Lobinstown Quarry

Environmental Impact Assessment Report

Section 7

Water

2024

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BREEDON IRELAND

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF GRAPHS

7 WATER

7.1 INTRODUCTION

This Water chapter of the Environmental Impact Assessment Report (EIAR) has been prepared for an extension to an existing working quarry at Heronstown, Lobinstown, Navan, Co. Meath.

The purpose of this section of the EIAR is to present the baseline hydrological and hydrogeological environment and to then complete the Impact Assessment as governed by EIA Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (EIA Directive). Specifically, this chapter uses the baseline studies of the site and the receiving environment to apply EPA (2022) Guidelines on the information to be contained in Environmental Impact Statements. An EPA (2022) directed Impact Assessment assesses potential impacts, assigns mitigation measures and then reassess potential resultant residual Impacts. Potential cumulative impacts are also addressed. Substantial field work was completed specifically for this assessment and the results of previous assessments were also considered.

The proposed development will consist of the continuance of operation of the existing permitted quarry and associated infrastructure (ABP Ref. 17.QD.0017; P.A. Ref. LB200106 & ABP Ref. 309109-21), deepening of the quarry extraction area by 1 no. 15 metre bench from 50 m OD to 35 m OD, a lateral extension to the quarry over an area of c. 4.8 ha to a depth of 35 m OD, provision for aggregates and overburden storage, and restoration of the site to natural habitat after uses following completion of extraction, within an overall application area of c. 18.5 hectares. An extraction capacity of up to 300,000 tonnes per annum is sought to provide the applicant with the ability to respond to demand for aggregates in the region. Permission is sought for a period of 20 years in order to extract a known resource with a further 2 years to fully restore the site.

Bedrock in the existing quarry is made up of a hard rock metamorphic sandstone and mudstone, which has a High Polished Stone Value (PSV). In the permitted working area, bedrock has been extracted from ground level to an elevation of c. 65 m OD.

In order to maintain a safe and dry working environment on the floors of quarries, waters arising drain by gravity flow to a floor sump and from there the waters are pumped to a treatment system (lagoon) for removal of suspended solids. Following treatment and retention, the final waters are discharged under Section 4 Discharge licence to a local surface water watercourse. The site's discharge is governed by a current Section 4 Discharge Licence, in accordance with the Local Government (Water Pollution) Act, 1977. Meath County Council issued the Section 4 discharge licence (Ref. 20/01) in November 2020. It is therefore understood that the licence conditions of Ref. 20/01 enable water management and discharge at the site in full compliance with the Water Framework (WFD) and its associated Irish

Regulations, namely the Surface Water Regulations (2009, as amended) and the Groundwater Regulations (2010, as amended).

This assessment will evaluate the potential for additional waters arising from the proposed development, in combination with the quantified waters currently arising, and will present reasoned determinations on the necessity or otherwise to update the Section 4 discharge licence Ref. 20/01 already in place.

Following treatment in the c. 2,000 m^2 plan area, lined, settlement lagoons, which were built to the specification of the Section 4 Discharge licence Conditions, the site's treated waters enter the east-west flowing Killary Stream (EPA Segment Code: 06_921), a tributary of the Killary Waters which subsequently enters the River Dee. Figure 7.1 illustrates this routing via the River Dee outfall to the Irish Sea at Annagassan.

With respect to hydrological setting, the site is mapped as sitting within the Newry, Fane, Glyde and Dee (Hydrometric Area HA06) and the Dee Sub-Catchment (SC_030). More details for regional river systems, Water Framework Directive (WFD) sub-catchments and sub-basins are provided later in this chapter. Characterisations, pressures and other significant information relating to the rivers, lakes and groundwater connected to the site have been presented by the catchment and WFD teams of the EPA and reported in the 2nd WFD Cycle (EPA, 2018) and 3rd WFD Cycle (EPA, 2021). All published data have been employed for the characterisation of the baseline and the assessment of impacts, required mitigations and residual impacts.

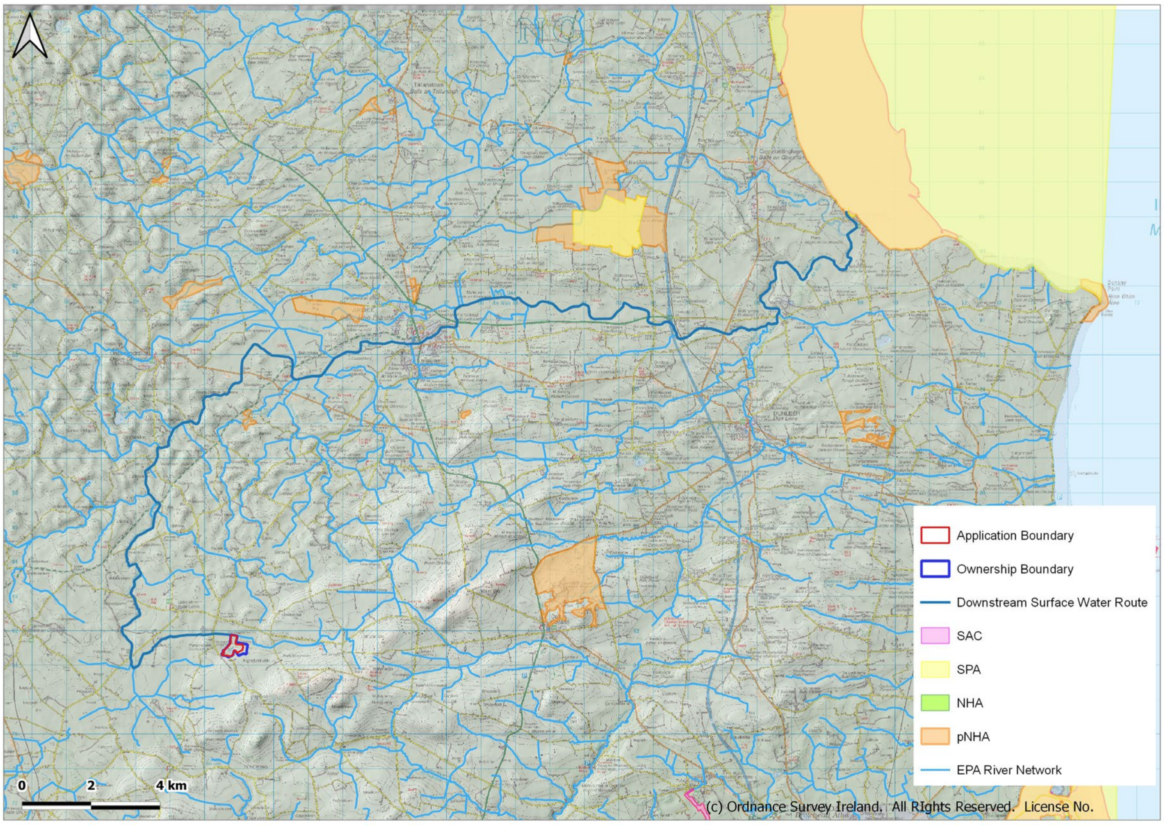


Figure 7.1 Designated Sites in Region

None of the surface watercourses which connect the site with the Irish Sea have been designated as European sites with Conservation Objectives. The coastal waters to which the River Dee outfalls has been designated as Dundalk Bay SAC (004026), SPA (004026) and pNHA (000455). The information presented in this chapter has been used by the ecologists in their evaluations as presented in the Biodiversity Chapter 5 of this EIAR.

With respect to the hydrogeological setting the site is within the Louth Groundwater Body (GWB). The GSI (2004a) reports that the hydrogeological regime of the Louth GWB is dominated by poor aquifers with short groundwater flow paths and rejected recharge entering local rivers and streams.

7.1.1 STATEMENT OF AUTHORITY

The evaluation of the hydrological and hydrogeological environment and the assessment of impacts was completed collaboratively between Dr. Pamela Bartley (Hydro-G) and Dr. Colin O'Reilly (Envirologic).

Dr. Pamela Bartley (Hydro-G) is a water focussed civil engineer with over 25 years practical experience in field-based groundwater investigations, drilling, instrumentation, surface water sampling, flow gauging and impact assessments, public water supply from groundwater boreholes, quarry assessments, Section 4 Discharge Licensing and wastewater treatment using Nature Based Systems. Pamela completed her primary training in the RTC system. She completed a Certificate in Civil Engineering from Letterkenny RTC and a Diploma in Water and Wastewater Engineering at Sligo RTC in the early 1990's. Her Bachelor of Engineering degree was completed in the school of Civil Engineering at Queen's University, Belfast, and her postgraduate education at the School of Civil Engineering at Trinity College, Dublin (TCD). She completed an MSc. in Environmental Engineering at the School of Civil Engineering at TCD, which had geotechnical, hydrology, hydrogeology and legislation specialties and later a hydrogeologically focussed Ph.D. at TCD. Pamela has become a specialist in quarry and discharge evaluations in the context of enacted Irish Regulation and EU Directives. She has completed impact assessments and assisted in successful permission attainment for many regionally important quarries in SAC settings. Quarry assessments, successful EIARs gaining planning and associated Section 4 Discharge Licences include, as follows:

(i) Bennettsbridge Limestone, Co. Kilkenny consent to continue at an existing site following previous refusals at Board level and successful review update of the Section 4 Discharge Licence (ENV/W/78, 2017) permitting a range of 22,000 m^3/d as the annual average with maximums up to 70,000 m^3/d throughout the rainfall season. The discharge is to a drain that discharges to the River Nore. The large range is because it is a diffuse karst aquifer and during high rainfall there is a large volume of water on the floor carried through the epikarst of the walls.

(ii) McGrath Limestone Works Ltd, Cong, Co. Galway (W391/05_R1, 2019) permitting a discharge of 10,000 m^3/d to the Cong Canal upstream of Lough Corrib (Public Water Supply for Galway City and environs).

(iii) Churchill Stone Ltd. (Cassidys), Keeloges, Churchill, Letterkenny, Co. Donegal. Section 4 Discharge (Lwat65) permitting discharge to a headwater and upstream of the commencement of mapping for a Pearl Mussel River.

(iv) Harrington Concrete and Quarries, Ardgaineen, Co. Galway (W_502_22) permitting a discharge of 1,435 m^3/d to a grassed vegetation area, following an oil interceptor, and subsequent discharge to groundwater via a Nature Based System in a conduit karst aquifer in a Hydrometric Area of Lough Corrib SAC and SPA.

Each of these quarries operate within SAC catchments and have successfully managed their discharge, under licence, for many years.

Dr. Colin O'Reilly has a doctorate degree in soil systems and hydrology. He has over 20 years of professional and field-based experience as a hydrogeologist coupled with a doctorate degree in hydrology, awarded by the Centre for Water Resources Research, School of Architecture, Landscape and Civil Engineering, UCD, while a recipient of a Teagasc Walsh Fellowship. Colin's company is Envirologic, which has key competencies in hydrogeology and hydrology with expertise in flood assessments in addition to assessment of quarries across a range of diverse hydrogeological conditions across Ireland. Examples of recent relevant projects completed by Envirologic include:

(i) Hydraulic capacity assessment and flood risk assessment relating to six crossings on R181 prior to road upgrade works, Shantonagh, Co. Monaghan (client: Monaghan County Council).

(ii) Hydrological assessment relating to proposed drainage channel upgrade and maintenance works on a 5.3 km stretch of a river and its tributaries, Oranmore, Co. Galway (client: Galway County Council).

(iii) Design and specification of a flood alleviation scheme to include a new quarry discharge route from an active limestone quarry, Co. Galway.

Both Pamela and Colin are members of Engineers Ireland and the International Association of Hydrogeologists (Irish Group).

Hydro-G and Envirologic have collaborated recently in the compilation of EIAR: Water chapters for quarries at Spink, Co. Laois, Castlepollard, Co. Westmeath and Kinnegad, Co Meath (Breedon), Claremorris, Co. Mayo (McGrath's), Castleisland, Co. Kerry (MC Group), Borrisoleigh, Co. Tipperary (Kelly's of Fantane) and Letterkenny, Co. Donegal (Churchill Stone).

Both Hydro-G and Envirologic hold the required Professional Indemnity Insurances, Employers and Public Liability Insurances.

7.1.2 SITE LOCATION

The site is located within the townland of Heronstown, 2 km southeast of Lobinstown, 9 km northwest of Slane and 9 km west of Collon (see Figure 7.1). The quarry is located on the northern side of a local road which connects the N51 at Slane with the N52 at Woodtown.

7.1.3 SITE LAYOUT & PROPOSED DEVELOPMENT

The existing quarry is generally rectangular in shape with an axial orientation of NE-SW across the existing extraction area which covers an area of c. 4.5 ha and has permission to extract bedrock to a depth of 50 m OD (permitted under P.A. Ref. LB200106 & ABP 309109-21). The proposed extension will extend east from the northern section of the existing extraction area and result in a roughly inverted L-shaped extraction area.

The proposed development will consist of the continuance of operation of the existing permitted quarry and associated infrastructure (ABP Ref. 17.QD.0017; P.A. Ref. LB200106 & ABP Ref. 309109-21), deepening of the quarry extraction area by 1 no. 15 metre bench from 50 m OD to 35 m OD, a lateral extension to the quarry over an area of c. 4.8 ha to a depth of 35 m OD, provision for aggregates and overburden storage, and restoration of the site to natural habitat after uses following completion of extraction, within an overall application area of c. 18.5 hectares.

To date, extraction has taken place to a depth of c. 65 m OD in the southern and central sections of the active, permitted quarry. The quarry comprises disturbed ground with a level processing area located in the central section of the site and an oval-shaped extraction area developed into the central and southern sections of the site. The northern section of the site accommodates the settlement lagoon (2,000 m^2) and screening embankment along the northern site boundary with the Killary Stream (KILLARY WATER_010, IE_NB_06K010100). The site holds a valid, current Section 4 Discharge Licence (Ref. 20/01), which was issued by Meath County Council in 2020, for a discharge from the treatment systems (settlement lagoons) to the Killary Stream.

In June 2022, Breedon were granted planning permission to develop a readymix concrete plant in the northern section of the quarry (P.A. Ref. 22/328). However, this concrete plant has not been developed to date.

In December 2023, Breedon were granted planning permission for construction of a new single story office building and associated ancillary works (P.A. Ref. 23/917) at the quarry entrance onto the L1603 local road.

The internal access road extends from the site entrance from the L1603 local road on the southern boundary around the western perimeter, connecting to the northern part of the active quarry. The portacabin office, wheelwash and weighbridge are adjacent to the internal access road on the western side of the active quarry. The application area under consideration will require no new access roads and can be accessed from the internal routes already established within the quarry.

Quarrying at the site consists of extraction, processing and production of aggregates. Rock is fragmented using conventional drilling and blasting method which reduces the rock into a manageable size. Blasted material is then transported to a mobile crushing and screening plant, located on the quarry floor, where material is processed into various grades of aggregate depending on market demand and stored in designated stockpiles. Processed material is sold as aggregate.

Plant and machinery that operate at the application area consist of tracked excavators, wheeled loaders and mobile processing plant. Ancillary plant, such as a drilling rig, water bowser and road sweeper will continue to be deployed on an intermittent basis.

Infrastructure including a surface water management system is already in place. This EIAR chapter will review the existing surface water management system which includes a quarry floor sump, a hydrocarbon interceptor, settlement lagoons and a controlled mechanism for discharge.

A Landscape & Restoration Plan for the site has been compiled. Full details for the Restoration Plan are presented Section 3.4 of this EIAR.

In summary, the final restoration will consist of the following:

- Landscaping works will be undertaken during the working life of the quarry, where required.
- At the end of quarrying, all plant and machinery will be removed off the site, all site boundaries will be secured, additional planting of trees and shrubs may be necessary in some areas.

7.1.4 DISCHARGE LICENCE

Meath County Council, in exercising the powers conferred on it by the Local Government (Water Pollution) Act 1977 and the Local Government (Water Pollution) (Amendment) Act (1990), originally granted a trade effluent discharge licence in 1999 (99/03). Following a cessation of activities at the site this licence was revoked in 2012.

Following submission of a new application in 2020 Meath County Council granted a new effluent discharge licence (20/01) on 16th November 2020 to Lagan Materials Ltd. to discharge effluent from the application site to the Killary Stream. For context, the site entrance from the road is on the south of the quarry, the settlement lagoon treating the quarry's waters are in the northern part of the quarry and the Killary Stream, named the KillaryWater_010 by the EPA, flows from east to west immediately north of the site's northern boundary. A copy of the 20/01 Section 4 Discharge Licence is presented as Appendix 7.1, which also contains the as built drawings of the associated and specified settlement lagoons and other components of the water management infrastructure. The licence enables safe discharge and compliance with all current water legislation. Screening for appropriate assessment (AA Screening) was undertaken as part of the discharge licence application process. The AA Screening concluded that a stage two appropriate assessment (Natura Impact Statement, (NIS)) was not required.

The licence permits the following maximum discharge rates:

- Daily maximum flow = 1,728 m^3/d.
- Hourly maximum flow = 72 m^3/hr.

The licence is subject to certain conditions, with items relevant to this assessment specified as follows:

- *The treatment shall comprise a main settlement lagoon area of 2,000 m^2, water depth 1.5 m, a settlement lagoon of area 100 m^2 at the western boundary which connects to the main settlement lagoon, a Class I hydrocarbon interceptor after the outlet of the main settlement lagoon. There will be a single point of discharge to surface waters.*

- *In the event of a prolonged period of heavy or sustained rainfall the licencee shall cease to discharge water from the quarry site where it appears that the discharge from the quarry is causing or is likely to cause flooding of lands downstream of the quarry.*
- *The licencee shall install an in-line flow measuring device in order to measure discharge flow rate of the final treated effluent.*
- *Effluent as discharged shall comply with the quality standards set out hereunder in respect of the following determinants:*
    - *BOD = 2 mg/l.*
    - *COD = 50 mg/l.*
    - *Suspended solids = 20 mg/l.*
    - *pH = 6.0 – 9.0.*
    - *Orthophosphate as P = 0.050 mg/l.*
    - *Nitrates as N = 10 mg/l.*
    - *Ammonium, as N = 0.10 mg/l.*
    - *BTEX Compounds = 10 µg/l.*
    - *Total Petroleum Hydrocarbons = 50 µg/l.*
- *The licencee shall arrange for quarterly sampling and analysis of the discharge for the determinants listed above.*
- *Oils and grease shall not be present in the discharge.*
- *Any damage caused will be repaired, including restoration of fish stock, if necessary.*
- *Annual biological (macroinvertebrate) surveying u/S and d/S of the receiving waters.*

Site observations by Hydro-G and Envirologic confirm that there is a single point of discharge, that there is a western 100 m^2 settlement lagoon, that waters in the floor sump and the 100 m^2 western lagoon are pumped to a c. 2,000 m^2 plan area, lined settlement system, and that there is a flow meter in place.

Quarterly water chemistry sampling is completed by TMS Environmental and reported to MCC.

Annual macroinvertebrate surveying (Q Value) is reported to MCC.

All Conditions are adhered to.

Monitoring results are discussed in the Field Investigations section of this Water Chapter.

7.1.5 CONSULTATIONS

7.1.5.1 Statutory Stakeholders

J Sheils Planning & Environmental Ltd. issued the project description to statutory consultees. Responses from all consultees are presented in Appendix 4 of this EIAR. Specific to the Water assessment of this EIAR, responses and requests from specific statutory consultees are as follows:

(A) Geological Survey of Ireland (GSI): A response from the GSI dated 26th September 2023 outlined all available data and map resources that the GSI makes available for use. There were no site-specific comments in the GSI response with respect to envisaged constraints. Hydro-G confirms that the authors of this assessment have used all of the publicly available datasets as recommended by the GSI. The GSI requested that the operator consider, with due regard to H&S, allowing GSI geologists access to the site in the future. This request is because the exposures of bedrock revealed during quarrying are valuable to geologists and the education sphere in general.

(B) Inland Fisheries Ireland (IFI): A response from IFI dated 10th October 2023 highlighted risks posed by construction activities near waters. They provided a link to their 2016 Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Waters. Hydro-G confirms that the authors of this assessment have taken due cognizance of IFI's Guidance. It is noted that the site's c. 2,000 m^2 area of lined settlement lagoons provide adequate separation between the site's activities and the receiving waters. Further, the discharge of treated waters from the site are appropriately governed by MCC's Section 4 Discharge Licence for the site (Ref. 20/01). Hydro-G confirms that there is capacity within the settlement lagoons and within Licence Ref. 20/01 for the development proposed in this application.

(C) Health Service Executive (HSE): A response from the HSE dated the 10th October 2023 (EHIS Reference No. 3415) provided direction that Hydro-G hereby confirms was duly incorporated into the assessment presented here.

7.1.5.2 Meath County Council Planning Section

John Sheils of J Sheils Planning & Environmental Ltd. managed all pre-planning discussions with Meath County Council, as per the provisions of Section 247 of the Planning and Development Acts 2000, as amended, and all stakeholders.

A pre-planning meeting took place between John Sheils and Meath County Council on 4th October 2023. Meath County Council issued minutes of the meeting in which the following items were noted that may or may not be of relevance to this chapter:

- '*Confirmed by applicant (ecologist and hydrogeologist) that springs (Petrified Tufa) on boundary are more recent features, but no impact on them.*

- *Mentioned screening for AA determined that 'the proposed project is not considered likely to results in any effects on any Natura 2000 sites and as a result there is no risk of undermining the conservation objectives of Natura 2000 sites. Site well removed from Dundalk Bay SAC/SPA c. 43 km downstream.*
- *Flood risk assessment (FRA) previously completed needs to be expanded to include quarry extension. Riparian strips standard from OPW, and Section 50 OPW consent adhered to.*
- *Applicant confirmed that drainage channel through site is functioning and extraction is south of this.*
- *Applicant confirmed that sediment lagoon for 2,000 m^2 constructed and includes oil interceptors and gauges, etc. This shall be confirmed as part of any planning submission. Also, to confirm existing discharge details, proposed discharge details, and if can be accommodated in existing lagoon. Applicant confirmed discharge to a single point to the north. Pamela Bartley can contact Emmet Conboy/David Keyes directly regarding this.*
- *Analysis required of water wells and data logging including impact on domestic wells within area.*

The authors of this chapter hereby confirm that this EIAR chapter and Impact Assessment have subsequently consulted, by telephone and emails on the 24th November 2023, with Mr. Emmet Conboy of Meath County Council (MCC) Environment Section. The main issues discussed were, as follows:

(i) The site's recorded average volume of discharge is currently 1/10th of that permitted under the Section 4 Discharge Licence for the site (Ref. 20/01). Therefore, the current settlement lagoons and licence will remain able to service the proposed extension area.

(ii) The issue of Mass Loading was discussed and Dr. Pamela Bartley confirmed that the site was discharging < Limit of Detection Suspended Solids and that for all parameters of the Licence, the site was discharging only a fraction of the permitted loads of the Discharge Licence Ref. 20/01.

(iii) The current activities at the site and the proposed extension present no potential for deterioration of water quality and compliance with all aspects of the WFD is envisaged.

(iv) Although there was an anomalous result for one discharge sample, with respect to Nitrates, this was likely a result of a lab issue and Mr. Conboy requested additional sampling to interrogate the entire site. This additional sampling round was already underway because the site itself wished for the evaluation, regardless. The interrogative sampling confirmed that there is no nitrates issue in the discharge waters or anywhere on the site.

(v) The updated Flood Risk Assessment (FRA) was completed.

(vi) The local area well search was completed.

The authors of this water chapter hereby confirm that all aspects relating to water, as discussed at the 4th October 2023 pre-planning meeting with MCC, have been addressed and completed to the satisfaction of the Water Pollution Act, Surface Water and Groundwater Regulations, which transpose the WFD into Irish legislation.

7.1.5.3 Project Ecologist and NPWS:

The ecologist for the project is Ger O'Donohoe of Moore Consulting. He briefed the scope of the hydrological and hydrogeological assessment from the perspective that the site does not lie within, or in close proximity to a European site. The ecologist made the project's water team aware that management of discharge and suspended solids is critical and that any Water Management System on site must ensure that the discharge of suspended solids from site is controlled to ensure no impact on the downstream designated site.

The ecologist and hydrogeologists independently viewed an ingress / seep of water from the boundary wall between the permitted working quarry and the proposed eastern extension area. This ingress / seep had previously been named as a tufa springs (SLR, 2020). The ecologist and hydrogeologists agreed and assert that this is not a tufa spring. It is an ingress / seep of groundwater from an exposed point of contact between two different types of bedrock. There is some calcite deposition around the ingress / seep of water but that does not make it a tufa spring in the sense of what has Conservation Objectives.

The water and ecological consultants engaged in dynamic consultation together throughout the assessment period.

With respect to NPWS, the Development Applications Unit of the Department of Housing, Local Government and Heritage responded on the 24 October 2023 and specified requests in relation to Archaeology only. There was no mention of ecology or water. Therefore, no specific actions were undertaken by the water or ecology team other than those undertaken as a matter of professional course for the assessors for the proposed development.

7.2 ASSESSMENT METHODOLOGY

7.2.1 OVERALL ASSESSMENT METHODOLOGY

The methodology adopted for this assessment is as follows:

- Review of appropriate guidance and legislation.
- Characterisation of the Receiving Environment (hydrology and hydrogeology).
- Review of the 'Subject' development.
- Site Investigations to explore the potential of the 'Subject' development to result in Environmental Impact.
- Assessment of Potential Effects.
- Identification of Mitigation Measures.
- Assessment of Residual Impacts.

7.2.2 ASSESSMENT OBJECTIVES

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

- Present the original review of baseline hydrogeological and hydrological conditions within the footprint of the site.
- Update the assessment based on additional monitoring information and assessments, including:
    i. New settlement lagoon installed in 2021.
    ii. New discharge structure installed in 2021.
    iii. Water quality records at the discharge point.
    iv. Client supplied Monitoring Reports for hydrochemical water quality sampling of the discharge and on the Killary Stream, including laboratory certificates of analysis.
    v. Client supplied and macroinvertebrate surveys for upstream and downstream of the discharge point.
    vi. Discharge rate and volume records recorded by the continuous flowmeter and datalogger at the discharge point.
    vii. Geophysical survey and interpretation of the application area (Apex, 2020) in the context of potential significance to hydrology and hydrogeology.

viii. Geotechnical Assessment of the application extension lands to the east (SLR, 2021) in the context of potential significance to hydrology and hydrogeology.

- Re-assess the potential impact of the proposed development on the underlying groundwater body, associated surface water bodies and ecosystems.
- Upon identification of potential impacts, provide appropriate mitigation measures for any identified potential impacts, as deemed necessary. The proposal impacts and proposed mitigations will then be reassessed, and residual impacts defined.

7.2.3 GUIDANCE DOCUMENTS & LEGISLATIVE INSTRUMENTS

Overall, the assessment was prepared with consideration of enacted Irish Regulations, EU Directives and Guidance Documents listed as follows:

- EIA Directive (2014/52/EU) Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment.
- European Communities Environmental Objectives (Quality of Salmonid Waters) Regulations (1988). S.I. No. 293/1988.
- European Communities Environmental Objectives (Surface Waters) Regulations (2009). S.I. No. 272/2009, amended as S.I. No. 327 of 2012, S.I. No. 386 of 2015 and S.I. No. 77 of 2019.
- European Communities Environmental Objectives (Groundwater) Regulations (2010). S.I. No. 9/2010, as amended 2019 as S.I. No. 366 of 2019.
- European Communities (Birds and Natural Habitats) Regulations (2011). S.I. No. 477/ 2011, as amended 2021 as S.I. No. 293 of 2021.
- Guidelines on the information to be contained in Environmental Impact Statements (EPA, 2022)
- Geology in Environmental Impact Statements: A Guide (IGI, 2002)
- Guidelines for the Preparation of Soils, Geology & Hydrogeology Chapters of Environmental Impact Statements, Institute of Geologists of Ireland (IGI, 2013)
- Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment. Department of Housing, Planning and Local Government (2018)
- The Planning System and Flood Risk Management: Guidelines for Planning Authorities. Office of Public Works and Department of Environment, Heritage and Local Government (2009)
- Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes, NRA @ https://www.tii.ie/technical-services/environment/planning/Guidelines-on-Procedures-for-Assessment-and-Treatment-of-Geology-Hydrology-and-Hydrogeology-for-National-Road-Schemes.pdf

- Environmental Management Guidelines for the Extractive Industry (Non-Scheduled Minerals) (EPA 2006)
- Quarries and Ancillary Activities – Guidelines for Planning Authorities, Dept. of Environment, Heritage and Local Government (2004)
- Guidance Document no. GW5: Guidance on the Assessment of the Impact of Groundwater Abstractions. WFD Working Group (2004)
- Using Science to Create a Better Place: Hydrogeological Impact Appraisal for Dewatering Abstractions. Environment Agency, Science Report – SC40020/SR1. Bristol, UK. Boak, et al. (2007)
- Reclamation Planning in Hard Rock Quarries. Department of Civil & Structural Engineering, University of Sheffield, Edge Consultants & Mineral Industry Research Organisation (2004).
- A Quarry Design Handbook. 2014 Edition. GWP Consultants and David Jarvis Associates Limited, UK (2014).

7.2.4 STUDY METHODOLOGY

Overall, the study components comprised as follows:

a) Desktop study review of all published national data from the OPW, EPA, GSI and NPWS. Mapped information and databases for the site and wider region. Consideration of responses to consultations.

b) Review of historical planning documentation and assessments for the site and wider area to include, but not limited to, the following:

   i. Previous applications for planning.

   ii. Review of as built drawings for the on-site water management infrastructure.

   iii. Site monitoring data.

   iv. Ecological reports.

c) Site walkovers, local area visual surveys and discussions with site personnel, including as follows:

   i. An initial walkover survey of the application site and surrounding area was undertaken by Hydro-G and Envirologic on 17th February 2023 to observe the general landscape position and environmental setting in terms of hydrology and hydrogeology.

   ii. Features of hydrological and hydrogeological significance were identified and used as a basis for discussing sources, pathways and receptors, and likely potential impacts to the general environs.

d) With respect to site-specific characterisations and assessments having a hydrological and hydrogeological focus, Hydro-G have completed a field programme which involved:

- i. surveying and description of groundwater and surface water systems at and in the vicinity of the site. Field gathered information was combined with available hydrometric and hydrochemical data.
- ii. Site investigations including both the drilling of larger diameter wells (3 no.) for aquifer pumping tests and Site Investigation BHs (2 no.) with 50 mm diameter piezometer installations to accommodate continuous water level data loggers. Hydraulic response tests were also performed on the piezometer installations. Results were used to calculate the hydraulic conductivity of the bedrock. All results of the 2023 assessment were compared to the results of previous assessments at the site (SLR EIAR 2020). All results compared well.
- iii. Groundwater and surface water quality sampling for hydrochemical evaluations. The applicant continues to implement an ongoing water monitoring programme.
- iv. Cross-section survey of receiving surface waters to determine hydraulic capacity Surface water level recording and spot flow measurements on a number of occasions.
- v. Local Area Well Search.
- vi. General catchments drive over for the specific purpose of review of potential pressures that are not mapped on national systems.

e) Field inspection and review of all water treatment and discharge infrastructure installed since the grant of Section 4 Discharge Licence 20/01: these include the as Conditioned 2,000 m^2 area of lined settlement lagoons and hydrocarbon interceptor, discharge flowmeter and rainfall gauge.

f) Analysis of data collected within the site to include:

- i. Discharge flows.
- ii. Discharge water quality.
- iii. Daily rainfall.
- iv. Groundwater levels.
- v. Groundwater quality.

g) Data analysis including quantification of aquifer characteristics to inform potential future dewatering requirements, establishment of groundwater and surface water level and flow regimes, design specifications for effective mitigation measures, e.g., settlement lagoon system, determination of hydraulic capacity of receiving waters, determination of chemical status of receiving waters and ability to assimilate discharge waters.

h) Integration of desk study and site investigation findings informed the development of a CSM (Conceptual Site Model) for the hydrogeological system at the site and the local surrounding area's hydrology and hydrogeology.

i) All works were employed in the population of a Hydrogeological Risk Assessment Framework (UK EA).

j) The EIA procedure, as guided by EPA (2022) was followed through the assessment, identification of impacts, mitigation proposals and evaluation of residuals' process.

7.2.5 IMPACT ASSESSMENT METHODOLOGY (EPA, 2022)

Unless otherwise stated, the EPA's method (2022) of determining the significance of impacts has been applied. There are seven generalised degrees of impact significance that are commonly used in EIA, which are provided in EPA (2022) Table 3.4 as follows:

1) **Imperceptible:** An impact capable of measurement but without noticeable consequences.
2) **Not Significant:** An effect which causes noticeable changes in the character of the environment but without significant consequences.
3) **Slight:** An impact which causes noticeable changes in the character of the environment without affecting its sensitivities.
4) **Moderate:** An impact that alters the character of the environment in a manner consistent with existing and emerging trends.
5) **Significant:** An impact, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.
6) **Very Significant:** An effect which, by its character, magnitude, duration or intensity, significantly alters most of a sensitive aspect of the environment.
7) **Profound:** An impact which obliterates sensitive characteristics.

7.2.6 ASSESSMENT OF MAGNITUDE AND SIGNIFICANCE OF IMPACT

With respect to hydrogeology and hydrology, the assessment of the importance of site attributes and their magnitude of importance were evaluated using criteria as outlined in the National Road Authority (NRA) Guidelines (NRA, 2008). This is industry standard in Ireland as it is prescribed in the Institute of Geologist's (IGI) 'Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements' (IGI, 2013). NRA rating criteria uses the same significance terminology as the EPA. However, the NRA and IGI Guidance suggest intermediate steps to justify using that terminology, as follows:

- **Step 1:** Quantify the Importance of a feature for geology (Table C2) and hydrogeology (Table C3).
- **Step 2:** Estimate the Magnitude of the impact on the feature from the proposed development (Table C4: Geology, Table C5: Hydrogeology).
- **Step 3:** Determine the Significance of the impact on the feature from the matrix (Table C6) based on the Importance of the feature and the Magnitude of the impact.

IGI (2013) and NRA (2008) tables of significance to this study are presented here as Table 7.1, Table 7.2, Table 7.3 and Table 7.4. These frameworks for assessment have been applied in this chapter.

Table 7.1 Criteria for Rating Site Importance of Hydrological Features (NRA, 2008)

Importance of Attribute	Criteria	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
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 > 2,500 homes • Quality Class A (Biotic Index Q4, Q5) • Floodplain protecting more than 50 residential or commercial properties from flooding • Nationally important amenity site for 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-Q4)** • **Floodplain protecting between 5 and 50 residential or commercial properties from flooding** • **Locally important amenity site for wide range of leisure activities**
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) • Floodplain 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) • Floodplain protecting 1 residential or commercial property from flooding • Amenity site used by small numbers of local people

Table 7.2 Criteria for Rating Site Importance of Hydrogeological Features (NRA, 2008)

Importance of Attribute	Criteria	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, significance 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
High	Attribute has a high quality, significance or value on a local scale	• Regionally important aquifer. Groundwater provides large proportion of base flow 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, significance or value on a local scale	• Locally important aquifer. Potable water source supplying >50 homes
Low	Attribute has a low quality, significance or value on a local scale	• Poor bedrock aquifer. Potable water source supplying < 50 homes

The assessment of the magnitude of an impact incorporates the timing, scale, size and duration of the impact. The magnitude criteria for geological impacts are defined in Table 7.3.

Table 7.3 Criteria Estimating Magnitude of Impact on Hydrogeology Attributes (IGI, 2013 Table C5, NRA, **2008)**

Impact Type	Magnitude of Impact	Example
Adverse	Negligible	• No measurable changes in attributes
	Small	• Removal of small proportion of aquifer • Changes to aquifer or unsaturated zone resulting in minor change to water supply springs and wells, river baseflow or ecosystems. Potential low risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >0.5% annually
	Moderate	• Removal of moderate proportion of aquifer • Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or ecosystems Potential medium risk of pollution to groundwater from routine runoff Calculated risk of serious pollution incident >1% annually
	Large	• Removal of large proportion of aquifer • Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems Potential high risk of pollution to groundwater from routine runoff Calculated risk of serious pollution incident >2% annually
Beneficial	Minor	• Minor enhancement of aquifer
	Moderate	• Moderate enhancement of aquifer
	Major	• Major enhancement of aquifer

The matrix in Table 7.4 determines the significance of the impacts based on the site importance and magnitude of the impacts as determined by Table 7.1 to Table 7.3.

Table 7.4 Criteria for Rating Significant Environmental Impacts (IGI, 2013, Table C6)

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

The application of criteria, as outlined in Table 7.1 to Table 7.4 above, to the specifics of the study area provides a general screening of the likely impact to the hydrological and hydrogeological environment. The methodology involves the identification all of the potential receptors within the site boundary and surrounding environment. This information was gathered during the desk study, site walkover, site investigation and monitoring phases of the study. The Impact Assessment is presented in tabular format towards the end of this chapter.

