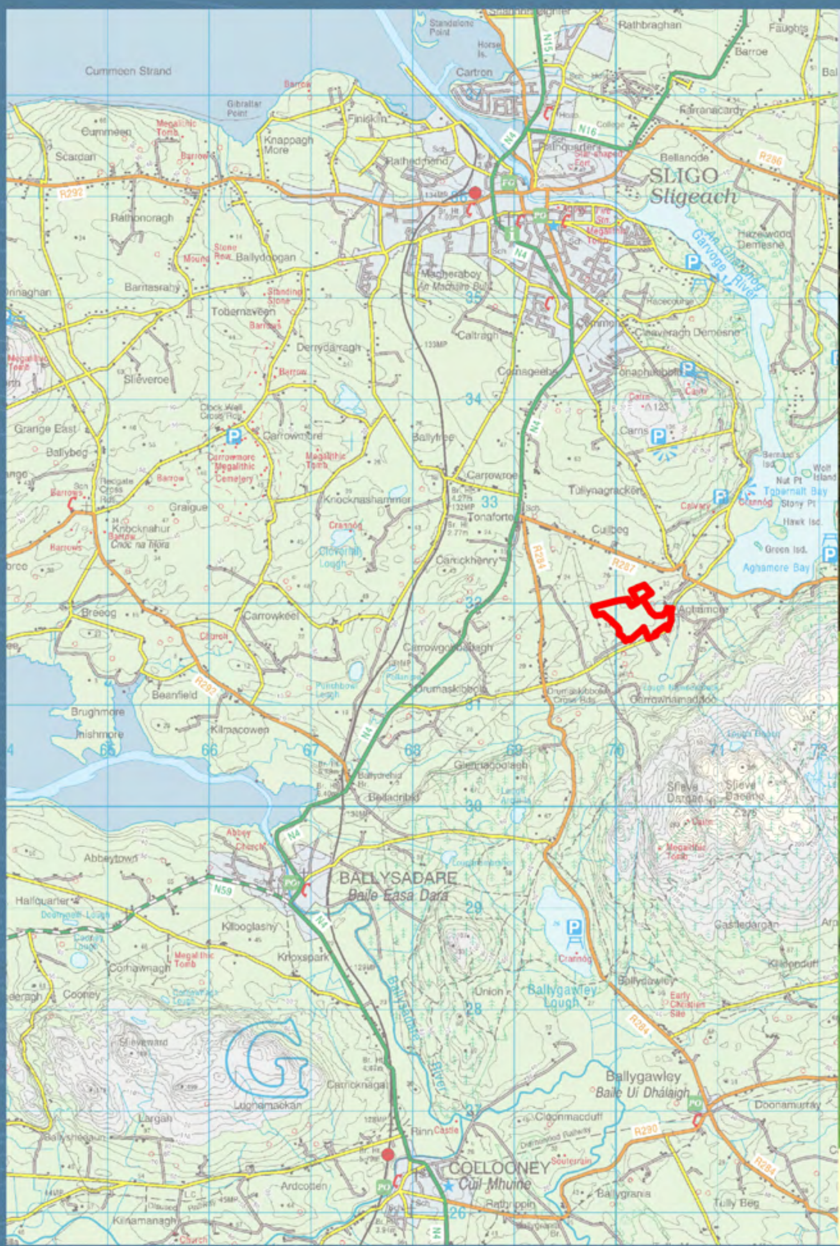
Continuance of Use and Deepening of Permitted Quarry
Aghamore Near And Carrownamaddoo Townlands, County Sligo

ENVIRONMENTAL IMPACT ASSESSMENT REPORT




AUGUST 2018

Lagan Bitumen Ltd.

Prepared by:
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SLR ref: 501.00396.00007

Continuance of Use and Deepening of Permitted Quarry

AGHAMORE NEAR AND CARROWNAMADDOO TOWNLANDS, COUNTY SLIGO

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

AUGUST 2018

Applicant: Lagan Bitumen Ltd.

Prepared By:

SLR Consulting Ireland

With contributions from:

Dr. Charles Mount
TMS
PMCE

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CHAPTER 1

INTRODUCTION

INTRODUCTION

1.1 This Environmental Impact Assessment Report (EIAR) provides supporting information to accompany a planning application to Sligo County Council submitted by Lagan Bitumen Ltd. in respect of their existing quarry at Aghamore Near and Carrownamaddoo townlands, Co. Sligo.

1.2 The application site extends to c.18 hectares – refer to Figures 1.1, 1.2 and 1.3.

1.3 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:

- Continued use and operation of the existing permitted quarry area (c. 10.9ha) within an overall application area of c.18 hectares;
- Deepening of the existing permitted quarry area by a further bench from -34.5m OD to -50m OD;
- The provision of a settlement lagoon (c. 2,800m2).

1.4 The application is made in accordance with the requirements of the Planning and Development Regulations 2001-2015 (as amended).

THE SITE

Site Location

1.5 The lands which are the subject of this application comprise c. 18 hectares and are located in the townlands of Aghamore Near and Carrownamaddoo, Co. Sligo (refer to Figure 1.1). The proposed development is located wholly within the existing permitted quarry area.

1.6 The quarry is located near two regional roads, the R287 to the South and the R284 to the East. The site occupies ground with elevations ranging between -21m OD and 34m OD. The lower quarry floor is currently at -21 m OD, with the current planning permission authorising extraction to -34.5m OD. The application area forms the existing quarry area (c. 10.9ha).

Site Description

1.7 The quarry operations comprise extraction of limestone using blasting techniques; processing (crushing and screening) of the fragmented rock to produce aggregates for use in the manufacture of value added products, road construction and site development works.

1.8 The application site relates to the quarry extraction area only, as per the previous planning application (Plan File Ref. No. 02/271). Material extracted from the permitted quarry area is processed within the quarry void using mobile processing plant. Material is also transported to the existing processing area located on the opposite side of the local road.

1.9 Ancillary facilities at the site include the offices, weighbridge & weighbridge office, canteen, toilets, bunded fuel storage areas and a garage / workshop. These facilities are located within the processing area on the opposite side of the local road and are not included in the planning application area.

Site Access

1.10 The site is located approximately 5 km southeast of Sligo Town and is accessed by the R284 and the R287 regional roads via the Drumskibbole crossroads and the Aghamore crossroads respectively.

1.11 The quarry and the processing area are located on opposite sides of the local road, with the material from the quarry being transported to the processing area via an existing access that forms a cross roads with the access to the quarry and is primarily used by lorries / dump trucks transporting material for processing.

1.12 There is a separate access to the processing area (on the Eastern side of the local road) used mainly by customers and staff, and HGV traffic delivering processed material to market. This access has been improved with road widening and upgrade works being made under Plan File Ref. No. 02/271: Condition no. 9.

1.13 All traffic enters Lagan's landholding via the site office and weighbridge and runs over a paved road surface up to the infrastructure area in the centre of the processing area.

1.14 All traffic exits the site via the weighbridge (located at the site office).

Surrounding Land-Use

1.15 The quarry area is surrounded by agricultural lands (improved agricultural grassland and arable). There are numerous industrial uses within 1 km of the quarry.

1.16 Residences within the general area consist of one-off rural houses, farmsteads with some ribbon development along the local road network – refer to EIAR Chapter 4 Population and Human Health.

THE APPLICANT

1.17 The applicant, Lagan Bitumen Limited, was previously part of the Lagan Group. On 20th April 2018, the Lagan Group was acquired by Breedon Group plc. Breedon is a public company with ordinary shares traded on the Alternative Investment Market (AIM). Throughout the UK and Ireland, the company employs approximately 3,000 people and operates 2 cement plants, 70 quarries, 40 asphalt plants, 200 ready-mixed concrete plants, 9 concrete and clay products plants, 4 contract surfacing businesses, 6 import/export terminals and 2 slate production facilities.

EIA SCREENING

1.18 Part 1 and Part 2 of Schedule 5 of the Planning and Development Regulations 2001 (as amended) set out the forms of development that require an environmental impact assessment report (EIAR).

1.19 Paragraph 19 of Part 1 of Schedule 5 states that the following form of development requires an EIA

"Quarries and open-cast mining where the surface of the site exceeds 25 hectares.

1.20 Paragraph 22 relates to changes or extensions. It states:

"Any change or extension of projects listed in this Annex where such a change or extension in itself meets the thresholds, if any set out in this Annex."

1.21 Paragraph 2 of Part 2 of Schedule 5 refers to extractive industry and part (b) of that section states that the following requires an EIA

"Extraction of stone, gravel, sand or clay, where the area of extraction would be greater than 5 hectares."

1.22 In addition, paragraph 13(a) of Part 1 requires EIA in respect of:

"Any change or extension of development already authorised, executed or in the process of being executed (not being a change or extension refer to in Part 1) which would:-

i. result in the development being of a class listed in Part 1 or paragraphs 1 to 12 of Part 2 of this Schedule and
ii. result in an increase in size greater than –

25 per cent, or

an amount equal to 50 per cent of the appropriate threshold,

whichever is the greater.

1.23 The proposed development relates to the continued use and deepening of an existing quarry within an application area of c. 18 ha. The extraction area of the quarry is greater than 5 hectares. On this basis the extraction area of the quarry exceeds the area stated under Part 2 and an EIAR is required.

EIA SCOPING

1.24 In preparing this Environmental Impact Assessment Report, consultations were had with a number of organisations and agencies including:

- Sligo County Council (Planning Section);
- Geological Survey of Ireland (to discuss geological heritage);
- National Parks and Wildlife Service (in respect of designated natural heritage sites).

1.25 A pre-planning consultation meeting was held between officials of Sligo County Council and representatives of SLR Consulting and Lagan Bitumen Ltd. on:

- 2nd September 2016, at the offices of Sligo County Council.

1.26 Other consultations and informal discussion held by contributors in undertaking their environmental impact assessments are detailed in the specialist environmental sections of the EIAR, together with details of relevant archives and documentation held by state agencies and organisations.

DIFFICULTIES ENCOUNTERED WITH EIAR COMPILATION

1.27 This Environmental Impact Assessment Report was compiled on the basis of published regional and local data and site-specific field surveys. No difficulties were encountered in compiling the required information.

ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR)

1.28 An Environmental Impact Assessment Report (EIAR) *"means a statement of the effects, if any, which the proposed development, if carried out, would have on the environment".* As such, it is a systematic analysis and assessment of the potential effects of a proposed project on the receiving environment.

1.29 The principal objectives of an Environmental Impact Assessment Report are to:

- Identify and / or predict the significant effects impacts of a development.
- Identify what mitigation measures should be incorporated into the development to eliminate or reduce the perceived impacts.
- Interpret and communicate the above information on the impact of the proposed development, in both technical and non-technical terms.
- Assist the Local Planning Authority in the decision making process with respect to the associated planning application.

Format of the Environmental Impact Assessment Report (EIAR)

1.30 To facilitate clarity, this EIAR has been prepared in accordance with the Environmental Protection Agency (EPA) Guidelines (Draft – May 2017). The EIAR is sub divided into fifteen parts. As an overview, they comprise of:

Chapter 1: Introduction / Screening / Scoping

1.31 An introduction to the development and a brief explanation of the aims and format of the EIAR. It also identifies the various professional consultants who have contributed to this EIAR and the screening / scoping process carried out.

Chapter 2: Project Description

1.32 Chapter 2 provides:

- details of the physical characteristics of the whole project, including, where relevant, demolition works, the land-use requirements during construction and operation as well as other works that are integral to the project;
- the main characteristics of the operational phase of the project e.g. nature and quantity of materials and natural resources;
- an estimate, by type and quantity, of the expected residues and emissions produced during the construction, operational and restoration phases of the proposed development.

Chapter 3: Reasonable Alternatives

1.33 Chapter 3 provides a description of the reasonable alternatives studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects.

Chapters 4 - 15

1.34 These Chapters provide detailed information on all aspects of the existing (baseline) environment, identifies, describes and presents and assessment of the likely significant impacts of the proposed project on the environment, recommends mitigation and monitoring measures to reduce or alleviate these impacts and describes the residual impacts and conclusions. They are grouped under the following Chapters:

- Chapter 4: Population and Human Health
- Chapter 5: Biodiversity
- Chapter 6: Land, Soils and Geology
- Chapter 7: Water
- Chapter 8: Air
- Chapter 9: Climate
- Chapter 10: Noise and Vibration
- Chapter 11 : Material Assets
- Chapter 12: Cultural Heritage
- Chapter 13: Landscape
- Chapter 14: Traffic and Transport
- Chapter 15: Interactions

1.35 The associated references, plates, figures and appendices are provided at the end of each Section 1 – 15.

1.36 A "*Non-Technical Summary of the Environmental Impact Statement*", incorporating all of the above chapters, is provided as a separate and self-contained document.

CONTRIBUTORS

1.37 Lagan Bitumen Ltd. appointed SLR Consulting Ireland to prepare this Environmental Impact Assessment Report (EIAR) in support of its Planning Application for the proposed development at Aghamore Near and Carrownamaddo townlands, Co. Sligo.

1.38 The contributors who have assisted in the preparation of this EIAR are identified in **Table 1-1** below. Each contributor has the appropriate qualifications, experience and competence for their topic.

Table 1 - 1
List of Contributors

TOPIC	CONTRIBUTOR	COMPANY
Introduction	Peter Kinghan BSc, Dipl. Env. Eng., MiM, MSCSI, MRICS	SLR Consulting Ireland
Description of Development	Peter Kinghan BSc, Dipl. Env. Eng., MiM, MSCSI, MRICS	SLR Consulting Ireland
Alternatives	Peter Kinghan BSc, Dipl. Env. Eng., MiM, MSCSI, MRICS	SLR Consulting Ireland
Population and Human Health	Aoife Byrne BSocSc(int), MRUP, MRTPI, MIPI	SLR Consulting Ireland
Biodiversity	Elaine Dromey BSc (Hons) MSc MCIEEM	SLR Consulting Ireland
Land, Soils and Geology	John Kelly PhD, PGeo, EurGeol	SLR Consulting Ireland
Water	Craig O'Connor MSc PGeo EurGeol	TMS Environment
Air	Aldona Binchy MSc. (Eng)	SLR Consulting Ireland
Climate	Aldona Binchy MSc. (Eng)	SLR Consulting Ireland
Noise and Vibration	Aldona Binchy MSc. (Eng)	SLR Consulting Ireland
Material Assets	Aoife Byrne BSocSc(int), MRUP, MRTPI, MIPI	SLR Consulting Ireland
Cultural Heritage	Dr. Charles Mount M.A., Ph.D.	Consultant
Landscape	Eimear O'Connor Dipl. Ing (FH) MILI	SLR Consulting Ireland
Traffic and Transport	David O'Brien BA, BAI, PgDip(PM), MIEI	PMCE Consultants
Co-ordination of EIA	Peter Kinghan BSc, Dipl. Env. Eng., MiM, MSCSI, MRICS	SLR Consulting Ireland

1.39 Each contributor has been fully briefed about the proposal and the background to it. They have also visited the site and are familiar with the local environment.

1.40 SLR Consulting Ireland, formerly John Barnett and Associates, have been preparing Environmental Impact Assessment reports (previously EIS) relating to Quarry developments since implementation of the EIA Directive in 1990.

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Site Location Map

Figure 1-2
Existing Site Contours

Figure 1-3
Aerial Photo

Figure 1-4
Context Map

NOTES

1. EXTRACT FROM 1:50,000 O.S DISCOVERY MAP NO. 25

2. ORDNANCE SURVEY IRELAND LICENCE NO. SU 0000718 (C) ORDNANCE SURVEY & GOVERNMENT OF IRELAND

LEGEND

SITE LOCATION

0 500 1000 1500 2000m 3000 4000 5000

Metres 1:50,000

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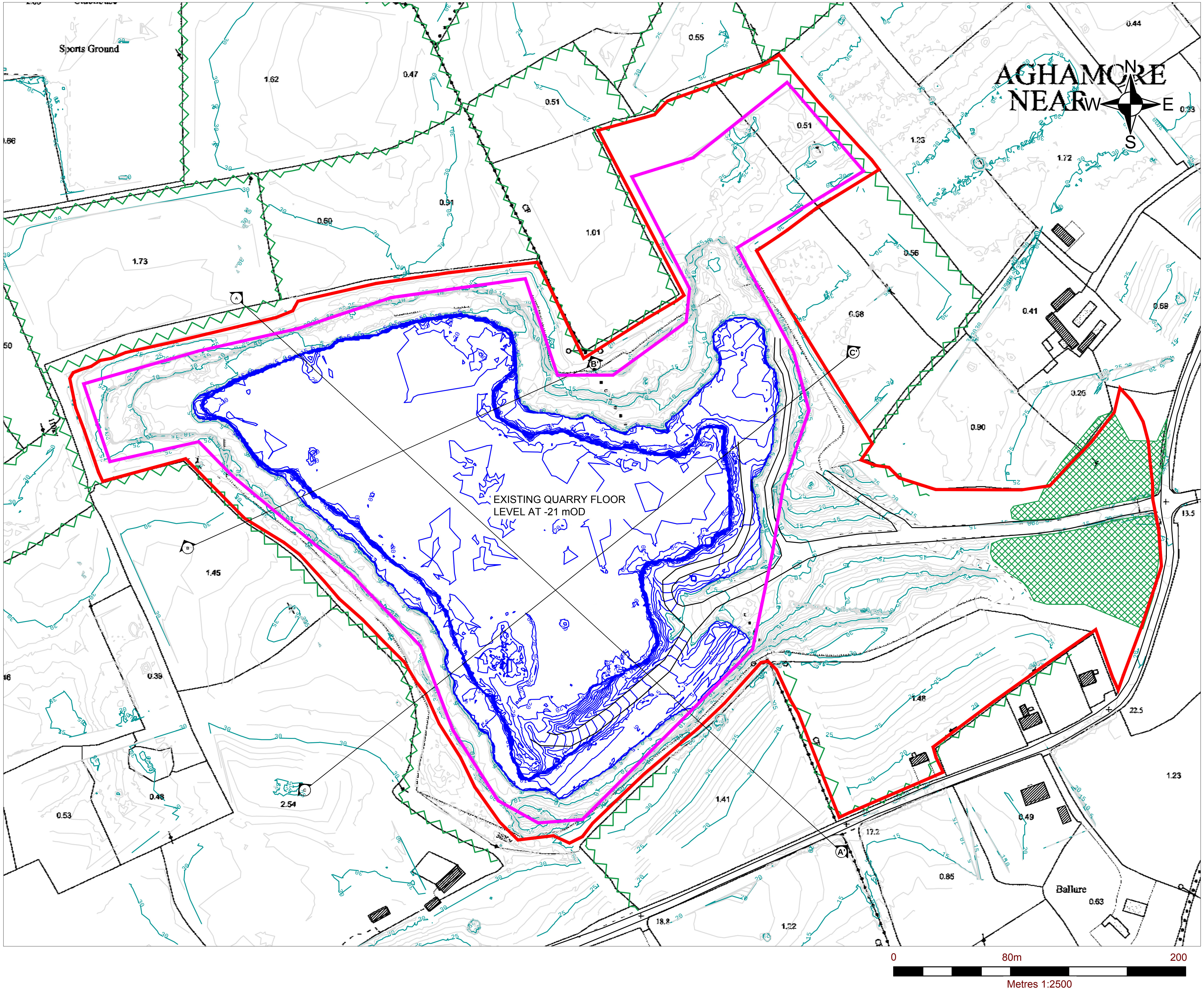
LIMESTONE QUARRY
AGHAMORE NEAR AND CARROWNAMADDOO TOWNLANDS, CO. SLIGO

SITE LOCATION

FIGURE 1.1

Scale	Date
1:50,000 @ A3	AUGUST 2018

501.00396.00007.EIAR Figure 1.1.Rev 0.dwg



NOTES

1. ORDNANCE SURVEY IRELAND LICENCE NO. SU 0000718 (C) ORDNANCE SURVEY IRELAND & GOVERNMENT OF IRELAND
2. AERIAL SURVEY CARRIED OUT BY SLR CONSULTING SEPTEMBER 2016

LEGEND

- APPLICATION AREA (c. 18 Ha.)
- QUARRY EXTRACTION AREA (c. 10.9 Ha.)
- CROSS SECTION LOCATION

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EXISTING SITE CONTOURS

FIGURE 1.2

Scale	Date
1:2,500 @ A3	AUGUST 2018

501.00396.00007.EIAR Figure 1.2 SITE CONTOURS.Rev.0.dwg

NOTES

1. ORDNANCE SURVEY IRELAND LICENCE NO. SU 0000718 (C) ORDNANCE SURVEY IRELAND & GOVERNMENT OF IRELAND
2. AERIAL PHOTOGRAPHY CARRIED OUT BY SLR CONSULTING SEPTEMBER 2016

LEGEND

APPLICATION AREA (c. 18 Ha.)

CROSS SECTION LOCATION

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AERIAL PHOTO

FIGURE 1.3

Scale	Date
1:2,500 @ A3	AUGUST 2018

501.00396.00007.EIAR Figure 1.3 AERIAL PHOTO.Rev.0.dwg

NOTES

1. ORDNANCE SURVEY IRELAND LICENCE NO. SU 0000718 (C) ORDNANCE SURVEY IRELAND & GOVERNMENT OF IRELAND

LEGEND

LAND OWNERSHIP (c. 47 Ha.)

APPLICATION AREA (c. 18 Ha.)

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CONTEXT MAP

FIGURE 1.4

Scale	Date
1:5,000 @ A3	AUGUST 2018

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CHAPTER 2

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FIGURE 2-2 LANDSCAPE MITIGATION AND RESTORATION PLAN

FIGURE 2-3 EXISTING, PROPOSED AND RESTORED CROSS SECTIONS

EXISTING DEVELOPMENT

2.1 The existing permitted quarry covers an area of approximately c.18 hectares, with details of the site layout shown on **Figure 1.2 and 1.3**. The lowest point on the existing quarry floor is c. -21m OD. The permitted quarry floor level is -34.5m OD.

2.2 Planning permission was granted in June 2003 (Sligo County Council Ref. No. 02/271) for the extension of the existing development.

2.3 The development comprised of the following:

- Deepening of an existing quarry by 30 metres from its base approved under planning register reference PL96/172 in two 15 metre lifts over an area of 10.9 Hectares and all other associated works including restoration works to the final quarry void at Aghamore Near and Carrownamaddoo, Co. Sligo.

2.4 The planning approval was granted for a period of 10 years, subject to 23 no. conditions.

2.5 The Planning Authority granted an extension of duration of planning permission in respect of PL02/271 until 14th September 2018, by order dated 3rd April 2013.

2.6 The existing quarry operations comprise extraction of limestone using conventional blasting techniques; processing (crushing and screening) of the fragmented rock to produce aggregates for use in the production of value added products, road construction and site development works.

2.7 There are existing manufacturing facilities located to the east of the application site on the opposite side of the local road. These facilities are not included as part of this planning application.

2.8 Ancillary facilities at the adjacent site include the site office, weighbridge, canteen, toilets, bunded fuel storage areas and a garage / workshop.

PROPOSED DEVELOPMENT

Development Overview

Operational Phase (Limestone Extraction and Processing)

2.9 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:

- Continued use and operation of the existing permitted quarry area (c. 10.9ha) within an overall application area of c.18 hectares;

- Deepening of the existing permitted quarry area by a further bench from -34.5m OD to -50m OD;

- Provision of a Water Settlement Lagoon (c. 2,800m2).

2.10 Aggregate extracted from the quarry will be processed within the quarry void and transported by HGV's to the existing processing area located on the Eastern side of the Local road – refer to Figure 2.1.

Restoration (Reinstatement to Nature Conservation Habitat Areas)

2.11 Upon the cessation of extraction operations it is proposed to return the worked lands to natural habitat after-uses – refer to Figure 2.2.

2.12 Where feasible, restoration of exhausted and redundant areas will be carried out at the earliest opportunity. However it is envisaged that the majority of restoration proposals will be carried out after extraction operations at the site have ceased.

Aggregate Reserve Assessment

2.13 The total recoverable reserve of limestone from within the proposed extraction area is assessed at c. 2 million tonnes.

Duration of Extraction

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

Table 2-3
Material Quantities

Material	Quantity
Topsoil / Overburden	0 m^3
Limestone	2 Million Tonnes

2.15 The duration of quarrying activities at the application site will largely be dictated by the rate at which approximately 2 Million Tonnes of limestone is extracted from the site. There are many factors which will influence this, including, but not limited to the:

- Prevailing economic climate and related construction industry output;
- Distance of construction projects from the facility (and scale of activity).

2.16 In light of these and other variables, calculation of intake rates and duration is not an exact science. It is anticipated that the annual extraction rate will range from 150,000 – 300,000 Tonnes. (Note: under planning permission PL02/271, an average annual extraction rate of 300,000 tonnes was permitted).

2.17 A planning permission duration of 15 years is sought for the extraction and processing period and a further 2 years to complete final restoration of the site.

Site Screening

2.18 Aghamore quarry has been in existence since the 1950's and is an established part of the landscape. Existing views into the quarry would be unchanged by the proposed deepening of the existing quarry void.

Removal of Topsoil and Overburden Soils

2.19 Within the planning application boundary an area of 10.9 hectares has been used for the extraction of limestone and therefore has been completely stripped of overburden and topsoil material.

2.20 No further stripping of topsoil or overburden materials will be carried out within the application area.

Site Drainage

2.21 A hydrological / hydrogeological assessment has been carried out taking into consideration the existing water regime at the site. It addresses mitigation measures to eliminate and/or minimise the potential impacts, if any, on surface water and groundwater – refer to Chapter 7 – Water.

Stability of the Quarry

2.22 Industry standard slope angles, bench heights, and bench widths will be used for extraction operations at the site.

Method of Extraction

2.23 Blasting is, and will continue to be used within the quarry area to fragment the stone prior to processing (crushing / screening etc.).

Processing Methods

2.24 The processing of the extracted rock, into aggregate products, will consist of crushing and screening by mobile processing plant within the quarry void. Quarried stone will also be transported to the processing area on the opposite side of the local road for further processing.

Quarry Working Hours

2.25 In accordance with condition 14 (b) of the existing planning permission no quarry operations will be carried out between 8.00 – 18.00 hrs Monday to Friday; or from 09.00 – 17.00 hrs Saturday. The quarry will not operate on Sundays or Bank Holidays, except in emergency situations.

Employment

2.26 The proposed development will provide employment of up to 6 people directly on-site, in addition to a number of indirect employees such as crushing contractors, HGV drivers, maintenance contractors, etc.

2.27 The continued development of the site is consistent with the policies set out in the National Planning Guidelines for the sector; the Regional Planning Guidelines and the Sligo County Development plan which recognise the requirement for:

- A secure supply of construction aggregates and related products is necessary for the continued development of the region;
- Proven aggregate reserves need to be safeguarded for future extraction;
- 'Best environmental management practice' to be implemented within quarry developments.

SITE INFRASTRUCTURE

Site Access

2.28 The quarry extraction area is accessed via an existing permitted entrance located on the western side of the Local road that leads to the R287 regional road.

Site Security

2.29 Vehicular access to the application site is from a Local road that is c. 400 meters south of the R287 regional road. There is no other vehicular access to the application site. The access gate is locked outside operational hours.

2.30 At the present time, the property boundary is secured by post and wire fencing and/or hedgerow. New fencing works have recently been completed along parts of the northern boundary of the site.

Site Roads, Parking and Hardstanding Areas

2.31 All HGVs utilising the quarry will be confined within the Applicant's landholding. Trucks turn into the site from the Local road that is c. 400 meters South of the R287 regional road and travel west over a section of paved internal roadway within the application site.

2.32 Adequate car parking provision for employees and visitors is provided at the existing weighbridge office as indicated in Figure 1.4.

Weighbridge

2.33 In order to track and record the amount of material exiting the quarry, all HGV traffic is directed across the existing weighbridge, the location of which are also indicated on the site infrastructure layout in Figure 1.4.

Offices and Ancillary Facilities

2.34 Ancillary facilities at the adjoining site include the main office, weighbridge & weighbridge office, canteen, toilets, bunded fuel storage areas and a garage / workshop.

Quarry Ancillary Facilities and Activities

2.35 Value added manufacturing facilities at the quarry include concrete manufacturing (readymix and blocks) and asphalt manufacturing, all of which are located within the ancillary area to the east of the application area.

Utilities and Services

2.36 Electrical power is currently provided to the application site via mains supply. Electricity will provide the principal source of energy for office lighting and heating.

2.37 Site based staff at the application site are contactable by mobile phone, landline and email and broadband connections to the site office are provided via a mobile network.

2.38 An existing effluent treatment system is located in the ancillary area to the East of the application area.

2.39 Potable water is provided to the site via a private well.

2.40 Given the lack of combustible waste materials at this site, it is considered highly unlikely that a fire will break out during quarry operations. A range of fire extinguishers (water, foam and CO_2) are kept at the site office to deal with any localised small scale fires which might occur. Additional fire-fighting capacity can be provided by storing water in a mobile bowser on unsealed hardstand areas around the infrastructure area.

Lighting

2.41 Sufficient lighting is provided at the site to ensure safe operations during winter periods.

Fuel and Oil Storage

2.42 Fuel and chemical storage will continue at the current location. The only chemicals to be stored on site for the quarry development that will have the potential to cause water pollution are lubricating oils, hydraulic oils and diesel fuel. All of these chemicals are / will continue to be stored in the following manner:

- suitably certified tanks within areas bunded to a capacity of 110% of the tank, in compliance with condition 11 of the existing planning permission;
- where two tanks are bunded, bund capacity will be 120% of the largest tank;
- no pipe work will go through the bund at any point to reduce the risk of leakage;
- Surface water from bunds will be pumped out through a suitable oil interceptor.

Landscape and Boundary Treatment

2.43 Fencing has recently been erected at the quarry site along some perimeter boundaries, where required. Prior to continuing further quarry development within the permitted extraction area a survey of the entire property boundary will be undertaken and where necessary, new boundary fencing will be erected, existing fencing will be repaired and/or replaced and hedgerows will be strengthened or fortified by additional planting.

WASTE MANAGEMENT

Extractive Waste Management

2.44 Almost all products and by-products arising from the aggregate processing have commercial value. Any waste materials from the site are stored, collected, recycled and/or disposed of in accordance with any requirements of Sligo County Council.

General Waste Management

2.45 Lagan Bitumen Ltd. are a member of the Irish Concrete Federation and commits themselves to the principles of the Federations Environmental Code. The code states:-

2.46 "ICF members will minimise production of waste and where appropriate consider its beneficial use including recycling. They will deal with all waste in accordance with the relevant legislation and other controls in place, including using waste contractors with valid Waste Collection Permits"

2.47 Potential waste produced and the measures used to control it are described as follows:-

- Scrap metal – these materials are chiefly produced from the maintenance of the possessing plants and can cause a nuisance if allowed to build up in an uncontrolled manner. A designated scrap metal area will be demarcated on site and the build-up of scrap is controlled by the regular removal by licensed scrap metal dealers.

- Used Oil and Oil Filters – any waste oil/oil filters that may arise from servicing of fixed or mobile plant will be removed from the site by a licensed waste contractor.

- Used Batteries – similarly all used batteries will be removed from site for collection and recycling by a licensed waste contractor in accordance with the Waste Management Regulations.

- Domestic Style Waste (Canteen Waste) – domestic waste generated at the offices and employee's facility will be collected by a licensed waste collection contractor.

EXISTING ENVIRONMENTAL CONTROLS

General

2.48 Extraction, processing and ultimately restoration activities at the application site require a number of environmental controls to eliminate or minimise the potential nuisance to the public arising from the extraction and processing operations. The environmental control measures in place at the site are outlined in the relevant EIAR Chapters.

2.49 The existing operations at the site are currently regulated by conditions attaching to Sligo County Council Ref. No 02/271 planning permission.

2.50 Any additional control measures, over and above those already in place and/or outlined below, which may be instructed on foot of the proposed planning application, will also be implemented.

Bird Control

2.51 As the process of limestone extraction is free of putrescible (food / kitchen) waste, site activities are unlikely to attract scavenging birds such as gulls and crows for the duration of works. Accordingly, it is not intended to implement any specific bird control measures at the site as is the case at present.

Traffic Control

2.52 As the planning application relates to the continued use and deepening of the existing quarry operation, the proposed development will continue to utilise the existing site entrance and established haul routes.

Litter Control

2.53 As the proposed development will be largely free of litter, the daily operational activities are unlikely to give rise to problems with windblown litter. Accordingly, there is no requirement to implement any specific litter control measures at the site.

2.54 In the unlikely event that any litter waste is identified, it will be immediately removed off-site to an authorised waste disposal or recovery site.

Odour Control

2.55 As the limestone extraction activities at the site are not biodegradable and do not therefore emit odorous gases, site activities do not give rise to odour nuisance. No odour control is required.

Vermin Control

2.56 As the proposed development is free of putrescible (food / kitchen) waste, on-site activities will not attract vermin for the duration of the extraction or subsequent restoration operations. Accordingly, no specific vermin control measures are required.

Fire Control

2.57 In the unlikely event that a fire does occur, the local fire stations in Sligo town will be contacted and emergency response procedures will be implemented. Fire extinguishers (water and foam) are provided at all offices to deal with any small outbreaks which may occur.

Surface Water and Groundwater Management

2.58 The current water management within the quarry involves pumping a combination of rainwater and groundwater from the quarry floor 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 (refer to EIAR Chapter 7: Paragraph 7.21).

2.59 It is proposed to install a settlement lagoon of c. 2,800m^2 (see area calculations in Chapter 7) 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. 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.

2.60 The discharge point from the settlement lagoon will remain at the current location (see **Figure 7-5**).

Dust Generation and Control

2.61 In dry, windy weather conditions, site activities may give rise to dust blows across and beyond the existing or planned development site areas.

2.62 The incidence of fugitive dust outside of the operation is reduced by some of the mobile crushing and screening plant being located within the quarry void. Generation of fugitive dust is generally limited to periods of very low rainfall (refer to Chapter 8 – Air Quality). Dust generation occurs from three main sources.

- Point sources – such as operating plant and machinery.
- Line sources – such as roads and conveyors.
- Dispersed Sources– such as quarry floors and stockpiles.

2.63 In order to control dust emissions, the following measures will be implemented:-

- Water will be sprayed from a tractor drawn bowser on dry exposed surfaces and stockpiles (paved roads, unsealed haul roads and hardstand areas);
- Provision of a fixed sprinkler system along the internal road from the site access to the office.
- Dust blows at the existing site are largely screened by the side walls of the existing quarry void;
- Areas of bare or exposed soils will, insofar as practicable, be kept to a minimum;
- The amount of dust or fines carried onto the public road network will be reduced by periodic sweeping of internal paved site roads and surrounding public roads as required;
- Emission of fugitive dust from machinery such as processing plant will be minimised by utilising dust suppression and by locating such plant within the quarry area.

2.64 Dust deposition monitoring is carried out, when the quarry is operational, as part of the environmental monitoring programme (refer to conditions 19 & 22 of the existing planning permission). Monitoring results will be submitted to Sligo County Council on an annual basis - refer to EIAR Chapter 8.

2.65 Mitigation measures are provided in accordance with the DoEHLG (2004) guidelines for the sector and EPA (2006), refer to EIAR Chapter 8.

Noise Generation and Control

2.66 The sources of noise located within the planning application area are primarily related to machinery / plant operation.

2.67 The potential for noise generation from the planning application area is reduced by locating some of the mobile crushing and screening plant within the quarry void. This means that the potential for noise generation from activities associated with the operation of the plant such as movement of vehicles and maintenance has been reduced – refer to Chapter 10.

2.68 In addition to the above the following good house-keeping measures are put in place in order to reduce noise emitted from plant and machinery as much as possible:

- All machinery used will be CE certified for compliance with EU noise control limits;
- The machinery will be regularly maintained. This includes regularly checking any muffler systems and servicing or replacing as required. It also ensures any loose or damaged panels or covers that suppress noise is fixed or replaced immediately;
- If there are further noise-reducing modifications available for any machinery, they will be fitted wherever practical (e.g. rubber-decked screens, rubber chute linings etc.)
- Haul road grades are kept as low as possible (</= 1:10) to reduce engine / brake noise from heavy vehicles.

2.69 Mitigation measures are provided in accordance with the DoEHLG (2004) and EPA (2006) guidelines for the sector.

2.70 There is an existing noise monitoring programme at the site (when operational) and ongoing noise monitoring is carried out as part of the environmental monitoring programme, refer to Section 2.73

below and conditions 20 & 22 of PL02271. Monitoring results will be submitted to Sligo County Council on an annual basis.

Blasting Control

2.71 Blasting mitigation measures will form part of the Environmental Management System for the quarry site. These measures relate to blasting procedures such as quantity of explosive and charge-hole spacing along rock face. Measures at the quarry will include:

- Include geological considerations in blast design.
- There will be no blasting outside the hours of 11:00 and 18:00 during Monday to Friday and none taking place at the weekend or public holidays
- Optimise blast design along the rock-face with adequately spaced charges.
- Minimise air overpressure through proper blast design, spacing and timing of multiple charges.
- Inform nearby residents on day prior to planned blasting schedule using house-calls, written note/signage at entrance (or combination). A warning siren will be sounded prior to blast taking place.

EXISTING ENVIRONMENTAL MONITORING

General

2.72 The site has an established environmental monitoring programme on site (when operational) – refer to Condition No. 22 imposed under Plan File Ref. No. PL02/271 and Appendix 2-A. Water, noise, dust and blast monitoring is carried out on a regular basis, to demonstrate that the development is not having an adverse impact on the surrounding environment.

Dust Monitoring: Planning Condition 19

2.73 Dust deposition monitoring is carried out at the application site, when operational. Dust monitoring locations shall be reviewed and revised where necessary. The results of the dust monitoring will be submitted to Sligo County Council on a regular basis for review and record purposes.

Noise Monitoring: Planning Condition 20

2.74 Noise monitoring is carried out at the application site, when operational. Noise monitoring locations shall be reviewed and revised where necessary. The results of the noise monitoring will be submitted to Sligo County Council on a regular basis for review and record purposes.

Water Monitoring

2.75 The site was granted a Trade Effluent Discharge Licence (TEDL) from Sligo County Council in December 2011 (DL(W)139) to discharge water from the quarry to the Aghamore Stream, subject to conditions.

2.76 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 7-5) and monitoring of discharge 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 EIAR Chapter 7: Paragraph 7.21).

PROPOSED FINAL RESTORATION

Proposed Restoration Scheme

2.57 The restoration scheme for the planning application area is shown on the restoration plan Figure 2-2.

2.58 The application area will be restored to a natural habitat, which is one of the beneficial after uses listed in the EPA Guidelines: 'Environmental Management in the Extractive Industry' (2006). This will be achieved by the following measures:

- The application area will be left for natural recolonisation by locally occurring grass and shrub/scrub species and the void will fill with water.
- All existing boundary fences and hedgerows will be retained to ensure that the site is secure.
- All plant and machinery will be removed from the quarry void.

2.59 The restoration works will be carried out in accordance with the EPA Guidelines (2006).

Site Management and Supervision

2.77 The Applicant will clearly define the management responsibility for the site restoration work and will ensure that this person has the necessary information (from the planning application) and authority to manage the whole restoration process. Relevant staff will be briefed on the scheme and will be adequately supervised / controlled. A system of record keeping for the key restoration activities will be put in place.

Long Term Safety and Security

2.78 Existing hedges surrounding the development will be gapped up and thickened where required. These, combined with fencing and the secure and locked entrance gates to the development will prevent unauthorised third party access.

Long Term Surface Water and Groundwater

2.79 Surface water will percolate to ground or be directed to the water body within the void created by quarrying – refer to EIAR Chapter 7.

2.80 On completion of extraction operations a lake will be formed on site as groundwater returns to its natural level.

Decommissioning of Plant and Machinery

2.81 Redundant structures, plant equipment and stockpiles will be removed from site on permanent cessation of extraction activity. Machinery and buildings will either be utilised by Lagans on other sites, or be sold as working machinery or scrap.

2.82 As part of the overall decommissioning process, all fuel, oil storage and septic / effluent treatment tanks within the existing site will be removed from the site by a licensed waste contractor. Therefore there will be no potential for fuel, oil or sewage to cause long-term water pollution following completion of extraction activities.

Aftercare and Monitoring

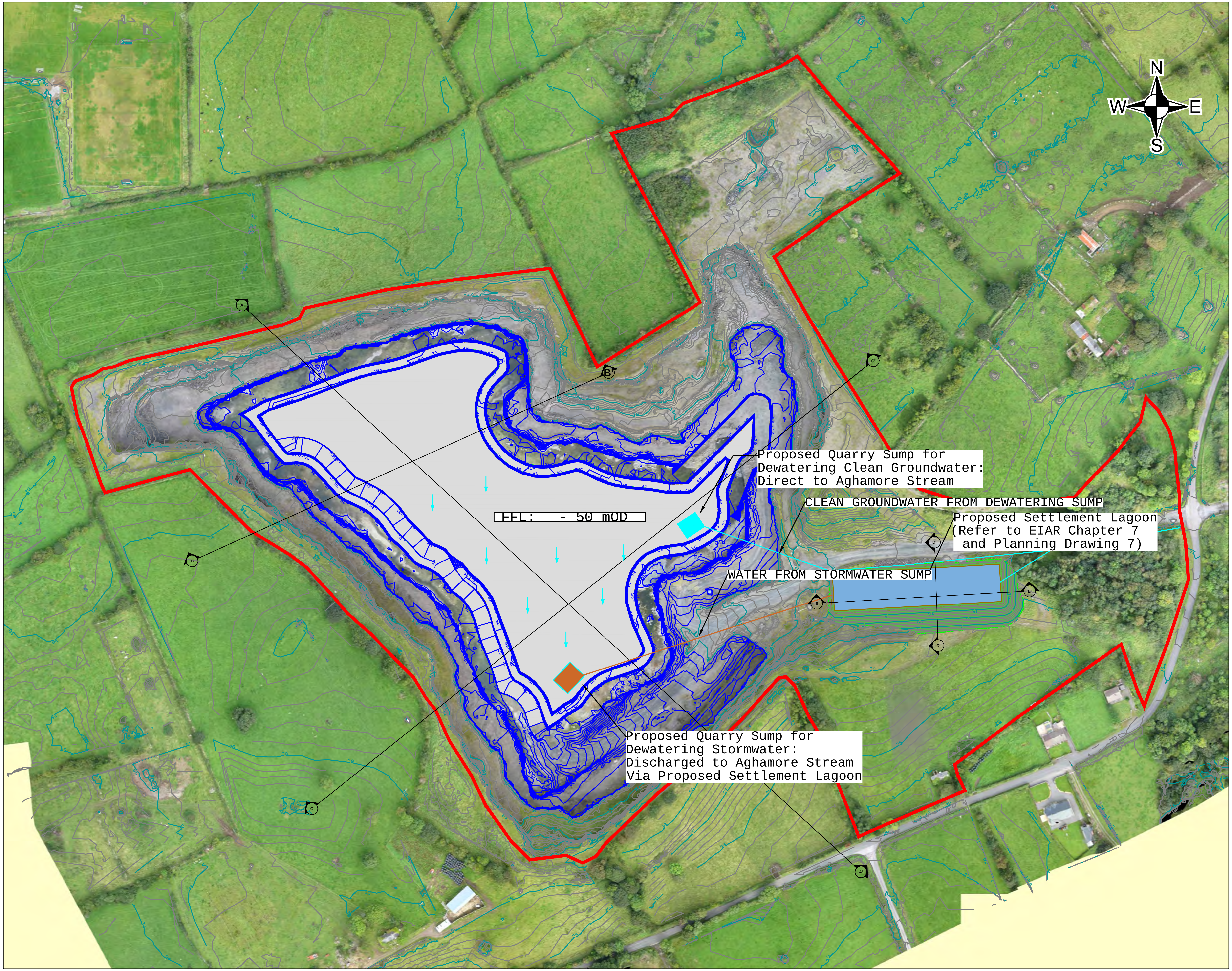
2.83 No aftercare or monitoring is required for the restoration proposals for the application area.

FIGURES

Figure 2-1
PROPOSED EXTRACTION PLAN

Figure 2-2
LANDSCAPE MITIGATION & RESTORATION PLAN

Figure 2-3
EXISTING, PROPOSED AND RESTORED CROSS SECTIONS



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NOTES

1. ORDNANCE SURVEY IRELAND LICENCE NO. SU 0000718 (C) ORDNANCE SURVEY IRELAND & GOVERNMENT OF IRELAND
2. AERIAL PHOTOGRAPHY CARRIED OUT BY SLR CONSULTING SEPTEMBER 2016

LEGEND

APPLICATION AREA (c. 18 Ha.)

CROSS SECTION LOCATION

SLR CONSULTING IRELAND
7 DUNDRUM BUSINESS PARK
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LAGAN BITUMEN LTD.

LIMESTONE QUARRY

AGHAMORE NEAR AND CARROWNAMADDOO TOWNLANDS, CO. SLIGO

PROPOSED SITE LAYOUT

FIGURE 2.1

Scale	Date
1:2,500 @ A3	AUGUST 2018

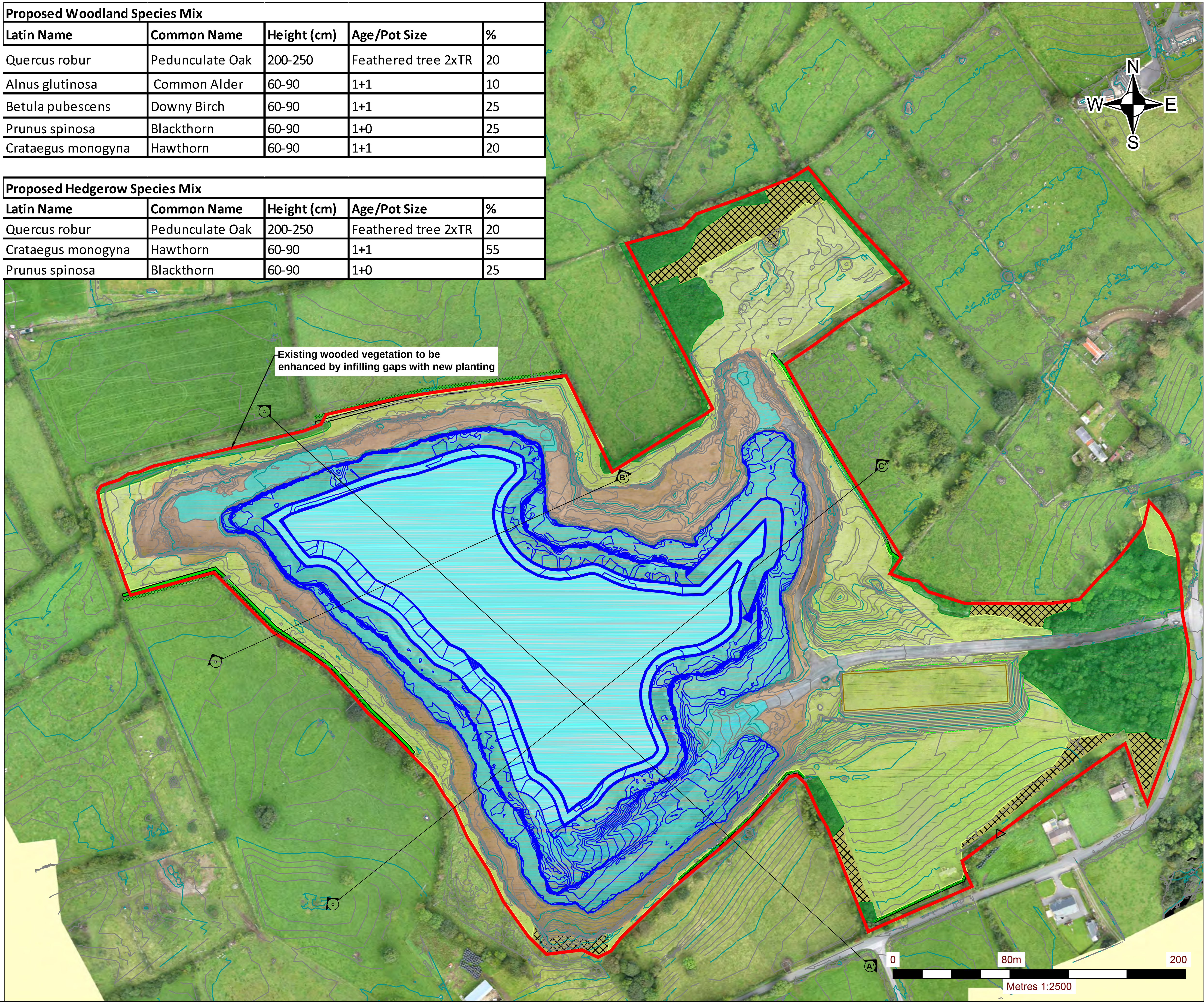
180822.501.00396.00007.FIGURE 2.1 PROPOSED SITE LAYOUT.REV.1.dwg

Proposed Woodland Species Mix

Latin Name	Common Name	Height (cm)	Age/Pot Size	%
Quercus robur	Pedunculate Oak	200-250	Feathered tree 2xTR	20
Alnus glutinosa	Common Alder	60-90	1+1	10
Betula pubescens	Downy Birch	60-90	1+1	25
Prunus spinosa	Blackthorn	60-90	1+0	25
Crataegus monogyna	Hawthorn	60-90	1+1	20

Proposed Hedgerow Species Mix

Latin Name	Common Name	Height (cm)	Age/Pot Size	%
Quercus robur	Pedunculate Oak	200-250	Feathered tree 2xTR	20
Crataegus monogyna	Hawthorn	60-90	1+1	55
Prunus spinosa	Blackthorn	60-90	1+0	25



NOTES

1. ORDNANCE SURVEY IRELAND LICENCE NO. SU 0000718 (C) ORDNANCE SURVEY IRELAND & GOVERNMENT OF IRELAND
2. AERIAL PHOTOGRAPHY CARRIED OUT BY SLR CONSULTING SEPTEMBER 2016

LEGEND

APPLICATION AREA (c. 18 Ha)

EXISTING ACCESS ROAD TO BE RETAINED

MITIGATION MEASURES TO BE IMPLEMENTED DURING OPERATION

Existing vegetation to be retained. Existing vegetation to be enhanced with additional planting - refer to target note on plan.

Proposed permanent waterbody (water rebound level c. 3 - 6 mOD)

Proposed woodland planting

Proposed hedgerow

Areas currently feature existing grassland or bare ground. Existing grassland areas are to be retained and areas of existing bare ground are to be restored to grassland

MEASURES TO BE IMPLEMENTED AT RESTORATION PHASE

Areas currently feature a combination of steep sideslopes together with relatively flat areas featuring either grassland or bare ground. The steep sideslopes are to be allowed to regenerate naturally. The relatively flat areas of grassland are to be retained. The relatively flat areas of bare ground are to be seeded.

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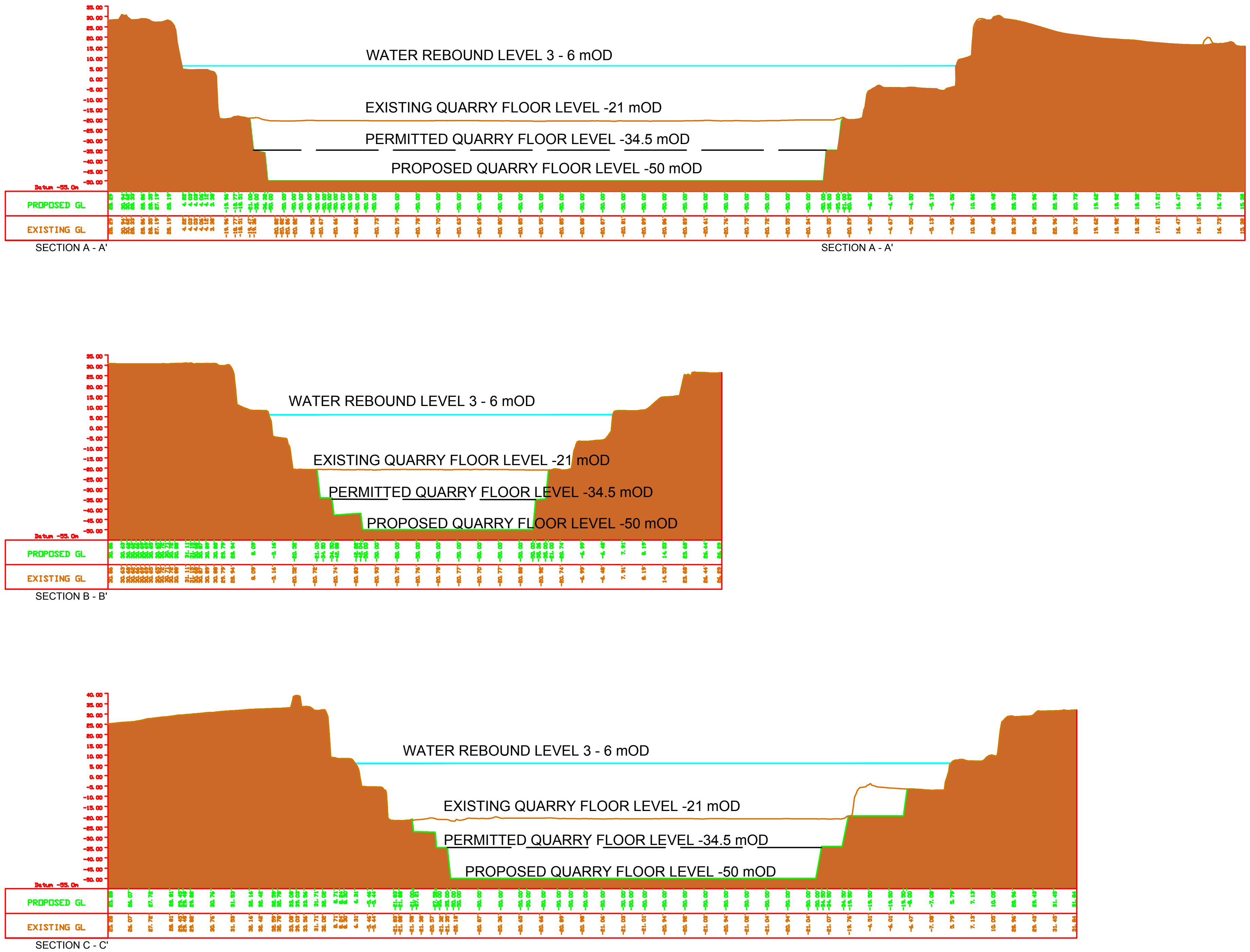
LANDSCAPE MITIGATION AND RESTORATION PLAN

FIGURE 2.2

Scale	Date
1:2,500 @ A3	AUGUST 2018

180822.501.00396.00007.FIGURE 2.2 PROPOSED RESTORATION PLAN.REV.0.dwg



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NOTES

1. REFER TO FIGURES 1.3 AND 2.1 FOR CROSS SECTION LOCATIONS.

LEGEND

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EXISTING AND PROPOSED CROSS SECTIONS

FIGURE 2.3

Scale	Date
1:2,500 @ A3	AUGUST 2018

180405.501.00396.00007.FIGURE 2.3 CROSS SECTIONS.REV.1.dwg

CHAPTER 3

ALTERNATIVES

INTRODUCTION

3.1 In the consideration of alternatives below, the issues of alternative sources of aggregates; and alternative site locations / designs / layouts have been addressed.

3.2 The current planning application is for continued use and deepening of an existing permitted quarry. The existing permitted quarry area is located in an area favourable to extraction activities, due to, *inter alia:*

- Established long history of extraction at this location;
- Proven limestone reserves – refer to EIAR Chapter 6;
- Located with direct access to the regional and national roads network – refer to EIAR Chapter 14;
- Best practice industry standard extraction and processing methods being used;
- Low development costs because infrastructure already in place at the site and the application is for continued use and extension (by deepening) to a long established quarry development.

DO NOTHING ALTERNATIVE

3.3 If no further works within the planning application area were carried out, the existing site would be restored to natural habitat after-uses as per the previously permitted proposals.

ALTERNATIVE SOURCES OF AGGREGATES

3.4 In the medium term there are no real alternatives to the current land-based sources of construction aggregates.

3.5 Until such time as end of waste criteria in respect of Construction & Demolition materials is agreed, these materials cannot be relied upon and for the foreseeable future there are no real alternatives to primary land-won aggregates.

3.6 Notwithstanding the above, the volume of C&D waste suitable for recycling into secondary aggregates would be considered very low in comparison to the overall demand for aggregates. The demographic spread of the population results in only the large urban centres potentially being capable of generating sufficient volumes of construction and demolition (C&D) waste to justify a commercial operation producing secondary aggregates going forward.

3.7 In the longer term (>25 years), there may be some scope for extraction of sand and gravel from marine sources.

3.8 In the absence of significant volumes of aggregates from recycled / secondary and marine sources, it is clear that land-based deposits (such as the proven reserves at Aghamore Near and

Carrownamaddoo townlands) will continue to be the main source of construction aggregates in Ireland, including Sligo and the northwest / west region.

ALTERNATIVE LOCATIONS

3.9 The current planning application is for continued use and deepening of an existing established quarry at Aghamore Near and Carrownamaddoo townlands.

3.10 The alternatives available to the Applicant relate to:

- Further development (into lands that do not currently have the benefit of planning permission for quarrying) and final restoration of the existing established quarry;

  or

- Development of a new replacement 'greenfield' quarry in Sligo to serve the established clients and markets in this region.

3.11 At the current time, there is no suitable alternative replacement quarry location available to the applicant in County Sligo. It is generally accepted that the overall timeframe for development of a 'greenfield' quarry site (from initial site selection, land acquisition, preparation of a planning application and accompanying EIAR, through planning process and site development to extraction of aggregates) takes between 5 and 10 years.

3.12 Notwithstanding the above, continued use and deepening of the existing quarry would be beneficial in planning terms by eliminating the need for:

- Extracting additional materials from other quarries within the county, should the applicant be unable to develop a new 'greenfield' site in the event that the existing quarry ceases operation. This would result in faster depletion of aggregate resources at these other quarry locations and potentially result in future intensification of those operations;
- Development of a 'greenfield' site at some other location within the county where there is little or no previous extractive industry landuse;
- Haulage of materials by road from other quarries within, and outside the county, with potentially longer haulage distances and increased traffic levels on the wider road network.

3.13 The development of the existing limestone quarry at Aghamore Near and Carrownamaddoo townlands will assist in continuing to provide extraction from a proven aggregate resource, with no significant increase in environmental emissions.

3.14 This development is not like a factory for example that can be located at many locations; this is a resource tied development. Aggregates can only be worked where they exist and where the environmental effects of working such resources can be managed to an acceptable level.

3.15 The proposed continued use and deepening is located within the existing permitted quarry extractive operational site that has a proven track record of environmental / planning compliance.

3.16 On the basis of the above, it is considered that continued development (and final restoration) of the existing quarry, subject to continued implementation of best environmental management practice and compliance with appropriate planning controls (i.e. planning conditions and recommended emission limit values for the sector) is preferable in an overall planning context, compared to the development of a new replacement 'greenfield' site at some alternative location in Sligo.

ALTERNATIVE DESIGNS / LAYOUTS

3.17 Alternative designs, including alternative layouts within the site were considered. No changes to the permitted quarry extraction area have been proposed as part of this EIAR. Quarry deepening will be carried out within the existing permitted area only and this is considered to best minimise the potential impacts on the environment from noise, dust, visual impacts.

Extraction Area

3.18 Lateral extension of the quarry is not possible at the current time as no suitable adjoining third party lands are available for purchase by the applicant.

ALTERNATIVE PROCESSES

3.19 Lagan Bitumen Ltd. are a company with expertise and experience in the field of quarrying, aggregates production, concrete manufacturing, road surfacing materials manufacturing and road making.

3.20 As this planning application is for continued use and deepening of an existing established quarry area, alternative processes are not considered relevant in this instance.

CHAPTER 4

POPULATION AND HUMAN HEALTH

INTRODUCTION

4.1 This chapter of the Environmental Impact Assessment Report (EIAR) relates to the potential effects of the continued use and deepening of the permitted quarry at Aghamore Near and Carrownamaddoo townlands in Co. Sligo on population and human health.

4.2 For further detail of the proposed development and the application site context, refer to chapter 2 of this EIAR.

Scope of Work

4.3 The EPA guidelines in relation to the preparation of EIAR[1] note the following in respect of population and human health:

- assessment of land-use planning and demographic issues or detailed socio-economic analysis is not generally required;
- economic development or settlement patterns are only relevant if they give rise to new development and associated effects;
- human health should be considered in the context of the relevant environmental topics addressed by the EIAR;
- the effects on human health via relevant pathways (such as air, soil and water) should be considered in the context of accepted standards for exposure, dose or risk;
- other health and safety issues are addressed under other EU directives.

4.4 On the basis of the guidelines, the scope of this chapter of the EIAR is limited to a consideration of population, employment, amenity and human health in the context of the topics addressed by this EIAR.

Consultations / Consultees

4.5 Consultation was not undertaken in the preparation of this chapter of the EIAR.

Contributors / Author(s)

4.6 This chapter of the EIAR was prepared by Aoife Byrne, who is an Associate with SLR Consulting Ireland. Aoife is a Chartered Town Planner and has worked previously on several extractive industry planning applications and EIAR.

[1] Environmental Protection Agency (2017). *Guidelines on the Information to be Contained in Environmental Impact Assessment Reports.* Draft dated May 2017. Environmental Protection Agency, Johnstown Castle Estate, Co. Wexford.

Limitations / Difficulties Encountered

4.7 No limitations or difficulties were encountered in the preparation of this chapter of the EIAR.

REGULATORY BACKGROUND

Legislation

4.8 There is no specific legislation relevant to this chapter of the EIAR. Legislation, if any, that is relevant to each pathway (noise, air, soil, water, etc.) is addressed elsewhere in this EIAR.

Planning Policy and Development Control

4.9 The current county development plan is Sligo County Development Plan 2017 – 2023.

4.10 Policy P-RDD 1 generally seeks to facilitate resource based rural enterprise. Chapter 4.3.4 recognises the importance of aggregates and concrete production to the economy, employment and the provision of essential construction materials. The relevant policies provide for the safeguarding of mineral resources (policy P-MEQ-1) and seek to ensure that extraction and associated processes are carried out in a sustainable manner, which minimises the impact on, *inter alia,* residential amenity (P-MEQ-2).

4.11 The county development plan also includes policies that seek to maintain water quality in accordance with the requirements of the Water Framework Directive (P-WQ-1 and P-WQ-4), ensure that existing and new development does not contribute to a deterioration in air quality (P-AQ-2) and ensure that proposals with the potential to generate noise will protect the amenity of noise sensitive developments by incorporating appropriate measures (P-CN-1).

Guidelines

4.12 As outlined above, this chapter of the EIAR has been prepared on the basis of the draft Guidelines on the Information to be contained in Environmental Impact Assessment Reports by the EPA (2017).

Technical Standards

4.13 There are no technical standards relevant to this chapter of the EIAR. Technical standards, if any, that are relevant to each pathway (noise, air, soil, water, etc.) are addressed elsewhere in this EIAR.

RECEIVING ENVIRONMENT

Study Area

4.14 The study area relates to the vicinity of the application site and to those dwellings and buildings on the roads surrounding the application site.

Baseline Study Methodology

4.15 The baseline study comprises a desk-top review of online and published resources, information provided by the applicant and information contained in the other chapters of this EIAR. A review of existing residential housing and sensitive receptors in the vicinity of the application site was undertaken. Ordnance Survey maps and aerial photography were also examined.

Sources of Information

4.16 Baseline information was obtained from the following sources:

- Myplan.ie (http://myplan.ie/index.html);
- Historic Environment Viewer (http://webgis.archaeology.ie/historicenvironment/);
- Sligo County Development Plan 2017;
- The environmental topic chapters of this EIAR;
- OSi Maps;
- Aerial Photographs;
- Openstreetmap.org;
- Live Register Statistics;
- Census 2016.

Context

4.17 The application site is located south of Sligo town, off the R287 regional road in the town lands of Aghamore Near and Carrownamaddoo. Although there is a dispersed pattern of housing development in the vicinity, there is no distinctive village or settlement in the immediate vicinity.

4.18 The application area is bounded on all sides by agricultural land and there are a number of dwellings located along the roads in the vicinity. There is a sports ground located to the northwest of the application area. The site is access from a local road (L3603). Lough Gill is located c. 520m north-east of the application site.

4.19 Ancillary facilities associated with the application site and the Aghamore Business Park are located to the east of the road. The application site comprises of a quarry. There are no manufacturing facilities or welfare facilities within the application site. These are located on lands to the east of the application site, within the ownership of the applicant.

Environmental and Heritage Designations

4.20 The Lough Gill SAC and pNHA is located 0.52km to the north- east of the application site. Other designated sites in the vicinity include Ballysadare Bay SAC, SPA and pNHA, the Ballygawley NHA, Unsin River SAC and the Union Wood SAC and pNHA, the closest of which is located c. 2.4km from the site

4.21 The Record of Monuments and Places includes the following recorded monuments within and in the vicinity of the application area:

- Ref. SL020-094 – A hachured enclosure located on the access road into the application area. This record is noted as having been removed by quarrying;
- Ref. SL020-093 – A ringfort or rath;
- Ref. SL020-086 – A ringfort or rath.

There are no recorded monuments within the application area.

4.22 There are no buildings on the National Inventory of Architectural Heritage in the vicinity. According to the OPW model, part of the quarry void is noted as being at risk of pluvial flooding and all of the void is at risk of coastal flooding.

Population

4.23 The review of population is based on the electoral divisions of Ballintogher West and Calry, in which the application site is located. The change in population from 2011 to 2016, as per Census 2016[2] for the electoral divisions, the county, the province and the state is outlined in the table below.

Table 4-1
Population 2011 - 2016

	2011	2016	% Change
Ballintogher West ED	435	443	1.8%
Calry	1,806	1,702	-5.8%
County Sligo	65,393	65,535	0.2%
Connaght	542,547	550,668	1.5%
Ireland	4,588,252	4,757,976	3.7%

4.24 The census results indicate that population growth in Ballintogher West, Sligo and Connacht, is significantly slower than at the national level and the population is in decline in Calry electoral division.

[2] http://census.cso.ie/sapmap/

Employment

4.25 According the August 2017 Live Register statistics[3], there were 3,160 persons in Sligo town on the live register. This figure has dropped from 3,724 in August 2016 and 4,009 in August 2015. Notwithstanding the downward trend, the current figure remains high compared to the August 2006 figure of 1,735. The current figure of 3,160 is an 82% increase on the August 2006 figure.

4.26 The application area is located in the electoral divisions of Ballintogher West and Calry.

4.27 According to the 2016 census results[4], Ballintogher West has a total population of 443. Of the 371 people aged 15 years or older, some 217 were at work, 3 were looking for their first job and 14 were unemployed. Others were students, working at home, retired, unable to work or other.

4.28 According to the 2016 census results[5], Calry has a total population of 1,702. Of the 1,433 people aged 15 years or older, some 719 were at work, 17 were looking for their first job and 51 were unemployed. Others were students, working at home, retired, unable to work or other.

4.29 The population in Ballintogher West and Calry and Sligo is categorised by occupation as per table 4.2. This shows that the trend in Ballintogher West and Calry is broadly similarly to that in the wider county, albeit that a higher proportion of people are engaged in managerial, professions and administrative and secretarial occupations in Calry than in Sligo and a higher proportion of people are engaged in technical and skilled occuptations in Ballintogher West than in Sligo.

Table 4-2
Population of Ballintogher West and Calry by Occupation

	Ballintogher West		Calry		County Sligo	
Occupation	**No.**	**%**	**No.**	**%**	**No.**	**%**
Managers, Directors and Senior Officials	8	3.46	76	9.87	1,927	6.46
Professional Occupations	35	15.15	193	25.07	5,151	17.28
Associate Professional and Technical Occupations	32	13.85	95	12.34	2,911	9.76
Administrative and Secretarial Occupations	21	9.09	88	11.43	3,034	10.18

[3] http://www.cso.ie/px/pxeirestat/Statire/SelectVarVal/Define.asp?Maintable=LRM07&Planguage=0

[4] http://census.cso.ie/sapmap2016/Results.aspx?Geog_Type=ED3409&Geog_Code=2AE196291A2613A3E055000000000001

[5] http://census.cso.ie/sapmap2016/Results.aspx?Geog_Type=ED3409&Geog_Code=2AE1962919A913A3E055000000000001#SAPMAP_T8_801

Skilled Trades Occupations	46	19.91	86	11.17	5,049	16.93
Caring, Leisure and Other Service Occupations	25	10.82	60	7.79	2,671	8.96
Sales and Customer Service Occupations	17	7.36	37	4.81	1,816	6.09
Process, Plant and Machine Operatives	14	6.06	40	5.2	2,087	7.00
Elementary Occupations	17	7.36	64	8.31	2,563	8.60
Not stated	16	6.93	31	4.03	2,605	8.74
Total	231	100	770	100	29,814	100.00

4.30 A breakdown of the industry in which those at work are employed is provided below as per table 4.3. This shows that:

a) a higher proportion of the population in Ballintogher West is likely to be engaged in building and construction, commerce and trade, transport and communications, and professional services than in Sligo and that a lower proportion is engaged in agriculture, forestry and fishing, manufacturing and public administration than in Sligo;

b) a higher proportion of the population in Calry is likely to be engaged in commerce and trade, transport and communications, public administration and professional services than in Sligo and that a lower proportion is engaged in agriculture, forestry and fishing, building and construction and manufacturing than in Sligo.

Table 4-3
Persons at work in Ballintogher West and Calry by industry

	Ballintogher West		Calry		County Sligo	
Industry	**No.**	**%**	**No.**	**%**	**No.**	**%**
Agriculture, forestry and fishing	12	5.53	27	3.76	1,868	7.18
Building and construction	22	10.14	27	3.76	1,165	4.48
Manufacturing industries	21	9.68	73	10.15	3,262	12.55
Commerce and trade	46	21.2	137	19.05	4,894	18.82
Transport and communications	17	7.83	34	4.73	1,224	4.71
Public administration	12	5.53	66	9.18	1,952	7.51
Professional services	64	29.5	244	33.94	7,203	27.70

	Ballintogher West		Calry		County Sligo	
Other	23	10.6	111	15.44	4,434	17.05
Total	217	100	719	100	26,002	100

Sensitive Receptors

4.31 The application site is located is a rural area, but the nearby roads and in particular the roads to the north-east and north-west display a pattern of ribbon development. There is a more dispersed pattern of residential development along the local road to the south of the site north. There is a number of industrial and commercial developments to the south-east of the site associated with the manufacturing area of the site and the nearby business park.

4.32 The closest residential dwelling to the application site is located south-west of the site entrance and c. 23m from the application boundary. There are no residences within 200 metres of the quarry void.

4.33 There are no schools, churches or shops in the vicinity. The St John's Football Club is located to the north-west of the application site.

4.34 Figure 4.1 identifies residential properties, community facilities and commercial operations within the locality and shows 500m and 1km bands from the application boundary.

IMPACT ASSESSMENT

Evaluation Methodology

4.35 The evaluation of effects on employment, human health and amenity comprises a qualitative assessment based on the quantitative and qualitative analysis of potential effects on the environment undertaken in other chapters of this EIAR. The assessment also takes into account a review of relevant literature and professional judgement in relation to impact on population and human health.

Employment

Operational Stage Impacts

4.36 The proposed development will provide employment of up to 6 people directly on-site, in addition to a number of indirect employees including hauliers, sub-contractors, materials suppliers and maintenance contractors. In addition, the proposed development will contribute indirectly to sustaining and developing the local and regional economy through continued supply of construction aggregates.

4.37 This is a medium-term and positive impact that would not have significant effects on the environment.

Post – Operational Stage Impacts

4.38 Following the cessation of operations, the application site will be restored. This would result in the loss of jobs within the quarry and related operations. Some short-term employment would be provided in relation to the aftercare of the restored site.

Human Health

1.48 The key pathways in relation to human health in this instance are air, noise, water and soil.

Operational Stage Impacts

4.39 The operational phase of the development relates to the extraction of aggregates within the quarry area using conventional quarrying techniques and the restoration of the quarry to a natural habitat. This stage of operations has the potential to generate impacts that would have effects on human health through the pathways of noise, dust, soil and water.

4.40 As outlined in chapter 6 regarding land, soils and geology, chapter 7 regarding water, chapter 8 regarding air and chapter 10 regarding noise & vibration, a number of mitigation measures are proposed and the residual effect of the proposed development is predicted to be negligible to acceptable.

4.41 On this basis, it is considered that there would be no likely significant temporary or permanent effects on human health during the construction and operational stage following mitigation.

Post – Operational Stage Impacts

4.42 Following restoration, the potential effects on air, vibration and noise would cease owing to the cessation of quarrying operations and restoration operations.

4.43 As outlined in chapters 6 (land, soils and geology), 7 (water), 8 (air) and 9 (noise and vibration) mitigation measures are proposed. Based on the proposed mitigation measures, the potential for residual effects is predicted to be negligible. On this basis, it is considered that there would be no likely significant effect on human health during the post-operational stage.

Amenity

4.44 The key matters in relation to amenity in this instance are air, noise, vibration, landscape and traffic.

Operational Stage Impacts

4.45 The construction & operational phase would require the extraction of aggregates, which has the potential to generate dust, noise and vibrations. In addition, there would be vehicle movements associated with the quarry and a change in the landscape.

4.46 As outlined in chapters 8 (air), 10 (noise and vibrations), 13 (landscape) and 14 (traffic), mitigation measures are proposed. Based on the proposed mitigation measures, the potential for residual effects during the construction and operational phase is likely to be negligible to acceptable. On this basis, it is considered that there would be no likely significant effect on amenity during the operational stage.

Post – Operational Stage Impacts

4.47 Following restoration, the potential effects on air, noise, vibration, and traffic would cease owing to the cessation of quarrying and restoration operations, the cessation of machinery operation and the growth of vegetation.

4.48 Clearly, following the cessation of the proposed works, the appearance of the application site will have altered. As outlined in chapter 13 relating to landscape, the effects of the restored development would be beneficial compared to the current baseline.

4.49 Based on the anticipated outcomes of the proposed development, the potential for residual effects during the post-operational phase is likely to be low. On this basis, it is considered that there would be no likely significant effect on amenity during the post-operational stage.

Unplanned Events

4.50 According to the EPA guidelines, unplanned events, such as accidents, can include *"spill from traffic accidents, floods or land-slides affecting the site, fire, collapse or equipment failure on the site"*. The 2014 EIA directive refers to *"major accidents, and/or natural disasters (such as flooding, sea level rise, or earthquakes)"*.

4.51 In this instance, the vulnerability of the proposed development to accidents, unplanned events or natural disasters is relatively limited owing to the relatively simple nature of the development works, the established nature of the techniques, regulations and procedures to be followed, the material to be handled on site and the relatively rural location of the proposed works.

4.52 Unplanned events in relation to the proposed development could potentially relate to:

- instability following the extraction of rock;
- spill from traffic accidents;
- flooding.

4.53 Adhering to the HSA Safe Quarry Guidelines to the Safety Health and Welfare at Work (Quarries) Regulations 2008 should limit the potential for unplanned events in the form of instability in the quarry faces. In any event, instability following the extraction of rock would be unlikely to have any significant impacts on employment, human health or amenity, particularly beyond the site. The final restoration will provide for the restoration of the quarry to a mixture of grassland, a water body, naturally regenerating quarry benches and woodland.

4.54 Chapter 7 (water) notes that 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. 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.

4.55 The traffic and transport assessment, carried out as part of the EIAR (Chapter 14), indicates that existing road network can accommodate the proposed development. Chapter 14 also recommends the erection of warning signage and the improvement of sightlines at the entrance to the application area. It is considered that the risk of an accident resulting in a spillage would be no greater in relation to this development than it is for any other form of development that relies on the transportation of goods and materials by HGVs. The potential for significant impacts on employment, human health in the wider population or amenity as a result of a road spillage is likely to be low and any such effects would be temporary.

Cumulative / Synergistic Impacts

4.56 A search of the Sligo County Council online planning search facility indicates that there are no other planned developments in the vicinity of the application site and in the adjoining townlands of Carrownamaddoo, Cuilbeg, Aghamore Near, Tullynagracken South, Drumaskibbole, Ballydawley, Castledargan, which were granted planning permission in the last five years[6] and have the potential to have any significant adverse cumulative impacts on the local environment. It is noted that planning permission has recently been granted for development consisting of the filling of lands with construction and demolition waste in Carrownamaddoo townland c. 450 metres from the application area (Plan File Ref. No. 18/49) subject to 7 no. conditions. This proposed development is considered small scale, short term in duration (5 years) and is located sufficient distance from the application area and therefore no cumulative impacts are considered.

4.57 It is considered that the only impact that has the potential for significant cumulative impact on population and human health and in particular on amenity is traffic. The traffic impact of the development is assessed and discussed in chapter 14 of this EIAR. The assessment concludes that the relevant junctions and links will have sufficient capacity for the traffic generated by the quarry development.

Transboundary Impacts

4.58 It is not anticipated that the impacts of the proposed development would have any significant transboundary effects on population and human health.

Interaction with Other Impacts

4.59 It is not anticipated that the effects of the proposed development on population and human health would interact significantly with other impacts.

‘Do-nothing Scenario’

4.60 If planning permission is not approved for the continued use and deepening of the existing quarry, the current permission would expire, after which, the site would be restored. This would result in a cessation of impacts related to noise, air, dust, water, vibration and traffic. This would also result in an adverse effect on employment, because the workforce that would have otherwise been employed by the quarry would not exist.

[6] Planning search conducted on 23rd August 2018 on Sligo County Council website.

MITIGATION MEASURES

Operational Stage

4.61 Mitigation measures to be adopted in relation to population and human health during the operational stage will relate to minimising the effect of the development on surrounding sensitive receptors in relation to air, noise, water, soil, traffic and landscape. These measures relate primarily to avoidance, prevention and reduction and are discussed in the relevant chapters of the EIAR.

4.62 These mitigation measures include the following:

Table 4-5
Construction & Operational Stage Mitigation Measures

Topic	Mitigation Measure
Soil	In order to limit the effects of erosion on any existing excavated soil material the following mitigation measures will be used on site during handling: • Soil material will be placed in permanent or temporary locations at a safe angle of repose; • Screening berms will be re-vegetated where they are in place for a sufficient length of time to justify such measures; and • The re-handling of soil material will be minimised as much as possible in order to preserve the integrity of the soil material; this is also an economically prudent practice.
Water	• Groundwater monitoring of neighbouring third party well; • Updating the Environmental Management System for the site to include a site specific blasting protocol; • All petroleum-based products (lubricating oils, waste oils, etc.) will be stored in a bunded area to prevent pollution by accidental leaks; • 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; • Spill kits will be maintained on site to stop the migration of any accidental spillages, should they occur; • Interceptors will be located in areas close to potential sources of hydrocarbon contamination; • A settlement lagoon will be installed to reduce suspended solids levels in the discharges; • No pumping during flooding events which eliminates the slight risk from flooding during extreme events.
Dust	• Minimise drop heights when handling materials. Soils placed directly into

Topic	Mitigation Measure
	screening berms or in progressive works. Avoid working in adverse/ windy conditions. • Minimise drop heights when handling material, protection from wind where possible. Use of water sprays / tractor & bowser to moisten surfaces during dry weather. • Minimise distances of onsite haul routes. • Restrict vehicle speeds through signage / staff training. • Location of haul routes away from sensitive receptors. • Use of road sweeper to reduce the amount of available material for re-suspension. • Pave the access road. • Avoid working in adverse weather conditions and faulty dust filters • Seed surfaces of completed mounds / bunds of top soil. • Limit mechanical disturbance. • Retention of hedgerows • Proposed perimeter berms • Avoid working in adverse weather conditions
Noise	• Existing screening berms and screen planting shall be retained to act as acoustic barriers. Berms should be inspected on a regular basis and maintained as necessary. • Plant:- ○ all mobile plant used at the development should have noise emission levels that comply with the limiting levels defined in EC Directive 86/662/EEC and any subsequent amendments; ○ all plant items should be properly maintained and operated according to the manufacturers' recommendations, in such a manner as to avoid causing excessive noise (i.e. all moving parts are kept well lubricated, all cutting edges are kept sharpened, the integrity of silencers and acoustic hoods are maintained); ○ all plant should be subject to regular maintenance, i.e. all moving parts are kept well lubricated, all cutting edges are kept sharpened, the integrity of silencers and acoustic hoods are maintained;

<table>
<tr><th>Topic</th><th>Mitigation Measure</th></tr>
<tr><td></td><td>all plant should be fitted with effective exhaust silencers which are maintained in good working order to meet manufacturers' noise rating levels. Any defective silencers should be replaced immediately.
Traffic:-
any deliveries should be programmed to arrive during daytime hours only;
care should be taken when unloading vehicles to reduce or minimise potential disturbance to local residents.
access / internal haul roads should be kept clean and maintained in a good state of repair, i.e. any potholes are filled and large bumps removed, to avoid unwanted rattle and "body-slap" from heavy goods vehicles;
vehicles waiting within the quarry should be prohibited from leaving their engines running and there should be no unnecessary revving of engines.</td></tr>
<tr><td>Vibration</td><td>Blast notifications provided by pre and post siren warnings.
All blasting operations should be carried out by a certified 'shotfirer' in accordance with the relevant health and safety regulations.
The optimum blast ratio is maintained and the maximum instantaneous charge is optimised.
To avoid any risk of damage to properties in the vicinity of the site, the groundborne vibration levels from blasting should not exceed a peak particle velocity of 12 mm/sec.</td></tr>
<tr><td>Traffic</td><td>The erection of warning signage on the approach roads.

The improvement of sightlines at the quarry entrance.</td></tr>
<tr><td>Landscape</td><td>Hedgerow and woodland planting using native species is proposed along the boundaries of the application area which, along with vegetation to be retained would mitigate landscape and visual effects.

The post operational stage mitigation comprises a restoration plan to be implemented at the end of the life of the quarry. The restoration plan includes a range of measures to restore the quarry site to an afteruse which would be more sympathetic with the surrounding landscape. Details of the restoration plan are presented in Figure 2.2.</td></tr>
</table>

Post – Operational Stage

4.63 The majority of effects of the proposed development will diminish or cease following the cessation of operations. No specific mitigation measures are proposed in relation to the post operational phase.

RESIDUAL IMPACT ASSESSMENT

Operational Stage

4.64 As outlined in chapters 6 (land, soils and geology), 7 (water), 8 (air), 10 (noise and vibration), 13 (landscape) and 14 (traffic) of this EIAR, the mitigation measures would successfully reduce the effects of the proposed development during the operational phase as follows:

- Land, Soils and Geology: None
- Water: None
- Dust: Insignificant to Acceptable
- Noise: Negligible to Minor
- Vibration: None
- Traffic: The assessments have concluded that the links and junctions will operate within capacity for each of the assessment years.
- Landscape: Very small and beneficial

4.65 No specific mitigation measures are proposed in relation to human health and population.

Post – Operational Stage

4.66 As outlined in chapters 6 (land, soils and geology), 7 (water), 8 (air), 10 (noise and vibration), 13 (landscape) and 14 (traffic) of this EIAR, the mitigation measures would successfully reduce the effects of the proposed development during the post operational phase as follows:

- Land, Soils and Geology: None
- Water: None
- Dust: Insignificant to Acceptable
- Noise: Negligible to Minor
- Vibration: None
- Traffic: None – all associated traffic will cease.

- Landscape: Beneficial following restoration when compared with the existing baseline.

4.67 No specific mitigation measures are proposed in relation to human health and population.

MONITORING

4.68 As outlined in chapters 2 (description of the development), 7 (water), 8 (air) and 10 (noise and vibrations), monitoring in relation to the proposed development will be undertaken in respect of water, noise, air and vibrations. On this basis, no specific monitoring is required in relation to population and human health

Environmental Monitoring Programme

4.69 The site has an established environmental monitoring programme– refer to Condition No. 22 imposed under Plan File Ref. No. PL02/271 and Appendix 2-A. Water, noise, dust and blast monitoring is carried out on a regular basis (when operational), to demonstrate that the development is not having an adverse impact on the surrounding environment.

Water

4.70 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.

4.71 Groundwater levels should 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 required. Permission will be sought from the land owner to monitor water levels in his farm well to the south of the quarry and a datalogger installed.

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

4.73 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 at this location.

Dust and Air

4.74 Dust deposition monitoring is carried out at the application site, when operational. Dust monitoring locations shall be reviewed and revised where necessary. The results of the dust monitoring will be submitted to Sligo County Council on a regular basis for review and record purposes.

Noise

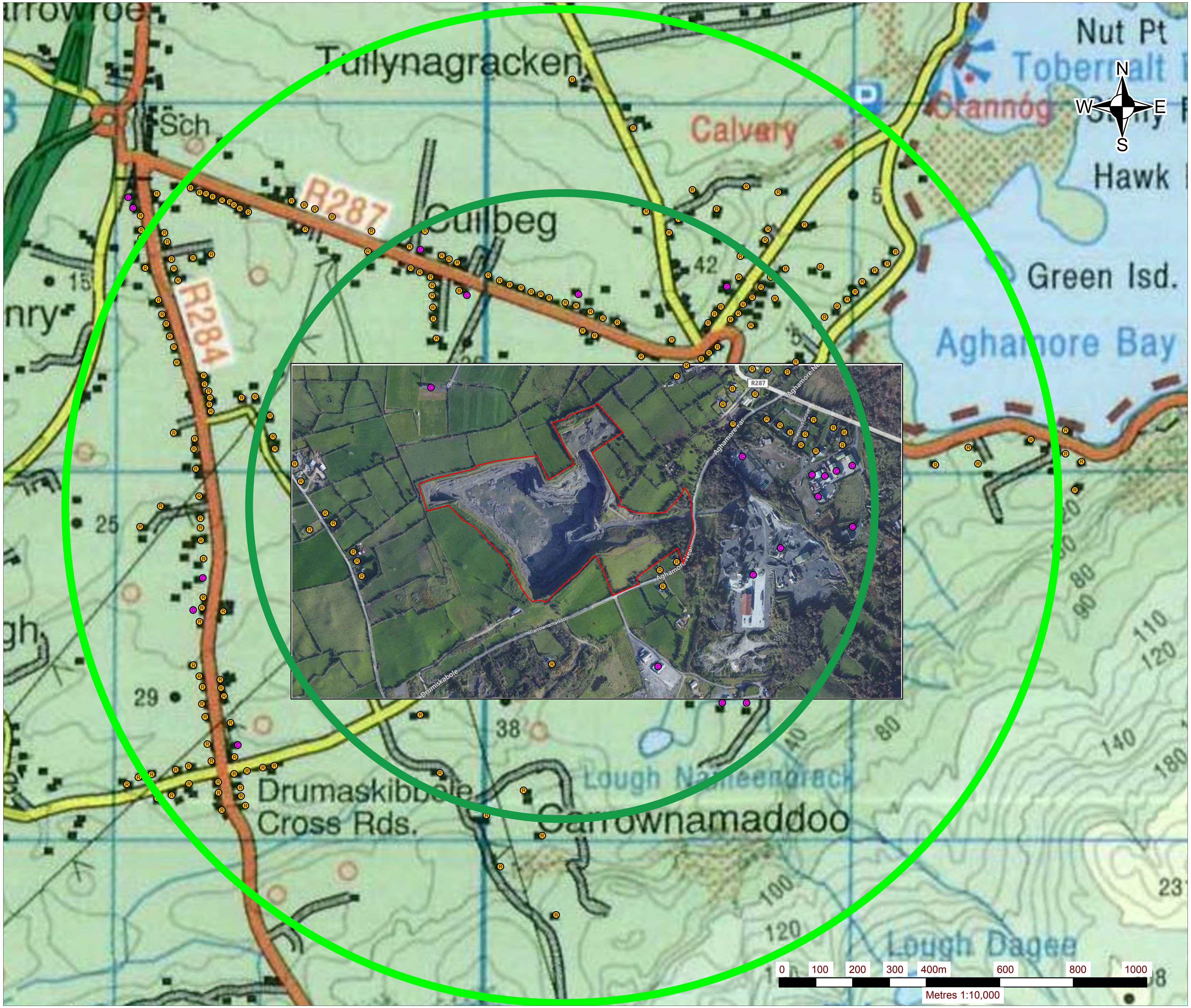
4.75 Noise monitoring is currently undertaken at the application site, when operational. Noise monitoring locations shall be reviewed and revised where necessary. The results of the noise monitoring will be submitted to Sligo County Council on a regular basis for review and record purposes.

Vibration

4.76 Monitoring of blasts (both for groundborne vibration and air overpressure) have been and will continue to be carried out at the site. The blast monitoring results have been and will continue to be submitted on a regular basis to Sligo County Council for record purposes.

FIGURES

Figure 4-1: Residences, Community Facilities and Commercial Operations



NOTES

1. ORDNANCE SURVEY IRELAND LICENCE NO. SU 0000718 (C) ORDNANCE SURVEY IRELAND & GOVERNMENT OF IRELAND

LEGEND

- APPLICATION AREA
- RESIDENCE
- COMMERCIAL
- 1 KM OFFSET
- 500 M OFFSET

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LAGAN BITUMEN LTD.

LIMESTONE QUARRY AT AGHAMORE NEAR AND CARROWNAMADDOO, CO. SLIGO

RESIDENCES, COMMUNITY FACILITIES AND COMMERCIAL OPERATIONS

FIGURE 4.1

Scale	Date
1:10,000 @ A3	AUGUST 2018

501.00396.00007.Sligo EIAR Figure 4.1.Rev.0.dwg

CHAPTER 5

BIODIVERSITY

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INTRODUCTION

5.1 This Biodiversity chapter forms part of the Environmental Impact Assessment Report (EIAR) prepared in support of a planning application for the continued use and deepening of an existing permitted quarry. A detailed description of the development site is outlined in Chapter 1 of this EIAR. The proposed development / project is described in detail in Chapter 2 of this Environmental Impact Assessment Report (EIAR).

General Description of the Site

5.2 Aghamore Quarry ("the Site") is located in the townlands of Aghamore and Carrownamaddoo, approximately 3.5 km south of Sligo Town. The quarry is set in an agricultural landscape with the most common land use in the surrounding area being pasture for grazing animals.

5.3 The Site is screened by planted trees at the Site entrance and a short distance along either side of the access track. The northernmost corner of the Site is also well vegetated with dense scrub and well-structured field boundaries. The remaining length of the Site perimeter is delineated by stock proof fencing with occasional semi-mature trees present. The quarry void is itself largely unvegetated with occasional ruderal species growing sparsely.

Brief Project Description

5.4 The proposed development being applied for is similar to that previously granted under Sligo County Council Ref. No 02/271 and will consist of:

- Continued use and operation of the existing permitted quarry area (c. 10.9ha) within an overall application area of c.18 hectares;
- Deepening of the existing permitted quarry area by a further bench from -34.5m OD to -50m OD[1];
- The provision of a settlement lagoon (c. 2,800m2).
- Quarry restoration.

5.5 Upon the cessation of extraction operations it is proposed to return the worked lands to natural habitat[2] after-uses. Where feasible, restoration of exhausted and redundant areas will be carried out at the earliest opportunity. However, it is envisaged that the majority of restoration proposals will only be carried out after extraction operations at the site have ceased.

5.6 The proposed development / project is described in more detail in Chapter 2 of the Environmental Impact Assessment Report (EIAR) prepared for this planning application.

[1] Ordnance Datum

[2] Natural habitat (lake, wetland – nature conservation) as defined by the EPA Environmental Management Guidelines for the Extractive Industry (2006)

Purpose of the Chapter

5.7 The purpose of this biodiversity chapter is to form part of the EIAR prepared to inform the application for continued use and deepening of an existing permitted quarry at Aghamore, Co. Sligo.

Evidence of Technical Competence and Experience

5.8 The biodiversity chapter was prepared by Elaine Dromey MCIEEM with input from Owen Twomey. Elaine Dromey and Steve Judge MCIEEM carried out the ecology field surveys.

5.9 Elaine Dromey holds a BSc in Earth Science from University College Cork and an MSc in Vegetation Survey and Assessment from the University of Reading, UK. She is a full member of the Chartered Institute of Ecology and Environmental Management. Elaine has prepared Ecological Impact Assessment (ECIA) reports for a variety of different projects including large wind farms, single turbine developments, power lines, quarry developments, anaerobic digesters, industrial development and single small developments.

5.10 Steve holds a BSc in Environmental Management & Monitoring and has over 17 years' experience in environmental and ecological consultancy. Steve a full member of the Chartered Institute of Ecology and Environmental Management (CIEEM) and has particular expertise in the ecology of freshwater systems. He has worked on a wide range of projects requiring ecological survey, assessment and evaluation Steve has prepared EcIA reports and EIAR chapters for developments such as quarries, mines, anaerobic digesters, industry and housing. He is experienced in design and implementation of mitigation strategies for a number of protected species both in the UK and Ireland.

5.11 Owen Twomey is an ecologist with SLR and has worked in ecological consultancy since 2016. Owen holds a BSc in Environmental Science (Zoology) and a Postgraduate Diploma in Ecological Assessment. Owen has prepared ecological reports including biodiversity chapters for Environmental Impact Assessment Reports (EIAR) Reports for a wide range of developments.

Relevant Planning Policy and Legislation

5.12 The planning policy and legislation that is relevant to the proposal for the continue of use and deepening of the quarrying operation at Aghamore are set out in the following sections.

County Planning Policies

5.13 The relevant planning policies and objectives have been extracted from Volume 1 of Sligo County Development Plan 2017 – 2023 and are set out below.

Natural heritage – general policies

5.14 It is the policy of Sligo County Council to:

- **P-NH-1** Protect, sustainably manage and enhance the natural heritage, biodiversity, geological heritage, landscape and environment of County Sligo in recognition of its importance for nature conservation and biodiversity, and as a non-renewable resource, in association with all stakeholders.

- **P-NH-2** Promote increased understanding and awareness of the natural heritage and biodiversity of the county.

- **P-NH-3** Protect and, where possible, enhance the plant and animal species and their habitats that have been identified under the EU Habitats Directive, EU Birds Directive, the Wildlife Act and the Flora Protection Order.

- **P-NH-4** Take full account of the precautionary principle where uncertainty exists regarding the potential impact of a proposed development on the natural heritage resource.

Designated sites for nature conservation – policies

5.15 It is the policy of Sligo County Council to:

- **P-DSNC-1** Protect and maintain the favourable conservation status and conservation value of all natural heritage sites designated or proposed for designation in accordance with European and national legislation and agreements. These include Special Areas of Conservation (SACs), Special Protection Areas (SPAs), Natural Heritage Areas (NHAs), Ramsar Sites, Statutory Nature Reserves. In addition, the Council will identify, maintain and develop non-designated areas of high nature conservation value which serve as linkages or 'stepping stones' between protected sites in accordance with Article 10 of the Habitats Directive.

- **P-DSNC-2** Promote the maintenance and, as appropriate, achievement of 'favourable conservation status' of habitats and species in association with the NPWS.

- **P-DSNC-3** Carry out an appropriate level of assessment for all development plans, land-use plans and projects that the Council authorizes or proposes to undertake or adopt, to determine the potential for these plans or projects to impact on designated sites, proposed designated sites or associated ecological corridors and linkages in accordance with the

Habitats Directive, All appropriate assessments shall be in compliance with the provisions of Part XAB of the Planning and Development Act 2000.

- **P-DSNC-4** Consider development within, or with the potential to affect, Natural Heritage Areas or proposed Natural Heritage Areas, where it is shown that such development, activities or works will not have significant negative impacts on such sites or features, or in circumstances where impacts can be appropriately mitigated.

Protected plant and animal species – policies

5.16 It is the policy of Sligo County Council to:

- **P-PPAS-1** Ensure that development does not have a significant adverse impact, incapable of satisfactory mitigation on plant, animal or bird species protected by law.

- **P-PPAS-2** Consult with the National Parks and Wildlife Service (DAHG) and take account of any licensing requirements when undertaking, approving and authorising development which is likely to affect plant, animal or bird species protected by law.

- **P-PPAS-3** Provide guidance to developers and others in relation to species protected by law and their protection and management in the context of development.

Nature conservation outside designated sites – policies

5.17 It is the policy of Sligo County Council to:

- **P-NCODS-1** Minimise the impact of new development on habitats of natural value that are key features of the County's ecological network. Developments likely to have an adverse effect on recognised sites of local nature conservation importance will be required to demonstrate the impacts on the ecological value of the site and will not be approved unless it can be clearly demonstrated that there are reasons for the development that outweigh the need to safeguard the nature conservation value of the site.

- **P-NCODS-2** Ensure that development proposals, where relevant, improve the ecological coherence of the Natura 2000 network and encourage the retention and management of landscape features that are of major importance for wild fauna and flora as per Article 10 of the Habitats Directive.

- **P-NCODS-3** Ensure that proposals for development protect and enhance biodiversity, wherever possible, by minimising adverse impacts on existing habitats and by including mitigation and/or compensation measures, as appropriate, which ensure that biodiversity is enhanced.

- **P-NCODS-4** Apply the precautionary principle in relation to development proposals with potential to impact on County Biodiversity Sites or on local nature conservation interest by requiring an ecological impact assessment (EcIA) to ensure that any proposed development will not affect the integrity and conservation value of the site.

- **P-NCODS-5** Ensure that no ecological networks, or parts thereof which provide significant connectivity between areas of local biodiversity, are lost without remediation as a result of implementation of this Plan.

- **P-NCODS-6** Provide guidance for developers and the general public in relation to nature conservation outside designated sites and the conservation and enhancement of biodiversity and geological heritage in general.

- **P-NCODS-7** Integrate biodiversity considerations into Local Authority plans, programmes and activities where appropriate.

Wetlands Policies

5.18 It is the policy of Sligo County Council to:

- **P-WET-1** Have regard to the County Sligo Wetlands Surveys 2008-2011 and subsequent wetland surveys that may be published during the lifetime of this Plan. Protect surveyed wetland sites that have been rated of A (International), B (National) and C+ (County) importance.

- **P-WET-2** Ensure that an ecological assessment at an appropriate level is undertaken in conjunction with proposals involving drainage or reclamation of wetland habitats.

Woodlands, trees and hedgerows policies

5.19 It is the policy of Sligo County Council to:

- **P-WTH-1** Protect trees, woodlands and hedgerows from development that would impact adversely upon them. Promote new tree and woodland planting and the enhancement of existing hedgerows by seeking increased coverage, in conjunction with new development using native species of local provenance, where possible.

- **P-WTH-2** Discourage the felling of mature trees to facilitate development and, where appropriate make use of tree preservation orders to protect important trees and groups of trees which may be at risk or have an important amenity or historic value.

- **P-WTH-3** Require the planting of native broadleaved species, and species of local provenance, in new developments.

- **P-WTH-4** Promote the planting of native tree and shrub species by committing to using native species (of local provenance wherever possible) in its landscaping works and on County Council property.

Invasive species policies

5.20 It is the policy of Sligo County Council to:

- **P-INV-1** Prevent and control the spread of invasive plant and animal species within the county.

- **P-INV-2** Require, where appropriate, Invasive Species Management Plans to be prepared for development proposals regulated by the Planning Authority or undertaken by the Local Authority, and in particular for Japanese Knotweed and Giant Hogweed.

Inland waters policies

5.21 It is the policy of Sligo County Council to:

- **P-INW-1** Protect rivers, streams and other water courses and their associated Core Riparian Zones (CRZs) from inappropriate development and maintain them in an open state, capable of providing suitable habitats for fauna and flora. Structures (e.g. bridges) crossing fisheries waters shall be clear-span and shall be designed and built in consultation with Inland Fisheries Ireland.

- **P- INW-2** Protect and enhance biodiversity richness by protecting rivers, stream corridors and valleys by reserving land along their banks for ecological corridors, maintaining them free from inappropriate development and discouraging culverting or realignment.

- **P- INW-3** Ensure that all proposed greenfield residential and commercial developments use sustainable drainage systems (SUDS) in accordance with best current practice, ensuring protection of the integrity of wetland sites in the adjoining area, including their hydrological regime.

- **P- INW-4** Ensure that floodplains and wetlands within the Plan area are retained for their biodiversity and flood protection value.

- **P- INW-5** Ensure that proposed developments do not adversely affect groundwater resources and groundwater-dependent habitats and species

Legislation

5.22 The '*Environmental Impact Assessment Directive'*, EIA Directive, means Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment as amended by Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment

5.23 The EIA Directive was first transposed into Irish law by the European Communities (Environmental Impact Assessment) Regulations, 1989 (S.I. No. 349 of 1989) which amended the Local Government (Planning and Development) Act, 1963 (and other legislation) to provide for environmental impact assessment.

5.24 The Habitats Directive ensures the conservation of a wide range of rare, threatened or endemic animal and plant species. Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora was adopted in 1992 and aims to promote the maintenance of biodiversity, taking account of economic, social, cultural and regional requirements. It forms the cornerstone of Europe's nature conservation policy with the Birds Directive and establishes the EU wide Natura 2000 ecological network of protected areas, safeguarded against potentially damaging developments.

5.25 The Natura 2000 network consists of protected areas known as Special Areas of Conservation (SAC) and Special Protection Areas (SPA). In general terms, they are considered to be of exceptional importance in terms of rare, endangered or vulnerable habitats and species within the European Community. The requirements of the Habitats Directive have been transposed into Irish law through the European Communities (Birds and Natural Habitats) Regulations 2011 [S.I. No. 477/2011]. This legislation affords protection to both Special Protection Areas and Special Areas of Conservation.

5.26 Special Areas of Conservation (SAC) are designated under the Conservation of Natural Habitats and of Wild Fauna and Flora Directive 92/43/EEC (Habitats Directive) which is transposed into Irish law by the EC (Birds and Natural Habitats) Regulations 2011 (S.I. 477 of 2011). Special Protection Areas (SPA) are classified under the Birds Directive (2009/147/EC on the Conservation of Wild Birds). Article 6(3) of the Habitats Directive requires an ‘appropriate assessment’ to be undertaken for any plan or project that is likely to have a significant effect on the conservation objectives of a Natura 2000 site. An ‘appropriate assessment’ is an evaluation of the potential impacts of a plan or project on the integrity of a Natura 2000 site, and the incorporation, where necessary, of measures to mitigate or avoid negative effects.

5.27 Flora and fauna in Ireland are protected at a national level by the Wildlife Acts 1976 to 2012 and the Flora (Protection) Order 2015. Natural Heritage Areas (NHA) are areas that are considered to be important for the habitats present or for the species of plants and animals supported by those habitats. Under the Wildlife Amendment Act 2000, NHAs are legally protected from damage from the date they were formally proposed for designation. Section 19(1) of the Act states that ‘*Where there is a subsisting natural heritage area order in respect of any land, no person shall carry out, or cause or permit to be carried out, on that land any works specified in the order or any works which are liable to destroy or to significantly alter, damage or interfere with the features by reason of which the designation order was made*’.

5.28 In addition, a list of proposed NHAs (pNHAs) was published in 1995 but to date these have not had their status confirmed. Prior to statutory designation, pNHAs are subject to limited protection under various agri-environment and forestry schemes and under local authority planning strategies such as County Development Plans.

Methodology

5.29 The methodology used to carry out the survey of the Site, to evaluate the ecological value and to prepare the biodiversity chapter is outlined in this section. The assessment methodology for this proposal was developed using the standard professional impact assessment guidance published in 2016 by Chartered Institute of Ecology and Environmental Management (CIEEM).

Scope of the Chapter

5.30 The scope of this Biodiversity Chapter is to identify potential impacts likely to occur as a result of the proposed continued use and deepening of the permitted quarry in the townlands of Aghamore and Carrownamaddoo, Co. Sligo and to determine if the effects on biodiversity are significant in the absence of mitigation. The scope of the report includes the provision of mitigation, compensation and enhancement measures as required.

Zone of Influence

5.31 The 'zone of influence' for a project is the area over which ecological features may be subject to significant effects because of the proposed project and associated activities. This is likely to extend beyond the project site, for example where there are ecological or hydrological links beyond the site boundaries. The zone of influence will vary for different ecological features depending on their sensitivity to an environmental change (CIEEM, 2016).

5.32 The Zone of Influence for the project can be identified through review of the nature of the proposed works, the presence / absence of surface water receptors, the presence of ecological connectivity to the wider landscape and distance from known ecologically sensitive sites.

Desk Study

5.33 A desk study was carried out to collate the available existing ecological information on the quarry at Aghamore and Carrownamaddoo, Co. Sligo. The Site and the surrounding area were viewed using existing available satellite imagery[3] (last accessed on 20 August 2018).

5.34 The websites of the National Parks and Wildlife Service (NPWS)[4] and the National Biodiversity Data Centre (NBDC)[5] were accessed for both information (last accessed 20 August 2018) on sites designated for nature conservation, and on protected habitats and species known from the 1 km grid squares G6931, G6932, G7031, AND G7032 within which the site is located. Only records for the past 15 years are considered within this report as older records are unlikely to still be relevant given their age and the changes in land management that is likely to have occurred in the intervening period.

5.35 Sligo County Council planning portal[6] was accessed for information on other planning applications within the Site and immediate area (last accessed 20 August 2018). Sligo County Council website

[3] https://www.google.ie/maps & https://www.bing.com/maps
[4] www.npws.ie
[5] http://maps.biodiversityireland.ie/#/Map
[6] http://www.sligococo.ie/planning/

was accessed for information on relevant planning policy to inform this report (last accessed 16 August 2018).

5.36 Birds of Conservation Concern in Ireland (BoCCI)[7], published by BirdWatch Ireland and the RSPB NI, is a list of priority bird species for conservation action on the island of Ireland. The BoCCI lists birds which breed and/or winter in Ireland and classifies them into three separate lists; Red, Amber and Green; based on the conservation status of the bird and hence their conservation priority. Birds on the Red List are those of highest conservation concern, Amber List are of medium conservation concern and Green List are not considered threatened. The BirdWatch Ireland website was accessed on 16 August 2018 for information on birds of conservation concern.

5.37 All bird species are protected under the Wildlife Acts 1976 – 2012 but for the purposes of this report only records of species within the last 15 years that are red or amber listed on BoCCI or listed on Annex 1 of the Birds Directive are included in the records generated by the NBDC and NPWS web searches (See Appendix A).

5.38 The conservation status of mammals within Ireland and Europe is using one or more of the following documents; Wildlife Acts (1976 - 2012), the Red List of Terrestrial Mammals (Marnell *et al*., 2009) and the EU Habitats Directive 92/43/EEC.

5.39 The Appropriate Assessment (AA) screening report prepared as a standalone document for the purposes of this planning application was used to inform this report as appropriate. Other chapters prepared for this EIAR, such as Chapter 2 (Project Description), Chapter 10 (noise), Chapter 13 (landscape) and Chapter 7 (water), were also reviewed to inform this report.

Consultation

5.40 Sligo County Council Heritage Officer was contacted by email on 21 May 2018. The email requested that they outline any particular concerns, with respect to biodiversity as a result of the proposal to continue and extend the operation of the quarry at Aghamore and Carrownamaddoo, so that any such concerns could be addressed adequately within the EIAR and AA screening report. As of 16 August 2018 a response has not been received from the Heritage Officer.

5.41 Irish Raptor Survey Group (IRSG) was contacted by email on 19 September 2017 for records of raptors breeding within or in close proximity to the quarry and extension area. The IRSG responded by email on 19 September 2017. The records provided by the IRSG are discussed later in this report.

Field Survey

5.42 The Site was visited on 20 May 2016 by Steve Judge MCIEEM who carried out an initial walkover survey of the Site. A further site visit and walkover survey was carried out by Elaine Dromey MCIEEM on 14 September 2017. The Site visit was carried out in dry overcast weather conditions with a light breeze and occasional rain showers. The objective of the site visit was to undertake a walkover survey to better understand the biodiversity of the Site and to determine its ecological value.

[7] http://www.birdwatchireland.ie/LinkClick.aspx?fileticket=VcYOTGOjNbA%3d&tabid=178

5.43 Habitats were identified and classified to level 3 of the standard Heritage Council classification scheme (Fossitt, 2000) during the walkover survey on 14 September 2017. The dominant plant species present in each habitat type were recorded. Species nomenclature follows Parnell & Curtis (2012) for scientific and English names of vascular plants.

5.44 Mammal tracks, signs or direct observations were recorded during the walkover survey of the Site. Trees with features; such as areas of loose flaking bark, splits, cavities; that could provide suitable roost sites for bats were noted during the ground level survey. Incidental sightings of birds, mammals or amphibians were also noted.

5.45 A breeding raptor survey was also carried out within the Site during May 2018.

Impact Assessment

5.46 The ecological evaluation and assessment within this chapter has been undertaken with reference to relevant parts of the 2016 Guidelines for Ecological Impact Assessment in the United Kingdom and Ireland developed by the Chartered Institute of Ecology and Environmental Management (CIEEM, January 2016)[8]. Although this is recognised as current best practice for ecological assessment, the guidance itself recognises that it is not a prescription about exactly how to undertake an ecological impact assessment (EcIA); rather, they "*provide guidance to practitioners for refining their own methodologies*". The approach to impact assessment also had regard to advice set out in the EPA draft guidelines on the information to be contained in Environmental Impact Assessment Reports (EIAR) published in August 2017.

Important Ecological Features

5.47 Ecological features can be important for a variety of reasons and the rationale used to identify them is explained in the text. Importance may relate, for example, to the quality or extent of the site or habitats therein; habitat and / or species rarity; the extent to which such habitats and / or species are threatened throughout their range, or to their rate of decline.

Evaluation: Determining Importance

5.48 The importance of an ecological feature should be considered within a defined geographical context. The following frame of reference has been used in this case, relying on known / published accounts of distribution and rarity where available, and professional experience:

- International (European).
- National (Ireland).
- County (Sligo)
- Townland (Aghamore and Carrownamaddoo).

[8] For the full guidance, refer to http://www.cieem.net/data/files/Publications/EcIA_Guidelines_Terrestrial_Freshwater_and_Coastal_Jan_2016.pdf.

- Local (intermediate between the Site and Townland).
- Site (Within redline application boundary).

5.49 The approach to impact assessment as set out in CIEEM guidelines only requires that ecological features (habitats, species, ecosystems and their functions/processes), that are considered to be important and potentially affected by the proposed development are carried forward to detailed assessment. It is not necessary to carry out detailed assessment of receptors that are sufficiently widespread, unthreatened and resilient to impacts from the proposed development and will remain viable and sustainable.

Impact Assessment

5.50 Where appropriate, the impact assessment process involves:

- identifying and characterising impacts;
- incorporating measures to avoid and mitigate (reduce) these impacts;
- assessing the significance of any residual effects after mitigation;
- identifying appropriate compensation measures to offset significant residual effects (if required); and
- identifying opportunities for ecological enhancement.

5.51 When describing impacts, reference has been made to the following characteristics, as appropriate:

- Positive or negative;
- Extent;
- Magnitude;
- Duration;
- Timing;
- Frequency; and
- Reversibility.

5.52 The impact assessment process considers both direct and indirect impacts: direct ecological impacts are changes that are directly attributable to a defined action, e.g. the physical loss of habitat occupied by a species during the construction process. Indirect ecological impacts are attributable to an action, but which affect ecological resources through effects on an intermediary ecosystem, process or feature, e.g. the creation of roads which cause hydrological changes, which, in the absence of mitigation, could lead to the drying out of wet grassland.

5.53 Consideration of conservation status is important for evaluating the effects of impacts on individual habitats and species and assessing their significance:

- Habitats – conservation status is determined by the sum of the influences acting on the habitat that may affect its extent, structure and functions as well as its distribution and its typical species within a given geographical area.

- Species – conservation status is determined by the sum of influences acting on the species concerned that may affect its abundance and distribution within a given geographical area.

Significant Effects

5.54 The 2016 CIEEM guidance sets out information in paragraphs 5.25 through to 5.29, of the guidance document, about the concept of ecological significance. Significant effects are qualified with reference to an appropriate geographic scale, and the scale of significance of an effect may or may not be the same as the geographic context in which the feature is considered important.

5.55 A significant effect, for the purposes of EcIA, is defined as an effect that either supports or undermines biodiversity conservation objectives for '*important ecological features*' or for biodiversity in general. Conservation objectives may be specific (e.g. for a designated site) or broad (e.g. national/local nature conservation policy) or more wide-ranging (enhancement of biodiversity). Effects can be considered significant at a wide range of scales from international to local.

5.56 The nature of the identified effects on each assessed feature is characterised. This is considered, along with available research, professional judgement about the sensitivity of the feature affected, and professional judgement about how the impact is likely to affect the site, habitat, or population's structure and continued function. Where it is concluded that an effect would be likely to reduce the importance of an assessed feature, it is described as significant. The degree of significance of the effect takes into account the geographic context of the feature's importance and the degree to which its interest is judged to be affected.

Cumulative Effects

5.57 Cumulative effects can result from individually insignificant but collectively significant actions taking place over a period of time or concentrated in a location. Cumulative effects can occur where a proposed development results in individually insignificant impacts that, when considered in-combination with impacts of other proposed or permitted plans and projects, can result in significant effects.

5.58 Other plans and projects that should be considered when establishing cumulative effects are:

- proposals for which consent has been applied but which are awaiting determination;
- projects which have been granted consent, but which have not yet been started or which have been started but are not yet completed (i.e. under construction);
- proposals which have been refused permission, but which are subject to appeal and the appeal is undetermined;
- constructed developments whose full environmental effects are not yet felt and therefore cannot be accounted for in the baseline; or
- developments specifically referenced in a National Policy Statement, a National Plan or a Local Plan.

Mitigation

5.59 Where significant effects have been identified, the mitigation hierarchy has been taken into account, as suggested in the 2016 EcIA Guidelines, which sets out a sequential approach of avoidance of impacts where possible, application of mitigation measures to minimise unavoidable impacts and then compensation for any remaining impacts. Once avoidance and mitigation measures have been applied, along with any necessary compensation measures, and opportunities for enhancement incorporated, residual impacts have then been identified.

Limitations / Difficulties Encountered

5.60 The walkover survey was carried out during suitable weather conditions and the Site was easily accessible. The timing of the second survey was slightly late in the year for botanical / vegetation survey. However, the first survey timing was within the optimum survey period and as both surveyors are experienced ecologists the survey timing is not considered a limitation. The habitats present are relatively species poor and the species are all commonly occurring thereby allowing confident identification. The timing of the survey is not therefore considered to be a limitation.

Baseline Ecological Conditions

5.61 This section sets out the baseline ecological conditions at Aghamore and Carrownamaddoo Quarry using the findings of the desk study and survey of the Site.

Desk Study

5.62 The sites designated for nature conservation within 5 km of Aghamore Quarry are discussed in the following section. The 5 km radius was selected as the search area as the zone of influence of quarrying typically would not extend beyond 2 km unless there are surface water pathways or other ecological connections to Natura 2000 sites outside this distance. The use of 5 km as a potential zone of influence is therefore applying a precautionary approach. The sites designated for nature conservation within 5 km of the Site are shown on **Figure 5-1**.

5.63 The results of the online search for rare and /or protected flora and fauna are also discussed within this section.

Natura 2000 (European sites)

5.64 The quarry at Aghamore and Carrownamaddoo townlands is not within a site designated for nature conservation or subject to any nature conservation designations.

5.65 There are seven Natura 2000 sites within 5 km of the boundary of the application area. Lough Gill SAC (Site code 001976) is within 520 m of the Site boundary at its closest point. Ballysadare Bay SAC (Site code 000622) and SPA (Site code 004129) are approximately 3 km east while the Unshin River SAC (Site code 001898) is approximately 4 km east of the Site. Union Wood SAC (Site code 000638) is approximately 2.7 km south – west of the Site. Cummeen Strand/Drumcliff Bay (Sligo Bay) SAC (Site code 000627) and Cummeen Strand SPA (Site code 004035) are approximately 4 km north and west of the Site at Aghamore.

5.66 Lough Gill SAC is designated for a mixture of lake, grassland and woodland habitats as well as several aquatic species. As the Site is outside the boundary of this SAC there is no potential for direct impacts such as loss of habitat as a result of the proposed works. There is potential for connectivity between this SAC and the Site through surface water pathways. The existing quarry discharges water to the Aghamore stream to the east of the Site which drains to Lough Gill SAC ca. 800m downstream. The proposed development will include a settlement lagoon and associated hydrocarbon interceptors for treatment of water prior to discharge. The hydrological studies carried out on the quarry determined that the possibility of this impacting surface water was low and groundwater bodies as negligible (refer to EIAR Chapter 7). There are no likely significant effects on Lough Gill predicted as a result of emissions to water. Additionally, the potential increased drawdown of ground water as a result of deepening the quarry was assessed to not extend beyond 286m of the Site, a distance that does not include Aghamore Stream or Lough Gill. Potential impacts of the proposed works are not considered likely to Lough Gill SAC.

5.67 Ballysadare Bay SAC is designated for a variety of coastal habitats as well as harbour sea *Phoca vitulna* and narrow-mouthed whorl snail *Vertigo anqustior*. The SAC is sufficiently distant from the quarry and is not connected via landscape features or surface water pathways to the quarry. The potential impacts of the quarry operation are therefore unlikely to result in effects on this SAC.

5.68 Ballysadare Bay SPA and Cummeen Strand SPA form part of the complex of SPA sites in the wider Sligo Bay. It is considered that, given the features of interest that they are classified for along with the distance from the Site and the lack of ecological connectivity; these sites are not within the potential zone of influence of the quarry at Aghamore.

5.69 Unshin River SAC is designated for a mixture of aquatic, grassland and woodland habitat as well as otter *Lutra lutra* and salmon *Salmo salar*. The SAC is sufficiently distant from the quarry and is not connected via landscape features or surface water pathways to the quarry. The potential impacts of the quarry operation are therefore unlikely to result in effects on this SAC.

5.70 Union Wood SAC is designated for sessile oak woodland and is not connected to the Site via ecological features or surface water pathways. The potential impacts, such as emissions to air, of the quarry operation are not considered likely to result in effects that could disperse and cause significant effects to Union Wood SAC.

5.71 Cummeen Strand/Drumcliff Bay (Sligo Bay) SAC is designated for a variety of coastal habitat as well as a mixture of grassland and freshwater habitats. Several aquatic species are also features of intertest, as is narrow-mouthed whorl snail. The SAC is sufficiently distant from the quarry and is not connected via landscape features. There is a limited surface water pathway to the quarry via Aghamore Stream and Lough Gill. However, the dilution factor of Lough Gill combined with the settlement lagoon and hydrocarbon interceptor ensure that the potential impacts of the quarry operation are highly unlikely to result in effects on this SAC.

5.72 There are no other Natura 2000 sites within 5 km of the Site boundary; the Site is not connected via ecological features or surface water pathways to any Natura 2000 sites beyond 5 km and Natura 2000 sites (and their features of interest) beyond 5 km not previously discussed can be considered to be sufficiently distant from the quarry at Aghamore to not be affected by the potential impacts and resultant effects arising from proposed continued use and operation of the quarry at Aghamore.

5.73 The AA screening report prepared for in support of the application for permission to deepen the quarry and continue quarry operations at Aghamore found that significant effects on Natura 2000 sites are not likely and that the project does not require progression to second stage Appropriate Assessment. There will be no loss of habitat within the Natura 2000 sites within the potential zone of influence. Noise and vibration will remain at existing permitted levels while emissions to air and water are not likely to cause significant effects that could undermine the conservation objectives of the Natura 2000 sites. Natura 2000 sites are therefore scoped out and excluded from any further consideration in this report.

Natural Heritage Areas (NHA) / Proposed Natural Heritage Areas (pNHA)

5.74 Lough Gill pNHA (Site code 001976) is approximately 520 m east of the Site at the closest point and the extents of the pNHA are the same as for Lough Gill SAC. The woodlands on the lake shore are of note as is heathland covering the hillsides above the woods. Several protected species of mollusc and aquatic species are documented within the site synopsis. This pNHA can be excluded for the same reasons Lough Gill SAC has been excluded (see paragraph 5.66 above)

5.75 Slieveward Bog NHA (Site code 001902) is approximately 4.6 km south – west of the quarry at its closest point. Slieveward Bog NHA[9] is designated for peatlands and is vulnerable to land drainage

[9] https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY001902.pdf

schemes, overgrazing, afforestation and erosion. This site is at a distance from the quarry and separated by multiple roads (including the N4), Ballysadare river, Ballysadare town, large areas of agriculture and forestry as well as the Ox mountains. The quarry at Aghamore is not connected to the NHA by any hydrological or landscape features. There is no pathway for potential impacts or effects on the NHA due to the proposed operation of the quarry at Aghamore.

5.76 Ballysadare Bay is also a pNHA (Site code 000622) the site code and boundary of which is the same as the SAC. Significant effects on the features of interest of Ballysadare Bay arising from the quarry have already been excluded within the Appropriate Assessment screening report prepared for this project and the pNHA can also be scoped out of this assessment.

5.77 Union Wood pNHA (Site code 000638) boundary mirrors that of the SAC and as it is not connected to the Site via ecological features or surface water pathways the potential impacts of the quarry operation are not considered likely to result in emissions that could cause significant effects.

5.78 Ballygawley Lough pNHA (Site code 001909) is approximately 2.4 km south - west of the eastern quarry boundary at the closest point. This pNHA is not connected to the Site via ecological features or surface water pathways and is sufficiently isolated from the quarry to ensure that significant effects as a result of emissions are not likely.

5.79 Lough Dargan pNHA (Site code 001906) is approximately 3.9 km south of the quarry boundary at the closest point. This pNHA is not connected to the Site via ecological features or surface water pathways and is sufficiently isolated from the quarry to ensure that significant effects as a result of emissions are not likely.

5.80 Unshin River pNHA (Site code 001898) is approximately 4.5 km south of the quarry boundary at the closest point. This pNHA is not connected to the Site via ecological features or surface water pathways and is sufficiently isolated from the quarry to ensure that significant effects as a result of emissions are not likely.

5.81 Cummeen Strand/Drumcliff Bay pNHA (Site code 000627) is approximately 4.5 km north of the quarry boundary at the closest point. This pNHA is not connected to the Site via ecological features or surface water pathways and is sufficiently isolated from the quarry to ensure that significant effects as a result of emissions are not likely.

5.82 NHA / pNHA sites are not likely to be affected by the deepening and continuation of works of the quarry at Aghamore and can therefore be scoped out and excluded from further consideration in this report.

Rare and Protected Flora and Fauna

5.83 The NBDC database was searched for records within the 1 km^2 grid squares G6931, G6392, G7031 and G7032within which the Site is located. The records returned are of varying ages so for the purposes of preparing this report only the relevant records dated within the last 15 years, are listed in Appendix A of this document.

5.84 The absence of recent (within 15 years) records of species from the NBDC database does not necessarily imply that a species does not occur within the search area rather it has not formally been recorded as present. Similarly, the presence of a record for a protected species within the 1 km^2 grid squares does not mean that the species is present within the Site.

5.85 The records generated from NBDC include protected species such as hedgehog *Erinaceus europaeus*, badger *Meles meles*, red squirrel *Sciurus vulgaris* and soprano pipistrelle *Pipistrellus pygmaeus*.

5.86 Hedgehog, badger and red squirrel are protected under the Wildlife Acts 1976 – 2012, pine marten is protected under both the Wildlife Acts 1976 – 2012 and the Habitats Directive. Hedgehog, badger and pine marten are listed as of “least concern” in the most recent Red List for terrestrial mammals in Ireland, red squirrel is considered near threatened.

5.87 Hedgehog is associated with edge habitat and pasture, with coniferous woodland, marsh and arable land being the least preferred habitats. Typically, hedgehog nests in hedgerows or old stone walls. Hedgehogs are vulnerable to pesticides and road deaths.

5.88 Badger are adaptable and can be found in a variety of lowland grassland and woodland habitats, and occasionally in upland and suburban areas. Badgers are vulnerable to persecution from people and road casualties.

5.89 Red squirrel has seen a population decline of c. 20% since 1911 with competition from the Norther American grey squirrel *Sciurus carolinensis* being the most important factor. Wooded areas including forests, parks and gardens are important to this species (Marnell *et al*. 2009).

5.90 Soprano pipistrelle is protected under both the Wildlife Acts 1976 – 2012 and the Habitats Directive. This species is listed as of “least concern” within the latest Red List for terrestrial mammals in Ireland. The population in Ireland is thought to be stable, abundant and widespread, occurring in all counties. This species roosts within confined spaces in buildings during the summer and forages in a wide range of habitats but some preference is shown towards aquatic habitats and riparian woodland. Threat to soprano pipistrelle include pesticides, removal of hedgerows, corpse and scrub, as is the destruction and disturbance of roosts.

5.91 There were no records of birds were returned from the National Biodiversity Data Centre for the four 1 km^2 within which the Site is located.

5.92 As the proposed works are concerned with the deepening of the existing quarry floor there will be no loss of important habitat for these species as a result it is not considered likely that the loss of small areas of scrub within the existing quarry void will significantly affect these species. The proposed bolstering of the hedgerows and woodland on the site by planting native species in advance of operations, as outlined in Chapter 13 – Landscape and shown on Figure 2.2, may result in a slight positive impact for these species. They can therefore be scoped out and excluded from further consideration.

Field Survey

5.93 The habitats and species recorded within the Site during surveys are described, classified and evaluated in this section of the report, and shown on Figure 5-2.

Active Quarry ED4

5.94 Active Quarry is the dominant habitat type within the Site and can be broadly described as exposed rock faces, stockpiles and bare ground sparsely recolonising with ruderal species. The quarry void also contains standing water. This area is largely unvegetated, with occasional clumps of yellow-wort *Blackstonia perfoliata* and creeping bent *Agrostis stolonifera* present in areas. Around the edges of the quarry void species such as gorse *Ulex europaeus* and bramble *Rubus fruticosus* agg. are encroaching and re-establishing on areas which were previously worked. With the exception of the use of the exposed faces by possibly breeding peregrine *Falco peregrinus*, kestrel *Falco tinnunculus*, and raven *Corvus corax* it does not offer suitable opportunities for fauna.

5.95 The active quarry habitat would be evaluated as important at Site level. The active quarry will continue to operate as previous and is not expected to be significantly affected by the proposal. Active quarry is scoped out of this assessment.

Improved Agricultural Grassland GA1

5.96 Areas of improved agricultural grassland are within the Site. These are mostly present as marginal areas from adjoining farmland. One large section of active pasture is present in the south east of the Site. As is typical of this species poor habitat this area is dominated by rye grasses *Lolium perenne*. Improved agricultural grasslands are widespread throughout Ireland and within the surrounding landscape. The improved agricultural grassland would be evaluated as important at the Site level. Improved agricultural grassland is scoped out of this assessment.

Improved Agricultural Grassland/Dry Calcareous Grassland GA1/GS1

5.97 Two large areas which included a mixed of these two habitats occur on either side of the entry road beyond the planted woodland. Additional areas of this habitat occur in areas bordering the existing quarry void. This lime rich grassland has a variety of ruderal species such as coltsfoot *Tussilago farafara*. Other species recorded include; red clover *Trifolium pratense,* mouse-eared hawkweed *Hieracium pilosella,* glaucous sedge *Carex flacca,* knapweed *Centaurea nigra,* oatgrass *Arrhenatherum* sp.*,* fairy flax *Linum catharticum,* red fescue *Festuca rubra,* wild carrot *Daucus carota,* creeping bent*,* oxeye daisy *Leucanthemum vulgare,* wild strawberry *Fragaria vesca* and eyebright *Euphrasia* sp. In some ranker areas species such as soft rush *Juncus effuses,* nettle *Urtica dioica*, gorse and bramble become more common.

5.98 Rougher areas of this habitat are "springier" underfoot with grasses such as red fescue being dominant and cocks-foot *Dactylis glomerata* being frequent and glaucous sedge abundant. An example of this habitat is found south of the entry road. Other species in these rougher areas include coltsfoot, fairy flax, Yorkshire fog *Holcus lanatus*, creeping bent, ragwort *Senecio jacobea*, butterfly bush *Buddleja davidii*, yellow-wort, bird's-foot trefoil *lotus corniculatus,* crested dog's-tail *Cynosurus cristatusl,* meadow vetchling *Lathyrus pratensis* and wild carrot. Alder *Alnus glutinosa* and willow *Salix sp.* are encroaching in places, as is bramble.

5.99 The grassland within Aghamore Quarry would be evaluated as important at Site level. It is not expected to be significantly affected by the proposal. This habitat is scoped out of this assessment.

Mixed Broadleaf Woodland WD1

5.100 Two areas of young planted mixed broadleaf woodland are present on either side of the site entrance. The canopy of these areas is primarily comprised of sycamore *Acer psuedoplatanus*, ash *Fraxinus excelsior*, alder *Alnus glutinosa* and birch *Betula pubescens*. Elder *Sambucus nigra* is also present.

5.101 The woodland habitat at Aghamore Quarry would be evaluated as important at Site level. This habitat will not be significantly affected by the proposed works. This habitat is scoped out of this assessment.

Hedgerows WL1

5.102 Numerous hedgerows are present along the perimeter of the Site. Combined these have an approximate length of 890 m. There are some trees present within the hedgerows, but overall, they are typically low in species diversity. The hedgerow comprising a field boundary to the north is noted as being dense with hawthorn *Crataegus monogyna*, ivy *Hedera Hibernica*, elder, bramble and other woody species.

5.103 Other hedgerows share this typical species composition but are less well-structured having been severely cut and managed. Other species noted within the hedgerows bordering the Site include blackthorn *Prunus spinose*, gorse, holly *Ilex aquifolium*, bramble, crab apple *Malus sylvestris* and sycamore.

5.104 The hedgerow habitat at Aghamore Quarry would be evaluated as important at Site level. There will be no reduction of hedgerows as part of this project. This habitat will not be significantly affected by this proposal. Hedgerow habitat is scoped out of this assessment.

Scrub WS1

5.105 Some sections of hedgerow along the Site perimeter have gone unmanaged and has widened into scrub. Other areas, such as that in the northern section of the Site, have become disused since the previous period of quarrying activity and scrub has encroached over the area These areas of scrub share a similar species composition with the hedgerows discussed above but are dominated by bramble and gorse.

5.106 The scrub habitat at Aghamore would be evaluated as important at Site level. The proposed works will not significantly affect this habitat. Scrub habitat is scoped out of this assessment.

Treeline WL2

5.107 There are sections of treelines around the boundary of the quarry in the south and west. The small section of treeline on the western boarder of the site consists of semi-mature ash *Fraxinus excelsior* and sycamore outside of the fence line that comprises the boundary. The longer treeline on the southern boundary of the site contains semi-mature species dominated by sycamore and also containing occasional beech *Fagus sylvatica*. These sections of treelines are positioned within areas of hedgerows are describes above. There is approximately 265 m of treelines within the Site.

5.108 The trees present within the treelines are commonly occurring and widespread throughout Ireland and the surrounding areas. The treelines would be evaluated as important at the Site level. It is not proposed to reduce the length of treelines within the Site as part of this project. Treelines will not the significantly affected by the proposed works. Treelines can be scoped out of this assessment.

Species

5.109 Incidental sightings or signs of birds, mammals or amphibians were noted during the walkover survey in May 2016 and September 2017. The findings are discussed in the following sections.

Birds

5.110 The IRSG was contacted with respect to records of breeding raptors within or in close proximity to the Site. The IRSG confirmed that peregrine falcon had nested in 2017 within the area[10] within which the quarry is located. The Site has regularly held breeding peregrine and kestrel in previous years and in addition supports a regular pair of nesting raven.

5.111 A raptor survey was carried out over two days on the Site. This survey determined that peregrine have not nested successfully at the Site during 2018, a single adult and subadult were observed during the survey perching within the quarry. The behaviour observed was highly indicative of non-breeding use of the Site. Kestrels were recorded on both days of survey and behaviour indicative of likely nesting were observed. These included prolonged sightings of courtship behaviour of at least one pair and in addition up to five subadults. Copulation and food provisioning was observed between the adult pair which are occupying a used ravens nest on the southern face of the quarry. On the second site survey a pair was observed in the north-eastern corner of the quarry. This area also contained an overhang and obvious “whitewashed” perch area. This strongly indicated an occupied site.

5.112 Incidental observations during this survey included a pair of breeding ravens nesting on the southern quarry face. Two grey wagtails *Motacilla cinereal* displaying breeding behaviour, a single common sandpiper *Actitis hypoleucos* and two non-breeding choughs *Pyrrhocorax* were also observed.

5.113 Breeding grey wagtails are red listed within the Birds of Conversation Concern in Ireland (BoCCI) (Coulhoun & Cummins, 2013). Kestrel is amber listed as is common sandpiper and chough. Peregrine and raven are both green listed species.

5.114 Grey wagtail and kestrel breeding within the Site would be evaluated as important at the Townland level.

Amphibians

5.115 The Site does not offer suitable aquatic habitat for amphibians and therefore the likelihood is that they are absent. Amphibians are scoped out of further detailed assessment for this reason.

Mammals

5.116 Mammal tracks, signs or direct observations were noted during the site visits carried out in 2016 and 2017

Bats

5.117 There was no dedicated bat survey carried out during the survey of the Site. A ground level daytime visual assessment of the trees within the Site was carried out and they were evaluated for their suitability to support roosting bats.

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[10] Exact grid references are confidential and not provided within this report due to concerns about persecution. IRSG can be contacted directly to verify the location of the peregrine nest site.

5.118 Active quarry and improved agricultural grassland habitats are the dominant ecological features within the Site. These habitats would be of negligible value to foraging and commuting bats as they are very large open areas within the landscape. It is not proposed to reduce the amount of hedgerow surrounding the Site as part of this proposal.

5.119 The bat population would be evaluated as important at the site level. They are not considered likely to be significantly affected by the proposal and are therefore scoped out of this assessment.

Other Mammals

5.120 Pine marten was recorded during the raptor surveys carried out at the site. It was observed in an area close to an overhang in the northeast corner which was deemed to be a likely kestrel nesting sight. A pine marten latrine was also recorded in this same area during the second site visit. The population of pine martens is thought to be increasing in Ireland after a long period of decline. The species status is regarded as being of “least concern” Woodland and scrub habitats are favoured but use of mature gardens has also been observed. They are known to den in hallow trees, burrows, brash and buildings. Persecution, habitat loss and fragmentation are threats to this species.

5.121 Other mammals, or their tracks and signs, were not observed during the site visits in 2016 and 2017. Given that the dominant habitats within the Site are active quarry it is not expected that mammals such as badger *Meles meles* or otter *Lutra lutra* would be using the Site at these habitats offer limited opportunities for foraging for these species.

5.122 The populations of other mammals would be evaluated as important at the Site level. They are not considered likely to be significantly affected by the proposal and are therefore scoped out of this assessment.

Invasive species

5.123 American mink *Mustela vison* and feral goat *Capra hircus* have been recorded within 1 km^2 grid square in which the site is located. There were no invasive species recorded within the Site during the field surveys. Invasive species can be scoped out of further consideration within this report as they are not known from the Site.

Summary Evaluation of Importance of Ecological Features

5.124 **Table 5-1** summarises the ecological features described and evaluated in the preceding section of this chapter. Following the approach in CIEEM guidelines only ecological receptors (habitats, species, ecosystems and their functions/processes), which are considered to be important and potentially affected by the proposed development are carried forward to detailed assessment. It is not necessary to carry out detailed assessment of features / receptors that are sufficiently widespread, unthreatened and resilient to impacts from the proposed development and will remain viable and sustainable.

5.125 The importance of the ecological features within the Site is summarised along with their legal status and a rationale, where appropriate, for not carrying forward any features for detailed assessment.

Table 5-1: Summary of Evaluation of Ecological Features

Ecological Feature		Scale at which Feature is Important[11]	Comments on Legal Status and/or Importance
Natura 2000 sites		International (European)	Scoped out of the assessment as the AA screening report for the proposal found significant effects are not likely.
NHA / pNHA		National	Scoped out of the assessment as significant effects are not likely.
Rare and /or Protected Flora and Fauna		Local	Scoped out of the assessment as significant effects are not likely as the quarry is not being extended laterally and there will be no loss of habitat where rare and / or protected flora and fauna are likely to occur.
Habitats		Site	The only habitat to be affected by the proposed continuation of use and deepening of the quarry is the active quarry habitat. There will be no reduction in any other habitats within the Site. The habitats can therefore be scoped out of further assessment.
Birds	Raptors	Townland	Wildlife Acts 1976 – 2012 confers protection on breeding birds using the Site. Peregrine falcon and kestrel are both known to be breeding or have a history of breeding within the Site and are evaluated as important at the townland level.

[11] See section 5.48 of this report for geographic scale of importance.

Ecological Feature		Scale at which Feature is Important[11]	Comments on Legal Status and/or Importance
	Amber and Red Listed Species	Townland	Wildlife Acts 1976 – 2012 confers protection on breeding birds using the Site. Grey wagtail was determined to be breeding on the Site and are evaluated as important at the townland level. Chough and common sand piper were observed on the site and are evaluated as important at site level.
	General Breeding Birds	Site	Wildlife Acts 1976 – 2012 confers protection on breeding birds using the Site. The breeding bird assemblage, with the exception of those above, is composed of species that are Green Listed. The population status of these species is stable and they occur commonly in a wide range of habitats throughout Ireland. The quarry operation is not likely to cause significant effects to these species. They are therefore excluded from detailed assessment.
Mammals	Bats	Site	Wildlife Acts 1976 – 2012 confers protection on bats. All Irish bats are also listed on Annex IV of the Habitats Directive. No potential roost features were identified within the Site. No records of bat species from the surround four 1 km^2 grid squares. The quarry operation is not likely to cause significant effects to these species. They are therefore excluded from detailed assessment.
Mammals	Other Mammals	Site	Badger, pine marten and otter are protected under the Wildlife Acts 1976 – 2012. Otter is also listed on Annex II & IV of the Habitats Directive while pine marten is listed on Annex V. Fox is not protected. Neither badger nor otter are likely to occur on the Site and can be scoped out of this assessment. Fox is widespread and occurs increasingly in urban areas. Pine marten is known to frequent the Site and is therefore considered further in this report.
Amphibians		Site	Wildlife Acts 1976 – 2012 confers protection on common frog and smooth newt. The terrestrial habitats within the Site offer limited suitable habitat for amphibians and there is no suitable aquatic habitat. The likelihood is that they are absent from the Site. Amphibians are scoped out of further detailed assessment for this reason.

Assessment of effects

5.126 The following design principles and "designed-in" mitigation have informed the assessment of impacts.

- A Landscape Mitigation and Restoration Plan is provided in Chapter 2 of the EIAR. Landscaping during operation and post – operation will include hedgerow and woodland gapping-up with native species where appropriate, and aftercare management to encourage dense, well-structured hedgerows and woodland throughout.

- It is proposed that restoration of the Site would be carried out once extraction activities have ceased. The full details of the proposed restoration are included in the Landscape Mitigation and Restoration Plan provided in Chapter 2 of the EIAR.

- The cliff faces in the quarry that are used by breeding raptors will be allowed to remain undisturbed at all times during the bird breeding season.

- Within the scheme design and operation, good practice environmental and pollution control measures will be employed with regard to current best practice guidance such as, but not limited to, *Environmental Good Practice on-site Guide* (Ciria, 2015).

5.127 Taking the above into account, the principal potential impacts of the continuance of use and deepening of Aghamore Quarry are outlined in the following sections.

Do Nothing Impact

5.128 The existing quarry, as permitted, would be restored in line with the conditions associated with the existing permission. The Do Nothing Impact would result in moderate significant positive change in the ecological interest of the Site should the quarry cease operating and restoration take place.

Potential Impacts

5.129 The potential direct and indirect impacts on ecology are discussed below. Potential impacts include disturbance of breeding peregrine falcon, kestrel and grey wagtail due to noise, and the disturbance of pine marten.

Raptors

5.130 Peregrine falcon is known to regularly nest on the faces within the quarry void, however the raptor survey carried out as part of this project determine that successful breeding of peregrine falcon did not occur at the Site in 2018. This species could potentially breed again at the Site during the next breeding season. Kestrel was observed nesting within a worked-out section of the previously active quarry. There is no proposal to alter areas of the worked-out quarry faces as the project is concerned with deepening the existing quarry floor, with no lateral extension proposed.

5.131 Raptors are evaluated as important at the townland level. Changes to the existing environment used by these species, i.e. the worked-out quarry faces, are not proposed. However, quarrying activities which have not occurred on this site in the last number of years, such as blasting, may indirectly impact breeding raptors through noise and vibration disturbance.

5.132 The operation of the quarry, including deepening, may potentially give rise to negative effects on breeding raptors.

Amber and Red Listed Bird Species

5.133 A pair of grey wagtails, a red listed species, were observed showing breeding behaviour in the Site. Common sandpiper and chough, amber listed species, were also observed in low numbers but showed no breeding behaviour.

5.134 Grey wagtail is evaluated as important at the townland level while common sandpiper and chough are evaluated as important as the site level. Changes to the existing environment used by grey wagtails are not proposed. However, quarrying activities which have not occurred on this site since 2014, such as blasting, may indirectly impact this species breeding through noise and vibration disturbance.

5.135 The operation of the quarry, including deepening, may potentially give rise to negative effects on breeding grey wagtail.

Pine Marten

5.136 A single pine marten was observed on the rocky edges around the existing water filled quarry void in the northeast. A pine marten latrine was also recorded here in the same areas as the nesting kestrel. It is possible that the pine marten was predating on the nesting kestrel.

5.137 Changes to the existing environment used by pine marten is not proposed. The operational phase is not likely to give rise to any negative effects on pine marten. The proposed bolstering of the hedgerows and woodland on the site by planting native species in advance of operations, as outlined in Chapter 13 – Landscape, may result in a slight positive impact for this species

Post – Operational Stage Impacts

5.138 The site will be restored to natural habitat once quarrying activities have ceased. The restoration scheme for the planning application area is shown on the restoration plan Figure 2-2. The proposed restoration scheme includes allowing the application are to be natural recolonised by locally occurring grass and shrub/scrub species and the quarry void will fill with water. All existing boundary fences and hedgerows will be retained to ensure site security and all plant and machinery will be removed from the quarry void.

5.139 The restoration plan for the Site has incorporated the retention of the cliff faces used by the breeding raptors. The restoration phase may result in a slight positive effect on the Site as the diversity of habitats present will increase resulting in increased opportunities for a wider range of flora and fauna.

5.140 Taking into account the ‘designed in’ measures the overall effect of the operational and post - operational phases is not likely to be significant and may result in a slight positive effect.

Cumulative Effects

5.141 Cumulative effects can result from individually insignificant but collectively significant actions taking place over a period of time or concentrated in a location. Cumulative effects can occur where a proposed development results in individually insignificant impacts that, when considered in-combination with impacts of other proposed or permitted plans and projects, can result in significant effects.

5.142 There is one active quarry operation located within 5 km of the Site, located at Ballysadare, approximately 4 km to the southwest of the Site. This quarry is with the 5 km zone of influence of the proposed works. The zone of influence of quarrying activities typically do not extend beyond 2 km, the 5 km using a precautionary approach and to incorporate ecological connectivity though surface water pathways or landscape features. As there is no connectivity between the Site and the Quarry at Ballysadare there is no pathway for significant effects to occur cumulatively when considered with the quarry at Aghamore.

5.143 There are no policies or objectives within Sligo County Development Plan that when considered with the quarry proposal could give rise to cumulative effects on the ecology of the Site and immediate environs.

5.144 The planning applications within the Aghamore area (refer to Chapter 4) are largely confined to single dwellings and small developments. When considered together with the quarry there is no pathway for cumulative effects to arise.

5.145 Cumulative effects are considered unlikely to occur as result of the quarry proposal when considered with other plans and projects.

MITIGATION

5.146 Mitigation measures are set out for the construction and operational / post operational stages in the following sections.

Raptors

5.147 During operation the cliff faces / rocky ledges currently used by raptor species within exhausted / worked out areas of the quarry will be retained.

5.148 Quarrying activity has not been carried out in the application area since 2014. The current raptor species breeding within the Site may not have been subjected to the disturbance associated with quarrying activity such as blasting. A breeding bird survey will be carried out on the Site prior to the recommencement of quarrying activities. This survey will consist on multiple site visits and assess whether raptors are nesting and/or breeding within the quarry and if so identify which areas are being utilised. Specific mitigation will be developed as part of the reporting of this survey in order to reduce the potential of any negative effects of the proposal on raptor species to an acceptable level.

Amber and Red Listed Bird Species

5.149 A pair of grey wagtails were observed in suitable nesting habitat during the first survey and a male was seen carrying a faecal sack or food for young during the second survey. This strongly indicates breeding occurring within or surrounding the Site. This species is usually associated with habitats along rivers and streams. This species will be included in a breeding bird survey of the Site prior to the recommencement of quarrying activities should the proposal be accepted. If this species is observed nesting and/or breeding on the Site specific mitigation will be developed as part of the reporting of the survey which will reduce any potential negative effects on this species to an acceptable level.

5.150 The amber listed species observed during surveys, i.e. common sandpiper and chough, were seen within suitable habitat and flying over the Site respectively. These species should also be included within the breeding bird survey.

RESIDUAL IMPACTS

5.151 With the mitigation measures, as detailed above, in place during construction, operation and post –operation stages residual negative impacts on the receiving environment are not anticipated to be significant.

MONITORING

5.152 The year after restoration has been completed the Site should be visited during bird breeding season, preferably in the period May – June, to check that the raptors continue to use the Site.

CONCLUSIONS

5.153 The proposed continuation of use and deepening of the limestone quarry at Aghamore, Co. Sligo will result in localised effects on the ecology of the Site. The active quarry area will continue to operate as before.

5.154 There will be no effect on sites designated for nature conservation as a result of the continued use and operation of the permitted quarry and quarry deepening at Aghamore. The scrub and hedgerows around the perimeter of the Site will be retained and will not be negatively impacted. The raptors will be allowed continue to utilise the Site as before.

