environment Agency's abstraction licensing process. It is also designed to operate within the Environment Agency's approach to environmental risk assessment, so that the effort involved in undertaking HIA in a given situation can be matched to the risk of environmental impact associated with the dewatering. The HIA methodology can be summarised in terms of the following 14 steps:*
>
> - **Step 1:** Establish the regional water resource status.
> - **Step 2:** Develop a conceptual model for the abstraction and the surrounding area.
> - **Step 3:** Identify all potential water features that are susceptible to flow impacts.
> - **Step 4:** Apportion the likely flow impacts to the water features.
> - **Step 5:** Allow for the mitigating effects of any discharges, to arrive at net flow impacts.
> - **Step 6:** Assess the significance of the net flow impacts.
> - **Step 7:** Define the search area for drawdown impacts.
> - **Step 8:** Identify all features in the search area that could be impacted by drawdown.
> - **Step 9:** For all these features, predict the likely drawdown impacts.
> - **Step 10:** Allow for the effects of measures taken to mitigate the drawdown impacts.
> - **Step 11:** Assess the significance of the net drawdown impacts.
> - **Step 12:** Assess the water quality impacts.
> - **Step 13:** If necessary, redesign the mitigation measures to minimise the impacts.
> - **Step 14:** Develop a monitoring strategy.
>
> *The steps are not intended to be prescriptive, and the level of effort expended on each step can be matched to the situation. Some steps will be a formality for many applications, but it is important that the same thought-process occurs every time, to ensure consistency. The methodology depends heavily on the development of a*

good conceptual model of the dewatering operation and the surrounding aquifer. The steps of the methodology are followed iteratively, within a structure with three tiers, and the procedure continues until the required level of confidence is achieved. Advice is also given on how to undertake HIA in karstic aquifers and fractured crystalline rocks." Boak, R. et. al. (2007).

In addition to the Irish EPA's 'Environmental Management Guidelines for the Extractive Industry (Non-Scheduled Minerals)' (EPA, 2006), Hydro-G also considers hard rock specific guidance as follows:

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

Hydro-G has adopted and applied knowledge of how groundwater moves in Irish aquifers to present a reasoned assessment of the potential for impact that might arise in response to deepening excavations at the site. It must be noted that the 2015 application presented a robust and worst-case Conceptual Model for dewatering operation in the surrounding aquifer. The conceptual 2015 model will be evaluated in light of the 2021 Site Investigation results.

7.2.1 Limitations / Difficulties Encountered

The assessment of the hydrological and hydrogeological environment is based on an extensive body of previous site investigations, modelling and designs that resulted in successful planning and the issuing by Cork County Council of the Discharge License for the site. In addition, the site has a long record for hydrochemistry of both the underlying groundwater and the site's discharge. Groundwater level information is available from continuous datalogger records. Hydro-G made seasonal observations from site visits, utilised monitoring information available, reviewed published information and held detailed discussions with the blast hole driller and the quarry manager. No specific difficulties were encountered in the preparation of this section.

7.2.2 Guidance Documents & Legislative Instruments

This report was prepared with consideration of the following guidance documents and ensuring compliance with Irish Regulations, listed as follows:

- Groundwater Regulations: European Communities Environmental Objectives (Groundwater) Regulations, 2010 as amended 2011, 2012, 2016.

- European Communities (Birds and Natural habitats) Regulations 2011. S.I. No. 477/2011.
- European Communities Environmental Objectives (Surface Waters) Regulations 2009 Statutory Instruments S.I. No. 272 of 2009 as Amended 2012 (S.I. No. 327/2012), 2015 (S.I. No. 386 Of 2015) and 2019 (S.I. No. 77 of 2019).
- Guidance on the Authorisation of Discharges to Groundwater. EPA (2011).
- Guidelines on the information to be contained in Environmental Impact Statements (EPA, 2002).
- Guidelines for the Preparation of Soils, Geology & Hydrogeology Chapters of Environmental Impact Statements, (IGI, 2013).
- Geology in Environmental Impact Statements a Guide, (IGI, 2002).
- Guidelines on the information to be contained in Environmental Impact Assessment Reports. (EPA, 2017).
- Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes, NRA Document.
- Environmental Management Guidelines for the Extractive Industry (Non-Scheduled Minerals), EPA, 2006.
- Quarries and Ancillary Activities – Guidelines for Planning Authorities, Dept. of Environment, Heritage and Local Government, April 2004.
- National Parks and Wildlife Service (NPWS). Database of Special Areas of Conservation, National Heritage Areas, National Parks, Special Protection Areas including Site Synopsis and Conservation Objectives.
- Using Science to create a better place: Hydrogeological impact appraisal for dewatering abstractions. Environment Agency, Science Report – SC40020/SR1. Bristol, UK, 2007. Authors: Boak, R. et. al.

7.2.3 Desk Study Resources

The following sources of information were used in the compilation of this assessment:

- Discharge Licence for the Site WP (W) & Discharge Licence for the adjacent Kilsaran site WP (W) 10/18.
- Ordnance Survey of Ireland, Maps, 1:50,000 and web based GeoHIVE viewer http://map.geohive.ie/mapviewer.html
- Geological Survey of Ireland Bedrock Geology Sheets No. 22 and 25 1:100,000 Map Series
- GSI on-line Groundwater database. Recharge, Bedrock, Aquifer Classification, Groundwater Vulnerability, Teagasc Soil Classification. https://dcenr.maps.arcgis.com/apps/MapSeries/.
- Midleton Groundwater Body (GWB) Description (GSI, 1st Draft, July 2004).
- Lamplugh, G.W., Kilroe, JR, Henry, M.A., Seymour, H.J., Wright, W.B. and Muff, H.B. (1905) The Geology of the Country around Cork and Cork Harbour. Memoirs of the Geological Survey of Ireland. Printed at His Majesties Stationery Office. Available at http://www.geologicalmaps.net/IrishHistMapsDownload/B02131.pdf
- 19th Century field mapping sheets, 1:10,560 Scale, Geological Survey of Ireland;
- Late Pleistocene-Holocene Buried Valleys in the Cork Syncline, Ireland (2006) Davis, T. et al., Journal of Maps, 79-93;
- Groundwater vulnerability assessment of the Cork Harbour area, SW Ireland (2007) Allen, A.R. & Milenic, D., Environ Geol, 53:485-492;
- Kelly, C. & Drew, D. (2014) KRAZY KORK KARST. "Cork & Waterford" ANNUAL IAH FIELDTRIP 2014. https://www.iah-ireland.org/field-guides/2014.pdf
- Hogan, D. & Larkin, D. (2014) Midleton Distillery Karst. "Cork & Waterford" ANNUAL IAH FIELDTRIP 2014. https://www.iah-ireland.org/field-guides/2014.pdf
- EPA online Hydrometrics, HydroTOOL, Water Quality Mapping, Status, Risk and WFD Reports (www.epa/maps, catchments.ie)

- National Parks and Wildlife Service (NPWS). Database of Special Areas of Conservation, National Heritage Areas, National Parks, Special Protection Areas including Site Synopsis and Conservation Objectives reports.

- South Western CFRAM Study. SEA Environmental Report. Office of Public Works. Mott MacDonald (2017).

- Conroy, P. (2012) Carrigtohill Flood Risk Assessment Study Groundwater Flood Risk Assessment. Prepared by: Peter Conroy On behalf of Cork County Council In Collaboration with: JBA Consulting. Available at http://corkcocoplans.ie/wp-content/uploads/bsk-pdf-manager/2016/07/Appendix-C-1023_CarrigtohillGroundwaterFRA_RevA-_withFig2Aand2B.pdf

- OPW national flood information portal, providing location specific access to flood risk and flood management information. https://www.floodinfo.ie/

- Flood Risk Management Plan Lee, Cork Harbour & Youghal Bay (OPW, 2018) & National CFRAM Programme.