7.2.7 DEWATERING IMPACT APPRAISAL

In addition to the application of Irish Guidelines as outlined in EPA (2022) and NRA (2008), and in the absence of Irish Guidance specifically focussed on quarries and hydrogeology, the work presented in this EIAR Section has also applied UK practical guidance as published by the **UK Environment Agency** (the UK's public body equivalent of the Irish EPA). The UK Guidance provides a **'Hydrogeological impact appraisal for dewatering abstractions'** (Boak, R. et. al. (2007) and the approach is succinctly outlined by the EA as follows:

"The methodology for hydrogeological impact appraisal (HIA) is designed to fit into the Environment Agency's abstraction licensing process. It is also designed to operate within the Environment Agency's approach to environmental risk assessment, so that the effort involved in undertaking HIA in a given situation can be matched to the risk of environmental impact associated with the dewatering. The HIA methodology can be summarised in terms of the following 14 steps:

- ***Step 1:*** Establish the regional water resource status.
- ***Step 2:*** Develop a conceptual model for the abstraction and the surrounding area.
- ***Step 3:*** Identify all potential water features that are susceptible to flow impacts.

- ***Step 4:*** Apportion the likely flow impacts to the water features.
- ***Step 5:*** Allow for the mitigating effects of any discharges, to arrive at net flow impacts.
- ***Step 6:*** Assess the significance of the net flow impacts.
- ***Step 7:*** Define the search area for drawdown impacts.
- ***Step 8:*** Identify all features in the search area that could be impacted by drawdown.
- ***Step 9:*** For all these features, predict the likely drawdown impacts.
- ***Step 10:*** Allow for the effects of measures taken to mitigate the drawdown impacts.
- ***Step 11:*** Assess the significance of the net drawdown impacts.
- ***Step 12:*** Assess the water quality impacts.
- ***Step 13:*** If necessary, redesign the mitigation measures to minimise the impacts.
- ***Step 14:*** Develop a monitoring strategy.

The steps are not intended to be prescriptive, and the level of effort expended on each step can be matched to the situation. Some steps will be a formality for many applications, but it is important that the same thought-process occurs every time, to ensure consistency. The methodology depends heavily on the development of a good conceptual model of the dewatering operation and the surrounding aquifer. The steps of the methodology are followed iteratively, within a structure with three tiers, and the procedure continues until the required level of confidence is achieved. Advice is also given on how to undertake HIA in karstic aquifers and fractured crystalline rocks." Boak et al. (2007).

While there are the Irish EPA's 'Environmental Management Guidelines for the Extractive Industry (Non-Scheduled Minerals)' (EPA 2006), Hydro-G and Envirologic also employ hard rock specific guidance, as follows:

- **Reclamation Planning in Hard Rock Quarries.** Department of Civil & Structural Engineering, University of Sheffield, Edge Consultants & Mineral Industry Research Organisation (2004).

- **A Quarry Design Handbook.** 2014 Edition. GWP Consultants and David Jarvis Associates Limited, UK.

Hydro-G and Envirologic adopted and applied the thought process and applied knowledge of how groundwater moves in Irish aquifers in order to present a reasoned assessment of the potential for impact that might arise in response to deepening excavations at the site.

7.2.8 DESK STUDY INFORMATION RESOURCES

The following sources of information relating to published and mapped information for the site and its region were used in the compilation of this assessment:

- An Bord Pleanála (2002). Inspector's Report, PL ABP 309109-21 (Assessment completed by An Bord Pleanála for the original planning for the site).
- Apex (2021) Report on The Geophysical Investigation At McGough Lands Lobinstown Co. Meath.
- Breedon Quarterly hydrochemical sampling reports, annual macroinvertebrate survey reports and continuous daily flow meter results for the site.
- Finch, T.F., Gardiner, M.J., Comey, A., Radford, T. (1983). *Soils of County Meath*. An Foras Taluntais.
- EPA (2018) Catchment Newry, Fane, Glyde and Dee, Subcatchment Dee_SC_030. Code 06_4Subcatchment Assessment WFD Cycle 2.
- EPA (2021)a 3rd Cycle Draft Catchment Report (HA 06). Catchment Science & Management Unit Environmental Protection Agency August 2021 Version no. 1.
- EPA (2021)b Assessment of the catchments that need reductions in nitrogen concentrations to achieve water quality objectives. WFD River Basin Management Plan – 3rd Cycle. June 2021. EPA Catchments Unit. Version no. 1.6. https://www.catchments.ie/assessment-of-the-catchments-that-need-reductions-in-nitrogen-concentrations-to-achieve-water-quality-objectives/
- EPA Envision Mapping On-line. WFD Status reported for the current period (2016-2021), 3rd Cycle Risk mapping, hydrochemical and Biological water quality mapping, https://www.catchments.ie online monitoring records for regional GWBs, https://gis.epa.ie/EPAMaps/ & historical monitoring records for the site's water quality.
- GSI (1996) County Meath Groundwater Protection Scheme. https://secure.dccae.gov.ie/GSI_DOWNLOAD/Groundwater/Reports/GWPS/MH_GWPS_MainReport 1996.pdf
- GSI (2004a) Louth GWB Description June. 2004
- GSI (2004b) Nobber PWS Groundwater Protection Zone Report. Revised by Geoff Wright.
- GSI (2004c) Slane PWS Groundwater Protection Zone Report. Revised by Geoff Wright.
- GSI (2012a) Establishment of Groundwater Source Protection Zones: Ardee Water Supply Scheme Curraghbeg Borehole. Gerry Baker, for GSI and Louth County Council.
- GSI (2012b) Establishment of Groundwater Source Protection Zones: Collon Water Supply Scheme Collon Boreholes. Pat Groves, for GSI and Louth County Council.
- GSI on-line Data and Maps Resources including but not limited to the Geology Mapper, Geoheritage Mapper, Climate Mapping, Landslides, Geotechnical Mapper, Tellus, Aggregate, Groundwater databases including Aquifer Classification, Groundwater

Vulnerability, Teagasc Soil Classification and GSI Subsoils mapping. https://dcenr.maps.arcgis.com.

- Met Eireann online historic climate data and publications. https://www.met.ie/
- McConnell, B., Philcox, M., Geraghty, M. (2001). *Sheet 13: Geology of Meath.* 1: 100,000 Bedrock Geology Map Series, Geological Survey of Ireland.
- Meath County Council On-line. Evaluation of groundwater usage and water supplies in the area using the County Council's ePlanning system, which provides comprehensive information of local houses and their water supply to supplement information gathered during the door to door well survey.
- NPWS On-line. Database of Special Areas of Conservation, National Heritage Areas, National Parks, Special Protection Areas including Site Synopsis and Conservation Objectives.
- Ordnance Survey of Ireland, 1:50,000 Discovery Map Series.
- SLR (2020) Water Chapter within EIAR submitted to accompany P.A. Ref. LB/200106.
- SLR (2020) Discharge Licence Application & Supporting Report(s) and Assessments.
- SLR (2021) Lobinstown McGough Lands Geological Assessment.

7.3 DESK STUDY - EXISTING ENVIRONMENT

7.3.1 METEOROLOGY

Preliminary, general, and unrefined surface water runoff calculations for the proposed overall quarry void area of c. 9.7 ha can be calculated using Met Éireann rainfall and evapotranspiration values along with GSI recharge coefficients.

Monthly gridded rainfall data was sourced from Met Éireann and is presented in Table 7.5

Table 7.5 Long Term Average Monthly Rainfall Data (mm) (Met Éireann)

30-Year Period	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1981-2010	82	63	68	63	68	73	67	80	73	93	85	88	902
1991-2020	80	69	63	64	64	74	79	83	74	95	96	88	929

As shown in Table 7.5, the published Average Annual Rainfall (AAR) over a 30-year period (1991 – 2020) at the site grid coordinates is 929 mm.

Rain falls and there will be some losses before it can either runoff to surface waters or recharge groundwater: the primary loss is evapotranspiration. Local weather data are provided by the nearest synoptic station to the site, which is Dunsany (Grange), which suggests that the average annual potential evapotranspiration (PE) rates are 536 mm.

Actual evapotranspiration (AE) is conventionally estimated by multiplying PE by 0.95, to allow for the reduction in evapotranspiration during periods when a soil moisture deficit is present (Water Framework Directive Working Group GW5, 2004). Actual evapotranspiration is therefore 509 mm/yr (0.95 PE).

The Effective Rainfall (ER) for the site, using Met Eireann AAR data, is determined as follows:

ER = AAR – AE = 929 mm/yr – 509 mm/yr = 420 mm/yr = **0.42 m/yr**

For comparative purposes,

(a) The GSI maps for groundwater recharge provide a value for effective rainfall at the site, which is 542 mm/yr (**0.54 m/yr**) (https://dcenr.maps.arcgis.com/). (The GSI mapped Effective Rainfall value is slightly higher than the value of 0.42 m/yr calculated using Met Eireann data.

(b) EPA Envision Mapping publishes Rainfall and Evapotranspiration values as part of the HydroTOOL model for nodes on the surface water system. HydroTOOL suggests that the weather environment at the Killary Water_010 has a Rainfall value of 924 mm/yr and an Evapotranspiration value of 507 mm/yr, which suggests an Effective Rainfall value of 397 mm/yr or **0.4 m/yr**, which is more in line with this team's calculation using Met Eireann data.

7.3.2 HYDROGEOLOGY

In these assessments hydrogeology is considered to include all aspects from the topsoil, subsoil, bedrock, aquifer classification and GSI mapped groundwater flow regime. There is a certain overlap with the information presented in the Lands, Soils & Geology Chapter of this EIAR (Chapter 6). In this Water Chapter, the characteristics of the subsurface components are described in terms of their significance in how rainfall travels through and recharges groundwater flows. The Land, Soils and Geology Chapter of this EIAR provides information for soils, subsoils and bedrock. This Water Chapter updates the geological components in terms of groundwater flow potential and the resultant surface water baseflow potential.

In overall summary, GSI maps the site as being underlain by the Louth Groundwater Body (GWB) (IEGBNI_NB_G_019). The Louth GWB has a descriptor sheet (GSI, 2004a) and it is reported as having an area of 1,621 km^2, which is large. The actual Poor Aquifer is mapped by the GSI as having a very small area of 129.52 km^2. This means that the Louth GWB has many different aquifer types within it. Details on all hydrogeological components are presented in the following sub sections.

7.3.2.1 Groundwater Recharge

Using vulnerability classifications and hydrogeological settings, recharge coefficients can represent the ratio of precipitation that theoretically infiltrates vertically to the water table to that which moves as surface overland flow. Based upon the vulnerability classification of extreme, the GSI assigns a groundwater recharge coefficient of 85%. When this recharge coefficient is applied to the GSI's Effective Rainfall value of 542 mm/yr the calculated resultant recharge rate to top of bedrock is equivalent to 461 mm/yr. However, because of the nature of the metamorphic rock under the site the GSI assigns a 'recharge cap' which restricts groundwater infiltrating into the bedrock aquifer to a rate of 100 mm/yr. This low value of potential groundwater recharge makes sense in the context of the bedrock observed in the walls of the site. The GSI's 100 mm/yr value for groundwater recharge suggests low potential for groundwater interception in the one more bench of excavation proposed for the working quarry and the proposed excavation in the eastern application greenfield area.

7.3.2.2 Groundwater WFD Status

The site lies within the Louth Groundwater Body (GWB). The EPA maps the Louth GWB (European Code IEGBNI _NB_G_019) as Good Status (2016 - 2021) and 3rd Cycle Not At Risk. WFD reports for the area (EPA 2018, 2021) do not indicate any significant pressures on the groundwater body (https://gis.epa.ie/EPAMaps/). The 2nd and 3rd Cycle reporting periods are concurrent to quarrying at the site. No pressures are reported by the EPA's WFD catchment teams, the GWB remains as Good Status, no risks are reported for the area for the duration of quarrying activity at the site.

7.3.2.3 Groundwater Vulnerability

Groundwater vulnerability is a function of the nature of the overlying soil and subsoil cover and the thickness of overburden above the water table. Groundwater vulnerability is a concept designed to assist and enable appropriate management of potentially polluting activities such as land spreading of agricultural slurries, landfills and on site wastewater treatment systems serving unsewered developments in rural areas.

Groundwater vulnerability is mapped by the GSI as Extreme (X) for the extension area and the active quarry (Figure 7.2). This is because there is rock at or near surface. This is the nature of quarrying bedrock, which requires removal of overburden. Groundwater vulnerability rating at all quarry sites is extreme. The flatter, low-lying part at the northern end of the existing quarry site, where the settlement lagoon is sited, is mapped as Extreme (E) groundwater vulnerability. These mapped groundwater vulnerability characteristics are not intended to prevent development, such as quarries, only to control pollutants in those areas under natural conditions. There are no organic sources of contamination at bedrock excavation areas, additionally comprehensive water management infrastructure is in place at this excavation area. Therefore, no risk to groundwater, on the basis of mapped groundwater vulnerability, is envisaged.

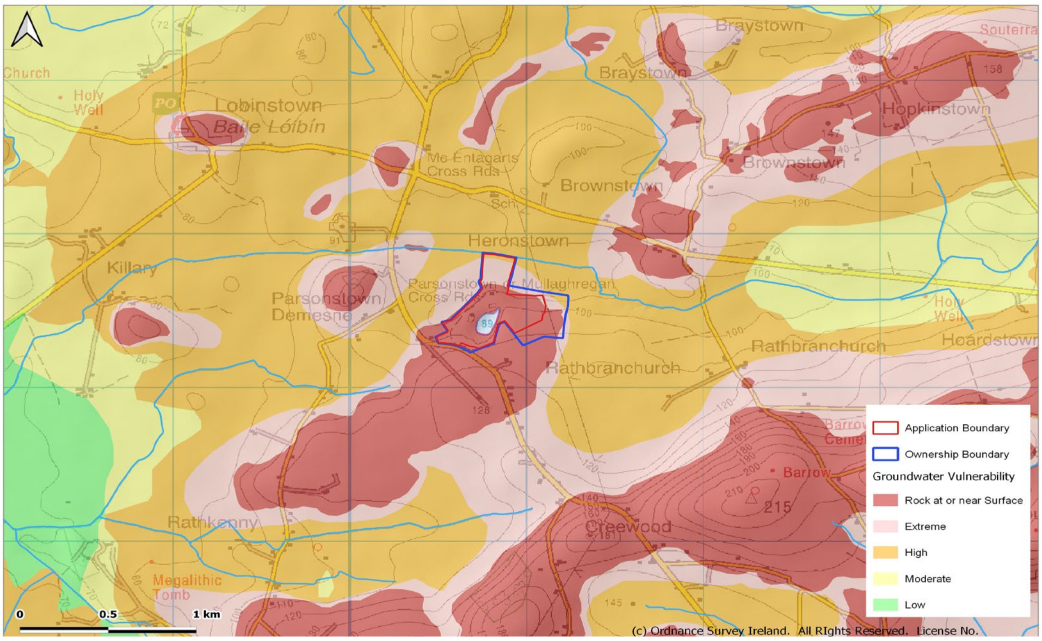


Figure 7.2 Groundwater Vulnerability Classification in Wider Area (GSI, 2023)

7.3.2.4 Bedrock

The Meath County Groundwater Protection Scheme (GSI, 1996) states that Lower Palaeozoic rocks of the Salterstown Formation which underlies the application area site generally consist of siltstones and mudstones with minor greywackes and sandstones. These rocks are very fine grained, have been intensively folded, faulted and altered and have a very low permeability. Groundwater is restricted to the shallow weathered zone at the surface or along fault and fracture zones. Well data for these geological units are very poor and yields are generally less than 40 m^3/d.

7.3.2.5 Aquifer Classification

The GSI describes the bedrock in the area as a Poor Aquifer, which is generally unproductive in terms of groundwater resources (Pu) (Figure 7.3). This aquifer is mapped by the GSI as covering an area of 129.52 km^2 and as having a Poorly Productive Groundwater Flow regime.

The GSI suggests that the Poor Aquifer classification means that the aquifer is only capable of supplying small abstraction (e.g., domestic supplies) or 'moderate' to 'low' yields (i.e. < 100 m^3/d). Groundwater in this type of aquifer flows through a poorly connected network of fractures, fissures and joints. Yield is often dependent upon the permeability developed in the uppermost few metres of broken and weathered rock. This GSI classification of the bedrock providing only Poor potential for groundwater (aquifer) tallies with the hard rock, *i.e.,* High Polished Stone Value (High PSV), resource provided to the construction and roads industry by the site. The rock is hard and has little ability to provide movement space for groundwater.

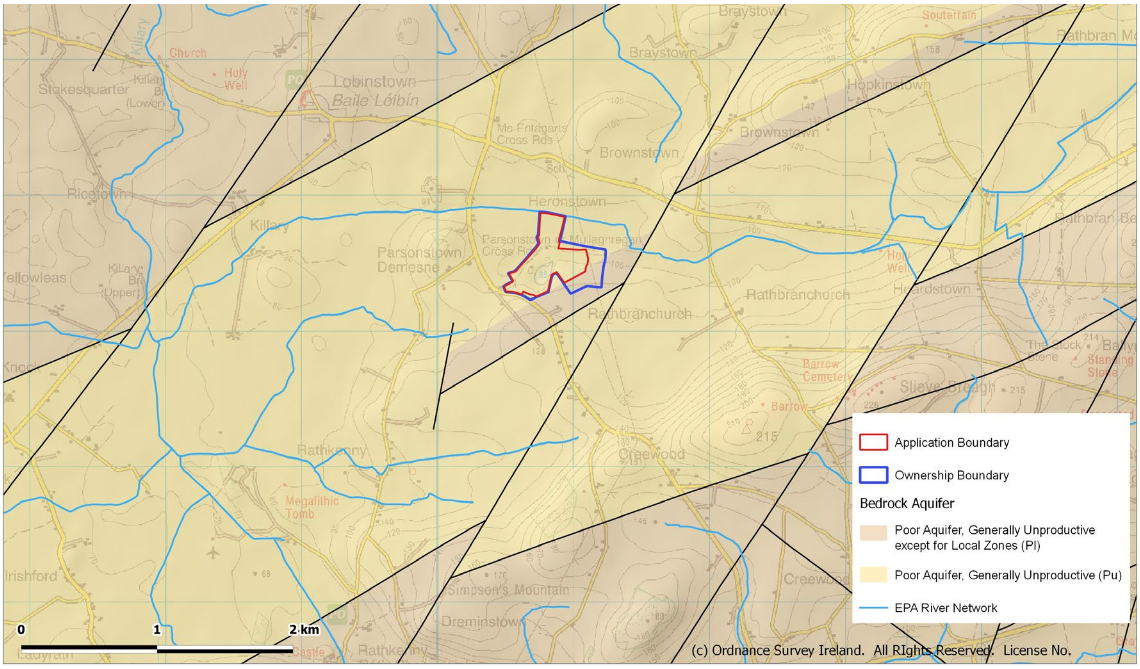


Figure 7.3 Bedrock Aquifer Classification in Wider Area (GSI, 2023)

7.3.2.6 Mapped Karst

Neither the application site nor any of the overall landholding is mapped as karst. There are no mapped karst features within the site or in any proximity of relevance. GSI karst mapping suggests as follows:

(i) There is a mapped karst "spring" at 9 km to the south east (IE_GSI_Karst_40K_260) but the details provided by the GSI database is that it is a BH drilled by KT Cullen in Slane, where 2,000 m^3/d is abstracted. That karst feature occurs in an area of intense bedrock deformation in the vicinity of Slane. The feature is on the southern banks of the River Boyne. It is asserted by Hydro-G that there is no potential for interaction with the proposed development under consideration in this assessment. There are no topographical or geological features at the application site to suggest that karst features may be present, even if they are not presented on the national scale mapping. The metamorphic bedrock of the application site does not provide the environment required for the development of karst features. Karst features form in bedrock where there is potential for rain to percolate and enhance zones of weakness. The metamorphic hard rock of the application area does not present an environment type in which rainfall can infiltrate.

(ii) There is a mapped karst "spring" at 10 km to the north east (GSI Karst Feature ID 2929SWK001) but details provided by the GSI database suggests that it is a borehole drilled by Minerex Ltd. at the Mental Hospital Farm, Ardee, Co., Louth. That feature occurs in a type of limestone bedrock that can be weakened by rainfall. The feature is in a different type of bedrock than occurs in the quarry under assessment here. It is asserted by Hydro-G that there is no potential for interaction with the proposed development under consideration in this assessment.

7.3.2.7 GSI Well Database

The nearest wells mapped on the GSI database are 0.5 km north of the site, as shown in Table 7.6. The wells are generally only capable of providing low yields suitable for domestic supplies.

Table 7.6 GSI Well Database in Wider Area

Ref/Owner	Location	Depth, m	Yield, m^3d^{-1}	Yield Class	Notes
Meath Co. Co.	0.5 km N	6.7			Installed 1964
	1.0 km S	6.7			Dug Well, 1962
	2.2 km W	21.3	5.5	Poor	178 mm dia. casing
	2.3 km N	2.7	10.9	Poor	Dug Well, 1972
Agri.	2.5 km SE	39.6	Fail		
	2.7 km SE	4.3	13	Poor	Dug Well, 1972

There are likely to be other wells in the area, because the GSI database is no longer complete, and the Field Investigations Section of this Water Chapter will present details of the local area well search.

In addition to review of GSI databases, historical Ordnance Survey of Ireland (OSI) maps were consulted as a reference point for identifying domestic wells and springs.

The application area is shown as a quarry on historic 25" mapping.

The OSI 25" map shows a well adjacent to a building mapped at the southeastern corner of the existing quarry. This building is no longer present. Very few of the dwellings in the wider area have adjacent wells indicated.

A surface watercourse is mapped running adjacent to the northern boundary of ownership, flowing in an east to west direction. This watercourse still exists and is the receiving water for the site's treated water, as specified in the Section 4 Discharge Licence Ref. 20/01.

7.3.2.8 Public Water Supplies & Source Protection Areas

The nearest mapped source protection areas serving Uisce Eireann Public Water Supply sources (PWS) abstracting groundwater, are as follows:

- Nobber PWS, Co. Meath, whose source is 9.2 km northwest of the application site. The Groundwater Source Protection Zone Report for Nobber Water Supply (Wright for the GSI, 2004b). Nobber PWS abstracts from the Carrickmacross GWB (IE_NB_G_016). The aquifer feeding the Nobber source is the Calp Limestone. This is overlain by up to 19.5 metres of interbedded silts, sands and gravels that are highly permeable, therefore the aquifer is considered to be unconfined. Permeabilities within the bedrock are increased by joints and fractures. The web published EPA Register of Abstractions (July, 2023) suggests that Nobber PWS and the Nobber abstractions of Uisce Eireann account for <300 m^3/d. The Zone of Contribution (ZOC) for those abstractions is remote from the application site. There are no geological or hydrogeological reasonings to suggest any potential for connection between the abstraction at Nobber, from 'calp' limestones and the application area.
- Slane PWS, Co. Meath, whose source is 9.3 km to the southeast of the application site. The Groundwater Source Protection Zone Report for Slane Water Supply (Wright for the GSI, 2004c). Slane PWS abstracts from the Trim GWB (IE_EA_G_002). The web published EPA Register of Abstractions (July, 2023) suggests that three mapped abstractions of Uisce Eireann at Slane are in the total order of ~2,000 m^3/d. The ZOC for those abstractions is remote from the application site. There are no geological or hydrogeological reasonings to suggest any potential for connection between the abstraction at Slane, from 'calp' limestones and the application area.
- Ardee PWS, Co. Louth, whose source is 9.5 km northeast of the application site. The Source Protection Zone Report for the Ardee PWS's source 'Curraghbeg Borehole' (GSI, 2012a) suggests that this PWS Bore Hole (BH) is in the Ardee GWB and abstracts from impure bedded limestones and 'sandy limestones' that are classified as a Locally important bedrock aquifer that is Moderately Productive. Ardee PWS abstracts from the Ardee GWB (IE_NB_G_018). Although close to the River Dee, the GSI (2012a) assessment concludes that the water abstracted from this 'excellent BH' is not in any way connected to the River Dee. Hydro-G therefore concludes, that on the basis of the Ardee BH being in a different GWB and in a different type of bedrock and not connected to the River Dee, there is no potential for the application area to interact with this PWS.

- Collon PWS, Co. Louth, whose source is 9.45 km east of the application site. The Source Protection Zone Report for the Collon PWS's source 'Collon Boreholes' (GSI, 2012b) suggests that the water supply abstracts groundwater from the Wilkinson GWB, from saturated sands and gravels that overlie volcanic rocks in the valley of the Mattock River. Hydro-G therefore concludes, that on the basis of the Collon PWS being in a different GWB and in a different type of bedrock, there is no potential for the application area to interact with this PWS.

The nearest mapped source protection area serving a National Federation of Group Water Schemes (NFGWS) groundwater source is Meath Hill GWS, which is 13 km northwest of the application site. There is another GWS groundwater source named Grangebellew, which is 19.6 km to the northeast of the application site. There is no potential for interaction between the application site and these GWS groundwater sources because they are each in different GWBs and different types of bedrock.

In overall summary, each of the listed schemes are within different topographical catchments, different GWBs and different bedrock types to those same mapped characteristics at the application site. Hence, it can be deduced that there are no groundwater sources for public supply at risk of impact from the proposed development.

7.3.2.9 Conceptual Understanding of the Groundwater Body

The GSI maps the site as being underlain by the Louth Groundwater Body (GWB) (IEGBNI_NB_G_019). The Louth GWB has a descriptor sheet (GSI, 2004a) and it is reported as having an area of 1,621 km^2, which is large.

The main rock unit reported for the Louth GWB (GSI, 2004a) are the Silurian Metasediments and Volcanics, which is the rock type of the application area. These rocks tend to dip in a predominantly southeast direction with a large number of faults with associated perpendicular faults.

The GSI (2004a) describes as follows:

- The main rock group in this GWB is the Silurian Metasediments and Volcanics (82.56%) although Granites & Other Igneous Intrusive Rocks dominate the northeast portion (12.34%). Smaller areas of other rocks (c. 1% each) are also recorded in the GWB (Dinantian Limestones, Sandstones and Shales; Ordovician Metasediments, Namurian Shales) with other minor areas.
- Well yields are generally low (<200 m^3/d). Those at the higher end of the range tend to be located near fault zones and along the margins of the groundwater body.
- No local transmissivity values are available for the Silurian rocks although national data generally reflect low (<20 m^2/d) transmissivity values.
- Specific dry weather flows from 6 hydrometric stations in the Silurian rocks are low (0.01–0.69 l/s/km^2). These values suggest that this aquifer does not make a significant baseflow contribution to streamflow.
- Storativity is also expected to be low.

- Groundwater levels tend to be within 10 m of surface and of 270 wells reviewed 50% displayed groundwater levels within 5 m of surface.
- Due to the low permeability of the rocks, groundwater gradients are expected to be relatively steep.
- The bedrock is comprised of low transmissivity rock.
- **Most groundwater flux is expected to be in the uppermost part of the aquifer comprising a broken and weathered zone typically less than 3 m thick**.
- There is potential for groundwater flow in a zone of interconnected fissuring approximately 10 m thick.
- There is a small potential for groundwater flow in a zone of isolated poorly connected fissuring typically less than 150 m deep.
- Diffuse recharge occurs via rainfall percolating through the subsoil and rock outcrops. Due to the low subsoil permeability a high proportion of the effective rainfall will quickly discharge to streams.
- In addition, steeper slopes in the hilly areas promote surface runoff.
- **Recharge occurs diffusely through the subsoil and rock outcrops, although can be limited by thicker till, and the low permeability bedrock.**
- **Therefore, most of the effective rainfall is not expected to recharge the aquifers.**
- Unconfined groundwater flow paths are short (i.e. 30-300 m), with groundwater generally following the local topography and then discharging rapidly to seeps, small springs, streams and lakes. The degree of permeability of this bedrock can be highly variable, depending on the degree of weathering and the density and connectivity of fractures.

7.3.2.10 Groundwater Flow Direction

Groundwater flow direction is determined on the basis of topography and surface water drainage, both of which influence the groundwater flow.

Groundwater will flow in a north to northeasterly direction towards the watercourse that flows adjacent to the northern boundary of the application area. It is likely that any groundwater flowing through the bedrock eventually discharges into this stream as baseflow. However, as stated by the GSI (2004a) in the Louth GWB Descriptor Sheet, the dominant mechanism for rainfall discharge in this GWB is directly to streams rather than recharging groundwater. On a local scale to the quarry, in low yielding aquifer environments such as this, small, localised flow towards the lowest elevation of the quarry is expected.

7.3.3 HYDROLOGY

The hydrological component of the assessment requires an understanding of surface water drainage patterns in the area and clarification of the surface water catchments contributing flow to the various watercourses in the area. This is hereby presented in the following sections.

7.3.3.1 Synopsis of Local & Regional Hydrology

The active quarry and the easterly extension lands both sit within Water Framework Directive (WFD) Catchment 06: Newry, Fane, Glyde and Dee.

Within this overall WFD Catchment 06, the site is mapped by the EPA as lying within sub-catchment Dee_SC_30 (ID 06_4) and sub basin KILLARY WATER_010 (IE_NB_06K010100), which has an EPA mapped catchment area of 25.9 km^2. The Killary Water merges with the River Dee_SC_15 downstream (and east) of Ardee.

The raised Ferrard Hills to the south of the application site form the WFD catchment divide between HA06 and HA07 (Boyne).

Regional hydrology is influenced by these Ferrard Hills, which are a southwest-northeast orientated raised ridgetop (215 m OD) to the south-southeast of the application site. From this raised area, lands fall to the north-northwest.

A much lower ridge extends from a peak at Creewood (181 m OD) in a northwest direction and terminates at a lower but still locally prominent hill at Parsonstown Demesne, which peaks at 110 m OD at a distance of 830 m to the west of the application site. This has the effect of creating a very minor valley a short distance west of the western boundary of ownership. This minor valley is drained by an open channel named by the EPA as Parsonstown Demesne.

There is a sloping topographical gradient continuing from south to north through the working quarry and its adjacent application area. Natural land elevation falls from the southerly entrance of the site to the northern boundary of ownership. Along the site's northern boundary there is a small valley that runs east to west. This minor valley on the northern boundary of ownership is drained by a first order stream, referred to on the EPA database as the Killary Water_010. The Killary Water_010 stream is the water body that receives the site's treated waters under MCC Ref. 20/01 Section 4 Discharge Licence. The surface water flows in a westerly direction and has a catchment of 6.63 km^2 at the quarry discharge point (see Figure 7.4) and 9.18 km2 at the point at which this stream merges with the Killary_020.

Field boundaries in the area tend to coincide with open field drains. The eastern boundary of the application site extends to a field boundary which includes an open drainage channel. This drainage channel is not a mapped surface water feature because it drains land only and is not considered a WFD surface water.

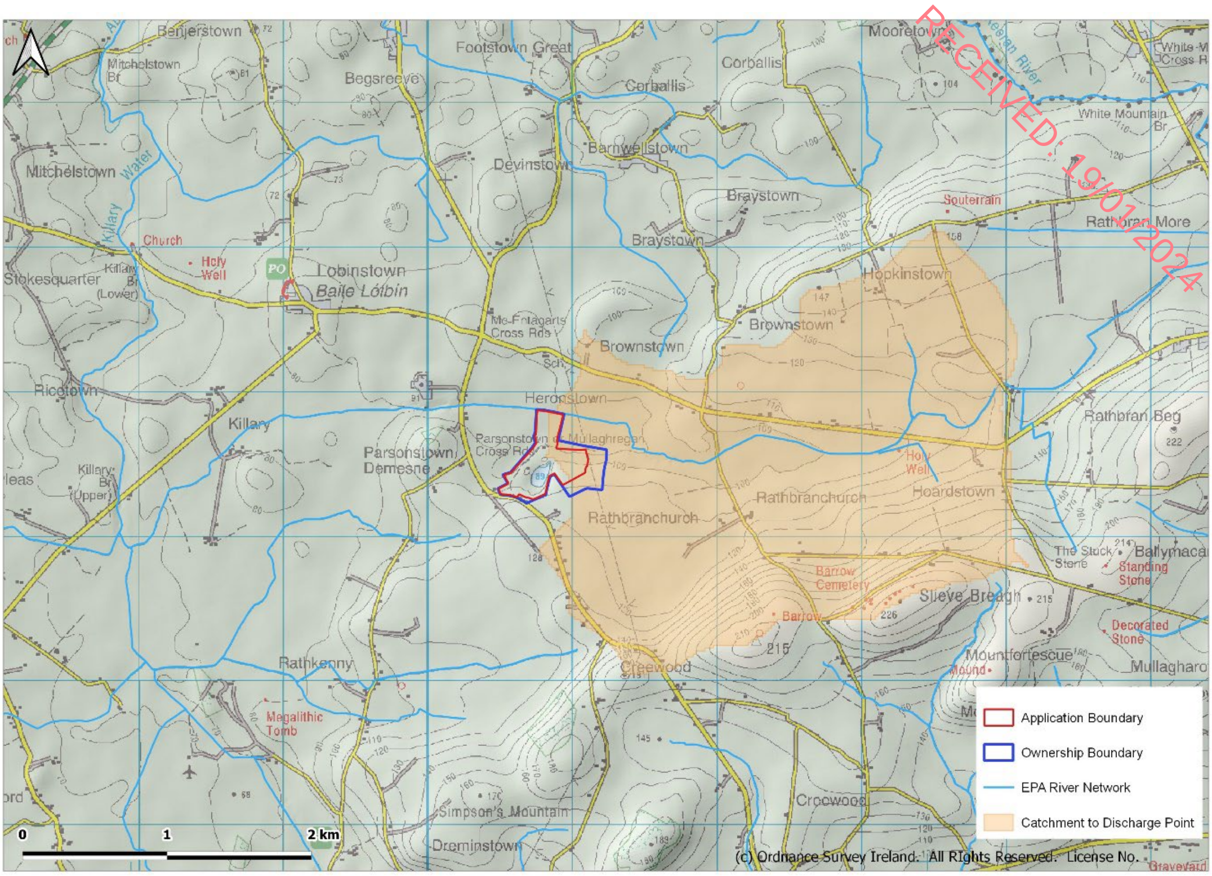


Figure 7.4 Surface Water Systems, Site and Catchment to the Site's Discharge Point (Ref. 20/01)

The Killary_010 stream enters the Killary_020 surface water at a distance of 3.0 km west of the application site, just upstream of a bridge crossing on the local road. Prior to the confluence of the Killary_010 and the Killary_020, the upgradient catchment to the Killary_020 is mapped by the EPA as 13.9 km^2.

The Killary_020 merges with the River Dee (Dee_050, IE_NB_06D010600) at a stream length, river flow, distance of 9.8 km downstream of the site, close to the N52 at Caddlestown. The catchment areas of the Killary Water and River Dee at this confluence are 44 km^2 and 113 km^2, respectively. The River Dee subsequently discharges to the Irish Sea at Annagassan.

7.3.3.2 Surface Water WFD Status

The Killary Water _010, which flows parallel to the site's northern boundary and is the licensed receiving water for the site's discharge, is mapped by the EPA, as follows:

- WFD Status (2016 to 2021) = Moderate Status
- WFD Risk 3rd Cycle = 'At Risk'
- River Significant Pressures mapped as Agriculture, Urban Wastewater, Peat extraction at Glaskeelan_010, Land drainage around Lough Gartan.

The 2nd Cycle Report (EPA, 2018) entitled WFD Cycle 2 Catchment Newry, Fane, Glyde and Dee (Sub-catchment Dee_SC_030. Code 06_4) provides an evaluation of priority sub-catchment issues as follows:

- *The five river water bodies within this subcatchment are all AT RISK due to their less than Good ecological status. Killary Water_010 is of Moderate ecological status but there are no chemistry data currently available.*
- *Elevated ammonia concentrations are an issue within the Dee_060, while elevated phosphate and ammonia are issues within the remaining water bodies (Killary Water_020, Dee_070 and Dee_080).*
- *Throughout the subcatchment, agricultural activities (e.g., landspreading, farm yards) have being identified as a significant pressure impacting nutrient conditions, in addition to channelisation as this activity may impact physical habitat conditions (particularly in relation to excessive fine sediment).*
- *Wastewater treatment is also an issue impacting Killary Water_010, Dee_070 and Dee_080.*

The quarry is not mentioned in any EPA report. None of the WFD catchment reports cite the quarry as presenting any issue with respect to WFD characterisations.