5.155 Overall the residual effects on ecology are not anticipated to be significant.

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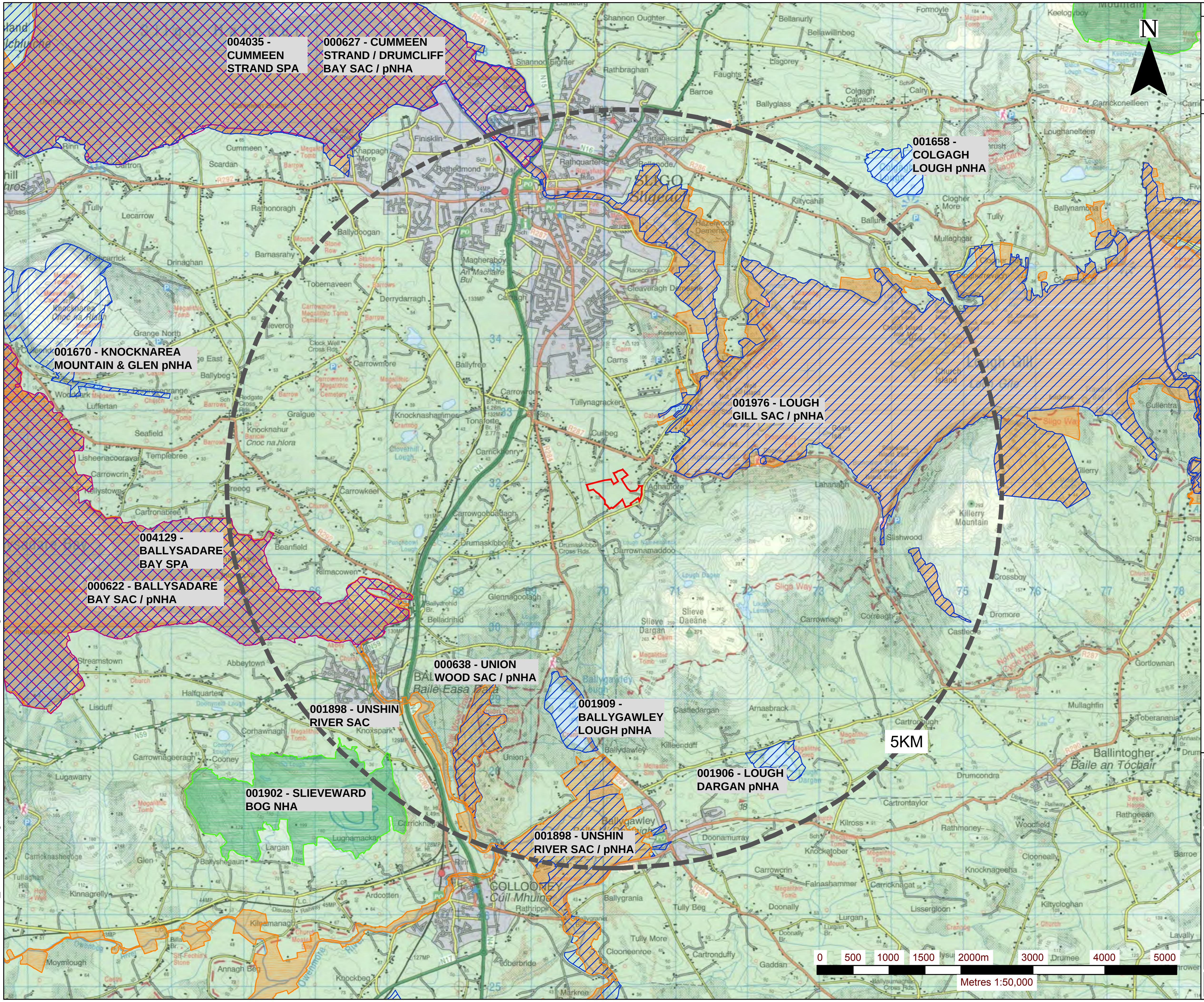
FIGURES

Figure 5-1 Sites designated for nature conservation within 5 km of Aghamore Quarry

Figure 5-2 Habitat Map



NOTES

1. EXTRACT FROM 1:50,000 O.S DISCOVERY MAP NO. 25

2. ORDNANCE SURVEY IRELAND LICENCE NO. SU 0000718 (C) ORDNANCE SURVEY & GOVERNMENT OF IRELAND

LEGEND

- LOCATION OF PROJECT SITE
- 5KM OFFSET FROM APPLICATION SITE
- SPECIAL AREA OF CONSERVATION (SAC)
- SPECIAL PROTECTION AREA (SPA)
- NATURAL HERITAGE AREA (NHA)
- PROPOSED NATURAL HERITAGE AREA (pNHA)

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SITES DESIGNATED FOR NATURE CONSERVATION WITHIN 5KM

FIGURE 5.1

Scale	Date
1:50,000 @ A3	AUGUST 2018

501.00396.00007.FIG_5.1.Sites Designated for Nature Conservation within 5km.dwg

LEGEND

- SITE BOUNDARY

HABITATS (FOSSITT CODE)

- BL3 - BUILDING & ARTIFICIAL SURFACES
- ED4- ACTIVE QUARRIES
- GA1 - IMPROVED AGRICULTURAL GRASSLAND
- GA1/GS1 - IMPORVED AGRICULTURAL GRASSLAND/DRY CALCAREOUS GRASSLAND
- WD1 - MIXED BROADLEAVED WOODLAND
- WS1 - SCRUB
- WL2 - TREELINE
- WL1 - HEDGEROW

N

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HABITAT MAP

FIGURE 5-2

Scale	Date
1:2,500 @ A3	AUGUST 2018

501.00396.00007. Figure 5.2 Habitat map

APPENDIX A: RARE AND /OR PROTECTED SPECIES WITHIN 1 KM GRID SQUARES G6931, G 6932, G7031 AND G7032

Rare and / or protected flora & fauna within the 2 km grid squares G6931, G 6932, G7031 and G7032

Species record	Grid reference	Date of last record	Protected Status	Source / Dataset
West European Hedgehog *Erinaceus europaeus*	G6932	22/03/2011	Wildlife Acts 1976 - 2012	NBDC Atlas of Mammals in Ireland 2010-2015
Eurasian badger *Meles meles*	G6931	20/10/2007	Wildlife Acts 1976 - 2012	NBDC Atlas of Mammals in Ireland 2010-2015
Red squirrel *Sciurus vulgaris*	G7032	07/12/2013	Wildlife Acts 1976 - 2012	NBDC Atlas of Mammals in Ireland 2010-2015
Soprano pipistrelle *Pipistrellus pygmaeus*	G7032	30/07/2007	Wildlife Acts 1976 – 2012 Habitats Directive: Annex IV	NBDC National Bat Database of Ireland

APPENDIX B: BAT CONSERVATION TRUST GUIDELINES FOR ASSESSING THE POTENTIAL SUITABILITY OF PROPOSED DEVELOPMENT SITES FOR BATS

Guidelines for assessing the potential suitability of proposed development sites for bats

Suitability	Description of Roosting Habitats	Description of Communing and Foraging Habitats
Negligible	A building, structure, tree or other feature with negligible habitat features likely to be used by bats.	Negligible habitat features on site likely to be used by commuting or foraging bats.
Low	A building or structure with one or more potential roost features that could be used by individual bats opportunistically, but do not provide enough space, shelter, protection or appropriate conditions (for example temperature, humidity, height above ground, light levels, levels of disturbance) and/or suitable surrounding habitat to be used on a regular basis, or by larger numbers of bats. Buildings in this category are unlikely to support a maternity colony or be used by hibernating bats. A tree of sufficient size and age to contain potential roost features but with none seen from the ground, or features seen with only very limited roosting potential (i.e. some small cracks or crevices, low ivy cover).	Habitat that could be used by small numbers of commuting bats such as a gappy hedgerow or un-vegetated stream, but isolated and not very well connected to the surrounding landscape by other habitat and/or features. Suitable but isolated habitat that could be used by small numbers of foraging bats.
Moderate	A building, structure, tree or other feature with one or more potential roost sites that could be used by bats due to their size, shelter, protection or appropriate conditions (for example temperature, humidity, height above ground, light levels, levels of disturbance) and surrounding habitat but unlikely to support a roost of high conservation value status. Buildings, structures and trees falling into this category would not be expected to support a maternity colony, or significant hibernation or transitory roost.	Continuous habitat connected to the wider landscape that could be used by bats for commuting such as lines of trees and scrub or linked back gardens. Habitat that is connected to the wider landscape that could be used by bats for foraging such as trees, scrub, grassland or water.
High	A building, structure, tree or other feature with one or more potential roost sites that are obviously suitable for use by large numbers of bats on a more regular basis and potentially for longer periods of time due to their size, shelter, protection or appropriate conditions (for example temperature, humidity, height above ground, light levels, levels of disturbance) and surrounding habitat. Buildings, structures and trees falling into this category may be expected to support a maternity colony, or significant hibernation or a significant transitory roost.	Continuous high-quality habitat that is well connected to the wider landscape that is likely to be used regularly by commuting bats such as river valleys, streams, hedgerows, lines of trees and woodland edge. High-quality habitat that is well connected to the wider landscape that is likely to be used regularly by foraging bats such a broadleaved woodland, tree-lined watercourses and grazed parkland. Site is close to and connected to known roost.

APPENDIX C: PHOTOGRAPHS

Plate 5-1 Active Quarry (ED4)

Plate 5-2 Improved agricultural grassland/Dry calcareous grassland (GA1/GS1)

Plate 5-3 Improved agricultural grassland (GA1)

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INTRODUCTION

Background

6.1 This chapter of the Environmental Impact Assessment Report (EIAR) evaluates the regional and local geological conditions at the established Quarry at Aghamore Near and Carrownamaddoo townlands to accompany a Planning Application to Sligo County Council by Lagan Bitumen Ltd. in respect of a continuation of operations and proposed quarry deepening within the existing permitted quarry area.

6.2 The proposed application area is for an area of approximately c.18 ha. and comprises of the continued use and deepening of the existing permitted quarry area. A description of the site and proposed development is outlined in Chapters 1 & 2 of this EIAR.

Scope of Work / EIA Scoping

6.3 This Chapter describes the local land, soil and geology at and around the application site based on the available information for the area. This assessment is based on a detailed examination of the existing quarry and a review of previous geological works carried out in the surrounding area.

Consultations / Consultees

6.4 The Irish Geological Heritage (IGH) section of the GSI has been consulted in relation to this site.

Contributors / Author(s)

6.5 The information presented in this chapter is based on a detailed examination of the existing quarry at Aghamore and the surrounding area and was prepared by EurGeol Dr John Kelly PGeo, MIMMM, MIQ. Dr Kelly is a Professional Geologist with over 27 years professional experience.

Limitations / Difficulties Encountered

6.6 The assessment of the land, soils and geology presented in this chapter is based on visual observations from site visits, published information and available ground investigation records.

6.7 No specific limitations or difficulties were encountered in the preparation of this EIAR.

REGULATORY BACKGROUND

Legislation

EU Directives

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

- Environmental Impact Assessment Directive (2011/92/EU);
- The management of waste from extractive industries (2006/21/EC); and
- Environmental Liability Directive (2004/35/EC).

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

Irish Legislation

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

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

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

Planning Policy and Development Control

6.12 The following Planning Policy and Development Control relating to land, soils and geology at the site in this EIAR is set out in the:

- Sligo County Development Plan 2017-2023.

6.13 The county development plan sets out conservation objectives in relation to soils, geology, geomorphology and geological heritage in Sligo.

Guidelines

6.14 The following guidelines relating to Land, Soils and Geology and have been used in the preparation of this EIAR:

- DoEHLG, 2010. Appropriate Assessment of Plans and Projects in Ireland - Guidance for Planning Authorities;
- Environmental Protection Agency, 2002. Guidelines on the information to be contained in Environmental Impact Statements;
- Environmental Protection Agency, 2003. Advice Notes on current practice (in the preparation of Environmental Impact Statements);
- GSI, Irish Concrete Federation, 2008. Geological Heritage Guidelines for the Extractive Industry;
- Institute of Geologists of Ireland, 2002. Geology in Environmental Impact Statements, A Guide;
- Institute of Geologists of Ireland, 2007. Recommended collection, presentation and interpretation of geological and hydrogeological information for quarry developments;
- Institute of Geologists of Ireland, 2013. Guidelines for the preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements;
- National Roads Authority, 2008. Environmental Impact Assessment of National Road Schemes - A Practical Guide; and
- National Roads Authority, 2008. Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.

6.15 The above guidelines are relevant to the preparation of a Land, Soils and Geology section of this EIAR.

Technical Standards

6.16 The following Technical Standard relating to Land, Soils and geology at the site in this EIAR:

- British Standards (2015). Code of Practice for Site Investigations BS5930:2015.
- British Standard (2001). Geotechnical investigation and testing – Identification and classification of soil BS EN ISO 14688-2:2004
- British Standard (2003). Geotechnical investigation and testing – Identification and classification of rock BS EN ISO 14689-1:2003

RECEIVING ENVIRONMENT

Study Area

6.17 The study area for this Land, Soils and Geology section of the EIAR comprises the application area (c.18 ha.) and surrounding lands.

Baseline Study Methodology

6.18 Existing information on the regional soils, superficial deposits and bedrock geology of the Aghamore area and its surrounds was collated and evaluated. Subsequent to this data compilation and review, site visits and inspections were undertaken to review the superficial deposits and bedrock geology at Aghamore Quarry and in the surrounding area.

Sources of Information

6.19 The following activities were undertaken as part of this geological assessment:

- Examination of GSI 1:100,000 geology map sheet 07 Geology of Sligo and Leitrim.
- Review of available geological information and literature.
- Review of previous rotary core borehole records and ground investigation reports.
- Site / quarry face inspections.
- Review of previous and on-going geology and geotechnical assessments and aggregate testing results.

Regional Geology

Soil

6.20 Teagasc soil mapping, reproduced in **Figure 6-1**, indicates that the current extraction area at the Aughamore site was originally underlain by renzinas and lithosols, with adjacent areas of lithosols and regosols and surface water gleys. Due to previous extraction, few areas of original, undisturbed soil remain across the application area.

Superficial Deposit Geology

6.21 Teagasc sub-soil (parent material) mapping, reproduced in **Figure 6-2**, shows that the lands that form part of the application areawere underlain by bedrock at, or close to, surface and glacial tills derived from metamorphic rocks. The plant area is mapped by Teagasc as being composed of made ground or sands and gravels derived from Carboniferous limestones.

Bedrock Geology

6.22 The GSI 1:100,000 geology map Sheet 07 shows the existing extraction area to be developed within the Dartry Limestone Formation, refer to **Figure 6-3**.

Local Geology

Introduction

6.23 The current extraction area at the site is located to the south of the R287 road. The processing facilities and ancillary infrastructure is located to the east of a local road which separates the extraction area from the plant area.

Soil and Superficial Deposits

6.24 Soils and superficial deposits have been entirely stripped from the footprint of the current and previous extraction areas. A small amount of soils / subsoil material will be removed to construct the proposed settlement lagoon.

6.25 Previous drilling work in the unextracted areas indicates that the total thickness of soils and superficial deposits in this area varied from 3.0m to 6.0m.

Bedrock Geology

6.26 The bedrock geology at Aghamore Quarry is well understood from abundant quarry face exposures and rotary core drilling to the north, east and southeast of the existing extraction area.

6.27 The existing extraction area is developed within the Dartry Limestone Formation (see Table 6-1) located on the hangingwall (downthrown) side of a northwest downthrowing major fault, part of the Ox Mountains fault complex.

6.28 The information available indicates that the current and future extraction at the existing quarry is derived from strong, fresh, mid to dark-grey, fine-grained well bedded bioclastic cherty silicified and dolomitised limestones of the Dartry Limestone Formation.

6.29 Three sub-units have been identified within the Dartry Limestone at the site, as follows:

a. The lowermost unit is composed of dark grey, well-bedded poorly fossiliferous fine-grained cherty limestones. This unit lies below the quarry floor and is only known from drilling.

b. The middle unit is composed of dark grey, well-bedded (0.4m to 1.0m thick) fossiliferous cherty fine-grained limestone and dolomite with abundant calcite and dolomite infilled vugs.

c. The uppermost unit, only exposed in the northwest area of the quarry is composed of massive, pale-grey fine-grained (micrite) fossiliferous limestones.

6.30 Due to the geological structure of the area and the proposed final depth of extraction, no geological units except the Dartry Limestone Formation will be extracted.

Table 6-1
Lithological Sequence of Geological Units Present in the Existing Quarry Area (after MacDermot, 1996)

Formation	Estimated Thickness	Description
DARTRY LIMESTONE FORMATION	200m+	The dominant facies is a massive to thick-bedded, mostly very fine-grained and dark wackestone, locally rich in sponge spicules. Bedding is picked out by bands and nodules of irregular chert, sometimes forming 50% of the rock. There is pervasive dolomitization and silicification.
OX MOUNTAINS FAULT COMPLEX		
OX MOUNTAIN METAMORPHIC COMPLEX SLISHWOOD DIVISION		Pelitic and semi-pelitic paragneiss, psammites, schists, gneisses and metabasites/serpentinite.

6.31 When operational, quarry aggregates produced at the site will be independently tested and geologically assessed on an annual basis to confirm that the aggregates are compliant with the requirements of the relevant aggregate quality standards and to ensure that the aggregates are of suitable quality and are fit for purpose including:

- NRA Series 500, 600 and 800 compliant aggregates.
- SR 21:2014 + A1:2016 Annex E. Guidance on the use of IS EN 13242:2002.
- SR 16:2016 Guidance on the use of IS EN 12620:2002 + A1:2008 - Aggregates For Concrete.
- SR 17:2004 Guidance on the use of IS EN 13043:2002 Aggregates for Bituminous Bound Aggregate Products.

Structure

6.32 The bedding thickness within the Dartry Limestone averages 1.0m and the rocks dip from 8^{o} to 20^{o} to the north or northwest.

6.33 One major fault has been identified at Aughamore, trending north-northwest and dipping steeply (80^{o}) to 247^{o} (north-northwest). The fault zone has been solutionally enlarged and is partially infilled with clays.

6.34 Analysis of joint sets exposed on quarry faces indicates that three main joint sets are present. Set one is sub-vertical and dips 76^{o} to 344^{o}, set two and three are almost vertical and dip 89^{o} to 100^{o} and 85^{o} to 256^{o} respectively.

6.35 All joints are typically tight with some having a calcite infill. Rock strength is strong to very strong and weathering is rarely present below the epikarst zone.

Geological Heritage

6.36 Review of available geological heritage literature (McAteer and Parkes 2004) does not list the application site as a Geological Heritage site.

6.37 Consultations were held with the Geological Heritage programme to ascertain if there was any geological heritage value of the rock exposures at Aughamore.

6.38 Arising from consultations, staff working on the IGH Programme have indicated that there may be some interest due to the good quality exposures of the Dartry Limestone and this would be considered when a review of the heritage audit is undertaken in the future. Consideration has been given to this in the proposed restoration plan for the quarry – refer to Figure 2.2.

Economic Geology

6.39 Crushed rock which is extracted from the application site is used to produce standards compliant aggregates which have a wide variety of construction and engineering end-uses including:-

- Structural backfills for specified engineering purposes and sub-concrete fills;
- Concrete products;
- Readymix concrete;

- Road sub-base, base and blacktop (tarmacadam) surfacing;
- General aggregate.

Karstification

6.40 Limestones with a high calcium carbonate ($CaCO_3$) content, are readily dissolved by weak acids such as carbonic acid in rainfall or humic acids derived from agricultural soils. The dissolution and enlargement of discontinuities in the limestone (such as joints, fractures, etc.) over geological time leads to the formation of rock dissolution landforms such as closed depressions (dolines), sinkholes, springs, turloughs and caves.

6.41 Strictly speaking, the term 'karst' is applied to areas where surface drainage has been disrupted by underground capture of surface streams by dissolution of the bedrock. A broader definition of the term however includes landscapes where distinctive karst landforms occur as a result of dissolution of the underlying bedrock.

6.42 Dissolution features in karst limestones, whether open or infilled with sediments present significant environmental challenges, particularly with respect to protection of groundwater quality and groundwater fed ecosystems. They also present unique engineering challenges, particularly with respect to slope stability, control of drainage or contamination of high-quality limestone resources.

6.43 A review of the GSI Karst Database (Quarter 2, 2016) indicates that there are no known karst related features in the vicinity of the application site.

6.44 A single spring has been recorded 800m northeast of the site – refer to Chapter 7 Hydrogeology.

6.45 The presence, nature and extent of any karstification at Aughamore Quarry has been separately assessed by inspection of existing quarry faces.

6.46 A clay-infilled solutionally enlarged fracture (fault) has been identified within the existing quarry void – refer to Figure 7.9 for location.

IMPACT ASSESSMENT

Evaluation Methodology

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

Evaluation of Impacts

Direct Impacts

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

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

Attribute	Status / Occurrence	Importance
Geohazards	None identified	Low
Geological Heritage	Excellent exposures of the bedrock sequence at Aghamore are present in the extraction area at Aghamore.	Medium
Economic Geology	The development involves extraction from an area within the existing quarry and deepening of the quarry within the existing permitted area.	Low
Agricultural Soil	The quarry is at its current maximum extent and no further agricultural soils will be removed.	Low

6.49 The magnitude of these impacts on the soil and geology attributes is assessed in **Table 6-3** overleaf:

Table 6-3
Significance of Impacts on Land, Soil and Geology

Attribute	Impact of Proposal on Land, Soil and Geology	Magnitude
Geohazards	n/a	n/a
Geological Heritage	No impact	None
Economic Geology	Direct impact on the existing in-situ bedrock within the proposed extraction area.	Small, negative
Agricultural Soil	Earlier restoration of landform and placement of topsoil / subsoil will restore part of the lands to basic agricultural use.	Small, positive

6.50 There will be no impact on geological heritage in the vicinity of the site.

Unplanned Events (i.e. Accidents)

6.51 It is highly unlikely that any unplanned events within the application site would result in a noticeable impact on the land, soils and geology.

6.52 Adhering to the HSA Safe Quarry Guidelines to the Safety Health and Welfare at Work (Quarries) Regulations 2008 should limit the potential for unplanned events in the form of instability in the quarry faces.

'Do-nothing Scenario' (esp. where deterioration will arise)

6.53 If the proposed continued use and deepening of Aghamore Quarry is not permitted, the existing void would remain in its current state, with no appropriate restoration plan and probable development of instability of exposed and unmanaged rock faces.

MITIGATION MEASURES

6.54 There will be no lateral extension of the quarry and therefore no soil and subsoil is to be removed. The quarry area will be restored following completion of quarrying at the site, refer to Chapter 2 of this EIAR for details of the site restoration plan and on **Figures 2-3**.

6.55 A small area of soil / subsoil material will be removed to enable construction of the proposed settlement lagoon – refer to Figure 2.1. In order to limit the effects of erosion on any excavated soil material the following mitigation measures will be used on site during handling:

- Soil material will be placed in permanent or temporary locations at a safe angle of repose; and
- The re-handling of soil material will be minimised as much as possible in order to preserve the integrity of the soil material; this is also an economically prudent practice.

RESIDUAL IMPACT ASSESSMENT

6.56 Based on the impact assessment and existing mitigation measures described above, there will be no residual impact on land, soils or geology as a result of this proposed development.

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

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McAteer, C. and Parkes, M. 2004 The Geological Heritage of Sligo. Geological Survey of Ireland Publication.

Teagasc, 2004, Ireland Subsoil Parent Materials Map (digital version).

Teagasc, 2007, Ireland Soils Map (digital version).

FIGURES

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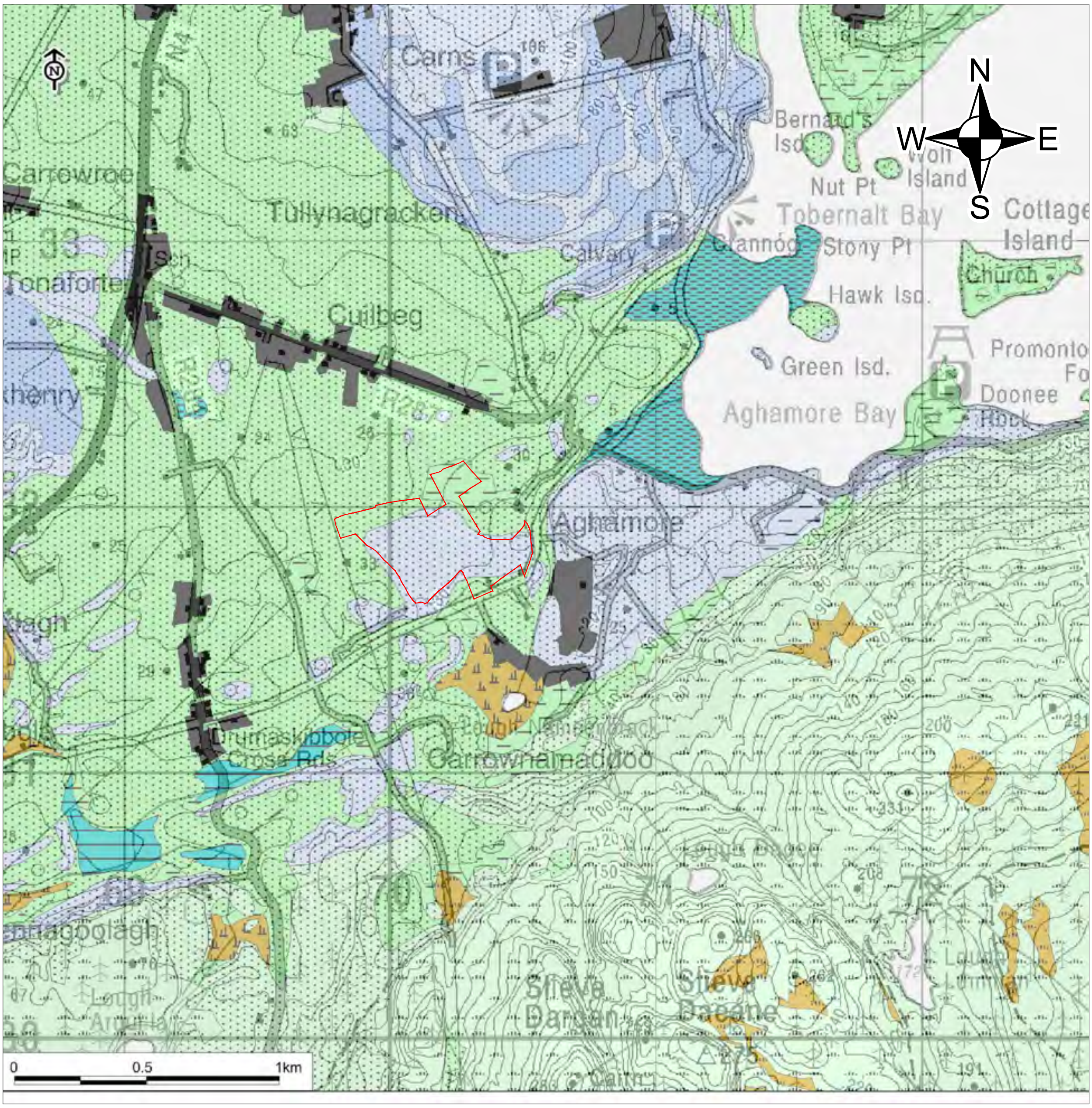
Regional Soils Map

Figure 6-2
Regional Superficial Deposits Map

Figure 6-3
Regional Bedrock Geology Map



TEAGASC SOIL MAPPING

IFS SOIL TYPE

- Blanket Peats
- Cutaway and Cutover Peat
- Lacustrine Sediments
- Alluvium - Mineral
- Acid Brown Earths and Brown Podzolics
- Grey Brown Podzolics and Brown Earths
- Lithosols and Regosols
- Renzinas and Lithosols
- Surface Water Gleys derived from non-calcareous parent
- Surface Water Gleys derived from calcareous parent
- Peaty Podzols, Lithosols and Peats derived from non-calcareous parent
- Made Ground

PLANNING APPLICATION AREA

0 800m 2000

Metres 1:25,000

1. ORDNANCE SURVEY IRELAND LICENCE NO. SU 0000718 (C) ORDNANCE SURVEY IRELAND & GOVERNMENT OF IRELAND
2. EXTRACT FROM TEAGASC SOILS MAPPING

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SOILS MAPPING

FIGURE 6.1

Scale	Date
1:25,000 @ A4	AUGUST 2018

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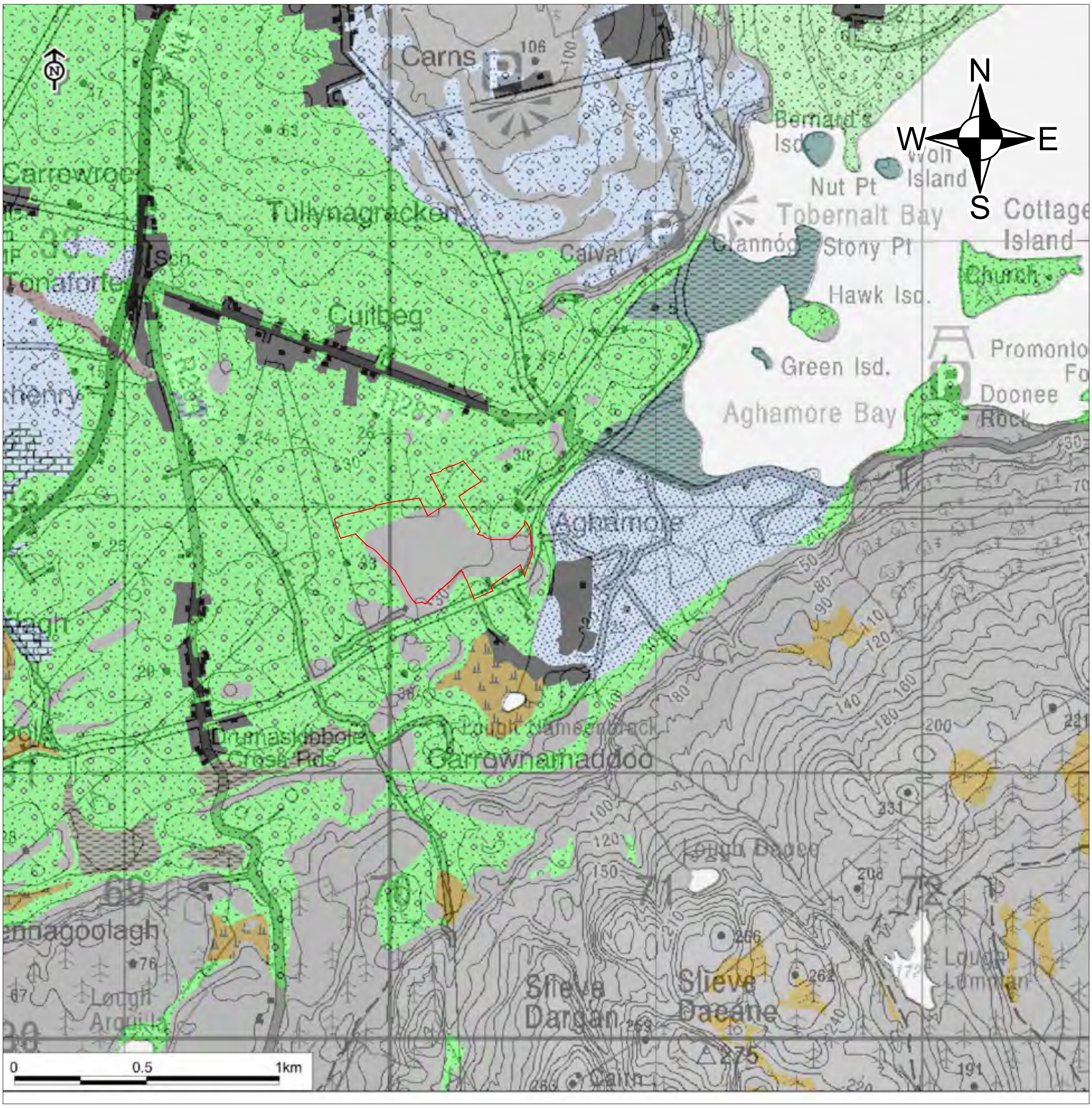

Teagasc Subsoil Mapping
Parent Material Type

- Blanket Peat
- Cutover Peat
- Alluvium
- Lacustrine Sediments
- Sand and Gravel - Carboniferous Limestones
- Till - Namurian Clasts
- Till - Carboniferous Limestone
- Till - Metamorphics
- Limestone Bedrock
- Outcrop & Subcrop
- Made Ground

PLANNING APPLICATION AREA

1. ORDNANCE SURVEY IRELAND LICENCE NO. SU 0000718 (C) ORDNANCE SURVEY IRELAND & GOVERNMENT OF IRELAND
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Metres 1:25,000

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SUBSOILS MAPPING

FIGURE 6.2

Scale	Date
1:25,000 @ A4	AUGUST 2018

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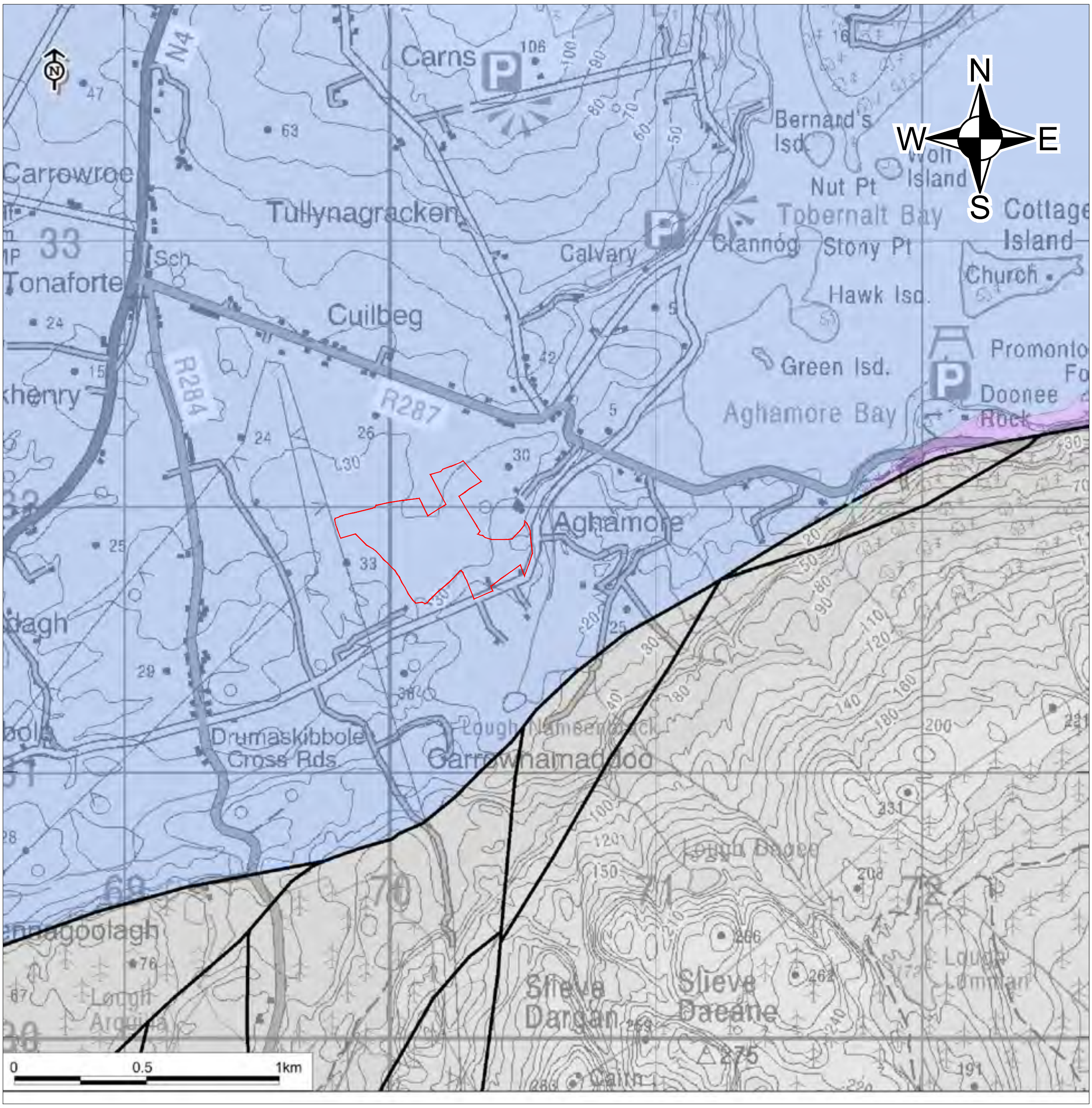

Aghamore Area
Bedrock Geology Units

- Dartry Limestone Formation
- Mudbank limestone
- Ox Mountain Metamorphic Complex

PLANNING APPLICATION AREA

1. ORDNANCE SURVEY IRELAND LICENCE NO. SU 0000718 (C) ORDNANCE SURVEY IRELAND & GOVERNMENT OF IRELAND
2. EXTRACT FROM GSi BEDROCK GEOLOGY MAPPING

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BEDROCK GEOLOGY

FIGURE 6.3

Scale	Date
1:25,000 @ A4	AUGUST 2018

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CHAPTER 7

WATER

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INTRODUCTION

Background

7.1 Quarrying activity and the associate processing operations were established at Aghamore 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 current floor level (c. -21mOD) of the Lagan quarry at Aghamore Near and Carrownamaddoo townlands, Co. Sligo, 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. 800m downstream of the discharge point.

7.3 The current permitted level of the existing quarry is -34.5m OD and it is proposed by Lagan to deepen the quarry by a further bench below this to -50mOD. A comprehensive assessment of potential water-related impacts for the proposed development has therefore been undertaken.

7.4 Lagan Bitumen Ltd. proposes 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.

7.5 Details of the site and a description of the proposed development are provided in Chapter 2.

Scope of Work / EIA Scoping

7.6 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).

7.7 In order to provide the information necessary to assess the potential impacts of the proposed development on the water environment, a detailed site investigation and monitoring programme for surface water and groundwater were 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.

7.8 Further details of the site investigation and monitoring programme are provided in Sections 7.42 to 7.49.

Consultations / Consultees

7.9 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.

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

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

Contributors / Author(s)

7.12 This section of the EIAR has been completed by Craig O'Connor of TMS Environment Ltd (TMS). Craig is a chartered geologist with 18 years' experience in surface water and groundwater assessments. Craig has a BSc (Hons) in Geology from University College Cork and an MSc in Hydrogeology from University College London.

Limitations / Difficulties Encountered

7.13 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.

7.14 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.

7.15 Some limitations were encountered when installing groundwater monitoring wells around the quarry. 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 denied by the landowner. Notwithstanding such limitations, satisfactory alternatives were identified and a satisfactory network of wells was installed to allow completion of a very comprehensive study.

7.16 The duration of the extended monitoring programme undertaken is 12 months, 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

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

7.18 The current planning permission (Planning Register No. PL 02/271) granted in June 2003 contains a number of water-related conditions. Condition 18 lists a number of measures that are required, mainly to do with surface water treatment, discharge and monitoring at the quarry.

7.19 A trade effluent discharge licence (DL(W)139) was more recently granted by Sligo County Council in November 2011, following an application and submission of further information by the former owner Cemex. The trade effluent discharge licence replaces or supersedes some of the original planning conditions in PL 02/271.

7.20 The site was purchased by Lagan Bitumen Ltd. from Cemex 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.

7.21 Lagan formally notified Sligo County Council on 28th May 2015 that the site had been purchased from Cemex on 28th November 2014 and closed from that date. Since the site was inactive and the only discharge from site 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.

Legislation

7.22 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.

7.23 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) 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.

7.24 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.

7.25 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

7.26 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.

7.27 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

7.28 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*'.

7.29 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 7.28 below)

Guidelines

7.30 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)

Technical Standards

7.31 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

7.32 The potential for significant human health/environmental effects from activities connected to the proposed development is considered to be low.

7.33 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. Any potentially significant impacts identified as arising from the proposed development will be mitigated against with appropriate measures to ensure there are no significant human health/environmental effects from activities connected to the proposed development.

RECEIVING ENVIRONMENT

Study Area

7.34 The study area mainly comprises the permitted area of the existing quarry (shown in **Figure 2-1**), surrounding lands and the Aghamore River and Lough Gill (receiving waters). The study area is highlighted on **Figure 7-3**.

Baseline Study Methodology

7.35 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).

7.36 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

7.37 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, water abstractions, areas at risk of flooding, known discharges to surface water or groundwater, habitat designations.

Character

7.38 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

7.39 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

7.40 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

7.41 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
- Catchment information, Environmental Protection Agency website www.catchments.ie
- EPA Maps (WebGIS browser), Environmental Protection Agency website www.gis.epa.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)
- 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'
- Golder Associates report no. 10507150048.A0 (2011) 'Discharge Licence Application RFI'
- Trade Effluent Discharge Licence DL(W)139, Sligo County Council

Field Survey / Monitoring / Inspection Works

7.42 Some off-site monitoring work was required in relation to the Aghamore Stream (sampling and channel survey) and Lough Gill (sampling and bathymetric survey), 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.

7.43 A detailed site investigation and monitoring programme for surface water and groundwater were 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.

7.44 9 No. boreholes were drilled and installed as monitoring wells to the north, east and south of the quarry (MW1-MW9). 2 No. 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 7-1**.

7.45 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.

7.46 2 No. 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 7-5. 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.

7.47 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 c.800m downstream. A bathymetric survey of Aghamore Bay in Lough Gill was completed by Hydrographic Surveys Ltd in February 2018 to assist in assessing the discharge to Lough Gill.

7.48 4 No. 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 7-5**. 2 No. rounds of groundwater sampling were carried out to characterise the background groundwater quality at the site.

7.49 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.

Hydrology

Rainfall & Evaporation

7.50 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 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.

7.51 The annual average rainfall at Markree over the available record is 1,260mm/year. Wind is not recorded at Markree therefore evaporation and evapotranspiration are not calculated for this station by Met Eireann.

7.52 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 for the last 3 years are 547mm/year and 781mm/year respectively for Finner Camp, and 451mm/year and 662mm/year for Knock Airport. Taking the average of these records, the estimated potential evapotranspiration and evaporation for the site are 499mm/year and 722mm/year.

Drainage

7.53 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.

7.54 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 7-2**.

7.55 There are few surface water bodies in the vicinity of the site. A small unnamed stream (referred to in this assessment as the 'Aghamore Stream') lies c. 300m to the east of the quarry void (**Figure 7-5**) and drains water from Lough Nameenbrack (c. 450m to the southeast of the quarry) to Lough Gill (c. 800m to the northeast of the quarry). Further to the east and southeast, a few small streams drain the uplands of the Slieve Dargan/Slieve Daeáne Mountains towards Lough Gill.

7.56 There are no active hydrometric stations in the 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.

Flooding

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

7.58 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. 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.

7.59 The Preliminary Flood Risk Assessment maps for the area (No. 351 and No. 368 – see Appendix 7-4), 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.

7.60 Sligo County Council maintain a level gauge on Lough Gill (station no. 35073) c. 1.2km north of where the Aghamore Stream discharges into Lough Gill. Long-term records (Figure 7-2) 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.

Quarry Water Management

7.61 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 7.21).

7.62 Incidental rainwater and groundwater seepages entering the quarry drain across the quarry floor to a sump located in the southern corner. Two electric submersible pumps are installed in the sump, one larger 37kW pump and a smaller 22kW pump. The pumps operate on float switches and discharge directly to the Aghamore Stream via two 160mm uPVC pipelines. The discharge point at the Aghamore Stream is c. 330m east of the quarry void – refer to Figure 7.21.

7.63 Until recently, these submersible pumps were running at low efficiencies (larger pump c. 29l/s, smaller pump c. 3-6l/s) and were not able to keep the quarry floor dry during the wetter months (c. November to April/May). The quarry floor was allowed to flood during these months as there was no requirement to keep the quarry floor dry while the quarry was inactive.

7.64 The larger pump was refitted in June 2018 and is now pumping at a higher efficiency (c. 36l/s).

Plate 7-1: Pumping, quarry floor dry (12/7/2017)

Plate 7-2: No pumping, quarry floor partially flooded (24/5/2018)

Discharge to Surface Water

7.65 The site was granted a Trade Effluent Discharge Licence (TEDL) from Sligo County Council in December 2011 (DL(W)139) to 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.

7.66 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 7-3**). These results show 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.

7.67 TMS collected a suite of monthly samples of the discharge from February to June 2016 (**Appendix 7-3**); the results showed elevated BOD concentrations above the 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. There was no groundwater sampling in 2016 for comparison however recent sampling in 2018 shows occasionally elevated BOD concentrations up to 3.98mg/l O_2 in groundwater samples outside the quarry void (**Appendix 7-8**).

7.68 The most recent samples of the discharge collected from January-April 2018 as part of the monitoring for this assessment show all parameters below the TEDL emission limit values (**Appendix 7-3**).

7.69 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 7-5) 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 7.21).

Surface Water Quality

7.70 4 No. rounds of surface water sampling were undertaken as part of the current assessment (January-April 2018). 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 7-5** and the results are presented in **Appendix 7-4**.

7.71 Background water quality in the Aghamore Stream in these samples is quite good, with elevated faecal bacteria and traces of total ammonia typical of runoff from an agricultural catchment. All other parameters are below the relevant water quality standards (**Appendix 7-4**), with total ammonia levels mostly below these standards (one exceedance only downstream). One instance of elevated BOD above the assessment criteria was recorded upstream of the quarry discharge and thus related to background quality. 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. The effect of the quarry discharge is noted downstream of the discharge, with slightly raised conductivity, calcium and sulphate; BOD and orthophosphate levels are normal. There is no change in water quality between the samples downstream of the discharge and before the stream enters Lough Gill, indicating no further discharges downstream.

7.72 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.

Hydrogeology

Geology

7.73 The geology of the site is discussed in detail in Chapter 6.

7.74 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 (**Figures 7-6** and **7-7**). Gravels occur within the overburden in the shallow valley to the east, between the quarry and the mountains. The depth to rock varies from c. 2.5-4m below ground level, a thin or absent weathered zone occurs at the top of bedrock. Bedrock is made up of well-bedded to massive dark grey micritic limestone of the Dartry Limestone Fm. (**Figure 7-8**). Chert bands and 'vuggy' cavities infilled with calcite crystals delineate bedding in the more massive beds. Colonial corals occur within the limestone beds as isolated concentrations which are laterally discontinuous.

7.75 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.

7.76 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.

7.77 A single large sub-vertical fault is noted in the east of the quarry 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.

Aquifer Classification

7.78 The Dartry Limestone Fm. is mapped regionally by the GSI as a Regionally Important Karstified Bedrock Aquifer, dominated by conduit flow (Rkc)(**Figure 7-10**). Karst features are present in this bedrock formation further to the west of the site (**Figure 7-11**)(enclosed depressions/dolines, springs, swallow holes), however no enhanced flow due to karst features are noted in the bedrock within the quarry however.

7.79 The gravels in the shallow valley to the east of the quarry 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-$10km^2$.

7.80 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 7-12**).

Aquifer Characteristics

7.81 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 (refer to **Figure 7.1**) which hit significant groundwater inflows in a collapsing fracture zone (c. 400m^3/d) which may/may not have been laterally continuous. Yields tended to increase gradually with depth once below the level of the water table (**Appendix 7-5**), suggesting the permeability is not related to a single flow-zone but a diffuse flow through fractures.

7.82 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 7-6**). 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. 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.

7.83 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). Some more discrete localised inflows occur specifically along bedding planes.

7.84 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. This draining of fractures vertically downwards after heavy rainfall was noted during monitoring in MW2.

Groundwater Vulnerability

7.85 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.

7.86 GSI regional mapping of groundwater vulnerability is indicated in **Figure 7-13**. 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

7.87 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.

7.88 The GSI groundwater recharge map for the area (**Figure 7-14**) 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.

Groundwater Abstractions

7.89 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 7-15**), 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.

7.90 The only private wells identified in this assessment are indicated in **Figure 7-16**; GSI borehole records are indicated on **Figure 7-17**.

7.91 The closest well to the quarry is a disused farm well located on lands owned by a third party just south of the quarry site boundary. The landowner has confirmed that this well is shallow and has been disused for several years. The landowner has confirmed that the farm is served by the mains water supply.

7.92 Cemex (the previous quarry owner) installed a supply well in the processing area across the road from the proposed development (also now in the ownership of the applicant) c. 12 years ago. The well was drilled to c. 60-90m depth and is installed with a submersible pump. Water from this well is used for non-potable use in the processing area.

7.93 A pumphouse owned by a third party is located across the road from the entrance to the Top Coast Oil depot, c. 360m northeast from the quarry void. This pumphouse is connected to the Aghamore Stream across the road by a pipe culvert, at the upstream end of the culvert at the entrance to Top Coast Oil. The third party has indicated that the pumphouse is not currently in use.

7.94 The only other private well identified in the area is a pumphouse c. 300m to the west of the quarry void; the pumphouse appears to be in use however no information could be obtained on this well.

Groundwater Levels

7.95 Groundwater level monitoring was carried out for 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 removed, however the 'Old Well' monitored in the most recent investigation is likely to be BH5 from the 2002 EIS work.

7.96 For this current assessment, 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 response zone.

7.97 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).

7.98 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). 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.

7.99 A record of manually measured groundwater levels and continuously monitored levels is presented in **Appendix 7-7**.

7.100 Groundwater levels in the 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 7.133.

7.101 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).

7.102 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.

7.103 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.

7.104 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.

7.105 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.

Groundwater Flow Direction

7.106 Regionally, groundwater flow would be expected to follow the topography similar to the surface water catchments. Groundwater to the east of the quarry would be expected to discharge to Lough Gill, and groundwater to the west of the quarry would be expected to discharge to the coast (Ballysadare Bay) (**Figure 7-18**).

7.107 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.

7.108 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 7-19) which is clear from the monitoring data. Groundwater levels measured during prolonged dry weather are representative of the average piezometric level of the response zones of the boreholes; as such, they are not representative of the piezometric levels in the shallow bedrock, therefore the levels measured in the monitoring wells would be slightly lower than that expected in the shallow bedrock.

Groundwater Quality

7.109 Two rounds of groundwater samples (February 2018 and April 2018) were collected from the new monitoring wells installed as part of this assessment.

7.110 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 7-8**.

7.111 When the major ions are plotted on a Piper Diagram (**Figure 7-20**), 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.

7.112 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).

7.113 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 (2010-2015).

Potential Sources of Groundwater Pollution

7.114 Land use immediately surrounding the quarry is predominantly agricultural (grazing), with a few small farms and ribbon development along local roads.

7.115 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. land-spreading, fertilizer application).

Conceptual Model

7.116 Groundwater flow within the zone of influence of the quarry can be conceptualised as radial flow through an unconfined fractured rock aquifer that acts like an equivalent porous medium at the large scale. This can be justified based on the high degree of fracturing observed laterally and vertically in the quarry/boreholes, relatively uniform permeability throughout the bedrock as evidenced by packer testing in rotary cored boreholes, the gradually increasing yields shown in boreholes with depth during drilling, and similarities in groundwater level and chemistry between boreholes which indicate connectivity.

7.117 Bedrock is acting as a multi-layered aquifer (bedding planes), with connections between layers (joints) allowing crossflow between layers. For the deep monitoring wells drilled through the entire section, this is analogous to a single-layer aquifer with characteristics that are an average of all layers (i.e. head and groundwater chemistry).

7.118 Groundwater outside the zone of influence of the quarry flows radially away from the quarry mirroring the topography surrounding the site. Groundwater to the east of the quarry discharges to Lough Gill and groundwater to the west of the quarry discharges to the coast (Ballysadare Bay).

7.119 The Aghamore Stream all but dries up in prolonged dry weather, indicating it is above the water table close to the quarry in summer; flow monitoring during the winter suggests a level of baseflow to this stream, therefore groundwater is likely to discharge to the Aghamore Stream in the vicinity of the quarry in winter. Further downstream, the Aghamore Stream passes through a gravel deposit which is likely to add a small additional level of baseflow to the stream before discharge to Lough Gill.

Sensitive Receptors

7.120 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) and is also a popular lake for fishing.

7.121 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.

7.122 Other potential receptors in the vicinity of the quarry are the bedrock aquifer itself (Dartry Limestone Fm.) which is classified as a Regionally Important Karstified Aquifer, the Aghamore Stream and a private well (currently not in use).

IMPACT ASSESSMENT

Evaluation Methodology

7.123 The impacts on the local surface water and groundwater environment of the proposed development are assessed in this section.

7.124 The methodology applied here is a qualitative risk assessment methodology in which the probability of an impact occurring and the magnitude of the impact, if it were to occur, are considered. This approach provides a mechanism for identifying the areas where mitigation measures are required, and for identifying mitigation measures appropriate to the risk presented by the development. This approach allows effort to be focused on reducing risk where the greatest benefit may result.

7.125 The assessment of risk is based on the matrix outlined in **Table 7-1** below.

Table 7-1
Matrix Used to Assess Potential Impacts

Probability of Occurrence	Magnitude of Potential Impacts			
	Severe	Moderate	Mild	Negligible
High	High	High	Medium	Low
Medium	High	Medium	Low	Near Zero
Low	Medium	Low	Low	Near Zero
Negligible	Low	Near Zero	Near Zero	Near Zero

7.126 The assessment of likely magnitude of potential impacts in relation to hydrogeology and hydrology is assessed in accordance with criteria detailed in **Table 7-2** below.

Table 7-2
Magnitude of Potential Hydrological and Hydrogeological Impacts

Magnitude	Potential Impact
Negligible	No alteration or very minor changes with no impact to watercourses, hydrology, hydrodynamics, erosion and sedimentation patterns; No alteration to groundwater recharge or flow mechanisms; and No pollution or change in water chemistry to either groundwater or surface water.
Mild	Minor or slight changes to the watercourse, hydrology or hydrodynamics; Changes to site resulting in slight increase in runoff well within the drainage system capacity; Minor changes to erosion and sedimentation patterns; and

Magnitude	Potential Impact
	Minor changes to the water chemistry of surface runoff and groundwater. .
Moderate	Some fundamental changes to watercourse, hydrology or hydrodynamics; Changes to site resulting in an increase in runoff within system capacity; Moderate changes to erosion and sedimentation patterns; and Moderate changes to the water chemistry of surface runoff and groundwater.
Severe	Wholesale changes to watercourse channel, route, hydrology or hydrodynamics; Changes to site resulting in an increase in runoff with flood potential Significant changes to erosion and sedimentation patterns; and Major changes to the water chemistry or hydro-ecology.

7.127 In addition to their nature and significance, the potential impacts will be assessed in terms of their duration, whether they are direct or indirect impacts. Any cumulative impact of the potential impacts will be assessed.

7.128 The following sections identify the potential impacts of the proposed development on the hydrogeological and hydrological environments. It also assesses the likelihood of occurrence of each identified impact in accordance with **Table 7-1** and **Table 7-2**. It should be noted that the impacts are initially assessed with no mitigation or design measures incorporated to reduce the risk.

Construction Stage Impacts

Proposed Development

7.129 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. 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.

7.130 The size of the settlement lagoon will depend on the pumping rate and calculations are presented in **Appendix 7-9**. 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 7-11**), 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 7-9).

7.131 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.

7.132 The discharge point from the settlement lagoon will remain at the current location (see **Figure 7-5**).

Direct Impacts

7.133 There is the potential for generating suspended sediment in rainfall runoff during the construction stage of the settlement lagoon. There is also the potential for spills or leaks of fuels/oils from vehicles during the construction stage. 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.

7.134 Using the criteria outlined in **Table 7-1** and **Table 7-2**, the potential construction phase impacts are assessed below.

7.135 Without mitigation, the probability of occurrence for spills or leaks of fuels/oils is **medium-low** during the construction stage. The magnitude of such an impact on surface water and groundwater could be '**moderate**', should fuels/oils drain to the quarry sump. Therefore, the overall risk to surface water and groundwater, without mitigation, is '***medium***'.

7.136 Without mitigation, the probability of fine sediment impacting on the water environment is **low** during the construction stage. The magnitude of such an impact on surface water and groundwater would be '**mild**'. Therefore, the overall risk to surface water and groundwater, without mitigation, is '***low***'.

Indirect Impacts (if any)

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

Operational Stage Impacts

Direct Impacts

Drawdown

7.138 Deepening of the quarry will increase drawdown on the water table surrounding the quarry.

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

7.140 An initial indication of the radius of influence was calculated using the Sichardt equation (Appendix 7-11), 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 7-22** 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 -34.5 mOD is also shown on **Figure 7-22**.

7.141 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 (3110m^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 2857m^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.

7.142 The estimated radius of influence at the lowest quarry floor level of -50mOD is expected to be some **286m** from the quarry face. Calculations of the drawdown profile leading away from the quarry face for the final quarry floor level of -50mOD (**Appendix 7-11**) would suggest a future increase in drawdown at the third party farm well to the South of the quarry of c. 12-18m from the existing water level. It is noted the farm well is disused.

7.143 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 reduction of baseflow to the stream is predicted. Lough Gill is further away from the site (c. 520m from the application area) and will not be affected by drawdown from the quarry.

7.144 Therefore, the probability of drawdown impacting on the surface water receptors, in particular Lough Gill, is **low** during the operation stage. The magnitude of the drawdown on surface water receptors is '**mild**'. Therefore, the overall risk to surface water receptors is '***low***'.

7.145 Without mitigation, the probability of drawdown impacting on groundwater receptors (in particular the third party disused well to the South of the quarry) is **high** during the operation stage. The magnitude of the impact of the drawdown on the well is '**mild**', as the well disused. Therefore, the overall risk to groundwater receptors is '***medium***'.

Groundwater Quality

7.146 There is a potential risk of groundwater contamination in the operational stage from blasting activities. Other sources of potential groundwater pollution within the quarry in the operational stage are leaks or spills of stored fuel/chemicals and suspended solids from site activities. There are no sources of waste water within the quarry, toilets are provided in the offices across the road (outside the proposed development).

7.147 Prior to discharge, abstracted groundwater will be passed through the newly constructed settlement pond with associated hydrocarbon interceptors.

7.148 Without mitigation, the probability of an impact on groundwater quality is **medium-low** during the operational stage. The magnitude of such an impact on surface water and groundwater is '**mild**', as abstracted groundwater will be treated prior to discharge. Therefore, the overall risk to surface water and groundwater, without mitigation, is '***medium-low***'.

Flooding

7.149 For a storm event with a 10-year return period, and a pumping rate of 28.3l/s the storm water attenuation volumes in the quarry would be c. 4699m^3 and would take 46 hours to pump out (see

Figure 7-21 and **Appendix 7-10**). The quarry floor will be allowed to flood in extreme weather events, and in that case a separate attenuation pond outside the quarry will not be required. This volume of water would equate to c. 9cm of water across the lower quarry floor, but the quarry floor level can be sloped so the water accumulates to one side.

7.150 In the case of a storm event, groundwater inflows will be separated from stormwater within the quarry and pumped directly to the Aghamore Stream. The groundwater will not require discharge via the settlement lagoon, as the stormwater will not be allowed to mix with the dewatering sump. Therefore, rainfall will be directed to a separate quarry sump and discharged via the settlement lagoon.

7.151 The discharge of water from the quarry has the potential to exacerbate the existing flood risk along the Aghamore Stream, although relative to the existing situation the change in discharge volume is expected to be negligible. A channel survey was carried out along the Aghamore Stream as part of this assessment. The channel survey was carried out from the quarry discharge point to Lough Gill. A summary of the survey is provided in **Figure 7-23**.

7.152 The stream was divided into a number of separate reaches between culverts (**Figure 7-24**), between which 40No. cross-sectional profiles were measured (**Figure 7-25**) and a longitudinal profile constructed (**Figure 7-26**). Photographs of the stream channel and the cross-sectional profiles are presented in **Appendix 7-12**.

7.153 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 (see **Appendix 7-13**). 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).

7.154 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.

7.155 On the basis of this assessment, 5No. areas liable to flooding along the Aghamore Stream are identified (**Figure 7-27**). 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 could exacerbate such flooding downstream, however it is noted that relative to the existing situation the change in discharge volume is negligible.

7.156 Using the criteria outlined in **Table 7-1** and **Table 7-2**, the probability of potential operational phase impacts relating to increased risk of flooding from the proposed deepening of the quarry is assessed as **low.** The magnitude of increased risk of flooding flooding caused by the proposed deepening of the quarry is **'negligible'** to '**mild**', and the overall risk is '***low***'.

Discharge to Surface Water

7.157 There is potential for spills or leaks of fuels/oils from vehicles during the operational stage, as well as increased suspended sediment in runoff, to impact on the discharge to surface water. Suspended sediment is likely to settle out over the quarry floor before reaching the sump. The water will be passed through the settlement lagoon and associated hydrocarbon interceptors prior to discharge, which will minimise impact from any spills or leaks of fuels/oil.

7.158 Water quality results have been assessed to consider any potential impact on surface water receptors by the discharge. In particular, faecal bacteria can be present in both groundwater and surface water in the area as a result of agricultural activities in the lands surrounding the quarry, and the discharge of water to the Aughamore Stream could create a preferential pathway to Lough Gill. Recent sampling of surface water between the discharge and Lough Gill (**Appendix 7-4**) 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. Traces of total ammonia and orthophosphate typical of runoff from an agricultural catchment have also been reported in discharge.

7.159 To investigation the potential impact of water quality on Lough Gill, a simple assimilative capacity model used by the EPA in 2011 to assess licence compliance with the Surface Water Regulations was used to examine the potential impact of these parameters in the discharge on water quality in Lough Gill. The average depth of water in the lake within 100m of the discharge point is required for the model; a bathymetric survey of Aghamore Bay was carried out as part of this assessment and the results are presented in **Appendix 7-14**. The model and calculations are presented in **Appendix 7-15**.

7.160 The results show that using the median concentrations of total ammonia and orthophosphate in the discharge and in Lough Gill (EPA WFD monitoring data), the change in background concentrations in the mixing zone 100m from the discharge point is a negligible c. 0.5% increase for each parameter. This is a reflection of the large volume of water that dilutes the discharge on entry to the lake. The model is highly conservative as it only considered the first 100m from shore, in reality a much larger volume of Aghamore Bay is available for dilution.

7.161 The chemical loading for the parameters in the discharge water from the quarry is low, and the quantitative impact of such a small loading on the mass balance of Lough Gill is considered to be negligible.

7.162 Using the criteria outlined in **Table 7-1** and **Table 7-2**, the probability of discharge of surface water impacting on surface water receptors, in particular Lough Gill, is assessed as **low.** The magnitude of such an impact on surface water is however considered to be '**moderate**' given the sensitivity of Lough Gill, and therefore the overall risk is '***medium***'.

Water Framework Directive

7.163 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.

7.164 The probability of an impact to the groundwater bodies is assessed as **negligible.** The magnitude of such an impact on surface water is '**negligible**', and the overall risk is '***near zero***'.

Indirect Impacts (if any)

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

Post – Operational Stage Impacts

Direct Impacts

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

7.167 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.

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

Indirect Impacts (if any)

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

Unplanned Events (i.e. Accidents)

7.170 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).

7.171 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.

7.172 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.

Cumulative / Synergistic Impacts (if any)

7.173 The cumulative impact of the quarry dewatering with other groundwater abstractions in the area is considered negligible. No other potential cumulative/synergistic impacts have been identified.

Transboundary Impacts (If any)

7.174 No potential transboundary impacts have been identified.

Interaction with Other Impacts (if any)

7.175 No potential interaction with other impacts have been identified.

'Do-nothing Scenario' (esp. where deterioration will arise)

7.176 If the quarry did not continue operations, pumping of water from the quarry floor would cease and the quarry void would flood to approximately the level of the surrounding water table. All plant and equipment has been removed from the site therefore there are no sources of potential contamination remaining.

7.177 The discharge of water from the quarry to the Aghamore Stream augments the low flows in this 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.

7.178 No impacts on the water environment have been identified for the 'Do-nothing' scenario.

Summary

7.179 A summary of the unmitigated risk and magnitude of potential impacts are presented in **Table 7-3** and

7.180

7.181

7.182 Table 7-4 below, and indicates that if no mitigation measures are applied, there is potential for the proposed activity to cause a direct and medium impact to the surface water quality, in particular Lough Gill and for drawdown in aquifer to cause a direct and medium impact to the closest well (currently disused).

Table 7-3
Unmitigated Risk and Magnitude of Potential Impacts (Construction)

Potential Impact	Spatial Impact, Duration, Direct/Indirect	Probability of Occurrence	Magnitude of Impact	Significance of Impact	Mitigation Required?
Surface Water and Groundwater Quality					
Accidental spillages of fuel	Local, Short Term, Direct	Medium - Low	Moderate	Medium	Yes

Release of suspended solids	Local, Short-Term, Direct	Low	Mild	Low	No

Table 7-4
Unmitigated Risk and Magnitude of Potential Impacts (Operational)

Potential Impact	Spatial Impact, Duration, Direct/Indirect	Probability of Occurrence	Magnitude of Impact	Significance of Impact	Mitigation Required?
Groundwater Drawdown and Quality					
Drawdown from dewatering impacting on currently disused well	Local, Medium Term, Direct	High	Mild	Medium	Yes
Impact on groundwater quality from blasting, accidental spillages of fuel and suspended solids	Local, Short Term, Direct	Medium - Low	Mild	Medium - Low	Yes
Flooding					
Increase risk of flooding due to discharge	Local, Short Term, Direct	Low	Negligible-Mild	Low	Yes
Surface Water Quality					
Impact of discharge	Local, Short Term,	Low	Moderate	Medium	Yes

Potential Impact	Spatial Impact, Duration, Direct/Indirect	Probability of Occurrence	Magnitude of Impact	Significance of Impact	Mitigation Required?
on surface water quality, in particular Lough Gill	Direct				
Groundwater Bodies					
Impact of abstraction on groundwater bodies	Local, Medium Term, Direct	Negligible	Negligible	Near Zero	No

MITIGATION MEASURES

Construction Stage

7.183 There is the potential for accidental spills of fuels/oils from construction vehicles during the construction stage. Suspended sediment would most likely settle out over the quarry floor before reaching the sump and so impacts from suspended sediment during the construction stage was not deemed to require mitigation. No other impacts on surface water or groundwater have been identified for the construction stage.

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

7.185 Taken together, these measures reduce the potential impact of

- accidental spillage of fuels from '*medium*' to '*low*'.

Operational Stage

Groundwater Drawdown

7.186 Monitoring of groundwater levels in the third party well located to the South of the quarry will be carried out as part of the proposed monitoring (with permission). If water levels in the well drop significantly and affect the use of the well as a water supply then a replacement well will be provided by Lagan.

Groundwater Quality

7.187 To mitigate the potential impact of explosives on groundwater quality during blasting operations it is proposed to develop a site-specific protocol for blasting. The protocol will be developed in cooperation with the blasting contractor and will follow current international best practice. On completion, the protocol will be incorporated into the Environmental Management System for the quarry.

7.188 All petroleum-based products (lubricating oils, waste oils, etc.) will be stored in a bunded area to prevent pollution by accidental leaks.

7.189 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.

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

7.191 Interceptors will be located in areas close to potential sources of hydrocarbon contamination.

7.192 A settlement lagoon will be installed to reduce suspended solids levels in the discharges.

Flooding

7.193 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 Bitumen will ensure that there is no pumping during flooding events which eliminates the slight risk from flooding during extreme events.

Surface Water Quality

7.194 The mitigation measures outlined in Sections 7.188 to 7.192 above will also apply to surface water quality.

7.195 Taken together, these measures reduce the potential impact of

- Drawdown at the nearest well (disused) from '*medium*' to '*low*';
- Groundwater quality from '*medium - low*' to '*low';*
- Flooding at the culverts from '*low' to* '*negligible';*
- Discharge on surface water receptors, in particular Lough Gill, from '*medium*' to '*low'.*

Post – Operational Stage

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

RESIDUAL IMPACT ASSESSMENT

Construction Stage

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

Operational Stage

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

Post – Operational Stage

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

MONITORING

7.200 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.

7.201 Groundwater levels should 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 required. Permission will be sought from the land owner to monitor water levels in his farm well to the south of the quarry and a datalogger installed.

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

7.203 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 at this location.

FIGURES

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

Fig. 7-2 Surface Water Catchment & Sub-Catchments Map

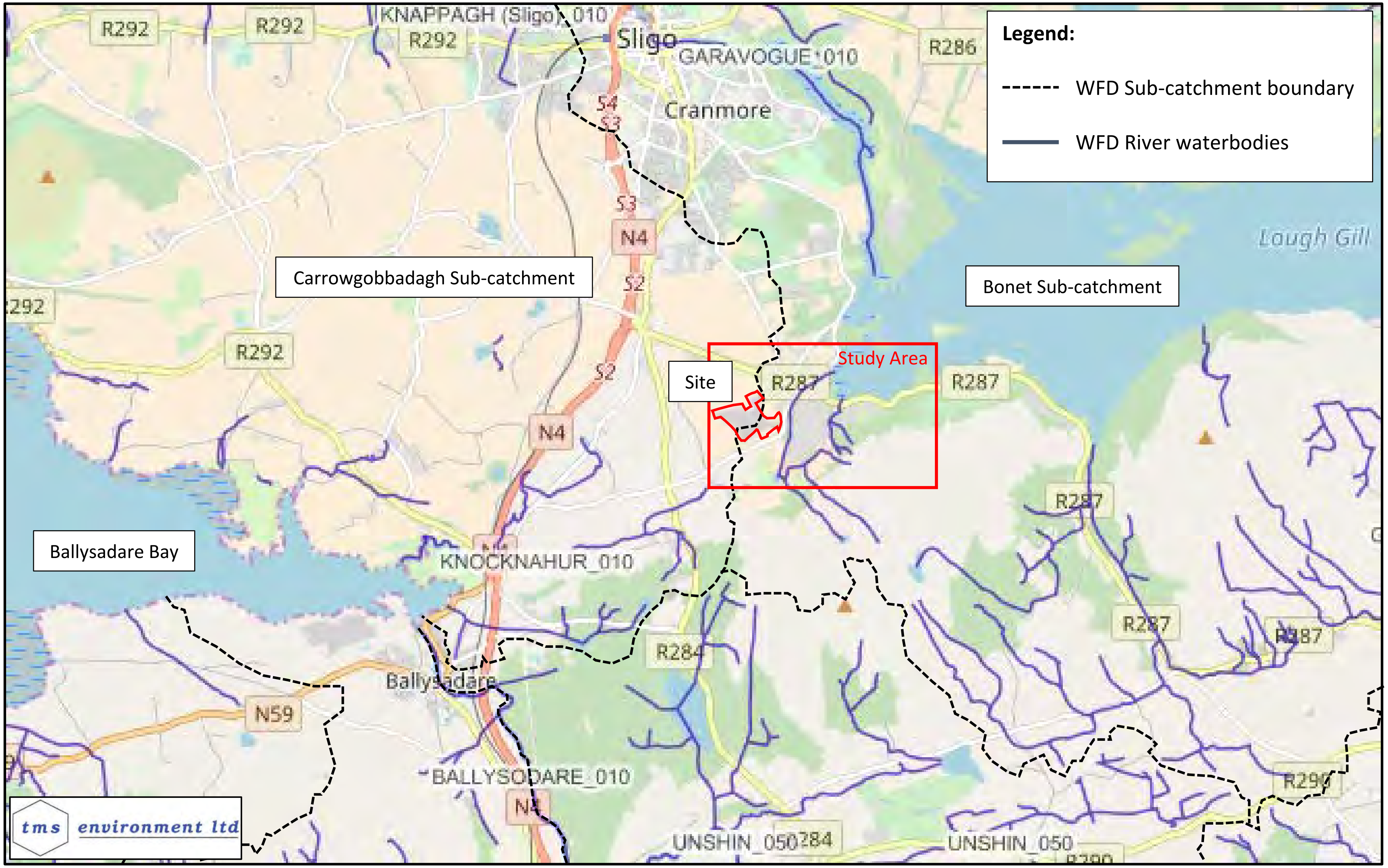
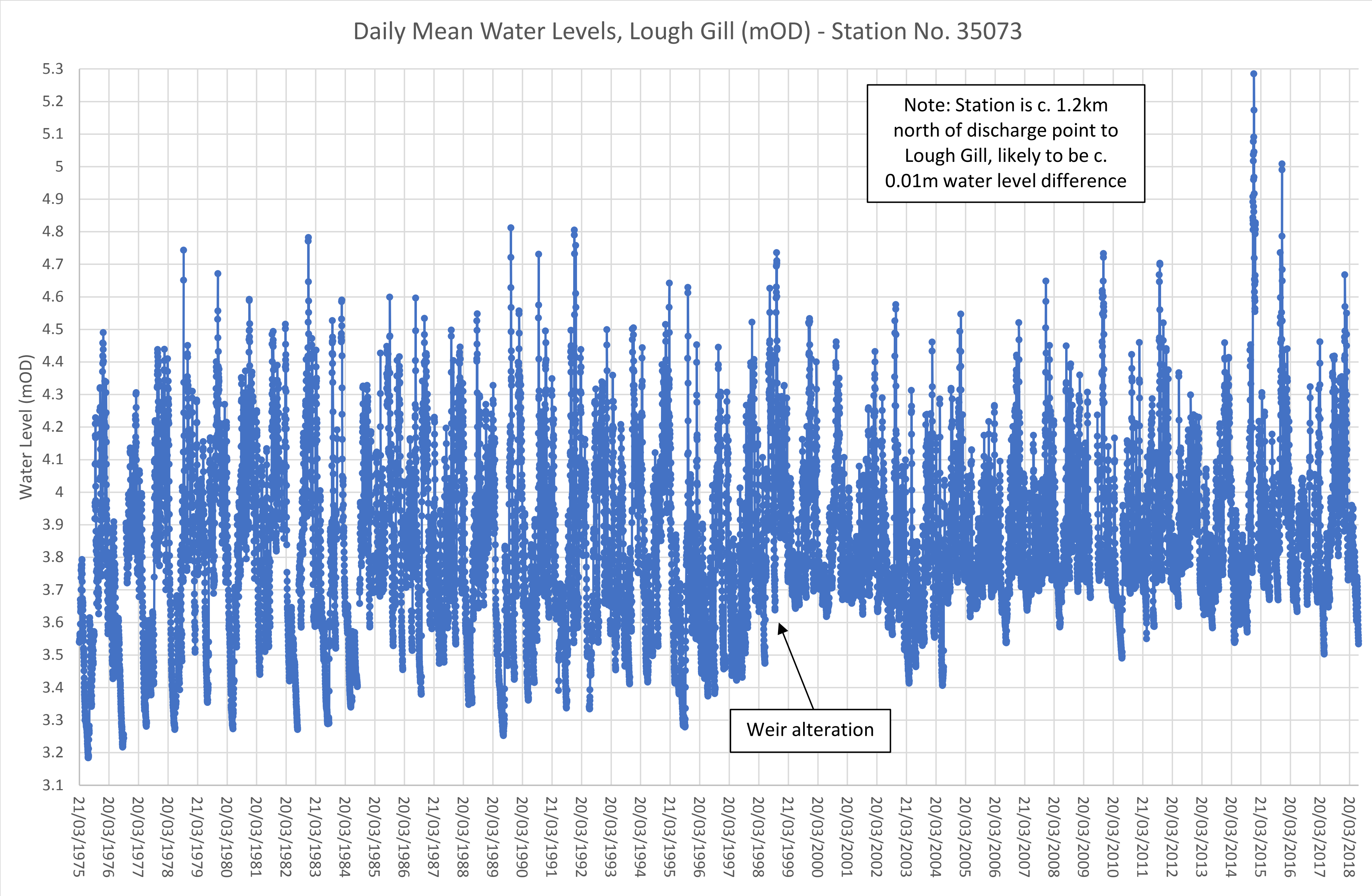


Fig 7-3 Surface Waterbodies Map (Catchments.ie website)


Daily Mean Water Levels, Lough Gill (mOD) - Station No. 35073
Water Level (mOD)
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
Note: Station is c. 1.2km north of discharge point to Lough Gill, likely to be c. 0.01m water level difference
Weir alteration
21/03/1975
20/03/1976
20/03/1977
20/03/1978
21/03/1979
20/03/1980
20/03/1981
20/03/1982
21/03/1983
20/03/1984
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20/03/2009
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20/03/2016
20/03/2017
20/03/2018

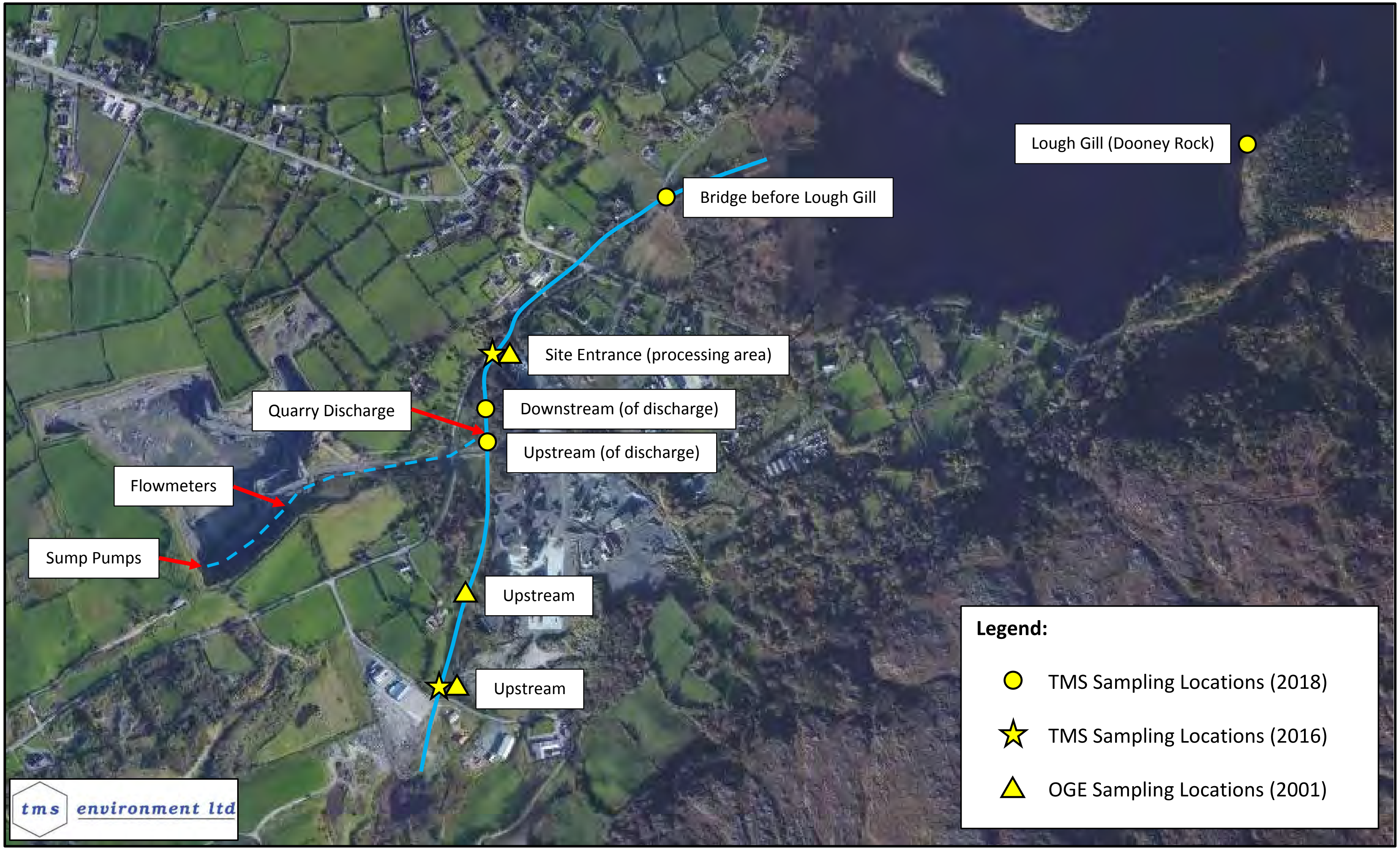


Fig 7-5 Surface Water Sampling Locations Map (Bing Maps)

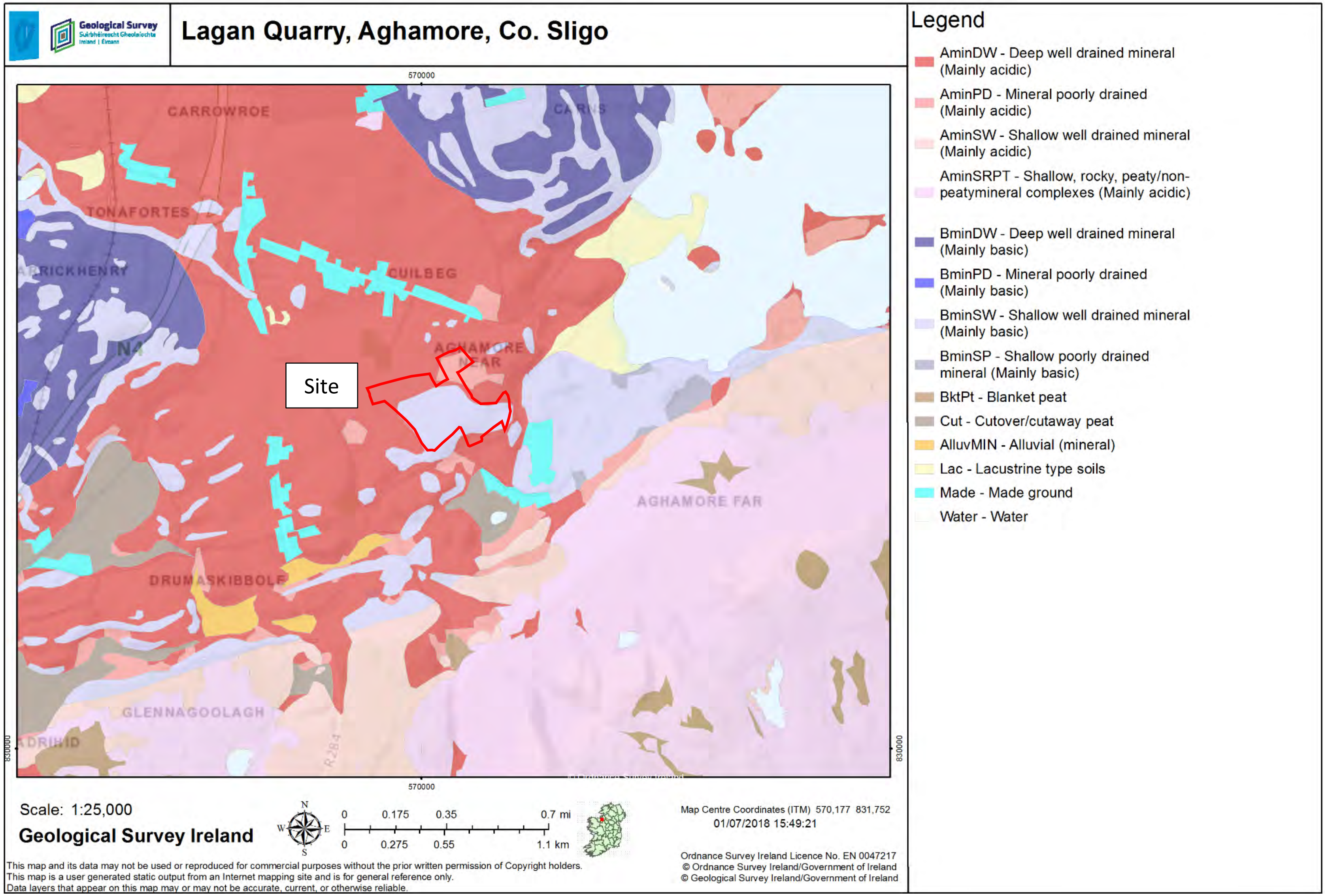


Fig. 7-6 Soils Map (GSI Groundwater Data Viewer)

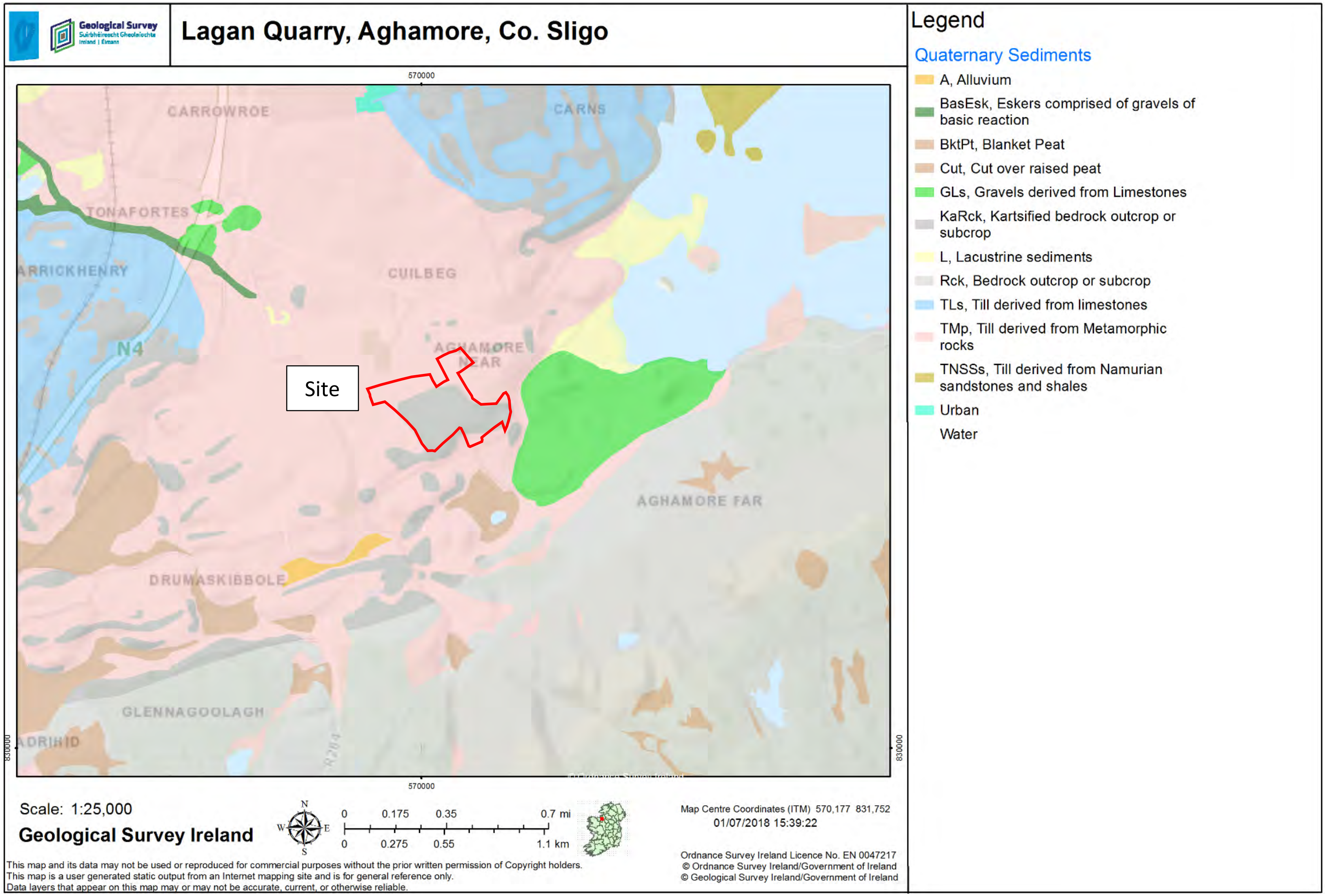


Fig. 7-7 Subsoils Map (GSI Groundwater Data Viewer)

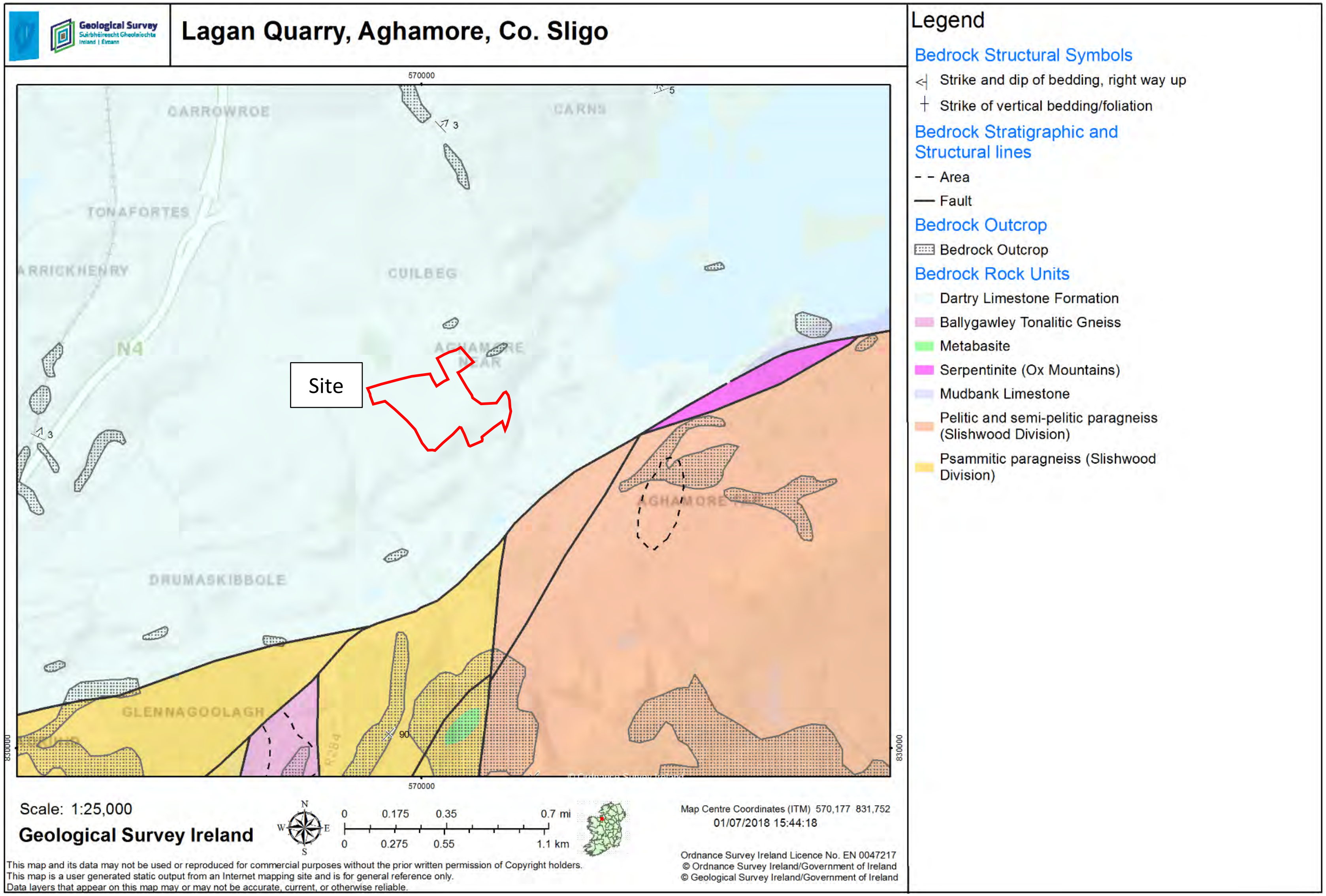


Fig. 7-8 Bedrock Map (GSI Groundwater Data Viewer)

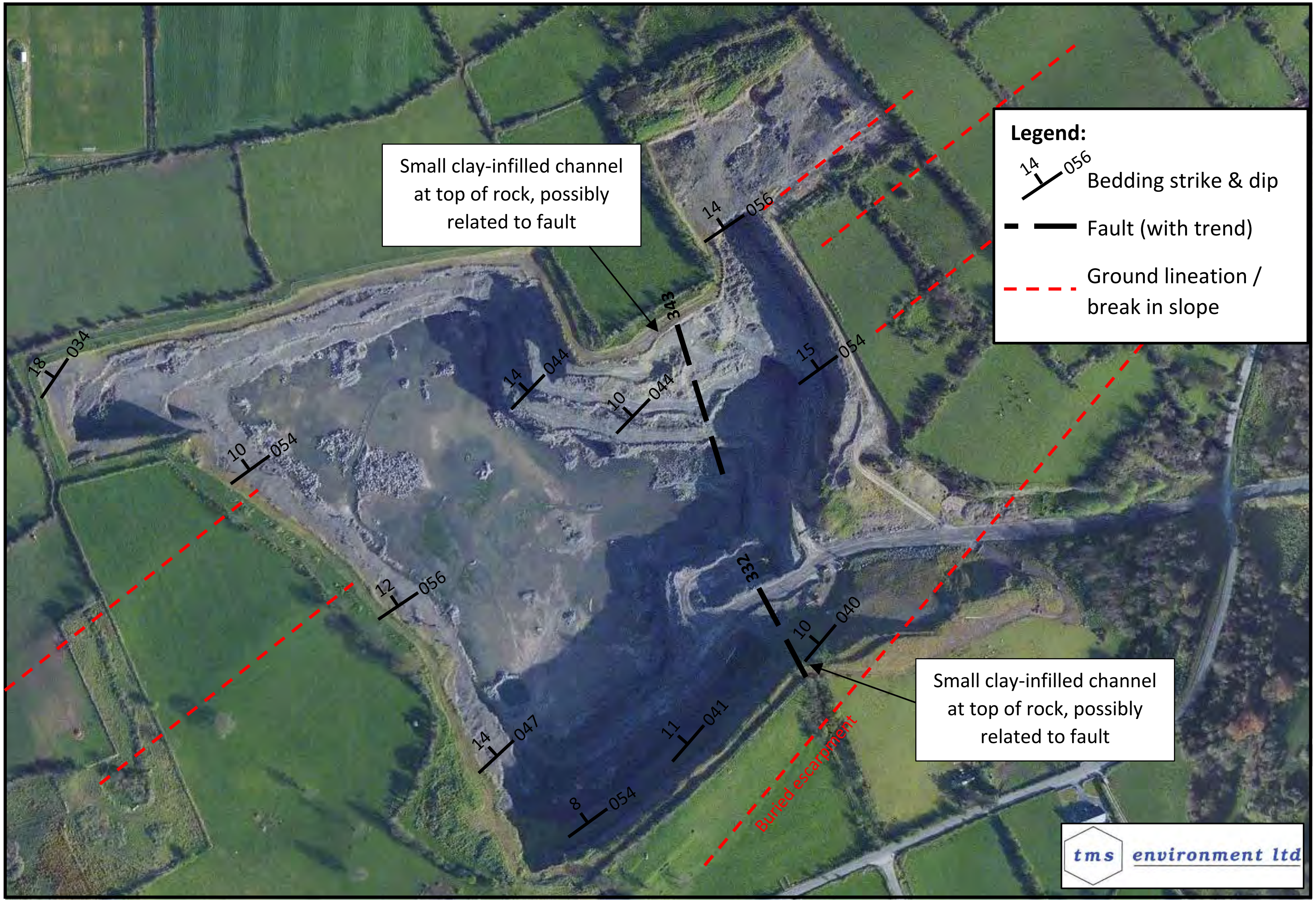


Fig. 7-9 Bedrock Structure Map (Bing Maps)

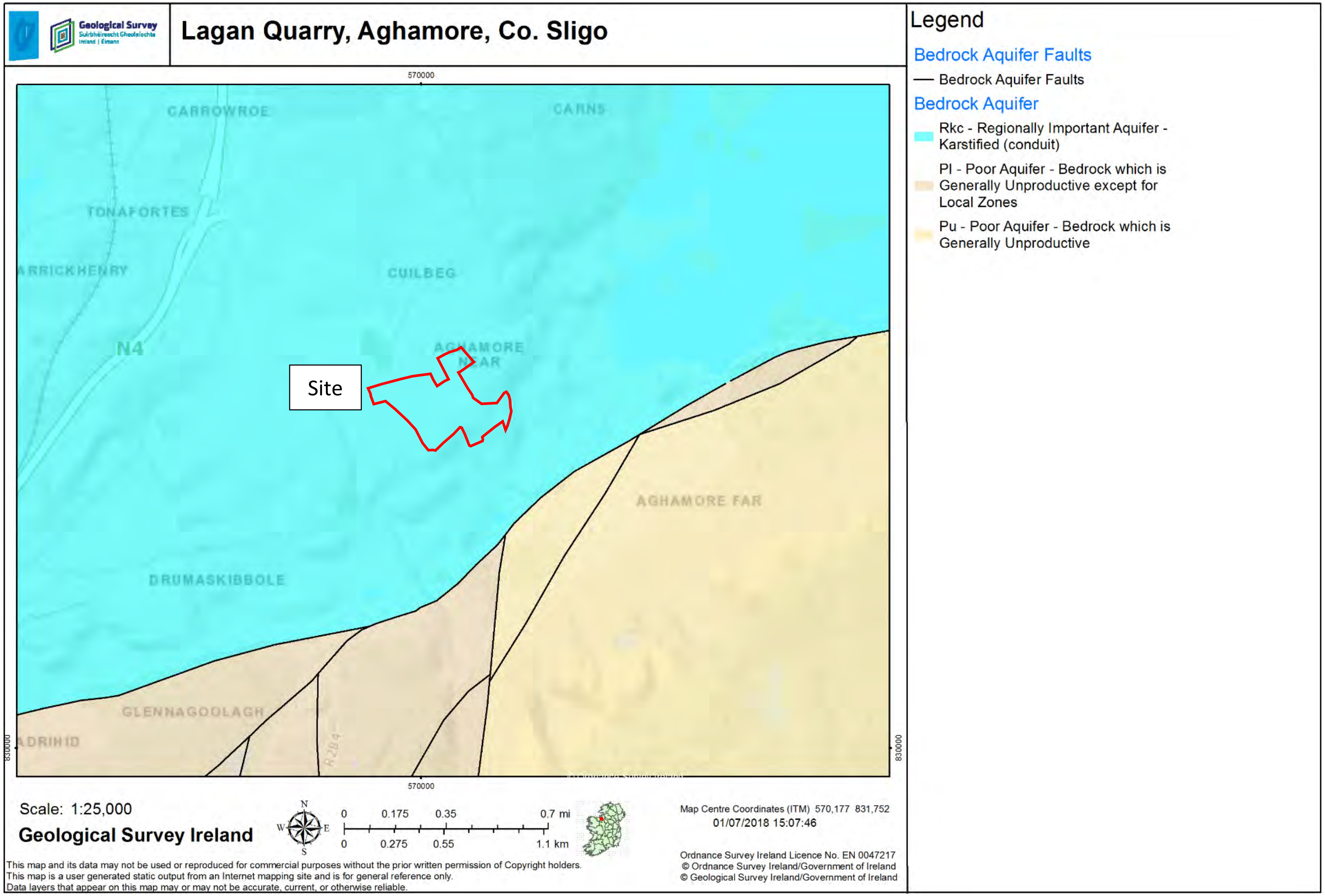


Fig. 7-10 Bedrock Aquifers Map (GSI Groundwater Data Viewer)

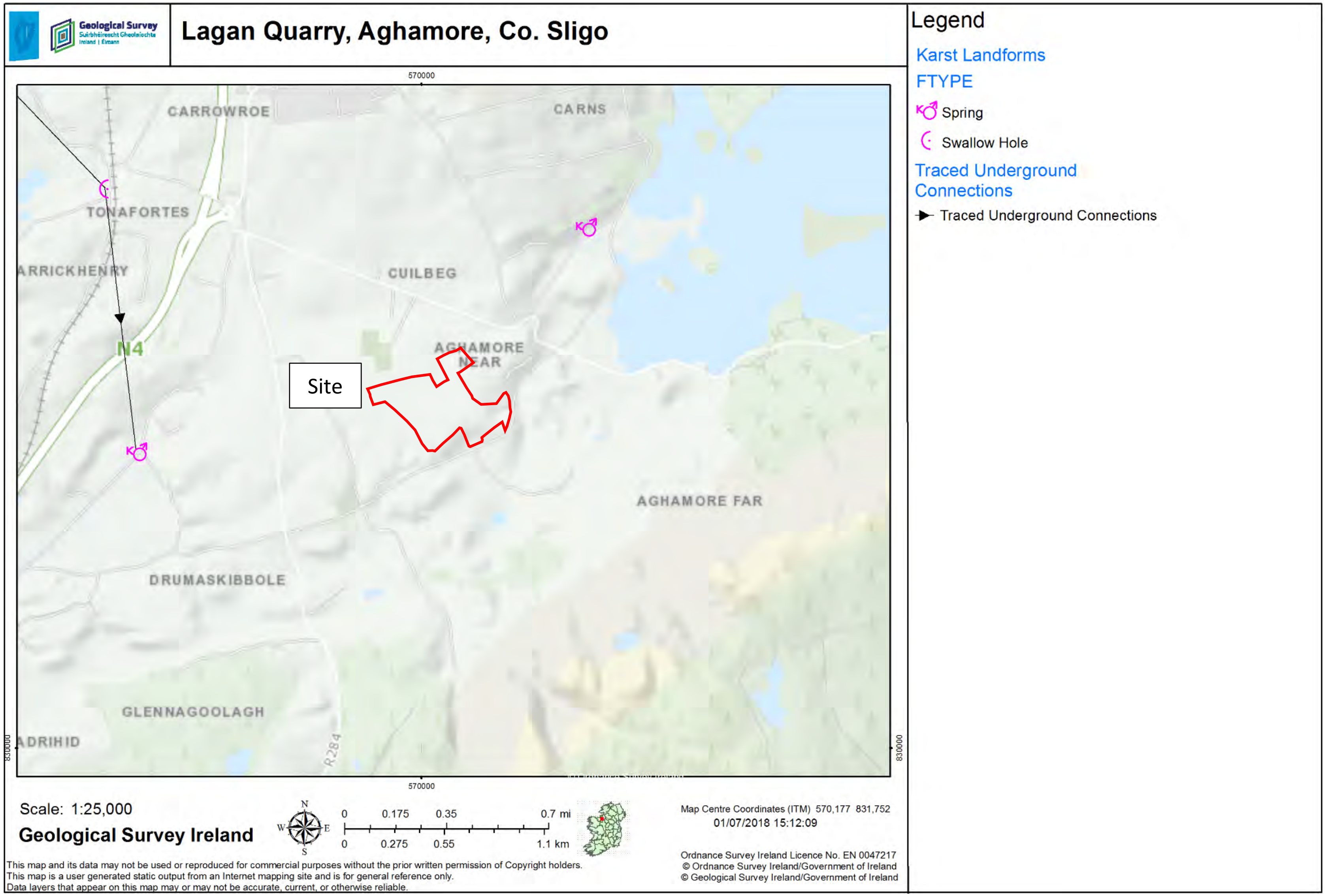


Fig. 7-11 Karst Features Map (GSI Groundwater Data Viewer)

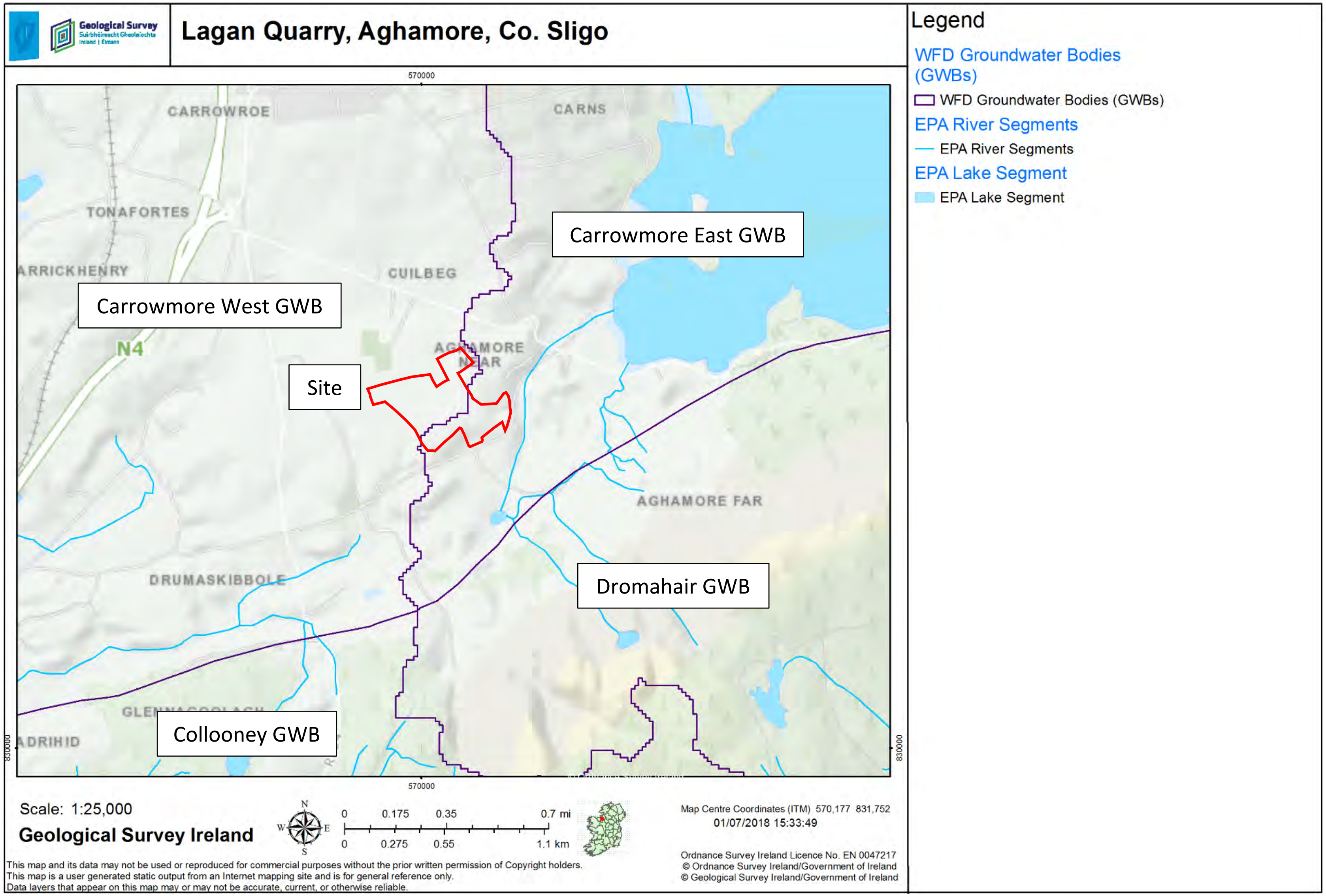


Fig. 7-12 Groundwater Bodies Map (GSI Groundwater Data Viewer)

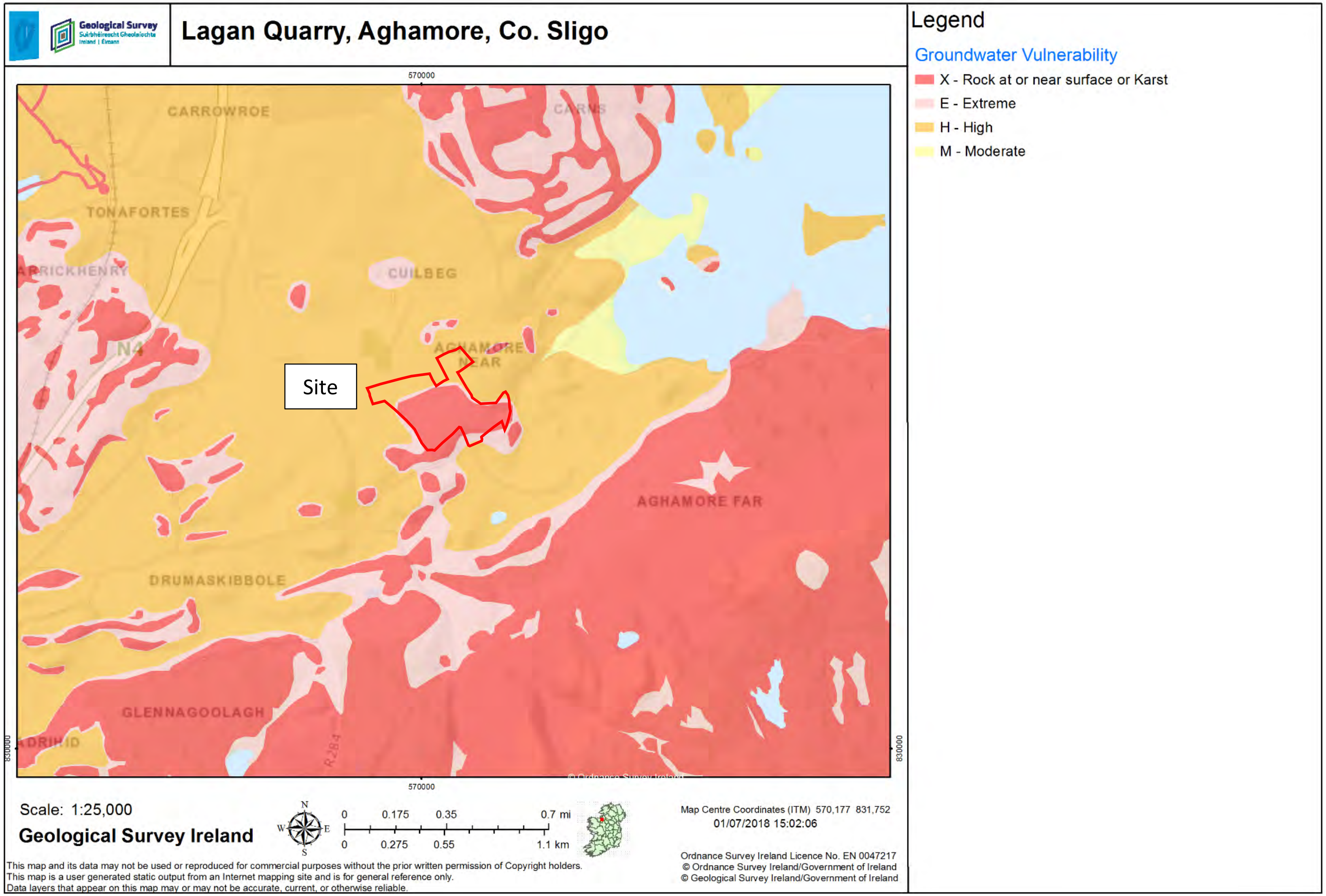


Fig. 7-13 Groundwater Vulnerability Map (GSI Groundwater Data Viewer)

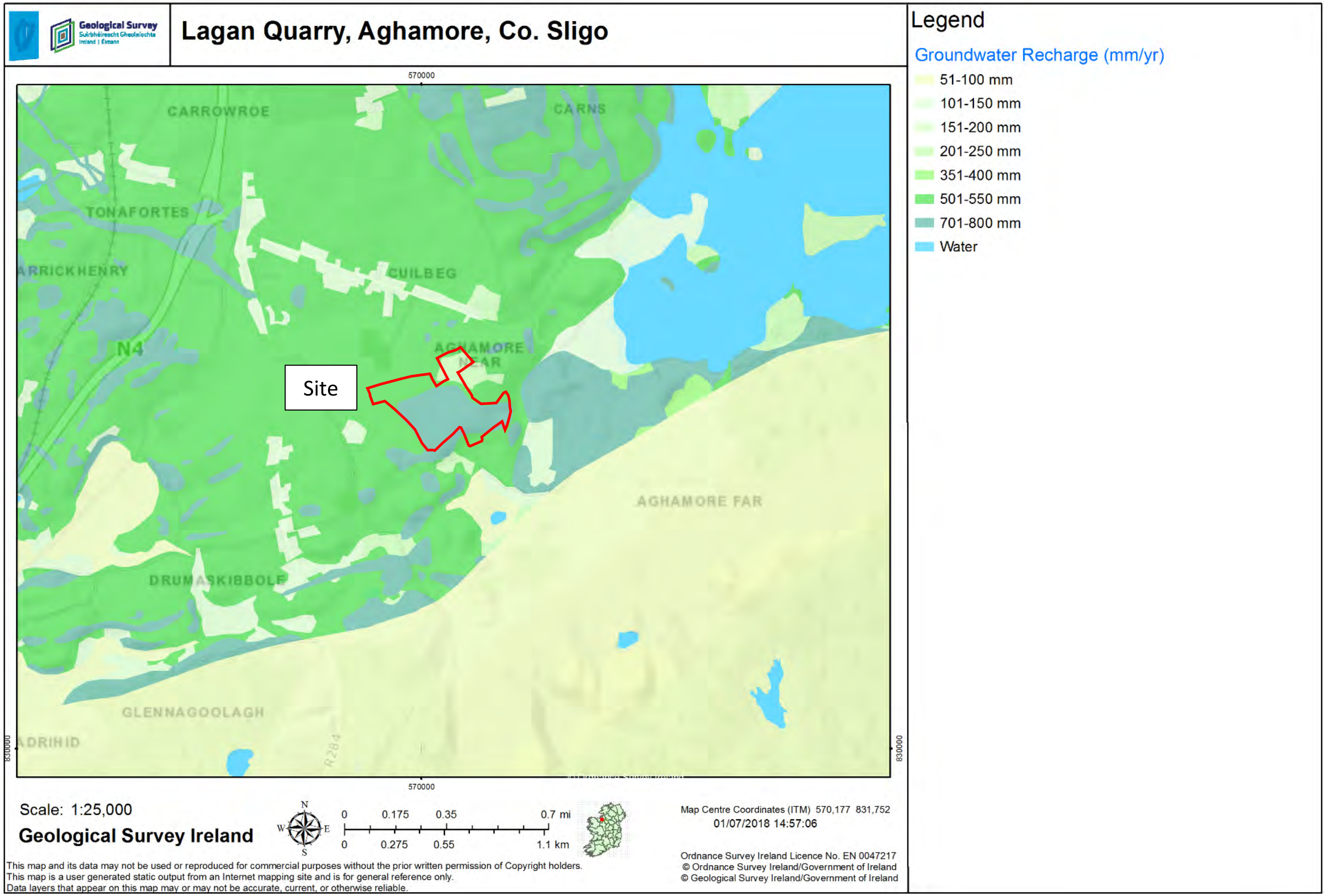


Fig. 7-14 Groundwater Recharge Map (GSI Groundwater Data Viewer)

Aughamore

May 28, 2018

1:9,028

0 0.1 0.2 0.4 mi

0 0.175 0.35 0.7 km

Legend

Gravity Main (Irish Water Owned)
- Surface

Gravity Main (Non-Irish Water Owned)
- Surface
- Treatment plant

Sewer Gravity Mains (Irish Water owned)
- Combined
- Foul
- Overflow
- Unknown

Sewer Gravity Mains (Non-Irish Water owned)
- Combined
- Foul
- Overflow
- Unknown

Sewer Pressurized Mains
- Combined
- Foul
- Overflow
- Unknown
- Treatment Plant

Reservoir
- Potable
- Raw Water
- Pump Stations

Water Mains(Irish Water Owned)
- Untreated
- Potable Water

Water Mains(Non Irish Water Owned)
- Untreated
- Potable Water

Water Lateral Lines
- Irish Water
- Non IW
- Water Abandoned Lines

UISCE ÉIREANN : IRISH WATER

Fig. 7-16 Private Wells within 500m of Quarry (Bing Maps)

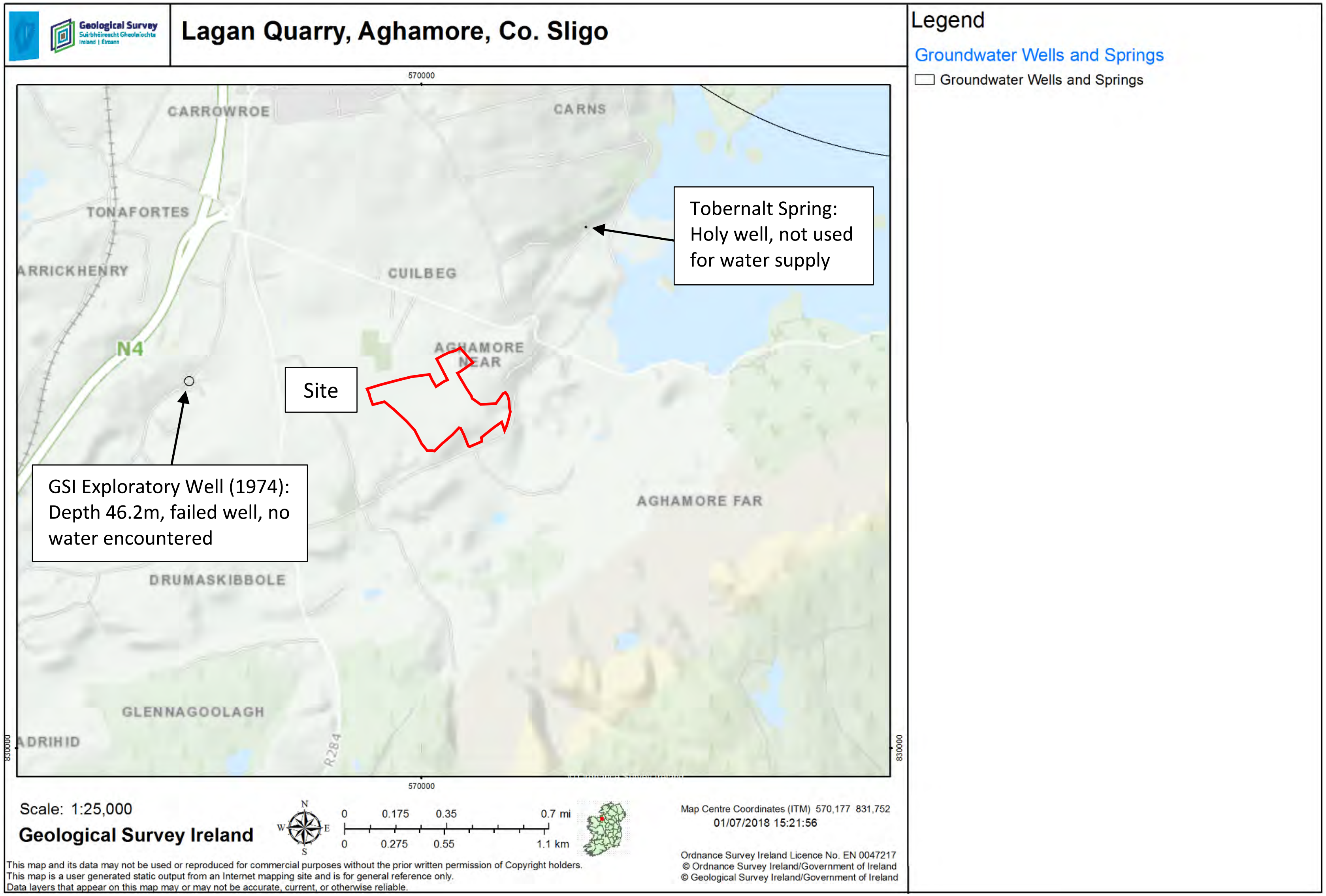


Fig. 7-17 Well Records Map (GSI Groundwater Data Viewer)

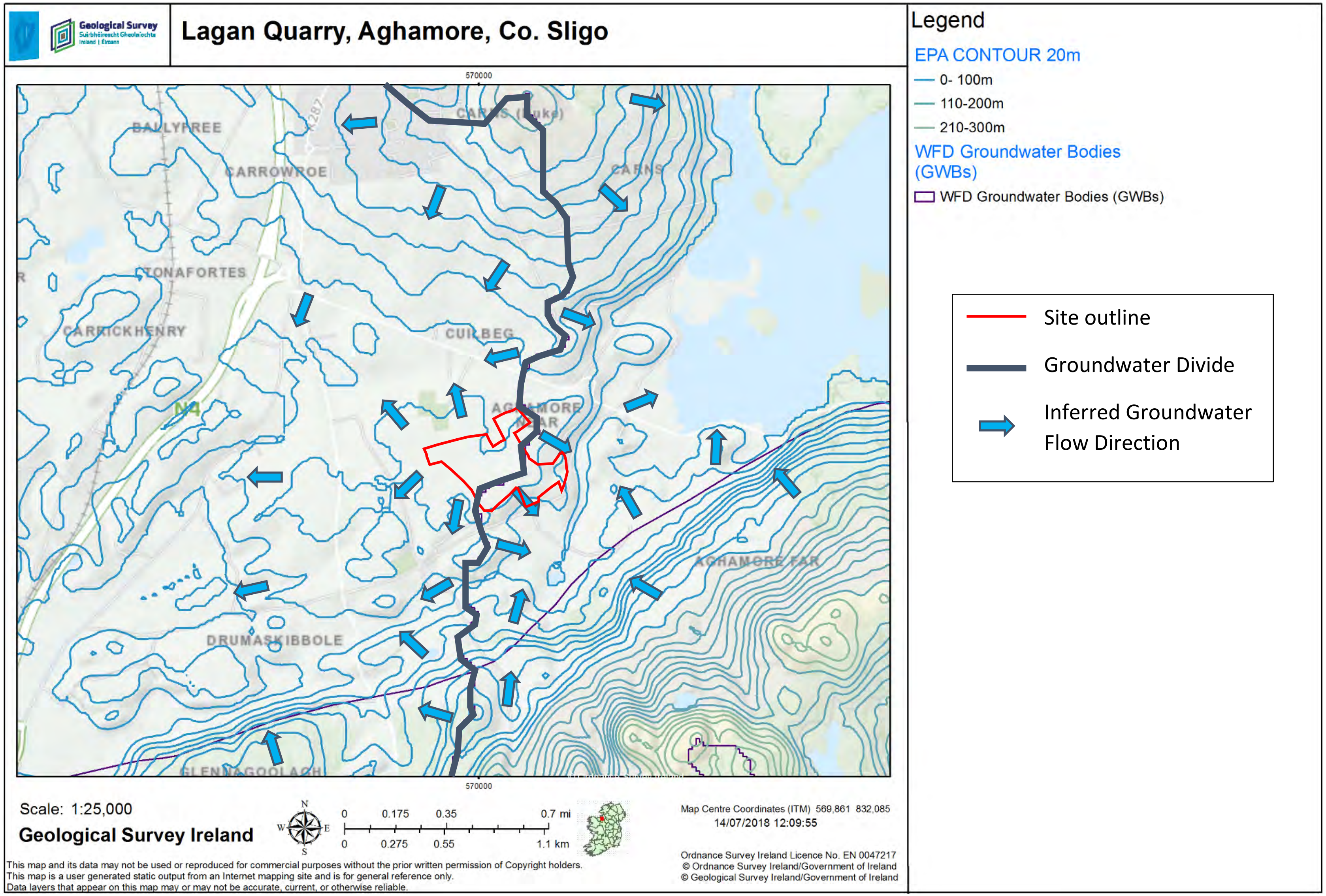


Fig. 7-18 Regional Groundwater Flow Map (GSI Groundwater Data Viewer contour map)

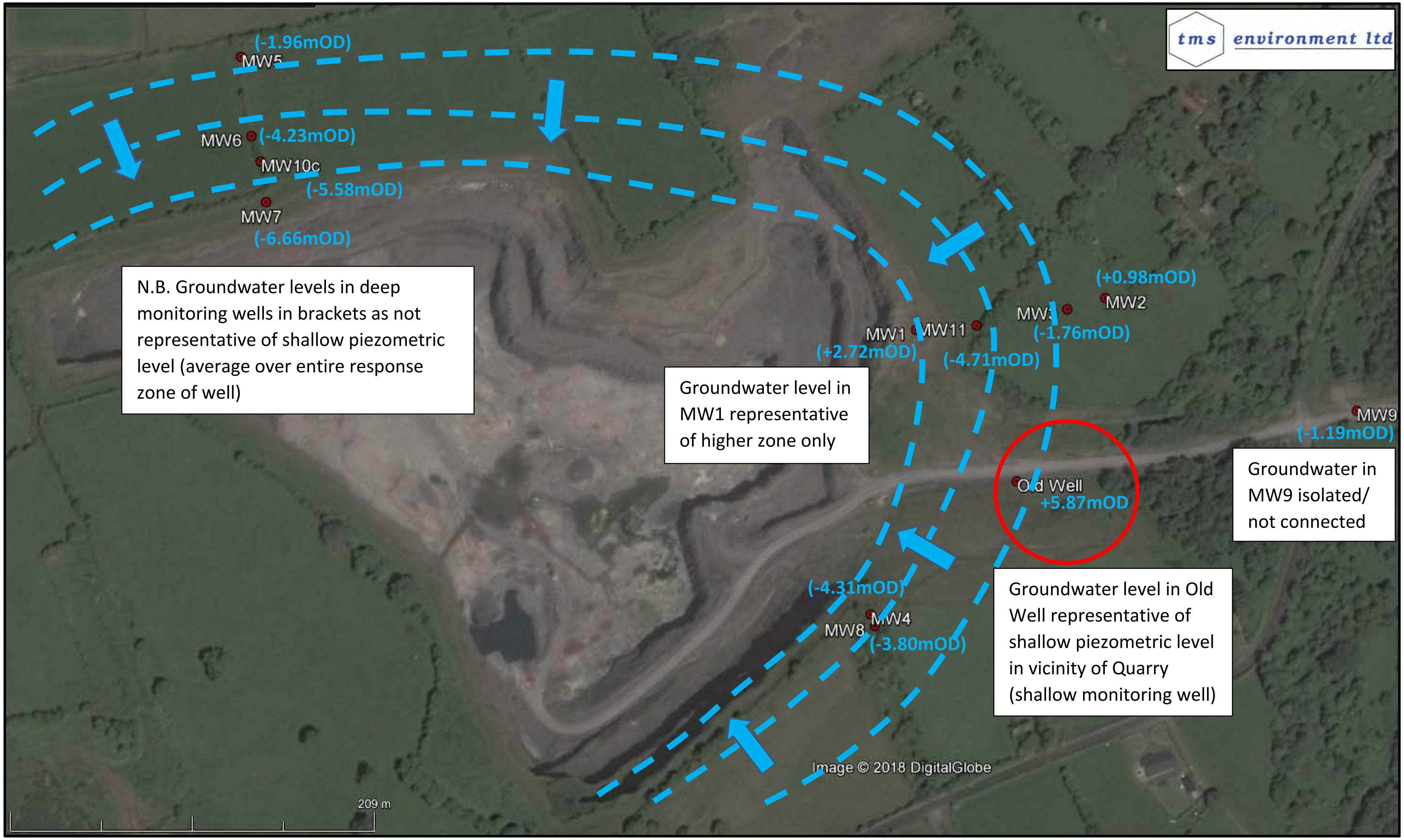
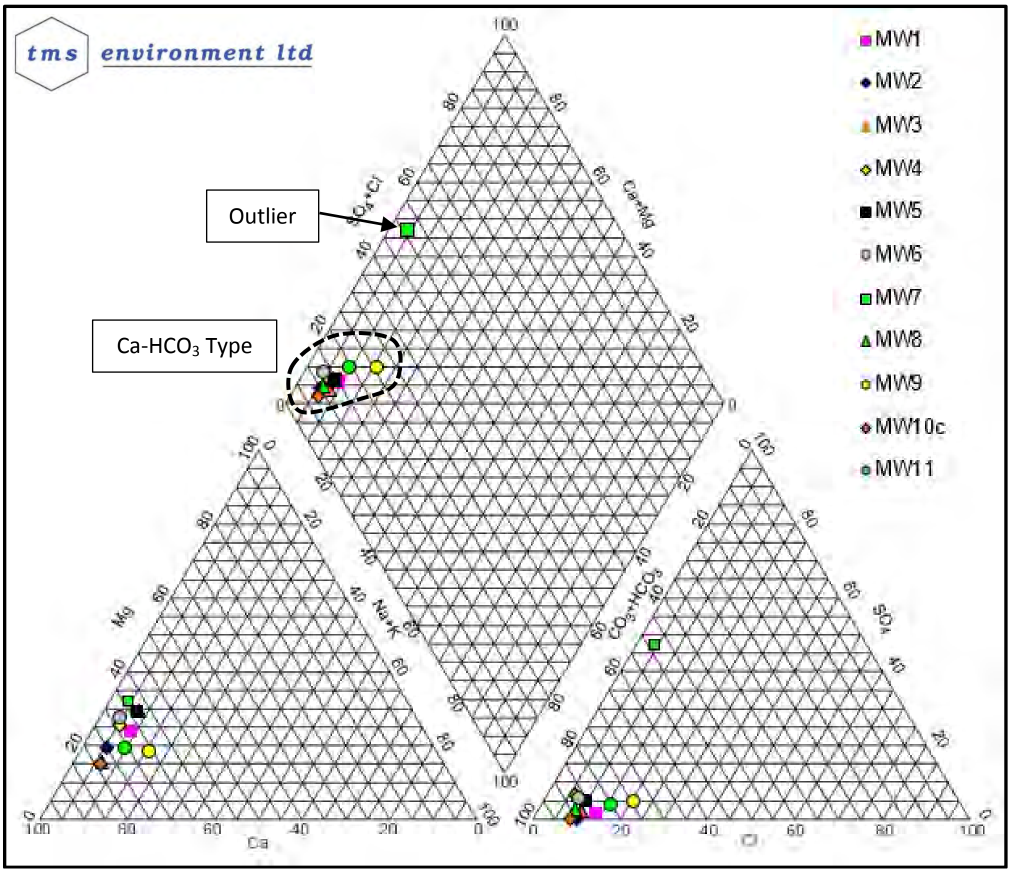
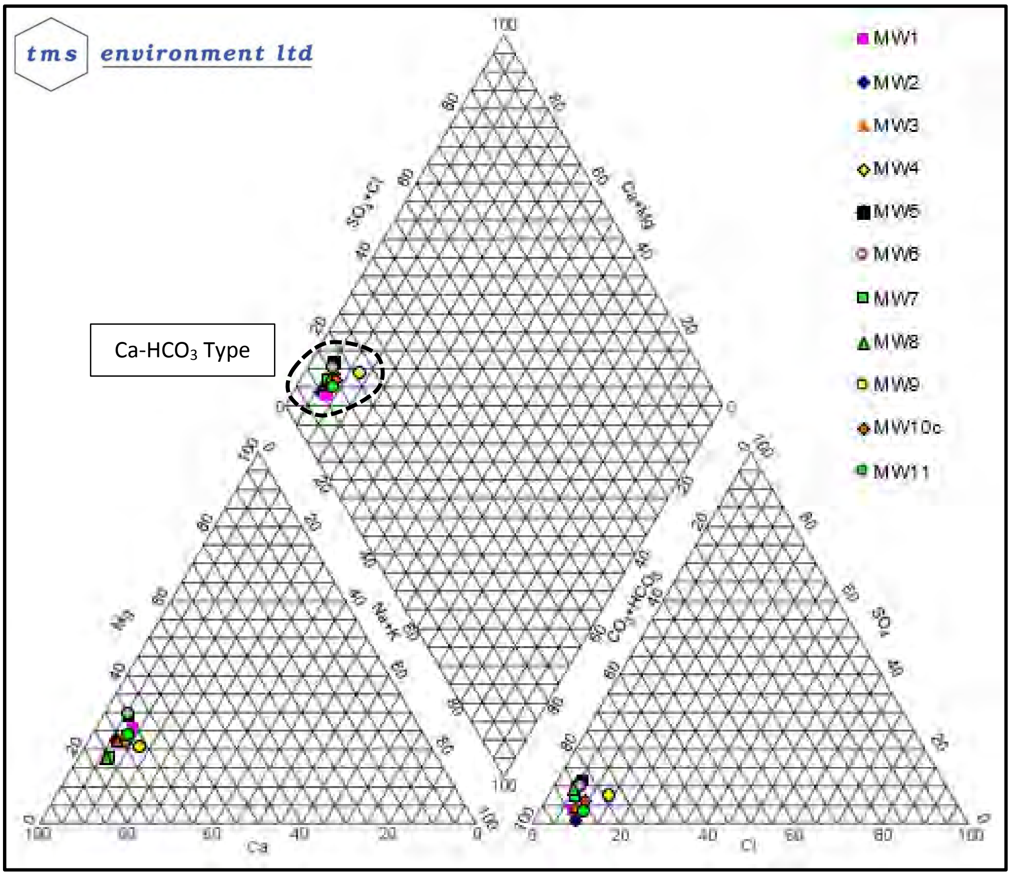


Fig. 7-19 Local Groundwater Flow Map (Groundwater Levels on 16/5/2018)



Piper Plot of Groundwater Samples, 8/2/2018



Piper Plot of Groundwater Samples, 19/4/2018

Fig. 7-21 Stormwater Catchment Map (Bing Maps)

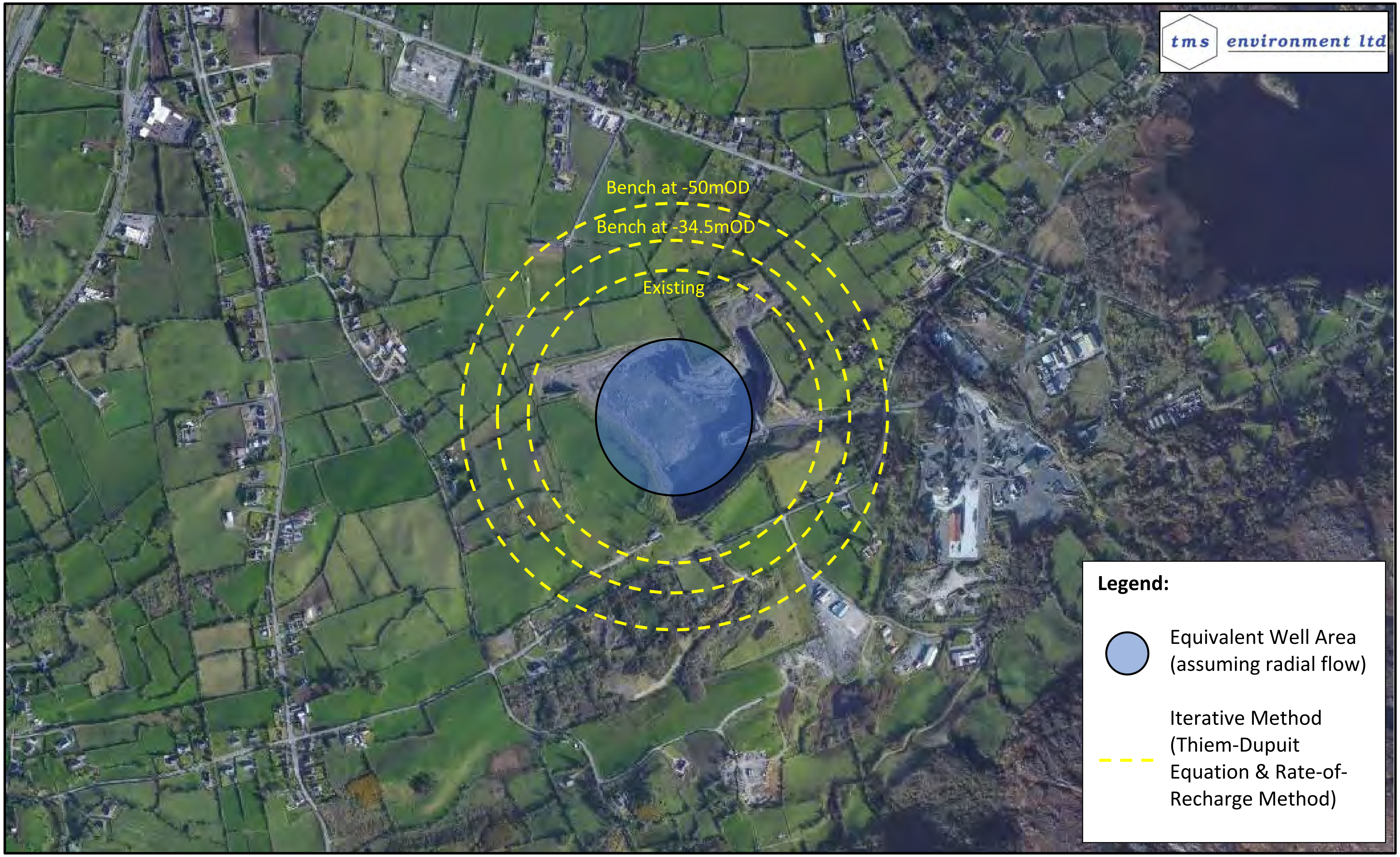


Fig. 7-22 Radius of Influence Map (Bing Maps)

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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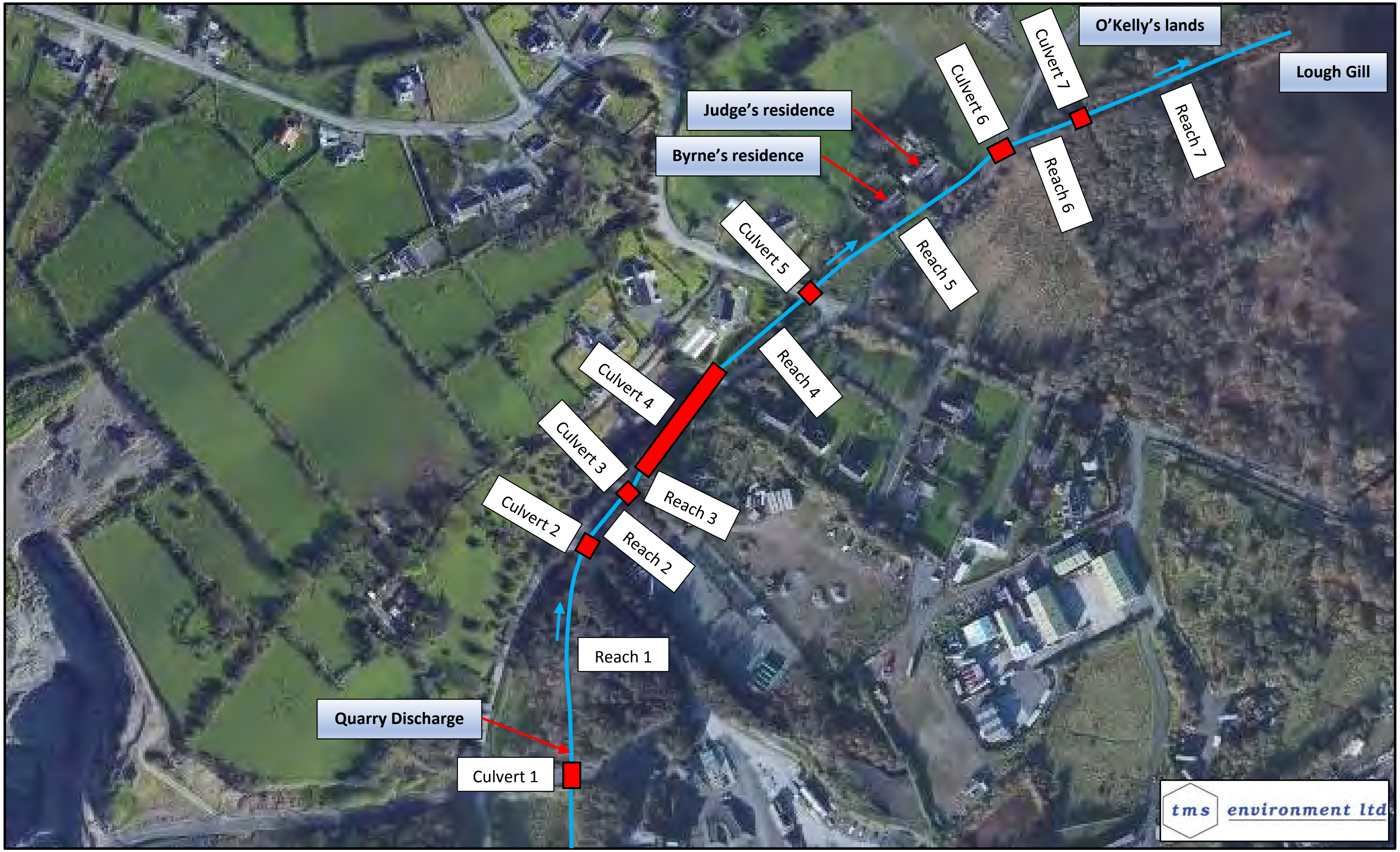


Fig. 7-24 Stream Channel Survey (Bing Maps)

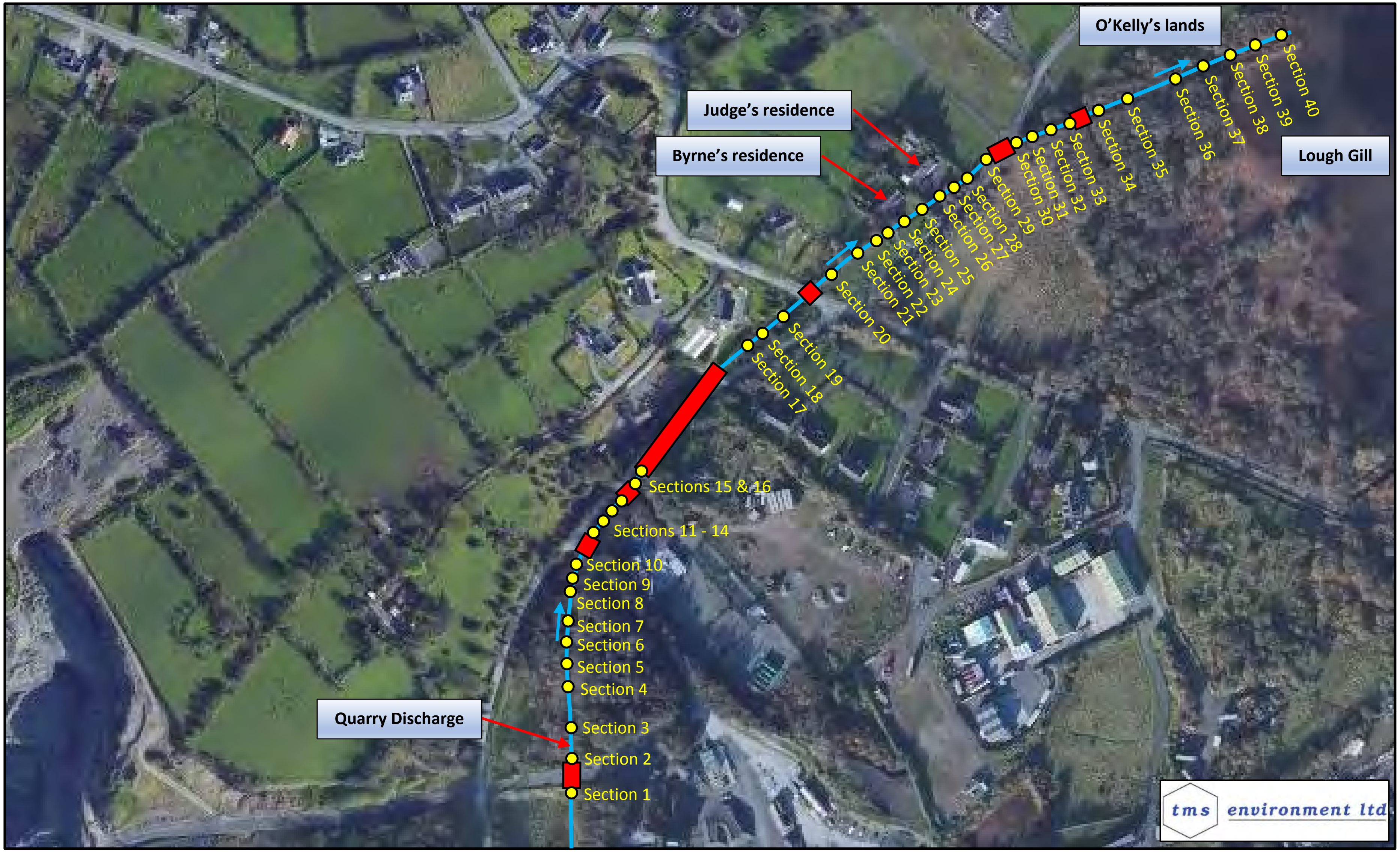
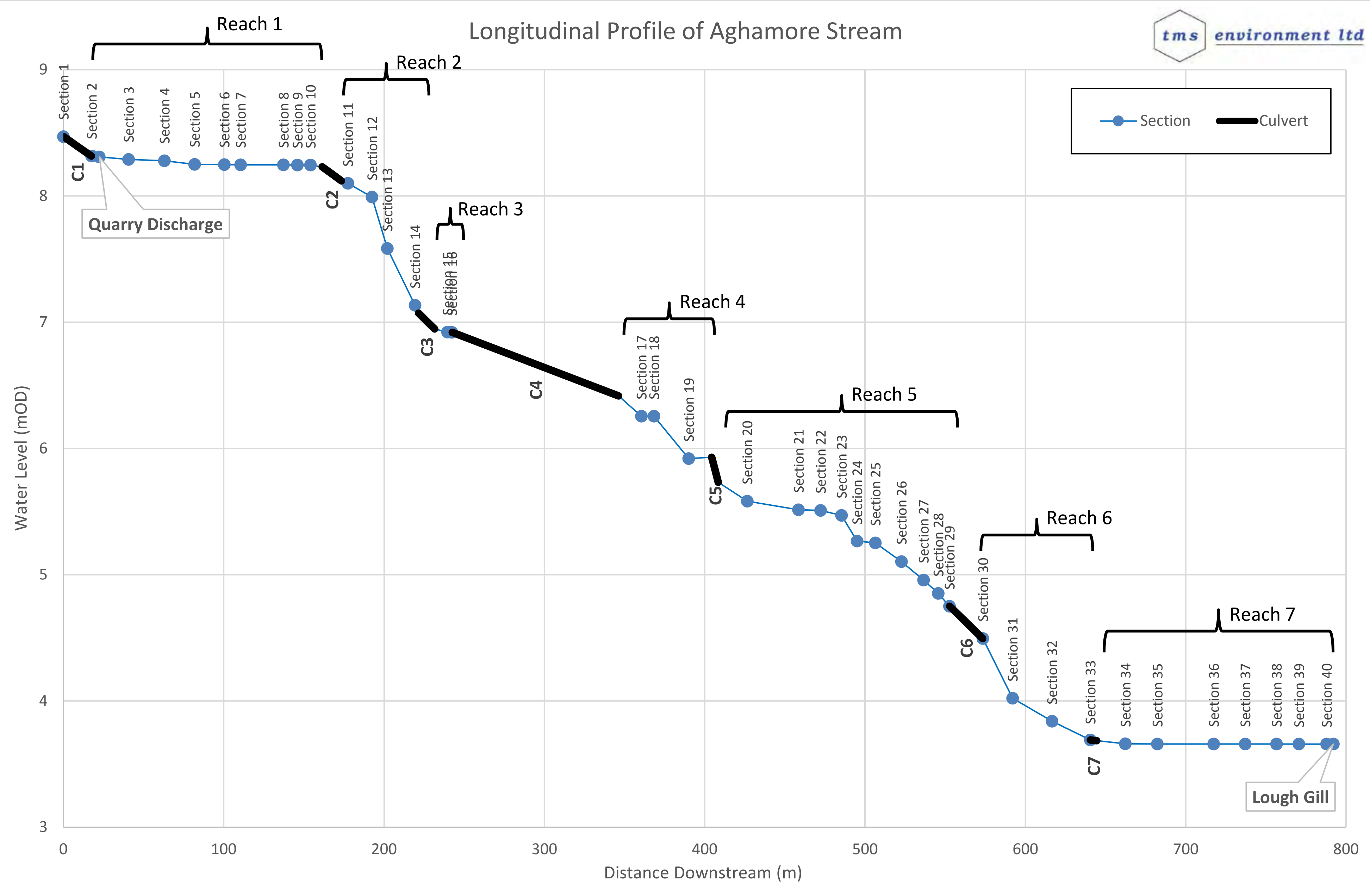


Fig. 7-25 Location of Stream Cross-Sections (Bing Maps)



Longitudinal Profile of Aghamore Stream
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Reach 1
Reach 2
Reach 3
Reach 4
Reach 5
Reach 6
Reach 7
Section
Culvert
Quarry Discharge
Lough Gill
C1
C2
C3
C4
C5
C6
C7
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
Water Level (mOD)
Distance Downstream (m)
3
4
5
6
7
8
9
0
100
200
300
400
500
600
700
800

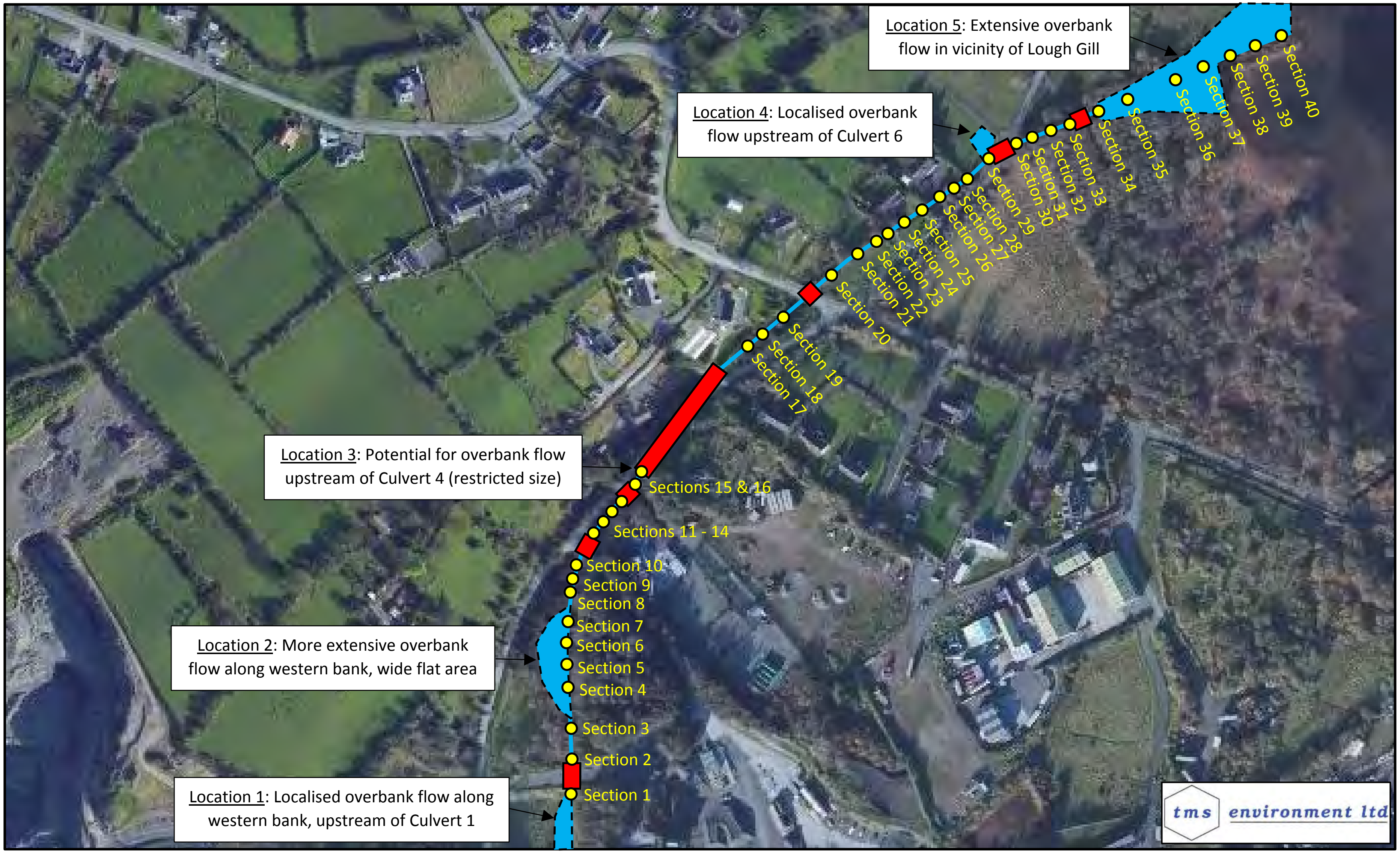

Fig. 7-27 Stream Areas Liable to Flood (Bing Maps)

APPENDICES

Monitoring Well Summary Details

	Date Drilled	Easting	Northing	TOC Elevation	Casing Height	Ground Level	Drilled Depth	Diameter	Open Section	Notes
		ITM	ITM	mOD	magl	mOD	mbgl	mm	mbgl	
MW1	27/06/2017	570276.80	831934.69	27.52	0.84	26.68	80	150	3.0 - 80.0	
MW2	28/06/2017	570386.63	831952.24	28.19	1.01	27.18	39*	150	6.0 - 39.0	*Borehole collapsed at 39m, plumbed depth 26.23mbgl
MW3	28/06/2017	570364.49	831945.75	28.56	1.03	27.53	66*	150	6.0 - 66.0	*Borehole collapsed at 66m, plumbed depth 43.86mbgl
MW4	29/06/2017	570249.17	831768.59	29.28	0.09	29.19	80	150	6.0 - 80.0	
MW5	30/06/2017	569888.26	832094.09	31.15	1.07	30.08	80	150	6.0 - 80.0	
MW6	03/07/2017	569892.70	832048.87	28.01	0.08	27.93	80	150	6.0 - 80.0	
MW7	04/07/2017	569899.80	832011.04	29.41	0.92	28.49	80	150	6.0 - 80.0	
MW8	05/07/2017	570251.68	831761.91	30.25	0.80	29.45	80	150	12.0 - 80.0	
MW9	06/07/2017	570534.46	831885.97	13.51	0.80	12.71	17.3*	150	15.3 - 17.3	*Drilled to 18mbgl
MW10c	21/07/2017	569897.59	832034.33	28.99	1.09	27.90	80*	76	3.0 - 80.0	*Borehole partially blocked at 32-37mbgl
MW11	15/08/2017	570312.05	831936.89	30.85	1.08	29.77	80	76	6.0 - 80.0	
Old Well	Unknown	570334.89	831846.19	12.17	0.47	11.70	7.91*	170	Unknown	*Plumbed depth, drilling details unknown

Notes:
ITM - Irish Transverse Mercator
TOC - Top Of Casing
mOD - meters above Ordinance Datum
magl - meters above ground level
mbgl - meters below ground level
mm - millimeters

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DRILLERS LOG

WELL DRILLING AND HORIZONTAL DRILLING ENGINEERS
Dublin Road, Dromiskin, Dundalk, Co. Louth.
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Borehole for: Lagan
at Aghamore Quarry
Sligo

MW1 (top of access ramp on right, near quarry face)

Date	Depth m	Diam	Conditions
27/6/17	0 - 3	200mm	Rock. Install 3m x 150mm steel lining.
	3 - 30	150mm	Grey rock. Dry
	30 - 42	"	Grey rock. Maybe 10 to 20gph at 36m
	42 - 67	"	Grey rock. 20gph.
	67 - 73	"	Grey rock. Water increase at 70m. 30gph.
	73 - 80	"	Grey rock. 30gph.

