7 HYDROLOGY & HYDROGEOLOGY

7.1 Introduction

7.1.1 Background and Objectives

Hydro-Environmental Services (HES) was engaged by Milford Quarries Ltd to carry out an assessment of the potential effects of the proposed dimension stone quarry at Bannagagole, Old Leighlin, Co. Carlow on the water (hydrological and hydrogeological) environment. The Proposed Development site (~9.34ha) is located ~15km south of the village of Old Leighlin and ~5km southwest of Leighlinbridge, Co. Carlow.

The Proposed Development comprises the development of a greenfield bedrock quarry in the townland of Bannagagole, Old Leighlin, Co. Carlow. The proposed extraction area will comprise ~2.44ha and it is proposed to extract ~84,000 tonnes (30,000m^3) of material annually from the site over a period of 12 to 13 years. The proposed quarry void will extend to a final floor level of ~56.5mOD (metres above Ordnance Datum). The Proposed Development will also include the implementation of a restoration plan following the cessation of the proposed extraction activities.

The objectives of the assessment are:

- Produce a baseline study of the existing water environment (surface water (hydrology) and groundwater (hydrogeology)) on the area of the Proposed Development site;
- Identify likely significant effects of the Proposed Development on surface and groundwater during construction, operation, and restoration phases of the development;
- Identify mitigation measures to avoid, reduce or offset significant negative effects;
- Assess significant residual effects; and,
- Assess likely cumulative effects of the Proposed Development and other local developments.

7.1.2 Quality Assurance and Competence

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

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

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

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

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

7.1.3 Relevant Legislation

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

The following legislation has been complied with:

- Planning and Development Acts, 2000 (as amended);
- Planning and Development Regulations, 2001 (as amended);
- S.I. No 296/2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 which transposes the provisions of the EIA Directive as amended by the Directive 2014/52/EU into Irish Law;
- S.I. No. 94/1997: European Communities (Natural Habitats) Regulations, resulting from EU Directives 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and 79/409/EEC on the conservation of wild birds (the Birds Directive);
- S.I. No. 293/1988: Quality of Salmon Water Regulations;
- S.I. No. 272/2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009, as amended, and S.I. No. 722/2003 European Communities (Water Policy) Regulations, as amended, which implement EU Water Framework Directive (2000/60/EC) and provide for implementation of 'daughter' Groundwater Directive (2006/118/EC);
- S.I. No. 684/2007: Wastewater Discharge (Authorisation)Regulations, resulting from EU Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the Groundwater Directive);
- S.I. No. 249/1989: Quality of Surface Water Intended for Abstraction (Drinking Water), resulting from EU Directive 75/440/EEC concerning the quality required of surface water intended for the abstraction of drinking water in the Member States (as amended by 2000/60/EC in 2007);
- S.I. No.106/2007: European Communities (Drinking Water)Regulations and S.I. No. 122/2014: European Union (Drinking Water) Regulations, arising from EU Directive 98/83/EC on the quality of water intended for human consumption (the Drinking Water Directive) and WFD 2000/60/EC (the Water Framework Directive);

- S.I. No. 9/2010: European Communities Environmental Objectives (Groundwater) Regulations 2010, as amended; and,
- S.I. No. 296/2009: European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009, as amended.

7.1.4 Relevant Guidance

The guideline relevant to this assessment include:

- Department of the Environment, Heritage and Local Government (2004) 'Quarries and Ancillary Activities, Guidelines for Planning Authorities';
- Environmental Protection Agency (2006): Environmental Management in the Extractive Industry;
- Environmental Protection Agency (2022): Guidelines on the Information to be contained in Environmental Impact Assessment Reports;
- Institute of Geologists Ireland (2013): Guidelines for the preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements;
- National Roads Authority (2008) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Watercourses;
- PPG1 - General Guide to Prevention of Pollution (UK Guidance Note);
- PPG5 – Works or Maintenance in or Near Water Courses (UK Guidance Note);
- CIRIA (Construction Industry Research and Information Association) Guidance on 'Control of Water Pollution from Linear Construction Projects' (CIRIA Report No. C648, 2006); and,
- Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors. CIRIA C532. London, 2001.

7.2 Study Methodology

7.2.1 Desk Study

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

- Environmental Protection Agency database (www.epa.ie);
- Geological Survey of Ireland - Groundwater Database (www.gsi.ie);
- Met Eireann Meteorological Databases (www.met.ie);
- National Parks & Wildlife Services Public Map Viewer (www.npws.ie);
- Water Framework Directive "catchments.ie" Map Viewer (www.catchments.ie);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 19; Geological Survey of Ireland (GSI, 1999);
- Geological Survey of Ireland - Groundwater Body Characterisation Reports; and
- OPWs National Flood Information Portal (www.floodinfo.ie).

7.2.2 Baseline Monitoring and Site Investigations

An initial site visit and walkover survey was undertaken by HES on 10th March 2022 with follow-up site visits, investigations, drainage mapping and baseline monitoring/sampling undertaken by HES on 15th August, 17th August, 23rd August, 13th September, 10th October, 15th November 2022, and 19th December 2022.

Site investigations to address the Water Chapter of the EIAR included the following:

- Walkover surveys and drainage mapping of the site and the surrounding area were undertaken whereby water flow directions and drainage patterns were recorded;
- Drilling and logging of 5 no. groundwater monitoring wells (BH1 – BH5) within the Proposed Development site in August 2022. Drilling was completed by Irish Drilling Ltd and the cores were logged by Michael Gill and Conor McGettigan of HES;
- 3 no. trial pits (TP1 – TP3) were excavated within the site on 15th August 2022;
- Mineral soils and subsoil were logged according to BS: 5930:2015 Code of Practice for Ground Investigations;
- Monitoring of groundwater levels (manual and automated) in the 5 no. groundwater monitoring wells over a period of 4 no. months from 17th August 2022 to 19th December 2022; and,
- Surface water sampling and field hydrochemistry in 2 no. nearby surface watercourses.

7.2.3 Impact Assessment Methodology

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

In addition to the above methodology, the sensitivity of the water environment receptors was assessed on completion of the desk study and baseline study. Levels of sensitivity which are defined in **Table 7-1** for hydrology and **Table 7-2** for hydrogeology are used to assess the potential effect that the Proposed Development may have on them.

Table 7-1: Estimation of Importance of Hydrology Criteria (NRA, 2008)

Importance	Criteria	Typical Example
Extremely High	Attribute has a high quality or value on an international scale	River, wetland or surface water body ecosystem protected by EU legislation, e.g. 'European sites' designated under the Habitats Regulations or 'Salmonid waters' designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988.
Very High	Attribute has a high quality or value on a regional or national scale	River, wetland or surface water body ecosystem protected by national legislation – NHA status. Regionally important potable water source supplying >2500 homes. Quality Class A (Biotic Index Q4, Q5). Flood plain protecting more than 50 residential or commercial properties from flooding.

Importance	Criteria	Typical Example
		Nationally important amenity site for a wide range of leisure activities.
High	Attribute has a high quality or value on a local scale	Salmon fishery locally important potable water source supplying >1000 homes. Quality Class B (Biotic Index Q3-4). Flood plain protecting between 5 and 50 residential or commercial properties from flooding.
Medium	Attribute has a medium quality or value on a local scale	Coarse fishery. Local potable water source supplying >50 homes Quality Class C (Biotic Index Q3, Q2-3). Flood plain protecting between 1 and 5 residential or commercial properties from flooding.
Low	Attribute has a low quality or value on a local scale	Locally important amenity site for small range of leisure activities. Local potable water source supplying <50 homes. Quality Class D (Biotic Index Q2, Q1) Flood plain protecting 1 residential or commercial property from flooding. Amenity site used by small numbers of local people.

Table 7-2: Estimation of Importance of Hydrogeology Criteria (NRA, 2008)

Importance	Criteria	Typical Example
Extremely High	Attribute has a high quality or value on an international scale	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation, e.g. SAC or SPA status.
Very High	Attribute has a high quality or value on a regional or national scale	Regionally Important Aquifer with multiple wellfields. Groundwater supports river, wetland or surface water body ecosystem protected by national legislation - NHA status. Regionally important potable water source supplying >2500 homes Inner source protection area for regionally important water source.
High	Attribute has a high quality or value on a local scale	Regionally Important Aquifer Groundwater provides large proportion of baseflow to local rivers. Locally important potable water source supplying >1000 homes. Outer source protection area for regionally important water source. Inner source protection area for locally important water source.
Medium	Attribute has a medium quality or value on a local scale	Locally Important Aquifer. Potable water source supplying >50 homes. Outer source protection area for locally important water source.
Low	Attribute has a low quality or value on a local scale	Poor Bedrock Aquifer Potable water source supplying <50 homes.

7.2.4 Impact Assessment Process

Where potential effects are identified, the classification of impacts in the assessment follows the descriptors provided in the Glossary of Impacts contained in the following guidance documents produced by the Environmental Protection Agency (EPA):

- Environmental Protection Agency (May 2022): Guidelines on the Information to be Contained in Environmental Impact Assessment Reports.

The description process clearly and consistently identifies the key aspects of any potential impact source, namely its character, magnitude, duration, likelihood and whether it is of a direct or indirect nature.

In order to provide an understanding of the stepwise impact assessment process applied below, a summary guide is presented below, which defines the steps (1 to 7) taken in each element of the impact assessment process. The guide also provides definitions and descriptions of the assessment process and shows how the source-pathway-target model and the EPA impact descriptors are combined.

Using this defined approach, this impact assessment process is then applied to all quarry construction, operation and restoration phase activities which have the potential to generate a source of significant adverse impact on the geological and hydrological/ hydrogeological (including water quality) environments.

Table 7-3: Impact Assessment Process Steps

Step 1	Identification and Description of Potential Impact Source This section presents and describes the activity that brings about the potential impact or the potential source of pollution. The significance of effects is briefly described	
Step 2	Pathway / Mechanism	The route by which a potential source of impact can transfer or migrate to an identified receptor. In terms of this type of development, surface water and groundwater flows are the primary pathways, or for example, excavation or soil erosion are physical mechanisms by which potential impacts are generated.
Step 3	Receptor	A receptor is a part of the natural environment which could potentially be impacted upon, e.g. human health, plant / animal species, aquatic habitats, soils/geology, water resources, water sources. The potential impact can only arise as a result of a source and pathway being present.
Step 4	Pre-mitigation Impact	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impact before mitigation is put in place.
Step 5	Proposed Mitigation Measures	Control measures that will be put in place to prevent or reduce all identified significant adverse impacts. In relation to this type of development, these measures are generally provided in two types: (1) mitigation by avoidance, and (2) mitigation by (engineering) design.
Step 6	Post Mitigation Residual Impact	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impacts after mitigation is put in place.

Step 1	Identification and Description of Potential Impact Source This section presents and describes the activity that brings about the potential impact or the potential source of pollution. The significance of effects is briefly described	
Step 7	Significance of Effects	Describes the likely significant post-mitigation effects of the identified potential impact source on the receiving environment.

7.3 The Existing and Receiving Environment (Baseline Situation)

7.3.1 Site Description and Topography

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

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

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

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

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

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

7.3.2 Water Balance

Long term rainfall and evaporation data were sourced Met Éireann. The 30-year annual average rainfall recorded at Paulstown Castle rainfall station, located ~6km southeast of the site are presented in **Table 7-4**.

Table 7-4: Monthly Rainfall Averages (mm) 1981 - 2010

Station		X-Coord		Y-Coord		Ht (mOD)		Opened		Closed		
Paulstown Castle		266000		157300		52		1966		1994		
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
77.8	58.2	64.5	60.6	58.3	60.6	58.7	75.5	71.6	90.8	80.3	81.2	838.1

The closest synoptic station where the average potential evapotranspiration (PE) is recorded is at Kilkenny, approximately 17.5km southwest of the site. The long-term average PE for this station is 458.8mm/yr. This value is used as the best estimate of the site PE. Actual Evaporation (AE) at the site is estimated as 435.9mm/yr (which is 0.95 × PE).

