Water Chapter

Appendix 8A

Planning Files

considered in the

Water Assessment

Planning Permissions & Associated Documentation reviewed by the authors of the Chapter for Lands, Soils & Geology and the Chapter for Water (Hydrology & Hydrogeology).

Breedon (formerly Lagan) has operated at Killaskillen, Kinnegad, Co. Meath, since 2002. All existing activities at the site function under planning permissions granted by Meath County Council and An Bord Pleanála. Permissions relevant to this application are briefly summarised in Table 8.A.1.

Table 8.A.1 List of Planning permissions at the site

Pl. Ref. No.	Year of Decision	Area (ha)	Brief Description
982026 (MCC) 17.111198 (ABP)	1999 2000	161	Cement manufacturing plant, shale quarry, limestone quarry, access road and associated activities. Limestone quarry to 5 benches (70, 55, 40, 25 and 10 mOD) to a base floor of 10 mOD, over an area of 24.8 ha. Shale quarry to 25 mOD.
01967	2001		Asphalt plant
TA/20196*	2002	36	Extend permitted shale quarry by 1.7 ha to include extraction of an additional 500,000 tonnes per annum
TA/40228*	2004		Increase in processing capacity of cement kiln from 450,000 to 600,000 tonnes per annum. Retention of extension of the southeastern face of the limestone quarry over an area of 0.276 ha. Includes additional diesel tank, water treatment plant building and drainage sump. Retention of settlement lagoon 1 (0.55 ha) and settlement lagoon 2 (2 ha) as constructed.
TA70518*	2007	15	Amendments to development of a concrete products production facility.
TA800654	2008		Increase on the quantum and range of alternative fuels used in the cement manufacturing process.
TA900603	2009	77	Extension of existing limestone quarry by 52.5 ha to 77.25 ha over adjoining lands to north, south and east by 1 bench (to 70 mOD). Quarry life extended to 20 years. The quarry extension will be carried out in three phases: Phase 1: Development of northern extension to a depth of 70 mOD. Phase 2: Development of south-eastern and south-western extensions to a depth of 70 mOD. Phase 3: Removal of asphalt plant and subsequent development of the quarry in a southerly direction to a depth of 70 metres AOD.
TA100444	2010		Increase in range of alternative fuels used in cement manufacturing process
TA120195*	2012		Relocate existing asphalt plant to a position north of the existing cement works. All structures located within the existing asphalt plant area will be removed or demolished as appropriate to facilitate the permitted future quarrying of this area (this development has not taken place to date).
TA150677	2015		Increase in quantum of alternative fuels from 95,000 tonnes to 105,000 tonnes per annum
TA160840	2016		Infrastructural works to include installation of a bypass petrol interceptor, rainwater harvesting system, bore-well water supply, underground firewater storage tank with pump and hydrant system, connection to existing storm and foul water systems.

*** indicates planning files not available online.**

Water Chapter

Appendix 8B

Licence P0487-07

Headquarters
P.O. Box 3000
Johnstown Castle Estate
County Wexford
Ireland

INDUSTRIAL EMISSIONS LICENCE

Licence Register Number:	**P0487-07**
Company Register Number:	**237663**
Licensee:	**Lagan Cement**
Location of Installation:	**Killaskillen Kinnegad County Meath**

ENVIRONMENTAL PROTECTION AGENCY ACT 1992 AS AMENDED

INDUSTRIAL EMISSIONS LICENCE

Decision of Agency, under Section 83(1) of the Environmental Protection Agency Act 1992 as amended.

Reference number in Register of licences: P0487-07.

Further to notice dated 23rd June 2017, the Agency in exercise of the powers conferred on it by the Environmental Protection Agency Act 1992 as amended, for the reasons hereinafter set out, hereby grants an Industrial Emissions licence to

Lagan Cement, Killaskillen, Kinnegad, County Meath, CRO number 237663,

to carry on the following activities:

10.2 Production of cement clinker in rotary kilns with a production capacity exceeding 500 tonnes per day or in other kilns with a production capacity exceeding 50 tonnes per day.

11.1 The recovery or disposal of waste in a facility, within the meaning of the Act of 1996, which facility is connected or associated with another activity specified in this Schedule in respect of which a licence or revised licence under Part IV is in force or in respect of which a licence under the said Part is or will be required.

11.2 Disposal or recovery of hazardous waste with a capacity exceeding 10 tonnes per day involving one or more of the following activities:

(c) blending or mixing prior to submission to any of the other activities listed in paragraph 11.2 or 11.3.

11.3 Disposal or recovery of waste in waste incineration plants or in waste co-incineration plants -

(a) for non-hazardous waste with a capacity exceeding 3 tonnes per hour,

(b) for hazardous waste with a capacity exceeding 10 tonnes per day.

11.4 (b) Recovery, or a mix of recovery and disposal, of non-hazardous waste with a capacity exceeding 75 tonnes per day involving one or more of the following activities, (other than activities to which the Urban Waste Water Treatment Regulations 2001 (S.I. No. 254 of 2001) apply):

(ii) pre-treatment of waste for incineration or co-incineration.

11.6 Temporary storage of hazardous waste, (other than waste referred to in paragraph 11.5) pending any of the activities referred to in paragraph 11.2, 11.3, 11.5 or 11.7 with a total capacity exceeding 50 tonnes, other than temporary storage, pending collection, on the site where the waste is generated.

at Killaskillen, Kinnegad, County Meath, subject to the conditions as set out.

GIVEN under the Seal of the Agency this 22nd day of February 2018

PRESENT when the seal of the Agency
was affixed hereto:

Mary Turner/Authorised Person

INTRODUCTION

This introduction is not part of the licence and does not purport to be a legal interpretation of the licence.

Lagan Cement is authorised to produce up to 700,000 tonnes of cement per annum. This licence review authorises the increased use (up to 105,000 tonnes per annum) of waste as alternative fuel and raw materials. The licensee already accepts a wide range of waste at the installation for co-incineration as alternative fuel and use as raw materials. Newly available wastes for co-incineration will be subject to test burns under the conditions of this licence to ensure their combustion takes place in a manner that complies with the requirements of this licence.

This licence review authorises an increase in the acceptance of waste, a change in the TOC emission limit value, an increase in the maximum storage volume of waste liquid recovered fuel, the acceptance of one new List of Waste code and the operation of an SRF (solid recovered fuel) treatment facility within the existing bounds of the installation. This licence review also incorporates the requirements of the BAT Conclusions published in the Commission Implementing Decision of 26/3/2013 establishing the best available techniques (BAT) conclusions under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions for the production of cement, lime and magnesium oxide (2013/163/EU).

The relevant categories of activity as per Annex I of the Industrial Emissions Directive (2010/75/EU) are as follows:

3.1(a) Production of cement clinker in rotary kilns with a production capacity exceeding 500 tonnes per day or in other kilns with a production capacity exceeding 50 tonnes per day.

5.1(c) Disposal or recovery of hazardous waste with a capacity exceeding 10 tonnes per day involving blending or mixing prior to submission to any of the other activities listed in points 5.1 and 5.2.

5.2 Disposal or recovery of waste in waste incineration plants or in waste co-incineration plants:
(a) for non-hazardous waste with a capacity exceeding 3 tonnes per hour;
(b) for hazardous waste with a capacity exceeding 10 tonnes per day.

5.3(b) Recovery, or a mix of recovery and disposal, of non-hazardous waste with a capacity exceeding 75 tonnes per day involving one or more of the following activities, and excluding activities covered by Directive 91/271/EEC:

(ii) pre-treatment of waste for incineration or co-incineration.

5.5 Temporary storage of hazardous waste not covered under point 5.4 pending any of the activities listed in points 5.1, 5.2, 5.4 and 5.6 with a total capacity exceeding 50 tonnes, excluding temporary storage, pending collection, on the site where the waste is generated.

The licence sets out in detail the conditions under which Lagan Cement will operate and manage this installation.

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Glossary of Terms

All terms in this licence should be interpreted in accordance with the definitions in the Environmental Protection Agency Act 1992 as amended / Waste Management Act 1996 as amended, unless otherwise defined in the section.

Adequate lighting	20 lux measured at ground level.
AER	Annual Environmental Report.
Agreement	Agreement in writing.
Annually	All or part of a period of twelve consecutive months.
Application	The application by the licensee for this licence.
Appropriate facility	A waste management facility or installation, duly authorised under relevant law and technically suitable.
Attachment	Any reference to Attachments in this licence refers to attachments submitted as part of this licence application.
BAT	Best Available Techniques.
BAT conclusions	A document containing the parts of a BAT reference document laying down the conclusions on best available techniques, their description, information to assess their applicability, the emission levels associated with the best available techniques, associated monitoring, associated consumption levels and, where appropriate, relevant site remediation measures.
BAT reference document	A document drawn up by the Commission of the European Union in accordance with Article 13 of the Industrial Emissions Directive, resulting from the exchange of information in accordance with that Article of that Directive and describing, in particular, applied techniques, present emissions and consumption levels, techniques considered for the determination of best available techniques as well as BAT conclusions and any emerging techniques.
Biannually	At approximately six – monthly intervals.
Biennially	Once every two years.
BOD	5 day Biochemical Oxygen Demand (without nitrification suppression).
CEN	Comité Européen De Normalisation – European Committee for Standardisation.

COD	Chemical Oxygen Demand.
Containment boom	A boom that can contain spillages and prevent them from entering drains or watercourses or from further contaminating watercourses.
CRO Number	Company Register Number.
Daily	During all days of plant operation and, in the case of emissions, when emissions are taking place; with at least one measurement on any one day.
Day	Any 24 hour period.
Daytime	0700 hrs to 1900 hrs.
dB(A)	Decibels (A weighted).
Dioxins and furans	As defined in Directive 2010/75/EU on industrial emissions.
DO	Dissolved oxygen.
Documentation	Any report, record, results, data, drawing, proposal, interpretation or other document in written or electronic form which is required by this licence.
Drawing	Any reference to a drawing or drawing number means a drawing or drawing number contained in the application, unless otherwise specified in this licence.
Emission limits	Those limits, including concentration limits and deposition rates, established in *Schedule C: Emissions, Monitoring and Control* of this licence.
EMP	Environmental Management Programme.
Environmental damage	As defined in Directive 2004/35/EC.
EPA	Environmental Protection Agency.
Evening Time	1900 hrs to 2300 hrs.
Facility	Any site or premises used for the purpose of the recovery or disposal of waste.
Fire authority	Meath County Council.

Fortnightly	A minimum of 24 times per year, at approximately two week intervals.
GC/MS	Gas chromatography/mass spectroscopy.
Groundwater	Has the meaning assigned to it by Regulation 3 of the European Communities Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010).
ha	Hectare.
Hazardous Substances	Substances or mixtures as defined in Article 3 of Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures.
Heavy metals	This term is to be interpreted as set out in "Parameters of Water Quality, Interpretation and Standards" published by the Agency in 2001. ISBN 1-84095-015-3.
Hours of operation	The hours during which the installation is authorised to be operational.
Hours of waste acceptance	The hours during which the installation is authorised to accept waste.
ICP	Inductively coupled plasma spectroscopy.
IE	Industrial Emissions.
Incident	The following shall constitute as incident for the purposes of this licence: (i) an emergency; (ii) any emission which does not comply with the requirements of this licence; (iii) any malfunction or breakdown of key environmental abatement, control or monitoring equipment; (iv) any exceedance of the daily duty capacity of the waste handling equipment; (v) any trigger level specified in this licence which is attained or exceeded; and, (vi) any indication that environmental pollution has, or may have, taken place.
Industrial Emissions Directive	Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (Recast).
Industrial waste	As defined in Section 5(1) of the Waste Management Act 1996 as amended.

Installation	A stationary technical unit or plant where the activity concerned referred to in the First Schedule of EPA Act 1992 as amended is or will be carried on, and shall be deemed to include any directly associated activity, which has a technical connection with the activity and is carried out on the site of the activity.
Irish Water	Irish Water, Colvill House, 24/26 Talbot Street, Dublin 1.
K	Kelvin.
kPa	Kilopascals.
$L_{Aeq,T}$	This is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period (T).
$L_{Ar,T}$	The Rated Noise Level, equal to the L_{Aeq} during a specified time interval (T), plus specified adjustments for tonal character and/or impulsiveness of the sound.
Licensee	Lagan Cement, Killaskillen, Kinnegad, County Meath, CRO Number 237663.
List of Waste (LoW)	A harmonised, non-exhaustive list of wastes drawn up by the European Commission and published as Commission Decision 2000/532/EC, as amended by Commission Decision 2014/955/EU and any subsequent amendment published in the Official Journal of the European Community.
Liquid recovered fuel	Liquid waste or blend of liquid wastes produced to a technical specification as fuel for co-incineration
Liquid waste	Any waste in liquid form and containing less than 2% dry matter.
List I	As listed in the EC Directives 2006/11/EC and 80/68/EEC and amendments.
List II	As listed in the EC Directives 2006/11/EC and 80/68/EEC and amendments.
Local Authority	Meath County Council.
Maintain	Keep in a fit state, including such regular inspection, servicing, calibration and repair as may be necessary to perform its function adequately.
Mass flow limit	An emission limit value expressed as the maximum mass of a substance that can be emitted per unit time.
Mass flow threshold	A mass flow rate above which a concentration limit applies.

Monthly	A minimum of 12 times per year, at intervals of approximately one month.
Night-time	2300 hrs to 0700 hrs.
Noise-sensitive location (NSL)	Any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other installation or area of high amenity which for its proper enjoyment requires the absence of noise at nuisance levels.
Nominal capacity	As defined in Directive 2010/75/EU on industrial emissions.
Odour-sensitive location	Any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other premises or area of high amenity which for its proper enjoyment requires the absence of odour at nuisance levels.
Oil separator	Device installed according to the International Standard I.S. EN 858-2:2003 (Separator system for light liquids, (e.g. oil and petrol) – Part 2: Selection of normal size, installation, operation and maintenance).
PRTR	Pollutant Release and Transfer Register.
Quarterly	All or part of a period of three consecutive months beginning on the first day of January, April, July or October.
Relevant hazardous substances	Those substances or mixtures defined within Article 3 of Regulation (EC) No 1272/2008 on the classification, labelling and packaging of substances and mixtures (CLP Regulation) which, as a result of their hazardousness, mobility, persistence and biodegradability (as well as other characteristics), are capable of contaminating soil or groundwater and are used, produced and/or released by the installation.
Sample(s)	Unless the context of this licence indicates to the contrary, the term samples shall include measurements taken by electronic instruments.
Sanitary effluent	Wastewater from installation toilet, washroom and canteen facilities.
Shut-down	Shut-down is that period of time during which the cement kiln is allowed to cool from operating temperature to a lower temperature.
Soil	The top layer of the Earth's crust situated between the bedrock and the surface. The soil is composed of mineral particles, organic matter, water, air and living organisms.
SOP	Standard operating procedure.

Specified emissions	Those emissions listed in *Schedule C: Emissions, Monitoring and Control* of this licence.
Standard method	A National, European or internationally recognised procedure (e.g. I.S. EN, ISO, CEN, BS or equivalent); or an in-house documented procedure based on the above references; a procedure as detailed in the current edition of "Standard Methods for the Examination of Water and Wastewater" (prepared and published jointly by A.P.H.A., A.W.W.A. & W.E.F.), American Public Health Association, 1015 Fifteenth Street, N.W., Washington DC 20005, USA; or an alternative method as may be agreed by the Agency.
Start-up	Start-up is that period of time during which the cement kiln is heated to operating temperature from a lower temperature.
Storage of waste	Includes holding of waste.
Storm water	Rain water run-off from roof and non-process areas.
The Agency	Environmental Protection Agency.
TOC	Total organic carbon.
Trade effluent	Trade effluent has the meaning given in the Water Services Act, 2007.
Trigger level	A parameter value, the achievement or exceedance of which requires certain actions to be taken by the licensee.
Waste	Any substance or object which the holder discards or intends or is required to discard.
Water Services Authority	Meath County Council.
Weekly	During all weeks of plant operation and, in the case of emissions, when emissions are taking place; with at least one measurement in any one week.
WWTP	Waste water treatment plant.

Decision & Reasons for the Decision

The Environmental Protection Agency is satisfied, on the basis of the information available, that subject to compliance with the conditions of this licence, any emissions from the activity will comply with and will not contravene any of the requirements of Section 83(5) of the Environmental Protection Agency Act 1992 as amended.

The Agency has applied the Commission Implementing Decision of 26/3/2013 establishing the best available techniques (BAT) conclusions under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions for the production of cement, lime and magnesium oxide (2013/163/EU) as a reference when setting licence conditions.

The Agency has accordingly decided to grant a licence to Lagan Cement to carry on the activities listed in *Part I, Schedule of Activities Licensed* subject to the conditions set out in *Part III, Conditions*, such licence to take effect in lieu of licence register number P0487-06.

In reaching this decision the Agency has considered the documentation relating to the existing licence, Register Number P0487-06, the review application, Register Number P0487-07, and the supporting documentation received from the applicant, the submissions received, the Inspector's Report dated 8/6/2017, the objection received from the Applicant, the Technical Committee Report dated 1/2/2018 and addendum report dated 8/2/18 on the objections to the proposed determination, and has carried out an Environmental Impact Assessment (EIA) and an Appropriate Assessment Screening of the likely significant effects of the activities on European Sites.

It is considered that the Inspector's Report contains a fair and reasonable examination, evaluation and analysis of the likely significant effects of the activities on the environment and adequately and accurately identifies, describes and assesses those effects. The assessment as reported in the Inspector's Report is adopted as the assessment of the Agency. Having regard to that assessment, it is considered that the activities, if managed, operated and controlled in accordance with the licence, will not result in the contravention of any relevant environmental quality standards or cause environmental pollution.

A screening for Appropriate Assessment was undertaken to assess, in view of best scientific knowledge and the conservation objectives of the site, if the activities, individually or in combination with other plans or projects are likely to have a significant effect on any European Site. In this context, particular attention was paid to the European Sites at River Boyne and River Blackwater SAC [2299], Mount Hevey Bog SAC [2342]; Lough Ennell SAC [685] and Lough Ennell SPA [4044].

The activities are not directly connected with or necessary to the management of any European Site and the Agency considered, for the reasons set out below, that it can be excluded, on the basis of objective information, that the activities, individually or in combination with other plans or projects, will have a significant effect on any European Site and accordingly determined that an Appropriate Assessment of the activities was not required. The reasons for this determination are as follows:

- the licensee's monitoring data for discharges to surface water for the period 2014 to mid-2016 are compliant with licence conditions and show no evidence of an adverse environmental impact on the Kinnegad River which flows, 12km downstream, to the River Boyne and River Blackwater SAC;
- EPA monitoring data for the Kinnegad River Upstream at "Br SE of Cloonfad Ho" shows at 2015 Q value of 3-4*. Downstream at "Ballivor Rd Br Kinnegad" shows a Q value of 3-4 in 2012, at "Kilwarden Br" a 2015 Q value of 3-4 and at "Clonard Br", a 2012 Q value of 4.

Part I Schedule of Activities Licensed

In pursuance of the powers conferred on it by the Environmental Protection Agency Act 1992 as amended, the Agency hereby grants this revised Industrial Emissions licence to:

Lagan Cement, Killaskillen, Kinnegad, County Meath, CRO Number 237663,

under Section 90(2) of the said Act to carry on the following activities:

10.2 Production of cement clinker in rotary kilns with a production capacity exceeding 500 tonnes per day or in other kilns with a production capacity exceeding 50 tonnes per day.