7.3.3.3 EPA Hydrochemistry

The EPA's Envision catchments.ie/data tool allows download of water chemistry data for National Water Monitoring Stations. There is a station RS06K010100 on the Killary_010 but it reports data only for the year 2007. Given that these data are from 16 years ago, they are not deemed relevant to the assessment of this application. There are, of course, data from previous applications for planning associated with the site. These are discussed later in the chapter as this section addresses national datasets.

7.3.3.4 EPA Biological Water Quality

The status of the Killary Water_010 is reported by EPA Envision mapping as Moderate for the period 2016 – 2021.

The nearest Q-rating monitoring point relevant to the site is 3.5 km downstream on the Killary Water as it flows under the local road connecting Knock Crossroads and Lobinstown, referred to as Killary Bridge Upper, as shown in Figure 7.5. Water monitored at this point includes a blend of the Killary Stream, which flows past the site, and tributaries of the Killary Water south of this bridge.

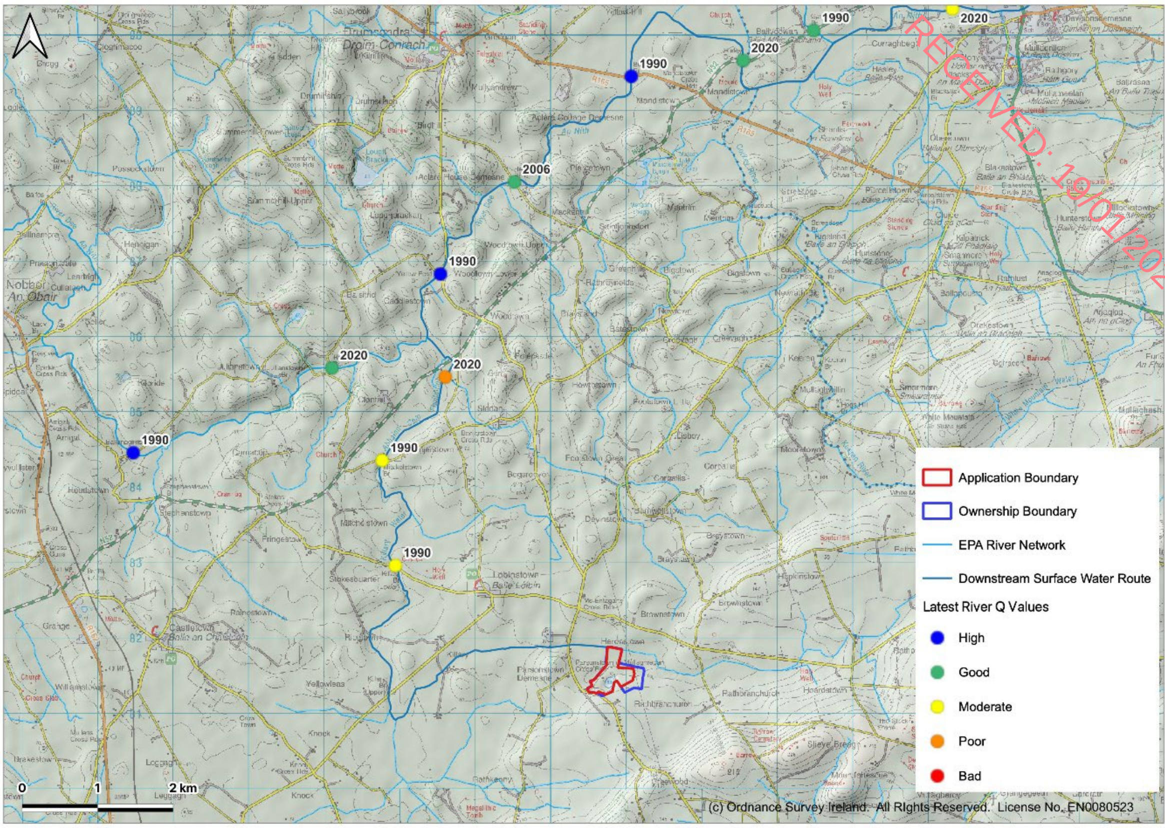


Figure 7.5 Latest Biological Q-Rating Values (EPA)

The latest biological score at this point was 3-4 (Moderate), recorded in 2020. This station has had a relatively consistent score of Q3-4 across the monitoring period 1990–2020, with the recent exception of Q4 recorded in 2018. The latest Biological Monitoring report for Hydrometric Area 06 (https://epawebapp.epa.ie/qvalue/webusers/PDFS/HA6.pdf) does not provide data for the reasons for the Q3-4 ecological rating. However, the 3rd Cycle report for the HA (EPA, 2021) cites that "Meath CC has done a lot of survey work in this catchment in 2019. Potential to build on this and get improvements." Considering that MCC issued the site its Section 4 Discharge Licence in the year 2020, it seems reasonable to infer that the quarry is not a contributing factor in the Q = 3-4 ecological rating for the Killary Water_010.

Locations of additional downstream biological water quality monitoring stations are also shown in Figure 7.5. These stations show a downward trend in biological water quality between Killary Bridge Upper and the next downstream monitoring station on the N52, just upstream of the outfall to the River Dee, which returned Q3 (Poor). Further downstream on the River Dee biological water quality was shown to improve under the 2020 monitoring programme, with a Q4 rating measured at Burley Bridge upstream of Ardee.

7.3.3.5 Hydrometric Stations & Low Flows

There are no hydrometric stations on the Killary Stream or Killary Water. There are two active hydrometric gauges on the River Dee.

- Burley Bridge (OPW:06025), a short distance upstream of Ardee. Although EPA HydroNET suggests that the station has historic flows, the OPW Hydro Data only presents water levels. This station is 15 km stream length from the site. It is too far to be of relevance to the application assessment.
- Charleville (OPW: 06013), between Ardee and the coastal outfall, records flow and level. This station is even farther from the application site. OPW HydroDATA reports a 95%tile (low flow value) of 12.926 m^3/s, which is broadly equivalent to a daily low flow rate of 1,116,806 m^3/d or ~1.1 Million m^3/d. The scale is what is important. The value of ~1.1 Million m^3/d low flow (95%tile) flow on the river system receiving the Section 4 discharge from the site before the river joins the ocean is important in terms of the scale of the ELV of the licence being 1,728 m^3/d.

7.3.3.6 Designated Areas

Designated sites were also presented in Figure 7.1. The application site is not within a designated area and there are no designated areas within 6 km. The closest designated site is Mentrim Lough pNHA, 6 km to the north, though there is no hydrological connectivity between this waterbody and the application site.

It is noted that there is a European site Stabannan-Braganstown SPA (004091) 9 km to the north east of the application site and 5.7 km to the west of the southern portion of Dundalk Bay SAC and SPA. EPA Envision mapping presents that the catchment of Stabannan-Braganstown SPA is part of the Glyde River's catchment. The application site is mapped by the EPA to be part of a completely different river, named the Dee. There is no connectivity between the application site and Stabannan-Braganstown SPA.

The application area, and Lobinstown Quarry itself, are 8 km to the north west of the River Boyne and River Blackwater SAC (002299) and SPA (004232), at their closest. However, the site and the Boyne and River Blackwater SAC and SPA are neither hydrologically nor hydrogeologically connected. EPA Envision mapping maps the Boyne and River Blackwater SAC and SPA as being part of Hydrometric Area 07. Given that the application site is mapped as part of Hydrometric Area 06, there is therefore no connection between the proposed development and the River Boyne and River Blackwater SAC and SPA.

The only designated site with Conservation Objectives that may have hydrological or hydrogeological connectivity with the site is Dundalk Bay SAC (004026), SPA (004026) and pNHA (000455). The hydrological distance between the application site and Dundalk Bay is 43 km. Given the relatively small scale of the application area with respect to the scale of Dundalk Bay itself and its catchment area (2,125 km^2 reported in EPA, 2021) and the 40 km distance from the application site, there is no potential for any negative impact to the Conservation Objectives of Dundalk Bay SAC or any other designated site in the wider area. This is again discussed in the Impacts section of this EIAR.

7.3.3.7 Abstractions from Surface Waters

A review of the EPA Abstraction Register was undertaken for this assessment and it shows that there are no registered surface water abstractions from the Killary Water_010 or Killary Water_020.

Ardee PWS (2,995 m^3/d) and Greenmount (2,060 m^3/d) source drinking water in proximity to the River Dee. As previously stated, there is no potential for interaction or impact between the application site and associated proposed activities and any PWS for reasons including distance, different geology, different catchments and scale.

There is one private abstraction registered for the River Dee_080, which suggests that at that point the river is in its eighth phase of growth. The private registered abstraction (Register No. R01621-01, Abstraction Point Code APR002907) is an agricultural irrigation abstraction of 200 m^3/d but registered also as maximum 2,000 m^3/yr. This information suggests that it is an occasional drought response measure. Given that the abstraction is at least 20 km stream flow length from the application site, there is no potential for interaction. The abstraction is <0.4% of the HydroTOOL NATQ95 value for low flow of the river and therefore considered insignificant.

7.3.3.8 Discharges to Surface Waters

Other than the site's own Section 4 Discharge to the Killary Water_010, there is a discharge from Lobinstown WWTP to the downstream Killary Water_020. Lobinstown's WWTP has design capacity to discharge 13.5 m^3/d (current PE 44. design PE 60) to an unnamed tributary which flows west from Lobinstown and outfalls to the Killary Water_020, downstream of its confluence with the Killary Water_010. The WWTP comprises primary (septic tank) and secondary treatment (peat filter). Given that there are no sources of organic wastes at the application site, it can reasonably be inferred that there is no potential for cumulative impact resulting from the quarry in respect to Lobinstown WWTP's discharge.

There are no other Section 4 Discharge Licences mapped on EPA Envision mapping for the river systems or GWB associated with the application site.

7.3.3.9 Flood Risk

With respect to Desk Study, there is no national agency mapping to suggest any surface water or groundwater flood risk in the area.

A site-specific flood risk assessment (FRA) was carried out by Envirologic in November 2023 for this assessment and is discussed in the Field Investigations Section of this Water Chapter. The site-specific FRA is presented as Appendix 7.2.

7.4 EXISTING WATER MANAGEMENT INFRASTRUCTURE

7.4.1 PRIMARY COMPONENTS

The primary components of the site's water management systems were developed in 2021 in accordance with P.A. Ref. LB/200106 (with ABP 309109-21) and were built as per the Conditions of the Section 4 Discharge Licence issued by MCC in November 2000 (Ref. 20/01).

The components of the site's water management systems are explained in this Section. The systems are designed to safeguard receiving waters, fish life and downstream European Sites. The surface water management system's layout is shown in Figure 7.6.

Figure 7.6 Site Layout and Surface Water Management System

7.4.1.1 Clean Water Source

Clean water is sourced from PW01, located just inside the site entrance in the south eastern portion of the overall site area (Refer to Figure 7.8). This water is used to as a potable water supply source in the staff canteen and toilets.

Groundwater pumped from PW01 is also used for process water within the quarry. It is pumped directly to a series of overground storage tanks with a combined capacity of approximately 35 m^3. Water levels in the tanks are relayed to PW01 well pump using float switches.

The quarry manager reports elevated iron in the water sourced from PW01. As such the rising main serving PW01 needs to be backflushed intermittently.

The quarry manager intends to alter the water management system such that clean process water is sourced from the main settlement lagoon rather than PW01.

7.4.1.2 Sump

With respect to the extraction area, some settlement of water occurs in the quarry floor sump. The sump is currently located in the southern portion of the working quarry floor. The existing quarry has been excavated below surrounding ground has a footprint of approximately 56,000 m^2. This is essentially a topographically enclosed depression. The lowest part of this void, which could be termed the current quarry floor, has a footprint of approximately 18,000 m^2. The depression within the lowest part of the void which collects waters is referred to as the sump (Plate 7.1). It is generally contained within an area of less than 500 m^2 but its perimeter can expand over any area required to accommodate rainfall-runoff within the quarry void. Currently, it has a capacity depth of approximately 1 m, but the water level has never been observed by the hydrogeologists to be 1 m deep.

Plate 7.1 View of Active Quarry Sump

Water collected in the quarry sump consists only of rainfall landing directly within the void along with any groundwater ingress. It has previously been described that surface water collecting in open field drains on lands to the east also enters the void. There is no additional catchment providing surface water to the sump. Sump water is pumped directly to the main settlement lagoon in the northern part of the site.

The interrogative sampling of November 2023 demonstrated that the sump acts efficiently and does not retain any nitrogen compounds.

7.4.1.3 Dust Suppression

Dust generated within the site during dry periods is suppressed using either water bowsers or spray cannons (Model: Komet Twin 101 Ultra), which are strategically positioned to serve active areas. Water supplying the dust suppression jets is sourced from the sump or water storage tanks.

7.4.1.4 Hardstanding Runoff

Rainfall-runoff generated on hardstanding areas in the upper yard inside the site entrance is collected in perimeter ACO drains and diverted to a soakaway.

Rainfall-runoff generated on the internal access road between the upper yard and the weighbridge area is diverted to Settlement Lagoon 2 (western lagoon), which is a specified design component Condition of the site's Section 4 Discharge Licence. The interrogative sampling of November 2023 demonstrated that the final large area Settlement Lagoon No. 1 efficiently removes excess solids collected in the Settlement Lagoon 2, which does not contain any nitrogen compounds.

7.4.1.5 Wheelwash

The wheelwash is a two-stage operation. Vehicles initially pass through a wheel bath (see Plate 7.2), which includes heavy duty bars on the entrance and exit. This is followed by side jets which spray the vehicle as it passes over a slatted tank. Water from the slatted tank is recycled to the spray jets. Overflows from both stages pass to the adjacent Settlement Lagoon 2 and they are then pumped to the final large main Settlement Lagoon 1, which as stated, efficiently removes excess solids collected in the Settlement Lagoon 2.

Plate 7.2 View of Wheelwash Looking from North to South

7.4.1.6 Settlement Lagoon 2 (West)

Settlement Lagoon 2 collects runoff from the internal haul road between the site entrance and the weighbridge area and overflow from the wheelwash. This settlement lagoon consists of three chambers (Plate 7.3) with overall footprint of approximately 180 m^2 (9 m x 20 m). The settlement pond requirement as specified in Condition 1.3 of the Ref. 20/01 Section 4 Discharge Licence, has been installed with increased capacity. This provides more treatment function and security to the site and its surrounding environment. Treated waters spillover into a linear trough before being diverted to a manhole from which treated waters are pumped to the main settlement lagoon. Settlement Lagoon 2 is cleaned as required, which is generally once a quarter.

Plate 7.3 View of Settlement Lagoon 2 (West), Adjacent to Wheelwash, Looking from North to South

7.4.1.7 Settlement Lagoon 1 (Main, North)

As stated, as part of the application granted under LB/200106 it was proposed that a new settlement lagoon be installed. The lagoon is supported by raised earthen banks and is made impermeable by a HDPE liner (see Plate 7.4).

The main settlement lagoon has a footprint of c. 2,000 m^2 and is fully functional.

Treated waters leaving the main settlement lagoon are discharged, as per the Ref. 20/01 Section 4 Discharge Licence, to the Killary Stream as it passes the northern boundary of ownership.

Surface water level in the settlement lagoon was measured to be 86.1 m OD in November 2023, with a bank top of 86.5 m OD, above a lagoon base elevation of 85 m OD, approximately. The depth capacity of this main settlement lagoon is therefore 1.5 m.

Plate 7.4 View of Main Settlement Lagoon Looking from South to North

Please refer to Appendix 7.1 for the Conditions of the Discharge licence and the as built drawings of the settlement systems.

7.4.1.8 Hydrocarbon Interceptor

All waters leaving the site boundary via the licensed discharge point pass through a hydrocarbon interceptor, which has been installed immediately downstream of the outlet of the main settlement lagoon. This will ensure removal of all oils and hydrocarbons from discharge waters prior to leaving the site.

The interceptor is a NS20 Klargester Class 1 Full Retention Separator to EN 858, designed to treat inflows of 20 l/s. The device is fitted with an alarm which is triggered when the separator requires servicing/emptying.

7.4.1.9 Discharge Point

Having passed through the hydrocarbon interceptor treated waters leave the site at the northern boundary, whereupon they enter the Killary Stream. The discharge pipe is contained within a precast concrete headwall structure. The invert level of the discharge pipe was surveyed as 83.96 m OD. Images of the discharge point are shown as Plate 7 .5.

Plate 7.5 View of Discharge Point Looking from North to South

7.4.1.10 Hydrocarbon Storage

There is one fuel storage tank located adjacent to the weighbridge. This is a 5,000 litre double-skinned tank stored on a bund and is used to refuel mobile site machinery. Refuelling of mobile machinery takes place on a hardstanding pad and runoff from same is directed towards Settlement Tank 2. All waters leaving the site boundary via the licensed discharge point pass through a hydrocarbon interceptor, which has been installed immediately downstream of the outlet of the main settlement lagoon.

A double-skinned mobile fuel tank, operated by a licensed third party, refuels fixed and semi-mobile machinery (e.g., crushers) on an as needs basis.

Strict adherence to pollution control protocols is in place for re-fueling operations. Drip trays are used and hydrocarbon spill kits are available if required.

Waste oils and lubricants are stored on bunds within a sealed, lockable container positioned inside the eastern site boundary.

7.4.1.11 Domestic Wastewater

Domestic effluent generated by on-site office workers is treated by the wastewater treatment system (WWTS) providing secondary treatment (Tricel). This is located south of the portacabin office at the weighbridge. Treated effluent is disposed of via soil polishing filters.

The proposed development will not result in an increase of on-site staff. The wastewater treatment service shall remain fit for purpose.

7.5 SITE INVESTIGATIONS

7.5.1 Site's Licenced Discharge

As previously stated, the site operates under discharge licence Ref. 20/01 which permits a **Daily maximum flow of 1,728 m^3/d, with an hourly maximum flow of 72 m^3/hr**.

It is a Condition of the Licence that flow is continuously recorded.

The Discharge Licence and the as built drawings for the site are presented as Appendix 7.1.

As part of the application granted under LB/200106 it was proposed that a new settlement lagoon be installed. The lagoon is supported by raised earthen banks and is made impermeable by a HDPE liner. The main settlement lagoon has a footprint of c. 2,000 m^2 and is fully functional. Surface water level in the settlement lagoon was measured to be 86.1 m OD in November 2023, with a bank top of 86.5 m OD, above a lagoon base elevation of 85 m OD, approximately. The depth capacity of this main settlement lagoon is therefore 1.5 m.

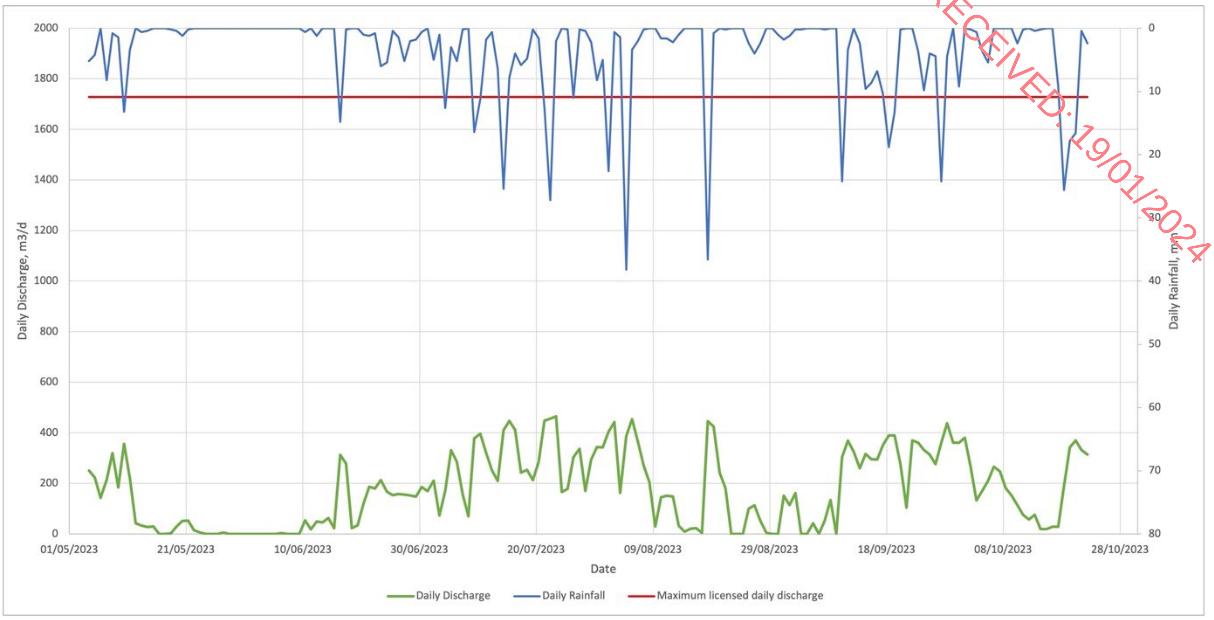
Given the dimensions of the final settlement lagoon, the hydraulic capacity is 3,105 m^3. On the basis that the maximum discharge rate is 1,728 m^3/d, there is a guaranteed 1.75 day retention time in the settlement lagoons. This retention time is far greater than the usual specification for settlement of solids. Mathematics supporting the adequate design capacity are presented later in the Site Metrics Section of the EIAR, specifically Section 7.7.5.

Site Monitoring data, including a daily record of discharge flow rate, hydrochemistry and macroinvertebrate surveying of the receiving water, are presented in Appendix 7.3.

As conditioned in the Section 4 Discharge Licence Ref. 20/01, all waters arising at the site are pumped to the final lagoon. This lagoon treatment unit is large and has been sized, as per documentation submitted with the Discharge Licence application in 2020 (SLR), for the removal of solids prior to discharge to the receiving Killary_Water_010.

7.5.1.1 Discharge Flow

The pipe that delivers the treated water discharge from the settlement lagoons is fitted with a continuous flow meter. The mechanism of discharge is a well-engineered concrete plinth designed to prevent changes to the hydromorphological regime. The discharge diffuses on the concrete plinth before joining the receiving water. The mechanism of discharge enables the introduction of oxygen to the discharge waters to mitigate the long settlement time afforded in the c. 2,000 m^2 area lined settlement lagoon. The configuration of the discharge pipe at the river, following the settlement lagoons, are presented in Plate 7.5. Recorded daily discharge rates are presented in Graph 7.1.



Graph 7.1 Lobinstown Quarry Daily Discharge Flows (m^3/d) and Daily Rainfall (mm/d)

With respect to the information recorded on the site's discharge flow meter, as presented in Graph 7.1, the maximum daily discharge rate recorded between May and October 2023 was **454 m^3/d.** The maximum permitted daily discharge limit is indicated by the horizontal red line in Graph 7.1. The average daily discharge over this same period was **174 m^3/d**. **As previously stated, the maximum daily discharge permitted is 1,728 m^3/d.** The significance of the results for daily flow recording is that the site currently discharges 10%, approximately, of the permitted Emission Limit Value for flow volume. This has significance to the consideration for extension of the quarry. It is envisaged that considering the same bedrock is proposed for excavation, there is capacity and headroom in the existing licence, which can accommodate increases in waters arising. Considering that the total quarry void area proposed is c. 9.7 ha and the lateral extension part of that total area is c. 4.1 ha. Those areas essentially suggest that the footprint of the excavation area will be doubled. Considering that the site currency discharges an average of 174 m^3/d, even if that average volume increased at the same rate of areal increase at the site, the future total discharge would be 348 m^3/d. This is still only 20% of the maximum permitted ELV for volume. The maximum ELV volume of the current Discharge Licence is a volume that has been proven as a safe discharge amount to protect WFD Status, to ensure no presentation of risk to the rivers, protection of fish life and safe operations. The peak rainfall response in the discharge was 454 m^3/d. Even if this doubled, the peak storm response at the site would be c. 900 m^3/d. This is still only c. 50% of the available and permitted maximum daily discharge volume. It is therefore concluded that the site's existing infrastructure has a very large capacity available to accommodate, attenuate and treat the waters that will arise from the proposed development, *i.e.*, deepening by one bench of the existing extraction area, and the lateral extension to the east.

To compliment the analyses for the site's discharge response, a rainfall gauge was installed on the roof of the office close to the southern boundary. It is evident from Graph 7.1 that discharge is highly responsive to rainfall. The flashy nature of the response suggests there is negligible storage in the upgradient bedrock. Discharge rates show a recession which regularly approaches zero following cessation of rainfall. This is as expected and would further reinforce that there is little to no groundwater baseflow to the bedrock faces of the quarry from the upgradient bedrock aquifer.

7.5.1.2 Discharge Quality

As per the Conditions of the Section 4 Discharge Licence for the site (Ref. 20/01), discharge quality is sampled on a quarterly basis for hydrochemical quality at the discharge point. The routine quarterly monitoring is completed by TMS Environment Ltd. and reports are issued to MCC. The samples analysed quarterly, as reported to MCC, are those that are specified in Condition 2.2. The quarterly monitoring results for the lagoons built in compliance with the Discharge Licence are presented as Table 7.7. Also shown are results of samples collected specifically in 2023 by the Water assessment team for this EIAR. These are extra discharge samples collected to enable evaluation of the current impact on surface water with respect to evaluating the proposal under consideration. The results of surface and groundwater sampling throughout the site are discussed in the following sections.

Table 7.7 Discharge Water Quality

Discharge Sample From 2000m2 Lagoons		11/04/2023	13/07/2023	19/06/2023	31/07/2023	12/09/2023	14/11/2023	Meath CoCo Discharge Licence (20-01) Emission Limit Value
Parameter	**UNIT**							
Hydrogen Ion (pH)	pH units	6.5	8.7	8.4	8.3	8.0	7.5	6 to 9 pH
Biological Oxygen Demand (BOD)	mg/L	3.5	2.9	< 1.0	< 1.0	< 1.0	*	2 mg/l BOD
Suspended Solids	mg/L	<3	3	< 2	< 4	< 4	3	20 mg/l
Ammonium as N	mg/L N	0.04	0.08	< 0.02	0.03	< 0.02	>0.06	0.1 mg/l as N
Nitrate as N	mg/L N	9.78	7.49	10.84	lab issue	12.30	8.50	10 mg/l as N
MRP-P	mg/L P	<0.02	<0.02	< 0.01	0.01	< 0.01	<0.02	0.05 mg/l as P
Chemical Oxygen Demand (COD)	mg/L	11	3	< 10	< 10	< 10	*	50 mg/l COD
Total Petroleum Hydrocarbons (C10 - C40)	µg/L	<10	<10	< 10.0	< 10.0	< 10.0	*	50 ug/l Total Hydrocarbons
BTEX (Water)	µg/L	<3	<3	< 2.1	< 2.1	< 2.1	*	10 ug/l BTEX
Laboratory		**TMS**	**TMS**	**Southern Scientific**	**Southern Sci & Element UK**	**Southern Sci & Element UK**	**ALS**	

*Note = on the 11th of November 2023, interrogative nutrient sampling was completed in order to evaluate whether the September result of 12.3 mg/l NO_3-N for the discharge was reasonable or reliable. It was reported by the laboratory as in excess of the ELV of 10 mg/l. However, the November sampling returned a compliant discharge quality. Because the sampling was nutrient focussed, the sample was only analysed for nutrients and SS. Other locations at the site were also sampled. No nutrient issues were found at any location across the site.

With respect to the sample results presented for the site's discharge quality (Table 7.7), it is noted that the discharge is compliant with the Conditions of the Discharge Licence Ref. 20/01. In particular, the following comments can be made with respect to the quality of water discharged under licence from the site:

- The discharge is relatively neutral pH with the 6-9 pH ELV always being complied with.
- Suspended Solids (SS) concentrations are very low, with respect to the 20 mg/l ELV. On average, the SS concentration is generally <3 mg/l.
- Orthophosphate as P concentrations are always less than the Limit of Detection of the laboratory. The results are always a small fraction of the ELV for MRP-P.
- The discharge does not present a Biochemical Oxygen Demand (BOD), in general. The samples collected and delivered within the appropriate time frame in June, July and September 2023 are all < 1 mg/l BOD, *i.e.,* less than the Limit of Detection of the laboratory for BOD. Accounting for the Degree of Precision of laboratories for BOD, only the April 2023 result could be considered an exceedance. This exceedance is not repeated in the results of any of the five subsequent sampling events.
- The discharge does not present a Chemical Oxygen Demand (COD), in general. Results are usually less than the Limit of Detection of the laboratory for COD. The results are always a small fraction of the ELV for COD.
- Ammonium-N concentrations are an order of magnitude lower than specified in the ELV of the Licence.
- On average, Nitrate-N concentrations in the discharge are less that the 10 mg/l NO_3-N ELV.
- There are no detections of petroleum hydrocarbons in the discharge.
- There are no detections of BTEX compounds in the discharge.

It is therefore concluded that the site's discharge complies with the hydrochemical ELVs of Condition 2.2 of the Discharge Licence.

7.5.1.3 Receiving Water's Biological Quality

The receiving water is surveyed for macroinvertebrates on an annual basis. This is specified in Condition 3.5 of the Ref. 20/01 Discharge Licence. Annual reports (Refer to Appendix 7.3) are submitted to MCC. The most recent report (TMS, 2023) presents results that conclude as follows:

- The results of the macroinvertebrate survey for this year (May 2023) indicate a Q Value of 3-4 for the upstream and 3-4 for the downstream monitoring locations.
- As the Q Value is identical downstream of the quarry discharge relative to upstream, it can be inferred that the discharge from the quarry at Lobinstown is not having a deleterious effect on the biological quality of the stream.

7.5.2 GROUNDWATER QUALITY

Groundwater quality sampling was undertaken on four occasions in 2023: 19th June, 31st July, 12th September and 14th November.

The groundwater sampling points (Refer to Figure 7.8) and references are as follows:

- Sample Ref. GW1 = Site's Water Supply Well, near offices, PW01
- Sample Ref. GW2 = New PW drilled in 2023, northern stockpile area, PW1
- Sample Ref. GW3 = New SI Piezometer, greenfield extension area, PBH01

Groundwater samples were retrieved from wells using low flow sampling technique following stabilisation of field physiochemical parameters: temperature, dissolved oxygen, pH, conductivity and oxidation-reduction potential (ORP), which were measured using an in-situ multiparameter sonde.

Bottled samples were delivered to local accredited laboratories on the day of sampling for analysis of microbiological parameters and biochemical oxygen demand (BOD). Remaining samples were filled into the appropriate sample containers that contained the appropriate fixation substance per parameter, stored in cooler boxes and dispatched by courier on the sampling day for analysis of remaining hydrochemical parameters to Southern Scientific (Rounds 1, 2 and 3), QA check sampling for hydrocarbons and BTEX to Element Laboratory UK (Rounds 2 and 3) and ALS for nutrient specific check sampling (November, 2023, Round 4).

Round 1 analysis returned detections of hydrocarbons in one surface water sample and three groundwater samples. There was a detection of hydrocarbons in the upstream surface water sample but not in the downstream or discharge. This raised a red flag of query that the lab could not resolve to the satisfaction of the project's hydrogeologists, each of whom have field sampling and laboratory experience at Teagasc laboratories at Ph.D level. As a Quality Assurance / check measure, subsequent samples were sent to Element Laboratories, Deeside, UK for Round 2 and Round 3. No hydrocarbons were detected in any subsequent samples analysed at both laboratories for Rounds 2 and 3 and the detections in Round 1 can reasonably be assumed to have been caused by a laboratory error because hydrocarbons are a persistent contaminant. The absence in subsequent sample events is taken to be the true representation of the site: there are no hydrocarbons.

Important parameter results are presented in Table 7.8. All results are presented in the laboratory Certificates of Analysis of Appendix 7.3.

Table 7.8 Summary Groundwater Quality Results and Groundwater Regulation (2010, as amended) Threshold Values

		GW1 (Water Supply Well PW01)			GW 2 (Stockpile 2023 PW1)			GW 3 (2023 SI Piezo PBH01)			GW Regulations Threshold Value
Parameter	UNITS	19/06/2023	31/07/2023	12/09/2023	19/06/2023	31/07/2023	12/09/2023	19/06/2023	31/07/2023	12/09/2023	
Hydrogen Ion (pH)	pH units	6.9	7.0	6.9	7.8	7.8	7.5	7.4	7.5	7.4	6 < pH < 9
Conductivity	µS/cm @ 20 °C	283	283	283	462	460	307	525	509	531	800 — 1875 uS/l
Ammonium	ug/l as N	20	10	20	70	40	lab error	50	10	60	65 to 175 ug/l
Nitrate as NO3	mg/l as NO3	0.6	0.6	0.6	11.99	11.95	0.6	27.26	33.85	34.69	37.5 mg/l as NO3
Mol Reactive Phosphorus (MRP)	ug/l as MRP-P	5	5	5	5	5	5	5	5	5	35 ug/l
Chloride	mg/L	22.2	19.0	22.4	12.2	18.5	10.7	13.9	13.0	13.8	24 — 187.5
Sulphate	mg/L	13.0	14.0	12.5	23.5	13.9	20.1	11.9	9.7	8.8	187.5 mg/l
Potassium (K)	mg/L	1.3	< 1.0	1.3	3.1	2.5	2.7	2.6	2.5	3.2	
Sodium	mg/L	15.0	13.0	12	11.0	11.0	9	11.0	9.0	9	not specified
K:Na (calculated GSI Indicator Parameter)	RATIO	0.09	0.004	0.1	0.28	0.23	0.30	0.2	0.3	0.4	**not specified**
Fluoride	mg/L	0.2	0.2	0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	
Total Organic Carbon (TOC)	mg/L	1.1	1.0	1.1	1.3	1.5	2.9	3.0	2.7	3	not specified
Arsenic	µg/L	3.0	14.0	14	5.0	10.0	< 1	< 1	1.0	2	
Chromium	µg/L	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	not specified
Copper	µg/L	1.0	< 1	< 1	< 1	< 1	< 1	2.0	< 1	4	not specified
Lead	µg/L	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	not specified
Nickel	µg/L	4.0	2.0	5	5.0	1.0	1	< 1	< 1	2	not specified
Total Petroleum Hydrocarbons (C10 - C40)	µg/L	lab error	< 10.0	< 10.0	lab error	< 10.0	< 10.0	lab error	< 10.0	< 10.0	7.5 ug/l
BTEX (Water)	ug/l	< 0.5	< 2.1	< 2.1	< 0.5	< 2.1	< 2.1	< 0.5	< 2.1	< 2.1	

** PLEASE NOTE: The laboratory certificates of analysis report ammonium and ortho-P results in the mg/l units, which are not the units of the Groundwater Regulations (2009, as amended). Therefore, Hydro-G converts the mg/l to the correct ug/l unit for direct comparison with the units prescribed in the Threshold Values of the Regulations. Similarly, the laboratories sometimes report nitrate concentration in the form of NO_3-N, which has no statutory basis. It is the NO_3 form that is prescribed in the Threshold Value of the Groundwater Regulations, the Drinking Water Regulations and the Nitrates Directive. Therefore, Hydro-G converts NO_3-N to NO_3 for direct comparison with the units prescribed in the Threshold Values of the Regulations.

The results presented in Table 7.8 suggest, as follows:

- Groundwater quality results adhere to the Threshold Values for groundwater as a resource and for Public Use, as specified by the Groundwater Regulations (2010, as amended).
- Electrical Conductivity, pH, Alkalinity and Total Hardness are within the normal range expected for the type of bedrock hydrogeology.
- Groundwater pH is relatively neutral with a range of results from 7 to 7.5 pH.
- The Electrical Conductivity (EC) signal in the water supply well (GW1/ PW01) is much lower than in wells sampled in the application area. This is not a problem, merely interesting, from a hydrogeological perspective. To the hydrogeologists, the lower EC value for the water supply well is further evidence that the south eastern corner of the site is in the 'In Salterstown' Fm as opposed to the high PSV of the quarry's Salterstown Fm bedrock.
- Chloride and sulphate concentrations in the groundwater are normal and they comply with the Threshold Values of the Groundwater Regulations (2010, as amended).
- The ortho-Phosphate concentration at all groundwater sampling locations is very low, averaging 5 ug/l as MRP as P where the Groundwater Regulations specify a Threshold Value of 35 mg/l MRP as P. It is therefore concluded that MRP concentrations are a fraction of those suggested as environmentally appropriate in the Groundwater Regulations.
- At all three sampling locations, ammonium as N is compliant with the Threshold Values of the Groundwater Regulations (2010, as amended).
- Within the current working quarry groundwater nitrate concentrations are very low: they are a fraction of the Threshold Values of the Groundwater Regulations (2010, as amended) and it is therefore concluded that there is no evidence of explosive residues in the groundwater of the quarry.
- With respect to commentary on other groundwater quality results, it makes sense to discuss the results per sampling location because there are real differences that can be related to surrounding land use, as follows:
    - GW1, which is the water supply well PW01 in the south eastern part of the site, has an extremely low Electrical Conductivity and a very low Total Organic Concentration (TOC) of 1 mg/l. This suggests a very pure water that is not affected by organic influences, whether they be from soils, agricultural influences or domestic type wastewater. This low TOC is accompanied by very low ammonium concentrations. There are no petroleum hydrocarbons and no BTEX compounds at this south eastern part of the operational quarry. The K:Na ratio calculating is a tool advised by the GSI as an 'indicator parameter' with respect to potential for contamination with a local source of organic contamination. At GW1, the K:Na ratio is very low and this is taken as a sign that the onsite WWTP and associated discharge is not presenting a pressure to the groundwater environment. A K:Na value >0.3 is advised by the GSI as a trigger for investigation of organic wastes influencing

groundwater. At GW1, the K:Na is calculated to be >0.1, which is a positive result for groundwater quality.