The effective rainfall (ER) represents the water available for runoff and groundwater recharge. The ER for the site is calculated as follows:

Effective rainfall (ER) = AAR – AE

= 838 mm/yr – 436mm/yr

ER = 402mm/yr

According to the GSI (www.gsi.ie), groundwater recharge coefficient estimates at the site range from 15-22.5% across the vast majority of the site due to the presence of low permeability subsoils. A small area in the west of the site is estimated to have a recharge coefficient of 85%. A recharge coefficient of 20% is taken as an approximate value for the site due to the presence of low permeability till subsoils. Therefore, recharge and runoff rates at the site can be estimated to be 80mm/yr and 322mm/yr respectively.

7.3.3 Surface Water - Hydrology

7.3.3.1 Regional and Local Hydrology

The site is located in the Barrow River surface water catchment within Hydrometric Area 14 of the South Eastern River Basin District. This catchment includes the area drained by the River Barrow upstream of the River Nore confluence and all streams entering tidal water between the Barrow railway bridge at Great Island and Ringwood, Co. Kilkenny, draining a total area of 3,025km². The Barrow catchment comprises 20 sub-catchments.

On a more local scale, the site is located in the Barrow_110 sub-catchment (Barrow_SC_110) and the Old Leighlin Stream_020 river sub-basin. Further to the south, the southern section of the overall landholding is located in the Barrow_190 river sub-basin.

A regional hydrology map is attached as **Figure 7-1**.

Within the Old Leighlin Stream_020 river sub-basin, the Baunleath stream (EPA Code: 14B95) originates to the southeast of the site along the L3036. This stream flows to the east before veering northwards and discharging into the Old Leighlin stream (EPA Code: 14O02) (also known as the Madlin River) ~2km northeast of the site. The Old Leighlin stream then flows to the southeast, discharging into the Barrow River (EPA Code: 14B01) to the south of Leighlinbridge.

Site walkover surveys have also revealed the presence of a second drain and culvert which enters a small ditch and flows eastwards along a hedgerow north east of the norther corner of the proposed site. This drainage pathway crosses the L3036 via a culvert and flows to the east before discharging into the Bauleath stream. The locations of the water feature is shown on **Figure 7-2.**

Within the Barrow_190 river sub-basin, the Burgage stream (EPA Code: 14B96) flows eastwards to the south of the overall landholding and discharges into the Barrow River ~3.5km east of the site.

A local hydrology map is shown in **Figure 7-2**.

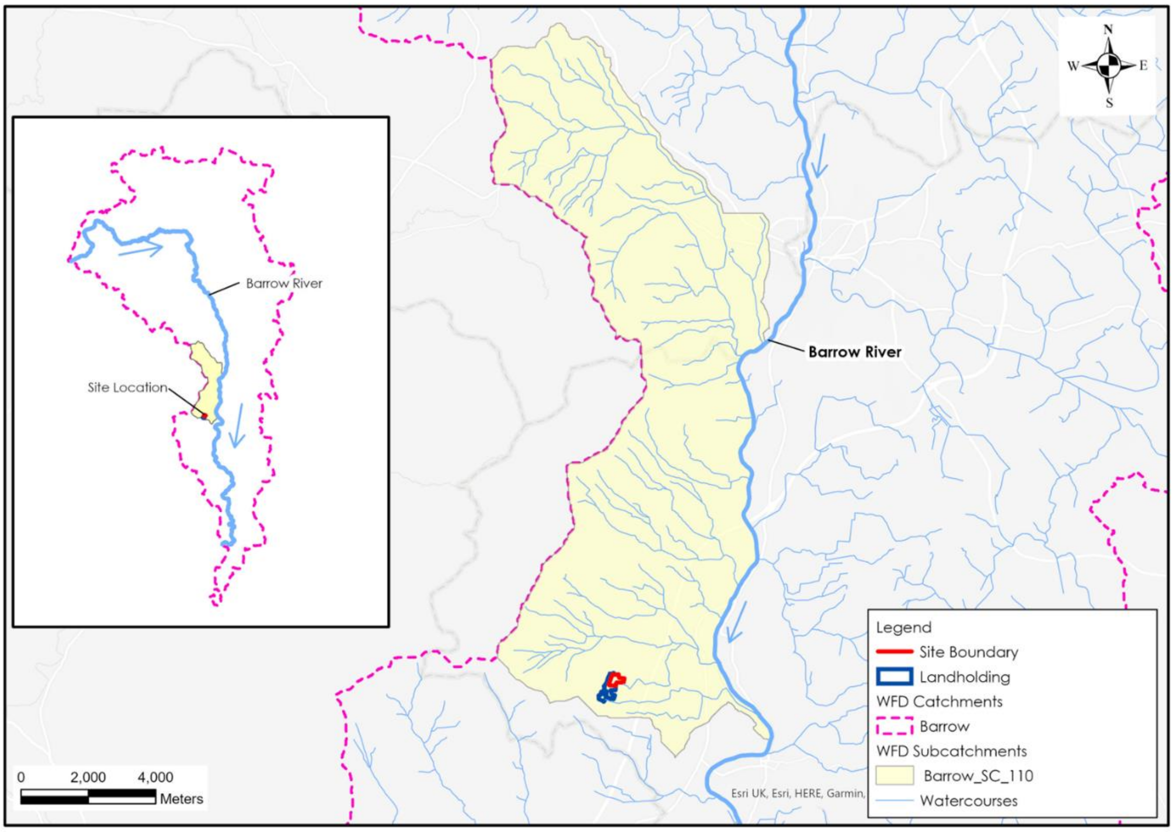

Figure 7-1: Regional Hydrology Map

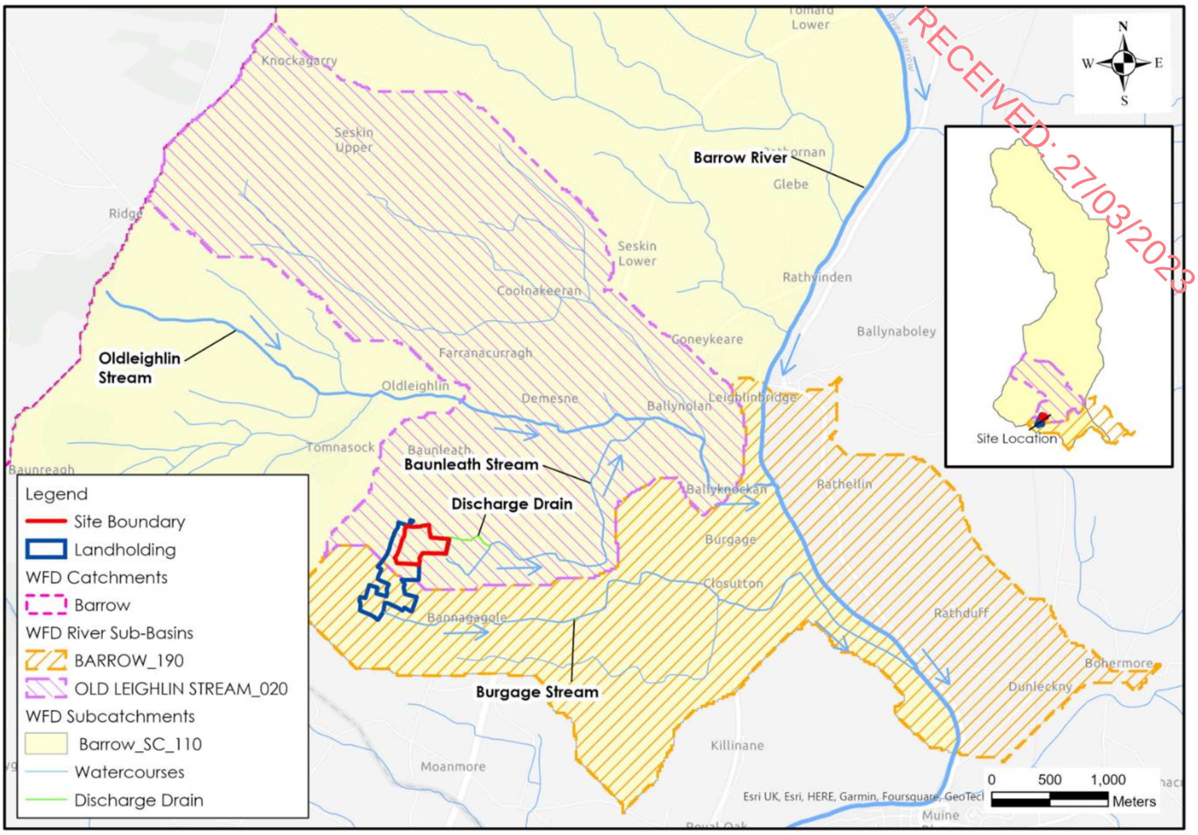

Figure 7-2: Local Hydrology Map

7.3.3.2 Surface Water Flows

As stated above, the site is located in the Old Leighlin Stream_020 river sub-basin with the EPA mapping the Baunleath stream to originate ~50m southeast of the site. This watercourse flows to the east before veering northwards ~1.4km east of the site and flowing to the north before discharging into the Old Leighlin Stream/Madlin River further downstream.

There is no continuous flow monitoring of the Madlin River is being carried out by the OPW or EPA. There are flow gauging stations on the River Barrow upstream of Leighlinbridge and downstream at Bagenalstown.

As part of work for the Water Framework Directive, the EPA has prepared an internet-based model for the calculation of ungauged catchments (www.catchments.ie). For the Madlin River catchment at Ballynockan, catchment area c. 12 km^2, the flow duration percentiles are shown in **Table 7-5**.

Table 7-5: Flows Estimated for the Madlin River at Ballynockan (www.catchments.ie)

Flows equalled or exceeded for the given percentage of time											
5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	
0.473	0.344	0.236	0.177	0.181	0.132	0.103	0.075	0.063	0.046	0.031	

The EPA flow estimation for ungauged catchments indicates that the 5%ile high flow in the Madlin River at Ballynockan is estimated to be 0.473m^3/sec, the 50%ile flow is estimated to be 0.132m^3/sec while the 95%ile flow is estimated to be 0.031m^3/sec.

7.3.3.3 Surface Water Quality

Biological Q-rating data for EPA monitoring points on the Old Leighlin Stream and the Barrow River downstream of the site are shown in **Table 7-6** below. The Q-Rating is a water quality rating system based on both the habitat and the invertebrate community assessment and is divided into status categories ranging from 0-1 (Poor) to 4-5 (Good/High).

The Old Leighlin Stream (Madlin River) achieved a Q-rating of 4-5, i.e. High status, to the east of Old Leighlin (Station Code: RS14O020500) and upstream of the site in the latest WFD monitoring round (2020). Meanwhile downstream of its confluence with the Baunleath stream, the Old Leighlin stream achieved a Q-rating of 3-4, *i.e.* Moderate status (Station Code: RS14O020500). Further downstream the Barrow River also achieved Moderate status at the Royal Oak Bridge to the west of Bagenalstown (Station Code: RS14B012900).

Table 7-6: Latest EPA Water Quality Monitoring Q-Rating Values (2020)

WFD SWB	Station ID	Easting	Northing	EPA Q-Rating (Status)
Old Leighlin Stream_020	RS14O020500	266301.37	165363.98	Q4-5 (High)
Old Leighlin Stream_020	RS14O020700	268740.26	164563.21	Q3-4 (Moderate)
Barrow_200	RS14B012900	268957	161462	Q3-4 (Good)

Surface samples were taken from the Baunleath stream (SW1) on 15th November 2022. The location of the SW sampling point is shown on Figure 7-2.

Results of analysis are show in Table 7-7 alongside relevant Environmental Quality Standards (EQS) values for surface water. Laboratory reports are presented in Appendix E.

