CHAPTER 7

WATER

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INTRODUCTION

Background

7.1 Quarrying activity and the associate processing operations were established at Aghamore Near, Aghamore Far and Carrownamaddoo townlands in the 1950s, with permission for works in additional lands to the west, north and north-east of the original quarry granted in 1996 (Planning Ref. 96/172). Planning permission to further extend and deepen the quarry was granted in June 2003.

7.2 Dewatering of the site and discharge to the stream leading into Lough Gill have been occurring for more than 10 years. The site holds a current reviewed discharge licence (DL(W)151: 2020) and prior to the revision of the licence, there was a discharge licence for the site, albeit in the name of the previous owner of the site, CEMEX (ROI) Ltd.

7.3 The current floor level (c. -21mOD) of the quarry is below the water table requiring surface water and groundwater to be pumped from the quarry to a nearby stream which leads directly to Lough Gill c. 765m downstream.

7.4 The previous permitted floor level of the quarry was one bench below the existing floor level (i.e. -34.5mOD) and it is proposed to deepen the quarry by a further bench below this (i.e. to -50mOD), potentially increasing both the drawdown on the water table surrounding the quarry and the volume of water discharged to surface water. A comprehensive assessment of potential water-related impacts for the proposed development is therefore required.

7.5 Lagan propose to recommence operations at this site which were suspended temporarily since November 2014. During the suspension of activity, the environmental monitoring programme was continued for some of the time. A very comprehensive programme of work has since been completed as part of the detailed hydrogeological and hydrological studies undertaken to support this application.

7.6 Details of the site and a description of the proposed development are provided in Chapter 2. In summary:

> *The proposed development being applied for under this current planning application is shown on **Figure 2-1** and is similar to that previously granted under Sligo County Council Ref. No 02/271 and will consist of:*
>
> - *Recommencement of quarry operations within the previously permitted quarry extraction area (c. 10.9ha);*
> - *Deepening of the previously permitted quarry area by 2 No. extractive benches from c. -21mOD to -50mOD;*
> - *Recommencement of aggregate processing (crushing and screening) within the existing processing area, located to the east of the local road that bisects the site;*
> - *The provision of a settlement lagoon (c. 2,830m^2);*
> - *The provision of 2 No. wheelwashes;*

- *The Provision of a wastewater treatment system;*
- *The Provision of a double stacked portacabin office;*
- *Additional stockproof / trespass proof boundary fencing;*
- *All within an application area of 22.5 Ha.*

ADDITIONAL INFORMATION

7.7 As outlined in Chapter 1, a planning application was submitted to Sligo County Council (Plan File Ref. No. 18/345 / ABP Ref. 305821-19) in August 2018 for similar development to that proposed as part of this application. In October 2019 Sligo County Council granted planning permission for the development (subject to 23 no. conditions). 2 no. third party appeals of the decision by Sligo County Council to grant permission for the proposed development were made to An Bord Pleanala (ABP-305821-19). An Bord Pleanala refused permission for the proposed development on the 30th June 2020 for the 2 no. reasons – refer to Chapter 1 for further details.

7.8 In order to comprehensively address the reasons for refusal, and further comments contained within the An Bord Pleanala Inspectors Report, a number of additional surveys / site investigations, field work and assessments have been carried out.

7.9 This Chapter 7 of the EIAR has been updated as follows:

- A second site investigation and monitoring programme for surface water and groundwater was undertaken by TMS from August 2020 to March 2021 (Phase II). This investigation was undertaken to supplement the findings of the first site investigation and collect new information in relation to the processing area of the site.
- Five additional boreholes were drilled and installed as monitoring wells within the quarry along the access road (MW12, MW13, MW14) and on the northern boundary (MW18, MW19). Nine shallow boreholes were drilled and installed as monitoring wells within the processing area. The locations of the monitoring wells are indicated on **Figure 7.1**. Summary details of the monitoring wells and borehole logs are provided in **Appendix 7-4**.
- Four rounds of surface water sampling were carried out, with samples being collected from the same locations as in the first site investigation, plus upstream and downstream of the infilled area located upstream of the site at Lough Nameenbrack (i.e. reclaimed land surrounding Lough Nameenbrack). The surface water sampling locations are indicated on **Figure 7-2**. One round of groundwater sampling was carried out of all monitoring wells on site.
- Groundwater level and flow monitoring for the quarry was continued, with additional dataloggers installed in the new monitoring wells in the processing area.
- Two biological assessments of the Aghamore Stream were carried out by TMS in September and November 2020. The first biological assessment examined surface water quality upstream and downstream of the quarry discharge, the second assessment looked at surface water quality in the Aghamore Stream at five different locations. The TMS biological assessment reports are provided in **Appendix 7-5**.

- A geophysical survey of the quarry floor and land to the northeast of the quarry was carried out by APEX Geophysics in January 2021 to determine if any weathered or karst zones in bedrock were present. The APEX geophysical report is provided in **Appendix 7-6**.

Scope of Work / EIA Scoping

7.10 The objectives of this EIAR chapter are to:

- establish the baseline conditions for surface water/groundwater;
- develop a conceptual understanding of the quarry hydrology/hydrogeology;
- identify any potential impacts from the proposed development on the baseline conditions;
- assess the likelihood and significance of any potential impacts;
- propose mitigation measures (if required);
- identify any residual impacts after mitigation measures are implemented (if any).

7.11 In order to provide the information necessary to assess the potential impacts of the proposed development on the water environment, detailed site investigations and monitoring programmes for surface water and groundwater were undertaken by TMS from June 2017 to July 2018, and from August 2020 to March 2021. The scope of these site works was based on a review of the available information, the nature of the proposed development and the environmental sensitivity of the site.

7.12 Further details of the site investigations and monitoring programmes are provided in Paragraphs 7.47 to 7.61.

Consultations / Consultees

7.13 A pre-planning consultation document for the proposed development was prepared and issued to statutory and other consultees during the EIA scoping stage; responses from Irish Water, National Parks & Wildlife Service, Inland Fisheries Ireland and the Geological Survey of Ireland are of relevance to this chapter and are included in **Appendix 7-1**.

7.14 The Environmental Protection Agency (EPA) was consulted on surface water monitoring data for Lough Gill, undertaken by the EPA as part of the Water Framework Directive Monitoring Programme.

7.15 Sligo County Council (Environment Section) was consulted on surface water monitoring of the Aghamore Stream undertaken by Sligo County Council.

7.16 Sligo County Council (Water Services Section) was consulted on the mains water supply in the area surrounding the proposed development.

7.17 Irish Water, Sligo County Council, Leitrim County Council and An Bord Pleanála case records were consulted in relation to the Abstraction Orders, and information associated, for the Sligo Town and North Leitrim Public Water Supply abstractions at Foxes Den (Sligo) and Moneyduff (Leitrim).

Contributors / Author(s)

7.18 Fieldwork and the Water Chapter of the EIAR has been completed by Craig O'Connor of TMS Environment Ltd (TMS). Craig is a chartered geologist with 20 years' experience in surface water and groundwater assessments. Craig holds a BSc (Hons) in Geology from University College Cork and an MSc in Hydrogeology from University College London.

7.19 Following Irish Waters response to Scoping, the project team requested advice and information for Sligo's regional hydrological and hydrogeological regimes and Karst features from Suzanne Tynan of Tynan Environmental. Suzanne is a hydrogeologist and hydrologist with 18 years' experience in the area of hydrology and hydrogeology and 20 years' experience in the areas of environmental science and environmental geology. Suzanne holds a BSc in Geology and Botany from University College Dublin, an MSc in Environmental Science from Trinity College Dublin and an MSc in Hydrology and Water Resources Management from Imperial College London. Suzanne has studied the karst responses in the Sligo area for over 5 years. Her long-term characterisation of the karst responses in the vicinity of the Aghamore quarry was originally commissioned by Sligo County Council, who gave permission for Suzanne to share information for the benefit of an integrated assessment of the proposal under consideration. Suzanne's detailed report (2021) describing the regional hydrogeology and karst features of the Sligo peninsula is presented in **Appendix 7-2**.

7.20 Also, in response to the Irish Water response to scoping, Dr. Pamela Bartley of Hydro-G Hydrogeological & Hydrological Consulting was invited to assist in the impact assessment for the potential threat posed to the Public Water Supply Sources (PWSS's) abstracted each day from Lough Gill. Pamela is a water supply focussed civil engineer with 24 years' experience in groundwater sourced water supply, quarry assessments, surface water resource and assimilation capacity assessments and wastewater engineering. Pamela holds a Diploma in Water and Wastewater Technology from Sligo RTC, a BEng in Civil Engineering from Queens University Belfast, an MSc in Environmental Engineering and a Ph.D in groundwater impact characterisation from the Department of Civil Engineering, Trinity College Dublin. As a result of Pamela's involvement in appeal cases, she has become a specialist in assessing quarries in the context of planning, water and ecological Regulations. Separate to this project, Pamela is a panel hydrogeologist consultant to Irish Water. The evaluation of the potential impact on the PWSS abstractions is presented in **Appendix 7-2**. In addition, the final impact assessment section of this chapter is an integration of Craig O'Connor's and Pamela Bartley's work.

7.21 Dr. Pamela Bartley of Hydro-G Hydrogeological & Hydrological Consulting was also contracted by Lagan to carry out a peer review of the Water Chapter of the EIAR.

Limitations / Difficulties Encountered

7.22 The pre-existing monitoring record for surface water and groundwater was limited prior to this assessment, mainly consisting of information contained in the Environmental Impact Statement accompanying the 2002 planning application, and information submitted with the trade effluent discharge licence application in 2010, further information submitted in support of this application in 2011.

7.23 A comprehensive site investigation and monitoring programme for surface water and groundwater was necessary to provide the baseline information required to assess the potential impacts of the

proposed development Some limitations were encountered during the investigation, but these were addressed, and satisfactory outcomes were achieved.

7.24 Some limitations were encountered when installing groundwater monitoring wells around the quarry area. Collapsing-rock conditions were encountered in two monitoring wells drilled to the east, limiting the depths of these wells. Thick clay overburden to the south of the quarry limited the installation of monitoring wells to the area close to the quarry. It was not possible to install groundwater monitoring wells to the west of the quarry as access was not available. Notwithstanding such limitations, satisfactory alternatives were identified, and a satisfactory network of wells was installed to allow completion of a comprehensive study.

7.25 The duration of the extended monitoring programme undertaken at the application site is over 3 years, during which time sufficient information has been gathered to assess the potential impacts of the proposed development on groundwater/surface water. The monitoring programme is continuing which will add to the database of information for the future management of discharges from this site.

REGULATORY BACKGROUND

7.26 The planning history of the site is detailed in a separate planning report submitted with the planning application.

7.27 The most recent planning permission (Planning Register No. PL 02/271) granted in respect of the quarry in June 2003 contained a number of water-related conditions. Condition No. 18 identifies a number of measures that are required, mainly to do with surface water treatment, discharge and monitoring at the quarry. PL 02/271 is now expired.

7.28 A trade effluent discharge licence (DL(W)139) was granted by Sligo County Council in November 2011, following an application and submission of further information by the previous owner of the site Cemex (ROI) Ltd. The trade effluent discharge licence superseded some of the original water related planning conditions in PL 02/271.

7.29 The site was purchased by Lagan from Cemex (ROI) Ltd. in November 2014, and at that time none of the water monitoring/treatment infrastructure proposed in the discharge licence application (October 2010) and further information submitted (September 2011) had been installed by Cemex.

7.30 Lagan formally notified Sligo County Council on 28th May 2015 that the site had been acquired from Cemex on 28th November 2014 and that the quarry closed from that date. Since the quarry was inactive and the only discharge from the quarry was clean groundwater/rainwater to prevent the quarry from flooding, it was proposed by Lagan to discontinue the environmental monitoring programme at the site until activities recommenced. It was proposed to give Sligo County Council 8 weeks' notice prior to commencement of activities at the site and the environmental monitoring programme would fully commence prior to activities re-starting at the site.

7.31 A new trade effluent discharge licence (DL(W)151) was granted by Sligo County Council in January 2020, following an application and submission of further information by Lagan – the documents submitted to Sligo County Council for the new discharge licence are included in **Appendix 7-3**. The new discharge licence replaces the previous discharge licence (DL(W)139).

Legislation

7.32 The Water Framework Directive (Directive 2000/60/EC) was adopted in 2000 as a single piece of legislation covering rivers, lakes, groundwater and transitional (estuarine) and coastal waters. Its objectives are to prevent further deterioration of and to protect, enhance and restore the status of all bodies of water with the aim of achieving at least good status by 2015, or later in some cases.

7.33 The Water Policy Regulations (S.I. No. 722 of 2003), Surface Waters Regulations (S.I. No. 272 of 2009, amended by S.I. No. 385 of 2015, S.I. No. 327/2012 and SI No. 77 Of 2019) and Groundwater Regulations (S.I. No. 9 of 2010, amended by S.I. No. 366 of 2016) are the principal instruments for determining the Water Framework Directive characterisation, monitoring and status assessment programmes.

7.34 The Surface Water Regulations set a wide range of environmental standards for Irish surface waters. The Groundwater Regulations establish environmental objectives for groundwater bodies and include groundwater quality standards and threshold values for the classification of groundwater and the protection of groundwater against pollution.

7.35 A non-exhaustive list of water legislation relevant to this assessment is listed below:

- Local Government (Water Pollution) Acts, 1977 (No.1 of 1997)
- Local Government (Water Pollution) (Amendment) Act, 1990 (No. 21 of 1990)
- European Communities (Water Policy) Regulations, 2003 (S.I. No. 722 of 2003)
- European Communities Environmental Objectives (Surface Water) Regulations 2009 (S.I. No. 272 of 2009)
- European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010)
- European Communities (Drinking Water) Regulations 2014 (S.I. 122 of 2014)
- European Union Environmental Objectives (Surface Water) (Amendment) Regulations 2015 (S.I. No. 386 of 2015)
- European Union Environmental Objectives (Groundwater) (Amendment) Regulations 2016 (S.I. No. 366 of 2016).

Planning Policy and Development Control

7.36 The planning system is of central importance in protecting the water environment and meeting the objectives of the Water Framework Directive through the regulation of land-use and physical development.

7.37 Local Authorities develop forward planning policy (e.g. County Development Plans) and implement this policy through the development control process (i.e. the planning application system). The current County Development Plan for Sligo is effective from August 2017 (Sligo County Development Plan 2017-2023). Recent amendments to the Planning and Development Act (Planning and Development (Amendment) Act 2010) have required Local Authorities to introduce greater rigor into the planning system with respect to water management, including:

- a specific requirement that Local Authority forward planning policies support compliance with environmental standard required under the Surface Water and Groundwater Regulations
- a greater obligation to implement statutory planning guidance issued by Government (e.g. The Planning System and Flood Risk Management: Guidelines for Planning Authorities)
- greater integration between the planning system and protection/enhancement of ecological integrity and conservation objectives of Natura 2000 sites
- stricter control on quarries (Section 261A of the Amendment Act)
- the policies and objectives of all development plans must be aligned with the relevant River Basin Management Plan (implemented under the Water Framework Directive) and must include mandatory objectives for the promotion of compliance with WFD environmental standards for water.

7.38 Section 4.3.4 of the current County Development Plan for Sligo outlines the Council's approach to the development of quarries in Sligo. It states: '*The Council seeks to ensure that the extractive and concrete products industry operates in a manner that minimise the potential adverse impacts on the environment and local communities.*' It further states that: '*It is the policy of Sligo County Council to… ensure that extraction and associated processes are carried out in a sustainable manner, which minimises the impact on residential amenities, natural environment and water quality*'.

7.39 The development plan makes specific reference to a guidance document on quarries: '*In assessing development applications relating to existing or proposed quarries, the Council will take full account of the document 'Quarries and Ancillary Activities: Guidelines for Planning Authorities' (DoE, 2004).*' (listed in Section 7.35 below)

Guidelines

7.40 A non-exhaustive list of guidelines relevant to this assessment is listed below:

- EPA (2002) 'Guidelines on the information to be contained in Environmental Impact Statements'
- EPA (2003) 'Advice notes on current practice (in the preparation of Environmental Impact Statements)'
- Department of the Environment, Heritage and Local Government (2004) 'Quarries and Ancillary Activities, Guidelines for Planning Authorities'
- EPA (2006) 'Environmental Management in the Extractive Industry'
- IGI Guidelines (2013) 'Guidelines for the preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements'
- EPA (2015) 'Advice Notes for Preparing Environmental Impact Statements' (Draft)
- EPA (2017) 'Guidelines on the Information to be contained in Environmental Impact Assessment Reports' (Draft)
- WFD Pressures and Impacts Assessment Methodology, Guidance document No. GW5 (2004) 'Guidance on the assessment of the impact of groundwater abstractions'

Technical Standards

7.41 TMS holds Irish National Accreditation Board accreditation for surface water and groundwater sampling, complying with the following water sampling standards:

- I.S. EN ISO 5667-6:2016, 'Water quality – Sampling – Part 6: Guidance on sampling of rivers and streams (ISO 5667-6:2014)', National Standards Authority of Ireland
- ISO 5667-4:2016, 'Water quality – Sampling – Part 4: Guidance on sampling from lakes, natural and man-made', International Organization for Standardization
- ISO 5667-11:2009, 'Water quality – Sampling – Part 11: Guidance on sampling of groundwaters', International Organization for Standardization
- I.S. EN ISO 5667-3:2012, 'Water quality – Sampling – Part 3: Preservation and handling of water samples (ISO 5667-3:2012)', National Standards Authority of Ireland
- I.S. EN ISO 19458:2006, 'Water quality – Sampling for microbiological analysis', National Standards Authority of Ireland

Significant Risks

7.42 The potential for significant human health/environmental effects from activities connected to the proposed development is considered to be low because the site is regulated by the Conditions of the recently issued, 2020, reviewed Discharge Licence for the Site DL(W)151 (2020).

7.43 Potentially significant human health/environmental effects could result (in the worst case, with no monitoring or management) from accidental spillages on site, uncontrolled discharges to surface water and flooding. However, any potentially significant impacts identified as arising from the proposed development will be mitigated against with appropriate measures, which are clearly set out in DL(W)151, to ensure there are no significant human health/environmental effects from activities connected to the proposed development.

RECEIVING ENVIRONMENT

Study Area

7.44 The study area mainly comprises the previously permitted area of the existing quarry (shown in **Figure 2-1**), surrounding lands, processing area and the Aghamore Stream and Lough Gill (receiving waters).

7.45 The study area is highlighted on **Figure 7-4**.

7.46 EPA mapping for Status of the water features in the study area are as follows:

- Aghamore Stream (Garavouge_010) = Poor Status (attributed in the Bonet Sub catchment report available at https://catchments.ie/ as a January 2019 WFD Cycle 2 report entitled 'Catchment Sligo Bay & Drowse', Subcatchment Bonet_SC_030 (Code 35_10), which presents the known pressures and risks for the GARAVOGUE_010 as Forestry, Road Runoff and Wastewater. Sligo County Council, as the Local Authority, is fully aware of the quarry and robustly assessed its potential impacts in the procedure resulting in the recent grant of Discharge Licence DL (W)151 (2020) to the current operators and proposers of further workings at the site.
- Lough Gill SAC is 765m downstream of the quarry discharge point and mapped as Moderate Status and at Risk due to Forestry, Agriculture, Urban Wastewater, Domestic Wastewater, Invasive Species and extractive Industries (WFD Cycle 2 Sub catchment Report 'Catchment Sligo Bay & Drowse', Subcatchment Bonet_SC_030 (Code 35_10) January 2019). Given the importance of Lough Gill as a SAC and a Public Water Supply for Sligo and North Leitrim, the significance of this local attribute is noted.
- Cummeen Strand/Drumcliff Bay SAC and Cummeen Strand SPA form part of the Garavoge Estuary Transitional Waterbody (IE_WE_470_0100) which is 7km downstream of the quarry (downstream of Lough Gill) and mapped as Moderate Status (2013-2018) with the WFD risk currently under review – the significant pressures identified for the waterbody by the EPA are Anthropogenic pressures.
- Groundwater is a receptor. The area proposed for the deepening of the quarry void is mostly in the GSI mapped Carrowmore West Groundwater Body (IE_WE_G_0040) and the access roads and boundary screening berms are underlain by the GSI mapped Carrowmore East Groundwater Body (IE_WE_G_0042). Both mapped groundwater bodies are classified as Good Status 2013 to 2018 (EPA Envision map series https://gis.epa.ie/EPAMaps/Water). Of the total quarry void area on the west side of the local road, 110,000m^2 is mapped as being in the Carrowmore West Groundwater Body and the access road to the void and its associated screening berms occupy 50,000m^2, approximately, of the Carrowmore East Groundwater Body.
- Ballysadare Bay SAC and SPA forms part of the Ballysadare Estuary Transitional Waterbody (IE_WE_460_0300) is located 3.3km to the southwest and hydraulically downgradient of the quarry at its closest point and is mapped as Moderate Status (2013-2018) and at Risk due to Agricultural and Urban Wastewater pressures.

Baseline Study Methodology

7.47 The methodology used for the baseline study follows the guidelines and advice notes provided by the Environmental Protection Agency on Environmental Impact Assessments (May 2017), and the Institute of Geologists of Irelands guidelines for the preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements (2013).

7.48 A combination of desk study and field study was used to establish the baseline conditions at the site. A wide range of water issues was considered under a number of headings including context, character, significance and sensitivities.

Context

7.49 Establishing baseline conditions is necessary to place the proposed development (and its likely impacts) within the context of the local/regional water environment. The description includes all relevant information about the existing water environment which could be impacted by the development, information such as surface water bodies, groundwater bodies, surface water and groundwater flow direction and relative magnitude of flow, private or public water abstraction points, areas at risk of flooding, known discharges to surface water or groundwater, habitat designations.

Character

7.50 A clear description of the character of the existing water regime is required to enable evaluation of any qualitative or quantitative impact. The description includes information such as groundwater levels and seasonal variation, groundwater flow direction, surface water and groundwater quality, extent of any flooding, aquifer characteristics and vulnerability, hydraulic characteristics, and flow regime, etc.

Significance

7.51 Any assessment of the significance of surface water and groundwater needs to evaluate beyond the boundary of the proposed development, as surface water and groundwater are part of a constantly moving hydrological cycle. The description of baseline conditions includes information such as water body status (surface water and groundwater) in relation to quality, water body status in relation to quantities, water use, the importance as a habitat/supporting a habitat, the local status in relation to flooding, etc.

Sensitivities

7.52 Changes in the natural surface water or groundwater regime, either qualitative (i.e. change in chemistry) or quantitative (e.g. dewatering) due to a development will depend on the sensitivity of the water environment and the scale and duration of the impact. The description of baseline conditions includes information on water quality, water levels, water volumes, water abstractions/discharges and future resource availability.

Sources of Information

7.53 The following sources of information have been consulted to establish the baseline hydrology and hydrogeology at and surrounding the site as part of the desk study:

- Groundwater Data Viewer, Geological Survey of Ireland website www.gsi.ie

- EPA Maps (WebGIS browser), Environmental Protection Agency website www.gis.epa.ie
- Catchment information, Environmental Protection Agency website www.catchments.ie
- 'Catchment Sligo Bay & Drowse', Subcatchment Bonet_SC_030 (Code 35_10) www.catchments.ie
- Surface water levels and flow, Environmental Protection Agency website www.epa.ie/hydronet
- National Flood Hazard Mapping, Office of Public Works website www.floodmaps.ie
- Preliminary Flood Risk Assessment Maps, The National Catchment Flood Risk Assessment and Management Programme, Office of Public Works website www.cfram.ie
- Flood Maps, Office of Public Works website www.floodinfo.ie
- Flood Estimation Methods, Web Portal of the Flood Studies Update Programme, Office of Public Works website www.opw.hydronet.com
- Office of Public Works (2018) 'Flood Risk Management Plan, Sligo Bay and Drowse'
- NPWS Map Viewer, National Parks & Wildlife Service website www.npws.ie
- OSI Map Viewer, Ordinance Survey of Ireland website www.maps.osi.ie/publicviewer
- Meteorological data, Met Eireann website www.met.ie
- Department of Housing, Planning and Local Government (2018) 'River Basin Management Plan for Ireland, 2018-2021'.
- Map of water mains, Sligo County Council (Water Services Section).
- EPA (2016), UGEE JRP Final Report 1: Baseline Characterisation of Groundwater, Surface Water and Aquatic Ecosystems.
- IFI (2012), Water Framework Directive Fish Stock Survey of Lough Gill, July 2011. Fiona L. Kelly, Lynda Connor, Emma Morrissey, Ciara Wogerbauer, Ronan Matson, Rory Feeney and Kieran Rocks. Inland Fisheries Ireland, Swords Business Campus, Swords, Co. Dublin.
- Thompson, E., Ryan, S. and Cotton, D.C.F (1998) 'Management Plan for the Lough Gill Catchment' for Sligo County Council. ISBN 0-948870-16-8.
- Environmental Impact Statement (2002) 'Quarry Deepening at Aghamore, Co. Sligo' Tom Philips and Associates
- Golder Associates report no. 10507150048/R02/A1 (2010) 'Discharge Licence Application Supporting Documents' 2010.
- Golder Associates report no. 10507150048.A0 (2011) 'Discharge Licence Application RFI' 2010.
- Previous Trade Effluent Discharge Licence DL(W)139 for the site, Sligo County Council.
- Abstraction Orders for the Foxes Den (Sligo WTP) and Moneyduff (Leitrim WTP).
- Tynan, S. (2018), Slides from the IEI NW Region Presentation: The 2015 Sligo Flood Event Winter 2015-2016 Flooding Co. Sligo. Characterisation and Potential Mitigation Measures. Suzanne Tynan, MSc. (Hydro), MSc. (Env Sci), PGeo. with the assistance of Sligo County Council, OPW and the residents and landowners at Carrowroe and Ballyfree.

- Information contained to support the successful grant of the current Discharge Licence Application (2019). SLR Consulting correspondence 'RE: Application for review of discharge licence Ref: DL(W)139 under Section 4 of the Local Government (Water Pollution) Act 1977, for Lagan Bitumen Ltd. at Aghamore Quarry, Aghamore Near and Carrownamaddoo townlands, Co. Sligo'. SLR ref. 190521.0501.00396.038.L.Rev0.Aghamore DL Cover Letter (7/8/2019)
- Technical detail presented in the Reply to the Request for Further Information to support the successful grant of the current Discharge Licence. 'RE: Request for Further Information in relation to review of discharge licence DL(W)139 for Aghamore Quarry Co. Sligo'. SLR Consulting correspondence ref. 191118.501.0396.038.R0.Aghamore DL FI.Rev1 (27/11/2019)
- Current Trade Effluent Discharge Licence DL(W)151, Sligo County Council (2020).

Field Survey / Monitoring / Inspection Works

7.54 Some off-site monitoring work was required in relation to the Aghamore Stream (sampling and channel survey) and Lough Gill (sampling), and monitoring wells installed outside the permitted area of the quarry in adjacent lands under the ownership of Lagan or with the permission of the landowner.

Initial Discharge Sampling

7.55 TMS collected a suite of monthly samples of the discharge from February to June 2016 (**Appendix 7-9**) prior to more detailed site investigation and monitoring.

Phase I Site Investigation

7.56 Site investigations comprising of drilling, geophysics and monitoring were completed over a 4-year period from July 2017 to March 2021.

7.57 The work was completed in phases.

7.58 There is also a body of baseline information from the previous owner's original application and operation of the site until the site was acquired by Lagan.

7.59 For the purposes of this application's Phase I, drilling commenced in 2017.

7.60 A monitoring programme for surface water and groundwater was then undertaken by TMS from June 2017 to July 2018. The scope of these site works was based on a review of the available information, the nature of the proposed development and the environmental sensitivity of the site. Nine boreholes were drilled and installed as monitoring wells to the north, east and south of the quarry (MW1-MW9). Two additional rotary cored boreholes were drilled as used as monitoring wells (MW10c, MW11). The locations of the monitoring wells are indicated on **Figure 7.1**. Summary details of the monitoring wells and borehole logs are provided in **Appendix 7-4**.

7.61 Dataloggers (Solinst Leveloggers) were installed in a number of monitoring wells to continuously record groundwater levels. Manual measurements were taken on site visits and used to verify datalogger levels.

7.62 Two electromagnetic flowmeters (Siemens SITRANS FM Mag8000) were installed on the two discharge lines running from the quarry sump pumps to the stream to monitor the volumes of water discharged off-site, their location is indicated on **Figure 7-2**. An ultrasonic-Doppler flowmeter (Unidata Starflow 6526H) was installed in the culvert upstream of where the quarry discharges to the Aghamore Stream to measure upstream flows.

7.63 A survey of the stream channel profile and culverts was carried out by DMC Survey in March 2018 from the quarry discharge point on the Aghamore Stream to Lough Gill 765m downstream.

7.64 Four rounds of surface water sampling were carried out, with samples being collected from the quarry discharge itself, upstream of the quarry discharge, downstream at two locations and from a headland in Aghamore Bay on Lough Gill. The surface water sampling locations are indicated on **Figure 7-2**. 2 No. rounds of groundwater sampling were carried out to characterise the background groundwater quality at the site.

7.65 Site visits were made on both wet and dry days to inspect quarry faces for inflows/seepages, evidence of karst features, bedrock fracture patterns, etc.

Additional Monitoring

7.66 Following the Phase I site investigation, additional monitoring continued from August 2018 to March 2019. Four additional rounds of surface water sampling and two rounds of groundwater sampling were carried out, as well as continued groundwater level and flow monitoring.

Phase II Site Investigation

7.67 A second site investigation and monitoring programme for surface water and groundwater were undertaken by TMS from August 2020 to March 2021 (Phase II). This investigation was to supplement the findings of the first site investigation and collect new information on the processing area of the site.

7.68 Five boreholes were drilled and installed as monitoring wells within the quarry along the access road (MW12, MW13, MW14) and on the northern boundary (MW18, MW19). Nine shallow boreholes were drilled and installed as monitoring wells within the processing area. The locations of the monitoring wells are indicated on **Figure 7.1**. Summary details of the monitoring wells and borehole logs are provided in **Appendix 7-4**.

7.69 Four rounds of surface water sampling were carried out, with samples being collected from the same locations as in the first site investigation, plus upstream and downstream of the infilled area located upstream of the site at Lough Nameenbrack (i.e. reclaimed land surrounding Lough Nameenbrack). The surface water sampling locations are indicated on **Figure 7-2**. One round of groundwater sampling was carried out of all monitoring wells on site.

7.70 Groundwater level and flow monitoring for the quarry was continued, with additional dataloggers installed in the new monitoring wells in the processing area.

7.71 Two biological assessments of the Aghamore Stream were carried out by TMS in September and November 2020. The first biological assessment examined surface water quality upstream and downstream of the quarry discharge, the second assessment looked at surface water quality in the Aghamore Stream at five different locations. The TMS biological assessment reports are provided in **Appendix 7-5**.

7.72 A geophysical survey of the quarry floor and land to the northeast of the quarry was carried out by APEX Geophysics in January 2021 to determine if any weathered or karst zones were present in the bedrock. The APEX geophysical report is provided in **Appendix 7-6**.

Hydrology

Rainfall & Evaporation

7.73 The nearest active weather station to the site is Markree Castle Automatic Weather Station (synoptic station), c. 6km to the south at a similar elevation to original ground levels at the application site of 34mOD. An historic weather station (Lough Gill, voluntary station, elevation 15mOD) was located c. 1.2km to the east of the site however this station ceased recording in July 2017.

7.74 The annual average rainfall at Markree for the 1981-2010 period is 1,260mm/year. Wind is not recorded at Markree therefore evaporation and evapotranspiration are not calculated for this station by Met Eireann.

7.75 The neareast two synoptic stations to the site are Knock Airport (c. 42km to the southwest) and Finner Camp (c. 32km to the northeast). Long term averages are unavailable for these stations however the average potential evapotranspiration and evaporation as calculated by the Penman-Monteith equation are 551mm/year and 784mm/year respectively for Finner Camp from 2018-2020, and 467mm/year and 684mm/year respectively for Knock Airport from 2018-2019. Taking the average of these records, the estimated potential evapotranspiration and evaporation for the site are 509mm/year and 734mm/year.

Drainage

7.76 The site is located at the top of a low hill at an elevation of c. 30mOD, with a gentle topographic slope away from the site to the north, west and south; the topographic gradient to the east is slightly steeper, into a wide shallow valley between the site and the Slieve Dargan/Slieve Daeáne Mountains, trending northeast-southwest.

7.77 The site lies in the Sligo Bay & Drowse Catchment, on the boundary of two sub-catchments: the Bonet Sub-Catchment to the east and the Carrowgobbadagh Sub-Catchment to the west. Drainage in the Bonet Sub-Catchment is towards Lough Gill, and drainage in the Carrowgobbadagh Sub-Catchment is towards the coast (Ballysadare Bay). The locations of these catchments are indicated in **Figure 7-3**.

7.78 There is only one river in the vicinity of the site. An unnamed stream, referred by the EPA as the Garravogue_010, and in this assessment as the 'Aghamore Stream', lies c. 300m to the east of the

quarry void (**Figure 7-4**) and drains water from Lough Nameenbrack (c. 450m to the southeast of the quarry) to Lough Gill (c. 765m to the northeast of the quarry discharge point). There are several culverts downstream of the site along Aghamore Stream under local roads, details of the culverts and their locations are provided in **Figure 7-27** and **Figure 7-28**. One of these culverts extends to 80 metres in length.

7.79 Further to the east and southeast, a few small streams drain the uplands of the Slieve Dargan/Slieve Daeáne Mountains towards Lough Gill.

7.80 There are no active hydrometric stations in the immediate vicinity of the site. An historic gauging station (station no. 35045) maintained by Sligo County Council was located on the Aghamore Stream close to Lough Gill and consisted of a staff gauge with periodic spot flow measurements only between 1996 and 2004.