- GW2, which is in the northern part of the permitted, operational, working quarry, also has a relatively pure TOC signal, low nitrates, low ammonium, low ortho-P, no petroleum hydrocarbons and no BTEX compounds.

- GW3, which is in the greenfield eastern extension area, has a TOC concentration of 3 mg/l TOC and although not excessively high it is higher than the values obtained in the working quarry. The biggest difference in the physical characteristics between GW3 and the other two locations is SOIL cover. GW1 and GW2 are in the hard rock environment of the quarry where the rock is exposed for supply to the public and road projects. Therefore, there is no source of organic carbon. GW3 has soil cover, is in lands that are grazed by weanling beef and sheep and it is a location very close to the point of contact and flow zone of the two different bedrock types. It is possible that infiltration of nutrients as a result of animal grazing at this location has occurred. The nitrate concentration at this location is approaching the Groundwater Threshold Values. However, subsequent sampling of two ingresses to the wall of the operational quarry, immediately west of GW3 location (PBH1 greenfield site investigation borehole), revealed no nitrates whatsoever. The location is compliant with the Threshold Value (TV) of the Groundwater Regulation, it is just called out here as a result that shines a light on how the working quarry has no nitrates, relatively speaking. GW3 has an agricultural signal (K:Na ratio is elevated with NO_3) but the results still conform with the requirements of the Groundwater Regulations. The results merely highlight the differences between groundwater in the hard rock quarry (pure) and water in the greenfield setting (slight anthropogenic impacts).

- There are no petroleum hydrocarbon detections in any samples sent to a specialist contaminant laboratory (Element, UK). Results for groundwater samples in both July and September 2023 suggest hydrocarbon concentrations less than the Limit of Detection of the laboratory analyser. Results conform with the Threshold Values of the Groundwater Regulations (2010, as amended). This suggests no historical impacts of hydrocarbons reside at the site.

- There are no BTEX compounds in the groundwater.

- With respect to metals, all the Groundwater Regulation's specified metals are within Regulatory values for the open Production Wells (PWs) in the Bedrock. For example, Aluminium, cadmium and zinc concentrations in the groundwater are low, which is good because those parameters have potential to threaten the ecology of waters receiving the discharge of quarry waters. At this site there is no potential for harm. The concentration of zinc in the groundwater conforms with the TVs of the Groundwater Regulations (2010, as amended). The regulations do not specific TVs for other metals analysed.

Based on the results in Table 7.8, groundwater quality at the site complies with the European Communities Environmental Objectives (Groundwater) Regulations 2010 (as amended 2011, 2012, 2016) and discharge of these waters will not have a detrimental impact on receiving waters.

7.5.3 RECEIVING WATER HYDROCHEMICAL QUALITY

Receiving water sampling had previously been completed by SLR in 2020, for the purpose of demonstrating assimilation capacity of the receiving water, which resulted in the grant of the site's Section 4 Ref. 20/01 Discharge licence. Historic results are on file with MCC.

Sampling of the receiving water upstream and downstream of the licensed point of discharge was completed for this assessment on three routine occasions in 2023: June, July and September. The upstream and downstream sampling was completed to enable evaluation of the discharge and its impact on the receiving water. Summary results for the routine sampling are presented as Table 7.9 (June, July, September 2023). Full results are presented in the Certificate of Analyses of Appendix 7.3.

Surface water commentary, based on the results of Table 7.9 for the June, July and September samples suggests, as follows:

- Both upstream and downstream water samples comply with the Good Status Environmental Quality Objectives of the Surface Water Regulations (2009, as amended) for pH, BOD and Total Ammonium.
- Ortho-P concentrations are elevated upstream and the discharge dilutes this slightly. The discharge has no ortho-P content.
- Although not a Surface Water Regulation parameter, the Electrical Conductivity (EC) results are interesting. The EC results are the exact same upstream and downstream of the discharge. This suggests that there is very little groundwater in the discharge because the EC signal of groundwater is much higher than surface water. If there was a dominant groundwater component of the discharge, the downstream EC value would be higher than the upstream value.
- Those metals deemed important to Fish Life are recorded as less than the Limit of Detection of the laboratory analyser for both the upstream and downstream surface water.
- The stream's upstream and downstream Suspended solids concentrations are a fraction of that specified in the Salmonid Regulations.
- In general, surface water quality is better downstream of the site's discharge. This is because the discharge is of very high hydrochemical quality. Refer to Section 7.5.1.2 for discharge characteristic. With specific reference to suspended solids, for example:
    - The stream upstream of the discharge averages 13 mg/l SS.
    - The discharge itself averages <3 mg/l SS.
    - The stream downstream of the discharge averages 10 mg/l SS, which is a 25% reduction of the upstream concentration.
- Overall, the discharge does not cause a negative effect or any negative change in the quality of the receiving water.

Table 7.9 Project Routine Surface Water Sampling Upstream and Downstream of Discharge (June, July, September 2023)

Surface Water Sampling			19/06/2023	31/07/2023	12/09/2023	Surface Water Reg EQOs (2009, as amended)	19/06/2023	31/07/2023	12/09/2023
Parameter	UNIT	LOQ	Upstream	Upstream	Upstream		Downstream	Downstream	Downstream
Hydrogen Ion (pH)	pH units	4	8.2	7.9	7.9	Hard Water 6 to 9 pH	8.2	7.9	7.9
Conductivity	µS/cm @ 20 °C	15	373	302	378		375	30[illegible]	374
Biological Oxygen Demand (BOD)	mg/L	1	1.9	1.8	1.5	≤ 1.5 (mean) or ≤ 2.6 (95%ile)	1.5	1.6	1.5
Suspended Solids	mg/L	2	17	10	12	not specified. Salmonid Regs = 25mg/l	9	10	10
Total Ammonia	mg/L N	0.02	0.11	< 0.02	0.03	≤ 0.065 (mean) ≤ 0.140 (95%ile)	0.10	< 0.02	0.03
Ammonium as N	mg/L N	0.02	0.1	< 0.02	0.03		0.1	< 0.02	0.03
Nitrate as N	mg/L N	0.25	1.76	2.66	2.76	not specified	2.06	2.78	1.71
MRP-P	mg/L P	0.01	0.08	0.10	0.12	0.035 (mean) ≤ 0.075 (95%ile)	0.07	0.09	0.12
Chloride	mg/L	0.5	16.7	14.1	17.2	not specified	16.0	13.6	17.1
Sulphate	mg/L	0.5	9.7	10.6	11.2	not specified	10.2	10.8	8.9
Chemical Oxygen Demand (COD)	mg/L	10	15	27	< 10	not specified	16	21	16
Fluoride	mg/L	0.1	< 0.1	< 0.1	< 0.1	Parameters not specified in the SW Reegs but of importance to Fish Life	< 0.1	< 0.1	0.1
Total Organic Carbon (TOC)	mg/L	0.5	5.6	9.6	7.1		5.3	8.9	7.8
Aluminium	µg/L	10	81	109	52		77	100	66
Arsenic	µg/L	1	1	< 1	5		2	< 1	2
Chromium	µg/L	1	< 1	< 1	< 1		< 1	< 1	< 1
Copper	µg/L	1	1	2	2		1	2	2
Lead	µg/L	1	< 1	< 1	< 1		< 1	< 1	< 1
Nickel	µg/L	1	1	2	1		1	2	2
Zinc (Zn)	µg/L	8	< 8	< 8	< 8		< 8	< 8	< 8
Total Petroleum Hydrocarbons (C10 - C40)	µg/L	10	lab contamination	< 10.0	< 10.0		< 10.0	< 10.0	< 10.0
BTEX (Water)	µg/L	2.1	< 2.1	< 2.1	< 2.1		< 2.1	< 2.1	< 2.1

7.5.4 INTERROGATIVE NITROGEN SPECIES WATER SAMPLING AT THE SITE

In the final round of routine sampling, in September 2023, a slightly elevated nitrate result was reported by the laboratory for the final discharge. An interrogative round of sampling for Nitrogen species was completed throughout the site in November 2023 with the purpose of attempting to determine if the laboratory had made an error or if there was indeed a source of elevated nitrate at the site. Following assessment, it would seem that the September laboratory result was completely anomalous and absolutely no nitrogen species compounds were found in any of the seven sampling locations throughout the site. Sampling points are shown on Figure 7.7 and are described in the text that follows.

Figure 7.7 Surface Water Monitoring Locations

With reference to the locations shown in Figure 7.7, the November 2023 Sampling Locations for Interrogative Nitrogen Investigation are described, as follows:

(i) The Discharge itself.

(ii) The floor sump in the south of the quarry, which pumps to the final settlement lagoon.

(iii) Settlement Tank 2 = West of the site, final chamber settlement tank at weighbridge.

(iv) SW Upstream = 60 m upstream and east of discharge point.

(v) SW Downstream = 120 m downstream and west of discharge point.

(vi) An ingress / seep on the quarry wall between the working quarry and the greenfield extension area to the east = Sampling Point ID 'Ingress 1'.

(vii) A second ingress / seep on the quarry wall between the working quarry and the greenfield extension area to the east = Sampling Point ID 'Ingress 2'.

The Nitrogen species focussed sampling of November 2023 were sent to ALS Laboratory due to proximity to the site and the avoidance of any delays with couriers. Results for the investigative sampling are presented as Table 7.10 (November 2023). Full results are presented in the Certificate of Analyses of Appendix 7.3.

Table 7.10 November 2023 Interrogative Nitrogen Species Surface Water Sampling Results

Date: 14/11/2023	Ref	Discharge	Floor Sump	SS Tank (2) [West]	SW U/S	SW D/S	Eastern Wall Ingress 1	Eastern Wall Ingress 2
Nitrate as N	**mg/l**	**8.5**	**5.1**	**<0.7**	**2.5**	**2**	**<0.7**	**<0.7**
Nitrite as N	mg/l	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Ammoniacal Nitrogen as N (LL)	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Ammonium as NH4, Low Level	mg/l	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Phosphate, Ortho as P LL	mg/l	<0.02	<0.02	<0.02	0.06	0.06	<0.02	<0.02
Total Suspended Solids	mg/l	3	12	152	12	12	3	2
Chloride as Cl	mg/l	13.1	11.4	7.9	9.3	9	13	11.4

Results presented in Table 7.10 suggest that there is no source of elevated nitrates or ammonium at any locations of the site's water components. Results can be discussed, as follows:

- Note: interrogative nutrient sampling was completed in order to evaluate whether the September result of 12.3 mg/l NO_3-N for the discharge was reasonable or reliable. It was reported by the laboratory as in excess of the ELV of 10 mg/l. However, the November sampling returned a compliant discharge quality. Because the sampling was nutrient focussed, the sample was only analysed for nutrients and SS.

- Results returned for the November sampling suggested that the site's discharge concentration was 8.5 mg/l NO_3-N, which is in compliance with the ELV of the Discharge Licence.

- The site's discharge reduced and improved the nitrate-N concentration quality of the receiving water by reducing the upstream from 2.5 mg/l NO_3-N to 2 mg/l NO_3-N.

- Ammonium and nitrite concentrations are less than the Limit of Detection of the laboratory analyser at all locations throughout the site. These results suggest no explosives residues in the waters of the site.

- The nitrate concentration in the floor sump is lower than the discharge quality. The floor sump would be the place where explosive influenced waters would accumulate. Given the relatively low concentrations of ammonium, nitrite and nitrate in the sump, it is confidently concluded that there are no explosives residues in the waters of the site.

- The concentration of Suspended Solids (SS) pumped to the final lagoon are 12 mg/l from the Floor Sump and 152 mg/l from the western settlement lagoon near the wheel wash. The efficacy of the c. 2,000 m^2, 1.5 m depth, lined settlement lagoons is proven by virtue that the discharge concentration is 3 mg/l SS.
- Results for nitrate, ammonia and SS suggest compliance with the ELV of the Discharge Licence.

In the eastern wall of the working quarry, all concentrations of parameters sampled are low. Nitrate concentrations are very low and suggest neither diffuse agriculture nor on-site wastewater treatment systems are significant pressures.

7.5.5 Hydraulic & Assimilative Capacity of Receiving Waters

The documents submitted by SLR with the application for discharge licence in 2020 demonstrated mathematically that the receiving waters had the required hydraulic and assimilative capacity for the licensed discharge volume and the Emission Limit Values that are specified in the site's Section 4 Discharge Licence issued by Meath County Council in 2020 (Ref. 20/01).

Given that the site's measured discharge rates are $1/10^{th}$, on average, of those permitted in the Section 4 discharge licence Ref. 20/01 and that the total volumes calculated for rainfall and groundwater that will be encountered in the future are less than that permitted ELV for volume in the licence, the receiving waters remain with hydraulic and assimilative capacity to support the proposed further development at the site.

Further, a revised FRA was completed for the receiving waters, as documented earlier in this chapter, and this also confirmed capacity in the receiving waters.

7.5.6 Site Specific Flood Risk Assessment

A site-specific flood risk assessment was carried out by Envirologic in November 2023 and is included as Appendix 7.2. The two primary aims of the flood risk assessment were:

1. To quantify the capacity of the stream route to receive the Section 4 Discharge Licence's maximum permitted quarry discharge waters.
2. To ascertain whether a proposed quarry extension area is within the active floodplain serving the Killary Stream.

Hydraulic modelling was used to predict river water levels under various flow regimes. Results of these simulations showed that during a Q_{1000} event the Killary Stream is not at risk of flooding.

Results of the FRA surveying and simulations suggests that the addition of the maximum quarry discharge (0.02 m^3/sec) to the river when it is under flood conditions does not cause any discernible increase in flood elevations downstream of the discharge point.

The proposed discharge from the quarry will not cause any increase in flood risk to downstream receptors during flood conditions. Hence upgrade works are not deemed necessary on the route to facilitate the predicted discharge during a storm event.

The input from the quarry discharge is small relative to stormflows in the surface water system.

The significance of the quarry discharge becomes smaller as the catchment size increases progressing downstream, as is the case in most evaluations. What this means is that specifically to the Killary Water_010, there are no downstream impediments to flow and no restrictions that could result in impact from the maximum permitted discharge rate of the Section 4 Discharge Licence for the site.

7.5.7 GEOPHYSICAL SURVEY

Lagan Materials Ltd. commissioned Apex Geophysics to undertake a geophysical survey of the application site in July 2021 (Refer to Appendix 6.2). The survey involved EM ground conductivity mapping with follow-up 2D Electrical Resistivity Tomography (ERT) and Seismic Refraction profiling. The key findings from the survey are summarised as follows:

- Overburden cover on the greenfield area is relatively thin on higher ground at the southern end of the site (< 5 m), thickening to up to 20 on the lower ground at the northern end.
- A weathered bedrock (or transition zone) is present with thicknesses of 3–10 m. Competent bedrock is present throughout the centre of the site to depths below the proposed floor of the extension area. This rock is of good quality. Bedrock underlying the site is compact and described as greywacke, shale, mudstone.
- A more highly weathered strata of rock is present just south of the application area. This marks the transition into a formation with higher shale content. It is of poor quality and was therefore excluded from the application area.

7.5.8 WELL DRILLING

A comprehensive number of boreholes have been drilled at the site. A borehole location map is included as Figure 7.8.

In the course of historic investigations and previous applications, wells were drilled as follows: MW1, MW2, MW3, MW4, PW01, MW7, MW8 and BH03.

In the course of the Geological Assessment (SLR, April 2021) for the eastern extension greenfield application area, five cored boreholes were drilled as follows: 20-LOB-01 to 20-LOB-05.

For the specific purpose of this hydrogeological (water) assessment, five boreholes were drilled across the current working quarry and the greenfield eastern application area, as follows: PW1, PW2, PW3, PBH1 and PBH2.

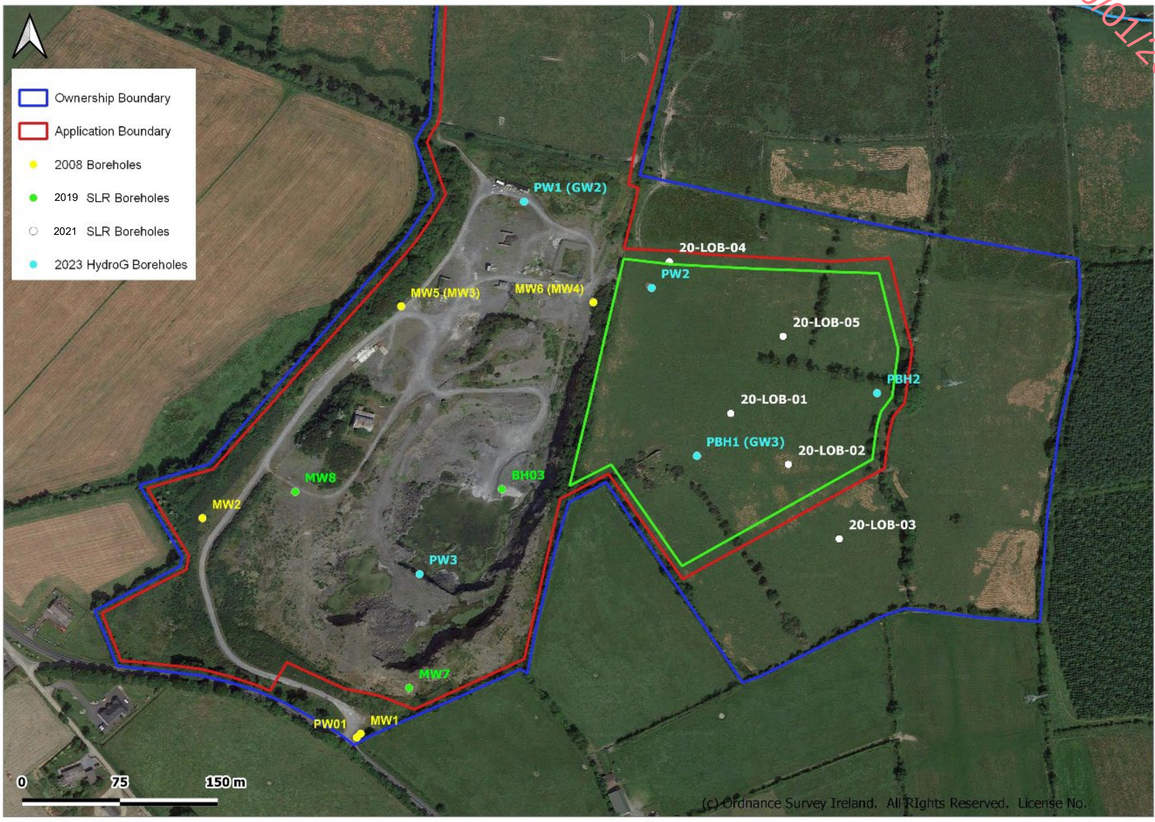


Figure 7.8 On-Site Boreholes

Additional details related to hydrogeology such as water strike depths and estimated yields encountered during drilling are included as Table 7.11.

The drilling experiences for each well are discussed under separate sub-headings for the Production Wells and Monitoring Wells in subsequent sections. Drilling and bedrock conditions were also presented in the Land, Soils and Geology (LSG) Chapter of this EIAR. The detail discussed in the LSG Chapter had a geological focus. Drilling is discussed in this Water Chapter with a groundwater focus.

Table 7.11 Summary Well (BH) Details

Year & (Contractor)	Ref.*	Ground Elevation (m OD)	Top of Casing (m OD)	BH Depth (m bgl)	BH Base Elevation (m OD)	Screen interval (m bgl)	Water Strikes (m bgl)	Estimated yield (m^3/d)
2008 (Dunnes)	PW01	111.49	111.73	73	38.49	37-73 (no seal)	17, 24, 27, 36, 50	382
	MW1	111.32	111.39	63	48.32	47 - 56	16, 19, 30, 40	2.18
	MW2	95.56	95.98	50	45.56	32 - 50	33, 40	2.18
	MW3					34 - 55	40	2.18
	MW4					3 m intervals	None	0
2019 (Dunnes)	MW5	89.80	92.03	50	39.80	none	12 (2.4 m^3/d), 40 (2.4 m^3/d)	4.8
	MW6	93.35	94.97	28.7	64.65	none	18 (24 m^3/d), 30 (24 m^3/d), 32 (7.2 m^3/d), 48 (14.4 m^3/d)	79.2
2019 (Irish Drilling)	MW7	108.68	109.88	70	38.68	0.5 – 4.5	None reported	None reported
	MW8	94.56	95.75	60	34.56	0.5 – 3.0	None reported	None reported
	BH03	81.54	82.95	30.4	51.14	0.5 – 9.0	None reported	None reported
2021 (SLR)	20-LOB-01	c. 103.35	n/a	80	c. 25	n/a	None reported	None reported
	20-LOB-02	c. 105.05	n/a	80	c, 28	n/a	None reported	None reported
	20-LOB-03	c, 108.77	n/a	80	c, 30	n/a	None reported	None reported
	20-LOB-04	c. 89.26	n/a	80	c.15	n/a	None reported	None reported
	20-LOB-05	c. 95.95	n/a	80	c.35	n/a	None reported	None reported
2023 (Briody)	PW1 (GW2)	90.62	91.20	61	29.12	n/a	40	10
	PW2	92.79	93.43	61	31.29	n/a	11 (9 m^3/d), 25 (1 m^3/d)	10
	PW3	65.97	66.82	35	30.97	n/a	None	0
2023 (Priority Geotechnical Inv.)	PBH1 (GW3)	107.74	108.29	75	32.74	8.0 - 68	13	13
	PBH2	99.62	100.12	75	24.62	48 - 72	15.8	15.8

7.5.8.1 2008 Drilling

PW01 was drilled to a depth of 73 mbgl in lands of the southern boundary to the site, close to the quarry entrance. The drilling location is elevated above the working quarry. PW01 was designed to serve as a water supply well and returned a favourable yield of 332 m^3/d to serve this purpose. Water strikes were encountered frequently in the upper weathered bedrock and in fracture zones in the competent bedrock. The groundwater strikes encountered in the bedrock located in the S.E. corner, where the site's PW01 water supply is situated, portrays a different groundwater signature to the rest of the site. This is because PW01 is very close to the GSI mapped point of contact between the high PSV quarried 'Salterstown' formation bedrock and the different, less economically useful rock resource, that is the inlier mapped as the 'In Salterstown' that is a black shale and chert. With reference to the LSG Chapter and its Figure 6.4, the mapped point of contact between the two bedrocks is evident. The Apex (2021) geophysical survey and interpretation detected the less economically useful 'In Salterstown' formation and that location constrained the southern boundary of the application area in the greenfield extension area to the east of the working quarry. The likely reasons that there are water bearing strikes in the upper weathered bedrock and in fracture zones in the competent bedrock in PW01 is because the structural deformation associated with the metamorphosis of the high PSV Salterstown formation will have caused weaknesses in the adjacent shale and chert 'In Salterstown' formation. It is therefore for both hydrogeological and geological reasons that the southern boundary of the application area in the eastern lands is set back from the southern boundary of the landholding.

MW01 was drilled adjacent to PW01 and returned a similar yield of 281 m^3/d. Water strikes occurred at similar depths to PW01. Drilling was terminated at 63 mbgl though the well was only installed to 56 m due to a minor collapse close to the base. The reasons for the water strikes were explained in the narrative for PW01 above.

There was only negligible groundwater encountered during drilling of MW02, MW03, and MW04, which were installed around the periphery of the existing quarry, outside the extraction zone. Bedrock was generally competent and clay lenses, calcite and fracture zones encountered tended not to yield water.

7.5.8.2 2019 Drilling

Drilling in 2019 was performed by Irish Drilling and involved drilling of three boreholes in a triangular arrangement around the current quarry sump. The drill logs do not provide any detail regarding water strikes or groundwater yields. The drill logs and SI report present packer tests for hydraulic conductivity suggesting 10^{-8} m/s permeability (K) in the bedrock beneath the working quarry. These results suggest a very low permeability bedrock. There is little potential for groundwater flow in this type of bedrock.

MW06, intended to serve as a replacement to MW4, was drilled to the north of the original MW04, and returned a slightly higher yield of 79 m^3/d. Groundwater ingress increased steadily, with the log suggesting these inflows coincided with clay lenses.

7.5.8.3 2021 Drilling

Following on from Apex (2021) geophysical Survey, SLR completed a Geotechnical Assessment in in the greenfield application lands to the east of the working site (SLR, 2021). In the course of their work, SLR drilled five core holes (20-LOB-10 to 05). The five cores were drilled to 80 mbgl depth along a northwest-southeast transect through the application site. Due to the nature of core hole drilling, necessitating water to cut the bedrock cores, geologists do not record water strikes in cored holes. However, upon interrogation of the SLR Core Hole BH logs (LSG Chapter's Appendix 6.2) by a hydrogeologist there are no reported zones of weakness and/or clays that would suggest likely water strikes. Nevertheless, in 2023 Hydro-G directed and supervised a specific drilling programme in the same area of lands investigated by SLR and Apex in 2021. Hydro-G's 2023 drilling comprised three more hydrogeologically focussed BHs in the greenfield application area and two more hydrogeologically focussed BHs in the working quarry floor.

7.5.8.4 2023 Drilling

As stated, a project specific hydrogeological drilling programme was completed in 2023 to supplement the SLR 2021 drilling programme in the application area.

As previously presented in the LSG Chapter, the 2023 drilling programme comprised five (Down the Hole hammer) boreholes in total, in two different forms of completion and with two different companies, as follows:

1. Firstly, P. Briody Water Well Drilling (Briody) were employed to drill three Test 'Production Wells' (PW1, PW2 and PW3) that would enable hydrogeological testing of the bedrock underlying the application area and the active quarry to depths deeper than the application's proposed target depth of 35 m OD. The base elevation of the wells was c. 30 m OD. Hydro-G specified 200 mm diameter drilling for the three PWs so that they could accommodate submersible pumps. The original design intention was to construct the PWs in a way that would facilitate tests for dewatering and hydraulic conveyance ability of the bedrock to 30 m OD, *i.e.,* 5 m below the proposed application floor area. The construction consisted of installing 200 mm diameter steel casing below the top of competent bedrock head and continuing to target depth with open hole bedrock drilling.

2. Secondly, Priority Geotechnical Ltd (Priority) was commissioned to drill boreholes with piezometers installed to test bedrock competency and hydraulic conveyance in the eastern area application area. Priority drilled two boreholes. The reasons for changing drilling company were twofold: (i) the test PWs resulted in no significant water strikes; and (ii) the PW drill rig was unable to negotiate the slope to the south eastern part of the application area. Instead, it was decided to bring the track mounted rig of Priority to site because the track mounted rig could negotiate the slope.

7.5.8.5 2023 Production Wells

The three 'Production Wells' (PWs) were drilled in March 2023 for the purposes of a hydraulic evaluation of the underlying bedrock to a depth of 5 m below this application's proposed floor level. PW1 and PW3 were drilled in the northern and southern end of the active quarry area, respectively, and PW2 was drilled on the low slope northern part of this application's eastern extension area.

PW design and drilling supervision was by Dr. Pamela Bartley of Hydro-G. Drilling was conducted by Briody Well Drilling Ltd. The 200 mm diameters of the PWs were chosen to facilitate pumping tests, the results of which were employed to calculate likely future volumes of groundwater that might be encountered during the lifetime of the application's excavations. Further, the pumping test, response data, were employed in the determinations of potential for impact on local groundwater sources of supply and the groundwater resource in general. The boreholes were located as close to the proposed extraction as practicable with the intention of retaining the boreholes as monitoring points in the future.

In general, construction involved opening with a 210 mm diameter drill bit and inserting 200 mm diameter OD steel casing to seal off the subsoil – bedrock interface. Drilling progressed below the steel casing using a 200 mm hammer to create an open hole in the bedrock. Each well was developed by airlifting for 3-4 hours at the end of the drilling so as to enable rough estimations of well yields. The open rock portions of the boreholes were left unlined because the rock is competent. Raised lockable steel headworks completed the installation.

Full details for the bedrock conditions encountered in the three PWs were presented in the Land, Soils and Geology (LSG) Chapter. With respect to groundwater potential, only very minor water strikes were encountered in PW1 and PW2, *i.e.,* in the northern portion of the site, with yields estimated as 10 m^3/d at both locations. No sustained yield of groundwater was encountered in PW3 on the floor of the quarry near the sump. The drill rig was able to blow the hole dry repeatedly.

Therefore, from a groundwater perspective, it is determined that the very hard bedrock proposed for excavation in this application, in both the rock beneath the permitted operational quarry and the rock underneath the eastern greenfield application area, is the high PSV metamorphic rock that presents aquifer characteristics in full agreement with the GSI's aquifer characteristic of Poor Aquifer and Poorly Productive Groundwater Flow Regime.

Given that none of the three PWs would be capable of supporting continued abstraction pumping. Therefore, although conventional constant rate tests were not completed, it was possible to pump the holes dry so as to measure the hydraulic response rate (hydraulic conductivity) of the bedrock. The results of that hydraulic response testing is discussed later in the section entitled 'Aquifer Testing' (Section 7.5.9).

7.5.8.6 2023 Monitoring Well Drilling

In addition to the three PWs, two monitoring Boreholes (PBHs) were installed in June 2023 by Priority Geotechnical Investigation Drilling, using a track mounted site investigation (SI) Rig. The Priority BHs were drilled in the higher elevation, higher sloping, lands of the southern extent of the greenfield application extension area to the east of the operational quarry. The BHs enabled more hydraulic response tests in the bedrock, they enabled long-term groundwater level monitoring by constant data loggers and were used to sample for groundwater quality.

The SI BHs were drilled and completed using Rotary Symmetrix technique with reference to industry guidelines (Guidance on the design and installation of groundwater quality monitoring points, EA, 2006). The drilling diameter was 104 mm within the bedrock. Installation consisted of 50 mm diameter internal diameter HDPE standpipe with factory slotted casing targeting the base of the BHs. The annulus around the slotted casing was using 10 mm gravel to create a gravel pack and bentonite clay was used as a seal above the gravel pack. Temporary ODEX subsoil withstanding casing was used during the drilling process and was removed upon completion after the HDPE standpipe was installed. Raised lockable headworks set within a concrete plinth, which extended to 0.5 m below ground, completed the installation. Both BHs were drilled to 75 m depth.

PBH1 was drilled close to the southern boundary of the application area, adjacent to a visible bedrock outcrop. Drilling in PBH1 encountered competent limestone at 2.3 m which becomes increasingly strong with depth. The only recorded feature of note was a minor broken zone between 44 and 48 m. No significant groundwater strike was encountered.

PBH2 was drilled just inside the eastern boundary of the application area. Upper bedrock (1.7 – 15.8 m) was described as a weak limestone and below this bedrock was described as hard rock limestone, as per PBH1. No significant groundwater strike was encountered.

It is clear from the drilling logs, which were composed by various drillers, that multiple descriptions of bedrock have been applied. These have included limestone, mudstone, sandstone and greywacke. In this regard the geological assessment (SLR, 2021) takes precedence because a chartered geologist inspected the bedrock cores: the bedrock is correctly described in geological parlance as a very hard metasandstone and metamudstone.

Each drilling experience for all five 2023 bored holes (PWs and MWs) confirmed to the supervising hydrogeologist, Dr. Pamela Bartley, that bedrock at the site presents very little groundwater and that, again, drilling in 2023 confirmed that the bedrock can be categorised in full agreement with the GSI's aquifer characteristic of Poor Aquifer and Poorly Productive Groundwater Flow Regime.

7.5.9 AQUIFER TESTING

7.5.9.1 Historical Data

With respect to the ability of the bedrock to transmit groundwater, *i.e.,* hydraulic conductivity determinations, historic results exist for three rotary cored boreholes (MW7, MW8 and BH3), which were drilled as part of the 2019 site investigation to inform P.A. Ref. LB/200106. Packer tests were carried out during Irish Drilling's borehole 2019 drilling. Resultant bedrock permeability values at the tested depths were reported during the previous planning application (Irish Drilling BHs, 2019, SLR Report, 2020) and are reproduced here for ease of reference, as shown in Table 7.12.

Table 7.12 Bedrock Permeability Results from 2019 Packer Testing (SLR, 2020)

BH3 (TOC = 82.90 m OD)			MW7 (TOC = 109.9 m OD)			MW8 (TOC = 95.75 m OD)		
Depth Interval, mbgl	Depth Interval, m OD	K, m/s	Depth Interval, mbgl	Depth Interval, m OD	K, m/s	Depth Interval, mbgl	Depth Interval, m OD	K, m/s
4 - 9	79 - 74	3.8×10^{-8}	6.6 – 11.6	103	5.1×10^{-7}	6 – 11	90	4.4×10^{-7}
9 - 14	74 – 69	1.2×10^{-8}	11.6 – 16.6		9.9×10^{-7}	11 – 16		1.9×10^{-7}
14 – 19	69 – 64	1.2×10^{-8}	16.6 – 21.6		5.0×10^{-8}	16 – 21		6.4×10^{-8}
19 – 24	64 - 59	1.6×10^{-8}	21.6 – 27.6		8.8×10^{-8}	21 – 26		1.8×10^{-8}
24 – 29	59 - 50	1.0×10^{-8}	27.6 – 32.6		6.4×10^{-8}	26 – 31		3.8×10^{-8}
			32.6 – 37.6		3.4×10^{-8}	31 – 36		2.4×10^{-8}
			37.6 – 42.6		1.6×10^{-8}	36 – 41		6.0×10^{-9}
			42.6 – 47.6		5.2×10^{-8}	41 – 46		2.2×10^{-8}
			47.6 – 52.6		6.6×10^{-8}	46 – 51		4.0×10^{-8}
			52.6 – 57.6		9.6×10^{-8}	51 – 56		4.0×10^{-9}
			57.6 – 62.6		1.4×10^{-8}	56 – 60	36	1.8×10^{-8}
			62.6 – 67.6	43	5.0×10^{-8}			
Mean	**79 – 50 m OD**	**5.8×10^{-8}**	**Mean**	**103 – 43 m OD**	**2.4×10^{-8}**	**Mean**	**90 – 36 m OD**	**1.2×10^{-8}**

The packer test results suggest a consistently low permeability with depth. The upper 10 m of the cored boreholes outside the quarry void show a slightly higher permeability due to a thin weathered zone at the top of bedrock. Results show a mean permeability of 5.80 x 10^{-8} m/s (0.005 m/d) for BH3, 2.40 x 10^{-8} m/s (0.002 m/d) for MW7, and 1.20 x 10^{-8} m/s (0.001 m/d) for MW8. BH3 is located adjacent to the western boundary of the proposed extension area.

Overall, the consistent 10^{-8} m/s value for hydraulic conductivity throughout the entire bedrock profile in all wells tested on the floor of the quarry suggests that water movement through this bedrock is very, very slow, akin to a very heavy CLAY or, MASSIVE rock, no water movement, no secondary porosity, no primary porosity.

7.5.9.2 Hydraulic Response Testing the 2023 Production Wells

Aquifer testing was attempted with the aim of:

(i) establishing the hydraulic properties of each of the geological formations in terms of transmissivity, specific capacity, hydraulic conductivity and storage coefficient, and

(ii) informing the conceptual understanding of the groundwater regime at the site.

Two of the 8" diameter PWs were evaluated (PW1 and PW2) using a series of pumping tests following installation. The tests planned included as follows:

1. Multi-stage step tests. Step tests involve pumping the well at three to five discrete pumping rates for periods of equal duration. The duration of each step is generally between 60 and 180 minutes, depending on the drawdown/discharge characteristics of the well. Multi-stage step tests are used at the start of an aquifer test to indicate the most appropriate pumping rate for the subsequent constant rate test. Step tests are also used to give an indication as to the performance of the well and the level at which to set the pump, amongst other things. The usual hydrogeological testing assumptions and conditions underlying the analysis of the step test are:

    - The aquifer from which groundwater is pumped has a seemingly infinite extent.
    - The hydraulic permeability of the aquifer is equal in all directions, the aquifer is of a certain thickness and homogeneous in rock composition over the area influenced by the step-pumping test.
    - Prior to pumping, the water level is (nearly) horizontal, and
    - The aquifer is pumped stepwise at increased discharge rates.