Total depth of well 80m
Estimated yield 30gph
Depth to rock Ground Level
Steel casing installed 3m of 150mm steel
PVC casing installed none
Well screen
Other remarks Bentonite pellets. Upstand pipe.

Operator Brendan Dunne

DUNNES
DRILLING

DRILLERS LOG

WELL DRILLING AND HORIZONTAL DRILLING ENGINEERS
Dublin Road, Dromiskin, Dundalk, Co. Louth.
E-Mail: info@dunnesdrilling.com website: www.dunnesdrilling.com
Tel: +353 42 9372188 Fax: +353 42 9372714

Borehole for: Lagan
at Aghamore Quarry
Sligo

MW2 (in field on right at top of ramp, furthest away)

Date	Depth m	Diam	Conditions
28/6/17	0 - 4	200mm	Clay. Rock at 4m
	4 - 6	"	Grey rock. Dry. Install 6m x 150mm steel.
	6 - 30	150mm	Grey rock. Dry
	30 - 36	"	Dirty brown broken rock from 30m. 50gph.
	36 - 39	"	Brown rock. Collapsing from 30m.
			Abandon drilling due to collapse.

Total depth of well 39m
Estimated yield 50gph
Depth to rock 4m
Steel casing installed 6m of 150mm steel
PVC casing installed none
Well screen
Other remarks Bentonite pellets. Upstand pipe.

Operator Brendan Dunne

DUNNES DRILLING

WELL DRILLING AND HORIZONTAL DRILLING ENGINEERS

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DRILLERS LOG

Borehole for: Lagan
at Aghamore Quarry
Sligo

MW3 (in field on right at top of ramp, middle bore)

Date	Depth m	Diam	Conditions
28/6/17	0 - 3.5	200mm	Clay. Rock at 3.5m
	3.5 - 6	"	Grey rock. Dry. Install 6m x 150mm steel.
	6 - 24	150mm	Grey rock. Dry
	24 - 42	"	Grey rock. Water strike at 39m. 160gph at 42m.
	42 - 49	"	Grey rock. Water increasing. 720gph at 49m.
	49 - 55	"	Grey rock. Water increasing. Big inflow at 52m. Not possible to measure flow.
			Estimate 3,000 to 4,000gph.
	55 - 61	"	Grey rock.
	61 - 66	"	Grey rock. Very broken. Getting caught. Abandon drilling.

Total depth of well 66m
Estimated yield 3,000 - 4,000gph
Depth to rock 3.5m
Steel casing installed 6m of 150mm steel
PVC casing installed none
Well screen
Other remarks Bentonite pellets. Upstand pipe.

Operator Brendan Dunne

DUNNES
DRILLING

DRILLERS LOG

WELL DRILLING AND HORIZONTAL DRILLING ENGINEERS
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Borehole for: Lagan
at Aghamore Quarry
Sligo

MW4 (up ramp on left and in middle of pass)

Date	Depth m	Diam	Conditions
29/6/17	0 - 4.5	200mm	Clay and stones. Rock at 4.5m
	4.5 - 6	"	Soft brown rock. Install 6m x 150mm steel
	6 - 12	150mm	Brown rock. Dry
	12 - 18	"	Grey rock.
	18 - 36	"	Grey rock. Damp.
	36 - 61	"	Grey rock. Damp.
	61 - 80		Grey rock. No flow.

Total depth of well 80m
Estimated yield no flow
Depth to rock 4.5m
Steel casing installed 6m of 150mm steel
PVC casing installed none
Well screen
Other remarks Bentonite pellets. Flush cap.

Operator Brendan Dunne

DUNNES DRILLING

DRILLERS LOG

WELL DRILLING AND HORIZONTAL DRILLING ENGINEERS
Dublin Road, Dromiskin, Dundalk, Co. Louth.
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Borehole for: Lagan
at Aghamore Quarry
Sligo

MW5 (Sean Gilmartin field in top corner)

Date	Depth m	Diam	Conditions
30/6/17	0 - 3	200mm	Clay
	3 - 6	"	Grey rock. Dry. Install 6m x 150mm steel.
	6 - 18	150mm	Grey rock. Trickle at 16m.
	18 - 30	"	Grey rock.
	30 - 36	"	Grey rock. 20 - 30gph.
	36 - 42	"	Grey rock. 30gph
	42 - 49	"	Grey rock. 50 - 60gph.
	49 - 55	"	Grey rock. 100gph.
	55 - 61	"	Grey rock. 180gph.
	61 - 67	"	Grey rock. 400gph
	67 - 73	"	Grey rock. 450gph
	73 - 80	"	Grey rock. 450gph

Total depth of well 80m
Estimated yield 450gph
Depth to rock 3m
Steel casing installed 6m of 150mm steel
PVC casing installed none
Well screen
Other remarks Bentonite pellets. Upstand pipe.

Operator Brendan Dunne

DUNNES DRILLING

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Borehole for: Lagan
at Aghamore Quarry
Sligo

MW6 (Sean Gilmartin field - middle bore)

Date	Depth m	Diam	Conditions
3/7/2017	0 - 2.5	200mm	Clay
	2.5 - 6	"	Grey rock. Dry. Install 6m x 150mm steel.
	6 - 36	150mm	Grey rock. Dry.
	36 - 42	"	Grey rock. Trickle at 42m.
	42 - 49	"	Grey rock. 20gph.
	49 - 55	"	Grey rock. 30 - 40gph
	55 - 61	"	Grey rock. Brown patch at 59m. 90gph.
	61 - 67	"	Grey rock. 200gph.
	67 - 73	"	Grey rock. 225gph.
	73 - 80	"	Grey rock. 275gph

Total depth of well 80m
Estimated yield 275gph
Depth to rock 2.5m
Steel casing installed 6m of 150mm steel
PVC casing installed none
Well screen
Other remarks Bentonite pellets. Flush cap.

Operator Brendan Dunne

DUNNES DRILLING

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Borehole for: Lagan
at Aghamore Quarry
Sligo

MW7 (Sean Gilmartin field - near quarry face)

Date	Depth m	Diam	Conditions
3/7/2017	0 - 2.5	200mm	Clay
	2.5 - 6	"	Grey rock. Dry. Install 6m x 150mm steel.
	6 - 18	150mm	Grey rock. Dry.
4/7/2017			Water in hole overnight.
	18 -30	"	Grey rock. Dry.
	30 - 36	"	Grey rock. Trickle.
	36 - 49	"	Grey rock. 30gph.
	49 - 55	"	Grey rock. 30gph.
	55 - 61	"	Grey rock. White bits. 80gph.
	61 - 73	"	Grey rock. 190gph
	73 - 80	"	Grey rock. 190gph.

Total depth of well 80m
Estimated yield 190gph
Depth to rock 2.5m
Steel casing installed 6m of 150mm steel
PVC casing installed none
Well screen
Other remarks Bentonite pellets. Upstand pipe.

Operator Brendan Dunne

DUNNES DRILLING

DRILLERS LOG

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Borehole for: Lagan
at Aghamore Quarry
Sligo

MW8 (up ramp on left - middle bore)

Date	Depth m	Diam	Conditions
4/7/2017	0 - 8	200mm	Clay & stones.
	8 - 12	"	Soft broken rock. Dry. Install 12m of 150mm steel.
	12 30	150mm	Grey rock. Dry.
5/7/2017			Very little water in hole overnight approx 4 - 5 gallons.
	30 - 49	"	Grey rock. Dry.
	49 - 66	"	Grey rock. 10 to 20gph.
	66 - 73	"	Grey rock.Brown patch at 69 - 70m. 150gph.
	73 - 80	"	Grey rock. 400gph.

Total depth of well 80m
Estimated yield 400gph
Depth to rock 8m
Steel casing installed 12m of 150mm steel
PVC casing installed none
Well screen
Other remarks Bentonite pellets. Upstand pipe.

Operator Brendan Dunne

DRILLERS LOG

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Borehole for: Lagan
at Aghamore Quarry
Sligo

MW9 (across road on side of entrance road)

Date	Depth m	Diam	Conditions
5/7/2017	0 - 6	200mm	Fill & earth material.
	6 - 8	"	Brown silt. Wet Install 10.4m x 150mm steel with casing shoe.
	8 - 10.4	150mm	Grey silt. Wet.
6/7/2017	10.4 - 15	"	Broken, crumbling rock. Water. Adding lining - cutting, welding, driving.
	15 - 17	"	Grey rock.
	17 - 18	"	Soft brown patch - water. Estimate 1 - 2m3/hr.
			Install 50mm PVC. 2m screen. 15.3m plain. Screen from 15.3 to 17.3m bgl.
			Gravel to 15m. Bentonite pellets. Bentocem grout to GL.

Total depth of well 18m drilled. (17.3m PVC)
Estimated yield 1 - 2m3/hr
Depth to rock 10.4m
Steel casing installed 14.8m x 150mm (300mm above GL. - steel to 14.5m bgl)
PVC casing installed 50mm PVC. - 15.3m plain.
Well screen 50mm PVC. - 2m screen.
Other remarks Bentonite pellets. Upstand pipe.

Operator Brendan Dunne

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DRILLHOLE LOG

Project	Aghamore Quarry	Location	Co Sligo	DRILLHOLE No
Job No: 17-SO-101	Date: 12-08-17 17-07-17	Ground Level (m OD)	Co-Ordinates ()	**MW10A**
Engineer: TMS Environmental				Sheet 1 of 3, Rev. 1

Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	Discontinuities / Detail	Main	Geology	Instrument/ Backfill
0.00	0 (-) -	NA			(12.00)	0.00 - 12.00 : overburden.	Open hole drilling - no recovery.		

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)
0	28.00	polymer	

GENERAL REMARKS

6 gallons polydrill used.
BH backfilled.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used: Hydreq	Bit Design: NQ	Driller: DC	Logged By: EAT

IDL AGS3 UK DH LAGAN QUARRY SLIGO FILE 1 SEPT 1 2017.GPJ IDL TP TEMPLATE.GDT 08/09/17

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DRILLHOLE LOG

Project	Location	DRILLHOLE No
Aghamore Quarry	Co Sligo	**MW10A**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
17-SO-101	12-08-17 17-07-17		

Engineer	Sheet	Rev.
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RUN DETAILS / STRATA

Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	Discontinuities / Detail	Main	Geology	Instrument/ Backfill
12.00					12.00		Open hole drilling - no recovery. *(continued)*		
13.00	100 (32) 0	NR/NI				12.00 - 28.00 Non-intact as probable weathered rock. No recovery as washout of fines during drilling. No record of cavities.	Weathered LIMESTONE rock. Recovered as subangular and angular fine to coarse gravel sized clasts of light grey cherty bioclastic fine and medium grained limestone with a little light brown silt/clay.		
16.00	22 (6) 0								
19.00	33 (9) 0								
22.00	43 (13) 0				(16.00)				

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

6 gallons polydrill used.
BH backfilled.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used: Hydreq	Bit Design: NQ	Driller: DC	Logged By: EAT

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DRILLHOLE LOG

Project: Aghamore Quarry	Location: Co Sligo	DRILLHOLE No: **MW10A**
Job No: 17-SO-101	Date: 12-08-17 17-07-17	Ground Level (m OD)
Co-Ordinates ()		
Engineer: TMS Environmental	Sheet: 3 of 3	Rev. 1

RUN DETAILS / STRATA

Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	Discontinuities	Detail	Main	Geology	Instrument/ Backfill
25.00	20 (19) 0							Weathered LIMESTONE rock. Recovered as subangular and angular fine to coarse gravel sized clasts of light grey cherty bioclastic fine and medium grained limestone with a little light brown silt/clay. *(continued)*		
28.00	28 (8) 0				28.00					
								BH terminated at 28.00m bgl on REs instruction.		

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

6 gallons polydrill used.
BH backfilled.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used: Hydreq	Bit Design: NQ	Driller: DC	Logged By: EAT

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DRILLHOLE LOG

Project	Aghamore Quarry	Location	Co Sligo	DRILLHOLE No	MW10B
Job No	17-SO-101	Date	17-07-17 17-07-17	Ground Level (m OD)	Co-Ordinates ()
Engineer	TMS Environmental			Sheet	1 of 3
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RUN DETAILS				STRATA						
Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	DESCRIPTION: Discontinuities / Detail	DESCRIPTION: Main	Geology	Instrument/ Backfill
0.00	0					0.00 - 22.00 : overburden.	Open hole drilling - no recovery.		

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)
0	22.00	water	

GENERAL REMARKS

BH backfilled.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used: Hydreq	Bit Design: NQ	Driller: DC	Logged By: EAT

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DRILLHOLE LOG

Project	Location	DRILLHOLE No
Aghamore Quarry	Co Sligo	**MW10B**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
17-SO-101	17-07-17 17-07-17		

Engineer: TMS Environmental

Rev. 1

RUN DETAILS: Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	DESCRIPTION: Discontinuities	Detail	Main	Geology	Instrument/ Backfill
	(-) -	NA			(22.00)			Open hole drilling - no recovery. *(continued)*		
22.00					22.00					

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

BH backfilled.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used: Hydreq	Bit Design: NQ	Driller: DC	Logged By: EAT

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DRILLHOLE LOG

Project: Aghamore Quarry		Location: Co Sligo	DRILLHOLE No **MW10B**
Job No: 17-SO-101	Date: 17-07-17 17-07-17	Ground Level (m OD):	Co-Ordinates ():
Engineer: TMS Environmental			Sheet 3 of 3, Rev. 1

RUN DETAILS: Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	DESCRIPTION: Discontinuities	Detail	Main	Geology	Instrument/ Backfill
								BH terminated at 22.00m bgl on REs instruction.		

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

BH backfilled.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used: Hydreq	Bit Design: NQ	Driller: DC	Logged By: EAT

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DRILLHOLE LOG

Project: Aghamore Quarry	Location: Co Sligo	DRILLHOLE No: **MW10C**
Job No: 17-SO-101	Date: 18-07-17 21-07-17	Ground Level (m OD):
Co-Ordinates ():	Engineer: TMS Environmental	Sheet 1 of 8, Rev. 1

Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	Discontinuities Detail	Main	Geology	Instrument/ Backfill
0.00 – 3.00	0 (-) -	NA			(3.00) 3.00	0.00 - 3.00 : overburden.	Open hole drilling - no recovery.		
3.00 – 4.00	100 (90) 61	9				3.00 - 80.00 Discontinuities, medium spaced, locally closely spaced, dipping 10 to 12°, stepped, rough, with 0.5 to 3mm thick grey silt smear. 4.80 - 4.95 Joint, subvertical dip, stepped, rough, with 0.5mm thick grey silt smear, open.	Strong thinly bedded grey and dark grey locally bioturbated sparry bioclastic fine and coarse grained LIMESTONE with vertical and subvertical milky white sparry and calcitic veins and veinlets along extent of core. 4.00m: carried out packer test.		
4.00 – 7.00	100 (95) 89	5, 5, 6							
7.00 – 10.00	100 (98) 91	6, 4, 6							
10.00 –		5							

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)
0	80.00	water	

GENERAL REMARKS

HQ casing and shoe left in BH to 3.00m bgl.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used: Hydreq	Bit Design: NQ	Driller: DC	Logged By: EAT

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DRILLHOLE LOG

Project: Aghamore Quarry	Location: Co Sligo	DRILLHOLE No: **MW10C**
Job No: 17-SO-101	Date: 18-07-17 21-07-17	Ground Level (m OD):
Co-Ordinates ()		
Engineer: TMS Environmental	Sheet: 2 of 8	Rev. 1

Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	Discontinuities	Detail	Main	Geology	Instrument/ Backfill
	100 (95) 91	4						Strong thinly bedded grey and dark grey locally bioturbated sparry bioclastic fine and coarse grained LIMESTONE with vertical and subvertical milky white sparry and calcitic veins and veinlets along extent of core. *(continued)*		
13.00		4								
	100 (98) 96	3						13.00m: carried out packer test.		
		4								
16.00		3								
	100 (98) 94	5								
		4								
19.00		5								
	100 (98) 97	1								
		3								
22.00		2								

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

HQ casing and shoe left in BH to 3.00m bgl.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used: Hydreq	Bit Design: NQ	Driller: DC	Logged By: EAT

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DRILLHOLE LOG

Project	Aghamore Quarry	Location	Co Sligo	DRILLHOLE No	MW10C
Job No	17-SO-101	Date	18-07-17 21-07-17	Ground Level (m OD)	Co-Ordinates ()
Engineer	TMS Environmental			Sheet	3 of 8
				Rev.	1

RUN DETAILS / STRATA

Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	Discontinuities Detail	Main	Geology	Instrument/ Backfill
25.00	100 (95) 92	3, 4, 2				22.35 - 22.50 Joint, vertical dip, undulating, tight. 22.85 - 23.00 Joint, vertical dip, stepped, tight, open as drilling induced? 23.60 - 23.75 Joint, subvertical dip, stepped, rough, with 0.5mm thick milky white calcite crystal veneer, open as drilling induced? 24.40 - 24.47 Joint, subvertical dip, stepped, rough, with orange brown and dark orange brown iron stain and powder, open.	Strong thinly bedded grey and dark grey locally bioturbated sparry bioclastic fine and coarse grained LIMESTONE with vertical and subvertical milky white sparry and calcitic veins and veinlets along extent of core. *(continued)* 22.00m: carried out packer test.		
28.00	100 (97) 87	8, 4, 5				27.00 - 27.10 Joint, dipping 60°, stepped, rough, with 0.5mm thick brown silt smear and 0.5mm thick milky white calcite crystal veneer, open.	25.90m to 25.95m: vuggy as 20mm deep 1 to 3mm milky white calcite crystal assemblage. 25.91m to 67.00m: vuggy as 10 to 20mm deep vugs with 1 to 3mm milky white calcite crystal assemblages. 26.45m to 26.60m: vuggy as 25 to 1mm deep 1 to 3mm milky white calcite crystal assemblage.		
31.00	100 (98) 94	3, 4, 3					28.40m to 28.42m: vuggy as 1 to 4mm milky white calcite crystal assemblage. 29.00m to 29.06m: vuggy as 1 to 4mm milky white calcite crystal assemblage. 29.80m to 29.82m: vuggy as 1 to 4mm milky white calcite crystal assemblage.		
	100 (98) 92	3, 2				30.80 - 30.90 Joint, dipping 60°, stepped, rough, with 0.5 to 1mm thick grey silt smear, open. 31.00 - 31.15 Joint, subvertical dip, stepped, rough, with 0.5mm thick grey silt smear, open to 31.10m, then tight.	31.00m: carried out packer test.		

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

HQ casing and shoe left in BH to 3.00m bgl.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used Hydreq	Bit Design NQ	Driller DC	Logged By EAT

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DRILLHOLE LOG

Project: Aghamore Quarry	Location: Co Sligo	DRILLHOLE No: **MW10C**
Job No: 17-SO-101	Date: 18-07-17 21-07-17	Ground Level (m OD)	Co-Ordinates ()
Engineer: TMS Environmental		Sheet 4 of 8 Rev. 1

Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	Discontinuities Detail	Main	Geology	Instrument/ Backfill
		4					Strong thinly bedded grey and dark grey locally bioturbated sparry bioclastic fine and coarse grained LIMESTONE with vertical and subvertical milky white sparry and calcitic veins and veinlets along extent of core. *(continued)*		
34.00		3				34.10 - 34.30 Joint, vertical dip, stepped, rough, with 0.5mm thick grey silt smear, open. 34.45 - 34.55 Joint, dipping 60°, stepped, rough, clean, open as drilling induced?			
	100 (93) 75	5							
		4				36.10 - 36.50 2 No parallel joints, vertical dip, undulating, tight.	35.85m to 35.90m: vuggy as 20mm deep 1 to 3mm milky white calcite crystal assemblage.		
37.00		6				37.35 - 37.55 Joint, subvertical dip, stepped, rough, with 0.5 to 1mm thick brown silt smear, open.			
	100 (97) 79	3							
		6					39.48m to 39.51m: vuggy as 20mm deep 1 to 3mm milky white calcite crystal assemblage. 40.00m: carried out packer test.		
40.00		5				40.50 - 40.80 Joint, subvertical dip, stepped, rough, with 0.5mm thick grey silt smear and 0.5mm thick milky white calcite crystal veneer, open.			
	100 (98) 88	3			(77.00)				
		6							
43.00		5				42.95 - 43.35 Joint, vertical dip, stepped, tight. 43.65 - 43.85 Joint, subvertical dip,			

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

HQ casing and shoe left in BH to 3.00m bgl.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used: Hydreq	Bit Design: NQ	Driller: DC	Logged By: EAT

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DRILLHOLE LOG

Project	Location	DRILLHOLE No
Aghamore Quarry	Co Sligo	MW10C

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
17-SO-101	18-07-17 21-07-17		

Engineer	Sheet	Rev.
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Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	Discontinuities Detail	Main	Geology	Instrument/ Backfill
	100 (98) 93	5				stepped, rough, with 0.5 to 1mm thick grey silt smear, open.	Strong thinly bedded grey and dark grey locally bioturbated sparry bioclastic fine and coarse grained LIMESTONE with vertical and subvertical milky white sparry and calcitic veins and veinlets along extent of core. *(continued)*		
46.00		4							
		4				46.05 - 46.30 Joint, subvertical dip, stepped, tight, open as drilling induced?			
	100 (98) 96	4				47.60 - 47.70 Joint, dipping 60°, stepped, smooth, with 0.5mm thick grey silt smear, open.			
49.00		4							
		4					49.00m: carried out packer test.		
	100 (98) 83	3							
52.00		7				51.40 - 51.55 Joint, subvertical dip, stepped, rough, with minor orange and orange brown iron stain and powder, open. 51.85 - 52.15 Joint, subvertical dip, stepped, rough, with 0.5 to 1mm thick grey silt smear, open.	51.70m to 51.76m: orange brown with no obvious reduction in strength. 51.90m to 51.93m: orange brown calcite crystal assemblage.		
		4							
	100 (97) 84	3							
55.00		5							

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

HQ casing and shoe left in BH to 3.00m bgl.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used: Hydreq	Bit Design: NQ	Driller: DC	Logged By: EAT

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DRILLHOLE LOG

Project	Location	DRILLHOLE No
Aghamore Quarry	Co Sligo	MW10C

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
17-SO-101	18-07-17 21-07-17		

Engineer	Sheet
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Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	Discontinuities / Detail	Main	Geology	Instrument/ Backfill
	100 (94) 86	2 3 6					Strong thinly bedded grey and dark grey locally bioturbated sparry bioclastic fine and coarse grained LIMESTONE with vertical and subvertical milky white sparry and calcitic veins and veinlets along extent of core. *(continued)*		
58.00	100 (91) 80	3 4 5					58.00m: carried out packer test.		
61.00	100 (85) 58	5 6 18				60.85 - 61.15 Joint, subvertical dip, stepped, rough, with 0.5 to 1mm thick orange brown clay smear, open. 63.30 - 64.25 Joint, vertical dip, stepped, rough, with 0.5 to 4mm thick grey silt smear, open to moderately wide.			
64.00	100 (85) 49	12 10				65.20 - 65.40 Joint, subvertical dip, stepped, rough, with 0.5 to 1mm thick grey silt smear, open.			

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

HQ casing and shoe left in BH to 3.00m bgl.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used Hydreq	Bit Design NQ	Driller DC	Logged By EAT

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DRILLHOLE LOG

Project	Aghamore Quarry	Location	Co Sligo	DRILLHOLE No	MW10C
Job No 17-SO-101	Date 18-07-17 21-07-17	Ground Level (m OD)	Co-Ordinates ()		
Engineer	TMS Environmental			Sheet 7 of 8	Rev. 1

RUN DETAILS / STRATA

Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	Discontinuities Detail	Main	Geology	Instrument/ Backfill
67.00		10				65.85 - 65.95 Joint, dipping 60°, stepped, rough, with 0.5 to 1mm thick grey silt smear, open. 66.25 - 66.35 Joint, dipping 60°, stepped, tight, open as drilling induced. 66.80 - 67.05 Joint, subvertical dip, stepped, smooth, with 0.5 to 1mm thick grey silt smear, open.	Strong thinly bedded grey and dark grey locally bioturbated sparry bioclastic fine and coarse grained LIMESTONE with vertical and subvertical milky white sparry and calcitic veins and veinlets along extent of core. *(continued)* 67.00m: carried out packer test.		
70.00	100 (90) 57	5, 8, 11				69.00 - 69.26 Joint, subvertical dip, stepped, rough, with 0.5mm thick dark grey silt smear, open. 69.30 - 70.20 Joint, subvertical dip, stepped, rough, with 0.5 to 2mm thick grey silt smear and 0.5 to to 1mm thick milky white calcite crystal smear, open to moderately wide.	68.80m to 68.85m: black coal.		
73.00	100 (87) 35	5, 9, 26				70.80 - 71.30 Joint, subvertical dip, stepped, rough, with 0.5mm thick orange brown clay smear, open. 71.85 - 73.05 2 No parallel joints, subvertical dip, stepped, rough, with 0.5 to 2mm thick grey silt smear, open.			
76.00	100 (97) 79	3, 9, 7				75.70 - 76.10 Joint, vertical dip, stepped, rough, with 0.5 to 1mm thick grey silt smear, open.	76.00m: carried out packer test.		
		6							

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

HQ casing and shoe left in BH to 3.00m bgl.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used Hydreq	Bit Design NQ	Driller DC	Logged By EAT

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DRILLHOLE LOG

Project	Aghamore Quarry	Location	Co Sligo	DRILLHOLE No
Job No 17-SO-101	Date 18-07-17 21-07-17	Ground Level (m OD)	Co-Ordinates ()	**MW10C**
Engineer	TMS Environmental			Sheet 8 of 8 Rev. 1

Depth	Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	Discontinuities Detail	Main	Geology	Instrument/ Backfill
		100 (91) 82	3					Strong thinly bedded grey and dark grey locally bioturbated sparry bioclastic fine and coarse grained LIMESTONE with vertical and subvertical milky white sparry and calcitic veins and veinlets along extent of core. *(continued)*		
79.00			6							
80.00		100 (95) 61	7			80.00	79.45 - 79.65 Joint, vertical dip, stepped, rough, with 0.5 to 2mm thick dark grey silt smear, open.			
								BH terminated at 80.00m bgl on REs instruction.		

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

HQ casing and shoe left in BH to 3.00m bgl.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used Hydreq	Bit Design NQ	Driller DC	Logged By EAT

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DRILLHOLE LOG

Project: Aghamore Quarry		Location: Co Sligo	DRILLHOLE No **MW11**
Job No: 17-SO-101	Date: 08-08-17 15-08-17	Ground Level (m OD)	Co-Ordinates ()
Engineer: TMS Environmental			Sheet 1 of 8 Rev. 1

Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	Discontinuities / Detail	Main	Geology	Instrument/ Backfill
0.00 - 6.00	0 (-) -	NA			(6.00) 6.00	0.00 - 6.00 : overburden.	Open hole drilling - no recovery.		
6.00 - 7.00	100 (98) 87	6				6.00 - 80.00 Discontinuities, medium spaced, locally closely spaced, dipping 12 to 14°, stepped, rough, with 0.5 to 2mm thick grey silt smear.	Strong thinly bedded grey and dark grey locally bioturbated sparry bioclastic fine and coarse grained LIMESTONE with vertical and subvertical milky white sparry and calcitic veins and veinlets along extent of core. 7.00m: carried out packer test.		
7.00 - 10.00	100 (96) 67	5 8 8							
10.00 -		6				10.10 - 10.45 Joint, vertical dip, stepped, rough, with 0.5mm thick grey silt smear and minor orange brown iron stain, open.			

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)
0	80.00	water	

GENERAL REMARKS

HQ casing and shoe left in BH to 6.00m bgl.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used: Hydreq	Bit Design: NQ	Driller: DC	Logged By: EAT

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DRILLHOLE LOG

Project	Location	DRILLHOLE No
Aghamore Quarry	Co Sligo	**MW11**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
17-SO-101	08-08-17 15-08-17		

Engineer	Sheet	Rev.
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Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	Discontinuities Detail	Main	Geology	Instrument/ Backfill
	100 (97) 68	10					Strong thinly bedded grey and dark grey locally bioturbated sparry bioclastic fine and coarse grained LIMESTONE with vertical and subvertical milky white sparry and calcitic veins and veinlets along extent of core. *(continued)*		
13.00		8				11.90 - 12.10 Joint, subvertical dip, stepped, rough, with 0.5mm thick grey silt smear, open.			
	100 (97) 74	7							
		6				14.70 - 14.90 Joint, vertical to subvertical dip, stepped, rough, with 0.5 to 1mm thick milky white calcite veneer and minor orange brown iron stain, open.	14.67m to 14.70m: grey silt.		
16.00		9							
	100 (88) 43	8					16.00m: carried out packer test.		
		8				17.75 - 18.15 Joint, subvertical dip, stepped, rough, with .05 to 1mm thick grey silt smear, open.			
19.00		15				18.50 - 19.00 Joint, subvertical dip, stepped, rough, with 0.5 to 2mm thick grey silt smear, open.			
	100 (92) 50	5							
		10				20.45 - 21.10 Joint, subvertical dip, stepped, rough, with 0.5 to 1mm thick grey silt smear, open.			
22.00		10				21.70 - 22.10 Joint, subvertical dip,			

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

HQ casing and shoe left in BH to 6.00m bgl.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used: Hydreq	Bit Design: NQ	Driller: DC	Logged By: EAT

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DRILLHOLE LOG

Project	Location	DRILLHOLE No
Aghamore Quarry	Co Sligo	**MW11**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
17-SO-101	08-08-17 15-08-17		

Engineer	Sheet	Rev.
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RUN DETAILS / STRATA

Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	Discontinuities Detail	Main	Geology	Instrument/ Backfill
	100 (94) 66	5				stepped, rough, with 0.5 to 1mm thick grey silt smear, open. 22.70 - 23.30 Joint, subvertical dip, stepped, rough, with 0.5 to 1mm thick grey silt smear, open.	Strong thinly bedded grey and dark grey locally bioturbated sparry bioclastic fine and coarse grained LIMESTONE with vertical and subvertical milky white sparry and calcitic veins and veinlets along extent of core. *(continued)*		
		6							
25.00		9				24.60 - 25.30 2 No parallel joints, subvertical dip, stepped, rough, with 0.5mm thick grey silt smear and minor dark orange brown iron stain and powder, open.	24.30m to 24.35m: vuggy as 10mm deep 1 to 3mm milky white calcite crystal assemblage. 25.00m: carried out packer test.		
	100 (96) 84	8							
		3							
28.00		4							
	100 (97) 94	6							
		3							
31.00		3							
	100 (98) 97	3							
		3							

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

HQ casing and shoe left in BH to 6.00m bgl.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used: Hydreq	Bit Design: NQ	Driller: DC	Logged By: EAT

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DRILLHOLE LOG

Project: Aghamore Quarry	Location: Co Sligo	DRILLHOLE No: **MW11**
Job No: 17-SO-101	Date: 08-08-17 15-08-17	Ground Level (m OD):
Co-Ordinates ():	Engineer: TMS Environmental	Sheet 4 of 8, Rev. 1

RUN DETAILS / STRATA

Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	Discontinuities Detail	Main	Geology	Instrument/ Backfill
		3					Strong thinly bedded grey and dark grey locally bioturbated sparry bioclastic fine and coarse grained LIMESTONE with vertical and subvertical milky white sparry and calcitic veins and veinlets along extent of core. *(continued)*		
34.00							34.00m: carried out packer test.		
	100 (98) 82	4							
		4							
		5							
37.00									
	100 (96) 55	7				37.65 - 38.15 Joint, subvertical dip, stepped, rough, with 0.5mm thick grey silt smear and 0.5mm thick milky white calcite crystal veneer, open.			
		6							
		8				39.50 - 39.85 Joint, subvertical dip, stepped, rough, with 0.5 to 1mm thick greenish grey silt smear, open.			
40.00									
	100 (94) 69	6				40.60 - 40.70 Joint, dipping 60°, stepped, smooth, with 0.5mm thick grey silt smear, open.			
		7							
		8							
43.00					(74.00)		43.00m: carried out packer test.		
		4							

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

HQ casing and shoe left in BH to 6.00m bgl.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used: Hydreq	Bit Design: NQ	Driller: DC	Logged By: EAT

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DRILLHOLE LOG

Project: Aghamore Quarry		Location: Co Sligo		DRILLHOLE No: **MW11**
Job No: 17-SO-101	Date: 08-08-17 15-08-17	Ground Level (m OD)	Co-Ordinates ()	
Engineer: TMS Environmental				Sheet 5 of 8, Rev. 1

Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	Discontinuities Detail	Main	Geology	Instrument/ Backfill
	100 (97) 86	4					Strong thinly bedded grey and dark grey locally bioturbated sparry bioclastic fine and coarse grained LIMESTONE with vertical and subvertical milky white sparry and calcitic veins and veinlets along extent of core. *(continued)*		
46.00		7				45.10 - 45.40 Joint, subvertical dip, stepped, rough, with 0.5 to 1mm thick grey silt smear, open.			
	100 (98) 85	4							
		5							
49.00		6				48.00 - 48.25 Joint, subvertical dip, stepped, rough, with 0.5mm thick grey silt smear, open.			
	100 (97) 86	6							
		6							
52.00		6							
	100 (96) 77	6					52.00m: carried out packer test.		
		9							
55.00		6							

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

HQ casing and shoe left in BH to 6.00m bgl.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used: Hydreq	Bit Design: NQ	Driller: DC	Logged By: EAT

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DRILLHOLE LOG

Project: Aghamore Quarry	Location: Co Sligo	DRILLHOLE No: **MW11**
Job No: 17-SO-101	Date: 08-08-17 15-08-17	Ground Level (m OD):
Co-Ordinates ():		
Engineer: TMS Environmental	Sheet: 6 of 8	Rev. 1

RUN DETAILS / STRATA

Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	Discontinuities	Detail	Main	Geology	Instrument/ Backfill
	100 (98) 82	6						Strong thinly bedded grey and dark grey locally bioturbated sparry bioclastic fine and coarse grained LIMESTONE with vertical and subvertical milky white sparry and calcitic veins and veinlets along extent of core. *(continued)*		
		8								
58.00		4								
	100 (97) 86	4								
		8								
61.00		6								
	100 (98) 95	9						61.00m: carried out packer test.		
		4								
64.00		5								
	100 (98) 82	6								
		7				65.30 - 65.40 Joint, dipping 60°, stepped, smooth, with 0.5 to 1mm thick grey silt smear, open.		65.30m to 65.40m: dark grey fine grained chert nodule.		

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

HQ casing and shoe left in BH to 6.00m bgl.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used: Hydreq	Bit Design: NQ	Driller: DC	Logged By: EAT

DRILLHOLE LOG

Project	Location	DRILLHOLE No
Aghamore Quarry	Co Sligo	MW11

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
17-SO-101	08-08-17 15-08-17		

Engineer	Sheet	Rev.
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Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	Discontinuities / Detail	Main	Geology	Instrument/ Backfill
		5					Strong thinly bedded grey and dark grey locally bioturbated sparry bioclastic fine and coarse grained LIMESTONE with vertical and subvertical milky white sparry and calcitic veins and veinlets along extent of core. *(continued)*		
67.00	100 (98) 95	5							
		5							
		3							
70.00	100 (98) 96	6				70.20 - 70.35 Joint, subvertical dip, stepped, rough, with 0.5 to 1mm thick grey silt smear, open. 70.90 - 71.00 Joint, dipping 60°, stepped, smooth, with 0.5 to 1mm thick grey silt smear, open.	70.00m: carried out packer test.		
		5							
		5							
73.00	100 (98) 96	4							
		5							
		5							
76.00		4							

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

HQ casing and shoe left in BH to 6.00m bgl.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used: Hydreq	Bit Design: NQ	Driller: DC	Logged By: EAT

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DRILLHOLE LOG

Project	Location	DRILLHOLE No
Aghamore Quarry	Co Sligo	**MW11**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
17-SO-101	08-08-17 15-08-17		

Engineer	Sheet	Rev.
TMS Environmental	8 of 8	1

Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thickness)	Discontinuities / Detail	Main	Geology	Instrument/ Backfill
79.00	100 (98) 96	5 3					Strong thinly bedded grey and dark grey locally bioturbated sparry bioclastic fine and coarse grained LIMESTONE with vertical and subvertical milky white sparry and calcitic veins and veinlets along extent of core. *(continued)*		
80.00	100 (97) 94	5			80.00				
							BH terminated at 80.00m bgl on REs instruction.		

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

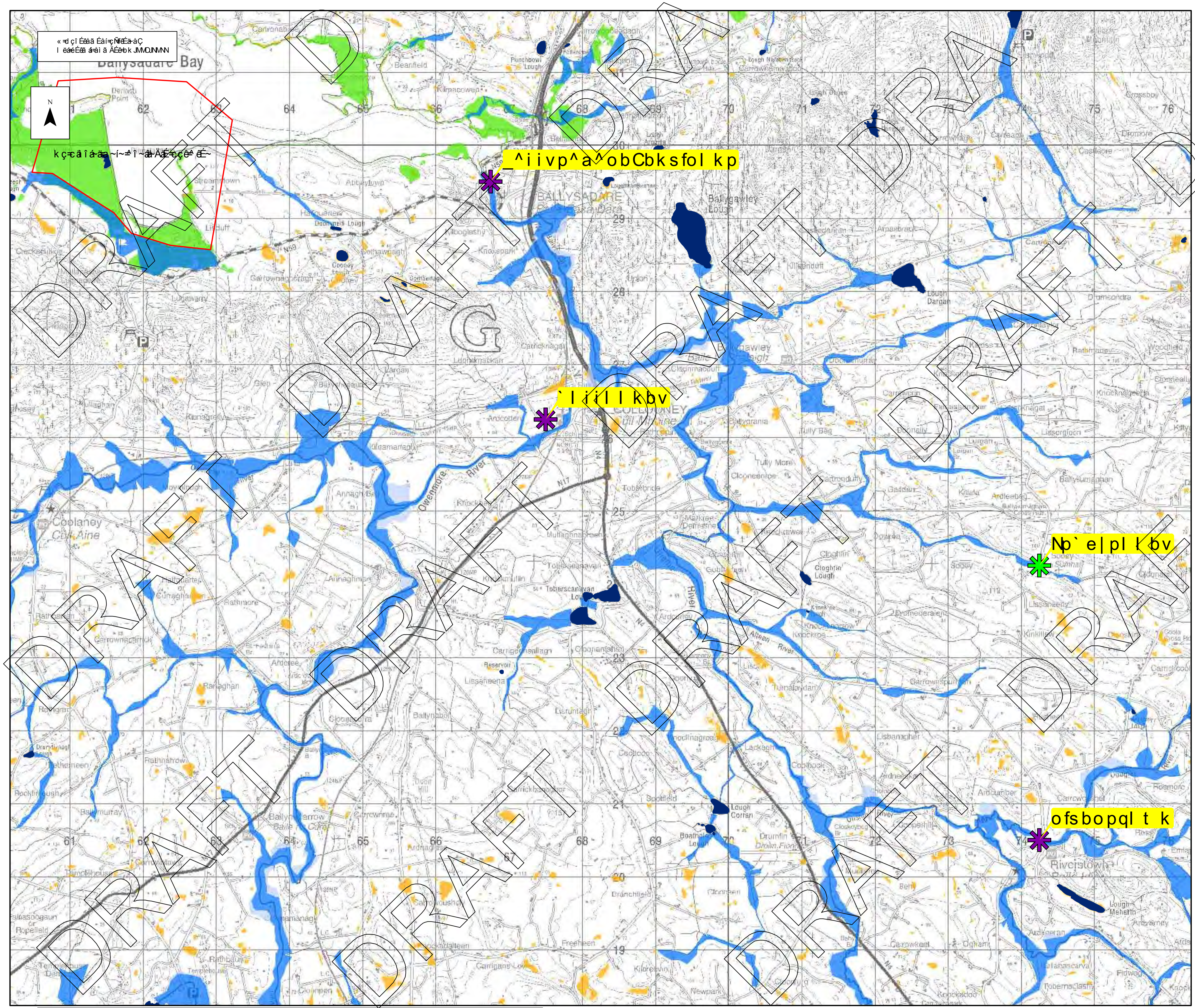
From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

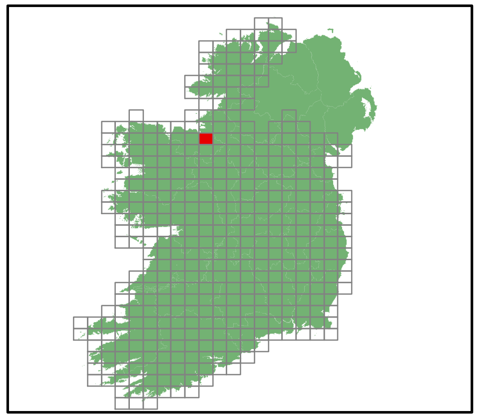
HQ casing and shoe left in BH to 6.00m bgl.

All dimensions in metres Scale 1:68.75	Client: Lagan Group	Method/ Plant Used: Hydreq	Bit Design: NQ	Driller: DC	Logged By: EAT

IDL AGS3 UK DH LAGAN QUARRY SLIGO FILE 2 SEPT 1 2017.GPJ IDL TP TEMPLATE.GDT 08/09/17



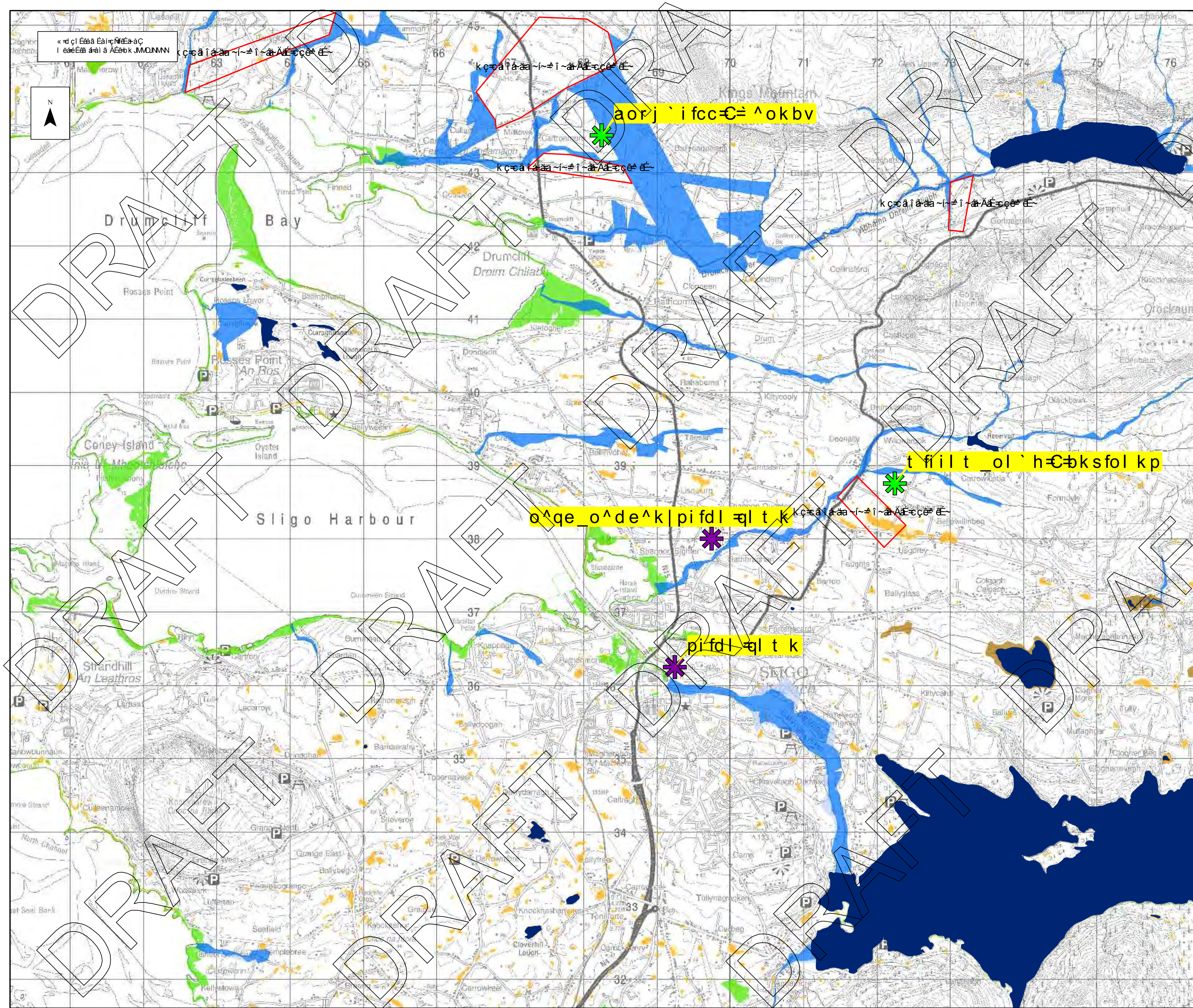
Location Plan :



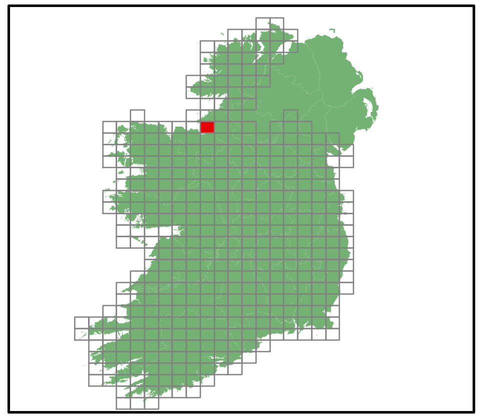
Legend:

Flood Extents

PFRA Outcomes



Location Plan :



Legend:

Flood Extents

PFRA Outcomes

Discharged Water Samples (all available)

Cemex/Golders Samples:

	Units	Discharge	Discharge	Discharge	Discharge	Discharge	Discharge	Discharge	Discharge	Discharge	Discharge	Discharge	Discharge	Discharge			Emission Limit Value
		02/07/2007	26/08/2008	30/07/2009	31/08/2009	30/10/2009	26/02/2010	30/04/2010	31/05/2010	30/06/2010	30/07/2010	27/08/2010	02/09/2010	19/04/2011			
Temperature	^{o}C	10.9	9.9	-	-	-	-	-	-	-	-	-	-	11.1			20
pH	-	7.2	7.7	-	-	-	-	-	-	-	-	-	8.08	8.24			6 - 9
Biological Oxygen Demand	mg/l O_2	< 2	2	4	8	1	< 1	4	4	4	2	4	2	< 1			2
Total Ammonia	mg/l N	0.049	0.008	0.008	0.008	< 0.008	< 0.008	< 0.008	0.09	0.025	0.008	< 0.008	0.33	0.02			0.1
Total Suspended Solids	mg/l	< 2	5	60	1	1.5	1.3	< 1	2.8	2	5	< 1	15	< 10			25
Molybdate Reactive Phosphorus (MRP)	mg/l P	< 0.002	0.02	< 0.01	0.07	0.1	0.03	0.12	0.08	0.07	< 0.01	0.14	< 0.019	< 0.005			0.05
Total Phosphorus	mg/l P	0.05	0.05	-	-	-	-	-	-	-	-	-	-	-			2
Sulphates	mg/l	37	24	-	-	-	-	-	-	-	-	-	51.3	47.6			200
Hydrocarbons (EPH)	mg/l	< 0.02	< 0.001	-	-	-	-	-	-	-	-	-	< 0.01	< 10			1

TMS Samples:

	Units	Discharge (W)	Discharge (E)	Discharge (W)	Discharge (E)	Discharge (W)	Discharge (E)	Discharge (W)	Discharge (E)	Discharge (W)	Discharge (E)	Discharge (W)	Discharge (E)	Discharge (W)	Discharge (W)	Discharge (W)	Emission Limit Value
		22/02/2016	22/02/2016	31/03/2016	31/03/2016	19/04/2016	19/04/2016	06/05/2016	06/05/2016	15/06/2016	15/06/2016	30/01/2018	30/01/2018	27/02/2018	27/03/2018	23/04/2018	
Temperature	^{o}C	-	-	-	-	-	-	-	-	-	-	7.1	7.3	3.3	8.4	11.9	20
pH	-	8	8	8.1	8.1	8.14	8.18	8.12	8.19	8.23	8.24	7.96	7.9	8.39	8.18	8.03	6 - 9
Biological Oxygen Demand	mg/l O_2	< 2	< 2	< 2	< 2	2.24	< 2	3.55	3.43	21.9	11.9	< 1	< 1	< 2	< 1	< 1	2
Total Ammonia	mg/l N	0.04	0.04	0.03	0.03	0.02	0.02	< 0.41	< 0.41	< 0.41	< 0.41	< 0.02	< 0.02	< 0.02	< 0.02	0.02	0.1
Total Suspended Solids	mg/l	< 3	< 3	10.3	< 3	< 3	< 3	3.1	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3	25
Orthophosphate	mg/l P	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.02	< 0.02	< 0.02	< 0.02	0.02	0.05
Total Phosphorus	mg/l P	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	2
Sulphates	mg/l	23.5	25.6	25.6	25.1	29	28	29.5	28.7	31.6	29.9	24	24.6	3	3.8	2.5	200
Hydrocarbons (TPH)	mg/l	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	1

Notes:

1. Trade Effluent Discharge Licence DL(W)139 (issued 9/12/2011)

2. All TMS Environment samples are grab samples/all previous samples assumed to be grab samples

3. Two discharge pipes at discharge point: W - West bank, E - East bank

4. Condition 2.1.3 of the licence: for discrete sampling, no grab sample shall exceed 1.2 times the Emission Limit Value (other than pH and temperature)

5. Condition 3.4 of licence: discharge will not cause receiving water to exceed limits in the Surface Water Regulations

Concentration shaded where ELV exceeded

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Surface Water Samples

	Parameter	Units	Upstream				Discharge (W) [4]				Discharge (E) [4]	Downstream				Bridge before Lough Gill				Lough Gill (Dooney Rock)				Surface Water Environmental Quality Standards [5]	Salmonid Water Quality Standard [6]	Drinking Water Parametric Value [7]
			30/01/2018	27/02/2018	27/03/2018	23/04/2018	30/01/2018	27/02/2018	27/03/2018	23/04/2018	30/01/2018	30/01/2018	27/02/2018	27/03/2018	23/04/2018	30/01/2018	27/02/2018	27/03/2018	23/04/2018	30/01/2018	27/02/2018	27/03/2018	23/04/2018			
Field	Temperature	°C	6.3	3.9	8.7	11.6	7.1	3.3	8.4	11.9	7.3	6.8	3.5	8.8	11.8	6.8	4	8.3	11.7	6.3	4.2	6.9	9.9	≤ 1.5 rise outside mixing zone	≤ 1.5 rise outside mixing zone [12]	-
	Conductivity (field)	µS/cm @ 25°C	ND [3]	557	212	209	630	654	697	548	660	430	630	441	415	427	638	449	499	177.6	210	201	205	-	-	2750 [14]
	pH	-	7.72	8.21	7.32	7.81	7.96	8.39	8.18	8.03	7.9	7.78	8.23	7.96	7.85	7.74	8.21	8.1	7.87	7.81	8.17	8.11	7.9	> 6 and < 9 (hard water)	≥ 6 and ≤ 9	≥ 6.5 and ≤ 9.5
	Dissolved Oxygen	% sat	93.8	102.5	95.7	95.6	99.3	109.5	101	100.7	100.2	94.6	102.1	99	95.7	96.2	114	97.3	97	95	110.1	102.8	96	> 80% and < 120% (95%ile)	-	-
	Dissolved Oxygen	mg/l O_2	11.57	13.15	11.14	11.78	12.03	14.71	11.92	12.16	12.06	11.52	13.35	11.51	11.91	11.7	15.36	11.41	11.99	11.76	13.05	12.45	11.83	-	50% ≥ 9	-
Whole Sample	Conductivity (lab) [1]	µS/cm @ 25°C	405	551	209	299	591	614	580	662	648	425	620	436	559	424	629	458	551	180	210	195	209	-	-	2750 [14]
	Total Suspended Solids	mg/l	< 3	< 3	3.1	< 3	< 3	< 3	< 3	< 3	< 3	3.5	3	3.5	3.2	< 3	3	4.4	3.7	< 3	< 3	13.4	< 3	-	≤ 25	-
	Turbidity	NTU	1.4	1	0.98	2.09	0.53	0.84	0.72	1.02	0.32	0.87	0.66	0.91	2.48	1.59	0.66	1.21	1.65	0.86	0.65	0.98	0.81	-	-	NAC [15]
	Biological Oxygen Demand	mg/l O_2	1	< 2	4	< 1	< 1	< 2	< 1	< 1	< 1	< 1	< 2	< 1	< 1	< 1	< 2	2	< 1	< 1	< 2	< 1	< 1	≤ 1.5 (mean) or ≤ 2.6 (95%ile) [8]	≤ 5	-
	Total Organic Carbon	mg/l	0.45	4	8.4	6.2	< 0.3	3	< 0.3	< 0.3	< 0.3	0.4	2.6	5.9	3.2	0.8	2.4	6	3.9	1.1	6.8	8.7	6.2	-	-	NAC [15]
	Total Hardness	mg/l $CaCO_3$	169	217	66.5	112	248	277	285	259	278	174	261	161	215	165	267	167	211	57.1	78.2	70.9	77.6	-	-	-
Major Constit	Calcium	mg/l	50.9	68.2	19.7	34.7	72.5	81.7	80.6	71.4	80.9	52.2	77.8	46.2	60.5	49.8	80.2	47.9	59.6	18.1	25.7	23.1	25.3	-	-	-
	Magnesium	mg/l	10.2	11.4	4.2	6.1	16.4	17.8	20.4	19.6	18.4	10.7	16.1	11.2	15.6	9.9	16.3	11.6	15.2	2.9	3.4	3.2	3.5	-	-	-
	Chloride	mg/l	33.2	41.2	24	23.5	38.7	43.7	56.5	59	41.2	30.8	44.2	39	47.5	30.8	43.7	42.7	45.9	20.8	17.4	19	19.5	-	-	250
	Sulphate	mg/l	3.05	< 2	< 2	< 2	24	3	3.8	2.5	24.6	4.34	28.4	24.3	22.7	5.75	30	27.3	24.2	< 2	5.35	< 2	< 2	-	-	250
Minor Constituents	Nitrate	mg/l NO_3	4.76	5.38	3.69	3	6.53	6.54	7.05	2.84	6.98	4.89	6.34	7.11	4.07	5.08	6.26	7.01	4.05	4.43	2.78	5.27	2.95	-	-	50
	Nitrite	mg/l N	0.006	0.008	0.004	0.003	0.007	0.003	0.003	0.005	0.003	0.006	0.004	0.003	0.003	0.008	0.005	0.005	0.004	0.002	0.006	0.004	0.004	-	0.015 [13]	0.152 [13]
	Total Ammonia	mg/l N	0.03	0.03	0.03	0.05	< 0.02	< 0.02	< 0.02	0.02	< 0.02	0.02	< 0.02	0.02	0.04	0.02	0.2	0.04	0.03	< 0.02	< 0.02	0.02	0.03	≤ 0.065 (mean) or ≤ 0.14 (95%ile) [8]	0.778 [13]	0.23 [13]
	Total Nitrogen	mg/l N	1.4	< 1	< 1	< 1	1	< 1	1.5	< 1.0	1	< 1	5.1	4.6	3.2	2.1	< 1	1.5	< 1	1.7	< 1	1.2	< 1	-	-	-
	Orthophosphate	mg/l P	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.02	< 0.02	< 0.02	0.02	0.03	< 0.02	< 0.02	< 0.02	< 0.02	≤ 0.035 (mean) or ≤ 0.075 (95%ile) [8]	-	-
	Total Phosphorus	mg/l P	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	-	-	-
Trace Metals	Aluminium (Total)	µg/l	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	-	-	200
	Arsenic (Total)	µg/l	< 1	< 1	< 2	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 2	< 1	< 1	< 1	< 2	< 1	< 1	< 1	< 2	< 1	25 (AA)	-	10
	Boron (Total)	µg/l	< 230	< 230	330	< 230	< 230	< 230	< 230	< 230	< 230	< 230	< 230	< 230	< 230	< 230	< 230	< 230	< 230	< 230	< 230	< 230	< 230	-	-	1000
	Cadmium (Dissolved) [2]	µg/l	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.09 - 0.25 (AA), 0.6 - 1.5 (MAC) [9]	-	5
	Chromium (Total)	µg/l	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	4.7 (AA), 32 (MAC) [10]	-	50
	Copper (Total)	µg/l	10	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	5 or 30 [11]	22 or 40 [11]	2000
	Lead (Dissolved) [2]	µg/l	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	14 (MAC)	-	10
	Mercury (Dissolved) [2]	µg/l	< 0.01	< 0.01	< 0.01	< 0.01	0.015	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	0.05 (AA), 0.07 (MAC)	-	1
	Nickel (Dissolved) [2]	µg/l	< 3	< 3	17	< 3	5	6	6	4	7	< 3	< 3	< 3	6	< 3	3	< 3	5	< 3	< 3	6	< 3	20 (AA)	-	20
	Selenium (Total)	µg/l	< 0.8	< 0.8	< 0.8	< 0.8	1.45	1.2	1.21	1.3	1.07	< 0.8	< 0.8	< 0.8	1.07	< 0.8	1.09	1.22	1.06	< 0.8	< 0.8	< 0.8	< 0.8	-	-	10
	Zinc (Total)	µg/l	< 18	< 18	< 18	< 18	< 18	< 18	< 18	< 18	< 18	< 18	< 18	< 18	< 18	< 18	< 18	< 18	< 18	< 18	< 18	< 18	< 18	50 or 100 [11]	200 or 300 [11]	-
Hydrocarb	Total Petroleum Hydrocarbons	µg/l	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	-	-	-
	Volatile Organic Compounds	µg/l	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	-	-	-
	Polycyclic Aromatic Hydrocarbons	µg/l	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	-	-	0.1
Micro	Total Coliforms	mpn/100ml	345	238	50 cfu/100ml	167	17	178	0 cfu/100ml	15	20	132	68	60 cfu/100ml	67	240	68	30 cfu/100ml	137	57	41	0 cfu/100ml	21	-	-	0
	Faecal Coliforms	mpn/100ml	64	40	172	129	3	32	0	3	3	23	21	70	40	39	21	46	22	22	9	0	9	-	-	-
	E. coli	mpn/100ml	32	26	50 cfu/100ml	119	1	82	0 cfu/100ml	1	1	24	15	60 cfu/100ml	58	32	13	30 cfu/100ml	43	5	4	0 cfu/100ml	12	-	-	0

Notes:

1. Conductivity (lab) converted to 25°C reference temperature assuming 2%/°C
2. Surface Water EQS's for Cadmium, Lead, Mercury and Nickel refer to dissolved concentrations
3. Not Detected (fieldmeter malfunction)
4. Discharge from the West stream bank (W) or East stream bank (E)
5. European Communities Environmental Objective (Surface Waters) Regulations 2009 (S.I. No. 272 of 2009), European Union Environmental Objectives (Surface Waters)(Amendment) Regulation 2015 (S.I. No. 386 of 2015)
6. European Communities (Quality of Salmonid Waters) Regulations 1988 (S.I. No. 293 of 1988)
7. European Union (Drinking Water) Regulations 2014 (S.I. No. 122 of 2014)
8. Surface Water EQS for 'Good' status
9. For Cadmium, EQS depends on water hardness
10. Annual Average (AA) and Maximum Allowable Concentration (MAC)
11. For Copper and Zinc, lower value applies for water hardness <100mg/l $CaCO_3$ and higher value applies for water hardness >100mg/l $CaCO_3$
12. Temperature must also not exceed 21.5°C, or 10°C from 1 November to 30 April where species which need cold water for reproduction are present
13. Converted to mg/l N
14. Corrected to 25°C
15. No Abnormal Change

Concentration shaded where standard/limit value exceeded

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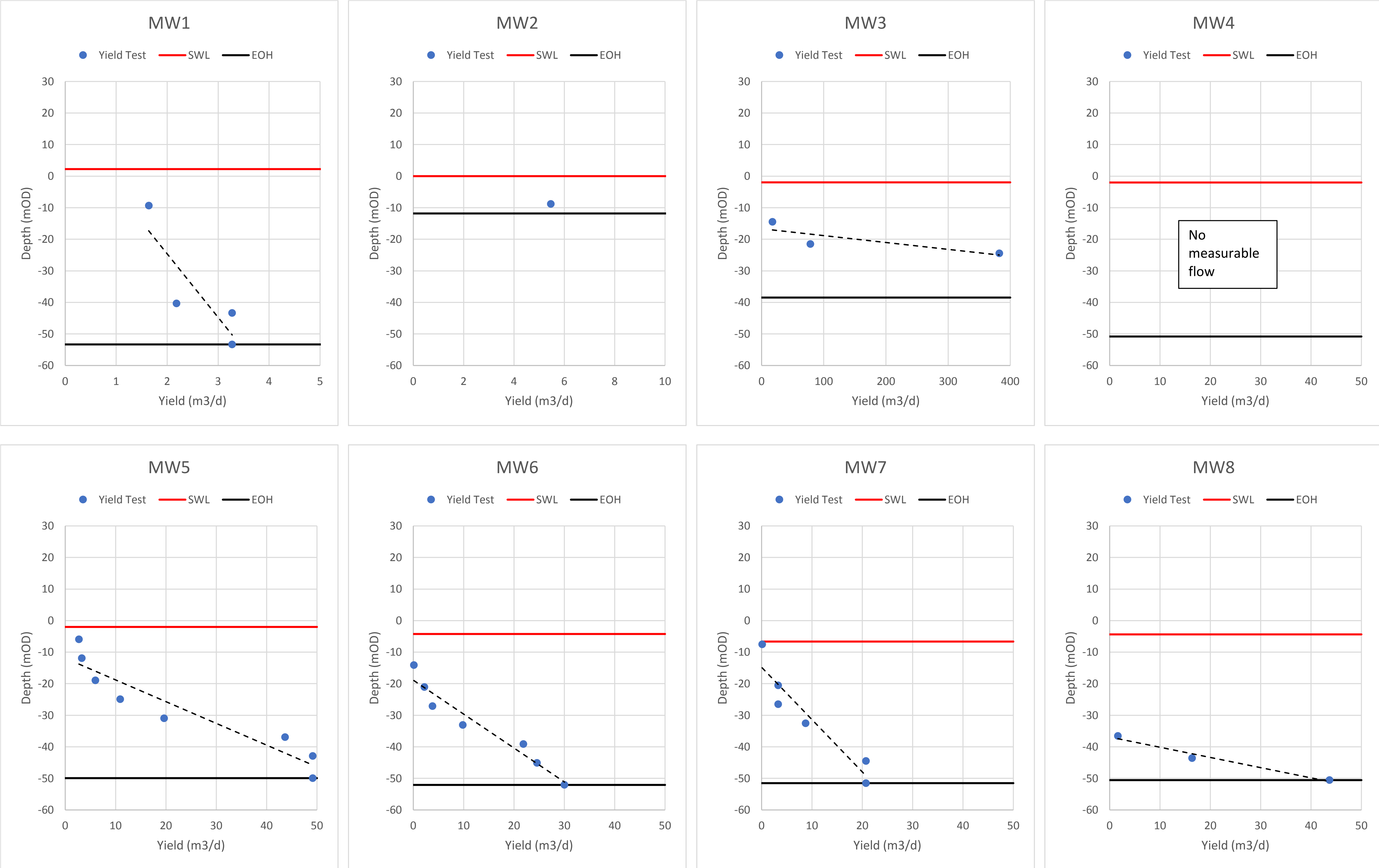
Yield Test Results



SWL - Static Water Level
EOH - End of Hole

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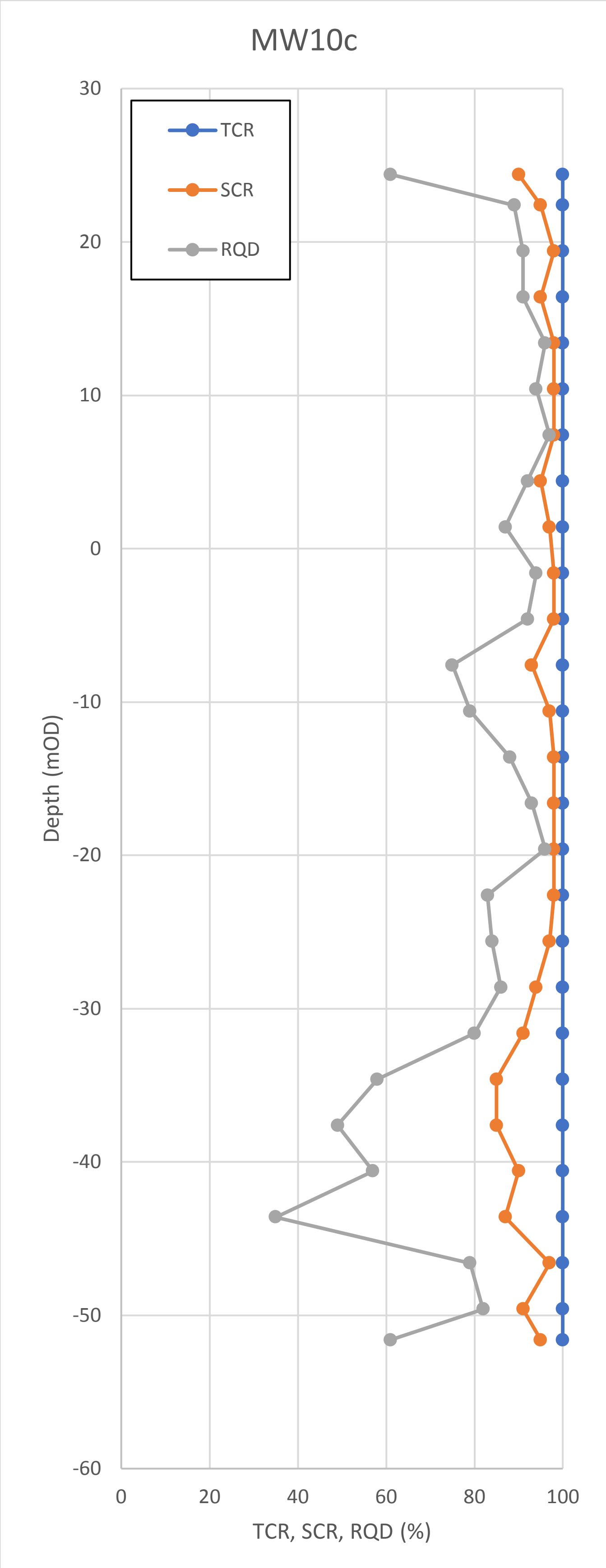
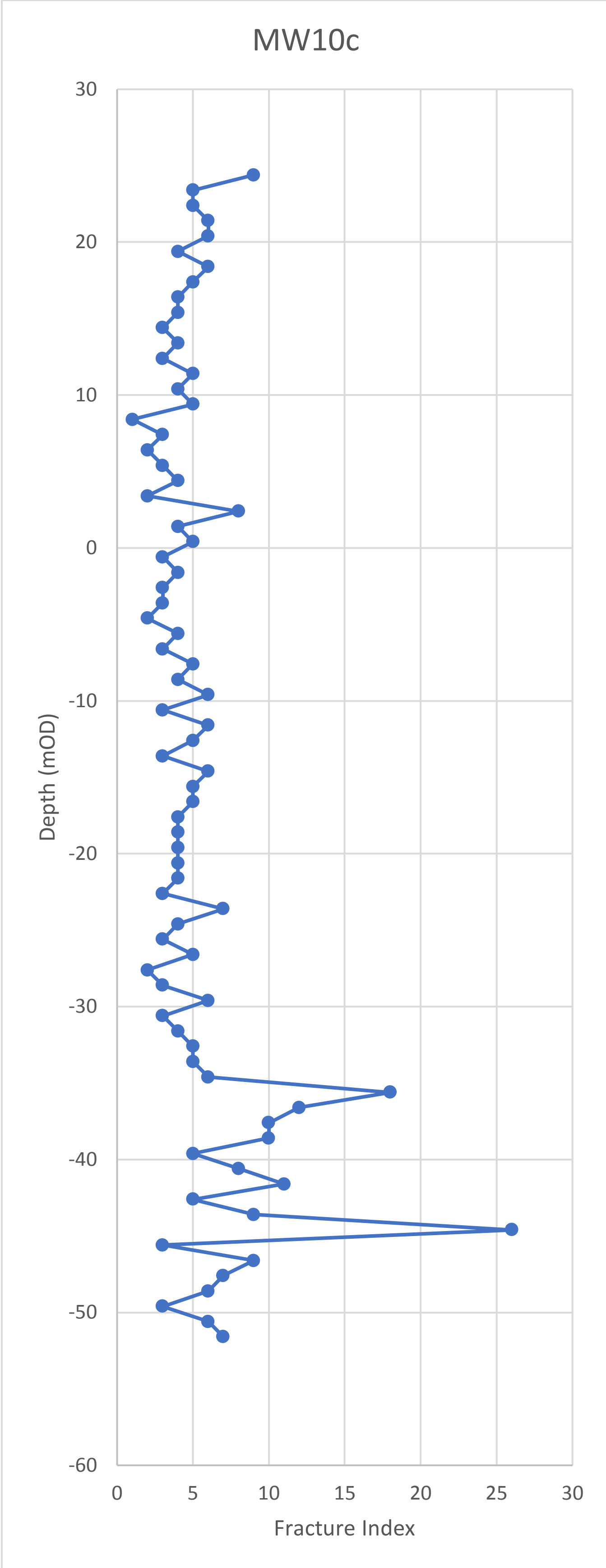
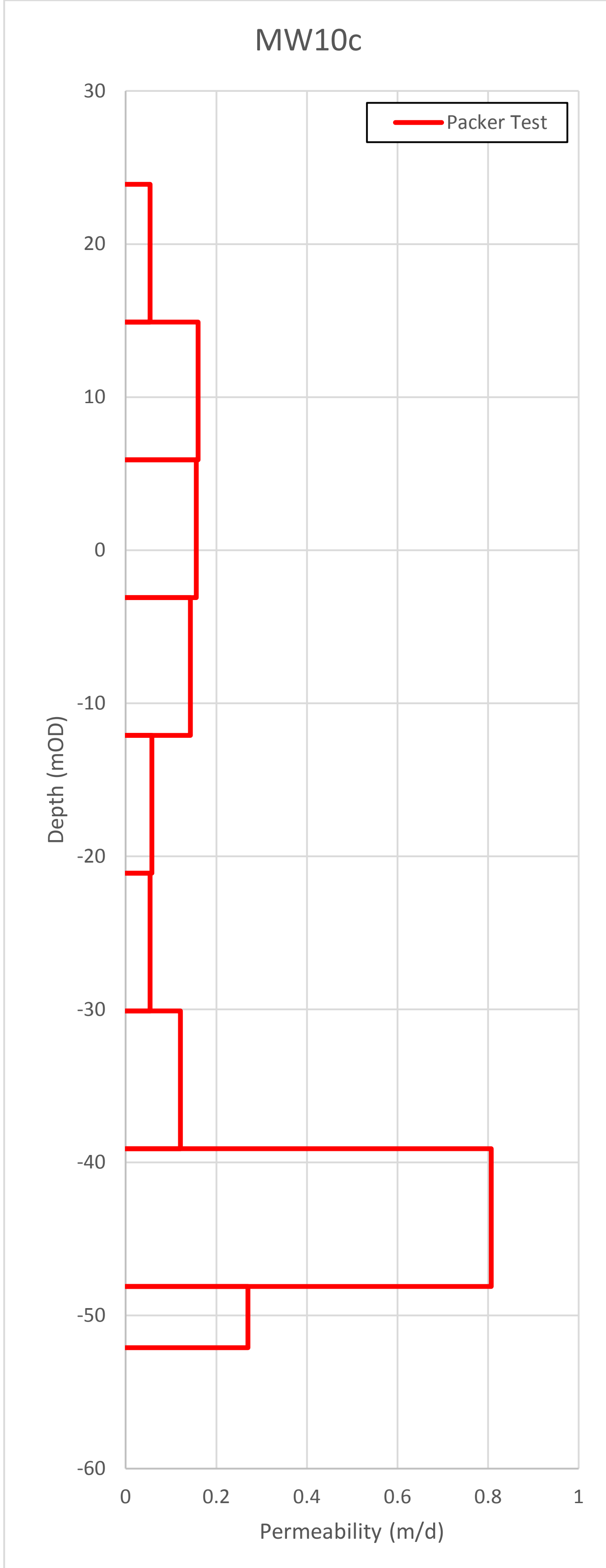
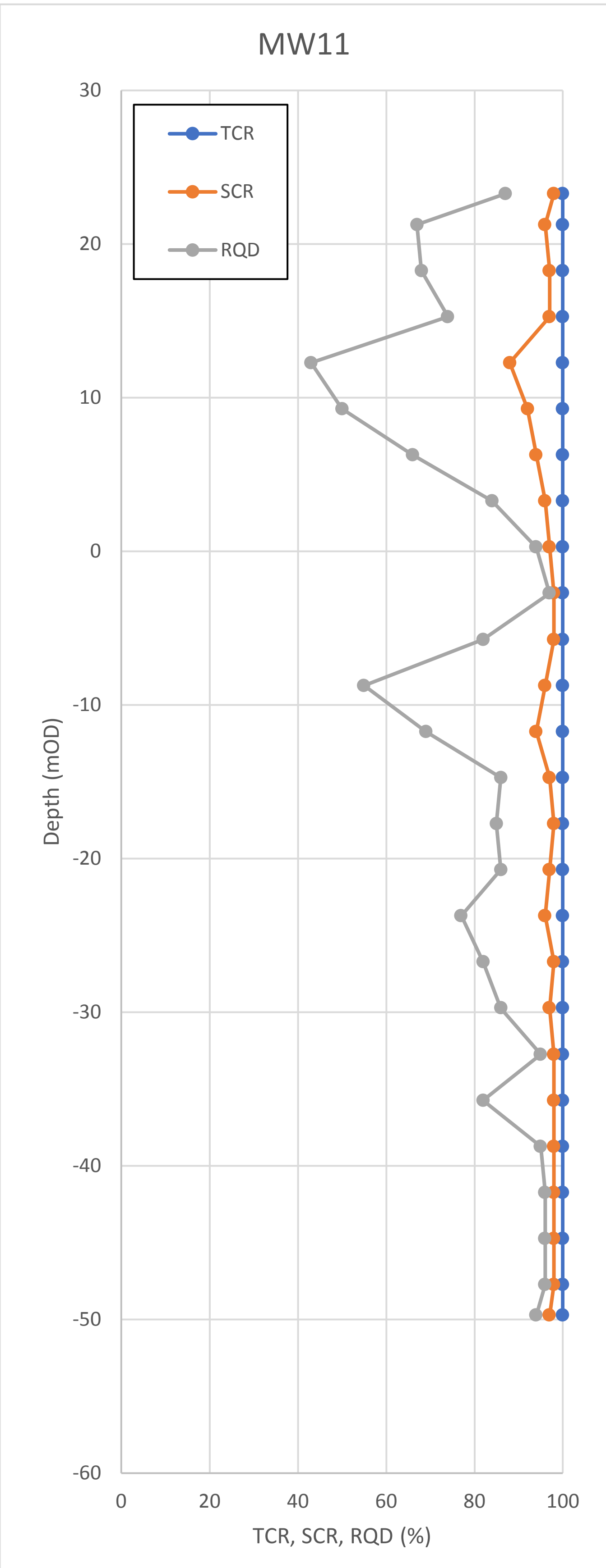
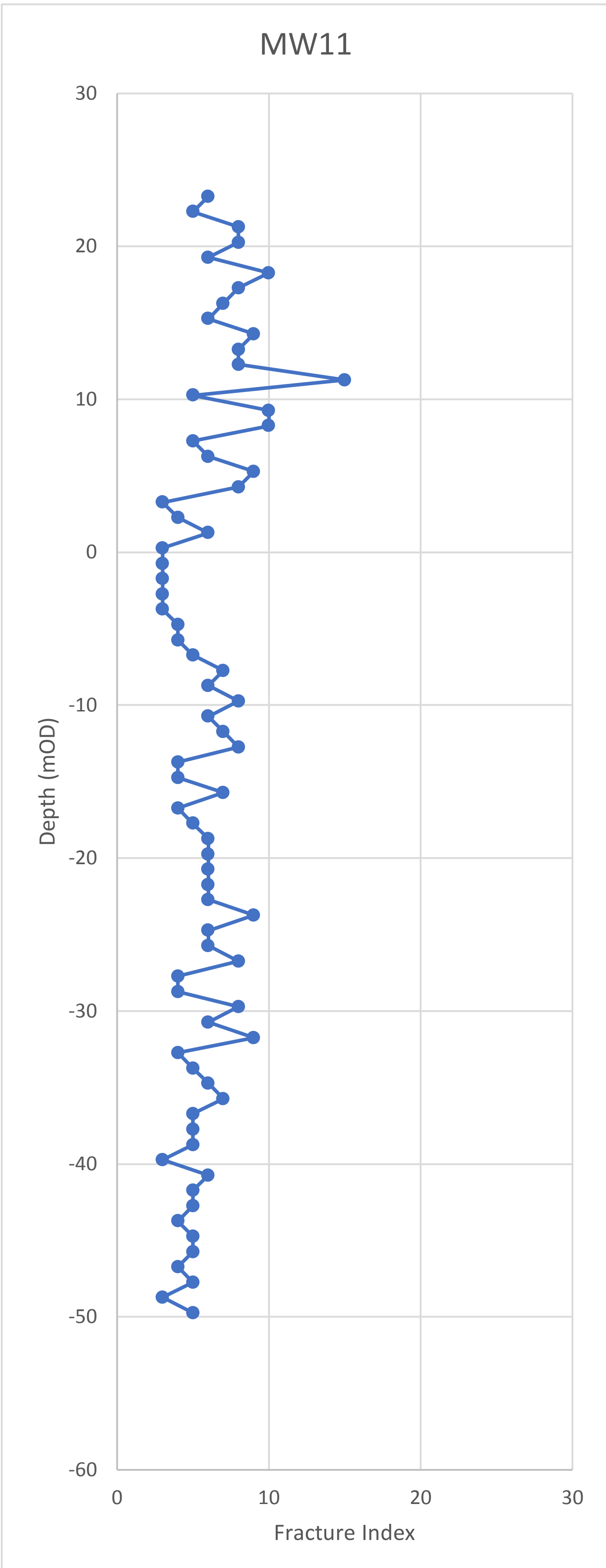
Corehole Results

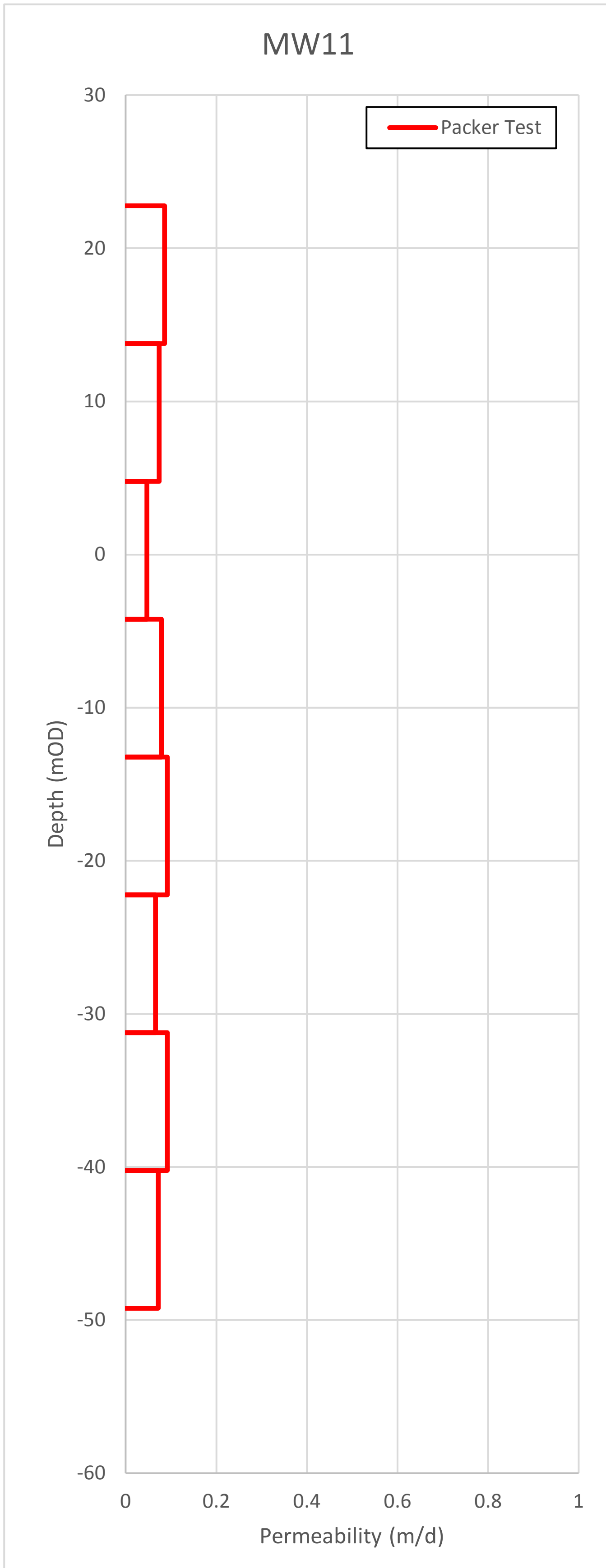












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PACKER TEST RESULTS

Contract: Aghamore
Client: Lagan
Engineer: TMS Environmental
Borehole: MW 10c
Bh. size: NQ
Date: 18/07/2017
Packer Type: Single

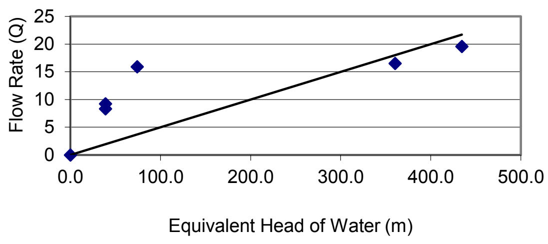
Top of test section (m bgl)	4
Bottom of test section (m bgl)	13
Centre of test section (m bgl)	8.5
Length of test section (m bgl)	9
Pressure gauge height (m agl)	0.2
Initial depth to G.W. (m bgl)	3.7
Packer inflation pressure (psi)	290

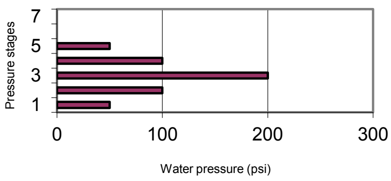
1. Site Records

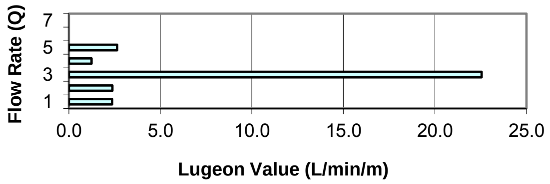
Pressure stage	Water pressure (psi)	Flow meter readings				Water taken over time period (litres)			
		start	5 min	10 min	15 min	0-5 min	5-10 min	10-15 min	0-15 min litres
1	50	8375	8415	8458	8500	40	43	42	125
2	100	8521	8599	8679	8760	78	80	81	239
3	200	8676	8773	8872	8970	97	99	98	294
4	100	8982	9065	9147	9230	83	82	83	248
5	50	9241	9286	9333	9380	45	47	47	139

2. Calculations

Pressure stage	Equiv. head of water (m)	Flow rate (Q) l/min	Stage Lugeon Value l/min/m
1	39.1	8.3	*2.4*
2	74.3	15.9	*2.4*
3	434.5	19.6	*22.6*
4	360.4	16.5	*1.2*
5	39.1	9.3	*2.6*
6	0	0	0







3. Permeability (k) analysis

Mean Lugeon Value Used: 6.24L

k (m/sec) 6.24E-07

PACKER TEST RESULTS

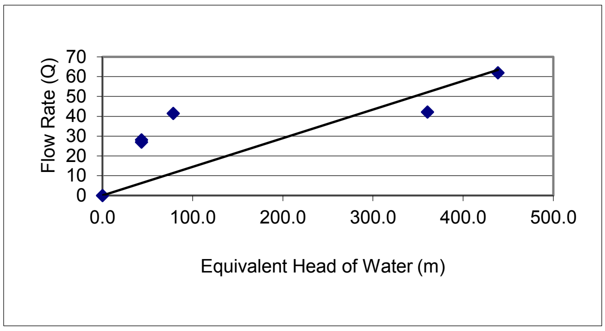
Contract:	Aghamore	Top of test section (m bgl)	13
Client:	Lagan	Bottom of test section (m bgl)	22
Engineer:	TMS Environmental	Centre of test section (m bgl)	17.5
Borehole:	**MW 10c**	Length of test section (m bgl)	9
Bh. size:	NQ	Pressure gauge height (m agl)	0.2
Date:	19/07/2017	Initial depth to G.W. (m bgl)	7.8
Packer Type:	Single	Packer inflation pressure (psi)	290

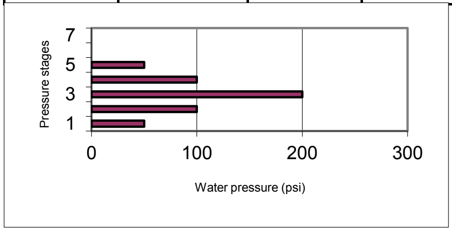
1. Site Records

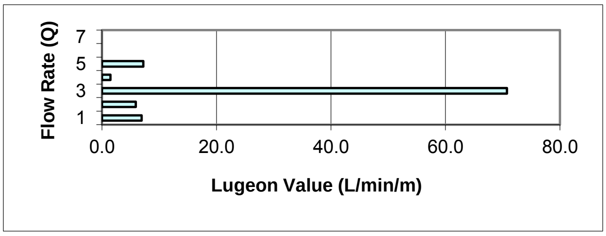
Pressure stage	Water pressure (psi)	Flow meter readings start	5 min	10 min	15 min	Water taken over time period (litres) 0-5 min	5-10 min	10-15 min	0-15 min litres
1	50	400	532	667	804	132	135	137	404
2	100	820	1025	1233	1443	205	208	210	623
3	200	1460	1767	2080	2391	307	313	311	931
4	100	2410	2621	2831	3042	211	210	211	632
5	50	3060	3202	3342	3482	142	140	140	422

2. Calculations

Pressure stage	Equiv. head of water (m)	Flow rate (Q) l/min	Stage Lugeon Value l/min/m
1	43.2	26.9	*6.9*
2	78.4	41.5	*5.9*
3	438.6	62.1	*70.8*
4	360.4	42.1	*1.5*
5	43.2	28.1	*7.2*
6	0	0	0







3. Permeability (k) analysis

Mean Lugeon Value Used: 18.46L

k (m/sec) 1.85E-06

PACKER TEST RESULTS

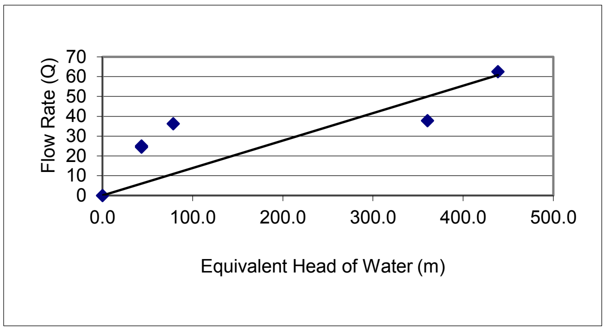
Contract:	Aghamore	Top of test section (m bgl)	22
Client:	Lagan	Bottom of test section (m bgl)	31
Engineer:	TMS Environmental	Centre of test section (m bgl)	26.5
Borehole:	**MW 10c**	Length of test section (m bgl)	9
Bh. size:	NQ	Pressure gauge height (m agl)	0.2
Date:	19/07/2017	Initial depth to G.W. (m bgl)	7.8
Packer Type:	Single	Packer inflation pressure (psi)	290

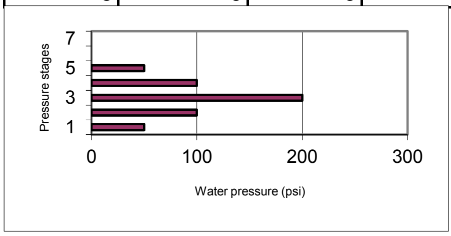
1. Site Records

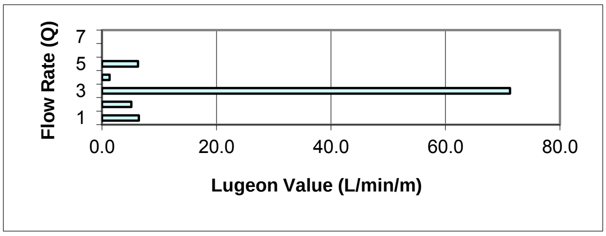
Pressure stage	Water pressure (psi)	Flow meter readings				Water taken over time period (litres)			
		start	5 min	10 min	15 min	0-5 min	5-10 min	10-15 min	0-15 min litres
1	50	390	510	633	766	120	123	133	376
2	100	790	972	1153	1335	182	181	182	545
3	200	1350	1660	1975	2288	310	315	313	938
4	100	2300	2488	2678	2867	188	190	189	567
5	50	2880	3003	3126	3248	123	123	122	368

2. Calculations

Pressure stage	Equiv. head of water (m)	Flow rate (Q) l/min	Stage Lugeon Value l/min/m
1	43.2	25.1	*6.4*
2	78.4	36.3	*5.1*
3	438.6	62.5	*71.3*
4	360.4	37.8	*1.3*
5	43.2	24.5	*6.3*
6	0	0	0







3. Permeability (k) analysis

Mean Lugeon Value Used: 18.08L

k (m/sec) 1.81E-06

PACKER TEST RESULTS

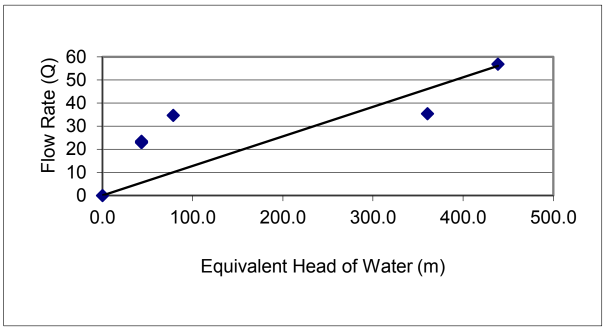
Contract:	Aghamore	Top of test section (m bgl)	31
Client:	Lagan	Bottom of test section (m bgl)	40
Engineer:	TMS Environmental	Centre of test section (m bgl)	35.5
Borehole:	**MW 10c**	Length of test section (m bgl)	9
Bh. size:	NQ	Pressure gauge height (m agl)	0.2
Date:	20/07/2017	Initial depth to G.W. (m bgl)	7.8
Packer Type:	Single	Packer inflation pressure (psi)	290

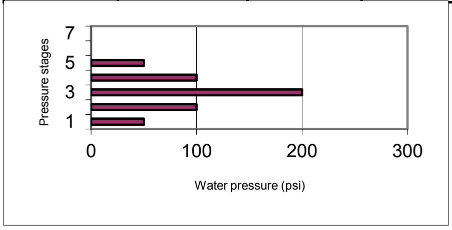
1. Site Records

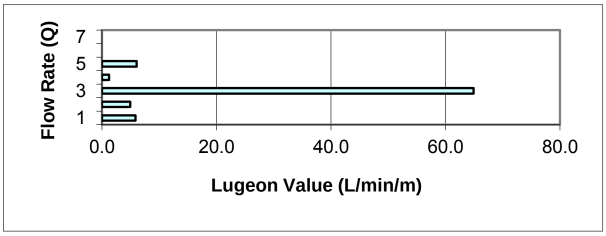
Pressure stage	Water pressure (psi)	Flow meter readings				Water taken over time period (litres)			
		start	5 min	10 min	15 min	0-5 min	5-10 min	10-15 min	0-15 min litres
1	50	3260	3372	3487	3603	112	115	116	343
2	100	3615	3787	3962	4136	172	175	174	521
3	200	4145	4428	4714	4999	283	286	285	854
4	100	5010	5185	5364	5542	175	179	178	532
5	50	5550	5669	5786	5903	119	117	117	353

2. Calculations

Pressure stage	Equiv. head of water (m)	Flow rate (Q) l/min	Stage Lugeon Value l/min/m
1	43.2	22.9	*5.9*
2	78.4	34.7	*4.9*
3	438.6	56.9	*64.9*
4	360.4	35.5	*1.3*
5	43.2	23.5	*6.1*
6	0	0	0







3. Permeability (k) analysis

Mean Lugeon Value Used: 16.62L

k (m/sec) 1.66E-06

PACKER TEST RESULTS

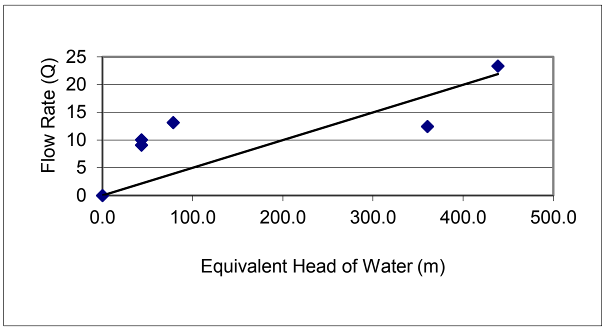
Contract:	Aghamore	Top of test section (m bgl)	40
Client:	Lagan	Bottom of test section (m bgl)	49
Engineer:	TMS Environmental	Centre of test section (m bgl)	44.5
Borehole:	**MW 10c**	Length of test section (m bgl)	9
Bh. size:	NQ	Pressure gauge height (m agl)	0.2
Date:	20/07/2017	Initial depth to G.W. (m bgl)	7.8
Packer Type:	Single	Packer inflation pressure (psi)	290

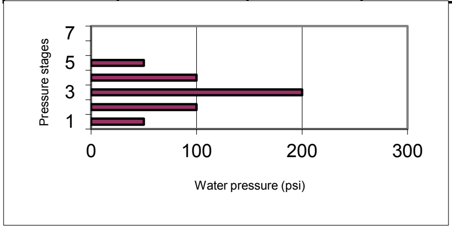
1. Site Records

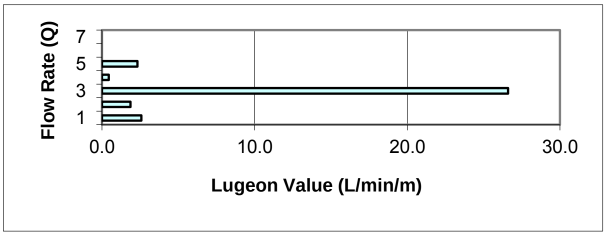
Pressure stage	Water pressure (psi)	Flow meter readings				Water taken over time period (litres)			
		start	5 min	10 min	15 min	0-5 min	5-10 min	10-15 min	0-15 min litres
1	50	5920	5970	6021	6071	50	51	50	151
2	100	6080	6147	6212	6277	67	65	65	197
3	200	6285	6401	6519	6635	116	118	116	350
4	100	6640	6704	6766	6827	64	62	61	187
5	50	6835	6881	6926	6971	46	45	45	136

2. Calculations

Pressure stage	Equiv. head of water (m)	Flow rate (Q) l/min	Stage Lugeon Value l/min/m
1	43.2	10.1	*2.6*
2	78.4	13.1	*1.9*
3	438.6	23.3	*26.6*
4	360.4	12.5	*0.4*
5	43.2	9.1	*2.3*
6	0	0	0







3. Permeability (k) analysis

Mean Lugeon Value Used: 6.76L

k (m/sec) 6.76E-07

PACKER TEST RESULTS

Contract: Aghamore
Client: Lagan
Engineer: TMS Environmental
Borehole: MW 10c
Bh. size: NQ
Date: 20/07/2017
Packer Type: Single

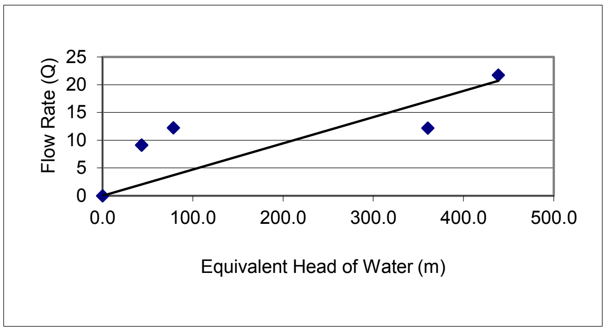
Top of test section (m bgl)	49
Bottom of test section (m bgl)	58
Centre of test section (m bgl)	53.5
Length of test section (m bgl)	9
Pressure gauge height (m agl)	0.2
Initial depth to G.W. (m bgl)	7.8
Packer inflation pressure (psi)	290

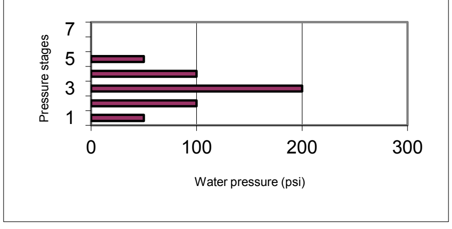
1. Site Records

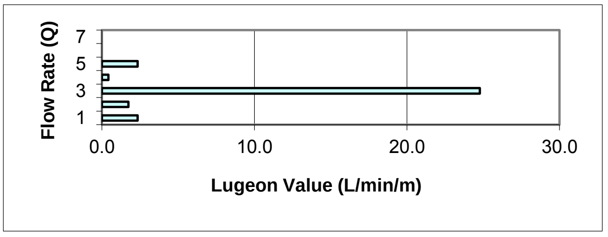
Pressure stage	Water pressure (psi)	Flow meter readings start	5 min	10 min	15 min	Water taken over time period (litres) 0-5 min	5-10 min	10-15 min	0-15 min litres
1	50	6990	7037	7082	7127	47	45	45	137
2	100	7140	7203	7264	7324	63	61	60	184
3	200	7350	7457	7567	7676	107	110	109	326
4	100	7690	7751	7813	7873	61	62	60	183
5	50	7890	7936	7981	8027	46	45	46	137

2. Calculations

Pressure stage	Equiv. head of water (m)	Flow rate (Q) l/min	Stage Lugeon Value l/min/m
1	43.2	9.1	*2.3*
2	78.4	12.3	*1.7*
3	438.6	21.7	*24.8*
4	360.4	12.2	*0.4*
5	43.2	9.1	*2.3*
6	0	0	0







3. Permeability (k) analysis

Mean Lugeon Value Used: 6.30L

k (m/sec) 6.30E-07

PACKER TEST RESULTS

Contract: Aghamore
Client: Lagan
Engineer: TMS Environmental
Borehole: MW 10c
Bh. size: NQ
Date: 21/07/2017
Packer Type: Single

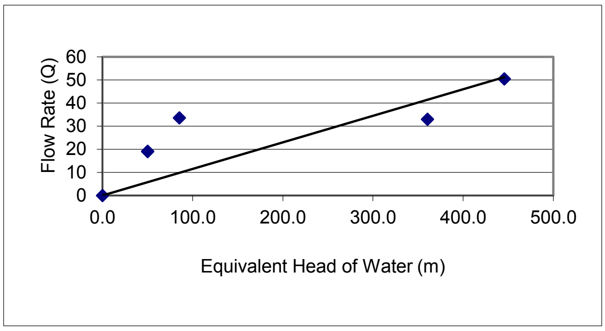
Top of test section (m bgl)	58
Bottom of test section (m bgl)	67
Centre of test section (m bgl)	62.4
Length of test section (m bgl)	9
Pressure gauge height (m agl)	0.2
Initial depth to G.W. (m bgl)	14.7
Packer inflation pressure (psi)	290

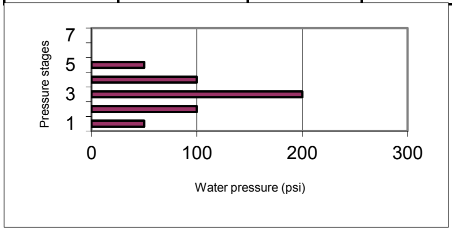
1. Site Records

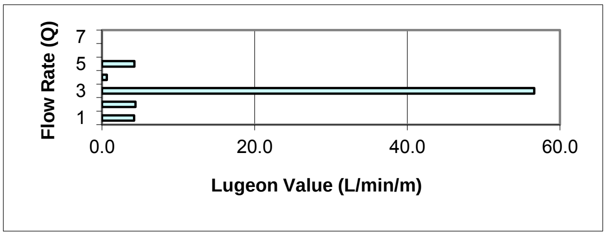
Pressure stage	Water pressure (psi)	Flow meter readings start	5 min	10 min	15 min	Water taken over time period (litres) 0-5 min	5-10 min	10-15 min	0-15 min litres
1	50	8050	8146	8241	8336	96	95	95	286
2	100	8345	8515	8683	8850	170	168	167	505
3	200	8870	9121	9374	9627	251	253	253	757
4	100	9640	9805	9971	10135	165	166	164	495
5	50	80140	80234	80331	80427	94	97	96	287

2. Calculations

Pressure stage	Equiv. head of water (m)	Flow rate (Q) l/min	Stage Lugeon Value l/min/m
1	50.1	19.1	*4.2*
2	85.3	33.7	*4.4*
3	445.5	50.5	*56.6*
4	360.4	33.0	*0.6*
5	50.1	19.1	*4.2*
6	0	0	0







3. Permeability (k) analysis

Mean Lugeon Value Used: 14.00L

k (m/sec) 1.40E-06

PACKER TEST RESULTS

Contract: Aghamore
Client: Lagan
Engineer: TMS Environmental
Borehole: MW 10c
Bh. size: NQ
Date: 21/07/2017
Packer Type: Single

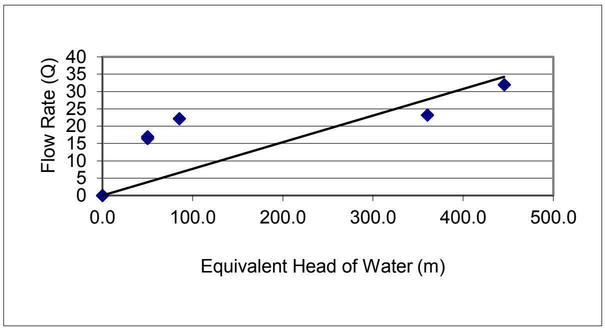
Top of test section (m bgl)	67
Bottom of test section (m bgl)	76
Centre of test section (m bgl)	71.5
Length of test section (m bgl)	9
Pressure gauge height (m agl)	0.2
Initial depth to G.W. (m bgl)	14.7
Packer inflation pressure (psi)	290

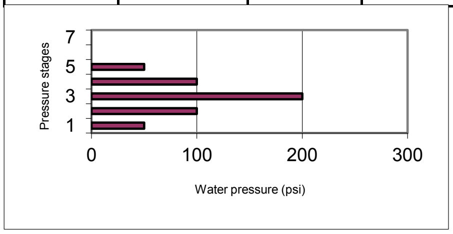
1. Site Records

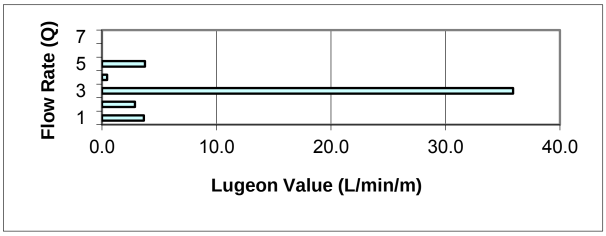
Pressure stage	Water pressure (psi)	Flow meter readings start	5 min	10 min	15 min	Water taken over time period (litres) 0-5 min	5-10 min	10-15 min	0-15 min litres
1	50	520	603	684	767	83	81	83	247
2	100	770	879	990	1103	109	111	113	333
3	200	1120	1277	1437	1600	157	160	163	480
4	100	1620	1737	1852	1968	117	115	116	348
5	50	1980	2065	2149	2234	85	84	85	254

2. Calculations

Pressure stage	Equiv. head of water (m)	Flow rate (Q) l/min	Stage Lugeon Value l/min/m
1	50.1	16.5	*3.7*
2	85.3	22.2	*2.9*
3	445.5	32.0	*35.9*
4	360.4	23.2	*0.4*
5	50.1	16.9	*3.8*
6	0	0	0







3. Permeability (k) analysis

Mean Lugeon Value Used: 9.34L

k (m/sec) 9.34E-06

PACKER TEST RESULTS

Contract: Aghamore
Client: Lagan
Engineer: TMS Environmental
Borehole: MW 10c
Bh. size: NQ
Date: 21/07/2017
Packer Type: Single

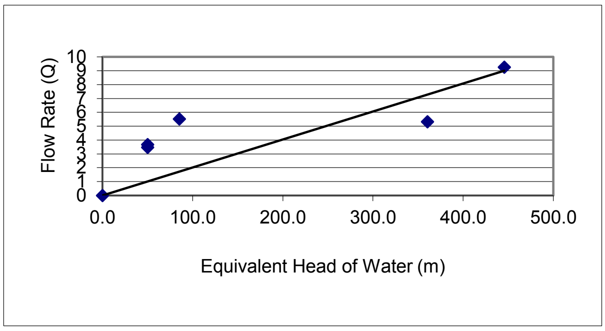
Top of test section (m bgl)	76
Bottom of test section (m bgl)	80
Centre of test section (m bgl)	78
Length of test section (m bgl)	4
Pressure gauge height (m agl)	0.2
Initial depth to G.W. (m bgl)	14.7
Packer inflation pressure (psi)	290

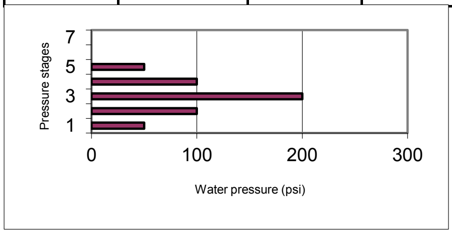
1. Site Records

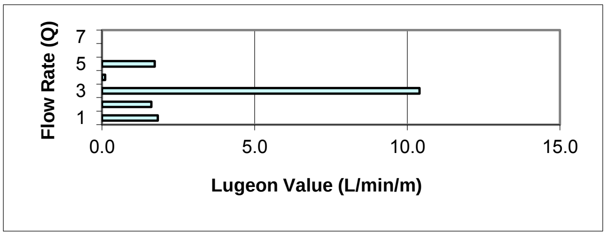
Pressure stage	Water pressure (psi)	Flow meter readings				Water taken over time period (litres)			
		start	5 min	10 min	15 min	0-5 min	5-10 min	10-15 min	0-15 min litres
1	50	2250	2267	2286	2305	17	19	19	55
2	100	2310	2338	2365	2393	28	27	28	83
3	200	2400	2445	2492	2539	45	47	47	139
4	100	2550	2577	2603	2630	27	26	27	80
5	50	2640	2658	2675	2692	18	17	17	52

2. Calculations

Pressure stage	Equiv. head of water (m)	Flow rate (Q) l/min	Stage Lugeon Value l/min/m
1	50.1	3.7	*1.8*
2	85.3	5.5	*1.6*
3	445.5	9.3	*10.4*
4	360.4	5.3	*0.1*
5	50.1	3.5	*1.7*
6	0	0	0







3. Permeability (k) analysis

Mean Lugeon Value Used: 3.12L

k (m/sec) 3.12E-06

PACKER TEST RESULTS

Contract: Aghamore
Client: Lagan
Engineer: TMS Environmental
Borehole: MW 11
Bh. size: NQ
Date: 10/08/2017
Packer Type: Single

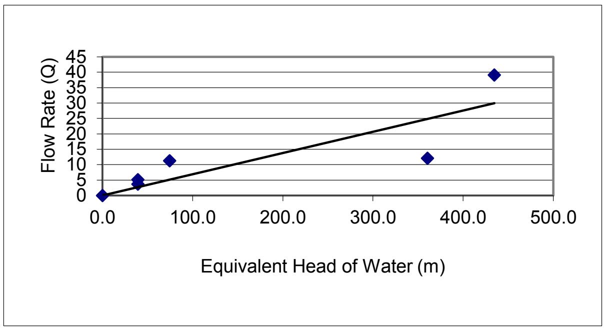
Top of test section (m bgl)	7
Bottom of test section (m bgl)	16
Centre of test section (m bgl)	11.5
Length of test section (m bgl)	9
Pressure gauge height (m agl)	0.2
Initial depth to G.W. (m bgl)	3.8
Packer inflation pressure (psi)	290

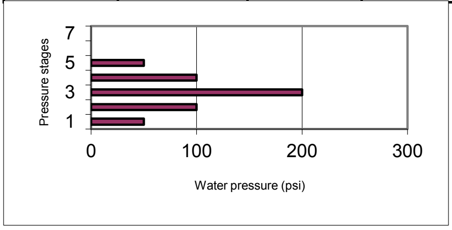
1. Site Records

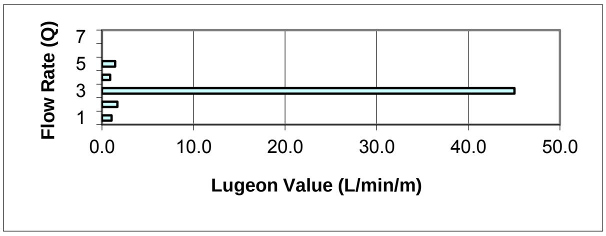
Pressure stage	Water pressure (psi)	Flow meter readings				Water taken over time period (litres)			
		start	5 min	10 min	15 min	0-5 min	5-10 min	10-15 min	0-15 min litres
1	50	2700	2719	2737	2756	19	18	19	56
2	100	2760	2816	2873	2929	56	57	56	169
3	200	2940	3137	3332	3527	197	195	195	587
4	100	3535	3596	3656	3717	61	60	61	182
5	50	3730	3757	3782	3807	27	25	25	77

2. Calculations

Pressure stage	Equiv. head of water (m)	Flow rate (Q) l/min	Stage Lugeon Value l/min/m
1	39.2	3.7	*1.1*
2	74.4	11.3	*1.7*
3	434.6	39.1	*45.0*
4	360.4	12.1	*0.9*
5	39.2	5.1	*1.5*
6	0	0	0







3. Permeability (k) analysis

Mean Lugeon Value Used: 10.04L

k (m/sec) 1.00E-06

PACKER TEST RESULTS

Contract: Aghamore
Client: Lagan
Engineer: TMS Environmental
Borehole: MW 11
Bh. size: NQ
Date: 10/08/2017
Packer Type: Single

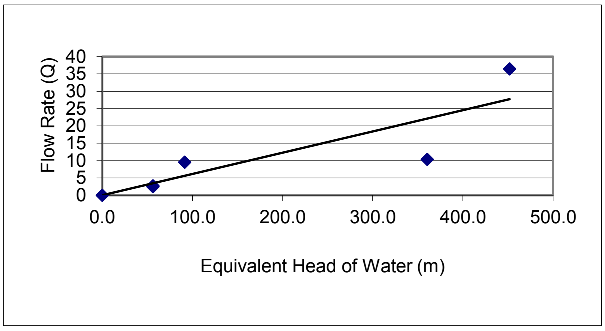
Top of test section (m bgl)	16
Bottom of test section (m bgl)	25
Centre of test section (m bgl)	20.5
Length of test section (m bgl)	9
Pressure gauge height (m agl)	0.2
Initial depth to G.W. (m bgl)	21
Packer inflation pressure (psi)	290

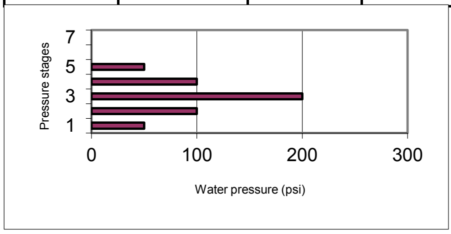
1. Site Records

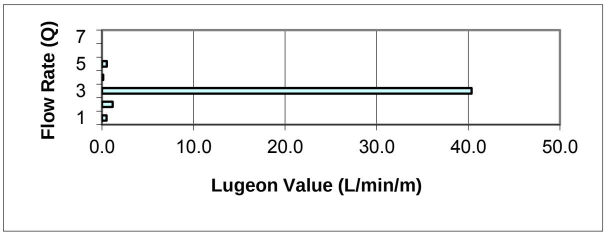
Pressure stage	Water pressure (psi)	Flow meter readings start	5 min	10 min	15 min	Water taken over time period (litres) 0-5 min	5-10 min	10-15 min	0-15 min litres
1	50	3830	3842	3855	3868	12	13	13	38
2	100	3880	3927	3976	4024	47	49	48	144
3	200	4035	4218	4400	4582	183	182	182	547
4	100	4595	4644	4692	4751	49	48	59	156
5	50	4760	4774	4788	4801	14	14	13	41

2. Calculations

Pressure stage	Equiv. head of water (m)	Flow rate (Q) l/min	Stage Lugeon Value l/min/m
1	56.4	2.5	*0.5*
2	91.6	9.6	*1.2*
3	451.8	36.5	*40.4*
4	360.4	10.4	*0.1*
5	56.4	2.7	*0.5*
6	0	0	0







3. Permeability (k) analysis

Mean Lugeon Value Used: 8.54L

k (m/sec) 8.54E-07

PACKER TEST RESULTS

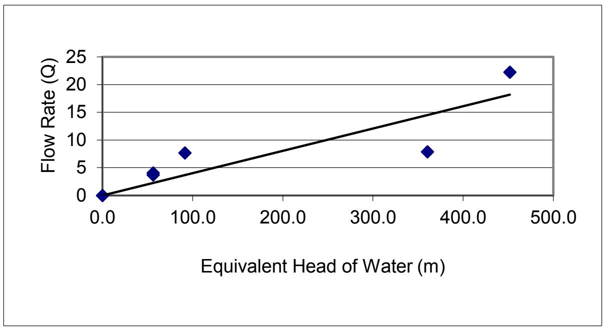
Contract:	Aghamore	Top of test section (m bgl)	25
Client:	Lagan	Bottom of test section (m bgl)	34
Engineer:	TMS Environmental	Centre of test section (m bgl)	29.5
Borehole:	**MW 11**	Length of test section (m bgl)	9
Bh. size:	NQ	Pressure gauge height (m agl)	0.2
Date:	11/08/2017	Initial depth to G.W. (m bgl)	21
Packer Type:	Single	Packer inflation pressure (psi)	290

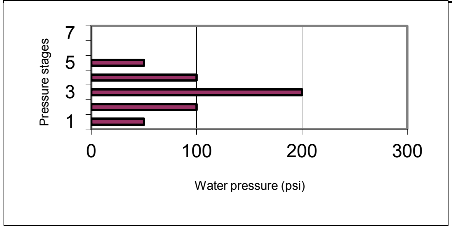
1. Site Records

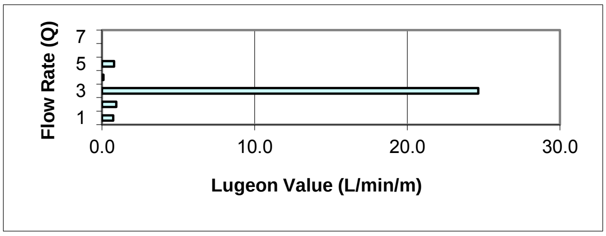
Pressure stage	Water pressure (psi)	Flow meter readings start	5 min	10 min	15 min	Water taken over time period (litres) 0-5 min	5-10 min	10-15 min	0-15 min litres
1	50	4830	4848	4867	4886	18	19	19	56
2	100	4895	4933	4971	5010	38	38	39	115
3	200	5020	5130	5241	5354	110	111	113	334
4	100	5360	5399	5439	5478	39	40	39	118
5	50	5480	5499	5520	5541	19	21	21	61

2. Calculations

Pressure stage	Equiv. head of water (m)	Flow rate (Q) l/min	Stage Lugeon Value l/min/m
1	56.4	3.7	*0.7*
2	91.6	7.7	*0.9*
3	451.8	22.3	*24.6*
4	360.4	7.9	*0.1*
5	56.4	4.1	*0.8*
6	0	0	0







3. Permeability (k) analysis

Mean Lugeon Value Used: 5.42L

k (m/sec) 5.42E-07

PACKER TEST RESULTS

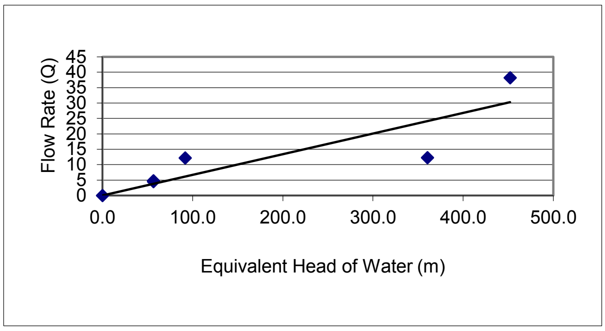
Contract:	Aghamore	Top of test section (m bgl)	34
Client:	Lagan	Bottom of test section (m bgl)	43
Engineer:	TMS Environmental	Centre of test section (m bgl)	38.5
Borehole:	**MW 11**	Length of test section (m bgl)	9
Bh. size:	NQ	Pressure gauge height (m agl)	0.2
Date:	11/08/2017	Initial depth to G.W. (m bgl)	21.2
Packer Type:	Single	Packer inflation pressure (psi)	290

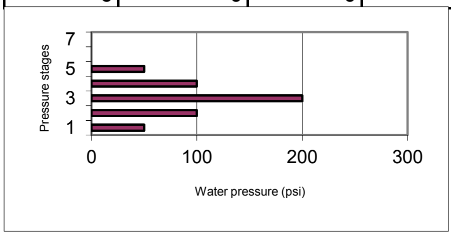
1. Site Records

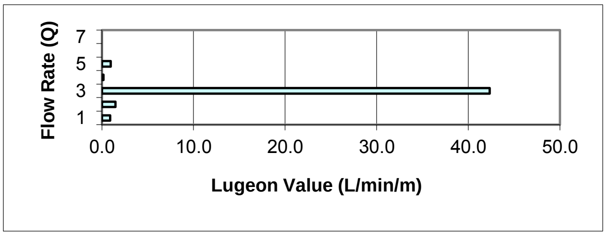
Pressure stage	Water pressure (psi)	Flow meter readings				Water taken over time period (litres)			
		start	5 min	10 min	15 min	0-5 min	5-10 min	10-15 min	0-15 min litres
1	50	5560	5581	5604	5628	21	23	24	68
2	100	5640	5699	5760	5823	59	61	63	183
3	200	5835	6032	6221	6409	197	189	188	574
4	100	6420	6481	6543	6605	61	62	62	185
5	50	6620	6643	6668	6692	23	25	24	72

2. Calculations

Pressure stage	Equiv. head of water (m)	Flow rate (Q) l/min	Stage Lugeon Value l/min/m
1	56.6	4.5	*0.9*
2	91.8	12.2	*1.5*
3	452.0	38.3	*42.3*
4	360.4	12.3	*0.2*
5	56.6	4.8	*0.9*
6	0	0	0







3. Permeability (k) analysis

Mean Lugeon Value Used: 9.16L

k (m/sec) 9.16E-07

PACKER TEST RESULTS

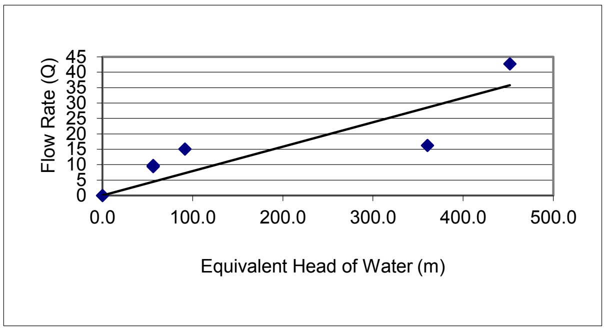
Contract:	Aghamore	Top of test section (m bgl)	43
Client:	Lagan	Bottom of test section (m bgl)	52
Engineer:	TMS Environmental	Centre of test section (m bgl)	47.5
Borehole:	**MW 11**	Length of test section (m bgl)	9
Bh. size:	NQ	Pressure gauge height (m agl)	0.2
Date:	14/08/2017	Initial depth to G.W. (m bgl)	21
Packer Type:	Single	Packer inflation pressure (psi)	290

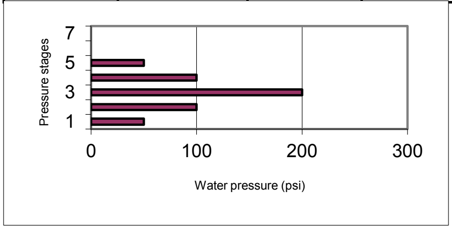
1. Site Records

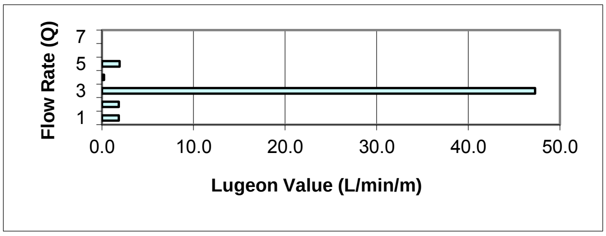
Pressure stage	Water pressure (psi)	Flow meter readings				Water taken over time period (litres)			
		start	5 min	10 min	15 min	0-5 min	5-10 min	10-15 min	0-15 min litres
1	50	6705	6751	6799	6846	46	48	47	141
2	100	6855	6928	7003	7081	73	75	78	226
3	200	7100	7312	7526	7741	212	214	215	641
4	100	7750	7831	7919	7994	81	88	75	244
5	50	8005	8054	8102	8151	49	48	49	146

2. Calculations

Pressure stage	Equiv. head of water (m)	Flow rate (Q) l/min	Stage Lugeon Value l/min/m
1	56.4	9.4	*1.9*
2	91.6	15.1	*1.8*
3	451.8	42.7	*47.3*
4	360.4	16.3	*0.2*
5	56.4	9.7	*1.9*
6	0	0	0







3. Permeability (k) analysis

Mean Lugeon Value Used: 10.62L

k (m/sec) 1.06E-06

PACKER TEST RESULTS

Contract: Aghamore
Client: Lagan
Engineer: TMS Environmental
Borehole: MW 11
Bh. size: NQ
Date: 14/08/2017
Packer Type: Single

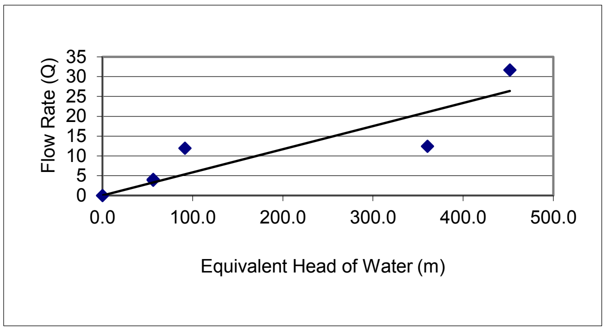
Top of test section (m bgl)	52
Bottom of test section (m bgl)	61
Centre of test section (m bgl)	56.5
Length of test section (m bgl)	9
Pressure gauge height (m agl)	0.2
Initial depth to G.W. (m bgl)	21
Packer inflation pressure (psi)	290

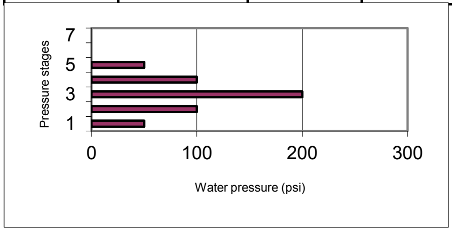
1. Site Records

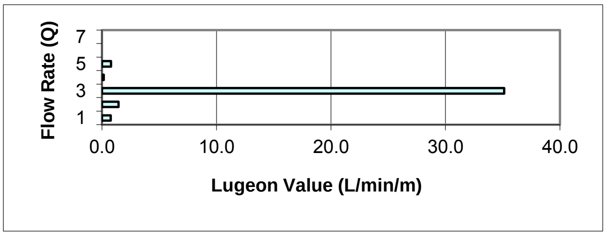
Pressure stage	Water pressure (psi)	Flow meter readings				Water taken over time period (litres)			
		start	5 min	10 min	15 min	0-5 min	5-10 min	10-15 min	0-15 min litres
1	50	8170	8189	8209	8228	19	20	19	58
2	100	8240	8299	8359	8419	59	60	60	179
3	200	8430	8587	8746	8906	157	159	160	476
4	100	8920	8983	9045	9107	63	62	62	187
5	50	9130	9151	9171	9191	21	20	20	61

2. Calculations

Pressure stage	Equiv. head of water (m)	Flow rate (Q) l/min	Stage Lugeon Value l/min/m
1	56.4	3.9	*0.8*
2	91.6	11.9	*1.4*
3	451.8	31.7	*35.1*
4	360.4	12.5	*0.2*
5	56.4	4.1	*0.8*
6	0	0	0







3. Permeability (k) analysis

Mean Lugeon Value Used: 7.66L

k (m/sec) 7.66E-07

PACKER TEST RESULTS

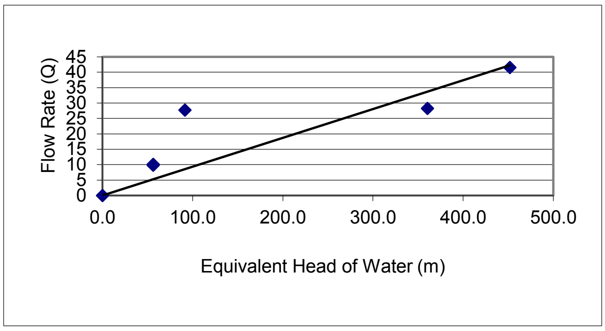
Contract:	Aghamore	Top of test section (m bgl)	61
Client:	Lagan	Bottom of test section (m bgl)	70
Engineer:	TMS Environmental	Centre of test section (m bgl)	65.5
Borehole:	**MW 11**	Length of test section (m bgl)	9
Bh. size:	NQ	Pressure gauge height (m agl)	0.2
Date:	15/08/2017	Initial depth to G.W. (m bgl)	21
Packer Type:	Single	Packer inflation pressure (psi)	290

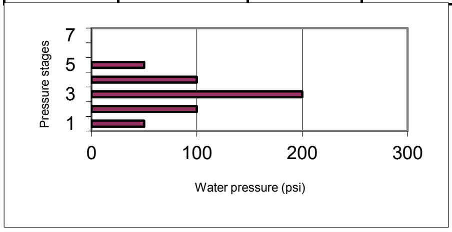
1. Site Records

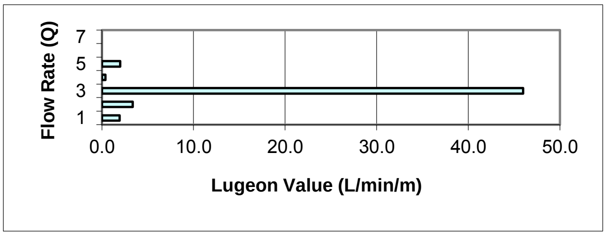
Pressure stage	Water pressure (psi)	Flow meter readings start	5 min	10 min	15 min	Water taken over time period (litres) 0-5 min	5-10 min	10-15 min	0-15 min litres
1	50	9200	9248	9297	9348	48	49	51	148
2	100	9360	9497	9636	9776	137	139	140	416
3	200	9785	9991	10200	10408	206	209	208	623
4	100	90418	90559	90701	90842	141	142	141	424
5	50	90730	90780	90831	90882	50	51	51	152

2. Calculations

Pressure stage	Equiv. head of water (m)	Flow rate (Q) l/min	Stage Lugeon Value l/min/m
1	56.4	9.9	*1.9*
2	91.6	27.7	*3.4*
3	451.8	41.5	*46.0*
4	360.4	28.3	*0.4*
5	56.4	10.1	*2.0*
6	0	0	0







3. Permeability (k) analysis

Mean Lugeon Value Used: 10.74L

k (m/sec) 1.07E-06

PACKER TEST RESULTS

Contract: Aghamore
Client: Lagan
Engineer: TMS Environmental
Borehole: MW 11
Bh. size: NQ
Date: 15/08/2017
Packer Type: Single

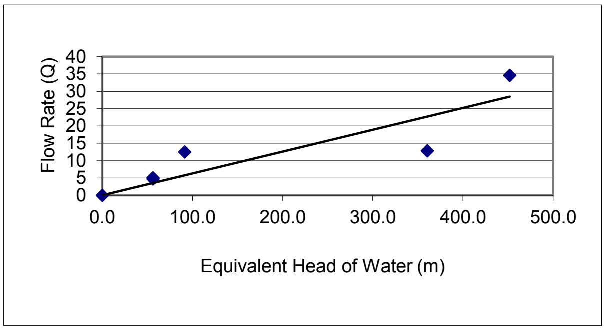
Top of test section (m bgl)	70
Bottom of test section (m bgl)	79
Centre of test section (m bgl)	74.5
Length of test section (m bgl)	9
Pressure gauge height (m agl)	0.2
Initial depth to G.W. (m bgl)	21
Packer inflation pressure (psi)	290

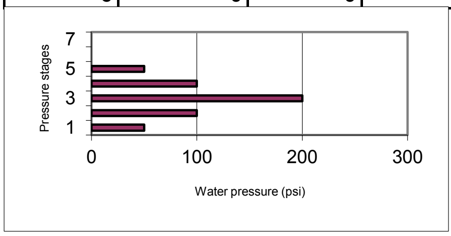
1. Site Records

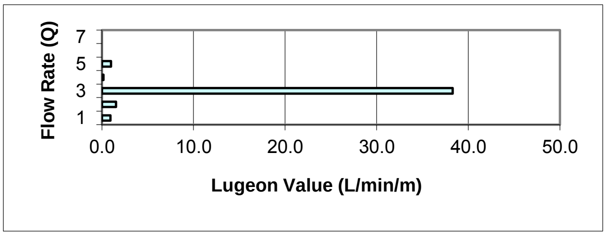
Pressure stage	Water pressure (psi)	Flow meter readings start	5 min	10 min	15 min	Water taken over time period (litres) 0-5 min	5-10 min	10-15 min	0-15 min litres
1	50	895	918	942	966	23	24	24	71
2	100	980	1043	1105	1168	63	62	63	188
3	200	1180	1352	1526	1699	172	174	173	519
4	100	1710	1775	1839	1903	65	64	64	193
5	50	1920	1946	1971	1996	26	25	25	76

2. Calculations

Pressure stage	Equiv. head of water (m)	Flow rate (Q) l/min	Stage Lugeon Value l/min/m
1	56.4	4.7	*0.9*
2	91.6	12.5	*1.5*
3	451.8	34.6	*38.3*
4	360.4	12.9	*0.2*
5	56.4	5.1	*1.0*
6	0	0	0







3. Permeability (k) analysis

Mean Lugeon Value Used: 8.38L

k (m/sec) 8.38E-07

Groundwater Levels (Manual Measurement)

Groundwater Levels (mbtoc)

	12/07/2017	23/08/2017	Notes	28/08/2017	Notes	07/09/2017	Notes	08/02/2018	Notes	26/03/2018	30/03/2018	Notes	11/04/2018	Notes	19/04/2018	Notes	16/05/2018	29/05/2018	01/06/2018	10/07/2018
MW1	34.41	18.61		23.35		25.14		17.220		25.040	24.950		23.515		21.485		24.800	25.285	25.390	26.515
MW2	27.6	*c. 12.58 - 13.18*	Strong cascading	*c. 15.00*	Cascading	*c. 17.00 - 25.00*	Feint cascading	*c. 14.99*	Feint cascading	Dry	Dry		26.715		26.32	Feint cascading	27.215	Dry	Dry	Dry
MW3	30.495	30.455		30.47		30.47	Feint cascading	30.475		30.500	30.500		30.510		30.565		30.315	30.525	30.545	30.505
MW4	35.04	30		30.465		31.73		29.550		34.340	33.110		30.350		30.320		33.595	34.225	34.39	35.34
MW5	35.335	34.66		34.455		34.53		29.990		32.495	32.58		32.8		33.945		33.105	33.155	33.19	34.04
MW6	34.68	33.65		33.66		33.935		26.255		31.310	31.470		31.860		32.005		32.240	32.255	32.315	33.235
MW7	38.555	37.415		37.5		37.81		32.355		35.495	35.56		35.76		35.935		36.075	36.055	36.075	36.895
MW8	35.52	31.14		31.28		32.43		30.625		33.920	33.760		31.065		31.090		34.050	34.625	34.885	35.675
MW9	14.88	14.58		14.655		14.68		14.070		14.670	14.640		14.640		14.610		14.700	14.710	14.745	14.655
MW10c	-	*c. 7.21*	Cascading	*c. 7.99*	Cascading	36.07	Dripping	*c. 12.27*	Dripping?	33.960	34.015		33.870		15.565		34.565	34.56	34.55	34.975
MW11	-	*c. 13.58*	Grease interfering	*c. 14.50*	Grease interfering	*c. 19.00*	Grease interfering	*c. 13.20*	Grease interfering	35.565	*c. 26.00*	Grease interfering	*c. 27.00*	Grease interfering	35.65		35.560	35.545	35.570	35.565
Old Well	-	-		4.17		4.52		5.975		7.210	6.580		4.195		6.120		6.305	6.4	6.95	Dry

Groundwater Levels (mOD)

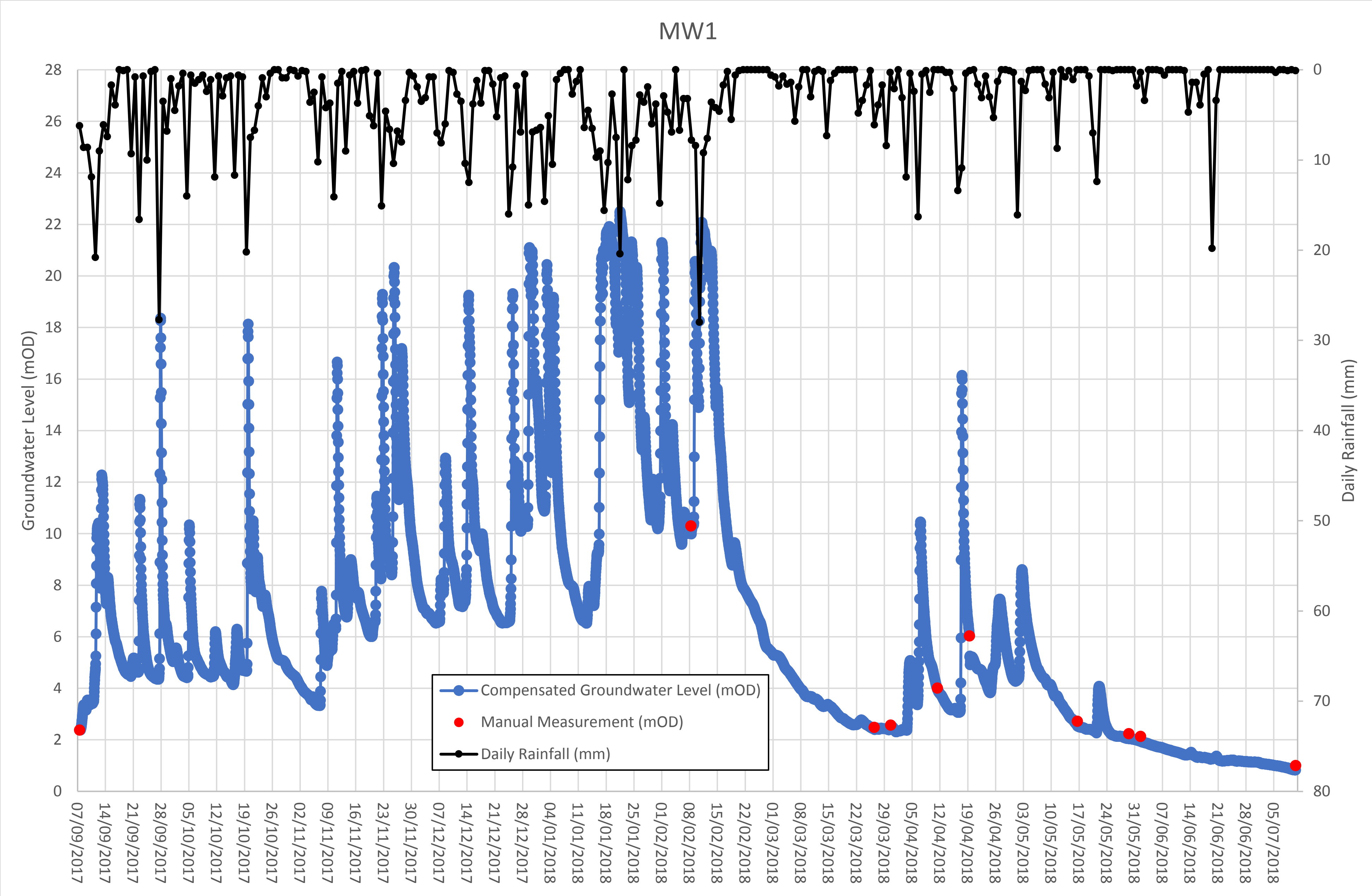
	12/07/2017	23/08/2017	28/08/2017	07/09/2017	08/02/2018	26/03/2018	30/03/2018	11/04/2018	19/04/2018	16/05/2018	29/05/2018	01/06/2018	10/07/2018
MW1	-6.89	8.91	4.17	2.38	10.30	2.48	2.57	4.01	6.04	2.72	2.237	2.132	1.007
MW2	0.59	15.31	13.19	7.19	13.20	Dry	Dry	1.48	1.87	0.98	Dry	Dry	Dry
MW3	-1.94	-1.90	-1.91	-1.91	-1.92	-1.94	-1.94	-1.95	-2.01	-1.76	-1.967	-1.987	-1.947
MW4	-5.76	-0.72	-1.18	-2.45	-0.27	-5.06	-3.83	-1.07	-1.04	-4.31	-4.943	-5.108	-6.058
MW5	-4.19	-3.52	-3.31	-3.39	1.16	-1.35	-1.44	-1.66	-2.80	-1.96	-2.01	-2.045	-2.895
MW6	-6.67	-5.64	-5.65	-5.93	1.76	-3.30	-3.46	-3.85	-4.00	-4.23	-4.245	-4.305	-5.225
MW7	-9.14	-8.00	-8.09	-8.40	-2.94	-6.08	-6.15	-6.35	-6.52	-6.66	-6.642	-6.662	-7.482
MW8	-5.27	-0.89	-1.03	-2.18	-0.37	-3.67	-3.51	-0.81	-0.84	-3.80	-4.373	-4.633	-5.423
MW9	-1.37	-1.07	-1.15	-1.17	-0.56	-1.16	-1.13	-1.13	-1.10	-1.19	-1.202	-1.237	-1.147
MW10c	-	21.78	21.00	-7.09	16.72	-4.98	-5.03	-4.89	13.42	-5.58	-5.575	-5.565	-5.99
MW11	-	17.27	16.35	11.85	17.65	-4.72	4.85	3.85	-4.80	-4.71	-4.696	-4.721	-4.716
Old Well	-	-	8.00	7.65	6.20	4.96	5.59	7.98	6.05	5.87	5.774	5.224	Dry

Notes:

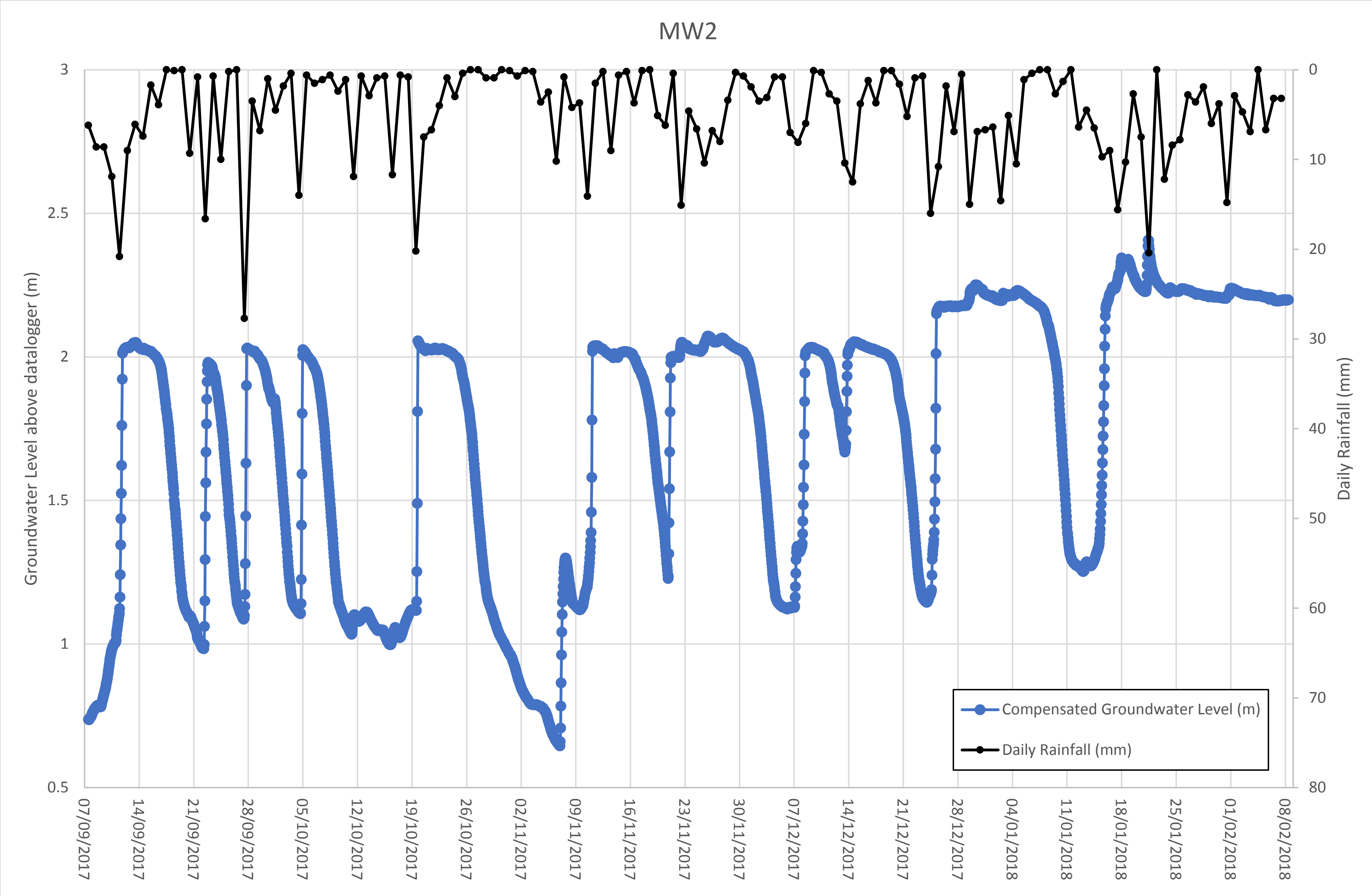
mbtoc - meters below top of casing

mOD - meters above Ordinance Datum

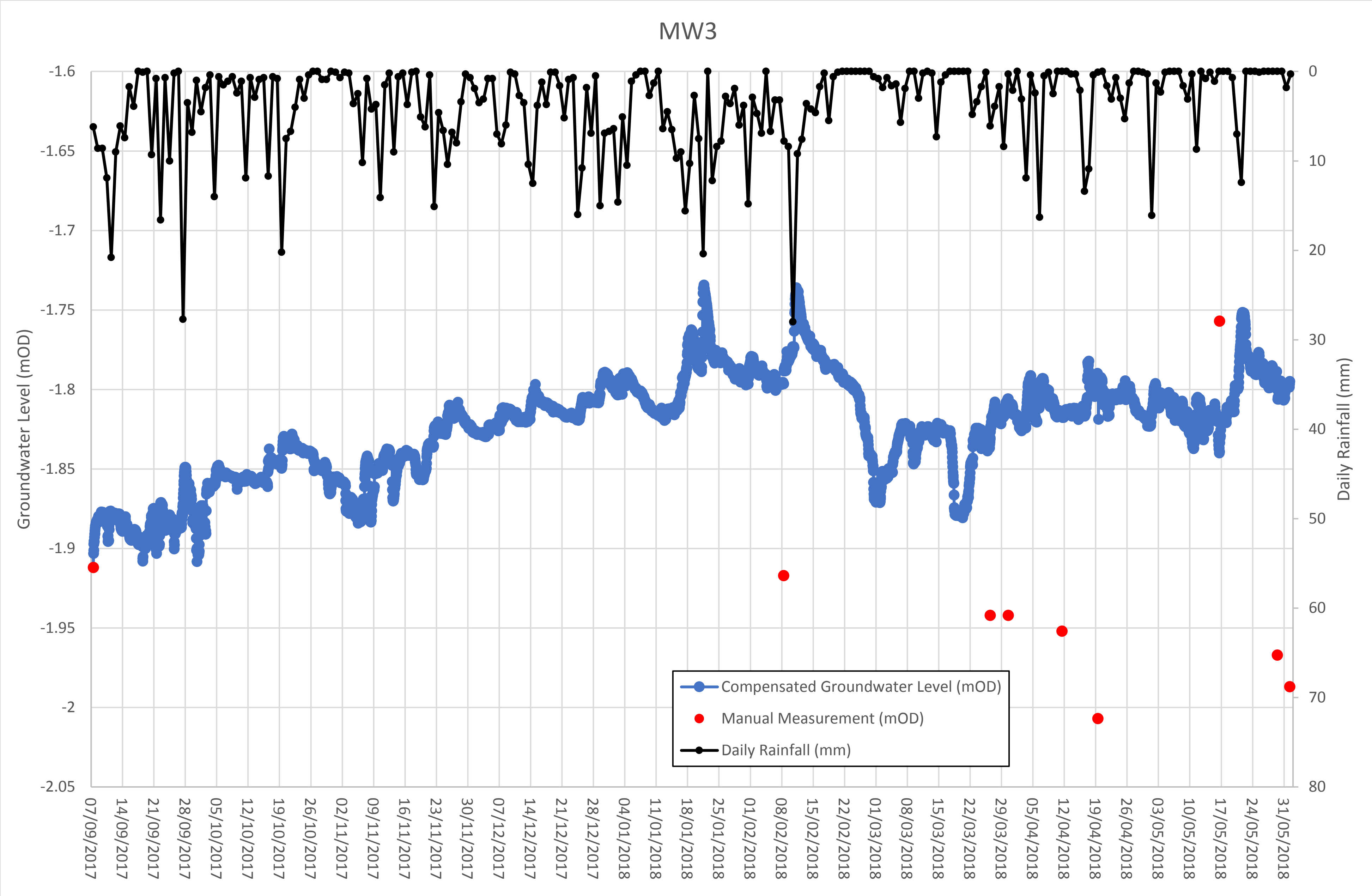
Estimated only, may not be correct



MW1
Groundwater Level (mOD)
Daily Rainfall (mm)
Compensated Groundwater Level (mOD)
Manual Measurement (mOD)
Daily Rainfall (mm)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
0
10
20
30
40
50
60
70
80
07/09/2017
14/09/2017
21/09/2017
28/09/2017
05/10/2017
12/10/2017
19/10/2017
26/10/2017
02/11/2017
09/11/2017
16/11/2017
23/11/2017
30/11/2017
07/12/2017
14/12/2017
21/12/2017
28/12/2017
04/01/2018
11/01/2018
18/01/2018
25/01/2018
01/02/2018
08/02/2018
15/02/2018
22/02/2018
01/03/2018
08/03/2018
15/03/2018
22/03/2018
29/03/2018
05/04/2018
12/04/2018
19/04/2018
26/04/2018
03/05/2018
10/05/2018
17/05/2018
24/05/2018
31/05/2018
07/06/2018
14/06/2018
21/06/2018
28/06/2018
05/07/2018