Table 7-7: Madlin River Surface Water Quality (15/11/2022)

Parameters	EQS	SW1
Total Suspended Solids (mg/L)	25$^{(+)}$	<5
Turbidity		0.63
Ammonia (mg/L)	Good Status: ≤0.065 High Status ≤ 0.04$^{(*)}$	<0.02
Nitrite NO2 (mg/L)	-	<0.05
Ortho-Phosphate – P (mg/L)	Good Status ≤ 0.035 to High Status: ≤0.025$^{(*)}$	0.03
Nitrate - NO3 (mg/L)	-	21.0

Parameters	EQS	SW1
Phosphorus (mg/L)	-	<0.1
Chloride (mg/L)	-	15.8
BOD	Good Status: ≤ 1.5 High Status: ≤ 1.3(*)	<1
TPH	0	<0.08

Total suspended solids were <5mg/L at SW1 which is well below the standard threshold of 25mg/L as set out in S.I. 293 of 1988. Meanwhile turbidity was recorded as 0.63NTU.

Results for ammonia, nitrite and phosphorus were below the detection limit of the laboratory. Ammonia was reported to be below the High Status threshold (≤0.04mg/L) with respect S.I. 272 of 2009.

Nitrate was reported to be 21mg/L while chloride was reported to be 15.8mg/L on 15th November 2022. Ortho-phosphate was reported to be 0.03mg/L which exceeds the High Status threshold of ≤0.025mg/L but is below the Good status threshold of ≤0.035mg/L.

Biological Oxygen Demand (BOD) was reported as <1mg/L in both samples which is below the High Status threshold of ≤1.3mg/L.

7.3.3.4 Flood Risk Assessment

A flood risk assessment for the Proposed Development is attached in Appendix F.

OPW's River Flood Extents Mapping, National Indicative Fluvial Mapping, Past Flood Event mapping (https://www.floodinfo.ie/map/floodmaps/) and historical mapping (i.e. 6" & 25" base maps) were consulted.

There is no text on local available historical 6" or 25" mapping for the proposed extraction area that identify areas that are "prone to flooding" within the site boundary, or immediately downstream.

OPW's Past Flood Event Mapping (**Figure 7-3**) was consulted to identify those areas as being at risk of flooding. There were no reports of historic or recurring flooding incidents within the site or in the immediate vicinity of the site. The closest mapped recurring flood incident is located at the village of Old Leighlin, ~1.2km north of the site. Here the Johnsduffswood road is noted to be periodically impassable however the OPW do not state the source of the flooding. Several historic and recurring flood events are also mapped to the east of the site along the River Barrow at Leighlinbridge (upstream of the site) and downstream of the site at Bagenalstown.

OPW's River Flood Extents Mapping has not been completed in the area of the Proposed Development. However, River Flood Extents mapping has been completed at Leighlinbridge and fluvial flood zones have been mapped along the Madlin River. The closest mapped fluvial flood zones on the Madlin River are located ~2km northeast of the site. The modelled fluvial flood levels at this location range from 47.05mOD for the 10-year flood event (high probability) to 48mOD for the 1,000 fluvial flood event (low probability).

The National Indicative fluvial flood maps show modelled flood zones for catchments greater than 5km^2 for which flood maps were not produced under the National CFRAM Programme.

For the Present Day Scenario, widespread medium (1 in 100-year event) and low probability (1 in 1,000-year event) flood zones occur ~1km northeast of the site with extensive flooding along the Madlin River and some flooding also mapped along the Baunleath stream. However, no fluvial flood zones encroach upon the site.

Furthermore, the GSI Winter 2015/2016 Surface Water Flood Map does not record any surface water flooding along the Madlin or Baunleath watercourses. The closest mapped surface water flood zones for this flood event are mapped along the Barrow River.

In terms of the potential effects of climate change on fluvial flooding in the local area, National Indicative Fluvial Flood Mapping has been produced for the Mid-Range and High-End Future Scenarios. The Mid-Range and the High-End Future Scenarios have been generated using an increase in rainfall of 20% and 30% respectively. These modelled future flood scenarios do not differ greatly from the Present Day Scenario and no fluvial flood zones are located within 1km of the site.

Overall the site is located on elevated ground, to the east of the Castlecomer Plateau and at the headwaters of the Baunleath stream, therefore no fluvial flooding risk would be expected at this site.

In terms of groundwater flooding, the GSI's Maximum Historic Groundwater Flood Map (www.gsi.ie) shows groundwater flooding in Old Leighlin Quarry to the north of the site. This quarry is operating below the groundwater table and the quarry void fills with groundwater when pumps are turned off. No modelled high, medium, or low probability groundwater flood zones are mapped in the site or in the surrounding lands.

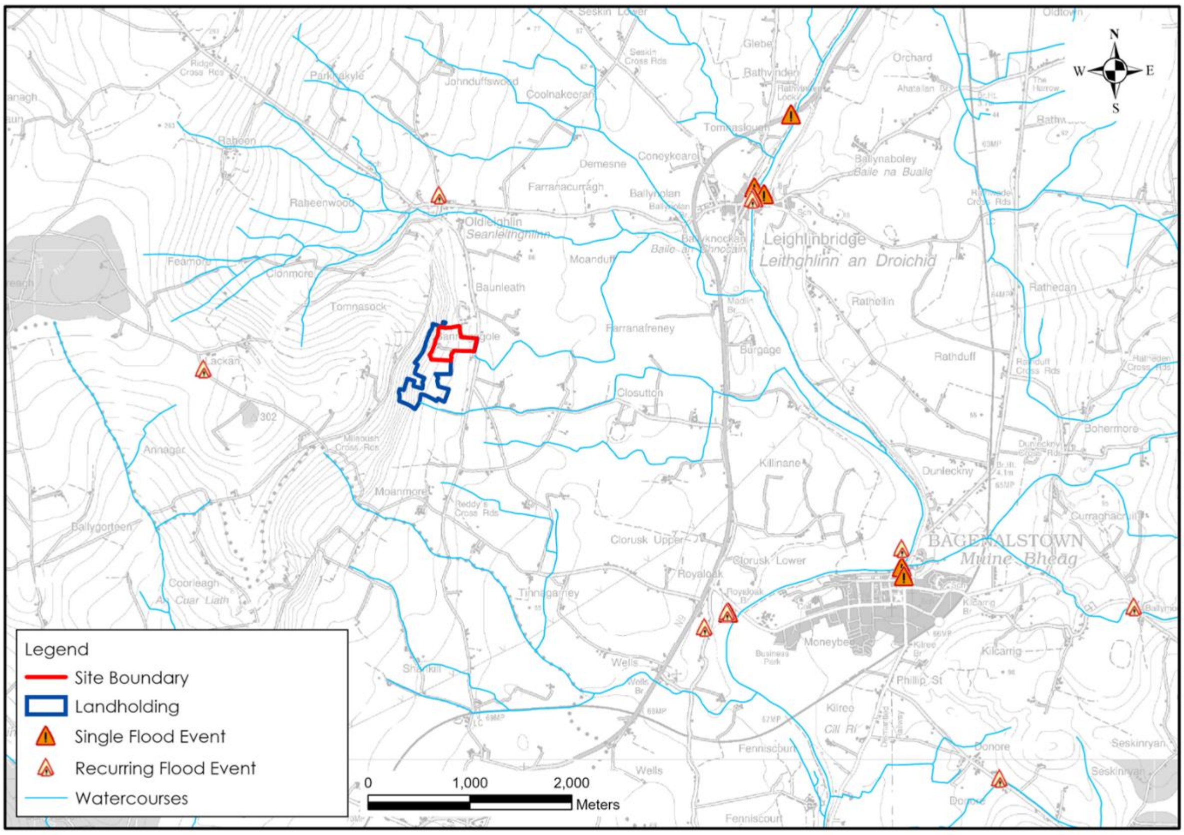

Figure 7-3: OPW Past Flood Events (www.floodinfo.ie)

7.3.3.5 Water Framework Directive

The River Basin Management Plan was adopted in 2018 and has amalgamated all previous river basin districts into one national river basin management district. The River Basin Management Plan (2018 – 2021) objectives include the following:

- Ensure full compliance with EU legislation;
- Prevent deterioration and maintain a 'high' status where it already exists;
- Protect, enhance and restore all waters with aim to achieve at least 'good' status by 2021;
- Ensure waters in protected areas meet requirements; and,
- Implement targeted actions and pilot schemes in focused sub-catchments aimed at (1) targeting water bodies close to meeting their objectives and (2) addressing more complex issues that will build knowledge for the third cycle.

Our understanding of these objectives is that surface waters, regardless of whether they have 'poor' or 'high' status, should be treated the same in terms of the level of protection and mitigation measures employed i.e. there should be no negative change in the status at all.

A WFD Compliance Report for the Proposed Development is attached in Appendix G.

7.3.3.6 Surface Water Body Status

A summary of the WFD status and risk result for Surface Water Bodies (SWBs) immediately downstream of the site is shown in

Table 7-8.

In the vicinity of the site, the Old Leighlin_020 SWB achieved 'Moderate' status in the latest WFD cycle (2016-2021) and was deemed to be 'at risk' of failing to meet its WFD objectives. Meanwhile, further downstream the Barrow_190 and the Barrow_200 SWBs also achieved 'Moderate' status. The risk status of the Barrow_190 SWB is under review while the Barrow_200 SWB is 'not at risk' of failing to meet its WFD objectives.

The 3rd Cycle Draft Barrow Catchment Report states that excess nutrients and morphological issues are the most prevalent issues in the Barrow Catchment. In the vicinity of the site, agriculture has been listed as a significant pressure on the Old Leighlin_020 SWB. No significant pressures have been identified for the Barrow_190 and Barrow_200 SWBs.

The Draft Catchment Report states that the issues relating to farming include diffuse phosphorous loss to surface water from direct discharges (e.g. runoff from roads) or runoff from poorly drained soils. High PIP (pollution impact potential) for surface water nitrates was noted in arable and pasture lands while sediment is also a problem from land drainage works and bank erosion.

Table 7-8: Summary WFD Information for SWBs

SWB	2010-2015 Overall Status	2013-2018 Overall Status	2013-2018 Risk Status	2016-2021 Overall Status	Pressures
Old Leighlin Stream_020	Moderate	Moderate	At risk	Moderate	Agriculture
Barrow_190	Unassigned	Unassigned	Under Review	Moderate	-

SWB	2010-2015 Overall Status	2013-2018 Overall Status	2013-2018 Risk Status	2016-2021 Overall Status	Pressures
Barrow_200	Good	Good	Not at risk	Moderate	-

7.3.3.7 Surface Water Abstractions

There are no recorded surface water abstractions from the Madlin River in the vicinity of the site as indicated by the EPA (www.epa.ie). Furthermore there are no surface water abstractions along the Barrow River downstream of the site. The closest abstractions within the Barrow Catchment are located on the Burren River at Carlow town, upstream of the site, and on the Mountain River, a tributary of the River Barrow, downstream of the site at Borris. There are no hydrological connections between the site and these waterbodies.

There is no Urban Waste Water Treatment Plant (UWWTP) at Old Leighlin or Leighlinbridge. However, there is a UWWTP at Bagenalstown, approximately 5.5km downstream of Leighlinbridge, and treated effluent from that plant discharges to the River Barrow.

7.3.4 Groundwater – Hydrogeology

7.3.4.1 Regional Bedrock Aquifer

The site is underlain by Dinantian Pure Bedded Limestones of the Clongrenan and Ballyadams Formations. These are classified by the GSI as being a Regionally Important Aquifer – Karstified (diffuse) (www.gsi.ie).

Dinantian Pure Bedded Limestones are also mapped to the north, south, and east of the site. Namurian Shales of the Killeshin Siltstone Formation and the Luggacurren Shale Formation are mapped to the west of the site and underlie the southwest of the overall landholding. These bedrock geology formations are classified by the GSI as being Poor Aquifers -Bedrock which is Generally Unproductive except for Local Zones (Pl) and Bedrock which is Generally Unproductive (Pu) respectively (www.gsi.ie).

A local bedrock aquifer map is shown in Figure 7-4.