- Cork County Council records for the site and adjacent sites (Cork County Council Planning website and Alan Costello *pers. Comm.)*. Previous Environmental Impact Statements, Flood Risk Assessments and other reports associated with developments as follows:

    - on behalf of Irish Asphalt Ltd, Declan Brassil & Co. Ltd. (2002), Planning Ref 02/5476.
    - overall quarry development under Cork County Council Planning Ref. No. 02/5476, and An Bórd Pleanála Ref. No. PL04.203762)
    - on behalf of Readymix (ROI) Ltd., Tom Philips & Associates (2003), Planning Ref. 03/4570.
    - on behalf of Healy Brothers Ltd., Dixon Brosnan Environmental Consultants (2005), Planning Ref. 05/7886.
    - on behalf of Lagan Materials Ltd., by SLR Planning Ref: 20/04124 for increased working hours at the site, including the Appropriate Assessment Screening Report (May 2021, SLR Ref 501.00584.00011).
    - on behalf of Lagan Materials Ltd., by SLR Planning Refs: 18/6874, 195050, 20/06709.
    - on behalf of neighbouring Kilsaran quarry Planning Refs: 215965, 186465, 034570.

- An Bord Pleanála Inspector Reports for the site and environs with specific attention to case files related to No. PL 04.203762 and QD04.QD0010 and the Tom Phillips 37L Supporting Information Chapter for Water (TMS, 2013 & 2015).

- Previous Site Investigation results as presented in documents as follows:
  - Tom Philips & Associates (2015) EIAR for Further Development of Quarry at Rossmore, Carrigtohill, Co Cork. Water Chapter 8.0 (TMS, 2015) and associated Appendices.
  - TMS Environment Limited (2013) WATER MANAGEMENT SYSTEM FOR PROPOSED DEEPENING OF EXISTING QUARRY AT ROSSMORE, CARRIGTWOHILL, CO. CORK Prepared on behalf of LAGAN BITUMEN LTD. Report Ref 18968-3 Rev. 1.0. 31st October 2013. (presented as Appendix 8.9, PROPOSED SURFACE WATER MANAGEMENT SYSTEM 2015 EIS Tom Phillips & Associates).
  - AGEC Ltd (2012) GEOTECHNICAL REVIEW ROSSMORE QUARRY, CARRIGTWOHILL, CO. CORK Prepared for: Irish Asphalt June 2012. Bagenalstown, Co. Carlow. Ireland.

7.2.4 Consultations/Screening

Rossmore quarry has existed as a commercial quarrying operation since the 2000's and is an established part of the landscape. SLR managed the Pre-Planning consultations and issued a report entitled Proposed Deepening of an Existing Quarry at Rossmore Quarry, Carrigtwohill, Co. Cork Pre-Planning Consultation Document February 2021 (SLR Ref: 501.00584.00024), in which the Planning requirements and the Cork County Development Plan 2015-2021 were considered.

With respect to consultations with the Environment Section of Cork County Council, Hydro-G consulted directly with Mr. Alan Costello and he issued recent monitoring results for the adjacent Kilsaran site.

In addition, SLR received the following advice from Mr. Costello in direct response to pre planning consultation:

- Include a risk assessment of the impact of the discharge on the adjacent shellfish waters.
- Include a risk assessment of the impact of the discharge on the SPA/SAC in the natura screening.
- Evaluate the existing discharge licence adequacy with respect to proposed deepening?

An Bord Pleanála's Inspectors report for the site previously concluded an AA Screening finding as *"satisfied that, the proposed development, either individually or in combination with other plans or projects would not adversely affect the integrity of any European site, having regard to the conservation objectives of those sites."* (Davis, 2017, QD04.QD0010). That 2017 assessment by the Board fully considered the adjacent quarry and the proposed construction and operation of the water

management lagoons and infiltration area which were subsequently built and currently service the licensed discharge. The Ecology Chapter of this EIAR provides the current assessment.

More recently, the ecologist's Appropriate Assessment Screening Report evaluating a proposal for increased operating hours at the site concluded no potential to affect local designated sites either on its own or in combination with other developments within 15km (May 2021, SLR Ref 501.00584.00011).

7.2.5 Statement of Expertise

This Water Chapter has been completed by Dr. Pamela Bartley (Hydro-G).

Dr. Pamela Bartley is a water focussed civil engineer with 24 year's field-based practice in groundwater, surface water and wastewater. She has karst hydrogeology expertise and completed specialist karst training by the GSI in the Burren (2013). Upon completion of a Diploma in Water and Wastewater Technology at Sligo RTC, Pamela completed her primary degree in Civil Engineering at Queens University, Belfast followed by postgraduate education at the school of Civil Engineering at Trinity College, Dublin. While a postgraduate at TCD she completed a taught MSc. in Environmental Engineering at the school of civil engineering, with a focus on geotechnics, hydrology, hydrogeology and legislation. Later, Pamela completed a hydrogeologically focussed Ph.D at Trinity College. As a result of work in evaluating planning appeals, Pamela has become a specialist in quarry and discharge evaluations in the context of enacted Irish Regulation and EU Directives concerning the environment such as the Groundwater Regulations (2010, 2011, 2012, 2016), Surface Water Regulations (2009, 2012, 2015), EU (Birds and Natural habitats) Regulations 2011, and Water Framework and habitats' Directives. She has completed hydrologically focussed impact assessments for many regionally important quarries in SAC settings including catchments with habitats for designated species pearl mussel and vertigo. Pamela's significant quarry assessments of note include Bennettsbridge Limestone, Co. Kilkenny, McGrath's Limestone of Cong, Co.s Galway and Mayo, Cassidy's of Buncrana, Co. Donegal, Harrington's of Turlough, Co. Mayo and Ardgaineen, Co. Galway and Mortimer's of Belclare, Co. Galway. Each of these quarries operate within SAC catchments and have successfully managed their discharge, under licence, for many years.

Pamela's key work areas also include the development of large-scale public supply water boreholes, surface water and groundwater assessments with a discharge focus, soil systems, soil and hydrology with a specific Regulatory focus on water and ecological constraints. Pamela is qualified and IOSH certified to act as PSDP (Project Supervisor Design Phase) & PSCS (Project Supervisor Construction Stage) as defined by the Construction Regulations. Hydro-G is a registered Irish Water Supplier (no. 1855) and Pamela Bartley is HSQE approved within Irish Water and is one of their Hydrogeologist service providers. She is a professional member of Engineers Ireland and International Hydrogeologists (Irish Group).

7.2.6 Walkover Survey

A walkover survey of the application site and surrounding area was undertaken by Hydro-G on multiple occasions between 2020 and 2021. Evaluation of the landscape position, surrounding lands, dwellings and roads was undertaken to evaluate any wells in proximity and to observe the general landscape and identify any potential karst features other than those mapped by the GSI. The first walkovers survey enabled focus points to inform further assessment of potential impacts to the general environs. The responses of the site were observed by Hydro-G at high, low and seasonal tides. In addition to the initial site walkovers, Hydro-G spent five consecutive full working days at the site for Production Well drilling in April 2021 and further time during pump testing in May 2021.

7.2.7 Site Investigations

The site has an extensive established network of monitoring boreholes within the site and in the upgradient neighbouring lands. Refer to Plate 7.1. Water levels and the groundwater regime is continuously monitored by datalogger. Water level responses are presented later in this chapter.

The site has the benefit of a robust site investigation programme completed for the previous planning application and EIS for the further development of the quarry (EIS Tom Phillips & Associates, 2015). Previously, site investigations were undertaken by TMS Environment Ltd from 2012 to better characterise the geology within the existing quarry and in the lands to the east of the private road where the settlement lagoon and infiltration pond system is now located. In the past, pumping tests were carried out to determine the hydraulic characteristics of the rock within the quarry in order to more accurately predict the expected groundwater inflows to the proposed quarry and to better estimate the potential impacts on the local water environment. The Water Chapter (TMS) of the 2015 EIS details the infiltration trials undertaken in the lands to the east of the private road to effectively demonstrate the infiltration capacity of the underlying sands & gravels. Results of the 2012 – 2015 investigations and modelling were presented in detail in the Water Chapter of the 2015 EIS. Hydro-G employed data to consolidate the 2021 assessment.