11.1 The recovery or disposal of waste in a facility, within the meaning of the Act of 1996, which facility is connected or associated with another activity specified in this Schedule in respect of which a licence or revised licence under Part IV is in force or in respect of which a licence under the said Part is or will be required.

11.2 Disposal or recovery of hazardous waste with a capacity exceeding 10 tonnes per day involving one or more of the following activities:

(c) blending or mixing prior to submission to any of the other activities listed in paragraph 11.2 or 11.3.

11.3 Disposal or recovery of waste in waste incineration plants or in waste co-incineration plants -

(a) for non-hazardous waste with a capacity exceeding 3 tonnes per hour,

(b) for hazardous waste with a capacity exceeding 10 tonnes per day.

11.4 (b) Recovery, or a mix of recovery and disposal, of non-hazardous waste with a capacity exceeding 75 tonnes per day involving one or more of the following activities, (other than activities to which the Urban Waste Water Treatment Regulations 2001 (S.I. No. 254 of 2001) apply):

(ii) pre-treatment of waste for incineration or co-incineration.

11.6 Temporary storage of hazardous waste, (other than waste referred to in paragraph 11.5) pending any of the activities referred to in paragraph 11.2, 11.3, 11.5 or 11.7 with a total capacity exceeding 50 tonnes, other than temporary storage, pending collection, on the site where the waste is generated.

at Killaskillen, Kinnegad, County Meath, subject to the following twelve conditions, with the reasons therefor and associated schedules attached thereto.

Part II Schedule of Activities Refused

None of the activities as set out in the licence application have been refused.

Part III Conditions

Condition 1. Scope

1.1 Industrial Emissions Directive activities at this installation shall be restricted to those listed and described in *Part I Schedule of Activities Licensed* and shall be as set out in the licence application or as modified under Condition 1.4 of this licence and subject to the conditions of this licence.

1.2 Activities at this installation shall be limited as set out in *Schedule A: Limitations* of this licence.

1.3 For the purposes of this licence, the installation authorised by this licence is the area of land outlined in red on Drawing No. "Fig.B.2(i)", 30/7/2012, of Attachment No. B.2 of the application. Any reference in this licence to "installation" shall mean the area thus outlined in red. The licensed activities shall be carried on only within the area outlined.

1.4 No alteration to, or reconstruction in respect of, the activity, or any part thereof, that would, or is likely to, result in:

(i) a material change or increase in:

- the nature or quantity of any emission;
- the abatement/treatment or recovery systems;
- the range of processes to be carried out;
- the fuels, raw materials, intermediates, products or wastes generated, or

(ii) any changes in:

- site management, infrastructure or control with adverse environmental significance;

shall be carried out or commenced without prior notice to, and without the approval of, the Agency.

1.5 The installation shall be controlled, operated and maintained, and emissions shall take place as set out in the licence. All programmes required to be carried out under the terms of this licence become part of this licence.

1.6 The licensee shall use, achieve, implement, and carry out the Best Available Techniques as set out in *Schedule B: Resource, Energy and Waste Management* and *Schedule C: Emissions, Monitoring and Control* of this licence.

1.7 This licence is for the purpose of IE licensing under the EPA Act 1992 as amended only and nothing in this licence shall be construed as negating the licensee's statutory obligations or requirements under any other enactments or regulations.

1.8 This licence shall have effect in lieu of licence register number P0487-06 granted on 12/3/2012.

Reason: ***To clarify the scope of this licence.***

Condition 2. Management of the Installation

2.1 Installation Management

2.1.1 The licensee shall employ a suitably qualified and experienced installation manager who shall be designated as the person in charge. The installation manager or a nominated, suitably qualified and experienced deputy shall be present on the installation at all times during its operation or as otherwise required by the Agency.

2.1.2 The licensee shall ensure that personnel performing specifically assigned tasks shall be qualified on the basis of appropriate education, training and experience as required and shall be aware of the requirements of this licence.

2.2 Environmental Management System (EMS)

2.2.1 The licensee shall maintain and implement an Environmental Management System (EMS), which shall incorporate energy efficiency management. The EMS shall be reviewed by senior management for suitability, adequacy and effectiveness and updated on an annual basis.

2.2.2 The EMS shall include, as a minimum, the following elements:

2.2.2.1 Commitment of the management, including senior management.

2.2.2.2 An environmental policy defined for the installation that includes the continuous improvement for the installation by the management.

2.2.2.3 Management and reporting structure and responsibility.

2.2.2.4 The necessary procedures, objectives and targets, in conjunction with financial planning and investment.

2.2.2.5 Procedures that ensure employee involvement in ensuring compliance with environmental legislation.

2.2.2.6 A procedure for checking performance by sectoral benchmarking on a regular basis including energy efficiency.

2.2.2.7 Schedule of Environmental Objectives and Targets.

The licensee shall maintain and implement a Schedule of Environmental Objectives and Targets. The schedule shall, as a minimum, provide for a review of all operations and processes, including an evaluation of practicable options, for energy and resource efficiency, the use of cleaner technology, cleaner production and the prevention, reduction and minimisation of waste and shall include waste reduction targets. The schedule shall include time frames for the achievement of set targets and shall address a five-year period as a minimum. The schedule shall be reviewed annually.

2.2.2.8 Environmental Management Programme (EMP).

The licensee shall maintain and implement an EMP, including a time schedule, for achieving the Environmental Objectives and Targets prepared under Condition 2.2.2.7. The EMP shall include:

- designation of responsibility for targets;
- the means by which they may be achieved;
- the time within which they may be achieved.

The EMP shall be reviewed annually.

A report on the programme, including the success in meeting agreed targets, shall be prepared and submitted to the Agency as part of the AER. Such reports shall be retained on-site for a period of not less than seven years and shall be available for inspection by authorised persons of the Agency.

2.2.2.9 Documentation

(i) The licensee shall maintain and implement an environmental management documentation system.

(ii) The licensee shall issue a copy of this licence to all relevant personnel whose duties relate to any condition of this licence.

2.2.2.10 Corrective and Preventative Action

(i) The licensee shall maintain and implement procedures to ensure that corrective and preventative action is taken should the specified requirements of this licence not be fulfilled. The responsibility and

authority for persons initiating further investigation and corrective and preventative action in the event of a reported non-conformity with this licence shall be defined.

(ii) Where a breach of one or more of the conditions of this licence occurs, the licensee shall without delay take measures to restore compliance with the conditions of this licence in the shortest possible time and initiate any feasible preventative actions to prevent recurrence of the breach.

(iii) All corrective and preventative actions shall be documented

2.2.2.11 Internal Audits

The licensee shall establish, maintain and implement a programme for independent internal audits of the EMS. Such audits shall be carried out at least once every three years. The audit programme shall determine whether or not the EMS is being implemented and maintained properly, and in accordance with the requirements of the licence. Audit reports and records of the resultant corrective and preventative actions shall be maintained as part of the EMS in accordance with Condition 2.2.2.9.

2.2.2.12 Awareness, Training and Competence

The licensee shall maintain and implement procedures for identifying training needs, and for providing appropriate training, for all personnel whose work can have a significant effect upon the environment to ensure awareness and competence in their work area. Appropriate records of training shall be maintained.

2.2.2.13 Communications Programme

The licensee shall maintain and implement a Public Awareness and Communications Programme to ensure that members of the public are informed, and can obtain information at the installation, at all reasonable times, concerning the environmental performance of the installation. The Public Awareness and Communications Programme shall include a specific programme of outreach to interested local residents on matters relating to the prevention of nuisance and other factors at the installation. The programme shall be to the Agency's satisfaction and a report on the programme shall be prepared and submitted to the Agency as part of the AER.

The Public Awareness and Communications Programme shall include provision for regular meetings with local residents and representatives together with the circulation of a newsletter at a frequency to be agreed with the residents which shall provide information of activities on-site and compliance with this licence.

2.2.2.14 Maintenance Programme

The licensee shall maintain and implement a programme for maintenance of all plant and equipment, including bag filters, based on the instructions issued by the manufacturer/supplier or installer of the equipment. Appropriate record keeping and diagnostic testing shall support this maintenance programme. The licensee shall clearly allocate responsibility for the planning, management and execution of all aspects of this programme to appropriate personnel (see Condition 2.1 above). The maintenance programme shall use appropriate techniques and measures to ensure the optimisation of energy efficiency in plant and equipment.

2.2.2.15 Efficient Process Control

The licensee shall maintain and implement a programme to ensure there is adequate control of processes under all modes of operation. The programme shall identify the key indicator parameters for process control performance, as well as identifying methods for measuring and controlling these parameters

and should take account of the best available techniques in Commission Implementation Decision 2013/163/EU for the production of cement, lime and magnesium oxide. Abnormal process operating conditions shall be documented, and analysed to identify any necessary corrective action.

2.3 Extractive waste and overburden

2.3.1 The licensee shall maintain and implement a Waste Management Plan (to be known as an Extractive Waste Management Plan) for the minimisation, treatment, recovery and disposal of extractive waste. This plan shall meet the requirements of Regulation 5 of the Waste Management (Management of Waste from the Extractive Industries) Regulations, 2009. The plan shall be to the satisfaction of the Agency at all times. The plan shall be reviewed at least once every five years to the satisfaction of the Agency and amended in the event of substantial changes to the operation of the extractive waste facility or to the waste deposited. Any amendments shall be notified to the Agency.

2.3.2 A report on the implementation of the Extractive Waste Management Plan shall be provided in the AER.

2.3.3 No extractive waste shall be deposited in a manner that would result in the extractive waste facility being classified as a Category A facility.

Reason: ***To make provision for management of the activity on a planned basis having regard to the desirability of ongoing assessment, recording and reporting of matters affecting the environment.***

Condition 3. Infrastructure and Operation

3.1 The licensee shall establish and maintain, for each component of the installation, all infrastructure referred to in this licence in advance of the commencement of the licensed activities in that component, or as required by the conditions of this licence. Infrastructure specified in the application that relates to the environmental performance of the installation and is not specified in the licence, shall be installed in accordance with the schedule submitted in the application.

3.2 The licensee shall have regard to the following when choosing and/or designing any new plant/infrastructure:

(i) Energy efficiency, and

(ii) The environmental impact of eventual decommissioning.

3.3 Installation Notice Board

(i) The licensee shall maintain an Installation Notice Board on the installation so that it is legible to persons outside the main entrance to the installation. The minimum dimensions of the board shall be 1200 mm by 750 mm.

(ii) The board shall clearly show:

(i) the name and telephone number of the installation;

(ii) the normal hours of operation;

(iii) the name of the licence holder;

(iv) an emergency out of hours contact telephone number;

(v) the licence reference number; and

(vi) where environmental information relating to the installation can be obtained.

(iii) A plan of the installation clearly identifying the location of each storage and treatment area shall be displayed as close as is possible to the entrance to the installation. The plan shall be displayed on a durable material such that is legible at all times. The plan shall be replaced as material changes to the installation are made.

3.4 The licensee shall install on all emission points such sampling points or equipment, including any data-logging or other electronic communication equipment, as may be required by the Agency. All such equipment shall be consistent with the safe operation of all sampling and monitoring systems.

3.5 In the case of composite sampling of aqueous emissions from the operation of the installation, a separate composite sample or homogeneous sub-sample (of sufficient volume as advised) shall be refrigerated immediately after collection and retained as required for EPA use.

3.6 The licensee shall clearly label and provide safe and permanent access to all on-site sampling and monitoring points and to off-site points as required by the Agency. The requirement with regard to off-site points is subject to the prior agreement of the landowners concerned.

3.7 Tank, Container and Drum Storage Areas

3.7.1 All tank, container and drum storage areas shall be rendered impervious to the materials stored therein. Bunds shall be designed having regard to Agency guidelines 'Storage and Transfer of Materials for Scheduled Activities' (2004).

3.7.2 All tank and drum storage areas shall, as a minimum, be bunded, either locally or remotely, to a volume not less than the greater of the following:

(i) 110% of the capacity of the largest tank or drum within the bunded area; or

(ii) 25% of the total volume of substance that could be stored within the bunded area.

3.7.3 All drainage from bunded areas shall be treated as contaminated unless it can be demonstrated to be otherwise. All drainage from bunded areas shall be diverted for collection and safe disposal.

3.7.4 All inlets, outlets, vent pipes, valves and gauges shall be within the bunded area.

3.7.5 All tanks, containers and drums shall be labelled to clearly indicate their contents.

3.7.6 All bunds shall be uniquely identified and labelled at the bund.

3.7.7 The licensee shall apply a leak detection system in accordance with BAT to all storage tanks, container and drum storage areas that contain liquid material other than water.

3.7.8 Liquid recovered fuels shall be stored under a nitrogen gas blanket in tanks protected against over-filling.

3.8 The licensee shall have in storage an adequate supply of containment booms and/or suitable absorbent material to contain and absorb any spillage at the installation. Once used, the absorbent material shall be disposed of at an appropriate facility.

3.9 Silt Traps and Oil Separators

The licensee shall install and maintain silt traps and oil separators at the installation as follows:

(i) Silt traps to ensure that all storm water discharges, other than from roofs, from the installation pass through a silt trap in advance of discharge;

(ii) An oil separator on the storm water discharge from yard areas. The separator shall be a Class I full retention separator.

The silt traps and separator shall be in accordance with I.S. EN-858-2: 2003 (separator systems for light liquids)

3.10 Fire-water Retention

3.10.1 The licensee shall review the fire-water risk assessment prior to the stored volume of liquid recovered fuel exceeding 20,000 litres. This risk assessment shall determine the requirements at the installation for fire fighting and fire water retention facilities. The fire authority shall be consulted by the licensee during this assessment.

3.10.2 The licensee shall ensure that there is adequate firewater retention capacity on site at all times.

3.10.3 In the event that a significant risk exists for the release of contaminated fire-water, the licensee shall, based on the findings of the risk assessment, prepare and implement, with the agreement of the Agency, a suitable risk management programme. The risk management programme shall be fully implemented within three months of date of notification by the Agency.

3.10.4 In the event of a fire or a spillage to storm water, the site storm water shall be diverted to the containment pond.

3.10.5 The licensee shall have regard to any guidelines issued by the Agency with regard to firewater retention.

3.10.6 The licensee shall have regard to the Environmental Protection Agency Draft Guidance Note to Industry on the Requirements for Fire-Water Retention Facilities when implementing Condition 3.10.

3.11 All pump sumps, storage tanks, lagoons or other treatment plant chambers from which spillage of environmentally significant materials might occur in such quantities as are likely to breach local or remote containment or separators, shall be fitted with high liquid level alarms (or oil detectors as appropriate).

3.12 The provision of a catchment system to collect any leaks from flanges and valves of all over-ground pipes used to transport material other than water shall be examined. This shall be incorporated into a Schedule of Environmental Objectives and Targets set out in Condition 2 of this licence for the reduction in fugitive emissions.

3.13 The licensee shall maintain in a prominent location on the site a wind sock, or other wind direction indicator, which shall be visible from the public roadway outside the site.

3.14 The licensee shall operate a weather monitoring station on the installation at a location satisfactory to the Agency, which records conditions of wind speed and wind direction on a continuous basis. A report from this weather station shall be supplied to the Agency with any report relating to an incident at the installation.

3.15 The licensee shall provide and maintain a wastewater treatment plant at the installation for the treatment of sanitary effluent arising on-site.

3.16 Co-incineration – Operational Controls

3.16.1 The licensee shall maintain standard operating procedures for the operation of the co-incineration plant.

3.16.2 The installation, when co-incinerating waste, shall be operated in such a way that the gas resulting from the process is raised, after the last injection of combustion air, in a controlled and homogeneous fashion and even under the most unfavourable conditions, to a temperature of 850°C, as measured near the inner wall or at another representative point of the combustion chamber as authorised by the Agency, for two seconds. Waste shall be charged into the plant only when these operating conditions are being complied with and when the emission limit values which are subject to continuous monitoring are not being exceeded.

3.16.3 The first burner and kiln shall each be equipped with at least one auxiliary burner. The auxiliary burner shall be switched on automatically when the temperature of the combustion gases after the last injection of combustion air falls below 850°C. The auxiliary burners shall also be used during plant start-up and shut-down operations in order to ensure the temperature of ≥850°C is maintained at all times during the co-incineration of waste and as long as there is unburned waste in the combustion chamber.

3.16.4 During start-up or shut down or when the temperature of the combustion gas falls below 850°C, the auxiliary burners shall be fed with coal, oils or gas.

3.16.5 The licensee shall maintain and operate an automatic system to prevent waste feed:

(i) at start-up, until the temperature of ≥850°C has been reached;

(ii) whenever the temperature falls below 850°C;

(iii) whenever the continuous measurements show that any emission limit value is exceeded;

(iv) whenever stoppages, disturbances or failure of the purification devices or the measurement devices may result in the exceedence of the emissions limit values;

(v) in the case of a breakdown or incident.

3.16.6 There shall be no bypass of the electrostatic precipitator system.

Reason: ***To provide for appropriate operation of the installation to ensure protection of the environment.***

Condition 4. Interpretation

4.1 Emission limit values for emissions to atmosphere in this licence shall be interpreted in the following way:

4.1.1 Continuous Monitoring

(i) No 24 hour mean value shall exceed the emission limit value.

(ii) 97% of all 30 minute mean values taken continuously over an annual period shall not exceed 1.2 times the emission limit value.

(iii) No 30 minute mean value shall exceed twice the emission limit value.

4.1.2 Non-Continuous Monitoring

(i) For any parameter where, due to sampling/analytical limitations, a 30 minute sample is inappropriate, a suitable sampling period should be employed and the value obtained therein shall not exceed the emission limit value.

(ii) For flow, no hourly or daily mean value, calculated on the basis of appropriate spot readings, shall exceed the relevant limit value.

(iii) For all other parameters, no 30 minute mean value shall exceed the emission limit value.

(iv) Mass flow thresholds refer to a rate of discharge expressed in units of kg/h, above which the concentration emission limit value applies. Mass flow threshold rates shall be determined on the basis of a single 30 minute measurement (i.e. the concentration determined as a 30 minute average shall be multiplied by an appropriate measurement of flow and the result shall be expressed in units of kg/h).

(v) Mass flow emissions shall be calculated on the basis of the concentration, determined as an average over the specified period, multiplied by an appropriate measurement of flow. No value, so determined, shall exceed the mass flow limit value.

4.1.3 For continuous monitoring of emissions to atmosphere from co-incineration of waste:

(i) No valid daily mean value shall exceed the emission limit value.

(ii) Half-hourly average values shall be determined within the effective operating time (excluding the start-up and shutdown periods if no waste is being incinerated) from the measured values after having subtracted the value of the confidence interval below. The daily average values shall be determined from those validated average values.

(iii) To obtain a valid daily average value no more than five half-hourly average values in any day shall be discarded due to malfunction or maintenance of the continuous measurement system. No more than ten daily average values per year shall be discarded due to malfunction or maintenance of the continuous measurement system.