7.81 The most significant surface water body in the vicinity of the site is the Lough Gill SAC (Site Code 001976) and Public Water Supply Source to Sligo and Leitrim. There is an EPA hydrometric gauge on Lough Gill (EPA HydroNET Stn. 35073) and a record of water levels on the lake is available for the 1971 to 2021 period. Weir control of the lake's water level is an important part of the management of the lake for Irish Water's PWSSs. Lough Gill's EPA Stn. 35073 is1.2km, approximately, north of where the Aghamore Stream discharges into Lough Gill. Long-term records (**Figure 7-5**) show that lake water levels rarely rise above 4.4mOD at this station, however levels as high as 5.285mOD have been recorded. Ground levels in the land adjacent Lough Gill in Aghamore Far slope from c. 5mOD to <4mOD close to the lake, showing the potential for flooding in this area.

7.82 The capacity of Lough Gill (bathymetry) was presented by the EPA (2016) and the information is used in this assessment.

7.83 The information presented in the EPA Water Maps Envision map-based database (https://gis.epa.ie/EPAMaps/Water) was employed for evaluation of the site in the context of river and lake network information as well as the drainage directions, catchment and subcatchments, status and risk information for the surface water systems.

7.84 Given that this is a study for a proposal in a Karst aquifer setting, historic information for the EPA hydrometric station at the discharge record for the Tobernalt spring (EPA HydroNET Stn. 35046) was also considered in the assessment of drainage in the wider area. The Tobernalt spring discharges at a distance of 1km north east of the site at an elevation of 4.305 mOD. It is unlikely that the groundwater regime at the quarry site and Tobernalt spring are connected given that the understanding is that the Tobernalt spring receives flow from either the west or north rather than from the southerly location of the quarry. However, the evaluation of the available Tobernalt spring discharge record (2013 to 2021), relative to the current -21mOD floor elevation at the site was deemed useful in the development of an understanding of the region.

7.85 The work reported by Tynan (2021) for this assessment and in a previous presentation of the Sligo groundwater flooding assessments were also consulted for the purposes of developing an understanding of the integrated drainage system incorporating the surface water and the groundwater regimes. The drainage to karst features north and west of the site is described by Tynan (2021). The drainage systems are understood to react quickly to rainfall because the shallow epikarst dominates responses, from which we infer limited capacity of the bedrock to accept rainfall recharge at certain locations in the Sligo peninsula.

Flooding

7.86 The Office of Public Works (OPW) maintains records of past flooding events which were collated as part of the National Flood Hazard Mapping programme.

7.87 No flood events are recorded by the OPW in the vicinity of the quarry site, however the Aghamore Stream is indicated as prone to recurring flooding further downstream at the crossroads of the N287 and the small road leading to the quarry, c. 380m downstream of the quarry discharge. This is a common reaction when a bridge presents a constraint to flow. An area engineer's report from November 2005 indicated that the R287 road was prone to flooding at this location during heavy rain where Lough Gill water levels swell and prevent runoff to the lake. A flooding event on the R287 at this location was recorded in November 2009 where the road was recorded as passable.

7.88 The Preliminary Flood Risk Assessment maps for the area (No. 351 and No. 368 – see **Appendix 7-7**), produced by the OPW as part of the early work on the Floods Directive in 2011, suggest that the Aghamore Stream would be liable to flood a narrow zone along its channel from Lough Nameenbrack to Lough Gill following an extreme rainfall event, and Lough Gill would be liable to flood the low-lying lands adjacent the lake as far as the N287 road. Several isolated pockets of pluvial flooding are predicted to occur across the lands within 2km of the quarry.

7.89 There are two areas close to the quarry prone to groundwater flooding; Geological Survey of Ireland (GSI) historic groundwater flood mapping (**Figure 7-6**) shows a low-lying area c. 350m to the north of the quarry in the townlands of Cuilbeg/Aghamore Near that has a history of flooding, and another low-lying area c. 700m to the northwest of the quarry in the townland of Tullynagracken South with a history of flooding. These features are described by the GSI as possible turloughs. The GSI groundwater flooding map is primarily based on the winter 2015/2016 flood event, which in most areas represented the largest groundwater flood event on record. Tynan's work (reported here in **Appendix 7-2**) has included both these groundwater flood zones, as well as the discharges from the only swallow hole in the peninsula, to springs north and west of the quarry. Refer to Tynan (2021), **Appendix 7-2**) for more detail. Tynan's (2021) contribution to the project was integrated to develop the understanding of the potential for the site to contribute to the known groundwater flood triggers in the lands surrounding and downgradient of the site. Tynan's (2021) report to this assessment details the elevation range of the active epikarst as operating between 0mOD and 22 mOD. While Tynan (2021) acknowledges that there could be deeper karst systems underlying Lough Gill, work completed by APEX (2021) under the current floor of the Aghamore Quarry void from its current floor level of -21mOD to an investigation depth of -60mOD (i.e. 10m below the proposed future excavation depth of -50mOD) found no evidence of karst conduits or systems under the existing quarry floor.

Quarry Water Management

Quarry

7.90 As previously stated, the site's water management and consequent discharge has recently been reviewed and a new licence was issued by Sligo County Council [DL(W)151, 2020].

7.91 Conditions of the recent licence specify control measures for the management of waters arising at and discharged from the site.

7.92 Defensible and justifiable Emission Limit Values (ELVs) for the quantity and the quality of the discharge have been prescribed in DL(W)151 (2000) cognisant of the importance of the ultimate receiving water, which is Lough Gill SAC and PWSSs.

7.93 The Conditions of the DL(W)151 [2020] licence specify the controls on the water management systems at the site for oils, waste management, accidents, and emergency situations. The discharge licence application and the Response to Further Information (SLR, 2019) presents the technical detail that facilitated the successful grant of the reviewed licence by Sligo County Council in the regularisation of activity at the site.

7.94 The current water management within the quarry involves pumping a combination of rainwater and groundwater from the quarry floor directly to the Aghamore Stream. This is an interim measure agreed with Sligo County Council as there is no activity on site and no sources of potential water pollution remain within the quarry void (see Section 7.24).

7.95 Incidental rainwater and groundwater seepages entering the quarry drain across the quarry floor to a sump located in the southern corner. One electric 37kW submersible pump is currently operating in the sump. The pump operates on float switches and discharge directly to the Aghamore Stream via a 160mm uPVC pipeline. The discharge point at the Aghamore Stream is c. 330m east of the quarry void – refer to **Figure 7-2**.

7.96 The submersible pump pumps at a constant c. 32l/s, which is approximately equivalent to 2,765 m3/d in the context of DL (W)151's ELV of 3,500m3/d). However, that one pump is not able to keep the quarry floor dry during the wetter months (c. November to April/May). The quarry floor is allowed to flood during these months as there is no requirement to keep the quarry floor dry while the quarry is inactive (**Plates 7-1 and 7-2, Appendix 7-8**).

Processing Area

7.97 Rainfall across the processing area infiltrates the permeable subsoils (sands), which underlie this area of the site (**Plates 7-3 and 7-4, Appendix 7-8**).

7.98 There is currently no point discharge arising from the processing area of the site (located to the east of the public road) as this area of the site is also inactive. Any historical discharges arising from the processing area would have originated from the wash-water associated with concrete production activities. This plant has not operated since the site was purchased by the applicant from Cemex (ROI) Ltd. in 2014 and is now obsolete. The applicant does not intend to recommence the production of concrete products at the site.

7.99 There will be no point discharges arising from the processing area of the site at any point in the future. Consequently, there will be no requirement for the treatment and disposal of run-off and wastewater from the processing area of the site.

7.100 Any surface water run-off arising from the processing area will continue to naturally infiltrate to ground. These lands are underlain by sand and gravel material with a significant unsaturated zone.

Discharge to Surface Water

7.101 As previously stated, the site holds a new discharge licence, issued by Sligo County Council, in 2020 [DL(W)151, 2020].

7.102 Historically, the site's previous owners (Cemex) held a Trade Effluent Discharge Licence (TEDL) for the site, which was issued by Sligo County Council in December 2011 (DL(W)139) to enable discharge water from the quarry to the Aghamore Stream, subject to conditions. The site was in the ownership of Cemex at the time the licence was granted.

7.103 Analysis results for samples of discharged water pre-Lagan are contained in the licence application documents submitted to Sligo County Council in 2010/2011 (**Appendix 7-9**). These results show that there are historically, slightly, elevated concentrations of Biological Oxygen Demand (BOD) and Molybdate Reactive Phosphorus (MRP) above levels that would be desirable in a river, which lead to the proposed water treatment infrastructure in the licence application documents.

7.104 TMS collected a suite of monthly samples of the discharge from February to June 2016 (**Appendix 7-9**); the results mostly show compliance with all parameters of significance. However, there are occasional detections of BOD concentrations above the historic TEDL emission limit values. However, as there was no activity on site at the time, these elevated concentrations are considered to be related to background groundwater quality in the groundwater seeping into the quarry from surrounding agricultural lands. Recent sampling in 2018-2020 shows occasionally elevated BOD concentrations up to 10.32mg/l O_2 in groundwater samples from outside the quarry void (**Appendix 7-10**). This supports the conclusion of impact outside the area controlled by the operators. BOD concentrations of 10mg/l suggest mild agricultural impacts.

7.105 The most recent samples of the discharge collected from 2019-2021 as part of the monitoring for this assessment show most parameters below the specified Emission Limit Values for the site with occasional isolated exceedances of BOD, total ammonia and orthophosphate (**Appendix 7-9**). Again, the influence of agriculture, wastewater discharges and forestry are understood to contribute loadings to the site.

7.106 A programme of surface water monitoring is currently ongoing at the site, which includes sampling of the quarry discharge, sampling of the Aghamore Stream upstream and downstream of the discharge (**Figure 7-2**) and monitoring discharged flows and streamflows in the Aghamore Stream. The full environmental monitoring programme will resume on site prior to activities recommencing, as notified to Sligo County Council in 2015 (see Section 7.24).

Surface Water Quality

7.107 The most recent surface water sampling events span between January 2018 and March 2021 as part of the ongoing monitoring programme on site (**Appendix 7-11**).

7.108 Samples were collected from the quarry discharge, upstream and downstream of the quarry discharge, further downstream before the discharge point to Lough Gill and from a headland in Aghamore Bay on Lough Gill (ITM coordinates 571924, 832411). The sampling locations are presented in **Figure 7-2**.

7.109 Background water quality in the Aghamore Stream in these samples is generally quite good. However, there are some occasions of elevated faecal bacteria and traces of total ammonia and

orthophosphate typical of runoff from an agricultural catchment. Aluminium was slightly elevated above the drinking water limit on one occasion only (26/8/2020) upstream of the site related to background water quality. All other parameters for background quality adhere to the requirements of the Surface Water Regulations' Environmental Quality Objectives and other relevant water quality standards. Total ammonia levels are mostly below these standards. Occasional instances of elevated BOD above the assessment criteria are recorded upstream of the quarry discharge and thus related to background quality.

7.110 The only parameters that exceed the Surface Water Environmental Quality Standards downstream of the discharge are single occurrences of slightly elevated mercury in November 2018 (0.2µg/l) and nickel (125µg/l) in January 2019. The slightly elevated mercury in November 2018 is also seen in the discharge (0.077µg/l), but neither parameter is elevated in samples further downstream at the bridge before Lough Gill, suggesting that the sampling location downstream of the discharge is within the mixing zone of the discharge and not far enough downstream (c. 30m) to represent fully mixed downstream concentrations. Traces of mercury and nickel are occasionally seen in groundwater surrounding the quarry, most likely as a result of either chemical fertilizers in the agricultural lands adjacent the quarry or atmospheric deposition from coal burning – there are no sources of mercury or nickel within the quarry itself.

7.111 Coliform bacteria (including *E.coli*) exceed the Drinking Water Parametric Values both upstream and downstream of the discharge and this is related to poor background bacterial quality in both the stream and in groundwater surrounding the quarry – there are no sources of coliform bacteria within the quarry. Levels of faecal bacteria and ammonia are higher in the upstream samples than the downstream samples which supports the hypothesis that agricultural activity is the dominant influence on water quality in this stream.

7.112 The effect of the quarry discharge is noted downstream of the discharge, with slightly raised conductivity, calcium and sulphate attributed to the residency in the flooded floor because of the inactivity at the site. BOD and orthophosphate levels are acceptable and adhere to the requirements of the Discharge Licence and the Surface Water Regulations. There is no change in water quality between the samples downstream of the discharge and before the stream enters Lough Gill, indicating no impact arising from the quarry and no further discharges downstream.

7.113 Regionally, the status of the Lough Gill lake waterbody is considered to be 'at risk' of not meeting the requirements of the WFD and accordingly Lough Gill is named as one of the 190 Areas of Action identified in the River Basin Management Plan 2018-2021 for better targeting of existing measures and the addition of supplementary measures to prevent deterioration and achieve the WFD objectives for the waterbody. The 'At Risk' status of Lough Gill is for reasons other than the quarry.

7.114 Two biological assessments of the Aghamore Stream were carried out by TMS in September and November 2020 (**Appendix 7-5**). The first biological assessment examined surface water quality upstream and downstream of the quarry discharge, and determined a Q-Value of 3-4 (slightly polluted) for both upstream and downstream of the discharge indicating that the discharge was not having a deleterious effect on the biological quality of the stream. The second assessment looked at surface water quality in the Aghamore Stream at 5 No. different locations and determined a Q-Value of 3 (moderately polluted) for all locations sampled. Note: these determined Q-Values are most likely artificially lower than if the survey was done during April-September due to the absence of the more ephemeral macroinvertebrates which are unlikely to be present in the winter months.

Hydrogeology

Geology

7.115 The geology of the site is discussed in detail in Chapter 6 and by Tynan (2021) in Appendix 7-2.

7.116 In summary, the upland area surrounding the quarry is underlain by thin glacial till deposits overlying bedrock; deep well draining mineral soils have developed over the till, with poorly drained gleys developing in some low-lying areas (**Figure 7-7** and **Figure 7-8**). Gravels occur within the overburden in the shallow valley to the east, between the quarry and the mountains, i.e. within the processing area. The depth to rock varies from c. 2.5-4m below ground level, a thin weathered zone occurs at the top of bedrock (**Plate 7-5, Appendix 7-8**). Bedrock is made up of well-bedded to massive dark grey micritic limestone of the Dartry Limestone Fm. (**Figure 7-9**). Chert bands and 'vuggy' cavities infilled with calcite crystals delineate bedding in the more massive beds (**Plates 7-6 to 7-9, Appendix 7-8**). Colonial corals occur within the limestone beds as isolated concentrations which are laterally discontinuous (**Plates 7-10 to 7-13, Appendix 7-8**).

7.117 Regionally, the site is located on the southern limb of a gentle syncline, whose limbs dip gently c. 5^{o} and whose axis trends northeast-southwest, bounded to the south by a major northeast-southwest trending fault separating the Carboniferous limestones from the Dalradian metamorphic rocks of the Ox Mountains inlier.

7.118 Permeability within the limestones is entirely related to fracturing, there is no primary permeability in the limestone matrix. The dominant structural element within the quarry which influences groundwater flow is the orientation of bedding planes. Examination of quarry faces shows that there is a consistent low dip (8^{o}-18^{o}) on bedding planes across the quarry to the northwest - this agrees with ground lineations seen in aerial photographs on adjacent lands outside the quarry (Figure 7-9). No evidence of the folding suggested by O'Neill Groundwater Engineering in the 2002 EIS was seen on examination of the quarry faces. Sub-vertical joints are present which link groundwater flow along bedding plane fractures in the vertical plane.

7.119 A single large sub-vertical fault is noted in the east of the quarry (**Plate 7-14, Appendix 7-8**) and in the southeast, most likely a continuation of the same fault. The fault zone is linear, trending northwest-southeast, and is clay filled, extending vertically from the top of bedrock to the quarry floor. A small clay-filled channel at the top of bedrock occurs close to the fault which may be related (**Figure 7-10**).

7.120 Site investigation across the processing area has shown >10m of sands/gravels (**Appendix 7-4**). Regional mapping by the GSI indicates these sands/gravels are fan deposits (Aghamore Fan) produced by the melting of ice at the end of the last glacial period.

Regional Hydrogeology

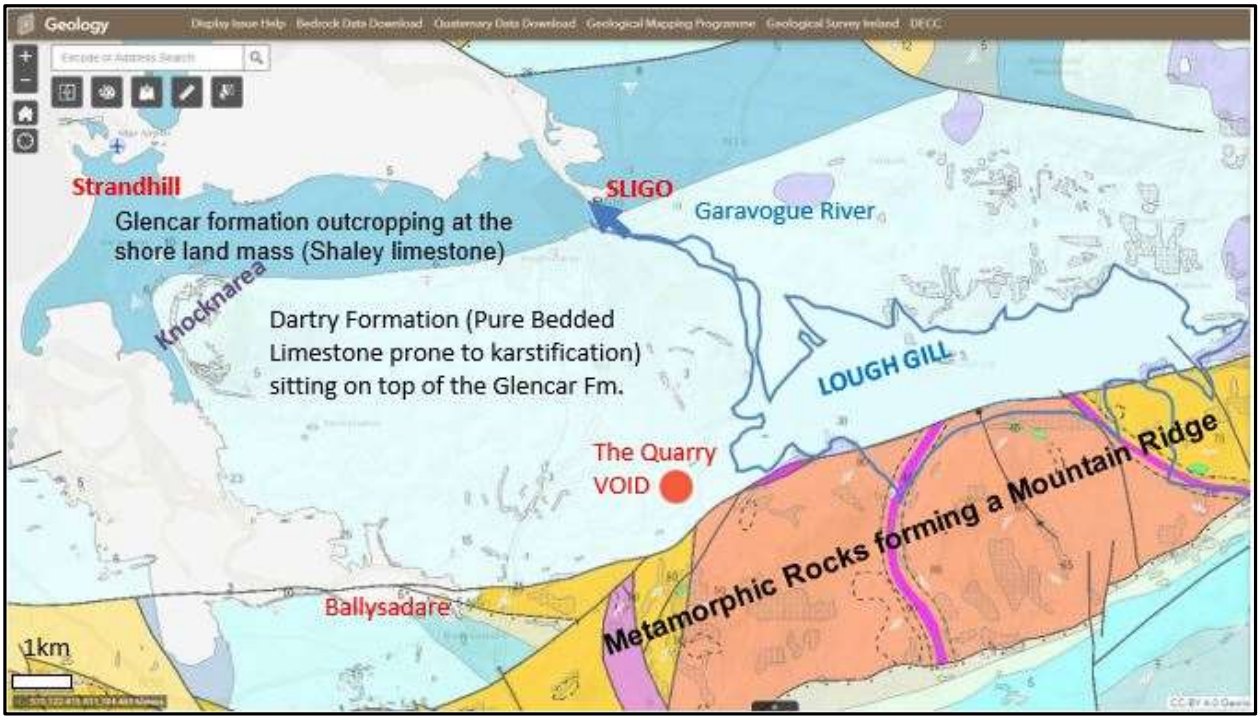
7.121 The regional hydrogeological setting of the site is discussed in detail by Tynan and Bartley (2021) in **Appendix 7-2**.

7.122 Bartley (**Appendix 7-2**) summarises as follows:

"The intensively studied Karst in the peninsula is highly active but relatively shallow compared to

the walls of the void and the floor of the quarry. The regional karst system in Sligo and around the quarry seems to be dominated by its epikarst. For purposes of clarity, epikarst means the weathered top layer of the limestone bedrock and it is in direct contact with the overlying subsoil cover of the landscape over rock. Epikarst is considered a critical link between rainfall and transport of water to the deep aquifer. In the Sligo peninsula the quarry is situated in the south east corner. The peninsula encompasses land from the site, around the western edge of Lough Gill, up northerly to Sligo town, heads west to Strandhill behind Knocknarea, down south to Ballysadare and its bay and back over east to the quarry, the land elevation is generally around 30 – 40m OD and it rises to heights at Knocknarea. Almost all of the quarry sits within the Darty Limestones, which is most probably underlain somewhere at depth with the muddier Glancar limestones. The quarry sits on the boundary of the limestones with the paragneisses of the Killery Mountain band to the South East of the site. Paragneiss is a metasedimentary rock with a gneissic texture; a gneiss is formed by the metamorphism of a sedimentary rock. The geology is better explained in the introduction of Tynan's (2021) report attached. However, simply, the regional structural geology is most easily understood with reference to a pictorial representation of the general GSI mapping for Bedrock for the region, as presented in Plate 7-1, in which I have marked the location of the quarry and Lough Gill. The reason the geology is important is because it controls the karst. You can see from Tynan's Figure 1 for the regional geology and karst that the surface water features are related to the boundaries of the different rock types."

PLATE 7-1 Regional Geology (www.gsi.ie) with Annotations for the purposes of communication



Karst

7.123 Regional mapping of karst features by the GSI has noted karst features (enclosed depressions/dolines, springs, swallow holes) in this bedrock formation further to the west of the site (**Figure 7-11**), however few features are recorded in the immediate vicinity of the quarry. Apex (2021) found no evidence of karst features beneath the floor of the quarry (survey depth to -60m OD).

7.124 The existing quarry provides a large cross-section of the bedrock formation down to a depth of -21mOD but shows little evidence of karst solution features. No karst conduits are present within the quarry. Evidence of solution weathering of fossils within the massive limestone beds has been noted (Section 7.90), however these cavities are not connected and do not form enhanced permeability within the rock. Examination of quarry faces and the results of the geophysical investigation (**Appendix 7-6**) show a thin (c. 5-10m) weathered zone at the top of bedrock (epikarst) across the quarry area.

7.125 A desk survey of potential karst features in the vicinity of the quarry was undertaken as part of the Phase II investigation and very few features are identified (**Appendix 7-12**); the probable turloughs to the north and northwest of the quarry are the most significant features in the vicinity.

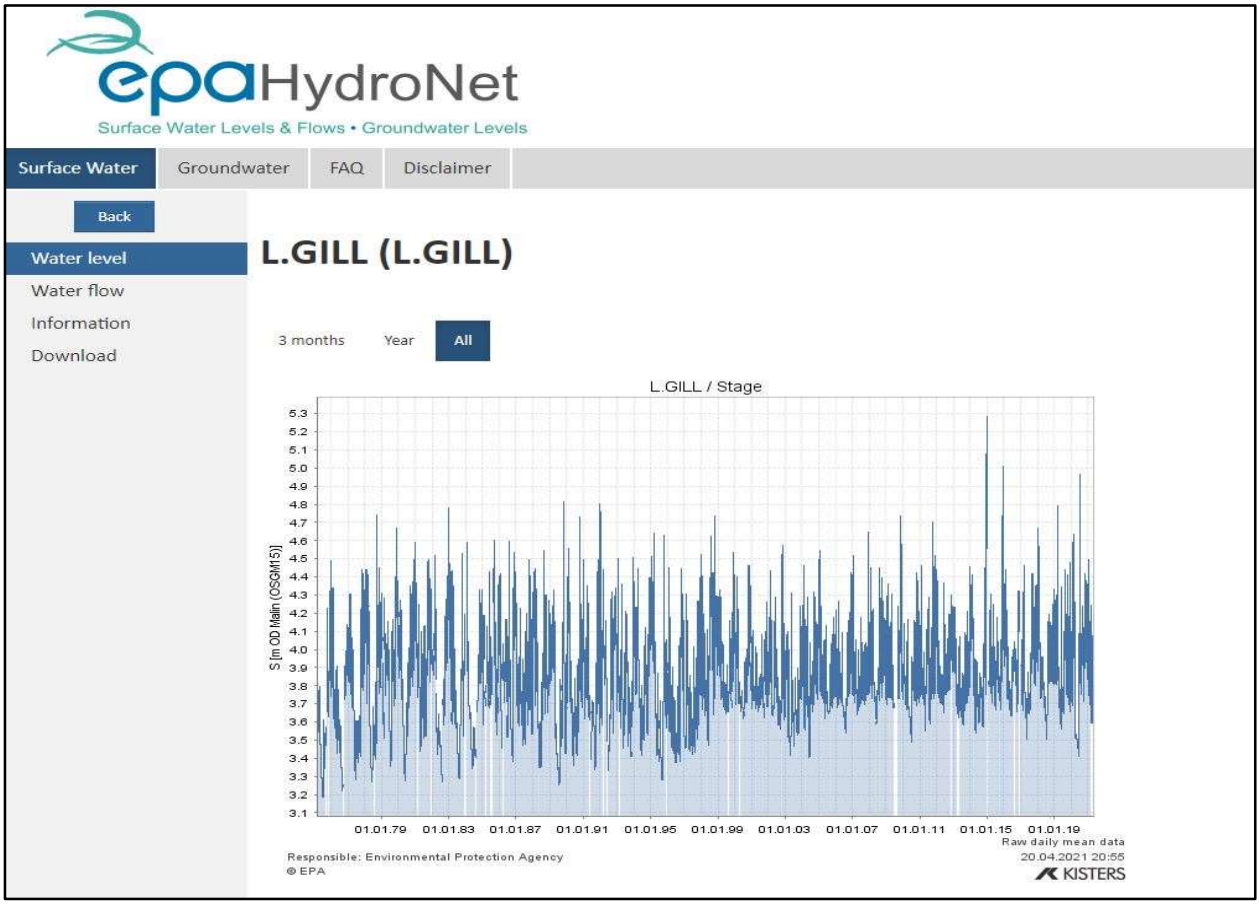
7.126 In response to Irish Waters request that the site evaluate the potential for karst in more detail, Tyan's work in the area was evaluated in detail. Bartley (**Appendix 7-2**) summarises as follows:

"With reference to the significance of the Karst, there is only one swallow hole system in the entire peninsula, located centrally in the Dartry formation (Refer to Tynan's Figure 1, 2021). Tynan refers to there being two adjacent swallow holes 'Ballyfree' and the GSI has this mapped as the 'Tonafortes Sink'. The mouth of this sink at the land surface has an elevation of 20mOD, approximately. Tynan's detailed studies of the rainfall response of the regional karst system includes, amongst much more fieldwork, continuous quantification of the volume of water flowing into Ballyfree (swallow holes) and relating it to concurrent rainfall and continuous monitoring of the spring discharges at Tobernaveen (15mOD, approximately) and Carrowbodogagh (5m OD approximately) [Diagram 1 and Figure 3 Tynan, 2021]. That underground flow goes in opposite directions from Ballyfree: to the NW and the SE and discharges from the Tobernaveen and Carrowbodogagh Springs, respectively. The discharge responses at the springs are rapid and therefore suggests that a relatively shallow, rainfall dominated, epikarst system plays a massive role in the hydrogeology of the area immediately west of the quarry. Tynan's Diagram 1 (2021, Appendix 7-2 to this Water Chapter) annotates the regional conceptual flow system with flow arrows for epikarst and deep karst flows. The 'deep' flows depicted, which Tynan refers to as conduit, are above the 0mOD elevation.

It was therefore a long time ago that the original perimeter ground level at the quarry was brought from 30mOD, approximately, to its current floor elevation at -21mOD. It was a long time ago that excavations at the quarry at Aghamore had potential for interception with the known, well studied (Tynan 2017 – 2018), active, often conduit type, active epikarst zone from 20mOD at surface to 0mOD at discharges. The floor's void is now at -21mOD. It is therefore suggested that the time for

big water strikes has long passed. Long ago is the time when impact would have been experienced if it were a thing. The EPA Hydrograph for 50 years of Lough Gill's water levels tell no story of any impact at any time (Plate 7-2)."

Plate 7-2 Lough Gill's Water Level Elevation (EPA HydroNET Stn. 35073): 1971 to 2021



Aquifer Classification

7.127 The Dartry Limestone Fm. is mapped regionally by the GSI as a Regionally Important Karstified Bedrock Aquifer, dominated by conduit flow (Rkc)(**Figure 7-12**).

7.128 The gravels in the shallow valley underlying the process area, to the east of the quarry void, are not classified by the GSI as an aquifer, due to the limited extent of the deposit (0.53km^2). Regionally Important Gravel Aquifers usually cover an area of >10km^2 and Locally Important Gravel Aquifers usually between 1-10km^2. Groundwater in the gravels is believed to be in hydraulic continuity with groundwater in the limestone bedrock and discharges to Lough Gill to the northeast.

7.129 As part of the implementation of the Water Framework Directive (WFD) in Ireland, Groundwater Bodies (GWBs) were delineated across the entire country. The GWB is the management unit under

the WFD necessary for the subdivision of large geographic areas of aquifer in order for them to be effectively managed. Similar to the surface water catchments, the quarry straddles the boundary of two GWBs: the Carrowmore West GWB to the west, and the Carrowmore East GWB to the east (**Figure 7-13**). A detailed description of the GWBs is provided in **Appendix 7-13**.

Aquifer Characteristics

7.130 Yields from boreholes in regionally important bedrock aquifers are typically >400m^3/d (4.6l/s). Yield tests on the boreholes drilled as part of this assessment were orders of magnitude lower than this (3-49m^3/d), the only exception was MW3 which hit significant groundwater inflows in a collapsing fracture zone (c. 400m^3/d) which may/may not have been laterally continuous. The significant inflow was noted at an elevation of -24.5mOD and the collapsing fracture zone was encountered at an elevation of -33.5mOD where the borehole was terminated. MW3 is located c. 150m to the northeast of the quarry void (see **Figure 7-1**) within the zone of drawdown surrounding the quarry void.

7.131 Yields within the limestone bedrock (below the epikarst) tended to increase gradually with depth once below the level of the water table (**Appendix 7-14**), suggesting the permeability is not related to a single flow-zone but a diffuse flow through fractures.

7.132 Two rotary cored boreholes (MW10c and MW11) were drilled to recover rock core and measure the permeability of the limestone at different intervals with depth (packer tests). The core results show a consistently high fracturing with depth (average fracture index of 5 fractures per 1m of core) and packer tests suggest a consistently low permeability with depth (**Appendix 7-15**) which indicates the absence of individual high-flowing fractures within the cored boreholes and the predominance of diffuse fracture flow within the deeper limestone. The packer tests were carried out during coring; once a 9m interval had been cored the coring assembly was withdrawn and the interval sealed and tested using a single inflatable packer. Results show a median permeability of 1.66 x 10^{-6}m/s (0.143m/d) for MW10c and 8.85 x 10^{-7}m/s (0.076m/d) for MW11. These permeabilities are not suggestive of karst conduit groundwater flowpaths. The slow recovery of water levels in the monitoring wells following groundwater sampling (e.g. MW4, MW10c) also suggests low permeability. Therefore, although bedrock at the site is classified regionally as a regionally important aquifer, evidence from the site investigations undertaken indicate that locally in the Aghamore area the limestone is of low permeability with poor well yields.

7.133 Groundwater inflows into the quarry are delineated by calcium-carbonate deposits on the quarry faces (yellow-white staining). Inflows tend to be diffuse through a network of bedding and joint planes, with more seepage in some areas than others (fracture controlled).

7.134 Shallow groundwater inflows to the quarry from the epikarst zone (c. top 5-10m of bedrock) are noted in 3 No. locations in particular within the quarry: the northwest corner (**Plates 7-15 to 7-17, Appendix 7-8**), the northeast corner (**Plates 7-18 and 7-19, Appendix 7-8**) and the southwest corner (**Plate 7-20, Appendix 7-8**). These locations are indicated on **Figure 7-14**.

7.135 One groundwater inflow was noted on the quarry floor at the base of a quarry wall (**Plate 7-21, Appendix 7-8**); the inflow was elongate and is resultant from flow along bedding planes rising into the quarry void. It is not believed to be connected to the fault in the east of the quarry as it does not fall along the trend of the fault.

7.136 The drawn-down water table level behind the quarry face occurs within the bottom 5-10m of the existing quarry floor. Temporary seepages are noted higher than this in the quarry faces and this

related to rainwater that has infiltrated through the overburden in the areas adjacent the quarry and is flowing along bedding planes above the saturated zone into the quarry (i.e. recharge). Observations during site visits note relatively strong seeps higher up in the quarry faces in the days following heavy rainfall; these seeps progressively 'switch off' in vertical order during prolonged dry spells and reflect shallow recharge and seepage from the epikarst. These observations concur with the region's groundwater flooding experiences studied and reported by Tynan (2021) (**Appendix 7-2**).

Water Balance

7.137 A water balance has been carried out to estimate the quantity of groundwater input to the quarry over a period of time of falling water levels in the quarry lake (**Appendix 7-16**). Total inputs of water to the quarry void (rainfall, runoff, epikarst inflow, deeper groundwater inflow) have been compared with total outputs (pumping, evaporation), plus changes in storage within the flooded floor of the void. The groundwater component was estimated by iteration to balance inputs/outputs.

7.138 The main inputs of water to the floor of the quarry are rainfall/runoff and drainage from the epikarst; the stormwater catchment and epikarst drainage catchment to the quarry is shown in **Figure 7-14**. The epikarst drainage catchment is estimated based on topography as the epikarst appears to mirror topography. This is clearly presented in Tynan's Cross- Section (Tynan 2021, **Appendix 7-2**).

7.139 The results of the water balance indicate that, for the period considered (26th January to 9th April 2021), the largest input of water to the quarry was from direct rainfall/runoff (71%), with indirect drainage via epikarst accounting for 19%, and deeper groundwater inflows making up only 10%. (Appendix 7-16).

Groundwater Vulnerability

7.140 The vulnerability of groundwater to potential contamination from surface activities is related to the ease with which water moves vertically down from the surface to either the water table (if within the bedrock) or top of rock (if overlying subsoils are saturated). Groundwater vulnerability is largely driven by the permeability and thickness of the subsoils overlying bedrock. Groundwater vulnerability has 4 categories: Extreme, High, Moderate and Low.

7.141 GSI regional mapping of groundwater vulnerability is indicated in **Figure 7-15**. The area of the quarry where rock has been exposed at the surface is categorised as extremely vulnerable (i.e. no protection from potential pollution), all other areas are categorised as highly vulnerable due to the thin cover of moderately permeable subsoils; site investigation results indicate cover of 2.5 to 4m.

Groundwater Recharge

7.142 A methodology for making initial estimates of groundwater recharge in Ireland was developed by the GSI on a regional scale by first calculating the effective rainfall (rainfall minus evapotranspiration) and then applying a recharge coefficient to indicate the proportion of the

effective rainfall that recharges groundwater. The recharge coefficient is mainly determined by the permeability and thickness of the overlying superficial deposits (subsoils) as well as the ability of the underlying aquifer to accept the percolated water. Groundwater recharge mapping is therefore closely linked to vulnerability mapping.