Previous site investigations comprised almost 30 boreholes, numerous trial pits, soakaway tests and Rotary Core drilling. Therefore, the geology and potential for interaction with the water environment has been characterised in detail previously. All Site Investigation results are presented in Appendix 7.2. In 2021 three new Production Wells (PWs) were drilled at 8" diameter to depths below the proposed

deepening elevation of -50m OD. Hydro-G supervised the Production Well drilling with fulltime site attendance. Each of the 2021 PW's were pump tested to evaluate potential future dewatering requirements. PW Locations are presented in Site Investigation Results.

There is a flowmeter on the discharge pipe conveying waters from the floor sump to the water management lagoon and infiltration system to the east of the site. Therefore, the record of waters arising is available. This information was used to assess water balance in the context of regional groundwater flow and the quarry's interception component. Recorded discharge volumes are presented as Appendix 7.3 and evaluated later in the chapter.

TMS Environment Ltd. routinely collect water samples and report groundwater and discharge (Surface Water) quality. Groundwater sampling is carried out bi-annually as per the monitoring proposal agreed with the Planning Authority for the site. Discharge quality sampling is carried out as specified in Condition 2.6 of the 2019 issued Cork County Council Discharge Licence WP(W) 08/18(R) in which some parameters are specified for quarterly analysis and some are specified for annual analysis. TMS Environment Ltd. monitoring and laboratory result reports for the site for the last 3 years are presented as Appendix 7.4.

One of the most significant points for consideration in the assessment of a working quarry is the Site Investigation observation of the walls of the area being worked. Natural surrounding ground level is 10m OD, approximately, to the west, north and east. Natural ground level to the south is 1m OD, approximately. The floor of the quarry is currently 19m below sea level. Hydro-G examined the rock face walls of the quarry. The limestone is tight with only two small cracks observed with any evidence of water ingress. Those two points were associated with corners in the rock under access road corners.

It is Hydro-G's experience that when a quarry is already operational, the walls and the number or size of the pumps dewatering the sump tell the story of current groundwater ingress. The evidence at the site presents a story of small-scale dewatering experience. There is small scale of dewatering infrastructure at the site: the area dedicated to the floor sump is relatively small, there is one small pump pontoon indicating that the pump is not that big, one duty pump provides adequate service and only one discharge pipe is required to convey water from the sump to the lagoons across the road. Those pieces of information suggest that little groundwater presents for management at the site at the current level of almost 20m below sea level.

Plate 7-1 Lagan's Long Term Groundwater Monitoring Wells

(Source: Google maps, annotated by Hydro-G)

7.3 Description of Development

The application site is a well-established quarry. The overall landholding measures c. 42.9ha. The proposed development being applied for under this current planning application is detailed in Chapter 2 of this EIAR, shown on Figure 2-1 and is similar to that previously granted under An Bord Pleanála reference number 04.QD.0010 and will consist of:

- Deepening of the existing permitted quarry extraction area by 2 no. 15 metre benches from -20m OD to -50 m OD, within a rock working application area of approximately 9.5ha within a total planning application of 12.6ha, which includes the operational water management lagoon and infiltration area (Licensed WP(W)08/18(R)) to the east of the quarry working area.

- An extraction capacity of up to 375,000 tonnes per annum is sought to provide the applicant with the ability to respond to demand for aggregates for large infrastructure projects in the Region.

- Upon the cessation of extraction operations, it is proposed to return the quarry area to natural habitat after-uses – refer to Figure 2.2. Where feasible, restoration of exhausted and redundant areas will be carried out at the earliest opportunity. However, it is envisaged that the majority of restoration proposals will be carried out after extraction operations at the site have ceased.

- Upon consideration of materials and likely economic activity, a planning permission duration of 20 years is sought for the extraction and processing period and a further 2 years to complete final restoration of the site.

- An outline of the proposed extraction plan and the final ground level contours is shown in Figure 2-1. Cross-sections through the final landform are shown in Figure 2-3.

- The site's topsoil and subsoil has already been stripped under operations permitted under previous permissions at the site. No further stripping of topsoil or overburden materials will be carried out within the application area.

- There is no requirement for new plant and machinery on site. Plant and machinery will be deployed from the existing quarry area to the application site, where required, and may consist of tracked excavators, wheel loaders, dump trucks and mobile processing plant. Ancillary plant such as an explosive's blast hole drilling rig and a water bowser may also be deployed where required.

- The application is for extraction of material only, there is no proposal to erect buildings or facilities at the application site. The existing working quarry consists of a wheelwash, portacabin offices, toilets, wastewater treatment system, storage yards, stockpiling area, ancillary plant, an asphalt plant and other permitted infrastructure associated with the day to day running of the site, which will be utilised for the application site.

- Rock will be extracted using conventional blasting methods to fragment solid rock to a manageable size to allow it to be extracted using excavators. Blasting will be undertaken on an as required basis by competent contractors. Aggregate will then crushed and screened to the required grades using mobile plant and stockpiled for sale. Activities undertaken on site as part of the day-to-day activities includes blasting, extraction, crushing, screening, processing and stockpiling.

- The existing quarry successfully operates below sea level, as will the proposed deepening.

- Currently, all waters arising within the quarry flow by gravity to a sump on the western boundary. From there it is pumped to the operational lagoons and infiltration area under Cork County Council Discharge Licence WP(W)08/18 (February 2019). The discharge licence permits a daily volume of 12,000 m3/d or 500 m3/hr.

- The site's Water Management System is operational. It was constructed to treat and infiltrate the WP(W)08/18(R) licensed 12,000m3/d. The system is located to the east of the quarry working site. The 2015 EIS submitted as part of the granted 37L application presented detail as follows:

    - The water management system was designed to accommodate the 1:100 year storm event as well as the combined effect of the adjacent working quarry and potential recirculating groundwater from the infiltration pond,
    - Designs also made provision for a future potential scenario for the cessation of the adjacent site (previously referred to as Cemex but now a Kilsaran quarry). Provision was made regarding "In the event that the Cemex operation ceased, Lagan would have to dewater both quarries and this treatment capacity is built into the lagoon systems".

- Currently the site dewaters 396m3/d on average while operating a floor level of -19.8m OD. Modelling for the 2015 planning application to go to -20m OD suggested that 12,000m3/d dewatering volume MIGHT be required. Considering that the site's water management systems are currently receiving <5% of the previously envisaged dewatering volumes, it is considered that the current Discharge Licence will remain fit for purpose for the proposed development to bring the floor from its current -20m OD to the proposed -50m OD.

7.4 Site Description

7.4.1 Site Location

The development site is located in a coastal setting and on a local county road approximately 2km south of Carrigtwohill and 6km southwest of Midleton, Co. Cork. It is located approximately 2km south of N25 National Primary Road (E-30 European Route) which links Cork city to Rosslare Europort (refer to Figure 7.1). The site is located in the townland of Rossmore, Carrigtwohill, Co. Cork. Access to the lands is via an existing access to the public road to the north which connects to the N25 National Primary Road to the north. The local county road forms the northern site boundary which links the R624 Regional Road to the west at Fota and the N25 National Primary Road at Middleton. Beyond the southern boundary of the lands is an access right of way to the adjacent Kilsaran quarry property lands, and Rossmore Bay, part of the Cork Harbour channel. Further beyond the immediate adjacent land uses there is Fota Island Wildlife Park

(2km to the northeast), the commercial/retail/residential centre of Carrigtwohill (2km to the north) and other extractive industries (2.5km to the north-east). The site and its regional context are shown in Figure 7.1.