(iv) At the daily emission limit value level, the values of the 95% confidence intervals of a single measured result shall not exceed the following percentages of the emission limit values:

Carbon monoxide	10%
Sulphur dioxide	20%
Nitrogen dioxide	20%
Total dust	30%
Total organic carbon	30%
Hydrogen chloride	40%
Hydrogen fluoride	40%

4.1.4 For non-continuous monitoring of emissions to atmosphere from co-incineration of waste:

(i) For any parameter where, due to sampling/analytical limitations, a 30-minute sample is inappropriate, a suitable sampling period should be employed and the value obtained therein shall not exceed the emission limit value.

(ii) For flow, no hourly or daily mean value, calculated on the basis of appropriate spot readings, shall exceed the relevant limit value.

(iii) For all other parameters, no 30-minute mean value shall exceed the emission limit value.

4.2 The concentration and volume flow limits for emissions to atmosphere specified in this licence shall be achieved without the introduction of dilution air and shall be based on gas volumes under standard conditions of:

4.2.1 From non-combustion sources:

Temperature 273K, Pressure 101.3 kPa (no correction for oxygen or water content).

4.2.2 From combustion sources:

Temperature 273K, Pressure 101.3 kPa, dry gas; 10% oxygen.

4.3 Emission limit values for emissions to waters in this licence shall be achieved without the introduction of aqueous dilution and shall be interpreted in the following way:

4.3.1 Continuous Monitoring

(i) No flow value shall exceed the specific limit.

(ii) No pH value shall deviate from the specified range.

(iii) No temperature value shall exceed the limit value.

4.3.2 Composite Sampling

(i) No pH value shall deviate from the specified range.

(ii) For parameters other than pH and flow, eight out of ten consecutive composite results, based on flow proportional composite sampling, shall not exceed the emission limit value. No individual results similarly calculated shall exceed 1.2 times the emission limit value.

4.3.3 Discrete Sampling

For parameters other than pH, temperature and flow, no grab sample value shall exceed 1.2 times the emission limit value.

4.4 Where the ability to measure a parameter is affected by mixing before emission, then, with approval from the Agency, the parameter may be assessed before mixing takes place.

4.5 Noise from the installation shall not give rise to sound pressure levels ($L_{Aeq, T}$) measured at the specified noise sensitive locations which exceed the specified limit values.

4.6 Off-site vibration and air overpressure

(i) Vibration levels measured at the noise sensitive locations shall not exceed the specified limit value.

(ii) 95% of all air overpressure levels measured at the noise sensitive locations shall conform to the specified limit value. No individual air overpressure value shall exceed the limit value by more than 2.5 dB(lin).

4.7 Dust and Particulate Matter

Dust and particulate matters from the activity shall not give rise to deposition levels which exceed the limit values.

Reason: ***To clarify the interpretation of limit values fixed under the licence.***

Condition 5. Emissions

5.1 No specified emission from the installation shall exceed the emission limit values set out in *Schedule C: Emissions, Monitoring and Control* of this licence. There shall be no other emissions of environmental significance.

5.2 No emissions, including odours, from the activities carried on at the site shall result in an impairment of, or an interference with amenities or the environment beyond the installation boundary or any other legitimate uses of the environment beyond the installation boundary.

5.3 No substance shall be discharged in a manner, or at a concentration, that, following initial dilution, causes tainting of fish or shellfish.

5.4 There shall be no discharges to surface water other than stormwater, pumped groundwater, treated sewage effluent and, from SW2, overland flow from undeveloped lands.

5.5 No potentially polluting substance or matter shall be permitted to discharge to ground or groundwater under the site.

5.6 The licensee shall ensure that all or any of the following:

- Mud
- Dust
- Litter

associated with the activity do not result in an impairment of, or an interference with, amenities or the environment at the installation or beyond the installation boundary or any other legitimate uses of the environment beyond the installation boundary. Any method used by the licensee to control or prevent any such impairment/interference shall not cause environmental pollution.

Reason: ***To provide for the protection of the environment by way of control and limitation of emissions.***

Condition 6. Control and Monitoring

6.1 Test Programme

6.1.1 The licensee shall prepare a test programme for abatement equipment installed to abate emissions to atmosphere.

6.1.2 The programme shall be completed within three months of the commencement of operation of the abatement equipment.

6.1.3 The criteria for the operation of the abatement equipment, as determined by the test programme, shall be incorporated into the standard operating procedures.

6.1.4 The test programme shall as a minimum:

(i) establish all criteria for operation, control and management of the abatement equipment to ensure compliance with the emission limit values specified in this licence; and

(ii) assess the performance of any monitors on the abatement system and establish a maintenance and calibration programme for each monitor.

6.1.5 A report on the test programme shall be submitted to the Agency within one month of completion.

6.2 The licensee shall carry out such sampling, analyses, measurements, examinations, maintenance and calibrations as set out below and as in accordance with *Schedule C: Emissions, Monitoring and Control* of this licence.

6.2.1 Sampling and analysis shall be undertaken by competent staff in accordance with documented operating procedures. Unless otherwise approved by the Agency, sampling and analysis of emissions to atmosphere shall be carried out by ISO 17025 accredited persons/organisations, with accreditation for the relevant scope of sampling and analysis.

6.2.2 Such procedures shall be assessed for their suitability for the test matrix and performance characteristics shall be determined.

6.2.3 Such procedures shall be subject to a programme of Analytical Quality Control using control standards with evaluation of test responses.

6.2.4 Where any analysis is sub-contracted it shall be to a competent laboratory.

6.3 Co-incineration – Test Programme

6.3.1 The licensee shall prepare to the satisfaction of the Agency, a test programme for the co-incineration of each waste material proposed for introduction into the kiln. This programme shall be submitted to the Agency prior to implementation.

6.3.2 This test programme, following agreement with the Agency, shall be implemented and a report on its implementation shall be submitted to the Agency within one month of completion.

6.3.3 The criteria for the operation of the abatement equipment as determined by the test programme shall be incorporated into the standard operating procedures.

6.3.4 The Test Programme shall as a minimum,

(i) Verify the residence time, the minimum temperature and the oxygen content of the exhaust gas which will be achieved during normal operation and under the most unfavourable operating conditions anticipated.

(ii) Establish all criteria for operation, control and management of the abatement equipment to ensure compliance with the emission limit values specified in this licence.

(iii) Assess the performance of any monitors on the abatement system and establish a maintenance and calibration programme for each monitor.

(iv) Establish criteria for the control of all waste material input including the maximum flow and maximum calorific value.

(v) Confirm that all measurement equipment or devices (including thermocouples) used for the purpose of establishing compliance with this licence have been subjected, in situ, to normal operating temperatures to prove their operation under such conditions.

(vi) Include analysis of dust emissions from A2-02 and cement for the presence of amino acids.

A report on the Test Programmes shall be submitted to the Agency within one month of completion.

6.3.5 Co-incineration of waste materials shall not be permitted (outside of the agreed Test Programme) until such time as the Agency has indicated in writing that it is satisfied with the results of the Test Programme for the individual waste streams.

6.4 The licensee shall ensure that the following operating parameters shall be continuously monitored and recorded when co-incinerating waste:

(i) the temperature near the inner wall of the combustion chamber (or other representative location agreed by the Agency);

(ii) the exhaust gas oxygen concentration;

(iii) the exhaust gas temperature;

(iv) the exhaust gas pressure; and

(v) if the gases are not dried prior to analysis, the exhaust gas water vapour content.

6.5 The licensee shall ensure that:

(i) sampling and analysis for all parameters listed in the Schedules to this licence; and

(ii) any reference measurements for the calibration of automated measurement systems;

shall be carried out in accordance with CEN-standards. If CEN standards are not available, ISO, national or international standards that will ensure the provision of data of an equivalent scientific quality shall apply.

6.6 All automatic monitors and samplers shall be functioning at all times (except during maintenance and calibration) when the activity is being carried on unless alternative sampling or monitoring has been agreed in writing by the Agency for a limited period. In the event of the malfunction of any continuous monitor, the licensee shall contact the Agency as soon as practicable, and alternative sampling and monitoring facilities shall be put in place. The use of alternative equipment, other than in emergency situations, shall be as agreed by the Agency.

6.7 Monitoring and analysis equipment shall be operated and maintained as necessary so that monitoring accurately reflects the emission, discharge or ambient conditions.

6.8 The licensee shall ensure that groundwater monitoring well sampling equipment is available or installed on-site at the installation and is fit for purpose at all times. The sampling equipment shall be to Agency specifications.

6.9 All treatment/abatement and emission control equipment shall be calibrated and maintained in accordance with the instructions issued by the manufacturer/supplier or installer.

6.10 The frequency, methods and scope of monitoring, sampling and analyses, as set out in this licence, may be amended as required or approved by the Agency following evaluation of test results.

6.11 The licensee shall prepare a programme, to the satisfaction of the Agency, for the identification and reduction of fugitive emissions using an appropriate combination of best available techniques. This programme shall be included in the Environmental Management Programme.

6.12 The integrity and water tightness of all tanks, bunding structures, containers and underground pipes and their resistance to penetration by water or other materials carried or stored therein shall be tested and demonstrated by the licensee. This testing shall be carried out by the licensee at least once every three years and reported to the Agency on each occasion. The testing shall be carried out in accordance with any guidance published by the Agency. A written record of all integrity tests and any maintenance or remedial work arising from them shall be maintained by the licensee.

6.13 The drainage system (i.e. gullies, manholes, any visible drainage conduits and such other aspects as may be agreed) shall be visually inspected weekly and desludged as necessary. Bunds, silt traps and oil separators shall be inspected weekly and desludged as necessary. All sludge and

drainage from these operations shall be collected for safe disposal. The drainage system, bunds, silt traps and oil interceptors shall be properly maintained at all times.

6.14 The licensee shall maintain a drainage map at the installation. The drainage map shall be reviewed annually and updated as necessary.

6.15 There shall be no discharge of effluent arising within the SRF building to the installation drainage system. Effluent arising within the SRF building shall be contained within the building and collected for safe disposal.

6.16 An inspection system for the detection of leaks on all flanges and valves on over-ground pipes used to transport materials other than water shall be developed and maintained.

6.17 Emissions to atmosphere

6.17.1 The licensee shall maintain a log of trip-out events of the electrostatic precipitator in use on the site. This log shall contain information on the time, duration, cause and corrective action taken, in the case of each trip-out event and shall be available for inspection at all times by Agency personnel.

6.17.2 Consistent with its safe operation, the kiln shall be taken off-line in the event that any trip or any other circumstances leads to a loss of operation of the electrostatic precipitator for a period in excess of 30 minutes. Details of such shut-down of the kiln shall be included in the log referred to in Condition 6.17.1 of this licence.

6.17.3 The licensee shall maintain a programme for the reduction of trip-outs of the electrostatic precipitator.

6.17.4 During weather conditions which favour the dispersion of dust, the licensee shall ensure that a procedure for the control of windblown dust and dust from the movement of machinery shall be operated and maintained by the licensee.

6.17.5 The licensee shall ensure that all operations on-site shall be carried out in a manner such that air emissions, including dust emissions, and/or odours do not result in significant impairment of, or significant interference with amenities or the environment beyond the site boundary.

6.17.6 The licensee shall carry out an investigation into measures to reduce dust emissions from the installation. Any recommendations arising from a report or reports on this investigation must be implemented within a period to the satisfaction of the Agency.

6.17.7 When heavy fuel oils are used as a fuel, only heavy fuel oil with a sulphur content of less than 1% shall be used.

6.17.8 The licensee shall submit to the Agency as part of the AER, calculations for total annual emissions of carbon dioxide.

6.17.9 The appropriate installation and functioning of the automated monitoring equipment for emissions to air shall be subject to an annual surveillance test. Calibration shall be carried out by means of parallel measurements with reference methods at least once every three years.

6.17.10 The licensee shall provide and use measures for the prevention of odour emissions from the installation.

6.17.11 The licensee shall undertake, at a frequency to be approved or directed by the Agency, and in any case no less than once every three years, an odour impact assessment. The assessment shall identify and quantify all significant odour sources at the installation, in particular the SRF buildings and waste storage areas, and shall include an assessment of the suitability and adequacy of the odour control system. Any recommendations arising from the odour impact assessment shall be implemented following agreement by the Agency.

6.17.12 The licensee shall, as part of the Schedule of Objectives and Targets in Condition 2.2.2.7 of this licence, establish and implement a programme of TOC emissions reductions at the main stack through a programme of process optimisation and raw material selection.

6.18 Emissions to water

6.18.1 The licensee shall maintain and utilise an automatic diversion system at a location prior to the final discharge point SW1, triggered by means of a calibrated photocell control, to ensure that the level of suspended solids in the discharge from the settlement lagoon does not exceed the specified limit.

6.18.2 The licensee shall ensure, during the period from 1 November to 30 April, that the discharge to waters from the installation will not cause the unaffected temperatures in the Kinnegad River at the edge of the mixing zone (as identified in "supplementary information XVIII" submitted to the Agency on 5/10/2000) to be raised by more than 1.5°C.

6.18.3 The licensee shall, in accordance with the requirements of *Schedule C: Emissions, Monitoring and Control* of this licence, establish suitable trigger levels for ammonia and nitrate in the discharge at SW1 or another suitable location.

6.18.4 The licensee shall have regard to the Environmental Protection Agency "Guidance on the setting of trigger values for storm water discharges to off-site surface waters at EPA IPPC and Waste licensed facilities" when establishing trigger levels.

6.19 Noise, Vibration and Air Overpressure

6.19.1 The licensee shall carry out a noise survey of the site operations annually. The survey programme shall be undertaken in accordance with the methodology specified in the 'Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)' as published by the Agency.

6.19.2 The licensee shall maintain and implement a programme to reduce noise emissions from blasting operations. The programme shall highlight specific goals and a timescale, together with options for modification, upgrading or replacement. An annual report on the implementation of the programme shall be submitted to the Agency as part of the AER.

6.19.3 The licensee shall carry out routine and non-routine monitoring for vibration and air overpressure at locations and frequencies to the satisfaction of or as may be directed by the Agency.

6.19.4 Air Overpressure minimisation programme

6.19.4.1 From the 1st April 2018, the licensee shall have in place a programme to minimise air overpressure from blasting operations;

6.19.4.2 The programme shall identify the set of measures that constitute best practice for air overpressure control;

6.19.4.3 The programme shall put in place systems such that the licensee can demonstrate that it is consistently applying best practice;

6.19.4.4 The relevant records shall be maintained on site for inspection, and

6.19.4.5 The programme shall be maintained and implemented.

6.20 Pollutant Release and Transfer Register (PRTR)

The licensee shall prepare and report a PRTR for the site. The substance and/or wastes to be included in the PRTR shall be determined by reference to EC Regulations No. 166/2006 concerning the establishment of the European Pollutant Release and Transfer Register. The PRTR shall be prepared in accordance with any relevant guidelines issued by the Agency and shall be submitted electronically in specified format and as part of the AER.

6.21 The licensee shall maintain a Data Management System for collation, archiving, assessing and graphically presenting the monitoring data generated as a result of this licence.

6.22 The licensee shall maintain a management plan for the conservation of bats at the installation.

6.23 Groundwater

6.23.1 The licensee shall annually assess groundwater monitoring data and determine compliance under this licence with the European Communities Environmental Objectives (Groundwater) Regulations 2010, S.I. No 9 of 2010 as amended.

6.23.2 A report on this assessment shall be included in the AER.

6.23.3 The licensee shall, in the event of a failure to demonstrate compliance with the European Communities Environmental Objectives (Groundwater) Regulations 2010 as amended or if instructed by the Agency, arrange for the completion, by an appropriately qualified consultant/professional, of a hydrogeological risk assessment to:

(i) identify the risk of groundwater contamination arising from licensed and past activities;

(ii) assess the impact of extant groundwater contamination;

(iii) propose preventative and, as appropriate, remedial actions to be undertaken;

(iv) propose groundwater compliance values to be maintained at compliance points; and,

(v) address other matters that may be identified by the Agency.

6.23.4 A hydrogeological risk assessment prepared under Condition 6.23.3 shall be submitted to the Agency.

6.23.5 The licensee shall implement the following:

(i) any proposals or recommendations arising from the hydrogeological risk assessment;

(ii) the installation of new groundwater monitoring boreholes where necessary to characterise groundwater quality; and

(iii) any other matters that may be directed by the Agency.

Reason: ***To provide for the protection of the environment by way of treatment and monitoring of emissions.***

Condition 7. Resource Use and Energy Efficiency

7.1 The licensee shall carry out an audit of the energy efficiency of the site within one year of the date of grant of this licence. The audit shall be carried out in accordance with the guidance published by the Agency, "Guidance Note on Energy Efficiency Auditing" and in accordance with the best available techniques in Commission Implementation Decision 2013/163/EU and, if applicable, *Schedule D: Energy Consumption* of this Licence. The energy efficiency audit shall be repeated at intervals as required by the Agency.

7.2 The audit shall identify all practicable opportunities for energy use reduction and efficiency and the recommendations of the audit will be incorporated into the Schedule of Environmental Objectives and Targets under Condition 2 above.

7.3 The licensee shall identify opportunities for reduction in the quantity of water used on site including recycling and reuse initiatives, wherever possible. Reductions in water usage shall be incorporated into Schedule of Environmental Objectives and Targets under Condition 2 above.

7.4 The licensee shall undertake an assessment of the efficiency of use of raw materials and fuels in all processes, having particular regard to the reduction in waste generated. The assessment should take account of best international practice for this type of activity and shall be in accordance with the best available techniques in Commission Implementation Decision 2013/163/EU. Where improvements are identified, these shall be incorporated into the Schedule of Environmental Objectives and Targets under Condition 2 above.

Reason: ***To provide for the efficient use of resources and energy in all site operations.***

Condition 8. Materials Handling

8.1 The licensee shall ensure that waste generated in the carrying on of the activity shall be prepared for re-use, recycling or recovery or, where that is not technically or economically possible, disposed of in a manner which will prevent or minimise any impact on the environment.

8.2 Disposal or recovery of waste on-site shall only take place in accordance with the conditions of this licence and in accordance with the appropriate National and European legislation and protocols.

8.3 Waste sent off-site for recovery or disposal shall be transported only by an authorised waste contractor and only to an appropriate facility. The waste shall be transported from the installation in a manner that will not adversely affect the environment and in accordance with the appropriate National and European legislation and protocols.

8.4 The licensee shall ensure that, in advance of transfer to another person, waste shall be classified, packaged and labelled in accordance with National, European and any other standards which are in force in relation to such labelling.

8.5 The loading and unloading of materials shall be carried out in designated areas protected against spillage and leachate run-off.

8.6 Waste and materials shall be stored in designated areas, protected as may be appropriate against spillage and leachate run-off. The waste and materials shall be clearly labelled and appropriately segregated.

8.7 Waste for disposal/recovery off-site shall be analysed in accordance with *Schedule C: Emissions, Monitoring and Control* of this licence.

8.8 Mixing of hazardous waste and non-hazardous waste

The licensee may mix hazardous wastes of different categories or mix hazardous waste with non-hazardous waste subject to the following:

- the mixing operation shall conform to best available techniques;
- the mixing operation shall be carried out in accordance with a Standard Operating Procedure;
- the purpose of the mixing operation shall be:
  - the bulk storage of incoming shipments of liquid recovered fuel intended for co-incineration at the installation; or
  - the mixing of waste upon its point of introduction into the cement kiln;
- the mixing operation shall result in no environmental emissions;
- the mixing operation shall present no risk of adverse or unexpected chemical reactions resulting in the sudden or gradual release of gases.