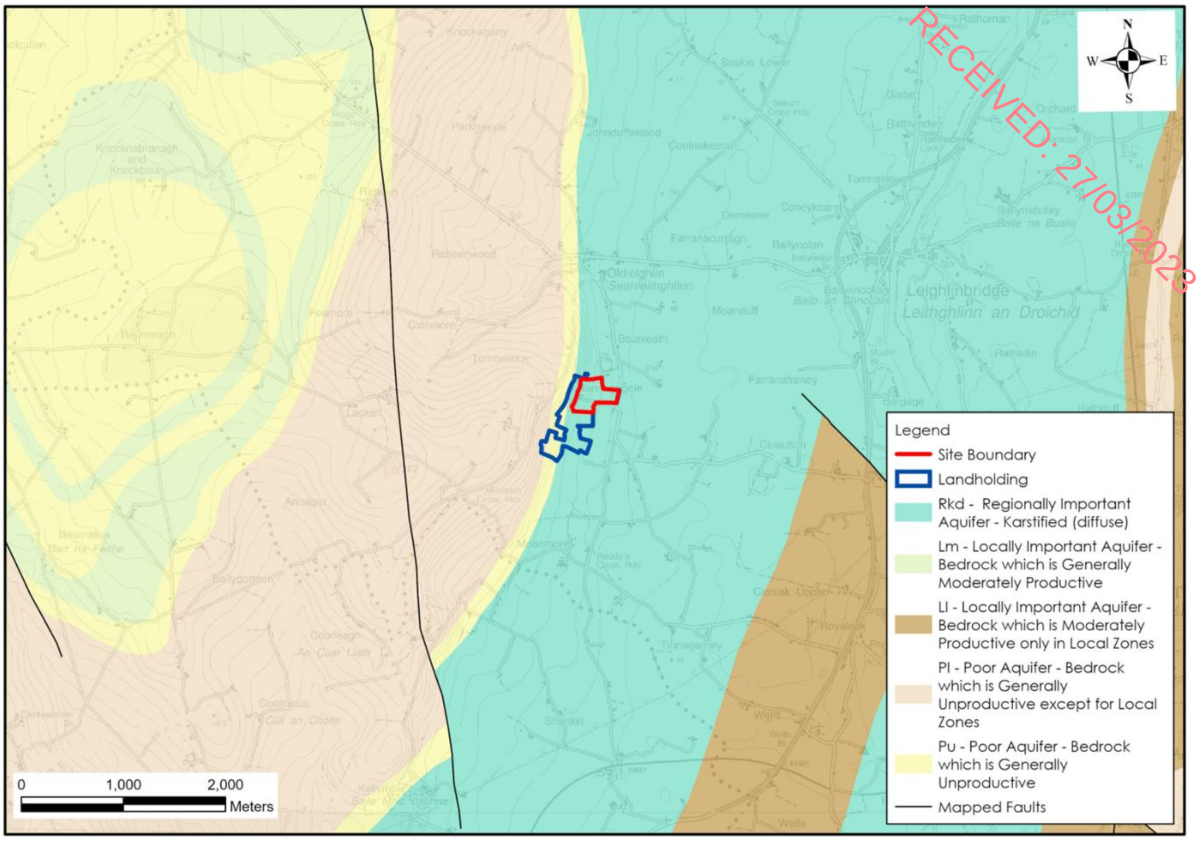

Figure 7-4: Local Bedrock Aquifer Map

7.3.4.2 Groundwater Body

The majority of the site is underlain by the Bagenalstown Lower Groundwater Body (GWB) which is characterised by a karstic flow regime. This GWB includes a Regionally Important Karstified Aquifer which is considered a major aquifer comprising of water-bearing units of pure limestone and dolomitised limestone. The dolomitisation of the aquifer has resulted in the development of fissures through the dissolution of bedding planes and joints. The transmissivity of the dolomites can range from 20-200m^2/day with lower transmissivities occurring on the slopes of the Castlecomer Plateau. Main recharge occurs along the slopes of the Castlecomer Plateau due to a thin subsoil covering. Sands and gravels overlie a significant portion of the GWB and are themselves discrete GWBs. Discharge from the aquifer occurs where the aquifers come into contact with the Barrow River (GSI, 2004).

Daly and Wrights (1979) divided the Barrow Valley into 3 no. areas.

1. A recharge zone along the slopes of the Castlecomer Plateaus where the water table is 15-30mbgl and there is an annual fluctuation of 10-20m.
2. An intermediate area where the aquifer is covered by extensive till deposits and the water table is 5-15mbgl with an annual fluctuation of 5-15m. (Note: this description is representative of the proposed site).
3. A discharge zone where the aquifer comes into contact with the Barrow River either directly or indirectly through overlying sand and gravel deposits. Here the water table is shallow and controlled by the level of the river (GSI, 2004).

Meanwhile, a small area in the southwest of the site is underlain by the Shanragh GWB which is characterised by poorly productive bedrock. This GWB consists of the Westphalian Shales of the Castlecomer Plateau and is not considered to be an important aquifer. Recharge will be in the elevated areas of the plateau, with groundwater flowing in the shallow weathered bedrock. Groundwater flow will follow surface topography and will discharge into the Barrow Valley (GSI, 2004).

7.3.4.3 Groundwater Vulnerability

Where rock is close (<3m) to the surface, i.e. with a thin subsoil cover, then the bedrock aquifer vulnerability is classified as Extreme. Where karstified bedrock is exposed at the surface with no subsoil cover then the highest vulnerability rating Extreme (X) is assigned by the GSI.

Groundwater vulnerability maps published on the GSI website (www.gsi.ie) indicate that the bedrock aquifer vulnerability decreases from west to east across the site. Extreme (X) vulnerability is mapped in the west of the site where rock is near the surface. Meanwhile high and moderate vulnerabilities are mapped in the east of the site. Furthermore, Extreme (X) vulnerability is mapped in the existing quarry void to the north of the site associated with Old Leighlin Quarry.

However, based on site-specific data, groundwater vulnerability is likely to be lowest in the south and west of the site where the subsoils are thickest (recorded as 12.3m and 15.7m in BH5 and BH1 respectively) and provide the greatest protection to the underlying bedrock aquifer. Meanwhile, groundwater vulnerability will be higher in the northeast of the site, where bedrock is close to the surface (4.1m and 4.3m in BH3 and BH4 respectively).

7.3.4.4 Groundwater Recharge

Based on GSI mapping, groundwater recharge at the site ranges from 15 to 85% (www.gsi.ie). The greatest recharge (~85%) occurs on the elevated ground in the west of the site where bedrock is close to the ground surface. Recharge rates are mapped by the GSI to decrease further to the east.

However, based on site-specific data, groundwater recharge is likely to be greatest in the east of the site where subsoils are thinner and lowest in the west where thick deposits of low permeability subsoils have been encountered (BH1 and BH5).

7.3.4.5 Local Groundwater Levels

Drilling works at the site were completed using a rotary coring method. No significant water strikes were noted during any of the drilling, and water level recovery in monitoring wells following drilling was slow, suggesting the underlying bedrock has a low to moderate permeability.

Groundwater monitoring has been completed in the 5 no. groundwater monitoring wells drilled by IDL in August 2022. The location of the groundwater monitoring wells are shown in **Figure 7-5**.

The monitoring wells have been manually dipped on 6 no occasions between 15th August 2022 and 19th December 2022. During the monitoring period, groundwater elevations ranged from 73.51mOD to 86.06mOD (5.98 – 23.93mbgl). The variation of the elevation of the local groundwater table is a function of surface topography with the greatest groundwater elevations recorded in the west of the site (BH1). A plot of the groundwater levels during the monitoring period is shown as **Figure 7-6**.

Continuous groundwater levels were also recorded using Diver dataloggers at 2-hour intervals in 2 no. boreholes (BH3 and BH5) (refer to **Figure 7-7**).

As seen in **Figure 7-6**, groundwater levels in the vicinity of the Proposed Development site are significantly greater than the proposed final floor level of the quarry void (~56.5mOD). Therefore an assessment of potential groundwater inflows is required and this is addressed in Section 7.5.2.