The site is accessed via an existing site entrance along a private road, which leads south from a crossroads with the east-west public highway to the north. The East Cork Civic Amenity site is at the end of the site's access road.

The quarry site is bounded to the south by a minor road which is not accessible to traffic and runs adjacent to Rossmore Bay. Rossmore Bay is within the Cork Harbour Special Protected Area (SPA) and the Great Island Channel Special Area of Conservation (SAC). The site is bounded to the West by the larger Kilsaran (formerly Cemex) quarry which is currently active. A private road runs along the Eastern boundary of the site which accommodates the Lagan Materials Ltd traffic and also traffic associated with the Local Authority landfill south of the site. There is a road running in an east-west direction north of the site and this has a number of residential dwellings located along it.

The existing site comprises of a permitted limestone quarry. A permitted asphalt plant is situated in the southern area of the site with the extractive area extending in a northerly direction. Planning permission was granted for the existing quarry in April 2004 (planning register ref. 02/5476 and An Bord Pleanála appeal PL04.203762); previous to this there was only minor sand and gravel quarrying at the site by Irish Asphalt and O'Mahony Sand and Gravel.

The centre of the site has the following ITM Grid References: ITM Easting 182448; ITM Northing 71056.

Corrine (2018) land use maps the land immediately east and north as 'Arable Land', to the immediate west as 'Mineral extraction sites' and to the south as 'Coastal Wetlands' or 'Intertidal Flats'. The Civil Amenity site is mapped by Corrine as 'Pastures'.

7.4.2 Site Services in Water & Wastewater

Drinking water at the site is provided in large water dispenser bottles to the office and kitchen.

With respect to toilet facilities, the site's toilets and kitchen are serviced by a Tricell system. Appendix 7.5 presents details. The Biofilter unit is self-contained in a GRP structure and consists of a combined Primary Settlement Tank/Final Settlement Tank, suitably sized and baffled to promote good flow balancing, settlement of solids and a sludge holding capacity. The unit is installed near the office buildings and the

treated effluent discharges to an adjacent percolation area. The wastewater systems and discharge were approved in the 37L application in 2015. The wastewater tank is emptied periodically by Licenced operator Countywide Drains (EWC Code 200304).

There is a well in the centre of the carpark that is used for the sprinkler systems, truck washing, toilet flushing and the wheel wash. The well feeds a tank for distribution to the various end uses.

7.4.3 Current Landuse & Size

The existing site comprises of a permitted limestone quarry. A permitted asphalt plant is situated in the southern area of the site with the extractive area extending in a northerly direction. Planning permission was granted for the existing quarry in April 2004 (planning register ref. 02/5476 and An Bord Pleanála appeal PL04.203762); previous to this there was only minor sand and gravel quarrying at the site by Irish Asphalt and O'Mahony Sand and Gravel.

The application is for extraction of material only, there is no proposal to erect buildings or facilities at the application site. The existing working quarry consists of a wheelwash, portacabin offices, toilet, storage yard, stockpiling areas and ancillary plant and other infrastructure associated with the day to day running of a quarry development, which will be utilised for the application site.

7.4.4 Historical Land Use

Historical land uses were reviewed using maps and aerial photography, which are detailed in Table 7.1.

Table 7.1: Historical Land-use at the Site and its Surroundings

Ordinance Survey Map Reference & / or dates	On Site	Immediate Surroundings
OS 6 inch colour (1837-1842)	No extraction activities are noted. Rossmore House is recorded immediately to the east of the site. The site is split up by field boundaries.	There are no other houses in the vicinity. There are a couple of buildings to the south, on the Civic Amenity Site, and a Brick Island is mapped as attached to the east of the Civic Amenity site.
OS 6 inch Cassini (1845)	No extraction activities are noted. Rossmore Cottage is now mapped as Rossmore House.	There are two Lodges now to the north and west, at road junctions, presumably associated with Rossmore house.

		Brick Island now has a Shell Mound mapped with it.
OS 25 inch (1888-1913)	No change from above	
Aerial Map 1995	There is a small sand and gravel quarry established in the southern portion of the site.	New dwellings are located along the east west road to the north of the site.
OSI Ortho 2010	Expansion of the quarry. Adjacent quarry is extensive. Other extractions and quarry voids now present to the northeast (now the Roadstone Quarry) and it is dry here on the aerial 2010.	No significant change in the immediate vicinity of the site.
OSI Digital Globe	No significant change in the footprint areas of the Lagan or adjacent Cemex (now Kilsaran) quarries. The Roadstone Quarry has a significant water component.	No significant change in the immediate vicinity of the site.

7.4.5 Topography

The site is located on a relatively flat coastal plain. Natural ground level prior to quarrying at the site was 10m OD, generally. There are some small elevation rises to 20m OD and 30m OD is the form of small rises but even the town of Carrigtwohill, 2km north, has a general land elevation of 10m OD. The land to the south, immediately outside the boundary berms, is coast with a 0m OD elevation. The regional topography of the land surrounding the site is relatively high ground in the townland of Ballintubbrid West, which is to the northeast of the Lagan quarry, falling towards Rossmore Bay in the southwest.

The GSI (2004) describe the topography of the area as the "floor of an elongate east west trending valley in east Cork. The valley is bounded to the north and south by parallel east west trending ridges which comprise the Ballinhassig and Knockadoon GWBs respectively. The valley floor is generally flat to gently undulating. Ground elevations range from 2–30 m OD. Areas of higher ground occur along the centre of the valley (20-30 m OD) but ground is generally lower along the valley margins, and in the east of the body near the coast (<20 m OD). The ready weathering & erosion of the thin shaly limestones which occur at the margins of the body is thought to be responsible for the topographic lows along the edges of the valley. In the west of the body large surface water channels extending to Lough Mahon intersect the body partially surrounding Little Island and Fota Island".

Figure 7.2 presents the Regional Topography Map.

7.4.6 Site Layout

The main quarry void is in the centre of the site. This area has previously been stripped of overburden and been subject to bedrock extraction to a depth of -20m OD. There are a number of stockpiles currently located in the central area of the site. The overall landholding measures c. 42.9ha. The application site covers an area of 12.6 hectares. The existing quarry site is bounded to the south by Rossmore Bay, to the west by the Kilsaran Quarry, to the north by a greenfield buffer zone to some residential dwellings dotted along the east-west local public road and to the east by a private road, which provides access to the site, with agricultural lands beyond. The site access is located to the southeast corner, which also accommodates the wheelwash, weighbridge, site offices and canteen facility associated with the site. Crushing and screening is carried out on the quarry floor by mobile processing plant. Stockpiling of aggregate materials also takes place on the quarry floor.

7.4.7 Site Drainage, Surface Water Runoff & Water Management at the Site

Currently all precipitation falling on the quarry floor flows naturally by gravity to the sump in the floor of the quarry. The sump is on the western boundary. The schematic flow of waters at the site is shown in Plate 7-2, the water supply well location relative to the weighbridge is shown in Plate 7.3 and photographs of the water management systems are presented in Plate 7-4.

Plate 7-2 Schematic of natural runoff Surface Water Flow, Sump & Discharge to Lagoon and Infiltration area.

Rainfall on the greenfield areas to the north and east of the quarry percolates through the underlying overburden and weathered rock. Rainfall runoff flows naturally from all haul roads in the quarry for ultimate collection in the sump on the floor.