7.143 The GSI groundwater recharge map for the area (**Figure 7-16**) would suggest an annual rate of recharge of 542mm/year for the upland surrounding the quarry, based on an effective rainfall of 903mm/year, a recharge coefficient of 60% and no recharge cap for the aquifer.

7.144 GSI mapping presents rainfall, effective rainfall and groundwater recharge values for the country. The GSI database for the quarry void site suggests as follows:

Table 7-1 Recharge Details (GSI)

Effective Rainfall	829.2
Recharge Coefficient (%)	85
Average Recharge (mm/yr)	705
Recharge Cap Apply	N
Subsoil description	Bedrock outcrop and subcrop
Groundwater Vulnerability	Extreme (X)
Groundwater Vulnerability description	Rock at or near Surface of Karst
Hydrogeological Setting Description	E Vul: Areas where rock is at ground surface or karst feature
Bedrock Aquifer Category	Rkc
Bedrock Aquifer Description	Regionally Important Aquifer - Karstified (conduit)
Rock Unit Group	Dinantian Pure Bedded Limestones

7.145 The GSI database for the area's surrounding the site as follows:

- To the immediate north and east of the site: groundwater recharge ranging from 474mm/yr to 498mm/yr;
- In the mountains to the south, which are classified as Poor Aquifer - Bedrock which is Generally Unproductive, Precambrian Quartzites, Gneisses & Schists, despite 805mm/yr rainfall mapped by the GSI, only 100mm is assigned to groundwater recharge. Therefore, 705mm is determined to be lost to evaporation, evapotranspiration and runoff from land and to watercourses.

- In the Glaciofluvial sands and gravels, whilst Effective Rainfall is mapped to amount to between 729mm/yr and 829 mm/yr, groundwater recharge is mapped to range from 671mm/yr to 701mm/yr.

7.146 Thus, the information available conveys the complexity of meteorological interaction with the various hydrogeological environments at and surrounding the site.

Groundwater Abstractions

7.147 The area surrounding the quarry is rural, with occasional farms and ribbon development of once-off houses along secondary roads. Sligo County Council has confirmed that the area is served by a mains water supply (**Figure 7-17**), with each of the public roads surrounding the quarry having its own water main; a well survey in the area was also completed. Most private houses in the area are built within the last 10-20 years and are connected to the mains water supply.

7.148 GSI well records are indicated on **Figure 7-18** and do not show any wells in the vicinity of the quarry, and there is no record of any groundwater sourced public supply or group scheme source protection area in the immediate vicinity of the quarry. As previously stated, it is Lough Gill surface water rather than groundwater that is the regional water supply source for Sligo (Foxes Den) and Leitrim (Moneyduff).

7.149 An updated survey of private wells within 1km of the quarry was carried out as part of the Phase II investigation and shows very few wells; the only private wells identified are indicated in **Figure 7-19**.

7.150 The closest well to the quarry was a disused farm well located on lands owned by a third party just south of the quarry site boundary, however the owner has confirmed that this well is now removed and his farm is served by the mains water supply.

7.151 Cemex (previous quarry operators) are reported to have installed a water supply well in the processing area. The well is not accessible, no information can be verified, it is reported it was used by Cemex for non-potable uses.

7.152 A pumphouse owned by Mr. Seamus McDaniel is located across the road from the entrance to the Top Coast Oil depot, c. 360m northeast from the quarry void. This pumphouse abstracts surface water from the Aghamore Stream via a pipe culvert, and therefore is not a groundwater abstraction.

7.153 The only other private wells identified in the area were a pumphouse c. 300m to the west of the quarry void owned by Mr. Noel Ward who confirmed that this well is not in use/inaccessible, and an old historic well-located c. 400m to the north of the quarry owned by the Mullane's who also confirmed that the well is not in use/inaccessible.

Groundwater Levels

7.154 Baseline groundwater level monitoring was provided in the 2002 EIS relating to the quarry, where groundwater levels were measured over a 4-month period in 5 No. shallow monitoring wells within the quarry area. These shallow monitoring wells have since been destroyed, however the 'Old Well' monitored in the most recent investigation is likely to be BH5 from the 2002 EIS work.

7.155 For the Phase I site investigation, groundwater levels were monitored in the 9 No. new deep monitoring wells (MW1-MW9) and also in the 2 No. rotary cored boreholes (MW10c and MW11) – refer to **Figure 7-1**. These monitoring wells were drilled to the level of the proposed deepening of the existing quarry (-50mOD) in order to investigate the depth of groundwater circulation which was previously unknown. Boreholes were completed as open-hole completions, therefore groundwater levels measured are an average of all groundwater inflows across the epikarst and deeper bedrock response zones.

7.156 In addition, one old shallow monitoring well was discovered during site visits which was included in the monitoring (this monitoring well is most likely BH5 from the 5 No. monitoring wells installed by O'Neill Groundwater Engineering in 2000).

7.157 Dataloggers (Levelogger Edges) were installed in eight boreholes to provide continuous groundwater level-monitoring and better characterise the hydrogeology in the bedrock. Groundwater levels were also measured manually by dipmeter on site visits. Difficulties were encountered making manual measurements of groundwater levels in a number of boreholes following heavy rain due to cascading water from a shallow level in the bedrock into the borehole (e.g. MW2, MW10c – epikarst drainage). Some boreholes were completed open-hole from the conductor casing to the bottom-of-hole, and therefore percolating rainwater could 'short-circuit' the normal percolation path and cascade into the open borehole.

7.158 For the Phase II site investigation, additional monitoring of groundwater levels was carried out in the shallow boreholes drilled on the northern quarry margin (MW18, MW19), as well as the new monitoring wells installed in the processing area.

7.159 A record of manually measured groundwater levels and continuously monitored levels is presented in **Appendix 7-17**. The information demonstrates that all wells react uniquely, which is expected of a karst system, and the water levels show rapid response to rainfall, which reflects the significance of the epikarst.

7.160 Groundwater levels in the immediate vicinity of the quarry are lowered due to the presence of the quarry. The current quarry floor level is below the water table therefore groundwater in the surrounding bedrock drains under gravity into the quarry void, lowering groundwater levels in the vicinity of the quarry ('drawdown'). The drawdown and distance of influence of the quarry on groundwater levels is discussed in detail in Section 7.224.

7.161 Groundwater levels around the quarry show a seasonal fluctuation of c. 4-8m, best seen in the levelogger records for MW6 and MW7. Groundwater levels in MW6 vary seasonally from c. -6mOD to 2mOD; groundwater levels in MW7 vary seasonally from c. -8mOD to -3mOD (Note these monitoring wells are within the zone of influence of the quarry and are subject to drawdown).

7.162 Percolating water cascading into the open boreholes following heavy rain is a regular feature in the monitoring record from the Leveloggers; this water has infiltrated the soils/subsoils and is slowly percolating down through the unsaturated zone in the bedrock. This would not normally occur (i.e. the borehole itself creates a short cut), therefore the raised groundwater levels following storm events are not representative of the piezometric level down deeper in the aquifer. This artificial 'sump' behaviour is more marked in the less permeable boreholes (MW2, MW10c) with rapid rises immediately following rainfall events. Damped oscillations in water levels are seen with rapid rises in some monitoring wells (e.g. MW4), this is due to the inertia of the long water column in the boreholes.

7.163 As part of the Phase II site investigation, 2 No. shallower monitoring wells were installed next to MW7 on the northern quarry margin, MW18 and MW19 – see **Figure 7-1**. MW7 was drilled to 80m, MW18 was drilled to 40m and MW19 was drilled to 20m. Monitoring of groundwater levels in these monitoring wells shows only a small downward vertical gradient below the water table (i.e. between MW18 and MW7), and the development of a temporary saturated zone in the epikarst during extended wet periods – see **Figure 7-20**.

7.164 Monitoring of groundwater levels during prolonged dry spells shows steps in long recessions, with changing recession slopes (e.g. MW1, MW10c) suggesting zones of slightly different permeability within the bedrock, most likely related to varying transmissivities of the bedding planes.

7.165 Evidence of individual fractures controlling rising or falling groundwater levels was seen in the monitoring record for MW2 and MW4; filling of fractures on a rising water table or draining of fractures on a falling water table suspends the water level for a time at the level of the fracture.

7.166 Small-scale regular fluctuations of groundwater levels in the order of 2-4cm were noted in some wells after barometric compensation (e.g. MW8); these fluctuations are not as a result of nearby groundwater pumping but are known as Earth Tides. Earth Tides are related to the position of the Moon and the slight changes in pull exerted by the Moon on the aquifer. The fluctuations are sinusoidal and cyclical, being stronger at New Moon and Full Moon.

7.167 Groundwater levels in the processing area are shallow, the exact depth to the water table varies depending on the ground elevation which varies across the area. Water strikes during the drilling of groundwater monitoring wells in the processing area were typically 6 metres below ground level. Groundwater was encountered between c. 1-5m below ground level depending on location during the monitoring period October 2020 to March 2021.

Groundwater Flow Direction

7.168 Regionally, groundwater flow would be expected to generally follow topography similar to the surface water catchments. Groundwater to the east of the quarry might be expected to discharge to Lough Gill, and groundwater to the west of the quarry might be expected to discharge towards the southwest and the coast (Ballysadare Bay) (**Figure 7-21**). However, local deflections do exist and topographical anomalies control groundwater discharge and directions in some parts of the catchment (Tynan, 2021, **Appendix 7-2** Figures 1, 2, 3).

7.169 A groundwater divide would have existed across the quarry site before the quarry was developed, this now would be shifted slightly to the west of the quarry due to the drawdown caused by pumping of groundwater from the quarry. The upland area surrounding the quarry would be considered a recharge area, and therefore a vertical component to groundwater flow would be expected due to the effects of elevation and recharge (**Figure 7-21**).

7.170 When groundwater levels measured during dry weather (without the influence of recharge in the boreholes) are plotted spatially, radial drawdown is apparent towards the quarry void (**Figure 7-22a**) which is clear from the monitoring data.

7.171 The groundwater flow direction across the processing area is generally towards the north and Lough Gill (**Figure 7-22b**); some natural minor discharges from the subsoils to the Aghamore Stream is expected from the sands and gravels.

Groundwater Quality

7.172 A total of five rounds of groundwater samples have been collected from the monitoring wells installed as part of the Phase I and Phase II site investigations. Samples were analysed for a wide range of parameters: field parameters, whole-sample parameters, major ionic content, minor constituents, trace metals, hydrocarbons and bacteria. The results are presented in **Appendix 7-10**.

7.173 When the major ions are plotted on a Piper Diagram (**Figure 7-23**), the relative proportions of the ions are shown to be very similar between the wells and between sampling rounds. This is typical of groundwater that is in connectivity. The groundwater is classified as a Calcium-Bicarbonate type groundwater, typical of shallow limestone aquifers.

7.174 No significantly elevated parameters were detected in the samples, other than faecal bacteria indicating recent faecal pollution. Elevated concentrations of faecal coliforms were detected at different times in MW5, MW6, MW7 and MW10c to the north of the quarry (agricultural grazing land), and in MW1, MW3 and MW11 to the east of the quarry (agricultural grazing land). Low levels of Total Ammonia and Orthophosphate above the laboratory detection limit but below water quality standards were detected sporadically in the samples, typical of rural land use. Total Ammonia exceeded the groundwater threshold value in only 2 samples (MW2, MW8), and Orthophosphate exceeded the groundwater threshold value in 1 sample (MW6).

7.175 With respect to compliance with the Groundwater Regulation Threshold Values, on most occasions, samples were compliant.

7.176 The new monitoring wells in the processing area were sampled on one occasion (October 2020) and elevated concentrations of Orthophosphate were detected in all wells in this round, with elevated Total Ammonia, Nitrite and coliform bacteria also detected. These samples were high in suspended sediment due to the silty sands the standpipes were installed in and it is likely the Orthophosphate results are artificially elevated due to interference of sediment in the samples with the laboratory analysis method. The elevated Total Ammonia, Nitrite and coliform bacteria are detected upgradient and downgradient of the processing area and are likely to be related to poor background groundwater quality; there are no sources of Total Ammonia, Nitrite or coliform bacteria within the application site.

7.177 Regionally, the Carrowmore East GWB is considered ‘at risk’ of not meeting the requirements of the WFD; the most significant pressure on the GWB is the impact of forestry on groundwater. The groundwater quality status in the GWB was ‘Good’ in the last assessment cycle (2013-2018).

Potential Sources of Groundwater Pollution

7.178 Land use immediately surrounding the quarry is predominantly agricultural (grazing), with a few small farms and ribbon development, which are likely to be served by on-site domestic wastewater systems, along local roads.

7.179 Given that groundwater is highly vulnerable to potential pollution due to the thin cover of moderately permeable subsoils, it is quite likely that the background groundwater quality entering the quarry is linked to agricultural activities (e.g. grazing animals, land-spreading, fertilizer

application). The quality of groundwater observed from monitoring wells on site reflects the agricultural land use of the lands surrounding the quarry.

7.180 An oil storage facility (Top Coast Oil depot) is located to the north of the processing area on the adjacent property. This facility is hydraulically upgradient of the processing area and any potential source of groundwater pollution on that site is unlikely to affect groundwater within the application site.

7.181 An area of land surrounding Lough Nameenbrack was recently infilled and developed for industrial use by third parties, this infilled area has the potential to affect surface water and groundwater quality upstream/upgradient of the site. TMS has recently carried out surface water sampling of the Aghamore Stream upstream and downstream of this infilled area and no impact on surface water quality has been identified (**Appendix 7-11**). No impact on groundwater quality has been observed in the monitoring wells located at the southern end of the processing area (MW17, MW22, MW23 – see **Appendix 7-10**) therefore this infilled area is not of concern as a potential source of groundwater pollution.

7.182 A Certificate of Registration was granted by Sligo County Council to Mullane Plant Hire Ltd in 2018 for a soil and stone recovery operation adjacent to and immediately south of Lough Nameenbrack (COR No. COR-SO-18-001-01). The operation involves the infilling of a 1.3ha site with inert soil and stone (100,000 tonnes) over a five-year period (20,000 tonnes/year) for the benefit of agricultural land. Similar to above, no impact on surface water and groundwater has been noted upstream/upgradient of the application site in recent monitoring, therefore this operation is not of concern as a potential source of groundwater pollution.

Conceptual Model

7.183 The conceptual site models for the site and surrounding area is presented diagrammatically in **Figure 7-24a** and **Figure 7-24b**.

7.184 The existing quarry is below the water table and there is local drawdown draining groundwater into the quarry void. Outside the zone of influence of the quarry, groundwater to the west of the quarry discharges towards the southwest and the coast (Ballysadare Bay), groundwater to the east of the quarry discharges towards the northeast and Lough Gill.

7.185 During wet periods, a temporary saturated zone develops within the epikarst and this can drain laterally following the topographic gradient. During extended wet periods, the storage capacity of the epikarst is temporarily exceeded leading to ephemeral springs or seepages further down-slope and flooding of surface depressions in the lowlands (groundwater flooding).

7.186 The Aghamore Stream all but dries up in prolonged dry weather, indicating it is above the water table in summer; flow monitoring during the winter suggests a level of baseflow to this stream, with most baseflow likely to come from the adjacent sands and gravels deposits underlying the processing area.

Sensitive Receptors

7.187 Designated sites surrounding the quarry are shown in **Figure 7-25**.

7.188 The most sensitive potential receptor in the vicinity of the quarry is Lough Gill. Lough Gill is a designated Special Area for Conservation (SAC), it is a source of drinking water for Sligo town and its environs (Foxes Den Water Treatment Plant), Leitrim (Moneyduff) and it is also a popular lake for fishing.

7.189 Lough Gill was designated as a SAC due to the presence of four habitats listed on Annex I of the Habitats Directive (Natural Eutrophic Lake, Orchid-rich Calcareous Grassland, Old Oak Woodlands, Alluvial Forests), including two with priority status, as well as a number of listed species (White-clawed Crayfish, Sea Lamprey, Brook Lamprey, River Lamprey, Atlantic Salmon and Otter). The raw water for the Foxes Den treatment plant is abstracted from Lough Gill 3km southeast of Sligo town and pumped at a rate of c. 550m^3/hour to the main treatment works. The Foxes Den Water Treatment Plant (WTP) is designed to treat and supply up to 11,000m^3/d and the North Leitrim Moneyduff WTP is designed to treat and supply up to 3,600m^3/d (Mr. Des Joyce, Irish Water, *pers.comm.,* 2021).

7.190 There is a direct hydrological (surface water) connection between the site and Lough Gill SAC via the discharge from the quarry. This hydrological link is regulated by DL(W)151 and the conditions of that discharge licence specify measures to control the link and protect the target.

7.191 There is an indirect hydrological link (surface water) connection between the site and Cummeen Strand SPA, Cummeen Strand/Drumcliff Bay SAC which is located downstream of Lough Gill. Given that Lough Gill occurs upstream of Cummeen Strand, if the assessment of impact finds no impact on Lough Gill then Cummeen Strand would also not be impacted.

7.192 There is a direct hydrogeological (groundwater) connection between the site and Lough Gill, as groundwater from the eastern half of the site discharges to Lough Gill (see **Figure 7-21**).

7.193 There is also a direct hydrogeological (groundwater) connection between the site and Ballysadare Bay SAC to the west, as groundwater from the western half of the site discharges to Ballysadare Bay – however given the distance to Ballysadare Bay (c. 3.3km), the size of the catchment to Ballysadare Bay and the very small groundwater abstraction rate from the quarry, Ballysadare Bay SAC is not considered a potentially sensitive receptor for the proposed development.

7.194 The quantitative impact of abstracting small volumes of groundwater from the two groundwater bodies (GWBs) that the quarry straddles is considered to be negligible as these GWBs are not identified as being under pressure from abstractions. There are few local groundwater abstractions, and no known large-scale groundwater abstractions elsewhere in these two groundwater bodies that would put these groundwater bodies under pressure of over-abstraction.

7.195 The potential significance of the quarry abstraction on the water balance for the two GWBs concerned and surface water features has been assessed by Hydro-G in **Appendix 7-2**. In summary,

- the potential maximum, licensed, discharge from the quarry is calculated as c. 1,277,500m^3/yr;
- the recharge to the Carrowmore East GWB is calculated as c. 31,900,000 m^3/yr, the recharge to the Carrowmore West GWB is calculated as c. 20,350,000 m^3/yr, therefore the recharge to the entire underlying Regionally Important Karst Aquifer is c. 59,950,000 m3/yr;

- the calculations show that the volume of water discharging from the quarry (1,277,500m^3/yr) is a small proportion compared to the 32 million or 20 million m^3/yr going into the local GWBs or the 59.9 million m^3/yr entering the regional aquifer by rainfall recharge;
- the volume of water discharging from the quarry accounts for 6% of the recharge to the underlying Carrowmore West GWB, 4% of the recharge to the underlying Carrowmore East GWB, and 2% of the total recharge to the regional aquifer. WFD Guidance document GW5 (2004) indicates that where a groundwater abstraction constitutes 2-10% of the recharge to a river or large lake there is low potential for impact, therefore the quarry abstraction is unlikely to affect either the water balance of the two GWBs or surface water features in connectivity with those GWBs.

IMPACT ASSESSMENT

Assessment Methodology

7.196 The description and assessment of potential impacts and effects on the water environment follows current guidelines and advice notes provided by the EPA on Environmental Impact Assessment (2002 and 2003), as well as draft EPA guidelines (2017) and guidelines provided by the Institute of Geologists of Ireland (2013).

7.197 There is a difference in definition between 'impact' and 'effect', although in some guidance the terms are used interchangeably; in this chapter, impacts are defined as the changes resulting from the project, or an action associated with the project, and effects are defined as the consequences of impacts.

7.198 The impact assessment focuses on the likely, significant effects of the proposed development on the water environment. 'Likely' effects are those that are planned or reasonably foreseen to be inevitable consequences of the normal construction and operation of the development.

Framework for Description of Potential Impact

7.199 The statutory criteria for presenting the characteristics of potential effects requires consideration of the magnitude, spatial extent, nature, transboundary nature (if applicable), intensity, complexity, probability, expected onset, duration, frequency and reversibility, cumulation of the impact and possibility of effectively reducing the impact (Annex III (3) of Directive 2014/52/EU).

7.200 The criteria and associated terminology used for describing potential effects in this chapter follow those recommended in the draft EPA guidelines (2017), with the exception of 'significance' which follows the criteria/terminology in guidelines provided by the Institute of Geologists of Ireland (2013).

7.201 With respect to the EPA's (2017) structure for description of the Impact, the descriptive criteria Tables employed are presented in full in **Appendix 7-18**. The EPA Impact assessment structures the

framework by full description of the type of Impact, which can be 'Positive, Neutral or Negative/Adverse' (Quality) and outlines other further qualifiers describing the Impact including 'Duration', 'Probability' and 'Extent'. Refer to **Table 7-1** to **Table 7-5, Appendix 7-18**.

Framework for Assessment of Potential Significance of Effect

7.202 The significance of potential impacts on geological, hydrogeological and hydrological sensitive receptors was estimated by implementing an assessment as per the Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes, NRA (2008) and the Guidelines for the Preparation of Soils, Geology & Hydrogeology Chapters of Environmental Impact Statements, IGI (2013). Those assessment frameworks require input of the Project's groundwater and geological type attributes and measures to determine the magnitude of the impact on the attribute. The NRA's (2008) Framework Assessment Tables employed in this assessment are presented as **Table 7-6** to **Table 7-10, Appendix 7-18**.

Do-nothing Scenario

7.203 If planning permission was not approved for the proposed development, pumping of water from the quarry floor would cease and the quarry void would flood to approximately the level of the surrounding water table. There is no plant and equipment located within the quarry void and therefore there are no sources of potential contamination remaining. Similarly, there is no plant and equipment located within the processing area and therefore no sources of potential contamination.

7.204 The quarry void's waters are primarily recent rainfall and epikarst contributions to the exposed walls. Therefore, abandonment of the site and cessation of the licensed dewatering (2020) would have a temporary negative effect for the time taken for the void's water levels to rise from their current -20m OD, approximate, elevations to the level of the epikarst (0m OD to 20m OD) and re-establish the site's function in the regional hydrogeological regime.

7.205 The pumping of water from the void and consequent licensed (2020) discharge of water from the quarry to the Aghamore Stream maintains the regional hydrological and hydrogeological regime and augments the low flows in the stream, especially during dry weather. The slight positive impact of this augmented flow on aquatic life along the stream would be lost if activities at the quarry were to discontinue.

Description of the Likely Impacts

7.206 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 application site lies within the existing quarry void and adjacent processing area, and when considered as a cumulative site, will be of moderate to large size. The site is therefore considered to be an attribute of high importance. 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.

7.207 The Aghamore River receives the discharge from the site and also forms a boundary between the hard rock quarry working area to the west of the local road and the processing area to the east, which is underlain by sand and gravel deposits. The Aghamore River is therefore a receptor, which is labelled in the EPA River Basin teams as the GARAVOGUE_010 and it is classified as Poor Status (IE_WE_35G010200). The GARAVOGUE_010 is a river within the WFD Cycle 2 'Catchment Sligo Bay & Drowse', Subcatchment Bonet_SC_030 (Code 35_10) and the sub catchment report available at https://catchments.ie/ presents the known pressures and risks for the GARAVOGUE_010 as Forestry, Road Runoff and Wastewater. The EPA do not mention the quarry in their itemisation of risks and pressures in the catchment. This is unlikely to be an oversight because the Local Authority Water Programme team (LAWPRO) is essentially a Local Authority staff moved over to EPA catchment assessment assistance. Therefore, the Sligo County Council, as the Local Authority, is fully aware of the quarry and robustly assessed its potential impacts in the procedure resulting in the recent grant of Discharge Licence DL (W)151 (2020) to the current operators and proposers of further workings at the site.

7.208 Lough Gill SAC is a potential receptor. Lough Gill SAC is 765m downstream of the quarry discharge point. Given the importance of Lough Gill as a SAC and a Public Water Supply for Sligo and North Leitrim, the significance of this local attribute is noted.

7.209 Groundwater is a receptor. The area proposed for the deepening of the current void is mostly in the GSI mapped Carrowmore West Groundwater Body (IE_WE_G_0040) and the access roads and boundary screening berms are underlain by the GSI mapped Carrowmore east Groundwater Body (IE_WE_G_0042). Both mapped groundwater bodies are classified as Good Status 2013 to 2018 (EPA envision map series https://gis.epa.ie/EPAMaps/Water). Of the total quarry void area on the west side of the local road, 110,000m^2 is mapped as being in the Carrowmore West Groundwater Body and the access road to the void and its associated screening berms occupy 50,000m^2, approximately, of the Carrowmore East Groundwater Body.

Potential Impacts

7.210 The assessment of potential impacts from the proposed development is presented in **Table 7-2**, using the headings discussed under the Framework Methodologies' criteria for determination of impacts (EPA, 2013 & NRA, 2008 as presented in **Appendix 7-18**). The main anticipated impact associated with the proposed deepening of the quarry, in relation to hydrology and hydrogeology, relates to the potential contamination of groundwater from quarrying activities or impacts on quantitative status arising from dewatering and the subsequent risk posed to Lough Gill SAC as an ecological resource and a source of water supply, which is the ultimate receptor of intercepted waters arising at and discharged from the site.

7.211 In the year 2020, Sligo County Council granted the site a justifiable and defensible Discharge Licence DL(W) 151. In the 2019 to 2020 evaluation of the site, Sligo County Council assessed the potential for the site's discharge to be safely assimilated in the Aghamore Stream with no potential for impact on Lough Gill SAC. Information presented for the site and the assimilation capacity simulations justified the licensing for a potential maximum daily discharge volume of 3,500m^3/d and ELVs are specified to ensure protection of Lough Gill SAC. The ELVs granted to the site in the 2020 DL (W)152

Licence are justifiable in the context of ensuring compliance with the Groundwater Regulations (2010 to 2016), the Surface Water Regulations (2009 to 2019) and in the context of water quality monitoring results at the quarry.

Construction Stage Impacts Discussion

Proposed Development

7.212 The potential direct and indirect impacts to surface water and groundwater are discussed below. In the context of the proposed deepening of the existing quarry, the construction stage is taken to be the installation of a settlement lagoon of 2,830m^2 (see area calculations below and proposed location on **Figure 2-1**) in advance of quarrying activities recommencing at the site to treat surface water pumped from the quarry floor before being discharged to the Aghamore Stream, along with construction of the proposed berm in the processing area, the proposed wastewater treatment system, the proposed portacabin and 2 no. wheelwashes. Any soil and subsoil stripping required will be carried out using earth moving machinery. The topsoil and overburden will be stored in temporary overburden storage berms or be placed onto worked out areas as part of the progressive restoration scheme. During the construction stage, the pumping of a combination of rainwater and groundwater from the quarry floor directly to the Aghamore Stream will continue, as presently occurs.

7.213 The size of the settlement lagoon will depend on the pumping rate and calculations are presented in **Appendix 7-19**. The maximum discharge rate in the existing trade effluent discharge licence to the Aghamore Stream is 40.5l/s. Groundwater inflows into the quarry at the final floor level of -50mOD would be c. 12.2l/s (see **Appendix 7-20**), leaving a maximum headroom of 28.3l/s to pump storm water out of the quarry at its lowest floor level. For a discharge rate of 28.3l/s, a settlement lagoon with a surface area of 2,830m^2 is required (**Appendix 7-19**).

7.214 The settlement lagoon will have a water depth of 1.5m, a minimum freeboard of 0.5m and will be lined to prevent leakage. Interceptors will be installed close to areas of potential risk such as the fuel storage area and refuelling station.

7.215 The discharge point from the settlement lagoon will remain at the current location (see **Figure 7-2**).

Direct Impacts

7.216 There is the potential for generating suspended sediment in rainfall runoff during the construction stage of the settlement lagoon, berm, wastewater treatment system, portacabin and wheelwashes. There is also the potential for spills or leaks of fuels/oils from vehicles during the construction stage.

7.217 The Processing Area stands on a deposit of sands and gravels, therefore with regards to drainage, it is anticipated that surface water will continue to percolate into the ground, prior to flowing in to Aghamore stream or Lough Gill to the northeast via the underlying limestone bedrock. Therefore, any suspended particulates in the surface water would be naturally removed prior to water moving in to Aghamore stream or Lough Gill.

7.218 Whilst it is noted that the location of the settlement pond will be outside the quarry floor, any generated suspended sediment in runoff, or spilled fuels/oils from vehicles, could ultimately drain

to the quarry sump and be pumped to the Aghamore Stream, which in turn drains to Lough Gill. Suspended sediment would most likely settle out over the quarry floor before reaching the sump. No other impacts on surface water or groundwater have been identified during the construction stage. The Discharge Licence for the site and SOPs for Lagan preclude impact at this stage.

7.219 A Construction Environmental Management Plan (CEMP) that outlines how potential adverse impacts on the water environment that may arise during the construction of the proposed settlement lagoon will be managed is provided in EIAR Appendix 2.2. Using the criteria outlined in **Table 7-1** to **Table 7-10, Appendix 7-18**, without mitigation, the potential effect of fine sediment is described as negative in quality, localised in extent, likely, temporary in duration, of rare frequency and irreversible. The importance of the surface water receptor (Lough Gill) is assessed as '**Extremely High**' (European site); the magnitude of impact is assessed as '**Small Adverse**'. The significance of the potential effect on the water environment is therefore assessed as '**Significant**'.

7.220 Without mitigation, the potential effect of spills or leaks of fuels/oils is described as negative in quality, localised in extent, unlikely, temporary in duration, of rare frequency and reversible. The importance of the surface water receptor (Lough Gill) is assessed as '**Extremely High**' (European site); the magnitude of impact is assessed as '**Small Adverse**'. The significance of the potential effect on the water environment is therefore assessed as '**Significant**'.

Indirect Impacts (if any)

7.221 No indirect construction stage impacts on the water environment have been identified.

Operational Stage Impacts

Proposed Development

7.222 The site layout for the processing area in the operational stage is provided in **Appendix 7-3**.

7.223 All storm water from the processing area to the east of the quarry will percolate to ground. There will be no stormwater discharge from this part of the site. There will be no point discharges from the processing area of the site at any point in the future. Consequently, there will be no requirement for the treatment and disposal of run-off and wastewater from the processing area of the site.

7.224 Within the Processing Area, there will be a standoff from Aghamore stream of a minimum 25m and all riparian and associated woodland will be retained. The Processing Area stands on a deposit of sands and gravels, therefore with regards to drainage, it is anticipated that surface water will continue to percolate into the ground, prior to flowing in to Aghamore stream or Lough Gill to the northeast via the underlying limestone bedrock. Therefore, any suspended particulates in the surface water would be naturally removed prior to water moving in to Aghamore stream or Lough Gill.

7.225 A supply well in the processing area will be used for water supply (see **Figure 7-1**); water from the well will be used for wheelwashes, dust suppression and non-potable use in the office canteen and toilets.

7.226 It is proposed to install a wheelwash system within the existing quarry and a second wheelwash will be installed before the weighbridge located within the processing area. The proposed wheelwashes will operate on closed loop systems meaning that there will be no discharges arising from them, and water will be recycled for re-use in the wheelwash system.

7.227 A new wastewater treatment unit is proposed to cater for the welfare facilities in the processing area. A site suitability assessment was carried out in February 2021 by Dr. Eugene Bolton of Trinity Green Environmental Consultants (**Appendix 7-24**) and a packaged treatment system (Oakstown BAF) with polishing filter was recommended. The proposed wastewater treatment system design specification is provided by O'Reilly Oakstown Environmental in **Appendix 7-24**.

7.228 The workshop located within the processing are is an enclosed and covered building and therefore does not require an oil interceptor. Bunded areas and spill trays are provided in the workshop to contain all oils and lubricants stored in the workshop.

7.229 There will be no bulk fuels held at the site. All mobile plant and equipment will be refuelled on an 'as required' basis by a local fuel supplier and HGV's serving the site will refuel at local service stations.

7.230 A hardstand area and hydrocarbon interceptor will be provided adjacent to the redundant fuel storage area to facilitate the refuelling of mobile plant. All treated runoff from the hydrocarbon separator will percolate naturally to the ground.

7.231 All oils / chemicals to be held at the site will be stored in the existing workshop / store, located within the processing area to the east of the quarry. The volume of oils / chemicals to be held at the site will be minimal and they will be stored within the existing bunded areas provided in the workshop. Any oils not stored within the bunded area, will be held on dedicated spill trays. Dedicated storage bins will also be provided in the workshop for oil filters and oily rags.

Direct Impacts

Increased Drawdown

7.232 Deepening of the quarry will increase drawdown on the water table surrounding the quarry. There is the potential for increased drawdown to impact on surface water bodies (Aghamore Stream and Lough Gill), private wells, groundwater flooding and the Groundwater Body's quantitative status under the Water Framework Directive.

7.233 An iterative method has been used to estimate the extent of drawdown at the lowest proposed quarry floor level (-50mOD) which is a combination of the Thiem-Dupuit Equation and the Rate-of-Recharge Method.

7.234 An initial indication of the radius of influence was calculated using the Sichardt equation (**Appendix 7-20**), indicating a radius of influence of approximately 350m at -50mOD. To further refine the expected radius of influence, the Thiem-Dupuit Equation is used for steady state unconfined conditions, and the rate-of-recharge method assumes all water pumped from the quarry comes from direct natural recharge in the area outside the quarry void (i.e. not including the quarry void area). The iterative method determines the distance out from the quarry face where recharge exactly balances the expected groundwater inflows. It is assumed in the calculations that there are

no large flowing fractures present at depth. **Figure 7-26** shows the estimated radius of influence at the lowest quarry floor level of -50mOD, some 286m from the quarry face. The estimated radius of influence for the existing site and for the quarry floor level at -34.5mOD is also shown on **Figure 7-26**.