MW2
Groundwater Level above datalogger (m)
Daily Rainfall (mm)
3
2.5
2
1.5
1
0.5
0
10
20
30
40
50
60
70
80
07/09/2017
14/09/2017
21/09/2017
28/09/2017
05/10/2017
12/10/2017
19/10/2017
26/10/2017
02/11/2017
09/11/2017
16/11/2017
23/11/2017
30/11/2017
07/12/2017
14/12/2017
21/12/2017
28/12/2017
04/01/2018
11/01/2018
18/01/2018
25/01/2018
01/02/2018
08/02/2018
Compensated Groundwater Level (m)
Daily Rainfall (mm)


MW3
Groundwater Level (mOD)
Daily Rainfall (mm)
-1.6
-1.65
-1.7
-1.75
-1.8
-1.85
-1.9
-1.95
-2
-2.05
0
10
20
30
40
50
60
70
80
Compensated Groundwater Level (mOD)
Manual Measurement (mOD)
Daily Rainfall (mm)
07/09/2017
14/09/2017
21/09/2017
28/09/2017
05/10/2017
12/10/2017
19/10/2017
26/10/2017
02/11/2017
09/11/2017
16/11/2017
23/11/2017
30/11/2017
07/12/2017
14/12/2017
21/12/2017
28/12/2017
04/01/2018
11/01/2018
18/01/2018
25/01/2018
01/02/2018
08/02/2018
15/02/2018
22/02/2018
01/03/2018
08/03/2018
15/03/2018
22/03/2018
29/03/2018
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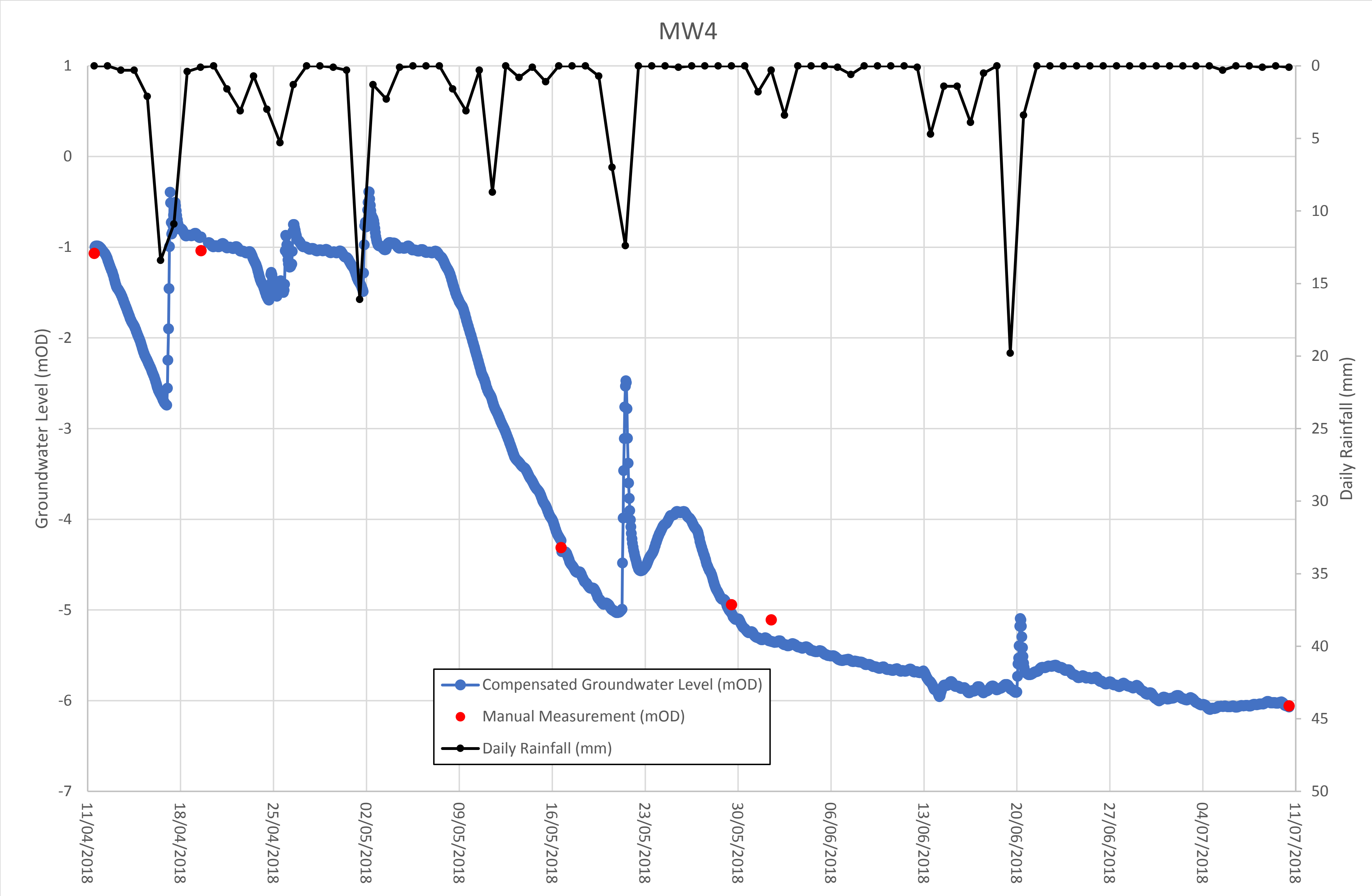
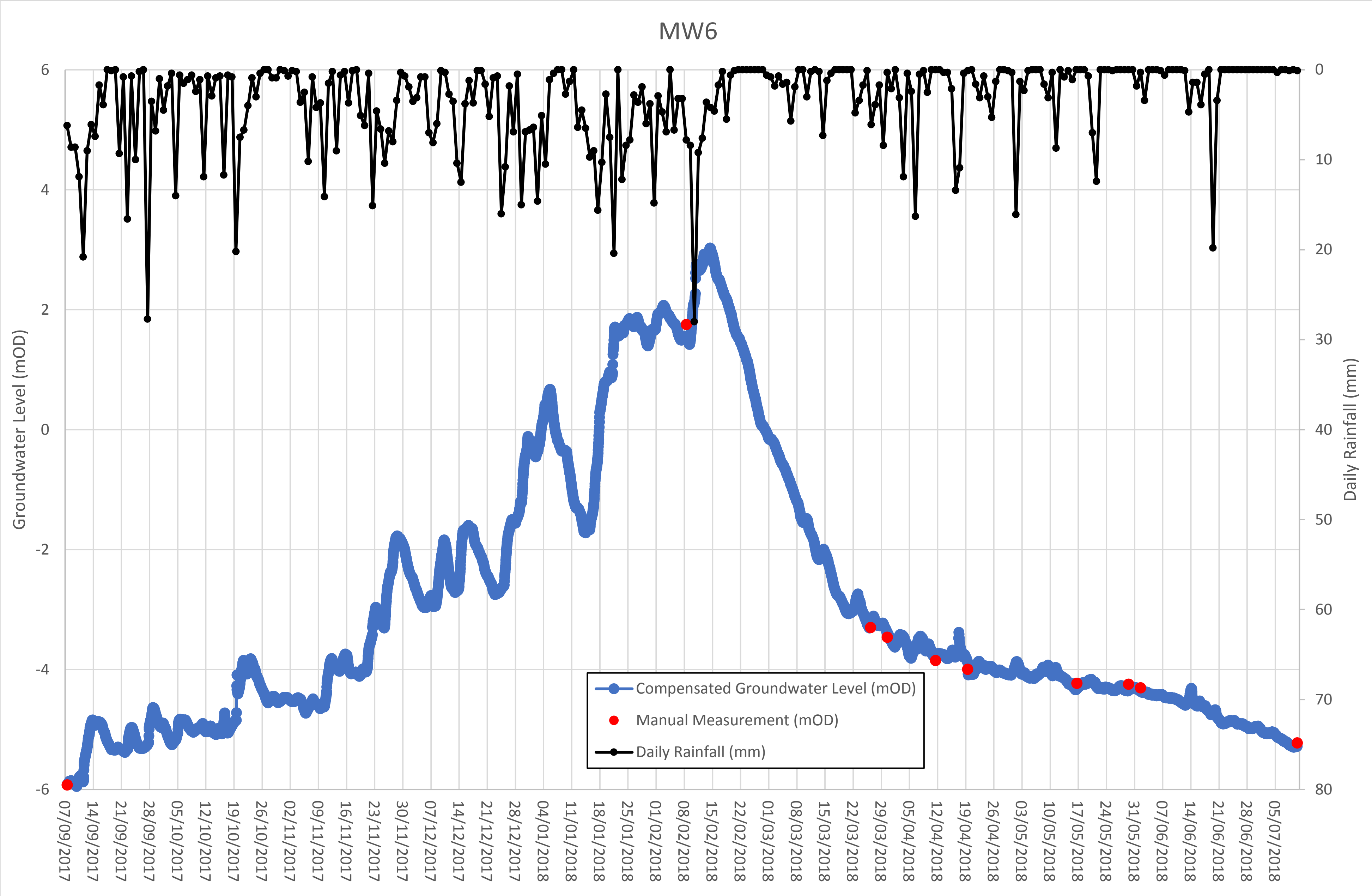
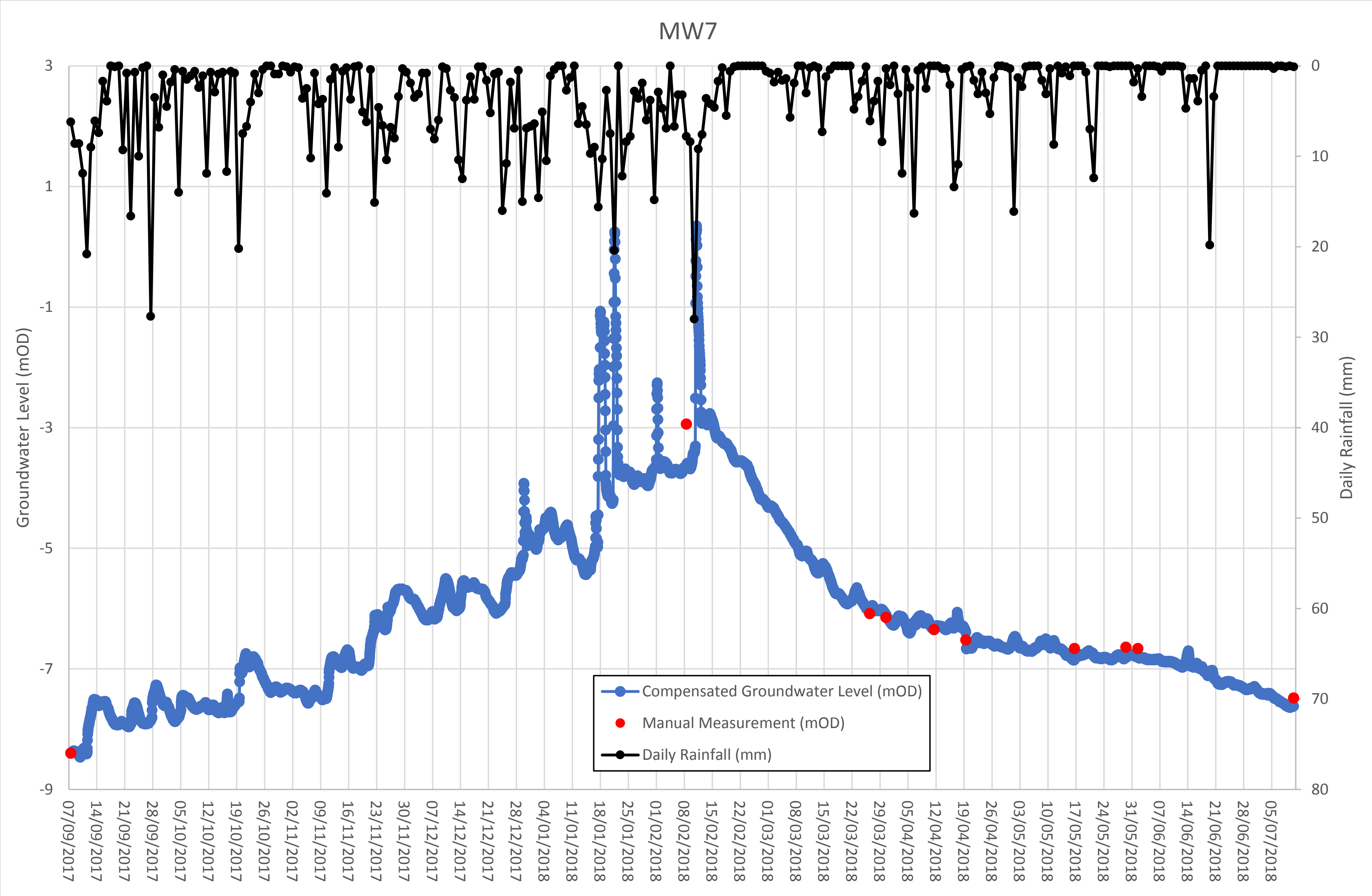
24/05/2018
31/05/2018



MW4
Groundwater Level (mOD)
Daily Rainfall (mm)
1
0
-1
-2
-3
-4
-5
-6
-7
0
5
10
15
20
25
30
35
40
45
50
11/04/2018
18/04/2018
25/04/2018
02/05/2018
09/05/2018
16/05/2018
23/05/2018
30/05/2018
06/06/2018
13/06/2018
20/06/2018
27/06/2018
04/07/2018
11/07/2018
Compensated Groundwater Level (mOD)
Manual Measurement (mOD)
Daily Rainfall (mm)



MW6
Groundwater Level (mOD)
Daily Rainfall (mm)
6
4
2
0
-2
-4
-6
0
10
20
30
40
50
60
70
80
Compensated Groundwater Level (mOD)
Manual Measurement (mOD)
Daily Rainfall (mm)
07/09/2017
14/09/2017
21/09/2017
28/09/2017
05/10/2017
12/10/2017
19/10/2017
26/10/2017
02/11/2017
09/11/2017
16/11/2017
23/11/2017
30/11/2017
07/12/2017
14/12/2017
21/12/2017
28/12/2017
04/01/2018
11/01/2018
18/01/2018
25/01/2018
01/02/2018
08/02/2018
15/02/2018
22/02/2018
01/03/2018
08/03/2018
15/03/2018
22/03/2018
29/03/2018
05/04/2018
12/04/2018
19/04/2018
26/04/2018
03/05/2018
10/05/2018
17/05/2018
24/05/2018
31/05/2018
07/06/2018
14/06/2018
21/06/2018
28/06/2018
05/07/2018



MW7
Groundwater Level (mOD)
Daily Rainfall (mm)
Compensated Groundwater Level (mOD)
Manual Measurement (mOD)
Daily Rainfall (mm)
3
1
-1
-3
-5
-7
-9
0
10
20
30
40
50
60
70
80
07/09/2017
14/09/2017
21/09/2017
28/09/2017
05/10/2017
12/10/2017
19/10/2017
26/10/2017
02/11/2017
09/11/2017
16/11/2017
23/11/2017
30/11/2017
07/12/2017
14/12/2017
21/12/2017
28/12/2017
04/01/2018
11/01/2018
18/01/2018
25/01/2018
01/02/2018
08/02/2018
15/02/2018
22/02/2018
01/03/2018
08/03/2018
15/03/2018
22/03/2018
29/03/2018
05/04/2018
12/04/2018
19/04/2018
26/04/2018
03/05/2018
10/05/2018
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24/05/2018
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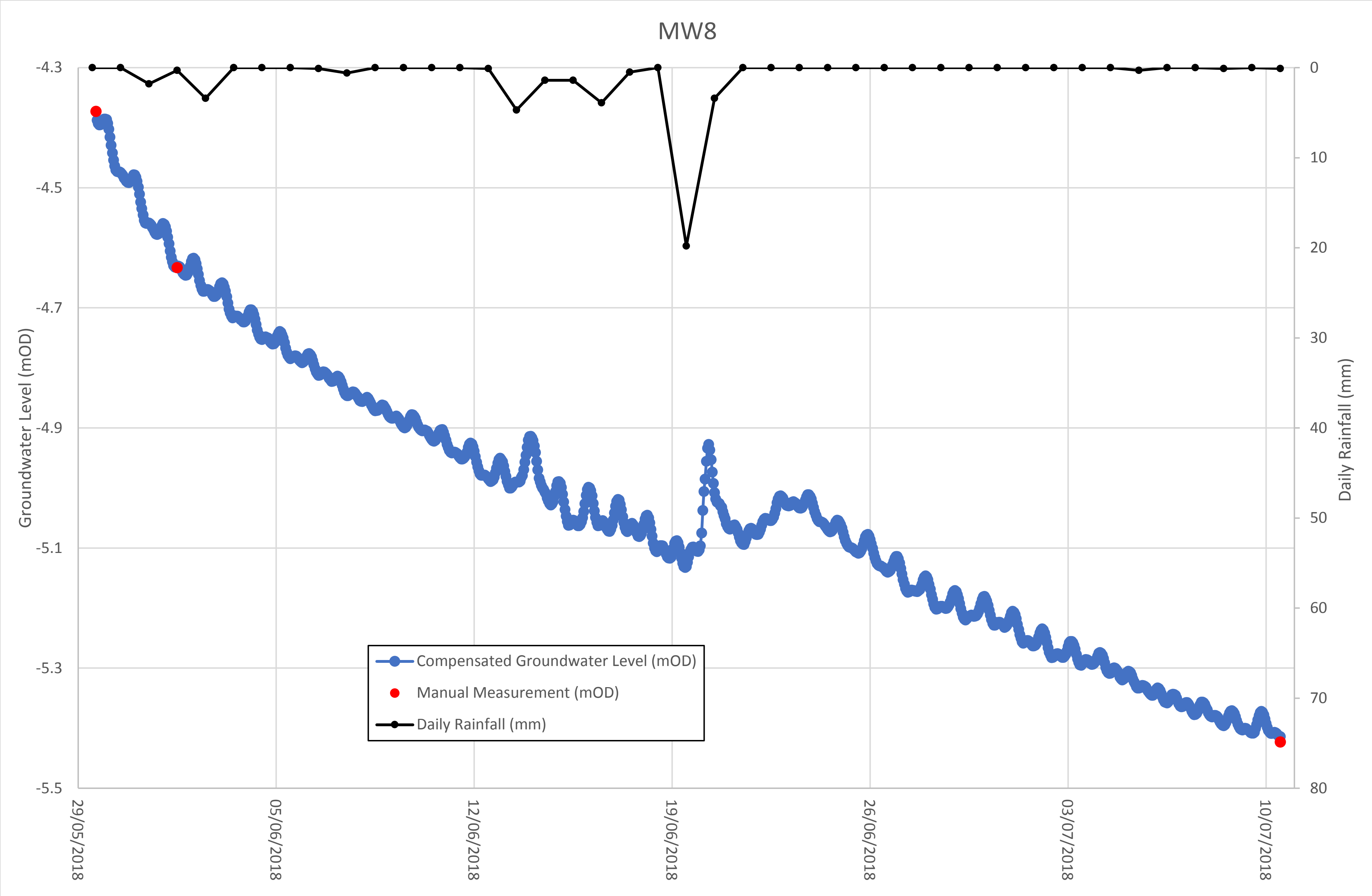
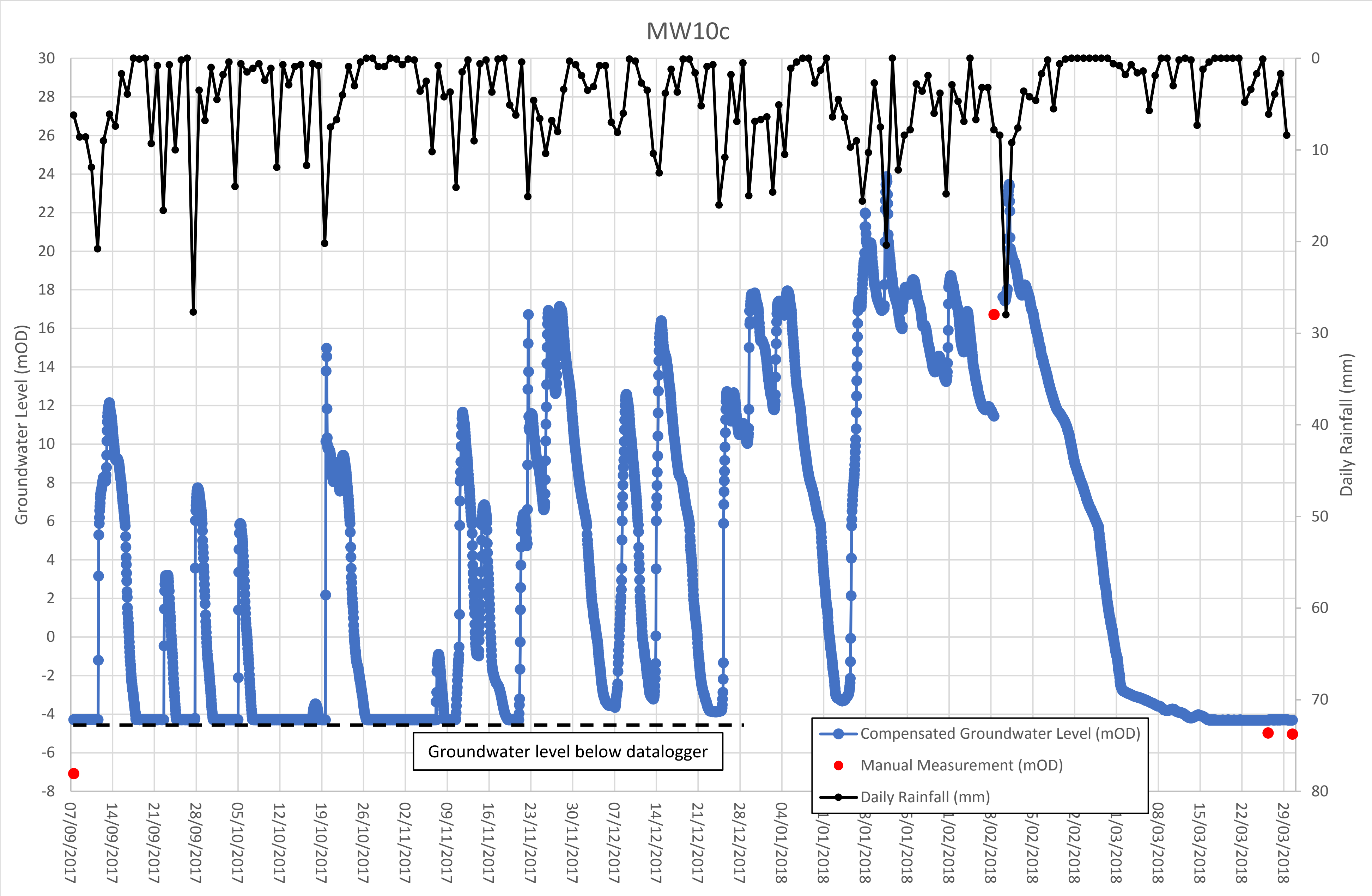
21/06/2018
28/06/2018
05/07/2018


MW8
Groundwater Level (mOD)
Daily Rainfall (mm)
-4.3
-4.5
-4.7
-4.9
-5.1
-5.3
-5.5
0
10
20
30
40
50
60
70
80
29/05/2018
05/06/2018
12/06/2018
19/06/2018
26/06/2018
03/07/2018
10/07/2018
Compensated Groundwater Level (mOD)
Manual Measurement (mOD)
Daily Rainfall (mm)



MW10c
Groundwater Level (mOD)
Daily Rainfall (mm)
Groundwater level below datalogger
Compensated Groundwater Level (mOD)
Manual Measurement (mOD)
Daily Rainfall (mm)

Groundwater Samples

			MW1		MW2		MW3		MW4		MW5		MW6		MW7		MW8		MW9		MW10c		MW11		Groundwater	Drinking Water
	Parameter	Units	08/02/2018	19/04/2018	08/02/2018	19/04/2018	08/02/2018	19/04/2018	08/02/2018	19/04/2018	08/02/2018	19/04/2018	08/02/2018	19/04/2018	08/02/2018	19/04/2018	08/02/2018	19/04/2018	08/02/2018	19/04/2018	08/02/2018	19/04/2018	08/02/2018	19/04/2018	Threshold Values [5]	Parametric Values [6]
Field	Temperature	°C	9.1	9.9	9.5	10.8	9.0	10.8	8.6	10.3	9.7	10.4	9.9	10.6	10.2	10.9	9.5	10.4	9.3	10.1	10.0	10.8	9.6	10.3	-	-
	Conductivity (field)	µS/cm @ 25°C	379	280	896	815	887	760	676	460	645	669	641	643	1142	397	830	481	756	663	576	373	910	315	800 - 1875	2750 [7]
	pH	-	8.01	8.11	7.18	7.17	7.13	7.09	7.22	7.35	7.33	7.40	7.40	7.42	7.11	7.02	7.15	7.21	7.31	7.39	7.35	7.38	7.17	7.22	-	≥ 6.5 and ≤ 9.5
	Dissolved Oxygen [1]	% sat	88.7	90.1	66.2	70.5	41.0	53.6	76.8	79.7	71.4	69.7	68.7	70.3	80.6	85.8	66.1	72.5	58.2	55.4	77.5	82.6	80.2	83.8	-	-
	Dissolved Oxygen [1]	mg/l O_2	8.79	9.07	6.51	7.41	4.06	5.45	7.67	7.86	7.07	6.84	6.92	7.02	7.99	8.64	6.42	7.50	5.72	5.53	7.62	8.31	8.18	8.37	-	-
Whole Sample	Conductivity (lab) [2]	µS/cm @ 25°C	373	348	888	914	883	623	820	479	633	703	635	575	1122	450	677	507	792	754	572	391	869	348	800 - 1875	2750 [7]
	Total Suspended Solids [3]	mg/l	50.3	114	278	78.6	149	> 200	84.8	186	180	70.1	313	> 200	227	35	83.6	49.7	101	32.6	< 3	35	228	20.1	-	-
	Turbidity [3]	NTU	65.3	76.8	143	101	22.4	14.3	140	80.3	31.9	47.3	104	72.3	77.1	101.4	87.4	92.3	59.4	62.7	1.74	1.34	563	415	-	NAC [8]
	Biological Oxygen Demand	mg/l O_2	< 2	< 2	< 2	< 2	3.51	< 2	< 2	< 2	3.34	< 2	3.98	< 2	< 2	< 2	3.93	< 2	2.85	< 2	< 2	< 2	< 2	< 2	-	-
	Total Organic Carbon	mg/l	4.2	3.7	1.8	0.6	0.5	< 0.3	0.4	<0.3	0.7	0.5	0.8	1.2	1.2	1.5	1.15	0.9	2.7	3.8	< 0.3	< 0.3	1.4	2	-	NAC [8]
	Total Alkalinity	mg/l $CaCO_3$	171	160	378	428	344	430	366	218	254	330	274	296	330	218	304	244	286	328	286	178	336	158	-	-
Major Constituents	Calcium	mg/l	55.5	53.4	149	137	85.7	125	123	75.6	73.4	98.5	115	101	200	72.2	123	83.2	117	109	95.7	58.2	135	50.2	-	-
	Magnesium	mg/l	12	12.5	24.1	26.4	24.5	24.2	28.1	10.8	20.5	26.7	28.9	27.6	61.5	10.6	15	11.8	20.5	20.3	11.5	11.3	22.9	10.7	-	-
	Sodium	mg/l	7.7	7.08	10	11.8	10.3	10.8	9.68	6.48	9.13	9.39	6.56	9.44	12.2	6.5	9.67	7.01	27.7	21.5	7.37	7.08	18.4	6.6	-	200
	Potassium	mg/l	0.59	0.62	2.17	1.65	2.34	1.69	0.62	1.03	1.34	0.65	0.78	0.68	0.8	0.83	1.17	1.1	5.11	3.15	0.53	0.74	1.59	0.58	-	-
	Bicarbonate	mg/l	209	195	461	522	420	525	447	266	310	403	334	361	403	266	371	298	349	400	349	217	410	193	-	-
	Chloride	mg/l	18.4	9.43	27.8	29.3	25.3	25.3	16.9	7.94	18.9	15.4	15.4	14.9	15.9	9.93	18.4	8.93	54.1	41.2	17.4	12.9	45.2	13.4	24 - 187.5	250
	Sulphate	mg/l	3.54	6.3	1.17	5.94	9.63	22.1	28.8	26.7	15.1	43.1	18	33.5	308	18.3	10.7	25.9	19.5	29	< 2.0	12.2	16.8	5.48	187.5	250
Minor Constituents	Fluoride	mg/l	0.09	1.27	0.07	0.23	0.22	0.32	0.59	0.14	0.79	0.14	0.15	0.26	0.06	0.32	0.18	0.54	0.10	0.11	0.15	0.17	0.09	0.12	-	1.5
	Nitrate	mg/l NO_3	1.76	3.74	7.66	11.2	5.5	7.97	7.62	2.99	3.58	1.83	< 1	2.99	< 1	4.97	2.56	4.67	9.46	4.9	2.3	3.35	7.34	1.77	37.5	50
	Nitrite	mg/l N	0.006	0.005	0.015	0.004	0.002	0.003	0.024	0.008	0.002	0.004	0.002	0.006	0.006	0.008	0.014	0.005	0.006	0.004	0.002	0.005	0.032	0.003	0.114 [9]	0.152 [9]
	Total Ammonia	mg/l N	< 0.02	0.03	0.09	0.02	< 0.02	0.04	< 0.02	0.03	< 0.02	0.02	0.04	0.03	< 0.02	0.03	0.26	0.04	< 0.02	0.05	< 0.02	0.03	0.06	0.04	0.065 - 0.175	0.23 [9]
	Total Nitrogen	mg/l N	< 1	< 1	< 1	2.7	< 1	1.9	< 1	< 1	< 1	< 1	< 1	< 1	< 1	1.2	< 1	1.1	< 1	1.2	< 1	< 1	< 1	< 1	-	-
	Orthophosphate	mg/l P	< 0.02	< 0.02	< 0.02	0.02	< 0.02	0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.04	< 0.02	0.03	< 0.02	0.03	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.035	-
	Total Phosphorus	mg/l P	< 0.12	<0.12	0.12	<0.12	< 0.12	<0.12	< 0.12	<0.12	< 0.12	<0.12	< 0.12	<0.12	< 0.12	< 0.12	< 0.12	< 0.12	0.20	< 0.12	< 0.12	< 0.12	0.27	< 0.12	-	-
	Iron (Dissolved) [4]	mg/l	< 0.23	< 0.23	<0.23	< 0.23	<0.23	< 0.23	<0.23	< 0.23	<0.23	< 0.23	<0.23	< 0.23	<0.23	< 0.23	< 0.23	< 0.23	<0.23	0.67	<0.23	< 0.23	<0.23	< 0.23	-	0.2
	Manganese (Dissolved) [4]	mg/l	< 0.007	< 0.007	0.013	0.01	0.046	< 0.007	< 0.007	< 0.007	0.012	< 0.007	0.027	0.01	0.513	< 0.007	0.008	< 0.007	< 0.007	0.335	< 0.007	< 0.007	0.058	< 0.007	-	0.05
Trace Metals	Aluminium (Dissolved) [4]	µg/l	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	150	200
	Arsenic (Dissolved) [4]	µg/l	< 1	< 1	< 1	< 1	< 1	< 1	1.2	< 1	1.2	< 1	< 1	6.2	4.3	< 1	< 1	< 1	< 1	< 1	< 1	< 1	1.3	< 1	7.5	10
	Boron (Dissolved) [4]	µg/l	< 230	< 230	< 230	< 230	< 230	< 230	< 230	240	< 230	< 230	< 230	< 230	< 230	< 230	< 230	< 230	< 230	< 230	< 230	< 230	< 230	< 230	-	1000
	Cadmium (Dissolved) [4]	µg/l	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	-	5
	Chromium (Dissolved) [4]	µg/l	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	2	< 2	< 2	< 2	37.5	50
	Copper (Dissolved) [4]	µg/l	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	15	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	< 9	-	2000
	Lead (Dissolved) [4]	µg/l	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6	7.5	10
	Mercury (Dissolved) [4]	µg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	0.04	< 0.01	0.75	1
	Nickel (Dissolved) [4]	µg/l	< 3	< 3	9	5	8	3	22	8	19	< 3	12	11	127	< 3	8	7	7	11	5	4	7	< 3	-	20
	Selenium (Dissolved) [4]	µg/l	< 0.8	< 0.8	< 0.8	< 0.8	2.8	0.86	1.71	0.99	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	1.26	< 0.8	-	10
	Zinc (Dissolved) [4]	µg/l	< 18	30	< 18	70	< 18	30	< 18	40	21	< 18	< 18	60	< 18	< 18	< 18	30	60	70	< 18	30	< 18	< 18	75	-
Hydrocarb	Total Petroleum Hydrocarbons	µg/l	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	7.5	-
	Volatile Organic Compounds	µg/l	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	-	-
	Polycyclic Aromatic Hydrocarbons	µg/l	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.075	0.1
Micro	Total Coliforms	mpn/100ml	166	> 2420	0	24	24	104	0	7	1	36	29	40	0	114	4	0	10	0	0	122	57	205	-	0
	Faecal Coliforms	mpn/100ml	112	687	6	10	25	89	1	5	1	96	21	47	2	276	15	2	4	0	0	138	29	99	-	-
	E. coli	mpn/100ml	42	4	0	12	21	5	0	0	1	0	4	0	0	0	4	0	5	0	0	1	13	0	-	0

Notes:

1. Dissolved Oxygen measured in bucket, indicative only
2. Conductivity (lab) converted to 25°C reference temperature assuming 2%/°C
3. Elevated Total Suspended Solids and Turbidity related to sampling method (bailer), not representative of mobile levels
4. Iron, Manganese and Trace Metals filtered on site using 0.45µm filter and preserved with nitric acid
5. European Union Environmental Objectives (Groundwater)(Amendment) Regulations 2016 (S.I. No. 366 of 2016)
6. European Union (Drinking Water) Regulations 2014 (S.I. No. 122 of 2014)
7. Corrected to 25°C
8. No Abnormal Change
9. Converted to mg/l N

Concentration shaded where threshold/limit value exceeded

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Settlement Lagoon Details

1. Design Settling Velocity

Parameter	Symbol	Value	Units	Notes
Diameter of particle	d	4.0×10^{-6}	m	Mid-range for fine silt
Density of settling particle	ϱ_p	2600	kg/m^3	
Density of water	ϱ_w	1000	kg/m^3	
Dynamic viscosity of water	μ	1.307×10^{-3}	kg/m.s	At 10 degrees Celcius
Acceleration due to gravity	g	9.81	m/s^2	
Settling Velocity (from Stokes Law)	V_s	1.067×10^{-5}	m/s	
Design Settling Velocity	V_s	1.0×10^{-5}	m/s	

Stokes Law:

$$V_s = \frac{g(\rho_s - \rho_w)d^2}{18\mu}$$

where
V_s = terminal settling velocity of the solid particle
g = gravitational acceleration
ρ_s = density of settling particle
ρ_w = density of water
d = diameter of particle
μ = dynamic viscosity

2. Design Flow Rate

Parameter	Symbol	Value	Units	Notes
Maximum discharge rate	Q	0.0405	m^3/s	As per discharge licence
Groundwater inflows	Q	0.0122	m^3/s	At final quarry depth of -50moD
Maximum excess discharge rate	Q	0.0283	m^3/s	Maximum rate available for storm water pumping
Design Flow Rate	Q_{max}	0.0283	m^3/s	

3. Surface Area Required

Parameter	Symbol	Value	Units	Notes
Surface Area	A	2830	m^2	Surface Area Required = Design Flow Rate/Settling Velocity

Notes:

1. Settlement lagoon to have standing water depth of 1.5m
2. Settlement lagoon to have freeboard of 0.5m
3. Settlement lagoon base/sides to be lined to prevent leakage

Storm Water and Attenuation Volumes

Total Contributing Area	125000	m^2
Excess Rate from Attenuation Storage	28.3	l/s

Rainfall Return Period 1 year (AEP [3] 100%)									
Rainfall Duration		Rainfall (mm)	Rainfall + 10% [4] (mm)	Excess Rainfall [5] (mm)	Excess Rainfall (m)	Storm Water (m^3)	Outflow (m^3)	Required Storage [6] (m^3)	Time to Empty (hrs)
5	min	3.8	4.18	-	-	-	-	-	-
10	min	5.3	5.83	0.83	0.00083	103.75	16.98	87	0.9
15	min	6.3	6.93	1.93	0.00193	241.25	25.47	216	2.1
30	min	8.2	9.02	4.02	0.00402	502.5	50.94	452	4.4
1	hr	10.7	11.77	6.77	0.00677	846.25	101.88	744	7.3
2	hr	14	15.4	10.4	0.0104	1300	203.76	1096	10.8
3	hr	16.3	17.93	12.93	0.01293	1616.25	305.64	1311	12.9
4	hr	18.2	20.02	15.02	0.01502	1877.5	407.52	1470	14.4
6	hr	21.3	23.43	18.43	0.01843	2303.75	611.28	1692	16.6
9	hr	24.8	27.28	22.28	0.02228	2785	916.92	1868	18.3
12	hr	27.7	30.47	25.47	0.02547	3183.75	1222.56	1961	19.3
18	hr	32.4	35.64	30.64	0.03064	3830	1833.84	1996	19.6
24	hr	36.2	39.82	34.82	0.03482	4352.5	2445.12	1907	18.7
2	day	46.7	51.37	46.37	0.04637	5796.25	4890.24	906	8.9
3	day	55.6	61.16	56.16	0.05616	7020	7335.36	-315	-3.1
4	day	63.8	70.18	65.18	0.06518	8147.5	9780.48	-1633	-16.0
6	day	78.7	86.57	81.57	0.08157	10196.25	14670.72	-4474	-43.9
8	day	92.4	101.64	96.64	0.09664	12080	19560.96	-7481	-73.4

Rainfall Return Period 5 years (AEP 20%)									
Rainfall Duration		Rainfall (mm)	Rainfall + 10% (mm)	Excess Rainfall (mm)	Excess Rainfall (m)	Storm Water (m^3)	Outflow (m^3)	Required Storage (m^3)	Time to Empty (hrs)
5	min	6	6.6	1.6	0.0016	200	8.49	192	1.9
10	min	8.4	9.24	4.24	0.00424	530	16.98	513	5.0
15	min	9.8	10.78	5.78	0.00578	722.5	25.47	697	6.8
30	min	12.6	13.86	8.86	0.00886	1107.5	50.94	1057	10.4
1	hr	16.1	17.71	12.71	0.01271	1588.75	101.88	1487	14.6
2	hr	20.5	22.55	17.55	0.01755	2193.75	203.76	1990	19.5
3	hr	23.7	26.07	21.07	0.02107	2633.75	305.64	2328	22.9
4	hr	26.3	28.93	23.93	0.02393	2991.25	407.52	2584	25.4
6	hr	30.3	33.33	28.33	0.02833	3541.25	611.28	2930	28.8
9	hr	35	38.5	33.5	0.0335	4187.5	916.92	3271	32.1
12	hr	38.7	42.57	37.57	0.03757	4696.25	1222.56	3474	34.1
18	hr	44.7	49.17	44.17	0.04417	5521.25	1833.84	3687	36.2
24	hr	49.5	54.45	49.45	0.04945	6181.25	2445.12	3736	36.7
2	day	61.6	67.76	62.76	0.06276	7845	4890.24	2955	29.0
3	day	71.8	78.98	73.98	0.07398	9247.5	7335.36	1912	18.8
4	day	81.1	89.21	84.21	0.08421	10526.25	9780.48	746	7.3
6	day	97.8	107.58	102.58	0.10258	12822.5	14670.72	-1848	-18.1
8	day	113.1	124.41	119.41	0.11941	14926.25	19560.96	-4635	-45.5

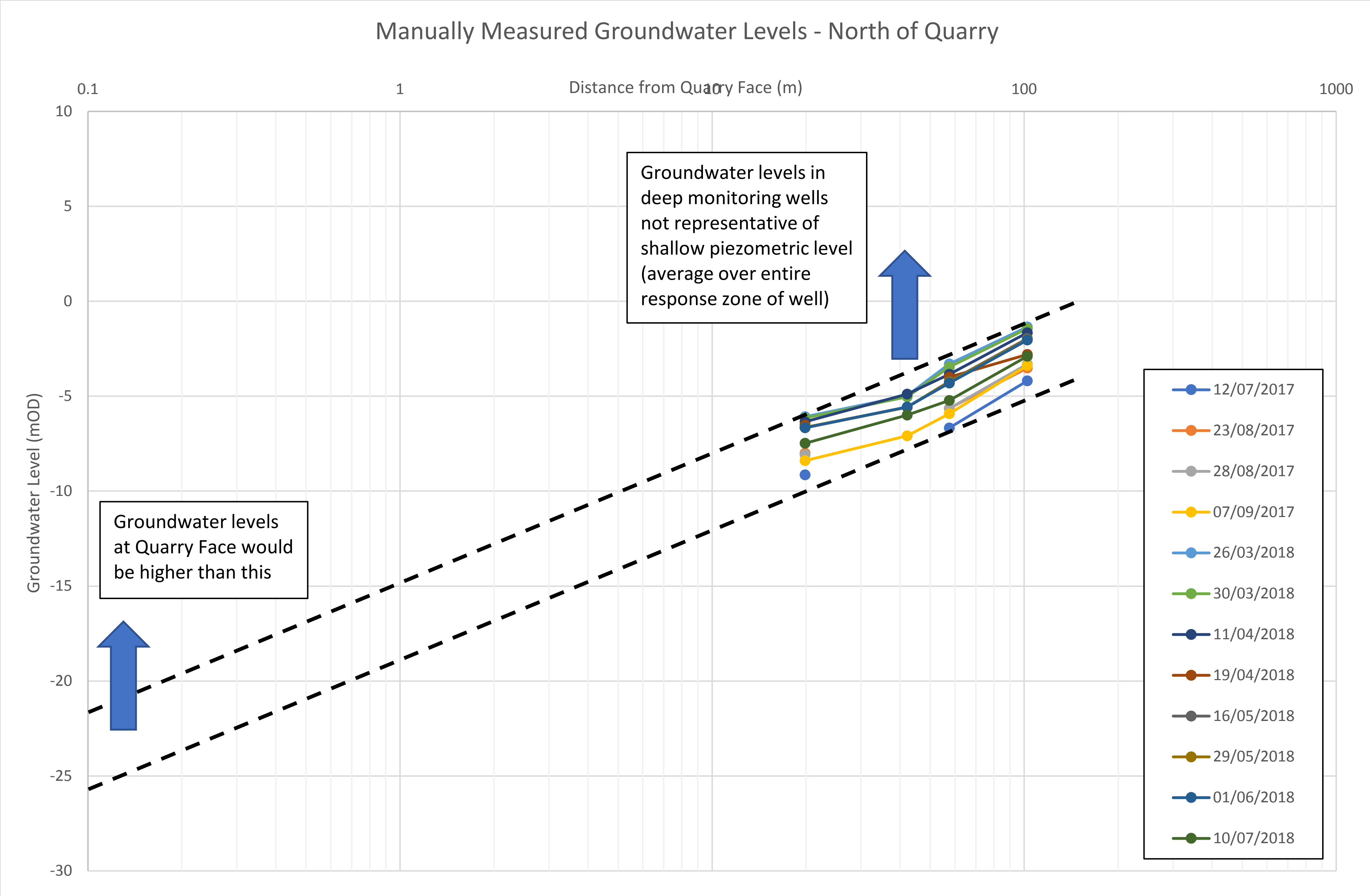
Rainfall Return Period 10 years (AEP 10%)									
Rainfall Duration		Rainfall (mm)	Rainfall + 10% (mm)	Excess Rainfall (mm)	Excess Rainfall (m)	Storm Water (m^3)	Outflow (m^3)	Required Storage (m^3)	Time to Empty (hrs)
5	min	7.2	7.92	2.92	0.00292	365	8.49	357	3.5
10	min	10.1	11.11	6.11	0.00611	763.75	16.98	747	7.3
15	min	11.9	13.09	8.09	0.00809	1011.25	25.47	986	9.7
30	min	15	16.5	11.5	0.0115	1437.5	50.94	1387	13.6
1	hr	19.1	21.01	16.01	0.01601	2001.25	101.88	1899	18.6
2	hr	24.2	26.62	21.62	0.02162	2702.5	203.76	2499	24.5
3	hr	27.8	30.58	25.58	0.02558	3197.5	305.64	2892	28.4
4	hr	30.6	33.66	28.66	0.02866	3582.5	407.52	3175	31.2
6	hr	35.2	38.72	33.72	0.03372	4215	611.28	3604	35.4
9	hr	40.4	44.44	39.44	0.03944	4930	916.92	4013	39.4
12	hr	44.6	49.06	44.06	0.04406	5507.5	1222.56	4285	42.1
18	hr	51.2	56.32	51.32	0.05132	6415	1833.84	4581	45.0
24	hr	56.5	62.15	57.15	0.05715	7143.75	2445.12	4699	46.1
2	day	69.2	76.12	71.12	0.07112	8890	4890.24	4000	39.3
3	day	79.9	87.89	82.89	0.08289	10361.25	7335.36	3026	29.7
4	day	89.6	98.56	93.56	0.09356	11695	9780.48	1915	18.8
6	day	107.2	117.92	112.92	0.11292	14115	14670.72	-556	-5.5
8	day	123.1	135.41	130.41	0.13041	16301.25	19560.96	-3260	-32.0

Rainfall Return Period 30 years (AEP 3.3%)									
Rainfall Duration		Rainfall (mm)	Rainfall + 10% (mm)	Excess Rainfall (mm)	Excess Rainfall (m)	Storm Water (m^3)	Outflow (m^3)	Required Storage (m^3)	Time to Empty (hrs)
5	min	9.5	10.45	5.45	0.00545	681.25	8.49	673	6.6
10	min	13.2	14.52	9.52	0.00952	1190	16.98	1173	11.5
15	min	15.6	17.16	12.16	0.01216	1520	25.47	1495	14.7
30	min	19.5	21.45	16.45	0.01645	2056.25	50.94	2005	19.7
1	hr	24.4	26.84	21.84	0.02184	2730	101.88	2628	25.8
2	hr	30.6	33.66	28.66	0.02866	3582.5	203.76	3379	33.2
3	hr	34.8	38.28	33.28	0.03328	4160	305.64	3854	37.8
4	hr	38.3	42.13	37.13	0.03713	4641.25	407.52	4234	41.6
6	hr	43.6	47.96	42.96	0.04296	5370	611.28	4759	46.7
9	hr	49.8	54.78	49.78	0.04978	6222.5	916.92	5306	52.1
12	hr	54.6	60.06	55.06	0.05506	6882.5	1222.56	5660	55.6
18	hr	62.3	68.53	63.53	0.06353	7941.25	1833.84	6107	59.9
24	hr	68.4	75.24	70.24	0.07024	8780	2445.12	6335	62.2
2	day	81.8	89.98	84.98	0.08498	10622.5	4890.24	5732	56.3
3	day	93.3	102.63	97.63	0.09763	12203.75	7335.36	4868	47.8
4	day	103.7	114.07	109.07	0.10907	13633.75	9780.48	3853	37.8
6	day	122.3	134.53	129.53	0.12953	16191.25	14670.72	1521	14.9
8	day	139.1	153.01	148.01	0.14801	18501.25	19560.96	-1060	-10.4

Rainfall Return Period 100 years (AEP 1%)									
Rainfall Duration		Rainfall (mm)	Rainfall + 10% (mm)	Excess Rainfall (mm)	Excess Rainfall (m)	Storm Water (m^3)	Outflow (m^3)	Required Storage (m^3)	Time to Empty (hrs)
5	min	12.6	13.86	8.86	0.00886	1107.5	8.49	1099	10.8
10	min	17.6	19.36	14.36	0.01436	1795	16.98	1778	17.5
15	min	20.7	22.77	17.77	0.01777	2221.25	25.47	2196	21.6
30	min	25.6	28.16	23.16	0.02316	2895	50.94	2844	27.9
1	hr	31.6	34.76	29.76	0.02976	3720	101.88	3618	35.5
2	hr	39.1	43.01	38.01	0.03801	4751.25	203.76	4547	44.6
3	hr	44.2	48.62	43.62	0.04362	5452.5	305.64	5147	50.5
4	hr	48.3	53.13	48.13	0.04813	6016.25	407.52	5609	55.1
6	hr	54.7	60.17	55.17	0.05517	6896.25	611.28	6285	61.7
9	hr	61.9	68.09	63.09	0.06309	7886.25	916.92	6969	68.4
12	hr	67.6	74.36	69.36	0.06936	8670	1222.56	7447	73.1
18	hr	76.5	84.15	79.15	0.07915	9893.75	1833.84	8060	79.1
24	hr	83.5	91.85	86.85	0.08685	10856.25	2445.12	8411	82.6
2	day	97.6	107.36	102.36	0.10236	12795	4890.24	7905	77.6
3	day	109.7	120.67	115.67	0.11567	14458.75	7335.36	7123	69.9
4	day	120.7	132.77	127.77	0.12777	15971.25	9780.48	6191	60.8
6	day	140.4	154.44	149.44	0.14944	18680	14670.72	4009	39.4
8	day	158.2	174.02	169.02	0.16902	21127.5	19560.96	1567	15.4

Notes:

1. Estimates of point rainfall depths for different sliding durations and frequencies (Met Eireann)
2. Point location 570088, 831876 (ITM)
3. AEP - Annual Exceedance Probability
4. 10% allowance for future climate change
5. First 5mm of rainfall assumed to infiltrate/evaporate
6. Required storage is the volume of stormwater remaining after the rainfall event (assuming pumping throughout the rainfall event)


Manually Measured Groundwater Levels - North of Quarry
Distance from Quarry Face (m)
0.1
1
10
100
1000
Groundwater Level (mOD)
10
5
0
-5
-10
-15
-20
-25
-30
Groundwater levels in deep monitoring wells not representative of shallow piezometric level (average over entire response zone of well)
Groundwater levels at Quarry Face would be higher than this
12/07/2017
23/08/2017
28/08/2017
07/09/2017
26/03/2018
30/03/2018
11/04/2018
19/04/2018
16/05/2018
29/05/2018
01/06/2018
10/07/2018

Estimated Radius of Influence

Sichardt's Empirical Equation:

Sichardt's Empirical Equation:

$$R_o = C(H - h_w)\sqrt{(k)}$$

Where:

C is a constant (usually 3000)

H-h_w is drawdown at the excavation (m)

k is permeability (m/s)

Equivalent Well radius is 160m (match on aerial photo for lower bench)

1. Existing Situation (floor at -21mOD)

			Notes:
C	3000	-	Constant
H-h_w	27.5	m	Annual average
k	1.25 E-6	m/s	Packer tests
R_0 (beyond Equivalent Well)	92	m	Excludes Equivalent Well radius
R_0	252	m	Includes Equivalent Well radius

2. Bench at -34.5mOD

			Notes:
C	3000	-	Constant
H-h_w	41	m	Annual average
k	1.25 E-6	m/s	Packer tests
R_0 (beyond Equivalent Well)	138	m	Excludes Equivalent Well radius
R_0	298	m	Includes Equivalent Well radius

3. Bench at -50mOD

			Notes:
C	3000	-	Constant
H-h_w	56.5	m	Annual average
k	1.25 E-6	m/s	Packer tests
R_0 (beyond Equivalent Well)	190	m	Excludes Equivalent Well radius
R_0	350	m	Includes Equivalent Well radius

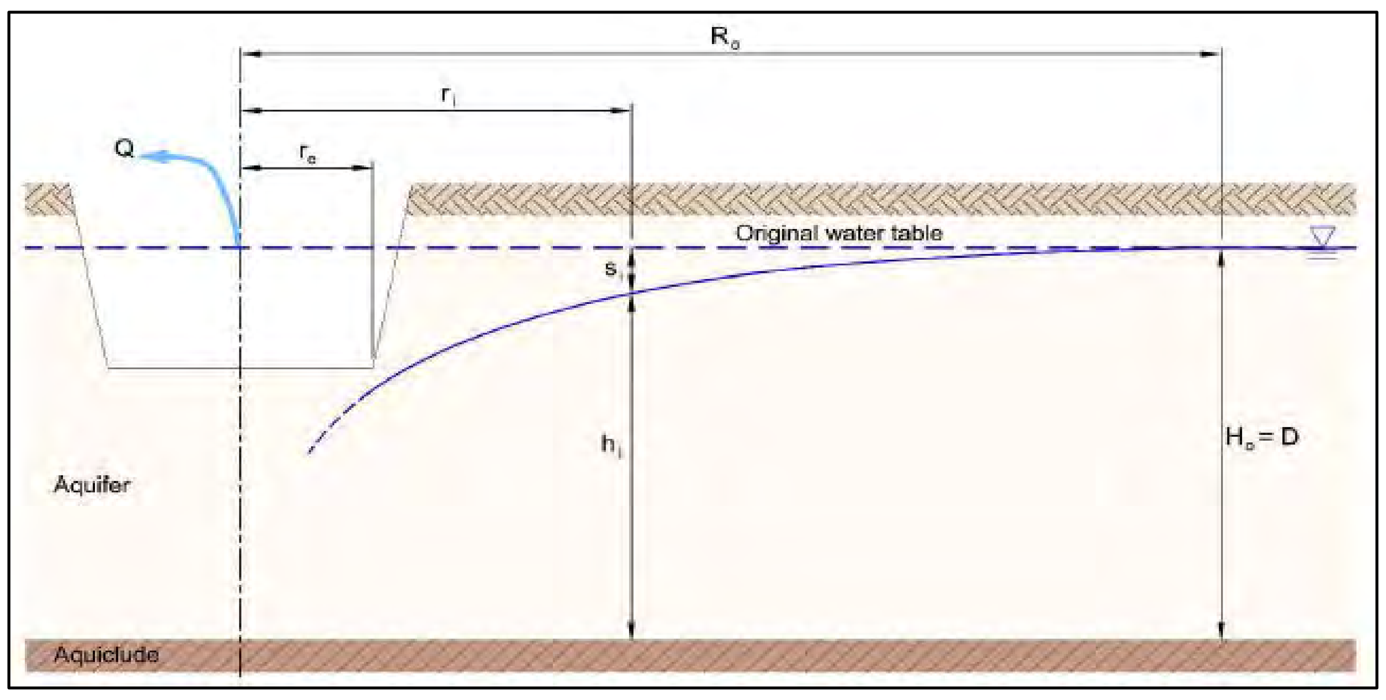
Radius of Influence and Groundwater Inflows

Iterative Method (Combined Thiem-Dupuit Equation & Rate-of-Recharge Method):

Existing Situation (floor at -21mOD):

1. Recharge Estimate:

			Notes:
Annual Rainfall (AR)	1,260	mm/yr	Annual mean at Markree Castle (Met Eireann)
Potential Evapotranspiration (PE)	499	mm/yr	Average of annual mean at Finner Camp and Knock Airport (Met Eireann)
Actual Evapotranspiration (AE)	474	mm/yr	Taken as 95% of PE
Effective Rainfall (ER)	786	mm/yr	AR - AE
Recharge Coefficient (rc)	90	%	Upper end estimate for thin moderately permeable overburden
Recharge (R)	707	mm/yr	ER x rc



2. Inputs:

			Notes:
k	0.108	m/d	Packer tests
H	27.5	m	Groundwater head above quarry floor outside zone of influence (annual average)
h_w	0	m	Groundwater head above quarry floor at quarry face
r_e	160	m	Equivalent Well radius, visual match on aerial photo for lower bench
R	0.001937	m/d	Recharge per day (annual average)

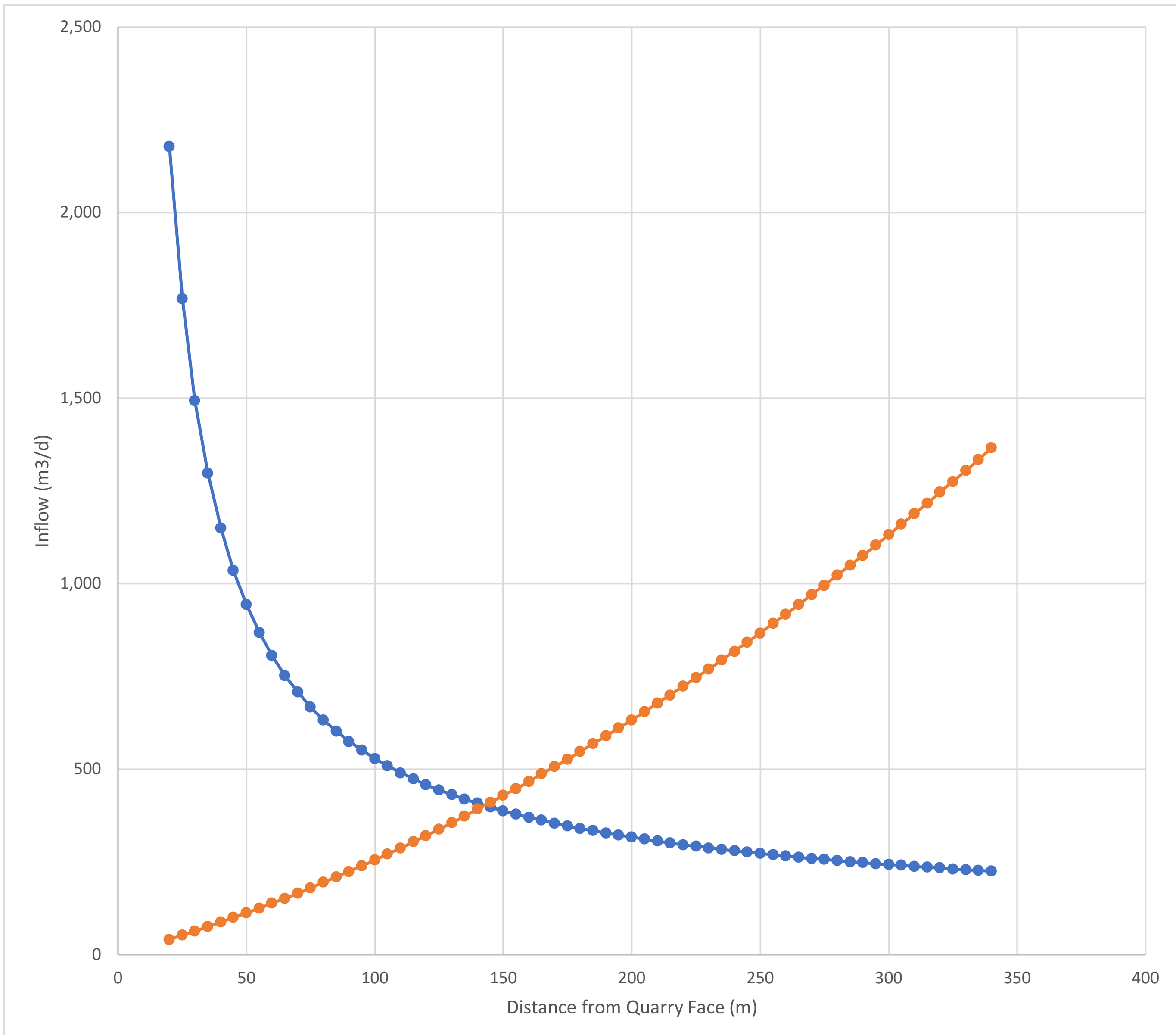
Thiem-Dupuit Equation:

$$Q = \frac{\pi k \left(H^2 - h_w^2\right)}{\ln\left[R_o / r_e\right]}$$

Assumptions:
- the aquifer is unconfined
- the aquifer has infinite areal extent
- the aquifer is homogeneous, and of uniform thickness
- there is only a small water table gradient
- groundwater flow is horizontal
- the pumping rate is constant
- the aquifer is fully penetrated
- the flow is in steady state
- the Dupuit assumptions are satisfied

3. Radius of Influence & Groundwater Inflows Estimate:

Distance from Quarry Face (m)	R_0 (m)	$Q_{groundwater\ inflows}$	$Q_{recharge}$
20	180	2178.49	41.38
25	185	1767.36	52.49
30	190	1493.10	63.90
35	195	1297.05	75.61
40	200	1149.89	87.63
45	205	1035.32	99.95
50	210	943.57	112.58
55	215	868.43	125.51
60	220	805.74	138.74
65	225	752.62	152.28
70	230	707.04	166.13
75	235	667.49	180.28
80	240	632.83	194.73
85	245	602.20	209.49
90	250	574.94	224.55
95	255	550.52	239.91
100	260	528.50	255.58
105	265	508.55	271.55
110	270	490.38	287.83
115	275	473.76	304.42
120	280	458.51	321.30
125	285	444.45	338.49
130	290	431.46	355.99
135	295	419.40	373.79
140	300	408.19	391.89
145	305	397.73	410.30
150	310	387.95	429.01
155	315	378.79	448.03
160	320	370.18	467.35
165	325	362.08	486.97
170	330	354.45	506.90
175	335	347.23	527.14
180	340	340.41	547.67
185	345	333.94	568.52
190	350	327.80	589.66
195	355	321.97	611.11
200	360	316.41	632.87
205	365	311.12	654.93
210	370	306.07	677.29
215	375	301.25	699.96
220	380	296.64	722.93
225	385	292.22	746.21
230	390	287.99	769.79
235	395	283.93	793.67
240	400	280.03	817.86
245	405	276.29	842.35
250	410	272.68	867.15
255	415	269.21	892.25
260	420	265.87	917.66
265	425	262.65	943.37
270	430	259.55	969.38
275	435	256.55	995.70
280	440	253.65	1022.32
285	445	250.85	1049.25
290	450	248.13	1076.48
295	455	245.51	1104.02
300	460	242.97	1131.86
305	465	240.51	1160.00
310	470	238.12	1188.45
315	475	235.81	1217.21
320	480	233.56	1246.26
325	485	231.38	1275.62
330	490	229.26	1305.29
335	495	227.19	1335.26
340	500	225.19	1365.53



For the Existing Situation:

R_0 (from Quarry Centre)	**303**	**m**
R_0 (from Quarry Face)	**143**	**m**
$Q_{groundwater\ inflows}$	**402**	**m^3/d**
$Q_{groundwater\ inflows}$	**4.7**	**l/s**

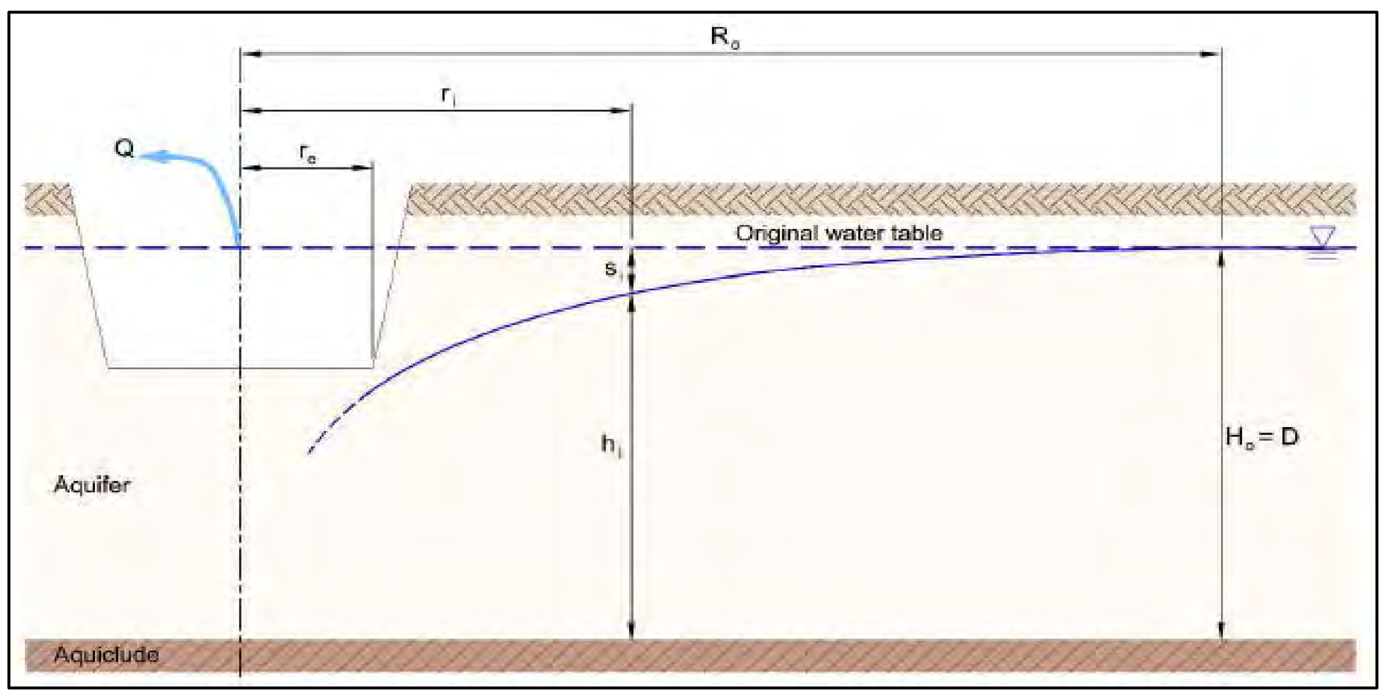
Radius of Influence and Groundwater Inflows

Iterative Method (Combined Thiem-Dupuit Equation & Rate-of-Recharge Method):

Bench at -34.5mOD:

1. Recharge Estimate:

			Notes:
Annual Rainfall (AR)	1,260	mm/yr	Annual mean at Markree Castle (Met Eireann)
Potential Evapotranspiration (PE)	499	mm/yr	Average of annual mean at Finner Camp and Knock Airport (Met Eireann)
Actual Evapotranspiration (AE)	474	mm/yr	Taken as 95% of PE
Effective Rainfall (ER)	786	mm/yr	AR - AE
Recharge Coefficient (rc)	90	%	Upper end estimate for thin moderately permeable overburden
Recharge (R)	707	mm/yr	ER x rc



2. Inputs:

			Notes:
k	0.108	m/d	Packer tests
H	41	m	Groundwater head above quarry floor outside zone of influence (annual average)
h_w	0	m	Groundwater head above quarry floor at quarry face
r_e	160	m	Equivalent Well radius, visual match on aerial photo for lower bench
R	0.001937	m/d	Recharge per day (annual average)

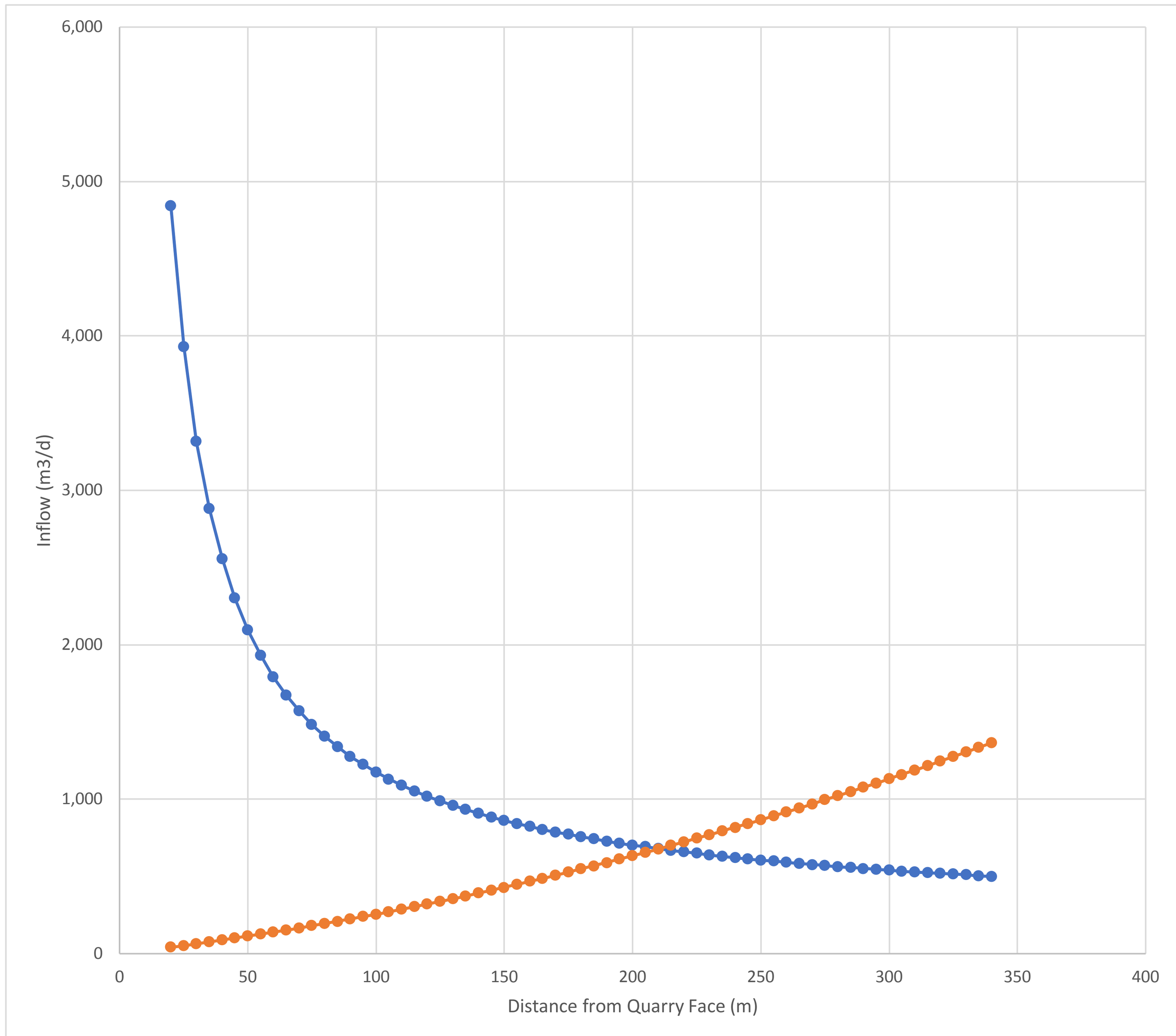
Thiem-Dupuit Equation:

$$Q = \frac{\pi k\left(H^2 - h_w^2\right)}{\ln\left[R_o / r_e\right]}$$

Assumptions:
- the aquifer is unconfined
- the aquifer has infinite areal extent
- the aquifer is homogeneous, and of uniform thickness
- there is only a small water table gradient
- groundwater flow is horizontal
- the pumping rate is constant
- the aquifer is fully penetrated
- the flow is in steady state
- the Dupuit assumptions are satisfied

3. Radius of Influence & Groundwater Inflows Estimate:

Distance from Quarry Face (m)	R_0 (m)	$Q_{groundwater\ inflows}$	$Q_{recharge}$
20	180	4842.38	41.38
25	185	3928.52	52.49
30	190	3318.88	63.90
35	195	2883.09	75.61
40	200	2555.98	87.63
45	205	2301.32	99.95
50	210	2097.39	112.58
55	215	1930.35	125.51
60	220	1791.00	138.74
65	225	1672.94	152.28
70	230	1571.62	166.13
75	235	1483.70	180.28
80	240	1406.66	194.73
85	245	1338.58	209.49
90	250	1277.99	224.55
95	255	1223.69	239.91
100	260	1174.75	255.58
105	265	1130.40	271.55
110	270	1090.02	287.83
115	275	1053.09	304.42
120	280	1019.18	321.30
125	285	987.93	338.49
130	290	959.04	355.99
135	295	932.25	373.79
140	300	907.32	391.89
145	305	884.07	410.30
150	310	862.34	429.01
155	315	841.97	448.03
160	320	822.84	467.35
165	325	804.84	486.97
170	330	787.86	506.90
175	335	771.83	527.14
180	340	756.66	547.67
185	345	742.28	568.52
190	350	728.64	589.66
195	355	715.67	611.11
200	360	703.33	632.87
205	365	691.56	654.93
210	370	680.34	677.29
215	375	669.62	699.96
220	380	659.37	722.93
225	385	649.55	746.21
230	390	640.14	769.79
235	395	631.12	793.67
240	400	622.46	817.86
245	405	614.13	842.35
250	410	606.12	867.15
255	415	598.41	892.25
260	420	590.99	917.66
265	425	583.83	943.37
270	430	576.92	969.38
275	435	570.25	995.70
280	440	563.81	1022.32
285	445	557.58	1049.25
290	450	551.56	1076.48
295	455	545.72	1104.02
300	460	540.08	1131.86
305	465	534.60	1160.00
310	470	529.30	1188.45
315	475	524.15	1217.21
320	480	519.15	1246.26
325	485	514.30	1275.62
330	490	509.59	1305.29
335	495	505.01	1335.26
340	500	500.56	1365.53



For Proposed Bench at -34.5mOD:

R_0 (from Quarry Centre)	**371**	**m**
R_0 (from Quarry Face)	**211**	**m**
$Q_{groundwater\ inflows}$	**678**	**m^3/d**
$Q_{groundwater\ inflows}$	**7.8**	**l/s**

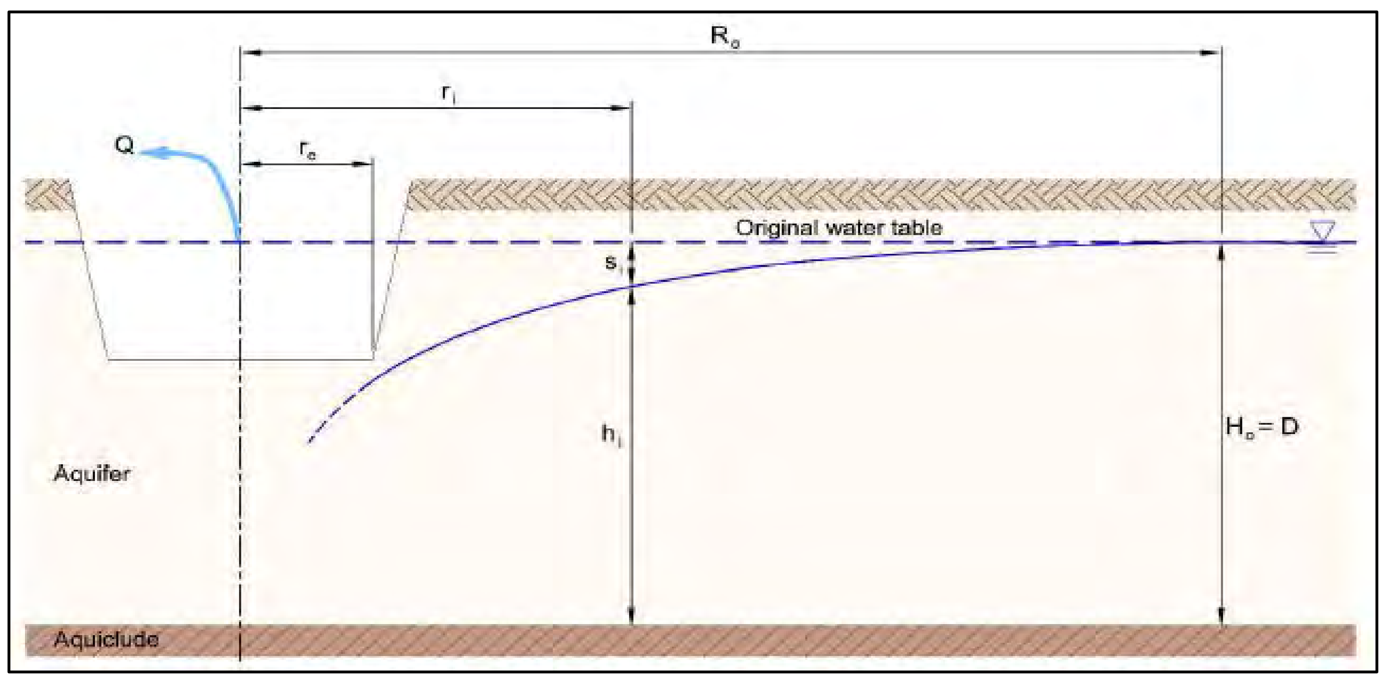
Radius of Influence and Groundwater Inflows

Iterative Method (Combined Thiem-Dupuit Equation & Rate-of-Recharge Method):

Bench at -50mOD:

1. Recharge Estimate:

			Notes:
Annual Rainfall (AR)	1,260	mm/yr	Annual mean at Markree Castle (Met Eireann)
Potential Evapotranspiration (PE)	499	mm/yr	Average of annual mean at Finner Camp and Knock Airport (Met Eireann)
Actual Evapotranspiration (AE)	474	mm/yr	Taken as 95% of PE
Effective Rainfall (ER)	786	mm/yr	AR - AE
Recharge Coefficient (rc)	90	%	Upper end estimate for thin moderately permeable overburden
Recharge (R)	707	mm/yr	ER x rc



2. Inputs:

			Notes:
k	0.108	m/d	Packer tests
H	56.5	m	Groundwater head above quarry floor outside zone of influence (annual average)
h_w	0	m	Groundwater head above quarry floor at quarry face
r_e	160	m	Equivalent Well radius, visual match on aerial photo for lower bench
R	0.001937	m/d	Recharge per day (annual average)

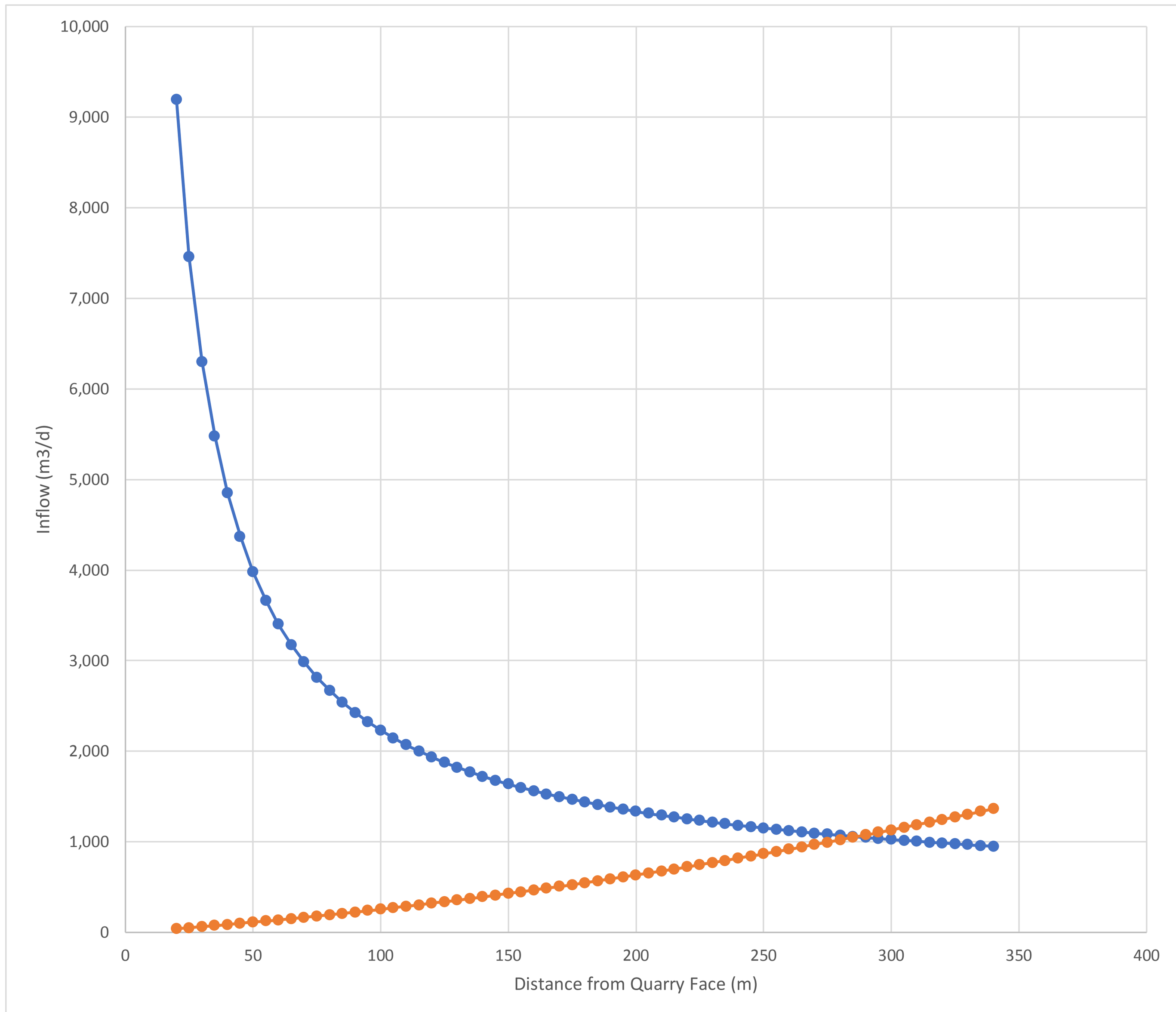
Thiem-Dupuit Equation:

$$Q = \frac{\pi k \left(H^2 - h_w^2\right)}{\ln\left[R_o / r_e\right]}$$

Assumptions:
- the aquifer is unconfined
- the aquifer has infinite areal extent
- the aquifer is homogeneous, and of uniform thickness
- there is only a small water table gradient
- groundwater flow is horizontal
- the pumping rate is constant
- the aquifer is fully penetrated
- the flow is in steady state
- the Dupuit assumptions are satisfied

3. Radius of Influence & Groundwater Inflows Estimate:

Distance from Quarry Face (m)	R_0 (m)	$Q_{groundwater\ inflows}$	$Q_{recharge}$
20	180	9195.76	41.38
25	185	7460.32	52.49
30	190	6302.61	63.90
35	195	5475.05	75.61
40	200	4853.85	87.63
45	205	4370.25	99.95
50	210	3982.97	112.58
55	215	3665.77	125.51
60	220	3401.14	138.74
65	225	3176.94	152.28
70	230	2984.54	166.13
75	235	2817.56	180.28
80	240	2671.27	194.73
85	245	2542.00	209.49
90	250	2426.92	224.55
95	255	2323.81	239.91
100	260	2230.87	255.58
105	265	2146.65	271.55
110	270	2069.96	287.83
115	275	1999.83	304.42
120	280	1935.44	321.30
125	285	1876.11	338.49
130	290	1821.24	355.99
135	295	1770.35	373.79
140	300	1723.02	391.89
145	305	1678.87	410.30
150	310	1637.60	429.01
155	315	1598.92	448.03
160	320	1562.59	467.35
165	325	1528.40	486.97
170	330	1496.17	506.90
175	335	1465.72	527.14
180	340	1436.91	547.67
185	345	1409.61	568.52
190	350	1383.70	589.66
195	355	1359.07	611.11
200	360	1335.63	632.87
205	365	1313.29	654.93
210	370	1291.98	677.29
215	375	1271.62	699.96
220	380	1252.15	722.93
225	385	1233.51	746.21
230	390	1215.64	769.79
235	395	1198.51	793.67
240	400	1182.05	817.86
245	405	1166.24	842.35
250	410	1151.04	867.15
255	415	1136.40	892.25
260	420	1122.29	917.66
265	425	1108.70	943.37
270	430	1095.58	969.38
275	435	1082.92	995.70
280	440	1070.68	1022.32
285	445	1058.86	1049.25
290	450	1047.42	1076.48
295	455	1036.34	1104.02
300	460	1025.62	1131.86
305	465	1015.22	1160.00
310	470	1005.15	1188.45
315	475	995.37	1217.21
320	480	985.88	1246.26
325	485	976.67	1275.62
330	490	967.72	1305.29
335	495	959.02	1335.26
340	500	950.56	1365.53



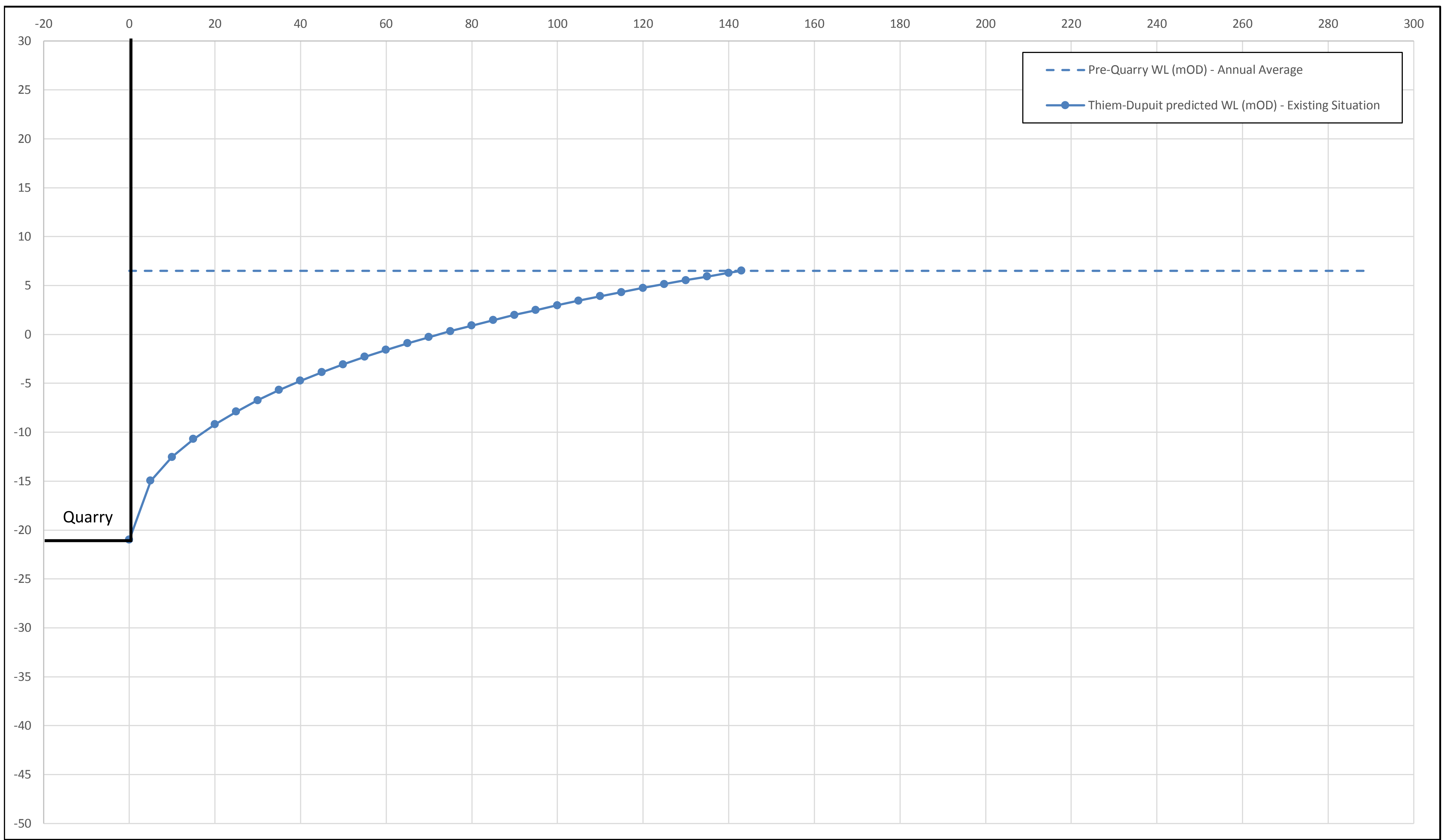
For Proposed Bench at -50mOD:

R_0 (from Quarry Centre)	**446**	**m**
R_0 (from Quarry Face)	**286**	**m**
$Q_{groundwater\ inflows}$	**1057**	**m^3/d**
$Q_{groundwater\ inflows}$	**12.2**	**l/s**

Drawdown Profile (Existing Situation)

Hydraulic Conductivity	K	0.108	m/d
Radius of Influence	R_0	303	m
Effective Radius of Quarry	r_e	160	m
Quarry Floor Level		-21	mOD
Aquifer Base		-21	mOD
Height of Water Table at Radius of Influence		6.5	mOD
Height of Water Table at Quarry Floor		-21	mOD
Head at boundary	H	27.5	m
Head at radius of interest	h_w	0	m
Drawdown at Quarry Face	s	27.5	m
Total flow into excavation	Q	401.826	m^3/d
	Q	4.7	l/s

R_0 (m)	Distance from Quarry Face (m)	Head (m)	Thiem-Dupuit predicted WL (mOD) - Existing Situation	Pre-Quarry WL (mOD) - Annual Average
160	0	0.00	-21.00	6.5
165	5	6.04	-14.96	6.5
170	10	8.47	-12.53	6.5
175	15	10.30	-10.70	6.5
180	20	11.81	-9.19	6.5
185	25	13.11	-7.89	6.5
190	30	14.27	-6.73	6.5
195	35	15.31	-5.69	6.5
200	40	16.26	-4.74	6.5
205	45	17.13	-3.87	6.5
210	50	17.95	-3.05	6.5
215	55	18.71	-2.29	6.5
220	60	19.42	-1.58	6.5
225	65	20.09	-0.91	6.5
230	70	20.73	-0.27	6.5
235	75	21.34	0.34	6.5
240	80	21.91	0.91	6.5
245	85	22.46	1.46	6.5
250	90	22.99	1.99	6.5
255	95	23.49	2.49	6.5
260	100	23.98	2.98	6.5
265	105	24.44	3.44	6.5
270	110	24.89	3.89	6.5
275	115	25.33	4.33	6.5
280	120	25.74	4.74	6.5
285	125	26.15	5.15	6.5
290	130	26.54	5.54	6.5
295	135	26.92	5.92	6.5
300	140	27.28	6.28	6.5
303	143	27.50	6.50	6.5
310	150			6.5
315	155			6.5
320	160			6.5
325	165			6.5
330	170			6.5
335	175			6.5
340	180			6.5
345	185			6.5
350	190			6.5
355	195			6.5
360	200			6.5
365	205			6.5
370	210			6.5
375	215			6.5
380	220			6.5
385	225			6.5
390	230			6.5
395	235			6.5
400	240			6.5
405	245			6.5
410	250			6.5
415	255			6.5
420	260			6.5
425	265			6.5
430	270			6.5
435	275			6.5
440	280			6.5
445	285			6.5
450	290			6.5

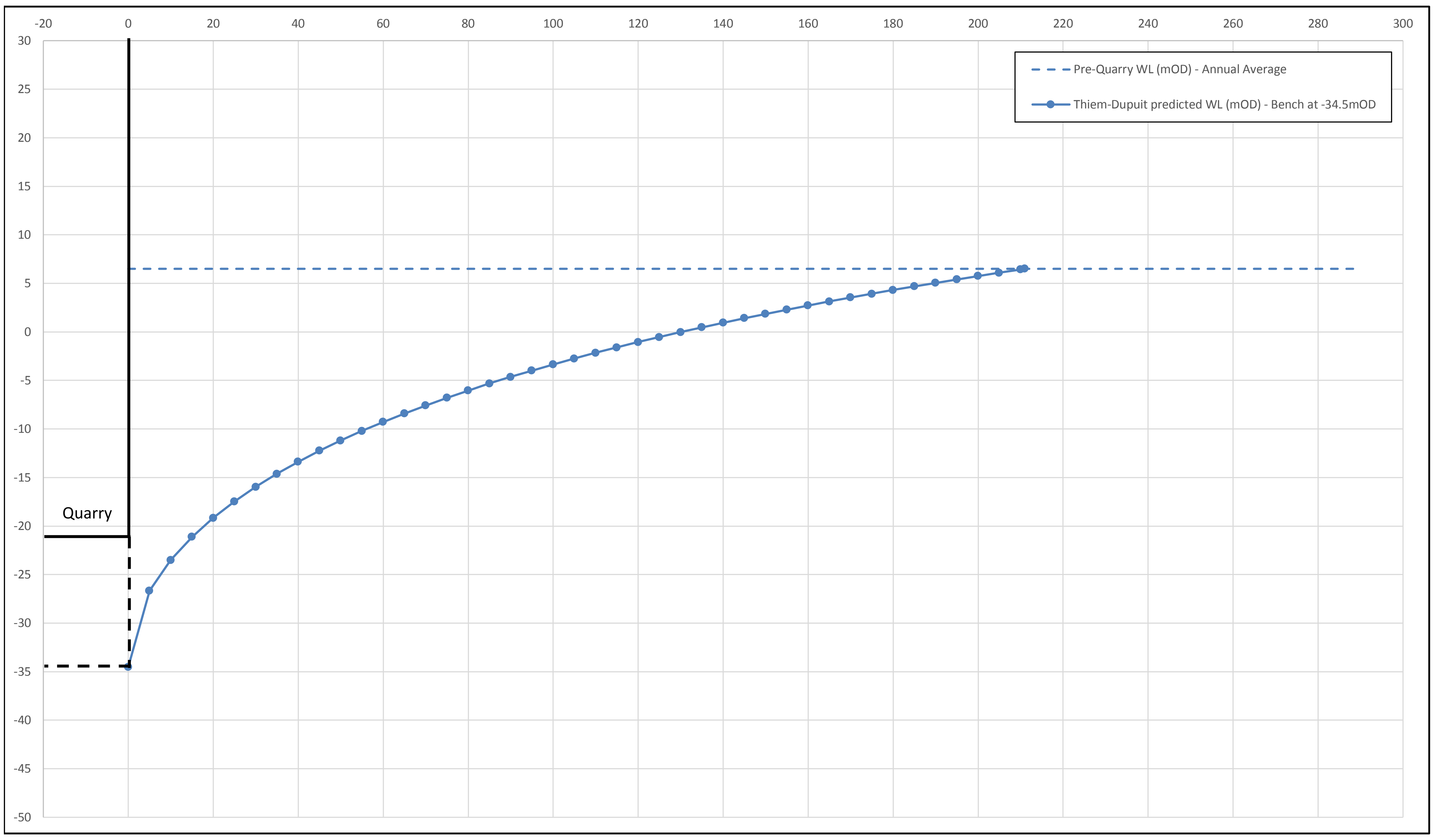


tms environment ltd

Drawdown Profile (Bench at -34.5mOD)

Hydraulic Conductivity	K	0.108	m/d
Radius of Influence	R_0	371	m
Effective Radius of Quarry	r_e	160	m
Quarry Floor Level		-34.5	mOD
Aquifer Base		-34.5	mOD
Height of Water Table at Radius of Influence		6.5	mOD
Height of Water Table at Quarry Floor		-34.5	mOD
Head at boundary	H	41	m
Head at radius of interest	h_w	0	m
Drawdown at Quarry Face	s	41	m
Total flow into excavation	Q	678.158	m^3/d
	Q	7.8	l/s

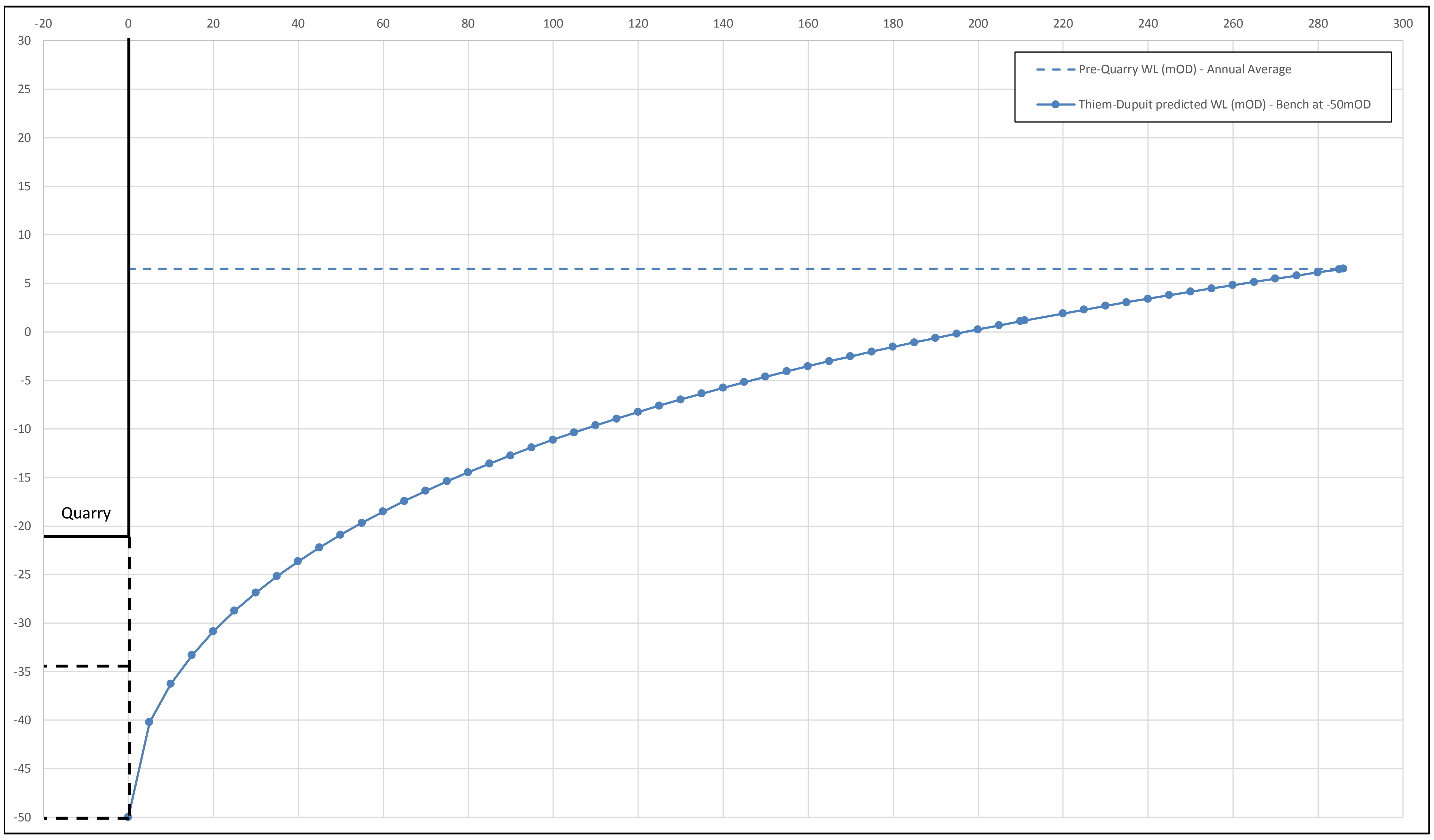
R_0 (m)	Distance from Quarry Face (m)	Head (m)	Thiem-Dupuit predicted WL (mOD) - Bench at -34.5mOD	Pre-Quarry WL (mOD) - Annual Average
160	0	0.00	-34.50	6.5
165	5	7.84	-26.66	6.5
170	10	11.01	-23.49	6.5
175	15	13.38	-21.12	6.5
180	20	15.34	-19.16	6.5
185	25	17.03	-17.47	6.5
190	30	18.53	-15.97	6.5
195	35	19.88	-14.62	6.5
200	40	21.12	-13.38	6.5
205	45	22.26	-12.24	6.5
210	50	23.31	-11.19	6.5
215	55	24.30	-10.20	6.5
220	60	25.23	-9.27	6.5
225	65	26.10	-8.40	6.5
230	70	26.93	-7.57	6.5
235	75	27.72	-6.78	6.5
240	80	28.47	-6.03	6.5
245	85	29.18	-5.32	6.5
250	90	29.87	-4.63	6.5
255	95	30.52	-3.98	6.5
260	100	31.15	-3.35	6.5
265	105	31.76	-2.74	6.5
270	110	32.34	-2.16	6.5
275	115	32.90	-1.60	6.5
280	120	33.44	-1.06	6.5
285	125	33.97	-0.53	6.5
290	130	34.48	-0.02	6.5
295	135	34.97	0.47	6.5
300	140	35.45	0.95	6.5
305	145	35.91	1.41	6.5
310	150	36.36	1.86	6.5
315	155	36.80	2.30	6.5
320	160	37.22	2.72	6.5
325	165	37.64	3.14	6.5
330	170	38.04	3.54	6.5
335	175	38.43	3.93	6.5
340	180	38.81	4.31	6.5
345	185	39.19	4.69	6.5
350	190	39.55	5.05	6.5
355	195	39.91	5.41	6.5
360	200	40.26	5.76	6.5
365	205	40.60	6.10	6.5
370	210	40.93	6.43	6.5
371	211	41.00	6.50	6.5
380	220			6.5
385	225			6.5
390	230			6.5
395	235			6.5
400	240			6.5
405	245			6.5
410	250			6.5
415	255			6.5
420	260			6.5
425	265			6.5
430	270			6.5
435	275			6.5
440	280			6.5
445	285			6.5
450	290			6.5



Drawdown Profile (Bench at -50mOD)

Hydraulic Conductivity	K	0.108	m/d
Radius of Influence	R_0	446	m
Effective Radius of Quarry	r_e	160	m
Quarry Floor Level		-50	mOD
Aquifer Base		-50	mOD
Height of Water Table at Radius of Influence		6.5	mOD
Height of Water Table at Quarry Floor		-50	mOD
Head at boundary	H	56.5	m
Head at radius of interest	h_w	0	m
Drawdown at Quarry Face	s	56.5	m
Total flow into excavation	Q	1056.538	m^3/d
	Q	12.2	l/s

R_0 (m)	Distance from Quarry Face (m)	Head (m)	Thiem-Dupuit predicted WL (mOD) - Bench at -50mOD	Pre-Quarry WL (mOD) - Annual Average
160	0	0.00	-50.00	6.5
165	5	9.79	-40.21	6.5
170	10	13.74	-36.26	6.5
175	15	16.70	-33.30	6.5
180	20	19.15	-30.85	6.5
185	25	21.26	-28.74	6.5
190	30	23.13	-26.87	6.5
195	35	24.82	-25.18	6.5
200	40	26.36	-23.64	6.5
205	45	27.78	-22.22	6.5
210	50	29.10	-20.90	6.5
215	55	30.33	-19.67	6.5
220	60	31.49	-18.51	6.5
225	65	32.58	-17.42	6.5
230	70	33.62	-16.38	6.5
235	75	34.60	-15.40	6.5
240	80	35.53	-14.47	6.5
245	85	36.43	-13.57	6.5
250	90	37.28	-12.72	6.5
255	95	38.10	-11.90	6.5
260	100	38.88	-11.12	6.5
265	105	39.64	-10.36	6.5
270	110	40.37	-9.63	6.5
275	115	41.07	-8.93	6.5
280	120	41.74	-8.26	6.5
285	125	42.40	-7.60	6.5
290	130	43.03	-6.97	6.5
295	135	43.65	-6.35	6.5
300	140	44.24	-5.76	6.5
305	145	44.82	-5.18	6.5
310	150	45.38	-4.62	6.5
315	155	45.93	-4.07	6.5
320	160	46.46	-3.54	6.5
325	165	46.98	-3.02	6.5
330	170	47.48	-2.52	6.5
335	175	47.97	-2.03	6.5
340	180	48.45	-1.55	6.5
345	185	48.91	-1.09	6.5
350	190	49.37	-0.63	6.5
355	195	49.82	-0.18	6.5
360	200	50.25	0.25	6.5
365	205	50.68	0.68	6.5
370	210	51.09	1.09	6.5
371	211	51.18	1.18	6.5
380	220	51.90	1.90	6.5
385	225	52.29	2.29	6.5
390	230	52.67	2.67	6.5
395	235	53.05	3.05	6.5
400	240	53.42	3.42	6.5
405	245	53.78	3.78	6.5
410	250	54.13	4.13	6.5
415	255	54.48	4.48	6.5
420	260	54.82	4.82	6.5
425	265	55.15	5.15	6.5
430	270	55.48	5.48	6.5
435	275	55.81	5.81	6.5
440	280	56.13	6.13	6.5
445	285	56.44	6.44	6.5
446	286	56.50	6.50	6.5



tms environment ltd

<u>Photograph 1</u>: Upstream of Culvert 1 (looking upstream)

<u>Photograph 2</u>: Culvert 1 (upstream end)

<u>Photograph 3</u>: Culvert 1 (downstream end) – Note Starflow flowmeter installed

<u>Photograph 4</u>: Reach 1 (looking upstream) – Note two quarry discharge pipes, one discharging

<u>Photograph 5</u>: Reach 1 (looking downstream)

<u>Photograph 6</u>: Reach 1 - Note overbank flow on west bank

<u>Photograph 7</u>: Reach 1 (looking downstream, approaching Culvert 2)

<u>Photograph 8</u>: Culvert 2 (upstream end)

Photograph 9: Culvert 2 (downstream end)

Photograph 10: Reach 2 (looking downstream)

<u>Photograph 11</u>: Culvert 3 (upstream end)

<u>Photograph 12</u>: Culvert 3 (downstream end)

<u>Photograph 13</u>: Reach 3 (looking downstream) – Note concrete brick wall surrounding reach

<u>Photograph 14</u>: Culvert 4 (upstream end) – Note smaller pipe on left diverts water to private pumphouse

<u>Photograph 15</u>: Culvert 4 (downstream end) – very overgrown on banks

<u>Photograph 16</u>: Reach 4 (looking downstream)

<u>Photograph 17</u>: Reach 4 (looking upstream from Culvert 5) – Note waterwheel in stream

<u>Photograph 18</u>: Reach 4 – Weir in stream next to waterwheel

<u>Photograph 19</u>: Reach 4 – Surface water drains on adjacent local road leading to stream

<u>Photograph 20</u>: Culvert 5 (upstream end) – Arched culvert under main public road R287

<u>Photograph 21</u>: Culvert 5 (downstream end)

<u>Photograph 22</u>: Reach 5 (looking downstream from bridge at Culvert 5)

<u>Photograph 23</u>: Reach 5 (looking downstream from bridge at Byrne's residence)

<u>Photograph 24</u>: Reach 5 (looking downstream from bridge at Judge's residence)

<u>Photograph 25</u>: Reach 5 (looking upstream at Culvert 6) – Note perforated concrete fence over stream

<u>Photograph 26</u>: Culvert 6 (upstream end)

Photograph 27: Culvert 6 (downstream end)

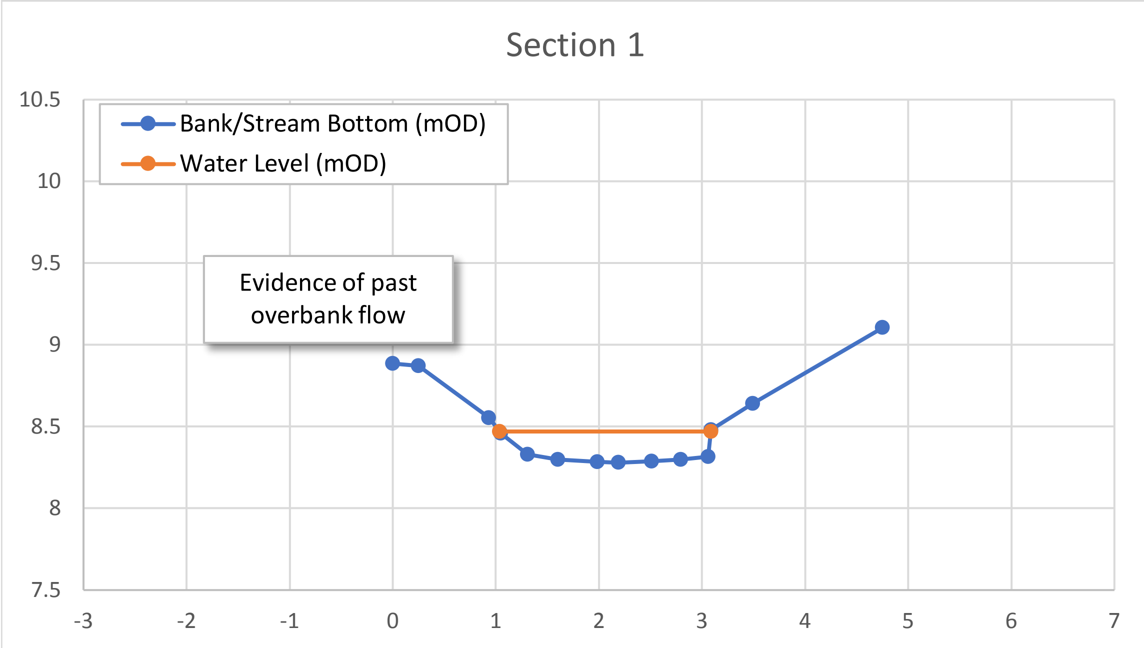
Photograph 28: Reach 6 (looking downstream from bridge at Culvert 6)

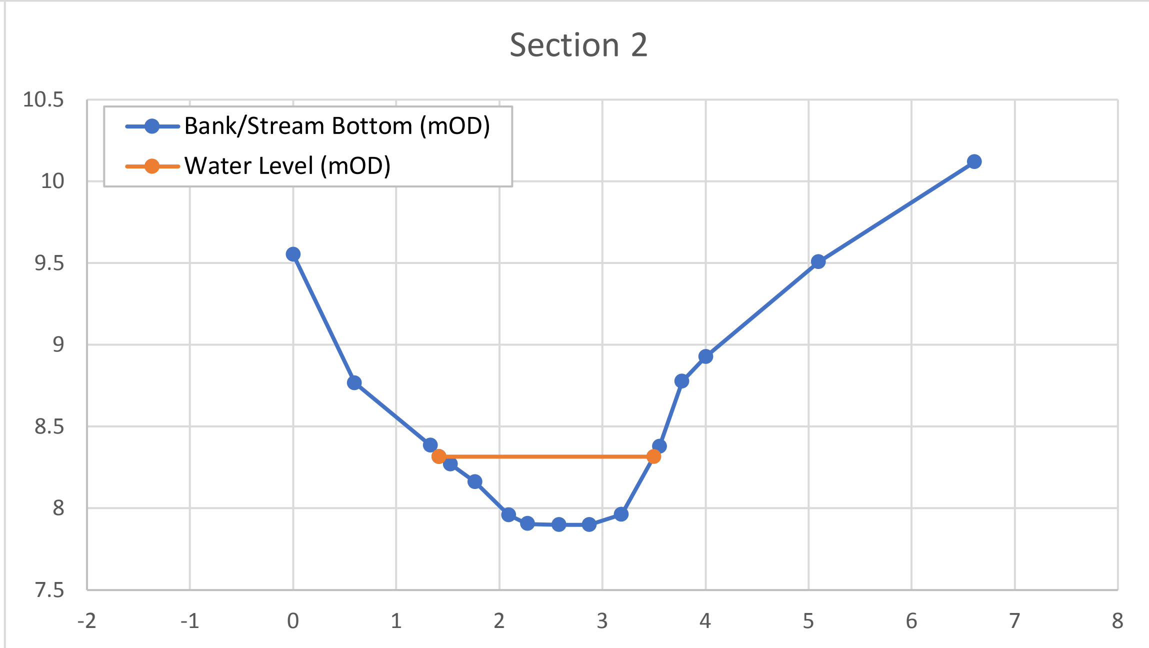
<u>Photograph 29</u>: Culvert 7 (upstream end)

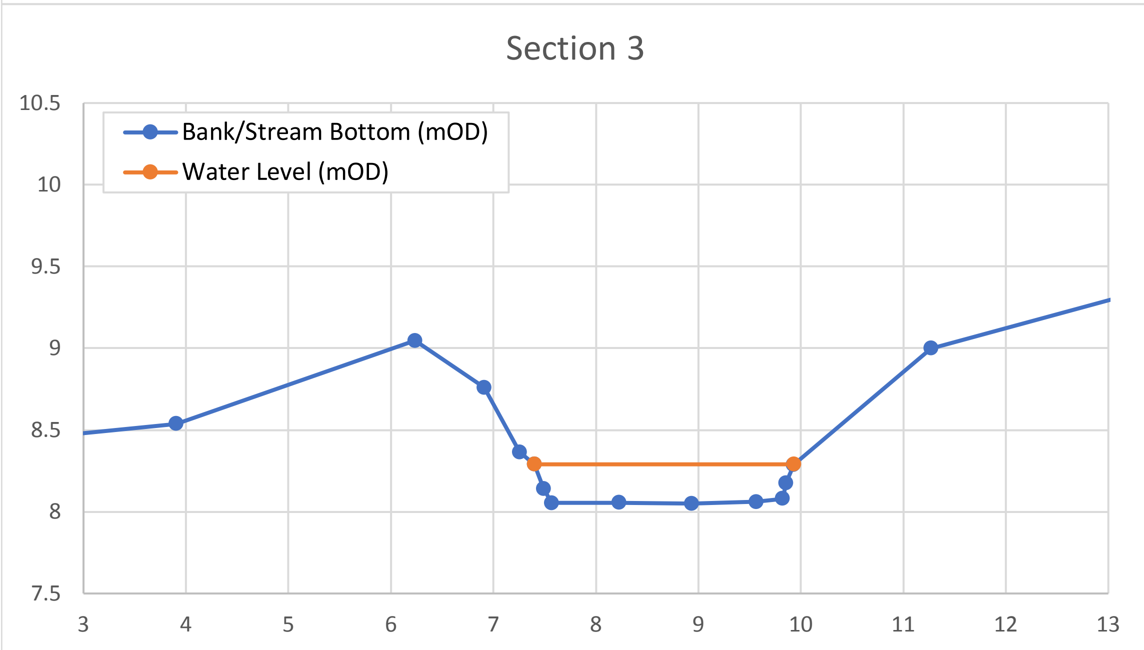
<u>Photograph 30</u>: Culvert 7 (downstream end)

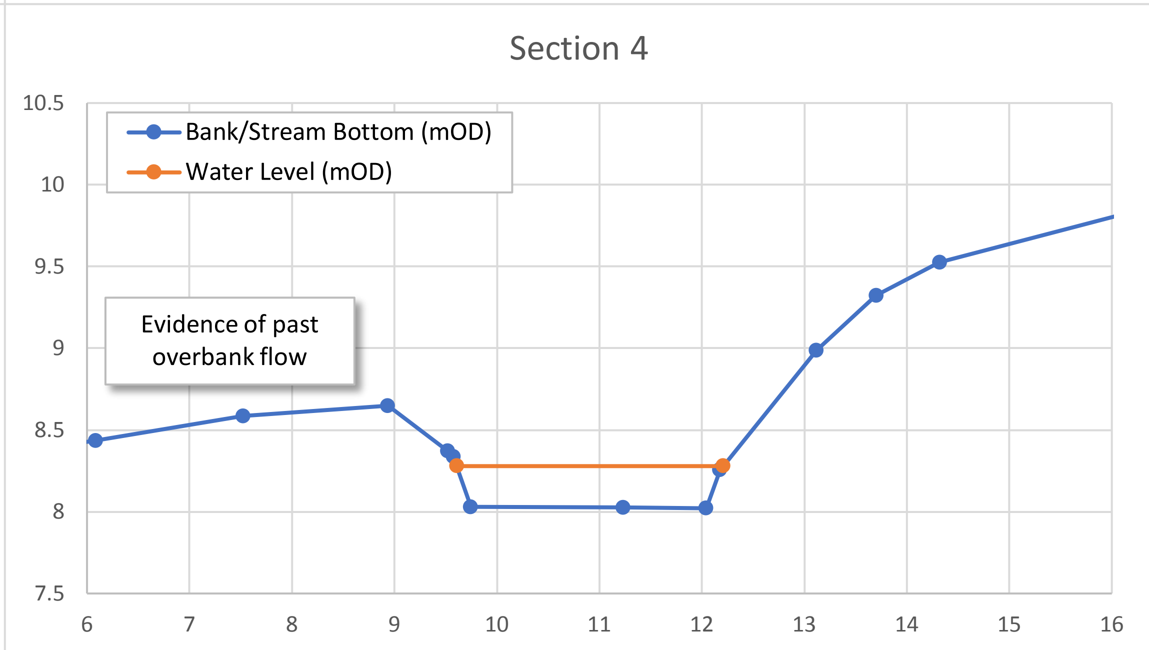
<u>Photograph 31</u>: Reach 7 (looking downstream to Lough Gill)

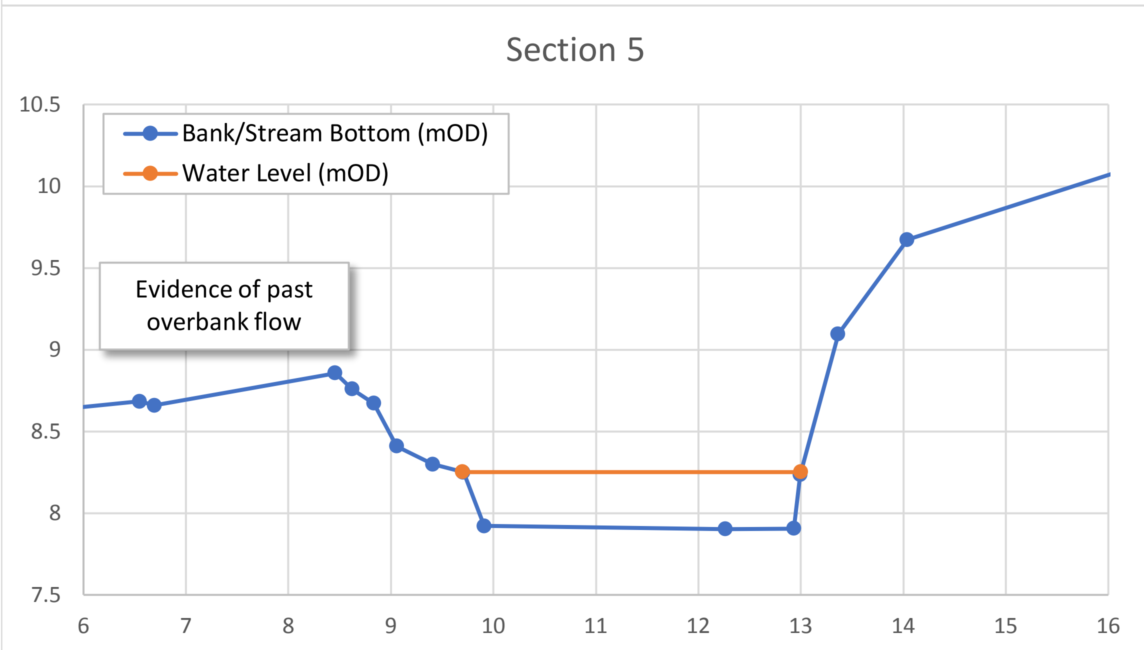
Stream Cross-Sectional Profiles

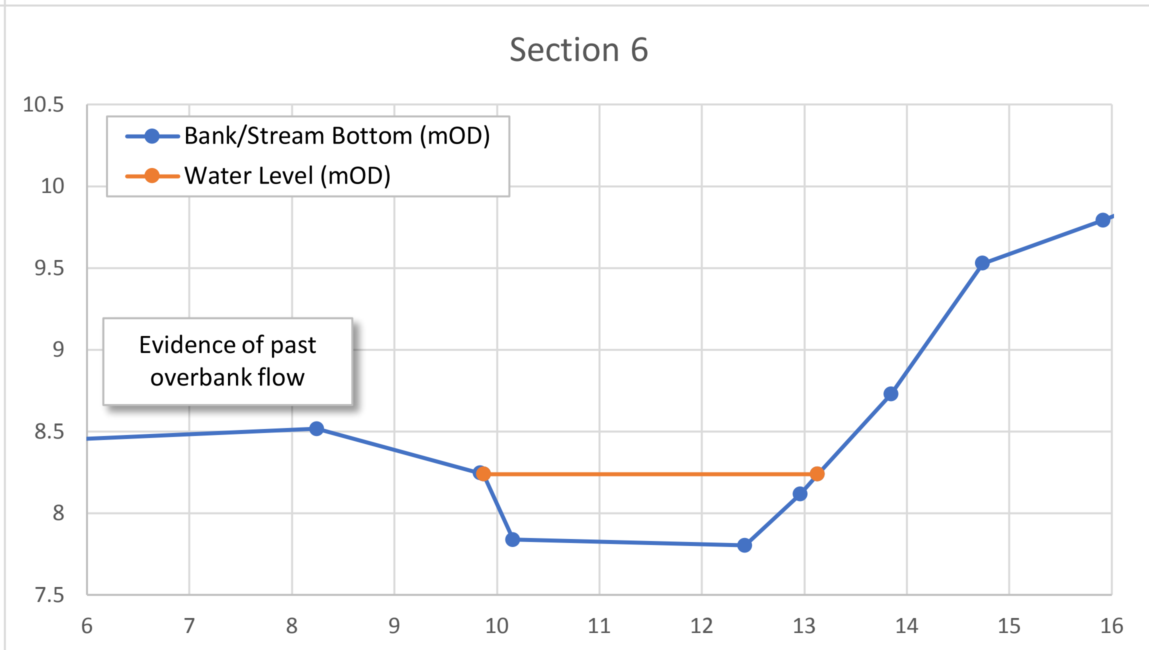


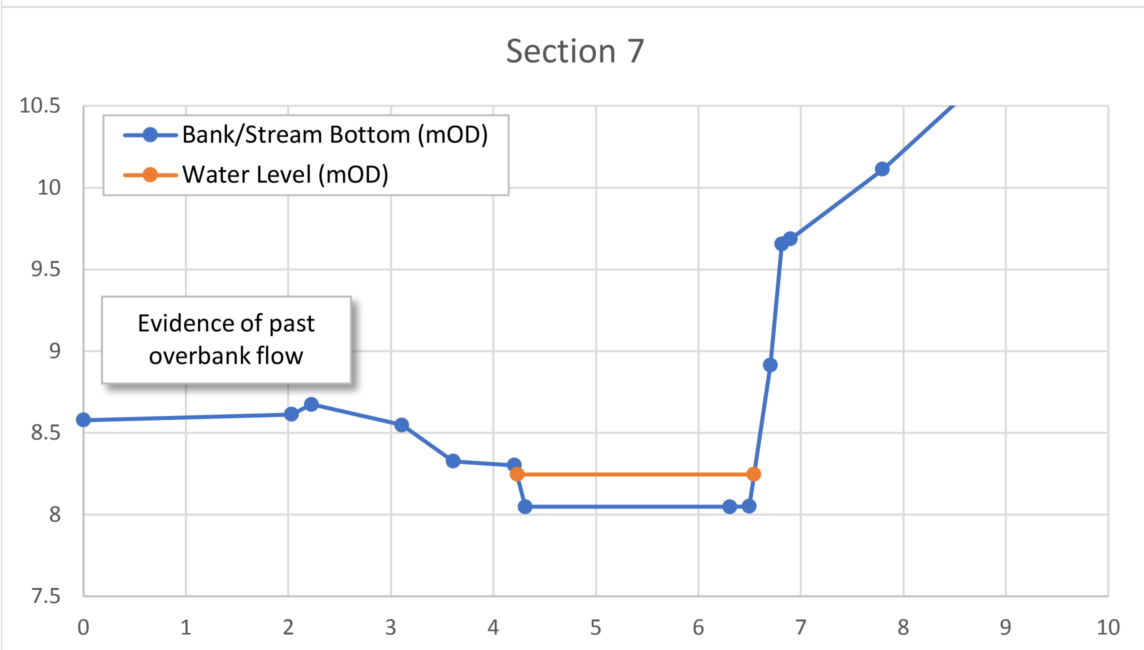


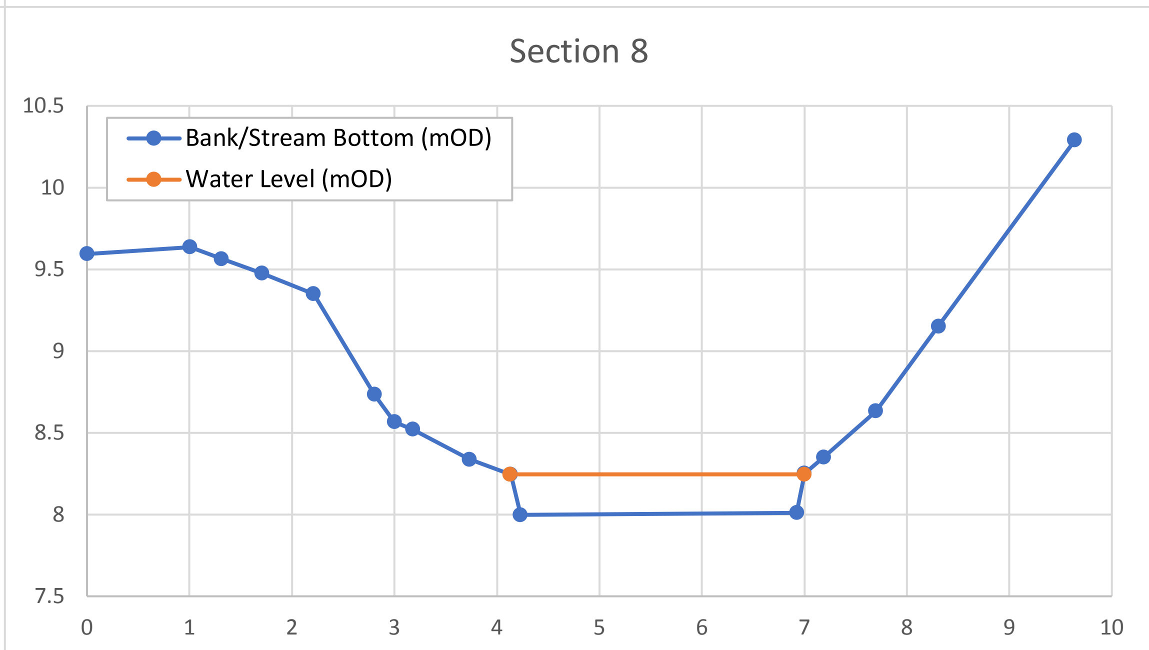


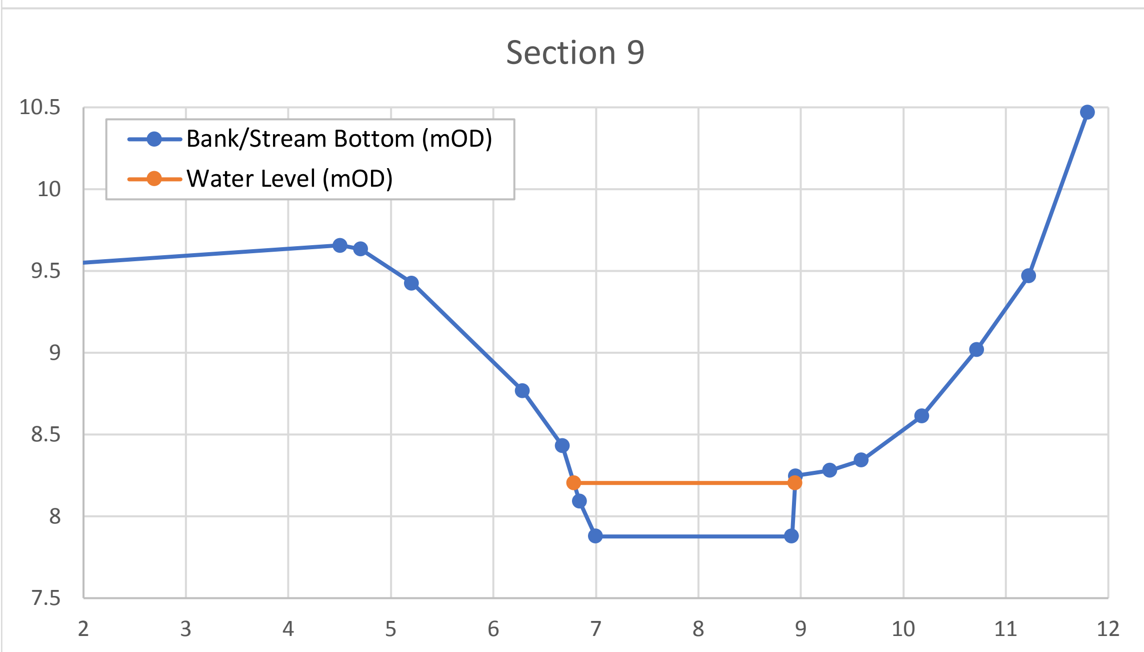


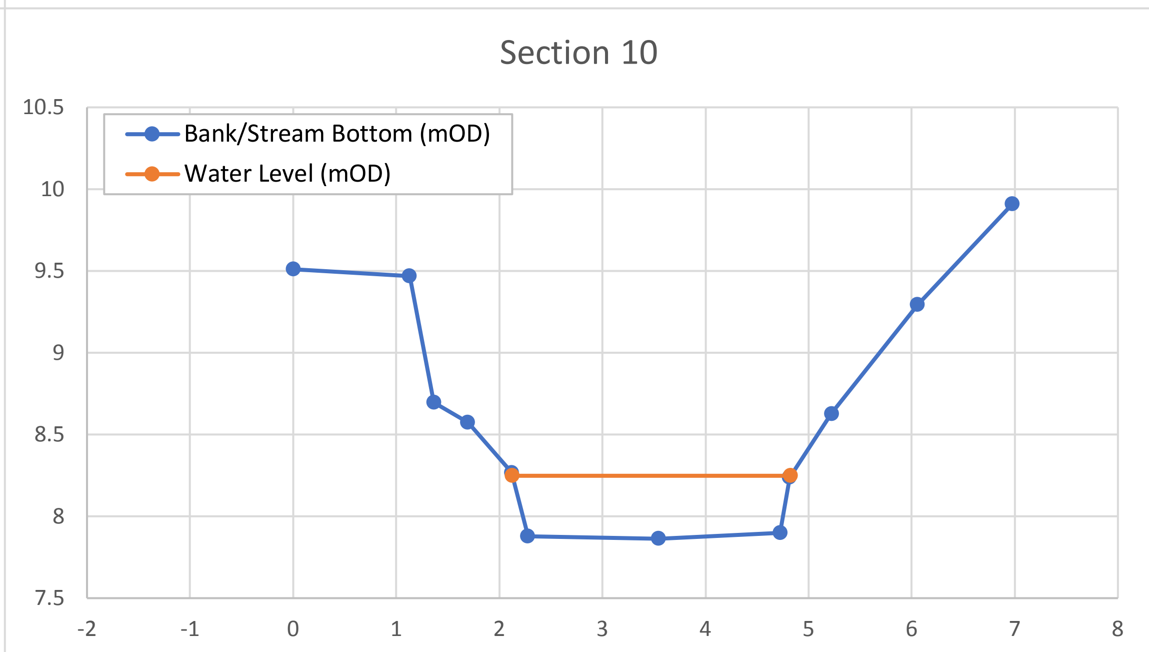






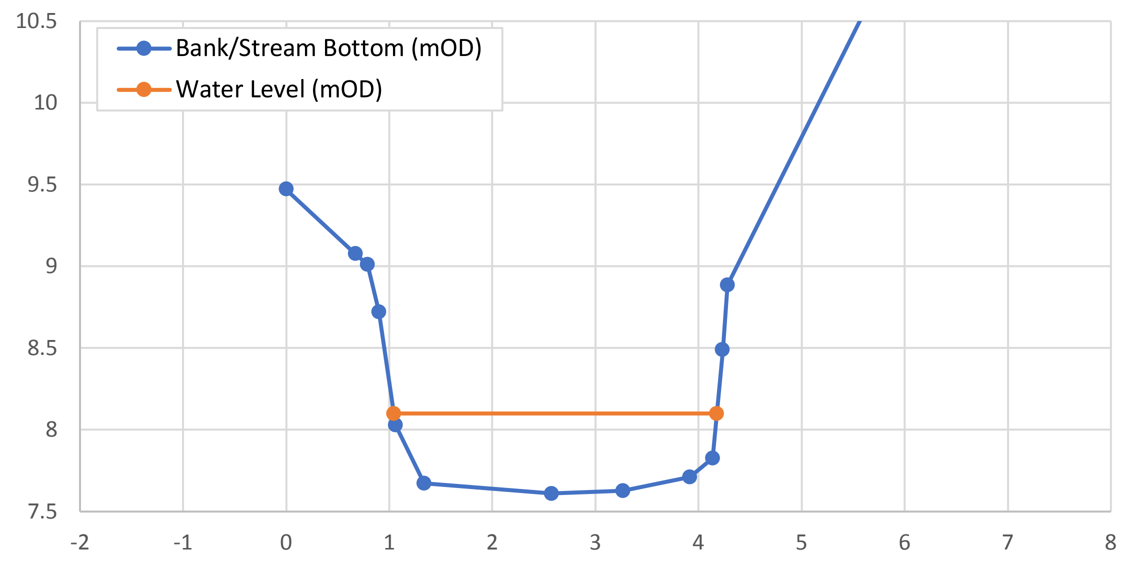




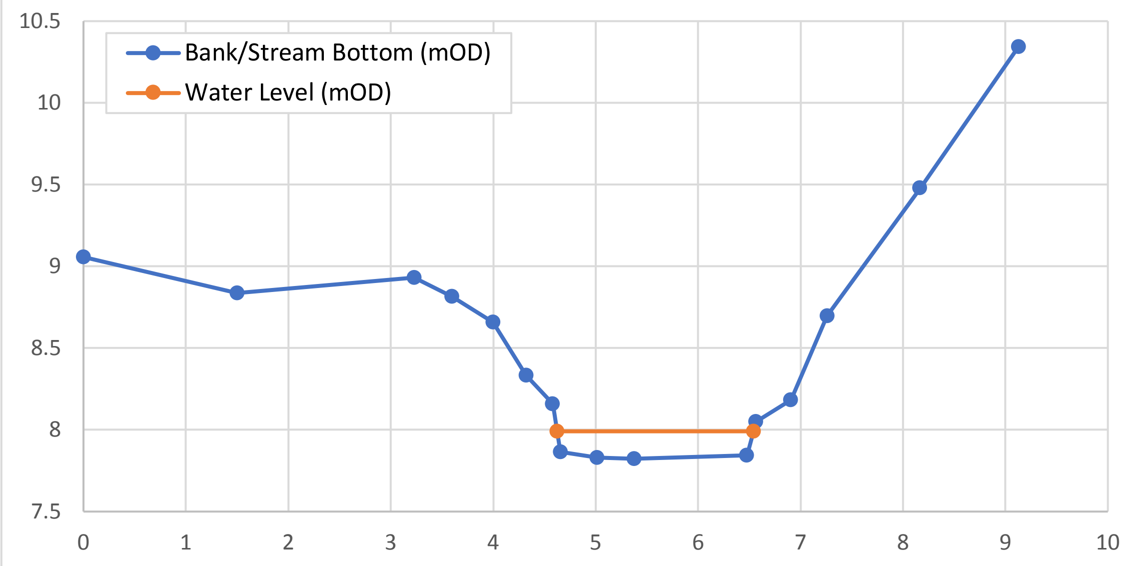


Stream Cross-Sectional Profiles

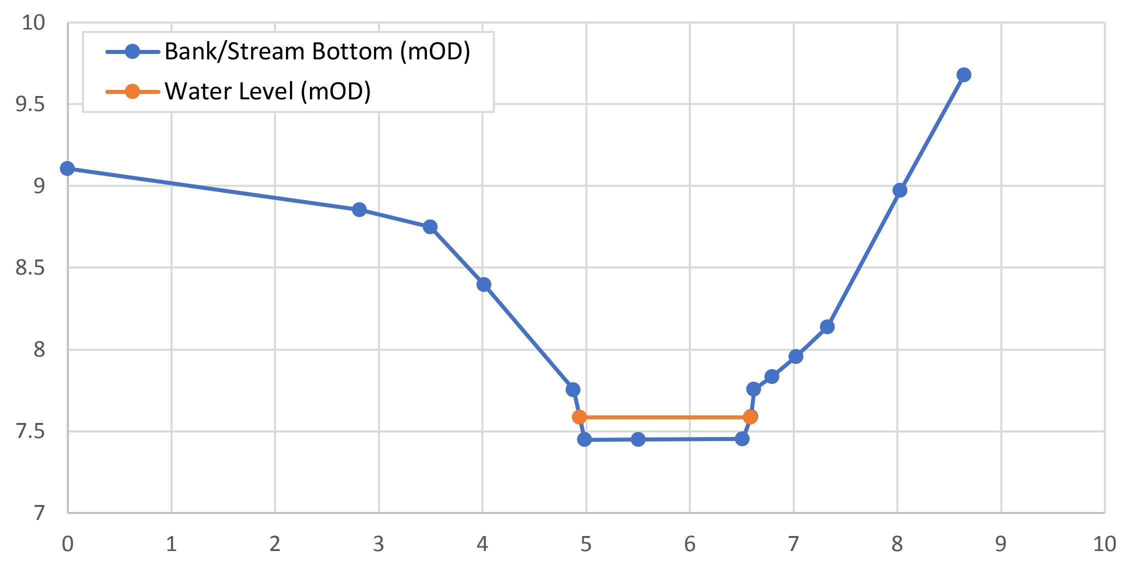
Section 11



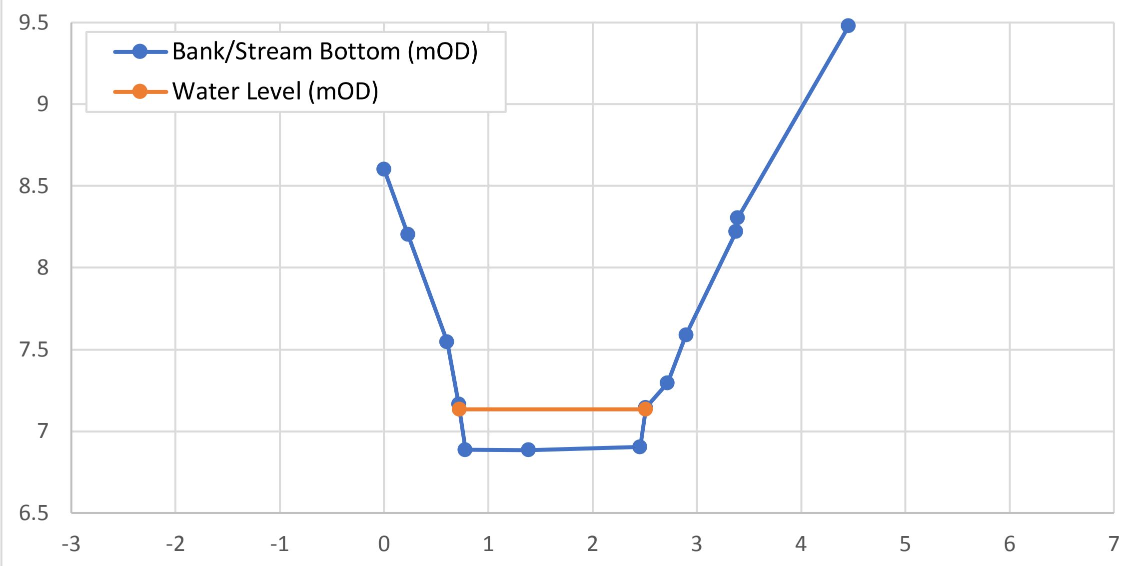
Section 12



Section 13



Section 14



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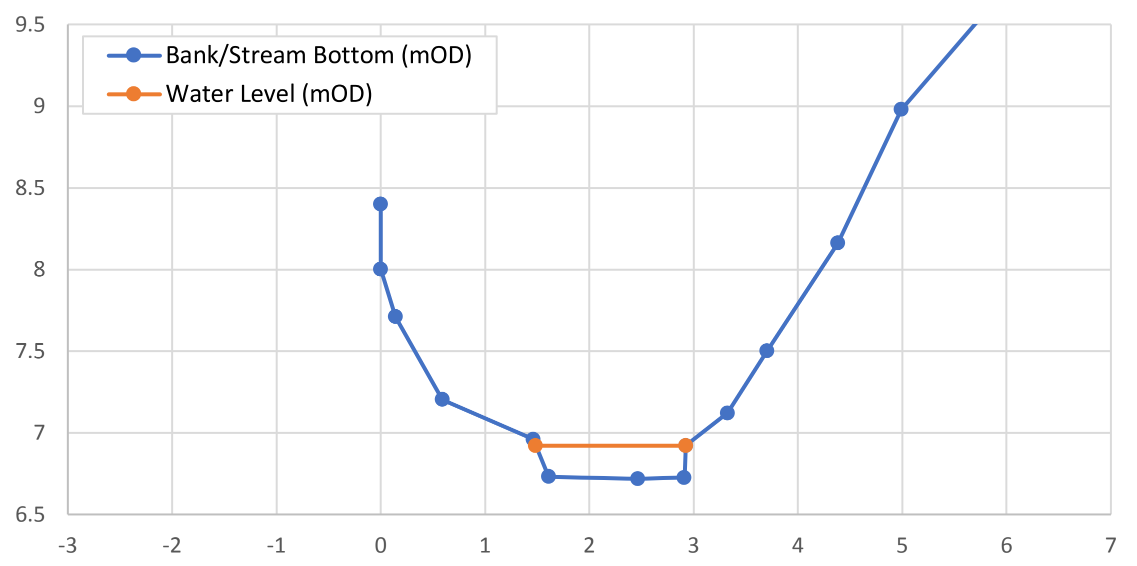
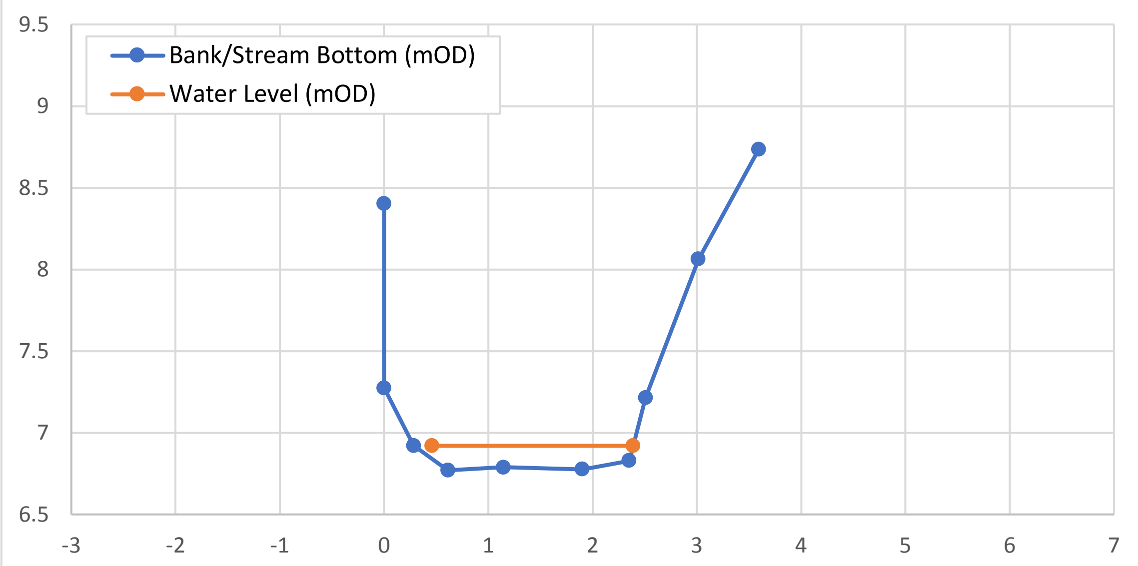
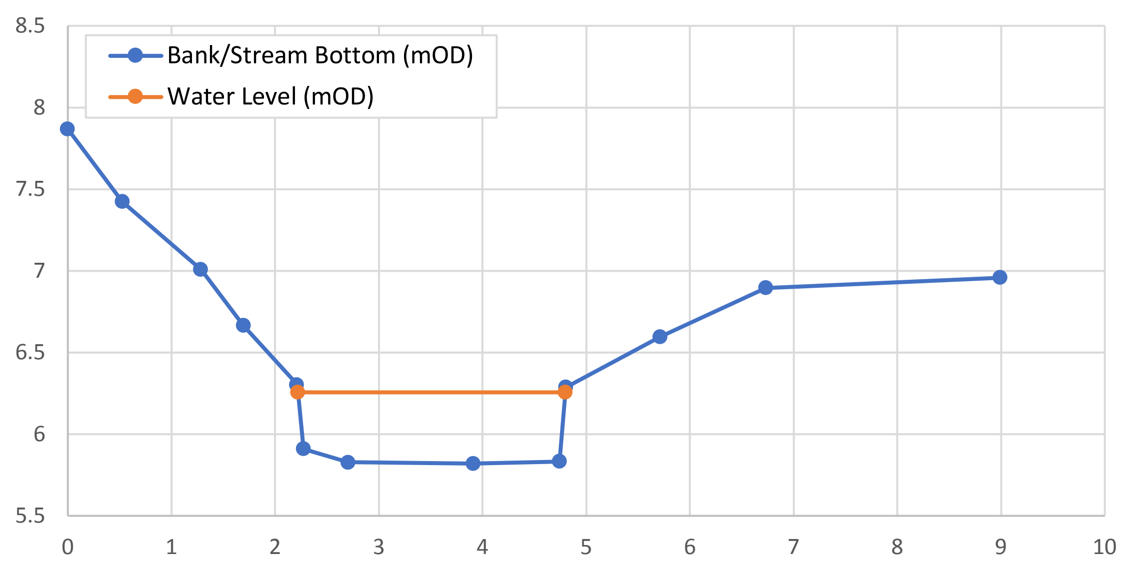