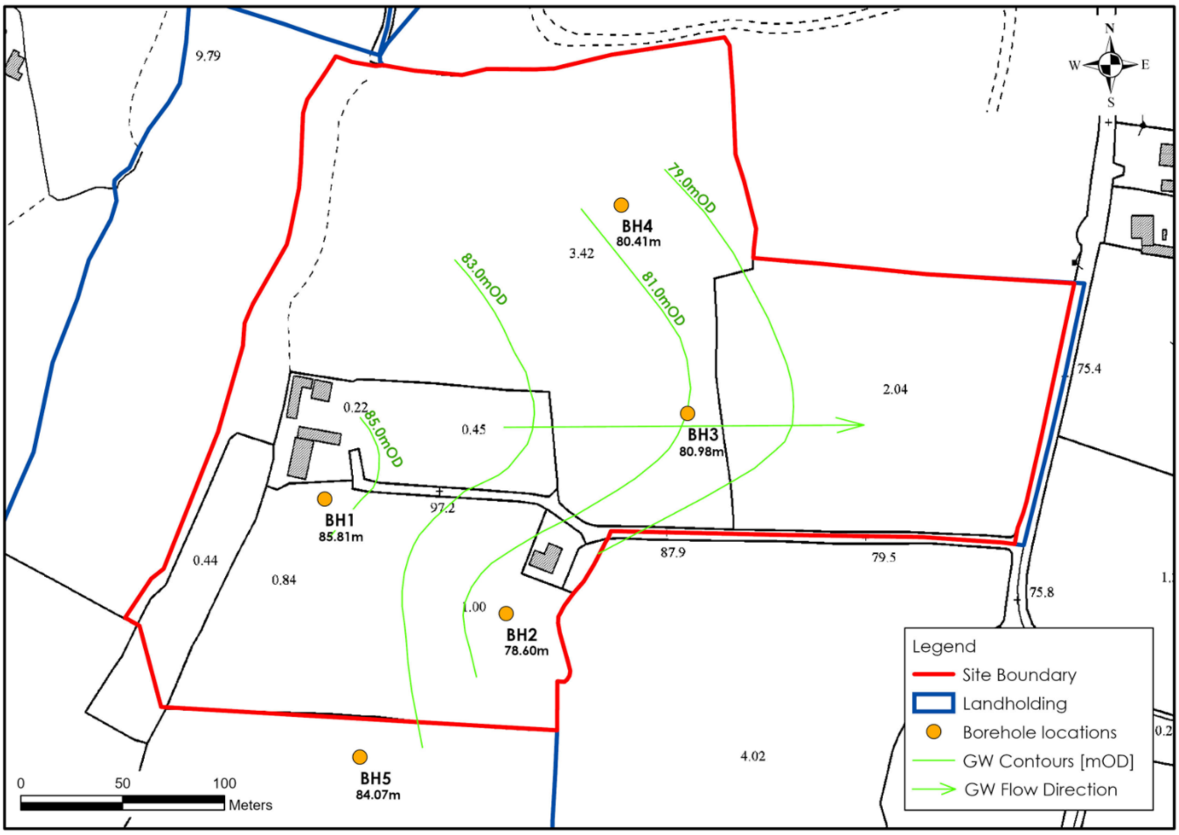

Figure 7-5: Groundwater Monitoring Wells

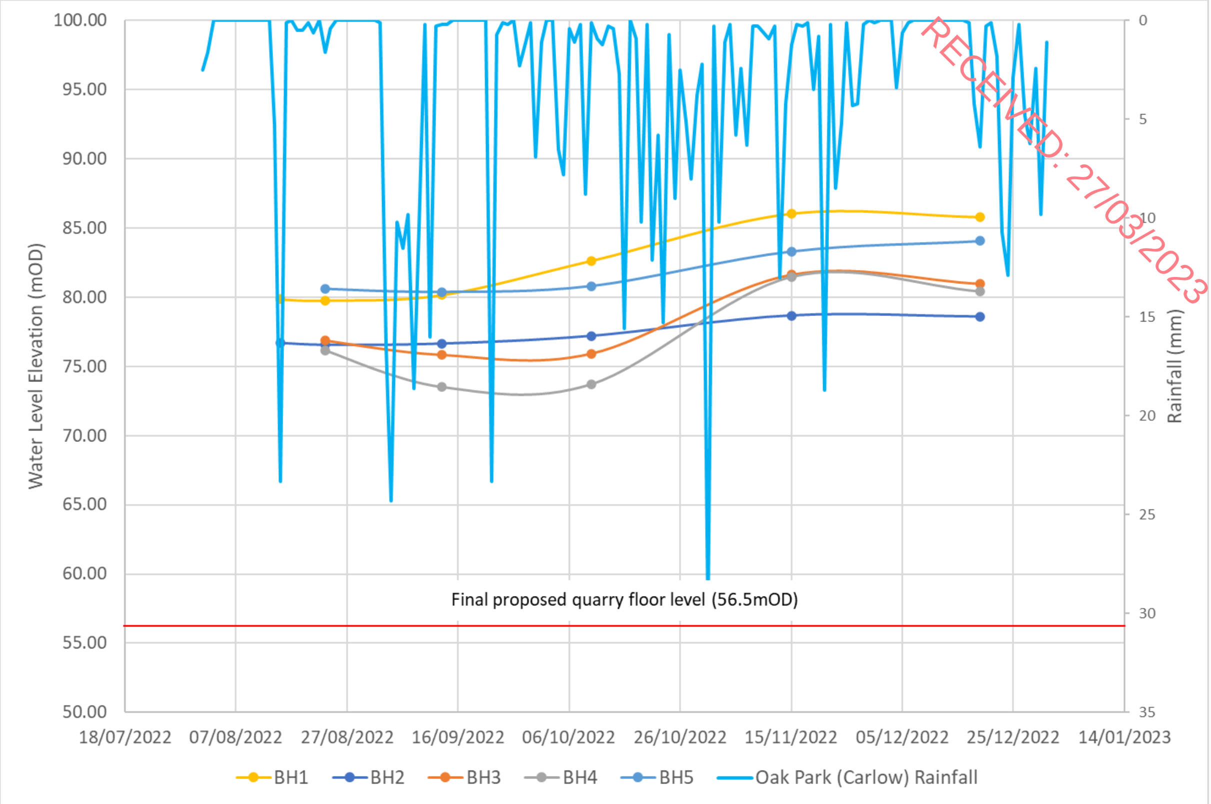

Figure 7-6: Manually Dipped Groundwater Levels

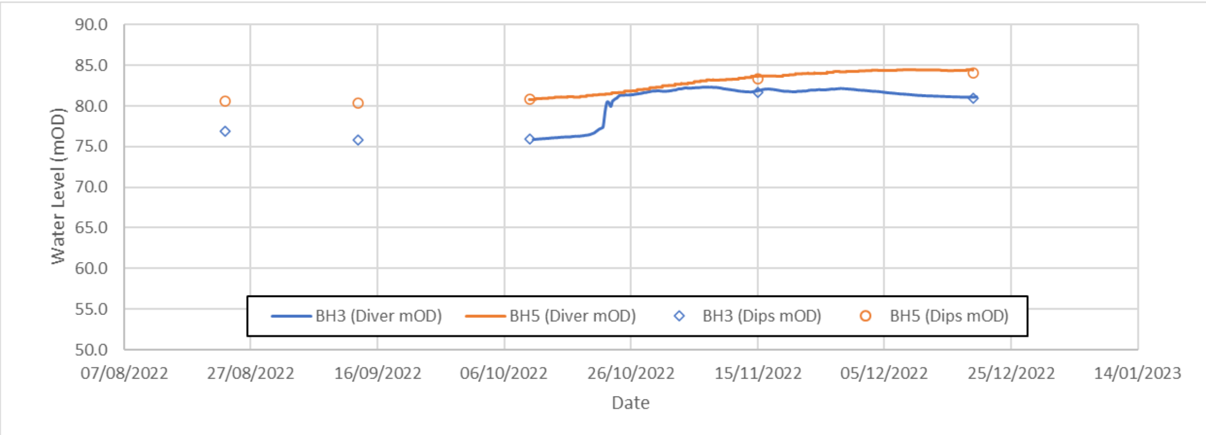

Figure 7-7: Continuous Groundwater Levels (BH3 and BH5)

Furthermore, the existing Old Leighlin Quarry to the north of the site has intersected the groundwater table and some groundwater has been discharged from this quarry in order to facilitate extraction activities. However, it has been noted that there is little groundwater inflow to this quarry due to the absence of any significant solutionally enlarged joints and cavities at depth. Any minor groundwater inflows to the quarry void come from the uppermost part of the quarry where the solutionally enlarged features occur (SLR, 2017).

As part of the planning application submitted for an extension and deepening of Old Leighlin Quarry, groundwater levels were measured at 2 no. wells in the vicinity of the quarry: the site supply well located in the south-eastern corner of the Old Leighlin Quarry site which stands at an elevation of ~70mOD and at a house well (~70.4mOD) located ~17km northeast of Old Leighlin Quarry. The recorded groundwater levels indicate that groundwater is in the upper weathered bedrock and that the quarry void at Old Leighlin is having little impact on groundwater levels in the 2 no. wells.

7.3.4.6 Groundwater Hydrochemistry

Groundwater sampling has not been completed.

The bedrock strata of the Bagenalstown Lower GWB are calcareous while the bedrock strata of the Shanragh GWB are siliceous (GSI, 2004).

7.3.4.7 Karst Features

Karst features are mapped by the GSI and are available through the GSI online viewer (www.gsi.ie).

The GSI do not map the presence of any karst features with the site, within the overall landholding or in the surrounding lands.

There are a large number of karst features mapped to the south and southwest of the site. The closest features are ~3.9km south of the site and include 2 no. springs in the townland of Kellymount, Co. Kilkenny.

A total of 213m of overburden and bedrock were logged following the drilling of the 5 no. boreholes at the site. Within this, 164m of dolomite and limestone were logged with only 1 no. potential karst feature being recorded. This feature was recorded in BH2 at a depth of 18.5m and was described as laminated clay which has been interpreted as a probably palaeokarst infill of a cavity within the bedrock. No other karst features were identified during the site investigation works, suggesting that the bedrock in the area of the site has not been subject to widespread karstification.

7.3.4.8 Groundwater Body Status

A summary of the WFD status and risk result for Ground Water Bodies (SWBs) in in the vicinity of the site is shown in **Table 7-9**.

The majority of the site is underlain by the Bagenalstown Lower GWB with a small area underlain by the Shanragh GWB. These GWBs achieved ‘Good’ status in all 3 no. WFD cycles (2010-2015, 2013-2018 and 2016-2021) and their risk status is currently under review. No significant pressures have been identified to be impacting on these GWBs.

Table 7-9: Summary WFD Information for GWBs

SWB	2010-2015 Overall Status	2013-2018 Overall Status	2013-2018 Risk Status	2016-2021 Overall Status	Pressures
Bagenalstown Lower	Good	Good	Under Review	Good	-
Shanragh	Good	Good	Under Review	Good	-

7.3.4.9 Groundwater Resources

There are no Group Water Schemes (GWS) or Public Water Supply Schemes) located in the area of the site. The closest Public Supply Source Protection Area is the Paulstown PWS. The Outer Source Protection area for this PWS is located ~1.8km west and upgradient of the site. The closest GWS is the Castlewarren GWS which is located ~2.5km northwest and upgradient of the site.

A search of private well locations (wells with location accuracy of 1–100m were only sought) was undertaken using the GSI well database (www.gsi.ie). The GSI national well database (www.gsi.ie) does not record any private wells in the immediate vicinity of the site.

Several wells are north-northwest of the site at Oldleighlin, centred at approximately 0.9km from the site. These wells generally have a poor to moderate yield class. An abstraction borehole is located to the north-northwest of the site at Oldleighlin, centred at approximately 0.9km from the site. This is a public supply owned by Carlow County Council and has a poor yield.

To the northeast of the site at Ballynolan, a public supply abstraction borehole is centred approximately 1km from the site. The abstraction at Old Leighlin is for a local Group Water Supply (GWS) scheme.

A groundwater abstraction is also located at Ballynolan, approximately 2.5km to the northeast of the site. The EPA has issued a source report for the abstraction – Ballynolan PWS Source Report (EPA, 2011). The abstraction is from two boreholes that supply the Leighlinbridge public water supply, and that scheme has c.330 connections on the mains supply. 1 no. borehole, referred to as Leighlinbridge WS (BH1) is a 60m deep borehole situated in Dinantian Pure Bedded Limestones. The scheme which comprises of 2 no. boreholes has a yield of c. 480m^3/day. The two boreholes are used alternately on a weekly basis. The groundwater is treated prior to use at a small water treatment works. The source protection report indicates that the zone of contribution extends in a westerly direction from the wells to Oldleighlin Village (EPA, 2011).

Several wells and boreholes are also mapped to the south of the site in the townland of Moanmore. These wells have a poor yield.

A supply well is also located in the south-eastern corner of the Old Leighlin Quarry site (please note that this well is not mapped on the GSI database), immediately north of the proposed site and it stands at ~70mOD.

To overcome the poor accuracy problem of other GSI mapped wells (>50m accuracy) it is conservatively assumed (for the purpose of assessment only) that every private dwelling in the area has a well supply and this impact assessment approach is described further below. (Please note wells may or may not exist at each property, but our conservative rationale here is that it is better to assume a well may exist at each downgradient property and assess the potential impacts from the Proposed Development on such assumed wells, rather than make rather than make no assessment and find out later that groundwater wells do actually exist).

7.3.5 Designated Sites

Within the Republic of Ireland designated sites include Natural Heritage Areas (NHAs), Proposed Natural Heritage Areas (pNHAs), candidate Special Areas of Conservation (SAC) and Special Protection Areas (SPAs). Designated sites within the same surface water catchments as the site are listed below.

The Madlin River downstream of the site has been designated as part of the River Barrow and River Nore SAC (Site Code: 002162). This designated site consists of the freshwater stretches of the Barrow and Note River catchments upstream as far as the Slieve Bloom Mountains. The site is a SAC due to the presence of several habitats and species which are listed on Annex I/II of the E.U. Habitats Directive.

Whitehall quarries pNHA (Site Code: 000858) is located ~2.2km southwest of the site.

Other designated sites within 10km of the site are listed in **Table 7-10**. A map of designated sites is shown as **Figure 7-8**.

Table 7-10: Designated Sites

Site Name	Site Code	Distance from Site	Hydrological / Hydrogeological Connection
River Barrow and River Nore SAC	002162	~1km north of the site	The site is hydrologically connected with this SAC via the Baunleath stream which flows from the site and discharges into the Madlin River.
Whitehall Quarries pNHA	000858	~2.2km to the southwest	None. Surface and groundwater flows at the site follow surface topography and flow to the northeast towards the Madlin River. Furthermore the Moanmore stream acts as a hydrological barrier between the site and this pNHA.
Coan Bogs NHA	002382	~9.1 to the northwest	None. NHA is located in Nore River catchment and is underlain by the Castlecomer GWB.
Cloghristrick Wood pNHA	000806	6km to the northeast	None. pNHA is located on the eastern banks of the Barrow River, upstream of the site.
Ballymoon Esker pNHA	000797	~5.8km to the southeast	None. River Barrow acts as a hydrological buffer between the site and this pNHA.