7.235 The estimated groundwater inflows for the current situation using this iterative method agree with field observations, adding confidence to the predicted radius of influence. During the extended dry spell in June 2018, the submersible pump was pumping at c. 36l/s (3,110m^3/d). Evaporation using estimates from Knock Airport was in the order of 220m^3/d over the entire flooded quarry floor area (c. 50,000m^2). The water level in the quarry was dropping by c. 0.4m/week, which would equate to a loss of 2,857m^3/d. Balancing the inflows and outflows, a total of 473m^3/d (5.5l/s) of groundwater must have been added to the quarry in that time.

7.236 The estimated radius of influence for the quarry with floor level at -50mOD of 286m does not extend as far as the Aghamore Stream, so no impact is predicted (i.e. reduction in baseflow). Lough Gill is further away from the site and will not be affected by drawdown from the quarry.

7.237 There are no private groundwater supply wells within the future estimated radius of influence of the quarry.

7.238 The increased drawdown will not affect groundwater flooding to the north and northwest of the site as these areas are flooded by outflows from the epikarst only; the proposed development is to deepen the existing quarry and no changes will be made to the surrounding epikarst, therefore increased drawdown will not affect these groundwater flooding areas.

7.239 The quantitative impact of abstracting small volumes of groundwater from the two groundwater bodies (GWBs) that the quarry straddles is considered to be negligible as these GWBs are not identified as being under pressure from abstractions. There are few local groundwater abstractions, and no known large-scale groundwater abstractions elsewhere in these two groundwater bodies that might put these groundwater bodies under pressure of over-abstraction.

7.240 Using the criteria outlined in **Table 7-1** to **Table 7-10, Appendix 7-18**, the potential operational phase impact of increased drawdown is assessed below.

7.241 Without mitigation, the potential effect of increased drawdown on Aghamore Stream is described as negative in quality, local in extent, likely, medium-term in duration, of constant frequency and reversible. The importance of the surface water receptor (Aghamore Stream) is assessed as '**Medium**' (Quality Class C); the magnitude of impact is assessed as '**Negligible**'. The significance of the potential effect on the Aghamore Stream is therefore assessed as '**Imperceptible'**.

7.242 Without mitigation, the potential effect of increased drawdown on Lough Gill is described as negative in quality, local in extent, likely, medium-term in duration, of constant frequency and reversible. The importance of the surface water receptor (Lough Gill) is assessed as '**Extremely High**' (European site); the magnitude of impact is assessed as '**Negligible**'. The significance of the potential effect on Lough Gill is therefore assessed as '**Imperceptible'**.

7.243 Without mitigation, the potential effect of increased drawdown on Groundwater Bodies is described as negative in quality, local in extent, likely, medium-term in duration, of constant frequency and reversible. The importance of the groundwater receptor (Carrowmore West GWB and Carrowmore East GWB) is assessed as '**High**' (Regionally Important Aquifer); the magnitude of impact is assessed as '**Negligible**'. The significance of the potential effect on the Groundwater Bodies is therefore assessed as '**Imperceptible'**.

Discharge to Surface Water

7.244 The quarry will continue to discharge to surface water (Aghamore Stream) in the operational stage. With increased discharge there is the potential for 1.) increased flood risk in the Aghamore Stream, and 2.) impact on surface water quality in Aghamore Stream and Lough Gill. These potential impacts are considered below.

7.245 There will be no point discharges arising from the processing area of the site at any point in the future. Consequently, there will be no requirement for the treatment and disposal of run-off and wastewater from the processing area of the site.

7.246 Any surface water run-off arising from the processing area will continue to naturally infiltrate to ground. These lands are underlain by sand and gravel material with a significant unsaturated zone – refer to Section 7.167.

Flooding

7.247 The increased discharge of water from the quarry has the potential to exacerbate the existing flood risk along the Aghamore Stream; the change is negligible and does not have a materially significant impact relative to the existing situation.

7.248 A channel survey was carried out along the Aghamore Stream as part of this assessment from the quarry discharge point to Lough Gill. A summary of the survey is provided in **Figure 7-27**. The Aghamore Stream channel has been culverted at several points - there are two culverts within the site boundary and five culverts in the c. 765m downstream between the site and Lough Gill (see **Figure 7-28**).

7.249 The stream was divided into a number of separate reaches between culverts (**Figure 7-28**), between which 40 No. cross-sectional profiles were measured (**Figure 7-29**) and a longitudinal profile constructed (**Figure 7-30**). Photographs of the stream channel and the cross-sectional profiles are presented in **Appendix 7-21**.

7.250 The maximum bank-full flows for each cross-section were calculated and the maximum pipe-full gravity flows in the culverts were calculated using the Manning Equation (**Appendix 7-22**). These were compared with the estimated peak flow in the stream in response to a storm with a 100-year return period calculated by the Rational Method, calibrating the runoff coefficient against monitored events in the existing monitoring record (events with unimodal distributions with durations close to the time of concentration for the catchment).

7.251 The peak flow for the Aghamore Stream at the quarry discharge point is estimated as c. 500-800l/s, which exceeds the maximum flow capacity of the culvert by the Top Coast Oil depot entrance. Anecdotal evidence would suggest this culvert floods onto the road every few years for a few days at a time. Estimation of peak flow for the catchment by the Flood Studies Update methodology yields a higher peak flow but these methods are not suitable for catchments under 5-10km^2. A new 5-parameter regression equation for flood estimation in small rural ungauged catchments developed by the OPW (FSU 4.2a) gives a similar result (c. 450l/s) to that calculated using the Rational Method.

7.252 On the basis of this assessment, 5 No. areas liable to flooding along the Aghamore Stream are identified (**Figure 7-31**). The most sensitive location is Location 3 (Culvert 4) where the restricted

size of the pipe culvert may result in flooding of the adjacent road in extreme weather events. Any discharge of water from the quarry at such times would exacerbate such flooding downstream.

7.253 Without mitigation, the potential effect of discharge on flooding in the Aghamore Stream is described as negative in quality, local in extent, likely, medium-term in duration, of constant frequency and reversible. The importance of the surface water receptor (Aghamore Stream) is assessed as '**Medium**' (Quality Class C); the magnitude of impact is assessed as '**Negligible**'. The significance of the potential effect on the Aghamore Stream is therefore assessed as '**Imperceptible'**.

Surface Water Quality

7.254 There is the potential that certain parameters in discharged water from the site could impact on water quality in the Aghamore Stream or Lough Gill.

7.255 Comparison of past discharge samples with the surface water quality limits indicates that Total Ammonia and Orthophosphate are the parameters of most interest in the discharged water (suspended solids will not be an issue in the future once the proposed settlement lagoon is constructed).

7.256 Faecal bacteria present in groundwater as a result of agricultural activities in the lands surrounding the quarry would make its way to Lough Gill quicker than normal by being discharged to the Aghamore Stream. Recent sampling of surface water between the discharge and Lough Gill (**Appendix 7-11**) shows that the concentrations of faecal bacteria in the discharge are lower than the background levels upstream, and downgradient faecal bacteria concentrations are lower than upstream due to the dilution effect of the discharge. Therefore, although some additional faecal bacteria are added to the stream from the discharge, the net effect of the discharge is to reduce the overall faecal bacteria concentrations in the stream going to Lough Gill.

7.257 The actual assimilative capacity available in the Aghamore Stream at times of low flow can be calculated using the estimated 95th percentile flow and background concentrations for individual parameters upstream of the discharge. For the general-case scenario, where background concentrations are taken as the mean of recent upstream monitoring data, the calculated assimilative capacity available is presented in **Appendix 7-23**.

7.258 To determine whether there is a negative impact on water quality in the stream, the concentrations downstream of the discharge have been estimated using a conservative mass balance. The mass balance uses the upstream flow (95th percentile flow) and background concentrations (mean of recent upstream monitoring data), as well as the discharge flow (maximum under existing trade effluent discharge licence) and concentrations (mean of recent discharge monitoring data), to estimate the fully mixed downstream concentrations. None of the calculated concentrations downstream of the discharge exceed the relevant water quality standards, therefore no negative impact on water quality in the stream is expected as a result of the discharge.

7.259 The results of additional surface water samples taken between August 2018 and March 2021 are presented in **Appendix 7-11**.

7.260 The only parameters that exceed the Surface Water Environmental Quality Standards downstream of the discharge are single occurrences of slightly elevated mercury in November 2018 (0.2µg/l) and nickel (125µg/l) in January 2019. The slightly elevated mercury in November 2018 is also seen in the discharge (0.077µg/l), but neither parameter is elevated in samples further downstream at

the bridge before Lough Gill, suggesting that the sampling location downstream of the discharge is within the mixing zone of the discharge and not far enough downstream (c. 30m) to represent fully mixed downstream concentrations. Traces of mercury and nickel are occasionally seen in groundwater surrounding the quarry, most likely as a result of either chemical fertilizers in the agricultural lands adjacent the quarry or atmospheric deposition from coal burning – there are no sources of mercury or nickel within the quarry itself. Coliform bacteria (including *E.coli*) exceed the Drinking Water Parametric Values both upstream and downstream of the discharge and this is related to poor background bacterial quality in both the stream and in groundwater surrounding the quarry – there are no sources of coliform bacteria within the application site.

7.261 The percentage of the assimilative capacity available in the stream that is used up by the discharge is estimated in **Appendix 7-23**. This is based on a comparison of the 'headspace' available in the stream before and after the discharge (i.e. 'headspace' is the difference between the stream concentration and the maximum permissible concentration). For the general-case scenario, only low percentages of the available assimilative capacity are used by some parameters (maximum of 27% by orthophosphate). In some cases, additional assimilative capacity is made available (e.g. TSS and BOD) as the mean concentrations in the discharge are lower than the background concentrations upstream of the discharge.

7.262 In summary, the assimilative capacity of the Aghamore Stream has been assessed in relation to the discharge and no negative impact on water quality is expected. The only exceedances of the Surface Water Environmental Quality Standards in recent monitoring downstream of the discharge point were single occurrences of slightly elevated mercury in November 2018 and nickel in January 2019, and these are believed to be related to background groundwater quality surrounding the quarry and not any activity within the quarry site itself.

7.263 Without mitigation, the potential effect of the discharge water quality on surface water quality in the Aghamore Stream and Lough Gill is described as negative in quality, local in extent, unlikely, medium-term in duration, of constant frequency and irreversible. The importance of the surface water receptor (Lough Gill) is assessed as '**Extremely High**' (European site); the magnitude of impact is assessed as '**Negligible**'. The significance of the potential effect on Lough Gill is therefore assessed as '**Imperceptible'**.

Groundwater Quality

7.264 There is a potential risk of surface water contamination in the operational stage from blasting activities. The risk to groundwater quality from blasting is negligible as groundwater surrounding the quarry is drawn into the quarry and pumped out as discharge to surface water.

7.265 It is proposed to infiltrate surface water runoff within the processing area (see Section 7.292); surface water runoff would be expected to be uncontaminated (i.e. rainwater) and is therefore not considered a potential risk to groundwater quality or Lough Gill.

7.266 Without mitigation, the potential effect of blasting on surface water quality is described as negative in quality, local in extent, unlikely, medium-term in duration, of constant frequency and irreversible. The importance of the surface water receptor (Lough Gill) is assessed as '**Extremely High**' (European site); the magnitude of impact is assessed as '**Small Adverse**'. The significance of the potential effect on Lough Gill is therefore assessed as '**Significant**'.

Indirect Impacts (if any)

7.267 No indirect operational stage impacts on the water environment have been identified.

Post – Operational Stage Impacts

Direct Impacts

7.268 On cessation of activities, pumping of water from the quarry will cease and the quarry will be allowed to flood and become a natural habitat.

7.269 All chemicals, petroleum-based products, mechanical and electrical equipment will be removed from the site prior to its closure to eliminate potential sources of groundwater contamination. Site security will be maintained post-closure to discourage unauthorised dumping or any other potentially contaminating activities in the vicinity of the quarry.

7.270 No direct post-operational impacts on the water environment have been identified.

Indirect Impacts (if any)

7.271 No indirect post-operational stage impacts on the water environment have been identified.

Unplanned Events (i.e. Accidents)

7.272 Potential impacts on surface water or groundwater could occur (in the worst case, with no monitoring or management) from 1.) accidental spillages on site, 2.) uncontrolled discharges to surface water and 3.) flooding (on-site or off-site).

7.273 Spillages of fuels or chemicals during site activities could happen without proper control and supervision. Discharged water off-site could potentially breach water quality limits without monitoring. Pump failure in the quarry could result in the quarry floor flooding leading to the potential for groundwater pollution by plant and equipment; uncontrolled discharge of water to the Aghamore Stream could potentially lead to localised flooding off-site in the worst case.

7.274 Appropriate mitigation measures and monitoring have been proposed to ensure that there are no potential impacts on the water environment as a result of unplanned events at the site.

7.275 Sligo County Council, in the 2020 Discharge Licence DL (W) 151, adequately specified Condition 7 (Condition 7.1, 7.2 and 7.3) for the control of Accidental Spillages.

Cumulative / Synergistic Impacts (if any)

Infilled Area Upstream

7.276 There is the potential for cumulative impact on surface water quality in combination with recently reclaimed land located upstream of the site surrounding Lough Nameenbrack, as well as the inert waste recovery operation to the south of Lough Nameenbrack – see Sections 7.176 and 7.177.

7.277 4 No. rounds of surface water sampling were carried out in the Phase II site investigation, which included samples from upstream and downstream of the infilled area at Lough Nameenbrack. The sampling locations are indicated on **Figure 7-2**.

7.278 The results of these surface water samples show that water quality upstream of the infilled area is the same as downstream, indicating that the infill materials used in the reclamation are not having a deleterious effect on surface water quality in the Aghamore Stream. Therefore, the potential for cumulative impact in combination with the proposed development is considered negligible.

7.279 Without mitigation, the potential cumulative effect of the proposed development in combination with the infilled area upstream is described as negative in quality, local in extent, unlikely, permanent in duration, of constant frequency and irreversible. The importance of the surface water receptor (Lough Gill) is assessed as '**Extremely High**' (European site); the magnitude of impact is assessed as '**Negligible**'. The significance of the potential effect on Lough Gill is therefore assessed as '**Imperceptible'**.

Asphalt Plant

7.280 There is the potential for cumulative impact in combination with runoff from the existing asphalt plant area which lies outside the proposed development site boundary in the processing area.

7.281 There is currently no point discharge arising from the processing area of the site (located to the east of the public road) as this area of the site is also inactive.

7.282 It is not the applicant's intention to resume any point discharges from the processing area of the site at any point in the future. Consequently, there will be no requirement for the treatment and disposal of run-off and wastewater from the processing area of the site.

7.283 Any surface water run-off arising from the asphalt plant area will continue to naturally percolate to ground. These lands are underlain by sand and gravel material with a significant unsaturated zone – see Section 7.167.

Concrete Plant/Block Yard (Obsolete)

7.284 There is the potential for cumulative impact in combination with runoff from the area where the obsolete concrete plant and block yard are located which is outside the proposed development site boundary.

7.285 As stated above, there is currently no point discharge arising from the processing area of the site as this area of the site is also inactive. Any historical discharges arising from the processing area would have originated from the wash-water associated with concrete production activities. The concrete production plant has not operated since the site was purchased by the applicant from

Cemex (ROI) Ltd. in 2014 and is now obsolete. The applicant does not intend to recommence the production of concrete products at the site.

7.286 There will be no point discharges from the processing area of the site at any point in the future. Consequently, there will be no requirement for the treatment and disposal of run-off and wastewater from the processing area of the site.

7.287 Any surface water run-off arising from the concrete plant / block yard area will continue to naturally percolate to ground. These lands are underlain by sand and gravel material with a significant unsaturated zone – see Section 7.167.

7.288 Without mitigation, the potential cumulative effect of the proposed development in combination with the infilled area upstream is described as negative in quality, local in extent, likely, permanent in duration, of constant frequency and irreversible. The importance of the surface water receptor (Lough Gill) is assessed as '**Extremely High**' (European site); the magnitude of impact is assessed as '**Small Adverse**'. The significance of the potential effect on Lough Gill is therefore assessed as '**Significant**'.

7.289 No other potential cumulative/synergistic impacts have been identified.

Transboundary Impacts (If any)

7.290 No potential transboundary impacts have been identified.

Interaction with Other Impacts (if any)

7.291 No potential interaction with other impacts have been identified.

MITIGATION MEASURES

Construction Stage

7.292 There is the potential for generating suspended sediment in rainfall runoff during the construction stage of the settlement lagoon, berm, wastewater treatment system and portacabin, and the potential for accidental spills of fuels/oils from construction vehicles. No other impacts on surface water or groundwater have been identified for the construction stage.

7.293 A Construction Environmental Management Plan (CEMP) that outlines how potential adverse impacts on the water environment that may arise during the construction of the proposed settlement lagoon will be managed is provided in EIAR Appendix 2.2.

7.294 Good site practice in managing runoff and spill prevention will be necessary during construction. Runoff into the quarry void will be monitored and if sediment laden water enters the quarry floor and sump then the sump pump will be switched off until the sediment laden water has settled on the quarry floor to prevent direct discharge of untreated water to the Aghamore Stream.

7.295 Due to the extreme sensitivity of Lough Gill, all precautions will be taken to minimise the potential for accidental spills of fuels/oils from construction vehicles. Fuels and oils will not be stored within the quarry during construction and refuelling of construction vehicles will only be permitted outside the quarry at the dedicated refuelling hardstand area and associated interceptor. Spill kits will be

maintained on site during construction to stop the migration of any accidental spillages, should they occur.

7.296 **Table 7-2**, **Table 7-3** and **Table 7-4** identified potential Impacts, Significance, Required Mitigation Measures and the potential Residual Impacts.

7.297 The proposed mitigation measures would reduce the significance of the potential impacts at construction stage from '**Significant'** to **'Imperceptible'** with the finding of **'No Residual Impacts'.**

Table 7-2 Potential Impact Assessment Table - Aghamore Quarry (following NRA 2008)

Activity	Attribute	Character of Potential Impact	Importance of Attribute (as defined by criteria assessment Table 7-6)	Magnitude of Potential Impact (as defined by criteria assessment Table 7-8)	Significance of Potential Impact (as defined by criteria assessment Table 7-10)
1. Fuel storage/usage on site	Groundwater Subsoils Bedrock Aghamore River (Garavogue_010) Lough Gill SAC & PWS Carrowmore West and East GWBs (IE_WE_G_0040 & IE_WE_G_0042) Ballysadare Bay SAC & SPA	Accidental spillage of contaminants during site operations may cause short to long-term, moderate to significant impacts to soils, groundwater and the surface water environment if not stored and used in an environmentally safe manner.	Extremely High	Moderate Adverse	Profound
2. Excavation works and vehicle movement on site		Excavation works will result the same vulnerability of groundwater at the site as is now experienced by the same area of open bedrock.	Extremely High	Moderate Adverse	Profound
3. Surface water Runoff		Road surface runoff or drainage systems have potential, if not correctly designed, to result in contamination of surface waters and groundwater. Accidental spillage could contaminate the aquifer by direct percolation or via the superficial water network.	Extremely High	Moderate Adverse	Profound
4. Increased dewatering		Lowering the quarry bench could lead to an increase of groundwater component in the sump. Interception of rainfall and groundwaters from one catchment and re-direction back to the adjacent catchment presents impact potential.	Extremely High	Large Adverse	Profound
5. Discharge from the Site		Direct discharge of waters arising at the site could contaminate the receiving waters, which is primarily the Aghamore River (Garavogue_010), or the groundwater body underlying the processing site (eastern area). The ultimate receptor that could be impacted is Lough GIll. Flooding and scour are also potential impacts.	Extremely High	Moderate Adverse	Profound

Table 7-3 Mitigation Measures Table - Aghamore Quarry (following NRA 2008)

Activity	Attribute	Character of Potential Impact	Mitigation	Residual Impact
1. Fuel storage/ usage on site	Groundwater Subsoils Bedrock Aghamore River (Garavogue_010), Lough Gill SAC & PWSS, Carrowmore West and East GWBs (IE_WE_G_0040 & IE_WE_G_0042) Ballysadare Bay SAC & SPA	Accidental spillage of contaminants during site operations may cause short to long-term, moderate to significant impacts to soils, groundwater and the surface water environment if not stored and used in an environmentally safe manner.	• The 9 specified 'Waste & Oil Management' Conditions of the 2020 Discharge Licence DL(W)151 will be enacted prior to re-commencement of activity at the site. In addition, Condition 7's three Measures regarding 'ACCIDENT PREVENTION & EMERGENCY PROCEDURES' shall be enacted including the onsite availability of containment booms and/or suitable absorbent material to contain and absorb any spillage. • Waste and fuel materials will be stored in designated bunded areas that are isolated from surface water drains or open waters (*e.g.* excavations). All materials will be considered as Hazardous Wastes, including waste oil, chemicals and preservatives, will be stored in sealed, labelled containers. Fuelling, lubrication and storage areas and site offices will not be located within 30m of drainage ditches or the settlement sumps. • All waste containers (including all ancillary equipment such as vent pipes and refuelling hoses) will 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 the tank capacity. Where more than one tank is stored, the bund must be capable of holding 110% of the largest tank of 25% of the aggregate capacity (whichever is greater). Drip trays used for drum storage must be capable of holding at least 25% of the drum capacity. Where more than one drum is stored the drip tray must be capable of holding 25% of the aggregate capacity of the drums stored. 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. • In addition to Maintenance Agreements with the suppliers of infrastructure, regular monitoring and maintenance of interceptors, separators and silt traps will be undertaken by the staff of the quarry in accordance with the manufacturer's specifications. Oil which accumulates within the hydrocarbon interceptor shall be regularly removed by an appropriately licensed contractor. In addition, the hydrocarbon interceptor shall be appropriately maintained in accordance with the manufacturer's specification. Regular visual monitoring of the attenuation sump will be undertaken to ensure no visual oil or fuel contamination is present. • Oil interceptors and separators shall be fitted, with the capacity to deal with the 2020 licensed discharge volume of 3,500m^3/d [DL(W)151].	Neutral

Activity	Attribute	Character of Potential Impact	Mitigation	Residual Impact
2. Excavation works and vehicle movement on site	Groundwater Bedrock Carrowmore West and East GWBs (IE_WE_G_0040 & IE_WE_G_0042) Ballysadare Bay SAC & SPA	Excavation works will result the same vulnerability of groundwater at the site as is now experienced by the same area of open bedrock.	• Procedures are in place for dealing with accidental spillages. The Discharge Licence [DL(W)151, 2020] for the site details all mitigation measures required for protection of the attributes. • No storage of unbunded fuel tanks or other site activities (*e.g.* fuel storage, refuelling, adding hydraulic oils, etc) will be permitted. • Excavations of rock will follow best management practices for maintenance of machinery. • Blasting of rock is governed by Industry Standards to ensure minimal loss of explosive constituents to the environment.	Neutral
3. Surface Water Runoff	Groundwater Aghamore River (Garavogue_010), Lough Gill SAC & PWSS, Carrowmore West and East GWBs (IE_WE_G_0040 & IE_WE_G_0042) Ballysadare Bay SAC & SPA	Road surface runoff or drainage systems have potential, if not correctly designed, to result in contamination of surface waters and groundwater. Accidental spillage could contaminate the aquifer by direct percolation or via the superficial water network.	• The Discharge Licence [DL(W)151, 2020] for the site details all mitigation measures required for protection of the attributes. • The settlement sump and the wider area of the floor of the quarry have volumetric capacity to accommodate all waters for the required residence time to settle and retain potential rainfall runoff generated solids and any vehicular contaminants associated with runoff. • The developers are an international company with SOPs clearly outlined to ensure no environmental degradation arising from their business activities.	Neutral
4. Increased Dewatering	Carrowmore West and East GWBs (IE_WE_G_0040 & IE_WE_G_0042). Lough Gill SAC & PWSS Ballysadare Bay SAC & SPA	Lowering the quarry bench could lead to an increase of groundwater component in the sump. Interception of rainfall and groundwaters from one catchment and re-direction back to the	The small loss to the Carrowmore west groundwater body is deemed insignificant in the context of the regional groundwater body recharge volume, when the WFD GW5 Characterisation Assessment procedure is adopted. The potential maximum 3,500m3/d licensed future discharge from the quarry and its underlying Carrowmore East GWB/CARROWGOBBADAGH_SC_010 Surface water catchment to the western Bonet_SC_030, ultimately adding more recharge to Lough Gill, can only be considered a positive in terms of providing a water balance mitigation for	Neutral

Activity	Attribute	Character of Potential Impact	Mitigation	Residual Impact
		adjacent catchment presents impact potential.	the 14,600 m3/d combined design abstraction rate for Irish Water's supply of Public Water from Lough Gill for Sligo and North Leitrim.	
5. Discharge from the Site	Groundwater Aghamore River (Garavogue_010), Lough Gill SAC & PWSS, Carrowmore West and East GWBs (IE_WE_G_0040 & IE_WE_G_0042) Ballysadare Bay SAC & SPA	Direct discharge of waters arising at the site could contaminate the receiving waters, which is primarily the Aghamore River (Garavogue_010), or the groundwater body underlying the processing site (eastern area). The ultimate receptor that could be impacted is Lough GIll. The discharge could cause scouring of the riverbed. Discharge volumes could cause flooding in the downstream surface water environments.	In advance of this planning application the site engaged with Sligo County Council and a new Discharge Licence for the site was issued. That Discharge Licence evaluation procedure demonstrated that the site could justifiably and defensibly discharge a daily maximum volume of 3,500m3/d and present no threat to the integrity of the receiving environments. The 2020 issued DL (W)151 presents ELVs and Mitigation measures required for the continued operation of the site. Site investigations and conclusions arising from this assessment suggest that the region's groundwater regime primarily operates in the shallow epikarst, in the 0m OD to 20m OD elevation range, and is forcibly driven by recent rainfall. Given that the site's floor is currently c. 20m below the regionally active epikarst zone and that the proposal to go to -50m OD has been thoroughly evaluated using intensive geophysical assessment across the entire floor of the void to -60m OD, with no evidence of deep conduits connecting the site to Lough Gill, it is considered that no further mitigation is necessary other than the current Discharge Licence Conditions. A Reno Mattress will be installed at the discharge point to prevent scour. With respect to potential for flooding, the application presents evaluation of the potential for flooding and associated appropriate mitigation measures.	Neutral

7.298 The 'Residual Effects' Conclusions for the site are presented as Table 7-4. In summary, NO Residual Effect is anticipated for any Impact arising for the continued operation of the site.

Table 7-4 Residual Effects Table - Aghamore Quarry (following NRA 2008)

Aghamore Quarry Residual Effect Evaluation	No.	Potential Impact	Potential Effect	Description of Effect						Mitigation Required?	Residual Effect
				Quality	Significance	Extent	Probability	Duration	Type		
Construction Phase	1	Generated suspended solids in runoff	Surface water quality	Negative	Significant	Local	Likely	Temporary	Irreversible	Yes (Runoff into the quarry void will be monitored, if sediment laden water enters the quarry floor and sump then the sump pump will be switched off until the sediment laden water has settled on the quarry floor)	**No**
	2	Accidental leaks/spills of fuels or oils	Surface water quality	Negative	Significant	Local	Unlikely	Temporary	Irreversible	Yes (Fuels & oils will not be stored within quarry, refuelling of construction vehicles will only be permitted outside the quarry, spill kits will be maintained on site to stop the migration of any accidental spillages)	**No**
Operational Phase	1	Increased drawdown	a) Aghamore Stream	Negative	Imperceptible	Local	Likely	Medium-Term	Reversible	No	**No**
			b) Lough Gill	Negative	Imperceptible	Local	Likely	Medium-Term	Reversible	No	**No**
			c) Groundwater Bodies	Negative	Imperceptible	Local	Likely	Medium-Term	Reversible	No	**No**
	2	Discharge to surface water (quarry)	a) Flooding	Negative	Imperceptible	Local	Unlikely	Medium-Term	Reversible	No	**No**
			b) Surface water quality	Negative	Imperceptible	Local	Unlikely	Medium-Term	Irreversible	No (Reno mattress will be installed at the discharge point to prevent scour)	**No**
	3	Blasting	Groundwater quality	Negative	Significant	Local	Unlikely	Medium-Term	Irreversible	Yes (Development of site-specific blasting protocol)	**No**
	4	Accidental leaks/spills of fuels or oils	Surface water quality	Negative	Significant	Local	Unlikely	Temporary	Irreversible	Yes (bunding of petroleum-based products, regular plant inspections, no refuelling in quarry void, spill kits, interceptors, settlement lagoon)	**No**
	5	Infilled area upstream	Surface water quality	Negative	Imperceptible	Local	Unlikely	Permanent	Cumulative, Irreversible	No	**No**
	6	Discharge to surface water (processing yard)	Surface water quality	Negative	Significant	Local	Likely	Medium-Term	Cumulative, Irreversible	Yes (construction of berm to prevent runoff into Aghamore Stream)	**No**
Post-Operational Phase	1	**None identified**									

Operational Stage

7.299 To mitigate the potential impact of explosives on surface water quality during blasting operations site-specific protocol for blasting is provided in EIAR Appendix 2.3.

7.300 The type of explosive to be used at the quarry is Kemex 70. Kemex 70 is supplied by Irish Industrial Explosives (IIE) and is a waterproof, pumped emulsion product, which is designed for wet conditions. It is a site manufactured explosive whereby non-explosive materials are transported to site in a specifically designed pump truck. The materials are blended on-site and pumped directly into the blast holes by trained and experienced operators.

7.301 IIE provides blasting services to all of the applicant's quarry operations throughout Ireland. IIE operates an ISO9000 Quality Management System and its occupational health and safety management system is based on OHSAS 18001. IIE carries out all blasting activities in accordance with its Quarry Blasting Procedure, a copy of which is enclosed in EIAR Appendix 2.3. IIE's blasting procedure controls the loading of the explosive product into the drill holes and two points of initiation are used in each drill hole to ensure that initiation occurs, and the explosive product is fully consumed.

7.302 Discharge Licence DL(W)151 (2020) outlines Conditions 6.1 to 6.9 for the Operational Stage and Environmental Protection. Amongst other measures, all petroleum-based products (lubricating oils, waste oils, etc.) will be stored in labelled containers and in bunded areas to prevent pollution by accidental leaks as is Conditioned in the discharge licence.

7.303 All plant used on site will be inspected regularly for signs of leaks. Mobile plant/machinery will only be serviced on a hardstand refuelling area draining to an interceptor to prevent uncontrolled releases of pollutants to ground. No refuelling or servicing will be undertaken within the quarry void.

7.304 Spill kits will be maintained on site to stop the migration of any accidental spillages, should they occur.

7.305 Interceptors and separators are conditioned and will be installed, managed, maintained and inspected as Conditioned in the discharge licence.

7.306 A settlement lagoon will be installed to reduce suspended solids levels in the discharges conditioned in the discharge licence.

7.307 To mitigate the potential for erosion (scour) of the stream bed from the quarry discharge, a reno mattress will be installed at the discharge point to dissipate the energy of the discharge.

7.308 To mitigate the potential for exacerbating flooding at Culvert 4 downstream of the quarry discharge, where the restricted size of the pipe culvert may result in flooding of the adjacent road in extreme weather events, Lagan will ensure that there is no pumping during flooding events which eliminates the slight risk from flooding during extreme events.

7.309 To mitigate the potential for cumulative impact in combination with runoff from the area where the obsolete concrete production plant is located, a berm will be constructed across the open perimeter of the processing area where runoff from a collection sump overflows the Aghamore Stream. The berm will prevent any direct discharge to surface water from the processing area. Ponded runoff in the collection sump will be pumped to a soakaway nearby and allowed to infiltrate to groundwater. Any historical discharges arising from the processing area would have originated

from the wash-water associated with concrete production activities. This plant has not operated since the site was purchased by the applicant from Cemex (ROI) Ltd. in 2014 and is now obsolete. The applicant does not intend to recommence the production of concrete products at the site.

7.310 These proposed mitigation measures would reduce the significance of the potential impacts at the operational stage from '**Significant'** to **'Imperceptible'**.

Post – Operational Stage

7.311 No direct post-operational impacts on the water environment have been identified.

RESIDUAL IMPACT ASSESSMENT

Construction Stage

7.312 If the proposed mitigation measures are fully implemented, no residual impacts are anticipated in the Construction Stage.

Operational Stage

7.313 If the proposed mitigation measures are fully implemented, no residual impacts are anticipated in the Operational Stage.

Post – Operational Stage

7.314 No residual impacts are anticipated in the Post-Operational stage.

Summary

7.315 **Table 7-4** presented the summary findings of the Residual Impact Assessment and the conclusion in each case is 'No Residual Impact'. Residual impacts on the hydrological or hydrogeological environment are not envisaged to result from the proposed quarry development in the vertical plane and the site's mitigation measures. Karst Limestone Aquifer's bedrock at depth has little primary porosity. Research commissioned by Sligo County Council and the OPW has demonstrated the highly active epikarst zone to be significant in the local hydrological and hydrogeological regime (Tynan, 2021, **Appendix 7-2**) and this has been proven by field measurement in the course of this work. Not much new groundwater will be encountered at the site because the conduit and epikarst rainfall transit zones are not at depth: they are at a higher elevation than the current floor level. The site has been dealing with its relatively small groundwater volume allotment for years and it has easily been managed and no impacts have been detected in either the Groundwater Bodies or the Lough Gill lake environment. The significant majority of the quarry's groundwater comes in by epikarst. Most of the water in the void comes in at a relatively high elevation between the perimeter land elevation of 30mOD, approximately, and the epikarst bottom boundary of 0mOD. The working area of the quarry is already at -21mOD and the licensed discharge from the void

should comfortably be managed with no pressure placed on two appropriately specified 6" diameter pumps in the future.

MONITORING

7.316 All surface water monitoring required under the existing Trade Effluent Discharge Licence will be carried out once activities recommence on site. Flowmeters are already installed in the discharge pipes from the quarry sump and a flowmeter installed upstream of the quarry discharge to the Aghamore Stream.

7.317 Groundwater levels will be monitored in the existing monitoring wells as the quarry is developed to confirm the drawdown and estimated radius of influence. Monitoring of groundwater levels by datalogger with periodic site visits to download data will be carried out.

7.318 Groundwater quality monitoring will continue to be carried out on a biannual basis from a representative number of monitoring wells around the quarry.