Section 16



Section 17



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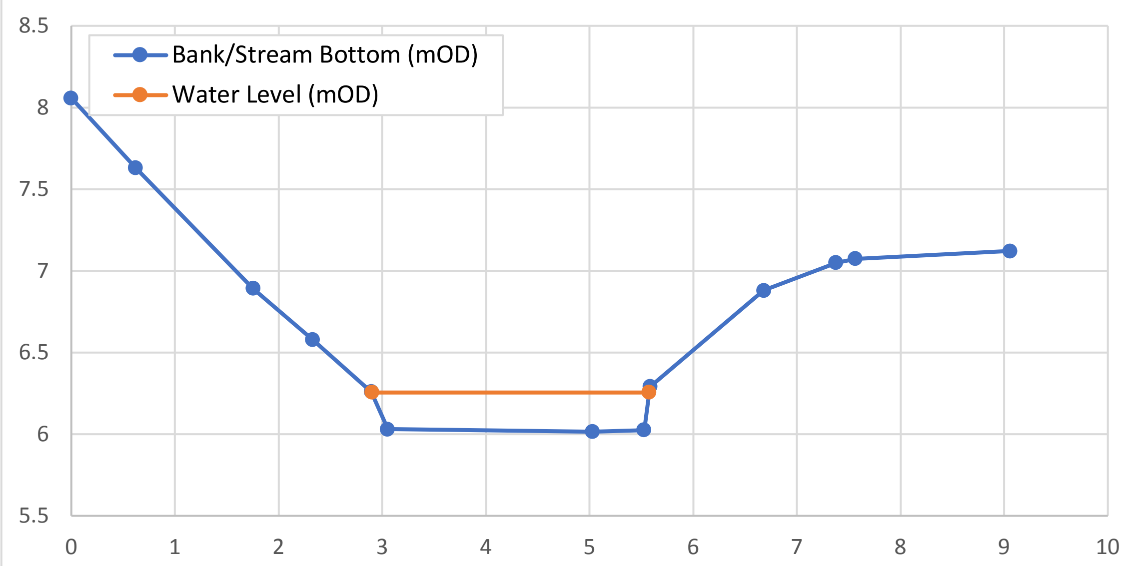

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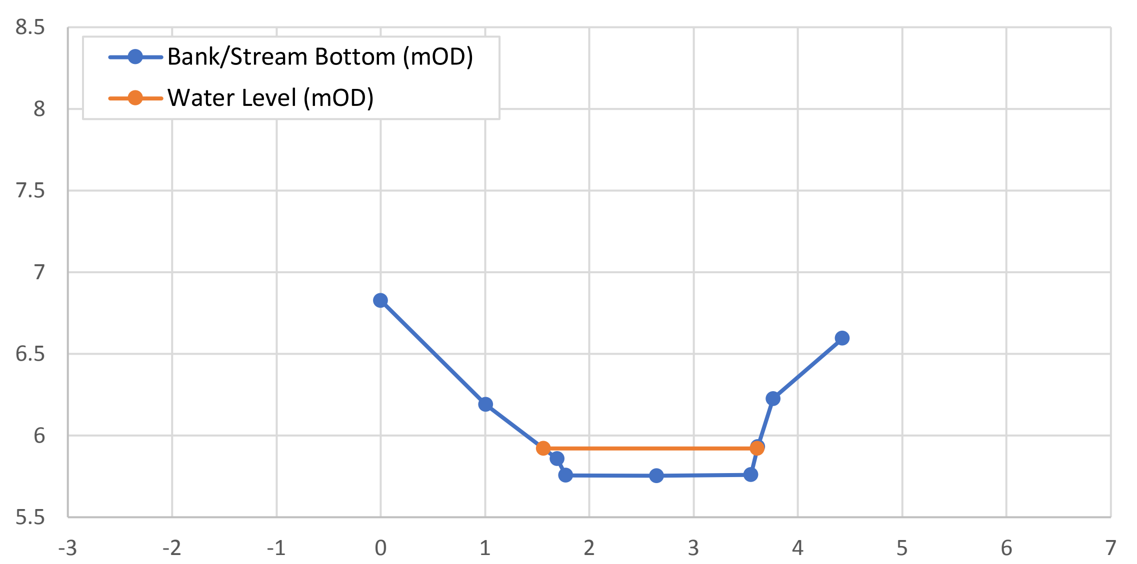

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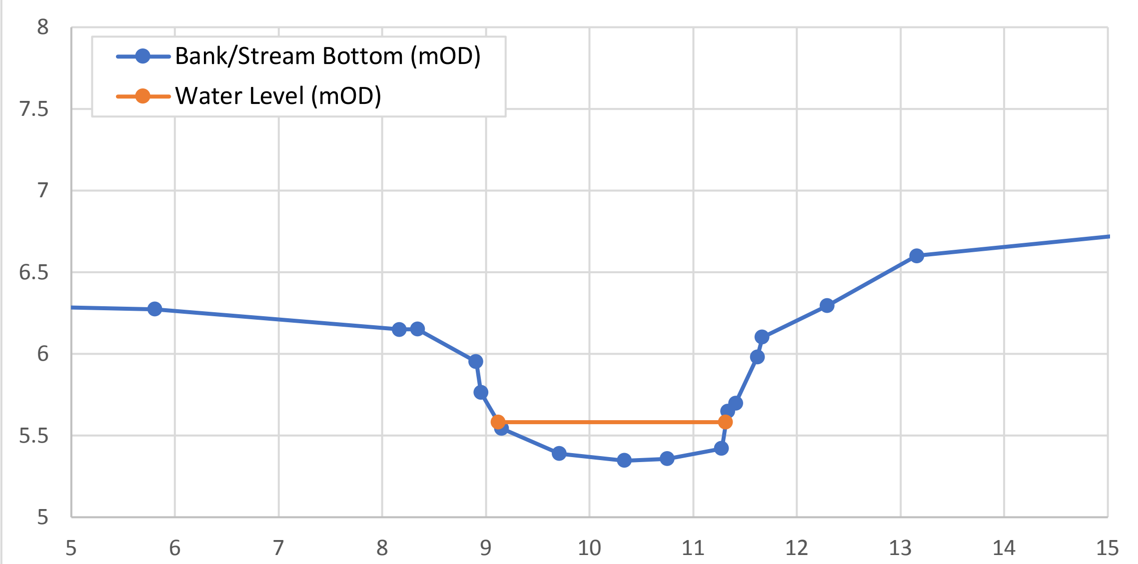
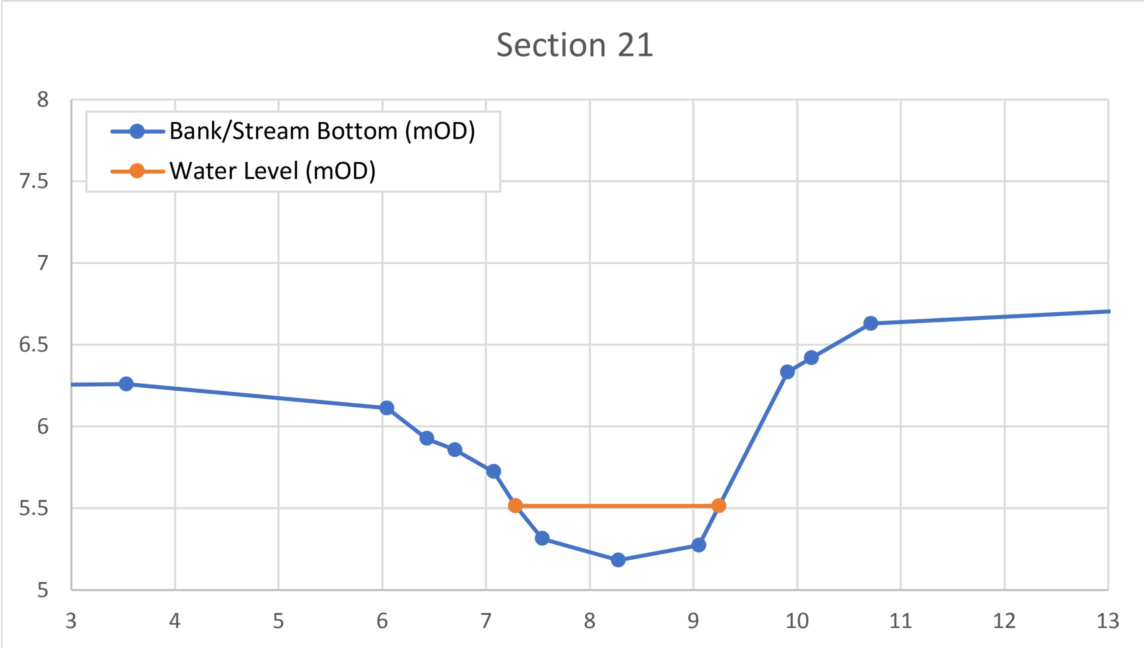
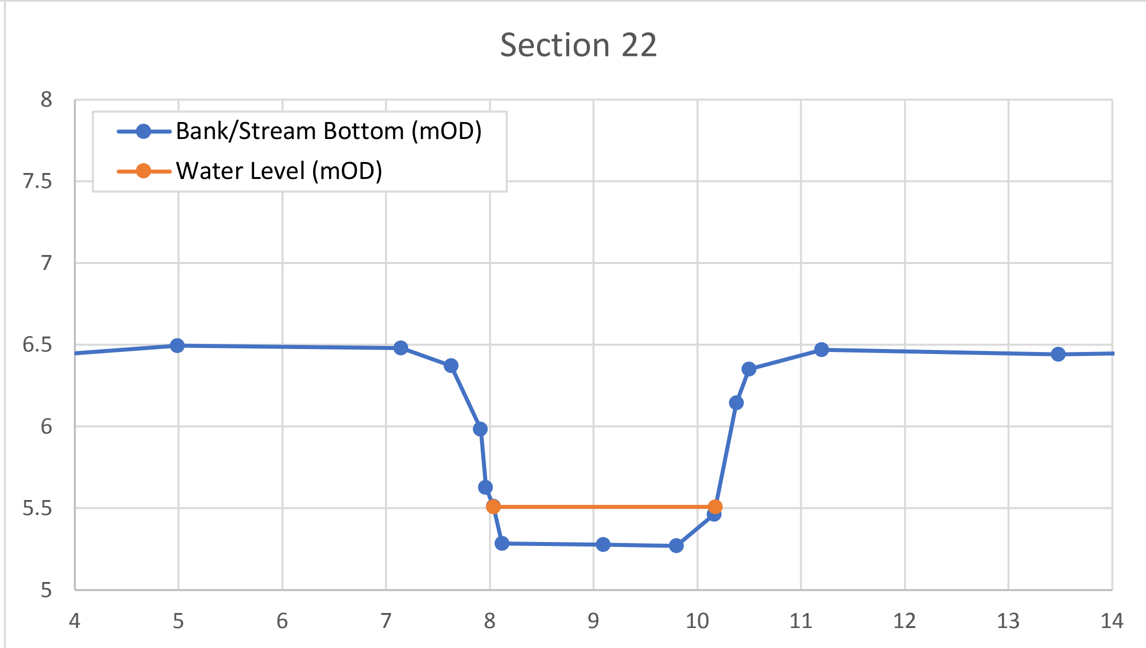
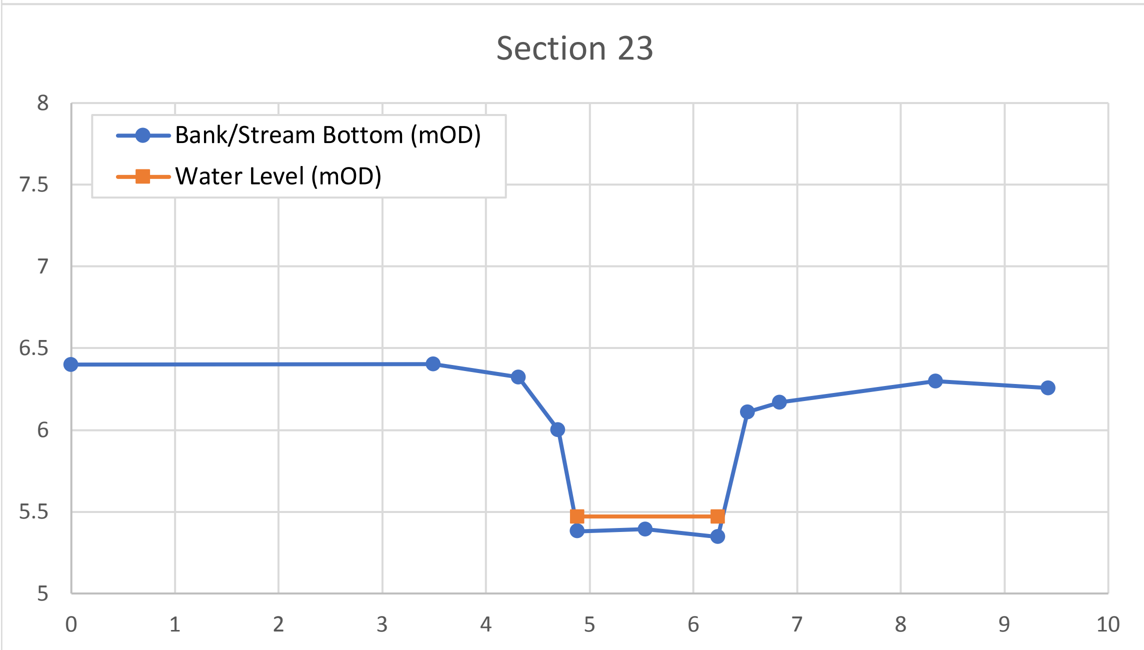
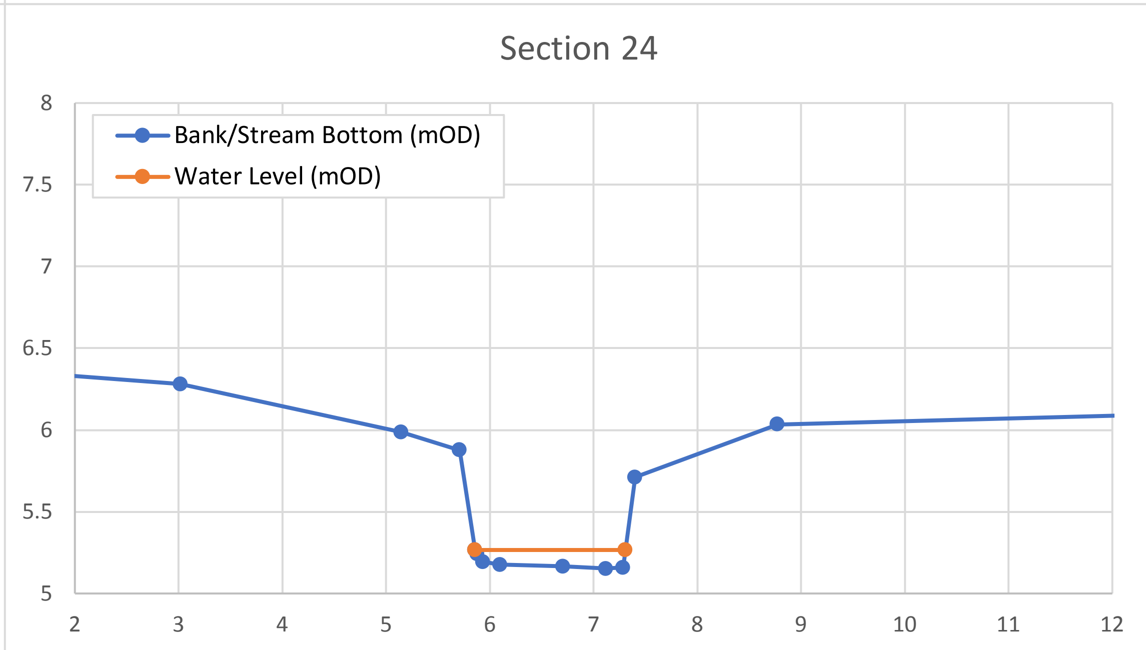


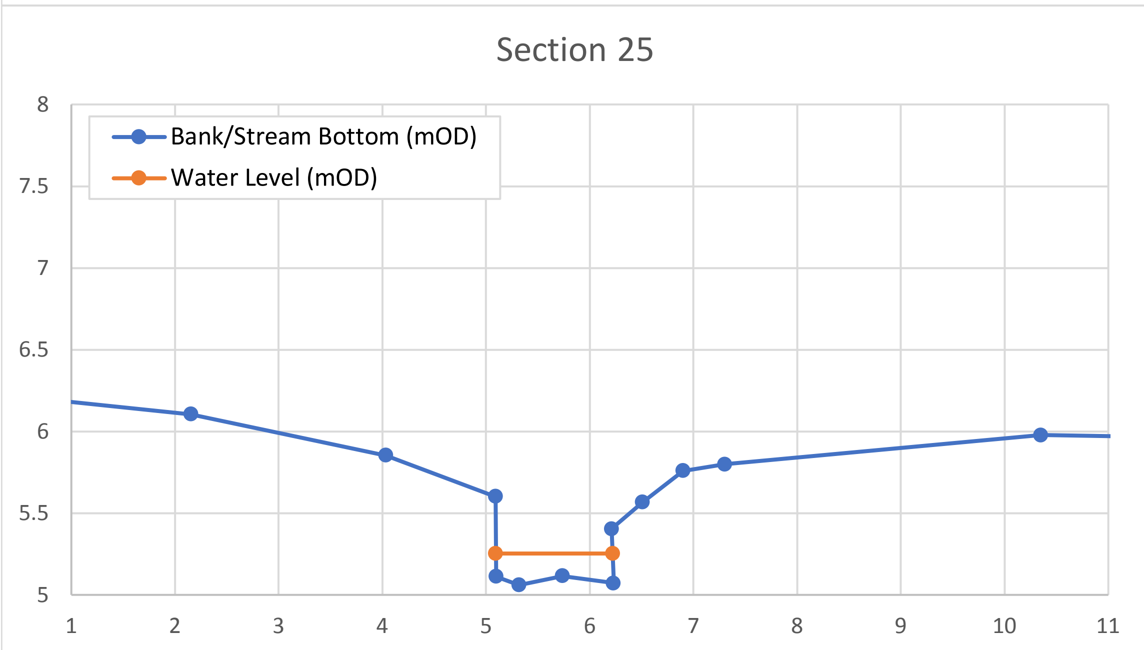
Stream Cross-Sectional Profiles

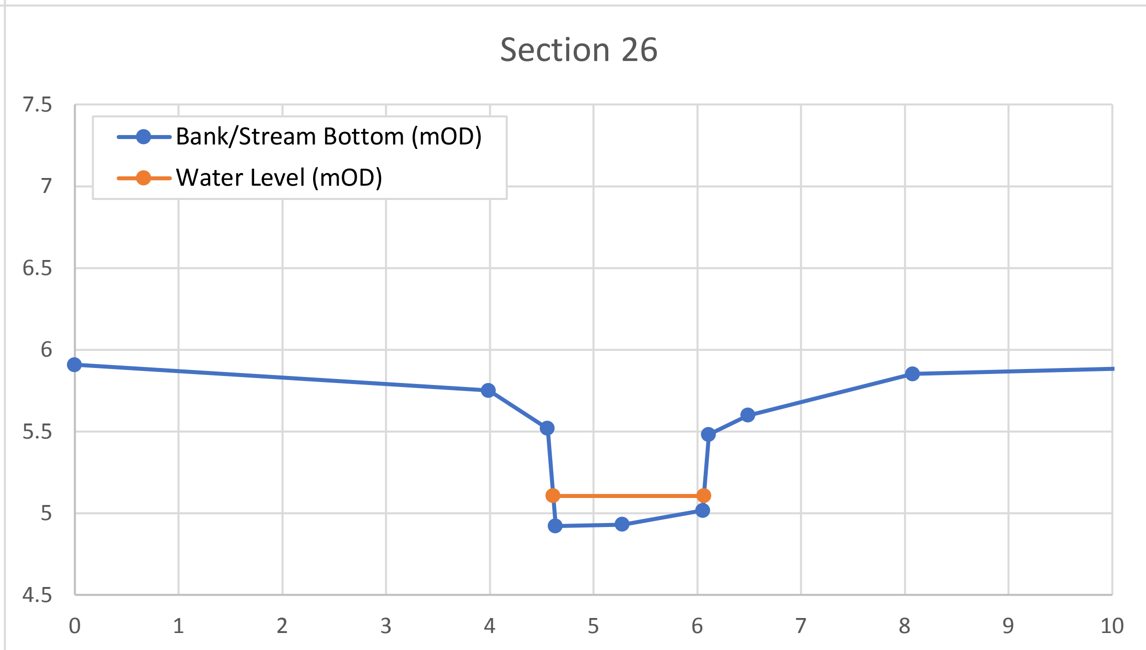


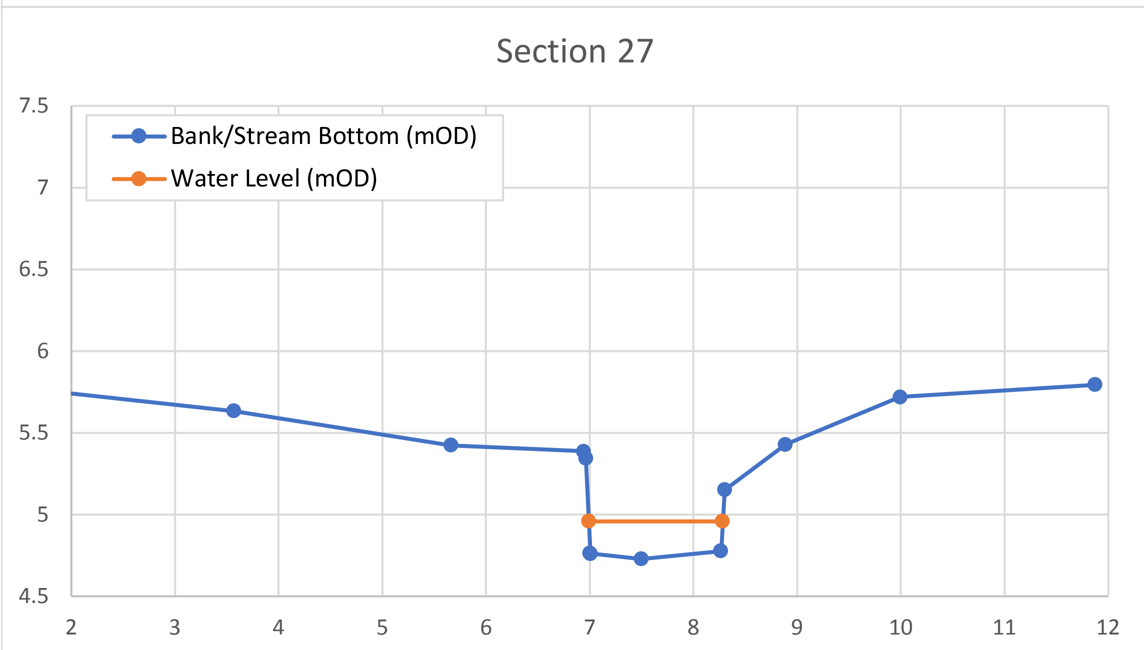


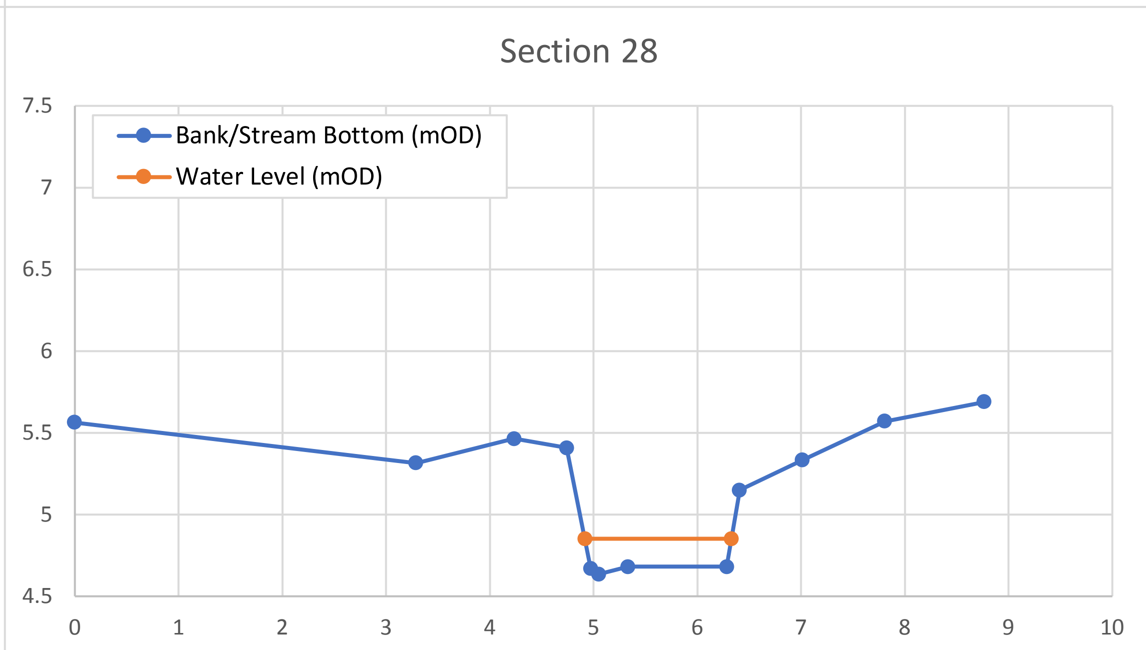


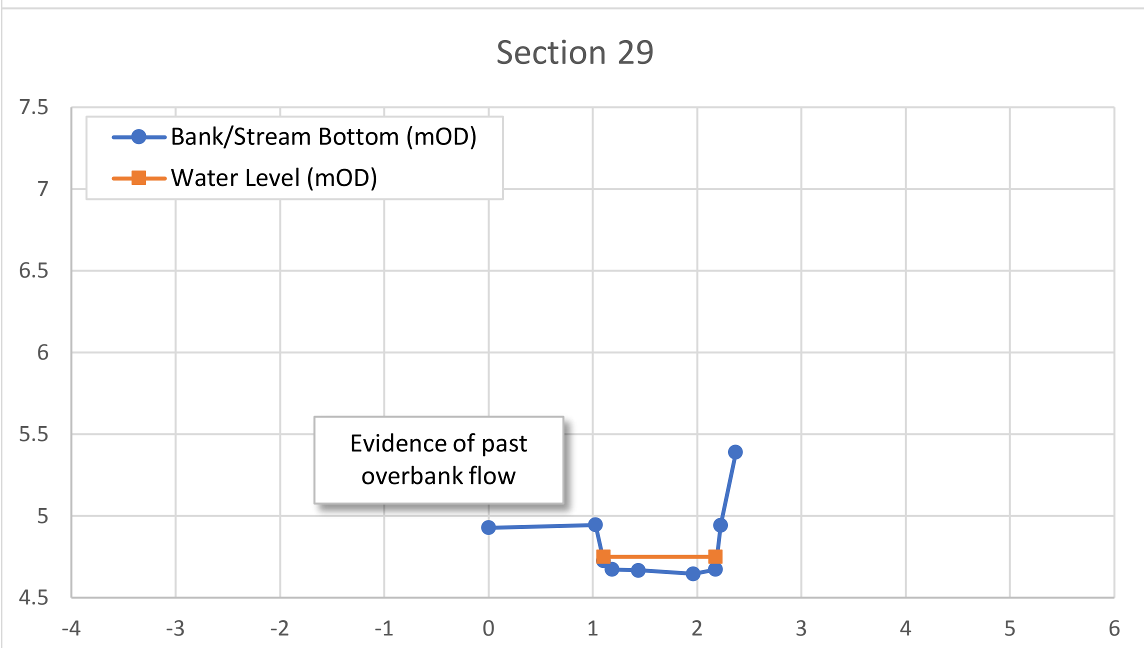


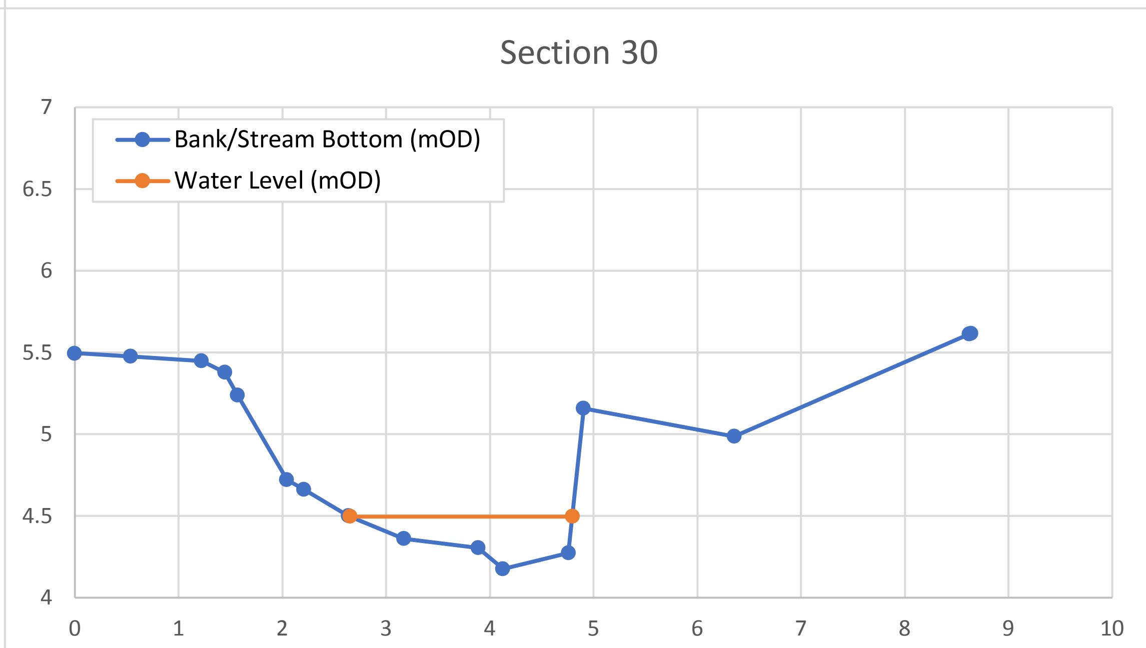




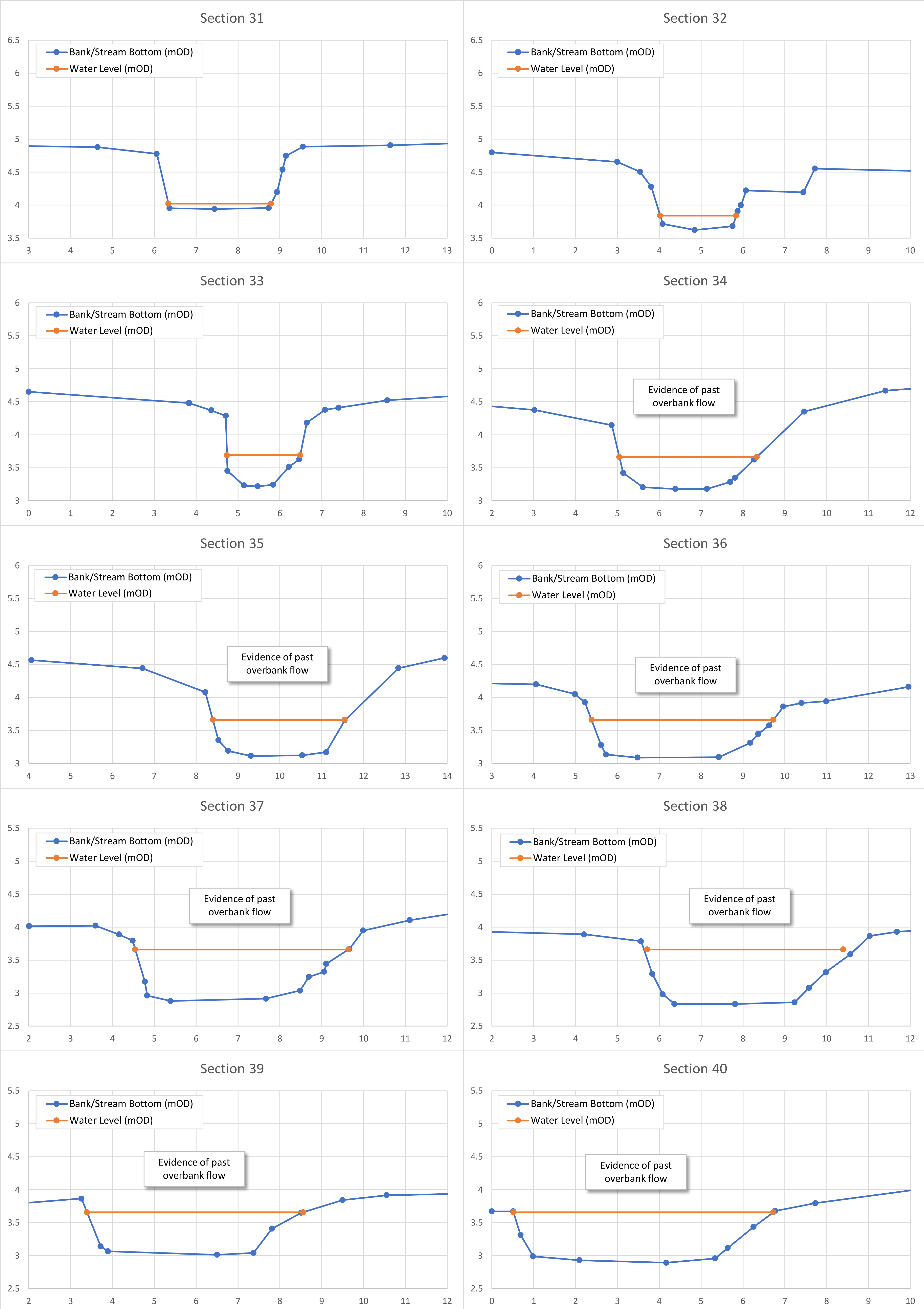


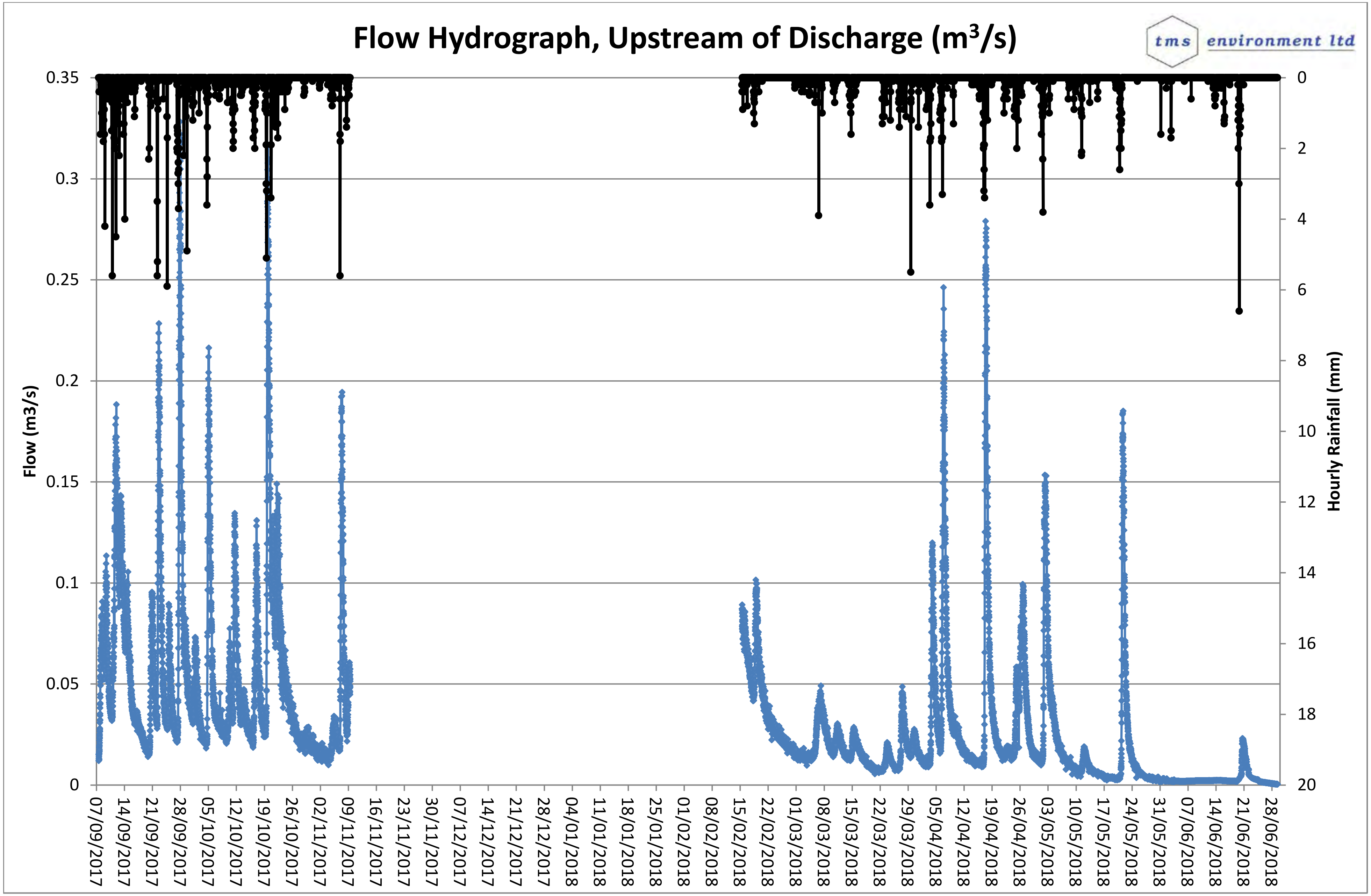




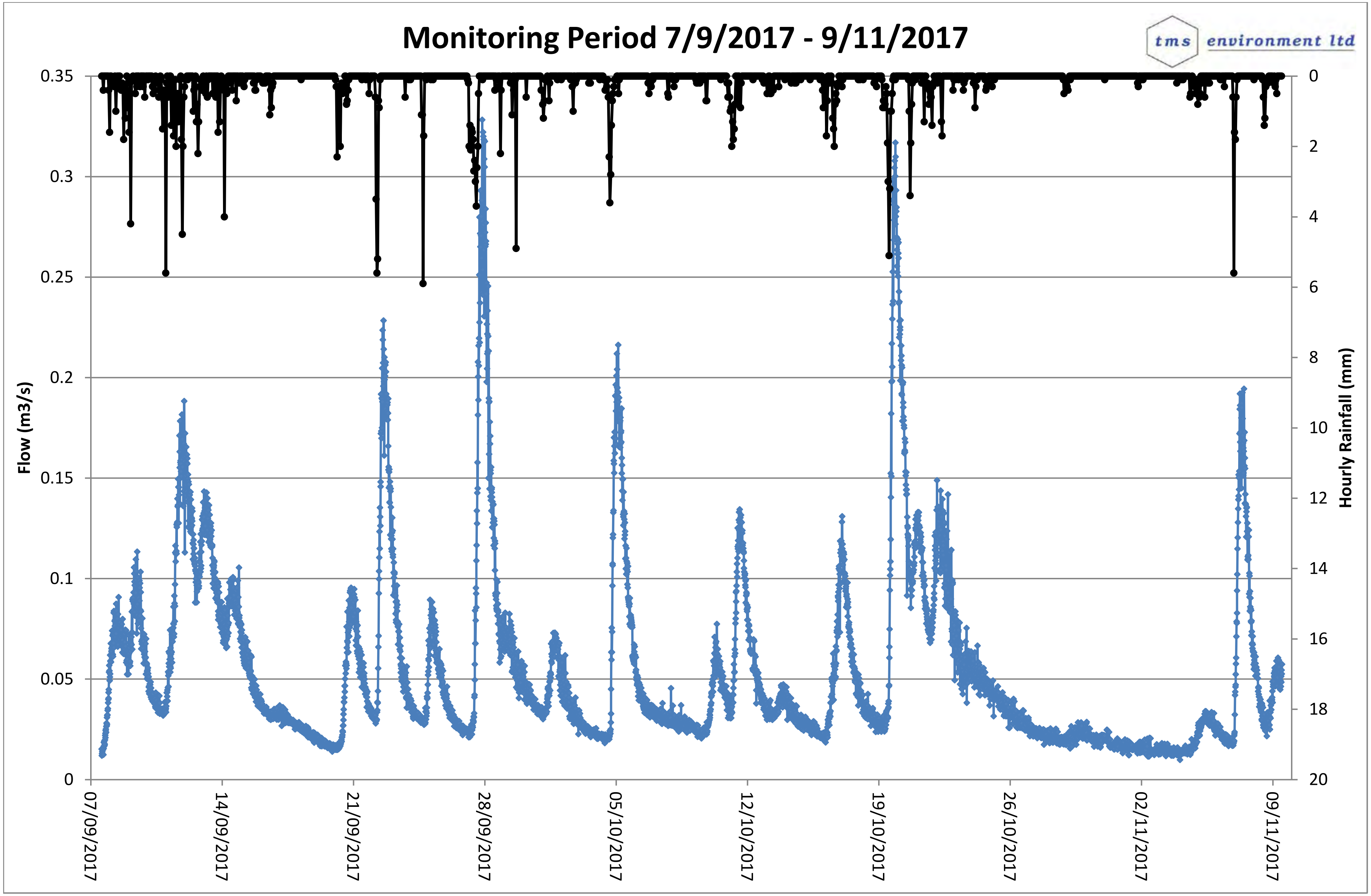


Stream Cross-Sectional Profiles





Flow Hydrograph, Upstream of Discharge (m³/s)
tms environment ltd
Flow (m3/s)
Hourly Rainfall (mm)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
2
4
6
8
10
12
14
16
18
20
07/09/2017
14/09/2017
21/09/2017
28/09/2017
05/10/2017
12/10/2017
19/10/2017
26/10/2017
02/11/2017
09/11/2017
16/11/2017
23/11/2017
30/11/2017
07/12/2017
14/12/2017
21/12/2017
28/12/2017
04/01/2018
11/01/2018
18/01/2018
25/01/2018
01/02/2018
08/02/2018
15/02/2018
22/02/2018
01/03/2018
08/03/2018
15/03/2018
22/03/2018
29/03/2018
05/04/2018
12/04/2018
19/04/2018
26/04/2018
03/05/2018
10/05/2018
17/05/2018
24/05/2018
31/05/2018
07/06/2018
14/06/2018
21/06/2018
28/06/2018



Monitoring Period 7/9/2017 - 9/11/2017
tms environment ltd
Flow (m3/s)
Hourly Rainfall (mm)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
2
4
6
8
10
12
14
16
18
20
07/09/2017
14/09/2017
21/09/2017
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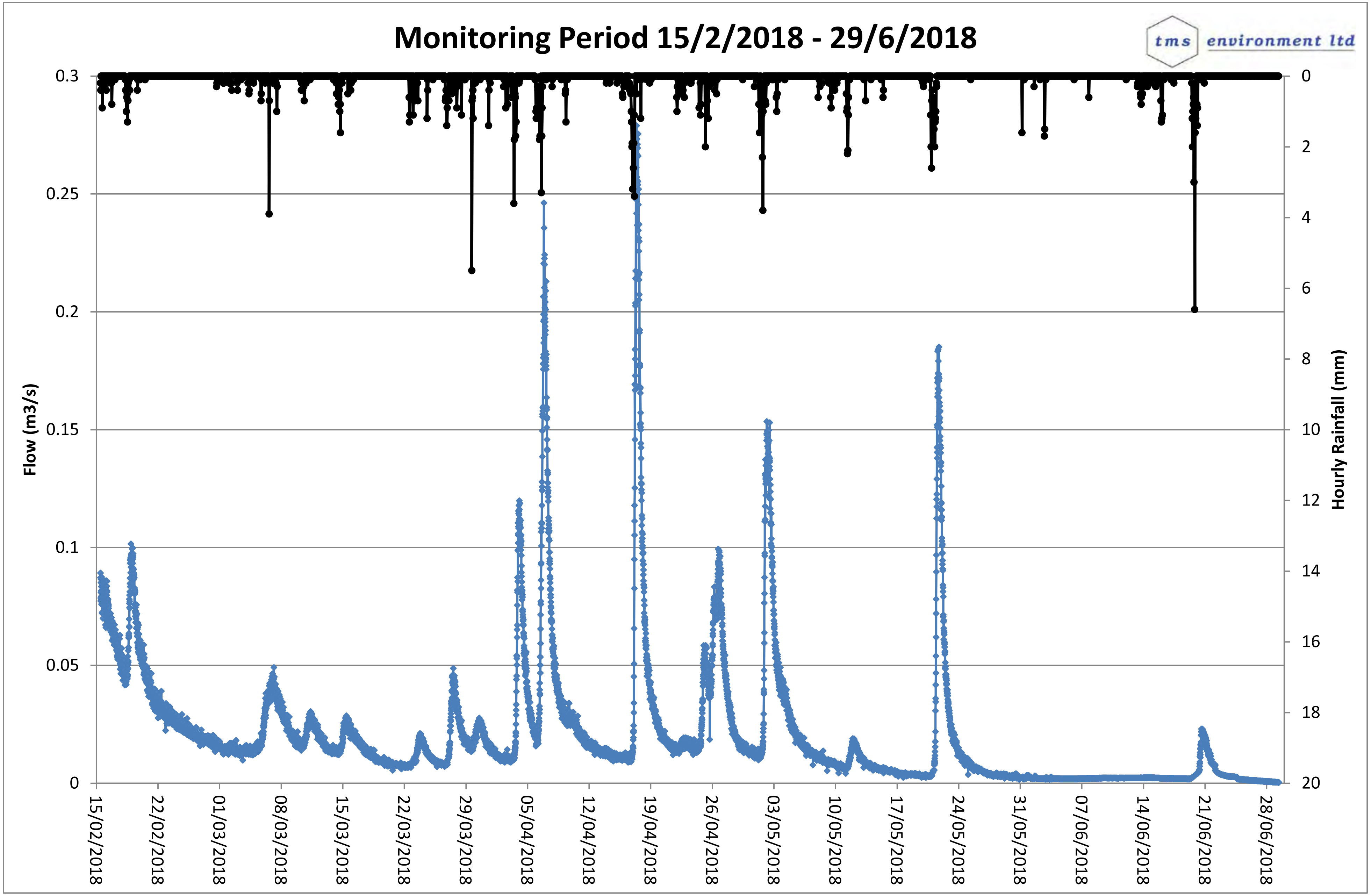
26/10/2017
02/11/2017
09/11/2017



Monitoring Period 15/2/2018 - 29/6/2018
tms environment ltd
Flow (m3/s)
Hourly Rainfall (mm)
0.3
0.25
0.2
0.15
0.1
0.05
0
0
2
4
6
8
10
12
14
16
18
20
15/02/2018
22/02/2018
01/03/2018
08/03/2018
15/03/2018
22/03/2018
29/03/2018
05/04/2018
12/04/2018
19/04/2018
26/04/2018
03/05/2018
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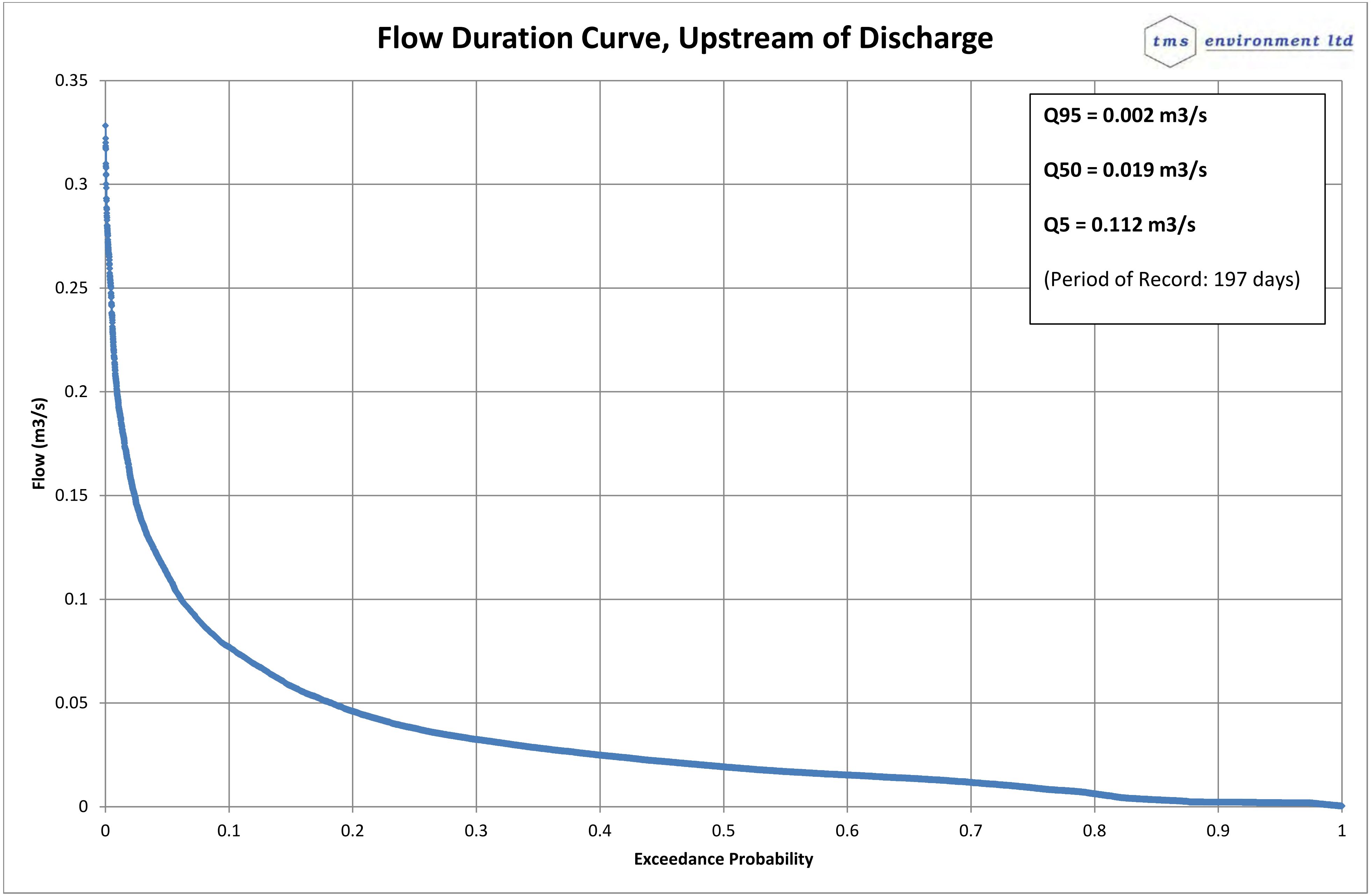
14/06/2018
21/06/2018
28/06/2018



Flow Duration Curve, Upstream of Discharge
tms environment ltd
Q95 = 0.002 m3/s
Q50 = 0.019 m3/s
Q5 = 0.112 m3/s
(Period of Record: 197 days)
Flow (m3/s)
Exceedance Probability
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Stream Cross-Section Calculations

	Reach No.	Channel Centre		Bank Full			S	n	Manning		Notes
		Easting (ITM)	Northing (ITM)	A (m^2)	WP (m)	R (m)			V (m/s)	Q_{max} (m^3/s)	
Section 1	-	570570.087	831874.943	1.545	4.498	0.343	0.00050	0.065	0.169	0.261	Field evidence of past overbank flow at this location
Section 2	1	570569.918	831892.256	5.044	6.447	0.782	0.00050	0.065	0.292	> 1.473	Section 2 located in small gorge, top of bank not surveyed
Section 3	1	570566.379	831915.101	3.378	5.821	0.580	0.00092	0.065	0.325	1.097	
Section 4	1	570564.762	831937.320	1.772	4.271	0.415	0.00092	0.065	0.260	0.460	Field evidence of past overbank flow at this location
Section 5	1	570563.232	831956.098	3.610	5.856	0.616	0.00008	0.065	0.097	0.348	Field evidence of past overbank flow at this location
Section 6	1	570562.130	831974.635	2.352	5.735	0.410	0.00008	0.065	0.074	0.173	Field evidence of past overbank flow at this location
Section 7	1	570564.670	831984.484	1.853	5.138	0.361	0.00008	0.065	0.068	0.125	Field evidence of past overbank flow at this location
Section 8	1	570569.095	832010.852	8.205	9.087	0.903	0.00008	0.065	0.124	1.021	
Section 9	1	570572.396	832018.913	7.285	8.313	0.876	0.00008	0.065	0.122	0.889	
Section 10	1	570576.044	832026.173	5.921	6.847	0.865	0.00008	0.065	0.121	0.716	
Section 11	2	570581.921	832048.599	6.265	7.035	0.891	0.00100	0.065	0.450	2.821	
Section 12	2	570595.658	832055.004	3.164	8.533	0.371	0.03210	0.070	1.321	4.180	
Section 13	2	570600.867	832062.909	5.806	9.469	0.613	0.03210	0.070	1.847	10.725	
Section 14	2	570609.168	832078.035	4.388	5.706	0.769	0.03210	0.070	2.148	9.427	
Section 15	3	570616.536	832090.897	5.453	6.301	0.865	0.00037	0.065	0.269	1.468	
Section 16	3	570616.125	832093.558	4.351	5.542	0.785	0.00037	0.065	0.252	1.098	
Section 17	4	570694.424	832181.212	3.941	8.786	0.449	0.01140	0.065	0.963	3.793	
Section 18	4	570700.250	832186.462	4.326	9.323	0.464	0.01140	0.065	0.985	4.259	
Section 19	4	570714.431	832202.855	2.394	5.137	0.466	0.01140	0.065	0.987	2.364	
Section 20	5	570739.284	832229.108	3.279	13.224	0.248	0.00189	0.065	0.264	0.866	
Section 21	5	570767.530	832244.169	2.835	7.040	0.403	0.00189	0.065	0.365	1.034	
Section 22	5	570779.033	832251.771	2.908	5.470	0.532	0.00189	0.065	0.439	1.277	
Section 23	5	570789.654	832259.343	1.722	5.141	0.335	0.01074	0.055	0.909	1.565	
Section 24	5	570798.425	832263.323	2.123	11.173	0.190	0.01074	0.055	0.623	1.322	
Section 25	5	570808.509	832268.818	1.944	9.184	0.212	0.01074	0.055	0.669	1.301	
Section 26	5	570822.717	832276.636	2.219	11.284	0.197	0.01074	0.055	0.637	1.414	
Section 27	5	570834.505	832283.738	3.231	12.907	0.250	0.01074	0.055	0.748	2.418	
Section 28	5	570841.960	832289.233	1.377	4.175	0.330	0.01074	0.055	0.899	1.239	
Section 29	5	570847.666	832293.155	0.319	1.602	0.199	0.01074	0.065	0.544	0.173	Field evidence of past overbank flow at this location
Section 30	6	570865.433	832303.567	4.534	9.433	0.481	0.01074	0.065	0.978	4.436	
Section 31	6	570881.121	832313.345	3.103	13.588	0.228	0.00684	0.065	0.475	1.475	
Section 32	6	570902.656	832325.211	2.408	5.672	0.425	0.00684	0.065	0.719	1.731	
Section 33	6	570922.170	832339.025	2.962	11.535	0.257	0.00684	0.065	0.514	1.523	
Section 34	7	570943.185	832345.099	5.747	11.513	0.499	0.00002	0.065	0.048	0.274	Field evidence of past overbank flow at this location
Section 35	7	570961.388	832353.255	5.765	10.648	0.541	0.00002	0.065	0.050	0.290	Field evidence of past overbank flow at this location
Section 36	7	570990.329	832373.123	6.215	14.544	0.427	0.00002	0.065	0.043	0.267	Field evidence of past overbank flow at this location
Section 37	7	571009.843	832375.621	5.771	11.880	0.486	0.00002	0.065	0.047	0.270	Field evidence of past overbank flow at this location
Section 38	7	571027.656	832383.554	5.252	13.279	0.396	0.00002	0.065	0.041	0.215	Field evidence of past overbank flow at this location
Section 39	7	571041.011	832387.681	3.821	7.180	0.532	0.00002	0.065	0.050	0.190	Field evidence of past overbank flow at this location
Section 40	7	571058.043	832390.662	3.920	6.787	0.578	0.00002	0.065	0.053	0.206	Field evidence of past overbank flow at this location

Notes:

A - Area
WP - Wetted Perimeter
R - Hydraulic Radius
S - Slope
n - Manning's roughness coefficient
V - Velocity
Q_{max} - Maximum flow rate

Manning Equation:

$$Q = VA = \left(\frac{1.00}{n}\right) A R^{\frac{2}{3}} \sqrt{S} \quad [SI]$$

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Culvert Calculations

	Description		Easting (ITM)	Northing (ITM)	IL (mOD)	WL (mOD)	A (m^2)	WP (m)	R (m)	S	n	V (m/s)	Q (m^3/s)	Q_{max} (m^3/s)	Notes
Culvert 1	Single concrete pipe, diameter 900mm	Upstream	570570.264	831874.957	8.333	8.470	0.636	2.827	0.225	0.00653	0.014	2.136	1.359	1.359	
		Downstream	570569.833	831892.249	8.220	8.316									
Culvert 2	Single concrete pipe, diameter 840mm upstream/1180mm downstream	Upstream	570578.629	832032.969	8.117	8.230	0.554	2.639	0.210	0.00917	0.014	2.416	1.339	1.339	Q_{max} restricted by smaller diameter upstream
		Downstream	570581.101	832044.712	*8.007*	8.120									
Culvert 3	Two concrete pipes, diameter 600mm	Upstream (L)	*570608.000*	*832076.000*	*6.833*	*7.071*	0.283	1.885	0.150	0.00950	0.014	1.967	0.557	1.113	
		Downstream (L)	*570615.000*	*832083.000*	*6.739*	*6.946*									
		Upstream (R)	*570608.000*	*832076.000*	*6.833*	*7.071*	0.283	1.885	0.150	0.00950	0.014	1.967	0.557		
		Downstream (R)	*570615.000*	*832083.000*	*6.739*	*6.946*									
Culvert 4	Two PVC/concrete pipes, diameter 450mm upstream (PVC)/600mm downstream (concrete)	Upstream (L)	570615.793	832093.607	6.805	6.920	0.159	1.414	0.112	0.00652	0.012	1.568	0.249	0.498	Q_{max} restricted by smaller diameter upstream
		Downstream (L)	570683.428	832172.200	6.129	6.416									
		Upstream (R)	570616.575	832093.490	6.783	6.920	0.159	1.414	0.112	0.00651	0.012	1.566	0.249		
		Downstream (R)	570683.943	832171.745	6.111	6.416									
Culvert 5	Arched culvert, height 766mm upstream, 1011mm downstream	Upstream	570722.439	832214.776	5.818	5.931	1.120	4.553	0.246	0.04696	0.030	2.836	3.176	3.176	Q_{max} restricted by smaller area upstream
		Downstream	570725.458	832217.564	5.625	5.732	1.564	5.050	0.310						
Culvert 6	Two concrete pipes, diameter 450mm upstream/600mm downstream	Upstream (L)	570847.521	832293.300	4.667	4.750	0.159	1.414	0.112	0.01071	0.014	1.722	0.274	0.509	Q_{max} restricted by smaller diameter upstream
		Downstream (L)	570865.375	832303.464	4.447	4.496									
		Upstream (R)	570847.895	832292.924	4.646	4.750	0.159	1.414	0.112	0.00788	0.014	1.477	0.235		
		Downstream (R)	570865.032	832302.853	4.490	4.496									
Culvert 7	Single concrete pipe, diameter 750mm	Upstream	570922.182	832339.001	3.268	3.691	0.442	2.356	0.188	*0.00378*	0.014	1.439	0.636	0.636	
		Downstream	*570925.938*	*832340.293*	*3.263*	*3.686*									

Notes:

IL - Invert Level
WL - Water Level (on date surveyed)
A - Area
WP - Wetted Perimeter
R - Hydraulic Radius
S - Slope
n - Manning's roughness coefficient
V - Velocity
Q - flow rate
Q_{max} - Maximum flow rate

Manning Equation:

$$Q = VA = \left(\frac{1.00}{n}\right) A R^{\frac{2}{3}} \sqrt{S} \quad [SI]$$

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Estimation of Peak Flow for Aghamore Stream at Culvert 1

1. Monitored Rainfall-Runoff Events

	Rainfall Event						Hydrograph						
No.	Start	Finish	Centre of Mass	Duration (hrs)	Total Rainfall (mm)	Mean Intensity (mm/hr)	Start RL	Peak Flow	Peak Flow (m^3/s)	T_p (hrs)	Lag (hrs)	1st IP	T_c (hrs)
1	27/09/2017 02:00	27/09/2017 16:00	27/09/2017 10:00	14	27.6	1.971	27/09/2017 09:00	27/09/2017 20:30	0.328	11.5	10.5	28/09/2017 18:15	26.25
2	04/10/2017 08:00	05/10/2017 00:00	04/10/2017 16:00	16	13.9	0.869	04/10/2017 15:00	05/10/2017 02:30	0.216	11.5	10.5	06/10/2017 06:15	30.25
3	05/04/2018 23:00	06/04/2018 17:00	06/04/2018 08:30	18	18.7	1.039	06/04/2018 03:45	06/04/2018 20:30	0.246	16.75	12	07/04/2018 19:00	26
4	16/04/2018 14:00	17/04/2018 04:00	16/04/2018 23:00	14	22.1	1.579	16/04/2018 20:00	17/04/2018 09:15	0.279	13.25	10.25	18/04/2018 08:15	28.25
5	01/05/2018 05:00	02/05/2018 03:00	01/05/2018 16:30	22	17.1	0.777	01/05/2018 14:00	02/05/2018 04:45	0.153	14.75	12.25	03/05/2018 03:30	24.5
6	20/05/2018 20:00	21/05/2018 12:00	21/05/2018 03:30	16	19.2	1.200	21/05/2018 02:30	21/05/2018 14:45	0.183	12.25	11.25	22/05/2018 12:00	24

Notes:

Start RL - Start of Rising Limb of Hydrograph

T_p - Time to Peak

1st IP - First inflection point on Receding Limb of Hydrograph

T_c - Time of Concentration

2. Estimation of Runoff Coefficient from Monitored Events

$Q_p = 0.278CiA$ Rational Method

Where:

Q_p	Peak flow (m^3/s)
C	Runoff Coefficient (-)
i	Mean intensity (mm/hr)
A	Catchment Area (km^2)

Rainfall Event	Q_p	i	A	C
1	0.328	1.971	2.722	0.220
2	0.216	0.869	2.722	0.329
3	0.246	1.039	2.722	0.313
4	0.279	1.579	2.722	0.234
5	0.153	0.777	2.722	0.260
6	0.183	1.200	2.722	0.202

3. Estimation of Peak Flow for Worst Case

No.	Duration (hrs)	Total Rainfall (mm)	ARF	Rainfall Frequency (AEP %)	Mean Intensity (mm/hr)
1	14	27.6	0.979	51.3	1.971
2	16	13.9	0.98	59.3	0.869
3	18	18.7	0.981	56.4	1.039
4	14	22.1	0.979	53.6	1.579
5	22	17.1	0.982	58	0.777
6	16	19.2	0.98	55.7	1.200
Worst Case	26.5	85.6	0.983	1	3.230

Notes:

ARF - Areal Reduction Factor

AEP - Annual Exceedance Probability

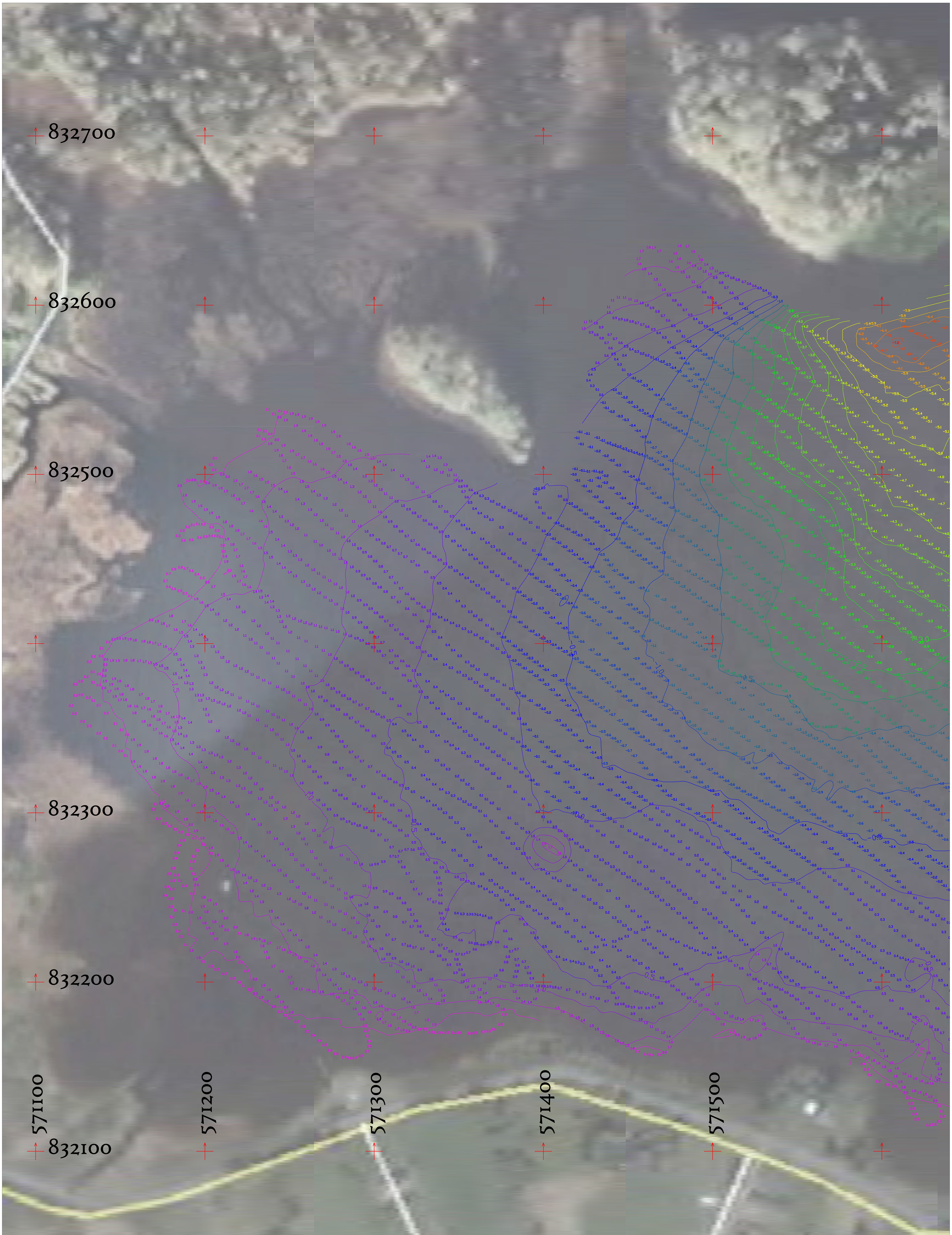
With lowest Runoff Coefficient:

C	0.202	-
i	3.230	mm/hr
A	2.722	km^2
Q_p	0.494	m^3/s

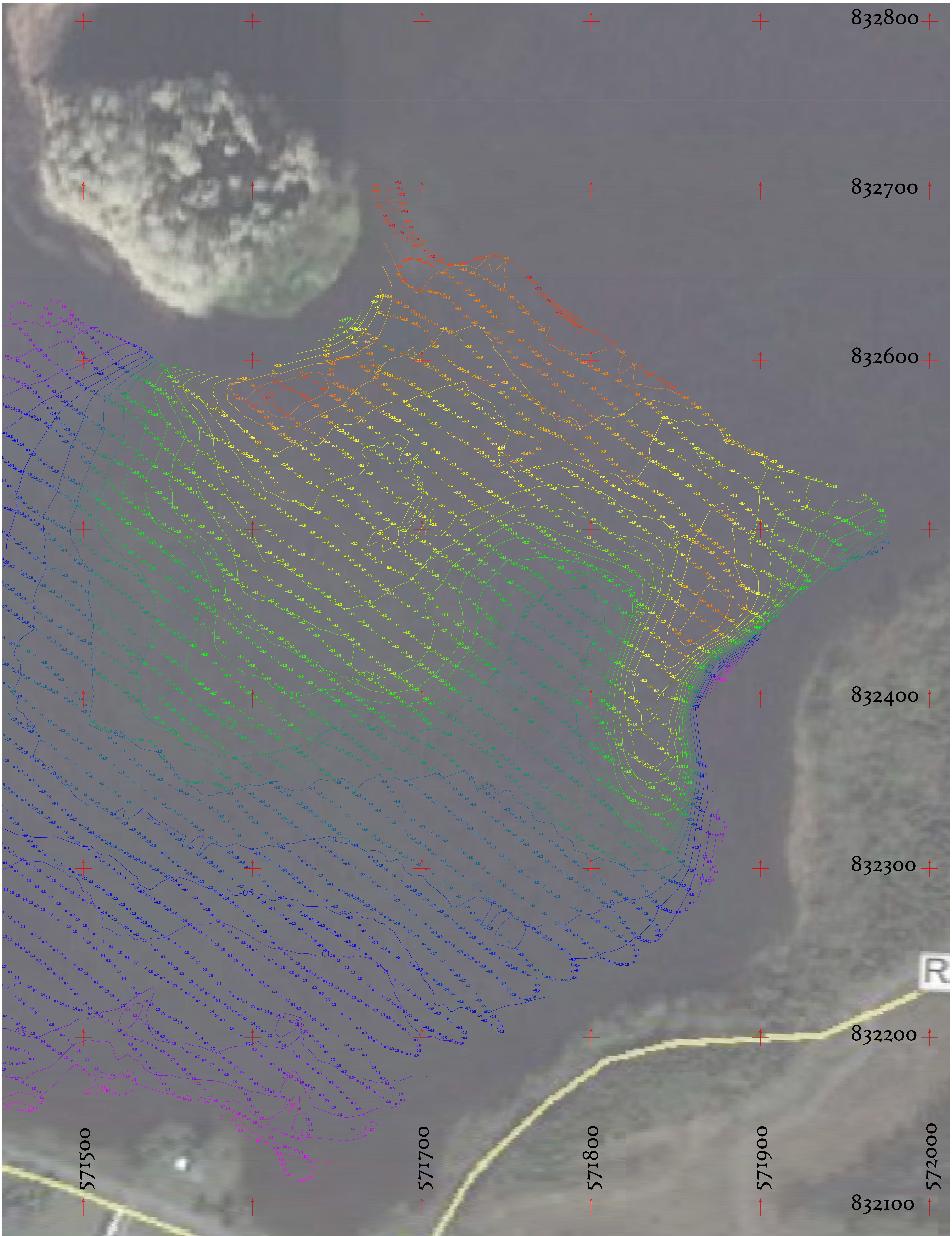
With highest Runoff Coefficient:

C	0.329	-
i	3.230	mm/hr
A	2.722	km^2
Q_p	0.804	m^3/s

Estimated Peak Flow (Q_p) ranges from 0.494 - 0.804 m^3/s



LOCATION: LOUGH GILL, CO. SLIGO	SHEET TITLE: TMS Environmental Ltd.	JOB NUMBER: PH18014	SURVEY DATE(S): 22nd February 2018		MEMOIR: 1. Constructed on Irish Transverse Mercator. 2. Soundings in meters and decimeters reduced to OD Malin. 3. Water level on day of survey 3.88m OD Malin via RTK GNSS surveying. 4. Background map roughly scaled, for display purposes only.	PREPARED BY: Hydrographic Surveys Ltd. The Cobbles, Crosshaven, Co. Cork, P43 C966 e: info:@hydrosurvey.com t: +353 21 483 1184 w: www.hydrosurvey.com
SHEET TITLE: BATHYMETRIC SURVEY OF LOUGH GILL, CO. SLIGO. SHEET 1 OF 2	SURVEYED BY: Hydrographic Surveys Ltd. The Cobbles, Crosshaven, Co. Cork, P43 C966 e: info:@hydrosurvey.com t: +353 21 483 1184	DRAWING NUMBER: PH18014_D01	SCALE: 1:1000 @ A1	APPROVED: J.B.J.		Hydrographic Surveys Ltd.
		DRAWN BY: Hugh Power	REVISION: Rev.00			
		COORDINATE SYSTEM: Irish Transverse Mercator	DATUM: OD Malin			



LOCATION: LOUGH GILL, CO. SLIGO	SHEET TITLE: TMS Environmental Ltd.	JOB NUMBER: PH18014	SURVEY DATE(S): 22nd February 2018		
		DRAWING NUMBER: PH18014_D02	SCALE: 1:1000 @ A1	APPROVED: J.B.J.	
SHEET TITLE: BATHYMETRIC SURVEY OF LOUGH GILL, CO. SLIGO. SHEET 2 OF 2	SURVEYED BY: Hydrographic Surveys Ltd. The Cobbles, Crosshaven, Co. Cork, P43 C966 e: info:@hydrosurvey.com t: +353 21 483 1184	DRAWN BY: Hugh Power	REVISION: Rev.00		
		COORDINATE SYSTEM: Irish Transverse Mercator	DATUM: OD Malin		

MEMOIR:

1. Constructed on Irish Transverse Mercator.
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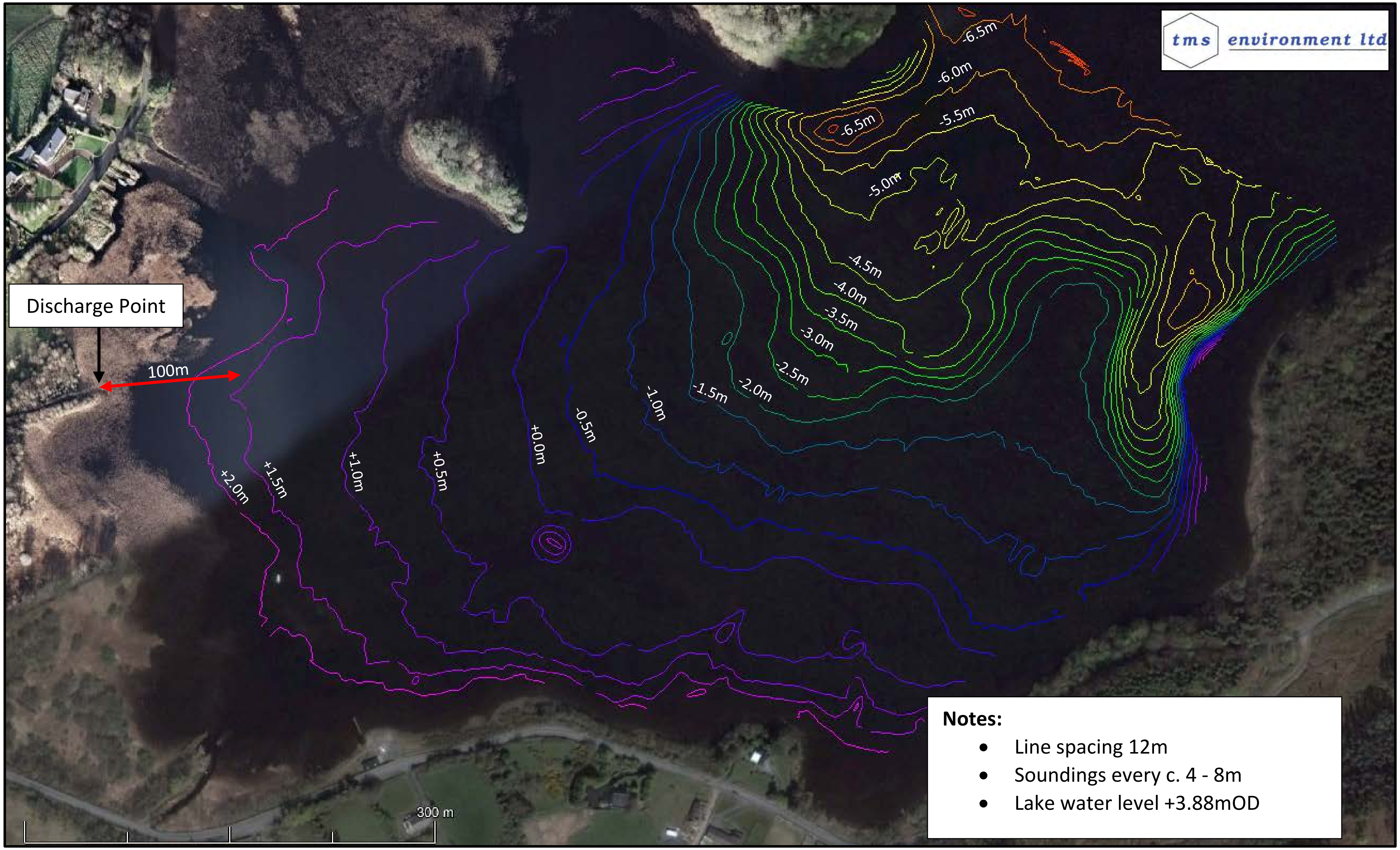
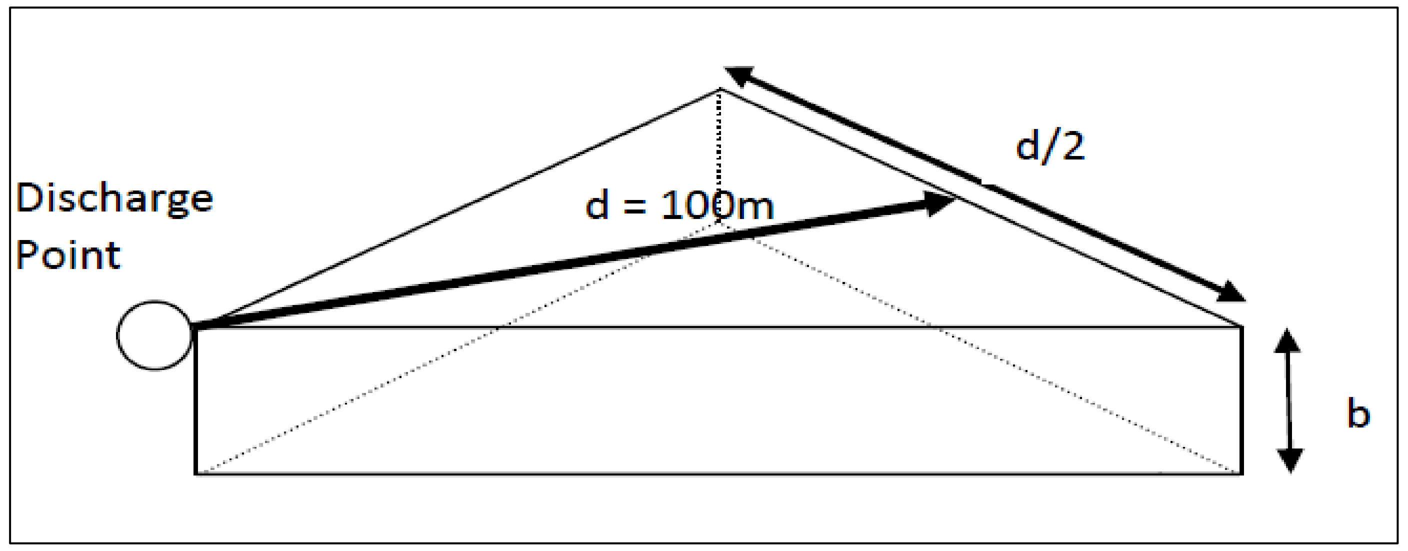


Bathymetric Survey of Aghamore Bay (22/2/2018)

Assimilative Capacity Analysis

EPA Simple Assimilative Capacity Model:



Assumptions:
1. The given distance from the discharge point to estimate the number of dilutions available is 100m
2. The forward rate of the discharge plume is an assumed velocity (s = 0.1m/s)
3. The lateral dispersion is taken to be half the forward velocity
4. Assumes no buoyancy effects
5. Assumes full vertical mixing in the plume
6. Assumes the receiving water is static

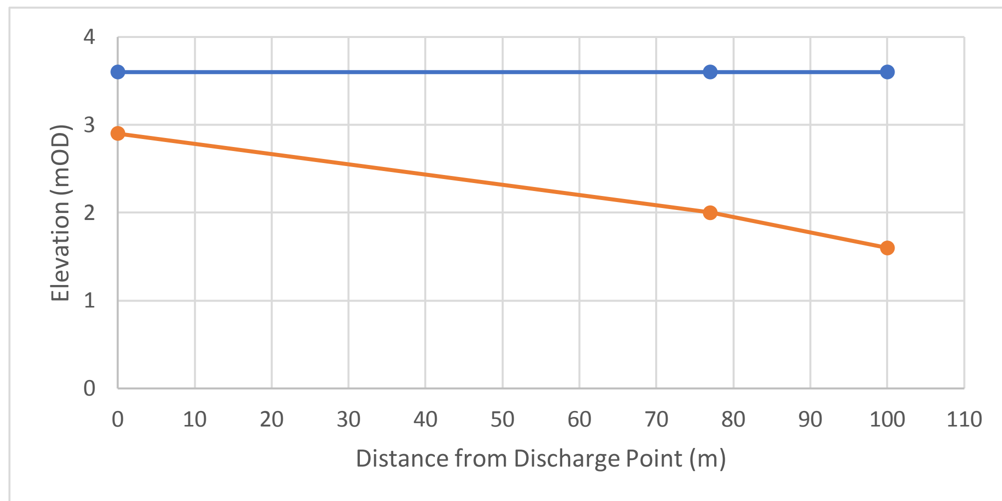
Formulae:

Dilutions Available = 8930b/F, where b = average depth and F = max hourly flow rate

C = Cb + ((Ce - Cb)/ (1 + D)), where C = concentration in receiving water, Ce = background concentration in receiving water and Ce = concentration in trade effluent

Average Depth in Receiving Water:
From the bathymetric survey undertaken in Aghamore Bay:

Distance from Discharge Point (m)	0	77	100
Water Level (mOD)	3.6	3.6	3.6
Base of Lake (mOD)	2.9	2	1.6
Water Depth (m)	0.7	1.6	2



Low lake water level used for worst case (lowest dilution)

Average depth over the first 100m = 1.3m

Dilutions Available:

Parameter	Value	Units	Notes
b	1.3	m	From above
F	146	m3/hr	From licence
D	79.513699	-	Dilutions available

For Orthophosphate (Median Concentrations):

Parameter	Value	Units	Notes
Cb	0.011	mg/l	Median concentration detected by EPA WFD monitoring in Lough Gill
Ce	0.015	mg/l	Median concentration detected in discharge samples
C	0.0110497	mg/l	
Change	0.45	%	Increase in background concentration in zone 100m from discharge point

For Total Ammonia (Median Concentrations):

Parameter	Value	Units	Notes
Cb	0.01	mg/l	Median concentration detected by EPA WFD monitoring in Lough Gill
Ce	0.015	mg/l	Median concentration detected in discharge samples
C	0.0100621	mg/l	
Change	0.62	%	Increase in background concentration in zone 100m from discharge point

Summary of Potential Impacts, Mitigation Measures and Residual Impacts

Potential Impact	Quality	Significance	Duration	Proposed Mitigation Measures	Mitigated Residual Impact	Mitigated Quality of Residual Impact
Construction Stage						
Generated suspended solids in runoff	Negative	Slight	Temporary	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	Imperceptible	Neutral
Accidental spills of fuel/oil from vehicles	Negative	Slight	Temporary	Spill kits will be maintained on site to stop the migration of any accidental spillages	Imperceptible	Neutral
Operational Stage						
Drawdown (impact on well)	Negative	Slight	Medium-term	Monitor GWLs in Brendan McDonagh's farm well (with permission), replace well if affected	Imperceptible	Neutral
Groundwater Quality (blasting, accidental leaks, suspended solids)	Negative	Slight	Medium-term	Development of site-specific blasting protocol, bunding of petroleum-based products, regular plant inspections, no refuelling in quarry void, spill kits, interceptors, settlement lagoon	Imperceptible	Neutral
Flooding (Exacerbation of flooding at Culvert 4)	Negative	Slight	Temporary	No pumping during flood events	Imperceptible	Neutral
Discharge to Surface Water	Negative	Imperceptible	Medium-term	None	Imperceptible	Neutral
Groundwater Bodies	Neutral	Imperceptible	Medium-term	None	Imperceptible	Neutral
Post-Operational Stage						
None identified						

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CHAPTER 8

AIR

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INTRODUCTION

Background

8.1 This chapter of the Environmental Impact Assessment Report (EIAR), prepared by SLR Consulting Ireland, provides supporting information to accompany a Planning Application to Sligo County Council by Lagan Bitumen Ltd. It assesses the potential air quality related impacts from the site associated with the planning application area and the wider quarry development at Aghamore Near and Carrownamaddoo townlands, Co. Sligo.

8.2 The quarry operations comprise extraction of limestone using blasting techniques; processing (crushing and screening) of the fragmented rock to produce aggregates for road construction, site development works and in the production of value added products.

8.3 Further information on the site infrastructure, operations, environmental management systems, and controls at the established quarry site is provided in the Chapter 2 of this EIAR.

8.4 The proposed development will have the potential to generate additional fugitive dust emissions and particulates (PM_{10}), which may result in impacts on local air quality.

8.5 Combustion emissions (primary PM_{10}, and oxides of nitrogen) from vehicle exhaust emissions associated with the extraction and transportation of aggregates will also have the potential to impact on local air pollution.

8.6 The proposed development provides for extraction in line with current permitted levels, i.e. up to 300,000 tonnes of rock per year. However, it is expected that extraction rates will vary from 150,000 to 300,000 tonnes per annum, depending on market demand. The quarry will use the existing established access and traffic routes.

Scope of Work

8.7 The main focus of this assessment is the potential impact on local amenity from increased fugitive dust emissions and particulate matter from the proposed development.

8.8 The chapter describes and assesses the existing air quality baseline characteristics of the local area. The project is then applied to these baseline conditions and the resulting air quality impacts are assessed. Mitigation measures are identified, where required, to insofar as is practical, eliminate and reduce these impacts.

8.9 The following sections of this EIAR Chapter describe the potential air quality impacts associated with activities within the proposed development. The following issues are addressed separately:

- relevant legislation, standards and guidance;
- methodology used to assess the potential impacts of the activities at the proposed development on air quality at sensitive receptors;
- baseline conditions pertaining to the measured (or estimated) existing air quality levels around the site;
- assessment of the impacts;

- description of mitigation measures that are incorporated into the construction, design and operation of the pit to eliminate or reduce the potential for increased air quality impacts (if required);
- summary of any residual impacts and reinstatement;
- summary of cumulative impacts; and
- monitoring proposals.

Consultations / Consultees

8.10 A pre-planning consultation meeting was held between officials of Sligo County Council and the applicant as part of this planning application.

Contributors / Author(s)

8.11 SLR Consulting Ireland undertook the impact assessment presented in this chapter on behalf of Lagan Bitumen Ltd. The lead consultant for the study was Sarah Errity MSc. (Environmental Science).

Limitations / Difficulties Encountered

8.12 This assessment is compiled on the basis of published regional and local data, guidance documents, and site-specific field surveys. No difficulties were encountered in compiling the required information.

REGULATORY BACKGROUND

8.13 The following sections describe the main legislative policy requirements in respect of air quality associated with the proposed development.

Legislation

Air Quality Standards

8.14 The Government's policy on air quality within Ireland is set out in the Air Quality Standards (AQS) Regulations 2011. The CAFE Directive was transposed into Irish legislation by the Air Quality Standards Regulations 2011 (S.I. No. 180 of 2011). It replaces the Air Quality Standards Regulations 2002 (S.I. No. 271 of 2002), the Ozone in Ambient Air Regulations 2004 (S.I. No. 53 of 2004) and the EPA Act 1992 (Ambient Air Quality Assessment and Management) Regulations 1999 (S.I. No. 33 of 1999). The 4th Daughter Directive was transposed by the Arsenic, Cadmium, Mercury, Nickel and Polycyclic Aromatic Hydrocarbons in Ambient Air Regulations 2009 (S.I.no. 58 of 2009).

8.15 The AQS sets out a framework for reducing hazards to health from air pollution and ensuring that international commitments are met in Ireland.

8.16 The AQS sets standards and objectives for ten priority pollutants. Standards establish concentrations of pollutants in the atmosphere which can broadly be taken to provide a certain level of environmental quality. Objectives are policy targets, often expressed as maximum concentrations, not to be exceeded (either without exception, or with a limited number of exceedances within a specified timescale).

8.17 Under the AQS, the following pollutants are monitored and controlled :

- nitrogen oxides;
- sulphur dioxide;
- carbon monoxide;
- ozone;
- particulate matter (PM10, PM2.5 and black smoke);
- benzene and volatile organic compounds;
- heavy metals; and
- polycyclic aromatic hydrocarbons.

8.18 These pollutants are monitored at 32 stations across the country and together they form the national ambient air quality network. A summary of relevant air quality limit values in relation to human health are presented in **Table 8-1**. Air quality limit values in relation to vegetation protection are presented separately in **Table 8-2**.

8.19 The air quality monitoring network is coordinated and managed by the EPA, as the National Reference Laboratory for air quality. The results of the monitoring are compared to limit values set out in EU and national legislation on ambient air quality. As was recommended in the 2011 Review of the Environmental Protection Agency, map-based assessments are prepared and published by the EPA.

Table 8- 1

Relevant Air Quality Limit Values for Protection of Human Health

Human Health	Limit or Target Value			Information and Alert Thresholds (where applicable)		Long Term Objective
Pollutant	**Averaging Period**	**Value**	**Maximum Number of Allowed Occurrences**	**Period**	**Threshold value**	
Nitrogen Dioxide (NO_2)	Hour Year	200 µg/m^3 40 µg/m^3	18 0	1 hour alert	400 µg/m^3 Exceeded for 3 consecutive hours	
Sulphur Dioxide (SO_2)	Hour Day	350 µg/m^3 125 µg/m^3	24 3	1 hour alert	500 µg/m^3 Exceeded for 3 consecutive hours	
Particulate matter with aerodynamic diameter of less than 10µm (PM_{10})	Day Year	50 µg/m^3 40 µg/m^3	35 0			
Particulate matter with aerodynamic diameter of less than 2.5µm ($PM_{2.5}$)	Year	25 µg/m^3 20 µg/m^3 (ECO)				0 8.5 to 18 µg/m^3

Table 8- 2

Summary of Air Quality Limit Values: Protection of Vegetation

Vegetation	Critical Level or Target Value		Long-term Objective	
Pollutant	**Averaging Period**	**Value**	**Value**	**Date**
Nitrogen dioxide (NOx)	Calendar year	30 µg/m^3		
Sulphur Dioxide (SO_2)	Calendar year and winter (October to March)	20 µg/m^3		

Planning Policy and Development Control

8.20 At present, there are no specific policies relating to air emissions in National Planning Policy for extractive industry or related production activities. It is left to Local Authorities to consider the land use and planning issues associated with extractive industry and related activities in preparing their County Development Plans. The general objective in planning is to ensure that activity and outputs are managed in a sustainable way, so as to achieve a balance between environmental, economic, and social considerations.

Local Planning Policy – Sligo County Development Plan

8.21 The current Sligo County Development Plan which was adopted in August 2017 includes a number policies and objectives for the planning and sustainable development of the County from 2017 to 2023. P-AQ-2 and P-AQ-4 state that is it the policy of Sligo County Council to:

"In conjunction with the EPA, ensure that all existing and new developments are operated in a manner that does not contribute to deterioration in air quality"

"Promote the retention of trees, hedgerows and other vegetation, and encourage tree planning as a means of air purification and filtering of suspended particles"

Existing Site Emission Limits

8.22 Condition No. 19 of PL02/271 states that when the quarry is operational:

(a) During (dry) weather conditions which favour the dispersion of dust, the Applicant shall ensure that a procedure for the control of windblown dust and dust from the movement of trucks/machinery shall be operated and maintained.

(b) Dust suppression systems shall be used and maintained on all internal roads, aggregate transfer points, stockpile areas, conveyors and at the crushing plant. Collection systems for runoff water shall be provided with adequately designed settlement traps, to reduce the likely discharge of suspended solids to adjacent water courses. Details of the systems (i.e. dust suppression and run-off collection systems) shall be submitted to the Planning Authority for approval prior to their installation.

(c) The Applicant shall maintain and operate the dust deposit gauges around the site to the satisfaction of the Local Authority.

(d) A new dust deposition gauge shall be installed on the western boundary of the quarry, the location shall be agreed with the Local Authority prior to its installation. Additional dust deposition gauges may be requested by the Local Authority at other locations around the site if the Authority deem necessary.

(e) The dust gauges shall be operated in accordance with BS1747 Part 1 of 1969: Methods for the Measurement of Air Pollution: Deposit Gauges (or such method as may be agreed in advance in writing with the Local Authority).

(f) Dust deposition shall not exceed 130 mg/m^2/day. Any excess of this shall be immediately notified to the Local Authority.

(g) Safe and permanent access shall be provided to each of the dust deposition monitoring sites.

(h) The results of monthly measurements from these gauges shall be retained on-site, for inspection by the Local Authority, for a period of 10 years after the measurements are made. A summary of these results shall be submitted to the Local Authority annually as part of the Annual Environmental Report.

8.23 It should be noted that the 130 mg/m^2/day limit is related to an outdated methodology. Current guidelines now recommend a limit of 350 mg/m^2/day, this is widely accepted throughout Ireland.

Guidelines Extractive Industry Emissions Limit Values

8.24 In 1996, the Irish Concrete Federation (ICF), the trade body representing the interests of quarry operators and producers of construction materials, published the ICF Environmental Code which provided guidance for its members on best practice in the environmental management of quarries. The document was subsequently updated in 2005.

8.25 Section 261 of the Planning and Development Act 2000 (as amended), which regulates a significant proportion of established pit development, came into effect in April 2004. The Department of Environment planning guidelines for the extractive industry 'Quarries and Ancillary Activities – Guidelines for Planning Authorities' (DoEHLG 2004) were published around the same time.

8.26 Separately, in 2006, the EPA published its Environmental Management Guidelines for Environmental Management in the Extractive Industry (Non-Scheduled Minerals).

Guidance Relating to Dust

8.27 Fractions of dust greater than 10 µm (micrometres) in diameter are not covered within the Air Quality Standards and typically relate to nuisance effects.

8.28 A range of monitoring techniques exist for dust deposition rates (i.e. Bergerhoff and Frisbee gauges). Extractive industry standard criteria levels for the gravimetric assessment of dust deposition which are generally used across extractive industry in Ireland include the DoEHLG (2004) planning guidelines for the extractive industry[1], the ICF Guidelines (2005) and EPA (2006) Environmental Management Guidelines.[2]

8.29 The Guidelines recommend the use of the Bergerhoff method for measuring dust deposition. In line with this approach, the guidelines recommend the TA Luft dust deposition limit value of 350 $mg/m^2/day$ (total dust deposition averaged over a 30 day period), measured at site boundaries.

8.30 When the rate of accumulation of this coarser fraction of dust (referred to as deposited dust) is sufficiently rapid to cause fouling or discolouration, then it is generally considered to introduce a nuisance. The point at which an individual perceives dust deposition as a nuisance and causes a complaint is highly subjective.

8.31 The action of wind over dry ground will carry dust particles into the air. Although large emissions of dust occur naturally, man-made dust events are caused by a range of activities including agriculture, road traffic, construction works (including the handling and storage of soils or C&D wastes) and by vehicles using paved and unpaved haul roads.

8.32 For operations involving the mechanical break up of solids, the most common concern regarding dust emissions is the potential nuisance effect from the larger fractions of dust.

Dust and Ecological Receptors

8.33 A majority of the research on the effects of particulate matter on vegetation has focussed on the chemical effects of alkaline dusts. A summary of a review of available research on behalf of the UK's Department for the Environment Transport and Regions (DETR) concluded that:

8.34 "The issue of dust on ecological receptors is largely confined to the associated chemical effect of dust, and particularly the effect of acidic or alkaline dust influencing vegetation through soils."

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[1] http://www.housing.gov.ie/sites/default/files/migrated-files/en/Publications/DevelopmentandHousing/Planning/FileDownLoad%2C1606%2Cen.pdf

[2] https://www.epa.ie/pubs/advice/general/EPA_management_extractive_industry.pdf

8.35 An Interim Advice Note (IAN) prepared as a supplement for Volume 11, Section 3, part 1 of the UK DMRB (Design Manual for Roads and Bridges) and now incorporated into HA207/07) suggests that only dust deposition levels above 1,000mg/m^2/day are likely to affect sensitive ecological receptors. This level of dust deposition is approximately five times greater than the level at which most dust deposition may start to cause a perceptible nuisance to humans. It states that most species appear to be unaffected until dust deposition rates are at levels considerably higher than this.

Air Quality and Health Effects

8.36 Two recent EPA reports, *Air Quality in Ireland 2015*[3] and *Ireland's Environment, An Assessment 2016* [4]detail the main air quality trends based on monitoring from the national ambient air quality network. There are monitored exceedances of the WHO guideline values for ozone, PM_{10} and $PM_{2.5}$ at a number of sites though there are no current exceedances of the lower (less protective) EU standards at the existing monitoring locations in Ireland. The reports also highlight the main challenges of reducing air pollution from key sources such as particulate matter emissions from solid fuel burning (e.g. peat, coal and wood) in the residential sector and NOx emissions from vehicles in the transport sector.

8.37 A summary of relevant Air Quality limit values in relation to human health was presented previously in **Table 8-1**.

RECEIVING ENVIRONMENT

Study Area

8.38 The application site is located in the townland of Aughamore Near and Carrownamaddoo, County Sligo approximately 7km south of Sligo and 5km east of the N4 Road.

8.39 The application site relates to the quarry extraction area on the western side of the local road, as per the previous planning application (Plan File Ref. No. 02/271). Material extracted from the permitted quarry area is processed within the quarry void or is transported to the processing area located on the opposite side of the local road. The processing area does not form part of the planning application area.

8.40 Dwellings within the vicinity of the site generally comprise one-off housing along the local road network. The nearest dwellings to the landholding site boundary are identified on **Figure 8-1**.

Baseline Study Methodology

8.41 The application site and surrounding area fall into Air Quality Zone D, categorised as rural Ireland. The air quality in each zone is assessed and classified with respect to upper and lower assessment thresholds based on measurements over the previous five years. Upper and lower assessment

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[3] Environmental Protection Agency, 2016. Air Quality in Ireland 2015 - Key Indicators of Ambient Air Quality. Available at:https://www.epa.ie/pubs/reports/air/quality/Air%20Quality%20Report%202015.pdf

[4] Environmental Protection Agency, 2016. Ireland's Environment, An Assessment 2016. Available at: http://www.epa.ie/pubs/reports/indicators/SoE_Report_2016.pdf

thresholds are prescribed in legislation for each pollutant. The number of monitoring locations required is dependent on population size and whether ambient air quality concentrations exceed the upper assessment threshold, are between the upper and lower assessment thresholds, or are below the lower assessment threshold.

8.42 The closest air quality monitoring locations to the proposed application site, and in a similar Zone D rural area, is located at Castlebar, Co. Mayo. As such, it is considered the most appropriate datasets available for assessment of air quality baseline concentrations in the study area around the proposed development.

8.43 Dust monitoring was conducted at and around the application site using the 'Bergerhoff method' referred to in the TA Luft Air Quality Standard. The deposition gauge used in the survey was the 'Bergerhoff' dust gauge, which comprises a plastic collection bottle and a post with protective basket, set at 1500mm above ground level. The input of the atmospheric material into the bottle is determined over a planned period measurement (usually one month) by exposing the plastic collection bottle to the environment. The total dust collected in the bottle is expressed as deposition of insoluble particulate matter (mg/m^2/day) arising from fugitive actions in the area surrounding the application site.

Sources of Information

8.44 A desk study was carried out to examine all relevant information relating to air quality conditions around the application site. Met Eireann, the National Meteorological Service, was consulted in relation to the climate / weather data in respect of the study area (http://www.met.ie/climate-ireland/1981-2010/dublin.html). The EPA website was examined to note information on baseline air monitoring data around the application site (http://www.epa.ie/air/quality/data/).

8.45 Information published on its website by the National Parks and Wildlife Service (NPWS) (http://webgis.npws.ie/npwsviewer/), (part of the Department of the Environment, Community and Local Government, DoECLG), in respect of designated ecological sites, protected habitats and species was also reviewed, together with Ordnance Survey maps and aerial photography (http://map.geohive.ie/mapviewer.html).

Field Survey / Monitoring / Inspection Works

8.46 A baseline dust deposition survey was undertaken at and around the application site for the period from February to April 2018, refer to **Figure 8-1** for monitoring locations. The dust deposition monitoring results recorded over this period were reviewed as part of this assessment. A survey of the extent of existing residential housing in the area of the quarry was also undertaken.

8.47 The location of the dust deposition monitors are shown on **Figure 8-1**:

- BD1 – at the south-west corner;
- BD2 – at the northern boundary;
- BD3 – at the north-east boundary.

Background Air Quality

8.48 The closest air quality monitoring locations to the proposed development, and in a similar Zone D area, is located at Castlebar, Co. Mayo.

8.49 The monitoring stations continuously monitor concentrations of particulate matter with an aerodynamic diameter of less than 10µm (PM_{10}). Recent annual mean concentrations monitored at Castlebar (published on the EPA website[5]) are presented in **Table 8-3** below.

Table 8- 3
Background PM_{10} Concentrations

Year	Annual Mean (µg/m^3)	Number of Days >50µg/m^3
2013	15	7
2014	12	2
2015	13	2
2016	11.9	1

8.50 **Table 8-3** illustrates that PM_{10} concentrations monitored at the Castlebar monitoring site are below the annual mean Air Quality Standards (AQS) of 40µg/m^3 and comply with the requirement that a 24-hour mean of 50µg/m^3 should not be exceeded more than 35 times in a calendar year.

8.51 For rural areas, such as those surrounding the application site, the primary source of PM10 would be residential solid fuel emissions and local agricultural or rural based activities for deposited dust.

Dust Deposition Monitoring

8.52 Dust deposition monitoring is carried out by BHP when quarry is operational. Five locations around the original site have been monitored and results are available from 2009 until 2014 (refer to **Figure 8-1** for locations). The results are presented in **Table 8-4**.

Table 8- 4
Dust Deposition Monitoring Results: 2009-2014

Period	D1 (mg/m^2/day)	D2 (mg/m^2/day)	D3 (mg/m^2/day)	D4 (mg/m^2/day)	D5 (mg/m^2/day)
22/12/08-30/01/09	60	31.1	90	39.4	142.8
30/01/09-26/02/09	123.9	58.9	27.8	53.3	170.5
26/02/09-27/03/09	16.1	28.9	261.7	80.6	80.4
27/03/09-29/04/09	122.7	55.5	108.3	84.4	30
29/04/09-29/05/09	133.9	97.8	91.1	163.9	52.8

[5] Secure Archive For Environmental Research Data – http://erc.epa.ie/safer/.

29/05/09-29/06/09	243.3	67.2	75.6	318.9	310.6
29/06/09-30/07/09	285.61	88.8	108.3	55	321.1
30/07/09-31/08/09	122.2	9.4	200	210	102.2
31/08/09-25/09/09	405	134.4	100	177.2	195.5
25/09/09-30/10/09	166.7	101.6	6.1	296.6	329.4
30/10/09-01/12/09	20	28.9	15.6	76.6	102.8
01/12/09-13/01/10	-	-	-	282.9	-
13/01/10-29/01/10	43.3	50	1.8	2.4	-
29/01/10-26/02/10	43.9	90.6	3.9	67.8	88.3
26/02/10-31/03/10	16.6	48.3	29.4	72.2	39.4
31/03/10-30/04/10	118.3	9.4	44.4	43.9	484.4
30/04/10-31/05/10	488.9	176.1	131.1	106.7	918.8
31/05/10-30/06/10	201.1	85.6	56.1	65	91.1
30/06/10-30/07/10	332.2	52.2	29.4	25	423.3
30/07/10-27/08/10	103.3	30.6	47.8	84.4	212.2
27/08/10-30/09/10	261.6	88.9	292.7	258.9	333.3
30/09/10-28/10/10	100	66.6	94.4	83.3	61.1
28/10/10-26/11/10	13.3	51.6	26.6	42.3	21.5
14/12/12-16/01/13	90.3	66	66.7	53.3	86.1
16/01/13-14/02/13	162.1	198.6	289.6	120	208.3
14/02/13-13/03/13	23	8.1	200	140	<1
13/03/13-10/04/13	<1	<1	20.8	21.4	109.5
10/04/13-14/05/13	72.5	76.5	340	52.5	106.3
14/05/13-17/06/13	36.8	101	215.9	31.2	172.9
17/06/13-15/07/13	<7.1	58.6	321.4	<7.1	264.3
15/07/13-09/08/13	10.7	61.3	802	23.2	171.2

09/08/13-12/09/13	103.7	209.3	212.7	55.4	59.4
12/09/13-08/10/13	113.1	541.5	316.9	126.2	659.2
08/10/13-11/11/13	32.4	120.6	216.5	670.6	45.9
11/11/13-10/12/13	77.9	117.2	215.2	171	183.4
10/12/13-20/01/14	29.8	133.7	191.7	106.8	104.9
20/01/13-13/02/14	250.7	246.5	238.2	263.2	376.4

8.53 The majority of recorded dust deposition rates presented in **Table 8-4** are below the more recently recommended emission limit value (ELV) of 350 mg/m^2/day. The following illustrates the percentage of time each monitoring location has been over this limit value during the three years of monitoring; D1 – 5%, D2 – 2%, D4-2% and D5- 14%. Reasons for these exceedances could be due to a number of factors such an extraordinarily dry weather or contamination of sample.

8.54 D 1 and D 2 are the most representative monitoring locations of dust deposition at the proposed development.

8.55 The results of the baseline dust deposition monitoring carried out by SLR Consulting Ireland in 2018 are presented in **Table 8-5**.

Table 8- 5
Baseline Dust Deposition Monitoring Results: 2018

Period	BD1 (mg/m^2/day)	BD2 (mg/m^2/day)	BD3 (mg/m^2/day)
26/02/2018-26/03/2018	<1	13	<1
26/03/2018-25/04/2018	25	<1	36

8.56 As it will be noted, the recorded baseline dust deposition rates at the proposed development over the recent period are below emission limit values (ELV's).

Meteorology: Dispersion of Emissions

8.57 The most important climatological parameters governing the atmospheric dispersion of particles are as follows:

- wind direction: determines the broad transport of the emission and the sector of the compass into which the emission is dispersed; and
- wind speed will affect ground level emissions by increasing the initial dilution of particles in the emission. It will also affect the potential for dust entrainment.

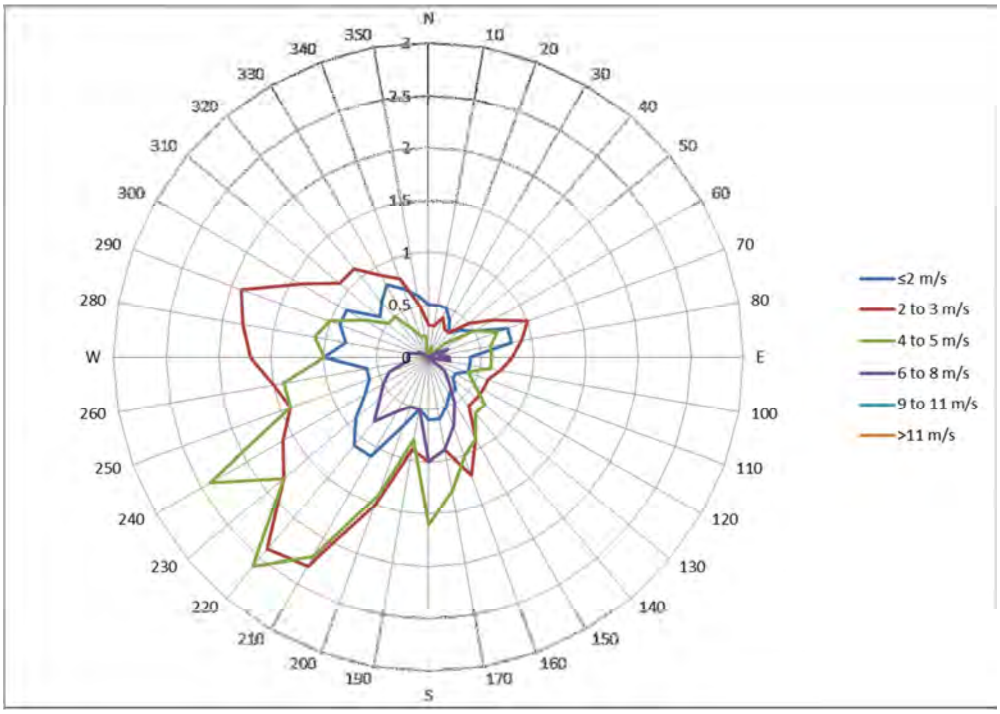
8.58 Rainfall is also an important climatological parameter in the generation of dust; sufficient amounts of rainfall can suppress dust at the source and eliminate the pathway to the receptor. According to Arup (1995) rainfall greater than 0.2mm per day is sufficient to suppress dust emissions.

Local Wind Speed and Direction Data

8.59 The closest weather station with sufficient records of wind direction and wind speed considered representative of conditions experienced at the application site is Mullingar Meteorological Station.

8.60 A windrose for the average conditions recorded at Mullingar over a ten year period is presented in **Figure 8-2**. The predominant wind direction is from the south-western quadrant. Moderate to high-speed winds (>2 m/s) occur for approximately 76.2% of the time.

Figure 8-2:
Windrose for Mullingar Meteorology Station



Rainfall Data

8.61 Relevant rainfall data applicable to the overall site has been obtained from the Irish Meteorological Service website for Claremorris meteorological station (1981 – 2010), located approximately 70km south west of the proposed development. The annual average days with rainfall greater than 0.2mm is 176 days per year. Natural dust suppression (from rainfall) is therefore considered to be effective for 48% of the year

Sensitive Receptors

Ecological Receptors

8.62 The application site is not subject to any statutory nature conservation designation; the nearest designated site is to the north of the application site, Special Area of Conservation – Lough Gill (Sligo) 001976.

Human Receptors

8.63 Sensitive locations are those where people may be exposed to dust from the existing or planned activities. Locations with a high sensitivity to dust include hospitals and clinics, hi-tech industries, painting and furnishing and food processing. Locations classed as being moderately sensitive include schools, residential areas, and food retailers.

8.64 Receptors have been identified within a 500m distance of the application site boundary at the proposed development (refer to **Figure 8-1**). The relevant receptors are listed in **Table 8-6** and their locations are shown in **Figure 8-1**. As residences are clustered in some areas, receptors have been identified at the nearest location to the application site boundary.

8.65 There are 12 sensitive receptors identified within the 500m study area of the application site.

Table 8-6: Receptors – refer to Figure 8.1

Receptor Reference	Receptor	Sensitivity	Distance (m) / Direction from Site Activities (approx.)
R Group 1	Residential	Medium	105(SE)
R Group 2	Residential	Medium	280(NE)
R Group 3	Residential	Medium	174(N)
R Group 4	Residential	Medium	215(W)
R5	Residential	Medium	154(S)
R Group 6	Residential	Medium	378(NW)
R Group 7	Residential	Medium	170(NE)
R Group 8	Residential/ Farm	Medium	177(E)
R Group 9	Residential	Medium	346(SE)
R10	Residential	Medium	404 (SW)
R11	Residential	Medium	507 (S)
R12	Residential	Medium	483(S)

IMPACT ASSESSMENT - METHODOLOGY

Evaluation Methodology

8.66 Fugitive dust emissions and particulate matter arising from the application site extraction and restoration activities has the potential to affect existing sensitive receptors in the area due to a potential increase in airborne dust deposition.

8.67 Given the short-term period of restoration activities, the magnitude for particulate matter release will be low. Given the nature of the rock extraction operation activities, the magnitude for particulate matter release will be low.

8.68 Combustion emissions (primarily oxides of nitrogen) from vehicle exhaust emissions associated with the quarry activities also have the potential to contribute to local air pollution.

8.69 The significance of impacts due to emissions from the application site are dependent upon the magnitude of the emissions, the prevailing meteorological conditions for the location, and the proximity of sensitive locations to the emission sources.

8.70 The impact assessment is based upon a comparison of the baseline situation (both current and projected without the development proposals) situation against the air quality impacts resulting from the 'with development' proposal scenario. The potential for 'in-combination' effects from other planned or proposed sources or air pollutants in the area has also been considered.

8.71 Each of the activities associated with proposed development have been assessed for potential air quality impacts including:

- Impact on ecological receptors;
- PM10 contribution from operational activities;
- Traffic exhaust emissions.

8.72 The methodology used in each assessment is presented in the sub-sections below which also provide an explanation of the significance criteria to describe the impacts of the proposed development on air quality.

8.73 For the purposes of environmental assessment of releases of dust from construction and mineral activities, the classifications of PM_{10} and 'deposited dust' are typically applied. The impacts associated with PM_{10} are related to potential health impacts while deposited dust is related to potential nuisance effects. The assessment of the potential impacts of each fraction has, therefore, been undertaken separately.

Significance Criteria

8.74 The following air quality specific significance criteria have been used to assess the significance of air quality impacts in preference to overall descriptors of significance.

8.75 To determine the significance of particulate matter effects associated with the development, an evaluation of the sensitivity of the surrounding area is required. Receptors can demonstrate different sensitivities to changes in environment, and are classified as per **Table 8-7** below (and IAQM Construction Dust Guidance[6]).

[6] http://www.iaqm.co.uk/text/guidance/mineralsguidance_2016.pdf

Table 8-7
Methodology for Defining Sensitivity to Dust and PM_{10} Effects

Sensitivity of Area	Examples	
	Human Receptors	Ecological Receptors[a]
Very High	Very densely populated area More than 100 dwellings within 20m Local annual mean PM_{10} concentrations exceed the Objective. Works continuing in one area of the site for more than 1-year	European Designated sites
High	Densely populated area. 10-100 dwellings within 20m of site. Local annual mean PM_{10} concentrations close to the Objective (36 – 40µg/m^3)	Nationally Designated sites
Medium	Suburban or edge of town Less than 10 receptors within 20m Local annual mean PM_{10} concentrations below the Objective (30 – 36µg/m^3)	Locally designated sites
Low	Rural area; industrial area No receptors within 20m Local annual mean PM_{10} concentrations well below the Objective (<30µg/m^3) Wooded area between site and receptors	No designations
Notes: (a)-Only applicable if ecological habitats are present which may be sensitive to dust effects.		

8.76 On this basis the sensitivity of the area is considered Low.

8.77 **Table 8-8** illustrates how the interaction of magnitude and sensitivity results in the significance of an environmental effect, with the application of mitigation measures as per the IAQM Construction Dust Guidance.

Table 8-8
Impact Significance Matrix – Dust Effects (With Mitigation)

Sensitivity of Surrounding Area	Risk of Site Giving Rise to Dust or PM_{10} Effects		
	High	Medium	Low
Very High	Slight Adverse	Slight Adverse	Negligible
High	Slight Adverse	Negligible	Negligible
Medium	Negligible	Negligible	Negligible
Low	Negligible	Negligible	Negligible

Restoration- Methodology

8.78 The Institute of Air Quality Management (IAQM) assessment of risk is determined by considering the predicted change in conditions as a result of the proposed development. The risk category for potential effects arising from site works is divided into two potential activities:

- earthworks
- trackout

8.79 Based on the scale and nature of the works including areas, soils and operations at the site, a dust emission class is defined for each of the activities. These dust emission classes are then used to determine the risk categories presented below. These risk categories determine the potential risk of dust soiling effects assuming no mitigation measures are applied.

8.80 **Table 8-9** illustrates how the interaction of distance to the nearest receptor and the dust emission class results in the determination of risk category from *earthworks activities*.

Table 8- 9
Determination of Risk Category from Earthworks Activities

Distance to Nearest Receptor		Dust Emission Class		
Human	Ecological	Large	Medium	Small
<20	-	High Risk Site	High Risk Site	Medium Risk Site
20 – 50	-	High Risk Site	Medium Risk Site	Low Risk Site
50 – 100	<20	Medium Risk Site	Medium Risk Site	Low Risk Site
100 – 200	20 – 40	Medium Risk Site	Low Risk Site	Negligible
200 – 350	40 – 100	Low Risk Site	Low Risk Site	Negligible

8.81 **Table 8-10** illustrates how the interaction of distance to the nearest receptor and the dust emission class results in the determination of risk category from *trackout movements*.

Table 8- 10
Determination of Risk Category from Trackout Movements

Distance to Nearest Receptor		Dust Emission Class		
Human	Ecological	Large	Medium	Small
<20	-	High Risk Site	Medium Risk Site	Medium Risk Site
20 – 50	<20	Medium Risk Site	Medium Risk Site	Low Risk Site
50 – 100	20 – 100	Low Risk Site	Low Risk Site	Negligible

8.82 Mitigation measures are recommended based on the evaluation of risk in accordance with the IAQM Dust and Air Emissions Mitigation Measures Guidance.

Rock Extraction - Methodology

8.83 A staged approach has been adopted; this ensures that the approach taken for the assessment of risk is proportional to the risk of an unacceptable impact being caused. As such, where a simple review of the situation shows that risk of a health or nuisance impact is negligible, this will be sufficient. In cases where the risk cannot be regarded as insignificant, a more detailed assessment may be required, such as a quantitative screening assessment or an advanced dispersion modelling exercise as appropriate.

8.84 Guidance on the assessment of the impacts of extractive operations on air quality has been prepared by the Institute of Air Quality Management (IAQM). This guidance uses a simple distance-based screening process to identify those operations where the dust impacts are unlikely to be significant and therefore require no further assessment. Where assessment that is more detailed is required, a basic assessment framework is presented which employs the Source-Pathway-Receptor approach to evaluate risk of impacts and effects.

8.85 The predicted scale of dust effects may be classified as either 'significant', or not 'significant'. Where effects are predicted to be 'significant', further mitigation is likely required before the proposals are to be acceptable under planning policy.

8.86 A semi-quantitative assessment of fugitive dust emissions from the proposed pit extension has been undertaken. The assessment has been undertaken by constructing a conceptual model that takes into consideration the potential sources, surrounding receptors, and the pathway between source and receptor in order to assess the magnitude of risk of impact on local amenities.

8.87 The distance from the source to the sensitive receptor is crucial. The initial risk screening stage (Tier 1) focuses upon the potential for dust generation at the site and the distance between source and receptors. In Tier 1 of the assessment, a representative selection of dust sensitive receptors in each direction of the application site is identified within the 500km study area.

8.88 Further assessment is considered to be required for those receptors within 500m of dust generating activities. Receptors within 500m of dust generating processes progress onto a Tier 2 assessment.

8.89 Tier 2 involves identifying source-pathway-receptor linkages and a semi-quantitative assessment of the likelihood and magnitude of any effects that could be associated with each pollutant linkage. This assessment takes account of:

- wind direction and speed data (to estimate frequency of exposure);
- proximity to source (to estimate magnitude of exposure);
- sensitivity of receptor; and
- occurrence of natural dust suppression (rainfall patterns).

8.90 This information is used to inform a semi-quantitative assessment of the likely magnitude of impact and is based upon professional experience of the assessor as the issue of dust nuisance on local receptors is a subjective issue, where public perception on what constitutes 'acceptable' levels varies from one person to the next. Assigning significance to nuisance impacts is qualitative and involves a judgement based on the likely magnitude, frequency, duration and reversibility (or recovery) of the impact. In this context, significant impact is taken to mean what is generally not publicly acceptable and desirable.

8.91 Note that the Tier 2 risk screening assessment does not take into account mitigation measures implemented at the proposed development. These currently include provision of perimeter screening berms, dust suppression measures etc., refer to the section dealing with Mitigation Measures later in this Chapter.

8.92 Following the results of the risk assessment, mitigation measures are detailed and the residual impact assessed. The detailed methodology used within the assessment is described in **Appendix 8-A**.

PM_{10} Contribution from Extraction Activities - Methodology

8.93 In terms of whether the PM_{10} concentration in the local area is likely to exceed the AQS, the following information has been reviewed:

- existing PM_{10} concentrations; and
- expected additional contribution of PM_{10} from site operations.

8.94 In terms of estimating the potential magnitude of impact from site operations, a UK edition of the LAQM Technical Guidance (LAQM.TG(03)) stated that fugitive dust from stockpiles, pit operations can potentially contribute up to 5µg/m^3 towards annual mean background concentrations of the coarse fraction (2.5 – 10µm diameters) of particulates in the immediate area.

8.95 Given the nature and scale of existing activities, the potential PM_{10} impact of increased intake is considered to be lower than this. However, to ensure a robust assessment of potential PM_{10} impacts, the upper limit of 5µg/m^3 has been applied to represent the development contribution to annual ambient PM_{10} concentrations. This value has then been added to existing background levels to assess whether the Air Quality Standards objective is likely to be exceeded.

Traffic Emissions - Methodology

8.96 Atmospheric emissions related to site proposals are primarily associated with the exhaust emissions from heavy duty vehicles (HDVs). The decision as to whether an assessment of potential impact is required is based upon the criteria set out in the DMRB.

8.97 The criterion for assessment of air quality contained within the latest DMRB guidance (207/07) focuses on roads with relatively high changes in flows or high proportion of HDV / HGV traffic. Affected roads are defined as those that meet any of the following criteria:

- road alignment will change by 5m or more; or
- daily traffic flows will change by 1,000 Annual Average Daily Traffic (AADT) movements or more; or
- HDV / HGV flows will change by 200 AADT or more; or
- daily average speed will change by 10 km/hr or more; or
- peak hour speed will change by 20km/hr or more.

8.98 No additional traffic movements over and above that associated with the existing permitted development are predicted and there will be no changes to road alignment or speed.

ASSESSMENT OF IMPACTS

Restoration - Assessment

8.99 An overview of the sources and processes associated with the above noted activities, and its respective potential for dust deposition (both dust and smaller particles), is presented below in **Table 8-11**.

Table 8-11
Site Activities: Sources of Dust Emissions

Activity	Source	Emission Potential	Comments
Restoration Works	Excavators/ HDV	High - dry or fine materials during strong windy weather Low – coarse or wet materials during conditions of low wind speed	Temporary, variable from day to day depending on prevailing meteorological conditions, level, and location of activity. Soils placed directly into in progressive works.

8.100 During the final restoration activities, earthworks will be confined within the application area. In light of this and the separation distance to receptors, the dust risk category is considered to be 'low risk' to 'negligible'.

8.101 During the final restoration activities, given the limited length of off-road routes (with no hardstanding), the trackout dust risk category is considered to be 'negligible'.

8.102 A summary of the determined risk category for proposed operation identified is presented within **Table 8-12**.

Table 8-12
Site Activities: Risk of Dust Emissions

Source	Risk of Dust Soiling Effects	Ecological Effects
Earthworks	Negligible	Negligible
Trackout	Negligible	Negligible

8.103 While the overall risk category has been assessed as 'negligible', if the restoration activities were not mitigated, the effects of dust during dry and windy conditions could possibly lead to occasional increases in nuisance dust immediately surrounding the application area. However, these are not considered to be significant given the limited duration of such meteorological conditions and the limited change in the extent and scale of proposed activities.

Rock Extraction - Assessment

8.104 An overview of the sources and processes associated with the extraction activities, and their respective potential for dust deposition, is presented below in **Table 8-13**.

Table 8-13
Sources of Particulate Emissions

Activity	Source	Emission Potential	Comments
Material transfer to processing area	Onsite vehicle, Dry loose material.	High when dry material being handled during strong windy weather	Emissions due to prevailing meteorological conditions and amount of dry loose material. Emissions due to re-suspension of loose material on surfaces.
Processing	Processing plant, Dry loose material	High when dry material being processed during strong windy weather	Emissions due to prevailing meteorological conditions (high winds).
Material transfer to storage area	Onsite vehicle, Dry loose material	High when dry material being handled during strong windy weather	Emissions due to prevailing meteorological conditions and amount of dry loose material. Emissions due to re-suspension of loose material on surfaces.
Material storage	Dry loose material in stockpiles	High when dry material being stored during strong windy weather	Emissions due to prevailing meteorological conditions (high winds).
Material Loading to HDV	Onsite vehicle, Dry loose material	High when dry material being handled during strong windy weather	Emissions due to prevailing meteorological conditions and amount of dry loose material. Emissions due to re-suspension of loose material on surfaces.
Transfer off site & traffic off site	HDV/Road vehicles	Low - on paved road surfaces	Dependant on the amount of loose material on road surface available for re-suspension and track out.
Blasting holes	Drilling Rig	Low if dust filters fitted on the drilling rig.	Depends on dust filters effectiveness.

8.105 There were 12 receptors identified within the 500m study area around the application site.

8.106 Using the tiered assessment methodology, receptors located within 500m have progressed onto a Tier 2 assessment as they are considered to have a greater risk of dust impact. Those receptors that are assessed within Tier 2 are detailed below in **Table 8-14**.

Table 8-14
Receptors Progressing to Tier 2

Receptor Reference	Receptor	Sensitivity	Distance (m) / Direction from Site Activities (approx.)
R Group 1	Residential	Medium	105(SE)
R Group 2	Residential	Medium	280(NE)
R Group 3	Residential	Medium	174(N)
R Group 4	Residential	Medium	215(W)
R5	Residential	Medium	154(S)
R Group 6	Residential	Medium	378(NW)
R Group 7	Residential	Medium	170(NE)
R Group 8	Residential/ Farm	Medium	177(E)
R Group 9	Residential	Medium	346(SE)
R10	Residential	Medium	404 (SW)

Receptor Reference	Receptor	Sensitivity	Distance (m) / Direction from Site Activities (approx.)
R11	Residential	Medium	507 (S)
R12	Residential	Medium	483(S)

8.107 Each receptor identified in **Table 8-14** above is assessed against the frequency of exposure and the distance from the source to the receptor (i.e. the pathway). The methodology is described fully in **Appendix 8-A**.

8.108 The frequency of exposure of each receptor is based upon the frequency of winds capable of carrying dust particles blowing in the direction, from the source to the receptor, on days when rainfall does not inhibit dust from becoming airborne. Representative data on the local wind climate is therefore required for this section of the assessment.

8.109 A wind-rose for the site is presented in **Figure 8-2** for Mullingar Meteorological Station and illustrates the predominant wind directions from the south-west. The potential for the generation of airborne dust will increase with wind speed, with winds greater than 3 m/s capable of carrying airborne dust[7].

8.110 The wind rose also shows the frequency of winds at wind speeds of greater than 2 m/s, with the individual frequencies for each 10 degree compass sector used within the assessment. In this assessment, wind speeds over 2 m/s were used; as this is how the data on percentage occurrence of wind frequency and wind speed is calculated and presented by Met Eireann. For this reason therefore, the impact assessment presented herein is conservative.

8.111 A summary of the risk assessment of dust impacts from sources within the proposed development is presented in **Table 8-15** below.

Table 8-15
Dust Risk Assessment Screening (Without Mitigation Measures)

Receptor Reference	Distance from Operations (m)	Relevant. Wind Direction (A)	Potential Exposure Duration (B)	Relative Wind / Distance Rank (C)	Risk Evaluation
R Group 1	105(SE)	250-60	14.2	5/5	Moderate Adverse
R Group 2	280(NE)	190-280	19.5	6/4	Slight Adverse
R Group 3	174(N)	150-240	19.3	6/5	Moderate Adverse
R Group 4	215(W)	30-120	5.9	2/4	Acceptable
R5	154(S)	320-50	3.6	2/5	Acceptable
R Group 6	378(NW)	110-190	10	5/3	Slight Adverse
R Group 7	170(NE)	160-250	19.7	6/5	Moderate Adverse
R Group 8	177(E)	210-300	19.3	6/5	Moderate Adverse
R Group 9	346(SE)	300-20	4.9	2/3	Insignificant
R10	404 (SW)	0-60	1.9	1/2	Insignificant
R11	507 (S)	0-50	1.2	1/1	Insignificant
R12	483(S)	340-30	1.6	1/2	Insignificant

Table Note:

(A) – relevant wind direction based on upwind sector which would potentially convey from site towards the receptor.

[7] Department of the Environment, Transport and the Regions, 1995. *The Environmental Effects of Dust from Surface Mineral Workings* – Volume 2. Technical Report. December 1995.

(B) – Potential duration of exposure based on frequency of moderate to high wind speed (adjusted for dry days only) as described in the methodology in **Appendix 8-A**.

(C) – Ranking as per methodology in **Appendix 8-A**

Refer to **Figure 8-1** for Receptor Locations

8.112 From **Table 8-15**, it is observed that the risk of impact from dust emissions associated with the proposed development (without any mitigation measures in place) generally varies from Insignificant at R Group 9, R10, R11, R12, Acceptable at R Group 4, R5, Slight Adverse at R Group 2, R Group 6 to Moderate Adverse at R Group 1, R Group 3, R Group 7, R Group 8.

Ecological Receptors

8.113 The application site is not subject to any statutory nature conservation designation. The nearest protected site is located to the north east of the application site boundary.

8.114 Studies have indicated that fugitive dust is typically deposited within 100 to 200m of the source, the greatest proportion of which, comprising larger particles (greater than 30 microns) is deposited within 100m. Where large amounts of dust are deposited on vegetation over a long time-scale (a full growing season for example) there may be some adverse effects upon plants restricting photosynthesis, respiration, and transpiration.

8.115 Baseline dust deposition monitoring at the site indicates that the levels of dust generated are low and well below the level of 1000 $mg/m^2/day$, where it is considered that dust could be likely to have a significant effect on sensitive ecosystems.

8.116 Based on the above, it is concluded that the activities within existing development and proposed development site will have no significant impact on ecological receptors from the deposition of fugitive dust.

Human Receptors

8.117 Using a screening assessment tool, the Air Quality Assessment (outlined in **Appendix 8-A**) considers that there is generally an acceptable to moderate adverse risk that dust may cause an impact at sensitive receptors within 500m of the source of the dust generated activities.

8.118 Note that this assessment *does not take into account implementation of mitigation measures* within the proposed development that include provision of perimeter screening berms, dust suppression measures etc. (outlined in the Mitigation Measures section below). This assessment is considered to be conservative on the basis of the moderate wind speeds included in the risk evaluation.

PM_{10} Contribution from Quarry Activities - Assessment

8.119 In terms of PM_{10}, the maximum annual mean measured baseline background concentration was 13$\mu g/m^3$ 2015 and 11.9$\mu g/m^3$ in 2016 at Castlebar, Co. Mayo monitoring station. Therefore, the potential contribution up of 5$\mu g/m^3$ towards annual mean background concentrations of the coarse fraction (2.5 – 10µm diameters) of particulates (in the immediate area of the site) is considered to be insignificant and well below the annual objective of 40$\mu g/m^3$.

8.120 Therefore, the potential impacts in relation to increase in ambient PM_{10} concentrations can be classified as 'negligible', when the limited duration of conditions and the magnitude of change in the extent and scale of activities are consider to significantly reduce the generation of airborne PM_{10} beyond the site development boundary.

Cumulative / Synergistic Impacts

8.121 In essence, cumulative impacts are those which result from incremental changes caused by other past, present or reasonably foreseeable actions together with the proposed development. Therefore, the potential impacts of the proposed development cannot be considered in isolation but must be considered in addition to impacts already arising from existing or planned development.

8.122 Baseline dust deposition monitoring carried out at the overall site boundaries at the proposed development, and the existing processing area to the East of the application area, typically complies with the recommended dust deposition emission limit value of 350 mg/m^2/day (averaged over 30 days).

8.123 There are no other significant sources of emission to air within close proximity to the site and therefore no potential for significant cumulative impacts has been identified.

8.124 The cumulative impact of the proposed development will be insignificant.

Interaction with Other Impacts

8.125 The potential impact on air quality by the project on sensitive receptors including sensitive ecological receptors and people living in the area has been fully assessed in this chapter. The overall impact of the project on these receptors is further considered in Chapter 4 Population and Human Health and Chapter 5 Biodiversity.

MITIGATION MEASURES

8.126 A range of mitigation measures are recommended for the proposed development. Specific mitigation measures are listed in **Table 8–16** below.

Site Specific Mitigation Measures

Table 8-16
Particulate Emission Mitigation Measures

Source	Emission Potential	Recommended Mitigation Measures	Effectiveness
Excavators/HDV	High – dry or fine material during strong windy weather	Minimise drop heights when handling materials. Soils placed directly into screening berms or in progressive works. Avoid working in adverse/ windy conditions.	High
	Low – material of high moisture content during conditions of low wind speed	Minimise drop heights when handling material, protection from wind where possible.	High
Onsite Vehicles	High when travelling	Minimise distances of onsite haul routes.	High

Source	Emission Potential	Recommended Mitigation Measures	Effectiveness
	over un-surfaced and dry site roads.	Use of water sprays / tractor & bowser to moisten surfaces during dry weather.	High
		Restrict vehicle speeds through signage / staff training.	High
		Location of haul routes away from sensitive receptors.	High
Road Vehicles (transfer offsite)	Low / Moderate on paved road surfaces	Use of road sweeper to reduce the amount of available material for re-suspension.	Moderate / High
		Pave the access road.	High
Drilling Rig Dust Emissions	High – during dry and strong windy weather if filets on rig not working	Avoid working in adverse weather conditions and faulty dust filters	High
Stockpiles	High when dry or fine material being stored or handled during strong windy weather	Seed surfaces of completed mounds / bunds of top soil.	High
		Limit mechanical disturbance.	High
Processing Plant	High – during dry and strong windy weather	Retention of hedgerows	High
		Proposed perimeter berms	High
		Avoid working in adverse weather conditions	High
		Locate plant within quarry void	High

RESIDUAL IMPACT ASSESSMENT

8.127 With the range of mitigation measures to be implemented and design measures to be incorporated into the working scheme, it is considered that the risk of dust impact at receptors from the proposed development reduces further.

8.128 After an assessment of potential adverse effects produced by the development it was concluded that there would be no significant adverse air quality effects for both human and ecological receptors (screened out) which cumulatively would not hinder the site or the surrounding area. Overall the effects of the proposed development on air quality have been considered to be negligible to acceptable.

8.129 A summary of the residual dust risk impact assessment is provided in **Table 8-17**.

Table 8-17
Residual Dust Risk Assessment (With Mitigation Measures)

Receptor Reference	Risk Evaluation
R Group 1	Acceptable
R Group 2	Acceptable
R Group 3	Acceptable
R Group 4	Insignificant
R5	Insignificant
R Group 6	Acceptable
R Group 7	Acceptable

Receptor Reference	Risk Evaluation
R Group 8	Acceptable
R Group 9	Insignificant
R10	Insignificant
R11	Insignificant
R12	Insignificant

8.130 On the basis of the assessment presented above, it is concluded that the proposed development, with the range of mitigation measures to be implemented and design measures incorporated into the working scheme, will not have a dust deposition impact on any assessed receptors.

MONITORING

8.131 Dust monitoring locations shall be reviewed and revised where and as/when necessary. The results of the dust monitoring shall be submitted to Sligo County Council on a regular basis for review and record purposes.

AIR QUALITY: APPENDIX 8

APPENDIX 8- A

DUST RISK SCREENING ASSESSMENT METHODOLOGY

The methodology applied in the assessment is a semi-quantitative risk assessment methodology, in which the probability of an impact occurring and the magnitude of the impact, if it were to occur, are considered. This methodology is the Tier 2 assessment of the dust assessment methodology. In the event that identified dust sensitive receptors are not screened out within Tier 1, this approach provides a mechanism for identifying the areas where mitigation measures are required, and for identifying mitigation measures appropriate to the risk presented by the development, (i.e. the assessment does not take account of existing mitigation in place at the quarry).

The magnitude of the potential risk at each receptor is classified depending on the frequency of exposure and the distance from the site to the receptor. Frequency of exposure is represented by the percentage of moderate to high winds (over 3m/s) from the direction of the site.

The screening assessment tool assesses the significance of the distance from site and the frequency of exposure of each receptor by assigning a ranked number. Receptors with a higher potential for dust impacts would therefore result in a higher value whilst receptors with lower potential would expect to carry a lower value. The value corresponding to an evaluation of risk is a product of the significance of the distance and frequency of exposure, each is assigned a value representing its significance. The multiplication of the two values assigned gives a total, which is then corresponded to a qualitative term of risk magnitude.

Frequency of Exposure Criterion

The potential for any site to emit dust is greatly influenced by weather. Increased wind speed increases the potential for the generation of airborne dust due to the suspension and entrainment of particles in airflow. A worst-case situation would be strong, warm, drying winds which increase the rate at which dust is lifted from an untreated surface and emitted into the air. Wind can also have the effect of spreading dust over a large area. Conversely, rainfall decreases dust emissions, due to both surface wetting and increasing the rate at which airborne dust is removed from air. An article on dust generation from quarry operations[8] suggests that rainfall of greater than 0.2mm per day is considered sufficient to effectively suppress windblown dust emissions.

The frequency of exposure to dust emissions represents the percentage of time that wind speeds capable of carrying airborne dust (greater than 3m/s) are blowing from the site to the direction of the receptor. Frequencies are calculated based on meteorological data. For screening assessment wind speeds greater than 2m/s were considered as this is how data on percentage occurrence of wind frequency and wind speed is calculated and presented by Met Eireann. For this reason, the assessment is considered to be conservative.

For the screening assessment, a value of 1mm would be used for the criteria to classify days as ‘dry’ or ‘wet’; five times the recommended value, using annual average rainfall data. The average number of days when rainfall exceeds 1.0mm would be provided for each month, and calculated over the year to provide an average.

[8] Leeds University. Good Quarry. http://www.goodquarry.com/article.aspx?id=55&navid=2

The resulting frequency of moderate to high wind speeds with the potential of carrying airborne dust towards receptors would then be classified into the criteria in Table 8 A-1 with the respective rank value assigned.

Table 8 A- 1
Frequency of Exposure – Risk Classification

Risk Category	Criteria
1	Frequency of winds (>2 m/s) from the direction of the dust source on dry days are less than 3%
2	The frequency of winds (>2 m/s) from the direction of the dust source on dry days are between 3% and 6%
3	The frequency of winds (>2 m/s) from the direction of the dust source on dry days are between 6% and 9%
4	The frequency of winds (>2 m/s) from the direction of the dust source on dry days are between 9% and 12%
5	The frequency of winds (>2 m/s) from the direction of the dust source on dry days are between 12% and 15%
6	The frequency of winds (>2 m/s) from the direction of the dust source on dry days are greater than 15%

Distance to Source Criterion

In assessing dust impacts, the distance from the source to the sensitive location is crucial, as airborne and deposited dust tend to settle out close to the emission source. Smaller dust particles remain airborne for longer, dispersing widely and depositing more slowly over a wider area.

Guidance indicates that larger dust particles (greater than 30µm) will largely deposit within 100m of sources. Smaller particles (less than 10µm) are only deposited slowly. Concentrations decrease rapidly on moving away from the source, due to dispersion and dilution.

To allow for this effect of distance, buffer zones are often defined by mineral planning authorities around potentially dusty activities to ensure that sufficient protection is provided. They have not been established in any rigorous scientific way, but usually range from 50m to 200m. The 1995 UK DoE Guidance on dust from surface mineral working's, however, recommends a stand-off distance of 100-200m from significant dust sources (excluding short-term sources), although it is recognised that these distances can be reduced if effective mitigation measures are identified and implemented. In terms of identifying sensitive locations therefore, and to represent an extreme worst case scenario, consideration only needs to be given to sensitive receptors within 500m of the site boundary. Receptors at a distance greater than 500m have therefore been screened out in Tier 1 of the assessment.

The criteria for classifying the distance from receptor to source and thus assigning a rank value has therefore been based on the various references to dust behaviour described above. The rank classifications are presented below in Table 8 A-2. A risk category is maintained for receptors in excess of 500m for circumstances where although a receptor is beyond 500m from the dust source, its sensitivity for example is sufficient for it to be taken onto a Tier 2 assessment.

Table 8 A- 2
Distance to Source – Risk Classification

Risk Category	Criteria
1	Receptor is more than 500m from the dust source
2	Receptor is between 400m and 500m from the dust source
3	Receptor is between 300m and 400m from the dust source
4	Receptor is between 200m and 300m from the dust source
5	Receptor is between 100m and 200m from the dust source
8	Receptor is less than 100m from the dust source

Sensitivity of Receptors

Sensitive locations are those where the public may be exposed to dust from the site. Locations with a high sensitivity to dust include hospitals and clinics, hi-tech industries, painting and furnishing and food processing. Locations classed as being moderately sensitive include schools, residential areas and food retailers. Table 8 A-3 below[9] shows examples of dust sensitive facilities.

Table 8 A- 3
Examples of Dust Sensitive Facilities

High Sensitivity	Medium Sensitivity	Low Sensitivity
Hospitals and clinics	Schools and residential areas	Farms
Retirement homes	Food retailers	Light and heavy industry
Hi-tech industries	Greenhouses and nurseries	Outdoor storage
Painting and furnishing	Horticultural land	
Food processing	Offices	

Evaluation of Risk

Once a rank value has been assigned to the frequency of exposure and distance to source, an overall risk can be evaluated by combining the two risk categories, along with consideration of the sensitivity of the receptor. For low sensitivity receptors the risk of dust impact are considered to be significantly lower than for medium and high sensitive receptors. Therefore, a factor of 0.5 would be applied to the final risk evaluation ranking.

For each receptor, the relative magnitude of risk is given by identifying which of the score categories in Table 8 A-4 it falls into. This final evaluation represents the risk of dust impacts prior to control and mitigation measures being employed on site.

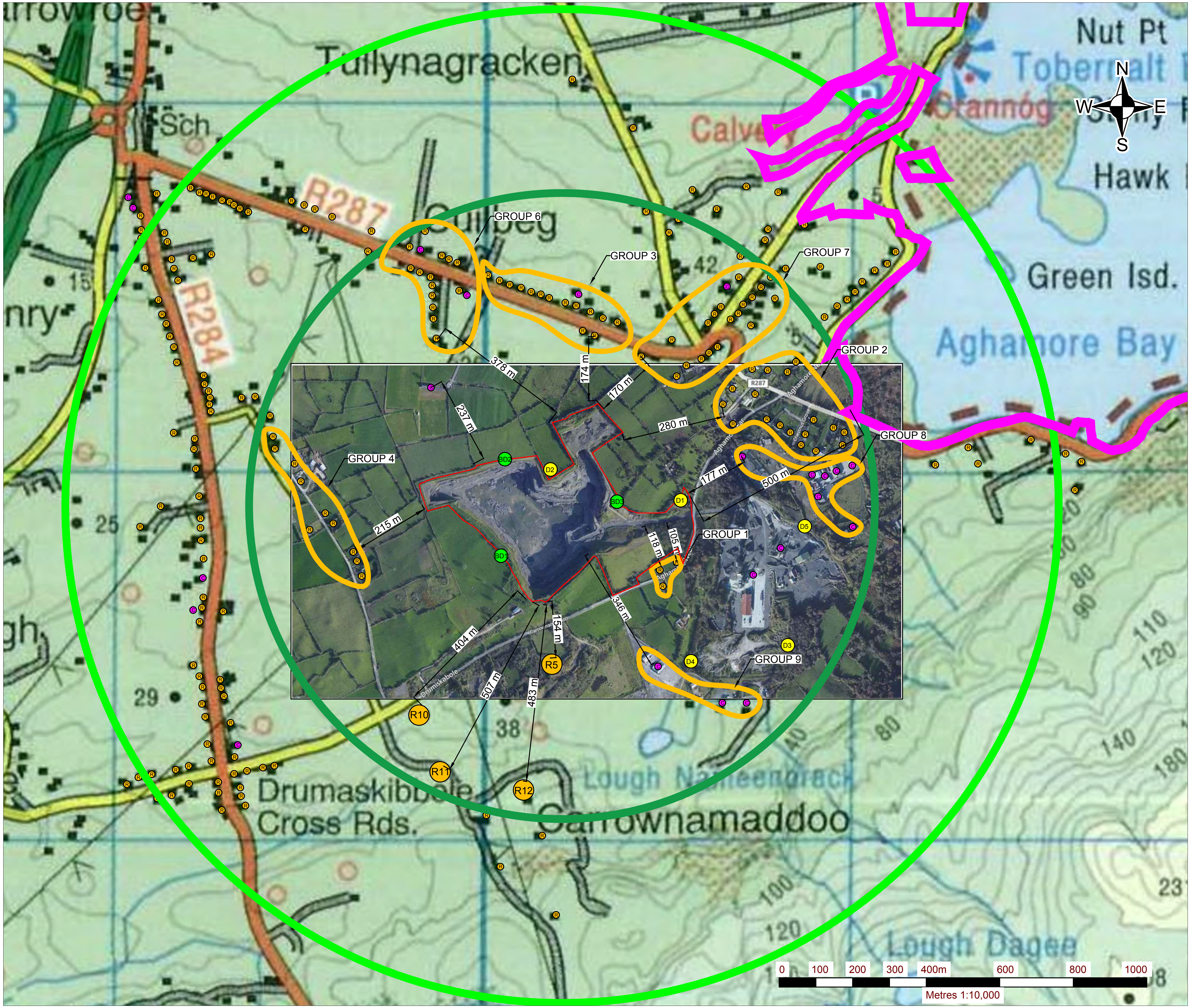
[9] **Ireland M. (1992)** "Dust: Does the EPA go far enough?", Quarry Management, pp23-24.

Table 8 A- 4
Risk Evaluation Ranking (Without Mitigation)

Magnitude of Risk	Score
Insignificant	7 or less
Acceptable	8 to 14
Slight Adverse	15 to 24
Moderate Adverse	24 or more

FIGURES

Figure 8-1
Local Receptors and Dust Monitoring Locations



NOTES

1. ORDNANCE SURVEY IRELAND LICENCE NO. SU 0000718 (C) ORDNANCE SURVEY IRELAND & GOVERNMENT OF IRELAND

LEGEND

- APPLICATION AREA
- RESIDENCE
- COMMERCIAL
- 1 KM OFFSET
- 500 M OFFSET
- GROUPS OF RECEPTORS
- BASELINE DUST MONITORING LOCATION (SLR)
- BASELINE DUST MONITORING LOCATION (BHP)
- LOUGH GILL SAC

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LOCAL RECEPTORS AND MONITORING LOCATIONS

FIGURE 8.1

Scale	Date
1:10,000 @ A3	AUGUST 2018

501.00396.00007.Sligo EIAR Figure 8.1.Rev.1.dwg

CHAPTER 9

CLIMATE

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FIGURES

FIGURE 9-1 BELLMULLET WINDROSE 2010-2014

INTRODUCTION

Background

9.1 This chapter of the Environmental Impact Assessment Report (EIAR), prepared by SLR Consulting Ireland, provides supporting information to accompany a Planning Application to Sligo County Council by Lagan Bitumen Ltd. It primarily addresses potential climate related impacts from the continued use and deepening of the existing permitted quarry at Aghamore Near and Carrownamaddoo townlands, Co. Sligo.

9.2 The development within an overall application area of 18 hectares consists of;

- Continued use and operation of the existing permitted quarry area (c. 10.9ha) within an overall application area of c.18 hectares;
- Deepening of the existing permitted quarry area by a further bench from -34.5m OD to -50m OD;
- The provision of a settlement lagoon (c. 2.800m2).

9.3 Further information on the site infrastructure, operations, environmental management systems, and controls at the established facility is provided in the Chapter 2 of this EIAR.

Scope of Work

9.4 The following sections of this Chapter describe the potential climate change impacts associated with the proposed development. The following issues are addressed separately:

- climate change legislative framework/policy context;
- analysis of evolving environmental baseline trends;
- identifying climate change concerns in relation to proposed development;
- assessing effects (cumulative effects and uncertainty);
- identifying alternatives and mitigation measures;
- identifying monitoring and adaptive management.

Consultations / Consultees

9.5 A pre-planning consultation meeting was held between officials of Sligo County Council and the applicant as part of this planning application.

Contributors / Author(s)

9.6 SLR Consulting Ireland undertook the impact assessment presented in this chapter on behalf of Lagan Bitumen Ltd. The lead consultant for the study was Sarah Errity MSc. (Environmental Science).

Limitations / Difficulties Encountered

9.7 No published guidelines and established methodology for assessment in Ireland for extractive industry sector.

Legislative Framework/ Policy Context

Adaptation to Climate Change

9.8 The DECLG published a National Climate Change Adaptation Framework (NCCAF) in December 2012[1]. The publication of the NCCAF was the first step in developing a comprehensive national policy position within which adaptation measures to address the impacts of climate change could be taken and planned. This non-statutory, but Government approved, framework mandated the development and implementation of sectoral adaptation plans and local government adaptation strategies which, together, would form part of the national response to the impacts of climate change.

9.9 The production of recycled aggregates from construction and demolition (C&D) wastes / mineral exploration sector was not identified under the National Adaptation Framework (NAF) to prepare sectoral adaptation plans in line with the requirements of the Climate Action and Low Carbon Development Act.

9.10 The policy in relation to climate adaptation, first set out in the NCCAF, was subsequently restated in the National Policy Position on Climate Change (2014)[2]. The National Policy Position provides a high-level policy direction for the adoption and implementation of plans to pursue the transition to a low carbon, climate resilient and environmentally sustainable economy by 2050 (known as the “national transition objective”).