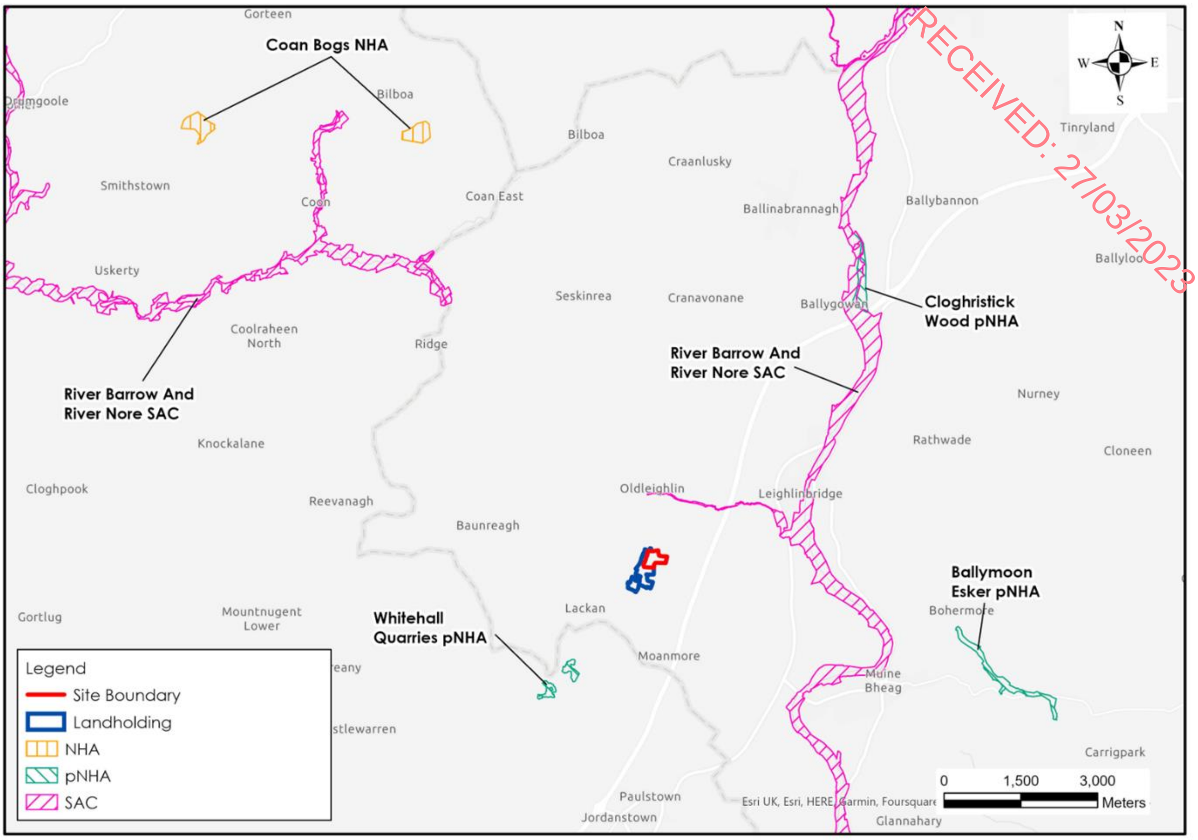

Figure 7-8: Designated Sites

7.3.6 Receptor Sensitivity

Based on the criteria set out in **Table 7-2**, the Regionally Important Karstified Aquifer which underlies the site can be classed as being of Very High Importance. The primary risks to groundwater would be from hydrocarbon spillage and leakages from plant serving and facilitating the construction and operational activities as well as the potential reduction in local groundwater levels as extraction progresses.

Local downstream surface waters including the Madlin River and the River Barrow can be considered as being of Very High Importance due to their designation as part of the River Barrow and River Nore SAC. The Madlin River also achieves a "High" Q-rating values (Quality Class A). The primary potential for surface water contamination is via elevated concentrations of suspended solids and potential oil/fuel leaks and spills from plant and machinery making their way into local surface watercourses.

All potential contamination sources are to be carefully managed at the site during the extraction phase of the development and mitigation measures are proposed to deal with these potential impacts.

7.4 Characteristics of the Proposed Development

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

Extraction will be preceded by site preparation which will involve stripping soils and subsoils from the proposed extraction area. The volume of overburden to be removed is estimated to be ~120,000m^3. The stripped overburden will be utilised in the construction of berms surrounding the extraction area while it is proposed to store the remainder in a soil storage area (~3.1ha) which will have an average fill depth of ~4m.

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

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

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

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

Drainage controls within the Proposed Development will include the following:

- A series of land drains are proposed below the soil storage area, and these drain to an open drain on the eastern edge of the soil storage area. Any drainage water and runoff arising from this area will be directed into the quarry void and managed via the quarry water management system.
- The setdown area will have a hardcore surface. Part of the setdown area also drains into the quarry void. The southern half of the setdown has bounding collection drains, and these will be filled with drainage stone (i.e. french drains), and any excess surface water arising from these French drains will discharge to ground via a proposed soakaway.
- Within the quarry void surface water and groundwater will be collected and pumped from temporary sumps to the main settlement pond. Water within the settlement pond will drain via gravity and flow through a hydrocarbon interceptor and then discharge to a drain at the northeastern corner of the proposed site. The drain flows via a culvert under the L3036 towards the Baunleath Stream which in turn flows into the Madlin

River further downstream. A discharge licence will be required for this proposed discharge.

- Drainage water from the main site access road will be collected in a roadside filter drain. Excess water from the filter drain will flow through a hydrocarbon interceptor and recharge to groundwater in a soakaway at the southeast of the site.
- Aco drains are proposed across the site entrance. The Aco drain closest to the entrance gate will drain into the filter drain/hydrocarbon interceptor/soakaway arrangement outlined in the previous paragraph. The second Aco drain prevents runoff from the site entrance area onto the public road. This Aco drain direct water to the south into a french drain/linear soakaway located inside the site boundary.
- Wastewater/greywater arising at the welfare units (during the construction and operational phases) will be collected and stored in a sealed tank, and this tank will be emptied by vacuum tanker and the contents transferred to a suitably licenced wastewater facility for treatment and disposal.

The Proposed Development will require discharge of surface water and a small amount of groundwater as the proposed quarry void intersects the local groundwater table. Similar to the existing quarry (to the north), there is likely to be little groundwater inflows to the quarry except for water entering from the upper weathered bedrock. Excess water can be stored in the quarry floor, so discharge can be limited/attenuated to ensure no impacts on downstream receiving waters.

Using an effective annual rainfall of 402mm/yr (refer to Section 7.3.2), for the proposed quarry void of 2.44Ha, then an average daily pumping requirement from the quarry can be determined, i.e. 26.87 m^3/day. If you include likely inflows from the soil storage area (which are directed to the quarry floor), and a nominal conservative groundwater inflow of ~50m^3/day, then we estimate the average water management requirements from the quarry will be ~76.87m^3/day.

7.5 Potential Impact of the Proposed Development

7.5.1 Construction Phase

In the context of the Proposed Development the construction stage is taken to be the preparation of the proposed extraction area of 2.44ha. As the proposed extraction area is currently a greenfield site, the Proposed Development will involve vegetation removal and soil/subsoil stripping. It is calculated that 120,000m^3 of overburden will require removal. This material will be used in the construction of berms surrounding the extraction area, with excess material stored in a soil storage area. This phase of the development will be completed using earth moving machinery (i.e. excavators and dump trucks).

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

7.5.1.1 Potential Impacts on Groundwater Vulnerability

The Proposed Development will involve the removal of soil/subsoil from 2.44ha of agricultural and forestry land. This will increase the groundwater vulnerability of the underlying Regionally Important Karstified Aquifer which is currently regarded as being of Very High Importance.

The GSI currently map the vulnerability of the bedrock aquifer to decrease from west to east across the site. Extreme (X) vulnerability is mapped in the west of the site where rock is near the surface. High and moderate vulnerabilities are mapped in the east of the site where the bedrock aquifer is covered by increasing thicknesses of glacial till.

The removal of 120,000m^3 of overburden will remove the protective till layer which currently protects the underlying aquifer. Therefore, the groundwater vulnerability at the proposed extraction area will increase to Extreme (X) across the whole extraction area.

The pre-mitigation potential impact on groundwater vulnerability during the construction stage will be a direct, negative, slight, likely and permanent impact.

7.5.1.2 Surface and Groundwater Contamination from Oil/Fuel Spills and Leaks

Removal of vegetation, soil/subsoil stripping and the construction of the site entrance, access roads, and compound area will be completed using machinery. Such machinery are powered by diesel engines and operate using hydraulics. Unless carefully managed such plant and machinery have the potential to leak hydraulic oils or cause fuel leaks. The accidental release of these compounds into the environment have the potential to negatively impact the groundwater quality in the underlying bedrock aquifer and the downstream surface watercourse which are linked to the proposed extraction area via groundwater flowpaths.

As part of the Proposed Development it is proposed to intermittently discharge surface water to a roadside drain located immediately to the east of the Proposed Development site. This drain discharges into the Baunleath Stream which in turn discharges into the Madlin River further downstream. Accidental release of hydrocarbons or oils into the local surface water environment will have a negative impact on downstream surface water quality and associated aquatic habitats and ecosystems.

Wastewater/greywater arising at the welfare units (during the construction phase) will be collected and stored in a sealed tank, and this tank will be emptied by vacuum tanker and the contents transferred to a suitably licenced wastewater facility for treatment and disposal. As such, there will be no potential effects on surface water or groundwater quality arising from wastewater generation at the site.

The pre-mitigation potential impact on surface and groundwater quality will be a negative, slight, indirect, unlikely, long-term impact on surface and groundwater quality.

7.5.1.3 Earthworks Resulting in Suspended Solids Entrainment in Surface Waters

There is the potential for the generation of suspended sediment in surface water runoff during the construction phase. Earthworks, the removal of vegetation and the stripping of soil/subsoil and the stockpiling of such material (berms surrounding the proposed extraction area, with all excess soil to be stored in the proposed soil storage area) which will be a potential source of sediment laden water. All excess surface water within the site will be directed to temporary settlement pond within the quarry void. The retention time within the settlement pond will be at least 24hrs and this will allow enough time to remove fine silts. After settlement, water will be directed to a roadside drain which in turn discharges into the Baunleath Stream. Construction phase activities can result in the release of suspended solids to surface waters which could affect the water quality of downstream receptors including the Baunleath stream, the Madlin River and the River Barrow and their associated aquatic ecosystems.

The pre-mitigation impact of suspended solids entrainment in downstream surface waters will be a negative, significant, indirect, temporary, likely impact.

7.5.1.4 Potential Effects on Surface and Groundwater WFD Status

The EU Water Framework Directive (2000/60/EC) requires that all member states protect and improve water quality in all waters, with the aim of achieving good status by 2027 at the latest. Any new development must ensure that this fundamental requirement of the Directive is not compromised.

The status of the surface and groundwater bodies in the vicinity and downstream of the site are described in Section 7.3.3.6 and 7.3.4.8 respectively.

In terms of surface waterbodies, the Old Leighlin Stream_020 SWB achieved 'Moderate' status in the latest WFD cycle. Further downstream the Barrow_190 and Barrow_200 SWBs achieved 'Moderate' status in the latest WFD cycle.

In terms of groundwater bodies, the Bagenalstown Lower GWB (IE_SE_G_078) was assigned 'Good' status in the latest WFD cycle (2013-2018).

Potential effects on groundwater and surface water quality and quantity as a result of the construction phase has the potential to negatively affect the WFD status of ground and surface water bodies in the vicinity and downstream of the Proposed Development. The underlying GWBs may be impacted due to an increase in groundwater vulnerability associated with the removal of the overlying soil and subsoil. In terms of surface waterbodies, watercourses in the vicinity and downstream of the site may be impacted by increased suspended sediment concentrations and hydrocarbon spillages which have the potential to affect the WFD status of river waterbodies. The potential impact on SWBs will decrease progressively downstream due to the dilution effect associated with increasing volumes of water within the River Barrow.

The potential change in WFD status for waterbodies resulting from the Proposed Development, and in the absence of any mitigation measures, is summarised in **Table 7-11**.

Our understanding of the WFD objectives is that water bodies, regardless of whether they have 'Poor' "Moderate", 'High' or 'Unassigned' status, should be treated the same in terms of the level of protection and mitigation measures employed in order to ensure there is no deterioration in the status of a waterbody.

The pre-mitigation potential impact is considered to be - Indirect, negative, moderate, short-term, likely effect on the WFD status of underlying bedrock GWBs (i.e. Bagenalstown Lower

GWB). Indirect, negative, moderate, short-term, likely effect on the WFD status of downstream surface waterbodies (Old Leighlin Stream_020 and Barrow_190 SWBs).