7.319 Water levels at Culvert 4 (by the entrance of the Top Coast Oil depot) will be monitored during periods of high rainfall to assess the likelihood of flooding onto the adjacent road. As noted above, discharges will be discontinued during periods of elevated rainfall to eliminate the slight potential risk of flooding at this location.

Discussion & Conclusions

7.320 In the absence of specifically hydrogeologically directed Competent Authority Guidance on quarry dewatering appraisals, UK practical guidance as published by the UK Environment Agency (the public body equivalent of the Irish EPA) can be applied to collate and conclude all information collected and presented for the assessment of viability for the site to continue in vertical extractions of rock in this Karst Limestone & significant receptor environment.

7.321 The UK Environment Agency Guidance Document is cited as Boak, R. et al. (2007) Using Science to create a better place: Hydrogeological impact appraisal for dewatering abstractions. (Environment Agency, Science Report – SC40020/SR1).

7.322 The approach adopted by the UK Environment Agency (Boak, R. et. al., 2007) is succinctly described in the Guidance Document 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, R. et. al. (2007).

7.323 The EA conceptual HIA and the understanding of the site and its regional context is now applied to present a reasoned assessment of the potential for impact that might arise in response to the proposed development. The answers to each of the EA HIA steps can now be summarised as follows:

- ***Step 1:*** Establish the regional water resource status:
    - **ASSESSMENT OUTPUT =**
        1. Regionally Important Karst Conduit Aquifer, named the Carrowmore East and West Groundwater Body, each assigned Good Status (EPA 2013-2018, https://gis.epa.ie/EPAMaps/).
        2. Receiving Water Aghamore Stream = Poor Status attributed to forestry, wastewater and road drainage (EPA, 2019).

3. Downstream Receptor Lough Gill SAC and PWSS is Moderate Status (EPA, 2019), at Risk and an important PWSS for two counties.

- ***Step 2:*** Develop a conceptual model for the quarry void's abstraction and the surrounding area:

  - **ASSESSMENT OUTPUT =**
    - The Site's groundwater inflows are primarily by the shallow epikarst zone. Regionally, that epikarst zone is reported to be active in the 0mOD to 22mOD and rainfall is a dominant driver in the hydrogeological responses observed at the site and in the surrounding areas. No conduits were identified in geophysical investigation across the entire quarry floor void to an investigation depth of -60m OD (Apex, 2021). The application site is currently at an elevation of -21mOD and the proposal is to bring it to -50mOD. Current groundwater ingress is known.
    - The conceptual model, based on drilling and hydraulic response testing, is that there will be little new groundwater encountered.
    - The site's water balance in the context of the entire underlying Regional Aquifer and Lough Gill's land overflow recharge (NOT ACCOUNTING FOR RIVER INFLOWS THEMSELVES) is 2% and between 4% and 6% dependent on the underlying groundwater body considered. Those percentages are of no significance, when the WFD GW5 Assessment scheme is applied. This therefore adds to support the finding that the site poses no risk to Lough Gill SAC nor Ballysadare Bay SAC and SPA.
    - Given that the site's floor is currently located c. 20m below the regionally active epikarst zone and that the proposal to go to -50mOD has been thoroughly evaluated using intensive geophysical assessment across the entire floor of the void to -60mOD, with no evidence of deep conduits connecting the site to Lough Gill.

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

  - **ASSESSMENT OUTPUT =**
    - Aghamore Stream (Garavogue_010),
    - Lough Gill SAC & Public Water Supply Source (PWSS),
    - The most easterly boundaries of Ballysadare Bay SAC (Site Code 000622) and Ballysadare Bay SPA (Site Code 004129) are situated south west of the quarry at a distance of 3km, approximately, from the site's most western boundary.

- Cummeen Strand SPA, Cummeen Strand/Drumcliff Bay SAC (Site Codes 004035 and 000627) are located 7km downstream of the quarry and downstream of Lough Gill.
- Carrowmore West Groundwater Body (IE_WE_G_0040)
- Carrowmore East Groundwater Body (IE_WE_G_0042).

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

  - **ASSESSMENT OUTPUT =**
    Project Information, Discharge Licence Information and Regional Water Balance calculations presented by Bartley (Appendix 7-2) suggests likely flow apportioning as follows:

    1. Aghamore Stream will receive all the site's pumped discharge under a 2020 issued licence DL(W)151 ELV for Volume of up to 3,500m^3/d.
    2. Lough Gill SAC & PWSS receives, amongst many river inputs in the catchment, flow from the Aghamore Stream at a distance of 765m downstream of the site's point of discharge. Regioanl Water Balance (Bartley, Appendix7-2) shows little low potential for impact. Ballysadare Bay SAC and SPA will receive a groundwater flow reduction of between 2 and 6%, approximately, depending on the scale of reference considered i.e. Regional Aquifer or Carrowmore West GWB. When considered over the entire Regionally Important Aquifer's rainfall recharge contribution area, the change in dynamic caused by the quarry's discharge heading to the Aghamore Stream rather than west towards the Bay is deemed insignificant in the context of WFD GW5 Guidance, which would this in the small risk category.
    3. The same conclusion is drawn for Cummeen Strand SPA, Cummeen Strand/Drumcliff Bay SAC (Site Codes 004035 and 000627) are located 7km downstream of the quarry and downstream of Lough Gill. Given that no impact is predicted for Lough Gill, no impact can be transferred to Cummeen Strand SPA, Cummeen Strand/Drumcliff Bay SAC (Site Codes 004035 and 000627).
    4. While the quarry site straddles two groundwater bodies and two surface water bodies, these are generally national scale mapping lines on GIS systems. Review of the catchment topography, regional and local highs and lows identified in Tynan's studies for the area (2021, **Appendix 7-2**) and the outcropping of rocks in the area suggests insignificance in the greater scheme of the site providing mitigation water balance for the design abstraction rate of 14,600m^3/d from the downstream Lough Gill surface water catchment for Public Water Supply to Sligo and Leitrim. (Refer to Bartley, 2021, **Appendix 7-2** for The Carrowmore East and West Groundwater Bodies and the Regional Water Balance Tables).

5. Regional Aquifer scale Water Balance calculations are tabulated by Bartley (2021, **Appendix 7-2**) and the resultant impact %'s are deemed insignificant in the context of GW5 Guidance.

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

  - **ASSESSMENT OUTPUT =**

    - No net flow impacts are envisaged for the following reasons:
      - In advance of this planning application the site engaged with Sligo County Council and a new Discharge Licence for the site was issued. That Discharge Licence evaluation procedure demonstrated that the site could justifiably and defensibly discharge a daily maximum volume of 3,500m3/d and present no threat to the integrity of the receiving environments. The 2020 issued DL (W)151 presents ELVs and Mitigation measures required for the continued operation of the site.
      - A Reno mattress will be installed at the discharge point to prevent scour.
      - With respect to potential for flooding, the application presents evaluation of the potential for flooding and associated appropriate mitigation measures.
      - Mitigation Effects and Residual Effects have been evaluated using EPA and NRA Guidance and the finding of "No Effects" Concluded after the application of the Mitigation Measures.

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

  - **ASSESSMENT OUTPUT =**
    - Negligible significance @ 2% of the Regional Aquifer's water balance, 4% of the Carrowmore East GWB, 6% of the Carrowmore West GWB & <1% of the Contribution of land surface runoff to Lough Gill SAC & PWS (Refer to Water Balance Tables in Bartley (2021, **Appendix 7-2**).

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

  - **ASSESSMENT OUTPUT =**

- ***Impact assessment determined that there are No Groundwater Source targets for impact.*** In any case, the groundwater flow mechanism is Karst Conduit flow with extremely low measured hydraulic conductivity in the matrix of the bedrock, as measured in site investigation boreholes. The conduit flow mechanism is therefore supported by field drilling and testing. This means that groundwater wells will source their water from discrete conduits. Site investigations suggest no conduits leading from the site or underlying the quarry floor.
- ***Numerous drawdown calculation methods were applied in this evaluation and the radius of influence could be between 250 and 350m from the centre of the quarry.*** Given that there are no groundwater source targets and that the ultimate resource target is Lough Gill at 765m, a conclusion of no potential for impact arising from dewatering is concluded.
- The Aghamore Stream is not a target at risk from the dewatering regime in the hard rock void of this quarry. The Aghamore stream is a rainfall driven stream coming from the mountains to the south east and the assimilation capacity simulations that supported the 2020 grant of Discharge Licence DL(W)151 showed that the discharge provided water quality improvement for the stream. The WFD sub catchment assessment for this stream identifies Forestry, road runoff and wastewater as risks to its integrity. Generally, correctly managed large scale regionally important quarries often provide a cleaner water to streams heavily impacted by forestry and agriculture.

- ***Step 8:*** Identify all features in the search area that could be impacted by drawdown:
  - **ASSESSMENT OUTPUT =**
    - Refer to comments above and Tables 7-2, 7-3, 7-4 above. No features will be affected by drawdown.

- ***Step 9:*** For all these features, predict the likely drawdown impacts:
  - **ASSESSMENT OUTPUT =**
    - ***None predicted.***

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

- **ASSESSMENT OUTPUT =**
  - ***Not relevant.***

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

  - **ASSESSMENT OUTPUT =**
    - ***Not applicable***

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

  - **ASSESSMENT OUTPUT =**
    - Assimilation capacity simulations sanctioned by Sligo County Council's 2020 grant of DL(W)151 suggest no deleterious impacts on water quality and some water quality improvements.

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

  - **ASSESSMENT OUTPUT =**
    - Not necessary. The Mitigation Measures of Table 7-3 are appropriate.

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

  - **ASSESSMENT OUTPUT =**
    - Monitoring specified in DL(W)151 and in the Monitoring Proposal set out in this application will ensure compliance with the Groundwater, Surface water and Birds and Habitats Regulations.

Lough Gill SAC Protection Measures

7.324 The main risk associated with the proposed extension in depth for a portion of the existing quarry at Aghamore, Co. Sligo, is the initially perceived potential adverse impact it could have on the Lough Gill SAC (Site Code 001976). The 2020 Discharge Licence provides a Protection Measure. The

potential maximum 3,500m3/d licensed future discharge from the quarry to Lough Gill could be considered a positive in terms of providing a water balance mitigation for the 14,600 m3/d combined design abstraction rate for Irish Water's supply of Public Water from Lough Gill for Sligo and North Leitrim. T. Recharge characteristics and water balance calculations suggest that the site's potential interference in the wider groundwater catchment's water balance is insignificant. Groundwater enters the quarry primarily through epikarst high up in the already exposed face of the quarry void's walls. Rainfall plays a big part. Groundwater settles in the sump at the lowest level of the quarry and is pumped to under licence DL(W)151 (2020) to the Aghamore Stream. Monitoring results and ELVs specified in the Licence suggest no potential to negatively affect groundwater or surface water quality.

7.325 With the proposed expansion of the quarry, the quarry floor will be lowered. This could result in a small increase in the volume of water in the quarry: the same volume of rainfall runoff will fall on a similar area – it will just be ground at a lower elevation, with the same runoff co-efficient and volumes derived.

7.326 Extensive geophysics across the floor of the current void have examined the geology to the depth of -60m OD and no evidence was found of deep karst conduits or voids that could connect the site to Lough Gill. No potential for impact is envisaged.

Cummeen Strand SAC & SPA Protection Measures

7.327 Cummeen Strand SPA, Cummeen Strand/Drumcliff Bay SAC (Site Codes 004035 and 000627) are located 7km downstream of the quarry and downstream of Lough Gill.

7.328 As previously stated, there is an indirect hydrological (surface water) connection between the site and Cummeen Strand SPA, Cummeen Strand/Drumcliff Bay SAC which is located downstream of Lough Gill. Given that Lough Gill occurs upstream of Cummeen Strand and that the assessment of impact finds no impact on Lough Gill then Cummeen Strand would also not be impacted.

7.329 Given that discharge monitoring results from the quarry and ELVs specified in the 2020 Discharge Licence suggest no potential to negatively affect surface water quality entering Lough Gill, Cummeen Strand SPA, Cummeen Strand/Drumcliff Bay SAC is not considered a potentially sensitive receptor for the proposed development.

Ballysadare Bay SAC & SPA Protection Measures

7.330 The most easterly boundaries of Ballysadare Bay SAC (Site Code 000622) and Ballysadare Bay SPA (Site Code 004129) are situated south west of the quarry at a distance of 3km, approximately, from the site's most western boundary.

7.331 As previously stated, there is no direct hydrological connection with Ballysadare Bay SAC and SPA *via* surface runoff or stream networks. There is a direct underlying subsurface hydrogeological connection between the site and Ballysadare Bay SAC and SPA to the west, as groundwater from the western half of the site discharges to Ballysadare Bay. However, given the distance to Ballysadare Bay (c. 3.3km), the size of the catchment to Ballysadare Bay and the very small groundwater abstraction rate from the quarry, Ballysadare Bay SAC and SPA is not considered a

potentially sensitive receptor for the proposed development. Water balance calculations for the Carromore East Groundwater Body, discharging from the site to Ballysadare Bay, suggest 'Low Potential for Impact' (Appendix 7-2).

Overall Conclusions

7.332 The site holds a defensible and justifiable discharge licence issued under review by Sligo County Council in 2020 [DL(W)151].

7.333 DL(W)151 establishes a management and operation system that will ensure discharge to the receiving waters and compliance with the Surface Water Regulations, Groundwater Regulations and Birds and Habitats Regulations.

7.334 The same management and operations will occur in the processing area. Evaluation of the sand and gravel subsoils and the groundwater regime at the processing area suggest no potential for interaction between the hard rock quarry void and the processing area. Mitigation measures will be in place for hydrocarbon management.

7.335 Geological and geophysical evaluations at the site proposed for further rock excavation suggest competent limestone beneath the current floor elevation of -21mOD to the investigation zone of -60mOD (Apex, 2021). The site investigations and evaluations therefore suggest that the proposal to deepen the quarry to -50mOD is viable.

7.336 The risk posed to Lough Gill SAC and PWSS is deemed negligible. Potential effects or interactions with the PWSSs abstractions for Sligo and North Leitrim have been robustly examined.

7.337 The risk posed to Ballysadare Bay SAC and SPA, and Cummeen Strand SAC and SPA, is deemed negligible.

7.338 The risk posed to the underlying Groundwater Bodies is deemed negligible.

7.339 The quarry void's perimeter land surface has an approximate elevation of 30mOD.

7.340 The regional karst system was well studied and reported to Sligo County Council independently of the assessment completed for the applicants. It is reported that there is an active and responsive, rainfall driven, epikarst system operating in the 0mOD to 20mOD elevation range.

7.341 Given that the quarry void's floor is currently at an elevation of -21mOD, the significant epikarst flow system's discharges are already encountered at the site, which currently discharges 3000m^3/d, approximately.

7.342 Water balance for the site itself suggests that the largest input of water to the quarry was from direct rainfall/runoff (71%), with indirect drainage via epikarst accounting for 19%, and deeper groundwater inflows making up only 10%.

7.343 It is therefore envisaged that as the void is progressed in depth, little more groundwater will be encountered. Apex geophysics analysis (2021) found no suggestion of groundwater flow paths beneath the area proposed for deepening.

FIGURES

Fig. 7-1 Monitoring Well Location Map (Google Earth)

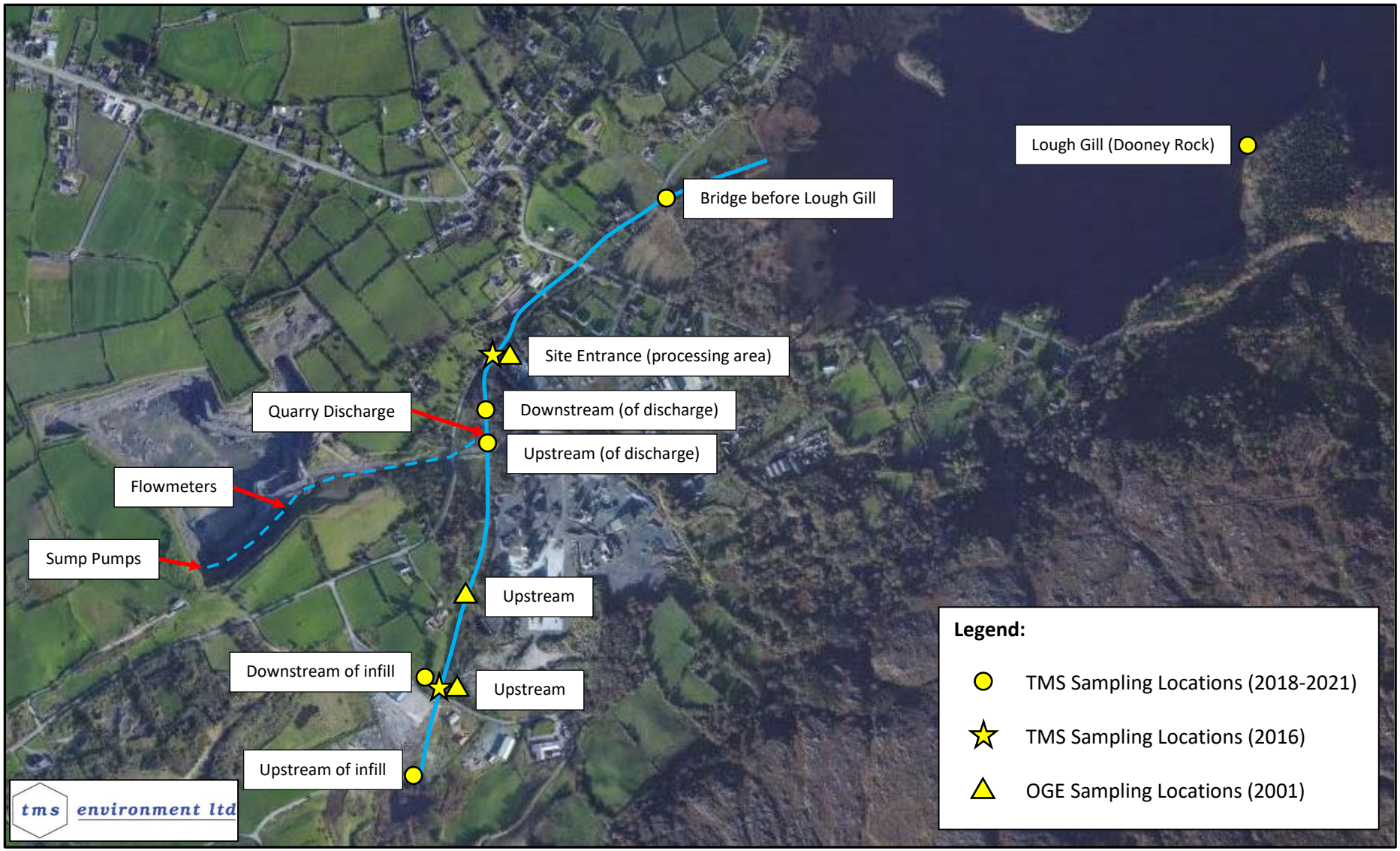


Fig. 7-2 Surface Water Sampling Locations Map (Bing Maps)

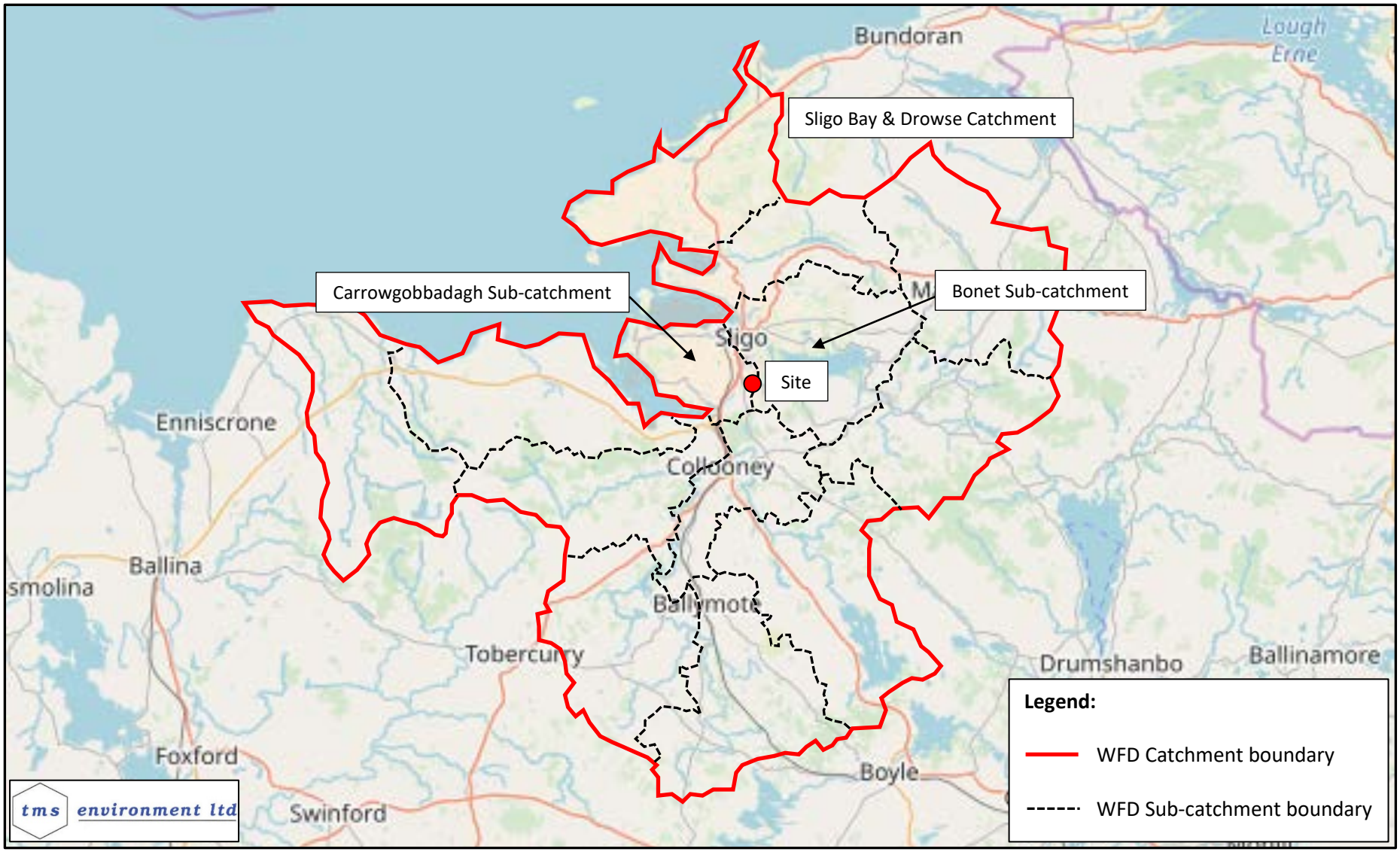


Fig. 7-3 Surface Water Catchment & Sub-Catchments Map

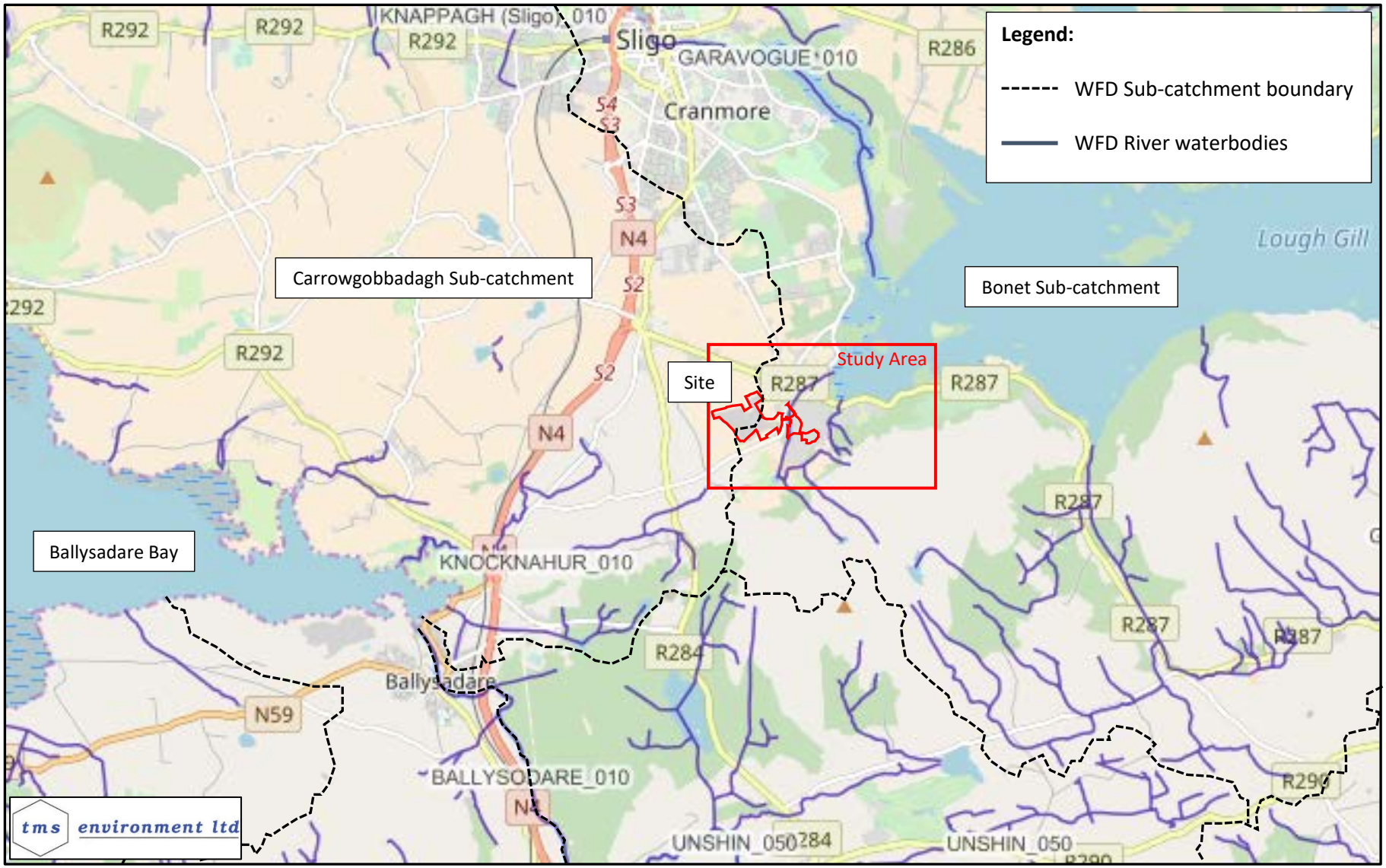
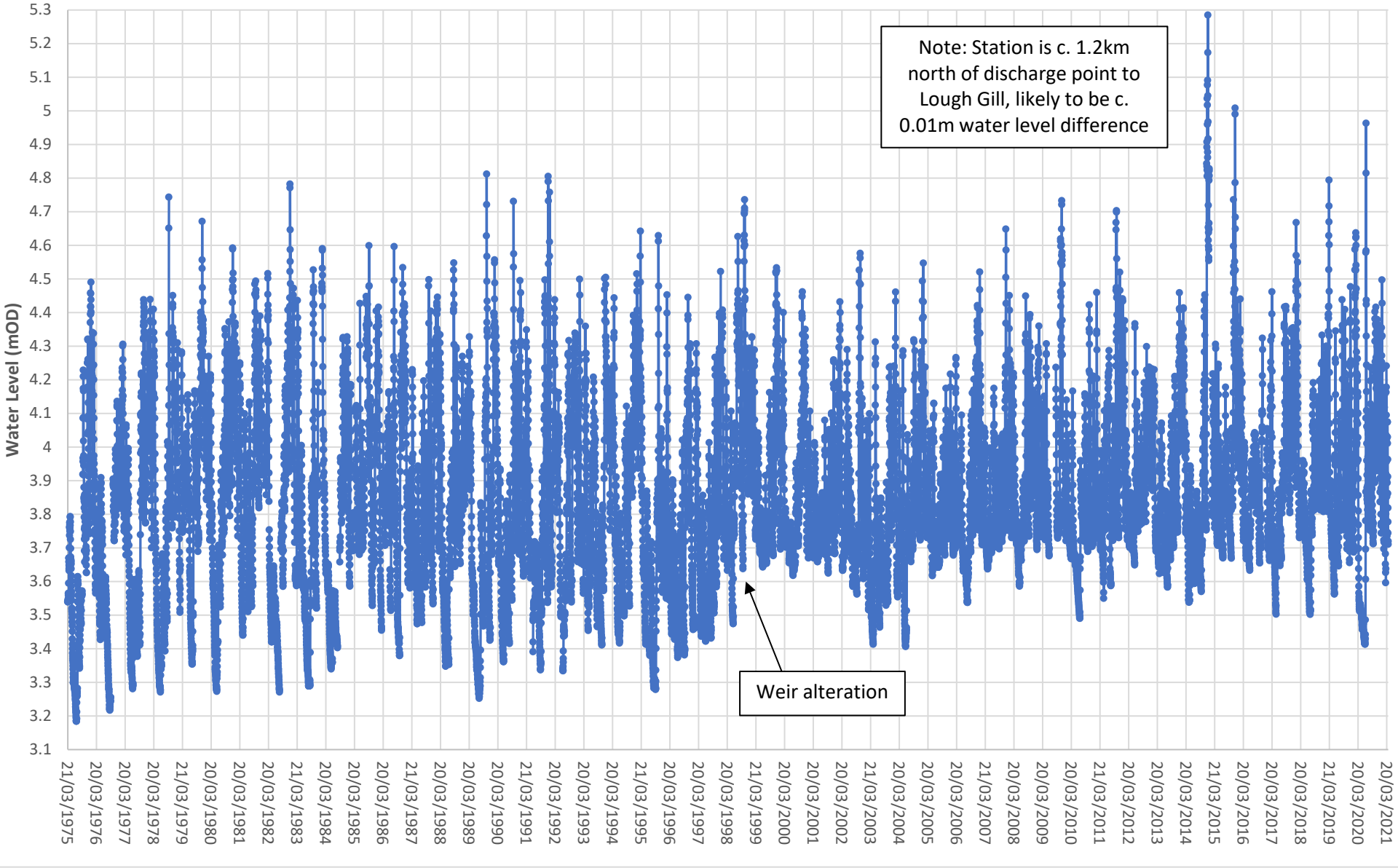


Fig. 7-4 Surface Waterbodies Map (EPA Water Maps website)

Fig. 7-5: Daily Mean Water Levels, Lough Gill (mOD)



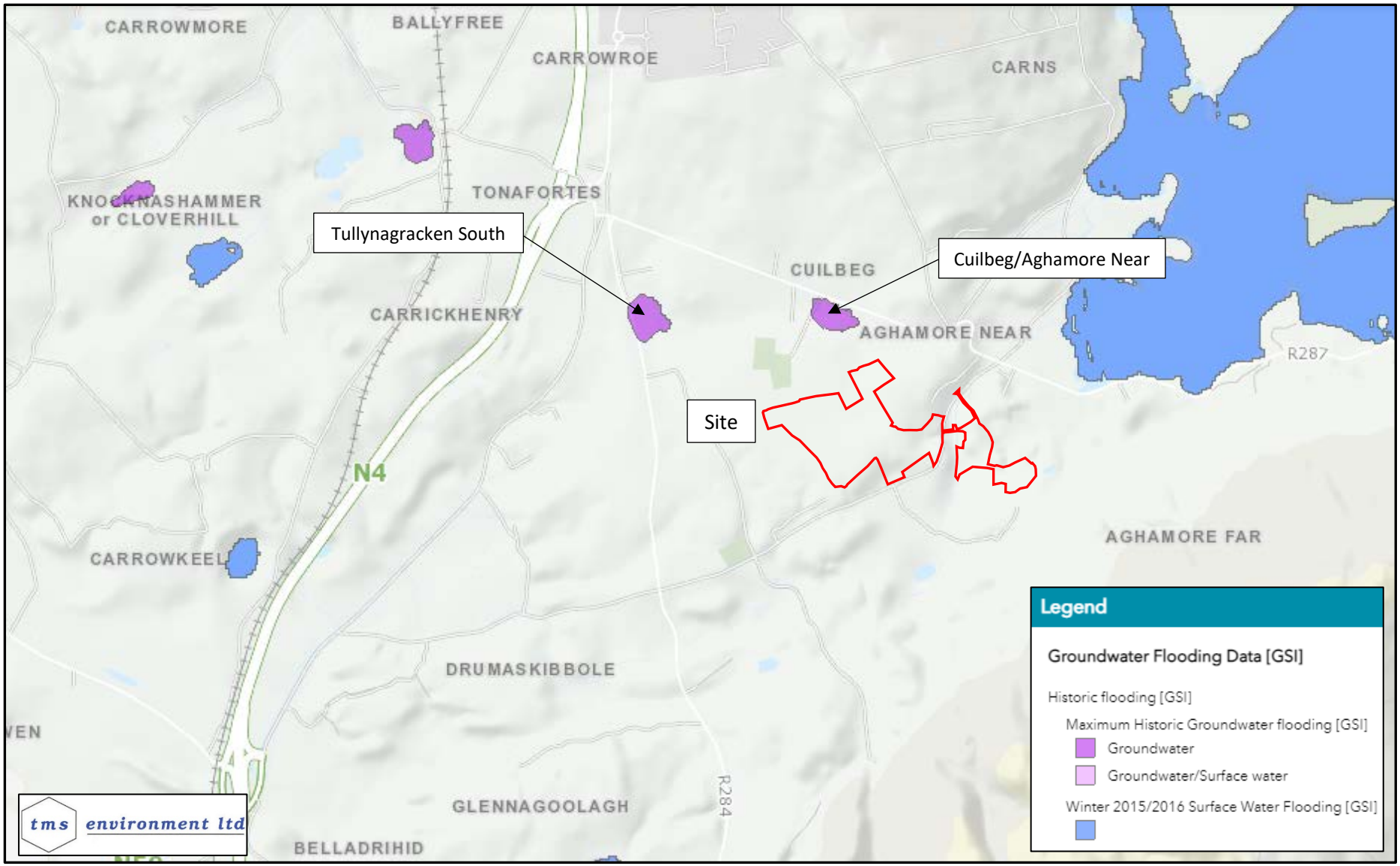


Fig. 7-6 Groundwater Flooding Map (GSI Groundwater Flooding Data Viewer)