8.9 The licensee shall neither import waste into the State nor export waste out of the State except in accordance with the relevant provisions of Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14th June 2006 on shipments of waste and associated national regulations.

8.10 All meat and bone meal accepted for co-incineration shall be passed through a 20mm screen prior to entering the meat and bone meal silos. Oversize material shall be temporarily stored and dispatched to an appropriate facility or a licensed rendering facility.

8.11 No hazardous waste that contains more than 1% of halogenated organic compounds, expressed as chlorine, shall be accepted for co-incineration or otherwise introduced into the kiln.

8.12 No more than 40% of the resulting heat release in the co-incineration plant shall come from hazardous waste.

8.13 No waste other than the List of Waste codes listed in *Schedule A: Limitations* of this licence shall be accepted at the installation.

8.14 No new waste type, according to its List of Waste code, shall be accepted at the installation without the prior approval of the Agency.

8.15 The acceptance of waste at the installation shall be for the purposes of:

- co-incineration, or
- use as a material additive in the manufacture of cement.

8.16 Waste Acceptance, Characterisation and Rejection Procedures

8.16.1 Waste and waste-based alternative fuel and raw material accepted at the installation shall be subject to a technical specification agreed between the licensee and the supplier.

8.16.2 The technical specification referred to in Condition 8.16.1 shall set out the criteria to be met in order that combustion or use of the material will not lead to failure to comply with the conditions of this licence. The technical specification shall have regard to any published or, as appropriate, draft Irish or international standard relevant to the supply of that material and any departure from such a standard shall be agreed by the Agency. The technical specification shall conform to relevant best available techniques in Commission Implementation Decision 2013/163/EU for the production of cement, lime and magnesium oxide.

8.16.3 Liquid recovered fuel shall have a minimum calorific value of 18MJ/kg.

8.16.4 The quantity of waste to be accepted at the installation on a daily basis shall not exceed the appropriate storage capacity available.

8.16.5 The licensee shall determine the mass of each category of waste prior to accepting the waste at the installation.

8.16.6 The licensee shall maintain a record of the quantity of each waste type co-incinerated at the installation, introduced into the kiln or otherwise used in the manufacture of cement. The record shall contain adequate data to demonstrate compliance with Condition 8.12 of this licence.

8.16.7 Waste shall only be accepted at the installation from known suppliers or new suppliers subject to initial waste profiling, analysis, characterisation off-site and demonstration of compliance with the technical specification.

8.16.8 Waste shall only be accepted at the installation if delivered in appropriate sealed leak-proof or covered containers.

8.16.9 Prior to commencement of the acceptance of each waste type at the installation, the licensee shall establish and maintain detailed written procedures for the acceptance and handling of each. These procedures shall include the following:

a) Inspection and sampling at the point of entry to the installation;
b) Criteria to be met prior to acceptance;
c) Rejection criteria and procedures;
d) Material characterisation and profiling from known customers or new customers prior to acceptance at the installation;
e) Frequency of technical testing and analysis and methods to be employed by the licensee to demonstrate compliance with the technical specification;
f) Recording of each load of material on arrival at the installation in accordance with Condition 11 of this licence;
g) Handling procedures, including unloading, transfer and cleaning of all plant.

8.16.10 Waste arriving at the installation shall have its documentation checked at the point of entry to the installation and subject to this verification, weighed, recorded and directed to the appropriate storage area or quarantine area as appropriate.

8.16.11 Each load of waste, except meat and bone meal and liquid recovered fuel, shall be subject to visual inspection prior to and during unloading at storage areas. Unloading of meat and bone meal and liquid recovered fuel shall be supervised.

8.16.12 Waste of each type accepted at the installation for the first time shall be subject to periodic technical testing/analysis by the licensee (independently of the supplier) to verify compliance with the technical specification. The period of such technical testing/analysis shall be fortnightly for the first three months, and thereafter in accordance with Condition 8.16.9.

8.16.13 Prior to the acceptance of other waste types for on-site recovery/disposal the licensee shall put forward proposals, to be agreed by the Agency, for the provision of dedicated unloading and, where appropriate, storage areas.

8.16.14 Any waste deemed unsuitable for processing at the installation or in contravention of this licence or the technical specification shall be immediately separated and returned to the location of supply within 48 hours or a longer time period as may be agreed by the Agency due to weekend and bank/public holidays closures. Secure temporary storage of such waste shall be provided in a dedicated waste quarantine area. Waste stored in the quarantine area shall be stored under appropriate conditions to avoid loss to the environment, putrefaction, odour generation, the attraction of vermin and other nuisances or objectionable condition. If the original supplier of rejected waste cannot take the material back, an appropriate alternative destination for the rejected waste shall be identified and agreed by the Agency.

8.16.15 The rejection of waste and any failure to demonstrate compliance with the technical specification shall be recorded and reported in the AER.

8.16.16 Waste shall not be accepted from a supplier of rejected waste until such time as the reasons for rejection have been investigated and corrective actions, agreed in writing between the licensee and the supplier, have been implemented to the licensee's satisfaction. All such correspondence shall be provided to the Agency upon request.

8.17 (a) Waste shall only be introduced to the kiln when the appropriate operating conditions have been achieved. These conditions shall, as a minimum, meet those set out in *Schedule C: Emissions, Monitoring and Control* of this licence.

(b) Waste shall only be introduced to the kiln when cement clinker is being manufactured.

8.18 No inert waste other than extractive waste shall be deposited at the installation.

8.19 The acceptance of waste at the SRF treatment building shall be limited to non-hazardous waste SRF that was manufactured to the requirements of Conditions 8.16.1 and 8.16.2 of this licence.

8.20 No food, residual or odour-forming waste shall be accepted at the installation.

Reason: ***To provide for the appropriate handling of material and the protection of the environment.***

Condition 9. Accident Prevention and Emergency Response

9.1 The licensee shall ensure that a documented Accident Prevention Procedure is in place that addresses the hazards on-site, particularly in relation to the prevention of accidents with a possible impact on the environment. This procedure shall be reviewed annually and updated as necessary.

9.2 The licensee shall ensure that a documented Emergency Response Procedure is in place that addresses any emergency situation which may originate on-site. This procedure shall include provision for minimising the effects of any emergency on the environment. This procedure shall be reviewed annually and updated as necessary.

9.3 Incidents

9.3.1 In the event of an incident the licensee shall immediately:

(i) carry out an investigation to identify the nature, source and cause of the incident and any emission arising therefrom;

(ii) isolate the source of any such emission;

(iii) evaluate the environmental pollution, if any, caused by the incident;

(iv) identify and execute measures to minimise the emissions/malfunction and the effects thereof;

(v) identify the date, time and place of the incident;

(vi) notify the Agency and other relevant authorities.

9.3.2 Where an incident or accident that significantly affects the environment occurs, the licensee shall, without delay take measures to limit the environmental consequences of the incident or accident and to prevent further incident or accident.

Reason: ***To provide for the protection of the environment.***

Condition 10. Closure, Restoration and Aftercare Management

10.1 Following termination, or planned cessation for a period greater than six months, of use or involvement of all or part of the site in the licensed activity, the licensee shall, to the satisfaction of the Agency, decommission, render safe or remove for disposal or recovery any soil, subsoil, buildings, plant or equipment, or any waste, materials or substances or other matter contained therein or thereon, that may result in environmental pollution.

10.2 Closure, Restoration and Aftercare Management Plan (CRAMP)

10.2.1 The licensee shall submit a revised CRAMP for agreement by the Agency prior to the storage of liquid recovered fuel exceeding 20,000 litres.

10.2.2 The licensee shall maintain a fully detailed and costed plan for the closure, restoration and long-term aftercare of the site or part thereof.

10.2.3 The plan shall be reviewed annually and proposed amendments thereto notified to the Agency for agreement as part of the AER. No amendments may be implemented without the agreement of the Agency.

10.2.4 The licensee shall have regard to the Environmental Protection Agency's Guidance on Assessing and Costing Environmental Liabilities (2014) and, as appropriate, Guidance on Financial Provision (2015), when implementing Conditions 10.2.1, 10.2.2 and 10.2.3 above.

10.3 The Closure, Restoration and Aftercare Management Plan (CRAMP) shall include, as a minimum, the following:

(i) a scope statement for the plan;

(ii) the criteria that define the successful closure and restoration and aftercare of the activity or part thereof, which ensures minimum impact on the environment;

(iii) a programme to achieve the stated criteria;

(iv) where relevant, a test programme to demonstrate the successful implementation of the plan;

(v) details of the long term supervision, monitoring, control, maintenance and reporting requirements for the restored installation; and

(vi) details of the costings for the plan and the financial provisions to underwrite those costs.

Reason: ***To make provision for the proper closure of the activity ensuring protection of the environment.***

Condition 11. Notification, Records and Reports

11.1 The licensee shall notify the Agency, in a format as may be specified by the Agency, one month in advance of the intended date of commencement of any new Scheduled Activity.

11.2 The licensee shall notify the Agency by both telephone and either email or webform, to the Agency's headquarters in Wexford, or to such other Agency office as may be specified by the Agency, as soon as practicable after the occurrence of any of the following:

(i) an incident or accident as defined by the glossary;

(ii) any release of environmental significance to atmosphere from any potential emissions point including bypasses;

(iii) any breach of one or more of the conditions attached to this licence;

(iv) any malfunction or breakdown of key environmental abatement, control or monitoring equipment; and

(v) any incident or accident as defined in the glossary requiring an emergency response by the Local Authority.

The licensee shall include as part of the notification, date and time of the incident, summary details of the occurrence, and where available, the steps taken to minimise any emissions. All details required to be communicated must be in accordance with any Guidance provided by the Agency.

11.3 The following shall be notified, as soon as practicable after the occurrence of any incident which relates to a discharge to water:

(i) Inland Fisheries Ireland in the case of discharges to receiving waters.

(ii) Irish Water and /or Water Services Authority in the case of any incident where the discharges have been identified as upstream of a drinking water abstraction point.

(iii) The local authority, in the case of discharges to designated bathing waters

11.4 The licensee shall make a record of any notification made under Conditions 11.2 or 11.3 of this licence. This record shall include details of the nature, extent, and impact of, and circumstances giving rise to, the incident or accident. The record shall include all corrective actions taken to manage the incident or accident, minimise wastes generated and the effect on the environment, and avoid recurrence. In the case of a breach of a condition, the record shall include measures to restore compliance.

11.5 The licensee shall record all complaints of an environmental nature related to the operation of the activity. Each such record shall give details of the date and time of the complaint, the name of the complainant (if provided), and give details of the nature of the complaint. A record shall also be kept of the response made in the case of each complaint.

11.6 The licensee shall record all sampling, analyses, measurements, examinations, calibrations and maintenance carried out in accordance with the requirements of this licence and all other such monitoring which relates to the environmental performance of the installation.

11.7 The licensee shall maintain a log of all scheduled and unscheduled start-ups and shutdowns.

11.8 The licensee shall as a minimum ensure that the following documents are accessible at the site:

(i) the licences relating to the installation;

(ii) the current EMS for the installation including all associated procedures, reports, records and other documents;

(iii) the previous year's AER for the installation;

(iv) records of all sampling, analyses, measurements, examinations, calibrations and maintenance carried out in accordance with the requirements of this licence and all other such monitoring which relates to the environmental performance of the installation;

(v) relevant correspondence with the Agency;

(vi) up-to-date site drawings/plans showing the location of key process and environmental infrastructure, including monitoring locations and emission points;

(vii) up-to-date Standard Operational Procedures for all processes, plant and equipment necessary to give effect to this licence or otherwise to ensure that standard operation of such processes, plant or equipment does not result in unauthorised emissions to the environment; and

(viii) any elements of the licence application or EIS documentation referenced in this licence.

This documentation shall be available to the Agency for inspection at all reasonable times.

11.9 The licensee shall submit to the Agency, by the 31st March of each year, an AER covering the previous calendar year. This report, which shall be to the satisfaction of the Agency, shall include as a minimum the information specified in *Schedule E: Annual Environmental Report* of this licence and shall be prepared in accordance with any relevant guidelines issued by the Agency.

11.10 A full record, which shall be open to inspection by authorised persons of the Agency at all times, shall be kept by the licensee on matters relating to the waste management operations and practices at this site including co-incineration of waste and use of waste as raw material. This record shall be maintained on a monthly basis and shall as a minimum contain details of the following:

(i) the tonnage and LoW Code for the waste materials and meat and bone meal imported and/or sent off-site for disposal/recovery;

(ii) the names of the agent and carrier of the waste, and their waste collection permit details, if required (to include issuing authority and vehicle registration number);

(iii) details of the ultimate disposal/recovery destination facility for the waste and its appropriateness to accept the consigned waste stream, to include its permit/licence details and issuing authority, if required;

(iv) written confirmation of the acceptance and disposal/recovery of any hazardous waste consignments sent off-site;

(v) details of all waste consigned abroad for Recovery and classified as 'Green' in accordance with the EU Shipment of Waste Regulations (Council Regulation EEC No. 1013/2006, as may be amended). The rationale for the classification must form part of the record;

(vi) details of any rejected consignments;

(vii) details of any approved waste mixing;

(viii) the results of any waste analyses required under *Schedule C: Emissions, Monitoring and Control* of this licence; and

(ix) the tonnage and LoW Code for the waste materials recovered/disposed on-site.

11.11 The written records of off-site waste profiling and characterisation shall be retained by the licensee for all active suppliers for a two-year period following termination of licensee-supplier agreements.

11.12 The licensee shall submit reports as required by the conditions of this licence to the Agency's Headquarters in Wexford, or to such other Agency office as may be specified by the Agency.

11.13 All reports shall be certified accurate and representative by the installation manager or a nominated, suitably qualified and experienced deputy.

11.14 The licensee shall maintain a record of the quantity of each waste type, by LoW code, co-incinerated at the installation or used as raw material in the manufacture in cement.

Reason: ***To provide for the collection and reporting of adequate information on the activity.***

Condition 12. Financial Charges and Provisions

12.1 Agency Charges

12.1.1 The licensee shall pay to the Agency an annual contribution of €24,645, or such sum as the Agency from time to time determines, having regard to variations in the extent of reporting, auditing, inspection, sampling and analysis or other functions carried out by the Agency, towards the cost of monitoring the activity as the Agency considers necessary for the performance of its functions under the Environmental Protection Agency Act 1992 as amended. The first payment shall be a pro-rata amount for the period from the date of grant of this licence to the 31st day of December, and shall be paid to the Agency within one month from the date of grant of the licence. In subsequent years the licensee shall pay to the Agency such revised annual contribution as the Agency shall from time to time consider necessary to enable performance by the Agency of its relevant functions under the Environmental Protection Agency Act 1992 as amended, and all such payments shall be made within one month of the date upon which demanded by the Agency.

12.1.2 In the event that the frequency or extent of monitoring or other functions carried out by the Agency needs to be increased, the licensee shall contribute such sums as determined by the Agency to defray its costs in regard to items not covered by the said annual contribution.

12.2 Environmental Liabilities

12.2.1 The licensee shall as part of the AER, provide an annual statement as to the measures taken or adopted at the site in relation to the prevention of environmental damage, and the financial provisions in place in relation to the underwriting of costs for remedial actions following anticipated events (including closure) or accidents/incidents, as may be associated with the carrying on of the activity.

12.2.2 The licensee shall arrange for the completion, by an independent and appropriately qualified consultant, of a comprehensive and fully costed revised Environmental Liabilities Risk Assessment (ELRA) which addresses the liabilities from past and present activities. The assessment shall include those liabilities and costs identified in Condition 10 for execution of the CRAMP. A report on this assessment shall be submitted for approval and agreement by the Agency in advance of the storage of LRF exceeding 20,000 litres and in any event within 6 months of the date of grant of this licence. The ELRA shall be reviewed as necessary to reflect any significant change on site, and in any case every three years following initial agreement. Review results are to be notified as part of the AER.

12.2.3 The licensee shall, in advance of the storage of LRF exceeding 20,000 litres and in any event within 6 months of the date of grant of this licence and to the satisfaction of the Agency, make financial provision to cover any liabilities associated with the operation (including closure, restoration and aftercare). The amount of financial provision held shall be reviewed and revised as necessary, but at least annually. Proof of renewal or revision of such financial indemnity shall be included in the annual 'Statement of Measures' report identified in Condition 12.2.1 of this licence.

12.2.4 The licensee shall revise the cost of closure, restoration and aftercare annually and any adjustments shall be reflected in the financial provision made under Condition 12.2.3 above.

12.2.5 The licensee shall have regard to the Environmental Protection Agency's Guidance on Assessing and Costing Environmental Liabilities (2014) and Guidance on Financial Provision (2015) and the baseline report when implementing Conditions 12.2.2, 12.2.3 and 12.2.4 above.

Reason:	***To provide for adequate financing for monitoring and financial provisions for measures to protect the environment***

SCHEDULE A: Limitations

A.1 Authorised waste activities

The following waste activities are authorised:

- Co-incineration of waste.
- Use of waste in the manufacture of cement.
- Pre-treatment of non-hazardous waste (solid recovered fuel manufactured by others) for co-incineration.
- Storage of waste and hazardous waste pending co-incineration or other use.
- Management of extractive waste.

No additions to these processes are permitted unless agreed in advance with the Agency.