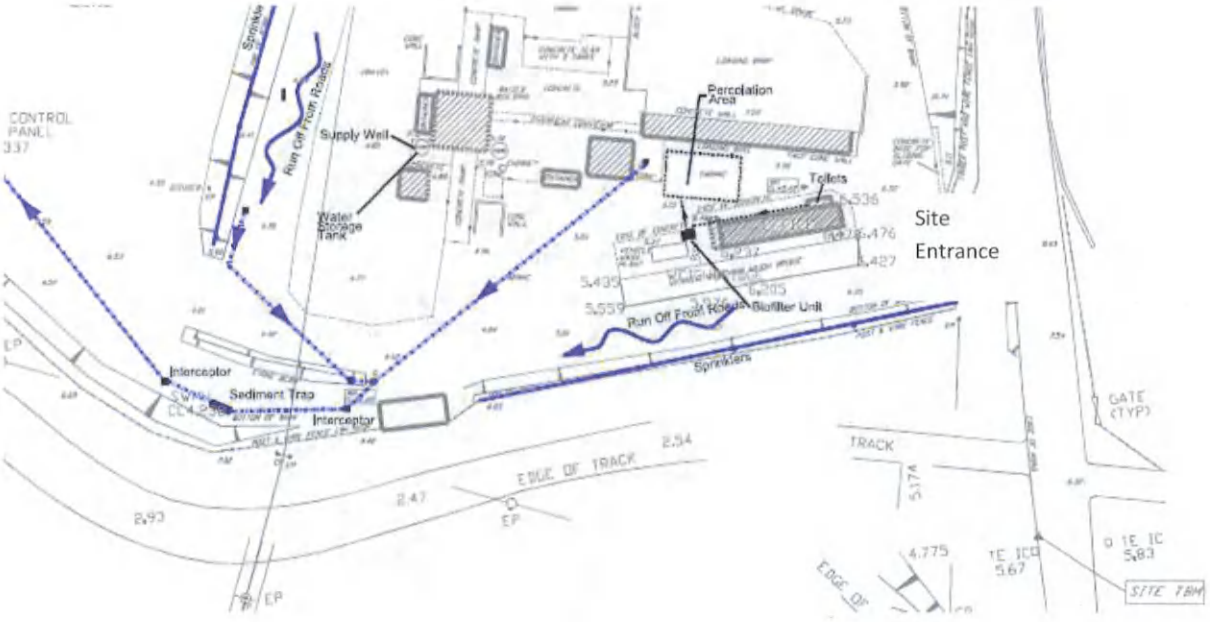
Sump waters are used for dust suppression and therefore that water either evaporates back into the air borne water cycle or flows back to the sump. For dust suppression, a tractor-drawn water tanker is filled from the settlement lagoon and sprayed around the quarry. A series of sprinklers are located along the

access road exiting the quarry floor and along the main entrance and are supplied directly from the supply well.

Runoff from the asphalt plant and surrounding hardstanding areas, including access roads, drains through two separate oil interceptors and a sediment trap along the southern site boundary before discharging to the settlement lagoon.

There are therefore two sources of water on site: the settlement lagoon/quarry sump (refer to Plate 7.2) and a non-potable supply well located in the car park (refer to Plate 7.3). The largest volume of water is used for dust suppression.

Plate 7.3 Location of the Supply Well



The uses of water from these sources are summarised in Table 7.2.

Table 7-2: Water Uses at the site and Sources

Settlement Lagoon	Supply Well
• Dust Suppression • Wash Plant	• Washing truck bodies • Wash Plant (supplementary) • Sprinklers • Toilets • Wheel wash (recycled)

The site's Water Management System is operational. It was designed and constructed to treat and infiltrate the WP(W)08/18(R) licensed 12,000m3/d. The lagoons are located to the east of the quarry working site. The 2015 EIS submitted as part of the granted 37L application presented detail as follows:

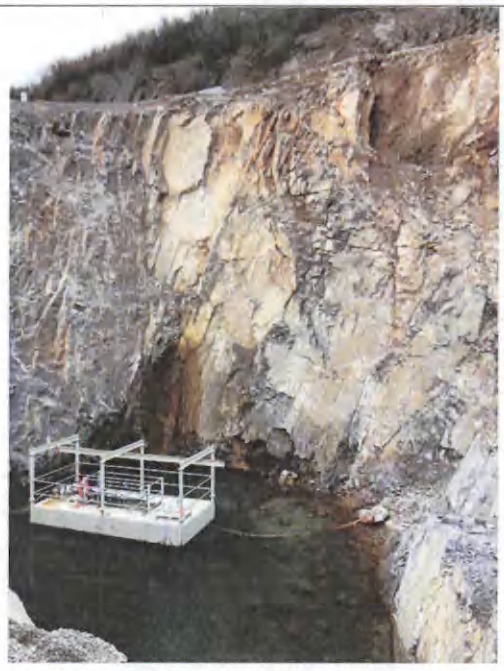
- *The water management system was designed to accommodate the 1:100 year storm event as well as the combined effect of the adjacent working Cemex quarry (now Kilsaran) and potential recirculating groundwater from the infiltration pond,*

- *Designs also made provision for a future potential scenario for the cessation of the adjacent Cemex site (now Kilsaran). Provision was made regarding "In the event that the Cemex operation ceased, Lagan would have to dewater both quarries and this treatment capacity is built into the lagoon systems".*

Currently the site dewaters 396m3/d on average while operating a floor level of c. -19.8m OD. Modelling for the 2015 planning application to go to -20m OD suggested that 12,000m3/d dewatering volume MIGHT be required. Considering that the site's water management systems are currently receiving <5% of the previously envisaged dewatering volumes, it is considered that the current Discharge Licence will remain fit for purpose for the proposed development to bring the floor from its current -20m OD to the proposed -50m OD. That conclusion is supported by direct experience of hydrogeologists that in the diffuse karst setting and coastal locations most groundwater is encountered before reaching the 20m OD elevation. It is noted that the neighbouring Kilsaran quarry is currently applying for permission to continue their progression through depth and therefore they will continue dewatering. Both sites are licensed to dewater and the interactions have previously been considered in the 2015 EIS's modelling and designs.

The Discharge Licence for the site and the Engineering Details returned to the Council as part of the compliance process (Lagan correspondence 25th May 2020) were presented in Appendix 7.1. Details of hydrocarbon management and mitigation measures as well as the discharge licence compliance sampling point are detailed in that Lagan correspondence dated 25th May 2020 (Appendix 7.1).

Plate 7.4: Existing discharge mechanism at the site.



Sump in floor of application area.

Discharge point from the floor sump to the settlement lagoons on the east side of the road.

Primary Settlement Lagoon

Infiltration Area

7.4.8 Quantification of Waters Requiring Management & Discharge

The volume of water requiring management will comprise rainfall runoff and some groundwater ingress.

Normal rainfall runoff calculations for the entire working area of the quarry (9.6ha) PLUS the potential higher ground around the working void (*i.e.* an additional local runoff landscape of 10ha, approximately) can be evaluated as presented in Table 7.3.

Table 7.3 Rainfall Runoff Calculations

Site Annual Average Rainfall (SAAR) [EPA envision]	~ 1047 (mm/yr)
Effective Rainfall	~626 (mm/yr)
Effective Rainfall	0.626 (m/yr)
Site Total Area	19.6 (ha)
Site Total Area	196,000 (m^2)
Whole Site Total Current rainfall runoff generation	122,696 (m^3/yr)
Whole Site Total Current rainfall runoff generation =	**336 (m^3/d)**

Note: The proposed deepening of the working area for further rock excavation and development will result in 0m3/d additional rainfall runoff because rain already runs off and into the working rock area proposed for deepening. Therefore, future deepening will not increase runoff volumes collected in the sump.

Storm event rainfall contributions to the site for the 1 in 10, 1 in 30 and 1 in 100-year storms were previously calculated and presented in the Water Chapter's Appendices (EIS, 2015). Those calculations are presented here in the Water Management Appendix 7.6, which provides design details suggesting that the adoption of a Total Catchment Contributing Area approach, with a +10% Factor for Climate Change, requires stormwater storage for the 18hr event and the 1 in 100-year return period = 6,100 m3. The existing lagoons and infiltration systems were designed and built to accommodate that volume of stormwater in addition to groundwater ingress. Refer to Appendix 7.6 for the Design Report.