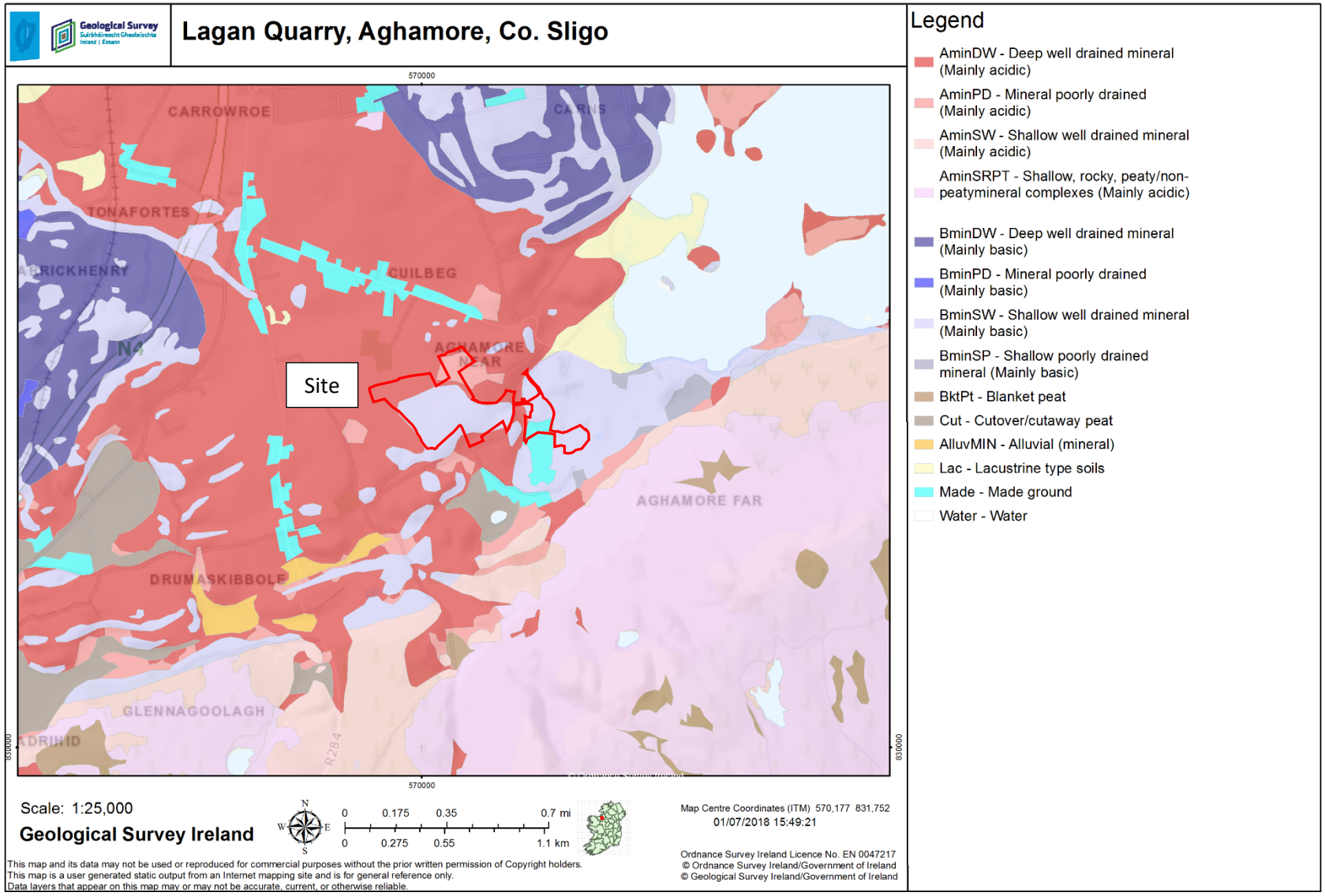


Fig. 7-7 Soils Map (GSI Groundwater Data Viewer)

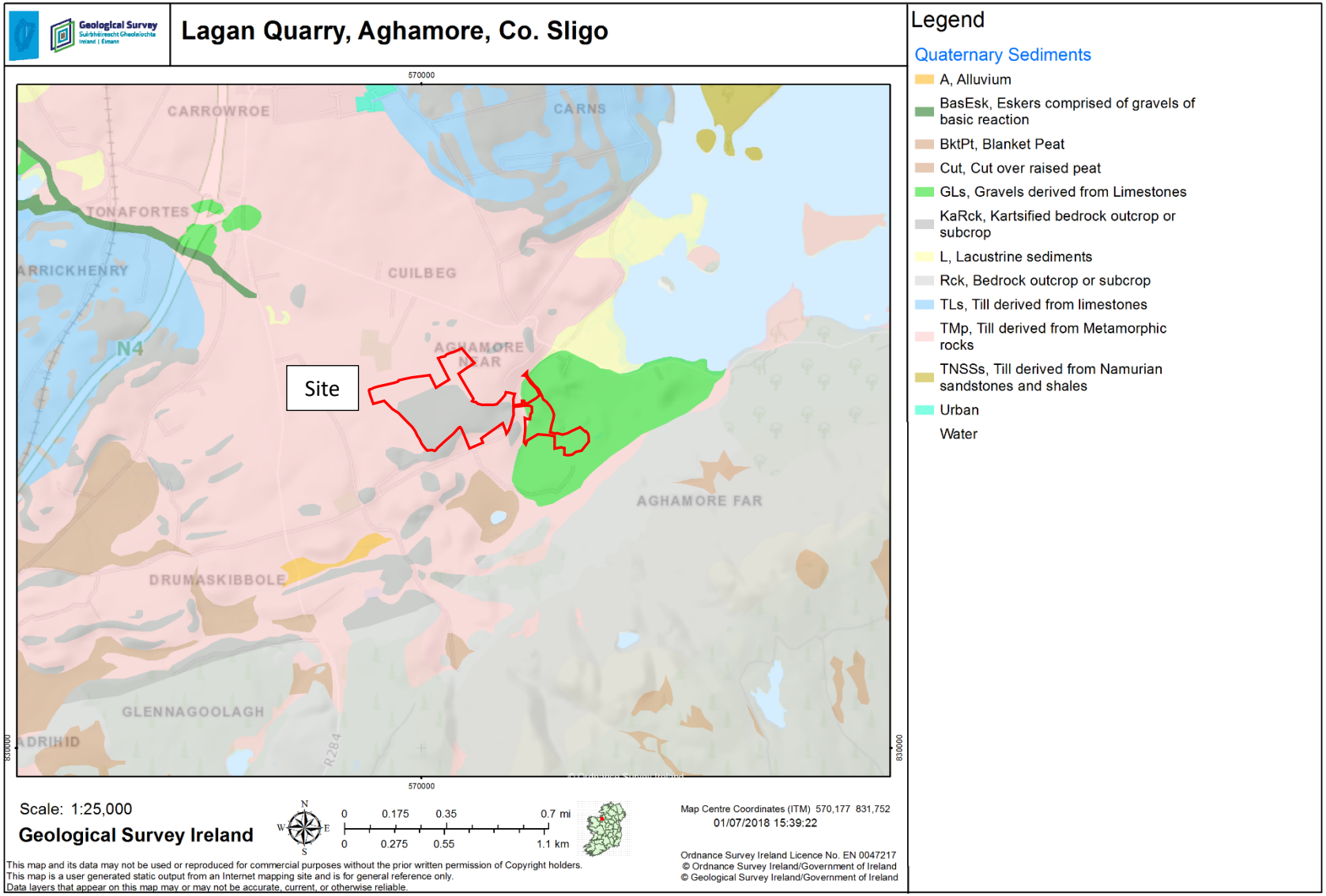


Fig. 7-8 Subsoils Map (GSI Groundwater Data Viewer)

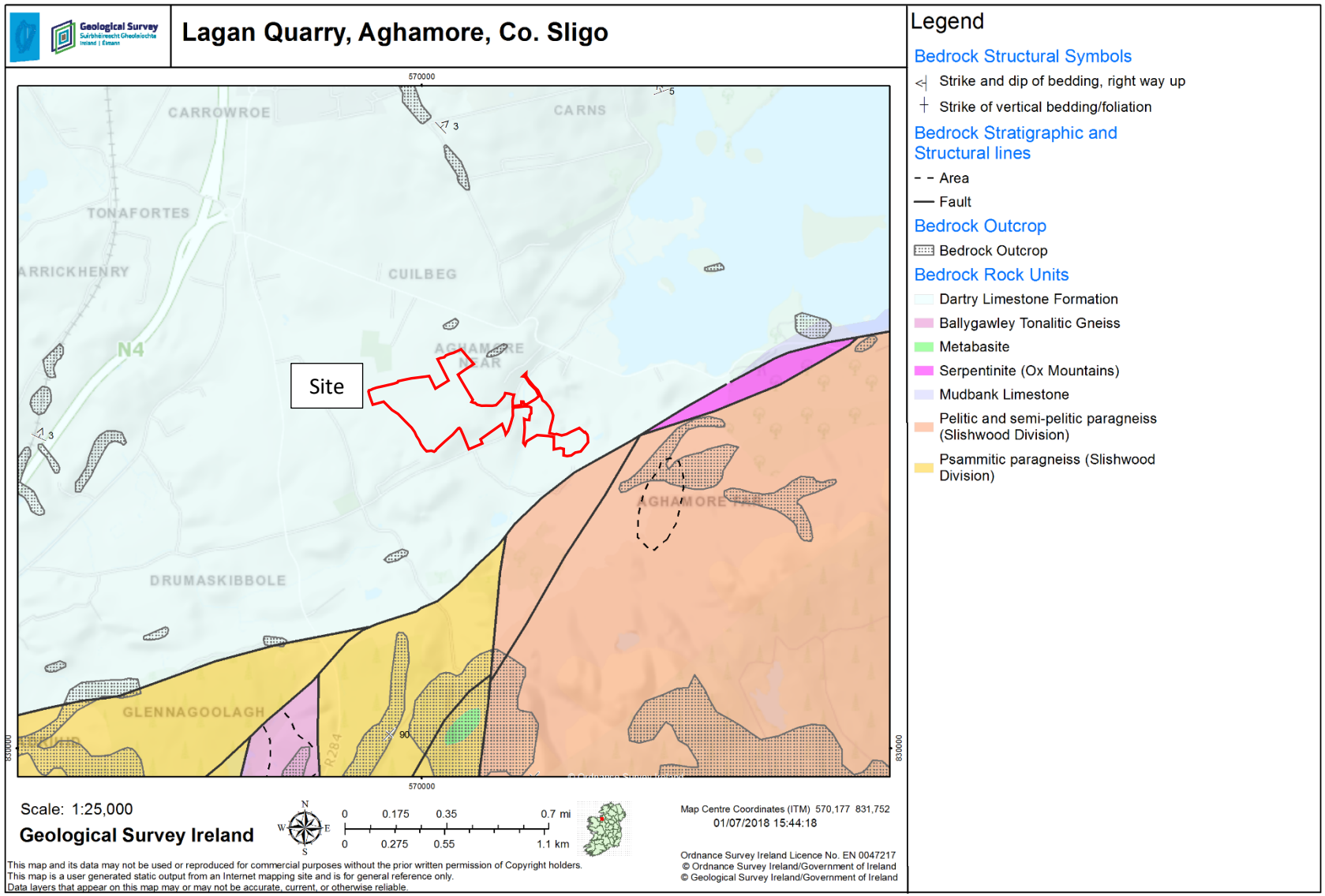


Fig. 7-9 Bedrock Map (GSI Groundwater Data Viewer)

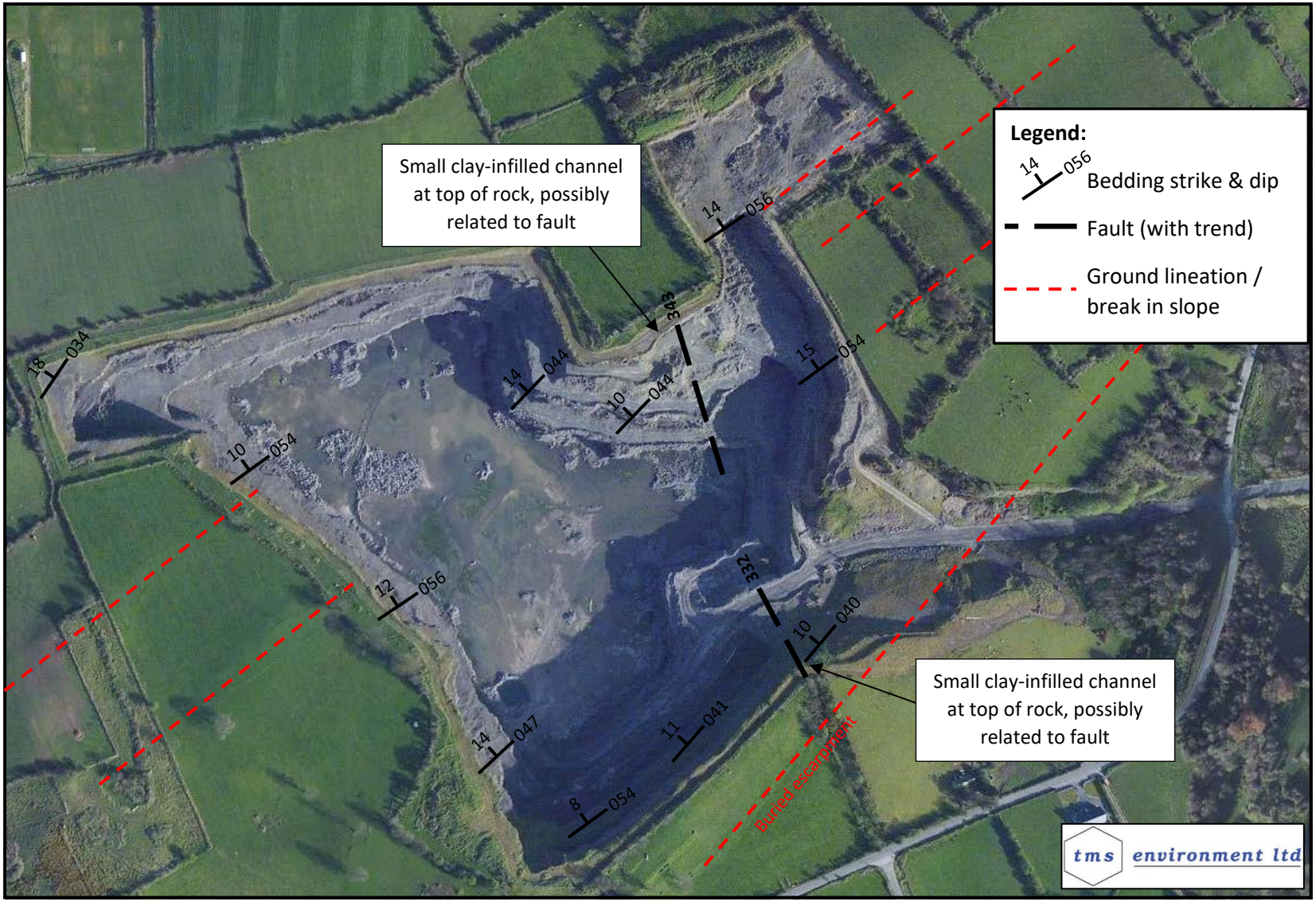


Fig. 7-10 Bedrock Structure Map (Bing Maps)

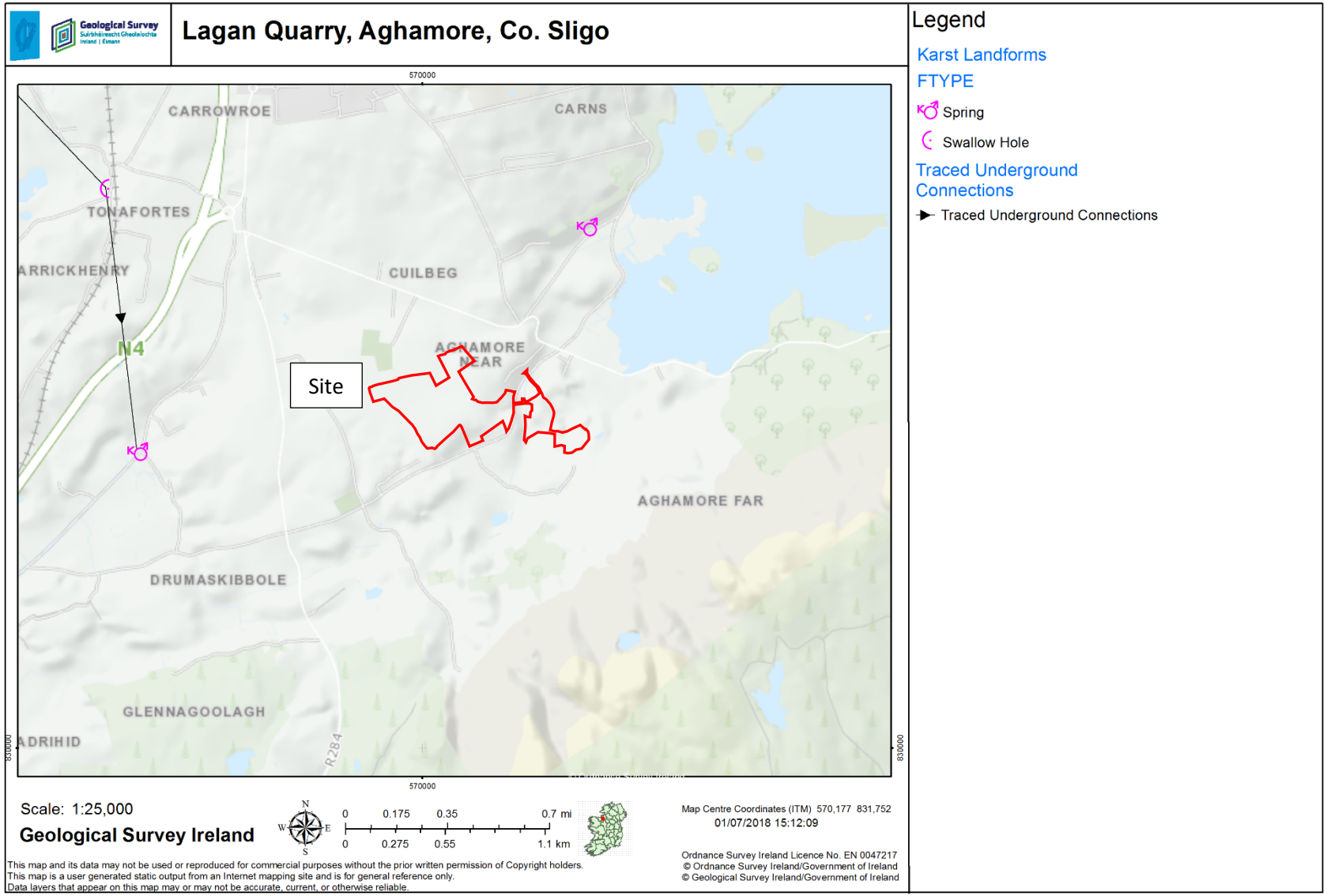


Fig. 7-11 Karst Features Map (GSI Groundwater Data Viewer)

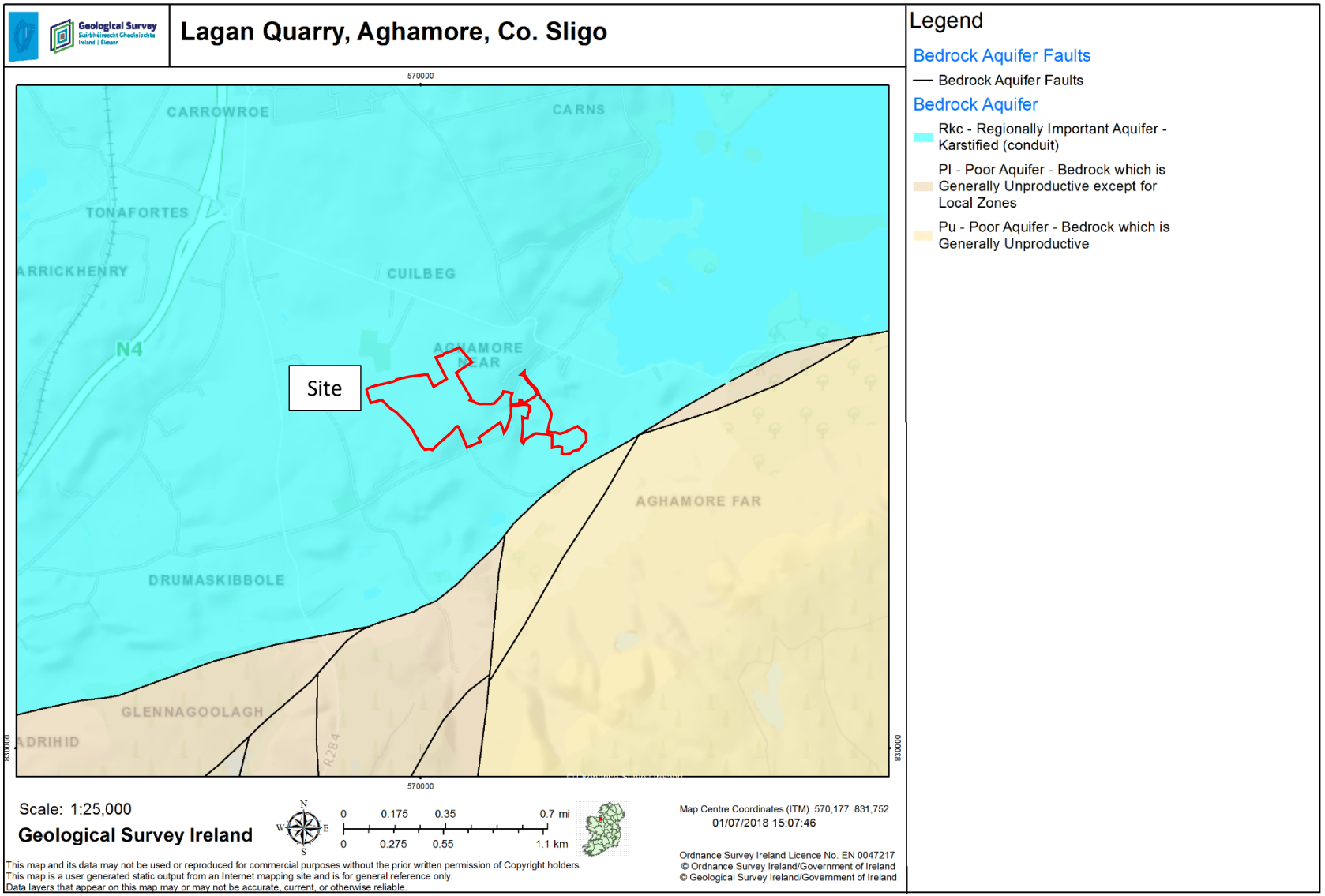


Fig. 7-12 Bedrock Aquifers Map (GSI Groundwater Data Viewer)

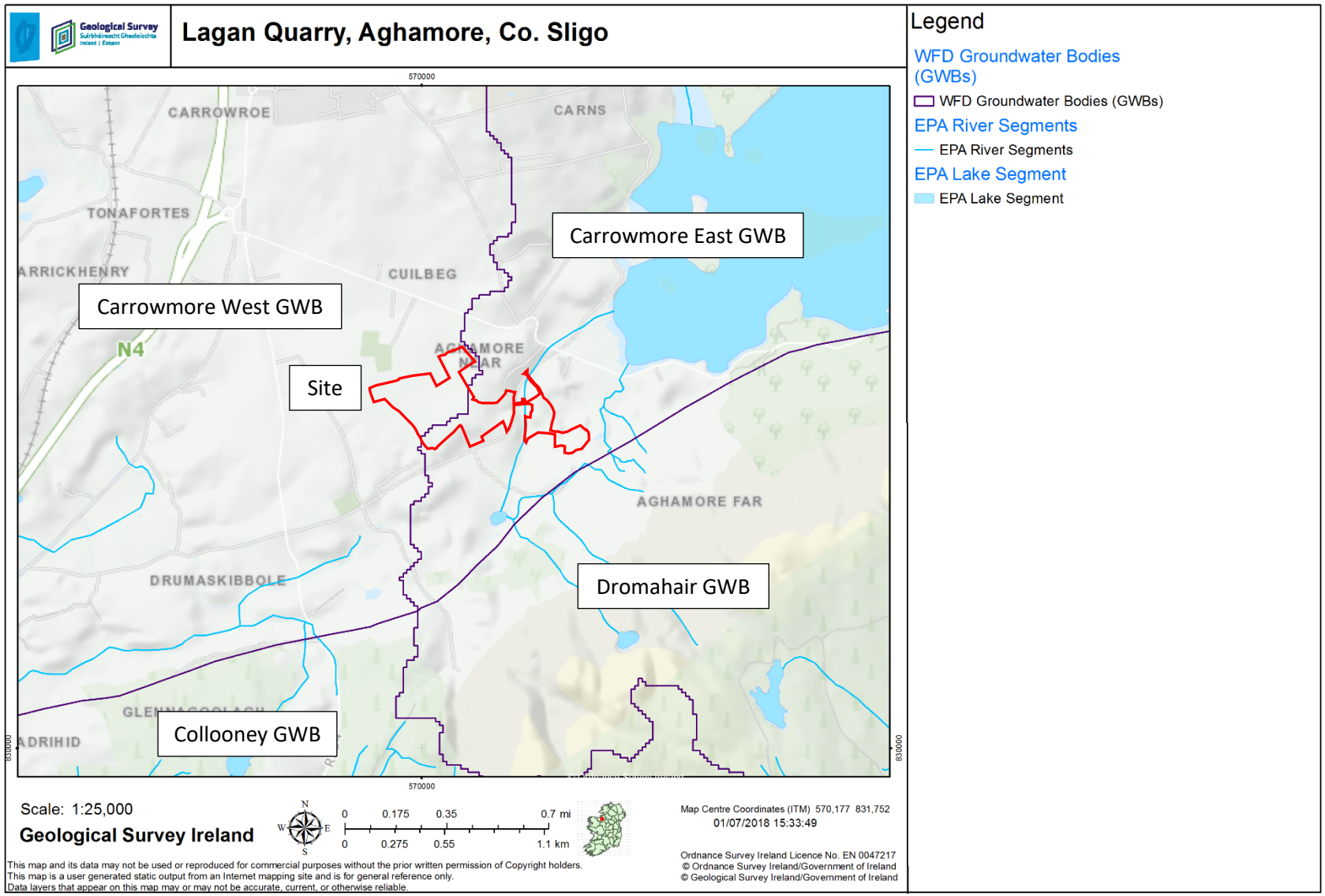


Fig. 7-13 Groundwater Bodies Map (GSI Groundwater Data Viewer)

Fig. 7-14 Stormwater Catchment & Epikarst Drainage Catchment Map (Bing Maps)

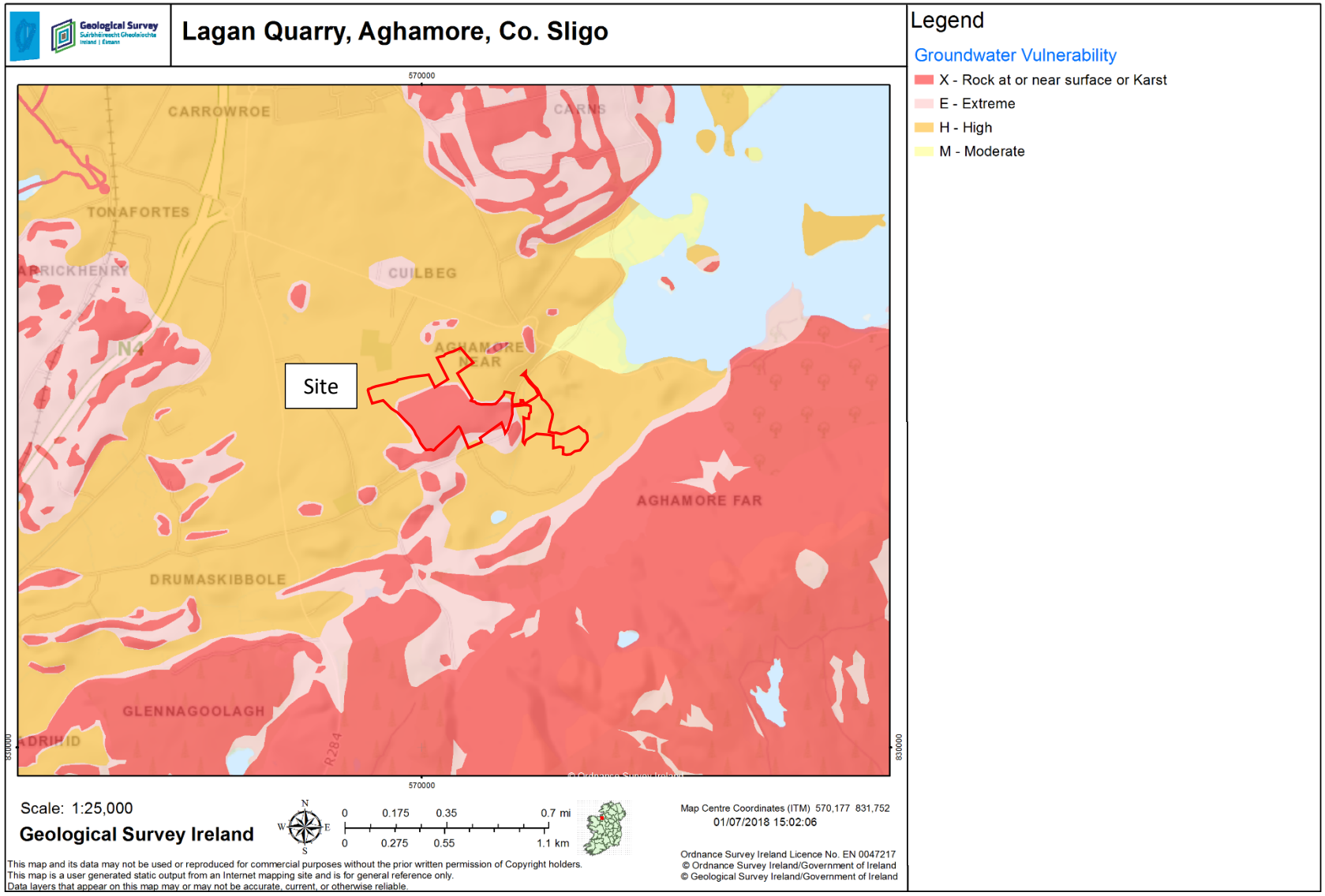


Fig. 7-15 Groundwater Vulnerability Map (GSI Groundwater Data Viewer)

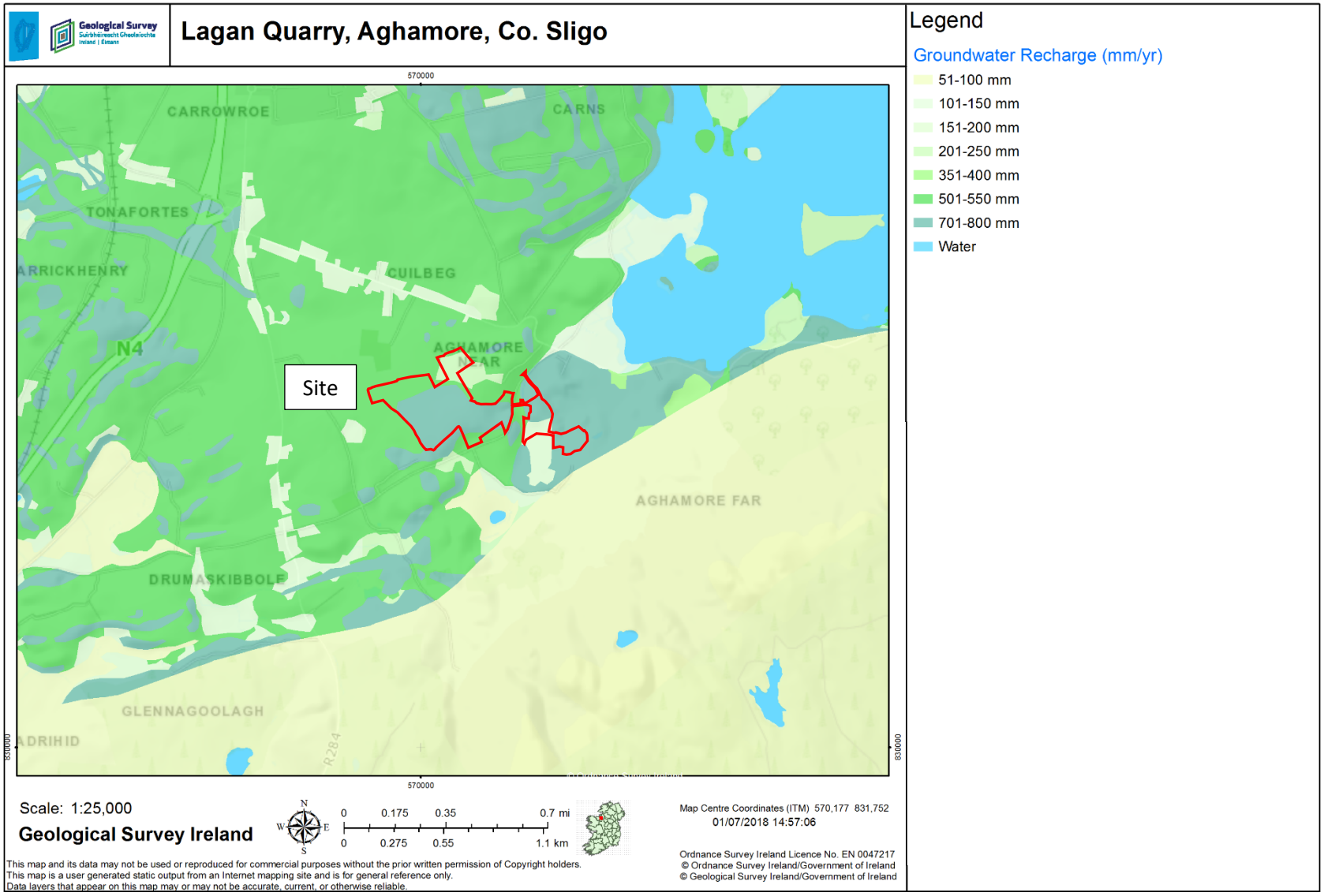


Fig. 7-16 Groundwater Recharge Map (GSI Groundwater Data Viewer)