A.2 Authorised acceptance and storage of waste

Maximum amount of waste, including liquid recovered fuel, authorised for acceptance at the installation	105,000 tonnes per annum
Maximum amount of liquid recovered fuel authorised for acceptance at the installation	20,000 tonnes per annum
Maximum amount of liquid recovered fuel authorised for storage at the installation at any one time	50,000 litres

A.3 Waste codes authorised for acceptance at the installation for co-incineration or use in the manufacture of cement

Waste Type	List of Waste (LoW) code			
Non-hazardous and hazardous municipal, commercial and industrial waste	01 01 01	07 05 13*	10 10 08	19 02 06
	01 01 02	07 05 14	10 11 03	19 02 07*
	01 03 06	07 06 01*	10 11 12	19 02 08*
	01 03 08	07 06 03*	10 12 03	19 03 05
	01 03 09	07 06 04*	10 12 06	19 05 01
	01 04 08	07 06 07*	11 01 10	19 05 02
	01 04 09	07 06 08*	12 01 01	19 05 03
	01 05 04	07 06 99	13 07 01*	19 06 03
	02 01 03	07 07 01*	13 07 03*	19 07 02*
	02 01 07	07 07 03*	14 06 02*	19 07 03
	02 01 09	07 07 04*	14 06 03*	19 08 02
	02 02 03	07 07 07*	14 06 04*	19 08 05
	02 02 04	07 07 08*	15 01 01	19 08 10*
	02 03 04	08 01 11*	15 01 03	19 08 12
	02 03 05	08 01 12	15 01 10*	19 08 14
	02 04 02	09 01 01*	16 01 03	19 09 01
	02 05 02	09 01 02*	16 01 07*	19 09 02
	02 07 04	09 01 03*	16 11 02	19 10 04
	02 07 05	09 01 04*	16 11 03*	19 12 01
	03 01 01	09 01 05*	17 01 06*	19 12 04
	03 01 05	09 01 06*	17 02 01	19 12 05
	03 03 01	09 01 13*	17 02 02	19 12 07
	03 03 08	10 01 01	17 05 03*	19 12 09
	05 01 03*	10 01 02	17 05 04	19 12 10
	06 02 01*	10 01 03	17 05 05*	19 12 11*
	06 02 03*	10 01 05	17 05 06	19 12 12
	06 02 04*	10 01 15	17 08 02	19 13 02
	06 02 05*	10 01 17	18 01 06*	19 13 04
	06 08 99	10 02 01	18 01 07	20 01 01
	06 09 04	10 02 02	18 01 09	20 01 02
	07 01 01*	10 03 05	18 02 05*	20 01 13*
	07 01 04*	10 03 17*	18 02 06	20 01 25
	07 05 01*	10 03 18	18 02 08	20 01 27*
	07 05 03*	10 03 26	19 01 12	20 01 28
	07 05 04*	10 08 04	19 01 14	20 01 32
	07 05 08*	10 09 03	19 01 18	20 01 38
	07 05 10*	10 09 06	19 01 19	20 01 39
	07 05 12	10 10 03	19 02 03	

SCHEDULE B: Resource, Energy and Waste Management

B.1 Monitoring and control of the manufacturing process

Parameter		Monitoring frequency
Temperature		Continuous at relevant locations BAT 5a
O_2 content		
Pressure		
Flow rate		
Fuel feed		Monitored at relevant locations BAT 5b
Raw material mix		
Regular dosage		
Excess oxygen		
Kiln processes:	Dust NOx SOx CO	Continuous BAT 5d
	PCDD/F Metal emissions	Frequency as specified in Schedule C BAT 5e
	HCl HF TOC	Continuous BAT 5f
	Visual assessment of plume	Daily
SNCR:	Ammonia flow, pressure and dosing rate	Continuous BAT 5c
	NH3 slip	
ESP:	Voltage, current	Continuous

B.2 Monitoring and control of bag filter installations

Parameter	Monitoring frequency
Differential pressure	Continuous
Filter integrity	
Dust emissions, non-kiln	Frequency as specified in Schedule C BAT 5g
Visual assessment of plume	Daily

SCHEDULE C: Emissions, Monitoring and Control

C.1 Emissions to Air

C.1.1 Description, limit values and monitoring at emission point reference number A2-01

Emission point reference number: **A2-01**

Description:	ESP exhaust from raw mill and cement kiln	
Emission point location:	257024E 242549N	
Minimum discharge height:	125 m above ground	
Volume to be emitted:	Maximum in any one day:	4,560,000 Nm^3
	Maximum rate per hour:	190,000 Nm^3

Parameter	Emission limit value	Monitoring		
		Period	Frequency	Analysis method or technique
SO_x (as SO_2)	400 mg/Nm^3 BAT 21 Note 1	24-hour mean BAT 21	Continuous BAT 5	EN standards are to be used or, if EN standards not available, ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality may be used BAT 5
NO_x (as NO_2)	450 mg/Nm^3 BAT 19	24-hour mean BAT 19		
Dust	20 mg/Nm^3 BAT 17	24-hour mean BAT 17		
Carbon monoxide (CO)	1,500 mg/Nm^3	24-hour mean		
TOC (total organic carbon)	40 mg/Nm^3	24-hour mean		
Hydrogen chloride (HCl)	10 mg/Nm^3 BAT 25	24-hour mean BAT 25		
Hydrogen fluoride (HF)	1 mg/Nm^3 BAT 26	24-hour mean BAT 26		
Ammonia slip (NH_3)	50 mg/m^3 BAT 20	24-hour mean BAT 20		
Dioxins and furans (PCDD/F I-TEQ)	0.1 ng/Nm^3 BAT 27	Average over the sampling period (6 - 8 hours) BAT 27	Quarterly Note 3 BAT 5	
Mercury (Hg)	0.05 mg/Nm^3 BAT 28 Note 2	Average over the sampling period (spot measurements, for at least half an hour) BAT 28		
The sum of cadmium (Cd) and thallium (Tl)	0.05 mg/Nm^3 BAT 28			
The sum of antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni), vanadium (V)	0.5 mg/Nm^3 BAT 28			

Note 1: The licensee shall investigate emission values higher than 200mg/Nm^3, the objectives being to identify the source of the elevated emission and ensure that the introduction of waste to the cement kiln has not become the source of SO_2 emissions and to eliminate any waste stream that might be such a source.

Note 2: The licensee shall investigate emission values higher than 0.03mgHg/Nm^3, the objective being to identify the source of the emission and reduce the emission level. BAT 28.

Note 3: Monitoring frequency may be reduced to biannually if approved by the Agency.

C.1.2 Description, limit values and monitoring at emission points reference number:

- A2-02 - 266530E 242761N
- A2-03 - 256946E 242681N
- A2-04 - 257016E 242587N
- A2-05 - 256993E 242644N
- A2-06 - 256948E 242638N
- A3-01 to A3-04, A3-06 to A3-14

Emission point ref. no.	Description	Minimum discharge height above ground	Volume to be emitted	
			Maximum in any one day	Maximum rate per hour
A2-02	Bag filter exhaust – cement mill	45m	1,440,000 Nm^3	60,000 Nm^3
A2-03	Bag filter exhaust – coal mill	32m	360,000 Nm^3	30,000 Nm^3
A2-04	Bag filter exhaust – kiln feed	30m	432,000 Nm^3	18,000 Nm^3
A2-05	Bag filter exhaust – clinker cooler	45m	960,000 Nm^3	40,000 Nm^3
A2-06	Bag filter exhaust – clinker conveyor	20m	336,000 Nm^3	14,000 Nm^3

Emission point ref. no.	Description
A3-01 to A3-04 and A3-06 to A3-14	Bag filters throughout the process, details as per Table E.1(iv) of the 2012 application.

Parameter and location		Emission limit value	Monitoring		
			Period	Frequency	Analysis method or technique
Dust	**A2-02**	20 mg/Nm^3 BAT18	24-hour mean BAT18	Continuous BAT 5	EN standards or, if EN standards not available ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality BAT 5
	A2-03	10 mg/Nm^3 BAT18 and EQS	1-hour mean BAT16 BAT18	Quarterly BAT5	
	A2-04	10 mg/Nm^3 BAT16			
	A2-05 A2-06	20 mg/Nm^3 BAT18			
	A3-01 to A3-04 and **A3-06 to A3-14**	10 mg/Nm^3 BAT16	1-hour mean BAT16	Annually Note 1 BAT5	

Note 1: For emission points <10,000Nm^3/hour, an alternative monitoring frequency based on a maintenance management system as required under Condition 2.2.2.14 may be proposed and implemented upon the Agency's approval and in accordance with Condition 6.10 of this licence.

C.2 Emissions to Water

C.2.1 Description, limit values and monitoring at emission point reference number SW1

Emission point reference number: SW1

Description:	Discharge to Kinnegad River from settlement lagoons, comprising stormwater, pumped water from quarry and treated sewage effluent
Emission point location:	257290E 244605N
Monitoring point location:	Grid reference to be notified to the Agency within 3 months of date of grant of this licence.
Volume to be emitted:	Maximum in any one day: 6,150 m^3
	Maximum rate per hour: 260 m^3

Parameter	Emission limit value	Monitoring		
		Period	Frequency	Analysis method or technique Note 1
Flow	As specified above	Daily and hourly flow	Continuous	Flowmeter
Temperature	22°C max	-	Continuous	Temperature probe
pH	6 – 9	Daily max and min	Continuous	pH meter
Suspended solids	35 mg/l	Daily average and max	Continuous	On-line sensor or probe
		24-hour composite sample	Daily	Gravimetric
Mineral oil	1 mg/l	24-hour composite sample	Daily visual	-
			Weekly	Standard method
Visual inspection	-	-	Weekly	-
BOD	5 mg/l	24-hour flow proportional composite sample	Weekly	Standard method
COD	-	24-hour flow proportional composite sample	Weekly	Standard method
Toxicity	1 TU	As required	As required	Standard method
Screening for organic compounds and heavy metals	-	24-hour flow proportional composite sample	Annually	Standard methods

Note 1: EN standards are to be used or, if EN standards not available, ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality may be used.

SW1 contd.

Parameter	Trigger level	Monitoring		
		Period	Frequency	Analysis method or technique Note 1
Ammonia	To be determined to the Agency's satisfaction within 18 months of date of grant of this licence	24-hour flow proportional composite sample	Monthly	Standard methods
Nitrate				

Note 1: EN standards are to be used or, if EN standards not available, ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality may be used.

C.2.2 Description, limit values and monitoring at emission point reference number SW2

Emission point reference number: **SW2**

Description:	Discharge to tributary of Kinnegad River of overland flow from lands around the cement factory
Emission point location:	266535E 242705N
Monitoring point location:	Grid reference to be notified to the Agency within 3 months of date of grant of this licence.
Volume to be emitted:	Not limited

Parameter	Trigger level	Monitoring		
		Period	Frequency	Analysis method or technique Note 1
Flow	-	Daily flow	Continuous	Flowmeter
Visual inspection	-	Grab sample	Weekly	-
Suspended solids	15mg/l	24-hour flow proportional composite sample	Quarterly	Standard methods Note 1
BOD	3mg/l			

Note 1: EN standards are to be used or, if EN standards not available, ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality may be used.

C.2.3 Description, limit values and monitoring at monitoring point reference number SE1

Monitoring point reference number: SE1

Description:	Discharge of treated sewage effluent to installation's water management network for ultimate discharge via SW1
Monitoring point location:	Grid reference to be notified to the Agency within 3 months of date of grant of this licence.
Volume to be emitted:	Not limited

Parameter	Trigger level	Monitoring		
		Period	Frequency	Analysis method or technique Note 1
BOD	20mg/l	Grab sample	Biannually	Standard methods
Suspended solids	30mg/l			
Ammonia	5mg/l			

Note 1: EN standards are to be used or, if EN standards not available, ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality may be used.

C.3 Emissions to Sewer

There shall be no process effluent emissions to sewer.

C.4 Noise, Vibration and Air Overpressure Emissions

C.4.1 Limit values and monitoring for noise, vibration and air overpressure at the following noise sensitive locations:

- NSR1
- NSR2
- NSR3
- NSR4
- NSR5
- NSR6
- NSR7
- NSR8
- NSR9

And any other location approved or directed by the Agency

Noise limit values

Daytime dB $L_{Ar,T}$ (30 minutes)	Evening time dB $L_{Ar,T}$ (30 minutes)	Night-time dB $L_{Aeq,T}$ (15-30 minutes)
55	50	45

Note: There shall be no clearly audible tonal component or impulsive component in the noise emission from the activity at any noise-sensitive location.

Noise monitoring

Period	Minimum Survey Duration
Daytime	A minimum of 3 sampling periods at each noise monitoring location Note 2
Evening-time	A minimum of 1 sampling period at each noise monitoring location.
Night-time Note 1	A minimum of 2 sampling periods at each noise monitoring location.

Note 1: Night-time measurements should be made between 2300 hrs and 0400 hrs, Sunday to Thursday, with 2300 hrs being the preferred start time.

Note 2: Sampling period is to be the time period T stated as per the table (Noise limit values) above. This applies to day, evening and night time periods.

Vibration and air overpressure limit values and monitoring from blasting

Parameter	Limit values	Locations at which limits apply and for monitoring	Monitoring frequency
Vibration	8 mm/second	Noise sensitive locations as listed above Note 1	Each blast
Air overpressure	125 dB(lin) max peak		

Note 1: The scope and extent of monitoring at each noise sensitive location may be varied with the approval of the Agency and in accordance with Condition 6.10 of this licence.

C.5 Ambient Monitoring

C.5.1 Monitoring of groundwater at the following monitoring locations:

At the installation [Note 1]		In the vicinity of the installation [Note 2]	
ONGW1	ONGW6	W01	OFGW4
ONGW2	ONGW7	W03	OFGW5
ONGW3	ONGW8	W16	OFGW6
ONGW4	LANS22	OFGW1	OFGW7
ONGW5		OFGW2	OFGW8
		OFGW3	OFGW9
			OFGW10

And any other location approved or directed by the Agency.

Parameter	Monitoring Frequency	Analysis Method/Techniques
PH	Biannually	pH electrode/meter
COD	Biannually	Standard Method
Nitrate	Biannually	Standard Method
Total Ammonia	Biannually	Standard Method
Total Nitrogen	Biannually	Standard Method
Conductivity	Biannually	Standard Method
Relevant hazardous substances as identified in the baseline report	Biannually	Standard Method

Note 1: The monitoring frequency specified in the schedule applies to these nine on-site monitoring locations only.
Note 2: The frequency of monitoring at these thirteen locations shall be as required by the Agency.

C.5.2 Monitoring of soil at the following monitoring locations:
At locations approved or directed by the Agency.

Parameter	Monitoring Frequency	Analysis Method/Techniques
Relevant hazardous substances as identified in the baseline report	Every ten years	Standard Method

C.5.3 Limit values and monitoring for dust deposition at the following monitoring locations:

- D1
- D2
- D3
- D4
- D5
- D6
- D7
- D8
- Any other location approved or directed by the Agency

Parameter and monitoring location		Limit value	Monitoring		
			Period	Frequency	Analysis method or technique
Dust deposition	D5 Note 1	130 mg/m^2/day	30 day composite sample	Monthly	VDI2119 Note 2
	D1, D2, D3, D4, D6, D7, D8 Note 1	240 mg/m^2/day			
PM_{10} $PM_{2.5}$ Arsenic Note 6	D1, D2, D3, D4, D5, D6, D7, D8 Note 1	Air quality standards Note 3	Standard sampling periods	Annually Note 4	Standard methods Note 5

Note 1: And any other location approved or directed by the Agency.
Note 2: Or other method approved by the Agency.
Note 3: Monitoring results to be compared against air quality standards. The licensee shall investigate monitoring results that exceed air quality standards, the objective being to identify the source of the emission and reduce the emission level.
Note 4: Monitoring frequency to increase to quarterly for at least two quarters for relevant parameters in the event of air quality standards being exceeded.
Note 5: EN standards are to be used or, if EN standards not available, ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality may be used.
Note 6: At two monitoring locations to be agreed by the Agency.

C.6 Waste Monitoring

Waste Class	Frequency	Parameter	Method
Waste accepted for co-incineration or other use **Other** Note 1	As per waste acceptance procedures	As per waste acceptance procedures	Standard methods

Note 1: Analytical requirements to be determined on a case by case basis.

SCHEDULE D: Energy Consumption

D.1 Energy Consumption Performance

Energy consumption limit range BAT 6

BAT-associated energy consumption level under normal and optimised operational conditions (excluding, for example, start-ups and shutdowns)	Applicability
2,900 – 3,300 MJ/tonne clinker	Applicable after next major upgrade

SCHEDULE E: Annual Environmental Report

Annual Environmental Report Content [Note 1]
Emissions from the installation.
Waste management record.
Resource consumption summary, including volume abstracted at water supply wells.
Complaints summary.
Schedule of Environmental Objectives and Targets.
Environmental management programme – report for previous year.
Environmental management programme – proposal for current year.
Pollutant Release and Transfer Register – report for previous year.
Pollutant Release and Transfer Register – proposal for current year.
Noise monitoring report summary.
Report on implementation of the programme to reduce noise emissions from blasting operations.
Ambient monitoring summary.
Tank and pipeline assessment report.
Reported incidents summary.
Report on Public Awareness and Communications Programme.
Energy efficiency audit report summary.
Report on the assessment of the efficiency of use of raw materials in processes and the reduction in waste generated.
Report on groundwater data assessment.
Report on progress made and proposals being developed to minimise water demand and the volume of trade effluent discharges.
Calculations for total annual emissions of carbon dioxide.
Report on programme of TOC emissions reductions.
Development/Infrastructural works summary (completed in previous year or prepared for current year).
Report on implementation of the Extractive Waste Management Plan.
Reports on financial provision made under this licence, management and staffing structure of the installation, and a programme for public information.
Review of Closure, Restoration & Aftercare Management Plan.
Statement of measures in relation to prevention of environmental damage and remedial actions (Environmental Liabilities).
Environmental Liabilities Risk Assessment Review (every three years or more frequently as dictated by relevant on-site change including financial provisions).
Report on implementation of the programme to minimise air overpressure from blasting operations.
Any other items specified by the Agency.

Note 1: Content may be revised subject to the approval of the Agency.

Sealed by the seal of the Agency on this the 22nd day of February 2018.

PRESENT when the seal of the Agency
Was affixed hereto:

Mary Turner, Authorised Person

Water Chapter

Appendix 8C

Hydrology & Hydrogeology

National Published Data & Reports

These data and the catchment map are outputs from the HydroTOOL mapped catchment which contributes to the Boyne_050, at the closest Conservation designation point on the Boyne, relative to the site.

Stream length distance from the site = 13.6km

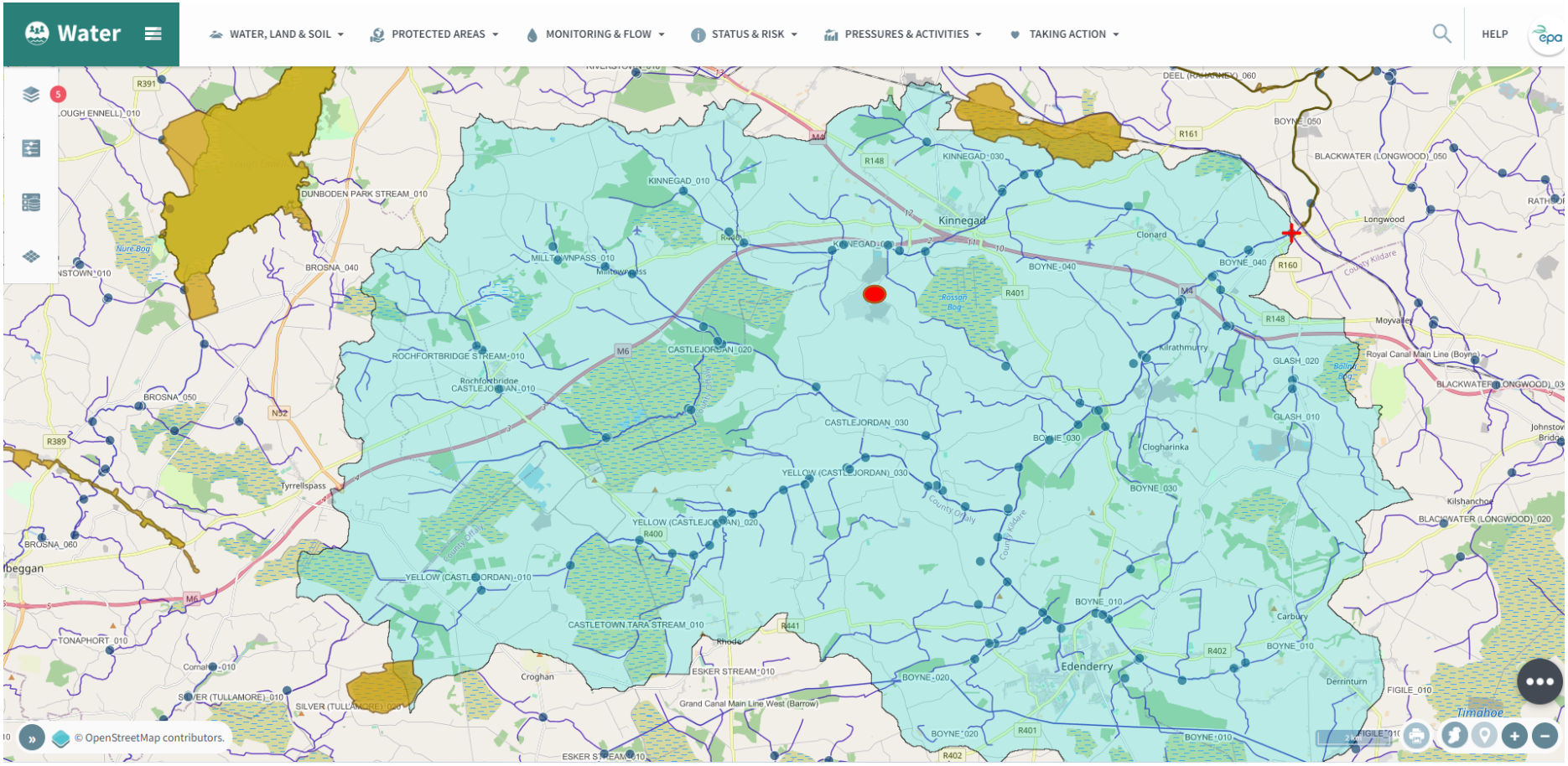
Total Catchment Area = 436km^2

River Flow Estimates - Hydrotool07_951

Hydro Catchment	View contributing catchment
RWSEG_CD	07_951
CatchmentArea_Km2	436.401
Easting	268940
Northing	245080
FARL	1
NATQ1 (m³/s)	29.501
NATQ5 (m³/s)	15.914
NATQ10 (m³/s)	12.168
NATQ20 (m³/s)	8.322
NATQ30 (m³/s)	6.324
NATQ40 (m³/s)	4.804
NATQ50 (m³/s)	3.851
NATQ60 (m³/s)	3.21
NATQ70 (m³/s)	2.725
NATQ80 (m³/s)	2.105
NATQ90 (m³/s)	1.463
NATQ95 (m³/s)	0.987
NATQ99 (m³/s)	0.609
NATAMF (m³/s)	5.915
RAINFALL_SAAR	862.70699904
EVAPOTRANSPIRATION	502.40443435
POORLYDRAINED	13.6318988
PEAT	37.98299599

Plate 8.C.1 Boyne_050 catchment at its start point of Designation closest to the application site.