2. Constant rate pumping test. The constant discharge test is used to determine hydraulic properties of the well, and to investigate the potential for drawdown in nearby wells. Transmissivity is the rate water is transmitted through an aquifer in terms of a unit width and a unit hydraulic gradient. It equals the aquifer's hydraulic conductivity (permeability) times the aquifer thickness. The higher the transmissivity, the more prolific the aquifer is considered. The purpose of the constant discharge test was also to establish the stability of the hydrochemistry of the groundwater.
3. Recovery test. Monitoring and analysis of groundwater levels following completion of test pumping. This phase facilitates the application of formulae without any potential interference from the pump and the act of pumping to further characterise the groundwater body.

Groundwater levels were recorded in each of the tested wells, both intermittently using a manual dipmeter and continuously with the use of submerged pressure transducers (dataloggers). Stilling tubes were installed temporarily to facilitate a groundwater level dipmeter. Pumps, control valves and pumping rates were calibrated on the day preceding each test. Flowrates were measured in real time using a flowmeter and checked manually on an intermittent basis.

Although the PWs were drilled at large diameters in case significant strikes were encountered, no significant water strikes were actually encountered. Therefore, a 3" Grundfos SQ 55-3 submersible pump sufficed for the pump testing.

7.5.9.2.1 Hydraulic Response Results PW1 Test

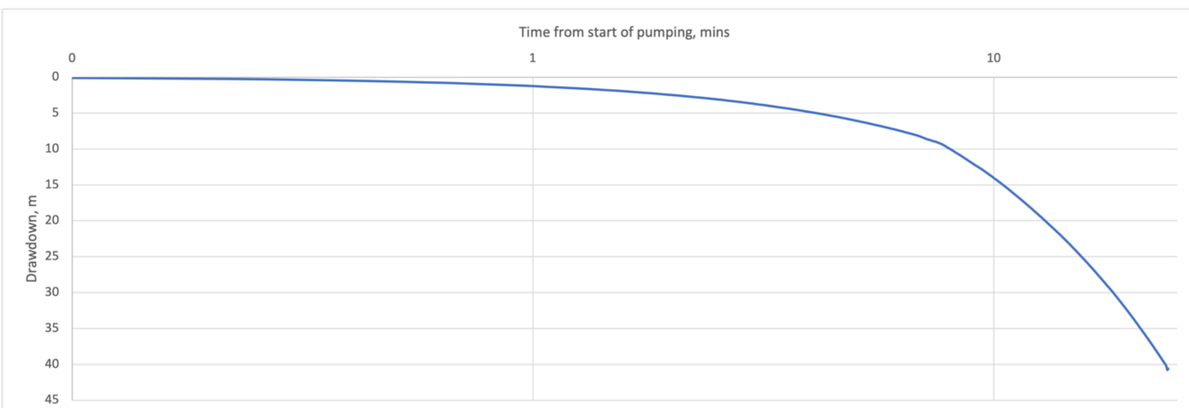
The pump was installed in PW1 at c. 56 mbgl. The pump is rated to lift 3.0 m^3/h (72 m^3/d) at a head of 60 m. Saturated thickness at start of the PW1 test was 53.5 m. On 11th June 2023, Envirologic personnel visited the site and performed a calibration of the pump. During the calibration stage, it became clear that well yield was too low to sustain an accurate step-test. To prevent the pump from running dry it was decided to abandon the step test increments, allow the well to recover and proceed straight to constant discharge rate test.

PW1's constant discharge pumping test commenced on 13th June 2023, at a discharge rate of 0.56 l/s (48 m^3/d). The starting groundwater level was 7.96 m below datum (top of steel casing), equivalent to 83.24 m OD. Groundwater level measurements indicated a rapid drawdown of 47.5 m in water level (35.7 m OD) within the first 25 minutes of the test.

Groundwater levels during the PW1 constant discharge test are shown in Graph 7.2. A review of the drawdown data reveals that the drawdown increases at a constant rate over time. This would indicate a very low permeability bedrock unit where water level response reflects simple emptying of the bored hole with no connection to a 'groundwater body'.

When plotted against time on a log scale a curve is indicated, rather than a typically expected straight line (Graph 7.3). The curve means that the well was being emptied and there was no groundwater recharge to the BH.

Graph 7.2 PW1 Constant Discharge Test Pumping Phase - Drawdown over Time



Graph 7.3 PW1 Constant Discharge Test Drawdown over Log Time

Transmissivity was calculated using the Cooper Jacob's Method (Cooper & Jacob 1946):

$$T = (2.30\ Q) / (4\ \pi\ \Delta s)$$

where: Q = discharge = 48 m^3/d = 0.033 m^3/min

Δs = drawdown over one log cycle (m) = 14.02 – 1.251 (1–10 mins)

= 12.77 m

For the 1–10 minute phase:

$$T = 2.3 \times 0.033 / 4 \times \pi\ (12.77)$$

$$T = 0.00047\ m^2/min$$

$$T = 0.681 = 0.7\ m^2/min = 0.01167\ m^2/s$$

The calculated T value of 0.7 m^2/min is a low transmissivity and suggests that water is not easily transmitted through the aquifer.

Permeability was calculated by dividing the transmissivity by the saturated thickness of the aquifer. The saturated portion of the borehole is unlined and fully exposed to the aquifer.

$$\text{Hydraulic Conductivity (K)} = 0.681\ m^2/day / 53.5\ m$$

$$K = 0.0127\ m/d$$

$$\mathbf{K = 1.5 \times 10^{-7}\ m/s}$$

The K value result is similar to the Hydraulic Conductivity value of a CLAY, as might be prescribed for a natural impermeable liner under an integrated constructed wetland. Hence, as the K-value derived for PW1 is comparable to impermeable clay liners, it can be accepted that the surrounding bedrock has poor, if any, permeability, which is a key property in aquifer classification.

Groundwater level recovery at PW1 was monitored at the end of the constant rate test. The response of residual drawdown was recorded until the groundwater level in the well recovered back to normal pre-test levels (Graph 7.4).

The Cooper Jacob's Method was used to estimate aquifer properties, this procedure involves fitting a straight line on a residual drawdown plot of s' (residual drawdown) versus log t/t' (ratio of time since pumping began to time since pumping stopped), as shown in Graph 7.5. This method is commonly used to estimate transmissivity (T) of an aquifer (Cooper & Jacob 1946 - Straight Line Solution).

For the 1–10 minute phase:

Δs = drawdown over one log cycle (m) = 44.48 (1–10 mins)

Transmissivity, T, is calculated as:

$$T = (2.30 \times 0.033) / (4 \times \pi \times 44.48)$$

$$T = 0.00014\ m^2/min$$

$$T = 0.195\ m^2/d$$

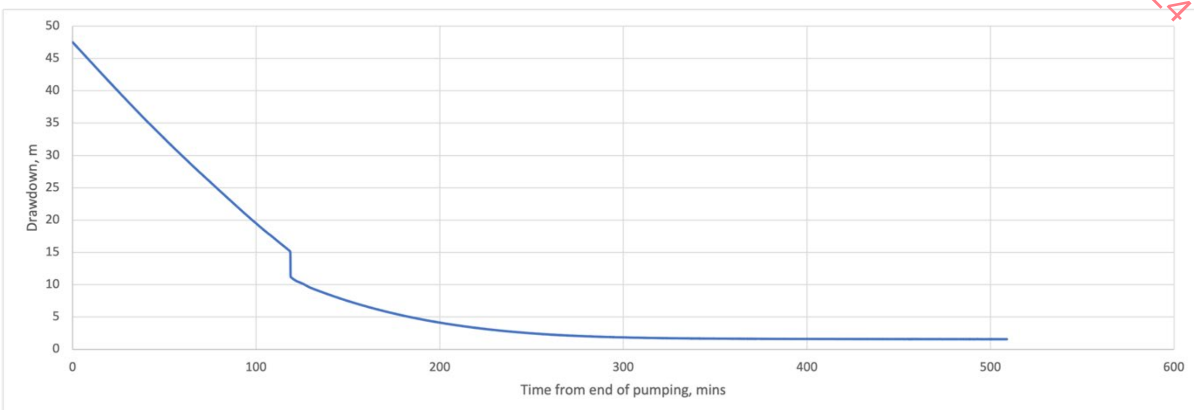
The consequent calculated Hydraulic Conductivity follows as:

$$K = 0.195\ m^2/d / 53.5\ m$$

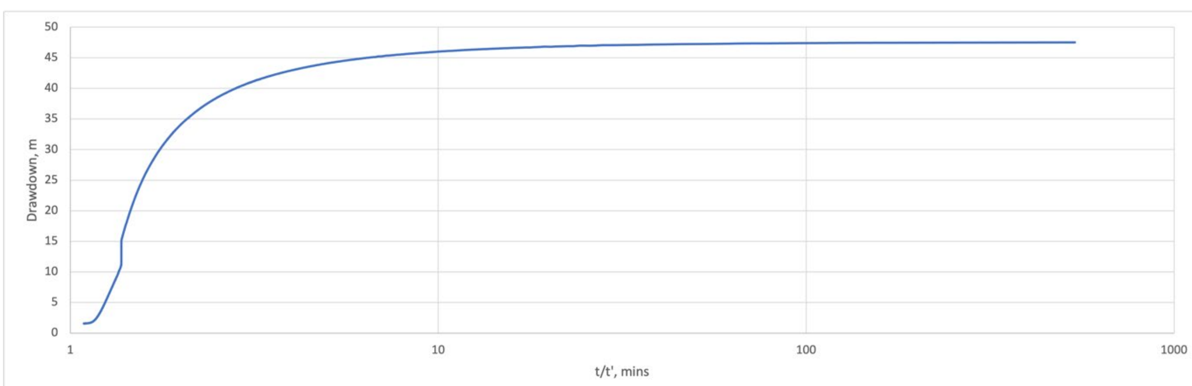
$K = 4.23 \times 10^{-8}$ m/s

Which is, again, suggesting little permeability in the rock.

The results for K, determined by analysis of the pumping response, and the value of K determined by the analysis of the recovery response, both suggest K lies between 10^{-8} and 10^{-7} m/s. This is consistent with the permeability results derived from the packer testing.



Graph 7.4 PW1 Drawdown Recovery following Cessation of Pumping



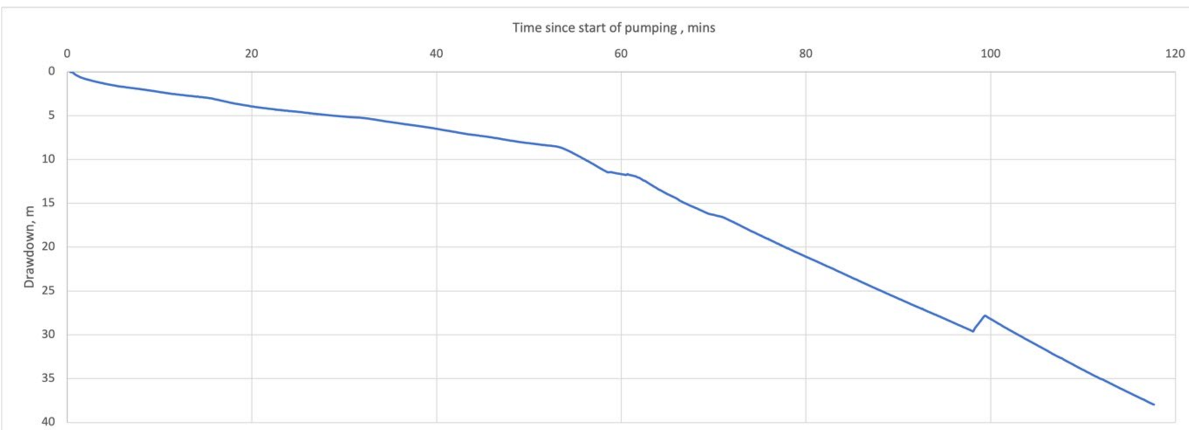
Graph 7.5 PW1 Drawdown Recovery following Cessation of Pumping Test Log Time

7.5.9.2.2 Hydraulic Response Results PW2 Test

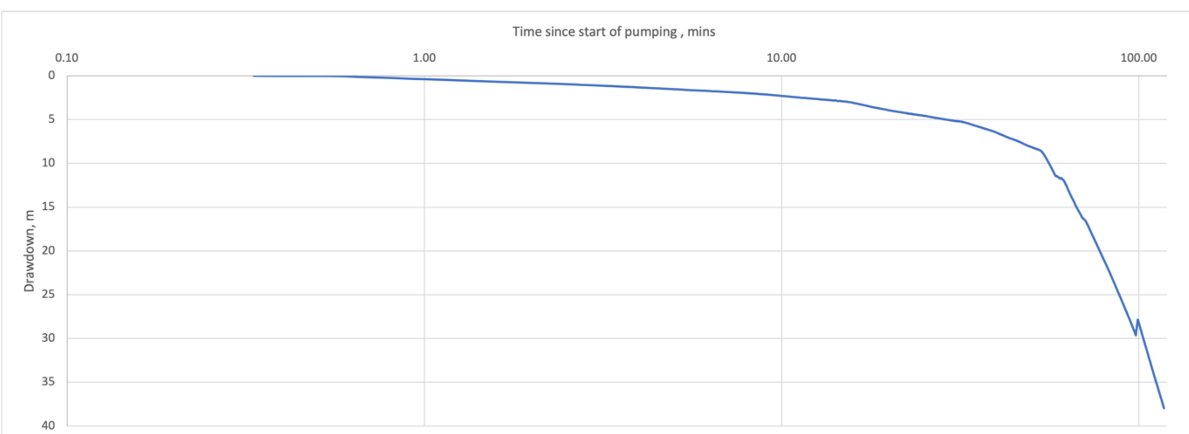
A 3” Grundfos SQ 55-3 submersible pump was installed in PW2 at c. 40 mbgl. Saturated thickness at start of the test was 52 m. PW2’s constant discharge pumping test commenced on 13th June 2023, at a discharge rate of 0.67 l/s (57.6 m^3/d). The starting groundwater level was 9.34 m below datum (top of the steel casing), equivalent to 84.09 m OD. Groundwater level readings indicated a rapid drawdown of 37 m in water level (46.3 mbtoc, 46.94 m OD) within the first 25 minutes of the test.

Groundwater levels during the PW2 constant discharge test are shown in Graph 7.6 A review of the drawdown data reveals that the drawdown increases at a constant rate over time. This would indicate a very low permeability bedrock unit where response is dominated by the simple emptying of the well void.

When plotted against time on a log scale, a curve is given rather than a typically expected straight line (Graph 7.7).



Graph 7.6 PW2 Constant Discharge Test Drawdown over Time



Graph 7.7 PW2 Constant Discharge Test Drawdown over Log Time

Transmissivity was calculated using the Cooper Jacob's Method (Cooper & Jacob 1946):

$$T = (2.30\ Q) / (4\ \pi\ \Delta s)$$

where: Q = discharge = 57.6 m^3/d = 0.04 m^3/min

Δs = drawdown over one log cycle (m) = 1.91 (1–10 mins)

= 25.92 (10–100 mins)

For the extended 10–100 minute phase:

$$T = 2.3 \times 0.04 / 4 \times \pi\ (25.92)$$

$$T = 0.00028\ m^2/min$$

$$T = 0.4067\ m^2/d$$

This is a low transmissivity and suggests that water is not easily transmitted through the aquifer.

Permeability is calculated by dividing the transmissivity by the saturated thickness of the aquifer. The saturated portion of the borehole is unlined and fully exposed to the aquifer.

$$K = 0.41\ m^2/d / 52\ m$$

$$K = 0.0078\ m/d$$

$$\mathbf{K = 9.1 \times 10^{-8}\ m/s}$$

Again, these data suggest little permeability in the rock. Again, these results confirm that the bedrock can be categorised in full agreement with the GSI's aquifer characteristic of Poor Aquifer and Poorly Productive Groundwater Flow Regime.

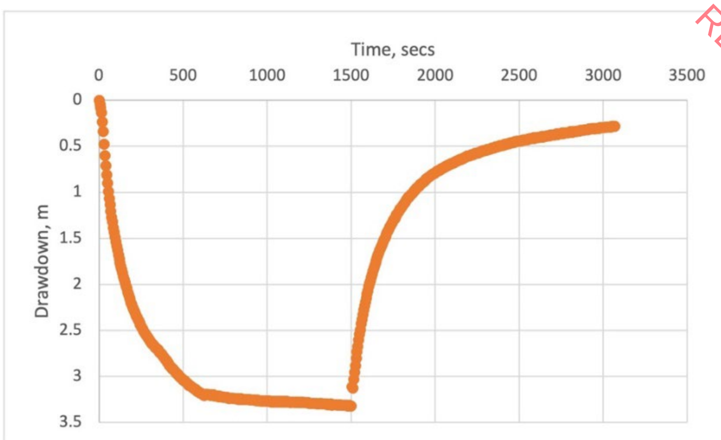
7.5.9.3 Hydraulic Response Testing Monitoring Wells

Small-scale pumping tests were performed on monitoring wells PBH01 and PBH02, both of these being within the greenfield extension application area to the east of the working quarry.

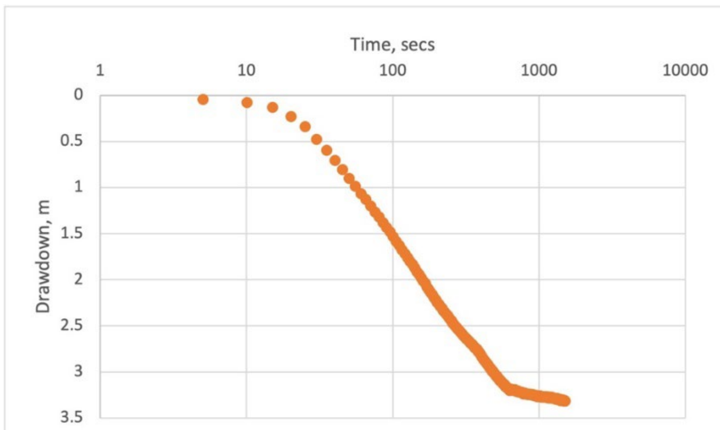
A 40 mm diameter piezometer submersible pump, battery powered, was used. Saturated thickness at start of the tests was 72.04 m and 69.22 m at PBH01 and PBH02, respectively. Discharge rates were 0.083 and 0.12 l/s at PBH01 and PBH02, respectively.

7.5.9.3.1 Hydraulic Response Testing PBH01

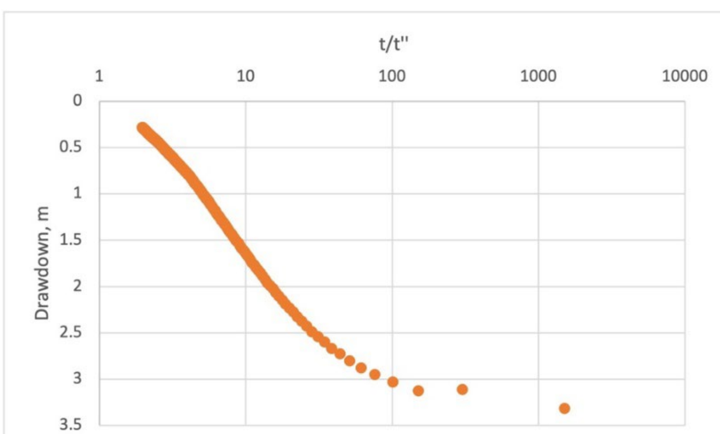
Response of the piezometer water level in PBH01 during the pumping and recovery phases are shown in Graph 7.8. Drawdown plotted against time on a log scale is shown in Graph 7.9 The recovery drawdown when plotted against t/t'' on a log scale is shown in Graph 7.10 (where t = time since start of pumping and t'' = time since cessation of pumping).



Graph 7.8 PBH01 Small-Scale Pumping Test Drawdown and Recovery over Time



Graph 7.9 PBH01 Small-Scale Pumping Phase Drawdown over Time on a Log Scale

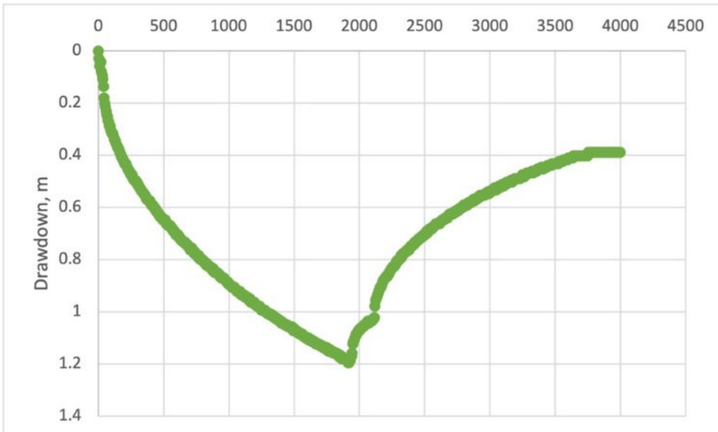


Graph 7.10 PBH01 Small-Scale Pumping Test Recovery over t/t'' on a Log Scale

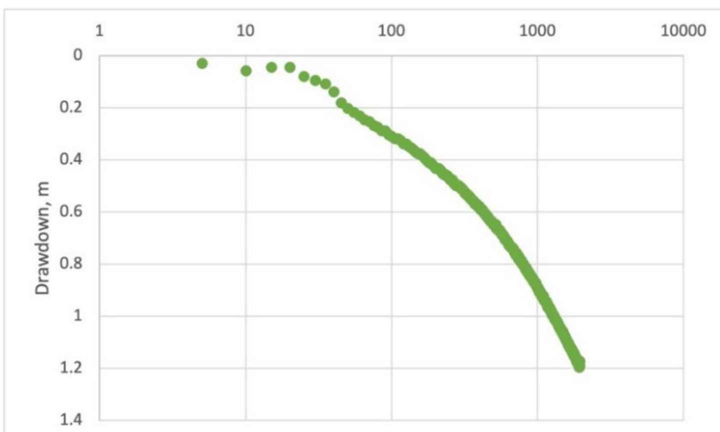
7.5.9.3.2 Hydraulic Response Testing PBH02

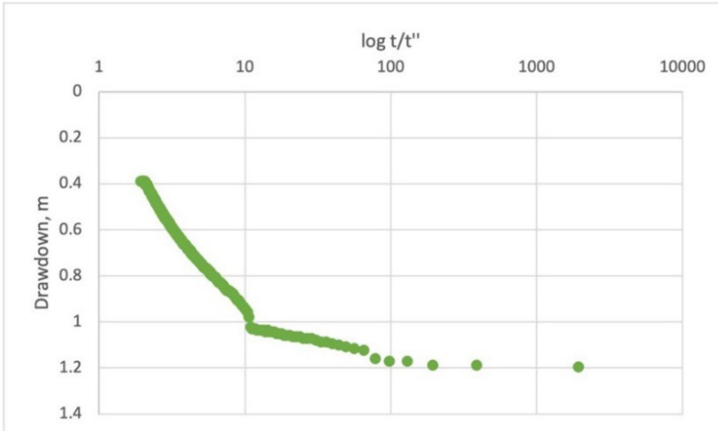
Response of the piezometer water level in PBH02 during the pumping and recovery phases are shown in Graph 7.11. Drawdown plotted against time on a log scale is shown in Graph 7.12. The recovery drawdown when plotted against t/t'' on a log scale is shown in Graph 7.13 (where t = time since start of pumping and t'' = time since cessation of pumping).

Graph 7.11 PBH02 Small-Scale Pumping Test Drawdown and Recovery over Time



Graph 7.12 PBH02 Small-Scale Pumping Phase Drawdown over Time on a Log Scale





Graph 7.13 PBH02 Small-Scale Pumping Test Recovery over t/t'' on a Log Scale

The same analysis conducted on the drawdown and recovery phases in PW1 and PW2 were repeated for PBH01 and PBH02 and yielded the following results:

- PBH01 pumping test K = 1.0 x 10^{-7} m/s
- PBH01 recovery test K = 1.1 x 10^{-7} m/s
- PBH02 pumping test K = 5.4 x 10^{-7} m/s
- PBH02 recovery test K = 5.4 x 10^{-7} m/s

These results show that bedrock permeability in the southern and eastern portions of the application area are consistent with that observed in other permeability tests carried out across the current quarry and the eastern extension area.

The hydraulic conductivity and groundwater flow rate at PBH01 is so low (10^{-7} m/s) that the bedrock here will act as a hydraulic barrier restricting groundwater flow from 'In Salterstown' cherty shale formation outside the application area, *i.e.,* immediately south of the site. This is an important part of the conceptual understanding for the site and it is the probable reason for the groundwater ingress / seep in the boundary wall between the working quarry and the eastern greenfield extension area. The formation divide between the Salterstown (high PSV) and the southern shaley cherty rock most likely acts as a pathway. This is why the calcite that SLR referred to as a 'tufa spring' is present. Whereas this hydrogeological and ecological team advise that it is not a spring but an expression of recent rainfall along a point of contact between two bedrock units that has been exposed due to quarry activity.

7.5.9.4 Aquifer Testing Summary

The results from all bedrock hydraulic conductivity testing at the site are summarised in Table 7.13. Hydraulic properties of the sandstone/mudstone that make up the Salterstown Formation in the area confirm that the primary porosity is low, with no discrete groundwater-bearing fractures encountered.

Table 7.13 Bedrock Permeability Summary Results

Test Well	Test Result	Borehole K, m/s	Area K, m/s	Site K, m/s
MW7		5.8×10^{-8}	Average K, Existing Quarry Void = 3.1×10^{-8}	**Average K, Overall Application Area = 10^{-8} m/s**
MW8		2.4×10^{-8}		
BH3		1.2×10^{-8}		
PW1 Pumping	1.5×10^{-7}	9.6×10^{-8}	Average K, Proposed Quarry Void = 9.9×10^{-8}	
PW1 Recovery	4.2×10^{-8}			
PW2 Pumping	9.1×10^{-8}	9.1×10^{-8}		
PBH01 Pumping	1.0×10^{-7}	1.1×10^{-7}		
PBH01 Recovery	1.1×10^{-7}			
PBH02 Pumping	5.4×10^{-7}	5.4×10^{-7}		
PBH02 Recovery	5.4×10^{-7}			

7.5.10 THIRD PARTY WELL SURVEY

Information on wells and springs in the area was gained during the desktop study using a combination of historical mapping, aerial photography, previous application details and information contained in the Meath County Council online planning system.

A third party well survey was carried out by an environmental scientific officer of Breedon, under direction and assistance from one of the project's hydrogeologists. Dr. Pamela Bartley. All properties within 500 m of the extraction area were visited on 14 and 15th November 2023. Where a homeowner was absent on 14th November that house was revisited on the 15th November.

Where a well was identified, it was surveyed using RTK VRS and groundwater level was measured using a dipmeter. Well head elevations were used to convert the dipped groundwater levels to elevations above Malin Head datum (m OD).

Coordinates and groundwater levels of surveyed wells are shown in Table 7.14. It is noted the 3rd party wells to the south east of the quarry have retained their water levels at elevations well above the water level in the quarry sump: the 3rd party wells have groundwater elevations ranging from 115 m to 122 m OD, whereas the quarry sump's water level is 65 m OD. This suggests that the current quarrying has not affected 3rd party wells.

The locations of the dwellings surveyed are presented in Figure 7.9

Although homeowners were absent at houses 1, 3, 5, 6, neighbours suggest that private supplies are present at those locations.

There is no information on potable water supplies for houses 8 to 16, 18 or 19.

Table 7.14 Results of Third Party Well Survey Performed 14th November 2023

Well Ref.	Easting	Northing	Depth, m	Top of Casing, m OD	Depth to GW, mbtoc	Groundwater Elevation, m OD	Notes
2	690,866	781,057	49.4	121.80	3.73	**118.07**	6" borehole. Good yield, iron present.
4	690,843	780,915	1.8	122.70	0.97	**121.73**	Dug well. 0.65 m diameter. Poor yield.
7	690,772	781,040	54.9	121.40	6.24	**115.16**	6" borehole. Good yield.
17	689,976	781,366	17.7	98.30	7.26	**91.04**	6" borehole. No reported issues.

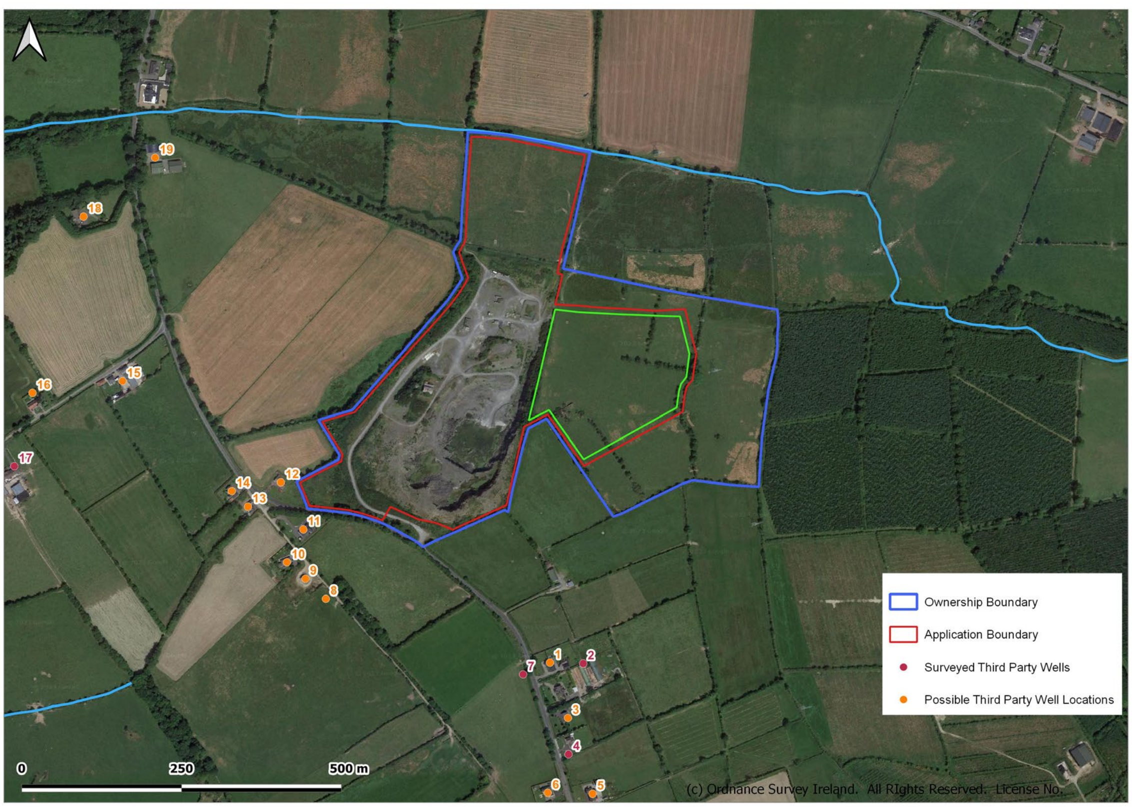
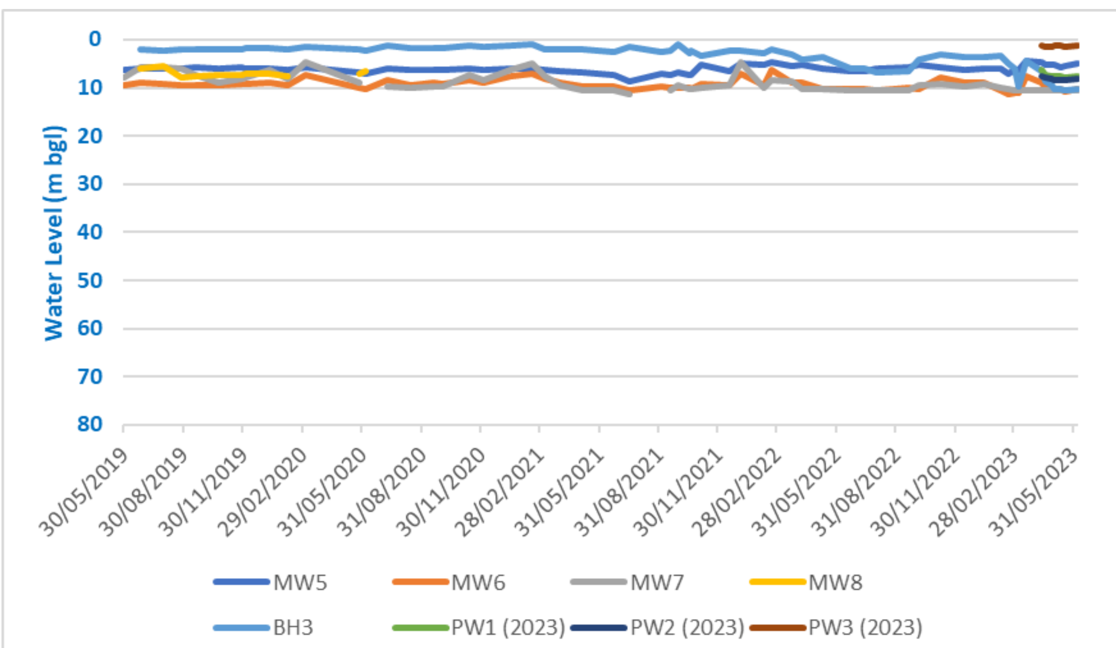


Figure 7.9 Third Party Well Survey Points

The hydrogeologists advise that groundwater flow direction is from south to north. There are no third-party wells north of the site between the quarry and the Killary Water_010, which is a hydraulic control. All wells surveyed are upgradient of the excavation and the proposed workings. Calculations will be presented later to evaluate potential for impact. It is understood from the drilling and hydraulic response tests that there is little potential for groundwater to be encountered in the bedrock quarried at the site, *i.e.,* the high PSV 'Salterstown' Formation. Instead, as with the site's own PW01 and MW1, the 'In Salterstown' bedrock is the likely supplier of groundwater to the domestic wells surveyed.

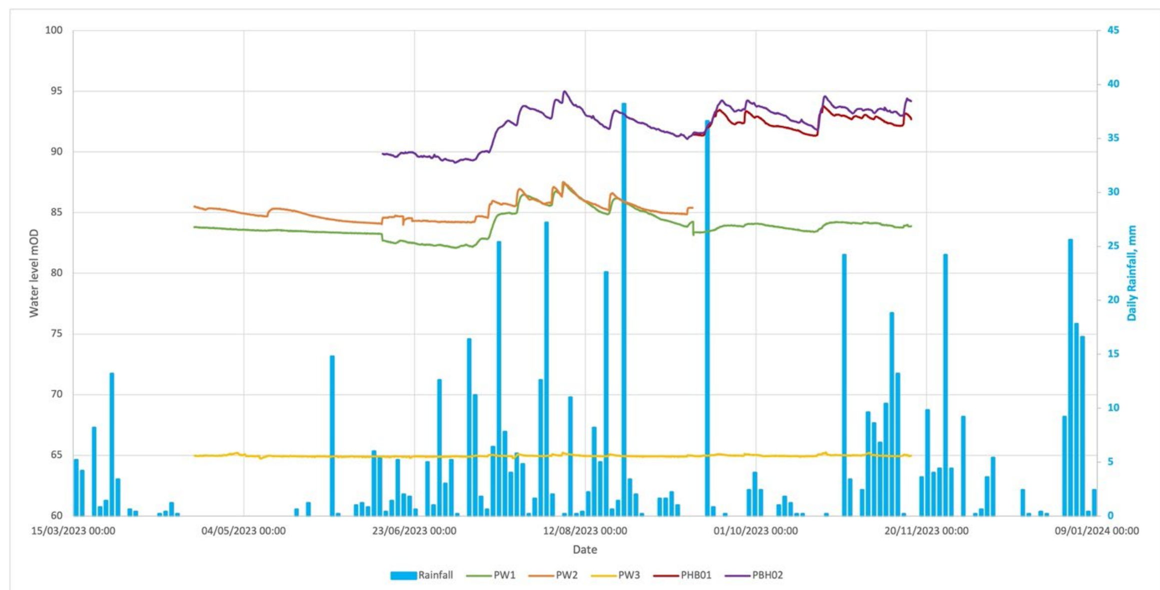
7.5.11 GROUNDWATER LEVELS

Groundwater monitoring points installed in the Salterstown formation within the quarry and in the greenfield eastern extension application area are manually dipped (measured) each month. Results for each month over the last four years are shown in Graph 7.14. The results suggest stable groundwater levels with the expected small variations throughout seasons. The results do not show a decreasing trend in water levels. The results show, as expected, that rain on the floor around each bored hole can enter the bored hole and move away over time. This is normal.



Graph 7.14 Monthly Manual Dips for Water Levels in PWs and MWs throughout the Site

In April 2023 dataloggers were installed in selected wells so as to continuously record water levels. Data are presented in Graph 7.15. The data show that the water level in the sump has been maintained at c. 65 m OD throughout the year. Groundwater levels in the application area showed a relatively stable trend, with temporary increases in groundwater levels following notable rainfall events.