9.11 On the 10 December 2015, the Climate Action and Low Carbon Development Act 2015 [3]was enactment; the 2015 Act identified and provided for the development and submission to Government of national mitigation and adaptation plans. It also established the institutional and governance framework within which these plans can be developed and implemented on a cyclical basis.

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[1]http://www.dccae.gov.ie/en-ie/climate-action/publications/Pages/National-Climate-Change-Adaptation-Framework.aspx

[2]http://www.dccae.gov.ie/en-ie/climate-action/publications/Pages/National-Policy-Position.aspx

[3] http://www.irishstatutebook.ie/eli/2015/act/46/enacted/en/html

9.12 Under section 5 of the 2015 Act, the Minister for Communications, Climate Action and Environment must submit to Government for approval (not later than 10 December 2017), a National Adaptation Framework (NAF), which must be reviewed not less than once in every five year period. The NAF must specify the national strategy for the application of adaptation measures in different sectors and by local authorities in their administrative areas in order to reduce the vulnerability of the State to the negative effects of climate change and to avail of any positive effects that may occur. The 2015 Act also provides that relevant Ministers will be required to develop sectoral adaptation plans which will specify the adaptation policy measures the Minister in question proposes to adopt.

9.13 The Climate Change Advisory Council [4](CCAC) was established by Ministerial Order on 18 January 2016 under section 8 of the Climate Action and Low Carbon Development Act 2015. The Council, which is independent in the performance of its functions, provides advice and recommendations to, inter alia, the Minister for Communications, Climate Action and Environment in relation to the preparation of the NAF; the making by a relevant Minister of a sectoral adaptation plan; and the approval by the Government of a NAF. In addition, the Council has a number of reporting obligations, including with regard to 'Annual' and 'Periodic Reviews' of progress towards meeting the national transition objective; it also established an Adaptation Committee in 2016 to focus specifically on adaptation related matters. **Table 9-1** summarises the adaptation actions to climate change in Ireland.

Table 9- 1

Summary of Adaptation to Climate Change Actions in Ireland[5]

Item	Status	Programs
National Climate Adaptation Strategy	Non-Statutory Framework adopted. Legislation enacted. Statutory Framework in development.	National Climate Change Adaptation Framework Climate Action and Low Carbon Development Act 2015 Consultation on development of statutory National Adaptation Framework
Action Plans	Sectoral Adaptation Plans in development. Local authority plans in development.	Local Authority Adaptation Strategy Development Guidelines (2016) Local Authority Adaptation Support Tool
Impacts, Vulnerability and Adaptation Assessments	National Vulnerability Assessment	2012 National Climate Change Vulnerability Scoping Study Climate Change Impacts on Biodiversity in Ireland (2013) Climate change Impacts on Phenology in Ireland(2013) COCOADAPT (2013) 2013 HydroDetect Project Robust Adaptation to Climate Change in the Water Sector in Ireland (2013) Ensemble of Regional Climate Projections for Ireland(2015) Urb-ADAPT

[4] http://www.climatecouncil.ie/

[5] http://climate-adapt.eea.europa.eu/countries-regions/countries/ireland

Item	Status	Programs
Research Programs	EPA Research Programme (Climate Pillar)	http://www.epa.ie
Climate services / Met Office	Established	http://www.met.ie
Web Portal	Established	http://www.climateireland.ie
Monitoring, Indicators, Methodologies	In development	
Training, Education	Ongoing / in development	http://www.climateireland.ie

Green House Gas Emissions

9.14 Ireland is a party to both the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, which together provide an international legal framework for addressing climate change.

Paris Agreement

9.15 In December 2015, an ambitious global agreement on climate change was agreed in Paris. The Paris Agreement aims to restrict global temperature rise to well below 2°C above pre-industrial levels, and to pursue efforts to limit the temperature increase to 1.5°C. It aims to increase global ability to adapt to the adverse impacts of climate change and to foster climate resilience and low GHG emissions development, in a manner that does not threaten sustainable food production. It also seeks to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century. The Paris Agreement entered into force on 4 November 2016.

9.16 The Paris Agreement aims to tackle 95% of global emissions through 188 Nationally Determined Contributions (NDCs) which will increase in ambition over time. Ireland's contribution to the Paris Agreement will be via the NDC tabled by the EU on behalf of its Member States. This is a binding EU target of an overall EU reduction of at least 40% in greenhouse gas emissions by 2030 compared to 1990 levels. The target will be delivered collectively by the EU with reductions in the Emissions Trading Scheme (ETS) and non-ETS sectors amounting to 43% and 30% by 2030 compared to 2005 respectively.

Kyoto Protocol (2008 – 2012)

9.17 The EPA has overall responsibility for the national greenhouse gas inventory in Ireland's national system, which was established in 2007 under Article 5 of the Kyoto Protocol[6]. The EPA's OCLR[7] performs the role of inventory agency in Ireland and undertakes all aspects of inventory preparation and management as well as the reporting of Ireland's submissions annually in accordance with the requirements of Decision 280/2004/EC and the UNFCCC.

9.18 Under the Kyoto Protocol, Ireland currently accounts for GHG emissions. Under the Kyoto Protocol, Ireland is required to limit total national greenhouse gas emissions to 314.2 Mtonnes of

[6] http://unfccc.int/kyoto_protocol/items/2830.php

[7] http://www.epa.ie/mobile/about/org/oclr/

CO_2eq over the five year period 2008 – 2012 which is equivalent to 62.8 Mtonnes of CO_2eq per annum. The Kyoto Protocol limit is calculated as 13% above Ireland's 1990 baseline value which was established and fixed at 55.61Mtonnes of CO_2eq following an in-depth review of Ireland's 2006 greenhouse gas inventory submission to the UNFCCC.[8]

EU 2020 Targets for non-ETS sector emissions[9]

9.19 Under the EU Commission's Climate and Energy Package, Ireland is required to deliver a 20% reduction in non-ETS greenhouse gas emissions by 2020 (relative to 2005 levels). In addition, Ireland also has binding annual emission limits for the period 2013-2020 to ensure a gradual move towards the 2020 target. The non-ETS sectors cover those sectors that are outside the EU Emissions Trading Scheme and includes agriculture, transport, built environment (residential, commercial/institutional), waste and non-energy intensive industry. Member States are permitted to meet their annual targets through a number of mechanisms which include carry forward of a quantity of its annual emission allocation from the following year, use of transfers from other Member States and the limited use of international credits from project activities as long as certain criteria are met.

Catchment Flood Risk Assessment and Management (CFRAM) Programme[10]

9.20 The current Catchment Flood Risk Assessment and Management (CFRAM) Programme (see www.cfram.ie) is the mechanism through which many of the adaptation to climate change actions will be implemented, including embedding adaptation into the development of capital projects and the long-term of flood risk management in Ireland. The future scenario flood maps produced under the CFRAM Programme will facilitate this approach, inform other sectors, and provide a valuable resource for local adaptation planning and sustainable land use management and planning.

EIA Directive 2014/52/EU on the Assessment of the Effects of Certain Public and Private Projects on the Environment

9.21 Directive 2014/52/EU[11] of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment. The Directive requires to be transposed by 16 May 2017, necessitating changes in laws, regulations, and administrative provisions across a number of legislative codes. Key Changes introduced by the 2014 Directive in Annex IV (information referred to in article 5(1) – Information for the Environmental Impact Assessment Report) include information on the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change to be included in the Environmental Impact Assessment Report.

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[8] http://unfccc.int/files/national_reports/annex_i_natcom/submitted_natcom/application/pdf/nc6_br1_ire.pdf

[9] http://www.epa.ie/climate/emissionsinventoriesandprojections/nationalemissionsprojections/

[10] https://www.cfram.ie/

[11] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32014L0052

Guidelines

Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment (EC, 2012)[12]

9.22 Guidelines give recommendations how to integrate climate change and biodiversity in Environmental Impact Assessment (EIA). The need for action on climate change and biodiversity loss is recognised across Europe and around the world. Guidelines contain explanation why climate change and biodiversity are so important in EIA and present the relevant EU-level policy background, provide advice on how to integrate climate change and biodiversity into selected stages of the EIA process. The annexes provide sources of further reading and links to other relevant information, data, and tools.

Assessing Greenhouse Gas Emissions and Evaluating their Significance (IEMA, 2017)[13]

9.23 This Guidance provides information to assist practitioners with addressing greenhouse gas (GHG) emissions assessment and mitigation in statutory and no statutory Environmental Impact Assessment (EIA). It complements IEMA's earlier guide on Climate Change Resilience and Adaptation and builds on the Climate Change Mitigation and EIA overarching principles. The requirement to consider this topic has resulted from the 2014 amendment to the EIA Directive.

Climate Change and Major Projects (EC, 2016)[14]

9.24 Guidance for assessing vulnerability and risk from Climate Change for major projects funded by the European Regional Development Fund (ERDF) and the Cohesion Fund and listed in the concerned operational programmes.

RECEIVING ENVIRONMENT

Climate Environmental Baseline

Regional Context

9.25 Observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising sea level are unequivocal evidence of warming of the climate system globally. Global mean temperature has increased by 0.8°C compared with pre-industrial times for land and oceans, and by 1.0°C for land alone. Most of the observed increase in global average temperatures is very likely due to increases in anthropogenic greenhouse gas concentrations.

9.26 Landmasses are expected to warm more than the oceans, and northern, middle and high latitudes. Despite possible reductions in average summer precipitation over much of Europe, precipitation amounts exceeding the 95th percentile are very likely in many areas, thus episodes

[12] http://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf

[13] https://www.iema.net/policy/ghg-in-eia-2017.pdf

[14] https://ec.europa.eu/clima/sites/clima/files/docs/major_projects_en.pdf

of severe flooding may become more frequent despite the general trend towards drier summer conditions. In an ensemble-based approach using outputs from 20 global climate models (GCMs), the Mediterranean, northeast and northwest Europe are identified as warming hot spots but with regional and seasonal variations in the pattern and amplitude of warming. Regional climate models (RCMs) also project rising temperatures for Europe until the end of the 21st century, with an accelerated increase in the second half of the century. For precipitation, the larger-scale summer pattern shows a gradient from increases in Northern Scandinavia to decreases in the Mediterranean region. By contrast, increases in wintertime precipitation primarily north of 45°N are a consistent feature of RCM projections over Europe, with decreases over the Mediterranean. Overall, then, there are consistent projections of change for northern and northwest Europe.

9.27 Ireland has a typical maritime climate, with relatively mild and moist winters and cool, cloudy summers. The prevailing winds are south-westerly in direction. The climate is influenced by warm maritime air associated with the Gulf Stream which has the effect of moderating the climate, and results in high average annual humidity across the country. The area of least precipitation is along the eastern seaboard of the country, in the rain shadow of the Leinster uplands.

9.28 Mean seasonal temperature will change across Ireland. A number of studies have applied selected IPCC Special Reports on Emissions Scenarios (SRESs) to model climatic changes across Ireland at a regional scale. Despite the different methods and scenario combinations used, there is agreement in projected changes in temperature for Ireland. However, there are more disparities in the magnitude and sign for the precipitation changes projected for the island.

9.29 **Table 9-2** summarises climate impact projections for Ireland, estimates of projections confidence are derived from published projection data from the Local Authority Adaptation Strategy Development Guidelines.

Table 9- 2
Climate Impacts Projections: 30-year overview[15]

Variable	Summary	Confidence	Projected changes
Sea Levels Rise	Strong increase	High	Projections of sea level rise to 2100 suggest a global increase in the range of 0.09-0.88m with a mean value of 0.48. For 2050, it is reasonable to assume a sea level rise in the region of 25 cm above present levels. It should be noted that due to an as yet limited understanding of some of the important effects that contribute to rates of increase, these estimates of sea level rise may prover optimistic , and estimates of up to 4-6 m have been projected by some models.
Storm surge	Strong increase	Medium	An increase in the numbers of intense cyclones and associated strong winds are expected over the north - east Atlantic. By the 2050s, storm surge heights in the range of 50-100cm are expected to increase in frequency for all coastal areas with exception of the southern coast.
Costal Erosion	Moderate increase	Low	Currently approximately 20% of Ireland's coastline is at risk of costal erosion, particularly areas of the south and east coast and also in isolated areas on the west coast. Rates of increase will be determined by local circumstances; however, it is expected that areas of the south-west are likely to experience the largest increase.
Cold Snaps/ Frost	Moderate decrease (winter/night)	High	By mid-century, minimum temperatures during winter are projected to increase by ~2^{0}C in the southeast and ~2.9^{0}C in the north. This change will results in fewer frost days and milder nigh-time temperatures.
Heatwaves	Strong increase (summer)	High	Seven significant heatwaves (defined as 5+ days@>25^{0}C) have been recorded in Ireland over the past 30 years, resulting in approximately 300 excess deaths. By mid-century, a projected increase in summer maximum daily temperature of approximately 2^{0}C will likely intensify heatwaves, with maximum temperatures increasing and heatwave duration lengthening.
Dry Spells	Strong increase (summer)	Medium	There have been seven periods of insignificant rainfall in Ireland in the past 40 years. Of these, the events of 1976 and 1995 were the most severe, averaging 52 and 40 days in duration respectively across Irish rainfall stations. An approximate 20% decrease in summer precipitation receipts in many areas is strongly indicated under a high emissions scenario. This decrease is likely to results in progressively longer periods without significant rainfall, posing potentially severe challenges to water sensitive sectors and regions.

[15] Local Authority Adaptation Strategy Development Guideline, EPA 2016

Variable	Summary	Confidence	Projected changes
Extreme Rainfall	Strong increase (winter)	Low	Heavy precipitation days (in which more than 20mm of rainfalls) are likely to increase in frequency in winter. By the 2050s an increase in the number of heavy precipitation days of around 20% above the level of 1981-2000 is projected under both low-medium and high emissions scenarios. This may have serious consequences for flood risk in sensitive catchments.
Flooding	Moderate increase (winter)	Low	An Irish Reference Network of hydrometric stations has been established to assess signals of climate charge in Irish hydrology. This network has detected an increasing trend in high river flows since 2000. Projections of future flows are beset by uncertainty at the catchment scale, but a broad signal of wetter winters and drier summers is evident across a number of independent studies.
Wind Speed	Minor increase (winter)	Medium	Observed wind speed over Ireland has not changed significantly in recent times, but it is anticipated that the distribution of wind will alter slightly in future, with winters marginally winder and summers marginally less so. Though the average wind speed is anticipated to change in only a minor way over the coming decades, the frequency of extreme windstorms is expected to increase due to alternations in the origin and track of tropical cyclones.

Local Context

9.30 The weather station at Markree which is located approximately 10km to the south of the application site is considered representative of conditions experienced at the application site.

9.31 The general climate of the Aughamore Near and Carrownamaddoo townlands is characterised by the passage of Atlantic low pressure weather systems and associated frontal rain belts from the west during much of the winter period. During the summer months, the occurrence of anticyclonic weather conditions and easterly winds can result in drier conditions over this part of Ireland, interspersed by the rain-bearing Atlantic frontal systems from the west.

9.32 The moderating influence of the Atlantic Ocean is felt throughout Ireland. The annual mean temperature for different areas in Ireland varies between mountainous regions, lowlands and the coast. The maximum average and maximum monthly air temperature reported at the Markree climatological station over the 4 years 2013-2016 give an average temperature range of 4.9 to 14.9 ^{o}C over the 4 year period (**Table 9.3**). The annual average temperature for these 4 years is 9.2 ^{o}C with a maximum temperature recorded of 28.6 ^{o}C in July 2013. A similar pattern in air temperature would be likely at the quarry.

Table 9- 3

Markree 2013-2016 Temperature Averages

Temperature (degrees Celsius)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average Temperature	4.9	4.7	5.4	7.5	10.3	13.2	14.9	14.1	12.7	10.1	6.4	6.3	9.2
Max Temperature	14.1	11.9	15.1	19.5	23.7	24.0	28.6	24.2	22.2	20.2	16.4	14.8	28.6

Source: Met Eireann: Markree, Co. Sligo Monthly Climatological Records[1]

9.33 Results from the meteorological station at Bellmullet, located approx. 120km west of the application site over the period 2010-2014 are indicative of long-term wind conditions experienced in the Sligo area. Approximately 28% of winds are from a west and south-westerly direction. The average wind speed in the region is about 5.8 m/s, with winds of 5 m/s or more recorded for about 57% of the time. The frequency of calm conditions is very low at about 4%, with strong winds above 9m/s recorded for about 12% of the time likely in the Sligo area. High wind speeds, with speeds in excess of 18 m/s are typically associated with Atlantic stormy conditions from the west during the winter months.

9.34 A windrose for the wind data recorded at Bellmullet station is presented in **Figure 9-1** for the period 2010-2014 inclusive.

9.35 Long-term rainfall records from a climatological station located at Markree for the period 2014-2016 gives an annual precipitation rate of 1,260mm (**Table 9.4**). The monthly total during the winter months (October-March) accounts for about 60% of the annual total, with a maximum monthly rate of 298 mm in December 2015. During the winter months, the rainfall will be commonly associated with Atlantic frontal depressions whereas during the summer months high rainfall amounts will tend to be associated with intense thundery showers.

Table 9- 4

Average Monthly Precipitation Markree(mm) 2013-2016

Rainfall (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
2013	143	72	35	83	120	75	69	66	94	115	68	191	1131
2014	195	197	91	28	93	48	68	123	10	116	145	150	1263
2015	204	95	119	74	139	51	111	94	65	75	228	298	1553
2016	177	134	101	83	67	113	111	99	100	30	99	91	1202
Average	131	92	109	78	81	82	93	102	104	134	128	126	1260

Source: Met Eireann: Markree, Co. Sligo Monthly Climatological Records[1]

IMPACT ASSESSMENT

Methodology

9.36 In Ireland some sectors have independently begun the process of identifying key vulnerabilities for their activities. The report by the Irish Academy of Engineering, Ireland at Risk Critical Infrastructure – Adaptation for Climate Change (The Irish Academy of Engineering, 2009) and the report by the Heritage Council and Fáilte Ireland (the National Tourism Development Authority), Climate Change, Heritage and Tourism, Implications for Ireland's Coast and Inland Waterways (ed. Kelly and Stack, 2009) are examples of initiatives of this kind.

9.37 Other research work on adaptation in specific sectors has been carried out or commissioned by other Government Departments/bodies such as the OPW, CoFoRD (programme of competitive forest research for development research programme, etc. (e.g. CLIMADAPT).

9.38 A National Climate Change Vulnerability Scoping Study (Sweeney and Coll, 2012) was undertaken to identify first generation vulnerabilities for Ireland based on a sensitivity analysis across key sectors. The analysis identified a clustering of impacts and their importance in relation to an assessment of likely resilience by sector. The assessment methodology used was an impacts-first, science-first classical approach. The priority sectors identified are: biodiversity and fisheries; water resources and the built coastal environment; forestry and agriculture. As each sector develops its sectoral adaptation plan (under the Climate Action and Low Carbon Development Act 2015), detailed vulnerability and risk analysis will be required. Some preliminary work has been undertaken on costing the impacts of climate change in Ireland. This is now being supported by more detailed analysis of the current and future costs of flood risk management.

9.39 The implementation of adaptation is being supported by the development of a suite of guidelines, tools and approaches. These include the Local Authority Adaptation Strategy Development Guideline; and the Irish climate information platform “Climate Ireland”, which includes data, information, tools and approaches for local level adaptation decision making. Work is ongoing to develop sectoral decision-making tools and supports.

9.40 The EPA is currently funding a research project called Urb-Adapt which aims to identify the impact of climate change on Dublin city and surrounding towns within the greater Dublin region. The project aims to identify possible risks to the population living in that area and future risks posed to it by the changing climate.

9.41 There are no specific tools developed for assessing climate change for extraction industry. The Climate Change and Major Project guideline on how to make vulnerable investments resilient to climate change provides methodology for undertaking a vulnerability and risk assessment.

9.42 Climate change adaptation and mitigation shall be integrated in the preparation and approval of proposed development. Adaptation seeks to ensure adequate resilience of proposed development to the adverse impacts of climate change based on Vulnerability. Mitigation seeks to reduce the emissions greenhouse.

Development Vulnerability

9.43 The aim of the vulnerability assessment is to identify the relevant climate hazards for the development at the foreseen location. Main steps in include identifying and combining the sensitivity and exposure of the project which will describe the vulnerability, the risk will be defined as like hood and impact.

9.44 Adaptation through project options, appraisal, and planning will depend on the assessed project vulnerability and risk.

9.45 Timescale for the project vulnerability and risk assessment shall correspond to the lifespan of the project. During the lifespan, there could be significant changes in frequency and intensity of weather events due to climate change, which should be taken into account. Detailed methodology charts for development vulnerability assessment is presented in **Appendix 9- A**.

Greenhouse Gases Emissions

9.46 All projects have the potential to emit greenhouse gas (GHG) emissions to atmosphere during the construction, operational and decommissioning phase of the development. Direct GHG emissions may be caused by operational activities, and project decommissioning. Indirect GHG emissions may be due to increased demand for energy and indirect GHG activities. Indirect GHG activities are linked to the implementation of the proposed project and may include transport, office space heating of buildings or loss of habitats that provide carbon sequestration, (e.g. through land-use change). The significance of project's GHG emissions should be based on its net impact, which may be positive or negative. Where GHG emissions cannot be avoided, significance of project's emissions shall be reduced by mitigation or project design. Where GHG emissions remain significant, but cannot be reduced further approaches to compensate project emissions should be considered.

9.47 Currently in Ireland, there is no set methodology to evaluate significance criteria or a defined threshold for GHG emissions for mineral extraction industry. Due to the inconsistences between the different methods and their assumptions for assessment, there is no single agreed method by which to assess a project carbon budget. The method of assessment varies according to the type and scale of the development.

9.48 Due to a lack of guidelines and an established methodology, the assessment of significance of the GHG emissions is based on whether the development's GHG emissions cumulatively represent a considerable contribution to the global atmosphere and whether the development as continued or extended will replace existing development that would have a higher GHG profile.

9.49 Where the GHG emissions cannot be avoided, the mitigation should aim to reduce the development emissions at all stages.

Assessment

Development Vulnerability

9.50 The aim of the vulnerability assessment is to identify the relevant climate hazards for the project at the foreseen location. Detailed development vulnerability assessment for the proposed development is presented in **Appendix 9-B.**

9.51 Based on the development vulnerability assessment, measures to improve the resilience of the project to extreme rainfall, flood, flash flood, storms, and winds are required.

Greenhouse Gas Emissions

9.52 The quarrying sector in Ireland contributed an estimated 0.2 million tonnes of Carbon Dioxide equivalent (CO2eq) emissions of a National total of 58.2 million CO2eq in 2014(2). This volume of greenhouse gas emissions is about 0.3% of the National total. As an industrial activity the quarrying sector have a responsibility to control and reduce greenhouse gas emissions.

9.53 The quantity of emissions from a quarry depend on the size and activities taking place within the site. Operation of large plant machinery, onsite asphalt, plant equipment and traffic all contribute to the carbon footprint for the site. The size of the quarry extends over an area of approximately 18 hectares with an extraction area of c. 10.9ha. The existing quarry has a permitted extraction rate of 300,000 tonnes per annum. However, it is anticipated that future extraction rates will range from between 150,000 and 300,000 tonnes per annum, depending on market demand. Although Greenhouse gas emissions will be small as a percentage of the National total from the extractive industrial sector, the site management for the quarry will include measures aimed at reducing the carbon footprint as part of the Environmental Management Plan for the whole site.

9.54 Rock extraction from the quarry will be the same process as was previously undertaken with no significant change in the quantity of emissions from trucks and other machinery associated with transporting and processing of the material. Any change in the carbon footprint of the quarry site related to rock recovery, truck transfer and operating the aggregate production plant will be insignificant.

9.55 Based on the scale and extent of proposed activities, GHG emissions are assessed as not making a significant contribution to the global atmosphere.

MITIGATION

9.56 Mitigation is designed to increase the resilience of the development, or wider environmental receptors, to climate change and should focus on increasing its capacity to absorb climate related shocks.

Project Adaptation against Expected Climate Change Effects

9.57 In the context of climate change adaptation to increase adaptive capacity of the quarry, disaster risk reduction strategies shall be developed with a view to reducing vulnerability and increase resilience of the development. Significant incidents related to the climate change that have affected operation of the quarry shall be recorded for future analysis.

9.58 Based on the development vulnerability assessment, measures to improve the resilience of the project to extreme rainfall, flood, flash flood, storms, and winds are required. **Table 9-6** details specific mitigation measures for the quarry related to climate change adaptation.

Table 9- 5
Mitigation Measures Related to Climate Change Adaptation

Main Concerns Related to:	Proposed Alternatives or Mitigation Measures
Extreme Rainfall, Flood, Flash Flood	Consider design that allows for rising water levels and ground water levels.
	Design adequate project's drainage.
Storms and Winds	Ensure the project design that can withstand increases high winds and storms
	Ensure the choice of equipment working at the project is weather efficient.
Risk Reduction Mechanism	Secure insurance for damage of assets / incidences.

Proposed Reduction of GHG Emissions

9.59 Lagan Bitumen Ltd. shall adopt GHG monitoring programme at the quarry at Aghamore Near and Carrownamaddoo townlands. Based on the GHG monitoring results Lagan Bitumen Ltd. shall establish short, medium, and long-term objectives and targets for GHG reduction programme and energy management plan.

9.60 **Table 9-7** details specific mitigation measures for the quarry related to GHG reduction programme.

Table 9- 6
Mitigation Measures Related to GHG Reduction Programme

Main Concerns Related to:	Proposed Alternatives or Mitigation Measures
Increased demand for energy	Consider using renewable energy sources/ suppliers. Use low carbon construction materials.
Direct GHG emissions	Use energy efficient machinery/ energy.
GHG emissions related to transport	Unnecessary equipment/ transport journeys should be avoided by management of transport and travel demands. Equipment should not be left idling.

MONITORING

Project Adaptation against Expected Climate Change Effects

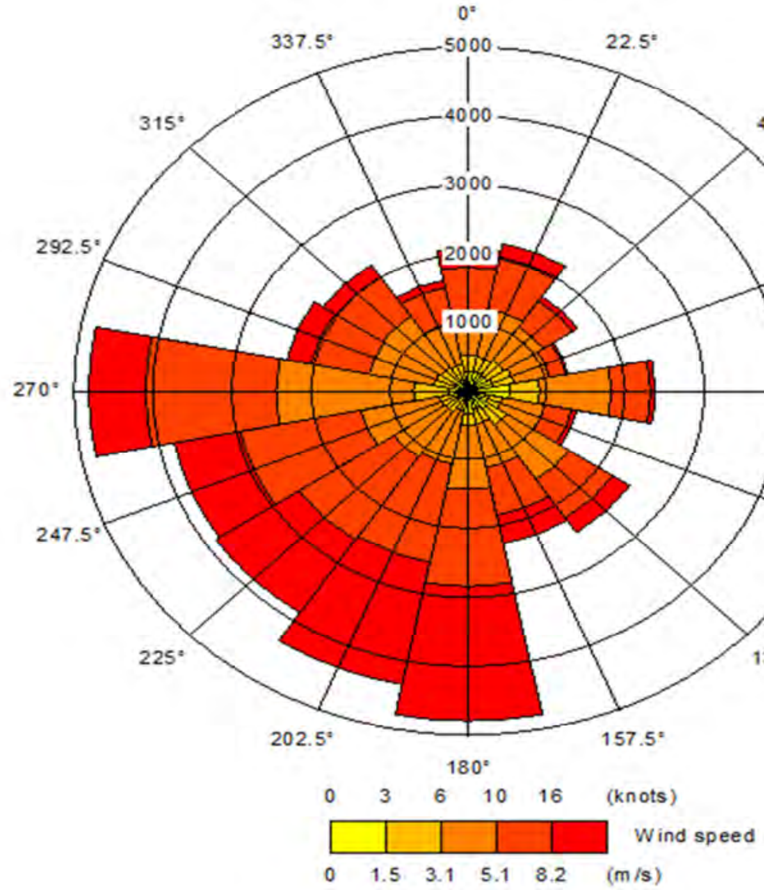
9.61 A framework and set of indicators shall be developed to assess project preparedness for adaptation against climate change. Provision shall be made for a periodic review of plans and the allocation of reporting responsibilities for a regime to measure and evaluate progress on adaptation. This process shall include updates from implementation the adaptation plans on regular basis. Enhancement and monitoring related to projects' predicted impacts with climate change should be set out in an Environmental Management Plan.

GHG Emissions

9.62 Monitor report and review GHG reduction progress.

FIGURES

Figure 9-1
Windrose for Bellmullet Meteorology Station 2010-2014



Appendix 9- A Development Vulnerability Assessment Methodology

9.63 The scale for assessing the likelihood of a climate hazard is presented in **Table 9A-1.** The output of the likelihood analysis is an estimation of the likelihood for each of the essential climate variables and hazards.

Table 9A- 1

Scale of Likelihood of Climate Hazard

Term	Qualitative	Quantitative
Rare	Highly unlikely to occur	5%
Unlikely	Unlikely to occur	20%
Moderate	As likely to Occur	50%
Likely	Likely to Occur	80%
Almost certain	Very likely to occur	95%

9.64 The scale for assessing the potential impact of a climate hazard is presented in **Table 9A-2**. The impact analysis provides an assessment of the potential impact of each of the essential climate variables and hazards.

Table 9A- 2

Example Table for Climate Hazard Impact Analysis

Risk Areas	Insignificant	Minor	Moderate	Major	Catastrophic
Asset damage, engineering, operational					
Safety and Health					
Environment					
Social					
Financial					
Reputation					

9.65 The matrix for assessing the sensitivity of project to climate hazards is presented in **Table 9A-3**. The sensitivity is summarised, along with the ranking of the relevant climate variables and hazards relating to the project.

Table 9A- 3
Example Table for Sensitivity of Project to Climate Hazards

	Extreme rainfall, flood , flash flood	Heath	Drought	Wildlife Fires	Storms and winds	Landslides	Cold Spells and snow	Freeze –thaw damage	Rising sea levels
On site assets									
Inputs - Water									
Inputs - Energy									
Outputs - product									
Transport links									

9.66 The matrix for assessing exposure of a project to climate hazards is presented in **Table 9A-4**. The exposure analysis ranks climate variables and hazards as low, medium or high based on current and future climate.

Table 9A- 4
Example Table of Exposure of the Project to Climate Hazards

	Extreme rainfall, flood , flash flood	Heat	Drought	Wildlife Fires	Storms and winds	Landslides	Cold Spells and snow	Freeze –thaw damage	Rising sea levels
Current Climate									
Future Climate									

9.67 An example of the vulnerability of a project to climate hazards is presented in **Table 9A-5.** The vulnerability combines the sensitivity and the exposure analysis.

Table 9A- 5
Example Table for Vulnerability Analysis of Project to Climate Hazards

Sensitivity	Exposure (Current & Future Climate)		
	Low	Medium	High
Low			
Medium			
High			

Appendix 9- B Development Vulnerability Assessment

9.68 The likelihood analysis of the proposed development to climate hazards is presented in **Table 9B-1.**

9.69 The proposed development has been assessed to be moderate affected by extreme rainfall, flood, flash flood, storms, and winds. The proposed development would be unlikely affected to cold spells and snow. The proposed development would not be affected by heat, drought, wildlife fires, landslides, and freeze –thaw damage. The proposed development will not be affected by rising sea level.

Table 9B- 1
Analysis of Likelihood of Climate Hazards at Quarry

	Extreme rainfall, flood , flash flood	Heat	Drought	Wildlife Fires	Storms and winds	Landslides	Cold Spells and snow	Freeze –thaw damage	Rising sea levels
Rare		√	√	√		√		√	√
Unlikely							√		
Moderate	√				√				
Likely									
Almost certain									

9.70 **Table 9B-2** shows the climate hazard impact analysis of the proposed development. It was assessed that climate hazards will have major impacts on health and safety, the environment and financial areas and climate hazards will have moderate impacts on asset damage and engineering, operational, social and reputation areas.

Table 9B- 2
Climate Hazard Impact Analysis

Risk Areas	Insignificant	Minor	Moderate	Major	Catastrophic
Asset damage, engineering, operational			√		
Safety and Health				√	
Environment				√	
Social			√		
Financial				√	
Reputation			√		

9.71 **Table 9B-3** below assesses the sensitivity of the project to climate hazard. It was assessed that site assets, energy inputs and transport links are of high sensitivity to extreme rainfall, flood, flash floods, storms and winds; water inputs will be highly sensitive to droughts. On site assets will be medium sensitive to cold spells and snow and freeze – thaw damage. Transport links will be medium sensitive to cold spells and snow.

Table 9B- 3
Sensitivity of Project to Climate Hazards

	Extreme rainfall, flood , flash flood	Heath	Drought	Wildlife Fires	Storms and winds	Landslides	Cold Spells and snow	Freeze –thaw damage	Rising sea levels
On site assets	High	Low	Low	Low	High	Low	Medium	Medium	Low
Inputs - Water	Low	Low	High	Low	Low	Low	Low	Low	Low
Inputs - Energy	High	Low	Low	Low	High	Low	Low	Low	Low
Outputs - product	Low	Low	Low	Low	Low	Low	Low	Low	Low
Transport links	High	Low	Low	Low	High	Low	Medium	Low	Low

9.72 In **Table 9B-4**, the exposure of the project to climate hazards was assessed. In the current climate, the exposure of the project extreme rainfall, flood, flash flood, storms and winds has been assessed to be medium. The project was assessed to have high exposure to rainfall, flood, flash flood, storms, and winds.

Table 9B- 4
Exposure of the Development to Climate Hazards without Mitigation

	Extreme rainfall, flood, flash flood	Heat	Drought	Wildlife Fires	Storms and Winds	Landslides	Cold Spells and Snow	Freeze –thaw damage	Rising sea levels
Current Climate	Medium	Low	Low	Low	Medium	Low	Low	Low	Low
Future Climate	High	Low	Low	Low	High	Low	Low	Low	Low

9.73 **Table 9B-5** shows the vulnerability analysis of the project to climate hazards; it combines the sensitivity and the exposure analysis. The project was assessed to be most sensitive to extreme rainfall, flood, flash flood, storms, and winds.

Table 9B- 5
Vulnerability Analysis of Project to Climate Hazards

Sensitivity	Exposure (Current & Future Climate)		
	Low	Medium	High
Low	Rising sea levels, Freeze –thaw damage, Landslides, Drought, Heat, Wildlife Fires		
Medium		Cold Spells and Snow	
High			Extreme rainfall, flood, flash flood, Storms and winds

CHAPTER 10

NOISE AND VIBRATION

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INTRODUCTION

Background

10.1 This chapter of the Environmental Impact Assessment Report (EIAR), prepared by SLR Consulting Ireland, provides supporting information to accompany a Planning Application to Sligo County Council by Lagan Bitumen Ltd. It assesses the levels of noise and vibration at the site associated with the planning application area and the wider quarry development at Aghamore Near and Carrownamaddoo townlands, Co. Sligo.

10.2 The quarry operations comprise extraction of limestone using blasting techniques, processing (crushing and screening) of the fragmented rock to produce aggregates for use in road construction, site development works and in the manufacture of value added products.

10.3 Further information on the site infrastructure, operations, environmental management systems, and controls at the established quarry site is provided in the Chapter 2 of this EIAR.

10.4 The noise impact assessment presented herein describes and assesses the noise baseline characteristics of the local area. The anticipated effects of the proposed development are then applied to these baseline conditions and the resulting noise impacts assessed. Mitigation measures are identified where necessary to eliminate or minimise adverse impacts, insofar as practical.

10.5 In order to assist the understanding of acoustic terminology and the relative change in noise, a glossary of terms and phrases, which specifically relate to this chapter, is provided in **Appendix 10-A.**

Scope of Work / EIA Scoping

10.6 The following sections of this EIAR Chapter describe the potential noise and vibration impacts associated with the proposed development. The following issues are addressed separately:

- methodology used to assess potential noise and vibration impacts from activities at properties (dwellings and farms) and sensitive ecological receptors;
- baseline conditions pertaining to existing background and ambient noise levels around the project site;
- noise and vibration impact evaluation criteria;
- prediction of the noise and vibration levels and identification of potential impacts;
- assessment of severity of impacts, with reference to the evaluation criteria;
- description of mitigation measures that will be incorporated into the design and operation of the scheme to eliminate or minimise the potential for noise and vibration impact;
- a summary of any residual impacts; and
- monitoring proposals.

Consultations / Consultees

10.7 A pre-planning consultation meeting was held between officials of Sligo County Council and the applicant as part of this planning application.

Contributors / Author(s)

10.8 SLR Consulting Ireland undertook the impact assessment presented in this chapter on behalf of Lagan Bitumen Ltd. The lead consultant for the study was Sarah Errity MSc. (Environmental Science). Baseline noise monitoring was carried out by SLR Consulting Ireland.

Limitations / Difficulties Encountered

10.9 This assessment is compiled on the basis of published guidance documents, and site-specific field surveys. No difficulties were encountered in compiling the required information.

REGULATORY BACKGROUND

10.10 The following sections describe the main legislative policy requirements in respect of noise and vibration associated with the proposed development.

10.11 Currently, there is no national or regional legislation which specifically addresses noise and vibrations for the mineral extraction and production of aggregates. However, there are a number of guidance documents that are relevant in the context of noise and vibrations action planning.

Planning Policy and Development Control

10.12 Sligo County Development Plan 2017-2023 P-NC-1 states that;

"*When assessing proposals for activities that are likely to generate significant levels of noise, seek to protect the amenity of dwellings, community facilities and other noise-sensitive developments by ensuring that all new (and where possible existing) developments incorporate appropriate measures to minimise noise nuisance.*"

British Standard 5228: 2009+A1:2014

10.13 British Standard 5228-1:2009+A:2014 Noise and vibration control on construction and open sites, Part 1: Noise (BS5228) sets out a methodology for predicting noise levels arising from a wide variety of construction and related activities. It can be used to predict noise levels arising from the operations of proposed minerals extraction sites. BS5228 also sets out tables of sound power levels generated by a wide variety of mobile equipment.

10.14 Noise levels generated by site operations and experienced at local receptors will depend upon a number of variables, the most significant of which are:

- the amount of noise generated by plant and equipment being used at the development site, generally expressed as a sound power level;
- the periods of operation of the plant at the development site, known as the "on-time";

- the distance between the noise source and the receptor, known as the "stand-off";
- the attenuation due to ground absorption or barrier screening effects; and
- any reflections of noise due to the presence of hard vertical faces (ie. walls).

Quarries and Ancillary Activities

10.15 EPA Guidance on Quarries and Ancillary Activities contain a discussion of the primary sources of noise associated with quarrying and offers guidance in relation to the correct approach to be followed in respect of assessment and mitigation. Suggested noise limit values are 55dB $L_{Aeq,1hr}$ and 45dB $L_{Aeq,1hr}$ for daytime and night-time respectively, although it suggests that more onerous values may be considered appropriate in areas with low levels of pre-existing background noise.

10.16 EPA guidance also states that *"blasting should not give rise to air overpressure values at the nearest occupied dwelling in excess of 125 dB(Lin) maximum peak with a 95% confidence limit"*.

10.17 The DoEHLG (2004) Guidelines for Planning Authorities (*Quarries and Ancillary Activities: Guidelines for Planning Authorities, DoEHLG 2004)* suggest similar noise limit values.

10.18 The DoEHLG (2004) contains advice on noise from temporary activities from rock extraction sites. The recommended derivation of free-field criteria for normal daytime operations, and the absolute criterion of 70 dB $_{LAeq,1hr}$ for temporary operations.

Guidelines for Noise Impact Assessment (IEMA)

10.19 The Guidelines for Noise Impact Assessment produced by the Institute of Environmental Management and Assessment (IEMA) are generally recognised as established good practice standards for scope, content, and methodology of noise impact assessment.

10.20 These guidelines address the key principles of noise impact assessment and are applicable to all development proposals where noise effects are likely to occur. These guidelines state that for any assessment, the noise level threshold and significance should be determined by the assessor, based upon the specific evidence and likely subjective response to noise. An example impact scale offered by the IEMA guidelines is shown in **Table 10-1**.

Table 10 - 1
Example Impact Scale from the Change in Sound Levels (IEMA)

Long-Term Impact Classification	Short-Term Impact Classification	Sound Level Change dB L_{pAeqT} (+ive or -ive) T = either 16hr day or 8hr night
Negligible	Negligible	≥ 0 dB and < 1 dB
	Minor	≥ 1 dB and < 3 dB
Minor	Moderate	≥ 3.0 dB and < 5 dB
Moderate	Major	≥ 5.0 dB and < 10 dB
Major		≥ 10.0

10.21 The criteria above reflect the key benchmarks that relate to human perception of sound. A change of 3dB is generally considered to be the smallest change in environmental noise that is perceptible to the human ear under most normal conditions. A 10dB change in noise represents a doubling or halving of the noise level. The difference between the minimum perceptible change and the doubling or halving of the noise level is split to provide greater definition to the assessment of changes in noise level.

10.22 To determine the overall noise impact, the magnitude and sensitivity Noise Effects Descriptors are presented in **Table 10-2.**

Table 10 - 2
Noise Effects Descriptors (IEMA)

Very Substantial	**Greater than 10 dB L_{Aeq} change in sound level perceived at a highly sensitive noise receptor**
Substantial	Greater than 5 dB L_{Aeq} change in sound level at a noise-sensitive receptor, or a 5 to 9.9 dB L_{Aeq} change in sound level at a highly sensitive noise receptor
Moderate	A 3 to 4.9 dB L_{Aeq} change in a sound level at a sensitive or highly sensitive noise receptor, or a greater than 5 dB L_{Aeq} change in sound level at a receptor of some sensitivity
Slight	A 3 to 4.9 dB L_{Aeq} change in a sound level at a receptor of some sensitivity
None / Not significant	Less than 2.9 dB L_{Aeq} change in sound level and/or all receptors of negligible sensitivity to noise or marginal to the zone of the influence of the proposed development

10.23 As recognised in the IEMA guidance, there are however many factors which affect people's perception and their responses to noise. Guidance on assessment of the magnitude of noise impact and the significance of the effects are presented in **Table 10-3**.

Table 10 - 3
Relationship between Noise Impact, Effect and Significance (IEMA)

<table>
<tr><th>Magnitude
(Nature of Impact)</th><th colspan="2">Description of Effect
(on a specific sensitive receptor)</th><th>Significance</th></tr>
<tr><td>Substantial</td><td rowspan="3">Beneficial</td><td>Receptor Perception = Marked Change
Causes a material change in behaviour and/ or attitude, e.g. individuals begin to engage in activities previously avoided due to preceding environmental noise conditions. Quality of life enhanced due to change in character of the area.</td><td rowspan="3">More Likely to be Significant
(Greater justification needed- based on impact magnitude and receptor sensitivities- to justify a non-significant effect)
↕
(Greater justification needed- based on impact magnitude and receptor sensitivities- to justify a significant effect)
Less Likely to be Significant</td></tr>
<tr><td>Moderate</td><td>Receptor Perception = Noticeable Improvement
Improved noise climate resulting in small change in behaviour and/or attitude, e.g. turning down volume of television; speaking more quietly; opening windows. Affects the character of the area such that there is a perceived change in the quality of life.</td></tr>
<tr><td>Slight</td><td>Receptor Perception = Just Noticeable Improvement
Noise impact can be heard, but does not result in any change in behaviour or attitude. Can slightly affect character of the area but not such that there is a perceived change in quality of life.</td></tr>
<tr><td>Negligible</td><td colspan="2">N/A = no discernible effect on receptor</td><td>Not Significant</td></tr>
<tr><td>Slight</td><td rowspan="4">Adverse</td><td>Receptor Perception = Non-intrusive
Noise impact can be heard, but does not cause change in behaviour or attitude, e.g. turning up volume of television, speaking more loudly; closing windows. Can slightly affect the character of the area but not such that there is a perceived change in the quality of life.</td><td rowspan="3">Less Likely to be Significant
Greater justification needed- based on impact magnitude and receptor sensitivities- to justify a significant effect)
↕
Greater justification needed- based on impact magnitude and receptor sensitivities- to justify a non-significant effect)
More Likely to be Significant</td></tr>
<tr><td>Moderate</td><td>Receptor Perception = Intrusive
Noise impact can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; closing windows. Potential for non-awaking sleep disturbance. Affects the character of area such that there is a perceived change in the quality of life.</td></tr>
<tr><td>Substantial</td><td>Receptor perception = Disruptive
Causes material change in behaviour and /or attitude, e.g. avoiding certain activities during periods of intrusion. Potential for sleep disturbance resulting in getting to sleep, premature awakening, and difficulty in getting back to sleep. Quality of life diminished due to change in character of area.</td></tr>
<tr><td>Severe</td><td>Receptor Perception = Physically Harmful
Significant Changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or psychological effects, e.g. regular sleep deprivation / awakening ; loss of appetite, significant , medically definable harm, e.g. auditory and non-auditory.</td><td>Significant</td></tr>
</table>

Design Manual for Roads and Bridges

10.24 The Design Manual for Roads and Bridges (DMRB) considers the following criterion to determine 'affected roads' which have the potential to impact at surrounding receptors:

- road alignment will change by 5m or more;
- daily traffic flows will change by 1,000 Annual Average Daily Traffic (AADT) or more;
- Heavy Duty Vehicle (HDV) flows will change by 200 AADT or more;
- daily average speed will change by 10km/hour or more; or
- peak hour speed will change by 20km/hour or more.

AQTAG09 - Guidance on Effects of Industrial Noise on Wildlife

10.25 AQTAG09 (Air Quality Technical Advisory Group 09) guidance provides guidance to assist planning and/or licensing officials handling pollution prevention and control applications for industrial installations on relevant noise emissions and relates these to the requirements of the Habitats Regulations.

10.26 The Habitats Directive (92/43/EEC) specifies that, where specific noise from industry, measured at the habitat / nest site is below the levels in **Table 10-4**, it is considered unlikely that it will have an adverse impact on designated species. Where noise levels are exceeded further, assessment that is more detailed will be required.

Table 10 - 4
Specific Noise Levels at Habitat / Nest Site

Parameter	Noise Level, dB
$L_{Amax,F}$	80
$L_{Aeq,1hr}$	55

British Standard 6472:2008

10.27 British standard 6472:2008 *Guide to Evaluation of Human Exposure to Vibration in Buildings* gives guidance on human exposure to blasting induced vibration in buildings. It is applicable to blasting associated with rock extraction.

10.28 BS6472 gives details of the maximum satisfactory magnitudes of vibration for residential properties which is shown in **Table 10-5**. This table relates to the magnitude of vibration below which the probability of adverse comment is low.

Table 10 - 5
Maximum Satisfactory Magnitudes of Vibration with Respect to Human Response for Up to Three Blasting Events per Day

Place	Time	Satisfactory Magnitude (Peak Particle Velocity, mm/sec)
Residential	Day (08.00 – 18.00 M to F) (08.00 – 13.00 Sat) Night Other Times	6.0 to 10.0 2.0 4.5
Offices	Any Time	14.0
Workshops	Any Time	14.0

British Standard 7385-2:1990

10.29 British Standard 7385-2:1990 *Evaluation and Measurement for vibration in Buildings – Part 2: Guide to Damage Levels from Groundborne Vibration* gives guidance on vibration limits to prevent building damage. It is applicable to blasting associated with rock extraction.

10.30 The damage threshold criteria provided in BS7385 are based on systematic studies using a carefully controlled vibration source in the vicinity of buildings. Vibration limits for transient vibrations (such as those associated with blasting operations) above which cosmetic damage could occur are provided in **Table 10-6** below.

Table 10 - 6
Transient Vibration Guide Values for Cosmetic Damage

Type of Building	PPV (mm/sec) 4 to 15 Hz	PPV (mm/sec) 15 Hz and Above
Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/sec	50 mm/sec
Unreinforced or light framed structures **Residential or light commercial buildings.**	15 mm/sec at 4Hz increasing to 20 mm/sec at 15 Hz	20 mm/sec at 15Hz increasing to 50 mm/sec at 40 Hz and above.

10.31 The definition of 'cosmetic damage' is the formation of hairline cracks or the growth of existing cracks in plaster, dry wall surfaces, or mortar joints. BS7385-2 notes that the probability of damage tends towards zero at 12.5mm/sec peak component particle velocity.

Site Specific Emission Limit Values

Noise

10.32 In addition to the above the following good house-keeping measures are put in place in order to reduce noise emitted from plant and machinery as much as possible:

- All machinery used will be CE certified for compliance with EU noise control limits;
- The machinery will be regularly maintained. This includes regularly checking any muffler systems and servicing or replacing as required. It also ensures any loose or damaged panels or covers that suppress noise is fixed or replaced immediately;
- If there are further noise-reducing modifications available for any machinery, they will be fitted wherever practical (e.g. rubber-decked screens, rubber chute linings etc.)
- Haul road grades are kept as low as possible (</= 1:10) to reduce engine / brake noise from heavy vehicles.
- Mitigation measures are provided in accordance with the DoEHLG (2004) and EPA (2006) guidelines for the sector.

10.33 Noise monitoring will be carried out as part of the environmental monitoring programme, refer to condition 20 of PL02/271.

Vibrations and Air Overpressure

10.34 Blasting mitigation measures will form part of the Environmental Management System for the quarry site. These measures relate to blasting procedures such as quantity of explosive and charge-hole spacing along rock face. Measures at the quarry will include:

- Include geological considerations in blast design;
- There will be no blasting outside the hours of 11:00 and 18:00 during Monday to Friday and none taking place at the weekend or public holidays;
- Optimise blast design along the rock-face with adequately spaced charges;
- Minimise air overpressure through proper blast design, spacing and timing of multiple charges;
- Inform nearby residents on day prior to planned blasting schedule using house-calls, written note/signage at entrance (or combination). A warning siren will be sounded prior to blast taking place.

Noise and Human Health

10.35 Environmental noise exposure response relationships and thresholds for health endpoints for industry are not available at European or Irish level in legislation or guidelines.

WHO Environmental Noise Guidelines

10.36 World Health Organisation (WHO) Europe is currently in the process of developing the WHO Environmental Noise Guidelines for the European Region as a regional update to the WHO Community Noise Guidelines. The Guidelines will include a review of evidence on the health effects of environmental noise to incorporate significant research carried out in recent years. The health outcomes for which the evidence will be systematically reviewed include: sleep disturbance, annoyance, cognitive impairment, mental health and wellbeing, cardiovascular diseases, hearing impairment and tinnitus and adverse birth outcomes.

10.37 The guidelines will assess several environmental noise sources such as aircraft, rail, road, wind turbines and personal electronic devices. The document will also consider specific settings such as residences, hospitals, educational settings and public venues. In addition, the guidelines will review the evidence on health benefits from noise mitigation and interventions to decrease noise levels. The guidelines will focus on the WHO European Region and provide guidance to its Member States that is compatible with the noise indicators used in the European Union (EU) Directive on Environmental Noise.

10.38 The 2002 EU Directive introduced annual average indicators of noise exposure (Lden and Lnight) as long-term exposure indicators, which differ from those used in the earlier WHO Guidelines for Community Noise (1999).

Good Practice Guide on Noise Exposure and Potential Health Effects

10.39 The guidelines present current knowledge about the health effects of noise associated with road traffic, railway and aircraft. The emphasis is first of all to provide end users with practical and validated tools to calculate health impacts of noise in all kinds of strategic noise studies such as the action plans required by the Environmental Noise Directive and/or environmental impact assessment reports.

10.40 This guidelines describe noise indicators such as Lden and Lnight, regardless of any weighing factors, describe the noise exposure situation. The link between exposure and outcome (other terms: endpoint, reaction, response) is given by reasonably well established exposure-response curves which are derived from research into noise effects that can be used for impact assessment.

10.41 The effect of noise on health and well-being with sufficient evidence is presented in **Table 10-7**.

Table 10 - 7
Effects of Noise on Health and Wellbeing with Sufficient Evidence

Effect	Dimension	Acoustic indicator*	Threshold**	Time domain
Annoyance disturbance	Psychosocial, quality of life	L_{den}	42	Chronic
Self-reported sleep disturbance	Quality of life, somatic health	L_{night}	42	Chronic
Learning, memory	Performance	L_{eq}	50	Acute, chronic
Stress hormones	Stress Indicator	L_{max} L_{eq}	n/a	Acute, chronic
Sleep (polysomnographic)	Arousal, motility, sleep quality	$L_{max, indoors}$	32	Acute, chronic
Reported awakening	Sleep	SEL_{indors}	53	Acute
Reported Health	Wellbeing clinical health	L_{den}	50	Chronic
Hypertension	Physiology somatic health	L_{den}	50	Chronic

Effect	Dimension	Acoustic indicator*	Threshold**	Time domain
Ischaemic heart diseases	Clinical health	L_{den}	50	Chronic

* Lden and Lnight are defined as outside exposure levels. Lmax may be either internal or external as indicated.

** Level above which the effects start to occur or start to rise above background.

RECEIVING ENVIRONMENT

Study Area

10.42 The application site is located in the townland of Aghamore Near and Carrownamaddoo, County Sligo approximately 3.5km south of Sligo and 1.5km east of the N4 Road.

10.43 The application site relates to the quarry extraction area only, as per the previous planning application (Plan File Ref. No. 02/271). Material extracted from the permitted quarry area is processed within the quarry void using mobile processing plant. Material is also transported to the processing area located on the opposite side of the local road. The processing area does not form part of the planning application area.

Baseline Study Methodology

10.44 Environmental noise surveys were carried out to capture typical background noise levels at the noise-sensitive receptors closest to the application site. The methodology of the surveys and the results are set out below. The weather conditions during the survey periods were acceptable for noise monitoring, being generally dry with little or no wind.

10.45 The baseline noise measurements were taken using a Larson Davis 831 Type 1 sound level meter (serial number A0527). The sound level meter was calibrated before the measurements, and its calibration checked after, using a Larson Davis Cal200 field calibrator (serial number 6970). No calibration drifts were found to have occurred during surveys. All noise equipment had been calibrated to a traceable standard by UKAS (United Kingdom Accreditation Service) accredited laboratories within 12 months preceding the surveys.

10.46 At the measurement positions, the following noise level indices were recorded:

LAeq,T is the A-weighted equivalent continuous noise level over the measurement period, and effectively represents an “average” value.

LA90,T is the A-weighted noise level exceeded for 90% of the measurement period. This parameter is often used to describe the background noise.

LA10,T is the A-weighted noise level exceeded for 10% of the measurement period. This parameter is often used to describe traffic noise.

10.47 LAmax is the maximum A-weighted sound pressure level recorded over the period stated. LAmax is sometimes used in assessing environmental noise, where occasional loud noises occur, which may have little effect on the overall Leq noise level, but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.

10.48 Environmental noise surveys were undertaken by SLR Consulting Ireland staff at the nearest noise sensitive receptors to the application site on 26th February 2018. Noise measurements were undertaken over four, non-consecutive, 15-minute periods during the daytime (07:00 to 19:00). The monitoring periods chosen are considered to give representative daytime noise levels at each noise sensitive location.

10.49 During the surveys, the sound level meter was located in free-field conditions (i.e. at least 3.5m from the nearest vertical reflecting surface, with the microphone approximately 1.5m above ground level).

10.50 All noise levels are recorded in 'A-weighted' decibels, dB(A). A-weighting is the process by which noise levels are corrected to account for the non-linear frequency response of the human ear. All noise levels are quoted in dB(A) relative to a sound pressure of 20 Pa.

10.51 Blasting operations at the quarry have been monitored at neighbouring residences by Irish Industrial Explosives. Ground borne vibration and air overpressure levels have been measured and recorded for each blast.

Sources of Information

10.52 Baseline information was gathered through a combination of desk-based study, site visit, and technical assessments consistent with current standard methodologies and published best practice guidelines, in order to provide relevant data to allow an assessment of likely significant effects of the proposed development on sensitive receptors within the zone of influence.

Field Survey / Monitoring / Inspection Works

Noise

10.53 The noise monitoring locations used for the purposes of the baseline noise survey, shown in **Figure 10-1**, comprise the following :

- BN1 at residences closest to the south eastern boundary;
- BN2 at the residences closest to north eastern boundary;
- BN3 at the residences closest to northern boundary;
- BN4 at the residences closest to western boundary.
- BN5 at the residences closest to south western boundary.

10.54 Noise monitoring results for the baseline survey on are provided in **Table 10-8**; logarithmic average LAeq values are provided in **Table 10-9**.

10.55 The baseline noise monitoring locations listed above are considered representative of the nearest noise sensitive locations (receptors) to the application site.

10.56 The following observations are made in respect of the baseline noise monitoring undertaken around the application site:

10.57 Measured baseline noise levels at monitoring point BN1 were mainly dominated by road traffic noise on the adjoining local road, sheep noises when traffic abated;

10.58 Measured baseline noise levels at BN2 were mainly dominated by road traffic noise on the adjoining local road, traffic on the R287 and vans pulling in and out of an ESB office;

10.59 Measured baseline noise levels at BN3 were mainly dominated by heavy road traffic noise along the R287;

10.60 Measured baseline noise levels at BN4 were mainly dominated by road traffic noise along the R284, dogs barking at residence and children playing;

10.61 Measured baseline noise levels at monitoring point BN5 were mainly dominated by road traffic noise on the adjoining local road.

Table 10 - 8
Summary of Measured Noise Levels, Free Field dB

Date	Location	$L_{Aeq,T}$(dB)	$L_{A10,T}$(dB)	$L_{A90,T}$(dB)
26/02/2018	BN1	49	42	31
26/02/2018	BN1	56	49	32
26/02/2018	BN1	51	44	30
26/02/2018	BN1	54	45	29
26/02/2018	BN2	56	51	40
26/02/2018	BN2	56	48	39
26/02/2018	BN2	53	47	38
26/02/2018	BN2	54	45	37
26/02/2018	BN3	73	75	42
26/02/2018	BN3	70	70	40
26/02/2018	BN3	74	76	43
26/02/2018	BN3	74	77	44
26/02/2018	BN4	48	45	37
26/02/2018	BN4	49	44	36
26/02/2018	BN4	42	44	35
26/02/2018	BN4	57	51	33
26/02/2018	BN5	59	49	37
26/02/2018	BN5	58	50	37
26/02/2018	BN5	63	57	33
26/02/2018	BN5	63	51	27

Table 10 - 9
Summary of Measured Noise Levels, Free Field dB (Average Values)

Location	Receptors effected	Period	$L_{AeqAVGE}$
BN1	R Group 1, R Group 9	Daytime	54
BN2	R Group 8, R Group 2, R Group 7	Daytime	55.3
BN3	R Group 3, R Group 6	Daytime	73
BN4	R Group 4	Daytime	52.9
BN5	R5, R10, R11, R12	Daytime	61.6

10.62 **Table 10-9** provides detail of the closest receptors affected by the noise emissions from the activities around at the application site in relation to the noise monitoring locations.

Sensitive Receptors

10.63 Sensitive locations are those where people may be exposed to noise from the existing or planned activities. The closest receptors to the application site have been identified (refer to **Figure 10-1**). This is a cautious approach, as noise generating activities are located at greater distances within the site. The relevant receptors are listed in **Table 10-10** and their locations are shown in **Figure 10-1**.

10.64 There are 12 sensitive receptors identified within the 500km study area of the application site. A summary of the closest sensitive receptors in each direction surrounding the planning application area and their respective proximity to the nearest noise generating activity within the site is presented in **Table 10-10** below.

Table 10 - 10
Noise Sensitive Receptors within 1km

Receptor Reference	Receptor	Sensitivity	Distance (m) / Direction from site activities
R Group 1	Residential	Medium	105(SE)
R Group 2	Residential	Medium	280(NE)
R Group 3	Residential	Medium	174(N)
R Group 4	Residential	Medium	215(W)
R5	Residential	Medium	154(S)
R Group 6	Residential	Medium	378(NW)
R Group 7	Residential	Medium	170(NE)
R Group 8	Residential/ Farm	Medium	177(E)
R Group 9	Residential	Medium	346(SE)
R10	Residential	Medium	404 (SW)
R11	Residential	Medium	507 (S)
R12	Residential	Medium	483(S)

Vibration and Air Overpressure

10.65 **Appendix 10-C** details blast monitoring results at the quarry from March 2010 to March 2014. The monitoring was carried out using mobile vibrograph units at these locations.

10.66 All blasts were monitored, with records kept detailing the results of vibration, air over pressure, and the blast design as part of the environmental monitoring programme implemented at the quarry.

10.67 Blasting was carried out by IIE's qualified "shotfirer". Blast designs are reviewed on a regular basis and modified where necessary to ensure compliance with groundborne vibration limits.

10.68 The blasting monitoring results at the quarry indicate that blasting operations have complied with condition limits previously imposed on the quarry and within the recommended emission limit values.

IMPACT ASSESSMENT

Evaluation Methodology

10.69 To determine the noise impact from the activities within the application site, SLR Consulting Ireland carried out a noise prediction assessment, whereby the existing measured noise levels within the site boundary have impact at the nearest noise sensitive receptors (residences) shown on **Figure 10-1.**

10.70 Noise levels (arising from site activities) at the residences have been calculated using the methodology set out in British Standard 5228:2009+A1:2014 Code of Practice for noise and vibration control on construction and open sites, Part 1: Noise (BS5228). This methodology includes provision for:

- Attenuation with distance between the source and receptor (K= - 20 log R/10 dB(A), for hard ground R=distance from source in metres).
- Adjustment for reflection from the building facade of +3 dB(A).

10.71 The residence locations and distances to the quarry are shown on **Figure 10 - 1.**

10.72 For the purposes of this assessment, it is assumed that all of the noise sources are active for 100% of the time, at the distances stated during the working hours of the site.

10.73 On this basis, it is considered that the noise assessment is very conservative and represents a worst-case scenario. The distances to the receptors are calculated from the noise measurement location. The measured average level of noise arising / measured from the existing operations within the overall site was used in the assessment. Detailed noise assessment calculations are provided in **Appendix 10-B**.

Impact Assessment

Noise

10.74 Within the planning application boundary, an area of 10.9 hectares has been used for the extraction of limestone and therefore has been completely stripped of overburden and topsoil material.

10.75 No further stripping of topsoil or overburden materials will be carried out within the application area.

10.76 The application site relates to the quarry extraction area only, as per the previous planning application (Plan File Ref. No. 02/271). Material extracted from the permitted quarry area is processed within the quarry area using mobile processing plant (crushers and screeners). Material is also transported to the processing area located on the opposite side of the local road. The processing area does not form part of the planning application area.

10.77 The noise prediction / assessment was undertaken to calculate the level of noise arising from the site activity at the nearest sensitive receptors shown on **Figure 10-1.** Detailed noise assessment calculations are provided in **Appendix 10-B.**

Sensitive Receptors

10.78 The following noise sources have been considered in the noise assessment for the stone extraction within planning application area:

- Drilling rig;
- Excavator;
- Dumper;
- Crusher

10.79 The operational LAr, 1hr noise prediction for each receptor location is presented in **Table 10-11** below. **Table 10-11** also shows the comparison between the predicted operational LAr, 1hr noise level and the prescribed noise limit.

Table 10 - 11
Operational Noise Levels

Activity	Receptors	Period	Noise Limit $L_{Aeq, 1hr}$ dB(A)	Operational $L_{Aeq, 1hr}$ dB(A)*	Difference
Stone Extraction	R Group 1	Daytime	55.0	50	-5
	R Group 2	Daytime	55.0	45	-10
	R Group 3	Daytime	55.0	47	-8
	R Group 4	Daytime	55.0	47	-8
	R5	Daytime	55.0	50	-5
	R Group 6	Daytime	55.0	42	-13
	R Group 7	Daytime	55.0	49	-6
	R Group 8	Daytime	55.0	49	-6
	R Group 9	Daytime	55.0	43	-12
	R10	Daytime	55.0	42	-13
	R11	Daytime	55.0	40	-15
	R12	Daytime	55.0	40	-15

*Operational Noise Level = Predicted Noise Level without a 5 dB penalty

10.80 It can be seen from the above figures that the daytime noise criterion limits arising specifically from site operations at the sensitive receptors are met at all noise sensitive locations during site operations.

10.81 To identify the potential impact of continuous (full-time) site activities, activity at the proposed site, predicted specific LAeq, 1hr dB(A) noise levels have been logarithmically added to existing ambient noise levels. The cumulative levels have been compared to the existing ambient noise levels at each of the noise sensitive locations for each time-period. The cumulative assessment is shown in **Table 10-12** below.

Table 10 - 12
Cumulative Operational Noise Levels

Activity	Location	Receptors	Period	Existing Baseline $L_{Aeq,T}$ dB(A)	Operational $L_{Ar,\ 1hr}$ dB(A)*	Cumulative $L_{Aeq,\ T}$ dB(A)*	Difference
Stone Extraction	BN1	R1	Daytime	54	50	55	+1
	BN2	R2	Daytime	55.3	45	55.3	+0
	BN3	R3	Daytime	73	47	73	+0
	BN4	R4	Daytime	52.9	47	52.9	+1
	BN5	R5	Daytime	61.6	50	61.6	+0
	BN3	R6	Daytime	73	42	73	+0
	BN2	R7	Daytime	55.3	49	56.3	+1
	BN2	R8	Daytime	55.3	49	56.3	+1
	BN1	R9	Daytime	54	43	54	+0
	BN5	R10	Daytime	61.6	42	61.6	+0
	BN5	R11	Daytime	61.6	40	61.6	+0
	BN5	R12	Daytime	61.6	40	61.6	+0

10.82 With reference to the Guidelines for Noise Impact Assessment produced by the Institute of Environmental Management and Assessment (IEMA), the cumulative short-term noise impact within the application area from plant associated with the rock extraction at the nearest receptors is Minor at R1, R4, R7, R8 and Negligible at all other receptors; long term associated noise effects are Negligible at all receptors.

10.83 In view of the above findings, it is considered that mitigation measures to reduce the noise impacts of plant associated with the planned development are not required.

Vibration and Air Overpressure

10.84 The existing quarry operations comprise of the extraction of limestone using conventional blasting techniques; processing (crushing and screening) of the fragmented rock to produce aggregates for road construction, site development works and for the production of value added products.

10.85 The number of blasts carried out at the quarry depends on market demand for construction materials. Typically however, blasting is carried out on average every one to two months (when operational); there are typically 8 to 10 blasts per year. The duration of a blast in terms of noise is of short duration, similar to a clap of thunder.

10.86 Blasting-induced vibration is of short duration and transient in nature. A typical blast consists of a number of drilled holes into which explosive charges are placed. The charged holes are detonated individually by use of detonators each with different delays.

10.87 The main reason for complaints from blast-induced vibration is usually attributed to the fear of damage and/or nuisance rather than actual damage or nuisance itself. The human body is very sensitive to vibration; this can result in concerns being raised at vibration levels well below the threshold of cosmetic damage to buildings or the levels stated in the existing planning conditions.

10.88 In general terms a person will become aware of blast-induced vibration at levels of around 0.3 mm/second peak particle velocity (ppv). However, people are very poor at determining relative magnitudes of vibration, for example, the difference between 4.0 mm/sec ppv and 6.0 mm/sec ppv is unlikely to be distinguishable by an individual person. Even though vibration levels between 0.6 mm/sec ppv and 50.0 mm/sec ppv are routinely experienced in everyday life within a property and are considered wholly safe, when similar levels are experienced through blasting operations, it is not unusual for such a level to give rise to subjective concern. **Table 10-13** gives examples of vibration levels routinely generated in a property.

Table 10- 13
Vibration Levels Generated by Everyday Activities

Activity	V Vibration Level (Peak Particle Velocity, mm/sec)
Walking, measured on a wooden floor	1.0 to 2.5
Door slam, measured on a wooden floor	2.0 to 5.0
Door slam, measured over the doorway	12.0 to 35.0
Foot stamps, measured on a wooden floor	5.0 to 50.0

10.89 With regard to physical damage to properties, extensive research has been carried out around the world, the most prominent being undertaken by the United States Bureau of Mines (USBM). Damage to a structure could occur if the dynamic stresses induced in a structure exceed the allowable design stress for the specific building material. Classifications of building damage range from very fine plaster cracking up to major cracking of structural elements. In particular, when defining damage to buildings, the following classification is used:

- Cosmetic – the formation of hairline cracks or the growth of existing cracks in plaster, dry wall surfaces or mortar joints.
- Minor – the formation of large cracks or loosening or falling of plaster on dry wall surfaces, or cracks through bricks/concrete blocks.
- Major or Structural – damage to structural elements of the building

10.90 Studies by USBM concluded that vibration levels in excess of 50 mm/sec ppv are required to cause structural damage. The onset of cosmetic damage can be associated with lower levels. Vibration levels between 19 mm/sec ppv and 50 mm/sec ppv are generally considered safe. It should be noted that these limits are for the worst-case structure conditions and that they are independent of the number of blasting events and their durations.

10.91 British Standard 7385-2:1990 Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Groundborne Vibration gives guidance on vibration limits to prevent building damage. It is applicable to blasting associated with mineral extraction.

10.92 The damage threshold criteria provided in BS7385 are based on systematic studies using carefully controlled vibration sources in the vicinity of buildings. Vibration limits for transient vibrations (such as those associated with blasting operations) above which cosmetic damage could occur are provided in **Table 10-6**.

10.93 BS7385-2 notes that the probability of damage tends towards zero at 12.5 mm/sec peak component particle velocity.

10.94 Previous blast monitoring results confirm that the blasting operations at the quarry have complied with the DoEHLG (2004) and EPA (2006) recommended threshold limit values for groundborne vibration (12 mm/sec peak particle velocity) and air overpressure (125 dB Linear max peak with a 95% confidence limit).

10.95 The comprehensive environmental monitoring programme implemented at the quarry (when operational) confirms that the quarry has operated within the recommended blasting emission limit values set out in the best practice guidelines for the sector - refer to **Table 10-14** for monitoring results carried out at the nearest receptor to the blast.

Table 10 - 14
Blast Monitoring Results at Lagan Quarry: 2010-2014

Date	Location	PPV (mm/sec)	Air Overpressure (dBL)
15/03/2010	Rooney	0.9	119
15/03/2010	Moran	1.9	-
28/04/2010	Rooney	0.6	123
28/04/2010	Moran	1.6	112
17/05/2010	Rooney	0.51	121
17/05/2010	Scanlons	<0.5	<125
08/06/2010	Rooney	2.4	112
08/06/2010	Hughes	0.3	114
08/06/2010	Moran	1	114
06/08/2010	Kelly	1.08	112
06/08/2010	Rooney	1.4	115
08/09/2010	House at Crossroads	2.15	107
08/09/2010	Mullanes	1.5	109
08/09/2010	Rooney	1.5	119
13/10/2010	Rooney	1.46	118
24/11/2010	Rooney	3.7	115

24/11/2010	Moran	0.6	121
23/01/2012	Location 1	4.57	124
23/01/2012	Location 2	<0.5	<125
15/06/2012	Location 1	4.7	125
15/06/2012	Location 2	5.5	108
06/07/2012	Location 1	2.7	122
06/07/2012	Location 2	1.4	116
13/08/2012	Location 1	2.3	114
13/08/2012	Location 2	0.5	101
31/08/2012	Location 1	0.7	109
31/08/2012	Location 2	5.72	125.8
26/10/2012	Location 1	1.2	122
26/10/2012	Location 2	1.5	111
29/01/2013	Location 1	<0.5	<125
27/02/2013	Location 1	4.3	111
27/02/2013	Location 2	1.3	114
14/03/2013	Location 1	1.8	118
14/03/2013	Location 2	1.3	117
24/04/2013	Location 1	3.4	112
24/04/2013	Location 2	3.8	106
02/10/2013	Location 1	5.3	118
02/10/2013	Location 2	1.7	111
14/01/2014	Location 1	7.3	123
14/01/2014	Location 2	3.2	118
10/03/2014	Location 1	2.9	114.4

10/03/2014	Location 2	6.3	116.7

10.96 Based on the above, it is concluded that blasting operations within the planning application area at Lagan Quarry will not have a significant impact on any sensitive receptors.

Ecological Receptors

10.97 Ecological receptors of concern are those areas designated under EU Habitats Directive (92/43/EEC).

10.98 The application site is not subject to any statutory nature conservation designation. There is a designated site to the north of the application site; Special Area of Conservation – Lough (Sligo) 001976.

10.99 Based on the nature, size and scale of the planned development, it is considered that the maximum distance for which the project should be evaluated in terms of Natura 2000 sites is up to a maximum radius of 2km from the application site unless there are any potential source-pathway-receptor links between the proposed development and any Natura 2000 site(s) beyond this distance.

10.100 At a distance greater than 2km, and in the absence of any potential source-pathway-receptor link, it is considered that no Natura 2000 sites would be affected by any direct loss of habitat or impacted upon by the effects of noise or vibration.

10.101 The operational LAr, 1hr noise measured at BN2 at ecological receptor location is presented in **Table 10-15** below. **Table 10-15** also shows the comparison between the measured operational LAr, 1hr noise level and the prescribed noise limit for protection of wildlife.

Table 10 - 15
Operational Noise Levels at Ecological Receptors

Location	Receptor	Period	Noise Limit $L_{Aeq, 1hr}$ dB(A)	Operational $L_{Aeq, 1hr}$ dB(A)	Difference
BN2	Lough Gill SAC 001976	Daytime	55.0	40	-15

10.102 As can be seen from the above figures, the noise criterion limits for protection of wildlife arising specifically from proposed development activity at the quarry are comfortably met at nearby ecological noise sensitive locations.

Traffic

10.103 The criterion for assessment of “affected roads” contained within the latest DMRB guidance focuses on roads with relatively high changes in flows or high proportion of HDV / HGV traffic. Affected roads are defined as those that meet any of the following criteria:

- road alignment will change by 5m or more; or
- daily traffic flows will change by 1,000 Annual Average Daily Traffic (AADT) movements or more; or

- HDV / HGV flows will change by 200 AADT or more; or
- daily average speed will change by 10 km/hr or more; or
- peak hour speed will change by 20km/hr or more.

10.104 As the planning application relates to the continued use and deepening of the existing quarry operation, the proposed development will continue to utilise the existing site entrance.

Noise Exposure and Potential Health Effects

10.105 To determine the potential health effects noise impact arising from proposed development, SLR Consulting Ireland carried out a calculation of Lden for operational noise, whereby the resultant noise levels were calculated at the nearest noise sensitive receptors (residences) shown on **Figure 10-1.**

10.106 The operational Lden noise predictions at each receptor location are based on all of the noise sources that are active and arise continuously and simultaneously during permitted working hours. On this basis, it is considered that the potential health effects presented herein is conservative.

10.107 The operational Lden noise prediction for receptor location is presented in **Table 10-16** below. The table also shows the comparison between the predicted operational Lden noise level and the prescribed noise threshold for reported health effects.

Table 10 - 16
Health Effects Noise Levels Screening Summary

Receptors	Period	Reported Health Effects Threshold L_{den} dB	Operational L_{den} dB	Difference
R Group 1	Daytime only	50	50	0
R Group 2	Daytime only	50	45	-5
R Group 3	Daytime only	50	47	-3
R Group 4	Daytime only	50	47	-3
R5	Daytime only	50	50	0
R Group 6	Daytime only	50	42	-8
R Group 7	Daytime only	50	49	-1
R Group 8	Daytime only	50	49	-1
R Group 9	Daytime only	50	43	-7
R10	Daytime only	50	42	-8
R11	Daytime only	50	40	-10
R12	Daytime only	50	40	-10

10.108 It can be seen from the above figures that the operational noise arising specifically from the proposed activity at the quarry complies with the *Reported Health Effects Threshold* at all nearby noise sensitive locations.

Cumulative Impacts

10.109 There are no cumulative noise impacts arising from the proposed development.

10.110 Noise levels arising from proposed activities will not have the potential to increase the existing ambient noise levels in the vicinity of the quarry.

'Do-nothing Scenario'

10.111 At present the noise environment within the study area is dominated by road traffic noise emanating from the local roads and R287 and R284. Locally, natural sounds such as farmyard animals or barking dogs are also audible.

10.112 Over time, it is anticipated that the volume of road traffic will increase as economic activity increases and that this in turn is likely to lead to an increase in ambient and background noise levels.

Interaction with Other Impacts

10.113 The potential impact of noise generated by the proposed development on sensitive receptors including sensitive ecological receptors and people living in the area has been assessed in this Chapter of the EIAR. The impact of the proposed development activity on these receptors is further considered in Chapter 3 'Population and Human Health' and Chapter 4 'Biodiversity'.

MITIGATION MEASURES

10.114 Where necessary, the three established strategies for impact mitigation are avoidance, reduction and remedy. Where it is not possible or practical to mitigate all impacts, then the residual impacts must be clearly described in accordance with the system for impact description set out in the EPA Guidelines. The adoption of Best Practicable Means is generally considered to be the most effective means of controlling noise emissions.

Noise

10.115 Notwithstanding the findings of the impact assessment presented above, which determined that the proposed activities at the quarry will have negligible noise impact, and in line with practice at other Lagan Bitumen Ltd. facilities, the following best practice measures will continue to be implemented wherever practicable at the existing permitted quarry to minimise the potential noise impact of on-site activities:

10.116 Screening:-

existing screening berms and screen planting shall be retained to act as acoustic barriers. Berms should be inspected on a regular basis and maintained as necessary.

10.117 Plant:-

all mobile plant used at the development should have noise emission levels that comply with the limiting levels defined in EC Directive 86/662/EEC and any subsequent amendments;

all plant items should be properly maintained and operated according to the manufacturers' recommendations, in such a manner as to avoid causing excessive noise (i.e. all moving parts are kept well lubricated, all cutting edges are kept sharpened, the integrity of silencers and acoustic hoods are maintained);

all plant should be subject to regular maintenance, i.e. all moving parts are kept well lubricated, all cutting edges are kept sharpened, the integrity of silencers and acoustic hoods are maintained;

all plant should be fitted with effective exhaust silencers which are maintained in good working order to meet manufacturers' noise rating levels. Any defective silencers should be replaced immediately.

10.118 Traffic:-

- any deliveries should be programmed to arrive during daytime hours only;
- care should be taken when unloading vehicles to reduce or minimise potential disturbance to local residents.
- access / internal haul roads should be kept clean and maintained in a good state of repair, i.e. any potholes are filled and large bumps removed, to avoid unwanted rattle and "body-slap" from heavy goods vehicles;
- vehicles waiting within the pit should be prohibited from leaving their engines running and there should be no unnecessary revving of engines.

10.119 Experience from other sites has shown that by implementing these measures, typical noise levels from construction works and/or recovery operations can bring about a reduction of 5dB(A) or more in ambient noise levels.

Vibration

10.120 The blast design and blasting methodology for the site operations carried out within the planning application area have been and are optimised to ensure that the levels have been and are within these recommended limits.

10.121 The following measures should be implemented at the planning application area to minimise disturbances due to blasting operations. These mitigation measures are in accordance with the 'best practice / mitigation' measures described in Section 3.2 of the DoEHLG (2004) guidelines.

- Blast notifications provided by pre and post siren warnings.
- All blasting operations should be carried out by a certified 'shotfirer' in accordance with the relevant health and safety regulations.
- The optimum blast ratio is maintained and the maximum instantaneous charge is optimised.
- To avoid any risk of damage to properties in the vicinity of the site, the groundborne vibration levels from blasting should not exceed a peak particle velocity of 12 mm/sec.

RESIDUAL IMPACT ASSESSMENT

Noise

10.122 The worst-case scenario noise assessment has shown that in accordance with the scale in the Guidelines for Noise Impact Assessment produced by the Institute of Environmental Management and Assessment (IEMA) the cumulative noise impact from plant associated with the development at all receptors is NEGLIGIBLE.

10.123 **Table 10-17** summarise the impacts, mitigation measures and residual impact for operational plant noise at each of the noise sensitive receptor considered.

Table 10 - 17
Operational Noise Summary Table

Receptors	Increase in $L_{Aeq,\ 1hr}$ dB(A) Noise Level from Operations	Impact	Mitigation
R Group 1	+1	Minor	Not Required
R Group 2	0	Negligible	
R Group 3	0	Negligible	
R Group 4	+1	Minor	
R5	0	Negligible	
R Group 6	0	Negligible	
R Group 7	+1	Minor	
R Group 8	+1	Minor	
R Group 9	0	Negligible	
R10	0	Negligible	
R11	0	Negligible	
R12	0	Negligible	

10.124 An assessment of residual operational noise arising from the proposed development has indicated that:

- The current permitted daytime time noise emission level (of 55dB LAeq 15min) is unlikely to be exceeded at nearby noise-sensitive receptors; and
- The resultant increase in noise level is unlikely to be perceptible at nearby noise-sensitive receptors during these hours.

Vibrations

10.125 On the basis of the historical blasting results, it is concluded that blasting operations carried out within the application area will not have residual impact on any sensitive receptors.

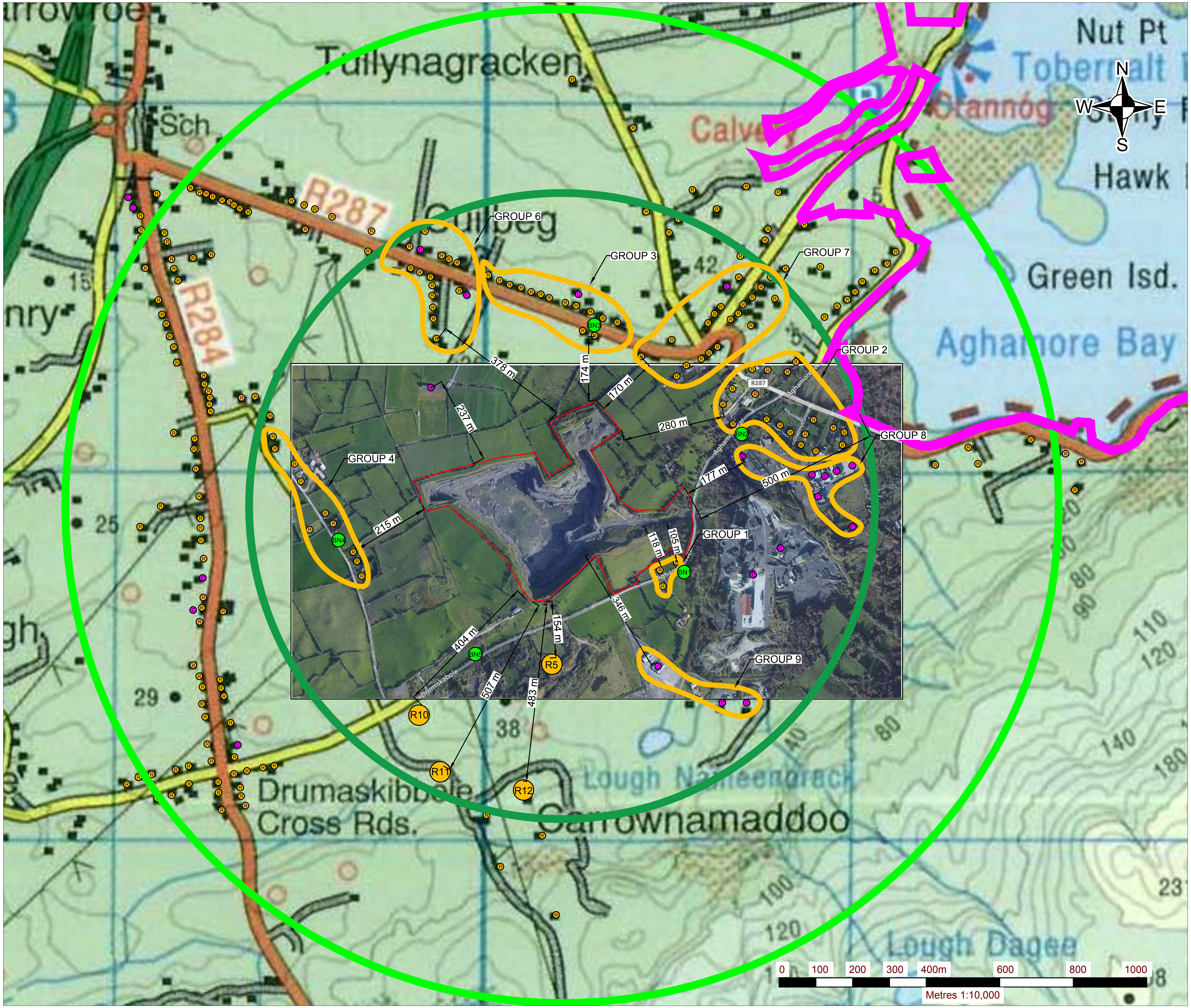
MONITORING

10.126 Noise monitoring will be undertaken around the application site. Noise monitoring locations shall be reviewed and revised where and as/when necessary. The results of the noise monitoring shall be submitted to the Sligo County Council on a regular basis for review and record purposes.

10.127 Monitoring of blasts (both for groundborne vibration and air overpressure) have been and will continue to be carried out at the site. The blast monitoring results have been and will continue to be submitted on a regular basis to Sligo County Council for record purposes.

FIGURES

Figure 10-1
Monitoring Locations



NOTES

1. ORDNANCE SURVEY IRELAND LICENCE NO. SU 0000718 (C) ORDNANCE SURVEY IRELAND & GOVERNMENT OF IRELAND

LEGEND

- APPLICATION AREA
- RESIDENCE
- COMMERCIAL
- 1 KM OFFSET
- 500 M OFFSET
- GROUPS OF RECEPTORS
- BASELINE NOISE MONITORING LOCATION

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LAGAN BITUMEN LTD.

LIMESTONE QUARRY AT AGHAMORE NEAR AND CARROWNAMADDOO, CO. SLIGO

LOCAL RECEPTORS

FIGURE 10.1

Scale: 1:10,000 @ A3
Date: AUGUST 2018

501.00396.00007.Sligo EIAR Figure 10.1.Rev.1.dwg

APPENDIX 10-A GLOSSARY OF TERMINOLOGY

In order to assist the understanding of acoustic terminology and the relative change in noise, the following background information is provided.

The human ear can detect a very wide range of pressure fluctuations, which are perceived as sound. In order to express these fluctuations in a manageable way, a logarithmic scale called the decibel, or dB scale, is used. The decibel scale typically ranges from 0dB (the threshold of hearing) to over 120dB. An indication of the range of sound levels commonly found in the environment is given in the following table.

Table 10.A
Noise Levels Commonly Found In the Environment

Sound Level	Location
0dB(A)	Threshold of hearing
20 to 30dB(A)	Quiet bedroom at night
30 to 40dB(A)	Living room during the day
40 to 50dB(A)	Typical office
50 to 60dB(A)	Inside a car
60 to 70dB(A)	Typical high street
70 to 90dB(A)	Inside factory
100 to 110dB(A)	Burglar alarm at one metre away
110 to 130dB(A)	Jet aircraft on take off
140dB(A)	Threshold of Pain

Acoustic Terminology

dB (decibel) — The scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and a reference pressure ($2x10^{-5}$ Pa).

dB(A) — A-weighted decibel. This is a measure of the overall level of sound across the audible spectrum with a frequency weighting (i.e. 'A' weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.

L_{Aeq} — L_{Aeq} is defined as the notional steady sound level which, over a stated period of time, would contain the same amount of acoustical energy as the A-weighted fluctuating sound measured over that period.

L_{10} & L_{90} If a non-steady noise is to be described it is necessary to know both its level and the degree of fluctuation. The L_n indices are used for this purpose, and the term refers to the level exceeded for n% of the time. Hence L_{10} is the level exceeded for 10% of the time and as such can be regarded as the 'average maximum level'. Similarly, L_{90} is the 'average minimum level' and is often used to describe the background noise. It is common practice to use the L_{10} index to describe traffic noise.

APPENDIX 10-B NOISE ASSESSMENT

		Average L_{Aeq} at 10m dB(A)								Activity L_{Aeq} dB(A)				Combined Noise Level LAeq dB(A)
Activity	Receptor	Drilling Rig	Excavator	HGV	Crusher	Screening	Reflection (dB(A))	Activity distance (m)	Attenuation with distance dB(A)	Drilling Rig	Excavator	HGV	Crusher	
Stone Extraction	R1	83	76	75	90	−20	+3	105	20/27[1]	46	39	38	46	50
	R2	83	76	75	90	−20	+3	280	29	37	30	29	44	45
	R3	83	76	75	90	−20	+3	174	23/30[2]	43	36	35	43	47
	R4	83	76	75	90	−20	+3	215	27	39	32	31	46	47
	R5	83	76	75	90	−20	+3	154	24	42	35	34	49	50
	R6	83	76	75	90	−20	+3	378	32	34	27	26	41	42
	R7	83	76	75	90	-20	+3	170	25	41	34	33	48	49
	R8	83	76	75	90	−20	+3	177	25	41	34	33	48	49

[1] Note: Crusher will be located c. 225 metres from receptors
[2] Note: Crusher will be located c. 350 metres from receptors

	R9	83	76	75	90	−20	+3	346	31	35	28	27	42	43
	R10	83	76	75	90	−20	+3	404	32	34	27	26	41	42
	R11	83	76	75	90	−20	+3	507	34	32	25	24	39	40
	R12	83	76	75	90	−20	+3	483	34	32	25	24	39	40
	SAC 001 976	83	76	75	90	−20	+3	500	34	32	25	24	39	40

CHAPTER 11

MATERIAL ASSETS

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INTRODUCTION

Background

11.1 This chapter of the Environmental Impact Assessment Report (EIAR) relates to the potential effects of the proposed continued use and deepening of the permitted quarry at Aghamore Near and Carrownamaddoo, Co. Sligo on material assets.

11.2 The proposed development provides for:

- Continued use and operation of the existing permitted quarry area (c. 10.9 ha) within an overall application area of c.18 ha;
- Deepening of the existing permitted quarry area by a further bench from -34.5m OD to -50m OD;
- The provision of a settlement lagoon (c. 2,800m2).

11.3 For further detail of the proposed development and the application site context, refer to chapter 2 of this EIAR.

Scope of Work

11.4 According to the EPA (EPA (2003) Advice Notes on Current Practice,

> *"Resources that are valued and that are intrinsic to specific places are called 'material assets'. They may be of either human or natural origin and the value may arise for either economic or cultural reasons".*

11.5 Under Schedule 6 of the Planning and Development Regulations (2001) as amended, material assets also refers to architectural and archaeological heritage and cultural heritage.

11.6 The EPA guidelines in relation to the preparation of EIAR[1] note the following in respect of material assets:

> *"Material assets can now be taken to mean built services and infrastructure. Traffic is included because in effect traffic consumes roads infrastructure."*

11.7 The specific headings in the guidelines in relation to material assets refer to built services, roads and traffic and waste management.

11.8 Chapter 14 of this EIAR addresses roads & traffic and chapter 12 addresses architectural heritage, archaeological heritage and cultural heritage separately to this section.

11.9 This material assets impact assessment comprises the consideration of existing resources pertinent to the proposed development and the application area that are not addressed elsewhere in this EIAR and the likely development impacts on those resources. On this basis, this

[1] Environmental Protection Agency (2017). *Guidelines on the Information to be contained in Environmental Impact Assessment Reports*.

section addresses built services and waste management. Built services are understood to refer to electricity, telecommunications, gas, water supply infrastructure and sewerage.

Consultations / Consultees

11.10 Consultation was not undertaken in the preparation of chapter of the EIAR.

Contributors / Author(s)

11.11 This section of the EIAR was prepared by Aoife Byrne, who is an Associate with SLR Consulting Ireland. Aoife is a Chartered Town Planner and has previously worked on numerous extractive industry planning applications and EIAR.

Limitations / Difficulties Encountered

11.12 No limitation or difficulties were encountered in the preparation of this chapter of the EIAR.

REGULATORY BACKGROUND

Guidelines

11.13 This section of the EIAR has been prepared on the basis of the draft Guidelines on the Information to be contained in Environmental Impact Assessment Reports by the EPA (2017).

Technical Standards

11.14 There are no technical standards relevant to this section of the EIAR.

RECEIVING ENVIRONMENT

Study Area

11.15 The study area relates to the vicinity of the application site and to those dwellings and buildings on the roads surrounding the application site.

Baseline Study Methodology

11.16 The baseline study comprises a desk-top review of online and published resources, information provided by the applicant and information contained in the other sections of this EIAR. Ordnance Survey maps and aerial photography were also examined.

Sources of Information

11.17 Baseline information was obtained from the following sources:

- Myplan.ie (http://myplan.ie/index.html);

- Historic Environment Viewer (http://webgis.archaeology.ie/historicenvironment/);
- Sligo County Development Plan 2017;
- The environmental topic chapters of this EIAR;
- OS Maps;
- aerial photographs;
- Openstreetmap.org.

Site Context

11.18 The application site is located south-west of Sligo town, off the R287 regional road in the town lands of Aghamore Near and Carrownamaddoo. Although there is a dispersed pattern of housing development in the vicinity, there is no distinctive village or settlement in the immediate vicinity.

11.19 The application area is bounded on all sides by agricultural land and there are a number of dwellings located along the roads in the vicinity. There is a sports ground located to the northwest of the application area. The site is access from a local road (L3603). Lough Gill is located c. 800m north-east of the application site.

11.20 A manufacturing area and welfare and office facilities associated with the application site are located to the east of the road. The application site comprises of a quarry. There are no manufacturing facilities or welfare facilities within the application site.

Built Services

11.21 Electrical power is currently provided to the application site via mains supply. Electricity will provide the principal source of energy for office lighting and heating.

11.22 Site based staff at the application site are contactable by mobile phone, landline and email and broadband connections to the site office are provided via a mobile network.

11.23 An existing effluent treatment system is located in the ancillary area to the East of the application area.

11.24 Potable water is provided to the site via a private well.

Waste Management

General Waste Management

11.25 Lagan Bitumen Ltd., as a member of the Irish Concrete Federation commits themselves to the principles of the Federations Environmental Code. The code states:-

> *"ICF members will minimise production of waste and where appropriate consider its beneficial use including recycling. They will deal with all waste in accordance with the*

relevant legislation and other controls in place, including using waste contractors with valid Waste Collection Permits"

11.26 Potential waste produced and the measures used to control it are described as follows:-

- Scrap metal – these materials are chiefly produced from the maintenance of the possessing plants and can cause a nuisance if allowed to build up in an uncontrolled manner. A designated scrap metal area will be demarcated on site and the build-up of scrap is controlled by the regular removal by licensed scrap metal dealers.

- Used Oil and Oil Filters – any waste oil/oil filters that may arise from servicing of fixed or mobile plant will be removed from the site by a licensed waste contractor.

- Used Batteries – similarly all used batteries will be removed from site for collection and recycling by a licensed waste contractor in accordance with the Waste Management Regulations.

- Domestic Style Waste (Canteen Waste) – domestic waste generated at the offices and employee's facility will be collected by a licensed waste collection contractor.

Extractive Waste Management

11.27 Almost all products and by-products arising from the aggregate processing have commercial value. Any waste materials from the site are stored, collected, recycled and/or disposed of in accordance with any requirements of Sligo County Council.

11.28 Topsoil and overburden stored within the application site is not considered waste; such materials are an essential component of the restoration programme. These materials are required for the reshaping and landscaping of the worked out area to make it more suitable for after-use.

Sensitive Receptors

11.29 The application site is located is a rural area, but the nearby roads and in particular the roads to the north-east and north-west display a pattern of ribbon development. There is a more dispersed pattern of residential development along the local road to the south of the site. There is a number of industrial and commercial developments to the south-east of the site associated with the manufacturing area of the site and the nearby business park.

11.30 There are no residences within 200 metres of the quarry void.

11.31 There are no schools, churches or shops in the vicinity. The St John's Football Club is located to the north-west of the application site.

11.32 Figure 4.1 identifies residential properties, community facilities and commercial operations within the locality and shows 500m and 1km bands from the application boundary.

IMPACT ASSESSMENT

Evaluation Methodology

11.33 The evaluation of effects on built services and waste comprises a qualitative assessment based on the quantitative and qualitative analysis of potential effects on the environment undertaken in other sections of this EIAR. The assessment also takes into account a review of relevant literature and professional judgement in relation to impacts on built services and waste.

Built Services

Operational Stage Impacts

11.34 The operational phase of the development would comprise the extraction of aggregate from the extraction area and the continuation of processing within the quarry. It also includes the restoration of the site.

11.35 No significant effects are anticipated in relation to built assets or waste management.

Post-Operational Stage Impacts

11.36 During the post operational period, all works on the site would have ceased and the site would have been restored. Any activity on the site would be limited to post-restoration uses and any aftercare required for a limited period following restoration.

11.37 No significant effects are anticipated in relation to built assets or waste management.

Waste

Construction and Operational Stage Impacts

11.38 During the operational stage, aggregate will be extracted from the quarry and will be handled in the existing processing facilities at the quarry. Following the cessation of extraction operations, the relevant areas will be restored.

11.39 As outlined above, there are existing waste management arrangements in place in relation to general waste, ancillary operational waste and extractive waste. These arrangements will remain in place for the duration of the construction stage. The waste produced by the operational stage will be limited to the domestic style waste generated by the employees operating the facility and any ancillary generation of operational waste (e.g. batteries, tyres, waste oil).

11.40 It is considered, therefore, that the generation of waste will be medium term, temporary and slight in its effects.

Post-Operational Stage Impacts

11.41 During the post-operational stage, extraction and restoration operations will have ceased and activities will be limited to intermittent aftercare for a limited period. Any waste generated on the site will be limited to general waste produced by any employees that are engaged in aftercare on an intermittent basis and any ancillary operational waste related to aftercare. Any such waste will be handled in accordance with the established practices on site and will be removed by a licenced contractor.

11.42 It is considered, therefore, that the generation of waste during this period will be short-term, temporary and slight in its effects.

Unplanned Events

11.43 According to the EPA guidelines, unplanned events, such as accidents, can include *"spill from traffic accidents, floods or land-slides affecting the site, fire, collapse or equipment failure on the site"*. The 2014 EIA directive refers to *"major accidents, and/or natural disasters (such as flooding, sea level rise, or earthquakes)"*.

11.44 In this instance, the vulnerability of the proposed development to accidents, unplanned events or natural disasters is relatively limited owing to the relatively simple nature of the development works, the established nature of the techniques, regulations and procedures to be followed, the material to be handled on site and the relatively rural location of the proposed works.

11.45 Unplanned events in relation to the proposed development could potentially relate to:

- instability following the extraction of rock;
- spill from traffic accidents;
- flooding.

11.46 Adhering to the HSA Safe Quarry Guidelines to the Safety Health and Welfare at Work (Quarries) Regulations 2008 should limit the potential for unplanned events in the form of instability in the quarry faces. In any event, instability following the extraction of rock would be unlikely to have any significant impacts on employment, human health or amenity, particularly beyond the site. The final restoration will provide for the restoration of the quarry to a mixture of grassland, a water body, naturally regenerating quarry benches and woodland.

11.47 Chapter 7 (water) notes that 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. 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.

11.48 The traffic and transport assessment, carried out as part of the EIAR (Chapter 14), indicates that existing road network can accommodate the proposed development. Chapter 14 also recommends the erection of warning signage and the improvement of sightlines at the entrance to the application area. It is considered that the risk of an accident resulting in a spillage would be no greater in relation to this development than it is for any other form of development that relies on the transportation of goods and materials by HGVs.

11.49 It is considered that the material assets as outlined in this section are not particularly vulnerable to such unplanned events and unplanned events would be unlikely to cause significant, sudden environmental effects in respect of built services or waste.

Cumulative / Synergistic Impacts

11.50 A search of the Sligo County Council online planning search facility indicates that there are no other planned developments in the vicinity of the application site and in the adjoining townlands of Carrownamaddoo, Cuilbeg, Aghamore Near, Tullynagracken South, Drumaskibbole, Ballydawley, Castledargan, which were granted planning permission in the last five years[2] and have the potential to have any significant adverse cumulative impacts on the local environment. It is noted that planning permission has recently been granted for development consisting of the filling of lands with construction and demolition waste in Carrownamaddoo townland c. 450 metres from the application area (Plan File Ref. No. 18/49) subject to 7 no. conditions. This proposed development is considered small scale, short term in duration (5 years) and is located sufficient distance from the application area and therefore no cumulative impacts are considered.

11.51 It is considered that the only impact that has the potential for significant cumulative impact on material assets is traffic. The traffic impact of the development is assessed and discussed in chapter 14 of this EIAR. The assessment concludes that the relevant junctions and links will have sufficient capacity for the traffic generated by the quarry development.

Transboundary Impacts (If any)

11.52 It is not anticipated that the impacts of the proposed development would have any significant transboundary effects on material assets.

Interaction with Other Impacts (if any)

11.53 It is not anticipated that the effects of the proposed development on material assets would interact significantly with other impacts.

'Do-nothing Scenario'

11.54 In a 'do-nothing scenario', operations at the quarry would not be extended.

11.55 A 'do-nothing scenario' would not result in any significant adverse impact in relation to built services and on-site waste generation and the effect of a 'do-nothing scenario' would be neutral in relation to these factors.

11.56 However, in the medium term an alternative source of aggregates would need to be found and there would potentially be effects on the long-term viability of employment at the quarry.

[2] Planning search conducted on 23rd August 2018 on Sligo County Council website.

MITIGATION MEASURES

Construction and Operational Stage

11.57 As no significant effects are anticipated in relation to built assets or waste management during the construction and operational stage, no specific mitigation measures are proposed.

11.58 Waste generated at the site will continue to be appropriately stored and removed by licenced contractors.

Post – Operational Stage

11.59 As no significant effects are anticipated in relation to built assets or waste management during the post-operational stage, no specific mitigation measures are proposed.

11.60 Waste generated at the site will continue to be appropriately stored and removed by licenced contractors.

RESIDUAL IMPACT ASSESSMENT

Construction Stage

11.61 As no significant effects are anticipated in relation to built assets or waste management and no mitigation measures are required during the construction stage, no residual impact is anticipated.

Operational Stage

11.62 As no significant effects are anticipated in relation to built assets or waste management and no mitigation measures are required during the operational stage, no residual impact is anticipated.

Post – Operational Stage

11.63 As no significant effects are anticipated in relation to built assets or waste management and no mitigation measures are required during the post-operational stage, no residual impact is anticipated.

MONITORING

11.64 Monitoring is not proposed in relation to material assets.

CHAPTER 12

CULTURAL HERITAGE

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FIGURE 12-1 RMP LOCATIONS

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APPENDIX 12-1 SITES IN THE RECORD OF MONUMENTS AND PLACES

INTRODUCTION

Background

12.1 This Chapter of the Environmental Impact Assessment Report (EIAR), commissioned by SLR Consulting Ireland on behalf of Lagan Bitumen Ltd., addresses the impacts on the archaeological, architectural and cultural heritage of the application site and the surrounding area of a proposal for the continued use and deepening of the existing permitted quarry at Aghamore and Carrownamaddoo townlands, County Sligo. The site location and study area are indicated in **Figure 1.4 and Figure 12.1**.

Scope of Work / Methodology

12.2 This study, which complies with the requirements of Directive EIA 2014/52/EU, is an assessment of the known or potential cultural heritage resource within a specified area and includes the information that may reasonably be required for reaching a reasoned conclusion on the significant effects of the project on the environment, taking into account current knowledge and methods of assessment. It consists of a collation of existing written and graphic information in order to identify the likely context, character, significance and sensitivity of the known or potential cultural heritage, archaeological and structural resource using an appropriate methodology (EPA 2002 and 2003).

12.3 The study involved detailed investigation of the archaeological and historical background of the development site, the landholding and the surrounding area extending from the development boundary (**Fig. 1.4**). This area was examined using information from the Record of Monuments and Places of County Sligo, the Sligo County Development Plan, lists of previous excavations and cartographic and documentary sources. A field inspection was carried out on 1 May 2018 in an attempt to identify and assess any known archaeological sites and previously unrecorded features and portable finds within the area of landholding.

12.4 An impact assessment and mitigation strategy have been prepared. An impact assessment is undertaken to outline potential adverse impacts that the proposed development may have on the cultural resource, while a mitigation strategy is designed to avoid, reduce or offset such adverse impacts.

12.5 The application site is located in the Townlands of Carrownamaddoo and Aghamore Near, Co. Sligo, on OS Six Inch sheet No. 20, 1.3km to the west of the N4 Dublin to Sligo road and to the south of the town of Sligo. The proposed development would involve the continuance of use of the existing operational area on an area of 10.9 ha. within an application area of 18 Ha.

12.6 Extracts from the Record of Monuments and Places for County Sligo are presented on a map of the local area around the site in Figure 12-1. RMP sites included on the Records of Monuments and Places statutory mapping are identified by black circles. The application area is indicated by the red line.

Contributors / Author(s)

12.7 The assessment was prepared by Dr. Charles Mount who is a member of the Institute of Archaeologists of Ireland and a member of the Discovery Programme and has more than twentyfive years of cultural heritage assessment experience. He holds M.A. and Ph.D. degrees in archaeology as well as a professional diploma in EIA and SEA Management.

Limitations / Difficulties Encountered

12.8 No difficulties were encountered during the desktop study, field survey or in the preparation of this report.

REGULATORY BACKGROUND

12.9 The following paragraphs set out the regulatory background with regard to cultural impact assessments in Ireland in general and the site-specific planning background relevant to this cultural impact assessment, in particular.

Legislation

12.10 No specific Irish legislation exists governing cultural heritage assessments.

Planning Policy and Development Control

12.11 The Co. Sligo Development Plan 2017-2023 (CDP) is the statutory plan detailing the development objectives/policies of the local authority. The plan includes objectives and policies, relevant to this assessment, i.e. with regard to cultural heritage.

Cultural Heritage

12.12 Chapter 7 of the Sligo County Development Plan sets out the policies on cultural heritage within the county. The Council recognises the importance of identifying, valuing and safeguarding the archaeological and architectural heritage of Sligo.

12.13 The Council's aim is to: protect and enhance archaeological sites, monuments, their setting, appreciation and amenity within the Plan area, including those that are listed in the Record of Monuments and Places (RMP) or newly discovered archaeological sites and/or sub-surface archaeological remains. The Plan contains a number of policies aimed at the protection of archaeological heritage in the county.

P-AH-1 Protect and enhance archaeological sites, monuments, their setting, appreciation and amenity within the Plan area, including those that are listed in the Record of Monuments and Places (RMP) or newly discovered archaeological sites and/or sub-surface archaeological remains.

P-AH-2 Require archaeological impact assessment, surveys, test excavation and/or monitoring for planning applications in areas of archaeological importance, if a development proposal is likely to impact upon in-situ archaeological monuments, their setting and archaeological deposits.

P-AH-3 Require the preservation of the context, amenity, visual integrity and connection of archaeological monuments to their setting. Views to and from archaeological monuments shall not be obscured by inappropriate development. Where appropriate, archaeological visual impact assessments will be required to demonstrate the continued preservation of an archaeological monument's siting and context.

P-AH-4 Secure the preservation in-situ or by record of:

- the archaeological monuments included in the Record of Monuments and Places as established under section 12 of the National Monuments (Amendment) Act, 1994;

- any sites and features of historical and archaeological interest;
- any subsurface archaeological features that may be discovered during the course of infrastructural/development works in the operational area of the Plan. Preservation relates to archaeological sites or objects and their settings. Preservation in-situ is most effectively achieved by the refurbishment of existing buildings, in situations where it is possible to retain the greater part of existing structures without the need for new foundations.

P-AH-5 Protect historic burial grounds that are recorded monuments and encourage their maintenance in accordance with best conservation principles. Development may be restricted or conditions requiring substantial excavation may be imposed in and adjacent to former burial grounds.
P-AH-6 Where possible, facilitate and enhance public access to and understanding of the archaeological heritage and disseminate archaeological information and advice to prospective developers and the general public.
P-AH-7 Require that all development proposals for industrial buildings and sites of industrial archaeological importance be accompanied by an industrial archaeology assessment of the surrounding environment. New development should be designed in sympathy with existing features and structures. Protect and preserve the archaeological value of underwater archaeological sites and associated features. In assessing proposals for development, the Council will take account of the potential underwater archaeology of rivers, lakes, intertidal and subtidal environments.

Cuil Irra Peninsula – Carrowmore, Knocknarea and Carns Hill
P-AH-9 Refer to the National Monuments Section, DAHG all development proposals within the archaeological and historic landscape of the Cuil Irra Peninsula (which includes the core areas of Knocknarea, Carrowmore and Carns Hill) as identified in Fig. 7.A (see Co. Development Plan).
P-AH-10 Ensure that Archaeological Impact Assessments are requested at pre-planning and planning application stage for all development proposals within the archaeological and historic landscape of the Cuil Irra Peninsula (which includes the core areas of Knocknarea, Carrowmore and Carns Hill).

Protected Structures

12.14 The Council's aim is to: Preserve, protect and enhance the architectural heritage of County Sligo for future generations. The area's architectural heritage is of national and regional importance and is central to Sligo's ability to promote itself as a centre for cultural tourism. The Plan contains a number of policies aimed at the protection of architectural heritage in the county.

P-ARH-1 Preserve, protect and enhance the architectural heritage of County Sligo for future generations. The area's architectural heritage is of national and regional importance and is central to Sligo's ability to promote itself as a centre for cultural tourism.

P-ARH-2 Ensure that any development, modifications, alterations, or extensions affecting a protected structure, an adjoining structure or a structure within an ACA is sited and designed appropriately and is not detrimental to the character of the structure, to its setting or the general character of the ACA.

P-ARH-3 Exempt a development proposal from the normal requirement for the payment of a development contribution if the proposal involves restoration/refurbishment of a protected structure to a high architectural standard.

P-ARH-4 Facilitate enabling development to be carried out in conjunction with works to protected structures where consistent with the parameters outlined in subsection 7.3.5 Enabling Development.

P-ARH-5 Protect important non-habitable structures such as historic bridges, harbours, railways or non-structural elements such as roadside features (e.g. historic milestones, cast-iron pumps and post-boxes), street furniture, historic gardens, stone walls, landscapes, demesnes and curtilage features, in cases where these are not already included in the Record of Protected Structures.

P-ARH-6 Promote the retention and re-use of the vernacular built heritage through increasing public awareness of its potential for re-use and its adaptability to change.

P-ARH-7 When considering proposals to adapt vernacular buildings to meet contemporary living standards and needs, require applicants to apply the conservation principles and guidelines set out in the ICOMOS Charter on the Built Vernacular Heritage (Mexico 1999) – refer to Appendix H of this Plan.

Architectural Conservation Areas (ACA)

12.15 An Architectural Conservation Area (ACA) is a place, area, group of structures or townscape that is of special architectural, historical, archaeological, artistic, cultural, scientific, social or technical interest or value, or contributes to the appreciation of Protected Structures.

12.16 There are a number of policy objectives outlined in Section 12.4.3 of the SDP in respect of architectural conservation which state:

P-ACA-1 Conserve and enhance the special character of the Architectural Conservation Areas in this plan. The special character of an area includes its traditional building stock and material finishes, spaces, streetscapes, shop fronts, landscape and setting.

P-ACA-2 Protect all buildings, structures, groups of structures, sites, landscapes and all features considered to be intrinsic elements to the special character of the ACA from demolition and non sympathetic alterations.

P-ACA-3 Promote appropriate and sensitive reuse and rehabilitation of buildings and sites within ACAs.

P-ACA-4 Require the retention of original windows, doors, renders, roof coverings, chimneys, rainwater goods and other significant features of structures of architectural heritage merit, whether protected or not.

P-ACA-5 Seek the repair and reuse of traditional shopfronts and where appropriate, encourage new shopfronts of a high quality architectural design.

P-ACA-6 Ensure that new development within or adjacent to an ACA respects the established character of the area and contributes positively in terms of design, scale, setting and material finishes to the ACA.

P-ACA-7 Promote high quality architectural design within ACAs, including redevelopment in the traditional or historicist manner, where appropriate.

P-ACA-8 Ensure that all new signage, lighting, advertising and utilities on buildings within an ACA are designed, constructed, and located in such a manner that they do not detract from the character of the ACA.

P-ACA-9 Protect and enhance the quality of open spaces within ACAs and ensure the protection and where necessary reuse of street furniture and use of appropriate materials during the course of public infrastructure schemes within ACAs.

Guidelines

12.17 The report format and some of the descriptions of effects are based on the **Guidelines on the Information to be contained in Environmental Impact Assessment Reports** (Draft), published by the Environmental Protection Agency (EPA) in May 2017.

Significant Risks

12.18 There are no known significant risks to human health or environmental effects, which may occur in relation to this cultural heritage assessment.

RECEIVING ENVIRONMENT

Study Area

12.19 The overall study area measures 2.04km by 1.89km, an area of 3.88 square kilometres is shown in **Figure 12-1**.

Baseline Study Methodology

12.20 Research has been undertaken in two phases. The first phase comprised a paper survey of all available archaeological, historical and cartographic sources. The second phase involved a field inspection and archaeological assessment of the proposed development area.

Paper Study

12.21 This involves a search of relevant documents. The following sources were examined and a list of sites and areas of archaeological potential compiled:

- Record of Monuments and Places County Sligo
- The Sites and Monuments Record
- Available aerial photography

- Cartographic and written sources relating to the study area
- Sligo County Development Plan 2017-2023
- The National Inventory of Architectural Heritage

The Record of Monuments and Places

12.22 This was established under section 12 (1) of the 1994 National Monuments (Amendment) Act and provides that the Minister shall establish and maintain a record of monuments and places where the Minister believes there are monuments, such record to be comprised of a list of monuments and relevant places and a map or maps showing each monument and relevant place in respect of each county in the State. The associated files contain information of documentary sources and field inspections where these have taken place. All available information on these sites is provided in Appendix 12.1.

Cartographic Sources

12.23 This included seventeenth century mapping as well the 1st and 2nd editions of the Ordnance Survey six-inch maps and Documentary sources provide more general historical and archaeological background.

The County Development Plan

12.24 This notes structures listed for preservation.

Field Inspection

12.25 A field inspection was carried out to determine the location, extent and ascertain the significance of any archaeological sites and to identify any previously unrecorded or suspected sites and potable finds.

RECEIVING ENVIRONMENT, HISTORICAL AND ARCHAEOLOGICAL LANDSCAPE

The Landscape

12.26 The application site is located in the Townlands of Carrownamaddoo and Aghamore Near, Co. Sligo, on OS Six Inch sheet No. 20, 1.3km to the west of the N4 Dublin to Sligo road and to the south of the town of Sligo. The application site is situated in flat to undulating countryside.

Historical and Archaeological Background

12.27 The following is a brief summation of the main types of sites and monuments that are known from the county along with the historical development of the study area. It is intended as a guide to the types of sites and monuments that might be encountered in the study area.

12.28 The site is situated in the townlands of Carrownamaddoo and Aaghamore Near, in the Barony of Carbury, and the civil parish of St. John’s.

The Prehistoric Period

12.29 To date no prehistoric settlements or artefacts have been identified from the study area.

The Early Medieval Period

12.30 In the Early Medieval period (500 AD-1170 AD) the study area formed part of the Kingdom of Cenel Cairpre which was ruled by the Cairpre Mor and the Cairpre Gabra kings. By the twelfth century the Sligo part of Cenel Cairpre was known as Carbridrumclif (MacCotter 2008, 132-3).

12.31 Classically settlement at this period is indicated by the presence of enclosed farmsteads known as ringforts, when enclosed with earthen banks, and cashels when enclosed by stone walls. There are 10 ringforts and cashels known in the study area in Drumaskibbole, Tullynagracken, Carrownamaddoo and Aghamore Near townlands indicating substantial settlement in the study area during the early medieval period.

The Later Medieval Period

12.32 In 1235 Richard de Burgo, who had been granted Connacht by King Henry III, carried out the conquest of Connacht and the study area. The Manor of Sligo, containing the study area, was granted to Hugh de Lacy who granted it to Maurice Fitz Gerald (Orpen 1911-20, Vol 2, 193-7). In the fourteenth century the study area came to William de Burgo, Earl of Ulster, but after his death in 1333 control of Leyny was assumed by local lords. Later medieval Anglo-Norman settlement is often indicated by the presence of earth and timber Motte and Bailey castle and Moated sites that were constructed for defence. However, there are no examples of either site type in the study area.

The Post-Medieval Period

12.33 In the Down Survey of 1655-6 Aghamore Near was held by the Scottish Nobleman Sir Frederick Hamilton and he retained it in 1670 and Carrownamaddoo was held by Captain John Parker and he retained it in 1670 (http://downsurvey.tcd.ie).

BUILDINGS

Protected Structures

12.34 The Sligo County Development Plan 2017-23 and the Record of Protected Structures was examined as part of the baseline study for this chapter of the EIAR. The review established that there are no Protected Structures situated within the application area. There are no Protected structures listed within the study area.

Non-designated Structures

12.35 The National Inventory of Architectural Heritage (NIAH) which is maintained by the Dept. of Culture, Heritage and the Gaeltacht was examined as part of the baseline study for this chapter of the EIAR on 28 March 2018. The review established that there are no additional structures included in the NIAH situated within the application area or the study area.

ARCHAEOLOGY

Archaeological Assessment

Recorded Monuments

12.36 Examination of the Record of Monuments and Places (RMP) for Co. Sligo indicated that the site of one Recorded Monument, SL020-094--- Aghamore Near Enclosure, is located within the application area (see Fig. 12-1 and Appendix 12.1). This is included in the RMP as:

12.37 SL020-094--- Aghamore Near Enclosure:

Shown as a hachured enclosure on the 1st edition OS 6-inch map with a road running N-S through it. A NE section of hachured enclosure is shown on the current OS 6-inch map. The site has since been removed by quarrying.

12.38 This site, as stated in the RMP, has been removed and will not be impacted by the proposal. A review of online Ordnance Survey aerial photography indicates that this feature had been removed prior to 1995.

12.39 The area of notification of one Recorded Monument is slightly within the application area SL020-093--- Ringfort – cashel in Aghamore Near townland. It is described in the RMP:

Comprises a circular area (int. diam. 20m) enclosed by a bank (Wth 3.50m, H 0.15m) and wide external ditch (Wth 6m). There is no indication of an entrance. The site is heavily overgrown.

12.40 This monument is situated 40m north-east of the application area and will not be directly impacted by the proposed development.

12.41 The next closest RMP site SL020-086---- a ringfort in Carrownamaddoo townland is situated 94m to the north-west of the application area. This and the remaining Recorded Monuments in the study area are situated further from the application area than SL020-158--- and are considered too far distant to be directly or indirectly impacted by the current proposal.

Undesignated Monuments

12.42 Examination of the Sites and Monuments Record (SMR) which is maintained by the Dept. of Culture, Heritage and the Gaeltacht on 4 April 2018 indicated that there are no undesignated monument included within the application area or the study area (see Figure 12.1 and Appendix 12-1).

Cartographic Sources

12.43 The Ordnance Survey 1st and 3rd edition six-inch maps and the first edition 25-inch maps of the area were examined. The analysis did not indicate any previously unrecorded archaeological sites in the application area or vicinity.

Place Name Evidence

12.44 The place names were extracted from the cartography in order to facilitate the search for structures and monuments and small finds, to help identify any unrecorded monuments or structures, to search for any published papers and documents related to the study area and to assist in the study of the historical development of the area. The English translations of the townland names of the study presented above below are based on Logainm.ie.

12.45 Aghamore Near and Far: Great big field
Carrownamaddoo: quarter of the dogs
Cuilbeg: small wood
Drumaskibbole: ridge of the barn
Tullynagracken South: hill of the skins

Previous archaeological investigations in the study area

12.46 The existing quarry development was the subject of an EIS carried out in 1996 by Frank L Benson & Partners (Reg No. 96172) that included an archaeological and cultural heritage assessment.

12.47 The existing quarry was the subject of licensed monitoring carried out by Mary Henry Archaeological Services in 2000 and 2002 the reports from Excavation.ie are presented below.

> Aghamore Near No archaeological significance 00E0757
> Monitoring was undertaken of ground disturbance at Aghamore Near, Co. Sligo. The owners of the site had obtained planning permission to extend an existing quarry into a greenfield area. One of the conditions of planning required that all groundworks be monitored. A number of archaeological sites, as recorded in the RMP for County Sligo, are close to the site of the development. However, there was no recorded monument within the confines of the part of the site being extended in late 2000.
>
> Aghamore Near No archaeological significance 00E0757 extension
> Monitoring of topsoil-stripping on a greenfield site was carried out as part of an extension to a quarry site. No archaeological remains were uncovered during the monitoring.

12.48 There has been one licensed monitoring project carried out within the study area that uncovered no archaeological material (see below).

> Aghamore Near and Carns No archaeological significance 11E0084
> Monitoring of the groundworks at Aghamore Near took place in May 2011. The works involved the replacement of existing pipes in the vicinity of sites SL020-093, 094 095 and SL10-238, classified as a ringfort, two enclosures and a ritual site (holy well) respectively. The trench was excavated using a JCB JC1320 machine with a 12in. toothed bucket. The excavated trench measured 0.4m (approx.) in width and was 0.8m in depth. The stratigraphy encountered during the excavation of the trench was generally uniform. A (0.1m) layer of humus was underpinned by a (0.5m) layer of gravel and deposited fill associated with the laying of the original pipe. A (0.2m) layer of natural grey clay was visible under this material. Nothing of archaeological significance was encountered during the groundworks.

12.49 There has been one geophysical survey carried out within the study area carried out by Target Archaeological geophysics (see below).

Aghamore Near, Co. Sligo 06R0161
Geophysical survey was undertaken over approximately 0.4ha of a single pasture field located in Aghamore Near townland, Co. Sligo. The survey was carried out for Readymix Concrete Plc. & The Irish Concrete Federation and has been requested as part of an Environmental Impact Assessment for a proposed quarry extension. The survey was undertaken in the location of ringfort site SL020:093. The aim of the geophysical survey was to gain detailed locational information on the nature form and extent of buried archaeological features within and at the perimeter of RMP SL020:093. No definitive archaeological type responses were identified from survey. It is expected that where buried archaeological remains are present within the investigation area they are likely to remain beyond detection due to the levels of natural variation recorded.

County Development Plan

12.50 No sites of archaeological importance, National Monuments, or protected structures listed in the Sligo Development Plan 2017-23 are located within the proposed development area.

Aerial Photographs

12.51 Examination of the Ordnance Survey 1995, 2000 and 2005 imagery as well as Google earth imagery from 2006, 2009, and 2014 and Bing imagery from 2016 did not indicate any additional cultural heritage sites in the application area.

Field Assessment

12.52 A field assessment was carried out on 1 May 2018 in an attempt to identify any previously unknown archaeological or cultural heritage sites.

12.53 Area 1
This is the existing area of extraction with an unextracted area of green field that has already been assessed under Planning Application Reg. No. 02/271 (see Plate 12-2, 12-3 and Fig. 12-1). There is no indication of any cultural heritage material.

ASSESSMENT OF POTENTIAL IMPACTS

Direct Impacts

12.54 There will be no direct impacts on any known items of archaeology, cultural heritage or buildings of heritage interest in the application area or the vicinity.

Indirect Impacts

12.55 There will be no indirect impacts on any known items of archaeology, cultural heritage or buildings of heritage interest in the application area or the vicinity.

Interactions with Other Impacts

12.56 No interaction with other impacts has been identified.

Do Nothing Impacts

12.57 If the proposed development were not to proceed there would be no negative impact on the cultural heritage.

Worst Case Impact

12.58 In the worst case scenario, the development might disturb previously unknown deposits or artefacts without preservation by record taking place in the unextracted green field area.

RECOMMENDATIONS / PROPOSED MITIGATION MEASURES

Direct Impacts

12.59 Due to the possibility of the survival of previously unknown subsurface archaeological deposits or finds within the unstripped part of the green field area topsoil-stripping in this area should be archaeologically monitored.

Indirect Impacts

12.60 No indirect impacts warranting specific mitigation were identified during the course of the cultural heritage assessment.

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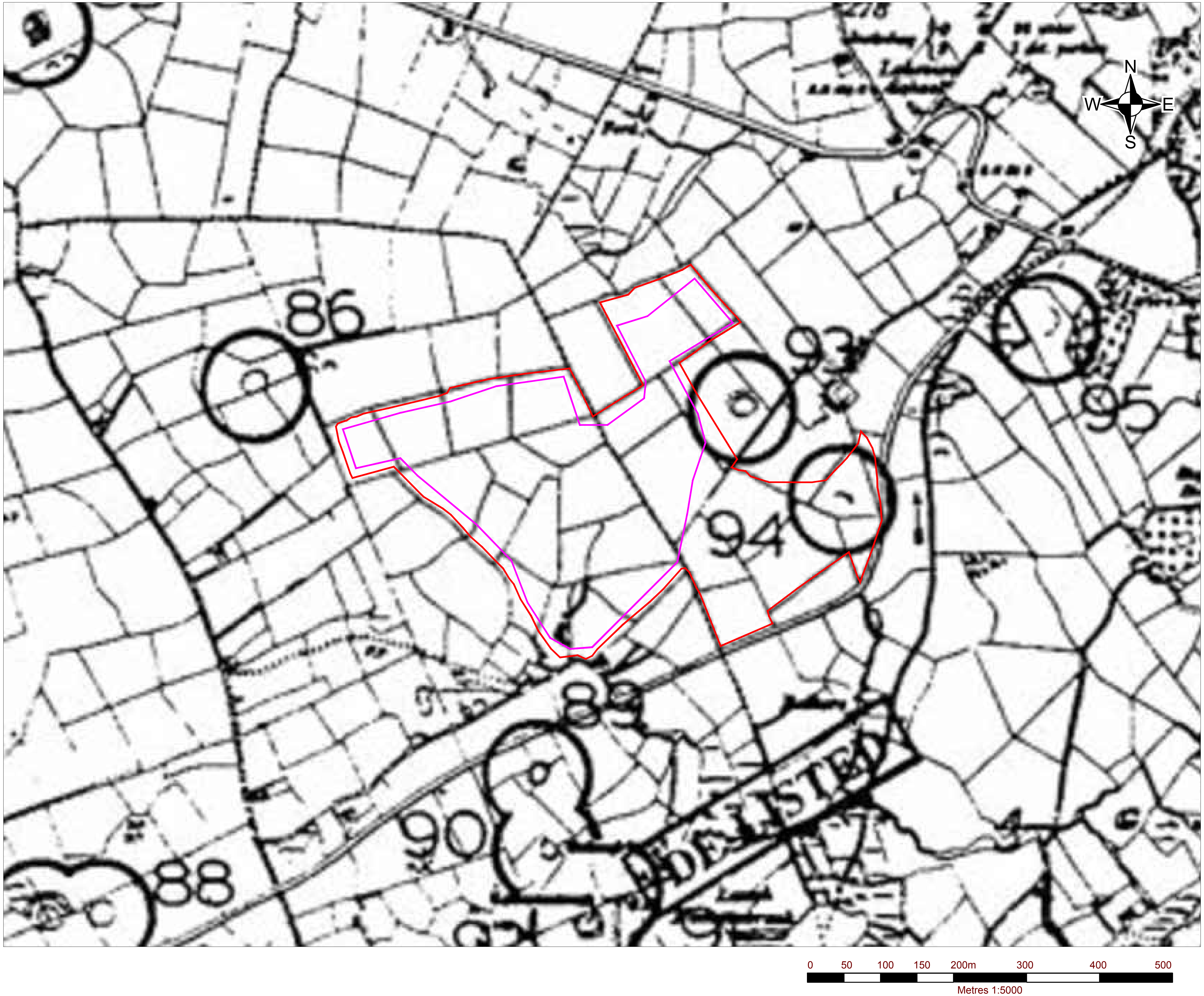
PLATES

Plate 12-1

Panoramic view of the existing extraction area looking north-west.

FIGURES



NOTES

1. ORDNANCE SURVEY IRELAND LICENCE NO. SU 0000718 (C) ORDNANCE SURVEY IRELAND & GOVERNMENT OF IRELAND

LEGEND

APPLICATION AREA (c. 18 Ha.)

QUARRY EXTRACTION AREA (c. 10.9 Ha.)

SLR CONSULTING IRELAND
7 DUNDRUM BUSINESS PARK
WINDY ARBOUR
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T: +353-1-2964667
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www.slrconsulting.com

LAGAN BITUMEN LTD.

LIMESTONE QUARRY

AGHAMORE NEAR AND CARROWNAMADDOO TOWNLANDS, CO. SLIGO

RMP LOCATIONS

FIGURE 12.1

Scale 1:5,000 @ A3

Date AUGUST 2018

501.00396.00007.EIAR Figure 12.1.Rev.0.dwg

Appendix 12-1
Sites in the Record of Monuments and Places

SL020-083--- Drumaskibbole Ringfort – rath
Located on a rise in undulating ground in pasture. Comprises an oval raised area (int. diam. 33m E-W by 20m N-S) enclosed by a low and broad bank of earth and stone (Wth 2m, H 0.50m). The entrance is on the W (Wth 2m) where a stretch of bank sweeps down off the site onto the level of the field. No indication of a ditch.

SL020-084001- Tullynagracken South Ringfort – rath
Located on a gentle S facing slope in flat to undulating ground in rough pasture. It overlooks the Ox Mountains and Knocknarea. Comprises a roughly circular raised area (int. diam. 22m). This is enclosed by a stone wall with an entrance on the S defined by a pair of upright stones. There is a hut in the interior (SL020-084002-OPW file).

SL020-084002- Tullynagracken Hut site
Located on a gentle S-facing slope in flat to undulating ground in rough pasture. Comprises a rectangular hut (int. dims. 5m by 4m) defined by a wall footing of upright stones with an entrance on the E situated within a cashel (SL020-084001-).

SL020-085001- Tullynagracken South Ringfort – rath
Located just off the summit of a ridge in undulating pasture with views onto the Ox Mountains and Knocknarea. Comprises a circular raised area (int. diam. 21m) enclosed by a bank (Wth 2.70m, H 0.60m) which has been removed in the N. There is an annex (int. diam. 7m) on the E enclosed by a badly preserved stone wall. No indication of a ditch or entrance.

SL020-085002- Tullynagracken South Enclosure
Located just off the summit of a ridge in undulating pasture with views onto the Ox Mountains and Knocknarea. There is an annex (int. diam. 7m) on the E of a cashel (SL020-085001-) which is enclosed by a badly preserved stone wall. No indication of a ditch or entrance.

SL020-086--- Carrownamaddoo Ringfort – rath
In pasture, on gently elevated ground, in undulating terrain. Raised, roughly circular area (26m E–W; 23.5m N–S) defined by a scarp (ext. H 1.2m at W; ext. H 1.6m at E). At SE–SW the scarp is incorporated into a field fence/property boundary which respects the curve of the rath. At W the scarp is topped with a low stony rim (Wth 1m), possibly wall footings. Elsewhere along the top of the scarp, a few stones are visible, barely protruding above the sod. Stones also protrude randomly in parts on the external slope of the scarp. The SW quadrant of the interior is slightly raised above the rest of the interior. In the E half of the interior, there is a slight slope down to E mirroring the contours of the low rise on which the rath is sited. There is a low stony rise (max. dim. c. 1.3m) slightly NE of centre in the interior.

SL020-087--- Drumaskibbole Ringfort – rath
Roughly circular area (int. diam. 24m) enclosed by a broad bank, external ditch and outer bank. There is an entrance in the SE part of the inner bank with a corresponding causeway through the ditch.

SL020-088--- Drumaskibbole Ringfort – rath
Circular raised area (int. diam. 26m) enclosed by a low, broad bank and an external ditch. On the E side the site has been partly embanked. There is an entrance gap in the SE.

SL020-089--- Carrownamaddoo Ringfort – rath
Oval raised area, heavily overgrown, and enclosed by a bank and external ditch. There is an entrance gap in the NE.

SL020-090--- Carrownamaddoo Children's burial ground
Identified as 'Caltragh' on the Current OS 6-inch map. Comprises a rectangular platform (int. dims. 25m by 25m, H 2.35-3m) composed of earth and stone and internally sloping. This is defined by a rectangular stone and earth field boundary at ground level.

SL020-091--- Carrownamaddoo Ritual site - holy well
Identified as 'Tobernacaltragh' on the 1st edition OS 6-inch map. Located along the course of a stream bed. There are no visible surface remains.

SL020-092--- Carrownamaddoo Ringfort – rath
Indicated as a roughly circular hachured area on the current OS 6-inch map. Comprises a circular, heavily overgrown area, enclosed by a bank. There are no indications of a ditch.

SL020-093--- Aghamore Near Ringfort – rath
Comprises a circular area (int. diam. 20m) enclosed by a bank (Wth 3.50m, H 0.15m) and wide external ditch (Wth 6m). There is no indication of an entrance. The site is heavily overgrown.

SL020-094--- Aghamore Near Enclosure
Shown as a hachured enclosure on the 1st edition OS 6-inch map with a road running N-S through it. A NE section of hachured enclosure is shown on the current OS 6-inch map. The site has since been removed by a quarrying.

SL020-095--- Aghamore Far Enclosure
The monument is not represented on the OS 6-inch 1st edition (1837). It is depicted on the OS 25-inch plan (1909) as a raised (potentially circular) area represented on the east by an arc of hachures; this appears to indicate a possible enclosure. Houses have been built on the site which predate 1995 as they are shown on the OSI photo for that year.

SL020-121001- Drumaskibbole Enclosure
Situated on a S-facing slope in pasture. Identified on an aerial photograph (ACP V 203/111 -2; Roll 177, pr. 19) as an irregularly shaped enclosure with associated field system (SL020-121002-). There are no surface remains.

SL020-121002- Drumaskibbole Field boundary
A field system of small irregular-shaped fields extending to N and NE of a possible enclosure (SL020-121001-) was identified on an aerial photograph (ACP V203/111-2). There are no visible surface remains.

SL020-126--- Drumaskibbole Ringfort – cashel
Located on an E-W running ridge with steep sides in pasture. Comprises an oval raised area (int. diam 19.50m) enclosed by a mostly ruined stone wall of which the inner and outer facing of the foundation course survives (Wth 2m, H 0.65m). The entrance is in the NE (Wth 2.60m) and a section of field wall is attached to the cashel wall on the N.

CHAPTER 13

LANDSCAPE

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INTRODUCTION

Background

13.1 This chapter documents the assessment of landscape and visual effects arising from the proposed development at Aghamore Near and Carrownamaddoo townlands, Co. Sligo.

13.2 Aghamore Quarry is located on a minor road route south west of the settlement of Aghamore. The existing quarry development consists of a large extraction area located on the western side of this minor road together with associated processing facilities, located on the eastern side of the minor road. This planning application concerns the facilities on the western side of the minor road, specifically the continuation of use of the existing permitted quarry development, and the deepening of the existing extraction area below the current permitted level of -34.5m OD to a depth of -50m OD within an overall application area of c. 18 hectares.

13.3 Landscape and visual effects are independent but related issues. Landscape effects are concerned with changes to the landscape, its character and quality, while visual effects relate to the appearance of these changes and the resulting effect on visual amenity. Wherever possible, identified effects are quantified, however the nature of landscape and visual impact assessment requires interpretation by professional judgement. In order to provide a level of consistency to the assessment, the appraisal of sensitivity and the prediction of magnitude of change and significance of effects have been assessed with reference to criteria defined in the methodology preceding the baseline and impact assessment sections of this report.

Scope of Work / EIA Scoping

13.4 The scope of the landscape and visual impact assessment and structure of this section of the EIAR is set out as follows:

- Regulatory Background / Planning policy (e.g. landscape policies, designated landscapes, sites of nature conservation importance);
- Receiving Environment – definition of the study area and description of the landscape and visual baseline;
- Impact Assessment – a description of the aspects of the development which are likely to cause landscape and/or visual effects, including the methodology for and an assessment of landscape and visual receptor sensitivity, as well as the magnitude and significance of the landscape and visual effects;
- Mitigation Measures – a description of the measures which will be integrated to mitigate any landscape and visual effects of the proposed development;
- Residual Impact Assessment – a summary of the landscape and visual effects with mitigation measures in place; and
- Conclusions.

13.5 The assessment is informed by Landscape Policy and the Landscape Characterisation Map in the Sligo County Development Plan 2011-2017 which remains valid for the 2017-2023 CDP. The assessment is also supported by a series of illustrated figures as follows:

- Figure 13.1 – Landscape Baseline and Designated Scenic Routes (representing approximately the Landscape Characterisation Map from the Sligo CDP);
- Figure 13.2 - Zone of Theoretical Visibility (ZTV) and Viewpoint Locations;

13.6 Photographs of the existing visual amenity at selected viewpoint locations are presented in Figures 13.3, and 13.4.

13.7 A description of the restoration scheme can be found in Chapter 2 of this EIAR and is illustrated in Figures 2.2 – Mitigation and Restoration Plan.

Consultations / Consultees

13.8 Following a review of published development plans and the site survey, it was considered that there was no requirement for a separate formal consultation to be carried out with regard to landscape and visual effects of the proposed development.

Contributors / Author(s)

13.9 The assessment including site work and completion of drawings was carried out by a suitably qualified Landscape Architect and full member of the Irish Landscape Institute with SLR Consulting Ireland.

Limitations / Difficulties Encountered

13.10 No difficulties were encountered during the assessment process. The field survey was undertaken from publicly accessible locations.

REGULATORY BACKGROUND

Planning Policy

Landscape

13.11 Chapter 7 of the CDP contains policies and objectives in relation to landscape. Section 7.4.3 of the Sligo CDP 2017-2023 refers to the Landscape Characterisation Map which formed part of previous County Development Plans including the CDP 2011-2017. This categorises the County's landscapes according to the following:

13.12 Normal Rural Landscapes: *"areas with natural features (e.g. topography, vegetation) which generally have the capacity to absorb a wide range of new development forms – these are largely farming areas and cover most of the County. At the same time, certain areas located within normal rural landscapes may have superior visual qualities, due to their specific topography, vegetation pattern, the presence of traditional farming or residential structures. These areas may* *have limited capacity for development or may be able to absorb new development only if it is designed to integrate seamlessly with the existing environment."*

13.13 Sensitive Rural Landscapes: *"areas that tend to be open in character, highly visible, with intrinsic scenic qualities and a low capacity to absorb new development – e.g. Knocknarea, the Dartry Mountains, the Ox Mountains, Aughris Head, Mullaghmore Head etc."*

13.14 Visually Vulnerable Areas: *"distinctive and conspicuous natural features of significant beauty or interest, which have extremely low capacity to absorb new development - examples are the Ben Bulben plateau, mountain and hill ridges, the areas adjoining Sligo's coastline, most lakeshores etc."*

13.15 Policies of relevance to this assessment contained in the Sligo CDP 2017-2023 are outlined below.

13.16 Policy P-LCAP-1: *"Protect the physical landscape, visual and scenic character of County Sligo and seek to preserve the County's landscape character. Planning applications that have the potential to impact significantly and adversely upon landscape character, especially in Sensitive Rural Landscapes, Visually Vulnerable Areas and along Scenic routes, may be required to be accompanied by a visual impact assessment using agreed and appropriate viewing points and methods of assessment."*

13.17 Policy P-LCAP-2: *"Discourage any development that would be detrimental to the unique visual character of designated Visually Vulnerable Areas."*

13.18 Policy P-LCAP-4: *"Strictly control new development in designated Sensitive Rural Landscapes while considering exceptions that can demonstrate a clear need to locate in the area concerned. Ensure that any new development in designated Sensitive Rural Landscapes:*

- *does not impinge in any significant way on the character, integrity and distinctiveness of the area;*
- *does not detract from the scenic value of the area;*
- *meets high standards of siting and design; and*
- *satisfies all other criteria with regard to, inter alia, servicing, public safety and prevention of pollution."*

13.19 Policy P-LCAP-5: *"Protect the historic and archaeological landscapes of the County."*

Scenic Routes and Protected Views

13.20 The CDP refers to Scenic Routes as *"public roads passing through or close to Sensitive Rural Landscapes, or in the vicinity of Visually Vulnerable Areas, and affording unique scenic views of distinctive natural features or vast open landscapes. In addition to remote views, scenic routes have often a distinctive visual character conferred by old road boundaries, such as stone walls, established hedgerows, lines of mature trees, adjoining cottages or farmyards together with their traditional, planted enclosures etc., all of which warrant protection."*

13.21 Policy in regard to Scenic Routes is set out in Policy P-LCAP-3 which states *"Preserve the scenic views listed in Appendix F and the distinctive visual character of designated Scenic Routes by controlling development along such Routes and other roads, whilst facilitating developments that* *may be tied to a specific location or to the demonstrated needs of applicants to reside in a particular area."*

13.22 The Scenic Routes with Scenic views to be preserved as documented in the Sligo CDP 2017-2023 under Policy P-LCAP-3 that occur within the study area are tabulated below and illustrated in Figure 13.1 – Landscape Baseline and Designated Scenic Routes.

Table 13-1
Scenic Routes

ID	Name	View Details
4	N4 Collooney By-Pass from northern roundabout.	Views of Ballysadare Bay, Knocknarea, at Collooney to Carrowroe Union Wood, Slieve Daeane, Slieve Dargan.
12	R284 from Carrowroe to junction with road L-3605.	Views of Ballygawley Lough, Slieve Dargan north of Ballygawley and Slieve Daeane.
14	R287 from Carrowroe to junction with road L-3605.	Views of Lough Gill, Slish Wood, at Correagh Slieve Dargan, Slieve Daeane and Killery Mountain.
36	L3602 along Garvoge River and Lough Gill from Sligo to junction with R287	Views of Garvoge River and Lough Gill.

Designated Nature Conservation Sites

13.23 A number of protected sites are located within the Study Area. The closest of these is Lough Gill SAC and pNHA which is located approximately 0.5km east of the application area. Unshin River pNHA is located approximately 2.5km south of the site. Further detail on these is provided in EIAR Chapter 4: Biodiversity.

Extractive Industry Policy

13.24 Section 4 of the CDP contains a number of relevant policies with regard to the extractive industry as follows.

13.25 Policy P-MEQ-2 *"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, and do not impinge on existing rights-of-way or walking routes."*

13.26 Policy P-MEQ-3 *"Seek the reuse of worked out quarries for recreational, industrial, ecological and other uses, following appropriate restoration."*

Protected Structures

13.27 Chapter 12 of this EIAR documents the assessment of effects on protected structures within the study area.

Guidelines

13.28 The landscape and visual impact assessment was undertaken in accordance with the published guidance entitled *Guidelines for Landscape and Visual Impact Assessment*, Landscape Institute and Institute of Environmental Management & Assessment, Third Edition, 2013, hereafter referred to as GLVIA 3.

RECEIVING ENVIRONMENT

Study Area

13.29 A study area measuring 3km from the centre of the Aghamore Quarry was identified following a desktop study and field based assessment. It should however be noted that the visual envelope, i.e. the area from where the planning application site is actually visible, was found to be smaller than the 3km radius study area, due largely to the visual screening afforded by existing topography and vegetation.

Baseline Study Methodology

13.30 The landscape and visual baseline study has involved a desktop study, field work, data processing and analysis. The aim of the landscape baseline study *"is to provide an understanding of the landscape in the area that may be affected"* (Section 3.15 of GLVIA 3), including its constituent elements, landscape character and its geographic extent.

13.31 With regard to the visual baseline GLVIA 3 (Section 3.15) states that it is the aim *"to establish the area in which the development will be visible the different groups of people who may experience views of the development, the places where they will be affected and the nature of the views and visual amenity at those points."*

13.32 Representative and illustrative viewpoints were selected for inclusion in the assessment in respect of the following parameters:

- types of receptor: to include residents of settlements and dwellings, road users, recreational users of footpaths, cycle paths, promoted viewpoints, picnic areas, beauty spots and other recreational locations where landscape is an important part of the experience;
- different distances from the development;
- different directions from the development with the aim of achieving a distribution of viewpoints from different compass points around the site; and
- different elevations.

Sources of Information

13.33 The desktop study and field work was supported, inter alia, by information available on the internet, digital as well as paper (Ordnance Survey) maps at different scales and the Sligo CDP 2017-2023.

Field Survey / Monitoring / Inspection Works

13.34 A site survey was carried out on 8th March 2018 in bright weather conditions with occasional showers. Visibility was good during the dry periods. The assessment concentrated on the publicly accessible areas such as the road and public footpath networks, residential and outdoor recreational areas.

Landscape Baseline

13.35 The County Development Plan 2017-2023 refers to the Landscape Characterisation Map which categorises the landscapes of Sligo into Normal Rural Landscapes, Sensitive Rural Landscapes and Visually Vulnerable Areas.

Landscape Character of the Application Site and its surroundings.

13.36 The application area is located south west of the settlement of Aghamore and comprises an existing quarry void, set within farmland at an elevation of approximately 30m AOD. The site, together with much of the farmed landscape of the Study Area is categorised as a Normal Rural Landscape according to the Landscape Characterisation Map in the Sligo CDP. The site is located west of Aghamore Bay on the westernmost edge of Lough Gill. A number of overhead powerlines cross the farmland close to the western site boundary. A number of regional and minor roads featuring individual and clusters of dwellings surround the site. The main regional road routes are the R287 located to the north east of the site and the R284 located west of the site.

Landscape character of the study area

13.37 The landscape immediately surrounding the site and in the north and western part of the study area comprises undulating farmland with a variable field pattern which is well defined by hedgerows with individual mature trees. To the north, the suburban edge of the town of Sligo, featuring residential areas and some larger scale buildings associated with industrial or commercial uses are present. Elevation in the farmed landscape within the study area varies between approximately 30m to 49m AOD. A number of overhead powerlines extend south and south west across the landscape from an existing substation on the R287 regional Road. This is categorised as a Normal Rural Landscape.

13.38 The eastern part of the study area features the Lakeland landscape associated with Lough Gill which is fringed with mature wooded vegetation. The shoreline of this landscape is categorised as Visually Vulnerable.

13.39 The southern part of the study area features an upland landscape associated with Slieve Dargan and Slieve Daeane and associated summits which collectively form a ridgeline with a south west to north east orientation. This mountain ridgeline overlooks Lough Gill, specifically Aghamore Bay and also the application site from the south and comprises rough terrain with rock outcrops and scant woody vegetation reaching maximum elevations of 263 and 275m AOD at Slieve Dargan and Slieve Daeane respectively. This is categorised as a Sensitive Rural Landscape. The ridgelines, categorised as Visually Vulnerable, presents a distinctive skyline backdrop to the farmland and Lough Gill further north.

Visual Baseline

General Visibility

13.40 The visibility of the application area was initially assessed by a desktop study of ordnance survey mapping (Discovery Map no. 25 at a scale 1:50,000) and available aerial photography followed by field survey.

13.41 The main areas from which the application site is currently visible are the mountain landscape associated with Slieve Dargan and Slieve Daeane to the south east of the site and the southern edge of the settlement of Sligo, in the vicinity of Tullynagracken and Carns, to the north of the site.

Visual Receptors

13.42 The visual receptors with existing and/or potential views of the application area consist of residents of dwellings, road users and recreational visitors to the area. The location of each of the viewpoints is indicated on Figures 13.1 and 13.2 and described in Table 13-2 below. The table lists the viewer types at each viewpoint and describes the nature of existing views. Photographs depicting the existing visual amenity at the selected viewpoint locations are presented in Figures 13.3 and 13.4.

Table 13-2
Viewpoints and Existing Visual Amenity

ID	Location	Viewer Types	Existing views / Visual amenity
A	Minor Road south west of the settlement of Aghamore.	Residents of Dwellings Road Users.	Open views are available of undulating pastoral farmland with hedgerow vegetation and occasional mature trees. A low voltage overhead powerline crosses this landscape. The fence boundary of the application site is visible on the horizon.
B	Minor Road north of the settlement of Aghamore.	Residents of Dwellings Road Users	Views are available of rolling farmland with mature hedgerow vegetation and mature trees against a backdrop of the mountain skyline associated with Slieve Dargan and Slieve Daeane and Union Wood. The application site featuring the existing quarry is partially visible as a small element, specifically the upper portion of the southern quarry face.
C	Minor road near Tullynagracken.	Residents of dwellings Road users	Panoramic views are available of a wide expanse of farmland with scattered dwellings against the backdrop of the mountain skyline associated with Slieve Dargan and Slieve Daeane. Overhead powerlines are clearly visible including one large pylon in the foreground. The application site is partially visible as a small element in the distance including part of the existing quarry face at the southern boundary of the site.
D	Southern	Residents of dwellings	Panoramic views are available of a wide expanse of farmland with scattered dwellings against the backdrop of the mountain skyline

	Edge of residential area of Sligo Town.	Road users	associated with Slieve Dargan and Slieve Daeane. The application site is partially visible as a small element in the distance including part of the existing quarry face at the southern boundary of the site.
E	Minor Road near Carns.	Residents of dwellings	A wide panoramic view is available of Lough Gill against the mountain skyline associated with Slieve Dargan and Slieve Daeane. The farmland at the foot of these mountains is also visible including the application site, of which the existing quarry faces are partially visible.
		Road users	
		Recreational Visitors	

IMPACT ASSESSMENT

Evaluation Methodology

13.43 In order to arrive at conclusions about the significance of landscape/visual effects, this LVIA links judgements about the sensitivity of a receptor with the magnitude of change. According to GLVIA 3, section 3.26, the sensitivity (or 'nature') of a receptor is *"made up of judgements about:*

- *The susceptibility of the receptor to the type of change arising for the specific proposal; and*
- *The value attached to the receptor"*.