(Source: https://gis.epa.ie/EPAMaps/Water)



Legend: = Application Site

3rd Cycle Draft
Boyne Catchment Report
(HA 07)

Catchment Science & Management Unit

Environmental Protection Agency

August 2021

Version no. 1

epaCatchments
Healthy • Resilient • Productive
Valued water resources supporting vibrant communities

Preface

This document provides a summary of the water quality assessment outcomes for the Boyne Catchment, which have been compiled and assessed by the EPA, with the assistance of the Local Authority Waters Programme (LAWPRO), local authorities and RPS consultants to inform the draft 3rd Cycle River Basin Management Plan. The information presented includes status and risk categories of all waterbodies, details on protected areas, significant issues, significant pressures, source load apportionment modelling and load reduction assessments for nutrients where applicable, an overview of the 2nd Cycle Areas for Action and a list of proposed 3rd Cycle Areas for Action. These characterisation assessments are largely based on information available to the end of 2018, including the WFD Status Assessment for 2013-2018. Protected Area assessments are based on water quality information up to 2018 for Natura 2000 and Salmonid Waters; 2019 for Drinking Water; and 2020 for Nutrient Sensitive Areas and Bathing Waters.

The purpose of this draft report is to provide an overview of the situation in the catchment, draw comparison between Cycle 2 and Cycle 3, and help support the draft River Basin Management Plan 2022-2027 consultation process. Once the consultation process is completed the report will be finalised to reflect any changes and comments made as a result of the consultation process.

Water Framework Directive – key dates and terminology	
Cycle 2 – EPA Characterisation and Assessment	Characterisation and assessment to inform the Cycle 2 RBMP was largely based on 2010-2015 WFD monitoring data.
Cycle 2 Catchment Assessments	Catchment Assessments based on the Cycle 2 characterisation and assessment were published in September 2018.
2nd Cycle River Basin Management Plan (RBMP) 2018-2021	This plan was for WFD Cycle 2 which runs from 2016-2021. This RBMP was published late, with this plan covering 2018-2021.
2nd Cycle Areas for Action	These 189 Areas for Action were selected under the RBMP 2018-2021
Cycle 3 -EPA Characterisation and Assessment	Cycle 3 runs from 2022-2027. Assessments to inform the Cycle 3 RBMP is largely based on 2013-2018 WFD monitoring data. This is the latest WFD monitoring assessment period for which all data are available.
Cycle 3 Catchment Assessments	Catchment Assessments based on the Cycle 3 characterisation and assessment were published in August 2021.
3rd Cycle River Basin Management Plan 2022-2027	This draft RBMP is for WFD Cycle 3 which runs from 2022-2027. Public consultation on this plan by the DHLGH and LAWPRO is taking place in late 2021 and early 2022.
3rd Cycle Recommended Areas for Action – Protection/ Restoration/Projects	These recommended Areas for Action have been identified in the draft RBMP 2022-2027 and feedback can be given in the public consultation on this plan. They fall into 3 categories – Areas for Protection, Areas for Restoration and Catchment Projects.

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1 Introduction

This report aims to provide an overview of the water quality status, risk, key issues and significant pressures for all waterbodies in the catchment based on the Characterisation Assessment undertaken for the 3rd Cycle River Basin Management Plan. In addition, a comparative overview of the water quality in the Boyne catchment between Cycle 2 and Cycle 3 characterisation is provided along with a summary of the progress made in the 2nd Cycle Areas for Action. The recommended list for the 3rd Cycle Areas for Action is also provided.

To provide context, the Boyne catchment includes the area drained by the River Boyne and by all streams entering tidal water between The Haven and Mornington Point, Co. Meath, draining a total area of 2,694km² (Figure 1). The largest urban centre in the catchment is Drogheda. The other main urban centres are Navan, Trim, Kells, Virginia, Bailieborough, Athboy, Kinnegad, Edenderry and Enfield. The total population of the catchment is approximately 196,400 with a population density of 73 people per km².

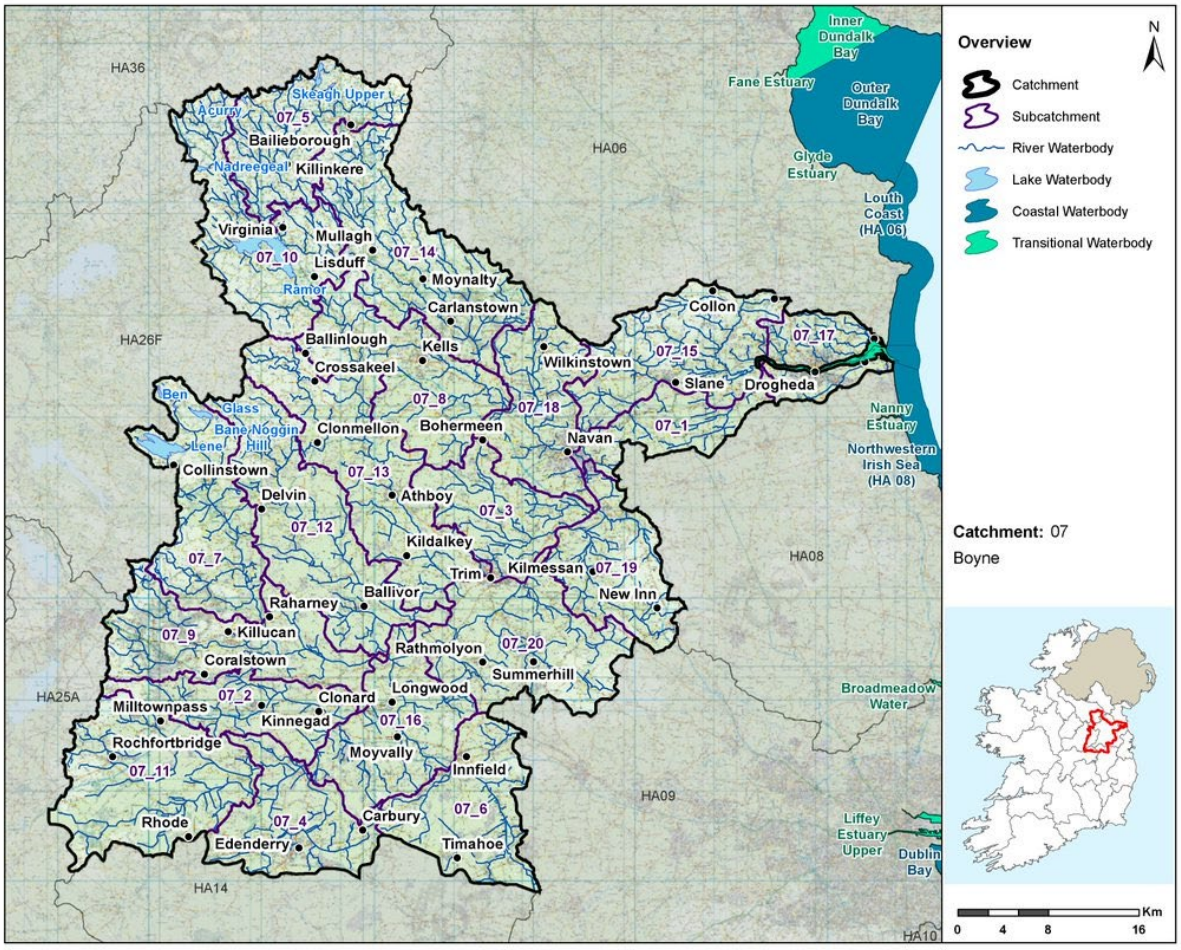


Figure 1: Overview of Subcatchments in the Boyne Catchment

The Boyne catchment is divided into 20 subcatchments (Figure 1) with 116 river waterbodies (which includes the Grand Canal Main Line (Boyne) & Royal Canal Main Line (Boyne) artificial waterbodies), 11 lakes, one transitional waterbody (Boyne Estuary), three coastal waterbodies (Boyne Estuary Plume Zone, Northwestern Irish Sea (HA 08) & Louth Coast (HA 06)) and 41 groundwater bodies (Figure 2).

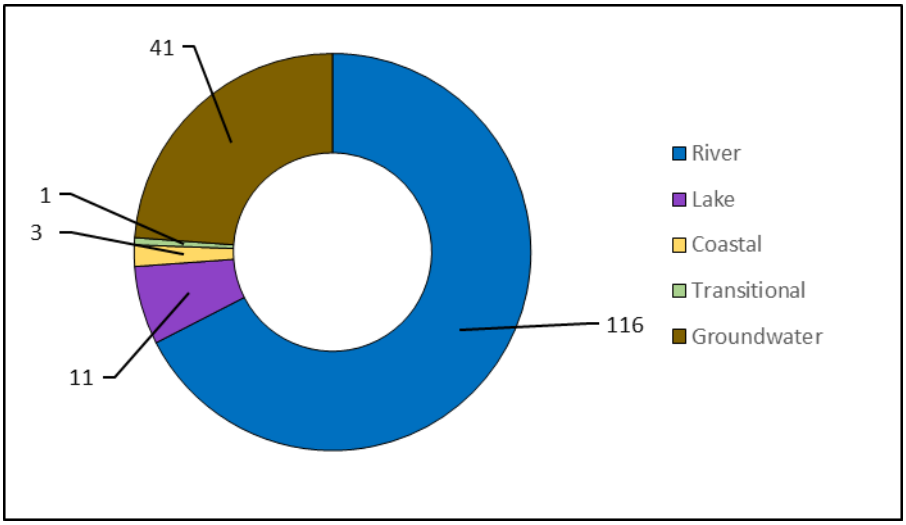


Figure 2: Waterbody types and numbers in the Boyne Catchment.

2 Waterbody Overview

2.1 Waterbody Status

- This assessment to inform the 3rd Cycle RBMP is largely based on WFD monitoring data for the period 2013-2018, which is the latest WFD monitoring assessment period for which all data are available.

- For this assessment to inform Cycle 3, there is one waterbody achieving High Status, 64 achieving Good Status, 50 achieving Moderate Status and 29 at Poor Status. There are 28 waterbodies that do not have status assigned for Cycle 3. All waterbodies must achieve at least Good Ecological status.

- In addition, there is one river waterbody, one lake waterbody and one coastal waterbody that must achieve High Ecological Status (HES) in this catchment. These waterbodies are listed in Appendix 1. Of the three HES Environmental Objective waterbodies, one coastal waterbody (Northwestern Irish Sea (HA 08)) is achieving High Status while the remaining two waterbodies (Chapel Lake Stream_010 & Bane Noggin Hill lake waterbody) are at Good Status.

- The overall number of waterbodies achieving High Status has reduced from two to one between Cycle 2 and Cycle 3 (Figure 3 & Table 1). In Cycle 2 there was one High Status River and one High Status lake, however in Cycle 3 there is one High Status coastal waterbody. The numbers of Good Status and Bad Status waterbodies have also reduced between Cycle 2 and Cycle 3 from 68 to 64 and from three to zero, respectively. There were increases in the numbers of waterbodies in the Moderate Status and Poor Status classes.

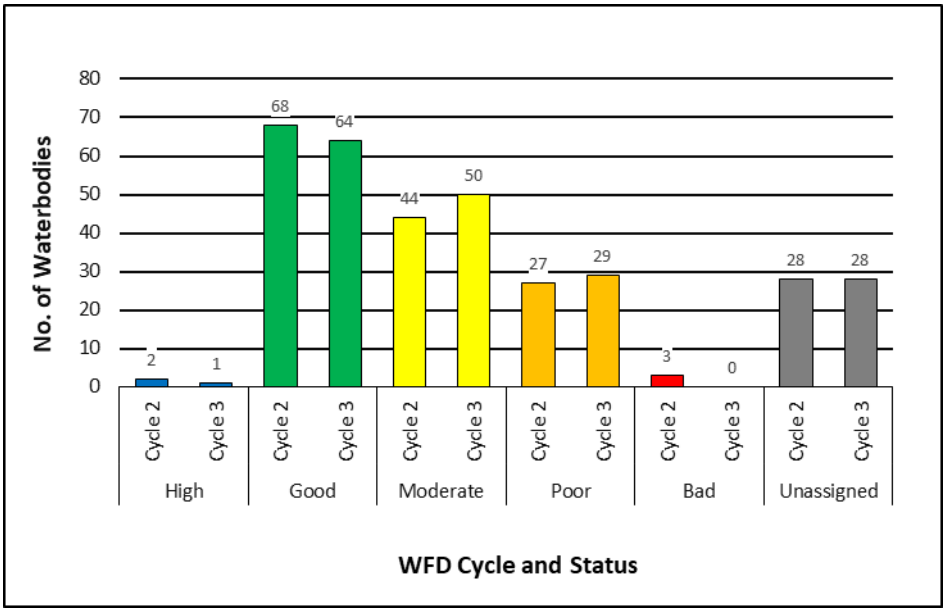


Figure 3: Waterbody Status Breakdown (All waterbodies)

Table 1: Waterbody Status Breakdown Table (All Waterbodies)

2013-2018 Status	River		Lake		Transitional		Coastal		Groundwater		Total	
	Cycle 2	Cycle 3	Cycle 2	Cycle 3	Cycle 2	Cycle 3	Cycle 2	Cycle 3	Cycle 2	Cycle 3	**Cycle 2**	**Cycle 3**
High	1	0	1	0	0	0	0	1	0	0	**2**	**1**
Good	28	24	2	2	0	0	2	0	36	38	**68**	**64**
Moderate	43	46	0	2	1	1	0	1	0	0	**44**	**50**
Poor	20	22	2	4	0	0	0	0	5	3	**27**	**29**
Bad	0	0	3	0	0	0	0	0	0	0	**3**	**0**
Unassigned	24	24	3	3	0	0	1	1	0	0	**28**	**28**
Total	116	116	11	11	1	1	3	3	41	41	**172**	**172**

- Figure 4 illustrates the change in status between Cycle 2 (assessment based largely on 2010-2015 WFD Monitoring data) and Cycle 3 (assessment largely based on 2013-2018 WFD monitoring data.
- Over this period 20 (14%) waterbodies have improved in status, 101 (70%) waterbodies have remained unchanged and 23 (16%) waterbodies have declined in status.[1]
- There is an overall decline in the status of three waterbodies across the catchment since the Cycle 2 assessment.

[1] Unassigned waterbodies have not been considered in this Status class change assessment and therefore are not represented in Figure 5. Percentage displayed in Figure 4 are in relation to the total number of waterbodies with status assigned in both cycles, as opposed to total number of all waterbodies.

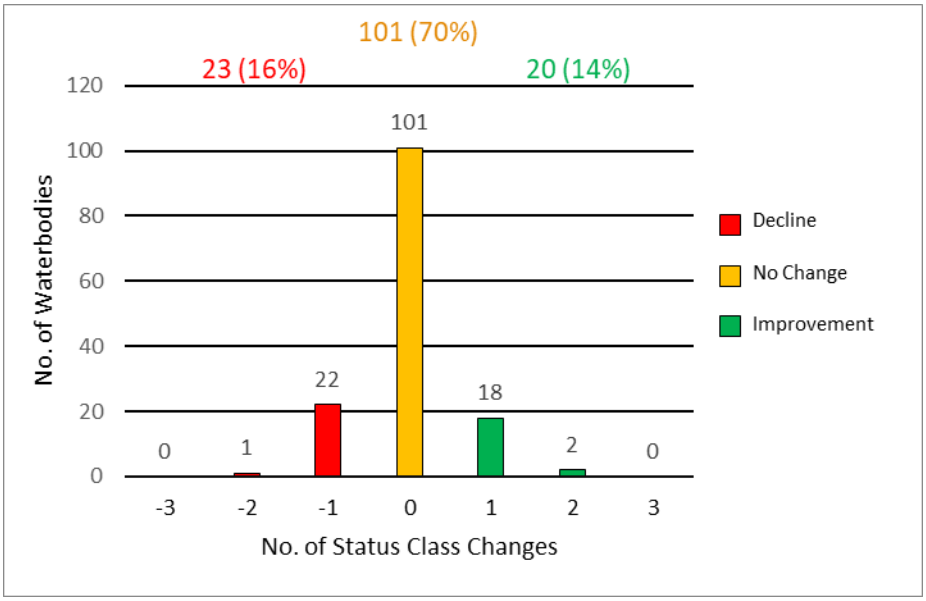


Figure 4: Status Class Changes between Cycle 2 and Cycle 3

2.2 Protected Areas

2.2.1 Drinking Water

- There are 12 surface waterbodies in the catchment identified as Drinking Water Protected Areas (DWPA) based on water abstraction data on the abstraction register and from other sources in 2018. All groundwater bodies nationally are identified as DWPA. DWPA layers can be viewed at https://gis.epa.ie/EPAMaps/Water - see *Protected Areas - Drinking Water*.

- One river waterbody and one lake waterbody in the catchment did not meet the DWPA objective in 2019:
    - Blackwater (Kells)_120 (IE_EA_07B011800) river waterbody is the source for the Navan-Mid Meath (2300PUB1016) public supply which had pesticide (Fluroxypyr) exceedances.
    - Nadreegeel (IE_EA_07_273) lake waterbody is the source for Ballyjamesduff RWSS (0200PUB0106) which had pesticide (MCPA & Metaldehyde) exceedance.

- For more detailed information please see the EPA reports on drinking water quality in 2019 for Public Supplies[2] and Private Supplies[3].