Table 7-11: Summary of WFD Status Change in an Unmitigated Scenario (Construction Phase)

WFD Element	WFD Code	Current WFD Status (2016 – 2021)	Assessed Status – Unmitigated Scenario
Old Leighlin Stream_020	IE_SE_14O020500	Moderate	Poor
Barrow_190	IE_SE_14B012820	Moderate	Poor
Barrow_200	IE_SE_14B012920	Moderate	Moderate
Bagenalstown Lower GWB	IE_SE_G_157	Good	Moderate

7.5.2 Operational Phase

In the context of the Proposed Development the operational phase is taken to be the extraction of limestone bedrock to a final proposed depth of ~56.5mOD. This phase of the Proposed Development will firstly involve the extraction of ~10m of unusable limestone which will be crushed and processed in the proposed working area to the south of the extraction area. Once the usable dimension stone is at the surface it will be extracted and transported off site for processing.

This phase of the Proposed Development will require the management of both minor groundwater inflows and surface water (from rainfall). With the proposed extraction extending to a final depth of 56.5mOD, well below the elevation of the local groundwater table, small groundwater inflows may occur. This will generate excess water on the quarry floor which will need to be discharged intermittently to allow for quarrying activities to continue. It is currently proposed to intermittently discharge excess surface water to a roadside drain located to the east of the site. This drain outfalls to the Baunleath stream. The discharge rate is estimated to be ~76m^3/day.

7.5.2.1 Increased Surface Water Discharge Volumes

The Proposed Development has the potential to increase volumes of water being discharged from the site to the Baunleath stream, which in turn discharges into the Madlin River. This increase in surface water discharge will be as a consequence of the increased volumes of surface and groundwater being generated within the proposed quarry void.

Current flow volumes in Madlin River downstream of the site are estimated to exceed 0.031m^3/sec 95% of the time.

However, comparisons can be made with the existing Old Leighlin Quarry to the north of the site. Extraction at Old Leighlin Quarry is currently permitted to a depth of 21mOD and is operating well below the groundwater table. However, little groundwater inflow has been noted in the quarry void due to the absence of any solutionally enlarged joints or cavities (i.e. the absence of any karst features). Furthermore, groundwater monitoring at Old Leighlin has revealed that the quarrying operations are having little impact on the elevation of the surrounding groundwater table. Therefore, the water being pumped from the quarry at Old Leighlin is predominantly comprised of rainfall)and subsequent surface water management) which falls within the void.

Similarly, site investigations at the site comprising a total of 5 no. boreholes do not indicate the presence of widespread karstification of the underlying bedrock at the site. Therefore, a similar hydrogeological regime will exist at the proposed site, whereby little groundwater inflow will occur into the proposed extraction area. As a consequence, the surface water being discharged to the Baunleath stream will consist largely of rainfall falling within the site. The discharge rate from the proposed quarry is estimated to be ~76m^3/day. This is a relatively small discharge, and therefore, no significant increase in flow volumes in the Baunleath stream or the Madlin River will result from the Proposed Development.

Any unmitigated and uncontrolled increases in discharge has the potential to adversely impact local hydromorphology, water quality, and increase flood risk downstream of the site. The pre-mitigation impact on surface water quantity is considered to be a negative, moderate, direct, medium-term, likely impact.

7.5.2.2 Potential Impacts on Surface Water Quality

During the operational phase runoff from the proposed extraction area will be directed to temporary settlement ponds on the quarry floor. En-route to the ponds, surface water will likely increase in turbidity due to the collection of sediment particles. Surface waters may also be contaminated with any leaked hydrocarbons on the quarry floor. This will reduce the quality of surface water runoff from the site and will have an adverse impact on local downstream receiving watercourses (Baunleath stream, Madlin River and River Barrow) and their associated aquatic ecosystems.

Wastewater/greywater arising at the welfare units (during the operational phase) will be collected and stored in a sealed tank, and this tank will be emptied by vacuum tanker and the contents transferred to a suitably licenced wastewater facility for treatment and disposal. As such, there will be no potential effects to surface water quality arising from wastewater generation at the site.

The pre-mitigation impact on surface water quality is considered to be a negative, moderate, direct, medium-term, likely impact.

7.5.2.3 Potential Impacts on Groundwater Quality

The removal of the protective layer of soil and subsoil will increase the vulnerability of the underlying bedrock to contamination. During the operational stage of the Proposed Development groundwater vulnerability in the extraction areas will be ‘Extreme’ with exposed bedrock at the surface. Groundwater contamination can occur due to hydrocarbon spills or leaks on the quarry floor or through the use of explosives during blasting operations.

Once quarrying extends below the groundwater table, the risk of contamination is reduced, as groundwater surrounding the quarry drains into the excavation footprint, acting as a hydraulic trap.

The greatest risk to groundwater quality occurs during excavation works above the groundwater table when groundwater contaminated from any accidental leaks or spills has the potential to migrate off-site.

Wastewater/greywater arising at the welfare units (during the operational phase) will be collected and stored in a sealed tank, and this tank will be emptied by vacuum tanker and the contents transferred to a suitably licenced wastewater facility for treatment and disposal. As such, there will be no potential effects on groundwater quality arising from wastewater generation at the site.

The pre-mitigation impact on groundwater quality is considered to be a negative, slight, direct, likely impact.

7.5.2.4 Groundwater Drawdown Associated with Dewatering

Quarrying activities below the water table have the potential to impact on local groundwater levels in the vicinity of the Proposed Development. Once the quarrying operations extend below the groundwater table, groundwater levels in the surrounding area will be lowered as the groundwater flows towards the newly created void. Drawdown may have a negative impact on local private groundwater wells including the supply well in the adjacent Old Leighlin Quarry.

However, site investigations have revealed an absence of karst features, conduits or preferential flowpaths in the bedrock aquifer beneath the site. Therefore, groundwater inflow into the extraction area will be minimal and as a result the Proposed Development will not have a significant impact on local groundwater levels. The discharge rate from the proposed quarry is estimated to be ~76m^3/day.

The existing Old Leighlin Quarry, located immediately to the north of the Proposed Development site, is operating to a permitted floor level of 21mOD. Extraction to this depth has not resulted in any significant effects on nearby wells and only minor dewatering has been required. Therefore given that the Proposed Development will operate to a final floor level of 56.5mOD, there will be no significant effects on local groundwater levels.

The pre-mitigation impact on local groundwater levels is considered to be a negative, slight, direct, long-term, medium probability impact on local groundwater levels and local wells.

7.5.2.5 Potential Impact on Designated Sites

The River Barrow and River Nore SAC is hydrologically connected to the site via the Baunleath stream. The site is also hydrogeologically connected to the SAC via the underlying Regionally Important Aquifer which makes a significant contribution to the baseflow of the River Barrow (GSI, 2004).

The Proposed Development has the potential to adversely impact both surface water and groundwater quantity and quality in the vicinity of the site. Therefore, the Proposed Development has the potential to adversely impact the qualifying interests of the River Nore SAC.

The pre-mitigation impact on the River Barrow and River Nore SAC is considered to be negative, slight, direct, unlikely, and short-term.

7.5.2.6 Potential Impact on WFD Status

The potential effects on groundwater and surface water during the operational phase are greater during the operational phase in comparison to the construction phase described above. Therefore, the potential for the operational phase of the Proposed Development to affect the WFD status of waterbodies in the vicinity and downstream of the site is increased compared to the construction phase.

During the operational phase, a large area of the underlying bedrock aquifer will be exposed (i.e. 2.44ha) at the surface and extracted using standard blasting and breaking techniques, and sawing as explained above. With extraction proposed below the groundwater table, management of surface water and minor groundwater inflows will be required. These activities have the potential to negatively affect groundwater quality and quantity within the Bagenalstown Lower GWBs, thereby effecting its WFD status. In addition the WFD status of surface waterbodies in the vicinity and downstream of the site may be affected by discharge from quarry into the Baunleath stream.

The potential change in WFD status for waterbodies resulting from the Proposed Development, and in the absence of any mitigation measures, is summarised in **Table 7-12**.

The pre-mitigation potential impact is considered to be - Indirect, negative, slight, long-term, likely effect on the WFD status of underlying groundwater body (i.e. Bagenalstown Lower GWB). Indirect, negative, slight, long-term, likely effect on the WFD status of downstream surface waterbodies (with the impact decreasing downstream due to the dilution effect associated with larger volumes of water within the River Barrow).

Table 7-12: Summary of WFD Status Change in an Unmitigated Scenario (Operational Phase)

WFD Element	WFD Code	Current WFD Status (2016 – 2021)	Assessed Status – Unmitigated Scenario
Old Leighlin Stream_020	IE_SE_14O020500	Moderate	Poor
Barrow_190	IE_SE_14B012820	Moderate	Poor
Barrow_200	IE_SE_14B012920	Moderate	Moderate
Bagenalstown Lower GWB	IE_SE_G_157	Good	Moderate

7.5.3 Potential Cumulative Impacts

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

Due to the proximity of the site to this existing quarry there is the potential for cumulative impacts to arise. However, in terms of surface water quantity and quality, the Proposed Development and Old Leighlin Quarry will operate under strict conditions set out in their respective Environmental Management Plans designed for the protection of surface water quality and surface water quantity. Due to the lack of any significant residual impacts from the development that would affect the wider hydrological environment, there will be no significant cumulative impacts to downstream surface watercourses.

Similarly, in terms of groundwater, both developments will adhere to strict mitigation measures designed to protect local groundwater quality. Furthermore, Old Leighlin Quarry and the Proposed Development will not have a significant impact on groundwater quantity (groundwater levels) due to the nature of the local hydrogeological regime with an absence of flow conduits and karst features.

No significant hydrological and/or hydrogeological cumulative effects will occur.

7.5.4 Restoration Phase

The restoration plan includes allowing the quarry void to naturally fill with water with some of the void backfilled with spoil from the surrounding berms. The void will be surrounded by a secure post and wire fence. The proposed soil storage areas will be allowed to revert to scrubland. Meanwhile, the proposed set down area and shed will be cleared and restored to scrubland. The remainder of the site will be planted with trees.

Potential impacts associated with the restoration phase are the same as during the construction phase with the potential for elevated concentrations of suspended sediment and leaked fuels and oils from plant and site vehicles to impact downstream surface water quality. Groundwater quality may also be negatively impacted due to accidental spills and leaks of fuels and oils.

However, the restoration and post-restoration phase will have a largely positive effect in terms of hydrology and hydrogeology, by returning much of the site back to natural scrubland habitats and ceasing any point discharge into downstream watercourses.

7.5.5 "Do Nothing" Impact

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

7.6 Avoidance, Remedial and Mitigation Measures

7.6.1 Construction Phase

7.6.1.1 Potential Impacts on Groundwater Vulnerability

There will be an increase in groundwater vulnerability rating due to the removal of overburden (i.e. soils and subsoils over 2.44ha). The increase in groundwater vulnerability will only be slight as subsoils are relatively thin at the site and the existing vulnerability is mapped largely as high to extreme.

The main increase in groundwater vulnerability will occur during the Operational Phase when extraction is proposed below the local groundwater table.

The main mitigation with respect to groundwater quality will be employed during the operational stage with the employment of best practice mitigation measures with respect to oil usage and refuelling of plant and machinery. However mitigation measures will also be employed throughout the construction phase to ensure no groundwater contamination occurs (refer to Section 7.5.1.2).

All construction phase operations on site will be completed in accordance with a comprehensive Environmental Management Plan (EMP) which will be updated as a working document and will oversee all activities at the site.

7.6.1.2 Surface and Groundwater Contamination from Oil/Fuel Spills and Leaks

The following mitigation by design is proposed:

- All plant and machinery will be serviced before being mobilised to site;
- Refuelling will be completed in a controlled manner using drip trays (bunded container trays) at all times;
- Only designated trained operators will be authorised to refuel plant on site;
- Procedures and contingency plans will be set up to deal with emergency accidents or spills; and
- All activities will be completed in accordance with the EMP.

7.6.1.3 Earthworks Resulting in Suspended Solids Entrainment in Surface Waters

The proposed construction phase is short-term.

Prior to the commencement of earthworks, silt fencing will be placed down-gradient of the construction areas where surface water may drain towards the Baunleath stream and/or other small drainage ditches present within or adjacent the site. These silt fences will be embedded into the local soils to ensure all site water is captured and filtered.