Graph 7.15 Groundwater Level Variation across Site 2021–2023

7.5.12 GROUNDWATER FLOW DIRECTION

As stated, groundwater levels were surveyed at on-site wells and available third-party wells, where accessible, on 14th November 2023. Surfer software was used to compile a groundwater level contour map from the available data, as shown in Figure 7.10.

The contour map confirms that the general groundwater flow direction is from southeast to northwest, as preciously explained. A steep hydraulic gradient is present from lands to the south of the existing quarry towards the quarry sump (99.4 m OD to 65 m OD over 87 m linear). This steep hydraulic gradient is indicative of very low permeability bedrock. Similarly, groundwater levels in the proposed eastern lateral extension area appear to be unaffected by current sump pumping from the sump because the water levels remain significantly above the excavation depth in the adjacent working quarry.

The data suggest that groundwater levels likely recover to pre-development levels between the sump and the Killary Water_010 stream. It can reasonably be concluded that the current dewatering regime is not reducing baseflows in the Killary Stream.

As previously stated, it is noted the 3rd party wells to the south east of the quarry have retained their water levels at elevations well above the water level in the quarry sump: the 3rd party wells have groundwater elevations ranging from 115 m to 122 m OD, whereas the quarry sump's water level is c. 65 m OD. This suggests that the current quarrying has not affected 3rd party wells.

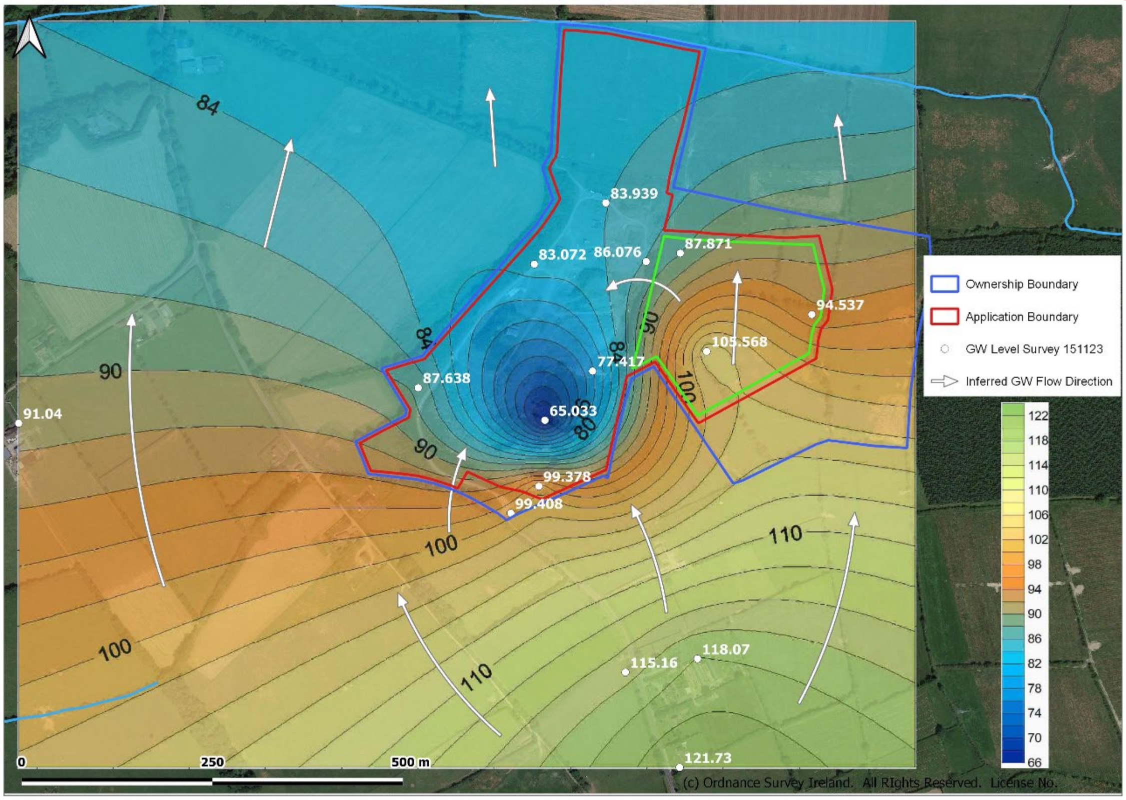


Figure 7.10 Groundwater levels and contour map 14th November 2023

7.5.13 GROUNDWATER FLOW REGIME

Based on the drilling experiences, observations of the quarry walls of rock at the site and hydraulic response testing, the conceptual model for the site is that the bedrock aquifer beneath the entire 2023 application area is the same as has been encountered in the operational, permitted, quarry. The rock encountered during drilling is metasandstone and very small groundwater strikes were encountered. These low groundwater yields were confirmed by pumping and response testing on PWs and MWs.

The salient point is that there is little ability for water to move and flow through the very hard, high PSV bedrock, which is the target rock for extraction in the planning application area.

Recorded discharge rates from the site are reflective of low pumping rates from the quarry floor's sump. What is pumped from the sump to the settlement lagoons is the same as what the settlement lagoons send to the receiving water: the discharge flow is measured by flow meter. The average discharge rate is 175 m^3/d and the maximum discharge rate, in response to heavy rainfall, was 465 m^3/d. The volume of waters arising at the site are relatively low and responsive to rainfall. This reinforces the inference that groundwater inflow rates to the current quarry void are very low and this pattern is expected to continue into future when the site is developed deeper in the quarry floor and across the eastern greenfield proposed extension area.

The notable exceptions are two discrete inflows emanating from the top of the eastern quarry face (See Plate 7.6), these being referred to as Ingress 1 and Ingress 2, the locations of which are shown on Figure 7.7 (interrogative nitrogen species sampling locations) and Figure 7.11, below.

Upon closer inspection, these inflows are from close to the top of the quarried rock face. Open field boundary drains were noted along the routes shown in Figure 7.11, and these terminate at locations which correlate to Ingress 1 and 2. Hence the ingresses are a result of open field drains, which would have previously flowed westwards, now out falling at the top of the quarry. It appears that an interceptor drain was excavated along the eastern quarry boundary, extending north from Ingress 2 however this channel was dry on 14th November 2023. The surface water being carried in the upgradient drains appears to infiltrate broken rock directly above Ingress 1.

Previous reporting has suggested that these are Tufa Springs. It can now be confirmed that these ingresses are not tufa springs but merely rainfall-runoff collected in open field boundary drains.

Plate 7.6 Ingress 1 on eastern quarry face

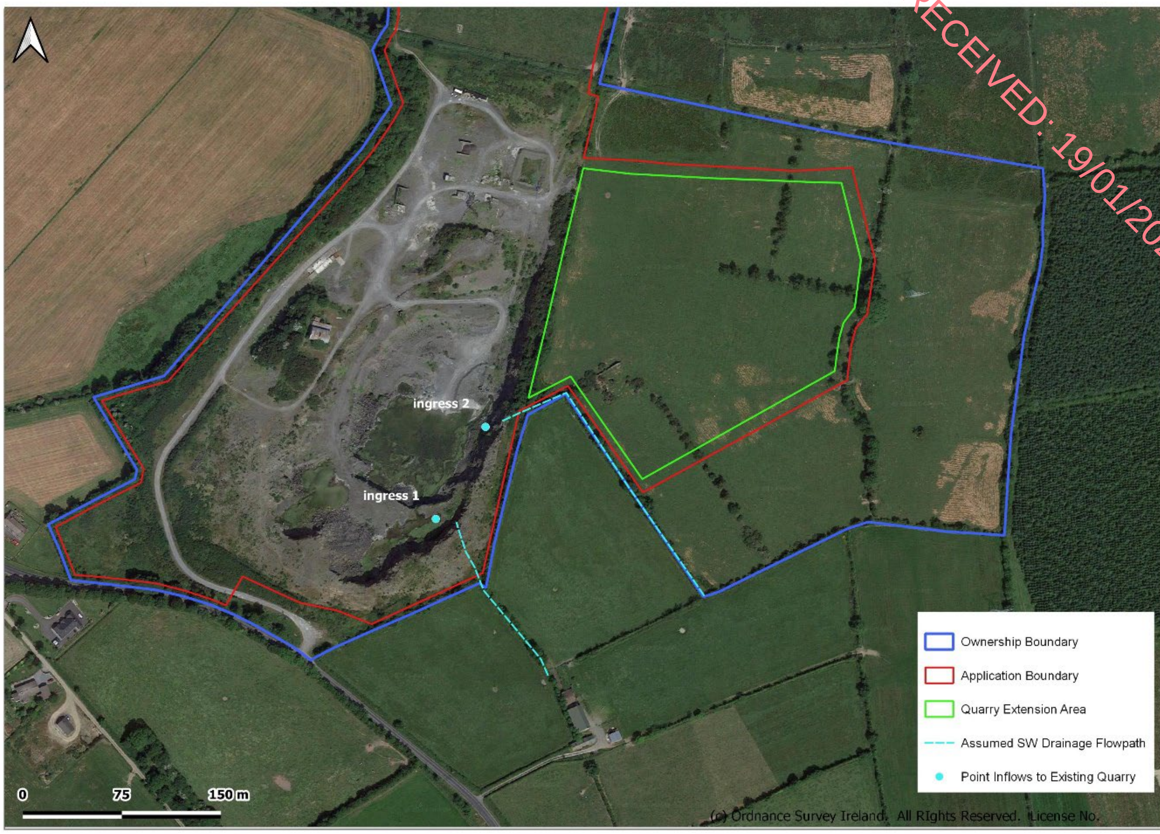


Figure 7.11 Location of Water Ingress Points on Eastern Face of Existing Quarry Area

7.6 SITE METRICS

7.6.1 SITE WATER BALANCE

7.6.1.1 Rainfall Runoff Generated

Rainfall landing within the areas where bedrock has been extracted generates runoff. The current active quarry excavation area is topographically enclosed. As such, rainfall-runoff is diverted towards the lowest part of the excavation, referred to as the quarry sump. This pattern will continue as quarry development progresses.

Some local groundwater intercepted by exposed bedrock faces will also be collected in the sump though permeability values suggest that groundwater inflows to the void from the wider surrounding area are negligible. This groundwater has been accounted for in the aquifer recharge shown in Table 7.15.

All of the specified site activities require some form of water management. Site water management at the site works towards minimising pumping costs. To achieve this water used in dust suppression and the wheelwash will continue to be recycled insofar as possible. During times of low rainfall and high water demand the water storage tanks can be further topped up with water pumped from PW01 or the main settlement lagoon.

The sump acts as an attenuation lagoon and is used to store water before sending it for treatment. The attenuation sump on the quarry floor must be large enough to store the volume of water associated with a 1 in 100-year storm event with further capacity in the quarry void to store multiple times the volume of water generated during a 1:100 storm event. This will be allowed to flood should it be required.

Whilst some excess rainwater can be stored in the sump following periods of heavy rainfall the majority of excess rainfall-runoff needs to be released to local surface waters in order to maintain a dry working environment. All other areas outside those listed will be undisturbed, and in terms of rainfall-recharge patterns, will be in line with current greenfield runoff rates.

The water balance derived from rainfall landing on the existing quarry void area (c. 5.6 ha) and proposed extension area (c. 4.1 ha) of the site are presented as Table 7.15.

Table 7.15 Rainfall Derived Water Balance for Extraction Areas

Parameter	Unit	Active Quarry Area	Quarry Extension	**Final Quarry Area**
Quarry Void Area	ha	5.6	4.1	**9.7**
Area	m^2	56,000	41,000	**97,000**
Effective rainfall	m/yr	0.542	0.542	**0.542**
Rainfall volume	m^3/yr	30,352	22,222	**52,574**
Rainfall volume	m^3/d	83	61	**144**
Recharge coefficient	%	0.85	0.85	**0.85**
Recharge reaching bedrock head	m^3/yr	25,799	18,889	**44,688**
Surface runoff (recharge rejected at surface)	m^3/yr	4,553	3,333	**7,886**
Surface runoff (recharge rejected at surface)	m^3/d	12	9	**22**
Recharge cap	m/yr	0.1	0.1	**0.1**
Recharge to bedrock aquifer	m^3/yr	2,580	1,889	**4,469**
Recharge to bedrock aquifer	m^3/d	7	5	**12**
Shallow subsurface flow (recharge rejected at bedrock head)	m^3/yr	23,219	17,000	**40,219**
Shallow subsurface flow (recharge rejected at bedrock head)	m^3/d	64	47	**110**
Surface runoff plus shallow subsurface flow	m^3/yr	27,772	20,333	**48,105**
	m^3/d	76	56	**132**
	l/s	0.88	0.65	**1.53**
Destination		Killary Stream		

Based on the final determinations of information presented in Table 7.15, **the combined total of runoff and shallow subsurface flow that needs to be managed by the site is 48,105 m^3/yr, equivalent to 132 m^3/d (1.53 l/s)**. The value of 132 m^3/d will be added to any envisaged groundwater that might be encountered.

The proposed development involves an extension to the current permitted extraction area. Under that scenario, any groundwater encountered must be removed to maintain a dry working environment. This requires site-specific data describing hydraulic properties of the bedrock, which is analysed and discussed later in the chapter.

This preliminary water balance is a ‘first run’, desk-based exercise and it is acknowledged that the approach has certain limitations, such as: The recharge coefficients and recharge caps are derived from literature sources that may differ from actual values.

Acknowledgement of calculation limitations facilitates the development of robust conceptual models and water management plans.

7.6.1.2 Process Water

Process water can be recycled from the main settlement lagoon or the sump which means that less water will have to be discharged from the site on a daily basis. Relatively small amounts of water will be used for the purpose of process water as follows:

- Wheelwash = 4 m^3/d.
- Dust suppression = in the order of 5 m^3/d (seasonal).
- Mobile plant sprinklers for washing of chips = in the order of 2 m^3/d.
- Toilet and canteen facilities = 2 m^3/d.
- Additional waters used on site = ≤0.5 m^3/d.

Given the nature of site topography any excess water from the above processes shall drain by gravity back to the existing water management system.

7.6.1.3 Extreme Rainfall Events

An assessment is required to ensure the lowest part of the quarry void is capable of temporarily storing stormwater that drains to it during intense rainfall events. Stormwater volumes draining to the sump are based on the contributing area of the combined current and proposed bare rock working quarry area of 97,000 m^2. From mapping and site walkover there is no upgradient surface water catchment to the proposed quarry working area. Using the Met Eireann Depth Duration Return Period data table for extreme rainfall at the site, calculations presented in Table 7.16 show that the 1 in 100-year rainfall contribution to the sump over a 24-hour period is 11,035 m^3. This includes a climate change growth factor of 20%.

Therefore, in order to store the Q_{100} rainfall event, with a climate change factor, the following indicative sump dimensions, or variations, could provide the 11,035 m^3 storage:

- Radius = 60 m, for a depth = 1 m (11,309 m^3)

There is adequate area are available on the working floor of every quarry site for the attenuation of stormwaters. It is best practice that stormwater accommodation is provided in the floor sump of the working area. The required calculated area can be provided in any variation in dimensions and configuration. The only requirement is that the required volume is achieved.

Table 7.16 Potential Rainfall-Runoff Inflows to the Quarry Sump during Extreme Rainfall Events

Considered Catchment m²	Rate	1 in 1 year	1 in 10 year	1 in 50 year	1 in 100 year
97,000	**24-hour event**				
	Mm	8	61.7	83.6	94.8
	m	0.008	0.0617	0.0836	0.0948
	Rainfall-runoff to sump, m³/d	776	5,985	8,109	9,196
	(m³) Required with +20% Climate Change	**931**	**7,182**	**9,731**	**11,035**
	6-hour event				
	mm	3.8	36.9	51.8	59.6
	m	0.0038	0.0369	0.0518	0.0596
	Rainfall-runoff to sump, m³/d	369	3,579	5,024	5,781
	(m3) Required with +20% Climate Change	**442**	**4,295**	**6,030**	**6,937**

7.6.1.4 Greenfield Runoff Rate

It has been shown that the bedrock to be quarried has a low permeability, so it can be reasonably assumed that during extreme storm events the contribution from groundwater seepages is low relative to the overall contribution from precipitation as runoff. It is therefore necessary to attenuate stormwater generated on site, such that it leaves the site at a rate less than or equal to greenfield runoff rates. This is an important feature of the quarry in that it provides large attenuation capacity storage, which will provide significant protection from flooding to downgradient receptors. An allowance needs to be made to allow a certain amount of precipitation to leave the site at a controlled rate.

Pre-development greenfield runoff rate is given by:

$$QBAR_{rural} = 0.00108\ (AREA)^{0.89} \times (SAAR)^{1.17} \times (SOIL)^{2.17}$$

where

$QBAR_{rural}$ = mean annual flood flow from a rural catchment (m^3/s)

AREA = exposed quarry floor upon completion (km^2) = 97,000 m^2, 0.097 km^2

SAAR = standard annual average rainfall depth (mm) = 929 mm

SOIL = soil index, a composite index determined from soil survey maps that accompany the Flood Studies Update

= 0.4, representing SOIL 3, applicable to moderately permeable subsoil

It is recommended that flood risk assessment based on the methodology in Volume 2 of the Greater Dublin Strategic Drainage Strategy (2005) is not applied to an area of less than 50 hectares. It suggests that the runoff from smaller areas is then linearly interpreted. A theoretical catchment area of 0.5 km^2 (50 ha) was used for initial calculations. The Q_{BAR} rate applicable to the theoretical catchment area of 0.5 km^2 is:

$$QBAR_{rural} = 0.00108\ (0.5)^{0.89} \times (929)^{1.17} \times (0.4)^{2.17}$$

$$QBAR_{rural} = 0.134\ m^3/s\ (134\ l/s) \text{ for the 50 ha catchment}$$

The linear interpolation of Q_{BAR} from a catchment of size 50 ha down to gross active site area c.19 ha and net hard standing (final quarry void area = 9.7 ha) is shown in Table 7.17. The limiting discharge rates for the 75- and 100-year return period storm events are presented in Table 7.17 using growth factors of 1.87 and 1.96, respectively, in accordance with relevant TII guidance (TII, 2015). The Climate Change growth factor is accounted for in the sump attenuation calculations and not the allowable greenfield runoff rate. It would be counterproductive to allow a growth factor to the allowable runoff rate.

Table 7.17 Linear Interpolation of QBAR for On-Site Hardstanding

Item	**Area, ha**	**Q_{BAR} (m^3/s)**	**Q_{75} (m^3/s)**	**Q_{100} (m^3/s)**
Unit	1	0.0047	0.0089	0.0093
50 ha as calculated	50	0.2369	0.4430	0.4643
Total active area	19	0.0900	0.1683	0.1764
Final quarry void area	9.7	**0.0460**	**0.0859**	**0.0901**

The applicant does not intend to vary the discharge rate in response to the return period greenfield runoff rate. The discharge rate will instead be fixed. The maximum potential pumping rate from the sump to the lagoons will be limited to less than the licensed discharge rate (1,728 = 0.02 m^3/s = 20 l/s), this being less than pre-development greenfield runoff rates during extreme rainfall events for the excavation area (0.046 m^3/s = 3,974 m^3/d = 46 l/s) Therefore, the quarry discharge will not increase flood risk to downgradient receptors.

7.6.1.5 Attenuation

In its most restrictive approach, attenuation storage is calculated when outflow is limited to Q_{BAR}. The quarry floor must be capable of storing the balance of the stormwater during intense rainfall events.

Table 7.18 presents the return period rainfall depths for a range of durations, as provided by OPW FSU online portal. Design rainfall rates were obtained from the OPW FSU facility. A 20% increase in design rainfall depths was adopted to account for climate change.

In line with standard practice, discharge surface water should be limited to the pre-quarrying discharge rate to mitigate against downstream flooding. The attenuation storage requirements when the outflow is restricted to Q_{BAR}, *i.e.,* 46 l/s, are shown in Table 7.18.

Table 7.18 Design Rainfall Rates and Attenuation Storage using Outflow of 46 l/s

Duration, D, hrs	R, mm	R x 1.2, mm	I, m^3	O, m^3	I – O, m^3
0.25	22.5	27	2,619	41	2,578
0.5	27.8	33.4	3,236	83	3,153
1	34.4	41.3	4,004	166	3,839
2	42.5	51	4,947	331	4,616
4	52.6	63.1	6,123	662	5,460
6	59.6	71.5	6,937	994	5,944
12	73.6	88.3	8,567	1,987	6,580
18	83.4	100.1	9,707	2,981	6,727
24	94.8	113.8	11,035	3,974	**7,060**
48	106.1	127.3	12,350	7,949	4,401
72	125.3	139.4	13,526	11,923	1,602
96	133.8	150.4	14,585	15,898	-1,313
144	141.8	160.6	15,574	19,872	-4,298

Information presented in Table 7.18 shows that the stormwater generated during a 1 in 100-year event of 24 hours duration is I = 11,035 m^3. Restricting the outflow to greenfield runoff rate, Q_{BAR}, results in a permissible outflow of O = 3,974 m^3. The balance, i.e., (I-O) = 7,060 m^3, must be withheld via attenuation, and released at greenfield runoff rate or less. As quarrying progresses, an enclosed quarry floor with a minimum available volume of 7,060 m^3 shall be maintained. A quarry floor volume in excess of that has already been specified in earlier calculations.

The licensed discharge rate (0.020 m^3/s) is lower than Q_{BAR} (0.046 m^3/s) which provides additional mitigation against flood risk. Limiting the outflow (O) to 0.020 m^3/s increases the maximum attenuation requirement to 9,307 m^3 which occurs during a 24-hour event. An enclosed quarry volume in excess of that has already been specified in earlier calculations. It is best practice to accommodate and attenuate the extreme storm on the floor and treat in the final settlement lagoons at the overflow rate appropriate to the settlement of solids and the licenced discharge rate. This will be how storms are managed at the site.

7.7 DEWATERING ESTIMATIONS

In order to assess the feasibility of the proposed development works, in terms capacity within the existing Section 4 Discharge Licence and of availability of both assimilative capacity and hydraulic capacity of receiving waters, calculations are presented below to predict likely dewatering rates following completion of proposed development works. The availability of actual discharge flow data will be used to validate the methodologies.

Groundwater seepage into an open quarry void has the potential to initiate a hydraulic response in the surrounding bedrock that can be conceptualised as radial flow towards a pumping well. Where the surrounding bedrock has low hydraulic conductivity, inflow rates and water management can be handled using sumps on the quarry floor. The aquifer testing completed suggests low permeability and potentially low water volumes requiring water management in the future at this site.

Projected dewatering rates are estimated for the proposed development using recommended formulae and site-specific data collected from drilling investigations. The site's future dewatering demands and consequent water management needs are determined using the average permeability calculated at seven wells in the existing quarry and proposed extension area.

The methodology to determine the potential radial effect and the possible quantity of water requiring management at the site in the future is now presented in calculation steps, as follows:

1. Determine the Radius of Influence.
2. Estimate the potential volume of groundwater inflows to the sump using empirical formulae.
3. Alternatively evaluate volumes that might occur by applying the concept of recharge.
4. Conclude on the total dewatering volumes that might arise in the future.

7.7.1 RADIUS OF INFLUENCE

The principles for estimating groundwater flows are typically based on radial inflows, so a preliminary step is required to convert the extraction area to its circular equivalent having the same area.

The proposed final quarry void area will have a footprint of 9.7 ha or 97,000 m^2, approximately. This area has an equivalent radius of 175 m.

The area is proposed to be deepened to 35 m OD. Based on maximum resting groundwater levels at PBH01 between July to October 2021 of 105 m OD, the final future requirement might be to draw water level down by 70 m.

Even though borehole drilling, piezometer installations and aquifer testing suggest little groundwater continuity at the site, it is convention to calculate, for the worst case possible future scenario, the radius of influence of site dewatering.

The Radius of Influence can be estimated using Sichardt's Empirical equation as follows:

$$R_0 = C(H - h_w)\sqrt{K}$$

Where:

R_0 = radius of influence (excluding radius of theoretical well = final quarry footprint = 175 m radius)

C = constant = 3,000

$H - h_w$ = proposed final drawdown to sump

= 105 m OD (PBH01) – 35 m OD (final floor level) = 70 m

K = bedrock permeability = 1.3×10^{-7} m/s = 0.011232 m/d (worst case results ext. lands)

Application of Sichardt's Empirical equation suggests that the Radii of Influence (R_0) of keeping the future floor dry and safe for working are as follows:

- R_0 = 76 m from edge of the proposed excavation area
- R_0 = 251 m from centre of final excavation area

Figure 7.12 Calculated Radius of Influence to Final Quarry Excavation

The potential radius of influence upon completion of works is illustrated in Figure 7.12.

With reference to Figure 7.12 and the calculated Ro, it can be confidently concluded that there are no active groundwater receptors (boreholes) that may be at risk of impact from groundwater drawdown within 75 m of the perimeter of the final excavation area. No domestic wells will be affected by proposals to continue high PSV bedrock extraction at the quarry.

7.7.2 GROUNDWATER INFLOWS TO SUMP

When the floor of an open quarry is excavated, there is potential for water to enter the quarry. There are commonly two components to the inflow as follows:

1. diffuse inflow widely distributed through the general rock mass, and
2. focused flow where permeable fractures intersect the exposed quarry faces.

Using these theoretical principles, the analytical solution put forward by Marinelli & Niccoli (2000) is derived from the Dupuit-Forcheimer approximation to estimate radial groundwater inflows to open pit quarries. Their solution incorporates a time-dependent factor.

$$Q(t) = (4 \pi K b s_w) / (2.3 \log (2.25 K b t / r_p^2 S))$$

where:

K = hydraulic conductivity = 0.011 m/d

b = thickness of the fractured bedrock horizon (70 m)

S_w = design drawdown (105 m OD – 35 m OD) = 70 m

r_p = equivalent radius of the final quarried area (175 m)

S = specific storage (1×10^{-5} m^{-1}), textbook value

t = time since 'instantaneous' placement of the open pit

The application of the Marinelli & Niccoli (2000) solution equation suggests potential future groundwater dewatering rates as follows:

- Dewatering Rate Q = 23 m^3/d after one month from the time that the site is brought to 35 m OD.
- Dewatering Rate Q = 17 m^3/d after six months from the time that the site is brought to 35 m OD.

When direct surface overland flow and shallow subsurface flow draining to the final sump (132 m^3/d) are added to this groundwater inflow the long-term dewatering rate becomes 155 m^3/d. Additional water will be contributed by rainfall runoff over the hard rock of the working site.

The final predicted average dewatering rates are less than the maximum daily discharge permitted under the discharge licence. Therefore, the current licence is fit for purpose and can service the proposed development.

The final predicted average dewatering rates are only slightly larger than the current average value because the current average incorporates some extreme storm response events.

7.7.3 GROUNDWATER RECHARGE CONCEPT

One could argue that the radial approach may not be entirely appropriate to the uniqueness of Irish hydrogeological features and that it can overestimate inflows from lands downgradient of the site in terms of groundwater flow and underestimate inflows from lands hydraulically upgradient. Therefore, an alternative approach was applied, which estimates the rate or volume of water to be removed from the quarry by assuming it will be equivalent to the rate of groundwater flow through the site that will be intercepted by excavation below static groundwater level.

Based on a recharge cap of 0.1 m/yr the predicted groundwater inflow to the quarry is 38.5 m^3/d (Table 7.19).

Table 7.19 Design Rainfall Rates

Area, m^2	Effective Rainfall, mm	Aquifer	Recharge cap, mm/yr	Recharge, m/yr	Recharge, m^3/yr	Recharge, m^3/d
140,607	929	Pu	100	0.1	14,061	38.5

7.7.4 FUTURE TOTAL DEWATERING VOLUMES

Based on preceding calculations relating to rainfall runoff, the amount of rainfall runoff to be managed over the entire proposed extraction area is equal to **132 m^3/d** (refer to Table 7.15). It can be assumed that this is a volume that will always require management.

In addition to the rainfall runoff component, two distinct methods for estimating groundwater inflows to the site as extraction nears completion were applied. The results of which are summarised as follows:

1. Based on an empirical formula, which utilizes permeability and final drawdown, the potential average daily amount of water to be managed is as follows:

   (a) Groundwater inflow based on drawdown and bedrock hydraulic conductivity = 17 m^3/d

   plus

   (b) Surface runoff and recharge rejected at bedrock head = 132 m^3/d

   Yields a Total = 149 m^3/d = 0.0017 m^3/s

   Or

2. Based on rainfall and recharge coefficients:

(a) Recharge to Pu aquifer in the area upgradient of the site in terms of groundwater flow = 38.5 m^3/d

plus

(b) Surface runoff and recharge rejected at bedrock head within site = 132 m^3/d

Yields a Total = 170.5 m^3/d = 0.002 m^3/s

It is therefore concluded that the future total discharge will be ~200 m^3/d (c. 0.002 m^3/s). This is a very low value for the total future discharge for a quarry void are of 9.7 ha. The potential total water management volumes are an order of magnitude lower than experienced at some quarries of similar acreage. The low values reflect the density of the rock and the fact that beneath the current hill being quarried, there is little groundwater in a bedrock with very low hydraulic conductivity.

The measured average discharge rate currently is 174 m^3/d. The calculated total future volume, using empirical academic formulae, is c. 200 m^3/d. There are multiple reasons that the current and future values are similar, which include, but are not limited to, the following:

(1) The existing quarry excavation shares a long eastern boundary wall with the application area. By virtue of excavating a wall of rock, a certain proportion of site runoff from the greenfield application extension area proposed to the east is already received in the working quarry – this is obvious from seep ingresses in the eastern wall of the working quarry.

(2) Any rainfall percolating through the subsoil of the eastern application extension area will hit the underlying high PSV bedrock, which is relatively impermeable, and travel laterally across the top of the bedrock to find the easiest way out of the ground. The quarry wall of rock and the exposed subsoil interface between the active working quarry and the eastern extension application area is c. 400 m long. Therefore, there is a long length that delivers rainfall and interflow from the eastern greenfield area. The site's water management infrastructure has always been able to appropriately attenuate and treat this water and it will continue to do so to the satisfaction of the Conditions of the Section 4 Discharge Licence.

(3) The final predicted average dewatering rates are only slightly bigger than the current average value because the current average incorporates some extreme storm response events.

These values are intended to be representative of discharge rates that are only likely to be realised close to completion of rock extraction operations. Interim discharge rates will relate to the phasing scheme. The phased development will initially involve the development of the upper quarry benches *i.e.* dry working.

Given the very low values calculated by the empirical methods, on a worst-case Factor of Safety (FOS) basis, the c. 200 m^3/d could be multiplied by a 2, 3, 4, 5, 6, 7, or 8 x FOS and the site's water management systems will still have the capacity to attenuate and treat the future waters arising over the entire application area.

On a very simple basis, consider that the total quarry void area proposed is c. 9.7 ha and the lateral extension part of that total area is c. 4.8 ha. Those values for the current quarry void and the increase to the full proposed c. 9.7 ha area essentially suggest that the footprint of the excavation area will be doubled. Considering that the site discharges an average of 174 m^3/d, even if that were doubled the discharge would be 348 m^3/d. This is still only 20% of the maximum permitted ELV for volume. It should be noted that the ELV for maximum volume in the Discharge Licence is a discharge volume that has been assessed by the competent authority (MCC) as safe to carry out and will protect WFD Status, to ensure no presentation of risk to the rivers, protection of fish life and all downstream European sites. The peak rainfall response in the discharge was 454 m^3/d. Even if this doubled, the peak storm response at the site would be c. 900 m^3/d. This is still only c. 50% of the available and permitted maximum daily discharge volume. It is therefore concluded, beyond any reasonable doubt, that the site's existing infrastructure can accommodate, attenuate and treat the waters that will arise from the proposed deepening by one bench the existing site and the proposed extension to the east.

7.7.5 SETTLEMENT LAGOON DESIGN CHECK

Waters collecting in the enlarged quarry void will be pumped to the existing settlement lagoon in the north of the site.

The main and final settlement lagoon, in the north of the site, was designed to remove fines less than 0.004 mm in diameter, indicative of mid-range to fine silt which is significantly smaller than the size of most rock fragments. The design throughflow rate of the existing settlement lagoon is equal to the Section 4 Discharge Licence's (Ref. 20/01) maximum permitted discharge volume ELV, *i.e.,* 1,728 m^3/d (72 m^3/hr), which is equivalent to a design flow through rate of **0.02 m^3/s**. The settlement lagoon is a passive overflow device and that is why the combined inflows to the main settlement lagoon are limited to the permissible discharge rate of **0.02 m^3/s**.

Given that the evaluations of this Water Assessment have determined that the site's existing discharge licence and associated water management systems can accommodate the proposed development's waters, it is prudent to prove the functionality of the lagoon again mathematically.

On a design basis, the overflow rate through the settlement lagoon should be equal to the settling velocity of the smallest particle the lagoon is designed to remove. The method for determining the size required for the settlement lagoons is based on Stoke's Law. The following equation is used to calculate the settlement velocity of particles:

$$V_s = g\ .\ (\rho_s - \rho_w)\ d^2 / 18\mu_w$$

Where:

g = acceleration due to gravity is 9.81 m/s^2

ρ_s = density of the particle requiring settlement = 2.6 g/cm^3 or 2,600 kg/m^3

ρ_w = density of fluid = 1.00 g/cm^3 or 1,000 kg/m^3

μ_w = dynamic viscosity of water = 1.307 x 10^{-3} kg/ms @ 10˚C

d = particle diameter = 0.0000040 m (*i.e.,* 0.004 mm)

The temperature of the fluid, in this case water, is dependent on the ambient temperature. In the calculations, 10°C is used as a conservative temperature. The simulated particle density adopted as 2.6 g/cm^3 is also considered conservative and it will produce an over specification system, which is good because it provides a reasonable factor of safety.

Using Stokes' Law, the settling velocity of particles of 0.040 mm, assumed spherical, in water is calculated for 10°C water temperature and particle density, as follows:

$$V_s = 0.00001067 \text{ m/s} = 1.067 \times 10^{-5} \text{ m/s}$$

The minimum surface area of the settlement lagoons are then sized so as to facilitate the settling velocity for the design overflow rate of the permitted Section 4 Discharge Licence, as follows:

$$A = Q / V_s$$

Where:

A = minimum lagoon surface area, m^2

Q = maximum inflow rate = 0.02 m^3/s

V_s = Settling velocity of the selected particle size = 0.00001067 m/s

$$\mathbf{A = 0.020\ m^3/s\ /\ 0.00001067\ m/s = 1{,}874\ m^2}$$

Calculations presented, above, demonstrate that the plan area of the settlement lagoons must be at least 1,874 m^2 in order to settle solids of particle size 0.004 mm, for a maximum discharge volume of 1,728 m^3/d, as permitted by the Section 4 Discharge Licence. Given that site built the settlement lagoon to adhere with the 2,000 m^2 plan area specified in Condition 1.3 of Licence Ref. 20/01, it can be concluded that the site's settlement lagoon has more than is required to achieve the settlement of solids of diameters 0.004 mm and greater.

Lagoon Dimensions

A minimum depth of 1 m is adopted for settlement. The constructed dimensions of the main settlement lagoon is 1.5 m. The depth of the settlement lagoon exceeds the minimum requirements and the constructed settlement lagoon is fit for purpose.

Overflow Rate CHECK

The actual surface overflow rate can be calculated using the actual dimensions of the settlement lagoon, as follows:

$$V_o = Q / A$$

$$V_o = 0.020 \text{ m}^3/\text{s} / 2{,}112 \text{ m}^2 = 0.0000095 \text{ m/s}$$

At this overflow rate, particles smaller than 0.004 mm diameter with a settling velocity of 0.00001 m/s will settle out. This meets the requirements for appropriate management.

Calculations demonstrate, similar to the site's monitoring data, that the existing settlement lagoons can accommodate, attenuate and treat current and future waters arising at the site. Similarly, the site's Section 4 Discharge Licence and its Conditions are equally suitable for the proposed development. No changes are required with respect to the water management systems or the Section 4 Discharge Licence (Ref. 20/01).

7.8 HYDROGEOLOGICAL UNDERSTANDING & SITE MODEL

A conceptual site model (CSM) is now presented using all the information collected in this Water assessment. The purpose of the CSM is to incorporate results from the different strands of testing and to present a coherent understanding of the hydrological and hydrogeological regimes in an around the site as they are understood to date. The site plan is presented as Figure 7.13 showing the Cross Section Line A-A' and that Cross Section follows as Figure 7.14.

Information employed in the development of the conceptual understanding of the site is summarised as follows:

Internally, the landholding has four distinct areas, as follows:

(i) The active quarry which has been cut into the northern side of a local hill.