Groundwater ingress is another component of water requiring management at the site. Groundwater ingress rates were calculated for the site under various scenarios including cessation of pumping at the adjacent quarry to the west. Modelling results for 'Predicted Groundwater Inflows' were presented in Appendix 8.6 of the 2015 EIS and discussions presented in Section 8.10 of that EIS. In summary, the following inflow rates were presented as the model outputs under differing scenarios, as follows:

a. The combined impact of dewatering the adjacent quarry to the east and the Lagan site could result in up to 70.5 l/s, which Hydro-G notes is equivalent to 6,092m3/d.

b. Potential recycling of groundwater pumped from the quarry through the infiltration pond could result in requirement to treat up to 70.5L/s of water = 6,092m3/d.

c. In the event that the neighbouring operation ceased, Lagan would have to dewater both quarries and a treatment capacity of up to 95L/s would be required. If this scenario arose combined with the potential for an additional 50% of recycled infiltration water, a treatment capacity of up to 143L/s would be required. The proposed management system has the capacity to treat this volume of water if the worst-case scenarios arose, which Hydro-G notes is equivalent to 12,355m3/d.

Hydro-G notes that the 2015 EIS Water chapter's modelling results for the site's hydrogeological characteristics **suggested** a potential future groundwater inflow of 6,092m3/d for the scenario that the site is currently operating under *i.e. rock* excavation to -20m OD. The actual monitoring data for dewatering at the site are presented as Table 7.4.

Table 7.4 Summary Site Dewatering Data

Licence Limit - 500m³/hr AND 12,000m³/day					
Reading Date	No Of Days Elapsed Since Previous Reading	Flow Total Reading On Meter (m³)	Total Flow For This Period (m³)	Average Daily Flow For this Period (m³/day)	Flow As a % Of Permitted Limit
26/08/2020	0	0	0	N/A	N/A
07/10/2020	42	20,607	20,607	491	4.1%
21/10/2020	14	27,881	7,274	520	4.3%
18/11/2020	28	50,205	22,324	797	6.6%
10/02/2021	84	106,534	56,329	671	5.6%
27/05/2021	106	153,094	46,560	439	3.7%
29/06/2021	33	155,023	1,929	58	0.5%
22/07/2021	23	157,136	2,113	91	0.8%
01/09/2021	41	161,427	4,291	104	0.9%
Annual Average Daily Discharge Measured Flow (m3/d)				396	3.3%
MAXIMUM Average Daily Flow (m3/d)				797	6.6%
2015 Modelled Predicted Groundwater Flow for -20m OD (m3/d)				6,092	

The site's monitoring data for flow pumped from the floor sump to the water management lagoons and infiltration area, as presented in Table 7.4, suggests an annual average daily volume = 396m3/d and a maximum average value of 797m3/d in October & November 2020. It is therefore concluded that the site did not intercept the 2015 EIS predicted groundwater volumes. The actual and currently observed, measured, values for discharge therefore align more with the normal rainfall runoff values as presented in Table 7.3, which are 3.3% of the water envisaged in the modelling outputs, for which the water management systems were built. Refer to Appendix 7.2. Hydro-G concludes that this provides great capacity for future developments. The lagoons and infiltration area already built can treat and infiltrate 12,000m3/d to ground. The water management systems are licensed under WP(W)08/18(R). Given that they operate at <10% of design capacity, 90% capacity remains available.

Deepening of the quarry is not expected to substantially increase dewatering requirements because, as previously stated, it is the direct experience of hydrogeologists that the diffuse karst and coastal setting suggests that limestone will be denser at depth. The current floor at an elevation of almost -20m OD, approximately, is 30m below sea level, which in this coastal setting, is the expected base of the aquifer. Therefore, any substantial groundwater there would have been experienced before now. Rock cores described in the previous EIS (2015) and 2021 Production Well drilling suggest competent rock at depth.

7.5 Receiving Environment

7.5.1 Designated Areas

Designated Sites are presented as Figure 7.3.

The following designated sites were noted to be within 15km of the site:

- Great Island Channel SAC (Site Code 001058) immediately adjacent to the south
- Cork Harbour SPA (Site Code 004030) to the south and at numerous inlets to the east and south
- Note: this estuarine channel immediately to the south of the site mapped as the Great Island Channel SAC and the Cork Harbour SPA is also mapped as a **'Nutrient Sensitive' Area estuary labelled by the EPA as the "Owennacurra Estuary / North Channel" (IE_SW_060_0400).**
- Cork Great Island North Channel (IE_SW_060_0300) is also a designated Shellfish Area:
  - AREA 3.38km2, EU_PA_Code IEPA2_0049, EU_PA_Type Shellfish.
- Owennacurra Estuary / North Channel (IE_SW_060_0400). EU_PA_TypeUrban Waste Water Treatment Directive Sensitive Area. LOCATION South Western RBD

WB_TYPE	Transitional/Coastal Waters
WFD_CODE	SW_060_0300
EU_PA_Code	IETW_SW_2004_0042

- While the main channel of the Blackwater River (Cork/Waterford) SAC (Site Code 002170) is 20km to the north, a southerly headwater is 15km from the Lagan and adjacent Kilsaran sites.

NPWS Site Synopsis for the Great Island Channel SAC states that:

"The Great Island Channel stretches from Little Island to Midleton, with its southern boundary being formed by Great Island. It is an integral part of Cork Harbour which contains several other sites of conservation interest. Geologically, Cork Harbour consists of two large areas of open water in a limestone basin, separated from each other and the open sea by ridges of Old Red Sandstone. Within this system, Great Island Channel forms the eastern stretch of the river basin and, compared to the rest of Cork Harbour, is relatively undisturbed. Within the site is the estuary of the Owennacurra and Dungourney Rivers. These rivers, which flow through Midleton,

provide the main source of freshwater to the North Channel."

The qualifying interests and conservation objectives of the Great Island Channel SAC are set out in the site synopsis report and conservation objective report [both are available at www.npws.ie]. The Great Island Channel SAC site is designated for the following habitats and/or species listed on Annex I / II of the E.U. habitats Directive:

- [1140] Tidal Mudflats and Sandflats
- [1330] Atlantic Salt Meadows

Hydro-G notes that the habitats for which the site is designated, have an ocean dependency rather than pure groundwater dependence. Water balance calculations later in this chapter shall assess potential for affecting the habitats.

It is worth noting, with respect to Groundwater Dependent Terrestrial Ecosystems (GWDTE), that the GSI (2004) has cited the following terrestrial ecosystems as associated with the Middleton GWB:

- Ballyvergan Marsh (Site Code 000078),
- Ballyquirk Pond (Site Code 001235),
- Clasharinka Pond (Site Code 001183),
- Loughs Aderry and Ballybutler (Site Code 000446)

The mapped extent of the Midleton Groundwater Body is shown on Figure 7.4.

The Cork Harbour SPA (Site Code 004030) is also located to the south of the site. The NPWS Site Synopsis for the site presents information of note, as follows:

- Cork Harbour is an internationally important wetland site.
- This SPA is designated for both nationally and internationally important and significant birdlife.
- The site is also of special conservation interest for holding an assemblage of over 20,000 wintering waterbirds.
- Owing to the sheltered conditions, the intertidal flats are often muddy in character. These muds support a range of macro-invertebrates, notably Macoma balthica, Scrobicularia plana, Hydrobia ulvae, Nepthys hombergi, Nereis diversicolor and Corophium volutator. Green algae species occur on the flats, especially Ulva spp. Cordgrass (Spartina spp.) has colonised the intertidal flats in places, especially where good shelter exists, such as at Rossleague and Belvelly in the North Channel. Salt marshes are scattered through the site and these provide high tide roosts for the birds.