2.2.2 Bathing Waters

- There is one bathing water designated lake (The Cut, Lough Lene) in the Boyne catchment identified under the Bathing Water Regulations 2008.

- This bathing water had an Excellent classification for 2020.

[2] https://www.epa.ie/publications/compliance--enforcement/drinking-water/annual-drinking-water-reports/drinking-water-quality-in-public-supplies-2019.php

[3] https://www.epa.ie/publications/compliance--enforcement/drinking-water/annual-drinking-water-reports/focus-on-private-water-supplies-2019.php

- For more detailed information please see the EPA report on bathing water quality in 2020[4].

2.2.3 Shellfish Areas

- There are no designated shellfish areas in the catchment.

The locations of Protected Areas associated with Public Health (Drinking Water, Bathing Water and Shellfish Areas, where applicable) are illustrated in Figure 5 below.

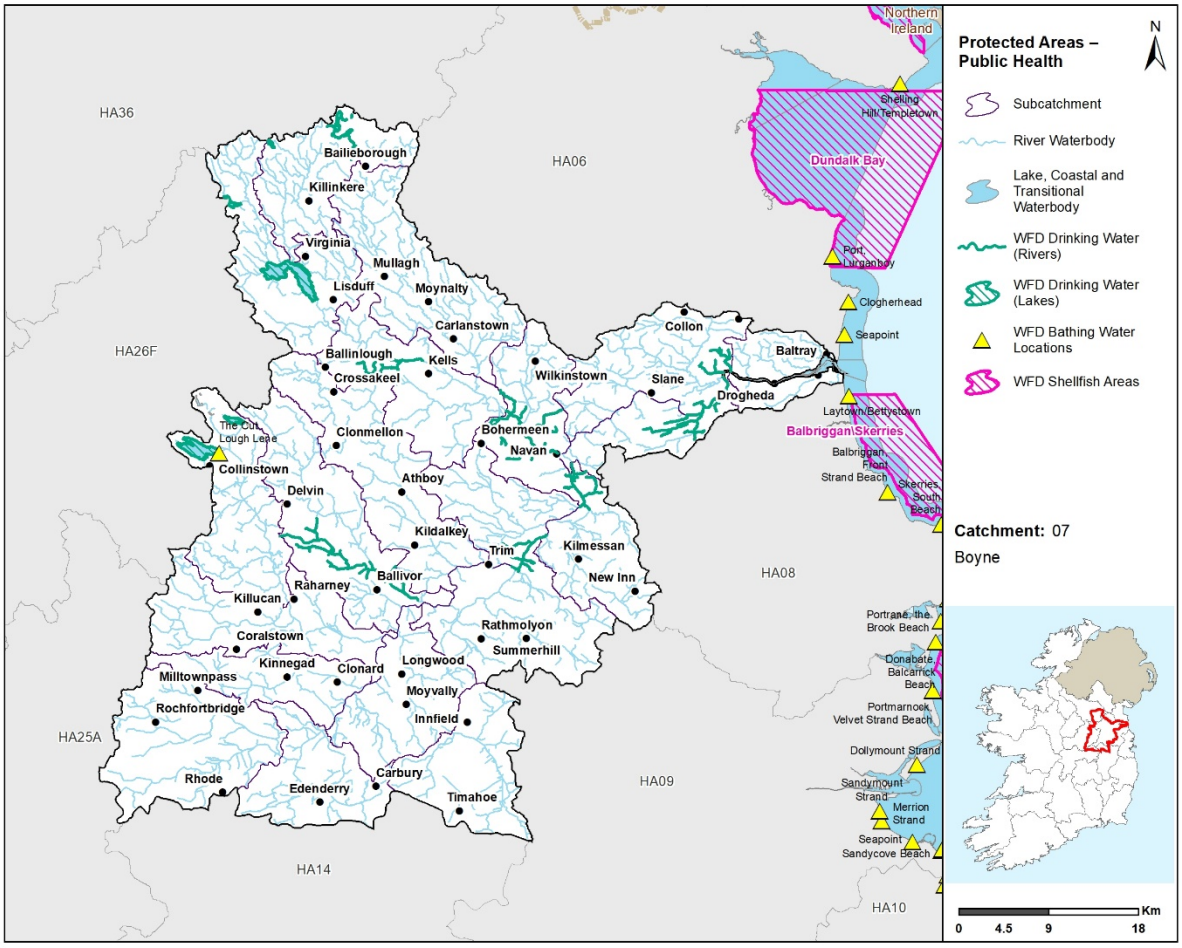


Figure 5: Protected Areas – Public Health

2.2.4 Natura 2000 Sites and Salmonid Waters

- Many of the habitats and species listed for protection in the Birds and Habitats Directives are water dependent. The Special Protection Areas (SPAs) and Special Areas of Conservation (SACs) with water dependent habitats or species in this catchment are presented in Figure 6, along with waterbodies designated as salmonid waters (S.I. No. 293 of 1988) and waterbodies with Fresh Water Pearl Mussel habitat, where identified.

- There are 10 SACs in this catchment all of which have water dependent habitats or species. The waterbodies within these SACs were assessed for associated water dependent habitats and species and if they met the supporting requirements for habitats and species using their 2013-2018 WFD

[4] https://www.epa.ie/publications/monitoring--assessment/freshwater--marine/bathing-water-quality-in-ireland-2020-.php

status. For the purposes of the assessment, it was assumed that Good ecological status is adequate to meet the supporting conditions of all habitats and species with the exception of the Freshwater Pearl Mussel, which has additional requirements for supporting conditions set out in the Freshwater Pearl Mussel Regulations (S.I. No 296 of 2009) for macroinvertebrates, filamentous algae, phytobenthos, macrophytes and siltation.

- Specific water supporting conditions have not been identified for the dependent bird species in the SPAs and so waterbodies associated with SPAs are not included in this assessment.

- Results of the overall assessment for this catchment are outlined in Table 2.

Table 2: Natura 2000 network assessment summary

Water Body Type	Total No.	Meeting the Requirements	Did not meet the Requirements	Unknown*
Rivers	44	10	23	11
Transitional & Coastal	1	1	0	0

**As the waterbody status was unassigned.*

- There are no Fresh Water Pearl Mussel (FWPM) habitats present in the Boyne Catchment.

- There are four groundwater bodies delineated and assessed as Groundwater Dependent Terrestrial Ecosystems (GWDTE) for this catchment. All four are at Good Status and *Not At Risk* in Cycle 3. The GWDTE groundwaters in the catchment are:

    - GWDTE-Mount Hevey Bog (SAC002342)
    - GWDTE-Killyconny Bog (Cloghbally) (SAC000006)
    - GWDTE-Raheenmore Bog (SAC000582)
    - GWDTE-Newtown Lough Fen (SAC002299)

- Water dependent SACs/ SPAs and salmonid waters in the catchment are illustrated in Figure 6.

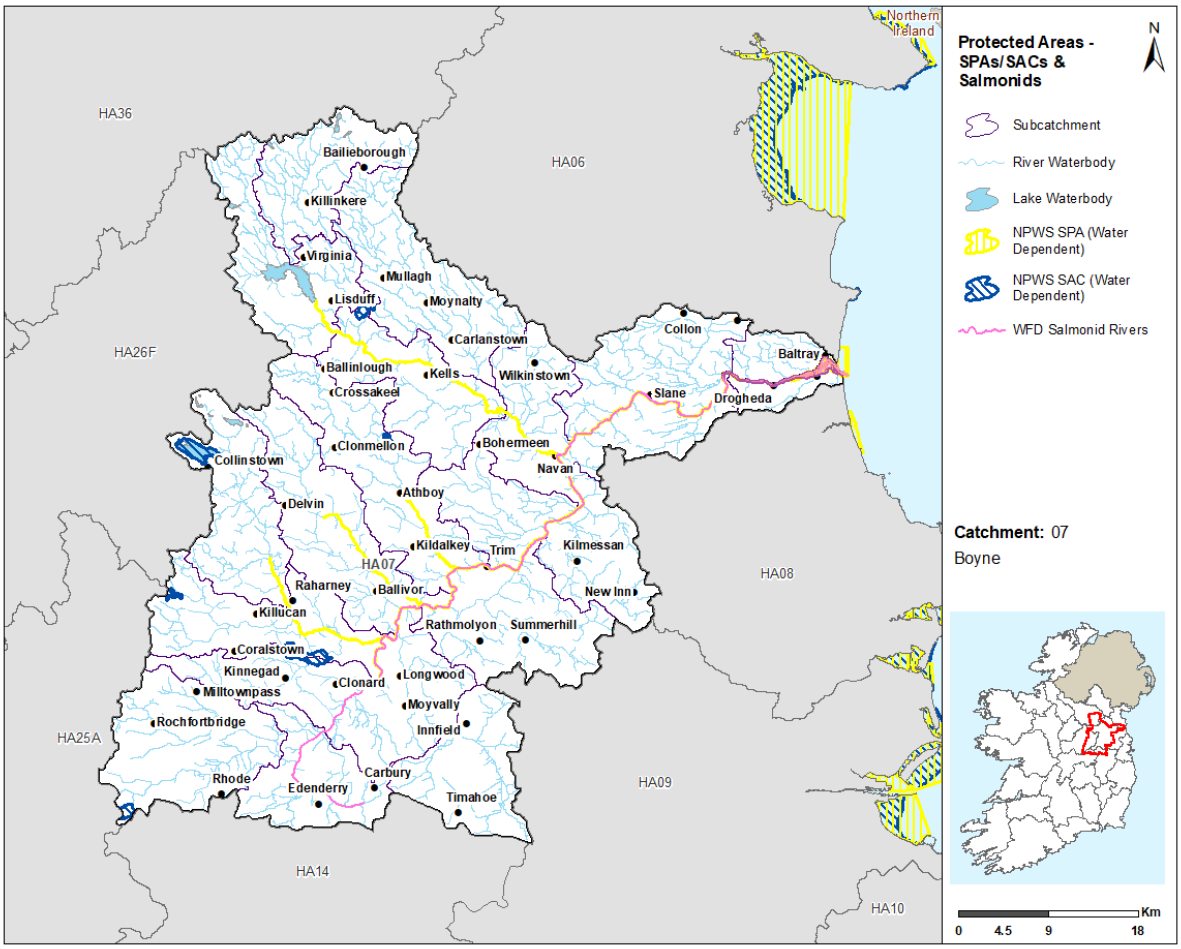


Figure 6: Water Dependent SPAs / SACs and Salmonid Waters

2.2.5 Nutrient Sensitive Areas

- The EPA carried out a review of nutrient sensitive areas downstream of large urban waste water discharges in 2020 and this assessment will inform the regulations. Once the regulations are in place, and nutrient sensitive areas have been identified, additional nutrient removal must be applied (if not already applied) to waste water treatment plants discharging to the sensitive area. If this treatment was in place the objective was deemed to have been met.

- There are three NSAs in the catchment and these are downstream of three urban wastewater agglomerations. The list of NSAs, associated agglomerations and intersecting water bodies are provided in Table 3.

- NSA objectives are being met in all three NSAs in the catchment.

Table 3: Nutrient sensitive areas in the catchment

Nutrient Sensitive Area	Agglomeration		Water body		Objective met?		Comment
	Name	Code	Name	Code	Yes	No	
Boyne River (100-120)	Trim	D0137-01	Boyne_100	IE_EA_07B041500			Tertiary Treatment in place
			Boyne_110	IE_EA_07B041600			
			Boyne_120	IE_EA_07B041700	✓		
	Navan	D0059-01	Boyne_150	IE_EA_07B042010			
			Boyne_160	IE_EA_07B042100	✓		

Boyne River (150-180)			Boyne_170	IE_EA_07B042150			Tertiary Treatment in place
			Boyne_180	IE_EA_07B042200			
Boyne Estuary	Drogheda	D0041-01	Boyne Estuary	IE_EA_010_0100	✓		Tertiary Treatment in place

2.3 Heavily Modified Waterbodies

- Based on the 1st and 2nd RBMPs there are currently no heavily modified water bodies (HMWBs) in the Boyne catchment. There will be a consultation period on HMWBs for the 3rd Cycle RBMP and this will be completed for inclusion in the 3rd Cycle Final RBMP.

2.4 Artificial Waterbodies

- In total, there are two artificial waterbodies in the Boyne Catchment, namely, Grand Canal Main Line (Boyne) and Royal Canal Main Line (Boyne).

- Both artificial waterbodies were at Good Status in Cycle 2 and remain at Good Status in Cycle 3, therefore, no change in status has been observed.

3 Waterbody Risk

3.1 Overview of Risk

- A waterbody that is *At Risk* means that either the waterbody is not achieving its Water Framework Directive (WFD) environmental objective of Good or High Ecological Status or that there is a trend indicating that by the end of Cycle 3 if the trend continues the waterbody will decline in Status and will fail to meet its environmental objective.

- A waterbody can be considered as *Review* for the following three reasons:
    - The waterbody does not have a status assigned to it yet, it is referred to as an unassigned waterbody, and therefore there is not enough evidence to determine if it is *At Risk* or*Not at Risk*.
    - The waterbody has shown some slight evidence or improvement, but more evidence is needed before it can be considered as *Not At Risk.*
    - Measures are planned or have already been implemented for the waterbody and no further measures should be applied until there is enough time to assess if these measures are working.

- A waterbody is *Not At Risk* when it is achieving its environmental objective of either High or Good Status and that there is no evidence indicating that there is a trend towards status decline.

- In total there are 172 waterbodies in the Boyne Catchment and 93 (54%) of these are currently *At Risk*, 32 (19%) in *Review* and 47 (27%) are *Not At Risk*.

3.2 Surface Waters

- For the 116 river waterbodies in the catchment, 75 (65%) are *At Risk*, 24 (21%) are in *Review* and 17 (15%) are *Not At Risk*.

- For the 11 lake waterbodies in the catchment, 7 (64%) are *At Risk*, three (27%) are in *Review* and one (9%) is *Not At Risk*.

- The Boyne Estuary transitional waterbody is *At Risk*.

- For the three coastal waterbodies in the catchment, one (33%) is *Not At Risk*, one (33%) is in *Review* and one (33%) is *At Risk*. Boyne Estuary Plume Zone is the coastal waterbody *At Risk*.

- The largest proportion of *At Risk* waterbodies are found in rivers, accounting for 75 (81%) of 93 *At Risk* waterbodies. Figure 7 gives an overview of the breakdown of risk across waterbody types for both Cycle 2 and Cycle 3.

- Overall there is an increase in *12 At Risk* waterbodies and a reduction of 10 *Review* waterbodies between Cycle 2 and Cycle 3. Two artificial waterbodies (Grand Canal Main Line (Boyne) & Royal Canal Main Line (Boyne)) did not have risk assigned in Cycle 2.

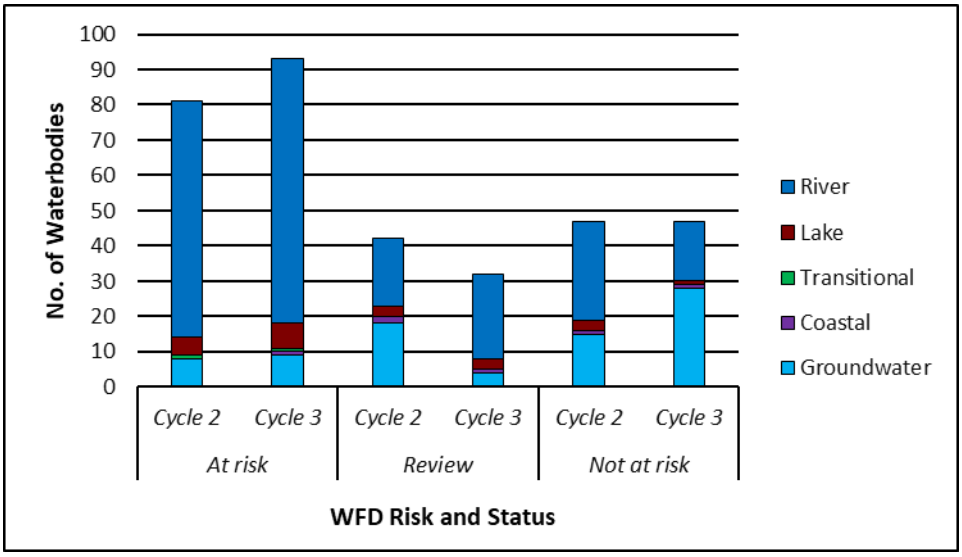


Figure 7: Number of waterbodies in each risk category

- The location of the *At Risk, Review and Not At Risk* surface waterbodies for Cycle 3 are shown in Figure 8 while the surface waterbodies that have experienced a change in risk between Cycle 2 and Cycle 3 are shown in Figure 9.