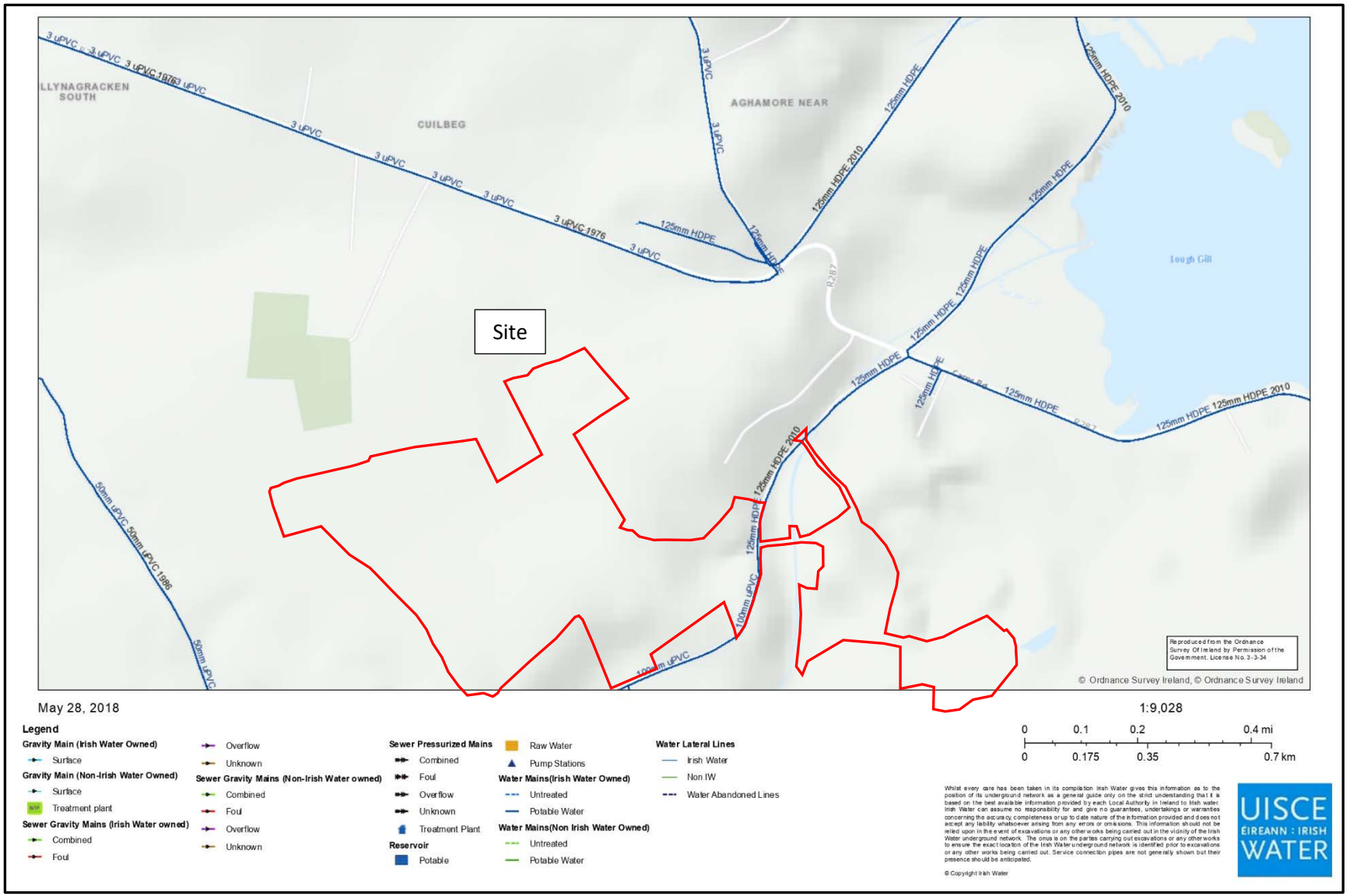


Fig. 7-17 Water Mains Map (Sligo County Council)

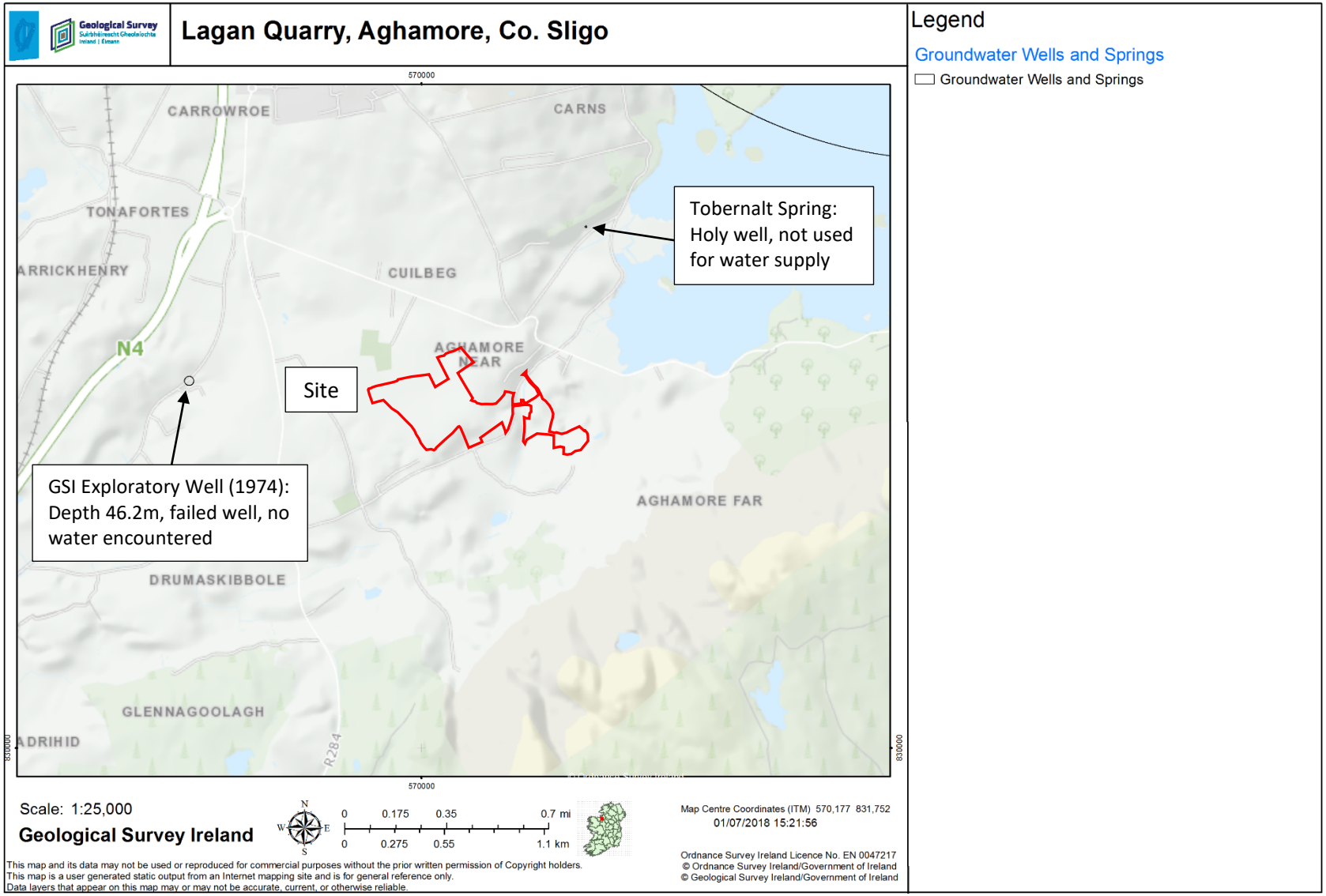
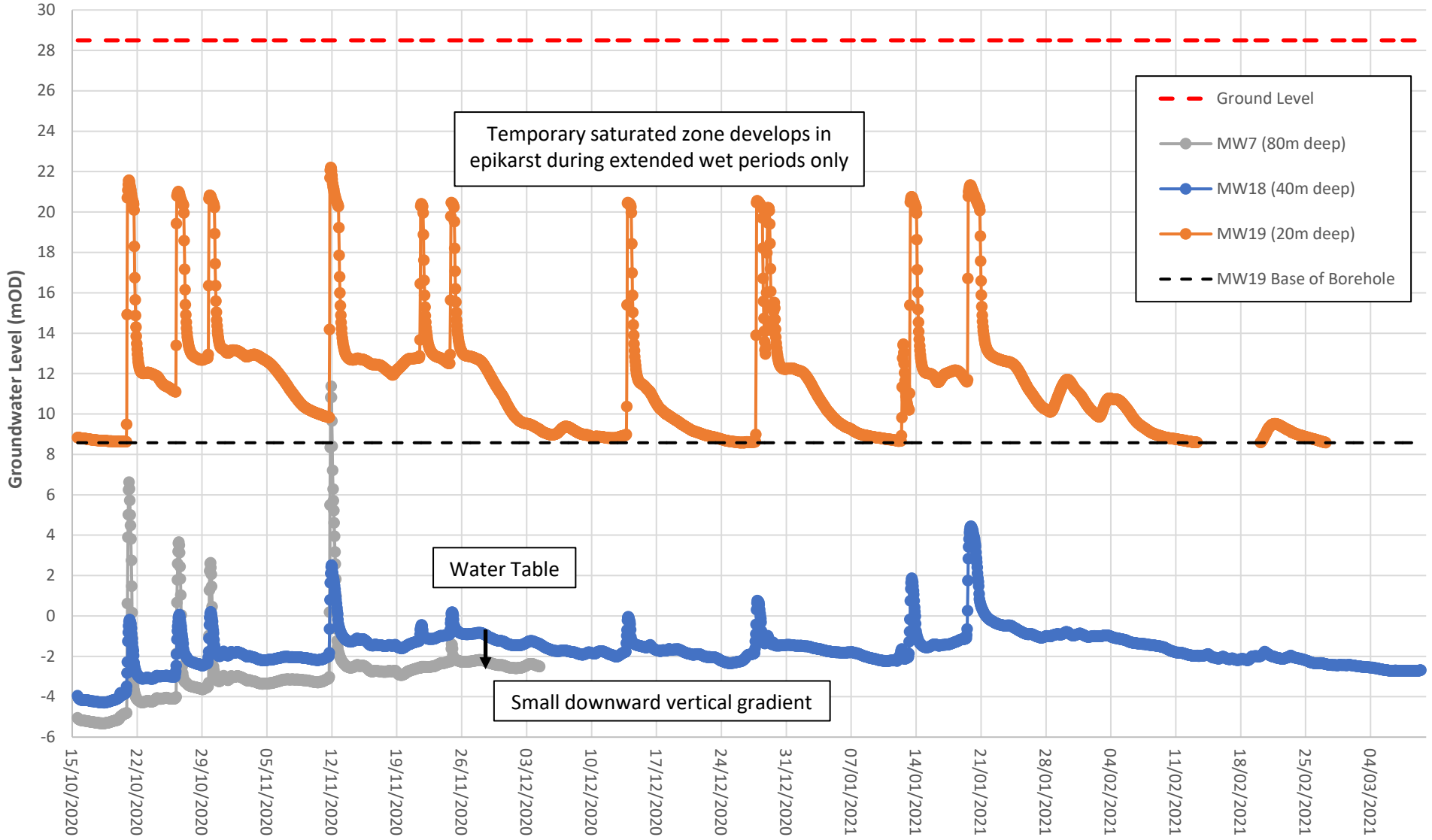


Fig. 7-18 Well Records Map (GSI Groundwater Data Viewer)

Fig. 7-19 Private Wells within 1km of Quarry (Bing Maps)

Fig. 7-20: Groundwater Levels at Northern Quarry Margin



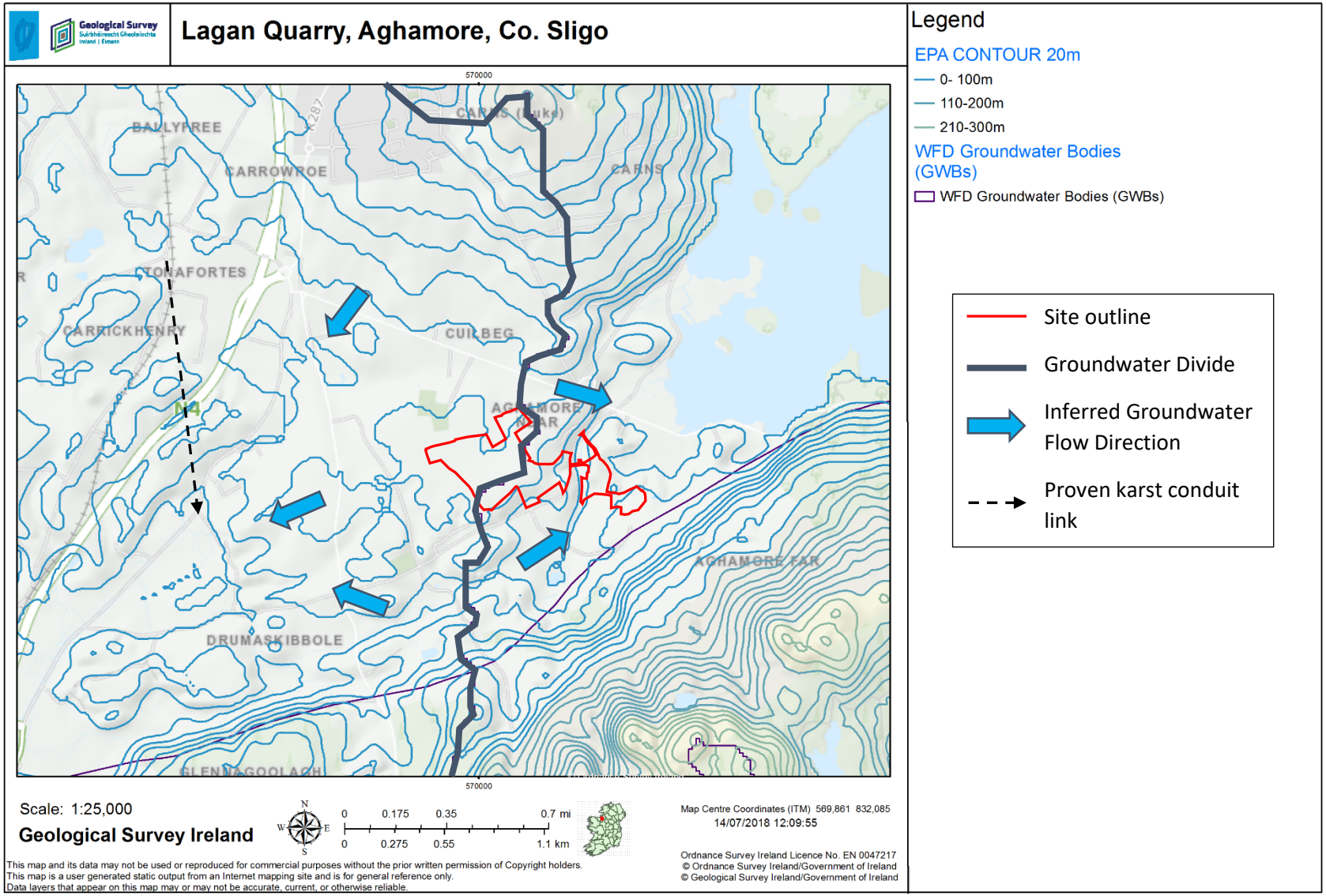


Fig. 7-21 Regional Groundwater Flow Map (GSI Groundwater Data Viewer contour map)

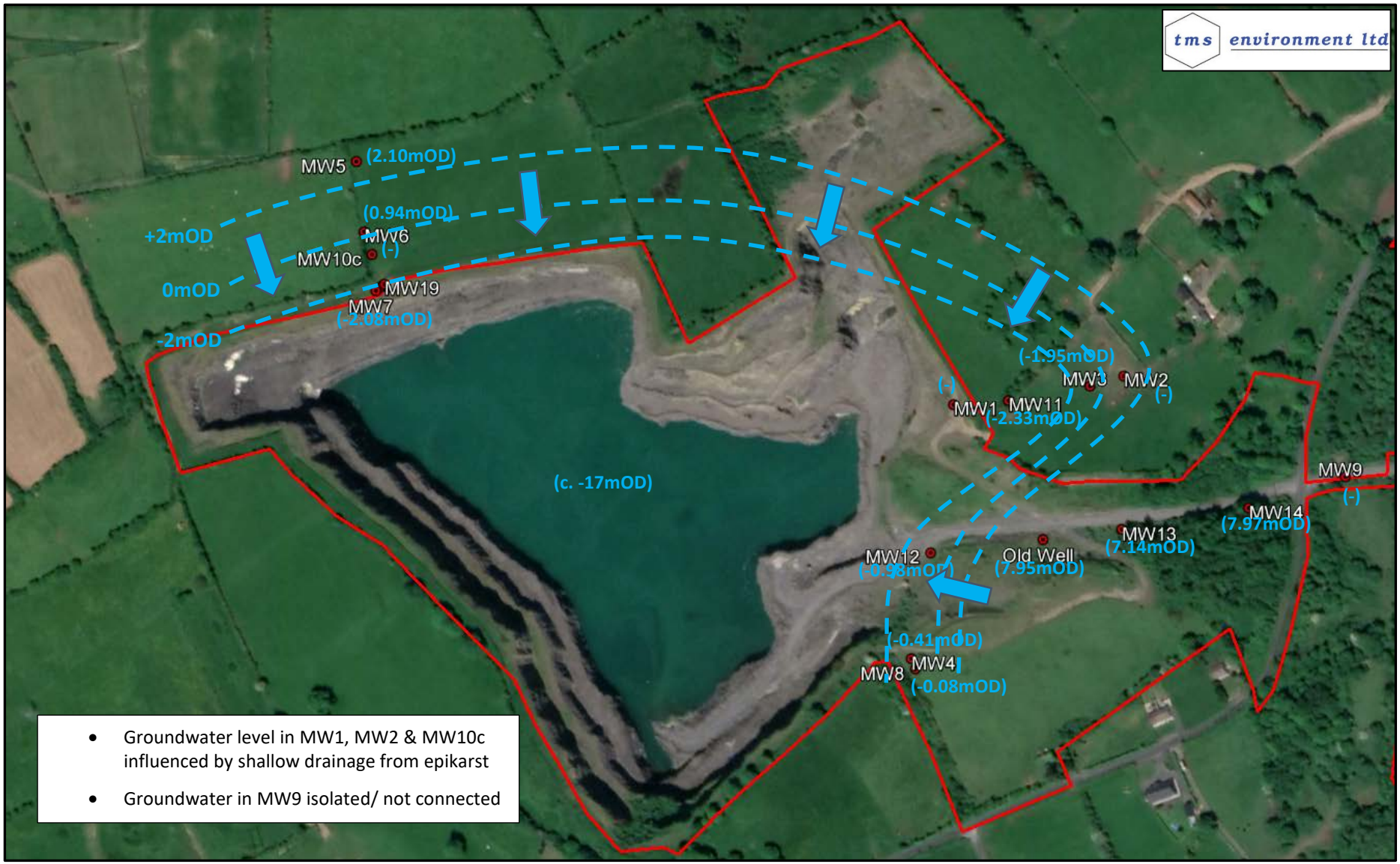


Fig. 7-22a Local Groundwater Flow Map – Quarry (30/11/2020)

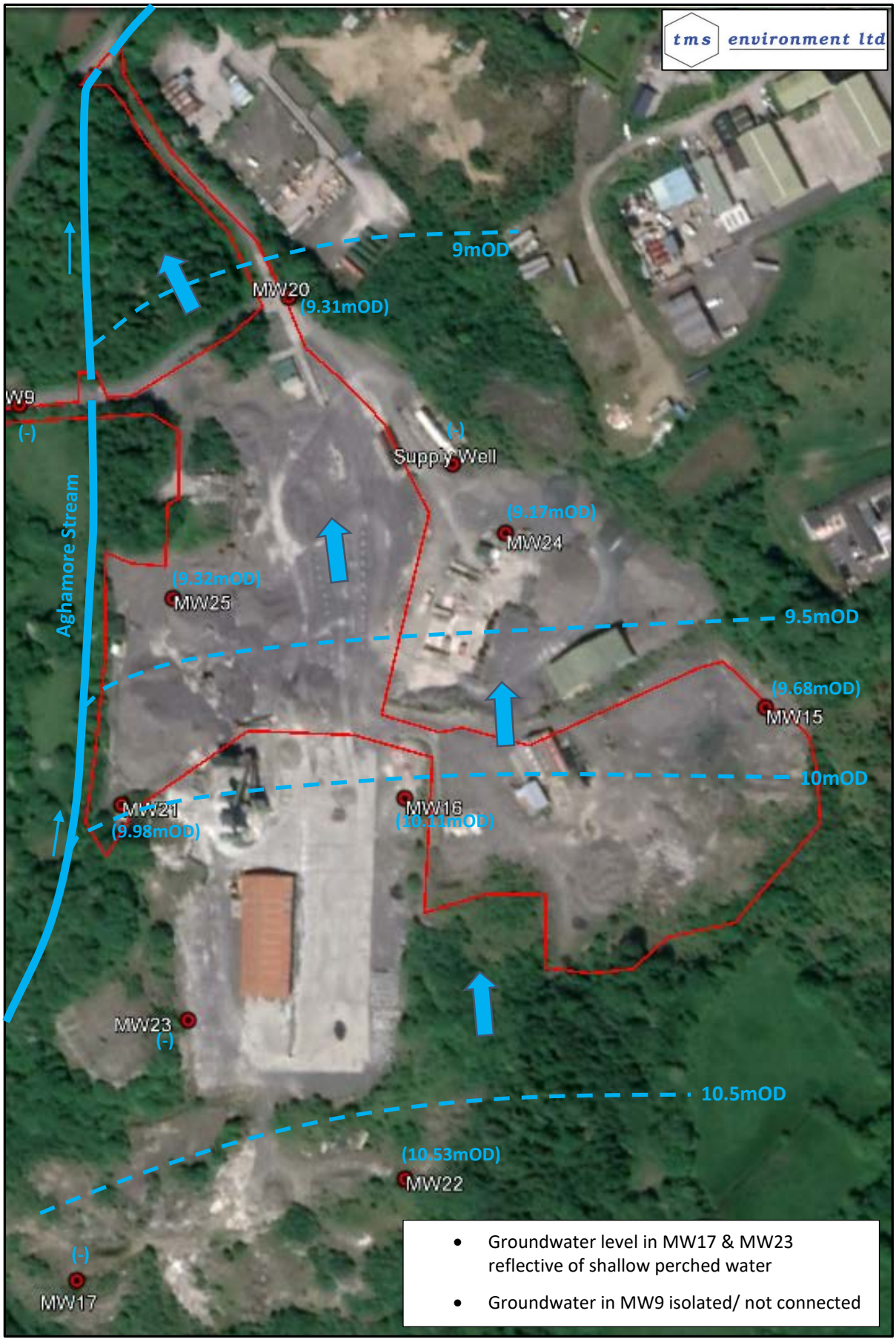


Fig. 7-22b Local Groundwater Flow Map – Processing Yard (30/11/2020)

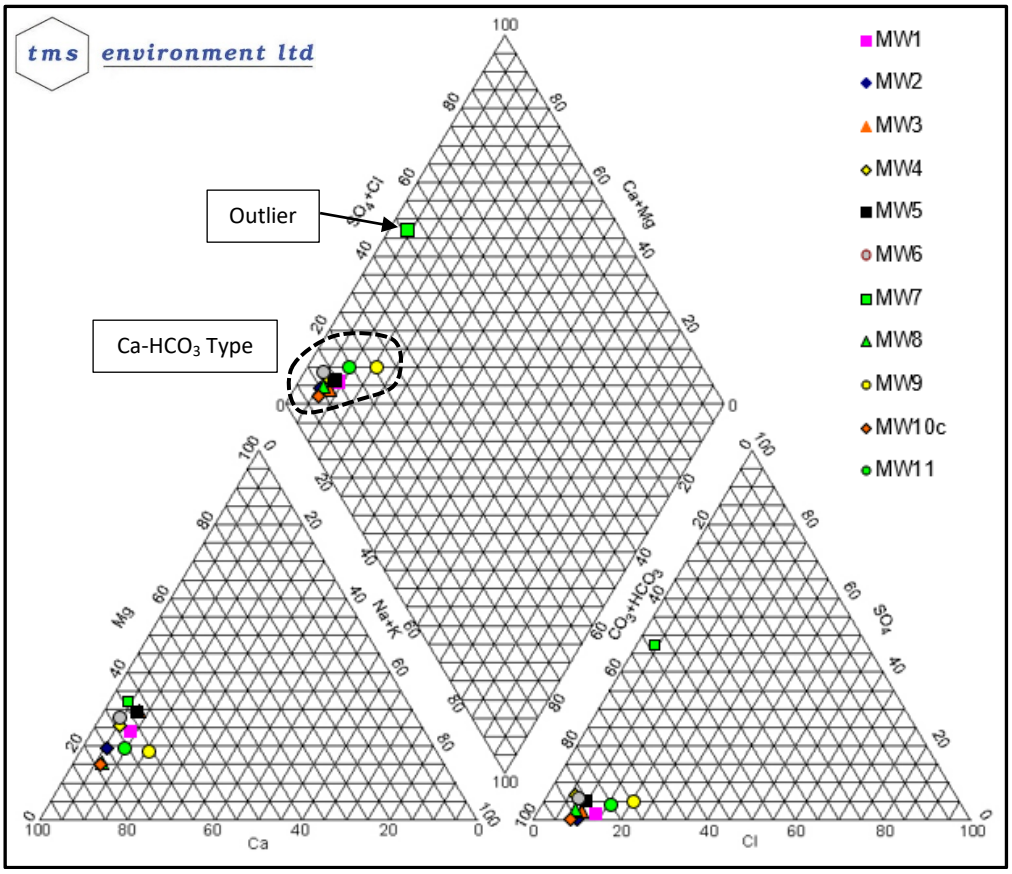


Fig. 7-23a Piper Plot of Groundwater Samples (8/2/2018)

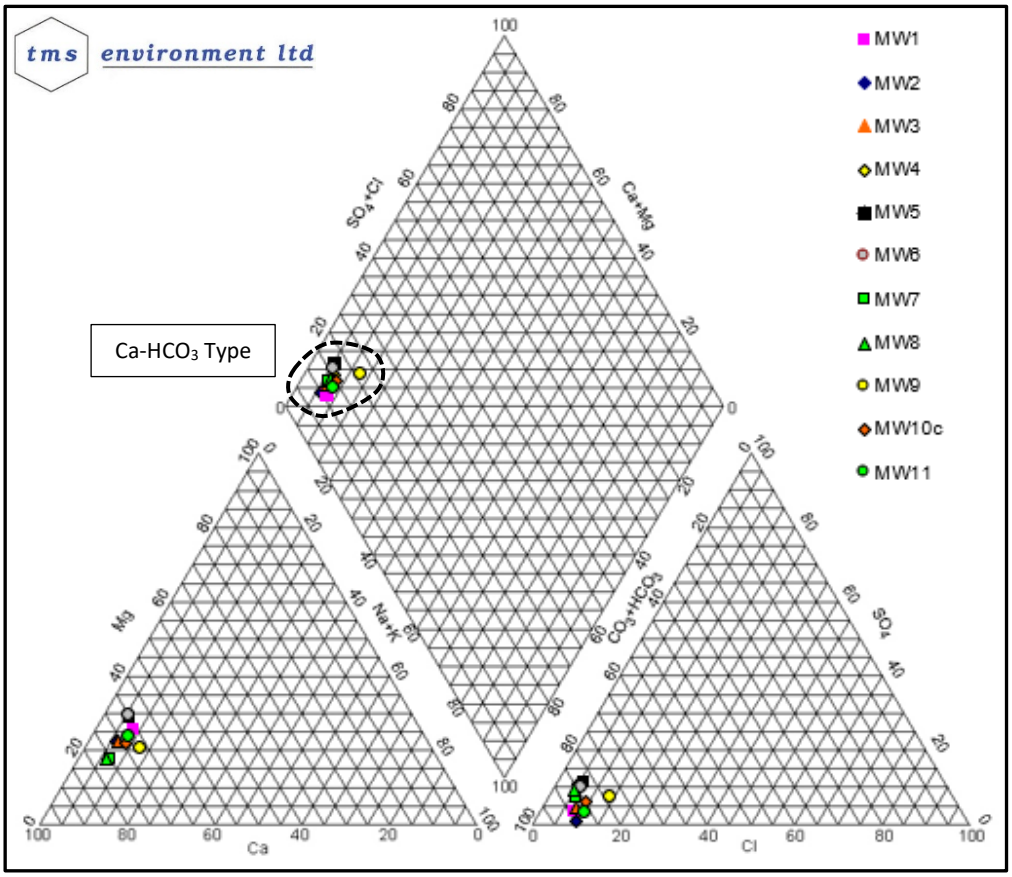


Fig. 7-23b Piper Plot of Groundwater Samples (19/4/2018)

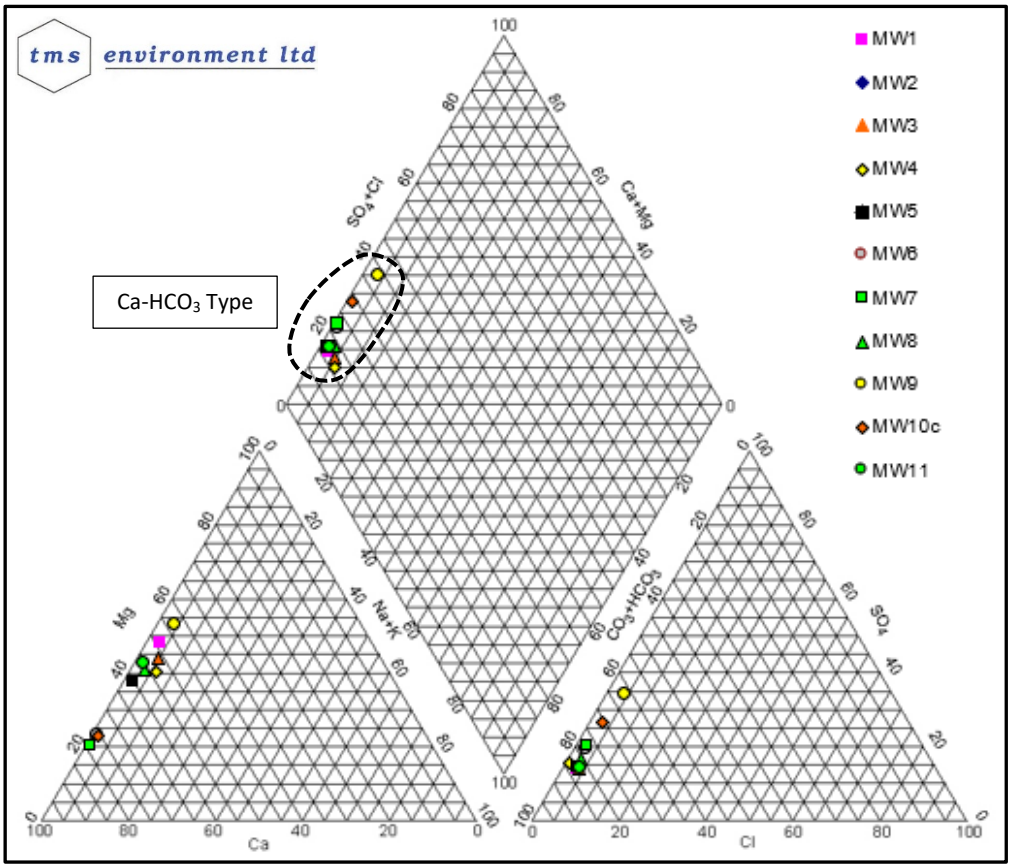


Fig. 7-23c Piper Plot of Groundwater Samples (28/8/2018)

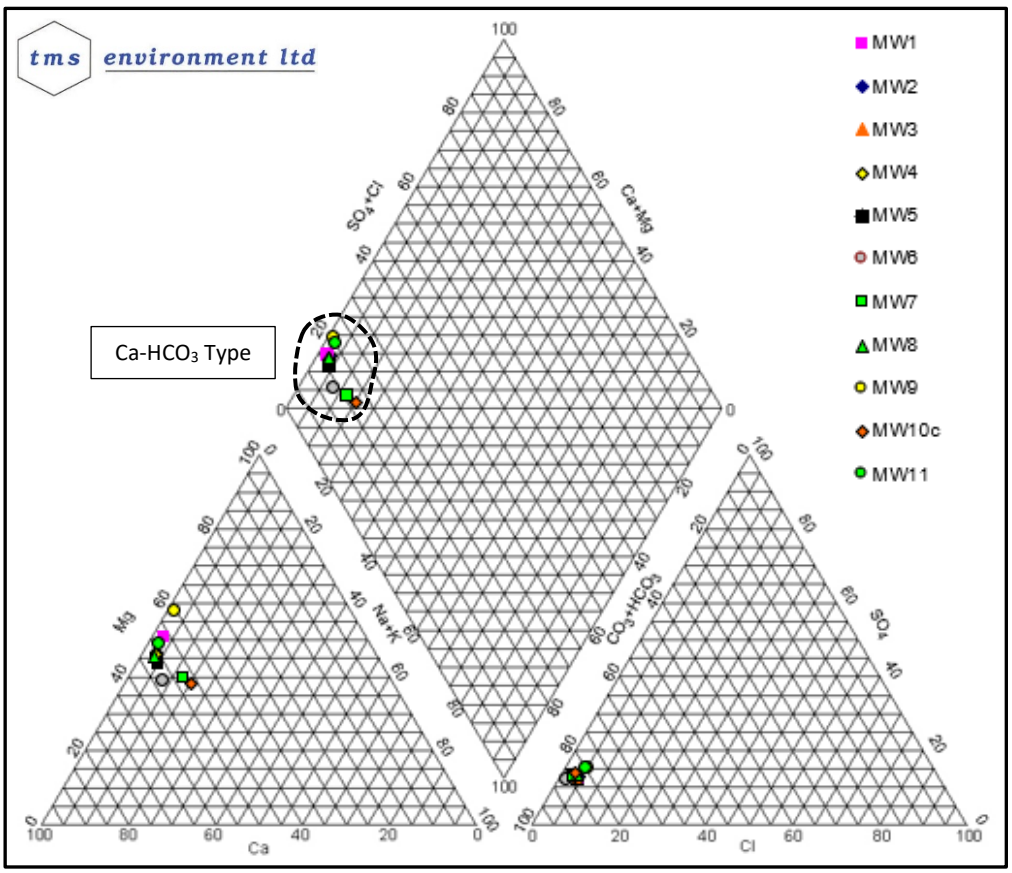


Fig. 7-23d Piper Plot of Groundwater Samples (5/2/2019)