- Some shallow bay water is included in the site. Rostellan Lake is a small brackish lake that is used by swans throughout the winter.
- The site also includes some marginal wet grassland areas used by feeding and roosting birds.
- The E.U. Birds Directive pays particular attention to wetlands and, as these form part of this SPA, the site and its associated waterbirds are of special conservation interest for Wetland & Waterbirds.
- The full bird species list, Conservation Objectives and the **Statutory Instrument of note** S.I. No. 237/2010 - European Communities (Conservation of Wild Birds (Cork Harbour Special Protection Area 004030)) Regulations 2010 is available at https://www.npws.ie/protected-sites/spa/004030.

Hydro-G's experience suggests that given the scale of the harbour and its large contributing catchment area, potential hydrological or hydrogeological impacts on this designated site are unlikely to result from the proposed development. Water balance for the catchment area of the harbour will be presented later in the chapter (Potential Impact Section).

As previously stated, the ecologist's Appropriate Assessment Screening Report evaluating a proposal for increased operating hours at the site concluded no potential to affect local designated sites either on its own or in combination with other developments within 15km (May 2021, SLR Ref 501.00584.00011).

7.5.2 Quaternary Geology: Soils & Subsoils

The GSI maps the Teagasc Soils categories in the southern half of the site as 'Bedrock at surface-Calcareous RckCa' and the northern half as 'Till derived chiefly from Devonian sandstones TDSs' (www.gsi.ie). Figure 7.5 presents the soils map. The soils in the surrounding lands are described by the GSI as 'Till derived chiefly from Devonian sandstones TDSs'. The adjacent quarry to the west is also mapped as 'Bedrock at surface-Calcareous RckCa'.

The GSI subsoils map for the area also shows that the southern half of the site and the quarry next door to the west is mapped as the subsoil (Quaternary Sediments) classification of 'Bedrock outcrop or subcrop' Rck (www.gsi.ie). Lands in the remainder of the overall landholding are mapped as subsoil type "Till derived chiefly from Devonian sandstones TDSs'. The Subsoils Map is shown as Figure 7.6.

These are free draining soils and subsoils.

Information previously presented for the site (Tom Philips & Associates, 2015), relating to soils, is as follows:

> *"The soils on the higher ground north of the quarry are deep well drained mineral soils derived from a non-calcareous parent material (Soil Code: AminDW), grading southwards towards the lower ground into shallow well drained mineral soils derived from a calcareous source (Soil Code: BminSW). These indicated soil types closely follow the mapped subsoils from which they would have been derived (see Section 7.3.1.2 below).*
>
> *Estuarine sediments (Soil Code: MarSed) are mapped within Rossmore Bay south of the quarry, with shallow lithosolic-podzolic soils possibly with peaty topsoil along the coastal margin (Soil Code: BminSRPT).*
>
> *Regional mapping suggests that the higher ground north of the quarry is underlain by boulder clay (till) derived from Devonian sandstones. The boulder clay would appear to thin southwards across the Lagan site to the coast where bedrock outcrops/subcrops in the vicinity of the site.*
>
> *Site investigations on site have shown that boulder clay exists north of the quarry however stratified silts with thin interbedded gravel layers become more common towards the south of the site.*
>
> *Drilling on the beach next to the Lagan quarry (BH18, Appendix 7.1, 2015 EIS, Tom Phillips & Associates) has shown that these stratified silts with thin gravels layers extend beyond the shore of Rossmore Bay, beneath the more recent estuarine mud deposits (Photo 2). The upper shore is composed of well sorted/well rounded beach gravel composed of sandstone washed out from the underlying subsoils (SP1, Appendix 7.1).*

Photo 2 *as referred to in the text, above, extracted from 'Soils & Geology' Section of the 2015 EIS.*

The subsoils in the south of the lands to the east of the private road also in the ownership of the applicant are quite different however. Thick sand and gravel deposits have historically been extracted from the southern end of these lands and the lands further to the south under the ownership of Kilsaran (formerly Cemex). Aerial photographs from the Ordinance Survey of Ireland suggest that gravel extraction in this area ceased sometime between 1995 and 2003.

The site investigation carried out from February-April 2012 in the southern part of the lands to the east of the quarry showed the presence of thick sand and gravel deposits. Particle size distributions undertaken on recovered samples confirmed the gravels to be very sandy silty gravels, with interbedded sandy gravelly silt layers (Appendix 7.3).

Thick fluvioglacial outwash deposits (sands & gravels) are known to fill two East-West trending buried channels in the Cork-Middleton valley, one to the north of the Lagan site at Carrigtwohill (Northern Buried Valley) and one to the south of the quarry in Rossmore Bay (Southern Buried Valley). The location of these buried channels is indicated on Figure 7.1. Little is known of the fluvioglacial deposits in the Southern Buried Valley in the vicinity of Rossmore Bay however it is clear from the site investigations and historic sand & gravel extraction that the boundary of this buried channel runs through the southern end of the lands to the east of the Lagan quarry - the gravels encountered here form part of this Southern Buried Valley."

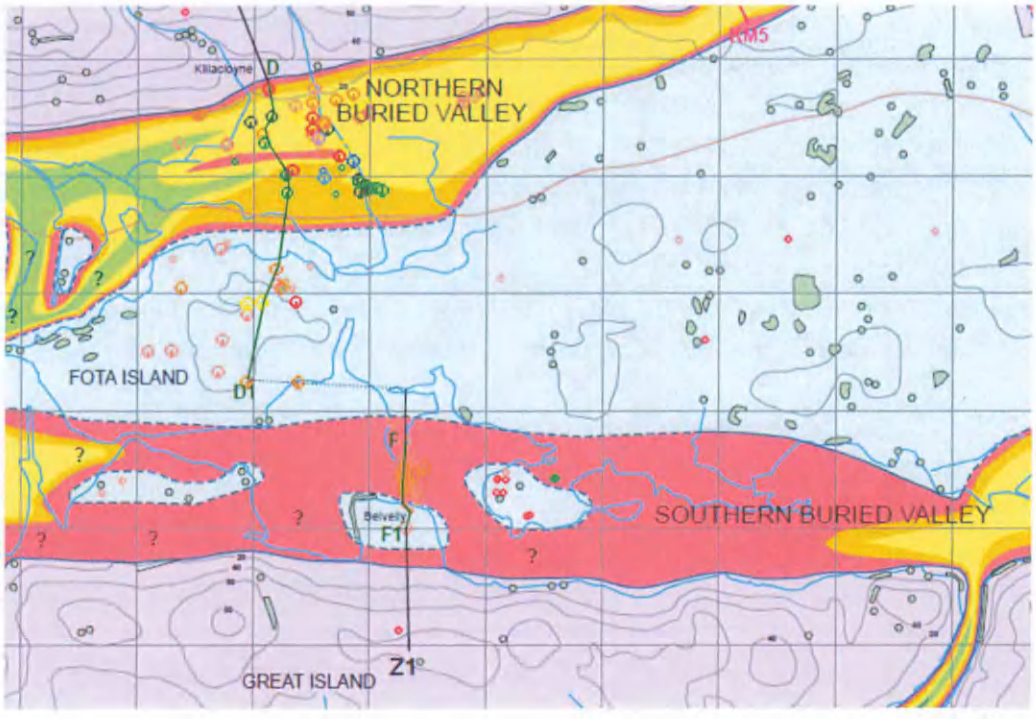


Figure 7.1: *Southern Buried Valley to the south of Rossmore (Davis et al., 2006)"*
(as extracted from the 2015 EIS)

7.5.3 Groundwater Vulnerability

Groundwater vulnerability for the site is mapped by the GSI as 'Extreme - X ' (Rock at or near surface). Due to the nature of quarrying which requires removal of overburden, the groundwater vulnerability rating at all quarry sites is 'Extreme – X'. Groundwater vulnerability within the overall landholding is of the surrounding lands is mapped as 'Extreme – X' in the vicinity of the site and 'Extreme – E' (soil less than 3m thick) in the northern portion of the site. Groundwater vulnerability in the surrounding lands is Groundwater vulnerability is largely Extreme-E and Extreme-X, with localised areas of 'H' high vulnerability. Groundwater vulnerability is presented as Figure 7.7.