13.44 The magnitude (or 'nature') of change is "made up of judgements about:

- *The size and scale of the change - for example whether there is complete loss of a particular element of the landscape or a minor change;*
- *The geographical extent of the area that will be affected; and*
- *The duration of the change and its reversibility."* Duration is described in GLVIA 3 with reference to three categories, short term lasting up to 5 years, medium term lasting between 5 and 10 years and long term lasting between 10 and 25 years.

13.45 The judgements about the sensitivity and magnitude are supported by a number of pre-defined parameters, where possible, as described in more detail below. They are then summarised using word scales and combined using a matrix to arrive at the overall significance of the effects.

Landscape Sensitivity

13.46 The sensitivity of the landscape is made up from a combination of judgements about the susceptibility of the landscape to change and the value attached to the landscape.

13.47 Susceptibility to change means the degree to which a landscape type/area/element is able to accommodate change (arising from a particular development) without detrimental effects on its character. Depending on the type of development proposed, this varies, inter alia, with the existing land use, the pattern and scale of the landscape, the visual enclosure/openness of views and the scope for appropriate mitigation. The value attached to the landscape can be judged, inter alia, by way of existing designations, landscape/scenic quality, rarity, recreation value.

13.48 For the purpose of this report landscape sensitivity is defined as HIGH, MEDIUM, LOW or NEGLIGIBLE, based on professional interpretation of the findings with regard to the susceptibility and value.

Visual Sensitivity

13.49 Viewpoint sensitivity is made up from a combination of judgements about the susceptibility of visual receptors to changes in views/visual amenity and the value attached to views.

13.50 The susceptibility to change in relation to different receptor types is defined in terms of high, medium and low susceptibility in Table 13-3 below.

13.51 The value attached to views is judged taking account of planning designations, such as protected views and other indicators of the values attached to views, e.g. in relation to heritage assets, views marked on maps or the provision of facilities for the enjoyment of views.

Table 13-3
Susceptibility of Visual Receptor to change

Susceptibility	Visual Receptor Types
High	Users of outdoor recreational facilities including strategic recreational footpaths, cycle routes or rights of way, whose attention may be focused on the landscape; important landscape features with physical, cultural or historic attributes; principal views from residential buildings, beauty spots or picnic areas; communities where views contribute to the landscape setting enjoyed by residents in the areas.
Medium	Other footpaths; secondary views from residential properties, people travelling through the landscape on roads, trains or other transport routes.
Low	People engaged in outdoor sports or recreation (other than appreciation of the landscape), commercial buildings, and other locations where people’s attention may be focused on their work or activity.

13.52 The overall sensitivity of the visual receptors is summarised on a scale of HIGH, MEDIUM, LOW or NEGLIGIBLE based on the criteria and professional judgement.

Magnitude of Landscape/Visual Change

13.53 The judgements of the size or scale, geographical extent and duration/reversibility of the changes in the landscape are based on guidance contained in GLVIA 3, sections 5.49-5.52 including:

- *"The extent of existing landscape elements that will be lost ...;*
- *The extent to which aesthetic or perceptual aspects of the landscape are altered ...;*
- *Whether the effect changes the key characteristics of the landscape ...;*

- Scale at which effects may have influence (e.g. site level, immediate setting, landscape type/character area);
- Duration of the effect (i.e. short term = 0-5 years, medium term = 5-10 years, long term = 10-20 years, 20+ years = permanent); and
- Whether full/partial reversibility is possible.

13.54 Based on GLVIA 3, sections 6.39-6.41, the judgements of the size or scale, geographical extent and duration/reversibility of visual effects are based on information including:

- *"The scale of the change in the view with respect to the loss or addition of features in the view and changes in its composition ...;*
- *The degree of contrast or integration of any new features or changes in the landscape with the existing or remaining landscape elements and characteristics in terms of form, scale and mass, line, height, colour and texture;*
- *The nature of the view of the proposed development, in terms of the relative amount of time over which it will be experienced and whether views will be full, partial or glimpses;*
- *The angle of view in relation to main activity of the receptor;*
- *The distance of the viewpoint from the proposed development;*
- *The extent of the area over which the changes would be visible;*
- Duration of the effect (i.e. short term = 0-5 years, medium term = 5-10 years, long term = 10-20 years, 20+ years = permanent); and
- Whether full/partial reversibility is possible.

13.55 The overall magnitude of change on the landscape and visual amenity is summarised on a scale of 'substantial', 'medium', 'slight' or 'negligible', based on professional interpretation of the findings with regard to size or scale, geographical extent and duration/reversibility. In order to assist the assessment, brief definitions of each level of magnitude are provided in Table 13-4, below.

Table 13-4
Magnitude of Change

Category	Description
Substantial	Total loss or major alteration of key elements/features/characteristics of the baseline conditions such that post development, landscape character or view composition attributes of the baseline would be fundamentally changed.
Medium	Partial loss or alteration to one or more key elements/features/characteristics of the baseline conditions such that post development, landscape character or view composition attributes would be partially changed.

Slight	Minor loss or alteration to one or more key elements/features/characteristics of the baseline conditions. Change arising from the loss/alteration would be discernible, but the underlying landscape character or view composition attributes would be similar to the baseline.
Negligible	Very minor loss or alteration to one or more key elements/features/ characteristics of the baseline conditions. Change would be barely distinguishable, approximating to 'no change'.

Significance of Effects

13.56 The significance of any identified landscape or visual impact has been assessed in terms of 'major' 'moderate', 'minor' or 'none'. These categories have been based on combining the overall sensitivity of landscape/visual receptors and overall magnitude of effects, as shown in Table 13-5 below. This process is not a quantitative process; there is not an absolute scoring system. Instead, the correlation of the two factors, although reflecting recognised features and methods, is in the end a matter of professional judgement.

Table 13-5
Significance of Landscape and Visual Effects

	Magnitude - Substantial	Magnitude - Medium	Magnitude - Slight	Magnitude - Negligible
Sensitivity - High	Major	Major/Moderate	Moderate	Moderate/Minor
Sensitivity - Medium	Major/Moderate	Moderate	Moderate/Minor	Minor
Sensitivity - Low	Moderate	Moderate/Minor	Minor	Minor/None
Sensitivity - Negligible	Moderate/Minor	Minor	Minor/None	None

13.57 The above matrix is not used as a prescriptive tool and the methodology and analysis of potential effects at any particular location must allow for the exercise of professional judgement. Thus in some instances a particular parameter may be considered as having a determining effect on the analysis.

13.58 Table 13-6, below, provides a brief definition of the full range of significance criteria. For the purpose of this report, it is considered that Major and Major/Moderate effects are significant.

Table 13-6
Definition of Significance Criteria for Landscape and Visual Effects

Category	Description
None	The proposed scheme is appropriate in its context. It may be difficult to differentiate from its surroundings and would affect very few or no receptors.
Minor	The proposed scheme would cause a barely perceptible impact, and would affect few receptors.
Moderate	The proposed scheme would cause a noticeable difference to the landscape, and would affect several receptors.

Major	The proposed scheme would completely change the character and/or appearance of the landscape for a long period of time or permanently. It would affect many receptors.

Construction Stage Impacts

13.59 The proposed development concerns the continuation of use and deepening of the quarry within the application area. In the context of this, effects on landscape and visual amenity are documented as operational stage effects.

Operational Stage Impacts

13.60 Impacts during operation are discussed below in terms of the sensitivity of each landscape and visual receptor and the magnitude of change that would arise.

13.61 The proposed development constitutes the continuation of the existing permitted quarry development and the deepening of the existing extraction area below the current permitted level of -34.5m OD to a depth of -50m OD within an overall application area of c. 18 hectares.

13.62 Aggregate extracted would be partially processed within the quarry void and transported by HGVs to the processing area located on the eastern side of the minor road for further processing.

13.63 Some very small and beneficial changes would be associated with the proposed mitigation measures comprising boundary hedgerow and woodland planting introduced to enhance and augment existing areas of hedgerow and woodland planting. This would provide further visual screening of the quarry during operation.

Direct Impacts on Landscape

13.64 Direct impacts would occur to the landscape of the existing quarry facility at Aghamore. These impacts would comprise the continuation of the existing permitted extraction activities and proposed deepening of the existing quarry void. These direct changes are considered to be very limited as they relate to an existing quarry void and would involve no loss of landscape elements of value including farmland and wooded vegetation. The introduction of planting along the site boundaries would also constitute a direct and beneficial change, proposed to mitigate landscape and visual effects.

Indirect Effects on-Landscape Character

13.65 The ZTV Figure 13.1 indicates that the proposed development (comprised of the existing permitted quarry and the proposed deepening of the existing quarry void) would be apparent in the elevated and mountain landscapes associated with Slieve Dargan and Slieve Daeane in the southern part of the study area. Further north, the farmed landscapes in the vicinity of Tullynagracken and Carns would be affected. In reality, the receiving landscape would be affected to a much lesser extent than indicated in the ZTV due to the screening afforded by existing mature hedgerows that currently enclose farmland and line existing roads along with areas of woodland.

13.66 The sensitive rural landscapes, visually vulnerable areas and the normal rural landscapes as identified in the Landscape Characterisation Map have been considered in terms of sensitivity to the proposed development where these occur within the study area. These are documented below.

Landscape Sensitivity – Normal Rural Landscapes

13.67 This assessment considers the Normal Rural Landscape to be of low susceptibility to the proposed change. This is due to the undulating topography and presence of hedgerow vegetation which provides visual screening thereby limiting the influence of future development on the character of this landscape. The presence of the existing quarry facility at Aghamore is a detracting element in this landscape. Vertical infrastructure in the form of existing overhead powerlines and pylons are notable elements which confer a partially altered and industrialised character to the landscape at and around these facilities. As a result of these landscape characteristics, and the nature of the proposed change (concerning, the deepening of the existing permitted quarry void) the susceptibility of this landscape is considered to be very limited.

13.68 The susceptibility of the main landscape elements including the remaining grassland at the western end of the site is also considered to be low as this is abundant in the surrounding landscape and none of this would be affected by the proposed development.

13.69 In terms of landscape value, the Normal Rural Landscape within the study area carries no designation. A number of designated scenic routes cross this landscape and contribute some value to this landscape.

13.70 Based on the above judgements regarding susceptibility and value, this assessment considers the Normal Rural Landscape, where it occurs within the study area, to have capacity to absorb development of the nature proposed and is of low sensitivity to the proposed change. This broadly corresponds with the county development plan which considers that Normal Rural Landscapes have the capacity to accommodate a wide range of development forms.

Landscape Sensitivity – Sensitive Rural Landscapes

13.71 The mountain and upland landscapes of Slieve Dargan and Slieve Daeane comprise elevated and visually open landscapes with rock outcrops and very limited vegetation cover. These landscapes overlook the farmland further north including the application site. The Sensitive Rural Landscapes are considered to be of high susceptibility to the proposed change.

13.72 Within the study area, there is a small area featuring mostly woodland located south east of the settlement of Sligo which is also designated as sensitive however based on the wooded cover and the ZTV Figure 13.1 which indicates scarcely any theoretical effect on this landscape, it is not considered to be affected and is excluded from the assessment.

13.73 The upland landscapes of Slieve Dargan and Slieve Daeane is of considerable value due to its scenic quality and designation status, categorised in the county landscape characterisation map as 'sensitive rural landscapes' and including ridgelines which are categorised as 'visually vulnerable'.

13.74 Based on the above judgements regarding susceptibility and value, the sensitivity of the upland landscape of Slieve Dargan and Slieve Daeane to the proposed change is considered to be high.

Landscape Sensitivity – Visually Vulnerable Landscapes

13.75 The visually vulnerable landscapes within the study area include parts of the shoreline of Lough Gill and islands within. There is extensive woodland cover surrounding the lake generally and it is therefore considered to be of medium/low susceptibility to the proposed change. A high value is attached to this landscape due to its scenic quality and status, categorised as 'visually vulnerable' according to the county landscape characterisation map. Based on these characteristics, an overall medium sensitivity to the proposed change is deemed to apply.

Magnitude of Landscape Change and Significance of Effect – Normal Rural Landscapes

13.76 The size and scale of the proposed change on the Normal Rural landscape would be very limited. The existing permitted quarry would continue to be partially apparent in the more elevated areas of this farmed landscape where breaks in the existing vegetation pattern afford views towards the site. In general, part of the existing quarry void (mineral faces and site boundaries) would continue to be apparent whilst the proposed deepening of the quarry void would not be apparent. Moving vehicles, namely HGVs transporting aggregate materials to the existing manufacturing / ancillary area located on the eastern side of the minor road would not be apparent due to screening afforded by topography and existing woodland.

13.77 In terms of geographic extent, the existing permitted quarry facility would continue to be apparent from very limited elevated parts of this landscape in locations where there are breaks in existing vegetation in the vicinity of Tullynagracken and Carns and also small areas of farmland immediately south of the application area. Thus the geographic extent of the landscape that would be affected is very limited compared to that indicated on the ZTV Figure 13.1 due to the screening afforded by intervening vegetation. The proposed development would be permanent, present in the landscape in the long term.

13.78 Taking into account the fact that the proposal comprises, for the most part, the continuation of operations within an existing permitted quarry and the fact that the proposed deepening of this existing void, would not be apparent from this landscape generally, a negligible magnitude of change is predicted for this landscape of low sensitivity resulting in a minor/none and not significant effect.

Magnitude of Landscape Change and Significance of Effect – Sensitive Rural Landscapes

13.79 The upland landscapes of Slieve Dargan and Slieve Daeane would be affected by the proposed change. Due to elevation, the existing quarry void and the proposed deepening would continue to be apparent. Intermittent activity associated with the HGVs transporting aggregate materials to the existing manufacturing / ancillary area located on the eastern side of the minor road may also be apparent. These activities would be apparent as very small scale elements from this landscape in the context of the wider landscape including Lough Gill, Sligo Bay and mountain skylines to the north. The size and scale of the proposed change is considered to be very limited because the change would take place in an existing quarry void.

13.80 In respect of the geographic extent of the change, the ZTV Figure 13.2 indicates that a part of this landscape would be affected by the proposed change, specifically the north facing slopes of Slieve Dargan and Slieve Daeane and part of the ridgeline further east. The ZTV does in fact reflect the extent of the landscape that would actually and realistically be affected as there is very little vegetation cover present in these upland areas as a visual screen.

13.81 The proposed change would be clearly apparent in the context of the existing quarry void and effects would be permanent (long term duration).

13.82 An overall slight magnitude of change is predicted to arise. This combined with a high sensitivity results in a moderate and not significant effect.

Magnitude of Landscape Change and Significance of Effect – Visually Vulnerable Landscapes

13.83 Short sections of the shoreline of Lough Gill, specifically the southern side of Aghamore Bay would be theoretically affected by the proposed development according to the ZTV Figure 13.1. In reality these effects would not arise due to the screening afforded by existing woody vegetation. As a result, no effects on these landscapes are predicted to arise.

Visual Effects

13.84 Effects on visual amenity at selected viewpoint locations presented in the baseline are documented below. An evaluation of sensitivity at each viewpoint location is presented along with an evaluation of magnitude of change which is determined with reference to the size and scale, geographical extent and duration/reversibility of the proposed change resulting in a judgement of the overall magnitude of visual change.

Visual Receptor Sensitivity

13.85 Table 13-7 below summarises the sensitivity of the visual receptors at each of the identified viewpoints, based on the methodology presented above. In terms of susceptibility, this is considered to be high for residents of dwellings due to their continued interest in their surroundings whilst road users are of low susceptibility as the existing view is incidental to the journey. Recreational viewers are considered to be of high susceptibility where their attention is focussed on the surrounding landscape.

13.86 In terms of value, no landscape designations, scenic routes or protected views apply at any of the viewpoint locations.

Table 13-7
Visual Receptor Sensitivity

ID	Susceptibility	Value	Sensitivity
A 237	Residents of dwellings - high.	No landscape designations, scenic routes or protected views.	HIGH
	Road users - low.		LOW
B 241	Residents of dwellings - high.		HIGH
	Road users - low.		LOW
C 242	Residents of dwellings - high.		HIGH
	Road users - low.		LOW
D 244	Residents of dwellings - high.		HIGH
	Road users - low.		LOW
E 245	Residents of dwellings - high.		HIGH
	Road users - low.		LOW
	Recreational viewers -high		HIGH

Magnitude of Change and Significance of Visual Effects

13.87 The magnitude of change and significance of visual effects at each viewpoint is discussed below. For each viewpoint the size and scale of the change to the existing view is assessed together with the extent of the view that would be affected by the change and the duration, concluding with an overall magnitude of change. Finally, the significance of visual effects at each viewpoint is documented.

13.88 From all of the viewpoints, the viewer would continue to see elements associated with the existing permitted quarry within the application area.

Viewpoint A -237

13.89 At viewpoint A, residents of dwellings and road users would experience some small changes to existing views and these relate to the introduction of woodland planting along the fence boundary introduced to mitigate landscape and visual effects. The scale of the proposed change is considered to be relatively small and a small proportion of the view would be affected. This would result in a slight beneficial magnitude of change as the proposed woodland would represent an enhancement to local landscape character as observed from this location.

13.90 A slight beneficial magnitude of change is considered to arise to residents of high sensitivity resulting in a moderate (beneficial) and not significant effect. Road users of low sensitivity would experience a minor (beneficial) effect.

Viewpoint B 241

13.91 At viewpoint B, residents of dwellings and road users would continue to see the existing permitted quarry at a distance of approximately 0.4km. These viewers would continue to see the upper portions of the existing quarry faces in the context of a panoramic view of the wider farmland and mountain skyline further afield. The proposed deepening of the existing void would not be visible. Proposed mitigation planting would be visible however scarcely noticeable within the panoramic view of the wider farmland. The magnitude of change is considered to be negligible. Residents of dwellings considered to be of high sensitivity would experience a minor and not significant effect. Road users considered to be of low sensitivity would experience a minor/none and not significant effect.

Viewpoint C 242

13.92 At viewpoint C, residents of dwellings and road users would continue to see the existing permitted quarry as a relatively small element in a wider panoramic view at a distance of approximately 1.1km and with an existing pylon in the foreground. The proposed deepening of the existing void would not be visible. The magnitude of change is considered to be negligible. Residents of dwellings considered to be of high sensitivity would experience a minor and not significant effect. Road users considered to be of low sensitivity would experience a minor/none and not significant effect.

Viewpoint D 244

13.93 At viewpoint D, residents of dwellings and road users would continue to see the existing permitted quarry as a relatively small element in a wider panoramic view at a distance of approximately 1.4km. The proposed deepening of the existing void would not be visible. The magnitude of change is considered to be negligible. Residents of dwellings considered to be of high sensitivity would experience a minor and not significant effect. Road users considered to be of low sensitivity would experience a minor/none and not significant effect.

Viewpoint E 245

13.94 At viewpoint E, residents of dwellings, recreational visitors and road users would continue to see the existing permitted quarry as a relatively small element in a wider panoramic view at a distance of approximately 1.4km. The proposed deepening of the existing void would not be visible. The existing facility would be relatively small in scale and would occupy a small proportion of the existing view in a southerly direction. The viewers attention is likely to be more focussed on views in a south easterly direction towards Lough Gill and mountain backdrop. The magnitude of change is considered to be negligible. Residents of dwellings and recreational visitors considered to be of high sensitivity would experience a minor and not significant effect. Road users considered to be of low sensitivity would experience a minor/none and not significant effect.

Impact on Landscape/Planning Designations

Landscape Policy

13.95 The proposed development would occur in a landscape which features an existing quarry facility located within an area categorised as Normal Rural Landscape according to the county Landscape Characterisation Map. Normal Rural Landscapes are considered to have the capacity to absorb a wide range of new development forms. In this regard, the proposed development is not considered to be in conflict with landscape policy.

Views and Prospects

13.96 A number of designated scenic routes occur within the study area and effects on these are documented in Table 13-8 below.

Table 13-8
Assessment of Scenic Routes

ID	Name	Description
4	N4 Collooney By-Pass from northern roundabout.	The screening afforded by intervening vegetation generally is such that there would be no effect on this scenic route.
12	R284 from Carrowroe to junction with road L-3605.	The presence of hedgerow vegetation and built structures as visual screens along the roadside and hedgerows within intervening farmland is such that the proposed development would not be visible from this route.
14	R287 from Carrowroe to junction with road L-3605.	A very short section of this route, close to the settlement of Aghamore would be affected by the proposed development, in particular the continuation of use of the existing quarry. The proposed deepening of the existing quarry void would not be visible from this route. The majority of the scenic route within the study area would not be affected.
36	L3602 along Garvoge River and Lough Gill from Sligo to	Views in an easterly direction towards Lough Gill and The Garvoge River are directed away from the proposed development and would therefore be unaffected. The ZTV indicates that theoretically very limited effects would

	junction with R287	arise on this route. In reality, the proposed development would not be visible from this route due to screening afforded by woodland.

Extractive Industry and Building Materials Production

13.97 A Landscape Mitigation and Restoration Plan is provided in Chapter 2 of this EIAR, detailing the restoration of the lands to an after use which would support future habitats and would result in ecological enhancement of the area. The proposed landscape mitigation and restoration plan is shown on Figure 2.2.

Post – Operational Stage Impacts

13.98 During the Post operational stage, the quarry would cease to operate. Plant and machinery would be removed and the site would be restored in accordance with the Mitigation and Restoration Plan illustrated in Figure 2.2. This would result in some beneficial effects on surrounding landscape and visual amenity compared with the current baseline.

‘Do-nothing Scenario’

13.99 If no further works within the planning application area were carried out, the existing quarry, would continue to be present in the landscape. The restoration of the site would result in improvements to existing landscape and visual amenity compared with the current baseline.

MITIGATION MEASURES

Operational Stage

13.100 Hedgerow and woodland planting using native species would be introduced in advance of operations along the boundaries of the application area which, along with vegetation to be retained would mitigate landscape and visual effects.

Post – Operational Stage

13.101 The post operational stage mitigation comprises a restoration plan to be implemented at the end of the life of the quarry. The restoration plan includes a range of measures to restore the quarry site to an afteruse which would be more sympathetic with the surrounding landscape. Details of the restoration plan are presented in Figure 2.2.

RESIDUAL IMPACT ASSESSMENT

Operational Stage

13.102 The effects during operation take account of the mitigation measures, namely the proposed planting at the site boundaries. In this regard, the residual effects are anticipated to be similar to that documented under operational stage impacts.

Post – Operational Stage

Direct Impacts on Landscape

13.103 At this stage, extraction activities would have ceased and measures associated with the restoration of the site would be implemented as indicated in Figure 2.2. This would result in beneficial effects on landscape and visual amenity compared with the current baseline.

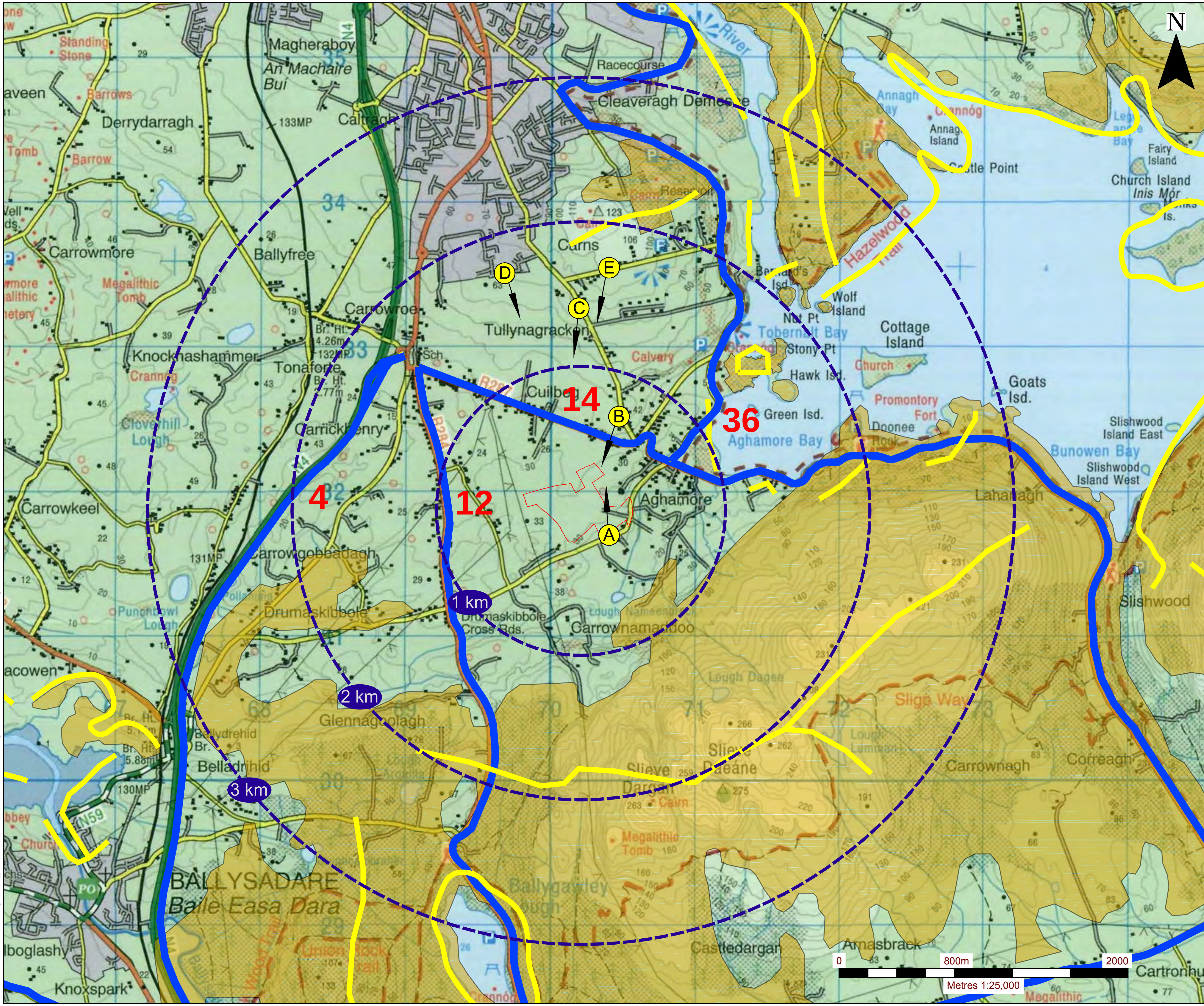
REFERENCES

The Landscape Institute with the Institute of Environmental Management and Assessment (2013) Guidelines for Landscape and Visual Impact Assessment, Third Edition, Routledge

The Landscape Institute (March 2011) Advice Note 01/11 – Photography and photomontage in landscape and visual assessment, The Landscape Institute.

Environmental Protection Agency (EPA) (May 2017) Guidelines on the Information to be contained in Environmental Impact Assessment Reports, EPA Ireland.

FIGURES



NOTES

1. EXTRACT FROM 1:50,000 O.S DISCOVERY MAP NO. 25
2. ORDNANCE SURVEY IRELAND LICENCE NO. SU 0000718 (C) ORDNANCE SURVEY & GOVERNMENT OF IRELAND

LEGEND

PLANNING APPLICATION AREA

2 km APPROXIMATE DISTANCE FROM CENTRE OF APPLICATION AREA

A VIEWPOINT LOCATIONS

LANDSCAPE CHARACTERISATION MAP - SLIGO COUNTY DEVELOPMENT PLAN

NORMAL RURAL LANDSCAPES

SENSITIVE RURAL LANDSCAPES

VISUALLY VULNERABLE AREAS

14 SCENIC ROUTES

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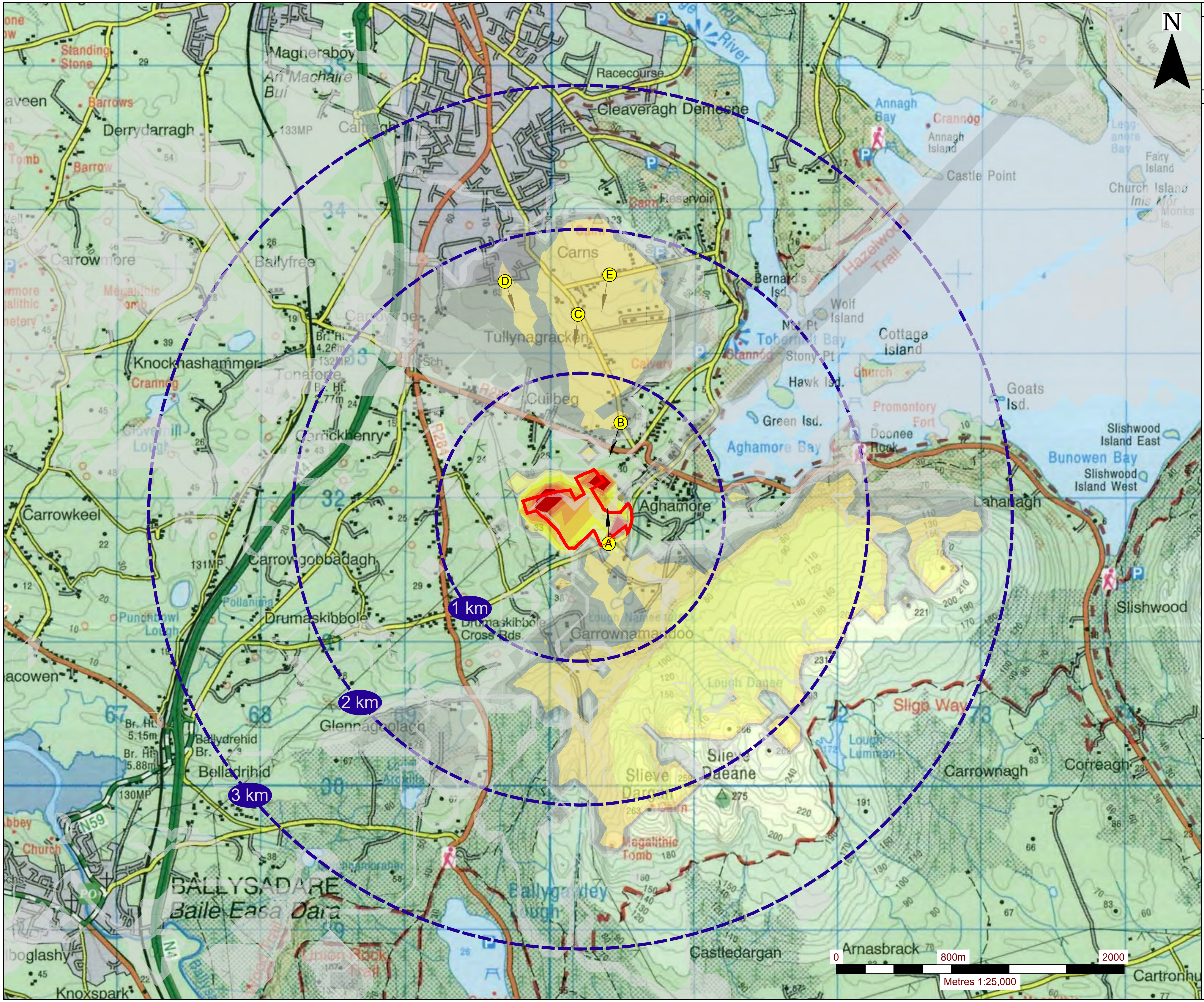
LANDSCAPE BASELINE AND DESIGNATED SCENIC ROUTES

(Landscape Characterisation Map Sligo CDP)

FIGURE 13-1

Scale	Date
1:25,000 @ A3	AUGUST 2018

00396.00007.0.16.Fig 13-1_Landscape Baseline and Designated Scenic Routes Rev 1.dwg



NOTES

1. EXTRACT FROM 1:50,000 O.S DISCOVERY MAP NO. 25
2. ORDNANCE SURVEY IRELAND LICENCE NO. SU 0000718 (C) ORDNANCE SURVEY & GOVERNMENT OF IRELAND

LEGEND

- PLANNING APPLICATION AREA
- VIEWPOINT LOCATIONS
- 2 km APPROXIMATE DISTANCE FROM CENTRE OF APPLICATION AREA

VERTICAL SUBTENDED ANGLES VISIBLE:

- SUBTENDED VERTICAL ANGLE GREATER THAN **25.6** DEGREES
- SUBTENDED VERTICAL ANGLE **12.8** TO **25.6** DEGREES
- SUBTENDED VERTICAL ANGLE **6.4** TO **12.8** DEGREES
- SUBTENDED VERTICAL ANGLE **3.2** TO **6.4** DEGREES
- SUBTENDED VERTICAL ANGLE **1.6** TO **3.2** DEGREES
- SUBTENDED VERTICAL ANGLE **0.8** TO **1.6** DEGREES
- SUBTENDED VERTICAL ANGLE **0.4** TO **0.8** DEGREES
- SUBTENDED VERTICAL ANGLE **0.2** TO **0.4** DEGREES
- SUBTENDED VERTICAL ANGLE **0.1** TO **0.2** DEGREES
- SUBTENDED VERTICAL ANGLE LESS THAN **0.1** DEGREES (= NO THEORETICAL VISIBILITY)

NOTE: Vegetation cover and built structures are not taken into account as part of the ZTV calculation process. Areas in grey (i.e. less than 0.4 degrees) tend to be screened by hedgerows and vegetation, if present. Please refer to Appendix 13-1 of the EIAR for the ZTV methodology.

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ZONE OF THEORETICAL VISIBILITY (ZTV) AND VIEWPOINT LOCATIONS

FIGURE 13-2

Scale	Date
1:25,000 @ A3	AUGUST 2018

00396.00007.0.16.Fig 13-2_ZTV_13.3,13.4 Photo Panoramas.Rev.0.dwg

VIEWPOINT A: Minor road south west of the settlement of Aghamore.

Grid Reference : 570417,831703 | Distance from site boundary: 0.1km | Approximate Elevation: 20m AOD | Direction of View: North

Description: Open views are available of undulating pasture with hedgerow vegetation and occasional mature trees. A low voltage overhead powerline crosses this landscape. The fence boundary of the application site is visible on the horizon.

VIEWPOINT B: Minor Road north of the settlement of Aghamore.

Grid Reference : 570445,832522 | Distance from site boundary: 0.4km | Approximate Elevation: 38m AOD | Direction of View: South / South West

Description: Views are available of rolling farmland with mature hedgerow vegetation and mature trees against a backdrop of the mountain skyline associated with Slieve Dargan and Slieve Daeane and Union Wood. The application site featuring the existing quarry is partially visible, specifically the upper portion of the southern quarry face.

NOTES

1. EXTRACT FROM 1:50,000 O.S DISCOVERY MAP NO. 25
2. ORDNANCE SURVEY IRELAND LICENCE NO. SU 0000718 (C) ORDNANCE SURVEY & GOVERNMENT OF IRELAND

LEGEND

- PLANNING APPLICATION AREA
- A — VIEWPOINT LOCATIONS
- 2 km — APPROXIMATE DISTANCE FROM CENTRE OF APPLICATION AREA

VIEWPOINT LOCATION MAP

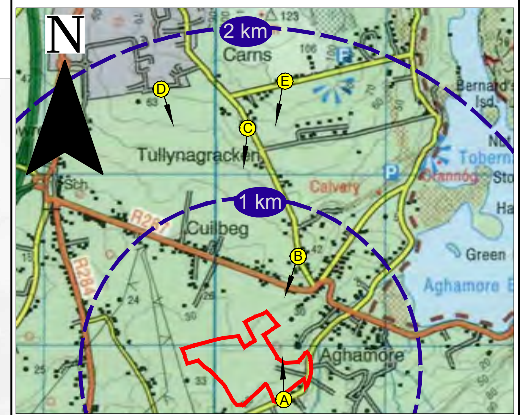

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PHOTO PANORAMAS OF EXISTING VIEWS AT VIEWPOINTS A and B

FIGURE 13-3

Scale: NTS | Date: AUGUST 2018

00396.00007.0.16.Fig 13-2_ZTV_13.3,13.4 Photo Panoramas.Rev.0.dwg

VIEWPOINT C: Minor Road near Tullynagracken.

Grid Reference : 570149, 833280 | Distance from site boundary: 1.1km | Approximate Elevation: 76m AOD | Direction of View: South

Description: Panoramic views are available of a wide expanse of farmland with scattered dwellings against the backdrop of the mountain skyline associated with Slieve Dargan and Slieve Daeane. Overhead powerlines are clearly visible including one large pylon in the foreground. The application site is clearly visible in the distance including part of the existing quarry face at the southern boundary of the site.

VIEWPOINT D:Southern Edge of residential area of Sligo Town.

Grid Reference : 569675,833519 | Distance from site boundary: 1.4km | Approximate Elevation: 71m AOD | Direction of View: South

Description: Panoramic views are available of a wide expanse of farmland with scattered dwellings against the backdrop of the mountain skyline associated with Slieve Dargan and Slieve Daeane. The application site is clearly visible in the distance including part of the existing quarry face at the southern boundary of the site.

VIEWPOINT E: Minor Road near Carns.

Grid Reference : 570379,833541 | Distance from site boundary:1.4km | Approximate Elevation: 96m AOD | Direction of View: South West

Description: A wide panoramic view is available of Lough Gill against the mountain skyline associated with Slieve Dargan and Slieve Daeane. The farmland at the foot of these mountains is also visible including the application site, of which the existing quarry faces are partially visible.

NOTES

1. EXTRACT FROM 1:50,000 O.S DISCOVERY MAP NO. 25
2. ORDNANCE SURVEY IRELAND LICENCE NO. SU 0000718 (C) ORDNANCE SURVEY & GOVERNMENT OF IRELAND

LEGEND

PLANNING APPLICATION AREA

VIEWPOINT LOCATIONS

APPROXIMATE DISTANCE FROM CENTRE OF APPLICATION AREA

VIEWPOINT LOCATION MAP

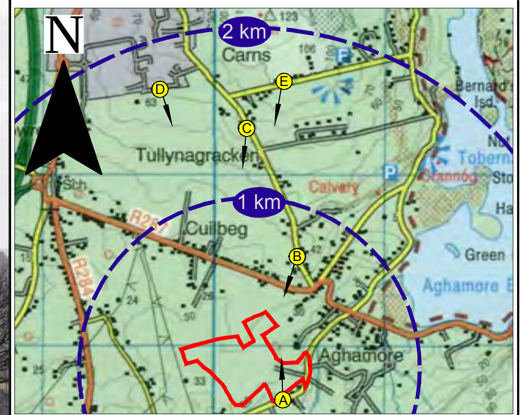

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PHOTO PANORAMAS OF EXISTING VIEWS AT VIEWPOINTS C, D and E

FIGURE 13-4

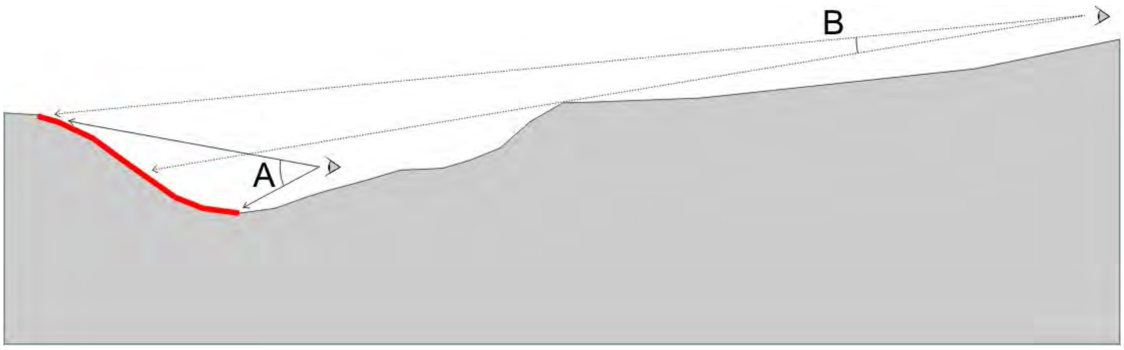
Scale: NTS | Date: AUGUST 2018

00396.00007.0.16.Fig 13-2_ZTV_13.3,13.4 Photo Panoramas.Rev.0.dwg

APPENDIX 1 – ZONE OF THEORETICAL VISIBILITY (ZTV) METHODOLOGY

13.104 A Zone of Theoretical Visibility (ZTV) Study was conducted for the existing and the proposed extent of the quarry void to help identify areas sensitive to visual impacts. This study used the measurement of the vertical subtended angle for its methodology. This method is explained below and illustrated by Figure A-1, below.

13.105 When a Target Area (red) is observed from a Viewpoint (A or B) its apparent height can be measured in the form of degrees, to give a Subtended Vertical Angle.



13.106 The use of the Subtended Vertical Angle in formulating a ZTV has the benefit of automatically reducing values to reflect the distance from the Target Area, and partial screening by intervening landforms. Generally the further the viewpoint is from the Target Area the smaller the Subtended Vertical Angle, reflecting the effect of distance on visual impacts.

13.107 Thus in the example section above Viewpoint A experiences a higher subtended angle due to proximity to the red target area. Viewpoint B has a lower subtended angle due to greater distance from the target area and partial screening by intervening landform.

13.108 If the Subtended Vertical Angle is measured from a series of grid points for a particular Target Area, the resultant data can then be used to generate contours. Each contour level representing a certain vertical angle, and thus potential level of visibility.

13.109 The subtended vertical angle method of calculating ZTVs using LSS digital terrain modelling software has been proven by field investigation on numerous sites to be an accurate method of predicting areas of potential visibility for on-site investigation.

13.110 However, the computer generated ZTV study is undertaken using a bare earth landform to give the worst case scenario. In reality any built structures (settlements, walls etc) or areas of vegetation (woodlands, scrub and hedgerows) will reduce the actual visibility of the target area. Therefore it is necessary to carry out fieldwork to validate the results of the ZTV.

CHAPTER 14

TRAFFIC

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Glossary of Terms

Road Network:	The existing and proposed public and private roads within the study area.
Traffic Growth:	The normal expected growth in traffic over time.
Trip:	One movement, in or out of the study area by foot, cycle or vehicle.
Thresholds:	Minimum intervention levels at which Transport and Traffic Assessments are to be conducted.
Generated Trips:	Additional trips made as a result of the presence of a development.
Peak Time:	Time of day at which the transport demands from a development are greatest.
Capacity Calculations:	Standardised methods of estimating traffic capacity on links and at junctions.
Trip Distribution:	The estimated directional distribution of the estimated traffic at each junction in the study area.
Trip Assignment:	The final estimated flows of traffic for each direction of travel at each junction and along each link within the study area.
TRICS:	A database containing empirically obtained trip generation data for a wide range of different types of developments.
AADT:	Annual Average Daily Traffic – The mean daily traffic volume over the course of a year on a particular route.
Level of Service:	Level of Service (LOS) is a measure of the capacity of a road related to the average vehicular speed and level of congestion on the road. It is ranges from LOS A to LOS F, with A representing free flow and F representing stop/start traffic. LOS C represents stable flow conditions

Introduction

General

14.1 PMCE Ltd. were commissioned by Lagan Bitumen Ltd. to undertake an assessment of the traffic impacts associated with the continued use and deepening of the existing permitted quarry at Aghamore Near and Carrownamadoo townlands, Co. Sligo, within an overall application area of 18ha.

14.2 This Traffic and Transport Assessment has been prepared as part of an Environmental Impact Assessment Report for the proposed development.

Information Reviewed

14.3 In preparing this report reference has been made to the following documents: -

- "Traffic and Transport Assessment Guidelines" (September 2014) published by Transport Infrastructure Ireland;
- Unit 5.3 (Travel Demand Projections) of the "Project Appraisal Guidelines" (2016) published by Transport Infrastructure Ireland;
- Traffic Count Survey Data, collected by NDC (Nationwide Data Collection); and
- Unit 16.1 (Expansion Factors for Short Period Traffic Counts) of the "Project Appraisal Guidelines" (2016) published by Transport Infrastructure Ireland;

Scope

14.4 The objective of this report is to examine the traffic implications associated with the proposed development in terms of its integration with existing traffic in the area. The report determines and quantifies the extent of additional trips generated by the development, and the impact on operational performance of such trips on the local road network.

Methodology

14.5 The methodology adopted for this appraisal and report involved, in brief: -

- A site visit, conducted on the 22nd February, 2018, during which the weather was dry and the ground surface was dry;
- Classified traffic counts undertaken on the 21st February 2018 at two locations: the R287/L3603/L36025 and the R284/L3603 junctions;
- Existing Traffic Assessment – The traffic count data was used to develop PICADY models for the quarry access, the R287/L3603/L36025 and the R284/L3603 junctions.
- Trip Generation and Trip Assignment – Development traffic volumes were derived and the likely distribution on the adjacent road network determined based on predicted routes vehicles will travel to/from the quarry;

- Future Year Assessments – The estimated future year volumes on the study area network, as a result of the increase in background traffic and any development related traffic, was used to assess the future operational performance of the junctions and surrounding road network for 2019 (assumed year of opening) and at two future assessment years, the opening year +5 (2024) and the opening year +15 (2034).

Location Plan

14.6 Figure 1 1 shows the existing Aughamore Quarry, Co. Sligo and surrounding area.

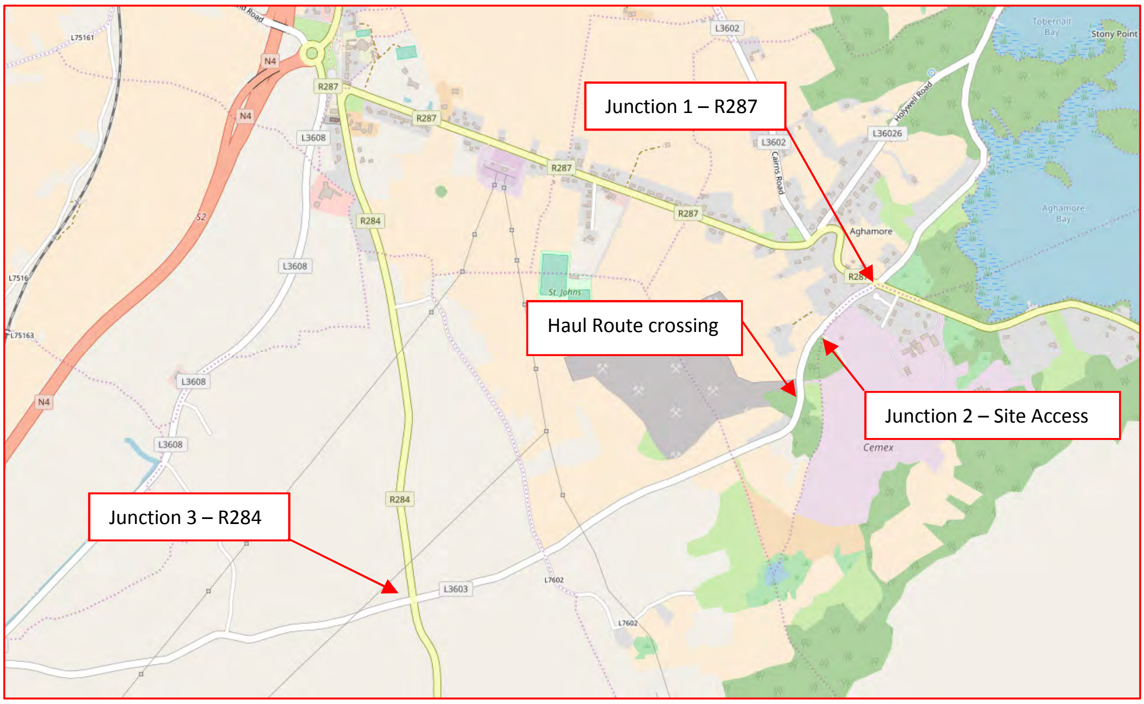


Figure 14.1: LOCATION PLAN (Source OpenStreetMap)

Existing Conditions

The Site

14.7 The existing quarry has historically been used for the extraction of limestone and the applicant intends to continue extracting limestone from the existing quarry area.

14.8 It is proposed that maximum extraction rates associated with the proposed development will remain in line with the current permitted output of 300,000 tonnes per annum, resulting in a maximum of 53 loads per day from the development. The development will directly employ approximately 6 full time staff and it is assumed that the arrivals and departures of staff will primarily occur during the peak hours.

14.9 Traffic to and from the development shall be accommodated using the main site access located to the north of the development.

14.10 The quarry and the processing plant are located on opposite sides of the L3603. Traffic to and from the quarry/processing plant will be achieved using an existing haul route crossing located south of the main site access. The haul route crossing will not be used as an access for vehicles travelling to and from the development and therefore does not form part of the traffic assessment.

Existing Road Network

L3603 Local Road

14.11 In the vicinity of the development site the L3603 Local Road extends in a predominantly northeast to southwest direction between its junctions with the R287 Regional Road to the northeast, and the R287 Regional Road to the southwest. It has an approximate carriageway width ranging between 4.8m and 6.0m with no hard shoulder or pedestrian facilities.

14.12 The L3603 has a posted speed limit of 80kph which reduces to 60kph on the approach to its junctions with the R284 and R287.

R287 Regional Road

14.13 In the vicinity of the development site the R287 Regional Road extends south-eastwards, from its junction with the N4 National Road, through Aughamore to its junction with the R280.

14.14 The R287 meets the L3603 at a crossroad junction formed by the L36025 to the east, the L3603 to the west and the R287 to the north & south of the junction. This junction is to the south of Aughamore on the R287, and approximately 250m east of the quarry access on the L3603. The R287 has a posted speed limit of 60kph at the junction and a paved width between 5.3m and 5.7m.

14.15 There are no hard shoulders or pedestrian facilities along the R287 in the vicinity of its junction with the L3603.

R284 Regional Road

14.16 The R284 Regional Road extends in a north to south direction from its junction with the R287 to the north, south to its junction with the R280 in Leitrim village.

14.17 The R284 meets the L3603 at a crossroad junction approximately 1.2km west of the quarry access along the L3603. The R284 has a posted speed limit of 60kph in the vicinity of the junction and a paved width between 6.0m and 6.2m.

14.18 The R287 has hard shoulders on both sides in the vicinity of its junction with the L3603, with flexible bollards within the hard shoulder on the northern arm of the junction.

Study Area

14.19 The study area for this assessment is shown on Figure 14.1, and includes: -

- Junction 1 – the R287/L3603/L36025 Junction;
- Junction 2 – the Quarry Access;
- Junction 3 – the R284/L3603 Junction; and
- The L3603.

Traffic Volumes

14.20 Classified traffic turning counts were carried out on Wednesday 21st February 2018 at the R287/L3603/L36025 junction and at the R284/L3603 junction. The counts were carried out between 7:00am and 7:00pm, this time period encompassing the proposed main operating hours of the quarry and also the peak hours on the adjacent road network.

Surveyed vehicles were split into two categories, LV (Light Vehicles) & HV (Heavy Vehicles).

14.21 The traffic count data has been converted to Annual Average Daily Traffic (AADT) values using the methods described in “Expansion Factors for Short Period Traffic Counts” (Unit 16.1 “Project Appraisal Guidelines” 2016). Annexes A to C of this document were used in the expansion of traffic counts to AADT.

14.22 A combined factor of 0.802 was arrived at by combining the individual hourly factors for the count duration. This factor was then used to determine the 24-hour traffic flow, which was then converted to a Weekly Average Daily Traffic (WADT) using a factor of 0.98 for a Wednesday traffic count. Finally, the WADT was converted to AADT using a factor of 1.08 for the month of February. These factors were used to calculate the AADT on the roads at each of the three junctions.

14.23 The results of the traffic survey at the R287/L3603/L36025 junction are summarised in Table 14.1. From the survey data the peak hours at this junction have been established as: -

- 07:45hrs to 08:45hrs – Weekday AM Peak Hour; and

- 17:00hrs to 18:00hrs – Weekday PM Peak Hour.

Table 14-1: JUNCTION 1 (R287/L3603/L36025 CROSSROADS)

Hour Ending	R287 (SE)	L3603	R287 (NW)	L36025
08:00	103	14	95	4
09:00	206	31	189	40
10:00	182	24	161	33
11:00	128	20	119	27
12:00	113	22	107	22
13:00	138	18	115	25
14:00	138	25	133	38
15:00	128	21	128	27
16:00	171	22	153	32
17:00	185	23	155	37
18:00	223	23	191	55
19:00	178	12	155	41
Period Total	**1893**	**255**	**1701**	**381**
Period Total HGVs	***45***	***31***	***60***	***2***
% HGVs	***2%***	***12%***	***4%***	***1%***
AADT	**2498**	**337**	**2245**	**503**

14.24 The results of the traffic survey at the R284/L3603 junction are summarised in Table 14.2. From the survey data, the peak hours at the junction have been established as: -

- 08:15hrs to 09:15hrs – Weekday AM Peak Hour; and
- 17:00hrs to 18:00hrs – Weekday PM Peak Hour.

Table 14-2: JUNCTION 3 (R284/L3603 CROSSROADS)

Hour Ending	R284	L3603 (E)	R284 (S)	L3603 (W)
08:00	128	17	122	21
09:00	273	37	311	71
10:00	194	35	191	42
11:00	161	26	155	28
12:00	175	26	174	33
13:00	155	33	145	31
14:00	160	27	158	43
15:00	181	31	169	37
16:00	202	36	201	31
17:00	251	42	242	55
18:00	298	48	295	55
19:00	224	22	217	37
Period Total	2402	380	2380	484
Period Total HGVs	*83*	*32*	*88*	*35*
% HGVs	*3%*	*8%*	*4%*	*7%*
AADT	3170	501	3141	639

Proposed Development

General - Quarry

14.25 The proposed development consists of the continued use and deepening of the existing permitted quarry within an overall application area of c.18ha.

14.26 The proposed development will have a maximum extraction rate of 300,000 tonnes per annum, which is in line with the output permitted under the current planning permission for the quarry.

Trip Generation and Assignment

Exported Quarried Material

14.27 Over the course of the life of the development it is proposed to extract a maximum of 300,000 tonnes of material per annum. This equates to approximately 53 loads per day (see Table 14.3) based on the following assumptions: -

- The facility will operate for 50 weeks per year;
- Material will be transported from the site in 20 tonne and 28 tonne loads (24 tonnes average assumed);
- The facility will operate for six days per week (Monday to Saturday) inclusive; and
- The facility opening times will be 08:00 to 18:00 Monday to Friday and 09:00 to 17:00 on Saturday.

Table 14-3: EXPORTED MATERIAL

Exported Quantities of Material	
Quantity per annum	300,000
Quantity per week (50 operational weeks / year)	6,000
Loads per week (24 tonnes / load)	250
Loads per Hour (48 working hours / week)	6 (5.2)
Loads per Day (10 working hours / weekday)	53 (52.1)

Staff Trips

14.28 It is anticipated that the development will employ approximately 6 full time staff. Staff movements will generate 12 peak hour trips, 6 trips inbound during the morning peak hour and 6 trips outbound during the evening peak hour

Miscellaneous Trips

14.29 10 trips have been assumed to occur daily to cater for possible miscellaneous trips associated with the site. These miscellaneous trips allow for operations meetings, site inspections, maintenance operations for plant and machinery, etc. It is not considered that these trips would coincide with the peak hours, however for a robust traffic assessment they have been included in the development's peak hour traffic.

Derived Trip Rate

14.30 Table 14.4 contains a summary of trips associated with the proposed development. The figure of 53 loads per day was used to calculate the total predicted daily trips for exported material. Using these figures (with staff and miscellaneous trips), the total number of trips is expected to be 132, based on the figures outlined in Table 14.3.

Table 14-4: SUMMARY OF PREDICTED DAILY TRIPS

	Daily Trips 2018		
	Arrivals	Departures	Total
Exported Material	53	53	**106**
Staff	6	6	**12**
Miscellaneous	10	10	**20**
Total	**69**	**69**	**138**

Trip Distribution and Assignment

Trip Distribution

14.31 Appendix A contains extracts from the TRICS database giving the forecast arrivals/departures distribution for quarry sites. Movements to and from quarries tend to have a short turn around within the sites, e.g. that vehicles generally arrive and depart within a short time period, likely to be less than an hour.

14.32 The TRICS database indicates that the AM peak accounts for 10.2% of total daily arrivals and 9.3% of the total departures at the site, and that the PM peak accounts for 3.53% of total daily arrivals and 8.05% of the total departures at the site.

Table 14-5: SUMMARY OF PREDICTED DAILY TRIPS DURING PEAK HOURS AT THE QUARRY ACCESS

	AM Peak		PM Peak	
	Arrivals	Departures	Arrivals	Departures
Exported Material	6 (53 x 10.2%)	5 (53x 9.3%)	2 (53 x 3.53%)	4.5 (53 x 8.05%)
Staff	6	0	0	6
Miscellaneous	10	10	10	10
Total	**22**	**15**	**12**	**20.5**

Trip Assignment

14.33 The assignment of the development traffic on the adjacent road network is based on an assessment of the existing traffic flows at the nearby junctions derived from the traffic count data. Traffic assignment at the Site access junction is based on the historical traffic distribution pattern, as advised by the applicant, with most traffic departing to, and arriving from, the direction of the R287 (Aghamore).

14.34 Figure 14.2 to Figure 14.4 illustrates the trip assignment that has been applied to the development traffic as part of the junction capacity analysis during the AM peak hour. The trip distribution has been examined for: -

- Cars and Light Goods Vehicles; and
- Heavy Goods Vehicles.

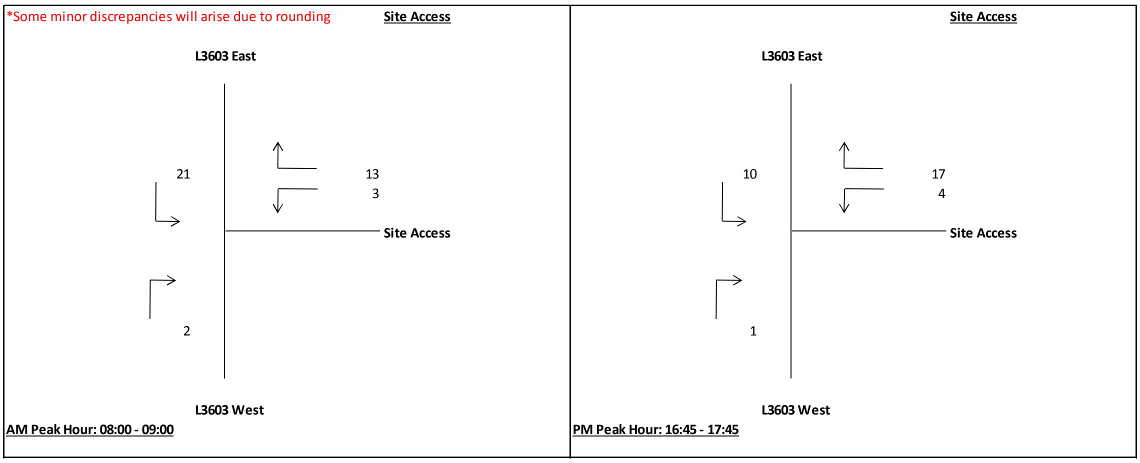


Figure 14.2: Site Access Peak Hour Site Development Movements

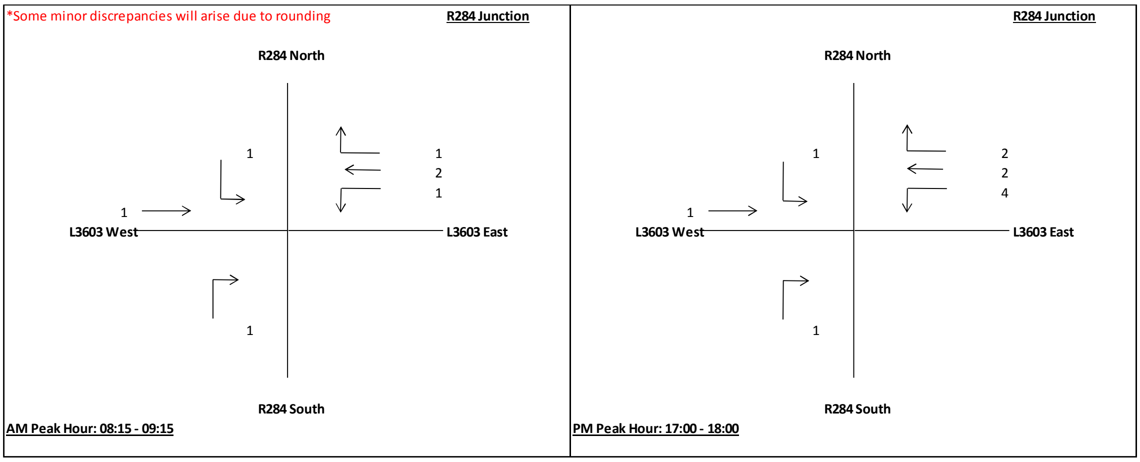


Figure 14.3: R284 Junction Peak Hour Site Development Movements

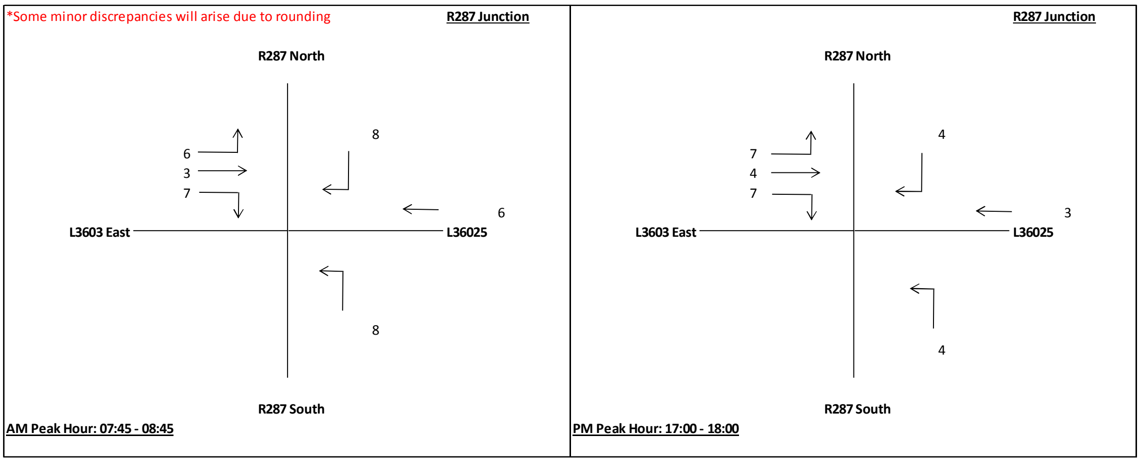


Figure 14.4: R287 Junction Peak Hour Site Development Movements

Road Impacts

Assessment Years

14.35 The “Traffic and Transport Assessment Guidelines” published by Transport Infrastructure Ireland recommend the assessment of traffic in the Opening Year, for the Opening Year +5 years and the Opening Year +15 years. The assessment years for the impact assessment are therefore 2019 for the Opening Year, 2024 and 2034 for the Future Assessment Years.

Traffic Growth

14.36 Unit 5.3 (Travel Demand Projections) of the “Project Appraisal Guidelines” (2016) published by Transport Infrastructure Ireland has been used to determine future year traffic flows on the network from the 2018 traffic count data. **Error! Reference source not found.** contains a summary of the traffic growth factors in the "Project Appraisal Guidelines". For this assessment, a central growth scenario has been adopted (a ‘central’ growth scenario was assumed given the site location and scale).

Table 14-6: FUTURE YEAR TRAFFIC GROWTH FIGURES (BORDER)

Year	Low Growth		Central Growth		High Growth	
	LV	HV	LV	HV	LV	HV
2013-2030	1.0082	1.0221	**1.0114**	**1.0237**	1.0124	1.0242
2030-2050	0.9998	1.0135	**1.0030**	**1.0176**	1.0044	1.0195

Link Capacity Assessment

General

14.37 Table 6.1 of the TII Publications document DN-GEO-03031 provides guidance on the capacity, for a Level of Service D (LoSD), of different road types by cross-section. It advises that the capacity of a Type 3 Single Carriageway road with 6.0m cross-section is 5,000 AADT for a Level of Service D. The following are the approximate carriageway widths of the roads which are part of this this study;

- L3603 - Average cross-section width of between 4.8 to 6.0m with no hard shoulders present.
- R287 - Average cross-section width between 5.3 and 5.7m with no hard shoulders present.
- R284 - Average cross-section width of between 6.0m and 6.2m with no hard shoulders present.

14.38 It is considered that the roads which are part of this study are most similar to the Type 3 Single Carriageway cross-section in this document with a capacity of 5,000 AADT for Level of Service D.

L3603 Local Road

14.39 The combined background and Site Traffic volumes on the L3603, outlined in Table 14.7 for each of the assessment years, is less than the LOS D capacity of 5,000 AADT for a Type 3 Single Carriageway. It is considered that the L3603 will operate within capacity for each of the assessment years. The traffic associated with the proposed development represents between 26.4% and 23.5% of the total traffic on the L3603 during the assessment years 2019 to 2034.

Table 14-7: COMBINED AADT FOR EACH ASSESSMENT YEAR (L3603)

	Assessment Year			
	2018	2019	2024	2034
Background Traffic	380	385	409	449
Additional Development Traffic	-	138	138	138
Combined Traffic (Background + Additional Dev. Traffic)	-	523	547	587

Additional Traffic as % of Combined Traffic	-	26.4%	25.2%	23.5%

R287 Regional Road

14.40 The combined background and Site Traffic volumes on the R287, outlined in **Error! Reference source not found.** for each of the assessment years, is less than the LOS D capacity of 5,000 AADT for a Type 3 Single Carriageway. It is considered that the R287 will operate within capacity for each of the assessment years. **Error! Reference source not found.** indicates that the traffic associated with the proposed development represents between 5.2% and 5.9% of the total traffic on the R287 during the assessment years 2019 to 2034.

Table 14-8: COMBINED AADT FOR EACH ASSESSMENT YEAR (R287)

	Assessment Year			
	2018	**2019**	**2024**	**2034**
Background Traffic	1893	1914	2029	2207
Additional Development Traffic	-	121	121	121
Combined Traffic (Background + Additional Dev. Traffic)	-	2035	2150	2328
Additional Traffic as % of Combined Traffic	-	5.9%	5.6%	5.2%

R284 Regional Road

14.41 The combined background and Site Traffic volumes on the R284, outlined in Table 14.9 for each of the assessment years, is less than the LOS D capacity of 5,000 AADT for a Type 3 Single Carriageway. It is considered that the R284 will operate within capacity for each of the assessment years. **Error! Reference source not found.** indicates that the traffic associated with the proposed development represents between 0.2% and 0.3% of the total traffic on the R284 during the assessment years 2019 to 2034.

Table 14-9: COMBINED AADT FOR EACH ASSESSMENT YEAR (R284)

	Assessment Year			
	2018	**2019**	**2024**	**2034**
Background Traffic	2402	2430	2577	2807

Additional Development Traffic	-	7	7	7
Combined Traffic (Background + Additional Dev. Traffic)	-	2436	2583	2813
Additional Traffic as % of Combined Traffic	-	0.3%	0.3%	0.2%

Junction Capacity Analysis

14.42 The capacity of the surveyed junctions was assessed using the Transport Research Laboratory's (TRL) computer programme PICADY (Priority Intersection CApacity and DelaY).

14.43 Junction performance is measured as a ratio between the flow and capacity (RFC). The capacity analysis has been carried out for both the AM and PM Peaks for each of the assessment years (2019, 2024 and 2034). A rural junction with an RFC below 0.85 is considered to be operating within capacity, and an RFC of 0.85 indicates a junction operating at capacity.

14.44 The detailed junction capacity analysis outputs for all of the junctions for the final future forecast assessment year (2034) are contained within Appendix C to this report. Outputs for all other future forecast assessment years are available if required.

Junction 1 - R287/L3603/L36025 Crossroads

14.45 A summary of the junction capacity analysis results for the junction of the R287/L3603/L36025 Crossroads are shown in Table 14.10. The results indicate that the junction will operate within capacity for each of the assessment years 2019, 2024 and 2034 for both AM and PM peak periods.

Junction 2 - Quarry Access

14.46 A summary of the junction capacity analysis results for the Junction of the Quarry access are shown in Table 14.10. As the quarry is currently closed, 2018 was excluded from the analysis as no queues or delays would occur at the junction. The results indicate that the junction will operate within capacity for each of the assessment years 2019, 2024 and 2034 for both AM and PM peak periods.

Junction 3 - R284/L3603 Crossroads

14.47 A summary of the junction capacity analysis results for the Junction of the R284/L3603 Crossroads are shown in **Error! Reference source not found.**. The results indicate that the junction will continue to operate within capacity for each of the assessment years 2019, 2024 and 2034 for both AM and PM peak periods.

Table 14-10: JUNCTION 1 -R287/L3603/L36025 CROSSROADS

Year	Peak	R287 (SE)			L3603			R287 (NW)			L36025		
		Max RFC	Max Queue (Veh)	Queuing Delay (Min/Veh)	Max RFC	Max Queue (Veh)	Queuing Delay (Min/Veh)	Max RFC	Max Queue (Veh)	Queuing Delay (Min/Veh)	Max RFC	Max Queue (Veh)	Queuing Delay (Min/Veh)
2018	AM Peak	0.031	0.03	0.1	0.04	0.04	0.1	0.04	0.04	0.1	0.04	0.04	0.1
	PM Peak	0.076	0.08	0.1	0.076	0.08	0.1	0.021	0.02	0.1	0.076	0.08	0.1
2019	AM Peak	0.041	0.04	0.1	0.057	0.06	0.2	0.057	0.06	0.2	0.057	0.06	0.2
	PM Peak	0.082	0.09	0.1	0.082	0.09	0.1	0.038	0.04	0.1	0.082	0.09	0.1
2024	AM Peak	0.043	0.05	0.1	0.058	0.06	0.2	0.058	0.06	0.2	0.058	0.06	0.2
	PM Peak	0.088	0.1	0.1	0.088	0.1	0.1	0.039	0.04	0.1	0.088	0.1	0.1
2034	AM Peak	0.049	0.05	0.1	0.065	0.07	0.2	0.065	0.07	0.2	0.065	0.07	0.2
	PM Peak	0.094	0.1	0.1	0.094	0.1	0.1	0.043	0.05	0.1	0.094	0.1	0.1

Table 14-11: JUNCTION 2 -QUARRY ACCESS

Year	Peak	L3603 (E)			Quarry Access			L3603 (W)		
		Max RFC	Max Queue (Veh)	Queuing Delay (Min/Veh)	Max RFC	Max Queue (Veh)	Queuing Delay (Min/Veh)	Max RFC	Max Queue (Veh)	Queuing Delay (Min/Veh)
2019	AM Peak	0.031	0.03	0.2	0.031	0.03	0.2	0.006	0.01	0.1
	PM Peak	0.038	0.038	0.1	0.038	0.04	0.1	0.008	0.01	0.1
2024	AM Peak	0.031	0.03	0.2	0.031	0.03	0.2	0.006	0.01	0.1
	PM Peak	0.038	0.04	0.1	0.038	0.04	0.1	0.008	0.01	0.1
2034	AM Peak	0.031	0.03	0.2	0.031	0.03	0.2	0.006	0.01	0.1
	PM Peak	0.038	0.04	0.1	0.038	0.04	0.1	0.008	0.01	0.1

Table 14-12: JUNCTION 3 - R284/L3603 CROSSROADS

Year	Peak	R284 (N)			L3603 (E)			R284 (S)			L3603 (W)		
		Max RFC	Max Queue (Veh)	Queuing Delay (Min/Veh)	Max RFC	Max Queue (Veh)	Queuing Delay (Min/Veh)	Max RFC	Max Queue (Veh)	Queuing Delay (Min/Veh)	Max RFC	Max Queue (Veh)	Queuing Delay (Min/Veh)
2018	**AM Peak**	0.045	0.03	0.2	0.045	0.05	0.2	0.045	0.05	0.2	0.045	0.05	0.2
	PM Peak	0.033	0.03	0.1	0.046	0.05	0.2	0.046	0.05	0.2	0.046	0.05	0.2
2019	**AM Peak**	0.047	0.04	0.2	0.047	0.05	0.2	0.047	0.05	0.2	0.047	0.05	0.2
	PM Peak	0.038	0.04	0.1	0.048	0.05	0.2	0.048	0.05	0.2	0.048	0.05	0.2
2024	**AM Peak**	0.044	0.05	0.2	0.055	0.06	0.2	0.055	0.06	0.2	0.055	0.06	0.2
	PM Peak	0.041	0.04	0.1	0.053	0.06	0.2	0.053	0.06	0.2	0.053	0.06	0.2
2034	**AM Peak**	0.046	0.05	0.2	0.057	0.06	0.2	0.057	0.06	0.2	0.057	0.06	0.2
	PM Peak	0.043	0.04	0.1	0.053	0.06	0.2	0.053	0.06	0.2	0.053	0.06	0.2

Road Safety

Site Access

14.48 There is a separate access to the processing area (on the Eastern side of the local road) used mainly by customers and staff, and HGV traffic delivering processed material to market. This access has a paved width of 25m at the mouth of the junction with the L3603. The existing pavement will require renewal, with a number of potholes and signs of structural damage evident.

14.49 There are no warning signs on the L3063 approaches to the quarry access. Warning signs on both approaches to the main quarry access and haul route access will be provided to advise approaching drivers of the upcoming quarry access.

Sightlines

Access to Processing Area

14.50 At present the sightlines at the access to the processing area are insufficient for a posted speed limit of 80kph as a result of vegetation within the southern verge of the L3603 either side of the access.


14.51 Drawing P18-014-DG-001 confirms that a sufficient sightline of 160m can be achieved to the south, set back 3.0m from the carriageway edge as per TII DN-GEO-03060 for a posted speed limit of 80kph. This is achieved by the cutting back of vegetation within the client's land ownership.

14.52 A sightline of 100m can be achieved to the north, set back 3.0m from the carriageway edge by the cutting back of vegetation. However, the sightline to the north is deemed acceptable, as approach speeds are passively limited by the location of the R287/L3603/L36025 crossroad junction located within 220m of the site access, which can be expected to constrain prevailing vehicle speeds as they approach the access.

Haul Route Crossing

14.53 This development will not generate traffic travelling to and from the haul route crossing access. However, vehicles will have to cross the L3603 to gain access to and from the quarry/processing plant.

14.54 Drawing P18-014-DG-001 confirms that a sufficient sightline of 160m can be achieved to the north, set back 3.0m from the carriageway edge as per TII DN-GEO-03060 for a posted speed limit of 80kph. This is achieved on both sides of the L3603 by the cutting back of vegetation within the client's land ownership.

14.55 A sightline of 160m can be achieved to the south for the haul route access located on the eastern side of the L3603, set back 3.0m from the carriageway edge as per TII DN-GEO-03060 for a posted speed limit of 80kph. This is achieved by the cutting back of vegetation within the client's land ownership.

14.56 A sightline of 140m can be achieved to the south for the haul route access located on the western side of the L3603, set back 3.0m from the carriageway edge as per TII DN-GEO-03060. This is achieved by the cutting back of vegetation within the client's land ownership and is considered acceptable as approach speeds are passively limited due to the close proximity of a high demand horizontal alignment along the L3603.

Parking

14.57 Adequate car parking provision for employees and visitors is provided at the existing weighbridge office.

Pedestrians & Cyclists

14.58 There are no pedestrian or cyclist provisions along the L3603. No pedestrians or cyclists were observed along the L3606 during the site visit.

Conclusions

14.59 An assessment has been undertaken of the link capacity for the L3603, R287 and the R284 and the junction capacity of the quarry access, the R287/L3603 junction and the R284/L3603/L36025 junction. These assessments have concluded that the links and junctions will operate within capacity for each of the assessment years.

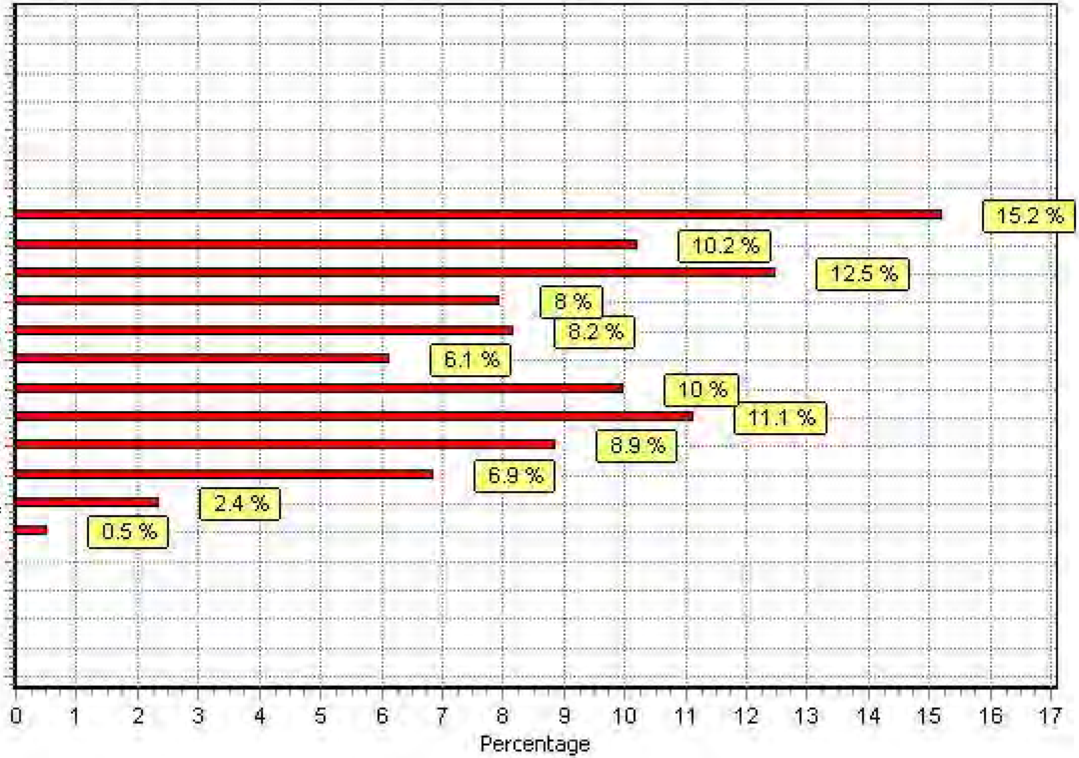
14.60 Warning signs on both approaches to the main quarry access will be provided to advise approaching drivers of the upcoming quarry access.

14.61 Sightlines at the quarry access can be achieved by the cutting back of vegetation.

Appendix A – TRICS Output

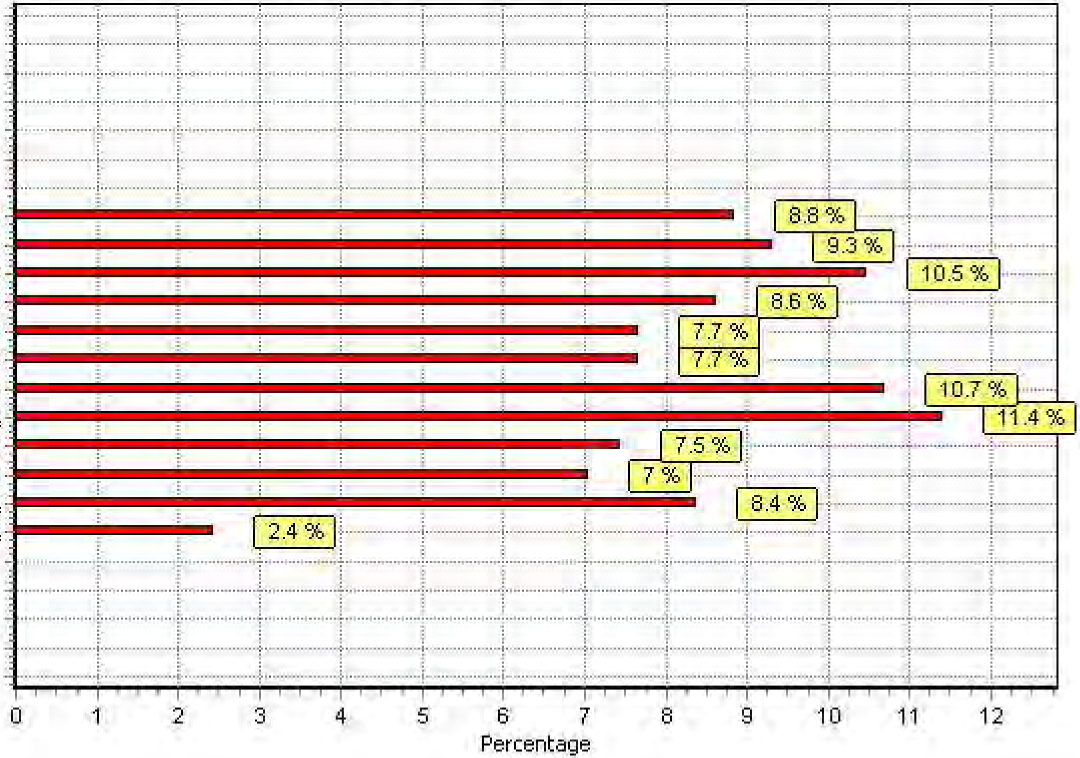
TRIP RATE GRAPH - ARRIVALS 02 - EMPLOYMENT H - QUARRY VEHICLES

TIME	DAYS	RATE	%
00:00-01:00			
01:00-02:00			
02:00-03:00			
03:00-04:00			
04:00-05:00			
05:00-06:00			
06:00-07:00			
07:00-08:00	5	0.642	15.2
08:00-09:00	5	0.431	10.2
09:00-10:00	5	0.527	12.5
10:00-11:00	5	0.336	8.0
11:00-12:00	5	0.345	8.2
12:00-13:00	5	0.259	6.1
13:00-14:00	5	0.422	10.0
14:00-15:00	5	0.470	11.1
15:00-16:00	5	0.374	8.9
16:00-17:00	4	0.290	6.9
17:00-18:00	4	0.100	2.4
18:00-19:00	4	0.022	0.5
19:00-20:00			
20:00-21:00			
21:00-22:00			
22:00-23:00			
23:00-24:00			

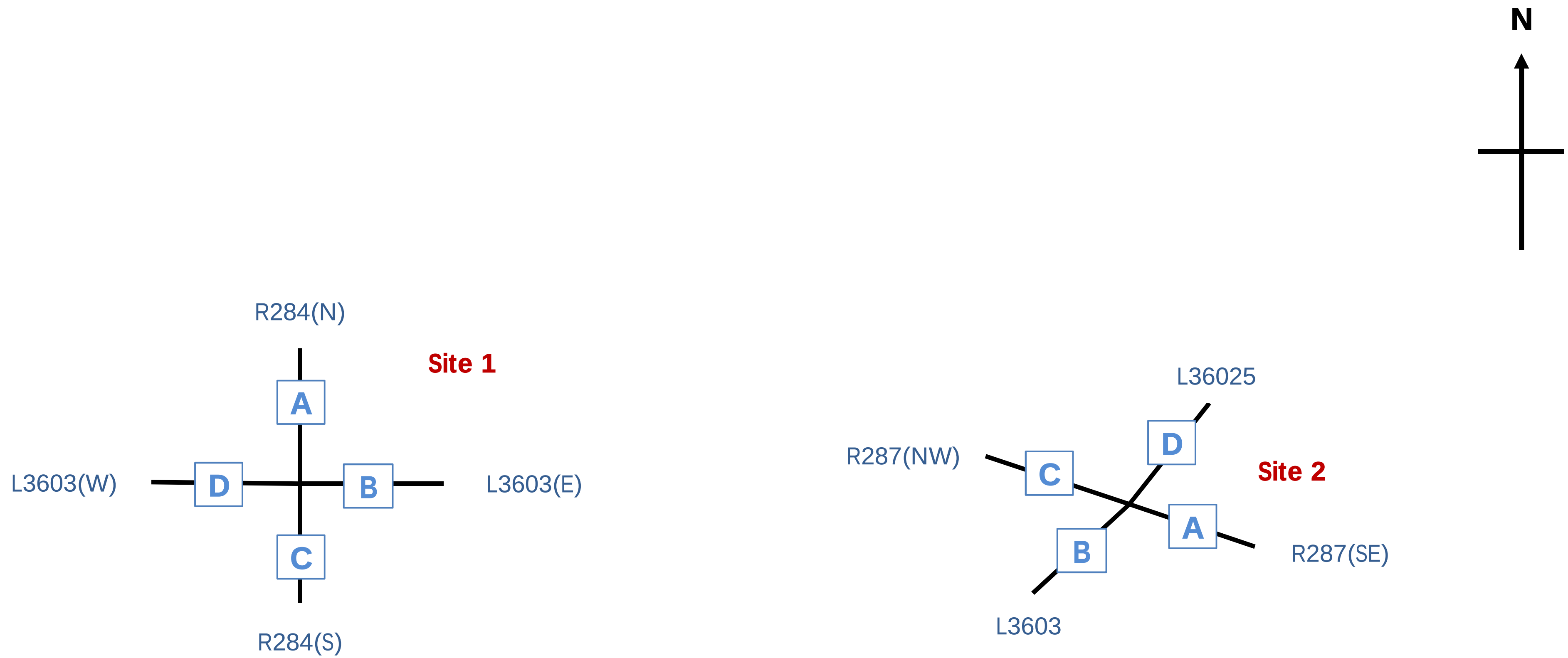


TRIP RATE GRAPH - DEPARTURES 02 - EMPLOYMENT H - QUARRY VEHICLES

TIME	DAYS	RATE	%
00:00-01:00			
01:00-02:00			
02:00-03:00			
03:00-04:00			
04:00-05:00			
05:00-06:00			
06:00-07:00			
07:00-08:00	5	0.364	8.8
08:00-09:00	5	0.384	9.3
09:00-10:00	5	0.431	10.5
10:00-11:00	5	0.355	8.6
11:00-12:00	5	0.316	7.7
12:00-13:00	5	0.316	7.7
13:00-14:00	5	0.441	10.7
14:00-15:00	5	0.470	11.4
15:00-16:00	5	0.307	7.5
16:00-17:00	4	0.290	7.0
17:00-18:00	4	0.345	8.4
18:00-19:00	4	0.100	2.4
19:00-20:00			
20:00-21:00			
21:00-22:00			
22:00-23:00			
23:00-24:00			



Appendix B – Traffic Survey Data



NDC NATIONWIDE DATA COLLECTION	**Sites / Location:**	1 & 2 / Sligo	**Project No:**	8459	**Drawing No:**	8459-02	**Drawn By:** AC
	Survey Date:	Wednesday 21st February 2018	**Project Name:**	AUGHNACLIFFE AND AUGHNAMORE			
	Survey Times:	07:00 to 19:00	**Drawing Title:**	Site Layout and Observed Movements			

Site No. 1
Location R284(N) / L3603(E) / R284(S) / L3603(W)
Date 21 February 2018

Time	A to D - R284(N) to L3603(W)		Veh. Total	A to C - R284(N) to R284(S)		Veh. Total
	LV	HV		LV	HV	
07:00	0	0	0	1	1	2
07:15	0	0	0	3	1	4
07:30	0	0	0	5	0	5
07:45	2	0	2	6	0	6
Hour	2	0	2	15	2	17
08:00	2	0	2	6	0	6
08:15	1	0	1	12	0	12
08:30	1	0	1	21	0	21
08:45	6	0	6	17	3	20
Hour	10	0	10	56	3	59
09:00	3	0	3	16	2	18
09:15	0	0	0	8	1	9
09:30	2	0	2	12	0	12
09:45	2	0	2	7	1	8
Hour	7	0	7	43	4	47
10:00	2	0	2	13	2	15
10:15	0	0	0	7	1	8
10:30	0	0	0	15	1	16
10:45	1	1	2	9	1	10
Hour	3	1	4	44	5	49
11:00	0	0	0	18	0	18
11:15	0	0	0	17	1	18
11:30	2	0	2	15	1	16
11:45	1	0	1	14	1	15
Hour	3	0	3	64	3	67
12:00	1	0	1	13	2	15
12:15	2	0	2	14	1	15
12:30	2	0	2	19	2	21
12:45	0	0	0	15	0	15
Hour	5	0	5	61	5	66
13:00	3	0	3	17	0	17
13:15	2	0	2	22	0	22
13:30	1	0	1	15	0	15
13:45	3	0	3	15	1	16
Hour	9	0	9	69	1	70
14:00	2	0	2	16	1	17
14:15	1	0	1	21	0	21
14:30	5	0	5	26	1	27
14:45	3	0	3	11	1	12
Hour	11	0	11	74	3	77
15:00	0	0	0	26	2	28
15:15	1	0	1	23	1	24
15:30	3	0	3	24	1	25
15:45	0	0	0	22	0	22
Hour	4	0	4	95	4	99
16:00	3	0	3	24	0	24
16:15	2	0	2	34	1	35
16:30	3	0	3	39	0	39
16:45	1	0	1	33	1	34
Hour	9	0	9	130	2	132
17:00	4	0	4	42	2	44
17:15	2	0	2	39	1	40
17:30	0	0	0	49	0	49
17:45	3	0	3	45	0	45
Hour	9	0	9	175	3	178
18:00	2	0	2	44	0	44
18:15	3	0	3	46	1	47
18:30	2	0	2	21	0	21
18:45	1	0	1	23	1	24
Hour	8	0	8	134	2	136
Total	80	1	81	960	37	997

Site No. 1
Location R284(N) / L3603(E) / R284(S) / L3603(W)
Date 21 February 2018

Time	A to B - R284(N) to L3603(E)		Veh. Total	B to A - L3603(E) to R284(N)		Veh. Total
	LV	HV		LV	HV	
07:00	0	0	0	0	0	0
07:15	0	0	0	0	0	0
07:30	1	0	1	1	0	1
07:45	1	0	1	1	0	1
Hour	2	0	2	2	0	2
08:00	0	0	0	0	0	0
08:15	0	0	0	1	0	1
08:30	1	0	1	0	0	0
08:45	0	0	0	1	0	1
Hour	1	0	1	2	0	2
09:00	1	0	1	2	0	2
09:15	0	0	0	1	1	2
09:30	0	0	0	4	1	5
09:45	2	0	2	2	0	2
Hour	3	0	3	9	2	11
10:00	2	0	2	1	0	1
10:15	1	0	1	1	0	1
10:30	3	0	3	0	0	0
10:45	1	0	1	2	0	2
Hour	7	0	7	4	0	4
11:00	5	0	5	0	0	0
11:15	0	1	1	1	0	1
11:30	1	0	1	0	1	1
11:45	1	0	1	0	0	0
Hour	7	1	8	1	1	2
12:00	1	0	1	1	0	1
12:15	2	0	2	3	0	3
12:30	3	0	3	2	0	2
12:45	2	0	2	0	0	0
Hour	8	0	8	6	0	6
13:00	1	0	1	2	0	2
13:15	1	0	1	2	0	2
13:30	0	0	0	0	0	0
13:45	1	0	1	1	0	1
Hour	3	0	3	5	0	5
14:00	3	0	3	2	1	3
14:15	1	0	1	2	0	2
14:30	2	0	2	2	0	2
14:45	2	1	3	0	0	0
Hour	8	1	9	6	1	7
15:00	6	0	6	3	0	3
15:15	1	0	1	1	0	1
15:30	1	0	1	2	0	2
15:45	0	0	0	1	0	1
Hour	8	0	8	7	0	7
16:00	4	0	4	1	0	1
16:15	1	2	3	2	0	2
16:30	1	0	1	0	1	1
16:45	4	0	4	1	0	1
Hour	10	2	12	4	1	5
17:00	1	0	1	3	0	3
17:15	3	1	4	3	0	3
17:30	0	0	0	1	0	1
17:45	1	0	1	0	0	0
Hour	5	1	6	7	0	7
18:00	2	0	2	0	0	0
18:15	2	0	2	0	0	0
18:30	2	0	2	0	0	0
18:45	0	0	0	2	0	2
Hour	6	0	6	2	0	2
Total	68	5	73	55	5	60

Site No. 1
Location R284(N) / L3603(E) / R284(S) / L3603(W)
Date 21 February 2018

Time	B to D - L3603(E) to L3603(W)		Veh. Total	B to C - L3603(E) to R284(S)		Veh. Total
	LV	HV		LV	HV	
07:00	0	0	0	0	0	0
07:15	0	0	0	0	0	0
07:30	2	0	2	0	0	0
07:45	3	0	3	0	0	0
Hour	5	0	5	0	0	0
08:00	2	2	4	1	0	1
08:15	3	0	3	0	0	0
08:30	3	2	5	0	0	0
08:45	4	0	4	0	0	0
Hour	12	4	16	1	0	1
09:00	1	0	1	0	0	0
09:15	0	1	1	0	0	0
09:30	2	0	2	0	0	0
09:45	1	0	1	2	0	2
Hour	4	1	5	2	0	2
10:00	2	1	3	3	0	3
10:15	1	0	1	0	0	0
10:30	0	0	0	0	0	0
10:45	3	0	3	1	0	1
Hour	6	1	7	4	0	4
11:00	1	0	1	0	0	0
11:15	0	0	0	1	0	1
11:30	3	0	3	2	0	2
11:45	1	0	1	0	0	0
Hour	5	0	5	3	0	3
12:00	4	2	6	0	0	0
12:15	1	0	1	1	0	1
12:30	3	0	3	1	0	1
12:45	0	0	0	0	0	0
Hour	8	2	10	2	0	2
13:00	2	0	2	0	0	0
13:15	1	0	1	2	0	2
13:30	6	0	6	1	0	1
13:45	1	0	1	0	0	0
Hour	10	0	10	3	0	3
14:00	1	1	2	1	0	1
14:15	0	0	0	2	0	2
14:30	0	0	0	1	0	1
14:45	0	0	0	0	0	0
Hour	1	1	2	4	0	4
15:00	0	1	1	1	0	1
15:15	0	0	0	0	0	0
15:30	2	0	2	1	0	1
15:45	4	0	4	3	0	3
Hour	6	1	7	5	0	5
16:00	2	1	3	3	0	3
16:15	3	1	4	2	0	2
16:30	3	1	4	2	0	2
16:45	2	0	2	1	0	1
Hour	10	3	13	8	0	8
17:00	3	0	3	3	0	3
17:15	4	0	4	2	0	2
17:30	4	0	4	2	0	2
17:45	3	0	3	2	0	2
Hour	14	0	14	9	0	9
18:00	1	0	1	1	0	1
18:15	1	0	1	1	0	1
18:30	2	1	3	1	0	1
18:45	1	0	1	0	0	0
Hour	5	1	6	3	0	3
Total	86	14	100	44	0	44

Site No. 1
Location R284(N) / L3603(E) / R284(S) / L3603(W)
Date 21 February 2018

Time	C to B - R284(S) to L3603(E)		Veh. Total	C to A - R284(S) to R284(N)		Veh. Total
	LV	HV		LV	HV	
07:00	0	0	0	7	2	9
07:15	1	0	1	14	0	14
07:30	0	0	0	34	0	34
07:45	1	0	1	40	3	43
Hour	2	0	2	95	5	100
08:00	1	0	1	45	0	45
08:15	2	0	2	63	0	63
08:30	6	0	6	51	1	52
08:45	4	0	4	37	2	39
Hour	13	0	13	196	3	199
09:00	2	1	3	33	1	34
09:15	1	0	1	36	0	36
09:30	0	0	0	31	1	32
09:45	1	0	1	19	0	19
Hour	4	1	5	119	2	121
10:00	0	0	0	16	0	16
10:15	0	0	0	24	1	25
10:30	1	0	1	27	1	28
10:45	0	0	0	22	1	23
Hour	1	0	1	89	3	92
11:00	1	0	1	22	0	22
11:15	0	0	0	12	1	13
11:30	0	0	0	24	1	25
11:45	0	0	0	30	0	30
Hour	1	0	1	88	2	90
12:00	0	0	0	17	0	17
12:15	0	0	0	18	0	18
12:30	1	0	1	18	1	19
12:45	0	0	0	14	0	14
Hour	1	0	1	67	1	68
13:00	2	1	3	10	0	10
13:15	0	0	0	17	1	18
13:30	1	0	1	19	1	20
13:45	0	0	0	18	0	18
Hour	3	1	4	64	2	66
14:00	0	0	0	17	2	19
14:15	0	0	0	12	1	13
14:30	2	0	2	22	2	24
14:45	0	0	0	17	0	17
Hour	2	0	2	68	5	73
15:00	0	0	0	20	0	20
15:15	0	0	0	23	0	23
15:30	1	0	1	18	0	18
15:45	1	0	1	18	4	22
Hour	2	0	2	79	4	83
16:00	0	0	0	26	4	30
16:15	0	0	0	16	1	17
16:30	0	0	0	21	0	21
16:45	0	0	0	15	0	15
Hour	0	0	0	78	5	83
17:00	1	0	1	23	0	23
17:15	2	0	2	19	1	20
17:30	1	0	1	23	1	24
17:45	0	0	0	22	0	22
Hour	4	0	4	87	2	89
18:00	0	0	0	19	0	19
18:15	0	0	0	12	0	12
18:30	1	0	1	17	0	17
18:45	0	0	0	16	1	17
Hour	1	0	1	64	1	65
Total	34	2	36	1094	35	1129

Site No. 1
Location R284(N) / L3603(E) / R284(S) / L3603(W)
Date 21 February 2018

Time	C to D - R284(S) to L3603(W)		Veh. Total	D to C - L3603(W) to R284(S)		Veh. Total
	LV	HV		LV	HV	
07:00	1	0	1	0	0	0
07:15	0	0	0	0	0	0
07:30	1	0	1	0	0	0
07:45	0	0	0	1	0	1
Hour	2	0	2	1	0	1
08:00	0	0	0	0	0	0
08:15	6	0	6	1	0	1
08:30	12	0	12	1	0	1
08:45	16	1	17	2	0	2
Hour	34	1	35	4	0	4
09:00	3	0	3	1	0	1
09:15	1	0	1	4	0	4
09:30	5	0	5	0	0	0
09:45	1	0	1	1	0	1
Hour	10	0	10	6	0	6
10:00	1	0	1	0	1	1
10:15	2	0	2	1	0	1
10:30	1	0	1	0	1	1
10:45	0	0	0	2	0	2
Hour	4	0	4	3	2	5
11:00	2	1	3	2	0	2
11:15	0	0	0	1	0	1
11:30	2	0	2	1	0	1
11:45	1	1	2	2	0	2
Hour	5	2	7	6	0	6
12:00	0	0	0	1	0	1
12:15	0	0	0	0	1	1
12:30	0	0	0	2	0	2
12:45	3	0	3	1	0	1
Hour	3	0	3	4	1	5
13:00	2	0	2	2	0	2
13:15	0	1	1	1	0	1
13:30	3	0	3	1	0	1
13:45	4	1	5	0	0	0
Hour	9	2	11	4	0	4
14:00	1	0	1	0	0	0
14:15	2	0	2	3	0	3
14:30	2	0	2	3	1	4
14:45	1	0	1	0	0	0
Hour	6	0	6	6	1	7
15:00	0	0	0	2	0	2
15:15	1	0	1	0	0	0
15:30	2	0	2	3	0	3
15:45	2	1	3	0	1	1
Hour	5	1	6	5	1	6
16:00	2	2	4	3	0	3
16:15	5	0	5	2	0	2
16:30	1	0	1	3	0	3
16:45	1	0	1	0	0	0
Hour	9	2	11	8	0	8
17:00	2	0	2	1	0	1
17:15	1	0	1	4	0	4
17:30	0	0	0	3	0	3
17:45	2	0	2	2	0	2
Hour	5	0	5	10	0	10
18:00	0	1	1	3	0	3
18:15	1	0	1	2	0	2
18:30	0	0	0	2	0	2
18:45	2	0	2	1	0	1
Hour	3	1	4	8	0	8
Total	95	9	104	65	5	70

Site No. 1
Location R284(N) / L3603(E) / R284(S) / L3603(W)
Date 21 February 2018

Time	D to B - L3603(W) to L3603(E)		Veh. Total	D to A - L3603(W) to R284(N)		Veh. Total
	LV	HV		LV	HV	
07:00	0	0	0	2	0	2
07:15	0	0	0	0	0	0
07:30	5	0	5	3	0	3
07:45	1	0	1	0	0	0
Hour	6	0	6	5	0	5
08:00	0	0	0	0	0	0
08:15	0	0	0	1	0	1
08:30	0	0	0	0	0	0
08:45	3	1	4	1	0	1
Hour	3	1	4	2	0	2
09:00	3	0	3	1	0	1
09:15	1	0	1	1	0	1
09:30	1	1	2	1	0	1
09:45	3	0	3	2	0	2
Hour	8	1	9	5	0	5
10:00	0	0	0	1	0	1
10:15	2	0	2	2	0	2
10:30	0	0	0	1	0	1
10:45	1	0	1	1	0	1
Hour	3	0	3	5	0	5
11:00	2	0	2	3	0	3
11:15	1	0	1	0	0	0
11:30	3	0	3	1	0	1
11:45	1	0	1	1	0	1
Hour	7	0	7	5	0	5
12:00	1	2	3	0	0	0
12:15	0	0	0	1	0	1
12:30	2	0	2	1	0	1
12:45	1	0	1	0	0	0
Hour	4	2	6	2	0	2
13:00	2	0	2	3	0	3
13:15	0	0	0	3	0	3
13:30	0	0	0	1	0	1
13:45	0	0	0	0	0	0
Hour	2	0	2	7	0	7
14:00	3	0	3	0	0	0
14:15	2	0	2	1	0	1
14:30	0	0	0	3	0	3
14:45	1	1	2	0	0	0
Hour	6	1	7	4	0	4
15:00	0	0	0	0	0	0
15:15	3	1	4	0	0	0
15:30	1	0	1	1	0	1
15:45	2	0	2	0	0	0
Hour	6	1	7	1	0	1
16:00	0	0	0	3	0	3
16:15	2	0	2	5	0	5
16:30	0	0	0	2	0	2
16:45	2	0	2	0	0	0
Hour	4	0	4	10	0	10
17:00	2	0	2	2	0	2
17:15	1	0	1	2	0	2
17:30	4	0	4	2	0	2
17:45	1	0	1	3	0	3
Hour	8	0	8	9	0	9
18:00	2	0	2	2	0	2
18:15	1	0	1	1	0	1
18:30	1	0	1	1	0	1
18:45	0	0	0	3	0	3
Hour	4	0	4	7	0	7
Total	61	6	67	62	0	62

Site No. 1
Location R284(N) / L3603(E) / R284(S) / L3603(W)
Date 21 February 2018

Time	To Arm A - R284(N)		Veh. Total	From Arm A - R284(N)		Veh. Total
	LV	HV		LV	HV	
07:00	9	2	11	1	1	2
07:15	14	0	14	3	1	4
07:30	38	0	38	6	0	6
07:45	41	3	44	9	0	9
Hour	102	5	107	19	2	21
08:00	45	0	45	8	0	8
08:15	65	0	65	13	0	13
08:30	51	1	52	23	0	23
08:45	39	2	41	23	3	26
Hour	200	3	203	67	3	70
09:00	36	1	37	20	2	22
09:15	38	1	39	8	1	9
09:30	36	2	38	14	0	14
09:45	23	0	23	11	1	12
Hour	133	4	137	53	4	57
10:00	18	0	18	17	2	19
10:15	27	1	28	8	1	9
10:30	28	1	29	18	1	19
10:45	25	1	26	11	2	13
Hour	98	3	101	54	6	60
11:00	25	0	25	23	0	23
11:15	13	1	14	17	2	19
11:30	25	2	27	18	1	19
11:45	31	0	31	16	1	17
Hour	94	3	97	74	4	78
12:00	18	0	18	15	2	17
12:15	22	0	22	18	1	19
12:30	21	1	22	24	2	26
12:45	14	0	14	17	0	17
Hour	75	1	76	74	5	79
13:00	15	0	15	21	0	21
13:15	22	1	23	25	0	25
13:30	20	1	21	16	0	16
13:45	19	0	19	19	1	20
Hour	76	2	78	81	1	82
14:00	19	3	22	21	1	22
14:15	15	1	16	23	0	23
14:30	27	2	29	33	1	34
14:45	17	0	17	16	2	18
Hour	78	6	84	93	4	97
15:00	23	0	23	32	2	34
15:15	24	0	24	25	1	26
15:30	21	0	21	28	1	29
15:45	19	4	23	22	0	22
Hour	87	4	91	107	4	111
16:00	30	4	34	31	0	31
16:15	23	1	24	37	3	40
16:30	23	1	24	43	0	43
16:45	16	0	16	38	1	39
Hour	92	6	98	149	4	153
17:00	28	0	28	47	2	49
17:15	24	1	25	44	2	46
17:30	26	1	27	49	0	49
17:45	25	0	25	49	0	49
Hour	103	2	105	189	4	193
18:00	21	0	21	48	0	48
18:15	13	0	13	51	1	52
18:30	18	0	18	25	0	25
18:45	21	1	22	24	1	25
Hour	73	1	74	148	2	150
Total	1211	40	1251	1108	43	1151

Site No. 1
Location R284(N) / L3603(E) / R284(S) / L3603(W)
Date 21 February 2018

Time	To Arm B - L3603(E)		Veh. Total	From Arm B - L3603(E)		Veh. Total
	LV	HV		LV	HV	
07:00	0	0	0	0	0	0
07:15	1	0	1	0	0	0
07:30	6	0	6	3	0	3
07:45	3	0	3	4	0	4
Hour	10	0	10	7	0	7
08:00	1	0	1	3	2	5
08:15	2	0	2	4	0	4
08:30	7	0	7	3	2	5
08:45	7	1	8	5	0	5
Hour	17	1	18	15	4	19
09:00	6	1	7	3	0	3
09:15	2	0	2	1	2	3
09:30	1	1	2	6	1	7
09:45	6	0	6	5	0	5
Hour	15	2	17	15	3	18
10:00	2	0	2	6	1	7
10:15	3	0	3	2	0	2
10:30	4	0	4	0	0	0
10:45	2	0	2	6	0	6
Hour	11	0	11	14	1	15
11:00	8	0	8	1	0	1
11:15	1	1	2	2	0	2
11:30	4	0	4	5	1	6
11:45	2	0	2	1	0	1
Hour	15	1	16	9	1	10
12:00	2	2	4	5	2	7
12:15	2	0	2	5	0	5
12:30	6	0	6	6	0	6
12:45	3	0	3	0	0	0
Hour	13	2	15	16	2	18
13:00	5	1	6	4	0	4
13:15	1	0	1	5	0	5
13:30	1	0	1	7	0	7
13:45	1	0	1	2	0	2
Hour	8	1	9	18	0	18
14:00	6	0	6	4	2	6
14:15	3	0	3	4	0	4
14:30	4	0	4	3	0	3
14:45	3	2	5	0	0	0
Hour	16	2	18	11	2	13
15:00	6	0	6	4	1	5
15:15	4	1	5	1	0	1
15:30	3	0	3	5	0	5
15:45	3	0	3	8	0	8
Hour	16	1	17	18	1	19
16:00	4	0	4	6	1	7
16:15	3	2	5	7	1	8
16:30	1	0	1	5	2	7
16:45	6	0	6	4	0	4
Hour	14	2	16	22	4	26
17:00	4	0	4	9	0	9
17:15	6	1	7	9	0	9
17:30	5	0	5	7	0	7
17:45	2	0	2	5	0	5
Hour	17	1	18	30	0	30
18:00	4	0	4	2	0	2
18:15	3	0	3	2	0	2
18:30	4	0	4	3	1	4
18:45	0	0	0	3	0	3
Hour	11	0	11	10	1	11
Total	163	13	176	185	19	204

Site No. 1
Location R284(N) / L3603(E) / R284(S) / L3603(W)
Date 21 February 2018

Time	To Arm C - R284(S)		Veh. Total	From Arm C - R284(S)		Veh. Total
	LV	HV		LV	HV	
07:00	1	1	2	8	2	10
07:15	3	1	4	15	0	15
07:30	5	0	5	35	0	35
07:45	7	0	7	41	3	44
Hour	16	2	18	99	5	104
08:00	7	0	7	46	0	46
08:15	13	0	13	71	0	71
08:30	22	0	22	69	1	70
08:45	19	3	22	57	3	60
Hour	61	3	64	243	4	247
09:00	17	2	19	38	2	40
09:15	12	1	13	38	0	38
09:30	12	0	12	36	1	37
09:45	10	1	11	21	0	21
Hour	51	4	55	133	3	136
10:00	16	3	19	17	0	17
10:15	8	1	9	26	1	27
10:30	15	2	17	29	1	30
10:45	12	1	13	22	1	23
Hour	51	7	58	94	3	97
11:00	20	0	20	25	1	26
11:15	19	1	20	12	1	13
11:30	18	1	19	26	1	27
11:45	16	1	17	31	1	32
Hour	73	3	76	94	4	98
12:00	14	2	16	17	0	17
12:15	15	2	17	18	0	18
12:30	22	2	24	19	1	20
12:45	16	0	16	17	0	17
Hour	67	6	73	71	1	72
13:00	19	0	19	14	1	15
13:15	25	0	25	17	2	19
13:30	17	0	17	23	1	24
13:45	15	1	16	22	1	23
Hour	76	1	77	76	5	81
14:00	17	1	18	18	2	20
14:15	26	0	26	14	1	15
14:30	30	2	32	26	2	28
14:45	11	1	12	18	0	18
Hour	84	4	88	76	5	81
15:00	29	2	31	20	0	20
15:15	23	1	24	24	0	24
15:30	28	1	29	21	0	21
15:45	25	1	26	21	5	26
Hour	105	5	110	86	5	91
16:00	30	0	30	28	6	34
16:15	38	1	39	21	1	22
16:30	44	0	44	22	0	22
16:45	34	1	35	16	0	16
Hour	146	2	148	87	7	94
17:00	46	2	48	26	0	26
17:15	45	1	46	22	1	23
17:30	54	0	54	24	1	25
17:45	49	0	49	24	0	24
Hour	194	3	197	96	2	98
18:00	48	0	48	19	1	20
18:15	49	1	50	13	0	13
18:30	24	0	24	18	0	18
18:45	24	1	25	18	1	19
Hour	145	2	147	68	2	70
Total	1069	42	1111	1223	46	1269

Site No. 1
Location R284(N) / L3603(E) / R284(S) / L3603(W)
Date 21 February 2018

Time	To Arm D - L3603(W)		Veh. Total	From Arm D - L3603(W)		Veh. Total
	LV	HV		LV	HV	
07:00	1	0	1	2	0	2
07:15	0	0	0	0	0	0
07:30	3	0	3	8	0	8
07:45	5	0	5	2	0	2
Hour	9	0	9	12	0	12
08:00	4	2	6	0	0	0
08:15	10	0	10	2	0	2
08:30	16	2	18	1	0	1
08:45	26	1	27	6	1	7
Hour	56	5	61	9	1	10
09:00	7	0	7	5	0	5
09:15	1	1	2	6	0	6
09:30	9	0	9	2	1	3
09:45	4	0	4	6	0	6
Hour	21	1	22	19	1	20
10:00	5	1	6	1	1	2
10:15	3	0	3	5	0	5
10:30	1	0	1	1	1	2
10:45	4	1	5	4	0	4
Hour	13	2	15	11	2	13
11:00	3	1	4	7	0	7
11:15	0	0	0	2	0	2
11:30	7	0	7	5	0	5
11:45	3	1	4	4	0	4
Hour	13	2	15	18	0	18
12:00	5	2	7	2	2	4
12:15	3	0	3	1	1	2
12:30	5	0	5	5	0	5
12:45	3	0	3	2	0	2
Hour	16	2	18	10	3	13
13:00	7	0	7	7	0	7
13:15	3	1	4	4	0	4
13:30	10	0	10	2	0	2
13:45	8	1	9	0	0	0
Hour	28	2	30	13	0	13
14:00	4	1	5	3	0	3
14:15	3	0	3	6	0	6
14:30	7	0	7	6	1	7
14:45	4	0	4	1	1	2
Hour	18	1	19	16	2	18
15:00	0	1	1	2	0	2
15:15	2	0	2	3	1	4
15:30	7	0	7	5	0	5
15:45	6	1	7	2	1	3
Hour	15	2	17	12	2	14
16:00	7	3	10	6	0	6
16:15	10	1	11	9	0	9
16:30	7	1	8	5	0	5
16:45	4	0	4	2	0	2
Hour	28	5	33	22	0	22
17:00	9	0	9	5	0	5
17:15	7	0	7	7	0	7
17:30	4	0	4	9	0	9
17:45	8	0	8	6	0	6
Hour	28	0	28	27	0	27
18:00	3	1	4	7	0	7
18:15	5	0	5	4	0	4
18:30	4	1	5	4	0	4
18:45	4	0	4	4	0	4
Hour	16	2	18	19	0	19
Total	261	24	285	188	11	199

Site No. 2
Location R287(SE) / L3603 / R287(NW) / L36025
Date 21 February 2018

Time	A to D - R287(SE) to L36025		Veh. Total	A to C - R287(SE) to R287(NW)		Veh. Total
	LV	HV		LV	HV	
07:00	0	0	0	4	0	4
07:15	0	0	0	8	0	8
07:30	0	0	0	21	0	21
07:45	2	0	2	43	0	43
Hour	2	0	2	76	0	76
08:00	2	0	2	30	1	31
08:15	8	0	8	42	0	42
08:30	5	0	5	34	0	34
08:45	8	0	8	22	0	22
Hour	23	0	23	128	1	129
09:00	7	0	7	24	0	24
09:15	2	0	2	25	0	25
09:30	5	0	5	23	1	24
09:45	3	0	3	25	0	25
Hour	17	0	17	97	1	98
10:00	2	0	2	13	0	13
10:15	1	0	1	17	0	17
10:30	1	0	1	10	1	11
10:45	2	0	2	15	1	16
Hour	6	0	6	55	2	57
11:00	0	0	0	8	0	8
11:15	2	0	2	9	0	9
11:30	2	0	2	8	0	8
11:45	2	0	2	11	2	13
Hour	6	0	6	36	2	38
12:00	2	0	2	17	0	17
12:15	0	0	0	14	0	14
12:30	2	0	2	10	0	10
12:45	1	0	1	9	1	10
Hour	5	0	5	50	1	51
13:00	1	0	1	11	1	12
13:15	2	0	2	17	1	18
13:30	1	0	1	13	0	13
13:45	4	0	4	11	0	11
Hour	8	0	8	52	2	54
14:00	1	0	1	10	0	10
14:15	1	0	1	17	0	17
14:30	1	0	1	12	1	13
14:45	0	0	0	16	0	16
Hour	3	0	3	55	1	56
15:00	4	0	4	13	0	13
15:15	2	0	2	17	2	19
15:30	0	0	0	20	0	20
15:45	0	0	0	11	0	11
Hour	6	0	6	61	2	63
16:00	3	0	3	13	1	14
16:15	1	0	1	13	2	15
16:30	2	0	2	10	0	10
16:45	2	0	2	15	0	15
Hour	8	0	8	51	3	54
17:00	2	0	2	15	0	15
17:15	4	0	4	10	1	11
17:30	3	0	3	16	1	17
17:45	1	0	1	13	0	13
Hour	10	0	10	54	2	56
18:00	0	0	0	11	0	11
18:15	3	0	3	18	0	18
18:30	2	0	2	8	0	8
18:45	0	0	0	9	0	9
Hour	5	0	5	46	0	46
Total	99	0	99	761	17	778

Site No. 2
Location R287(SE) / L3603 / R287(NW) / L36025
Date 21 February 2018

Time	A to B - R287(SE) to L3603		Veh. Total	B to A - L3603 to R287(SE)		Veh. Total
	LV	HV		LV	HV	
07:00	0	0	0	0	0	0
07:15	0	0	0	0	0	0
07:30	1	0	1	2	0	2
07:45	4	1	5	2	0	2
Hour	5	1	6	4	0	4
08:00	0	0	0	0	0	0
08:15	0	0	0	0	0	0
08:30	3	0	3	0	0	0
08:45	3	0	3	2	0	2
Hour	6	0	6	2	0	2
09:00	0	0	0	1	0	1
09:15	0	1	1	1	0	1
09:30	1	0	1	2	0	2
09:45	1	0	1	4	0	4
Hour	2	1	3	8	0	8
10:00	3	0	3	1	0	1
10:15	1	0	1	0	0	0
10:30	1	0	1	1	0	1
10:45	2	0	2	2	0	2
Hour	7	0	7	4	0	4
11:00	0	0	0	1	0	1
11:15	0	0	0	1	0	1
11:30	1	0	1	0	0	0
11:45	1	0	1	2	0	2
Hour	2	0	2	4	0	4
12:00	3	0	3	3	2	5
12:15	1	0	1	1	0	1
12:30	0	0	0	1	0	1
12:45	0	0	0	0	0	0
Hour	4	0	4	5	2	7
13:00	2	0	2	0	0	0
13:15	0	0	0	1	0	1
13:30	2	0	2	0	0	0
13:45	0	0	0	0	0	0
Hour	4	0	4	1	0	1
14:00	1	0	1	0	0	0
14:15	1	0	1	1	0	1
14:30	0	0	0	1	0	1
14:45	1	0	1	1	0	1
Hour	3	0	3	3	0	3
15:00	0	0	0	0	0	0
15:15	1	0	1	0	0	0
15:30	3	1	4	1	0	1
15:45	2	0	2	2	0	2
Hour	6	1	7	3	0	3
16:00	2	1	3	0	0	0
16:15	2	1	3	1	0	1
16:30	1	0	1	0	0	0
16:45	1	0	1	1	0	1
Hour	6	2	8	2	0	2
17:00	2	0	2	1	0	1
17:15	0	0	0	1	0	1
17:30	1	0	1	0	0	0
17:45	0	0	0	2	0	2
Hour	3	0	3	4	0	4
18:00	0	0	0	1	0	1
18:15	0	0	0	0	0	0
18:30	1	0	1	1	0	1
18:45	0	0	0	2	0	2
Hour	1	0	1	4	0	4
Total	49	5	54	44	2	46

Site No. 2
Location R287(SE) / L3603 / R287(NW) / L36025
Date 21 February 2018

Time	B to D - L3603 to L36025		Veh. Total	B to C - L3603 to R287(NW)		Veh. Total
	LV	HV		LV	HV	
07:00	0	0	0	0	0	0
07:15	0	0	0	1	0	1
07:30	0	0	0	0	0	0
07:45	0	0	0	0	1	1
Hour	0	0	0	1	1	2
08:00	2	0	2	5	0	5
08:15	0	0	0	0	0	0
08:30	2	0	2	1	1	2
08:45	6	0	6	0	0	0
Hour	10	0	10	6	1	7
09:00	2	0	2	0	0	0
09:15	0	0	0	2	0	2
09:30	0	0	0	0	0	0
09:45	1	0	1	0	1	1
Hour	3	0	3	2	1	3
10:00	0	0	0	0	0	0
10:15	1	0	1	0	0	0
10:30	0	0	0	1	0	1
10:45	0	0	0	1	0	1
Hour	1	0	1	2	0	2
11:00	1	0	1	1	0	1
11:15	1	0	1	0	0	0
11:30	2	0	2	1	1	2
11:45	0	0	0	0	0	0
Hour	4	0	4	2	1	3
12:00	0	0	0	0	0	0
12:15	0	0	0	0	0	0
12:30	0	0	0	0	0	0
12:45	1	0	1	1	0	1
Hour	1	0	1	1	0	1
13:00	1	0	1	3	1	4
13:15	1	0	1	0	0	0
13:30	0	0	0	0	1	1
13:45	0	0	0	0	0	0
Hour	2	0	2	3	2	5
14:00	0	0	0	1	1	2
14:15	1	0	1	2	0	2
14:30	0	0	0	0	1	1
14:45	2	0	2	0	0	0
Hour	3	0	3	3	2	5
15:00	0	0	0	2	1	3
15:15	0	0	0	1	0	1
15:30	2	0	2	0	0	0
15:45	1	0	1	0	0	0
Hour	3	0	3	3	1	4
16:00	0	0	0	0	0	0
16:15	0	0	0	0	0	0
16:30	0	0	0	0	0	0
16:45	1	0	1	0	0	0
Hour	1	0	1	0	0	0
17:00	0	0	0	1	0	1
17:15	0	0	0	0	2	2
17:30	1	0	1	3	0	3
17:45	0	0	0	0	0	0
Hour	1	0	1	4	2	6
18:00	0	0	0	0	0	0
18:15	0	0	0	0	0	0
18:30	1	0	1	0	0	0
18:45	0	0	0	0	0	0
Hour	1	0	1	0	0	0
Total	30	0	30	27	11	38

Site No. 2
Location R287(SE) / L3603 / R287(NW) / L36025
Date 21 February 2018

Time	C to B - R287(NW) to L3603		Veh. Total	C to A - R287(NW) to R287(SE)		Veh. Total
	LV	HV		LV	HV	
07:00	0	0	0	1	0	1
07:15	0	0	0	3	1	4
07:30	0	0	0	1	1	2
07:45	1	0	1	8	0	8
Hour	1	0	1	13	2	15
08:00	2	1	3	5	0	5
08:15	1	1	2	13	0	13
08:30	0	1	1	12	1	13
08:45	0	0	0	12	0	12
Hour	3	3	6	42	1	43
09:00	0	0	0	19	0	19
09:15	2	0	2	9	0	9
09:30	1	0	1	8	1	9
09:45	1	1	2	13	0	13
Hour	4	1	5	49	1	50
10:00	0	0	0	14	0	14
10:15	1	0	1	12	1	13
10:30	0	1	1	10	0	10
10:45	0	0	0	11	0	11
Hour	1	1	2	47	1	48
11:00	0	0	0	9	1	10
11:15	1	2	3	16	2	18
11:30	2	0	2	11	0	11
11:45	2	0	2	17	0	17
Hour	5	2	7	53	3	56
12:00	1	0	1	10	1	11
12:15	2	0	2	12	0	12
12:30	0	0	0	16	2	18
12:45	0	1	1	15	0	15
Hour	3	1	4	53	3	56
13:00	1	2	3	10	0	10
13:15	1	0	1	20	0	20
13:30	1	1	2	14	1	15
13:45	2	0	2	11	1	12
Hour	5	3	8	55	2	57
14:00	1	0	1	13	0	13
14:15	2	0	2	9	0	9
14:30	0	0	0	21	0	21
14:45	0	0	0	11	1	12
Hour	3	0	3	54	1	55
15:00	0	1	1	19	0	19
15:15	0	0	0	25	1	26
15:30	0	0	0	14	1	15
15:45	1	0	1	18	0	18
Hour	1	1	2	76	2	78
16:00	0	0	0	21	2	23
16:15	0	0	0	27	0	27
16:30	0	0	0	23	0	23
16:45	0	1	1	25	0	25
Hour	0	1	1	96	2	98
17:00	1	0	1	25	0	25
17:15	0	0	0	39	0	39
17:30	0	0	0	27	0	27
17:45	0	0	0	30	0	30
Hour	1	0	1	121	0	121
18:00	1	0	1	29	0	29
18:15	0	0	0	36	0	36
18:30	0	0	0	21	1	22
18:45	1	0	1	12	0	12
Hour	2	0	2	98	1	99
Total	29	13	42	757	19	776

Site No. 2
Location R287(SE) / L3603 / R287(NW) / L36025
Date 21 February 2018

Time	C to D - R287(NW) to L36025		Veh. Total	D to C - L36025 to R287(NW)		Veh. Total
	LV	HV		LV	HV	
07:00	0	0	0	0	0	0
07:15	0	0	0	0	0	0
07:30	0	0	0	0	0	0
07:45	0	0	0	1	0	1
Hour	0	0	0	1	0	1
08:00	0	0	0	2	0	2
08:15	0	0	0	2	0	2
08:30	0	0	0	0	0	0
08:45	0	0	0	0	0	0
Hour	0	0	0	4	0	4
09:00	1	0	1	1	0	1
09:15	1	0	1	0	0	0
09:30	0	0	0	1	0	1
09:45	0	0	0	1	0	1
Hour	2	0	2	3	0	3
10:00	1	0	1	3	0	3
10:15	1	0	1	1	0	1
10:30	1	0	1	1	0	1
10:45	0	0	0	2	0	2
Hour	3	0	3	7	0	7
11:00	0	0	0	0	0	0
11:15	1	0	1	0	0	0
11:30	1	0	1	0	0	0
11:45	0	0	0	1	0	1
Hour	2	0	2	1	0	1
12:00	0	0	0	0	0	0
12:15	1	0	1	0	0	0
12:30	0	0	0	0	0	0
12:45	1	0	1	1	0	1
Hour	2	0	2	1	0	1
13:00	2	0	2	1	0	1
13:15	2	0	2	2	0	2
13:30	0	0	0	0	0	0
13:45	1	0	1	1	0	1
Hour	5	0	5	4	0	4
14:00	0	0	0	2	0	2
14:15	1	0	1	3	0	3
14:30	1	0	1	1	0	1
14:45	0	0	0	1	0	1
Hour	2	0	2	7	0	7
15:00	0	0	0	0	0	0
15:15	0	0	0	0	0	0
15:30	2	0	2	2	0	2
15:45	1	0	1	1	0	1
Hour	3	0	3	3	0	3
16:00	0	0	0	1	0	1
16:15	1	0	1	0	0	0
16:30	0	0	0	0	0	0
16:45	0	0	0	0	0	0
Hour	1	0	1	1	0	1
17:00	0	0	0	1	0	1
17:15	1	0	1	0	0	0
17:30	2	0	2	1	0	1
17:45	1	0	1	1	0	1
Hour	4	0	4	3	0	3
18:00	1	0	1	1	0	1
18:15	1	0	1	1	0	1
18:30	0	0	0	1	0	1
18:45	2	0	2	1	0	1
Hour	4	0	4	4	0	4
Total	28	0	28	39	0	39

Site No. 2
Location R287(SE) / L3603 / R287(NW) / L36025
Date 21 February 2018

Time	D to B - L36025 to L3603		Veh. Total	D to A - L36025 to R287(SE)		Veh. Total
	LV	HV		LV	HV	
07:00	0	0	0	0	0	0
07:15	0	0	0	0	0	0
07:30	0	0	0	0	0	0
07:45	1	0	1	0	0	0
Hour	1	0	1	0	0	0
08:00	0	0	0	0	0	0
08:15	0	0	0	1	0	1
08:30	0	0	0	0	0	0
08:45	0	0	0	2	0	2
Hour	0	0	0	3	0	3
09:00	1	0	1	2	0	2
09:15	0	0	0	1	0	1
09:30	1	0	1	1	0	1
09:45	0	0	0	2	0	2
Hour	2	0	2	6	0	6
10:00	1	0	1	3	0	3
10:15	1	0	1	1	0	1
10:30	0	0	0	1	0	1
10:45	2	0	2	1	0	1
Hour	4	0	4	6	0	6
11:00	0	0	0	1	0	1
11:15	0	0	0	1	0	1
11:30	1	0	1	2	0	2
11:45	1	0	1	3	0	3
Hour	2	0	2	7	0	7
12:00	0	0	0	3	0	3
12:15	1	0	1	4	0	4
12:30	0	0	0	3	0	3
12:45	0	0	0	5	0	5
Hour	1	0	1	15	0	15
13:00	0	0	0	4	0	4
13:15	1	0	1	0	0	0
13:30	4	0	4	6	0	6
13:45	0	0	0	3	1	4
Hour	5	0	5	13	1	14
14:00	1	0	1	2	0	2
14:15	2	0	2	2	0	2
14:30	0	0	0	1	0	1
14:45	1	0	1	3	0	3
Hour	4	0	4	8	0	8
15:00	0	0	0	2	0	2
15:15	2	0	2	2	0	2
15:30	0	0	0	2	1	3
15:45	1	0	1	7	0	7
Hour	3	0	3	13	1	14
16:00	3	0	3	2	0	2
16:15	1	0	1	5	0	5
16:30	2	0	2	3	0	3
16:45	5	0	5	5	0	5
Hour	11	0	11	15	0	15
17:00	4	0	4	9	0	9
17:15	2	0	2	7	0	7
17:30	2	0	2	2	0	2
17:45	0	0	0	11	0	11
Hour	8	0	8	29	0	29
18:00	0	0	0	11	0	11
18:15	4	0	4	3	0	3
18:30	0	0	0	5	0	5
18:45	0	0	0	4	0	4
Hour	4	0	4	23	0	23
Total	45	0	45	138	2	140

Site No. 2
Location R287(SE) / L3603 / R287(NW) / L36025
Date 21 February 2018

Time	To Arm A - R287(SE)		Veh. Total	From Arm A - R287(SE)		Veh. Total
	LV	HV		LV	HV	
07:00	1	0	1	4	0	4
07:15	3	1	4	8	0	8
07:30	3	1	4	22	0	22
07:45	10	0	10	49	1	50
Hour	17	2	19	83	1	84
08:00	5	0	5	32	1	33
08:15	14	0	14	50	0	50
08:30	12	1	13	42	0	42
08:45	16	0	16	33	0	33
Hour	47	1	48	157	1	158
09:00	22	0	22	31	0	31
09:15	11	0	11	27	1	28
09:30	11	1	12	29	1	30
09:45	19	0	19	29	0	29
Hour	63	1	64	116	2	118
10:00	18	0	18	18	0	18
10:15	13	1	14	19	0	19
10:30	12	0	12	12	1	13
10:45	14	0	14	19	1	20
Hour	57	1	58	68	2	70
11:00	11	1	12	8	0	8
11:15	18	2	20	11	0	11
11:30	13	0	13	11	0	11
11:45	22	0	22	14	2	16
Hour	64	3	67	44	2	46
12:00	16	3	19	22	0	22
12:15	17	0	17	15	0	15
12:30	20	2	22	12	0	12
12:45	20	0	20	10	1	11
Hour	73	5	78	59	1	60
13:00	14	0	14	14	1	15
13:15	21	0	21	19	1	20
13:30	20	1	21	16	0	16
13:45	14	2	16	15	0	15
Hour	69	3	72	64	2	66
14:00	15	0	15	12	0	12
14:15	12	0	12	19	0	19
14:30	23	0	23	13	1	14
14:45	15	1	16	17	0	17
Hour	65	1	66	61	1	62
15:00	21	0	21	17	0	17
15:15	27	1	28	20	2	22
15:30	17	2	19	23	1	24
15:45	27	0	27	13	0	13
Hour	92	3	95	73	3	76
16:00	23	2	25	18	2	20
16:15	33	0	33	16	3	19
16:30	26	0	26	13	0	13
16:45	31	0	31	18	0	18
Hour	113	2	115	65	5	70
17:00	35	0	35	19	0	19
17:15	47	0	47	14	1	15
17:30	29	0	29	20	1	21
17:45	43	0	43	14	0	14
Hour	154	0	154	67	2	69
18:00	41	0	41	11	0	11
18:15	39	0	39	21	0	21
18:30	27	1	28	11	0	11
18:45	18	0	18	9	0	9
Hour	125	1	126	52	0	52
Total	939	23	962	909	22	931

Site No. 2
Location R287(SE) / L3603 / R287(NW) / L36025
Date 21 February 2018

Time	To Arm B - L3603		Veh. Total	From Arm B - L3603		Veh. Total
	LV	HV		LV	HV	
07:00	0	0	0	0	0	0
07:15	0	0	0	1	0	1
07:30	1	0	1	2	0	2
07:45	6	1	7	2	1	3
Hour	7	1	8	5	1	6
08:00	2	1	3	7	0	7
08:15	1	1	2	0	0	0
08:30	3	1	4	3	1	4
08:45	3	0	3	8	0	8
Hour	9	3	12	18	1	19
09:00	1	0	1	3	0	3
09:15	2	1	3	3	0	3
09:30	3	0	3	2	0	2
09:45	2	1	3	5	1	6
Hour	8	2	10	13	1	14
10:00	4	0	4	1	0	1
10:15	3	0	3	1	0	1
10:30	1	1	2	2	0	2
10:45	4	0	4	3	0	3
Hour	12	1	13	7	0	7
11:00	0	0	0	3	0	3
11:15	1	2	3	2	0	2
11:30	4	0	4	3	1	4
11:45	4	0	4	2	0	2
Hour	9	2	11	10	1	11
12:00	4	0	4	3	2	5
12:15	4	0	4	1	0	1
12:30	0	0	0	1	0	1
12:45	0	1	1	2	0	2
Hour	8	1	9	7	2	9
13:00	3	2	5	4	1	5
13:15	2	0	2	2	0	2
13:30	7	1	8	0	1	1
13:45	2	0	2	0	0	0
Hour	14	3	17	6	2	8
14:00	3	0	3	1	1	2
14:15	5	0	5	4	0	4
14:30	0	0	0	1	1	2
14:45	2	0	2	3	0	3
Hour	10	0	10	9	2	11
15:00	0	1	1	2	1	3
15:15	3	0	3	1	0	1
15:30	3	1	4	3	0	3
15:45	4	0	4	3	0	3
Hour	10	2	12	9	1	10
16:00	5	1	6	0	0	0
16:15	3	1	4	1	0	1
16:30	3	0	3	0	0	0
16:45	6	1	7	2	0	2
Hour	17	3	20	3	0	3
17:00	7	0	7	2	0	2
17:15	2	0	2	1	2	3
17:30	3	0	3	4	0	4
17:45	0	0	0	2	0	2
Hour	12	0	12	9	2	11
18:00	1	0	1	1	0	1
18:15	4	0	4	0	0	0
18:30	1	0	1	2	0	2
18:45	1	0	1	2	0	2
Hour	7	0	7	5	0	5
Total	123	18	141	101	13	114

Site No. 2
Location R287(SE) / L3603 / R287(NW) / L36025
Date 21 February 2018

Time	To Arm C - R287(NW)		Veh. Total	From Arm C - R287(NW)		Veh. Total
	LV	HV		LV	HV	
07:00	4	0	4	1	0	1
07:15	9	0	9	3	1	4
07:30	21	0	21	1	1	2
07:45	44	1	45	9	0	9
Hour	78	1	79	14	2	16
08:00	37	1	38	7	1	8
08:15	44	0	44	14	1	15
08:30	35	1	36	12	2	14
08:45	22	0	22	12	0	12
Hour	138	2	140	45	4	49
09:00	25	0	25	20	0	20
09:15	27	0	27	12	0	12
09:30	24	1	25	9	1	10
09:45	26	1	27	14	1	15
Hour	102	2	104	55	2	57
10:00	16	0	16	15	0	15
10:15	18	0	18	14	1	15
10:30	12	1	13	11	1	12
10:45	18	1	19	11	0	11
Hour	64	2	66	51	2	53
11:00	9	0	9	9	1	10
11:15	9	0	9	18	4	22
11:30	9	1	10	14	0	14
11:45	12	2	14	19	0	19
Hour	39	3	42	60	5	65
12:00	17	0	17	11	1	12
12:15	14	0	14	15	0	15
12:30	10	0	10	16	2	18
12:45	11	1	12	16	1	17
Hour	52	1	53	58	4	62
13:00	15	2	17	13	2	15
13:15	19	1	20	23	0	23
13:30	13	1	14	15	2	17
13:45	12	0	12	14	1	15
Hour	59	4	63	65	5	70
14:00	13	1	14	14	0	14
14:15	22	0	22	12	0	12
14:30	13	2	15	22	0	22
14:45	17	0	17	11	1	12
Hour	65	3	68	59	1	60
15:00	15	1	16	19	1	20
15:15	18	2	20	25	1	26
15:30	22	0	22	16	1	17
15:45	12	0	12	20	0	20
Hour	67	3	70	80	3	83
16:00	14	1	15	21	2	23
16:15	13	2	15	28	0	28
16:30	10	0	10	23	0	23
16:45	15	0	15	25	1	26
Hour	52	3	55	97	3	100
17:00	17	0	17	26	0	26
17:15	10	3	13	40	0	40
17:30	20	1	21	29	0	29
17:45	14	0	14	31	0	31
Hour	61	4	65	126	0	126
18:00	12	0	12	31	0	31
18:15	19	0	19	37	0	37
18:30	9	0	9	21	1	22
18:45	10	0	10	15	0	15
Hour	50	0	50	104	1	105
Total	827	28	855	814	32	846

Site No. 2
Location R287(SE) / L3603 / R287(NW) / L36025
Date 21 February 2018

Time	To Arm D - L36025		Veh. Total	From Arm D - L36025		Veh. Total
	LV	HV		LV	HV	
07:00	0	0	0	0	0	0
07:15	0	0	0	0	0	0
07:30	0	0	0	0	0	0
07:45	2	0	2	2	0	2
Hour	2	0	2	2	0	2
08:00	4	0	4	2	0	2
08:15	8	0	8	3	0	3
08:30	7	0	7	0	0	0
08:45	14	0	14	2	0	2
Hour	33	0	33	7	0	7
09:00	10	0	10	4	0	4
09:15	3	0	3	1	0	1
09:30	5	0	5	3	0	3
09:45	4	0	4	3	0	3
Hour	22	0	22	11	0	11
10:00	3	0	3	7	0	7
10:15	3	0	3	3	0	3
10:30	2	0	2	2	0	2
10:45	2	0	2	5	0	5
Hour	10	0	10	17	0	17
11:00	1	0	1	1	0	1
11:15	4	0	4	1	0	1
11:30	5	0	5	3	0	3
11:45	2	0	2	5	0	5
Hour	12	0	12	10	0	10
12:00	2	0	2	3	0	3
12:15	1	0	1	5	0	5
12:30	2	0	2	3	0	3
12:45	3	0	3	6	0	6
Hour	8	0	8	17	0	17
13:00	4	0	4	5	0	5
13:15	5	0	5	3	0	3
13:30	1	0	1	10	0	10
13:45	5	0	5	4	1	5
Hour	15	0	15	22	1	23
14:00	1	0	1	5	0	5
14:15	3	0	3	7	0	7
14:30	2	0	2	2	0	2
14:45	2	0	2	5	0	5
Hour	8	0	8	19	0	19
15:00	4	0	4	2	0	2
15:15	2	0	2	4	0	4
15:30	4	0	4	4	1	5
15:45	2	0	2	9	0	9
Hour	12	0	12	19	1	20
16:00	3	0	3	6	0	6
16:15	2	0	2	6	0	6
16:30	2	0	2	5	0	5
16:45	3	0	3	10	0	10
Hour	10	0	10	27	0	27
17:00	2	0	2	14	0	14
17:15	5	0	5	9	0	9
17:30	6	0	6	5	0	5
17:45	2	0	2	12	0	12
Hour	15	0	15	40	0	40
18:00	1	0	1	12	0	12
18:15	4	0	4	8	0	8
18:30	3	0	3	6	0	6
18:45	2	0	2	5	0	5
Hour	10	0	10	31	0	31
Total	157	0	157	222	2	224

Appendix C – PICADY/ARCADY/OSCADY Outputs

PICADY

GUI Version: 5.1 AE
Analysis Program Release: 5.0 (MAY 2010)

For sales and distribution information, program advice and maintenance, contact:

TRL Limited
Crowthorne House
Nine Mile Ride
Wokingham, Berks.
RG40 3GA, UK

Tel: +44 (0)1344 770758
Fax: +44 (0)1344 770864
E-mail: software@trl.co.uk
Web: www.trlsoftware.co.uk

Run Analysis

Parameter	Values
File Run	C:\Users\obriend\Desktop\temp\P18-014-Junction1.vpi
Date Run	18 June 2018
Time Run	15:20:02
Driving Side	Drive On The Left

Arm Names and Flow Scaling Factors

Arm	Arm Name	Flow Scaling Factor (%)
Arm A	R287 Southeast	100
Arm B	L3603	100
Arm C	R287 Northwest	100
Arm D	L36025	100

Stream Labelling Convention

Stream A-B contains traffic going from A to B etc.

Run Information

Parameter	Values
Run Title	P18-014-Junction1
Location	Co.Sligo
Date	07 March 2018
Enumerator	obriend [PMCE11]
Job Number	P18-014
Status	-
Client	Lagan Asphalt Group Ltd.
Description	Aughamore Quarry Co.Sligo - Junction 1 R287/L3603

Errors and Warnings

Parameter	Values
Warning	No Errors Or Warnings

Geometric Data

Geometric Parameters

Parameter	Minor Arm B	Minor Arm D
Major Road Carriageway Width (m)	6.00	6.00
Major Road Kerbed Central Reserve Width (m)	0.00	0.00
Major Road Right Turning Lane Width (m)	2.20	2.20
Minor Road Width 0m Back from Junction (m)	10.00	7.00
Minor Road Width 5m Back from Junction (m)	6.80	3.80
Minor Road Width 10m Back from Junction (m)	4.85	3.25
Minor Road Width 15m Back from Junction (m)	3.75	3.10
Minor Road Width 20m Back from Junction (m)	3.25	2.95
Minor Road Derived Flare Length (PCU)	2.000	0.000
Minor Road Visibility To Right (m)	5	5
Minor Road Visibility To Left (m)	5	5
Major Road Right Turn Visibility (m)	250	125
Major Road Right Turn Blocks Traffic	Yes (if over 1 veh)	Yes (if over 1 veh)

Slope and Intercept Values

Stream	Intercept for Stream	Slope for A-B	Slope for A-C	Slope for A-D	Slope for B-A	Slope for B-C	Slope for B-D	Slope for C-A	Slope for C-B	Slope for C-D	Slope for D-A	Slope for D-B	Slope for D-C
C-B	718.741	0.278	0.278	0.398	-	-	-	-	-	-	-	-	-
A-D	646.352	-	-	-	-	-	-	0.278	0.358	0.278	-	-	-
B-A	0.000	0.000	0.000	0.000	-	-	-	0.000	0.000	-	0.000	0.000	0.000
B-C	0.000	0.000	0.000	-	-	-	-	-	-	-	-	-	-
B-D(L)	0.000	0.000	0.000	0.000	-	-	-	0.000	0.000	0.000	-	-	-
D-A	0.000	-	-	-	-	-	-	0.000	-	0.000	-	-	-
D-B(L)	0.000	0.000	0.000	0.000	-	-	-	0.000	0.000	0.000	-	-	-
D-C	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-
B-D(R)	0.000	0.000	0.000	0.000	-	-	-	0.000	0.000	0.000	-	-	-
D-B(R)	0.000	0.000	0.000	0.000	-	-	-	0.000	0.000	0.000	-	-	-

Note: Streams may be combined in which case capacity will be adjusted
These values do not allow for any site-specific corrections

Streams marked with '(L)' and '(R)' refer to the 'left' and 'right' lane of the minor arm that the originating traffic is on.