Fig. 7-24a Conceptual Site Model: North of Quarry

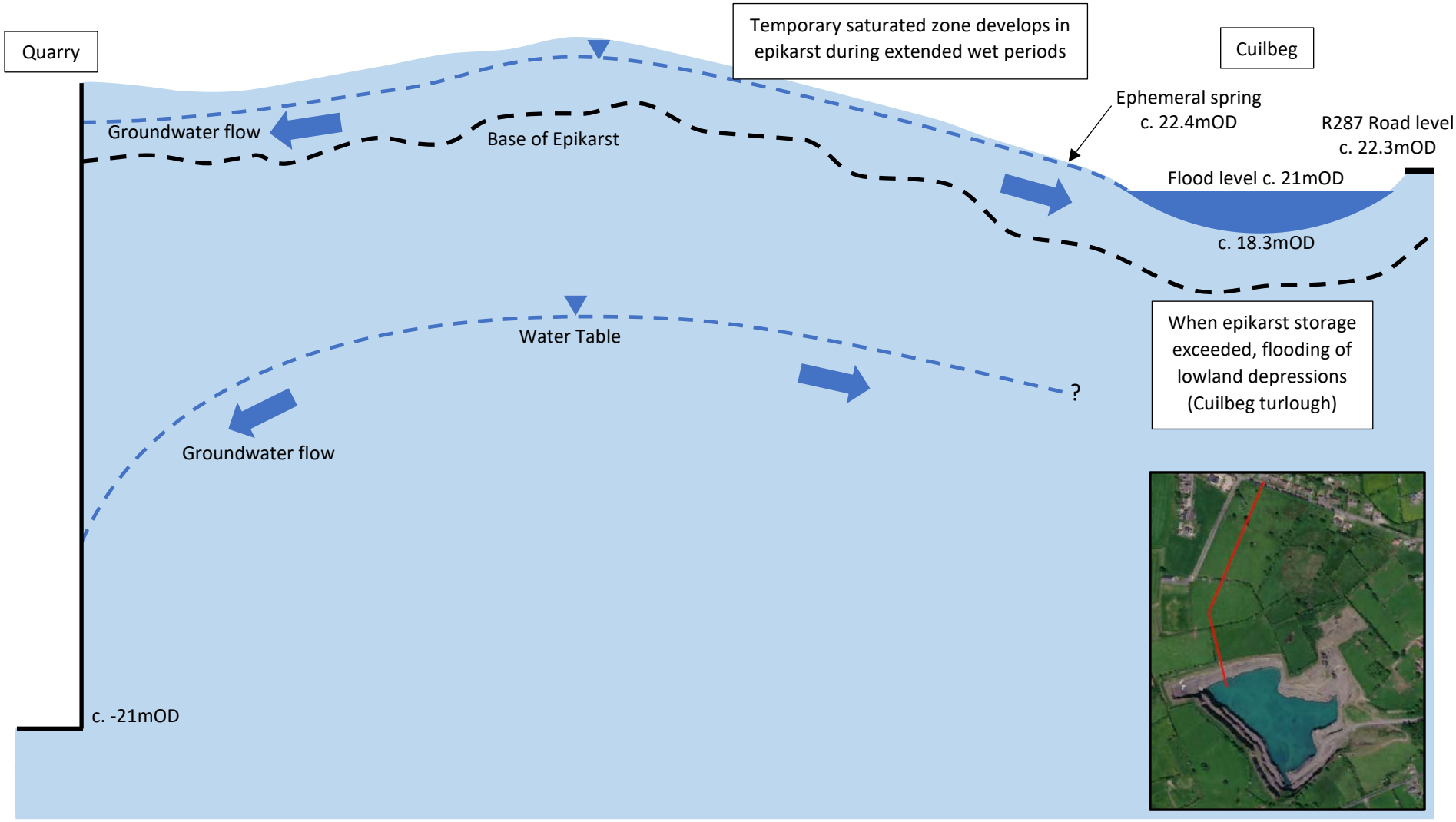
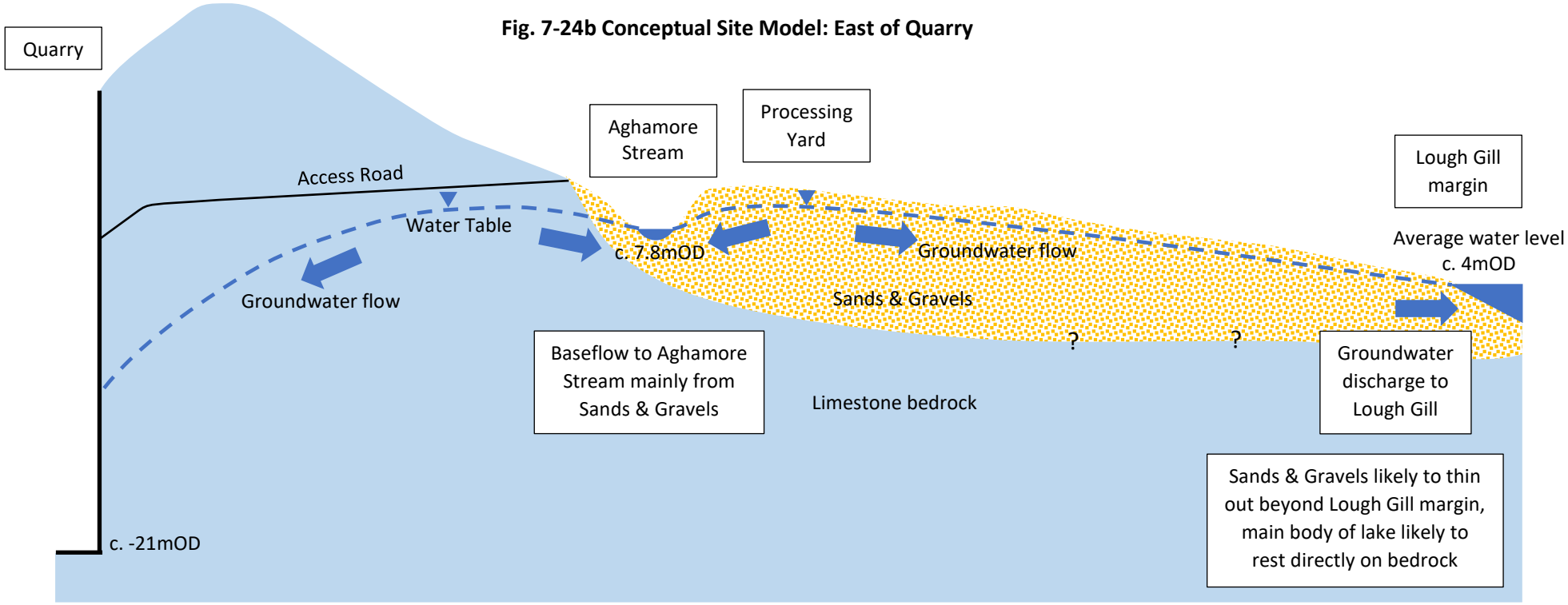


Fig. 7-24b Conceptual Site Model: East of Quarry



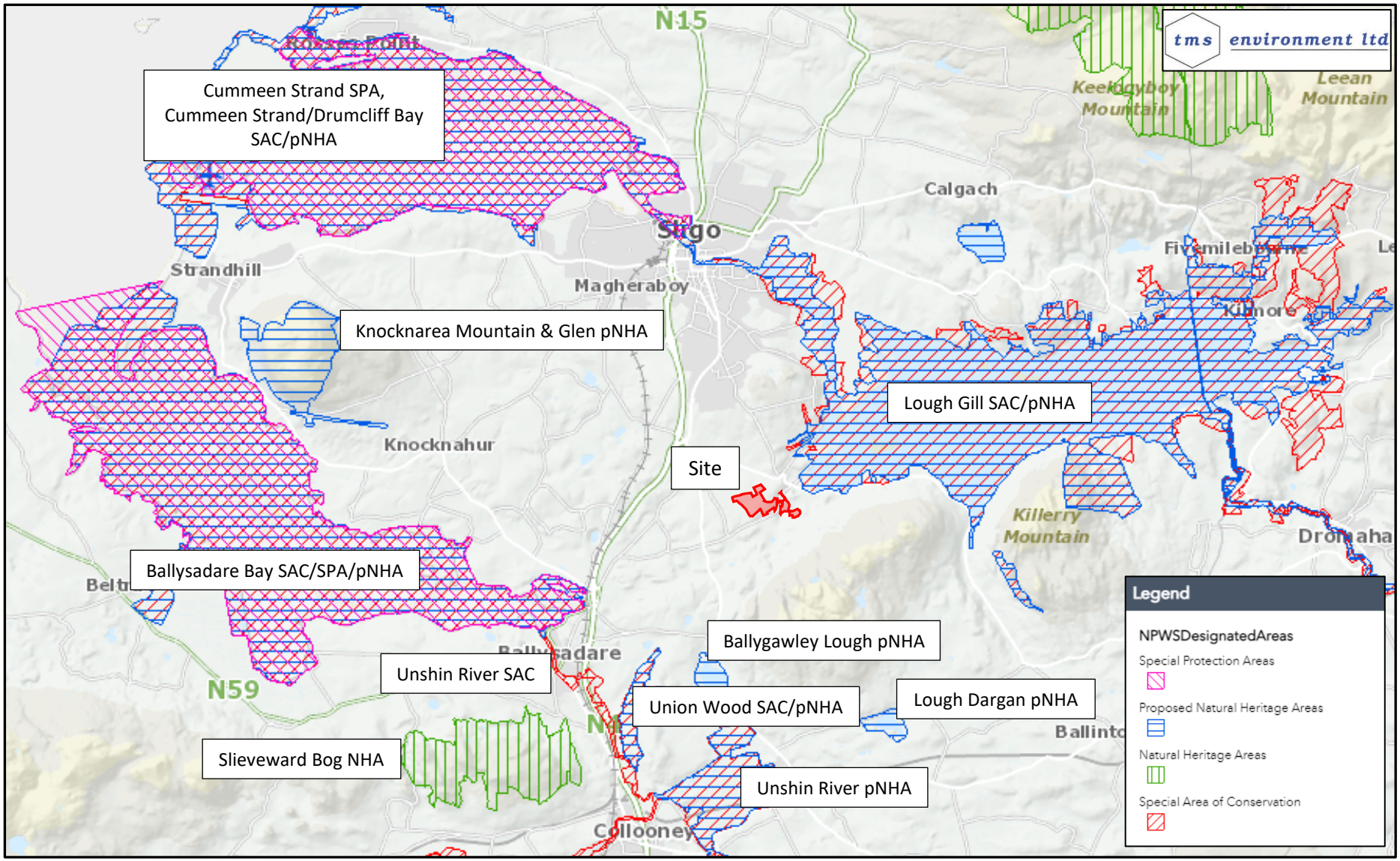


Fig. 7-25 Designated Sites (NPWS Designations Viewer)

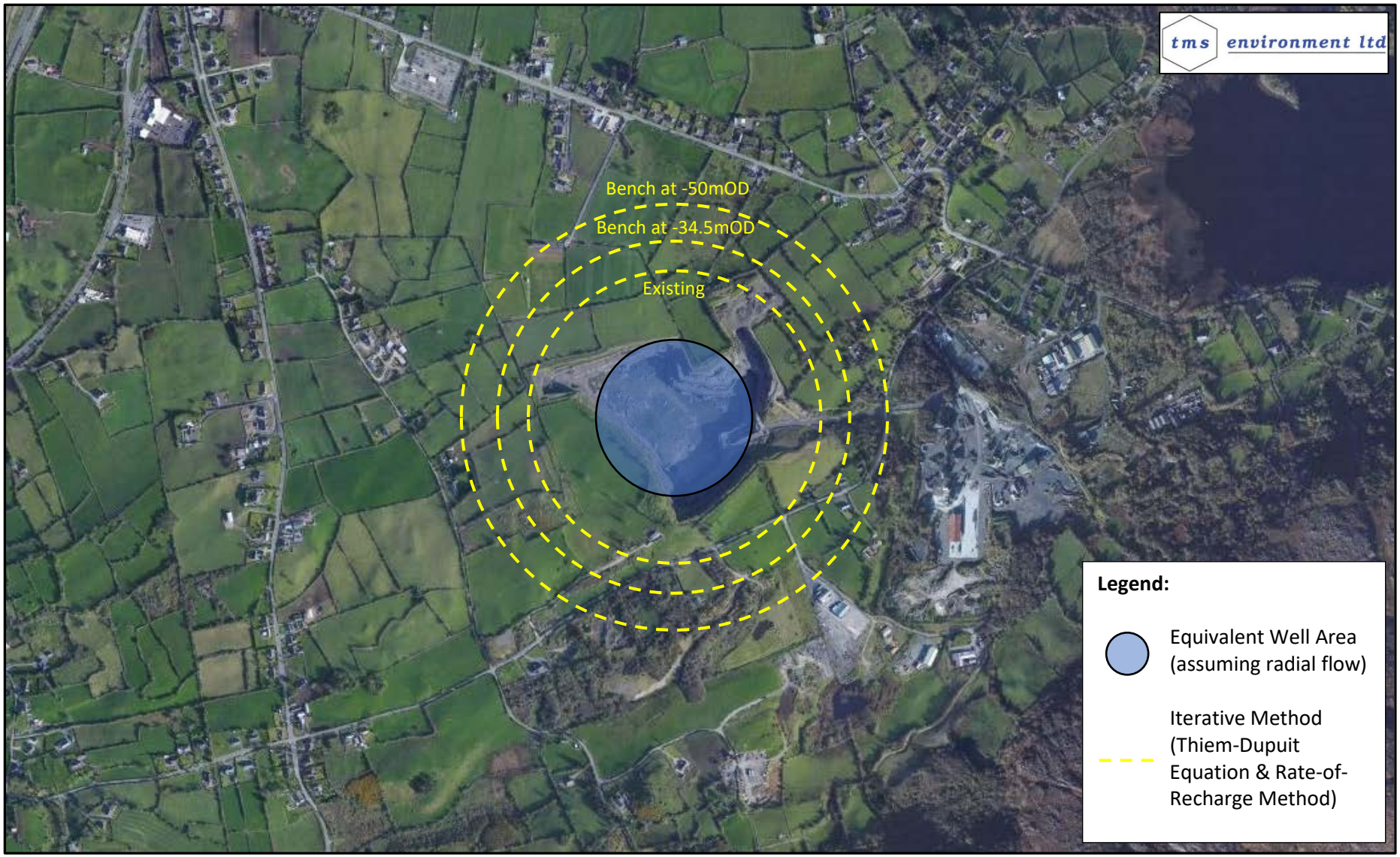


Fig. 7-26 Radius of Influence Map (Bing Maps)

Fig. 7-27 Summary of Channel Survey

	Location	Cross-Sectional Profiles	Description
-	Upstream of Culvert 1	Section 1	Regular channel, flat muddy base
Culvert 1	Under internal road from processing area to quarry	-	Single concrete pipe, diameter 900mm
Reach 1	Between Culvert 1 and Culvert 2	Section 2 - Section 10	Regular channel, flat muddy base (compound channel in middle of reach)
Culvert 2	Under entrance to main processing area	-	Single concrete pipe, diameter 840mm upstream/1180mm downstream
Reach 2	Between Culvert 2 and Culvert 3	Section 11 - Section 14	Regular channel, steeper gravelly/cobbly base
Culvert 3	Under entrance to Top Coast Oil depot	-	Two concrete pipes, diameter 600mm
Reach 3	Between Culvert 3 and Culvert 4	Section 15 - Section 16	Regular channel, steeper gravelly/cobbly base
Culvert 4	Under local public road	-	Two PVC/concrete pipes, diameter 450mm upstream (PVC)/600mm downstream (concrete)
Reach 4	Between Culvert 4 and Culvert 5	Section 17 - Section 19	Regular channel, steeper gravelly/cobbly base
Culvert 5	Under main public road (R287)	-	Arched culvert, height 766mm upstream, 1011mm downstream
Reach 5	Between Culvert 5 and Culvert 6	Section 20 - Section 29	Regular channel, steeper gravelly/cobbly base
Culvert 6	Under local public road	-	Two concrete pipes, diameter 450mm upstream/600mm downstream
Reach 6	Between Culvert 6 and Culvert 7	Section 30 - Section 33	Regular channel, flat muddy base
Culvert 7	Under small bridge in field	-	Single concrete pipe, diameter 750mm
Reach 7	Between Culvert 7 and Lough Gill	Section 34 - Section 40	Regular channel, flat muddy base

Notes:

1. Stream channel has been modified in all reaches (straightened, deepened, lined banks in some areas)
2. Quarry discharge located between Sections 2 & 3 in Reach 1
3. Pipe to divert water from the upstream end of Culvert 4 to private pumphouse across the road
4. Road drain into Reach 3
5. Four road drains into Reach 4
6. Waterwheel and associated weir in stream in middle of Reach 4

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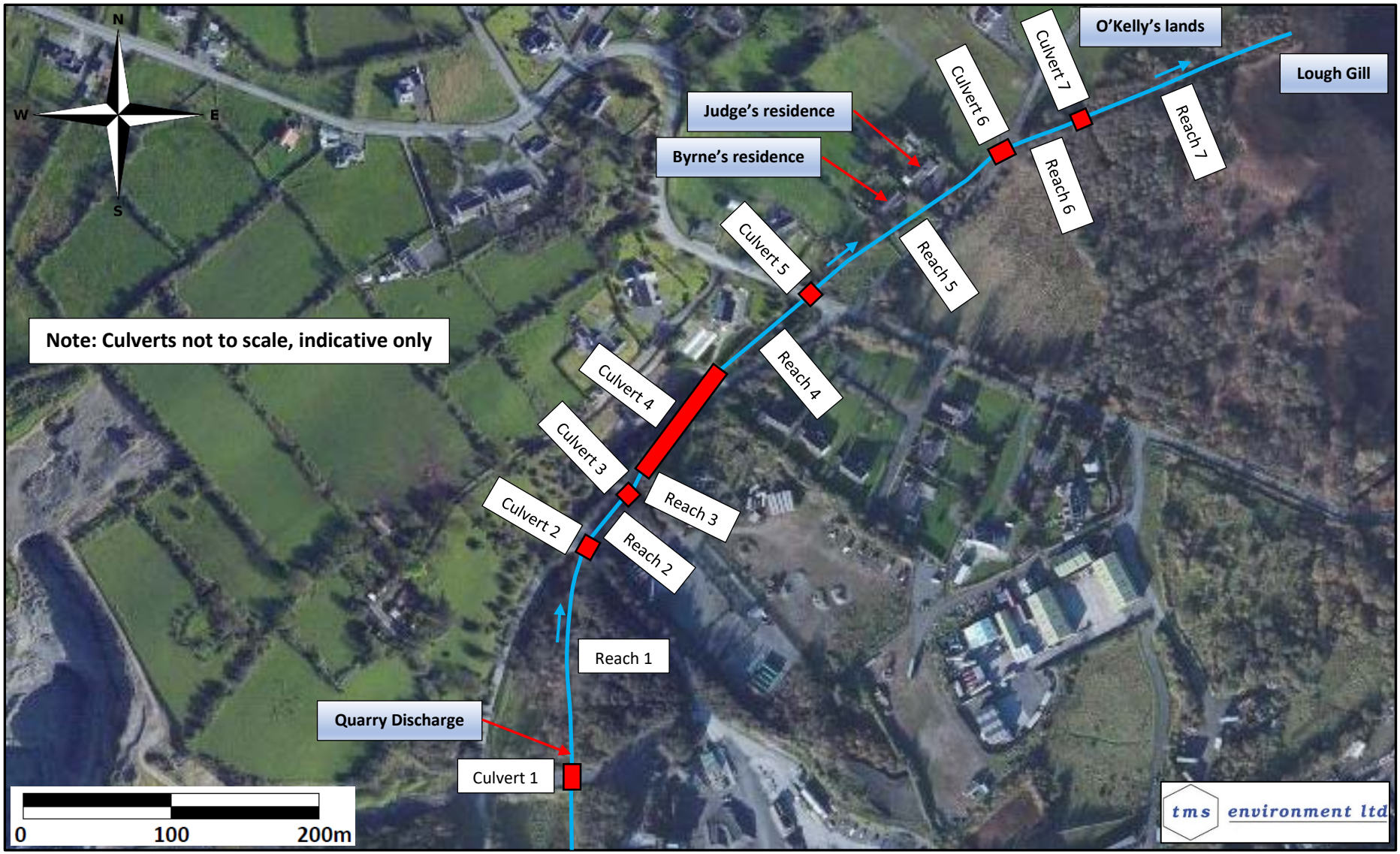

Fig. 7-28 Stream Channel Survey – Location of Reaches & Culverts (Bing Maps)

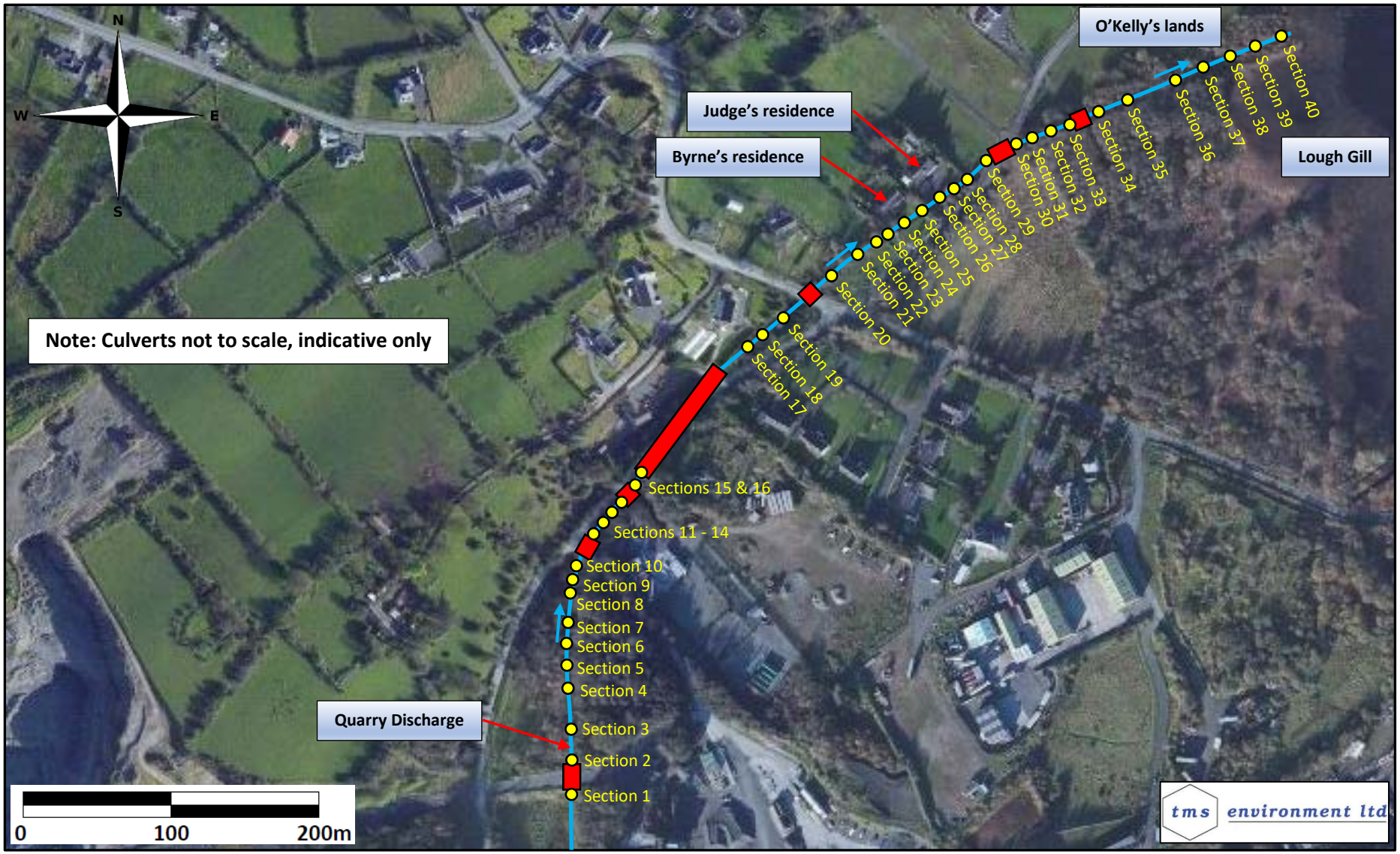

Fig. 7-29 Stream Channel Survey – Location of Stream Cross-Sections (Bing Maps)

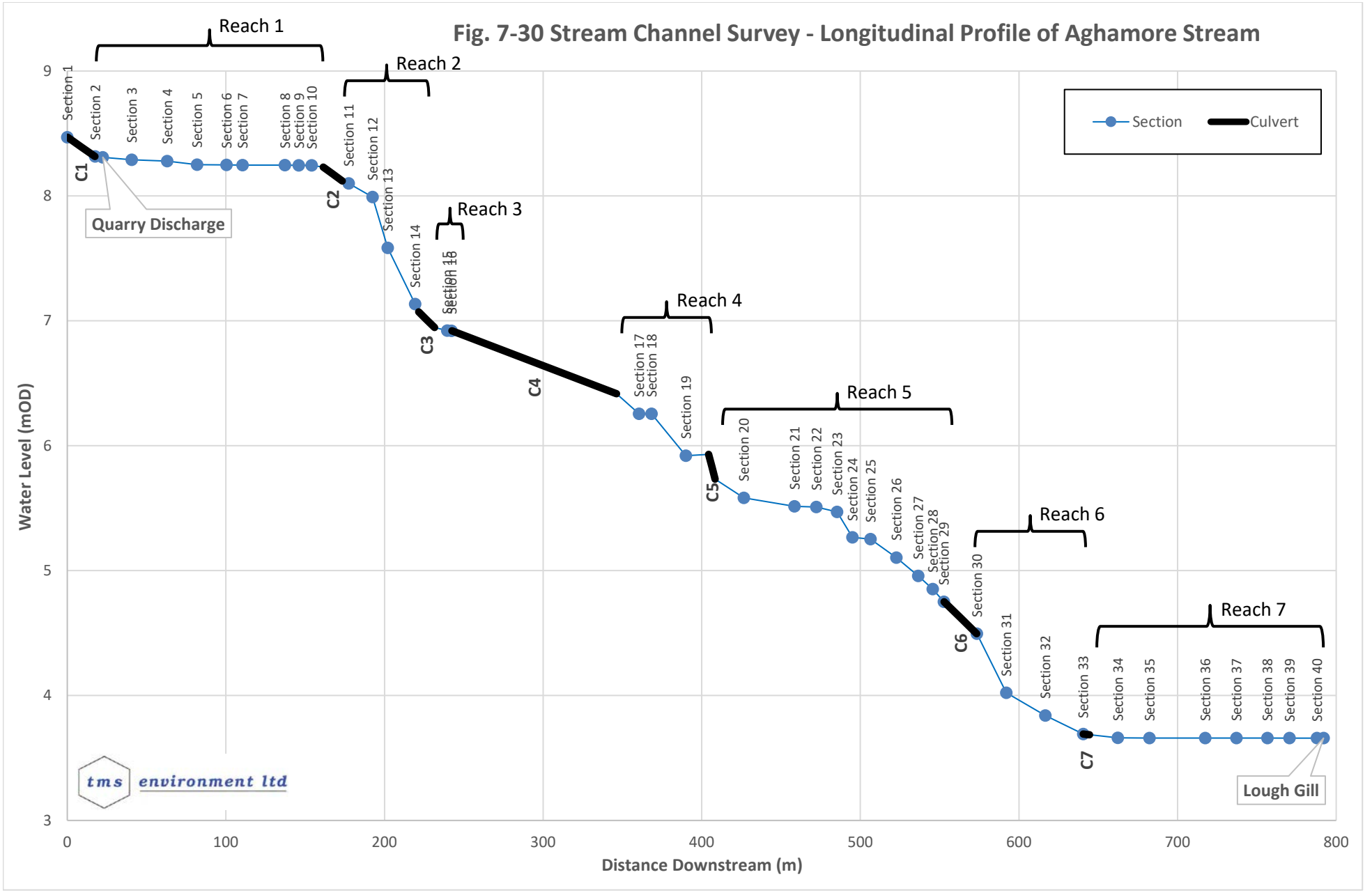
Fig. 7-30 Stream Channel Survey - Longitudinal Profile of Aghamore Stream
Reach 1
Reach 2
Reach 3
Reach 4
Reach 5
Reach 6
Reach 7
Section 1
Section 2
Section 3
Section 4
Section 5
Section 6
Section 7
Section 8
Section 9
Section 10
Section 11
Section 12
Section 13
Section 14
Section 15
Section 16
Section 17
Section 18
Section 19
Section 20
Section 21
Section 22
Section 23
Section 24
Section 25
Section 26
Section 27
Section 28
Section 29
Section 30
Section 31
Section 32
Section 33
Section 34
Section 35
Section 36
Section 37
Section 38
Section 39
Section 40
C1
C2
C3
C4
C5
C6
C7
Quarry Discharge
Lough Gill
Section
Culvert
Water Level (mOD)
Distance Downstream (m)
9
8
7
6
5
4
3
0
100
200
300
400
500
600
700
800
tms environment ltd

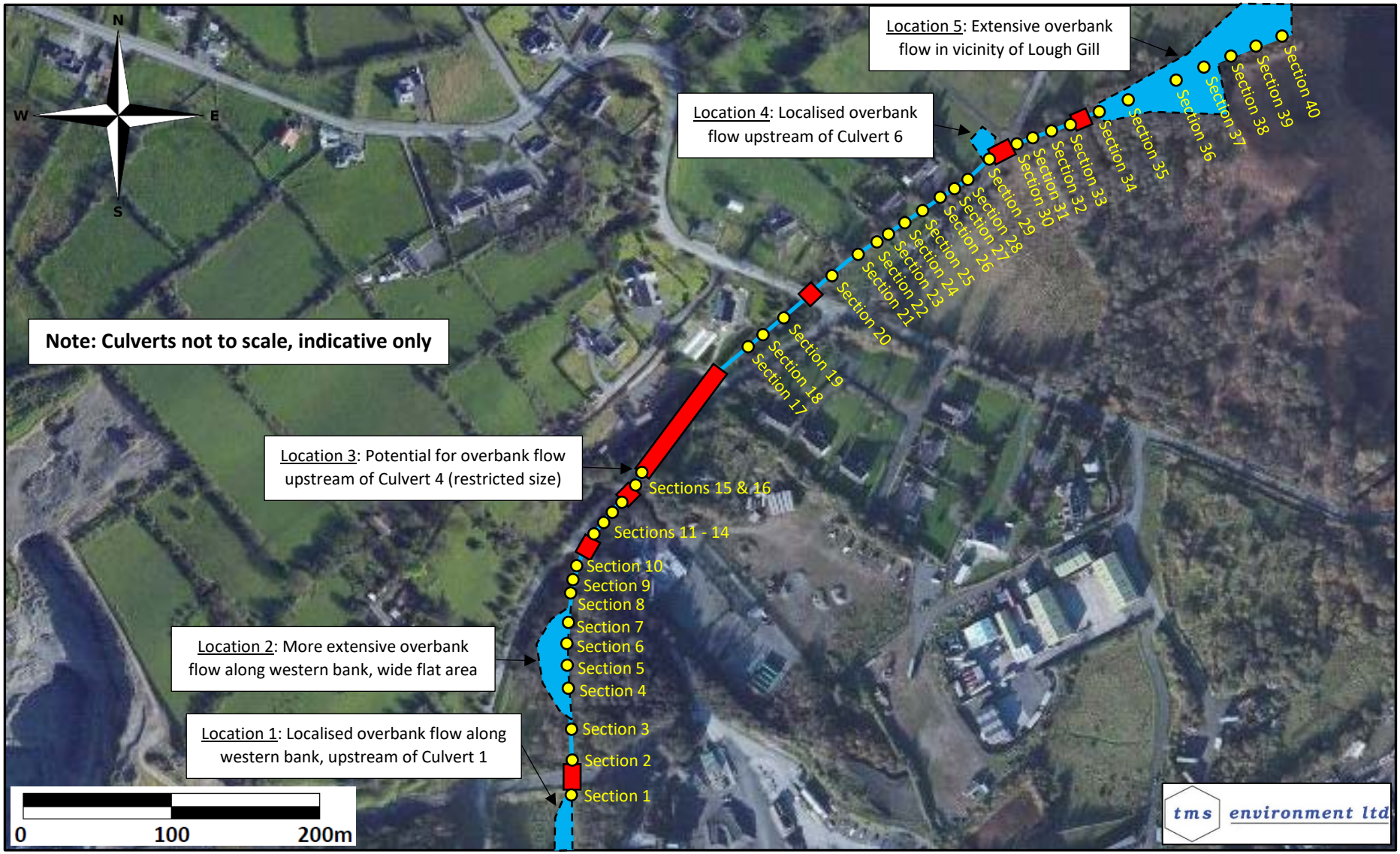

Fig. 7-31 Stream Channel Survey – Areas Liable to Flood (Bing Maps)