(ii) The western boundary's entrance route into the quarry working area and weighbridge, wheel wash and associated secondary settlement lagoon.

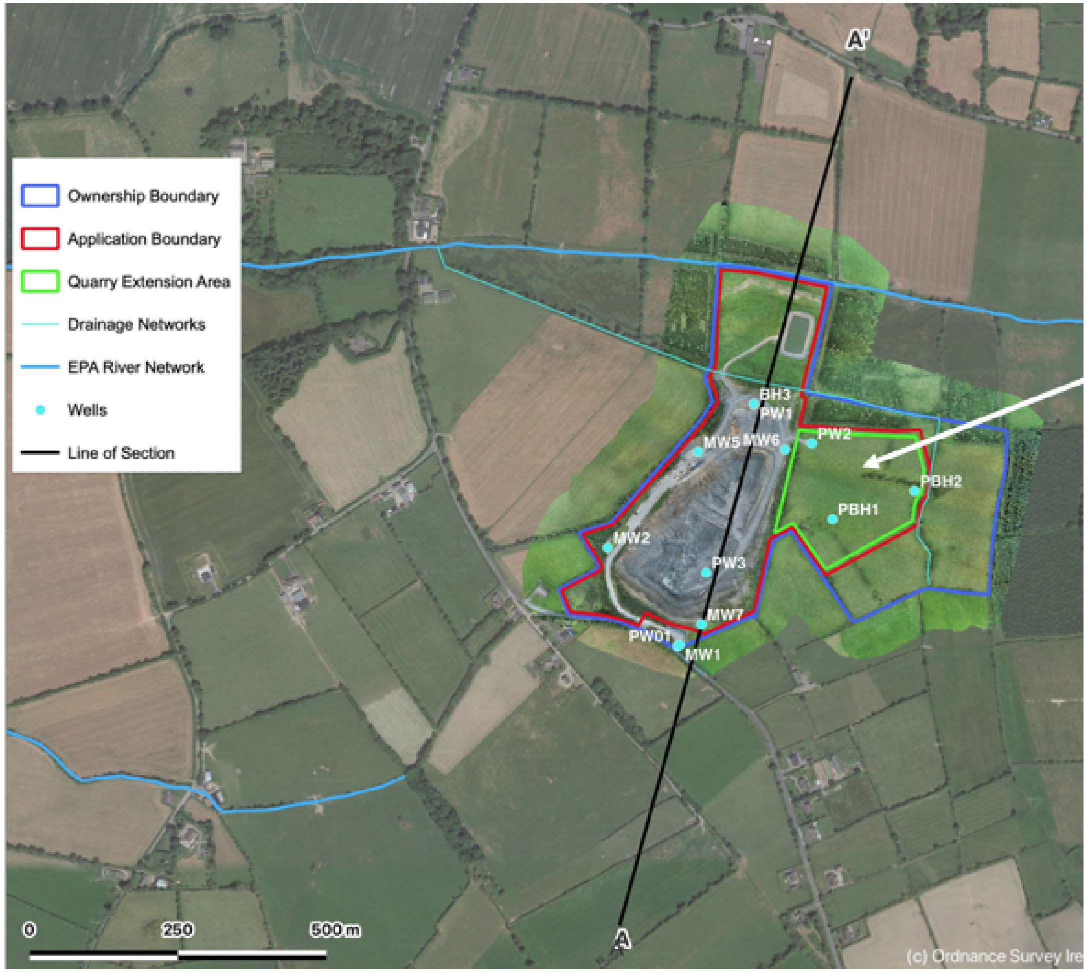
(iii) The plain of lands in the northern section of the landholding that accommodates the final settlement lagoon and the licensed discharge to the Killary Water_010, which runs east to west immediately outside the site's northern boundary.

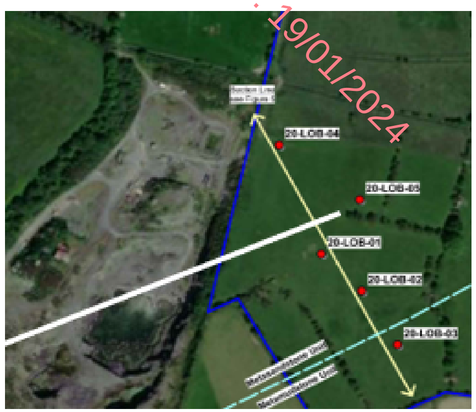
(iv) The undisturbed eastern part of the hilltop that is the proposed extension area into the greenfield part of the landholding. This eastern part is undeveloped from the southern to the northern site boundary. There is a pocket of forestry to the north.

Characteristics of the hydrogeological environment used to inform the conceptual understanding of the site includes, as follows:

Proposed works involve continued extraction of bedrock by blasting and mechanical means as an open quarry void. The current active quarry floor is at c. 65 m OD but has permission to work the floor to 50 m OD. It is proposed to deepen the operational quarry's floor from 50 m OD, when that level is reached, and to extend in an easterly direction also. This will bring the floor and the adjacent green field to the same future elevation to 35 m OD. Works will progress from the current floor to one bench deeper and also over a number of benches in an easterly direction.

- In terms of hydrogeology, the bedrock in the area has a low matrix permeability and supports only very low groundwater yields. Exposed faces around the active area show the metamorphic nature of the bedrock in the walls of the excavated areas and there is a high frequency of bedding at high deformation angles and jointing. The formation gets tighter and cleaner with increasing depth.





SLR SI Core Hole Locations in Greenfield Extension Area

Figure 7.13 Site Plan Showing Water Wells and Cross Section Line A-A' (With SLR SI Core Holes Shown as Excerpt)

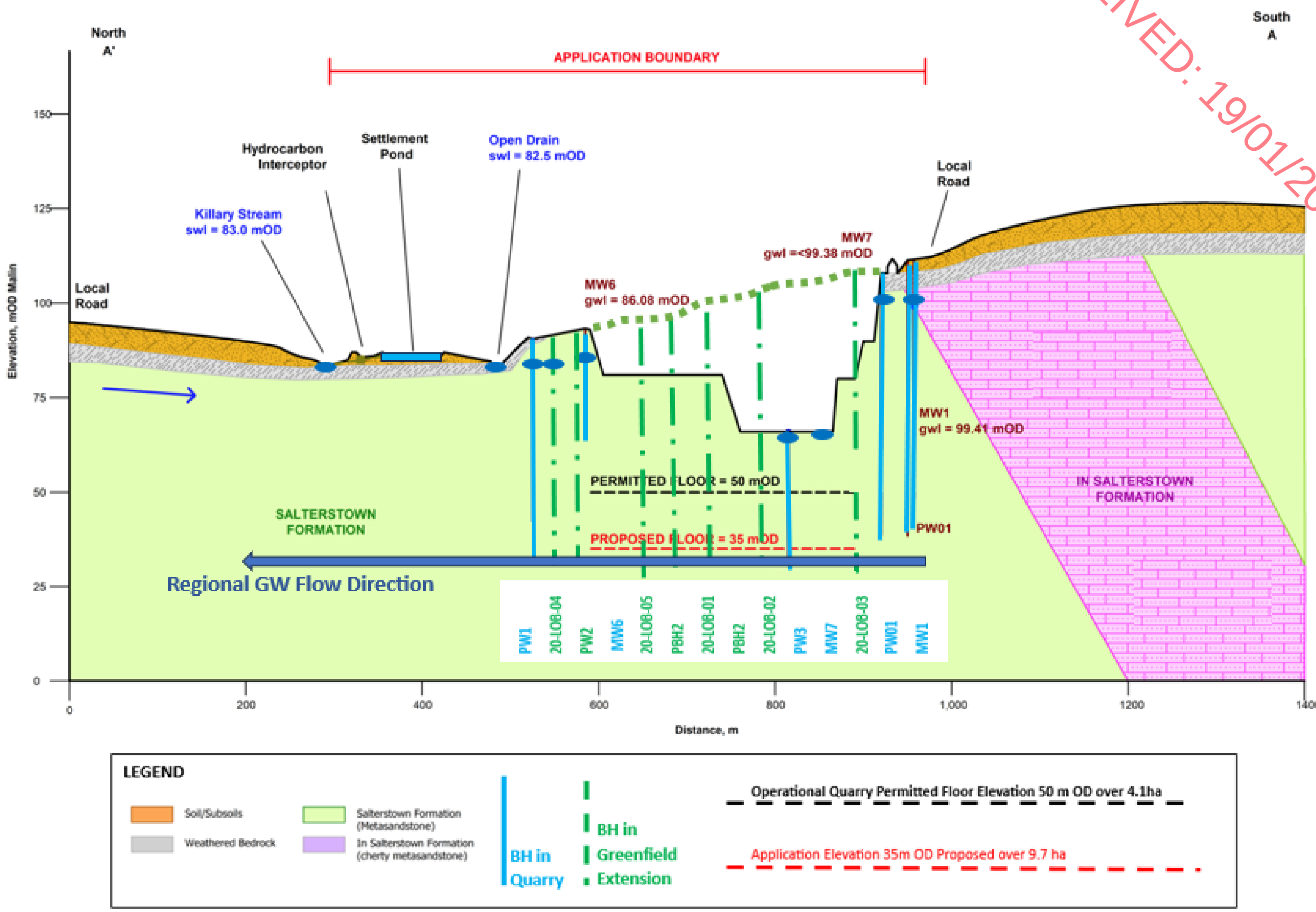


Figure 7.14 Site Cross Section Line A-A'

- The metamorphic, high PSV, bedrock beneath the site has been drilled into at five locations for this water assessment and at another five core hole locations for geotechnical characterisation of the extension greenfield's underlying bedrock. Site drilling has found little groundwater and little transmissive ability to move rainfall recharge.
- Measured hydraulic conductivities are very low and akin to a heavy CLAY liner's value of $K = 10^{-8}$ m/s.
- Site measurements and the drilling experience concur with the GSIs Poorly Productive Groundwater Flow Regime mapping for the site and their Poor Aquifer classification. All drilling and testing at the site support that GSI's mapping for the site.
- A survey of recently installed on-site groundwater monitoring points shows groundwater flow direction is from the south, from the hilltop to the north east. The upgradient groundwater catchment is negligible. Local area wells to the south east have water level elevations significantly higher (+50 m higher) and above the elevation of the sump on the floor of the quarry. Local wells are unaffected by the quarry.
- The site is already excavated as a quarry and a continuous flow meter records the amount of water discharged, which is 174 m^3/d, on average. This is one tenth, approximately, of the permitted 1,728 m^3/d maximum ELV for the discharge volume as specified in the site's Section 4 Discharge Licence (Ref. 20/01), which was issued in the year 2020.
- In addition, the maximum daily discharge observed was 454 m^3/d. The site is also fitted with a Rain Gauge so that the discharge pattern can be better evaluated and understood. The site's monitoring data suggests that the discharge is >90% rainfall runoff.
- All the monitoring data, site investigation results and hydrogeologically focussed calculations completed as part of this assessment suggest that the proposed extensions' waters can be managed within the Conditions of the existing Section 4 Licence and within the existing water management infrastructure.
- The existing settlement lagoons have the volumetric capacity to retain the Section 4 Licence's maximum ELV for volumetric discharge waters for 1.75 days and still maintain the surface overflow rate for the adequate settlement of solids. The proposed development will not create waters in excess of the Section 4 Licence's ELV for discharge volume.
- The application of two empirical academic methods suggests that the future total volume arising from the proposed future extraction area and rainfall runoff will be c. 200 m^3/d. The value returned by the academic calculations is close to the current

average value because there will be little extra groundwater encountered in the application bedrock and the rainfall runoff value for the site already includes some contribution from the eastern lands. On a worst-case Factor of Safety (FOS) basis, the c. 200 m^3/d could be multiplied by a 2, 3, 4, 5, 6, 7, or 8 x FOS and the site's water management systems will still have the capacity to attenuate and treat the future waters arising over the entire application area.

- An alternative method to estimate future water arisings on the site, on a very simple basis, is that the footprint of the excavation area will be doubled. Considering that the site currently discharges an average of 174 m^3/d, even if that were doubled the discharge would be 348 m^3/d. This is still only 20% of the maximum permitted ELV for volume. The peak rainfall response in the discharge was 454 m^3/d. Even if this doubled, the peak storm response at the site would be c. 900 m^3/d. This is still only c. 50% of the available and permitted maximum daily discharge volume. It is therefore concluded, beyond any reasonable doubt, that the site's existing infrastructure can accommodate, attenuate and treat the waters that will arise from the proposed deepening by one bench, the existing site and the proposed extension to the east. The Conceptual understanding of the site's hydrology and hydrogeology suggests that no more water management infrastructure is required.
- Hydraulic modelling of the surface water system, based on cross sections and surveying, has demonstrated that the local area's surface water network can accommodate the envisaged dewatering amounts, in combination with flood flows and allowances for climate change.
- Only a small proportion of the site's discharge volume is from groundwater and its quality is such that it complies with the requirements of the Groundwater Regulation Threshold Values (2010, as amended).
- The surface waters receiving the site's discharge has assimilative capacity and the required water quality.

The CSM is therefore summarised as follows:

- The dominant water balance component is surface water runoff. This is what the GSI have published for the groundwater body and this is what the site investigation results reveal. The GSI apply a groundwater recharge CAP of 100 mm/yr to the amount of effective rainfall that can move into groundwater.
- There is very little groundwater in this high PSV bedrock type. There is zero discharge from the site when there is no rainfall. This means that there is no groundwater baseflow to the river system.
- The bedrock is almost impermeable (10^{-8} m/s hydraulic conductivity). This means that in the pre-development condition, all of the rainfall runoff that would be flowing

off the land would enter the river. The site maintains this water balance system, returning rainfall runoff to the river system.

- The land falls from south to north, surface runoff will fall from south to north, regional groundwater flow direction is from south to north.
- The site has a valid, current, discharge licence to protect the surface water environment.
- The site has proven established water management infrastructure to treat waters arising and they have the capacity to treat additional waters arising from the proposed development.

The understanding of the hydrogeological regime at the site and surrounding area now enables advancement to Impact Assessment.

7.9 ASSESSMENT OF IMPACTS

The methodology for determination of impacts was outlined in Chapter 1 of the EIAR and presented more specifically for Hydrology and Hydrogeology in Section 7.2.5

of this Chapter. As previously presented:

a) The applied Impact Assessment Methodology adheres to EPA (2022) Guidelines and it is therefore taken that the assessment adheres to the requirements of the EIA Directive.

b) Criteria for assessing importance of site attributes and their magnitude of importance were evaluated using NRA Guidelines (NRA, 2008) [as prescribed in 'Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements' (IGI, 2013)]. NRA rating criteria uses the same significance terminology as the EPA.

7.9.1 POTENTIAL IMPACTS

This assessment will evaluate potential impacts from proposed works to the local and regional hydrological and hydrogeological environment. Only likely or significant impacts are included in the analysis. The assessment of potential impacts is divided into the three primary project phases:

i. Enabling (or Construction) phase,

ii. Operational phase, and

iii. Final Restoration, Decommissioning & Aftercare.

A summary table for potential impacts associated with each phase is presented as Table 7.20. The procedure for determination of potential impacts on the receiving hydrogeological environment was to identify potential receptors within the site boundary and surrounding environment and use the information gathered during the field work and desk study to assess the degree to which these receptors will be impacted upon.

The eastern extension area adjoins the existing quarry void, and when considered as a cumulative site, will be of moderate size. In terms of hydrology the local surface waters are an attribute of High Importance whilst in terms of hydrogeology the aquifer is an attribute of medium importance. In terms of overall scale, the proposed works will have a negative impact of small magnitude, by way of removal of a small proportion of aquifer. In line with best practice, the individual impacts will be considered with respect to the application site, plus the cumulative impacts with respect to the existing and application site.

Generally, at all quarry sites the primary activity with **potential** to impact the local and regional hydrological and hydrogeological environment is the removal of rainfall-runoff and groundwater from the local hydromorphological regime.

In terms of local hydrology, the site lies within the Dee_SC_030 sub-catchment. The discharge waters enter the Killary Stream which runs adjacent to the northern boundary of the active quarry and outfalls to the Killary Water_010, which in turn enters the River Dee. The Dee subsequently empties to Dundalk Bay at Annagassan.

With respect to designations, none of the watercourses connecting the site with Dundalk Bay are European sites. Dundalk Bay is designated as an SAC (000455), an SPA (004026) and pNHA (000455). The hydrological distance between the site and this designated site is c. 43 km. Given all site measurements for the discharge flow and quality, the low volume calculated for future water management at the entire proposed excavation area and the large, underutilised capacity of the site's existing water treatment infrastructure, there will be no impact on Dundalk Bay SAC and SPA. More details are provided on this issue, specifically for the AA Screening, at the end of this Water Chapter.

The proposed development site and surrounding working areas are within the Louth Groundwater Body (GWB). The Louth GWB report (GSI, 2004a) suggests that the hydrogeological regime of the area is influenced by rock-cored hills resembling drumlins interspersed with low-lying valleys and more mountainous areas further north. The majority (90%) of the GWB is underlain by a poor aquifer.

Table 7.20 Summary of Potential Impacts

Scenarios where impacts may arise	Activity	Attribute	Importance of attribute	Nature and description of the effect	Quality of effect	Significance/ magnitude of effect*	Extent & Context of effect	Probability of effects (pre-mitigation)	Duration and frequency	Type of effect
Construction Phase	Stripping of Overburden	Surface waters	Surface waters: High	Silt-laden runoff from exposed soil/subsoil. The increased silt content in runoff has potential to degrade local surface water quality.	Negative	Significant	Killary Stream, Killary Water. Bedrock Aquifer: Louth GWB	Likely	Occasionally (e.g., one week/year), Temporary	Direct
	Use of excavator & dumptrucks – spillages during refuelling, use and storage of lubricants	Surface waters; groundwater	Surface waters: High Aquifer: Medium	Contamination of surface waters and groundwaters with hydrocarbons	Negative	Significant	Killary Stream, Killary Water. Bedrock Aquifer: Louth GWB	Unlikely	Rarely Temporary	Direct
Operational Phase	Blasting of bedrock	Groundwater	Aquifer: Medium	Deterioration in groundwater quality	Negative	Significant	Bedrock Aquifer: Louth GWB	Likely	Occasionally (weekly-monthly) Long-term	Direct
	Extraction of bedrock	Bedrock aquifer	Aquifer: Medium	Change in unsaturated thickness resulting in change in groundwater vulnerability classification. Deterioration in groundwater quality. Site is already Extreme (X) vulnerability	Negative	Neutral	Bedrock Aquifer: Louth GWB within site boundary	Unlikely	Permanent	Direct
	Movement/storage of aggregates	Surface waters	Surface waters: High	Mobilisation and migration of suspended solids Sediment deposition in channels disrupting sensitive riverine habitats	Negative	Significant	Killary Stream, Killary Water.	Likely	Occasionally (weekly-monthly) Long-term	Direct
	Use of quarrying machinery and equipment – spillages during refuelling, use and storage of lubricants	Surface waters; groundwater	Surface waters: High Aquifer: Medium	Contamination of surface waters and groundwaters with hydrocarbons	Negative	Significant	Killary Stream, Killary Water. Bedrock Aquifer: Louth GWB	Unlikely	Rarely Temporary	Direct
	Quarry dewatering – lowering of groundwater levels in surrounding area	Bedrock aquifer	Aquifer: Medium	Reduction in third party well yields Reduction in baseflow to surface waters	Negative	Significant	Third party wells within 1 km Killary Stream, Killary Water.	Unlikely	Constantly Long-term (Reversible)	Direct
	Use of settlement lagoons	Surface waters	Surface waters: High	Removal and entrapment of particulate matter.	Positive	Moderate	Killary Stream, Killary Water.	Likely	Constantly Long-term	Direct

Scenarios where impacts may arise	Activity	Attribute	Importance of attribute	Nature and description of the effect	Quality of effect	Significance/ magnitude of effect*	Extent & Context of effect	Probability of effects (pre-mitigation)	Duration and frequency	Type of effect
	Cleaning of settlement lagoons	Surface waters	Surface waters: High	Improves efficiency of settlement lagoons; attenuation Mobilisation and migration of suspended solids	Neutral	Moderate	Killary Stream, Killary Water.	Likely	Annually Long-term	Direct
	Use of wheelwash	Surface waters	Surface waters: High	Removal and entrapment of particulate matter attached to vehicles	Positive	Moderate	Killary Stream, Killary Water.	Likely	Constantly Long-term	Direct
	Wheelwash maintenance	Surface waters	Surface waters: High	Improves wheelwash efficiency and reduces mobilisation and migration of suspended solids	Neutral	Moderate	Killary Stream, Killary Water.	Unlikely	Annually Long-term	Direct
	Use of hydrocarbon interceptors	Surface waters; groundwater	Surface waters: High	Entrapment of hydrocarbons	Positive	Moderate	Killary Stream, Killary Water.	Likely	Constantly Long-term	Direct
	Monitoring	Surface waters; groundwater	Surface waters: High Aquifer: Medium	Monitoring of surface water quality, groundwater quality, discharge flows	Positive	Imperceptible	On- and off-site	Unlikely	daily, quarterly, annually	n/a
	Pumped discharge of quarry waters	Surface waters	Surface waters: High	Increased flood risk to downgradient receptors	Negative	Imperceptible	Killary Stream, Killary Water.	Unlikely	Constantly Long-term	Direct
	Pumped discharge of quarry waters	Surface waters	Surface waters: High	Deterioration in surface water quality	Negative	Significant	Killary Stream, Killary Water.	Unlikely	Constantly Long-term	Direct
	Setback buffer between stream and quarrying activity	Surface waters	Surface waters: High	Mobilisation and migration of suspended solids Sediment deposition in channels disrupting sensitive riverine habitats	Positive	Significant	Killary Stream, Killary Water.	Llikely	Long-term	Direct

Scenarios where impacts may arise	Activity	Attribute	Importance of attribute	Nature and description of the effect	Quality of effect	Significance/ magnitude of effect*	Extent & Context of effect	Probability of effects (pre-mitigation)	Duration and frequency	Type of effect
Final Restoration Phase	Removal of semi-mobile and mobile plant (pumps, generators, etc.)	Surface waters; groundwater	Surface waters: High Aquifer: Medium	Elimination of hydrocarbon sources	Positive	Moderate	Within site boundary	Likely	Permanent	Direct
	Dismantling and removal of fixed plant & machinery (concrete manufacturing plant, wheelwash, etc.)	Surface waters; groundwater	Surface waters: High Aquifer: Medium	Elimination of hydrocarbon and cementitious sources	Positive	Moderate	Within site boundary	Likely	Permanent	Direct
	Landscaping and movement of infrastructure and overburden stockpiles necessary to facilitate site restoration	Surface waters; groundwater	Surface waters: High Aquifer: Medium	Mobilisation and migration of suspended solids Sediment deposition in channels disrupting sensitive riverine habitats	Negative	Moderate	Killary Stream, Killary Water.	Likely	Temporary	Direct & Indirect
	Cessation of pumping	Surface waters; groundwater	Surface waters: High Aquifer: Medium	Recovery of groundwater levels Reduction of flood risk Reduction in risk of contamination to surface waters	Positive	Significant	Within site boundary and 1 km radius	Likely	Permanent	Direct
Unplanned Events	Major Spillage	Surface waters; groundwater	Surface waters: High Aquifer: Medium	Hydrocarbon contamination	Negative	Significant	Within site boundary and 1 km radius	Likely	Temporary	Direct
	Intense Rainfall Events	Surface waters; groundwater	Surface waters: High Aquifer: Medium	On-site & off-site flooding	Negative	Moderate	Within site boundary and 1 km radius	Likely	Brief	Direct

7.9.2 POTENTIAL IMPACTS OF BLASTING AT THE SITE

Mass balance calculations are presented to demonstrate potential for effects of blasting to present nitrogen residues in the discharge waters, which have the potential to impact groundwater quality. The risk to groundwater and surface water is assessed by quantifying the resultant concentrations for the potential residual nitrogen compounds nitrate (NO_3), ammonia (NH_4) and nitrite (NO_2).

Peak activity rates of the extraction activities, blasting frequency and the type of explosives used were supplied to Hydro-G. The explosives used in the quarry are Kemex 70. Breedon operate a network of sites throughout the country and their handling and explosives use meets industry standards.

Kemex 70 is a site mixed bulk emulsion explosive produced from emulsion matrix. Emulsion matrix is essentially an aqueous solution of ammonium nitrate emulsified in oil. Kemex products may also contain ammonium nitrate prills, fuel oil, aluminium and/or gassing agents. The Technical Data Sheets (TDS's) and MATERIAL SAFETY DATA SHEET (MSDS's) for explosives, primers and detonators used at the site are held at the site and in the offices of the hydrogeologists.

Literature suggests that small percentages of N compounds can remain as residual coating on bedrock following blasting. This has the potential to be dissolved when it comes into contact with water, albeit potential concentrations are low. The study that is most referenced was completed by Environment Canada in 1988 (Ferguson & Leask, 1988). This study outlines a procedure for determining the residual N compounds for various mine site types. The stepwise procedure used in the 1988 study for predicting aqueous concentrations of N species, is as follows:

a) Calculate the annual leached nitrogen loading (kg/year) for the entire site based upon annual explosive mass usage and residual N fraction associated with explosive type.

b) Separate the leached nitrogen loading among quarry components (e.g., entering surface water, remaining on extracted rock, etc.).

c) Separate into loadings of N compounds (Nitrate, Nitrite and Ammonia.

d) Calculate the flow concentration.

e) Compare with Statutory Environmental Quality Objectives.

The total area of the quarry in which blasting could occur is the hard rock area. The current application is for an extension area of 4.1 ha appended to the existing quarry extraction area. For the purposes of impact assessment, the entire proposed bedrock quarry void area will be considered, which is 9.7 ha, approximately. The areas with the buildings, lagoons, stockpiles, processing equipment concrete and asphalt batching plant are not considered in the calculation of explosive residue concentrations. This presents a conservative calculation, *i.e.*, the worst case (highest) residual concentrations.

In addition, the highest residual upper limit of the range has been adopted in all simulations. In this way, the highest concentrations of N species concentrations have been calculated. These are very conservative assumptions. The calculation also assumes that 100% of residual N is dissolved in quarry drainage waters and is subsequently pumped from the quarry by dewatering. The predicted concentrations of N species in waters pumped from the sump at the active quarry and application site, calculated using this procedure, are presented in Table 7.21 .

Table 7.21 N-Compound Concentrations from Explosives in Water Pumped from Sump

EXPLOSIVE MASS BALANCE		
9.7	Total Bedrock Extraction Area	ha
97,000	Total Area	m2
2,222,222	Approximate Volume of rock to be extracted over lifetime	m3
0.2	Explosive Mass Required	kg/m3
444,444	Explosives Mass Required	kg
20	Planned Duration of extraction	years
22,222	Explosives Mass Required per year	kg/yr
NITROGEN MASS BALANCE Facts		
94%	% Explosive mass as Ammonium Nitrate	%
35%	% Ammonium Nitrate as N	%
7,311	Mass of N	kg/yr
0.06	Residual Fraction	
439	Residual N left behind	kg/yr
Residual N COMPOUNDS**		
434	MAXIUM Residual NITRATE NO_3 *(75-99% of Residual N value)*	**kg/yr**
105	MAXIUM Residual AMMONIA NH_4 *(0.5 - 24% of Residual N value)*	**kg/yr**
26	MAXIMUM Residual NITRITE NO_2 *(0-6% of Residual N value)*	**kg/yr**
****Highest possible % Residuals Adopted from the available ranges, as conservative measure.**		
WATER BALANCE		
540	Envisaged MAX waters arising on site (max)	m^3/day
197,100,000	Envisaged MAX waters arising on site (max)	litres/yr
INCREASE IN NITROGEN COMPOUND CONCENTRATIONS***		
Additional Residual NO_3	***0.006***	*mg/l/d*
Additional Residual NH_4	***0.001***	*mg/l/d*
Additional Residual NO2	***0.0004***	*mg/l/d*
*** Calculation of Residual Concentrations = (kg/yr*10^6 = mg/yr)/(litres/yr)		

The results of calculations presented in Table 7.21 clearly show that the residual N-compounds would have concentrations each of less than 0.006 mg/l N. Specifically, resultant increases in concentrations in waters within the quarry, if impacted by explosives within the entire quarry site area, would be: **0.006 mg/l NO_3, 0.001 mg/l NH_4 and 0.0004 mg/l NO_2.**

With respect to the calculated resultant concentrations determined for the site following blasting, as presented in Table 7.21, context is offered as follows:

- The limit for nitrate in waters affected by agriculture is 50 mg/l NO_3 (Nitrate & Good Agricultural Practice Regulations) and it is also 50 mg/l NO_3 for the Freshwater Fish Directive (2006/44/EC). Therefore, the simulated resultant increase in concentration of 0.006 mg/l NO_3 poses no threat to breach of Environmental Quality Objectives or the Threshold Value of 37.5 mg/l NO_3 as specified in the Groundwater Regulations.
- The limit for Ammonia in High Status Waters EQS (Surface Water Regulations 2009) is 0.04 mg/l NH_4 and the resultant maximum increase in concentration calculated for the waters is 0.001 mg/l NH_4. Environmental impact is not envisaged.
- Overall, the residual concentrations are so low that the site will continue to comply with the requirements of the Threshold Values of the Groundwater Regulations (2010) & the targets set out in both the Freshwater Fish Directive and Salmonid Waters Regulations.

In summary, having used conservative values in this approach the resulting N species concentrations are small, and below all relevant Regulatory EQS values. The risk of impact to local water quality arising from the use of explosives at the site is therefore negligible. These calculations are based on PEAK abstraction rates.

7.9.3 POTENTIAL QUANTITATIVE IMPACT TO THE GWB

In July 2023, the EPA issued the National Register of Abstractions and it is available for all assessors of potential impact to GWBs. The register is available at https://www.epa.ie/publications/monitoring--assessment/freshwater--marine/epa-water-abstraction-register.php. The EPA has published the register in a way that can be used by GWB name and its WFD Code. As presented in the Desk Study of this Chapter, the site is underlain by the Lough GWB (European Code IEGBNI _NB_G_019). Review of the EPA National Register of Abstractions enables extraction of abstraction data and a sum of registered abstractions from the Louth GWB as shown in Table 7.22

Although the management of waters at a quarry result in no nett loss of water, it is still a usual part of impact assessment to complete a GWB and aquifer scale hydrogeological QUANTITATIVE impact assessment, which is presented in Table 7.23. It is fair to say that there is no nett loss of water because the site's discharge is recharged back to the natural surface water system after treatment for suspended solids removal. The quantitative assessment presented in Table 7.23 is considered to provide the evaluating authorities with the most conservative assessment with respect to the potential for the site to affect WFD quantitative status. The assessment is considered conservative because waters arising at the site are not all groundwater and rainfall is a significant component. However, if the entire licensed discharge volume is modelled as having potential to be connected to groundwater, the results enable a robust determination of potential for impact.

Table 7.22 EPA Registered Abstractions from Louth GWB Underlying the Site

Reg No	Abstraction Point Code	Total Annual Volume (m^3/yr)	Waterbody Code
R00329-01	APR000592	21,000	IEGBNI_NB_G_019
R00389-01	APR000694	18,000	IEGBNI_NB_G_019
R00648-01	APR001144	312,805	IEGBNI_NB_G_019
R00936-01	APR001596	14,965	IEGBNI_NB_G_019
R01215-01	APR002006	63,875	IEGBNI_NB_G_019
R01456-01	APR002379	15,969	IEGBNI_NB_G_019
R01458-01	APR002382	876,000	IEGBNI_NB_G_019
R01458-01	APR002813	8,640	IEGBNI_NB_G_019
R01519-01	APR002471	14,600	IEGBNI_NB_G_019
R01597-01	APR002614	8,000	IEGBNI_NB_G_019
R01621-01	APR002642	13,505	IEGBNI_NB_G_019
Total Registered Groundwater Abstractions (m3/yr)		**1,367,359**	IEGBNI_NB_G_019

Table 7.23 Groundwater Body and Aquifer Scale Hydrogeological Impact Assessment

GWB WFD Quantitative Imapct & Breedon Lobinstown Quarry's Water Management	
GSI assigned area for 'Louth Groundwater Body' (km2)	1621
Louth Groundwater Body (m2)	1,621,000,000
AVERAGE Effective Rainfall (mm/yr)	542
AVERAGE GSI Groundwater Recharge (mm/yr)	100
GSI Groundwater Recharge (m/yr)	0.1
Groundwater Recharge to Louth GWB = [0.1 m Cap x Louth GWB m2 area] (m3/yr)	162,100,000
AVERAGE Groundwater Recharge to GWB / 365 days (m3/d)	444,110
Future Anticipated maximum daily discharge volume from the quarry (m3/d)	1,728
Annual Discharge based on MAX daily discharge from the quarry (m3/yr)	630,720
Hydro-G Calculation	
Proportion of Quarry's discharge volume as a % of Louth GWB's annual recharge amount to groundwater from rain falling on its catchment (%)	**0.4**
EPA July 2023 REGISTER OF ALL OTHER ABSTRACTIONS FROM LOUTH GWB (m3/yr)	1,367,359
Exisiting Abstractions + Quarry Volume as a Percentage of Available Groundwater in the Louth GWB (%)	**1.2**

With respect to the ‘Groundwater Test’, WFD Guidance document GW5 (2004) presents their own criteria (see Table 7.24) with which the percentage derived in Table 7.23 can be compared.

Table 7.24 Groundwater Thresholds for Rivers and Large Lakes (Table 4, GW5 Guidance Document: Guidance on Abstractions; WFD Working Group, 2004)

	Average Specific Yield or Storage of GW Screening Unit	
Groundwater Abstraction vs Average Recharge	**Low Storage (<5%)**	**High Storage (>=10%)**
>30%, i.e. if groundwater abstraction is greater than 30% of long-term recharge	High Potential Impact	High Potential Impact
20 – 30%	High Potential Impact	Moderate Potential Impact
10 – 20%	Moderate Potential Impact	Low Potential Impact
2 – 10%	Low Potential Impact	Low Potential Impact
<2%	No Potential Impact	No Potential Impact

With reference to the GW5 (WFD Irl, 2004) evaluation criteria reproduced as Table 7.24, the preliminary 'Groundwater Body' quantitative test results of Table 7.23 suggests that the volume of waters being managed at the quarry might account for 0.4% of the available groundwater resource at the GWB scale. Further, the in-combination effect of the quarry with all other EPA Registered Abstractions from this GB suggests that the total take is 1.2% of the available groundwater resource volume. It is taken that the calculated % is in the <2% bracket according to GW5 criteria, resulting in a conclusion of '**No Potential Impact'**. This water balance data provides the confidence to assert that there will be no negative quantitative impact on the GWB regime. The site's monitoring data has proved that there is no qualitative impact on the GWB or surface water regime.

7.9.4 MITIGATION MEASURES

The significant potential impacts identified in Table 7.20 are resolved under the mitigation measures set out under Table 7.25. The key principles of avoidance, prevention, reduction and remedy/off-set have been adhered to in this regard.

7.9.5 RESIDUAL IMPACTS

Residual impacts refer to the degree of environmental change that will occur after the proposed mitigation measures have taken effect. Assuming implementation of the mitigation measures, the majority of residual impacts on the hydrological and hydrogeological environment during all phases are assessed to be unlikely and imperceptible. Residual impacts are presented in the mitigation measures Table 7.25. There are no anticipated residual impacts on the hydrological or hydrogeological environment.

A potential residual impact at any quarry site is reduction of groundwater level in local third-party wells. The extremely low bedrock permeability values suggest short groundwater flow paths and thereby the proposed development should not impact local wells.