Junction Diagram

Demand Data

Modelling Periods

Parameter	Period	Duration (min)	Segment Length (min)
First Modelling Period	07:45-08:45	60	15
Second Modelling Period	17:00-18:00	60	15

Direct Entry Flows

Demand Set: Opening Year +15 - AM (2034)
Modelling Period: 07:45-08:45

Segment: 07:45-08:00

Arm	Flow (veh/interval)
Arm A	58.00
Arm B	4.00
Arm C	10.00
Arm D	2.00

Segment: 08:00-08:15

Arm	Flow (veh/interval)
Arm A	39.00
Arm B	8.00
Arm C	10.00
Arm D	2.00

Segment: 08:15-08:30

Arm	Flow (veh/interval)
Arm A	58.00
Arm B	0.00
Arm C	18.00
Arm D	3.00

Segment: 08:30-08:45

Arm	Flow (veh/interval)
Arm A	49.00
Arm B	5.00
Arm C	17.00
Arm D	0.00

Demand Set: Opening Year +15 - PM (2034)
Modelling Period: 17:00-18:00

Segment: 17:00-17:15

Arm	Flow (veh/interval)
Arm A	22.00
Arm B	2.00
Arm C	30.00
Arm D	16.00

Segment: 17:15-17:30

Arm	Flow (veh/interval)
Arm A	18.00
Arm B	4.00
Arm C	46.00
Arm D	10.00

Segment: 17:30-17:45

Arm	Flow (veh/interval)
Arm A	25.00
Arm B	5.00
Arm C	34.00
Arm D	6.00

Segment: 17:45-18:00

Arm	Flow (veh/interval)
Arm A	16.00
Arm B	2.00
Arm C	36.00
Arm D	14.00

Demand Set: Site Development Traffic AM - LV
Modelling Period: 07:45-08:45

Segment: 07:45-08:00

Arm	Flow (veh/interval)
Arm A	1.50
Arm B	2.03
Arm C	0.89
Arm D	1.38

Segment: 08:00-08:15

Arm	Flow (veh/interval)
Arm A	1.50
Arm B	2.03
Arm C	0.89
Arm D	1.38

Segment: 08:15-08:30

Arm	Flow (veh/interval)
Arm A	1.50
Arm B	2.03
Arm C	0.89
Arm D	1.38

Segment: 08:30-08:45

Arm	Flow (veh/interval)
Arm A	1.50
Arm B	2.03
Arm C	0.89
Arm D	1.38

Demand Set: Site Development Traffic PM - LV
Modelling Period: 17:00-18:00

Segment: 17:00-17:15

Arm	Flow (veh/interval)
Arm A	0.81
Arm B	3.25
Arm C	0.48
Arm D	0.74

Segment: 17:15-17:30

Arm	Flow (veh/interval)
Arm A	0.81
Arm B	3.25
Arm C	0.48
Arm D	0.74

Segment: 17:30-17:45

Arm	Flow (veh/interval)
Arm A	0.81
Arm B	3.25
Arm C	0.48
Arm D	0.74

Segment: 17:45-18:00

Arm	Flow (veh/interval)
Arm A	0.81
Arm B	3.25
Arm C	0.48
Arm D	0.74

Demand Set: Site Development Traffic AM - HV
Modelling Period: 07:45-08:45

Segment: 07:45-08:00

Arm	Flow (veh/interval)
Arm A	0.35
Arm B	1.00
Arm C	0.95
Arm D	0.00

Segment: 08:00-08:15

Arm	Flow (veh/interval)
Arm A	0.35
Arm B	1.00
Arm C	0.95
Arm D	0.00

Segment: 08:15-08:30

Arm	Flow (veh/interval)
Arm A	0.35
Arm B	1.00
Arm C	0.95
Arm D	0.00

Segment: 08:30-08:45

Arm	Flow (veh/interval)
Arm A	0.35
Arm B	1.00
Arm C	0.95
Arm D	0.00

Demand Set: Site Development Traffic PM - HV
Modelling Period: 17:00-18:00

Segment: 17:00-17:15

Arm	Flow (veh/interval)
Arm A	0.12
Arm B	0.87
Arm C	0.32
Arm D	0.00

Segment: 17:15-17:30

Arm	Flow (veh/interval)
Arm A	0.12
Arm B	0.87
Arm C	0.32
Arm D	0.00

Segment: 17:30-17:45

Arm	Flow (veh/interval)
Arm A	0.12
Arm B	0.87
Arm C	0.32
Arm D	0.00

Segment: 17:45-18:00

Arm	Flow (veh/interval)
Arm A	0.12
Arm B	0.87
Arm C	0.32
Arm D	0.00

Turning Counts

Demand Set: Opening Year +15 - AM (2034)
Modelling Period: 07:45-08:45

From/To	Arm A	Arm B	Arm C	Arm D
Arm A	-	10	174	20
Arm B	2	-	10	5
Arm C	45	9	-	0
Arm D	1	1	6	-

Demand Set: Opening Year +15 - PM (2034)
Modelling Period: 17:00-18:00

From/To	Arm A	Arm B	Arm C	Arm D
Arm A	-	3	65	12
Arm B	5	-	7	1
Arm C	140	1	-	5
Arm D	34	9	3	-

Demand Set: Site Development Traffic AM - LV
Modelling Period: 07:45-08:45

From/To	Arm A	Arm B	Arm C	Arm D
Arm A	-	6	0	0
Arm B	4	-	3	3
Arm C	0	4	-	0
Arm D	0	6	0	-

Demand Set: Site Development Traffic PM - LV
Modelling Period: 17:00-18:00

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	-	4	0	0
Arm B	6	-	4	4
Arm C	0	2	-	0
Arm D	0	3	0	-

Demand Set: Site Development Traffic AM - HV
Modelling Period: 07:45-08:45

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	-	2	0	0
Arm B	1	-	4	0
Arm C	0	4	-	0
Arm D	0	0	0	-

Demand Set: Site Development Traffic PM - HV
Modelling Period: 17:00-18:00

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	-	1	0	0
Arm B	1	-	3	0
Arm C	0	2	-	0
Arm D	0	0	0	-

Turning proportions are calculated from turning count data

Turning Proportions

Demand Set: Opening Year +15 - AM (2034)
Modelling Period: 07:45-08:45

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	0.000	0.049	0.853	0.098
Arm B	0.118	0.000	0.588	0.294
Arm C	0.833	0.167	0.000	0.000
Arm D	0.125	0.125	0.750	0.000

Demand Set: Opening Year +15 - PM (2034)
Modelling Period: 17:00-18:00

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	0.000	0.038	0.813	0.150
Arm B	0.385	0.000	0.538	0.077
Arm C	0.959	0.007	0.000	0.034
Arm D	0.739	0.196	0.065	0.000

Demand Set: Site Development Traffic AM - LV
Modelling Period: 07:45-08:45

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	0.000	1.000	0.000	0.000
Arm B	0.200	0.000	0.800	0.000
Arm C	0.000	1.000	0.000	0.000
Arm D	0.000	0.000	0.000	0.000

Demand Set: Site Development Traffic PM - LV
Modelling Period: 17:00-18:00

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	0.000	1.000	0.000	0.000
Arm B	0.429	0.000	0.286	0.286
Arm C	0.000	1.000	0.000	0.000
Arm D	0.000	1.000	0.000	0.000

Demand Set: Site Development Traffic AM - HV
Modelling Period: 07:45-08:45

From / To

Demand Set: Site Development Traffic PM - HV
Modelling Period: 17:00-18:00

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	0.000	1.000	0.000	0.000
Arm B	0.250	0.000	0.750	0.000
Arm C	0.000	1.000	0.000	0.000
Arm D	0.000	0.000	0.000	0.000

Heavy Vehicles Percentages

Demand Set: Opening Year +15 - AM (2034)
Modelling Period: 07:45-08:45

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	-	14.9	0.8	0.0
Arm B	0.0	-	29.0	0.0
Arm C	3.1	47.9	-	0.0
Arm D	0.0	0.0	0.0	-

Demand Set: Opening Year +15 - PM (2034)
Modelling Period: 17:00-18:00

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	-	0.0	4.3	0.0
Arm B	0.0	-	38.0	0.0
Arm C	0.0	0.0	-	0.0
Arm D	0.0	0.0	0.0	-

Demand Set: Site Development Traffic AM - LV
Modelling Period: 07:45-08:45

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	-	0.0	0.0	0.0
Arm B	0.0	-	0.0	0.0
Arm C	0.0	0.0	-	0.0
Arm D	0.0	0.0	0.0	-

Demand Set: Site Development Traffic PM - LV
Modelling Period: 17:00-18:00

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	-	0.0	0.0	0.0
Arm B	0.0	-	0.0	0.0
Arm C	0.0	0.0	-	0.0
Arm D	0.0	0.0	0.0	-

Demand Set: Site Development Traffic AM - HV
Modelling Period: 07:45-08:45

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	-	100.0	100.0	100.0
Arm B	100.0	-	100.0	100.0
Arm C	100.0	100.0	-	100.0
Arm D	100.0	100.0	100.0	-

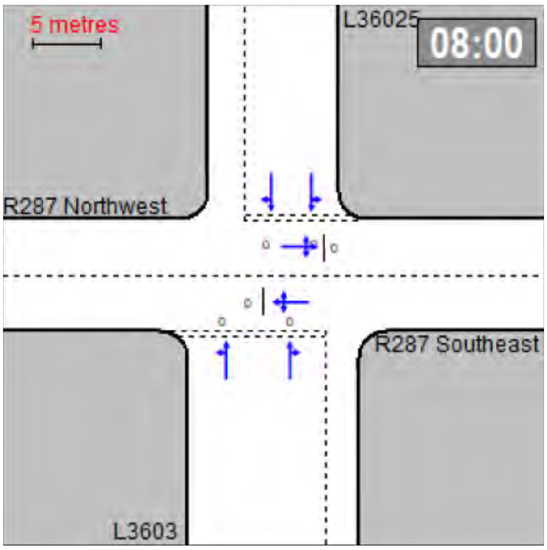
Demand Set: Site Development Traffic PM - HV
Modelling Period: 17:00-18:00

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	-	100.0	100.0	100.0
Arm B	100.0	-	100.0	100.0
Arm C	100.0	100.0	-	100.0
Arm D	100.0	100.0	100.0	-

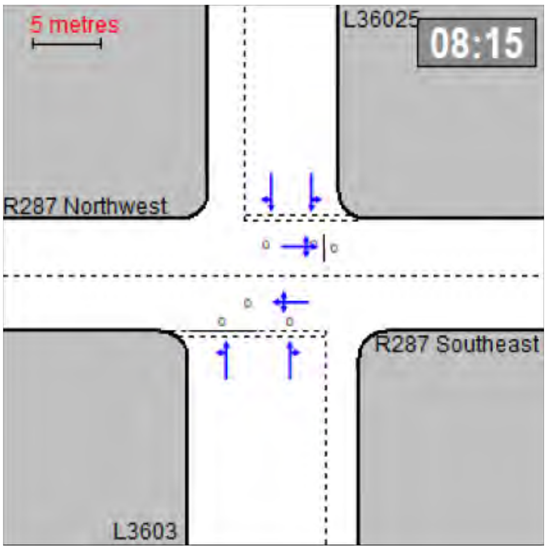
Queue Diagrams

Demand Set: Sum of Demand Sets for Modelling Period: 07:45 - 08:45
Modelling Period: 07:45-08:45
View Extent: 40m

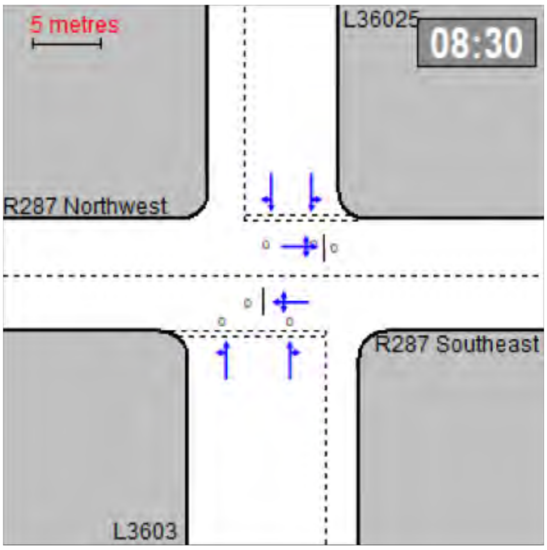
Queue Interval 1: 07:45-08:00



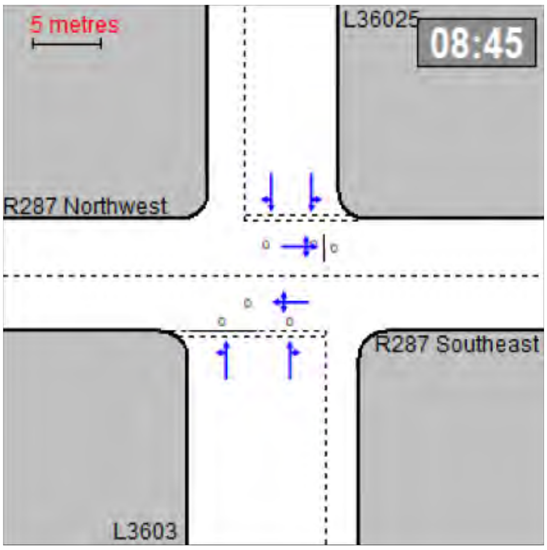
Queue Interval 2: 08:00-08:15



Queue Interval 3: 08:15-08:30

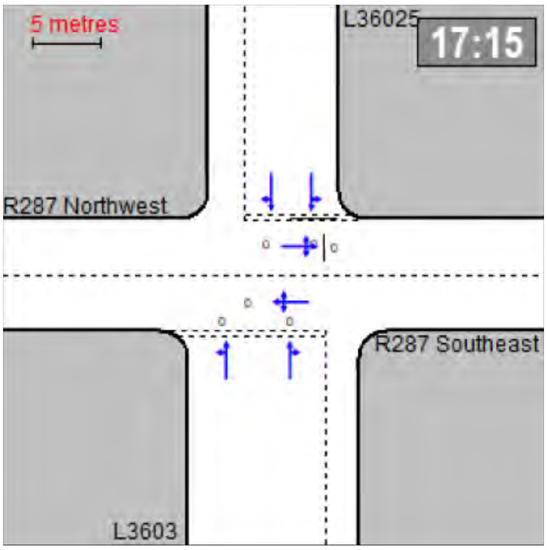


Queue Interval 4: 08:30-08:45

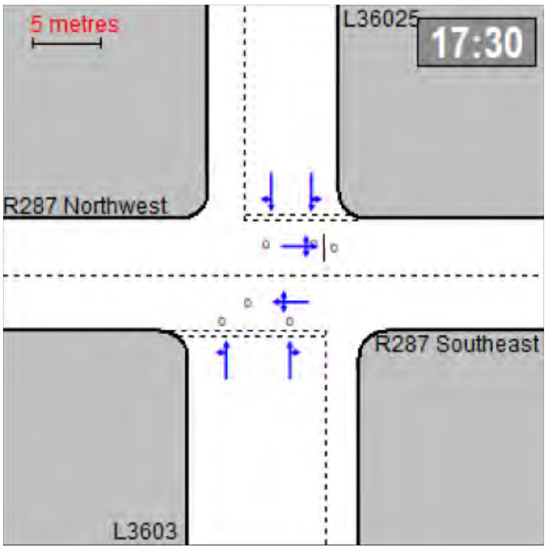


Demand Set: Sum of Demand Sets for Modelling Period: 17:00 - 18:00
Modelling Period: 17:00-18:00
View Extent: 40m

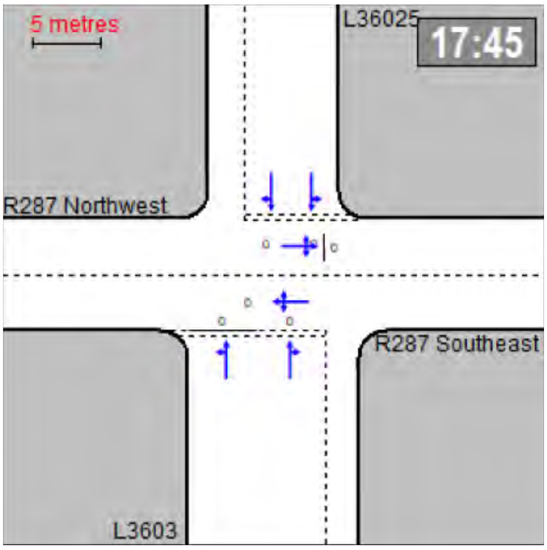
Queue Interval 1: 17:00-17:15



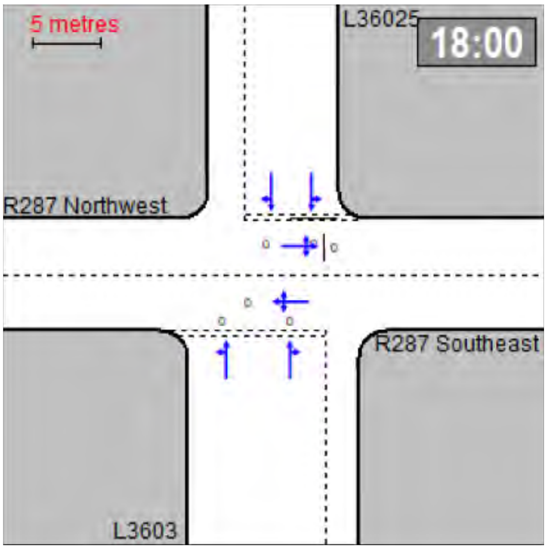
Queue Interval 2: 17:15-17:30



Queue Interval 3: 17:30-17:45

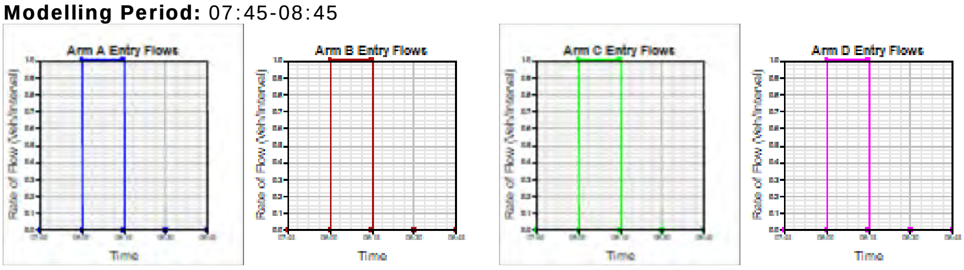


Queue Interval 4: 17:45-18:00

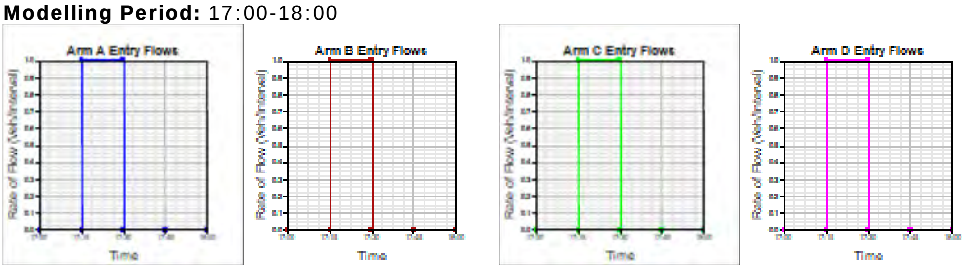


Demand Data Graph

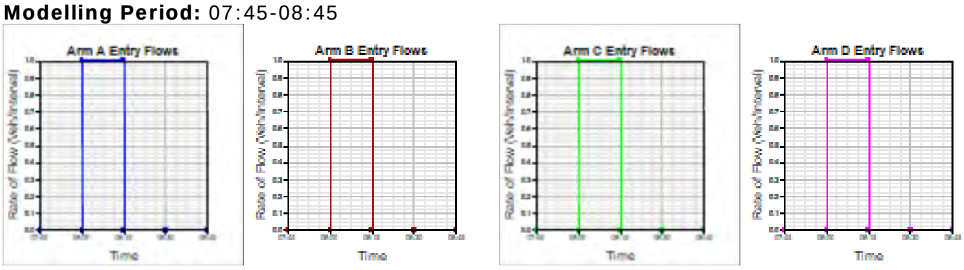
Demand Set: Opening Year +15 - AM (2034)
Modelling Period: 07:45-08:45



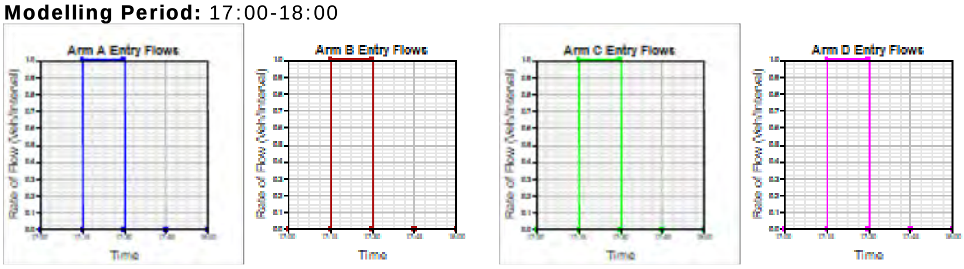
Demand Set: Opening Year +15 - PM (2034)
Modelling Period: 17:00-18:00



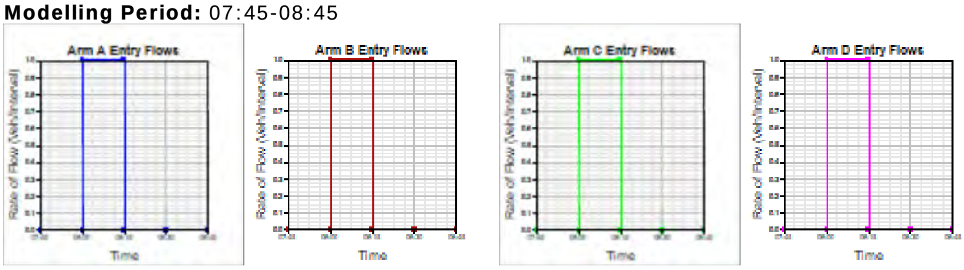
Demand Set: Site Development Traffic AM - LV
Modelling Period: 07:45-08:45



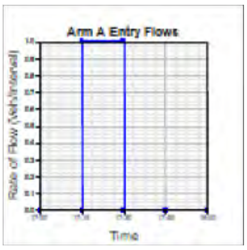
Demand Set: Site Development Traffic PM - LV
Modelling Period: 17:00-18:00

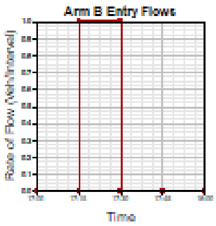


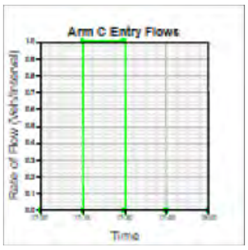
Demand Set: Site Development Traffic AM - HV
Modelling Period: 07:45-08:45

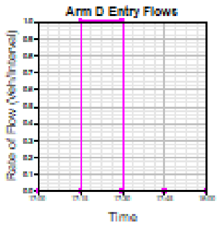


Demand Set: Site Development Traffic PM - HV
Modelling Period: 17:00-18:00


Arm A Entry Flows
Rate of Flow (Veh/Interval)
Time

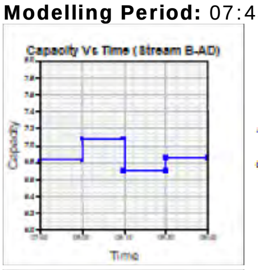

Arm B Entry Flows
Rate of Flow (Veh/Interval)
Time

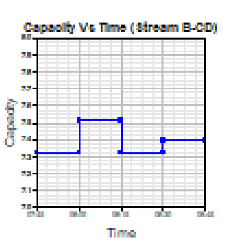

Arm C Entry Flows
Rate of Flow (Veh/Interval)
Time

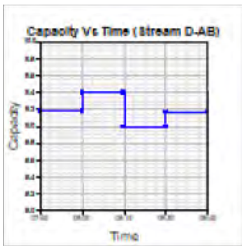

Arm D Entry Flows
Rate of Flow (Veh/Interval)
Time

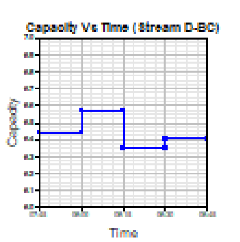
Capacity Graph

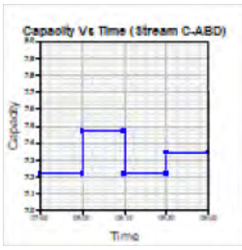
Demand Set: Sum of Demand Sets for Modelling Period: 07:45 - 08:45
Modelling Period: 07:45-08:45

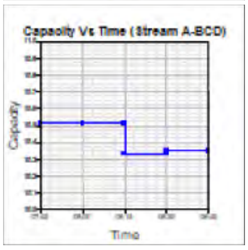




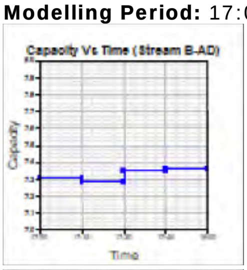


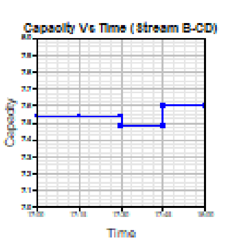


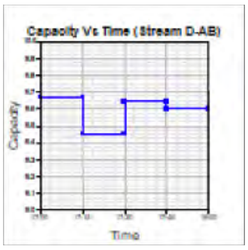


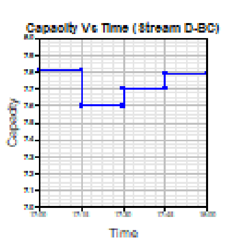


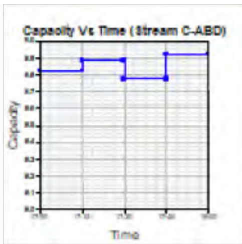
Demand Set: Sum of Demand Sets for Modelling Period: 17:00 - 18:00
Modelling Period: 17:00-18:00

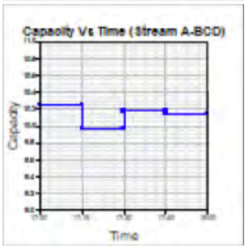






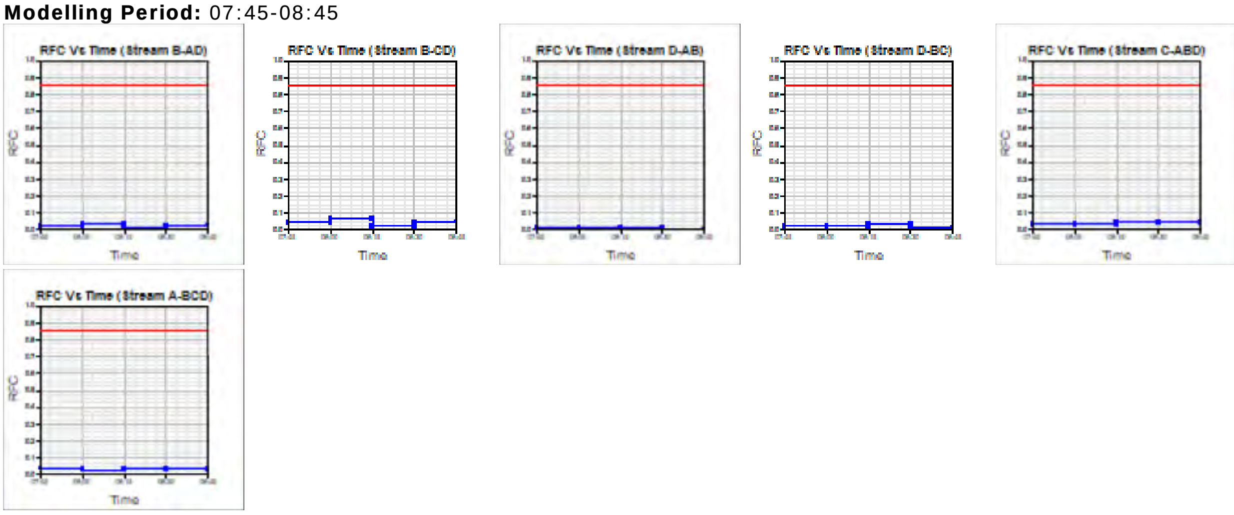




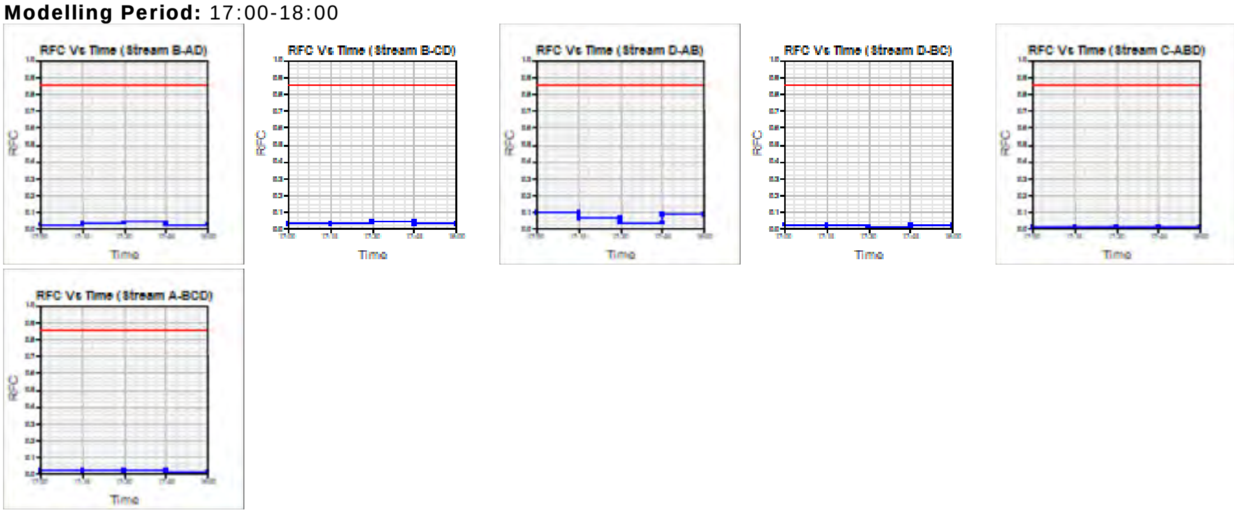


RFC Graph

Demand Set: Sum of Demand Sets for Modelling Period: 07:45 - 08:45
Modelling Period: 07:45-08:45

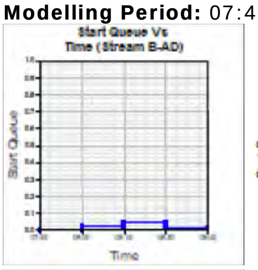


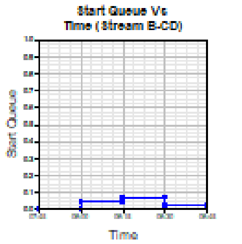
Demand Set: Sum of Demand Sets for Modelling Period: 17:00 - 18:00
Modelling Period: 17:00-18:00

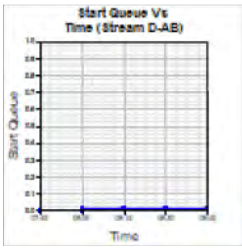


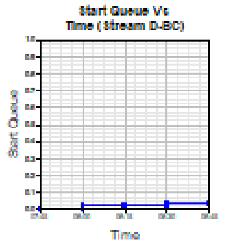
Start Queue Graph

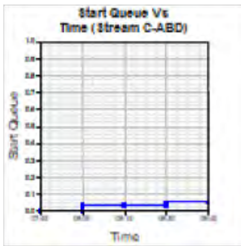
Demand Set: Sum of Demand Sets for Modelling Period: 07:45 - 08:45
Modelling Period: 07:45-08:45

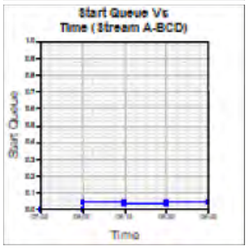




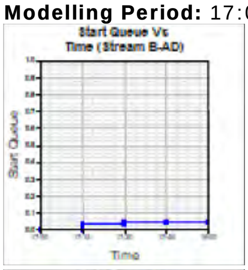


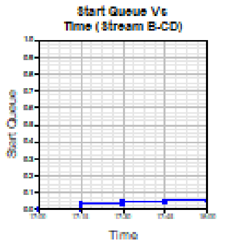


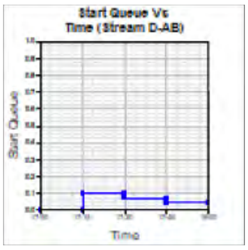


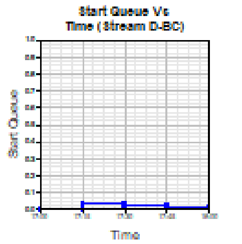


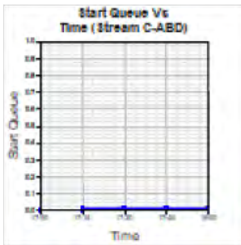
Demand Set: Sum of Demand Sets for Modelling Period: 17:00 - 18:00
Modelling Period: 17:00-18:00

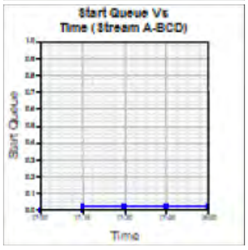






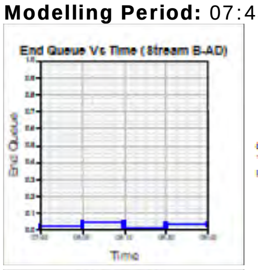


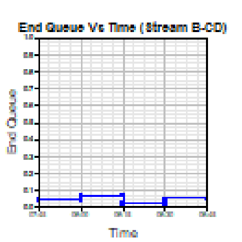


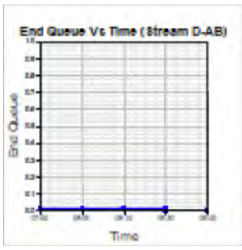


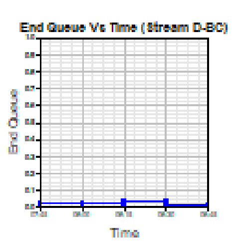
End Queue Graph

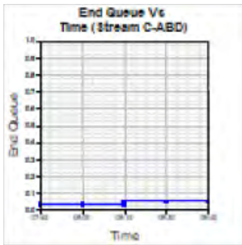
Demand Set: Sum of Demand Sets for Modelling Period: 07:45 - 08:45
Modelling Period: 07:45-08:45

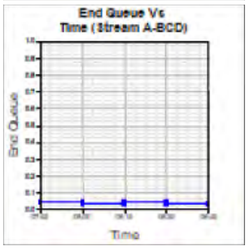




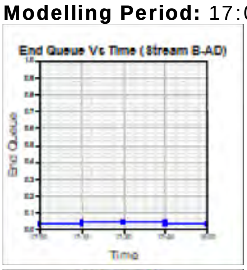


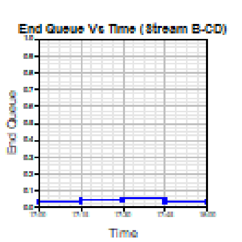


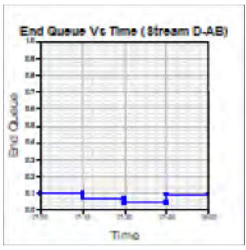


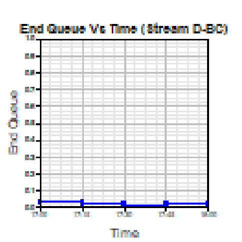


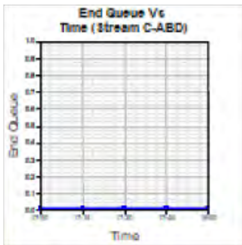
Demand Set: Sum of Demand Sets for Modelling Period: 17:00 - 18:00
Modelling Period: 17:00-18:00

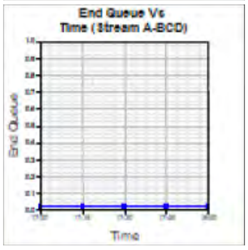






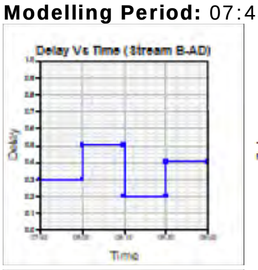


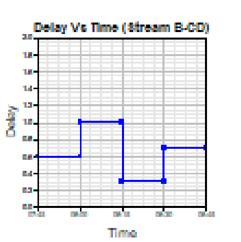


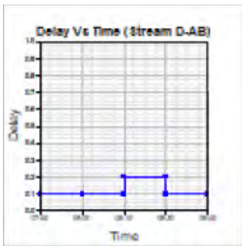


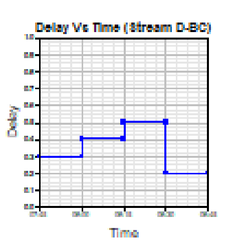
Delay Graph

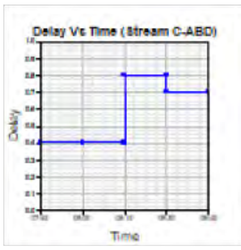
Demand Set: Sum of Demand Sets for Modelling Period: 07:45 - 08:45
Modelling Period: 07:45-08:45

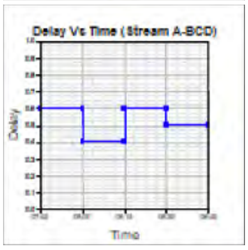




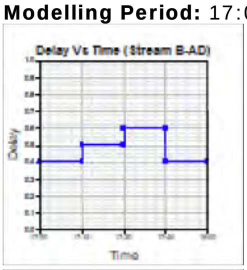


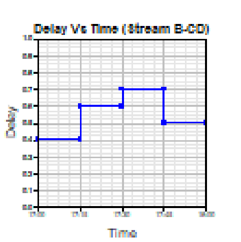


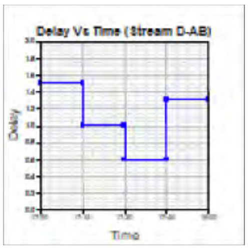


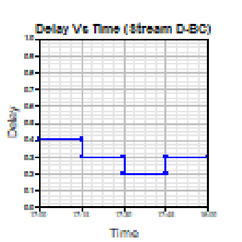


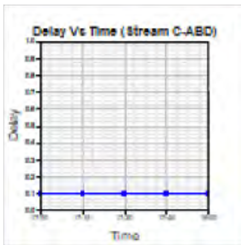
Demand Set: Sum of Demand Sets for Modelling Period: 17:00 - 18:00
Modelling Period: 17:00-18:00

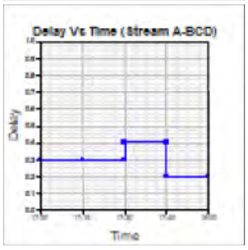












Queues & Delays

Demand Set: Sum of Demand Sets for Modelling Period: 07:45 - 08:45
Modelling Period: 07:45-08:45

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/segment)	Delay (veh.min/segment)	Mean Arriving Vehicle Delay (min)
07:45-08:00	B-AD	0.16	6.82	0.023	-	0.00	0.02	-	0.3	0.15
	B-CD	0.31	7.32	0.043	-	0.00	0.04	-	0.6	0.14
	D-AB	0.07	9.17	0.008	-	0.00	0.01	-	0.1	0.11
	D-BC	0.15	6.44	0.023	-	0.00	0.02	-	0.3	0.16
	C-ABD	0.21	7.22	0.029	-	0.00	0.03	-	0.4	0.14
	C-A	-	-	-	-	-	-	-	-	-
	C-D	-	-	-	-	-	-	-	-	-
	A-BCD	0.38	10.51	0.036	-	0.00	0.04	-	0.6	0.10
	A-B	-	-	-	-	-	-	-	-	-
	A-C	-	-	-	-	-	-	-	-	-

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/segment)	Delay (veh.min/segment)	Mean Arriving Vehicle Delay (min)
08:00-08:15	B-AD	0.24	7.08	0.035	-	0.02	0.04	-	0.5	0.15
	B-CD	0.49	7.51	0.065	-	0.04	0.07	-	1.0	0.14
	D-AB	0.07	9.39	0.008	-	0.01	0.01	-	0.1	0.11
	D-BC	0.15	6.57	0.023	-	0.02	0.02	-	0.4	0.16
	C-ABD	0.21	7.47	0.028	-	0.03	0.03	-	0.4	0.14
	C-A	-	-	-	-	-	-	-	-	-
	C-D	-	-	-	-	-	-	-	-	-
	A-BCD	0.26	10.51	0.025	-	0.04	0.03	-	0.4	0.10
	A-B	-	-	-	-	-	-	-	-	-
	A-C	-	-	-	-	-	-	-	-	-

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/segment)	Delay (veh.min/segment)	Mean Arriving Vehicle Delay (min)
08:15-08:30	B-AD	0.07	6.69	0.010	-	0.04	0.01	-	0.2	0.15
	B-CD	0.13	7.32	0.018	-	0.07	0.02	-	0.3	0.14
	D-AB	0.10	8.99	0.011	-	0.01	0.01	-	0.2	0.11
	D-BC	0.20	6.35	0.031	-	0.02	0.03	-	0.5	0.16
	C-ABD	0.35	7.22	0.049	-	0.03	0.05	-	0.8	0.15
	C-A	-	-	-	-	-	-	-	-	-
	C-D	-	-	-	-	-	-	-	-	-
	A-BCD	0.38	10.33	0.037	-	0.03	0.04	-	0.6	0.10
	A-B	-	-	-	-	-	-	-	-	-
	A-C	-	-	-	-	-	-	-	-	-

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/segment)	Delay (veh.min/segment)	Mean Arriving Vehicle Delay (min)
08:30-08:45	B-AD	0.18	6.85	0.026	-	0.01	0.03	-	0.4	0.15
	B-CD	0.36	7.39	0.048	-	0.02	0.05	-	0.7	0.14
	D-AB	0.03	9.16	0.003	-	0.01	0.00	-	0.1	0.11
	D-BC	0.06	6.40	0.010	-	0.03	0.01	-	0.2	0.16
	C-ABD	0.33	7.34	0.045	-	0.05	0.05	-	0.7	0.14
	C-A	-	-	-	-	-	-	-	-	-

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/segment)	Delay (veh.min/segment)	Mean Arriving Vehicle Delay (min)
	C-D	-	-	-	-	-	-	-	-	-
	A-BCD	0.32	10.35	0.031	-	0.04	0.03	-	0.5	0.10
	A-B	-	-	-	-	-	-	-	-	-
	A-C	-	-	-	-	-	-	-	-	-

Demand Set: Sum of Demand Sets for Modelling Period: 17:00 - 18:00
Modelling Period: 17:00-18:00

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/segment)	Delay (veh.min/segment)	Mean Arriving Vehicle Delay (min)
17:00-17:15	B-AD	0.19	7.31	0.026	-	0.00	0.03	-	0.4	0.14
	B-CD	0.22	7.54	0.029	-	0.00	0.03	-	0.4	0.14
	D-AB	0.91	9.67	0.094	-	0.00	0.10	-	1.5	0.11
	D-BC	0.20	7.81	0.026	-	0.00	0.03	-	0.4	0.13
	C-ABD	0.06	8.82	0.007	-	0.00	0.01	-	0.1	0.11
	C-A	-	-	-	-	-	-	-	-	-
	C-D	-	-	-	-	-	-	-	-	-
	A-BCD	0.22	10.25	0.021	-	0.00	0.02	-	0.3	0.10
	A-B	-	-	-	-	-	-	-	-	-
	A-C	-	-	-	-	-	-	-	-	-

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/segment)	Delay (veh.min/segment)	Mean Arriving Vehicle Delay (min)
17:15-17:30	B-AD	0.25	7.28	0.035	-	0.03	0.04	-	0.5	0.14
	B-CD	0.29	7.54	0.038	-	0.03	0.04	-	0.6	0.14
	D-AB	0.59	9.45	0.062	-	0.10	0.07	-	1.0	0.11
	D-BC	0.13	7.60	0.017	-	0.03	0.02	-	0.3	0.13
	C-ABD	0.09	8.88	0.010	-	0.01	0.01	-	0.1	0.11
	C-A	-	-	-	-	-	-	-	-	-
	C-D	-	-	-	-	-	-	-	-	-
	A-BCD	0.18	9.97	0.018	-	0.02	0.02	-	0.3	0.10
	A-B	-	-	-	-	-	-	-	-	-
	A-C	-	-	-	-	-	-	-	-	-

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/ segment)	Delay (veh.min/ segment)	Mean Arriving Vehicle Delay (min)
17:30-17:45	B-AD	0.28	7.35	0.039	-	0.04	0.04	-	0.6	0.14
	B-CD	0.33	7.48	0.043	-	0.04	0.05	-	0.7	0.14
	D-AB	0.37	9.64	0.038	-	0.07	0.04	-	0.6	0.11
	D-BC	0.08	7.70	0.011	-	0.02	0.01	-	0.2	0.13
	C-ABD	0.07	8.77	0.007	-	0.01	0.01	-	0.1	0.11
	C-A	-	-	-	-	-	-	-	-	-
	C-D	-	-	-	-	-	-	-	-	-
	A-BCD	0.25	10.18	0.024	-	0.02	0.02	-	0.4	0.10
	A-B	-	-	-	-	-	-	-	-	-
	A-C	-	-	-	-	-	-	-	-	-

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/ segment)	Delay (veh.min/ segment)	Mean Arriving Vehicle Delay (min)
17:45-18:00	B-AD	0.19	7.36	0.026	-	0.04	0.03	-	0.4	0.14
	B-CD	0.22	7.60	0.029	-	0.05	0.03	-	0.5	0.14
	D-AB	0.80	9.60	0.084	-	0.04	0.09	-	1.3	0.11
	D-BC	0.18	7.79	0.023	-	0.01	0.02	-	0.3	0.13
	C-ABD	0.07	8.92	0.008	-	0.01	0.01	-	0.1	0.11
	C-A	-	-	-	-	-	-	-	-	-
	C-D	-	-	-	-	-	-	-	-	-
	A-BCD	0.16	10.14	0.016	-	0.02	0.02	-	0.2	0.10
	A-B	-	-	-	-	-	-	-	-	-
	A-C	-	-	-	-	-	-	-	-	-

Entry capacities marked with an '(X)' are dominated by a pedestrian crossing in that time segment.
In time segments marked with a '(B)', traffic leaving the junction may block back from a crossing so impairing normal operation of the junction.
Delays marked with '##' could not be calculated.

Overall Queues & Delays

Queueing Delay Information Over Whole Period

Demand Set: Sum of Demand Sets for Modelling Period: 07:45 - 08:45
Modelling Period: 07:45-08:45

Stream	Total Demand (veh)	Total Demand (veh/h)	Queueing Delay (min)	Queueing Delay (min/veh)	Inclusive Delay (min)	Inclusive Delay (min/veh)
B-AD	9.7	9.7	1.4	0.1	1.4	0.1
B-CD	19.4	19.4	2.7	0.1	2.7	0.1
D-AB	4.1	4.1	0.4	0.1	0.4	0.1
D-BC	8.4	8.4	1.3	0.2	1.3	0.2
C-ABD	16.5	16.5	2.4	0.1	2.4	0.1
C-A	-	-	-	-	-	-
C-D	-	-	-	-	-	-
A-BCD	20.0	20.0	2.0	0.1	2.0	0.1
A-B	315.4	315.4	10.2	0.0	10.2	0.0
A-C	-	-	-	-	-	-
All	**-**	**-**	**-**	**-**	**-**	**-**

Demand Set: Sum of Demand Sets for Modelling Period: 17:00 - 18:00
Modelling Period: 17:00-18:00

Stream	Total Demand (veh)	Total Demand (veh/h)	Queueing Delay (min)	Queueing Delay (min/veh)	Inclusive Delay (min)	Inclusive Delay (min/veh)
B-AD	13.7	13.7	1.9	0.1	1.9	0.1
B-CD	15.7	15.7	2.1	0.1	2.1	0.1
D-AB	40.0	40.0	4.5	0.1	4.5	0.1
D-BC	8.9	8.9	1.2	0.1	1.2	0.1
C-ABD	4.2	4.2	0.5	0.1	0.5	0.1
C-A	-	-	-	-	-	-
C-D	-	-	-	-	-	-
A-BCD	12.2	12.2	1.2	0.1	1.2	0.1
A-B	312.4	312.4	11.4	0.0	11.4	0.0
A-C	-	-	-	-	-	-
All	**-**	**-**	**-**	**-**	**-**	**-**

Delay is that occurring only within the time period.
Inclusive delay includes delay suffered by vehicles which are still queuing after the end of the time period.
These will only be significantly different if there is a large queue remaining at the end of the time period.

PICADY 5 Run Successful

PICADY

GUI Version: 5.1 AE
Analysis Program Release: 5.0 (MAY 2010)

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Web: www.trlsoftware.co.uk

The user of this computer program for the solution of an engineering problem is in no way relieved of their responsibility for the correctness of the solution

Run Analysis

Parameter	Values
File Run	C:\Users\obriend\Desktop\temp\P18-014-Junction2.vpi
Date Run	18 June 2018
Time Run	15:14:03
Driving Side	Drive On The Left

Arm Names and Flow Scaling Factors

Arm	Arm Name	Flow Scaling Factor (%)
Arm A	L3603 East	100
Arm B	Quarry Access	100
Arm C	L3603 West	100

Stream Labelling Convention

Stream A-B contains traffic going from A to B etc.

Run Information

Parameter	Values
Run Title	P18-014-Junction 2
Location	Co.Sligo
Date	07 March 2018
Enumerator	obriend [PMCE11]
Job Number	P18-014
Status	-
Client	Lagan Asphalt Group
Description	Aughamore Quarry Co.Sligo - Junction 2 Quarry Access

Errors and Warnings

Parameter	Values
Warning	No Errors Or Warnings

Geometric Data

Geometric Parameters

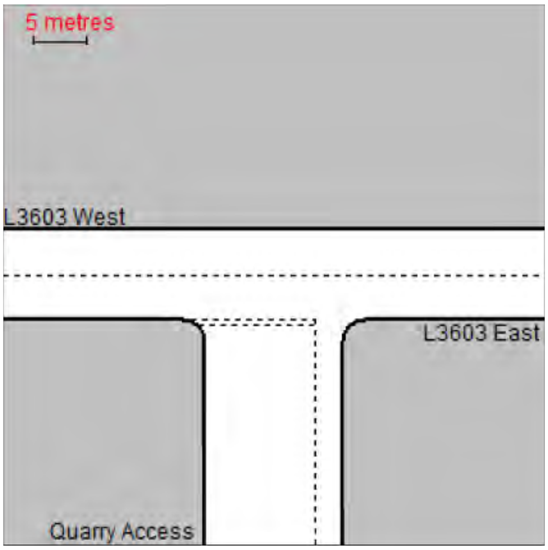
Parameter	Minor Arm B
Major Road Carriageway Width (m)	6.00
Major Road Kerbed Central Reserve Width (m)	0.00
Major Road Right Turning Lane Width (m)	2.20
Minor Road Width 0m Back from Junction (m)	10.00
Minor Road Width 5m Back from Junction (m)	7.65
Minor Road Width 10m Back from Junction (m)	4.55
Minor Road Width 15m Back from Junction (m)	3.65
Minor Road Width 20m Back from Junction (m)	3.50
Minor Road Derived Flare Length (PCU)	1.000
Minor Road Visibility To Right (m)	5
Minor Road Visibility To Left (m)	5
Major Road Right Turn Visibility (m)	110
Major Road Right Turn Blocks Traffic	Yes (if over 1 veh)

Slope and Intercept Values

Stream	Intercept for Stream	Slope for A-B	Slope for A-C	Slope for C-A	Slope for C-B
B-A	0.000	0.000	0.000	0.000	0.000
B-C	0.000	0.000	0.000	-	-
C-B	637.665	0.247	0.247	-	-

Note: Streams may be combined in which case capacity will be adjusted
These values do not allow for any site-specific corrections

Junction Diagram



Demand Data

Modelling Periods

Parameter	Period	Duration (min)	Segment Length (min)
First Modelling Period	08:00-09:00	60	15
Second Modelling Period	16:45-17:45	60	15

Direct Entry Flows

Demand Set: Opening Year (2034) - AM Peak
Modelling Period: 08:00-09:00

Segment: 08:00-08:15

Arm	Flow (veh/interval)
Arm A	4.00
Arm B	0.00
Arm C	8.00

Segment: 08:15-08:30

Arm	Flow (veh/interval)
Arm A	3.00
Arm B	0.00
Arm C	0.00

Segment: 08:30-08:45

Arm	Flow (veh/interval)
Arm A	5.00
Arm B	0.00
Arm C	5.00

Segment: 08:45-09:00

Arm	Flow (veh/interval)
Arm A	3.00
Arm B	0.00
Arm C	9.00

Demand Set: Opening Year (2034) - PM Peak
Modelling Period: 16:45-17:45

Segment: 16:45-17:00

Arm	Flow (veh/interval)
Arm A	8.00
Arm B	0.00
Arm C	2.00

Segment: 17:00-17:15

Arm	Flow (veh/interval)
Arm A	8.00
Arm B	0.00
Arm C	2.00

Segment: 17:15-17:30

Arm	Flow (veh/interval)
Arm A	2.00
Arm B	0.00
Arm C	4.00

Segment: 17:30-17:45

Arm	Flow (veh/interval)
Arm A	3.00
Arm B	0.00
Arm C	5.00

Demand Set: Site Development Traffic AM - LV
Modelling Period: 08:00-09:00

Segment: 08:00-08:15

Arm	Flow (veh/interval)
Arm A	3.76
Arm B	2.50
Arm C	0.24

Segment: 08:15-08:30

Arm	Flow (veh/interval)
Arm A	3.76
Arm B	2.50
Arm C	0.24

Segment: 08:30-08:45

Arm	Flow (veh/interval)
Arm A	3.76
Arm B	2.50
Arm C	0.24

Segment: 08:45-09:00

Arm	Flow (veh/interval)
Arm A	3.76
Arm B	2.50
Arm C	0.24

Demand Set: Site Development Traffic AM - HV
Modelling Period: 08:00-09:00

Segment: 08:00-08:15

Arm	Flow (veh/interval)
Arm A	1.27
Arm B	1.23
Arm C	0.08

Segment: 08:15-08:30

Arm	Flow (veh/interval)
Arm A	1.27
Arm B	1.23
Arm C	0.08

Segment: 08:30-08:45

Arm	Flow (veh/interval)
Arm A	1.27
Arm B	1.23
Arm C	0.08

Segment: 08:45-09:00

Arm	Flow (veh/interval)
Arm A	1.27
Arm B	1.23
Arm C	0.08

Demand Set: Site Development Traffic PM - LV
Modelling Period: 16:45-17:45

Segment: 16:45-17:00

Arm	Flow (veh/interval)
Arm A	2.03
Arm B	4.00
Arm C	0.15

Segment: 17:00-17:15

Arm	Flow (veh/interval)
Arm A	2.03
Arm B	4.00
Arm C	0.15

Segment: 17:15-17:30

Arm	Flow (veh/interval)
Arm A	2.03
Arm B	4.00
Arm C	0.15

Segment: 17:30-17:45

Arm	Flow (veh/interval)
Arm A	2.03
Arm B	4.00
Arm C	0.15

Demand Set: Site Development Traffic PM - HV
Modelling Period: 16:45-17:45

Segment: 16:45-17:00

Arm	Flow (veh/interval)
Arm A	0.44
Arm B	1.07
Arm C	0.03

Segment: 17:00-17:15

Arm	Flow (veh/interval)
Arm A	0.44
Arm B	1.07
Arm C	0.03

Segment: 17:15-17:30

Arm	Flow (veh/interval)
Arm A	0.44
Arm B	1.07
Arm C	0.03

Segment: 17:30-17:45

Arm	Flow (veh/interval)
Arm A	0.44
Arm B	1.07
Arm C	0.03

Turning Counts

Demand Set: Opening Year (2034) - AM Peak
Modelling Period: 08:00-09:00

From/To	Arm A	Arm B	Arm C
Arm A	-	0	15
Arm B	0	-	0
Arm C	22	0	-

Demand Set: Opening Year (2034) - PM Peak
Modelling Period: 16:45-17:45

From/To	Arm A	Arm B	Arm C
Arm A	-	0	22
Arm B	0	-	0
Arm C	13	0	-

Demand Set: Site Development Traffic AM - LV
Modelling Period: 08:00-09:00

From/To	Arm A	Arm B	Arm C
Arm A	-	16	0
Arm B	9	-	2
Arm C	0	1	-

Demand Set: Site Development Traffic AM - HV
Modelling Period: 08:00-09:00

From/To	Arm A	Arm B	Arm C
Arm A	-	6	0
Arm B	4	-	1
Arm C	0	1	-

Demand Set: Site Development Traffic PM - LV
Modelling Period: 16:45-17:45

From / To	Arm A	Arm B	Arm C
Arm A	-	9	0
Arm B	13	-	3
Arm C	0	1	-

Demand Set: Site Development Traffic PM - HV
Modelling Period: 16:45-17:45

From / To	Arm A	Arm B	Arm C
Arm A	-	2	0
Arm B	4	-	1
Arm C	0	1	-

Turning proportions are calculated from turning count data

Turning Proportions

Demand Set: Opening Year (2034) - AM Peak
Modelling Period: 08:00-09:00

From / To	Arm A	Arm B	Arm C
Arm A	0.000	0.000	1.000
Arm B	0.000	0.000	0.000
Arm C	1.000	0.000	0.000

Demand Set: Opening Year (2034) - PM Peak
Modelling Period: 16:45-17:45

From / To	Arm A	Arm B	Arm C
Arm A	0.000	0.000	1.000
Arm B	0.000	0.000	0.000
Arm C	1.000	0.000	0.000

Demand Set: Site Development Traffic AM - LV
Modelling Period: 08:00-09:00

From / To	Arm A	Arm B	Arm C
Arm A	0.000	1.000	0.000
Arm B	0.800	0.000	0.200
Arm C	0.000	1.000	0.000

Demand Set: Site Development Traffic AM - HV
Modelling Period: 08:00-09:00

From / To	Arm A	Arm B	Arm C
Arm A	0.000	1.000	0.000
Arm B	0.813	0.000	0.188
Arm C	0.000	1.000	0.000

Demand Set: Site Development Traffic PM - LV
Modelling Period: 16:45-17:45

From / To

Demand Set: Site Development Traffic PM - HV
Modelling Period: 16:45-17:45

From / To	Arm A	Arm B	Arm C
Arm A	0.000	1.000	0.000
Arm B	0.800	0.000	0.200
Arm C	0.000	1.000	0.000

Heavy Vehicles Percentages

Demand Set: Opening Year (2034) - AM Peak
Modelling Period: 08:00-09:00

From / To	Arm A	Arm B	Arm C
Arm A	-	0.0	29.0
Arm B	0.0	-	0.0
Arm C	6.0	0.0	-

Demand Set: Opening Year (2034) - PM Peak
Modelling Period: 16:45-17:45

From / To	Arm A	Arm B	Arm C
Arm A	-	0.0	6.5
Arm B	0.0	-	0.0
Arm C	21.5	0.0	-

Demand Set: Site Development Traffic AM - LV
Modelling Period: 08:00-09:00

From / To	Arm A	Arm B	Arm C
Arm A	-	0.0	0.0
Arm B	0.0	-	0.0
Arm C	0.0	0.0	-

Demand Set: Site Development Traffic AM - HV
Modelling Period: 08:00-09:00

From / To	Arm A	Arm B	Arm C
Arm A	-	100.0	100.0
Arm B	100.0	-	100.0
Arm C	100.0	100.0	-

Demand Set: Site Development Traffic PM - LV
Modelling Period: 16:45-17:45

From / To	Arm A	Arm B	Arm C
Arm A	-	0.0	0.0
Arm B	0.0	-	0.0
Arm C	0.0	0.0	-

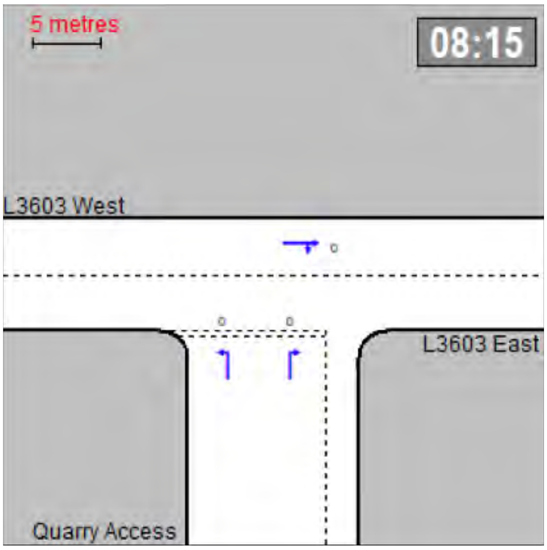
Demand Set: Site Development Traffic PM - HV
Modelling Period: 16:45-17:45

From / To	Arm A	Arm B	Arm C
Arm A	-	100.0	100.0
Arm B	100.0	-	100.0
Arm C	100.0	100.0	-

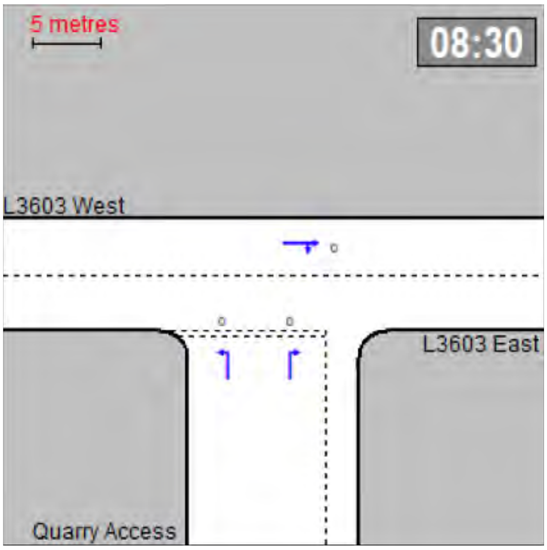
Queue Diagrams

Demand Set: Sum of Demand Sets for Modelling Period: 08:00 - 09:00
Modelling Period: 08:00-09:00
View Extent: 40m

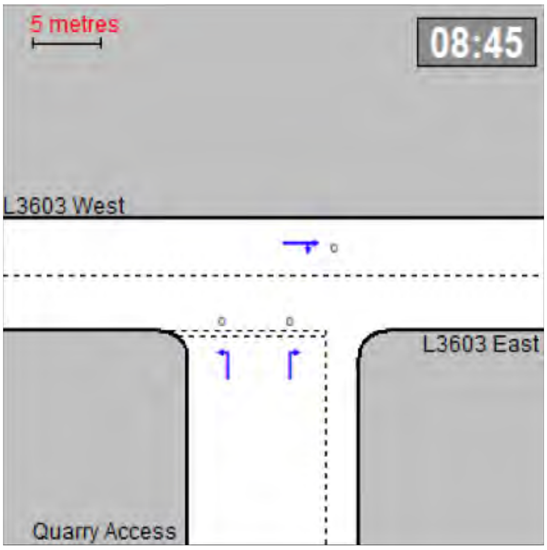
Queue Interval 1: 08:00-08:15



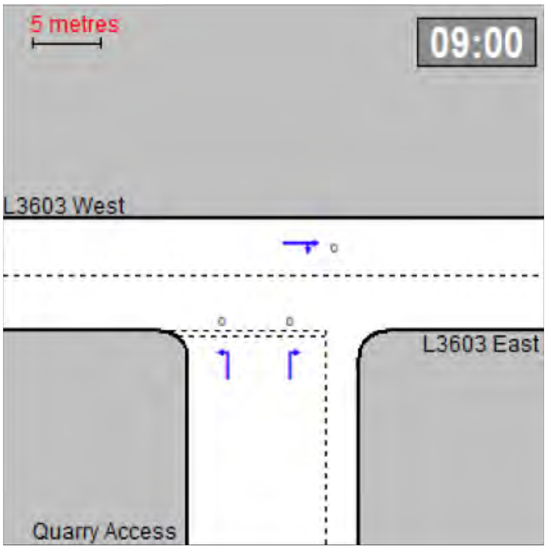
Queue Interval 2: 08:15-08:30



Queue Interval 3: 08:30-08:45

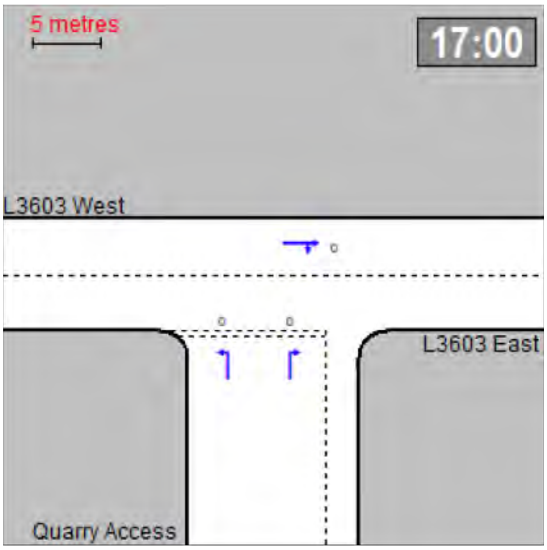


Queue Interval 4: 08:45-09:00

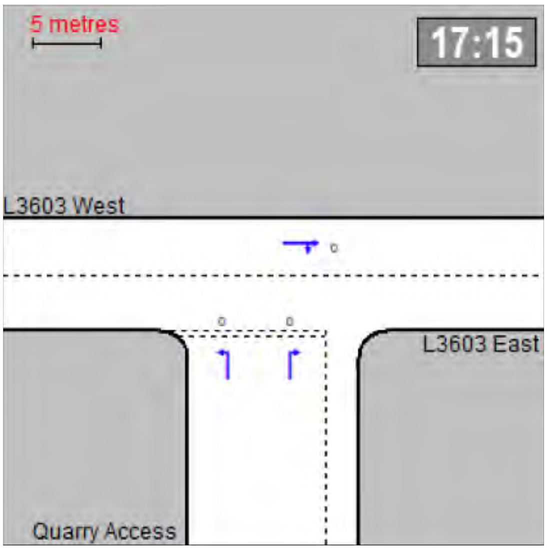


Demand Set: Sum of Demand Sets for Modelling Period: 16:45 - 17:45
Modelling Period: 16:45-17:45
View Extent: 40m

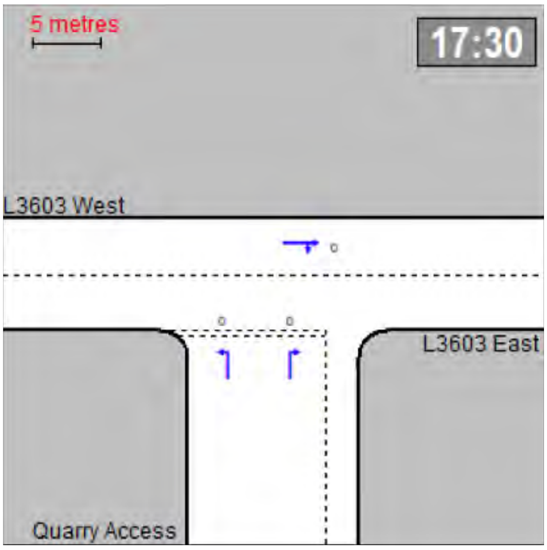
Queue Interval 1: 16:45-17:00



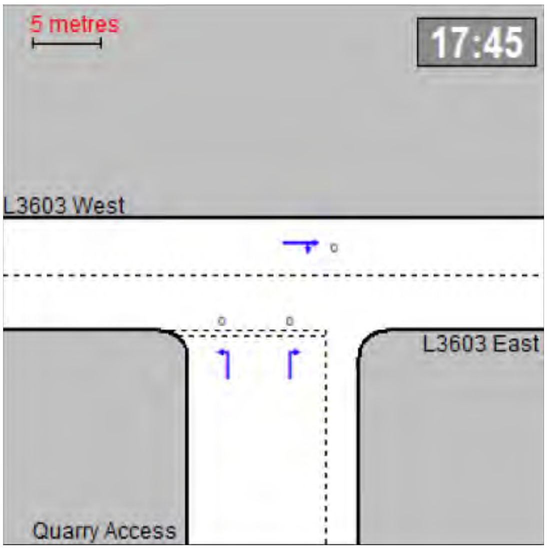
Queue Interval 2: 17:00-17:15



Queue Interval 3: 17:15-17:30

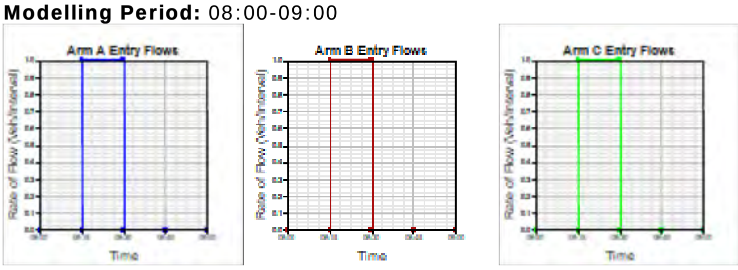


Queue Interval 4: 17:30-17:45

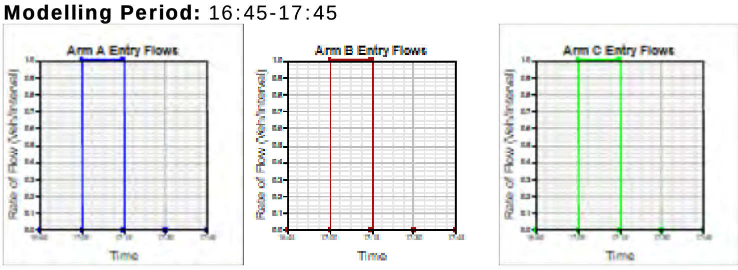


Demand Data Graph

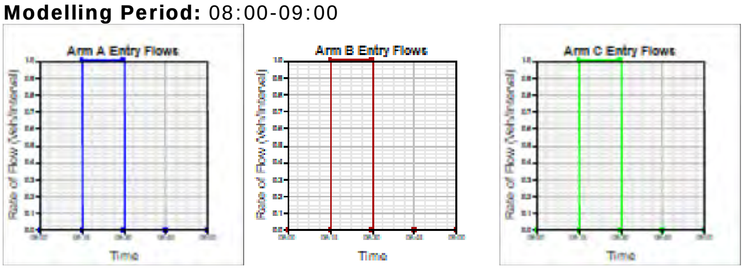
Demand Set: Opening Year (2034) - AM Peak
Modelling Period: 08:00-09:00



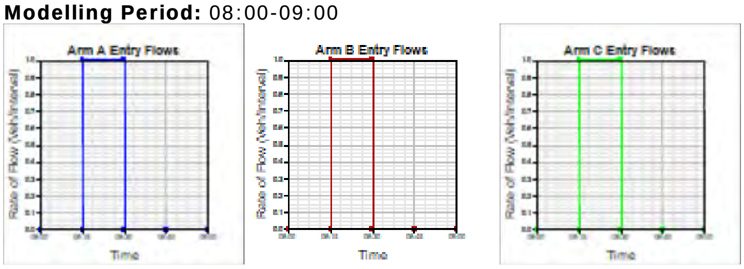
Demand Set: Opening Year (2034) - PM Peak
Modelling Period: 16:45-17:45



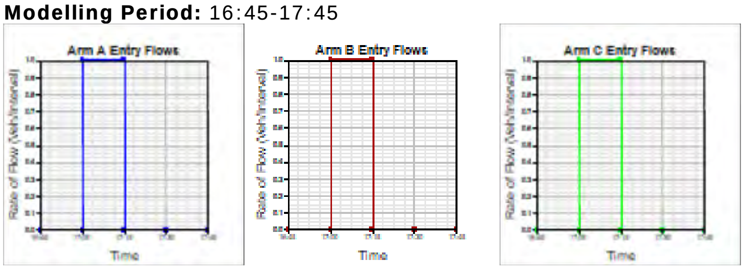
Demand Set: Site Development Traffic AM - LV
Modelling Period: 08:00-09:00



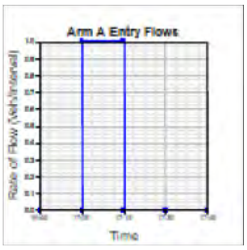
Demand Set: Site Development Traffic AM - HV
Modelling Period: 08:00-09:00

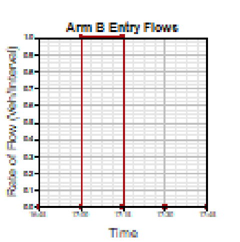


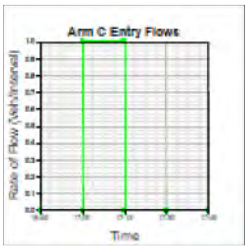
Demand Set: Site Development Traffic PM - LV
Modelling Period: 16:45-17:45



Demand Set: Site Development Traffic PM - HV
Modelling Period: 16:45-17:45

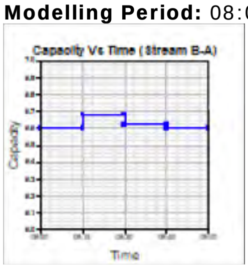


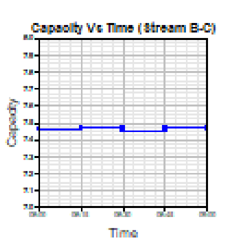


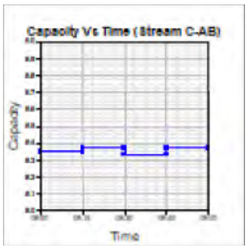


Capacity Graph

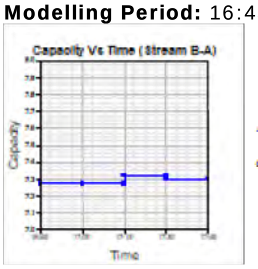
Demand Set: Sum of Demand Sets for Modelling Period: 08:00 - 09:00
Modelling Period: 08:00-09:00

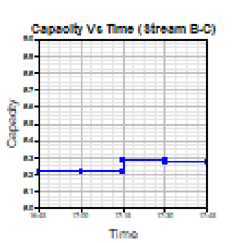


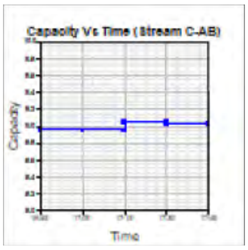




Demand Set: Sum of Demand Sets for Modelling Period: 16:45 - 17:45
Modelling Period: 16:45-17:45

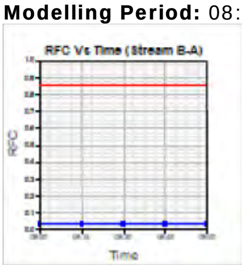


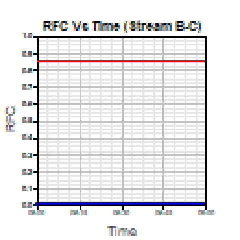


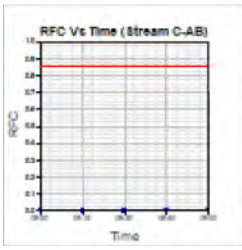


RFC Graph

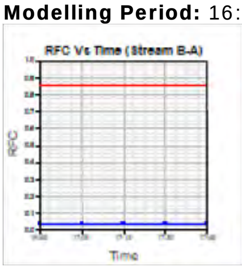
Demand Set: Sum of Demand Sets for Modelling Period: 08:00 - 09:00
Modelling Period: 08:00-09:00

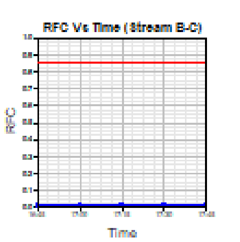


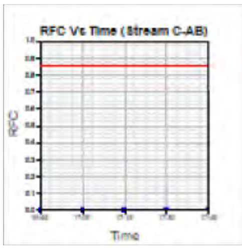




Demand Set: Sum of Demand Sets for Modelling Period: 16:45 - 17:45
Modelling Period: 16:45-17:45

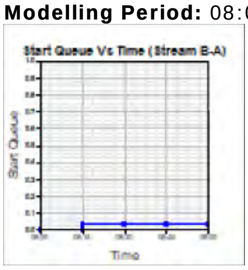


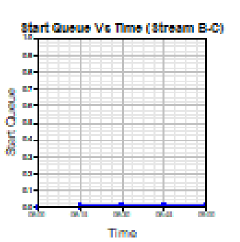


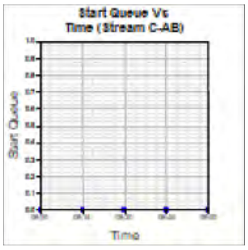


Start Queue Graph

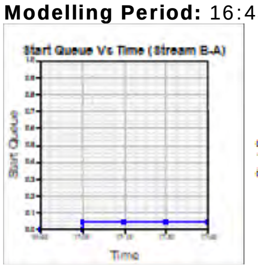
Demand Set: Sum of Demand Sets for Modelling Period: 08:00 - 09:00
Modelling Period: 08:00-09:00

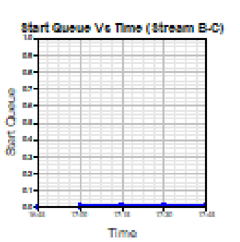


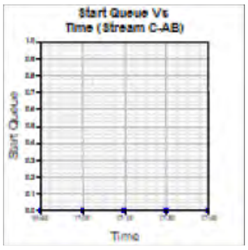




Demand Set: Sum of Demand Sets for Modelling Period: 16:45 - 17:45
Modelling Period: 16:45-17:45

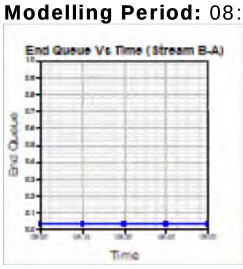


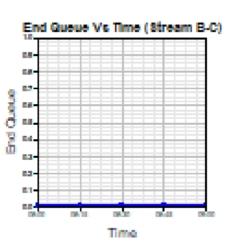


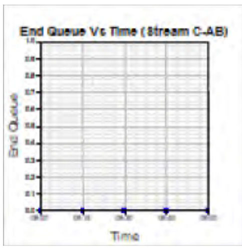


End Queue Graph

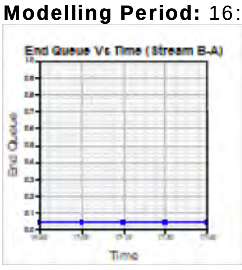
Demand Set: Sum of Demand Sets for Modelling Period: 08:00 - 09:00
Modelling Period: 08:00-09:00

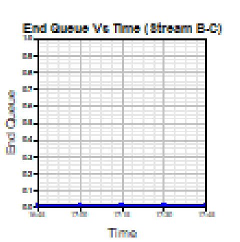


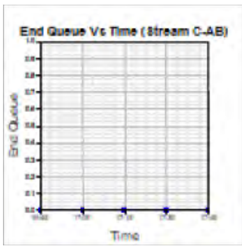




Demand Set: Sum of Demand Sets for Modelling Period: 16:45 - 17:45
Modelling Period: 16:45-17:45

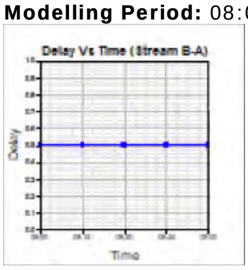


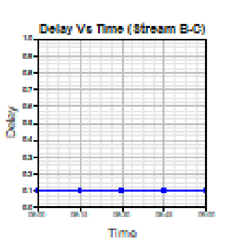


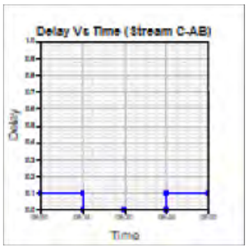


Delay Graph

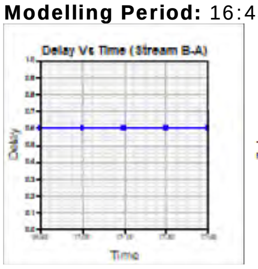
Demand Set: Sum of Demand Sets for Modelling Period: 08:00 - 09:00
Modelling Period: 08:00-09:00

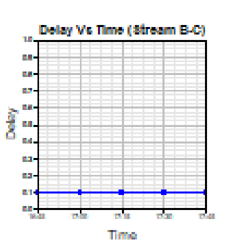


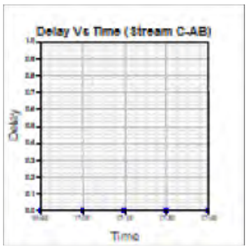




Demand Set: Sum of Demand Sets for Modelling Period: 16:45 - 17:45
Modelling Period: 16:45-17:45







Queues & Delays

Demand Set: Sum of Demand Sets for Modelling Period: 08:00 - 09:00
Modelling Period: 08:00-09:00

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/segment)	Delay (veh.min/segment)	Mean Arriving Vehicle Delay (min)
08:00-08:15	B-A	0.20	6.60	0.031	-	0.00	0.03	-	0.5	0.16
	B-C	0.05	7.46	0.006	-	0.00	0.01	-	0.1	0.13
	C-AB	0.03	8.35	0.004	-	0.00	0.00	-	0.1	0.12
	C-A	-	-	-	-	-	-	-	-	-
	A-B	0.34	-	-	-	-	-	-	-	-
	A-C	0.26	-	-	-	-	-	-	-	-

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/segment)	Delay (veh.min/segment)	Mean Arriving Vehicle Delay (min)
08:15-08:30	B-A	0.20	6.68	0.030	-	0.03	0.03	-	0.5	0.15
	B-C	0.05	7.47	0.006	-	0.01	0.01	-	0.1	0.13
	C-AB	0.00	8.37	0.000	-	0.00	0.00	-	0.0	0.00
	C-A	-	-	-	-	-	-	-	-	-
	A-B	0.31	-	-	-	-	-	-	-	-
	A-C	0.23	-	-	-	-	-	-	-	-

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/segment)	Delay (veh.min/segment)	Mean Arriving Vehicle Delay (min)
08:30-08:45	B-A	0.20	6.62	0.031	-	0.03	0.03	-	0.5	0.16
	B-C	0.05	7.45	0.006	-	0.01	0.01	-	0.1	0.14
	C-AB	0.02	8.33	0.002	-	0.00	0.00	-	0.0	0.12
	C-A	-	-	-	-	-	-	-	-	-
	A-B	0.38	-	-	-	-	-	-	-	-
	A-C	0.29	-	-	-	-	-	-	-	-

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/segment)	Delay (veh.min/segment)	Mean Arriving Vehicle Delay (min)
08:45-09:00	B-A	0.20	6.60	0.031	-	0.03	0.03	-	0.5	0.16
	B-C	0.05	7.47	0.006	-	0.01	0.01	-	0.1	0.13
	C-AB	0.03	8.37	0.004	-	0.00	0.00	-	0.1	0.12
	C-A	-	-	-	-	-	-	-	-	-
	A-B	0.31	-	-	-	-	-	-	-	-
	A-C	0.23	-	-	-	-	-	-	-	-

Demand Set: Sum of Demand Sets for Modelling Period: 16:45 - 17:45
Modelling Period: 16:45-17:45

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/ segment)	Delay (veh.min/ segment)	Mean Arriving Vehicle Delay (min)
16:45-17:00	B-A	0.27	7.27	0.038	-	0.00	0.04	-	0.6	0.14
	B-C	0.06	8.22	0.008	-	0.00	0.01	-	0.1	0.12
	C-AB	0.01	8.95	0.001	-	0.00	0.00	-	0.0	0.11
	C-A	-	-	-	-	-	-	-	-	-
	A-B	0.22	-	-	-	-	-	-	-	-
	A-C	0.47	-	-	-	-	-	-	-	-

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/ segment)	Delay (veh.min/ segment)	Mean Arriving Vehicle Delay (min)
17:00-17:15	B-A	0.27	7.27	0.038	-	0.04	0.04	-	0.6	0.14
	B-C	0.06	8.22	0.008	-	0.01	0.01	-	0.1	0.12
	C-AB	0.01	8.95	0.001	-	0.00	0.00	-	0.0	0.11
	C-A	-	-	-	-	-	-	-	-	-
	A-B	0.22	-	-	-	-	-	-	-	-
	A-C	0.47	-	-	-	-	-	-	-	-

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/ segment)	Delay (veh.min/ segment)	Mean Arriving Vehicle Delay (min)
17:15-17:30	B-A	0.27	7.32	0.037	-	0.04	0.04	-	0.6	0.14
	B-C	0.06	8.28	0.008	-	0.01	0.01	-	0.1	0.12
	C-AB	0.01	9.04	0.002	-	0.00	0.00	-	0.0	0.11
	C-A	-	-	-	-	-	-	-	-	-
	A-B	0.10	-	-	-	-	-	-	-	-
	A-C	0.20	-	-	-	-	-	-	-	-

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/ segment)	Delay (veh.min/ segment)	Mean Arriving Vehicle Delay (min)
17:30-17:45	B-A	0.27	7.30	0.038	-	0.04	0.04	-	0.6	0.14
	B-C	0.06	8.27	0.008	-	0.01	0.01	-	0.1	0.12
	C-AB	0.02	9.02	0.002	-	0.00	0.00	-	0.0	0.11
	C-A	-	-	-	-	-	-	-	-	-
	A-B	0.12	-	-	-	-	-	-	-	-
	A-C	0.25	-	-	-	-	-	-	-	-

Entry capacities marked with an '(X)' are dominated by a pedestrian crossing in that time segment.
In time segments marked with a '(B)', traffic leaving the junction may block back from a crossing so impairing normal operation of the junction.
Delays marked with '##' could not be calculated.

Overall Queues & Delays

Queueing Delay Information Over Whole Period

Demand Set: Sum of Demand Sets for Modelling Period: 08:00 - 09:00
Modelling Period: 08:00-09:00

Stream	Total Demand (veh)	Total Demand (veh/h)	Queueing Delay (min)	Queueing Delay (min/veh)	Inclusive Delay (min)	Inclusive Delay (min/veh)
B-A	12.1	12.1	1.9	0.2	1.9	0.2
B-C	2.8	2.8	0.4	0.1	0.4	0.1
C-AB	1.3	1.3	0.1	0.1	0.1	0.1
C-A	-	-	-	-	-	-
A-B	20.1	20.1	-	-	-	-
A-C	15.0	15.0	-	-	-	-
All	**73.3**	**73.3**	**2.4**	**0.0**	**2.4**	**0.0**

Demand Set: Sum of Demand Sets for Modelling Period: 16:45 - 17:45
Modelling Period: 16:45-17:45

Stream	Total Demand (veh)	Total Demand (veh/h)	Queueing Delay (min)	Queueing Delay (min/veh)	Inclusive Delay (min)	Inclusive Delay (min/veh)
B-A	16.4	16.4	2.3	0.1	2.3	0.1
B-C	3.9	3.9	0.5	0.1	0.5	0.1
C-AB	0.7	0.7	0.1	0.1	0.1	0.1
C-A	-	-	-	-	-	-
A-B	9.9	9.9	-	-	-	-
A-C	21.0	21.0	-	-	-	-
All	**64.9**	**64.9**	**2.9**	**0.0**	**2.9**	**0.0**

Delay is that occurring only within the time period.
Inclusive delay includes delay suffered by vehicles which are still queuing after the end of the time period.
These will only be significantly different if there is a large queue remaining at the end of the time period.

PICADY 5 Run Successful

PICADY

GUI Version: 5.1 AE
Analysis Program Release: 5.0 (MAY 2010)

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Web: www.trlsoftware.co.uk

Run Analysis

Parameter	Values
File Run	C:\Users\obriend\Desktop\temp\P18-014-Junction3.vpi
Date Run	18 June 2018
Time Run	13:38:45
Driving Side	Drive On The Left

Arm Names and Flow Scaling Factors

Arm	Arm Name	Flow Scaling Factor (%)
Arm A	R284 North	100
Arm B	L3603 East	100
Arm C	R384 South	100
Arm D	L3603 West	100

Stream Labelling Convention

Stream A-B contains traffic going from A to B etc.

Run Information

Parameter	Values
Run Title	P18-014-Junction3
Location	Co.Sligo
Date	07 March 2018
Enumerator	obriend [PMCE11]
Job Number	P18-014
Status	-
Client	Lagan Asphalt Group Ltd.
Description	Aughamore Quarry Co.Sligo - Junction 3 R284/L3603 XS

Errors and Warnings

Parameter	Values
Warning	No Errors Or Warnings

Geometric Data

Geometric Parameters

Parameter	Minor Arm B	Minor Arm D
Major Road Carriageway Width (m)	6.20	6.00
Major Road Kerbed Central Reserve Width (m)	0.00	0.00
Major Road Right Turning Lane Width (m)	2.20	2.20
Minor Road Width 0m Back from Junction (m)	8.00	6.60
Minor Road Width 5m Back from Junction (m)	3.50	3.20
Minor Road Width 10m Back from Junction (m)	3.15	2.80
Minor Road Width 15m Back from Junction (m)	2.90	2.55
Minor Road Width 20m Back from Junction (m)	2.70	2.55
Minor Road Derived Flare Length (PCU)	0.000	0.000
Minor Road Visibility To Right (m)	5	5
Minor Road Visibility To Left (m)	5	5
Major Road Right Turn Visibility (m)	200	75
Major Road Right Turn Blocks Traffic	Yes (if over 1 veh)	Yes (if over 1 veh)

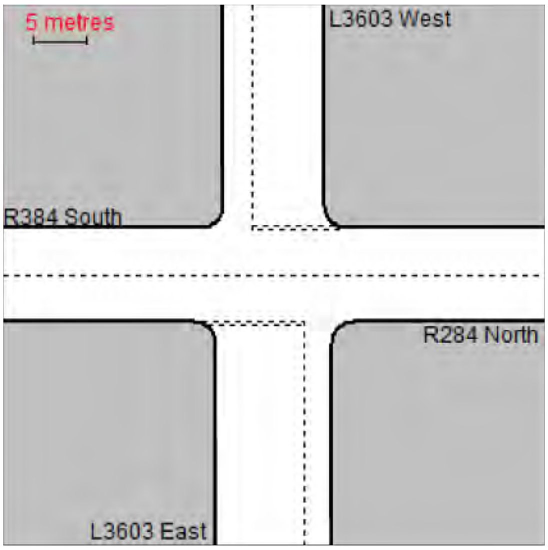
Slope and Intercept Values

Stream	Intercept for Stream	Slope for A-B	Slope for A-C	Slope for A-D	Slope for B-A	Slope for B-C	Slope for B-D	Slope for C-A	Slope for C-B	Slope for C-D	Slope for D-A	Slope for D-B	Slope for D-C
C-B	689.785	0.265	0.265	0.378	-	-	-	-	-	-	-	-	-
A-D	617.396	-	-	-	-	-	-	0.265	0.339	0.265	-	-	-
B-A	0.000	0.000	0.000	0.000	-	-	-	0.000	0.000	-	0.000	0.000	0.000
B-C	0.000	0.000	0.000	-	-	-	-	-	-	-	-	-	-
B-D(L)	0.000	0.000	0.000	0.000	-	-	-	0.000	0.000	0.000	-	-	-
D-A	0.000	-	-	-	-	-	-	0.000	-	0.000	-	-	-
D-B(L)	0.000	0.000	0.000	0.000	-	-	-	0.000	0.000	0.000	-	-	-
D-C	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-
B-D(R)	0.000	0.000	0.000	0.000	-	-	-	0.000	0.000	0.000	-	-	-
D-B(R)	0.000	0.000	0.000	0.000	-	-	-	0.000	0.000	0.000	-	-	-

Note: Streams may be combined in which case capacity will be adjusted
These values do not allow for any site-specific corrections

Streams marked with '(L)' and '(R)' refer to the 'left' and 'right' lane of the minor arm that the originating traffic is on.

Junction Diagram



Demand Data

Modelling Periods

Parameter	Period	Duration (min)	Segment Length (min)
First Modelling Period	08:15-09:15	60	15
Second Modelling Period	17:00-18:00	60	15

Direct Entry Flows

Demand Set: Opening Year +15 - AM (2034)
Modelling Period: 08:15-09:15

Segment: 08:15-08:30

Arm	Flow (veh/interval)
Arm A	15.00
Arm B	5.00
Arm C	82.00
Arm D	2.00

Segment: 08:30-08:45

Arm	Flow (veh/interval)
Arm A	27.00
Arm B	6.00
Arm C	81.00
Arm D	1.00

Segment: 08:45-09:00

Arm	Flow (veh/interval)
Arm A	31.00
Arm B	6.00
Arm C	70.00
Arm D	8.00

Segment: 09:00-09:15

Arm	Flow (veh/interval)
Arm A	26.00
Arm B	3.00
Arm C	47.00
Arm D	6.00

Demand Set: Opening Year +15 - PM (2034)
Modelling Period: 17:00-18:00

Segment: 17:00-17:15

Arm	Flow (veh/interval)
Arm A	57.00
Arm B	10.00
Arm C	30.00
Arm D	6.00

Segment: 17:15-17:30

Arm	Flow (veh/interval)
Arm A	54.00
Arm B	10.00
Arm C	27.00
Arm D	8.00

Segment: 17:30-17:45

Arm	Flow (veh/interval)
Arm A	57.00
Arm B	8.00
Arm C	29.00
Arm D	10.00

Segment: 17:45-18:00

Arm	Flow (veh/interval)
Arm A	57.00
Arm B	6.00
Arm C	28.00
Arm D	7.00

Demand Set: Site Development Traffic AM - LV
Modelling Period: 08:15-09:15

Segment: 08:15-08:30

Arm	Flow (veh/interval)
Arm A	0.07
Arm B	0.28
Arm C	0.04
Arm D	0.07

Segment: 08:30-08:45

Arm	Flow (veh/interval)
Arm A	0.07
Arm B	0.28
Arm C	0.04
Arm D	0.07

Segment: 08:45-09:00

Arm	Flow (veh/interval)
Arm A	0.07
Arm B	0.28
Arm C	0.04
Arm D	0.07

Segment: 09:00-09:15

Arm	Flow (veh/interval)
Arm A	0.07
Arm B	0.28
Arm C	0.04
Arm D	0.07

Demand Set: Site Development Traffic AM - HV
Modelling Period: 08:15-09:15

Segment: 08:15-08:30

Arm	Flow (veh/interval)
Arm A	0.04
Arm B	0.23
Arm C	0.00
Arm D	0.04

Segment: 08:30-08:45

Arm	Flow (veh/interval)
Arm A	0.04
Arm B	0.23
Arm C	0.00
Arm D	0.04

Segment: 08:45-09:00

Arm	Flow (veh/interval)
Arm A	0.04
Arm B	0.23
Arm C	0.00
Arm D	0.04

Segment: 09:00-09:15

Arm	Flow (veh/interval)
Arm A	0.04
Arm B	0.23
Arm C	0.00
Arm D	0.04

Demand Set: Site Development Traffic PM - LV
Modelling Period: 17:00-18:00

Segment: 17:00-17:15

Arm	Flow (veh/interval)
Arm A	0.04
Arm B	1.01
Arm C	0.02
Arm D	0.03

Segment: 17:15-17:30

Arm	Flow (veh/interval)
Arm A	0.04
Arm B	1.01
Arm C	0.02
Arm D	0.03

Segment: 17:30-17:45

Arm	Flow (veh/interval)
Arm A	0.04
Arm B	1.01
Arm C	0.02
Arm D	0.03

Segment: 17:45-18:00

Arm	Flow (veh/interval)
Arm A	0.04
Arm B	1.01
Arm C	0.02
Arm D	0.03

Demand Set: Site Development Traffic PM - HV
Modelling Period: 17:00-18:00

Segment: 17:00-17:15

Arm	Flow (veh/interval)
Arm A	0.01
Arm B	0.20
Arm C	0.00
Arm D	0.01

Segment: 17:15-17:30

Arm	Flow (veh/interval)
Arm A	0.01
Arm B	0.20
Arm C	0.00
Arm D	0.01

Segment: 17:30-17:45

Arm	Flow (veh/interval)
Arm A	0.01
Arm B	0.20
Arm C	0.00
Arm D	0.01

Segment: 17:45-18:00

Arm	Flow (veh/interval)
Arm A	0.01
Arm B	0.20
Arm C	0.00
Arm D	0.01

Turning Counts

Demand Set: Opening Year +15 - AM (2034)
Modelling Period: 08:15-09:15

From/To	Arm A	Arm B	Arm C	Arm D
Arm A	-	2	84	13
Arm B	5	-	0	16
Arm C	219	18	-	44
Arm D	3	8	6	-

Demand Set: Opening Year +15 - PM (2034)
Modelling Period: 17:00-18:00

From/To	Arm A	Arm B	Arm C	Arm D
Arm A	-	7	207	10
Arm B	8	-	10	16
Arm C	104	5	-	6
Arm D	10	9	12	-

Demand Set: Site Development Traffic AM - LV
Modelling Period: 08:15-09:15

From/To	Arm A	Arm B	Arm C	Arm D
Arm A	-	1	0	0
Arm B	1	-	1	1
Arm C	0	1	-	0
Arm D	0	1	0	-

Demand Set: Site Development Traffic AM - HV
Modelling Period: 08:15-09:15

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	-	0	0	0
Arm B	1	-	0	1
Arm C	0	0	-	0
Arm D	0	1	0	-

Demand Set: Site Development Traffic PM - LV
Modelling Period: 17:00-18:00

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	-	1	0	0
Arm B	1	-	1	1
Arm C	0	1	-	0
Arm D	0	1	0	-

Demand Set: Site Development Traffic PM - HV
Modelling Period: 17:00-18:00

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	-	0	0	0
Arm B	1	-	0	1
Arm C	0	0	-	0
Arm D	0	1	0	-

Turning proportions are calculated from turning count data

Turning Proportions

Demand Set: Opening Year +15 - AM (2034)
Modelling Period: 08:15-09:15

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	0.000	0.020	0.848	0.131
Arm B	0.238	0.000	0.000	0.762
Arm C	0.779	0.064	0.000	0.157
Arm D	0.176	0.471	0.353	0.000

Demand Set: Opening Year +15 - PM (2034)
Modelling Period: 17:00-18:00

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	0.000	0.031	0.924	0.045
Arm B	0.235	0.000	0.294	0.471
Arm C	0.904	0.043	0.000	0.052
Arm D	0.323	0.290	0.387	0.000

Demand Set: Site Development Traffic AM - LV
Modelling Period: 08:15-09:15

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	0.000	0.000	0.000	0.000
Arm B	0.500	0.000	0.000	0.500
Arm C	0.000	0.000	0.000	0.000
Arm D	0.000	1.000	0.000	0.000

Demand Set: Site Development Traffic AM - HV
Modelling Period: 08:15-09:15

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	0.000	1.000	0.000	0.000
Arm B	0.333	0.000	0.333	0.333
Arm C	0.000	1.000	0.000	0.000
Arm D	0.000	1.000	0.000	0.000

Demand Set: Site Development Traffic PM - LV
Modelling Period: 17:00-18:00

From / To

Demand Set: Site Development Traffic PM - HV
Modelling Period: 17:00-18:00

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	0.000	0.000	0.000	0.000
Arm B	0.500	0.000	0.000	0.500
Arm C	0.000	0.000	0.000	0.000
Arm D	0.000	1.000	0.000	0.000

Heavy Vehicles Percentages

Demand Set: Opening Year +15 - AM (2034)
Modelling Period: 08:15-09:15

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	-	0.0	8.5	0.0
Arm B	0.0	-	0.0	18.2
Arm C	2.6	8.0	-	3.2
Arm D	0.0	17.0	0.0	-

Demand Set: Opening Year +15 - PM (2034)
Modelling Period: 17:00-18:00

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	-	19.7	2.1	0.0
Arm B	0.0	-	0.0	0.0
Arm C	2.7	0.0	-	0.0
Arm D	0.0	0.0	0.0	-

Demand Set: Site Development Traffic AM - LV
Modelling Period: 08:15-09:15

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	-	0.0	0.0	0.0
Arm B	0.0	-	0.0	0.0
Arm C	0.0	0.0	-	0.0
Arm D	0.0	0.0	0.0	-

Demand Set: Site Development Traffic AM - HV
Modelling Period: 08:15-09:15

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	-	100.0	100.0	100.0
Arm B	100.0	-	100.0	100.0
Arm C	100.0	100.0	-	100.0
Arm D	100.0	100.0	100.0	-

Demand Set: Site Development Traffic PM - LV
Modelling Period: 17:00-18:00

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	-	0.0	0.0	0.0
Arm B	0.0	-	0.0	0.0
Arm C	0.0	0.0	-	0.0
Arm D	0.0	0.0	0.0	-

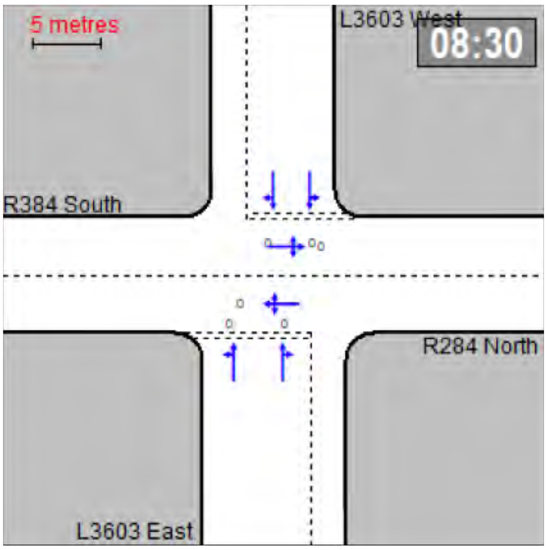
Demand Set: Site Development Traffic PM - HV
Modelling Period: 17:00-18:00

From / To	Arm A	Arm B	Arm C	Arm D
Arm A	-	100.0	100.0	100.0
Arm B	100.0	-	100.0	100.0
Arm C	100.0	100.0	-	100.0
Arm D	100.0	100.0	100.0	-

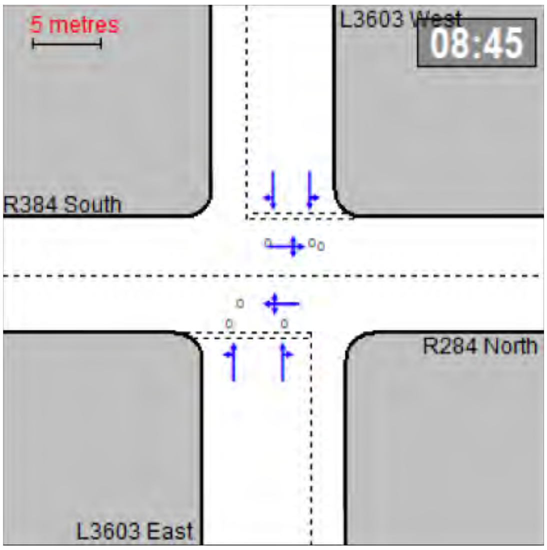
Queue Diagrams

Demand Set: Sum of Demand Sets for Modelling Period: 08:15 - 09:15
Modelling Period: 08:15-09:15
View Extent: 40m

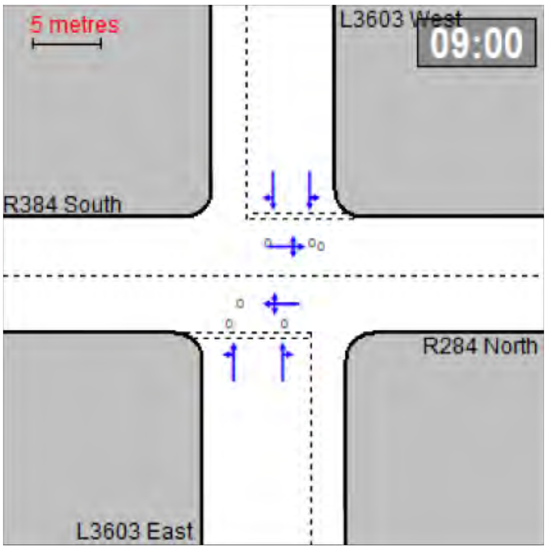
Queue Interval 1: 08:15-08:30



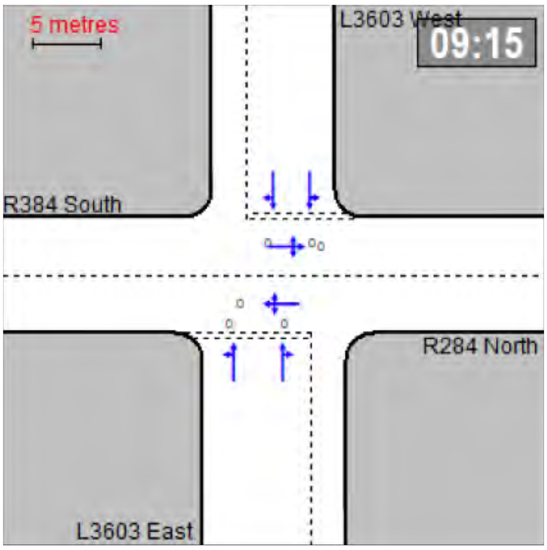
Queue Interval 2: 08:30-08:45



Queue Interval 3: 08:45-09:00

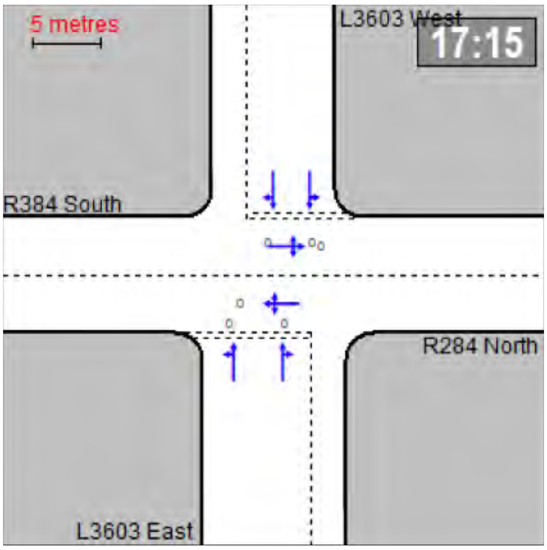


Queue Interval 4: 09:00-09:15

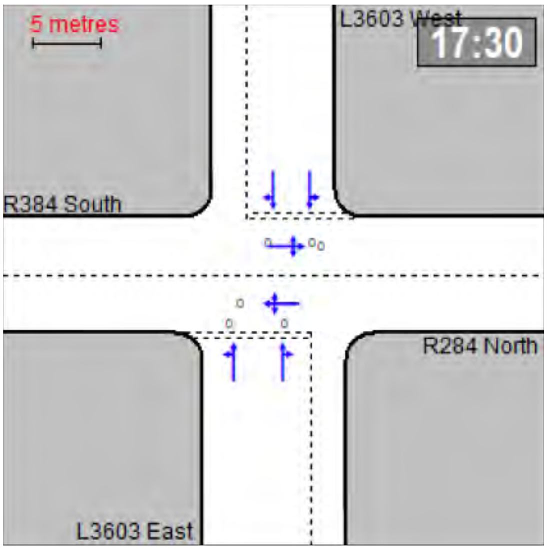


Demand Set: Sum of Demand Sets for Modelling Period: 17:00 - 18:00
Modelling Period: 17:00-18:00
View Extent: 40m

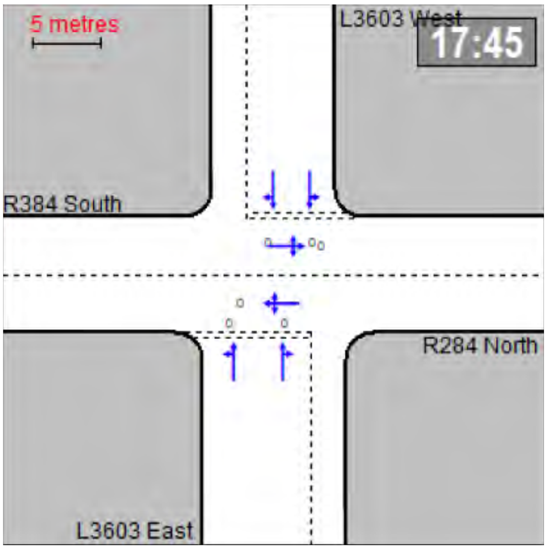
Queue Interval 1: 17:00-17:15



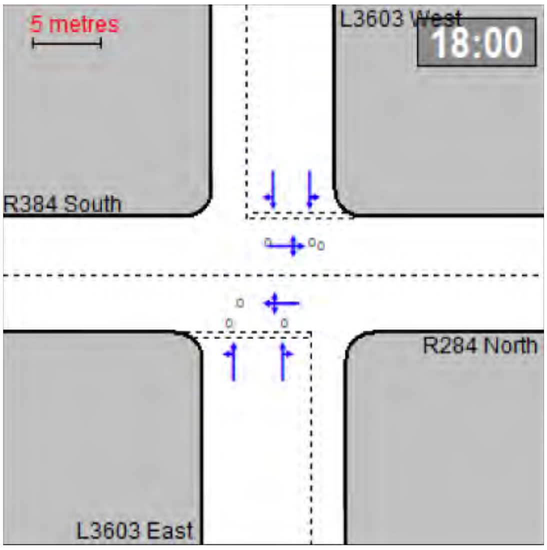
Queue Interval 2: 17:15-17:30



Queue Interval 3: 17:30-17:45

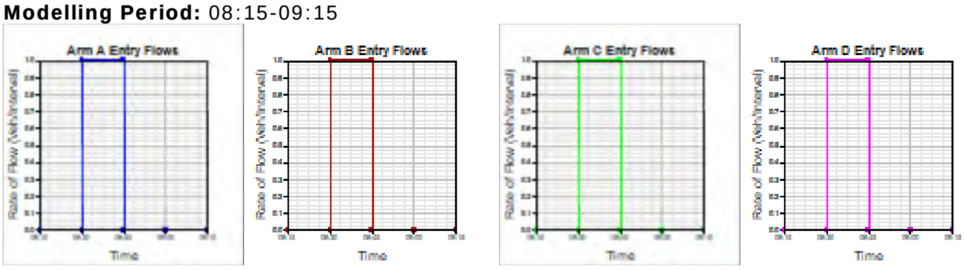


Queue Interval 4: 17:45-18:00

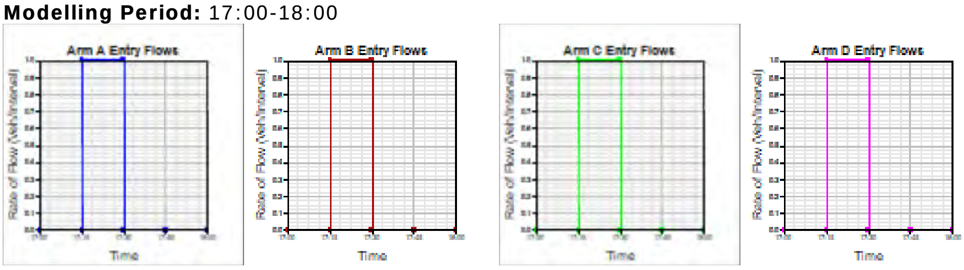


Demand Data Graph

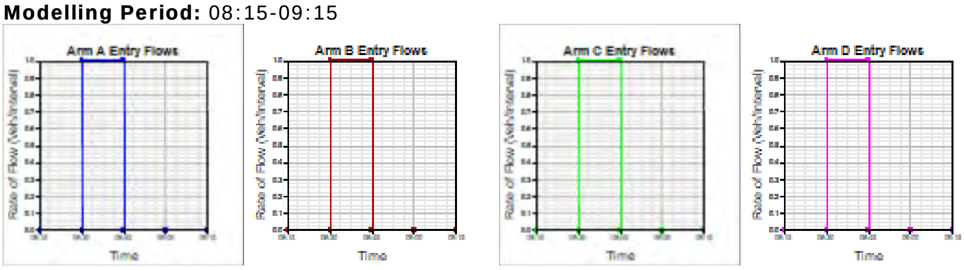
Demand Set: Opening Year +15 - AM (2034)
Modelling Period: 08:15-09:15



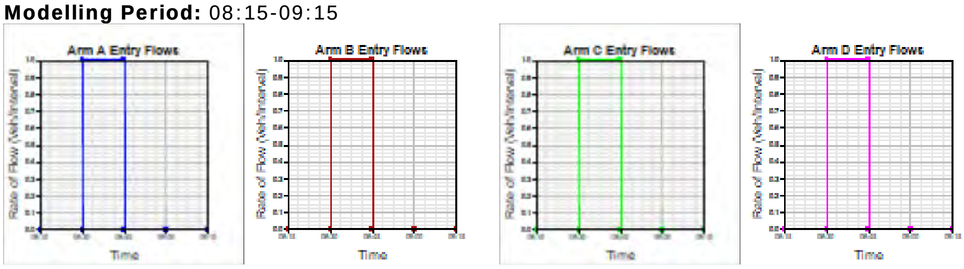
Demand Set: Opening Year +15 - PM (2034)
Modelling Period: 17:00-18:00



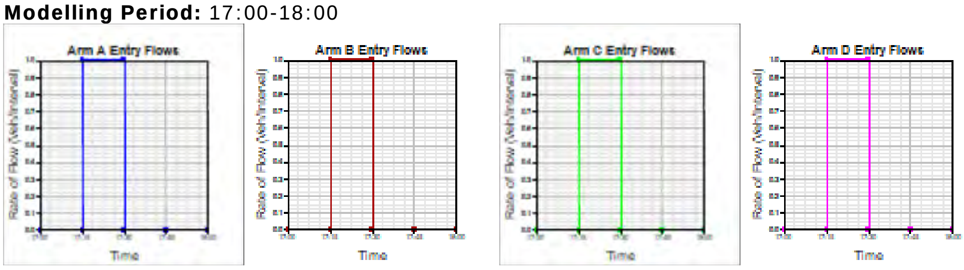
Demand Set: Site Development Traffic AM - LV
Modelling Period: 08:15-09:15



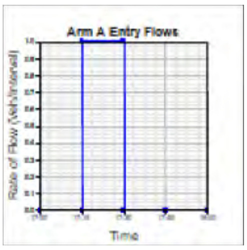
Demand Set: Site Development Traffic AM - HV
Modelling Period: 08:15-09:15

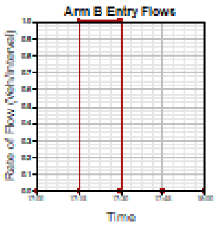


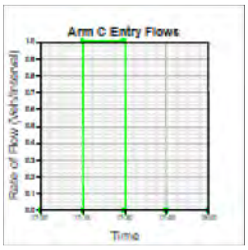
Demand Set: Site Development Traffic PM - LV
Modelling Period: 17:00-18:00

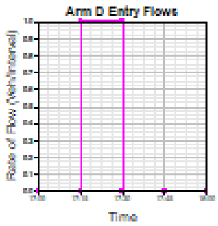


Demand Set: Site Development Traffic PM - HV
Modelling Period: 17:00-18:00


Arm A Entry Flows
Rate of Flow (Veh/Interval)
Time

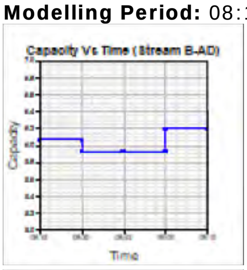

Arm B Entry Flows
Rate of Flow (Veh/Interval)
Time

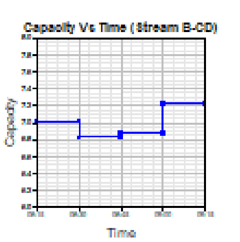

Arm C Entry Flows
Rate of Flow (Veh/Interval)
Time

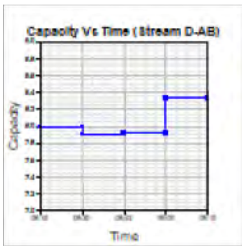

Arm D Entry Flows
Rate of Flow (Veh/Interval)
Time

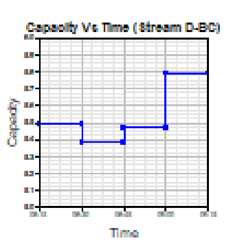
Capacity Graph

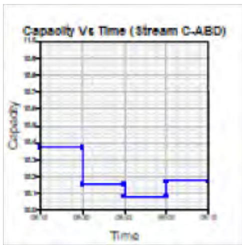
Demand Set: Sum of Demand Sets for Modelling Period: 08:15 - 09:15
Modelling Period: 08:15-09:15

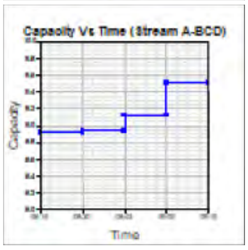




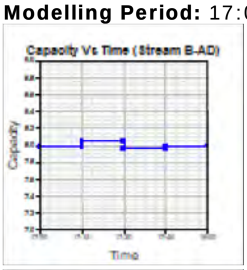


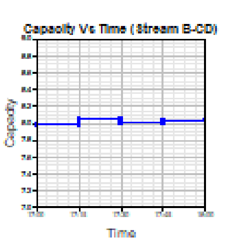


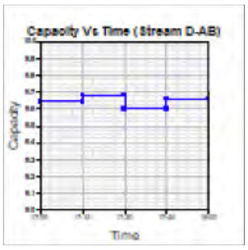


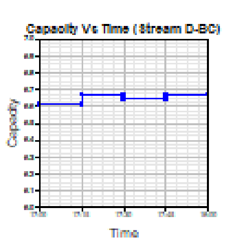


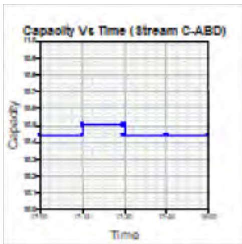
Demand Set: Sum of Demand Sets for Modelling Period: 17:00 - 18:00
Modelling Period: 17:00-18:00

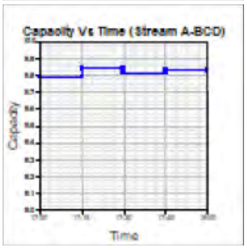






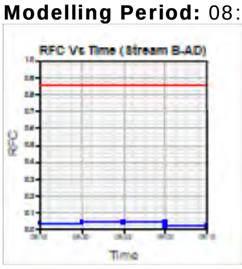


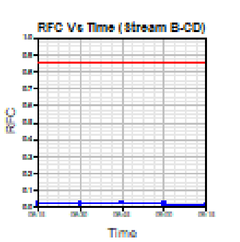


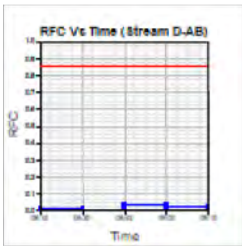


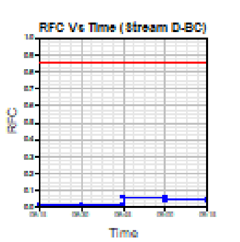
RFC Graph

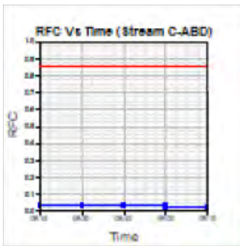
Demand Set: Sum of Demand Sets for Modelling Period: 08:15 - 09:15
Modelling Period: 08:15-09:15

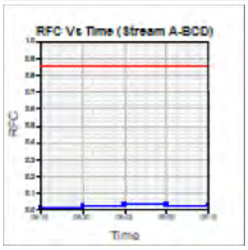




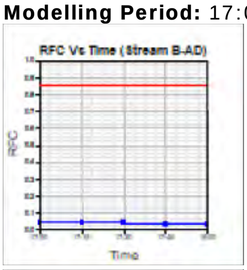


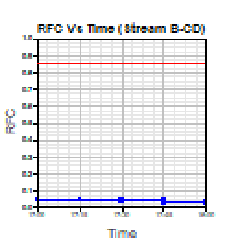


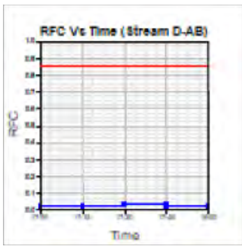


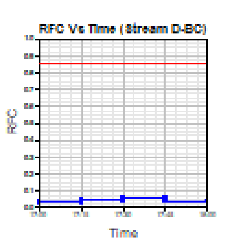


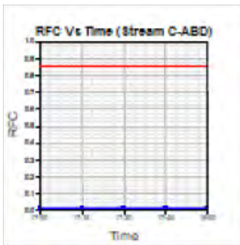
Demand Set: Sum of Demand Sets for Modelling Period: 17:00 - 18:00
Modelling Period: 17:00-18:00

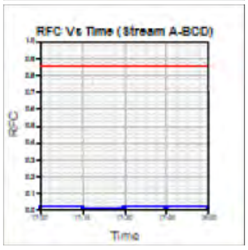






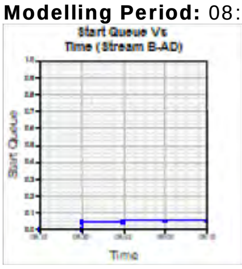


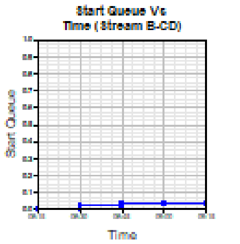


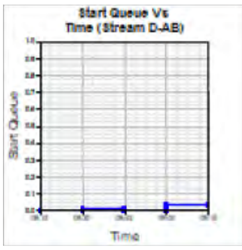


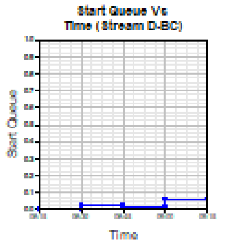
Start Queue Graph

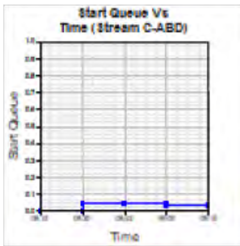
Demand Set: Sum of Demand Sets for Modelling Period: 08:15 - 09:15
Modelling Period: 08:15-09:15

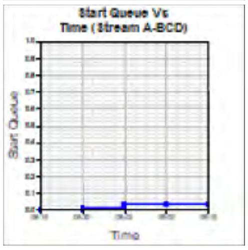




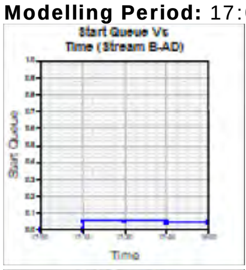


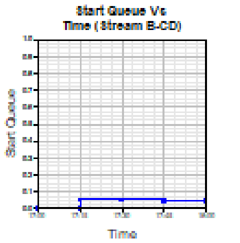


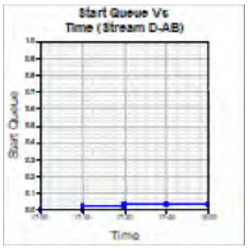


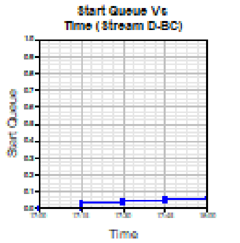


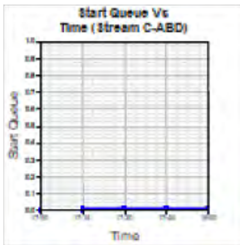
Demand Set: Sum of Demand Sets for Modelling Period: 17:00 - 18:00
Modelling Period: 17:00-18:00

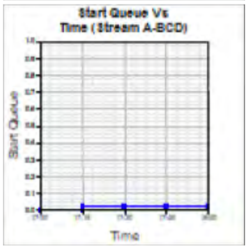






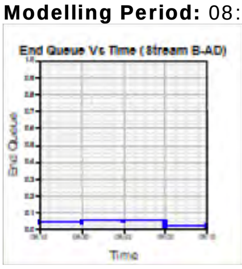


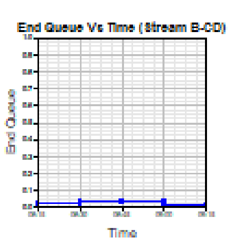


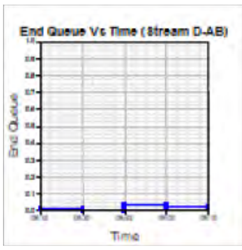


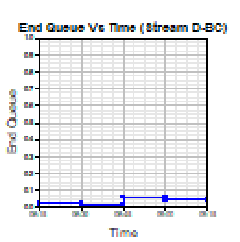
End Queue Graph

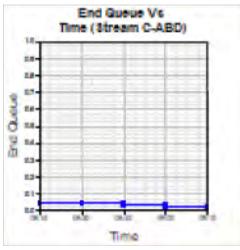
Demand Set: Sum of Demand Sets for Modelling Period: 08:15 - 09:15
Modelling Period: 08:15-09:15

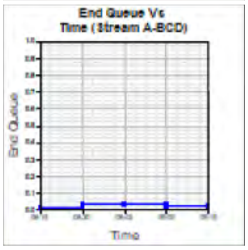




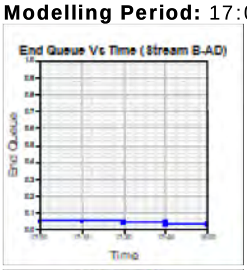


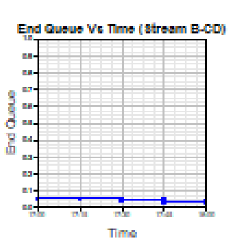


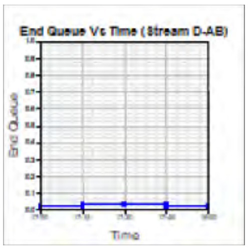


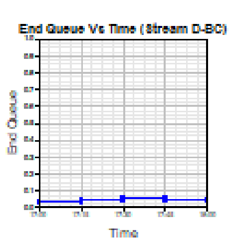


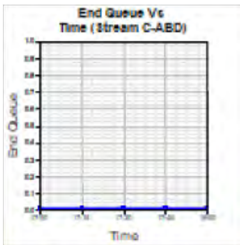
Demand Set: Sum of Demand Sets for Modelling Period: 17:00 - 18:00
Modelling Period: 17:00-18:00

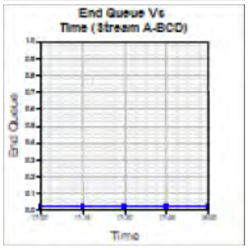






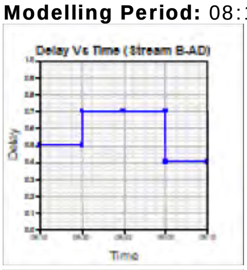


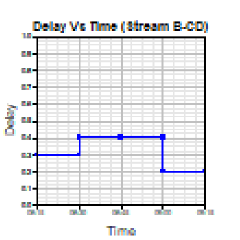


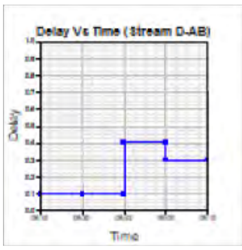


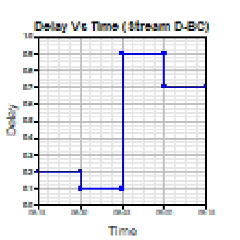
Delay Graph

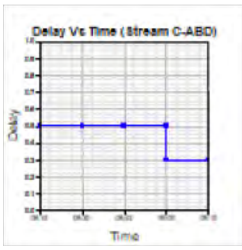
Demand Set: Sum of Demand Sets for Modelling Period: 08:15 - 09:15
Modelling Period: 08:15-09:15

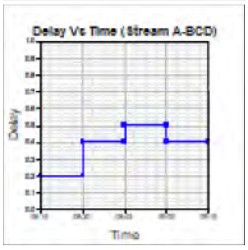




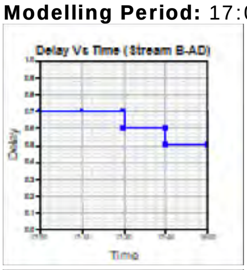


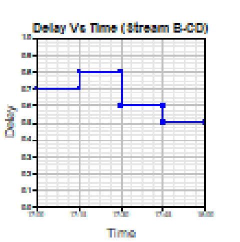


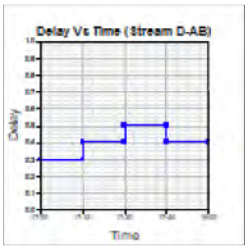


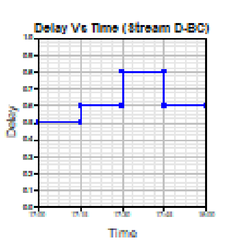


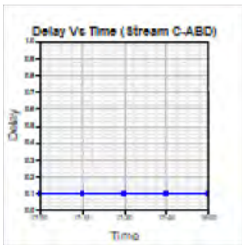
Demand Set: Sum of Demand Sets for Modelling Period: 17:00 - 18:00
Modelling Period: 17:00-18:00

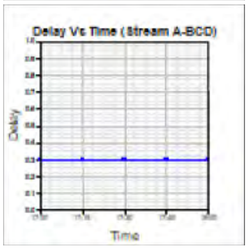












Queues & Delays

Demand Set: Sum of Demand Sets for Modelling Period: 08:15 - 09:15
Modelling Period: 08:15-09:15

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/segment)	Delay (veh.min/segment)	Mean Arriving Vehicle Delay (min)
08:15-08:30	B-AD	0.23	6.06	0.037	-	0.00	0.04	-	0.5	0.17
	B-CD	0.14	7.01	0.020	-	0.00	0.02	-	0.3	0.15
	D-AB	0.06	7.99	0.007	-	0.00	0.01	-	0.1	0.13
	D-BC	0.08	5.49	0.015	-	0.00	0.02	-	0.2	0.18
	C-ABD	0.35	10.37	0.034	-	0.00	0.04	-	0.5	0.10
	C-A	-	-	-	-	-	-	-	-	-
	C-D	-	-	-	-	-	-	-	-	-
	A-BCD	0.13	8.91	0.015	-	0.00	0.01	-	0.2	0.11
	A-B	-	-	-	-	-	-	-	-	-
	A-C	-	-	-	-	-	-	-	-	-

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/segment)	Delay (veh.min/segment)	Mean Arriving Vehicle Delay (min)
08:30-08:45	B-AD	0.27	5.92	0.045	-	0.04	0.05	-	0.7	0.18
	B-CD	0.17	6.82	0.025	-	0.02	0.03	-	0.4	0.15
	D-AB	0.03	7.90	0.004	-	0.01	0.00	-	0.1	0.13
	D-BC	0.04	5.38	0.008	-	0.02	0.01	-	0.1	0.19
	C-ABD	0.35	10.15	0.034	-	0.04	0.04	-	0.5	0.10
	C-A	-	-	-	-	-	-	-	-	-
	C-D	-	-	-	-	-	-	-	-	-
	A-BCD	0.24	8.93	0.026	-	0.01	0.03	-	0.4	0.11
	A-B	-	-	-	-	-	-	-	-	-
	A-C	-	-	-	-	-	-	-	-	-

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/segment)	Delay (veh.min/segment)	Mean Arriving Vehicle Delay (min)
08:45-09:00	B-AD	0.27	5.92	0.045	-	0.05	0.05	-	0.7	0.18
	B-CD	0.17	6.87	0.025	-	0.03	0.03	-	0.4	0.15
	D-AB	0.23	7.91	0.029	-	0.00	0.03	-	0.4	0.13
	D-BC	0.31	5.47	0.057	-	0.01	0.06	-	0.9	0.19
	C-ABD	0.30	10.08	0.030	-	0.04	0.03	-	0.5	0.10
	C-A	-	-	-	-	-	-	-	-	-
	C-D	-	-	-	-	-	-	-	-	-
	A-BCD	0.27	9.12	0.030	-	0.03	0.03	-	0.5	0.11
	A-B	-	-	-	-	-	-	-	-	-
	A-C	-	-	-	-	-	-	-	-	-

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/segment)	Delay (veh.min/segment)	Mean Arriving Vehicle Delay (min)
09:00-09:15	B-AD	0.14	6.19	0.023	-	0.05	0.02	-	0.4	0.17
	B-CD	0.09	7.22	0.012	-	0.03	0.01	-	0.2	0.14
	D-AB	0.17	8.33	0.021	-	0.03	0.02	-	0.3	0.12
	D-BC	0.24	5.79	0.041	-	0.06	0.04	-	0.7	0.18
	C-ABD	0.20	10.17	0.020	-	0.03	0.02	-	0.3	0.10
	C-A	-	-	-	-	-	-	-	-	-

	C-D	-	-	-	-	-	-	-	-	-
	A-BCD	0.23	9.50	0.024	-	0.03	0.02	-	0.4	0.11
	A-B	-	-	-	-	-	-	-	-	-
	A-C	-	-	-	-	-	-	-	-	-

Demand Set: Sum of Demand Sets for Modelling Period: 17:00 - 18:00
Modelling Period: 17:00-18:00

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/segment)	Delay (veh.min/segment)	Mean Arriving Vehicle Delay (min)
17:00-17:15	B-AD	0.35	7.98	0.044	-	0.00	0.05	-	0.7	0.13
	B-CD	0.39	7.98	0.049	-	0.00	0.05	-	0.7	0.13
	D-AB	0.19	9.64	0.020	-	0.00	0.02	-	0.3	0.11
	D-BC	0.21	6.61	0.032	-	0.00	0.03	-	0.5	0.16
	C-ABD	0.09	10.44	0.008	-	0.00	0.01	-	0.1	0.10
	C-A	-	-	-	-	-	-	-	-	-
	C-D	-	-	-	-	-	-	-	-	-
	A-BCD	0.17	9.79	0.017	-	0.00	0.02	-	0.3	0.10
	A-B	-	-	-	-	-	-	-	-	-
	A-C	-	-	-	-	-	-	-	-	-

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/segment)	Delay (veh.min/segment)	Mean Arriving Vehicle Delay (min)
17:15-17:30	B-AD	0.35	8.05	0.044	-	0.05	0.05	-	0.7	0.13
	B-CD	0.39	8.04	0.049	-	0.05	0.05	-	0.8	0.13
	D-AB	0.25	9.68	0.026	-	0.02	0.03	-	0.4	0.11
	D-BC	0.28	6.67	0.042	-	0.03	0.04	-	0.6	0.16
	C-ABD	0.08	10.50	0.008	-	0.01	0.01	-	0.1	0.10
	C-A	-	-	-	-	-	-	-	-	-
	C-D	-	-	-	-	-	-	-	-	-
	A-BCD	0.16	9.84	0.016	-	0.02	0.02	-	0.3	0.10
	A-B	-	-	-	-	-	-	-	-	-
	A-C	-	-	-	-	-	-	-	-	-

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/segment)	Delay (veh.min/segment)	Mean Arriving Vehicle Delay (min)
17:30-17:45	B-AD	0.29	7.96	0.037	-	0.05	0.04	-	0.6	0.13
	B-CD	0.32	8.00	0.040	-	0.05	0.04	-	0.6	0.13
	D-AB	0.32	9.60	0.033	-	0.03	0.03	-	0.5	0.11
	D-BC	0.35	6.64	0.053	-	0.04	0.06	-	0.8	0.16
	C-ABD	0.09	10.44	0.008	-	0.01	0.01	-	0.1	0.10
	C-A	-	-	-	-	-	-	-	-	-
	C-D	-	-	-	-	-	-	-	-	-
	A-BCD	0.17	9.81	0.017	-	0.02	0.02	-	0.3	0.10
	A-B	-	-	-	-	-	-	-	-	-
	A-C	-	-	-	-	-	-	-	-	-

Segment	Stream	Demand (veh/min)	Capacity (veh/min)	RFC	Ped. Flow (ped/min)	Start Queue (veh)	End Queue (veh)	Geometric Delay (veh.min/segment)	Delay (veh.min/segment)	Mean Arriving Vehicle Delay (min)
17:45-18:00	B-AD	0.23	7.99	0.029	-	0.04	0.03	-	0.5	0.13
	B-CD	0.25	8.03	0.031	-	0.04	0.03	-	0.5	0.13
	D-AB	0.22	9.66	0.023	-	0.03	0.02	-	0.4	0.11
	D-BC	0.25	6.67	0.037	-	0.06	0.04	-	0.6	0.16
	C-ABD	0.08	10.44	0.008	-	0.01	0.01	-	0.1	0.10
	C-A	-	-	-	-	-	-	-	-	-
	C-D	-	-	-	-	-	-	-	-	-
	A-BCD	0.17	9.83	0.017	-	0.02	0.02	-	0.3	0.10
	A-B	-	-	-	-	-	-	-	-	-
	A-C	-	-	-	-	-	-	-	-	-

Entry capacities marked with an '(X)' are dominated by a pedestrian crossing in that time segment.
In time segments marked with a '(B)', traffic leaving the junction may block back from a crossing so impairing normal operation of the junction.
Delays marked with '##' could not be calculated.

Overall Queues & Delays

Queueing Delay Information Over Whole Period

Demand Set: Sum of Demand Sets for Modelling Period: 08:15 - 09:15
Modelling Period: 08:15-09:15

Stream	Total Demand (veh)	Total Demand (veh/h)	Queueing Delay (min)	Queueing Delay (min/veh)	Inclusive Delay (min)	Inclusive Delay (min/veh)
B-AD	13.5	13.5	2.3	0.2	2.3	0.2
B-CD	8.5	8.5	1.2	0.1	1.2	0.1
D-AB	7.3	7.3	0.9	0.1	0.9	0.1
D-BC	10.1	10.1	1.9	0.2	1.9	0.2
C-ABD	18.1	18.1	1.9	0.1	1.9	0.1
C-A	-	-	-	-	-	-
C-D	-	-	-	-	-	-
A-BCD	13.0	13.0	1.5	0.1	1.5	0.1
A-B	418.9	418.9	9.6	0.0	9.6	0.0
A-C	-	-	-	-	-	-
All	**-**	**-**	**-**	**-**	**-**	**-**

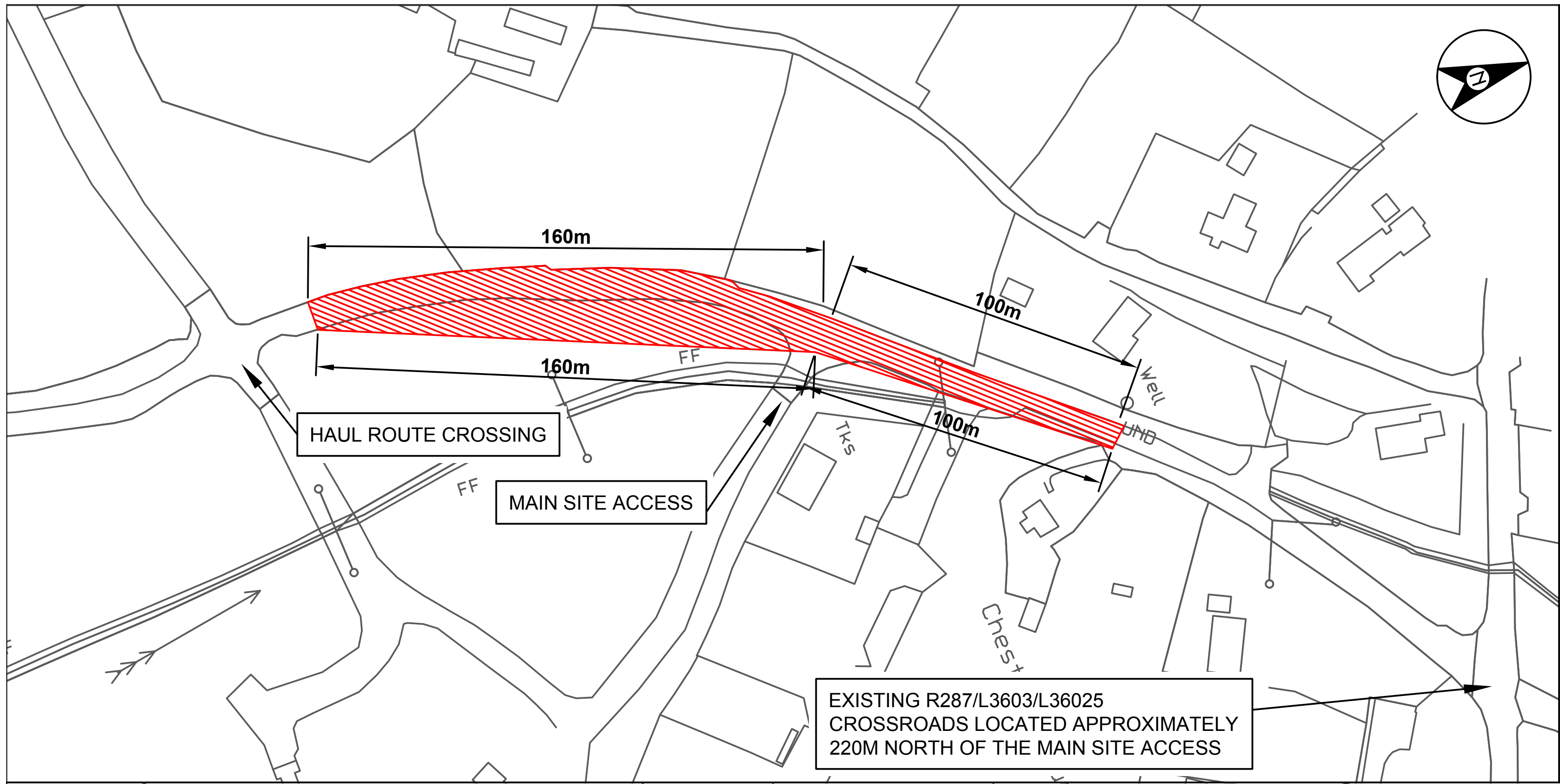
Demand Set: Sum of Demand Sets for Modelling Period: 17:00 - 18:00
Modelling Period: 17:00-18:00

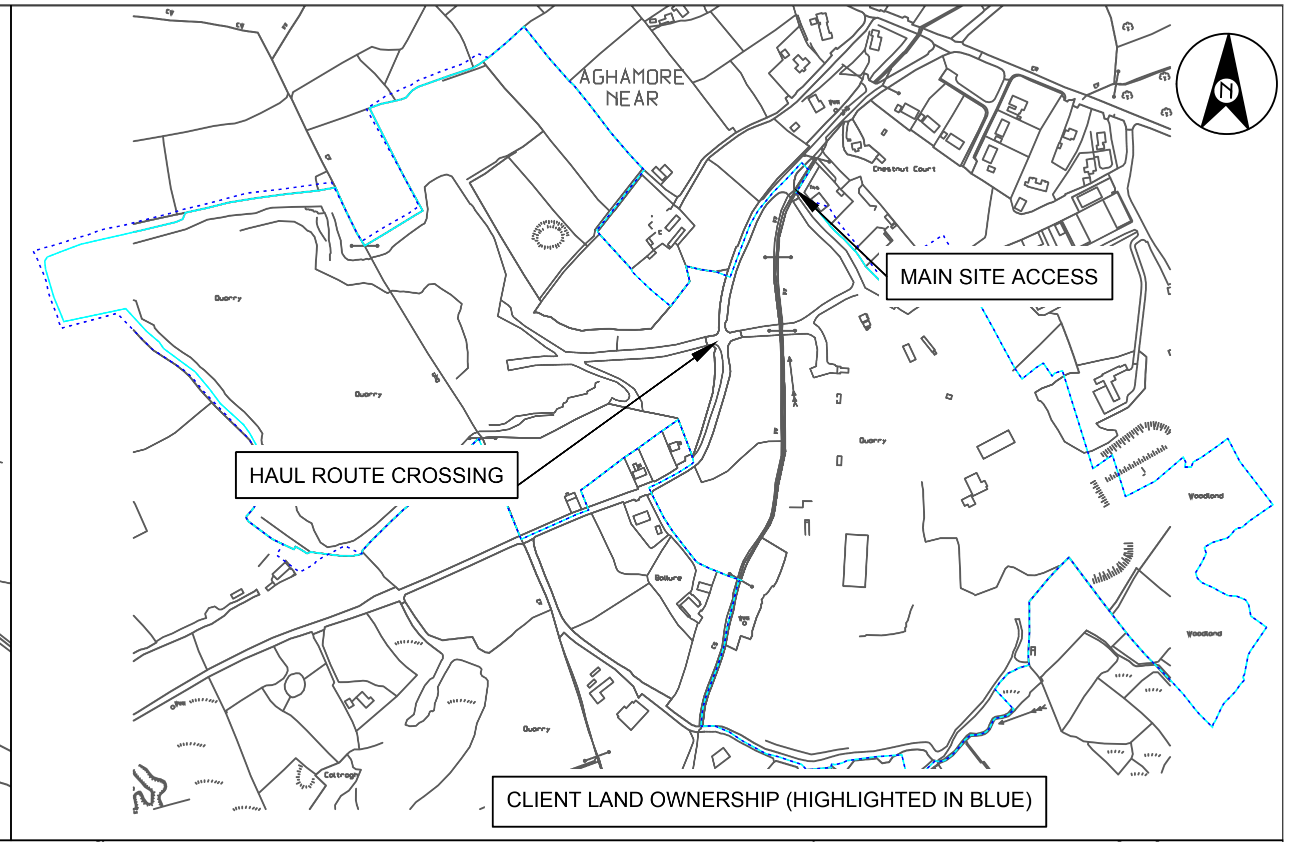
Stream	Total Demand (veh)	Total Demand (veh/h)	Queueing Delay (min)	Queueing Delay (min/veh)	Inclusive Delay (min)	Inclusive Delay (min/veh)
B-AD	18.4	18.4	2.4	0.1	2.4	0.1
B-CD	20.4	20.4	2.7	0.1	2.7	0.1
D-AB	14.7	14.7	1.5	0.1	1.5	0.1
D-BC	16.4	16.4	2.5	0.2	2.5	0.2
C-ABD	5.0	5.0	0.5	0.1	0.5	0.1
C-A	-	-	-	-	-	-
C-D	-	-	-	-	-	-
A-BCD	10.0	10.0	1.0	0.1	1.0	0.1
A-B	409.2	409.2	10.7	0.0	10.7	0.0
A-C	-	-	-	-	-	-
All	**-**	**-**	**-**	**-**	**-**	**-**

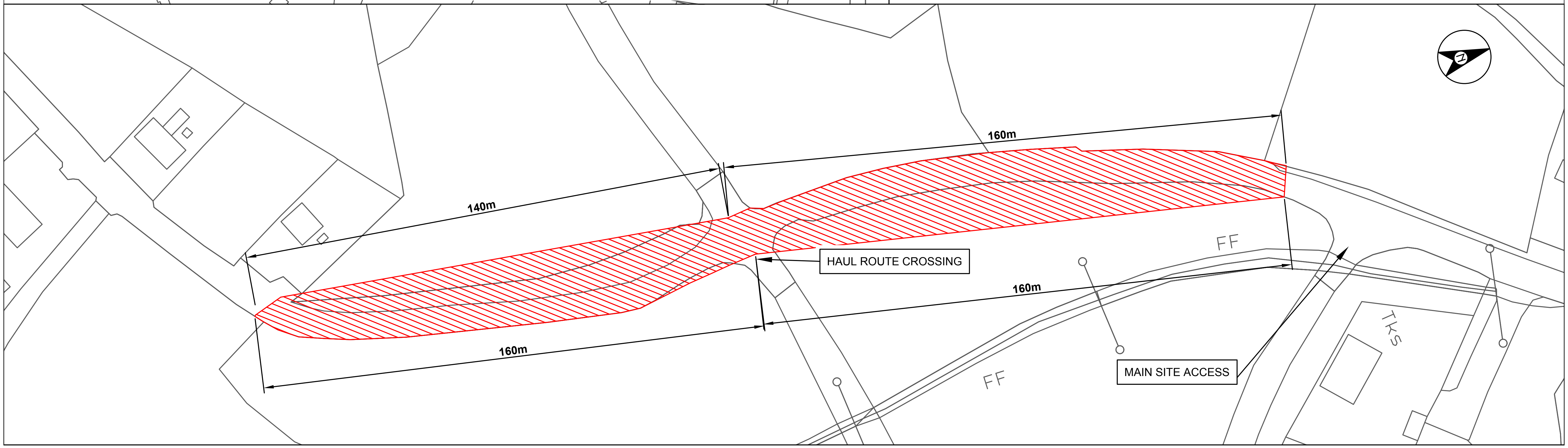
Delay is that occurring only within the time period.
Inclusive delay includes delay suffered by vehicles which are still queuing after the end of the time period.
These will only be significantly different if there is a large queue remaining at the end of the time period.

PICADY 5 Run Successful

Appendix D – Quarry Access Sightlines







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Client:

Rev.	Comment	Date
D1	Sightline Assessment	01/08/18

Notes:

1 Do Not Scale - use figured dimensions only.
2. Drawing is the property of PMCE Ltd.

Project:

Traffic and Transport Assessment
Aughamore Quarry, Carraroe, Co. Slgo

Drawing Title:

Sightline Assessment

Drawn: DOB	**Date:** 01/08/2018
Checked: PJM	**Scale:** NTS
Approved: PJM	**Status:** In Progress
Drawing No: P18-014-DG-001	**Revision:** D1

CHAPTER 15

INTERACTIONS
SUMMARY

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INTRODUCTION

15.1 All of the reasonably predictable significant impacts of the existing and proposed development and the measures in place to mitigate them have been outlined in the EIAR. However, for any development with the potential for significant environmental impact there is also the potential for interaction amongst these impacts. The result of these interactions may either exacerbate the magnitude of the impact or ameliorate it. The interaction of impacts on the surrounding environment needs to be addressed as part of the Environmental Impact Assessment process.

15.2 This Environmental Impact Assessment Report was prepared by SLR Consulting on behalf of Lagan Bitumen Ltd. as an integrated document, rather than a collection of separate reports. The impacts that arise as a result of the interaction between several aspects of the development have therefore been addressed in the main body of each EIAR section.

The Interaction of the Foregoing

15.3 The interaction between the various environmental topics has been covered within each of the EIAR Sections, 4 through to 14, where relevant. For example, the interaction of geology and groundwater has been addressed in EIAR **Section 7**.

15.4 The environmental components which might potentially be impacted by a development of this kind and at this location have been identified through the site assessment as follows:

- Effects on land use and amenity;
- Impacts on local sensitive receptors;
- Loss of natural heritage and wildlife habitats and disturbance to flora and fauna;
- Impacts on groundwater, soils and bedrock geology;
- Nuisance potential and or public health effects due to noise, dust, odour or lighting emissions;
- Impacts on local archaeology;
- Change in visual character;
- Impacts on material assets such as infrastructure or local utilities.

15.5 A matrix method has been used, in which the environmental components addressed in the previous sections of this EIAR have been placed on both axes of a matrix, these interactions are summarised in **Table 15-1** below.

15.6 The purpose of the effects matrix is to identify potential interactions. Actual interactions and their significance are dealt with in the relevant chapter of the EIAR with a brief overview of some of the more pertinent interactions provided in this chapter.

Table 15-1
Impact Interaction and Interrelationships Matrix

	Biodiversity	Land, Soils & Geology	Water	Air Quality	Noise & Vibration	Landscape and Visual	Traffic	Cultural Heritage	Population & Human Health
Biodiversity									
Land, Soils & Geology									
Water									
Air Quality									
Noise & Vibration									
Landscape and Visual									
Traffic									
Cultural Heritage									
Population & Human Health									

POTENTIAL INTERACTIONS

Biodiversity

15.7 Potential interaction associated with the proposed landscape mitigation and restoration proposals are discussed in Chapter 4 (Biodiversity), Chapter 13 (Landscape) and Figure 2.2 (Landscape Mitigation and Restoration).

Water

15.8 The potential impact of the continued use and operation of the permitted quarry and quarry extension in relation to water and the potential interactions with other environmental topics are discussed in Chapter 4 (Biodiversity), Chapter 6 (Land, Soils and Geology) and Chapter 7 (Water).

Air Quality

15.9 The interaction of Climate (Chapter 9), Air Quality (Chapter 8) and Population and Human Health (Chapter 4) are discussed in the relevant chapters of the EIAR.

15.10 The Air Quality Chapter presented in EIAR **Chapter 8**, indicates that with the implementation of industry standard air quality mitigation measures, no residual impacts will result from the proposed development. Therefore, the interaction is considered to be acceptable.

Noise & Vibration

15.11 The interaction between noise / vibration and population and human health is discussed in the relevant chapters of the EIAR.

15.12 The Noise and Vibration assessment, presented in EIAR **Section 10**, indicates that with the implementation of industry standard noise mitigation measures, no residual impacts will result from the proposed development. Therefore, the interaction is considered to be acceptable.

Landscape & Visual

15.13 The potential interaction with Biodiversity are discussed in Chapter 4 (Biodiversity), Chapter 13 (Landscape) and Figure 2.2 (Landscape Mitigation and Restoration).

Traffic

15.14 Potential interactions associated with traffic movements from the existing operational quarry development with the general population and air quality are addressed in the preceding sections of this chapter.

Cultural Heritage

15.15 The proposed development area is an existing quarry that has previously been assessed under Planning Application Reg. No. 02/271 (see Plate 12-2, 12-3 and Fig. 12-1).

15.16 Potential interactions with other environmental topics (e.g. Land, Soils & Geology and Landscape & Visual) are limited as there will be no topsoil stripping required as part of the proposed development. In addition direct changes to this landscape would be very limited as the nature of the proposal comprises for the most part, the continuation of the existing permitted development and the proposed deepening of the existing quarry void. Visual effects at a selection of viewpoint locations were assessed and judged to be not significant.

Population and Human Health

15.17 According to the relevant guidelines, human health should be considered in the context of the relevant environmental topics addressed by the EIAR. Also, effects on human health should be considered in relation to relevant pathways (such as air, soil and water) and should be considered in the context of accepted standards for exposure, dose or risk.

15.18 Human health is considered in the context of the relevant pathways, such as noise, air, soil and water in the context of acceptable doses or limits. The EIAR shows that the quarry would operate within acceptable limits for noise and dust and potential effects on soil and water would be addressed through good practice and mitigation measures to avoid accidental spillages of fuel, etc. Water would be discharged from the site in accordance with the existing discharge licence.

15.19 The key matters in relation to amenity are noise, dust, vibration, landscape and traffic. As stated above, the EIAR shows that the quarry would operate within acceptable levels for noise, dust and vibrations. From many locations, the changes to the landscape would not be visible or would not be significant. The restoration of the quarry would be beneficial when compared against the existing baseline. The traffic assessment shows that the existing road junctions have sufficient capacity to accommodate the quarry traffic to 2034 and beyond.