Daily monitoring and inspections of runoff during the construction phase will be completed. Earthworks for the construction phase will take place during periods of low rainfall to reduce run-off and potential siltation of downstream watercourses.

Excavated soil will be utilised in the construction of berms surrounding the proposed extraction area with any excess soil stored in the proposed soil storage area. These spoil areas will be vegetated as soon as practicable and silt fences placed downstream of all soil storage area until they have been stabilised.

All ground and earthworks will be completed in accordance with the EMP which will detail the above mitigation measures for the mitigation of suspended solids in surface water runoff.

7.6.1.4 Potential Effects on Surface and Groundwater WFD Status

Due to the hydrogeological regime at the proposed extraction area, characterised by high rates of groundwater recharge and low rates surface water runoff, the underlying GWBs are the most sensitive receptors. Surface watercourses will be less susceptible to effects during the construction phase due to the lack of surface water pathways between the extraction area and downstream SWBs.

Strict mitigation measures in relation to the use of oils and fuels on-site will be implemented during the construction phase and will ensure the ongoing protection of groundwater and surface water quality.

There will be no change in GWB or SWB status in the underlying GWBs or downstream SWBs resulting from the Proposed Development (refer to Table 7-12). There will be no change in quantitative (volume) or qualitative (chemical) status, and the underlying GWBs are protected from any potential deterioration from chemical pollution.

As such, the Proposed Development is compliant with the requirements of the Water Framework Directive (2000/60/EC).

7.6.2 Operational Phase

7.6.2.1 Increased Surface Water Discharge Volumes

The Proposed Development includes the provision of a water management system which will include the installation of surface water attenuation and settlement ponds on the quarry floor.

The proposed water management system will direct surface water and any minor groundwater inflows in the site towards suitably designed settlement lagoons on the quarry floor. These lagoons will serve to attenuate discharge from the site and will ensure that discharge rates to the Baunleath stream do not exceed the existing greenfield runoff rates or the maximum permitted daily discharge volume as per the discharge licence. The discharge rate is estimated to be ~76m^3/day.

The proposed infrastructure will attenuate storm water so that any increase in discharge volumes during storm events are gradual and controlled, preventing an increase in the flood risk downstream of the site.

7.6.2.2 Potential Impacts on Surface Water Quality

The Proposed Development will utilise a water management system designed to prevent contamination of local surface waters with elevation concentrations of suspended solids or hydrocarbons.

Water from the wheel wash will be recycled and will not enter the settlement ponds or be discharge to the Baunleath stream.

In addition the following measures will be implemented to ensure that surface waters are not contaminated with hydrocarbons:

- Hydrocarbons at the site will be delivered via fuel truck. There will be no storage of hydrocarbons on site.
- Major repairs will be completed off site. Emergency mechanical repairs will use spill kits kept on-site.
- All water from the site will be passed through a hydrocarbon interceptor prior to discharge to the receiving watercourse.
- All activities on site will be completed in accordance with the EMP.

7.6.2.3 Potential Impacts on Groundwater Quality

All quarrying activities at the site will operate within a site-specific protocol for extraction which will follow the current international best practice.

Mitigation measures to protect groundwater quality will be implemented throughout the operational phase. The primary risks to groundwater quality result from hydrocarbon spills and leaks. The following mitigation measures will be implemented at the site.

- No refuelling or maintenance of construction/operation vehicles or plant will take place within the extraction area;
- Preventative maintenance and relevant maintenance logs will be kept for all on-site plant and equipment;
- Refuelling will only occur at the designated fuel pad area, which will include an oil/fuel interceptor, from a mobile double skinned fuel bowser or equivalent;
- A spill kit will be kept beside the designated fuel pad area. The spill kit will contain fuel absorbent material, pads/mats and oil boom for use in the event of any accidental spill;
- Drip trays and fuel absorbent mats will be used during all refuelling operations;
- Onsite refuelling will be carried out by trained and competent personnel only;
- All plant and machinery will be serviced before been mobilized to site and regular leak inspections and fitness for purpose will be completed during the backfilling works;
- No substantial plant maintenance will be completed on site, any broken down plant will be removed from site to be fixed; and,
- The site will operate under a dedicated Environmental Management System.

7.6.2.4 Groundwater Drawdown Associated with Dewatering

The proposed extraction will only extend to 56.5mOD, thereby limiting the extent of any potential local groundwater drawdown. The discharge rate from the proposed quarry is estimated to be ~76m^3/day.

Groundwater monitoring has revealed that the quarrying activities immediately to the north of the site have not resulted in any impact on local groundwater wells (SLR, 2017). Therefore, given the absence of karst features and flow conduits in the bedrock aquifer beneath the site, groundwater inflow into the proposed quarry will be minimal. Hence, the Proposed Development will not have a significant impact on local groundwater levels.

No specific mitigation measures are required however groundwater monitoring in installed monitoring wells will be completed as part of the Proposed Development.

7.6.2.5 Potential Impact on Designated Sites

The Proposed Development is located upstream of the River Barrow and River Nore SAC. Surface water connections from the site to the Baunleath stream could transfer poor quality surface water that may affect this SACs. Groundwater from below the proposed extraction area may also discharge as baseflow to the River Barrow.

However, with the implementation of the mitigation measures outlined above for the protection of surface and groundwater quality/quantity, the River Barrow and River Nore SAC will not be affected by the Proposed Development.

7.6.2.6 Potential Impact on WFD Status

Strict mitigation measures in relation to the protection of surface and groundwaters are outlined above. The implementation of these mitigation measures during the operational phase of the development will ensure the qualitative and quantitative status of the receiving groundwaters waters and surface waters will not be altered by the Proposed Development.

There will be no change in GWB or SWB status in the underlying GWBs or downstream SWBs resulting from the Proposed Development (refer to Table 7-12). There will be no change in quantitative (volume) or qualitative (chemical) status, and the underlying GWBs are protected from any potential deterioration from chemical pollution.

As such, the Proposed Development is compliant with the requirements of the Water Framework Directive (2000/60/EC).

7.6.3 "Worst Case" Scenario

In the event that the Proposed Development was to proceed, and the proposed mitigation measures substantially fail then it is likely that there would be a significant impact on local surface water quality and groundwater quality with the potential for contamination via oils, hydrocarbons and elevated concentrations of suspended solids.

7.7 Residual Impacts

7.7.1 Construction Phase

7.7.1.1 Potential Impacts on Groundwater Vulnerability

The soils and subsoils present at the site will require removal in order to expose the underlying bedrock which will be extracted for economic purposes. This removal of overburden will increase groundwater vulnerability across the site by exposing bedrock at the surface. The residual effect is considered to be a direct, negative, slight, likely and permanent effect on groundwater vulnerability.

7.7.1.2 Surface and Groundwater Contamination from Oil/Fuel Spills and Leaks

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

7.7.1.3 Earthworks Resulting in Suspended Solids Entrainment in Surface Waters

Earthworks and quarrying operations have the potential to result in elevated concentrations of suspended solids in surface water runoff. Proven and effective measures to mitigate the risk of suspended solids entrainment in surface waters have been proposed. The residual effect will be negative, imperceptible, indirect, short-term, unlikely effect on surface water quality.

7.7.1.4 Potential Effects on Surface and Groundwater WFD Status

Strict mitigation measures in relation to the protection of surface and groundwaters are outlined. The implementation of these mitigation measures during the construction phase of the development will ensure the qualitative and quantitative status of the receiving surface and groundwaters waters will not be altered by the Proposed Development.

There will be no change in GWB or SWB status in the underlying GWBs or downstream SWBs resulting from the Proposed Development (refer to **Table 7-13**). There will be no change in quantitative (volume) or qualitative (chemical) status, and the underlying GWB and downstream SWBs are protected from any potential deterioration from chemical pollution.

As such, the Proposed Development is compliant with the requirements of the Water Framework Directive (2000/60/EC).

Table 7-13: Summary WFD Status with the implementation of Mitigation Measures (Construction Phase)

WFD Element	WFD Code	Current WFD Status (2016 – 2021)	Assessed Status – Unmitigated Scenario
Old Leighlin Stream_020	IE_SE_14O020500	Moderate	Moderate
Barrow_190	IE_SE_14B012820	Moderate	Moderate
Barrow_200	IE_SE_14B012920	Moderate	Moderate
Bagenalstown Lower GWB	IE_SE_G_157	Good	Good

7.7.2 Operational Phase

7.7.2.1 Increased Surface Water Discharge Volumes

With the implementation of the mitigation measures outlined above, and with the control of discharges to ~76m^3/day, we consider the residual impact to be negative, imperceptible, direct, unlikely, medium-term impact.

7.7.2.2 Potential Impacts on Surface Water Quality

With the implementation of the mitigation measures outlined above, we consider the residual impact to be negative, imperceptible, direct, unlikely, medium-term impact.

7.7.2.3 Potential Impacts on Groundwater Quality

With the implementation of the mitigation measures outline above, we consider the residual impact to be negative, imperceptible, direct, unlikely, medium-term.

7.7.2.4 Groundwater Drawdown Associated with Dewatering

Due to the nature of the bedrock geology at the site and the nature of the Proposed Development and the relatively small, proposed discharge volumes (~76m^3/day), we consider the residual impact to be negative, moderate, direct, likely impact on local groundwater levels.

7.7.2.5 Potential Impact on Designated Sites

With the implementation of the mitigation measures targeted at surface and groundwater quality, we consider the residual impact to be negative, imperceptible, indirect, unlikely, medium-term.

7.7.2.6 Potential Impact on WFD Status

Strict mitigation measures in relation to the protection of surface and groundwaters are outlined above in Section 7.6.2.1 to 7.6.2.5. The implementation of these mitigation measures during the operational phase of the development will ensure the qualitative and quantitative status of the receiving surface and groundwaters waters will not be altered by the Proposed Development.

As such, the Proposed Development is compliant with the requirements of the Water Framework Directive (2000/60/EC).

Table 7-14: Summary WFD status with the implementation of Mitigation Measures (Operational Phase)

WFD Element	WFD Code	Current WFD Status (2016 – 2021)	Assessed Status – Unmitigated Scenario
Old Leighlin Stream_020	IE_SE_14O020500	Moderate	Moderate
Barrow_190	IE_SE_14B012820	Moderate	Moderate
Barrow_200	IE_SE_14B012920	Moderate	Moderate
Bagenalstown Lower GWB	IE_SE_G_157	Good	Good

7.8 Restoration Phase

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

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

7.9 Monitoring

7.9.1 Construction Phase

Surface water quality monitoring should be completed during the construction phase of the Proposed Development.

Surface water quality monitoring will be completed at discharge points (downstream of settlement ponds). The monitoring will include the following analytes:

- Visual Inspection
- Temperature
- pH
- Flow
- BOD
- Suspended Solids
- Ammonia (as N)
- Orthophosphate
- Dissolved metals (Cd, Cu, Fe, Pb, Mg, Mn, Ni & Zn)
- Diesel Range Organics
- Petrol Range Organics

7.9.2 Operational Phase

Surface water monitoring will be completed through the operational phase of the Proposed Development as outlined in Section 7.9.1 above.

Groundwater quality should also be completed on a biannual basis and shall include testing for the following parameters:

- pH
- BOD
- Ammonia (as N)
- Nitrate
- Total Nitrogen (as N)
- Orthophosphate (as P)
- Total Dissolved Solids
- Dissolved Metals ((Cd, Cu, Fe, Pb, Mg, Mn, Ni & Zn)
- Total Petroleum Hydrocarbons
- Diesel Range Organics
- Petrol Range Organics
- Total Coliforms
- Faecal Coliforms

Groundwater level monitoring is also recommended throughout the operation phase of the Proposed Development. Groundwater level monitoring will be completed in the on-site monitoring wells (BH1, BH2 and BH5)

7.9.3 Restoration Phase

No monitoring required.

7.10 Interactions

None.

7.11 Difficulties Encountered When Compiling

No difficulties were encountered in compiling the Hydrology and Hydrogeology Chapter.

7.12 References

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PPG5 – Works or Maintenance in or Near Watercourses (UK Guidance Note).