Table 7.25 Summary of Mitigation Measures and Residual Impact Assessment

Scenarios where impacts may arise	Potential Impact			Mitigation measure	Residual effect (following mitigation)	
	Activity	Attribute/ receiving environment	Character of potential impact	Description of Mitigation	Significance or quality of Effect	Probability
Construction phase	Stripping of overburden	Surface waters	Silt-laden runoff from exposed soil/subsoil. The increased silt content in runoff has potential to degrade local surface water quality	Excavations at the site shall be clearly defined and restricted to the stated areas. Excavated overburden will remain exposed for as little time as possible. Topsoil stripping will be restricted to the minimum area required for efficient earthworks operation. Working contours will ensure no surface waters leave site in an uncontrolled manner. Any stockpiles shall be located over 15 m from drainage channels. Any stormwater leaving stripped areas shall be diverted towards the existing sump, preferably via a temporary settlement lagoon. Perimeter stockpiles shall be vegetated with grass seed. Maintain a vegetated margin of at least 10 m around the working area where possible.	Imperceptible	Unlikely
	Use of excavator and dumptrucks – spillages during refuelling, use and storage of lubricants	Surface waters, groundwater	Contamination of surface waters and groundwaters with hydrocarbons	Breedon SOPs have been designed to ensure responsible activity on their sites. Potentially contaminating substances will be stored in a designated area that is isolated from surface water drains or open waters and not within 30 m of drainage ditches or surface waters. Hazardous wastes such as waste oil will be stored in designated, sealed containers. All waste containers and fuel tanks shall be stored within a secondary containment system (e.g., a bund for static tanks or a drip tray for mobile stores and drums). The bunds will be capable of storing 110% of tank capacity, plus a minimum 30 mm rainwater allowance where the bund is uncovered. Where more than one tank is stored, the bund must be capable of holding 110% of the largest tank or 25% above the aggregate capacity.	Imperceptible	Unlikely

Scenarios where impacts may arise	Potential Impact			Mitigation measure	Residual effect (following mitigation)	
	Activity	Attribute/ receiving environment	Character of potential impact	Description of Mitigation	Significance or quality of Effect	Probability
				Drip trays used for drum storage must be capable of holding at least 25% of the drum capacity. Regular monitoring of water levels within drip trays and bunds due to rainfall will be undertaken to ensure sufficient capacity is maintained at all times. Refuelling and lubrication of semi-mobile plant and haulage vehicles is carried out by a trained and dedicated operative. Control measures exist as standard operating procedures in the overall quarry. A double skinned fuel tank is provided on-site for refueling of some mobile plant and machinery. For larger mobile plant such as crushers and screeners, refuelling takes place on the quarry floor on an as-needs basis by a mobile fuel truck. Servicing of vehicles will take place off-site. Small amounts of oils and lubricants will be stored on-site for use on mobile equipment. Spill trays and hydrocarbon spill kits will continue to be provided as necessary. The operator has in place an emergency response procedure for hydrocarbon spills and appropriate training of site staff in its implementation. The site access from the wheel wash to the entrance has been paved. All waste oils will be collected and removed off-site by an approved waste collection contractor in the area. Regular monitoring and maintenance of silt traps will be undertaken in accordance with the manufacturer's specifications. Oil that accumulates within hydrocarbon interceptors shall be regularly removed by an appropriately licenced contractor. In addition, the hydrocarbon interceptor shall be appropriately maintained in accordance with the manufacturer's specifications.		

Scenarios where impacts may arise	Potential Impact			Mitigation measure	Residual effect (following mitigation)	
	Activity	Attribute/ receiving environment	Character of potential impact	Description of Mitigation	Significance or quality of Effect	Probability
Operational Phase	Blasting of bedrock	Surface waters; groundwater	Deterioration in groundwater and surface water quality	The blasting protocol to be employed are regulated and controlled by industry standards. Breedon uses Kemex emulsion explosives across all sites. Hydro-G presented a sequence of calculations below to estimate N-residue in discharge waters due to blasting. The results of the calculations show that the simulated resultant concentrations for Nitrogen species' residues are very low and satisfy the relevant Environmental Quality Standards by at least an order of magnitude. The risk of impact to local water quality is imperceptible.	Imperceptible	Unlikely
	Extraction of bedrock	Bedrock aquifer	Change in unsaturated thickness resulting in change in groundwater Vulnerability classification. Deterioration in groundwater quality	Vulnerability classification in the area shall be maintained at the current classification: Extreme (X).	Imperceptible	Unlikely
	Movement of aggregate stockpiles	Surface waters	Mobilisation and migration of suspended solids Sediment deposition in channels disrupting	All rainfall-runoff generated on quarried areas will drain towards the quarry sump. These waters are pumped to the settlement lagoon prior to leaving site. A water management system is already in place and will continue to serve the proposed application area. There is no direct connectivity between site activities and local surface waters.	Imperceptible	Unlikely

Scenarios where impacts may arise	Potential Impact			Mitigation measure	Residual effect (following mitigation)	
	Activity	Attribute/ receiving environment	Character of potential impact	Description of Mitigation	Significance or quality of Effect	Probability
			sensitive riverine habitats			
	Use of quarrying machinery and equipment – spillages during refuelling, use and storage of lubricants	Surface waters; groundwater	Contamination of surface waters and groundwaters with hydrocarbons	Breedon SOPs have been designed to ensure responsible activity on their sites. Potentially contaminating substances will be stored in a designated area that is isolated from surface water drains or open waters and not within 30 m of drainage ditches or surface waters. Hazardous wastes such as waste oil will be stored in designated, sealed containers. All waste containers and fuel tanks shall be stored within a secondary containment system (e.g., a bund for static tanks or a drip tray for mobile stores and drums). The bunds will be capable of storing 110% of tank capacity, plus a minimum 30 mm rainwater allowance where the bund is uncovered. Where more than one tank is stored, the bund must be capable of holding 110% of the largest tank or 25% above the aggregate capacity. Drip trays used for drum storage must be capable of holding at least 25% of the drum capacity. Regular monitoring of water levels within drip trays and bunds due to rainfall will be undertaken to ensure sufficient capacity is maintained at all times. Refuelling and lubrication of semi-mobile plant and haulage vehicles is carried out by a trained and dedicated operative. Control measures exist as standard operating procedures in the overall quarry. A double skinned fuel tank is provided on-site for refueling of some mobile plant and machinery. For larger mobile plant such as crushers and screeners, refuelling takes place on the quarry floor on an as-needs basis by a mobile fuel truck. Servicing of vehicles will take place off-site. Small amounts of oils and lubricants will be stored on-site for use on mobile equipment.	Imperceptible	Unlikely

Scenarios where impacts may arise	Potential Impact			Mitigation measure	Residual effect (following mitigation)	
	Activity	Attribute/ receiving environment	Character of potential impact	Description of Mitigation	Significance or quality of Effect	Probability
				Spill trays and hydrocarbon spill kits will continue to be provided as necessary. The operator has in place an emergency response procedure for hydrocarbon spills and appropriate training of site staff in its implementation. The site access from the wheel wash to the entrance has been paved. All waste oils will be collected and removed off-site by an approved waste collection contractor in the area. Regular monitoring and maintenance of silt traps will be undertaken in accordance with the manufacturer's specifications. Oil that accumulates within hydrocarbon interceptors shall be regularly removed by an appropriately licenced contractor. In addition, the hydrocarbon interceptor shall be appropriately maintained in accordance with the manufacturer's specifications.		
	Quarry dewatering – lowering of groundwater levels in surrounding area	Bedrock aquifer	Reduction in third party well yields Reduction in baseflow to surface waters	Beneath both the current working area and the extension area, the entire depth to the proposed floor level of 35 m OD is homogenous metasandstone of very low permeability. Hence proposed works are unlikely to introduce notable volumes of additional bedrock groundwater. The proposed works have potential to create some minor drawdown effects around the site. However, groundwater gradients are very steep. Hence this is not likely to be a significant impact. There will be no net loss or gain in the GWB system because volume intercepted and managed at the site represents, by calculated water balance, 0.04% of the groundwater volume in the regional Poor aquifer (Pu). In any case, any waters intercepted at the site are returned to the place they were originally going, which is the Killary Stream. This maintains the hydromorphological and hydrogeological regime. Pumping and discharge does not transfer any groundwater across catchment boundaries.	Imperceptible	Unlikely

Scenarios where impacts may arise	Potential Impact			Mitigation measure	Residual effect (following mitigation)	
	Activity	**Attribute/ receiving environment**	**Character of potential impact**	**Description of Mitigation**	**Significance or quality of Effect**	**Probability**
	Use of settlement lagoons	Surface waters	Removal and entrapment of particulate matter entrained in site waters	Quarry waters pass through a recently installed HDPE lined settlement lagoon. This feature clarifies pumped quarry waters prior to them leaving the site. The quarry sump and settlement lagoon system have sufficient volumetric capacity to accommodate all waters for the required residence time.	Imperceptible	Unlikely
	Cleaning of settlement lagoons	Surface waters	Improves efficiency of settlement lagoons and capacity Mobilisation and migration of suspended solids	Particulate matter captured in settlement lagoons to be transferred to landscaped perimeter bunds.	Imperceptible	Unlikely
	Use of wheelwash	Surface waters	Removal and entrapment of particulate matter attached to vehicles	Positive impact so no mitigation required. Overflow from the wheelwash collection tank passes through the main two settlement tanks and hydrocarbon interceptor prior to leaving site.	Positive	Unlikely
	Wheelwash maintenance	Surface waters	Improves of wheelwash	The wheelwash is to be maintained in accordance with manufacturer's specifications.	Imperceptible	Unlikely

Scenarios where impacts may arise	Potential Impact			Mitigation measure	Residual effect (following mitigation)	
	Activity	Attribute/ receiving environment	Character of potential impact	Description of Mitigation	Significance or quality of Effect	Probability
			Mobilisation and migration of suspended solids			
	Use & maintenance of hydrocarbon interceptors	Surface waters	Entrapment of hydrocarbons lost during movement of site waters	Positive impact so no mitigation required. Oil that accumulates within hydrocarbon interceptors shall be regularly removed by an appropriately licensed contractor. The hydrocarbon interceptors shall be appropriately maintained in accordance with the manufacturer's specifications.	Positive	Unlikely
	Monitoring	Surface waters; groundwater	Monitoring of surface water quality, groundwater quality	Regular visual monitoring of the settlement lagoons will continue as per present to ensure no visual oil or fuel contamination. Water Quality monitoring will continue as per current regime.	Imperceptible	Unlikely
	Pumped discharge of quarry waters	Surface waters	Increase flood risk to downgradient receptors	A hydraulic capacity assessment was performed and shows that discharge does not increase risk of flooding to downstream receptors.	Imperceptible	Unlikely
	Pumped discharge of quarry waters	Surface waters	Deterioration in surface water quality	Monitoring of surface water quality shows that the discharge has no discernible impact on surface water quality. Analysis showed discharge quality is within the licensed limits.	Imperceptible	Unlikely

Scenarios where impacts may arise	Potential Impact			Mitigation measure	Residual effect (following mitigation)	
	Activity	Attribute/ receiving environment	Character of potential impact	Description of Mitigation	Significance or quality of Effect	Probability
	Setback buffer between stream and quarrying activity	Surface waters	Deterioration in surface water quality	Minimum of 10 m setback from all open drains and watercourses to be maintained around the excavation perimeter. Positive impact.	Imperceptible	Unlikely
Final Restoration phase	Removal of semi-mobile and mobile plant (pumps, generators, etc.)	Surface waters; groundwater	Elimination of hydrocarbon sources	Positive impact; no mitigation required.	None	None
	Dismantling and removal of fixed plant & machinery (batching plant, wheelwash, etc.)	Surface waters; groundwater	Elimination of hydrocarbon sources	Positive impact; no mitigation required. Materials such as concrete can be crushed and recycled for use as an aggregate in the construction industry.	None	None
	Landscaping and movement of overburden stockpiles necessary to facilitate site restoration	Surface waters; groundwater	Mobilisation and migration of suspended solids Sediment deposition in channels disrupting sensitive riverine habitats	Interceptor drains 500 mm wide and 500 mm deep will be excavated around the toe slope of any soil. Silt fences to be installed within the interceptor drains. Interceptor drains will divert captured runoff back in towards the site where runoff will enter the settlement lagoons. These will clarify any runoff waters prior to them leaving the site. Restored areas to be vegetated to enhance stability.	Imperceptible	Unlikely

Scenarios where impacts may arise	Potential Impact			Mitigation measure	Residual effect (following mitigation)	
	Activity	Attribute/ receiving environment	Character of potential impact	Description of Mitigation	Significance or quality of Effect	Probability
	Cessation of pumping	Surface waters; groundwater	Recovery of groundwater levels Reduction of flood risk Reduction in risk of contamination to surface waters	Post-completion groundwater levels will return to pre-development levels, thereby partially filling any voids. These voids may be left as open waterbodies for recreational or ecological benefits.	None	None
Unplanned events	Major Spillage	Surface waters; groundwater	Hydrocarbon contamination	All runoff generated on potentially at-risk areas pass through hydrocarbon interceptors prior to leaving the site. A contained spillage will be disposed of appropriately by a licensed contractor. Potentially harmful chemicals stored on site (e.g., lubricants) to be stored under cover on bund trays.	Imperceptible	Unlikely
	Intense Rainfall Events	Surface waters; groundwater	On-site & off-site flooding	The site has the ability to retain extreme storm events.	Imperceptible	Unlikely

7.9.6 CUMULATIVE IMPACT ASSESSMENT

A cumulative impact assessment is outlined below. The aim of this exercise is to examine whether any other proposed developments have the potential to act in-combination with the proposed application, subsequently giving rise to effects that would not otherwise be significant. The assessment considers the phasing of the proposed project.

The cumulative impact assessment considered activities within a 5 km radius in combination with the existing active quarry. The primary mitigating factor for this site, whether the water environment or other impacts are to be considered, is that the rock is so competent and the groundwater component so small there will be no spread of effects.

There are several major extractive and waste management developments in the wider area, including the O'Reilly Concrete Lobinstown Quarry c. 2.5 km to the west (currently in final stages of restoration), Roadstone's Slane Quarry, c. 7 km to the south, an unidentified quarry at Knockmooney on the N2 c. 8.5 km to the southeast, and a disused quarry, now operating as an SRF, at Mullaghdillon c. 6 km to the southeast. The only significant industrial activity within 5 km of the site is the industrial/warehouse estate in Grangegeeth, c. 4.5 km to the southeast, which houses Hibernia Steel Products, R&M Buckets, WK Composites, Dawn Paper & Tissue Manufacturing and Eiregramco.

The nearest substantial commercial activity is Meade Farm Group's Packing, Storage and Distribution facility c. 1.25 km northeast of the site at Braystown. The substantial facility employs c. 340 employees. Whites Auto Electrical have a small commercial unit in Matthews Transport Yard, Heronstown, c. 800 m north of the site on the L1603 (c. 185 m north of McEntegart's Cross Roads). PS Supplies, which is a company supplying doors and floors based in Navan, maintains a small commercial unit in Lobinstown Village, while Myles Staircases Ltd. also maintains a workshop and showroom c. 785 m south of the site on the L1603.

There are also other developments nearby, including solar farms, both existing and proposed, that could give rise to potential cumulative impacts. However, these developments are subject to planning and/or the requirements for EIA and are subject to compliance with both planning and licensing conditions. There is no other significant industrial/commercial activity within a 5 km radius of Lobinstown Quarry.

These developments are expected to be subject to similar mitigation measures with respect to protection of groundwater. In our review of the projects, no connection that could potentially result in significant cumulative impacts was identified.

A separate Cumulative Impacts Assessment has been included as Appendix 15, which provides an assessment of other projects located within the wider area that are potentially significant with respect to cumulative impacts.

No Irish Water or National Federation of Group Water Schemes were identified within 15 km of the application site. Hence there is no cumulative impact with groundwater abstractions in the area.

The nearest wastewater treatment plant serves Lobinstown village. Desk study information suggests that there is no cumulative impact in terms of licensed discharges.

Under cumulative impacts due consideration must be to all other planning permissions within the current site boundary, these being:

- 23917 = Offices replacing the containers acting as offices, car parking and retention of WWTP. Granted. Conditional.
- 22328 = Concrete Batching Plant. Granted. Conditional. Appealed Financial ABP-313691-22.

The developments listed above have no potential for interacting with or cumulatively impacting the proposed deepening of the working quarry by one more bench and the lateral extension to the east into the greenfield area.

With respect to cumulative impacts with other permitted developments, there are no developments shown on the planning system (https://www.myplan.ie/) that have potential for cumulative impact: all developments are small scale domestic or school related.

It is concluded that there is no potential for cumulative impact.

7.9.7 WORST CASE IMPACT

For other quarries in different bedrock the worst case of what might happen would be that a major groundwater strike could be intercepted and the quarry void would fill with groundwater. This will not happen here. The low discharge rates recorded to date, combined with the competent bedrock in the exposed faces of the operational quarry support a conclusion of no potential for a worst-case impact with respect to either surface water or groundwater.

National scale bedrock and aquifer mapping also support this conclusion of no potential for a 'worst case' scenario occurrence because the published desktop information suggests a Poorly Productive groundwater flow regime.

7.9.8 'DO NOTHING' SCENARIO

Under the 'Do Nothing' scenario, all quarrying and ancillary activities would continue under P.A. Ref. LB200106 until the existing permitted reserve was worked out. The site would then be restored as per the requirements of the existing planning permission (P.A. Ref. LB200106).

If the development did not proceed, the ground of the proposed development at the working quarry site would remain in its current exposed quarry condition and the extension area to the east would remain as greenfield condition. Surface runoff would continue to flow directly to field drains which form the Killary_Water_010 Stream. Recharge to the bedrock aquifer remains at the GSI capped 100 mm/yr in a do-nothing scenario.

7.9.9 TRANSBOUNDARY IMPACTS

EIA Directive 2014-52-EU invokes the Espoo Convention on Environmental Impact Assessment in a Transboundary Context, 1991, and applies its definition of transboundary impacts. Given the location of the site at 30 km, approximately, at its closest position to the border with Northern Ireland, the nature, size and scale of the proposed development, and the fact that water from the catchment flows directly to the sea, it is expected that the development will not have any significant transboundary effects with respect to water bodies.

7.9.10 APPLICATION OF HYDROGEOLOGICAL RISK ASSESSMENT METHODOLOGY

In addition to the EPA (2022) guided EIAR and EIA Directive requisite impact assessment, description of likely impacts and mitigation measures presented above, a 'best practice' approach to a hydrogeologically focussed assessment of quarrying and dewatering was also applied as per UK Environment Agency Guidance outlined in Boak *et. al.* (2007). As previously outlined in the Methodology Section of this Water Chapter (Section 7.2.7), the UK EA's approach suggests a stepwise thought-process. Following on from the completed desk and field studies, Hydro-G answers to each of the steps can be summarised as follows:

- ***Step 1:* Establish the regional water resource status:**

  Answer = The application site and surrounding lands overlie an aquifer that is mapped as a Poor Aquifer, named the Louth GWB, which is assigned Good Status (EPA 2016-2021, https://gis.epa.ie/EPAMaps/).

- ***Step 2:* Develop a conceptual model for the abstraction and the surrounding area:**

  Answer = The conceptual hydrogeological model is that there is no contiguous groundwater flow in this type of bedrock, which is a metamorphic rock where no significant water strikes were encountered in the drilling of multiple wells (PWs and MWs) in the application bedrock. Field hydraulic response testing returned 10^{-8} m/s hydraulic conductivity, which is akin to a CLAY liner that will not let water pass through it. The conceptual model for the Louth GWB (GSI, 2004a) is that surface water will receive most rainfall and groundwater recharge is capped at 100 mm/yr. Field drilling and response tests support the GSI's mapping that the site sits in a Poorly Productive Groundwater Flow Regime and a Poor Aquifer.

- **Step 3: Identify all potential water features that are susceptible to flow impacts:**

  Answer = Killary_Water_010 flows to the north of the quarry boundary and receives the discharge from the site. The Killary Water_010 merges with the Killary_Water_020, which in turn joins the River Dee as it travels towards the east coast and discharges to the Irish Sea at Annagassan. As well as surface water features, the Louth GWB underlies the site.

- **Step 4: Apportion the likely flow impacts to the water features.**

  Answer = None envisaged. The Section 4 Discharge Licence (Ref: 20/01) was issued in the year 2020. The Licence was issued to ensure compliance with the objectives of the WFD. The site's discharge maintains continuance of water delivery to the Killary_Water_010. Therefore, the hydromorphological regime is maintained. No likely flow impacts are envisaged. With respect to groundwater, no likely flow impacts are envisaged because there is little groundwater in the bedrock that could be affected.

- ***Step 5:* Allow for the mitigating effects of any discharges, to arrive at net flow impacts:**

  Answer: No net flow impacts are envisaged. There is large headroom available between the licensed discharge rates and the measured discharge rates to date.

- ***Step 6:*** Assess the significance of the net flow impacts.

  Answer: No significance

- ***Step 7:*** Define the search area for drawdown impacts.

  ***Answer* =** The groundwater flow mechanism is mapped, and confirmed, as 'Poorly Productive' flow with extremely low measured hydraulic conductivity in the bedrock. No drawdown impacts are envisaged. Surveying and well search revealed that the water levels in local domestic wells immediately south east of the working quarry are between 115 m OD and 121.73 m OD, whereas the sump's water level on the floor is 65 m OD. This suggests that there has been no drawdown effect arising from bedrock excavation at the site. This is envisaged to continue with no impact into the future.

- ***Step 8:*** Identify all features in the search area that could be impacted by drawdown.

  Answer = No features will be impacted.

- ***Step 9:*** For all these features, predict the likely drawdown impacts.

  Answer = None predicted.

- ***Step 10:*** Allow for the effects of measures taken to mitigate the drawdown impacts.

  Answer = Not relevant.

- ***Step 11:*** Assess the significance of the net drawdown impacts.

  Answer = Not applicable.

- ***Step 12:*** Assess the water quality impacts.

  Answer = Based on previous assimilative capacity calculations, and results of continuous monitoring of discharge quality and annual sampling of discharge and receiving waters none are predicted.

- ***Step 13:*** If necessary, redesign the mitigation measures to minimise the impacts.

  Answer = Not necessary.

- ***Step 14:*** Develop a monitoring strategy.

  Answer = The existing site monitoring strategy shall be continued. This means that groundwater levels will continue to be monitored, the discharge flow rate will continue to be monitored, discharge quality will continue to be monitored.

7.9.11 INTERACTIONS

The site's interaction with the Killary_Water_010 surface water is regulated and controlled by the site's Section 4 Discharge Licence, whose ELVs ensure compliance with the WFD and Water Pollution Act.

Hydrology and hydrogeology interact with flora and fauna. The location of the proposed activity is not within any features designated with conservation objectives. There is no potential for interaction with Designated sites.

7.9.12 SAC IMPACT POTENTIAL – HYDROLOGICAL SUMMARY

The application area and Lobinstown Quarry itself are neither hydrologically nor hydrogeologically connected to the River Boyne And River Blackwater SAC (002299) and SPA (004232). The site is not mapped by the EPA as part of the River Boyne's Hydrometric Area (07). There is therefore no connection between the proposed development and the River Boyne and River Blackwater SAC and SPA.

The application area and Lobinstown quarry are in the mapped catchment (Hydrometric Area) of Dundalk Bay SAC (000455) and SPA (004026). The site is mapped by the EPA as part of Hydrometric Area 06, which is named the "Newry, Fane, Glyde and Dee". Dundalk SAC and SPA is the coastal receiver of water from this entire Hydrometric Area. The EPA (2021) 3rd Cycle Catchment Assessment states "*This catchment includes the area drained by the Newry, Fane, Glyde and Dee rivers, and by all streams entering tidal water between Murlough Upper and The Haven, Co. Louth. This is a cross border catchment with a surface area of 2,125 km^2, 1390 km^2 of which is located within the Republic of Ireland (RoI). The largest urban centre is Dundalk. The other main urban centres are Carrickmacross, Ardee, Kingscourt, Dunleer and Castleblaney and the total population (in the RoI) is approximately 115,900, with a population density of 83 people per km^2. The catchment is characterised by the upland area of the Carlingford Peninsula, which is underlain by granites and other igneous rocks, and undulating land to the south, and a heavily drumlinised (lenticular, steep sloped hills) landscape in the western half of the catchment. There are extensive gravel deposits along much of the coast in this catchment, which are an important local groundwater resource.*"

With respect for the potential for the application proposed to impact Dundalk Bay SAC and SPA, the take home points from the EPA's description of the Hydrometric Area AND the application site under consideration, the catchment numbers of significance to scale include, as follows:

B. The catchment draining to Dundalk Bay and SAC has a land surface area of 2,125 km^2.

C. The catchment area of the application site's lands draining to the river that receives the site's discharge is mapped as c. 5 km^2.

D. The proportion of Dundalk Bay SAC and SPA's catchment that could be affected by site activities is a fraction of 1%, *i.e.,* 0.2%.

E. There is 43 km of water flow stream length between the application site and Dundalk Bay SAC and SPA.

F. Whilst there is a tentative hydrological pathway to European sites Dundalk Bay SAC and SPA via the Killary Water_010 and its downstream Dee River, potential impacts to the European sites are highly unlikely given the distance of water and potential contaminant assimilation and removal over 43 km downstream and the freshwater and estuarine water bodies between which would involve dilution to the extent that a pollution event would be imperceptible at 1km from the application site boundary. Monitoring results suggest that the Section 4 Compliant discharge is completely assimilated within 100 m of the site. Therefore, a pollution event would be assimilated within 1 km.

Upon review of the EPA Envision mapping by the project's hydrologist (Dr. Colin O'Reilly) and hydrogeologist (Dr. Pamela Bartley), Dundalk Bay SAC and SPA receives water from ELEVEN EPA mapped and named surface waters, as follows:

1) Big Louth River on the Cooley Peninsula to the north east of Dundalk.
2) Rockmarshal Stream on the Cooley Peninsula to the north east of Dundalk.
3) Flurry River on the Cooley Peninsula to the north east of Dundalk.

4) Ballymacscanlan Stream on the Cooley Peninsula to the north east of Dundalk.
5) Ranskeagh River north of Dundalk.
6) Castletown North River flowing from the north west and through Dundalk
7) Castletown South through Dundalk
8) Ramparts River flowing through southern Dundalk.
9) Hagerstown Stream to the south of Dundalk.
10) The Fane River south of Dundalk.
11) Drumeenagh Stream north of Castlebellingham.
12) Glyde River flowing through Castlebellingham.
13) Dee River flowing through Ardee and discharging to the coast at Annagassan.

It is the thirteenth river, named 'The Dee', that tentatively connects the application site with Dundalk Bay SAC and SPA. The site's licensed receiver of the treated discharge water is the surface water named the Killary Water_010. The Killary_Water_010 merges with the Killary_Water_020 and then joins the Dee River. The first protection to the Dee River is the water management system already in place, which has capacity to protect the receiving waters for the current and future proposed development. The discharge from the site is itself of higher hydrochemical quality than the receiving water. The discharge acts to reduce some concentrations in the receiving water. The discharge causes no change in any parameters of the receiving water.

EPA Envision mapping allows HydroTOOL model evaluation of the expected low flow rates (NATQ95) at model nodes along each river in the country. The HydroTOOL values for low flow at the final node on each river prior to its discharge at the coast to Dundalk SAC and SPA are presented in Table 7.26.

Table 7.26 HydroTOOL values for low flow in rivers discharging to Dundalk SAC and SPA

NATQ95	Node	Catchment Area (km2)	NATQ95 (m3/s)	NATQ95 (m3/d)	
Big Louth NATQ95 =	06_595	22.282	0.068	5875.2	
Rockmarshal NATQ95 =	N/A	not published		-	
Flurry NATQ95 =	06_599	25.416	0.076	6566.4	
Ballymacscanlan NATQ95 =	N/A	not published		-	
Ranskeagh NATQ95 =	06_1081	7.778	0.2	17280	
Castletown North NATQ95 =	06_1085	35.509	0.091	7862.4	
Castletown South NATQ95 =	06_1087	6.309	0.016	1382.4	
Ramparts NATQ95 =	06_1091	22.217	0.055	4752	
Hagerstown NATQ95 =	N/A	not published		-	
The Fane NATQ95 =	06_940	275.247	0.631	54518.4	
Drumeenagh NATQ95 =	N/A	-	-	-	
The Glyde NATQ95 =	06_1097	359.937	0.63	54432	
The Dee NATQ95 =	06_1099	389.066	0.602	52012.8	
NATQ95 Total flowing into Dundalk Bay SAC and SPA				**204,682**	**m3/d**

On the basis of the EPA Envision published HydroTOOL low flow (NATQ95) values for the rivers of the catchment (Hydrometric Area) feeding into Dundalk Bay SAC and SPA, the following is true:

1. The total NATQ95 low flow volume of waters entering Dundalk Bay SAC and SPA, *via* all of its rivers, is 204,682 m^3/d.
2. The site's Section 4 Discharge licence permits a maximum daily discharge volume of 1,728 m^3/d.
3. Even if the maximum permitted discharge volume was being discharged from the application site at the same time as all rivers were in the low flow condition, which is a highly unlikely scenario, the site’s discharge waters represent 0.8% of the waters contributing to Dundalk Bay SAC and SPA. This <1% value is considered in all assessment techniques for impact as presenting no potential for impact.

With respect to hydrochemistry, sample results presented for the site’s discharge quality suggest that the discharge is compliant with the Conditions of the Discharge Licence Ref: 20/01. It is noted that the Conditions of the Discharge Licence are specified so as to protect all downstream receptors. In particular, the following comments can be made with respect to the quality of water discharged under licence from the site:

a) The discharge is relatively neutral pH with the 6-9 pH ELV always being complied with.

b) Suspended Solids (SS) concentrations are very low, with respect to the 20 mg/l ELV. On average, the SS concentration is generally <3 mg/l.

c) Orthophosphate as P concentrations are always less than the Limit of Detection of the laboratory. The results are always a small fraction of the ELV for MRP-P.

d) The discharge does not present a Biochemical Oxygen Demand (BOD). Results are usually less than the Limit of Detection of the laboratory for BOD. There is a slight exceedance in April 2023. This is not repeated in the results for five subsequent sampling events.

e) The discharge does not present a Chemical Oxygen Demand (COD). Results are usually less than the Limit of Detection of the laboratory for COD. The results are always a small fraction of the ELV for COD.

f) Ammonium-N concentrations are an order of magnitude lower than specified in the ELV of the Licence.

g) On average, Nitrate-N concentrations in the discharge are less that the 10 mg/l NO3-N ELV.

h) There are no detections of petroleum hydrocarbons in the discharge.

i) There are no detections of BTEX compounds in the discharge.

It is therefore concluded that the site's discharge complies with the hydrochemical ELVs of Condition 2.2 of the Discharge Licence.

With respect to impact on the ecological quality of the receiving waters, the Biological Q Rating of the receiving water upstream and downstream of the discharge are monitored each year and they are the same. As the Q Value is identical downstream of the quarry discharge relative to upstream, it can be inferred that the discharge from the quarry at Lobinstown is not having a deleterious effect on the biological quality of the stream.

As previously stated, the site's Section 4 Discharge licence permits a maximum daily discharge volume of 1,728 m^3/d. The discharge meter on the discharge continuously records daily flow volume. The average discharge rate is 174 m^3/d and the maximum observed was 454 m^3/d. The site is also fitted with a Rain Gauge so that the discharge pattern can be better evaluated and understood. The site's monitoring data suggests that the discharge is >90% rainfall runoff. There is very little groundwater in this high PSV bedrock type. There is zero discharge from the site when there is no rainfall. This means that there is no groundwater baseflow to the river system.

The dominant water balance component is surface water runoff. This is what the GSI have published for the groundwater body and this is what the site investigation results reveal. The GSI apply a groundwater recharge CAP of 100 mm/yr to the amount of effective rainfall that can move into groundwater. The bedrock is almost impermeable (10^{-8} m/s hydraulic conductivity). This means that in the pre-development condition, all of the rainfall runoff that would be flowing off the land would enter the river. The site maintains this water balance system, returning rainfall runoff to the river system. The site treats the water before discharge, removes suspended solids. There is no ortho-P, no ammonium and no BOD or COD load being sent to the river. Under agricultural land usage there would be nutrients and suspended solids going to the river.

The significance of the recorded flows is that the site discharges, on average, 10% of the volume permitted. The maximum volume permitted was determined by MCC in 2020 to be a safe volume that will enable conservation of all river and fish life quality and, by default, also protects Dundalk Bay SAC and SPA.

On a very simple basis, consider that the total quarry void area proposed is 9.7 ha and the lateral extension part of that total area is 4.1 ha. Those values for the current area and the increase to the full proposed 9.7 ha area essentially suggest that the footprint of the excavation area will be doubled. Considering that the site discharges an average of 174 m^3/d, even if that were doubled the discharge would be 348 m^3/d. This is still only 20% of the maximum permitted ELV for volume. Remember the ELV for maximum volume in the Discharge Licence is the volume that has been set as the safe amount to protect WFD Status, to ensure no presentation of risk to the rivers, protection of fish life and all downstream European sites. The peak rainfall response in the discharge was 454 m^3/d. Even if this doubled, the peak storm response at the site would be c. 900 m^3/d. This is still only c. 50% of the available and permitted maximum daily discharge volume. It is therefore concluded, beyond any reasonable doubt, that the site's existing infrastructure can accommodate, attenuate and treat the waters that will arise from the proposed deepening by one bench the existing site and the proposed extension to the east.

On a more academic basis, the site's drilling, pump testing and hydraulic response testing enabled calculations of potential future dewatering volumes that could be encountered based on academic empirical hydrogeological equations. Two empirical academic methods were employed and both methods suggest that the future total volume arising from the proposed future extraction area and rainfall runoff will be c. 200 m^3/d. The value returned by the academic calculations is close to the current average value because there will be little extra groundwater encountered in the application bedrock and the rainfall runoff value for the site already includes some contribution from the eastern lands. On a worst-case Factor of Safety (FOS) basis, the c. 200 m^3/d could be multiplied by a 2, 3, 4, 5, 6, 7, or 8 x FOS and the site's water management systems will still have the capacity to attenuate and treat the future waters arising over the entire application area.

There is an extensive array of established, proven, water management components already in use at the site. These water management components were specified in the Section 4 Discharge Licence (Ref: 20/01) issued by MCC in November 2020. The water management components were specified in the Discharge Licence because they were designed by SLR to retain waters, attenuate for the required duration to remove solids, intercept contaminants (oil interceptor) and provide a mechanism of discharge (diffuse on the plinth) that would ensure protection of the receiving water. There are four components separating the site from the receiving water: the quarry sump, the western lagoon, the final lagoon and the oil separator.

The water management components already established include, as follows:

- The quarry floor sump in the south of the working bedrock extraction area.
- A western lagoon that collects rainfall runoff water from the road that is used by trucks entering and leaving the site.
- A fully functioning, engineered, wheel wash and associated sump.

- A final lagoon, which receives water pumped from the quarry floor sump and the western sump.
- A Class 1 oil separator.
- A flow meter.
- A discharge pipe with concrete plinth to diffuse and aerate discharge water as it is delivered to the receiving water.

With respect to the ability of the site's existing infrastructure to treat the future proposed total area's waters to the satisfaction of the Conditions of the existing Section 4 Discharge Licence, the only parameter that has the potential to change is the Suspended Solids concentrations arising. All other parameters will average the same for the working area. Suspended solids can change with blasting and workings. The site discharges an average Suspended Solids (SS) concentration of 3 mg/l SS. The permitted ELV for SS is 20 mg/l (Ref. 20/01). Therefore, the site uses 15% of the ELV limit as mg/l. However, if one were to consider that 1,728 m^3/d is permitted at 20 mg/l then the LOAD of SS permitted is 34.56 kg/d. The site discharges, on average, 174 m^3/d at 3 mg/l = 0.52 kg/d. Therefore, the site discharges 1.5% of the permitted load of SS. Therefore, there is treatment function and hydraulic capacity in the systems already in place on the site. There is so much unused capacity available in the Discharge Licence Conditions and so much underutilised treatment capacity and treatment function available in the as built settlement lagoons that the proposed expansion can be accommodated in the existing infrastructure. The proposed development's waters will be adequately treated and appropriately attenuated without the need for any more water treatment infrastructure.

It is noted that there is a European site Stabannan-Braganstown SPA (004091) 5.7 km to the west of the southern portion of Dundalk Bay SAC and SPA. The hydrogeologists for this assessment advise that the application site has no hydrological connectivity to Stabannan-Braganstown SPA by virtue of the fact that the EPA maps the catchment of the Stabannan-Braganstown SPA to be part of the Glyde River. The application site is mapped by the EPA to be part of a completely different river, named the Dee.

7.10 LANDSCAPING, FINAL RESTORATION, DECOMMISSIONING & AFTERCARE

When the appropriate planning period has expired at the application site and no further planning permission has been obtained, the applicant will be required to implement a final restoration and decommissioning plan.

As the excavation of rock at the quarry will result in the creation of a quarry void, it is important that restoration of this site is undertaken to protect public safety and to return the site to some beneficial use. All plant/machinery and facilities will be removed from the application site and reused at an alternative location or recycled as scrap metal. Final landscaping works will be undertaken where required and the restoration plan will be implemented. The landscape and restoration of the quarry is dealt with in Chapter 3.4 and 11.

7.11 CONCLUSIONS

EPA (2022) suggests that the impact assessment should be concise and that conclusions regarding the environment are unnecessary. Instead, conclusions on the impact assessment are required and it is hereby concluded that with the application of the specified mitigation measures there will be no residual impact on the water environment. The potential for impact on European sites was discussed in detail in its own potential impact section and it is concluded that there is no potential for any impacts.

Similarly, it has been determined that there is no potential for cumulative impact.

Given that guidance on impact assessment has been applied as per EPA (2022), it is respectfully proposed that the assessment presented also complies with the EIA Directive.

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