7.5.4 Bedrock Geology

The site is underlain by Carboniferous period Limestones. The Geological Survey of Ireland (GSI) 1:100000 geology sheets map the northern part of the site as underlain by the Clashavodig Limestone Formation, which is a cherty fine limestone, and the southern portion of the site as the Little Island Formation, which is a massive and crinoidal fine Limestone. Both the Little Island and the Clashavodig are mapped as

'Dinantian Pure Unbedded Limestones' (https://dcenr.maps.arcgis.com/). Bedrock geology and displacement lines are presented in Figures 7.8 (a&b).

Desk study review of site-specific geological information included previous works in relation to previous applications for planning at the site. The Soils & Geology chapter of 2015 37L EIS included 70 pages of Borehole Logs and Trial Pit Logs and a report presenting a Geotechnical Review of the site that was completed by geotechnical consultants (AGEC, 2012). These site investigation results are presented here as Appendix 7.2 because they provide relevant information of use in the development of the conceptual hydrogeological model for the site. Of particular significance, Hydro-G notes as follows:

- Previous Site Investigations included almost 30 boreholes
- Of the 30 SI boreholes, five of the investigation sites on the periphery of the site have been completed with piezometers to enable a long-term monitoring record
- The rock within the quarry is a fine-grained mud mound limestone. The rock was described as strong to locally moderately strong light grey fine-grained LIMESTONE with occasional calcite veining.
- Localised karst features were previously observed in the wall faces but not during borehole drilling.
- Localised karst features were described as clay infilled joints and zones of deeper weathering (AGEC, 2012).
- Solution weathering of joint surfaces to a shallow depth is occasionally seen within the Lagan quarry, the enlarged joints are infilled with clay which has been washed through from the overburden by infiltrating water. Solution weathering is very rarely seen along cleavage planes. (2015, Soils & Geology Chapter 7, Tom Phillips & Associates EIS accompanying 37L application).

7.5.5 Aquifer Classification

The site is underlain by an aquifer classified as a Regionally Important Aquifer which is karstified and dominated by diffuse flow (Rkd). The Aquifer Map is shown as Figure 7.9.

A regionally important aquifer is typically understood to be a bedrock aquifer unit capable of supplying regionally important abstractions (e.g. large public water supplies), or 'excellent' yields (>400 m3/d) and a continuous aquifer unit with an area >25km2. The Aquifer under the site is mapped as having an area of 128 km2 (https://dcenr.maps.arcgis.com/). The Aquifer is mapped as DIFFUSE. Conduits are NOT expected. Karstification is known to be most frequent in upper bedrock layers or along certain fractures, fissures and joints.

7.5.6 Karst Features

The underlying Middleton Groundwater body is mapped as a diffuse karst system (https://dcenr.maps.arcgis.com/ & GSI, 2004).

The GSI (20014) describe the Key Properties of the karst in the Middleton GWB as follows:

> *"There are numerous surface karst features in these limestones, (e.g. swallow holes, collapse features and closed depressions) and extensive cave systems (e.g. Carrigtohill, Midleton and Cloyne). The strong structural influence on the development of karstification is demonstrated by cave plans from Southeast Cork (e.g. Poulnahorka Caves, Castlemartyr, Co Cork) where the main passages or 'galleries' have developed."*

Example of the potential for big karst in the Middleton Groundwater Body was well documented by Hogan & Larkin (2014) in their description of the karst cave at the Middleton Irish Distillery site.

In addition, the potential for extensive karst in County Cork is evident from the work of Kelly & Drew (2014). However, the work of Kelly & Drew (2014) relates to the extensive 'Krazy Karst' of north Cork and that type of karst is not evidenced in the immediate area of influence around the site under consideration in this work.

The karst of the area is also well described in Conroy (2012)'s Groundwater Flood Risk Assessment for Carrigtwohill, which was completed by Conroy with JBA for Cork County Council. Conroy's brief specifically included all quarries in the area and in the course of his assessments no karst features were mapped in the vicinity of the site.

Site investigations at the site conducted for previous planning applications (2002 to 2015) include borehole logs for almost 30 Site Investigation boreholes, Rotary Core holes, trial pits and infiltration soakaways. Refer to Appendix 7.2. Hydro-G reviewed all borehole logs and geological reports (AGEC, 2012). No evidence of significant water bearing karst features have been revealed at the site, which is to be expected given the 'diffuse' karst mapping.

Geologists for the site refer to their mapping of the walls with reference to karst features, as follows:

> *"Examination of quarry faces shows that the depth of solution weathering along joints is generally less than 10m, most solution enlargement ends before reaching the base of the existing quarry. A few weathered joints have been observed to extend to the base of the quarry however drilling records within the quarry show that clay filled fractures are rare beyond approximately 30m below the original bedrock surface. Rock cores within the quarry show that the quality of rock improves with depth (RC2), with less weathering of fractures and an improvement in Rock Quality Designation.*

In 2002, a geophysical resistivity survey carried out in the Kilsaran (formerly Cemex) quarry immediately west of the Lagan quarry suggested the presence of several North-South trending features across the site in the limestone bedrock which were interpreted as preferentially weathered joints (Readymix Ltd EIS, 2003). Therefore, the solution weathering of joints is likely to be more widespread in the Little Island Fm. than just at the Lagan site.

Several narrow solution pipes can be seen in the quarry faces, extending from the bedrock surface to less than 10m depth. These features are less than 1m wide, circular to elliptical in cross-section and are clay filled".

There are no GIS mapped karst features at the site. Refer to Figure 7.10. It is noted that there is a mapped cave @ 1km to the east and a mapped spring @ 1.5km, approximately, to the southeast. The GSI (https://dcenr.maps.arcgis.com) describes these features as follows:

- GSI's no. for karst feature 1707SWK008
  - karst feature type CAVE karst feature local name GOAT HOLE
  - Townland name BALLINTUBBRID WEST County CORK
  - Spatial accuracy of the Grid Reference to within 20 m
  - General comments
    - Source of information "Caves of Ireland", J.C. Coleman.
    - Dominant composition Limestone, clean (>=90% CaCO3), unbedded
    - Stratigraphy LI
    - Easting ITM 583474, Northing ITM 571412

Hydro-G Notes that this cave is situated at a mapped change in limestone type between the 'Little Island Formation' and the 'Clashavodig Formation'. This is the same boundary that is mapped under the site. This is noted and informed site investigations / walkover for the site.

- GSI's no. for karst feature 1707SWK003
  - karst feature type SPRING karst feature local name n/a
  - Townland name BALLINTUBBRID WEST County CORK
  - Spatial accuracy of the Grid Reference to within 20 m
  - General comments
    - Source of information "Caves of East Cork", David Wright.
    - Comments on geological setting D. Wright thinks that the spring may be in discharge point (or one of them) for the Carrigtwohill stream sink (1707SWK004).
    - Dominant composition Limestone, clean (>=90% CaCO3), unbedded

- Stratigraphy LI
- Easting ITM 583814, Northing ITM 571062

Hydro-G Notes that the "Caves of East Cork" (Wright, D) relates that spring at 1.5km, approximately, to the southeast as possibly connected to the Carrigtwohill stream sink.

Conroy (2012)'s Hydrogeological Conceptual Model shows karst and flows, on a regional scale, and is presented here as Plate 7.5. At that time the neighbouring Kilsaran quarry was owned by Readymix and is labelled as such. The Regional scale model does not map any karst features at the site and this is confirmed by the work completed for this EIAR.

Plate 7.5 Conroy (2012) Conceptual Hydrogeological Model (Carrigtwohill Groundwater Flood Risk Assessment)