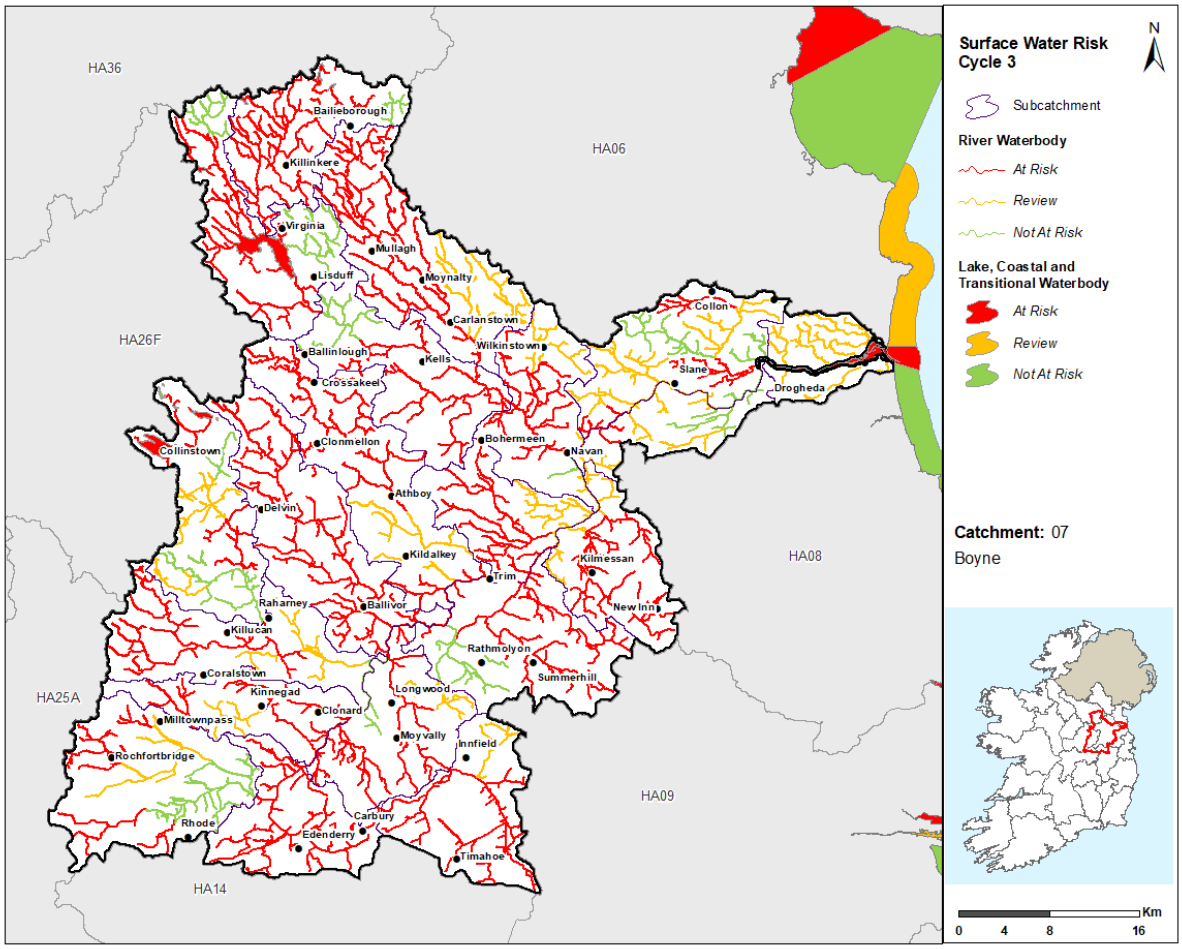


Figure 8: Surface Water Risk Cycle 3

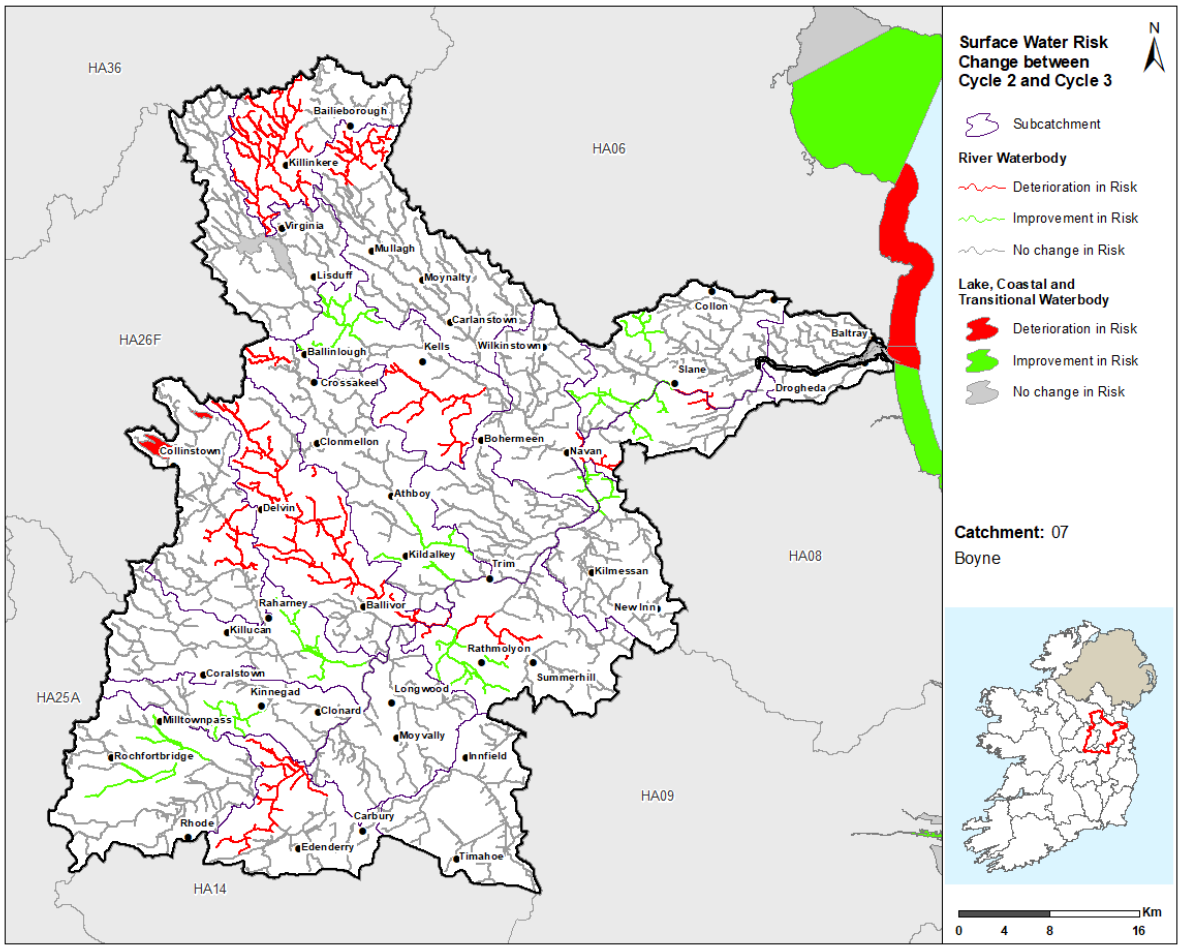


Figure 9: Surface Water Risk Change between Cycle 2 and Cycle 3

3.3 Groundwater

- For the 41 groundwater bodies in the catchment, nine (22%) are *At Risk*, four (10%) are in *Review* and 28 (68%) are *Not At Risk*.

- In Cycle 2, there were eight groundwater bodies *At Risk* in this catchment, 18 in *Review* and 15 *Not At Risk*.

- The location of the *At Risk, Review and Not At Risk* groundwater bodies for Cycle 3 are shown in Figure 10 while the groundwater bodies that have experienced a change in risk between Cycle 2 and 3 are shown in Figure 11.

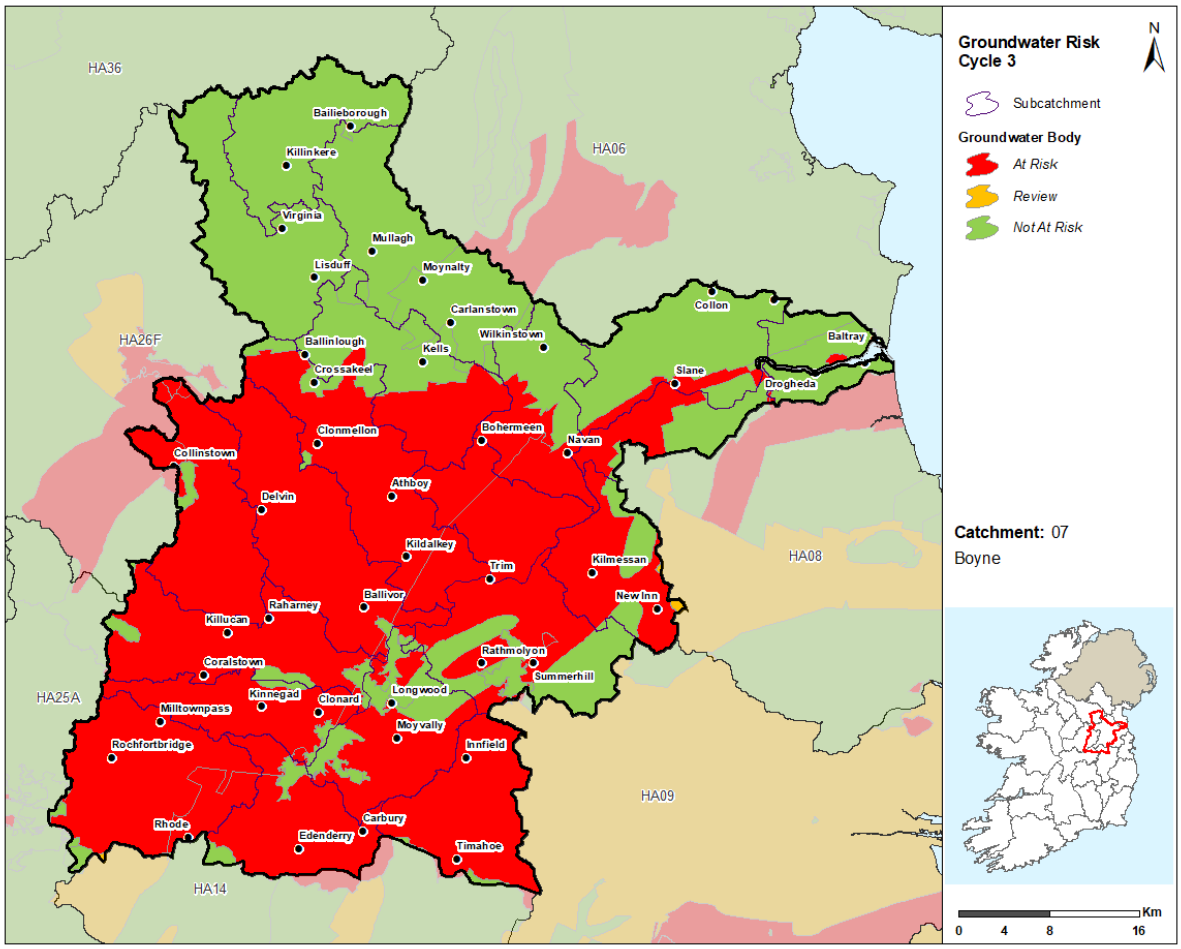


Figure 10: Cycle 3 Groundwater Body Risk

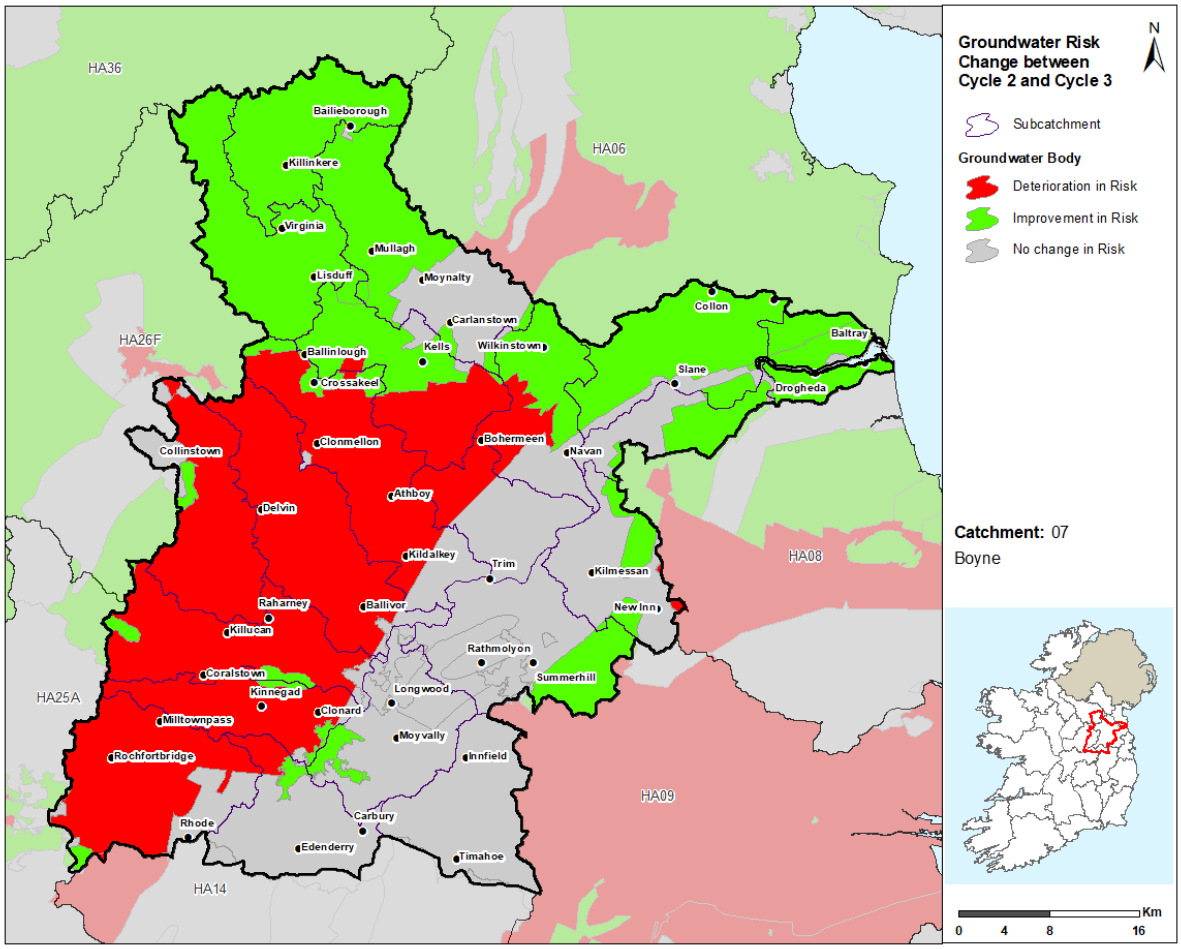


Figure 11: Groundwater Body Risk Change between Cycle 2 & Cycle 3

3.4 Heavily Modified Waterbodies

- There are currently no heavily modified water bodies (HMWBs) in the Boyne catchment. There may be changes to HMWB designation once the Cycle 3 HMWB assessment has been completed and consulted on for the 3rd Cycle Final RBMP.

3.5 Artificial Waterbodies

- There are two artificial waterbodies in the Boyne Catchment (Grand Canal Main Line (Boyne) & Royal Canal Main Line (Boyne)) both of which are *Not At Risk* in Cycle 3.

4 Significant Issues in *At Risk* Waterbodies

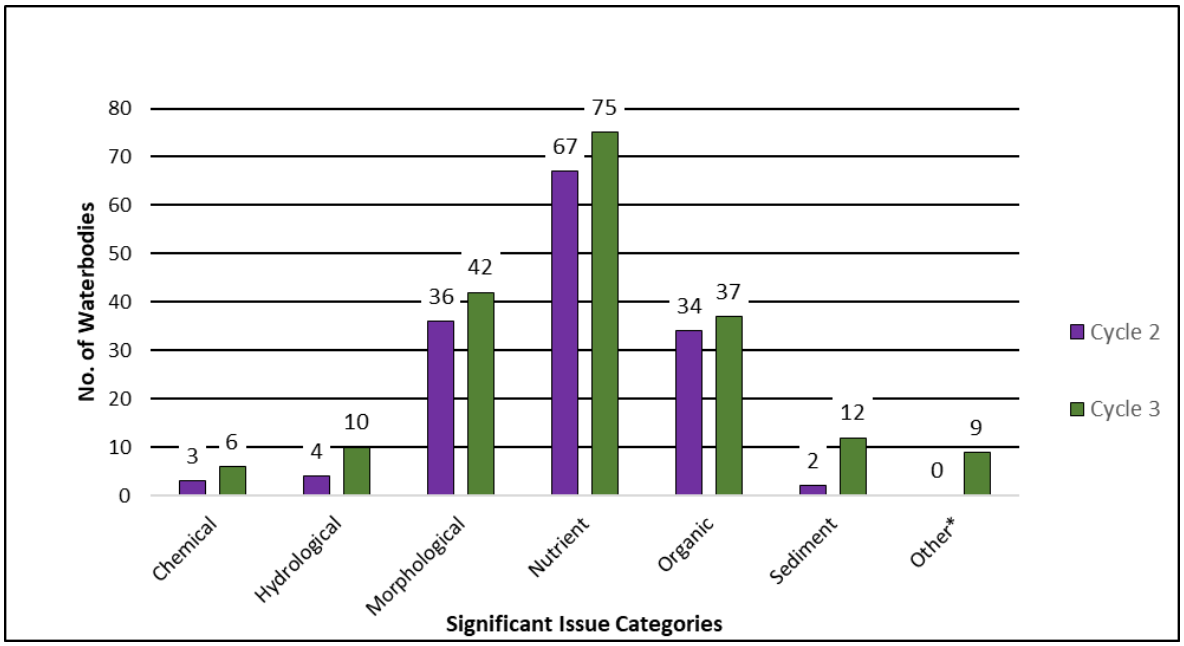
4.1 All Waterbodies

- Excess nutrients remain the most prevalent issue in the Boyne Catchment (Figure 12) impacting 75 waterbodies in Cycle 3. Morphological issues are impacting 42 waterbodies, organic pollution is impacting 37 waterbodies and sediment and hydrological impacts are affecting 12 and 10 waterbodies, respectively. Chemical pollution is a significant issue in six waterbodies.

- For rivers, the main significant issues are nutrient pollution (61), morphological impacts (42) organic pollution (34), hydrological impacts (9), and sediment (8).
- For Lakes, the main significant issues are nutrient pollution (6), sediment impacts (3), organic (2), chemical impacts (2) and hydrological impacts (1).
- Nutrient and organic pollution are significant issues impacting the Boyne Estuary transitional waterbody.
- Nutrient pollution is the issue impacting the Boyne Estuary Plume Zone.
- For groundwaters, the significant issues are nutrients pollution (6), chemical pollution (3), sediment (1) and other issues (7).

♦ Between Cycle 2 and Cycle 3 the number of waterbodies associated with each significant issue category has increased. The biggest increases are with sediment and nutrients, increasing from two to 12 and 67 to 75 respectively.

♦ All impacts under the other category in Figure 12 have unknown impacts and require further investigation.



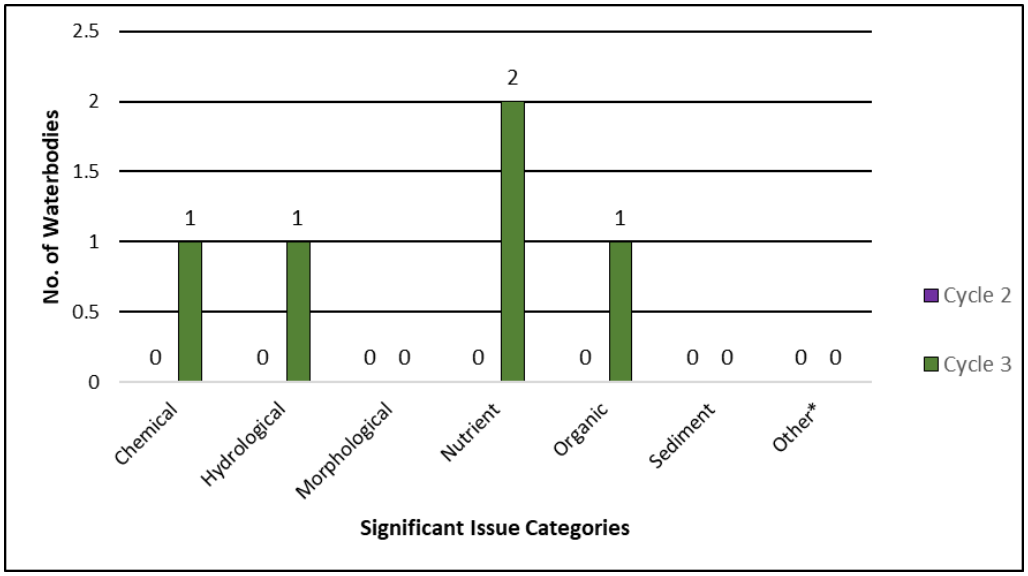
*Other - Acidification, saline intrusion, elevated temperature, litter, microbiological pollution and unknown impacts have all been grouped into the "Other" issues category for the purpose of this report

Figure 12: Significant Issues across all *At Risk* WBs between Cycle 2 and Cycle 3

4.2 High Status Objective Waterbodies

♦ In Cycle 3, for High Status Objective waterbodies, nutrient issues are impacting both (Chapel Lake Stream_010 river waterbody & Bane Noggin Hill lake waterbody) High Status Objective waterbodies currently *At Risk* (Figure 13). Organic pollution is also impacting on Chapel Lake Stream_010, while chemical and hydrological issues are also impacting Bane Noggin Hill.

♦ The absence of Cycle 2 significant issues in Figure 13 is because there were no *At Risk* High Status Objective waterbodies in Cycle 2.



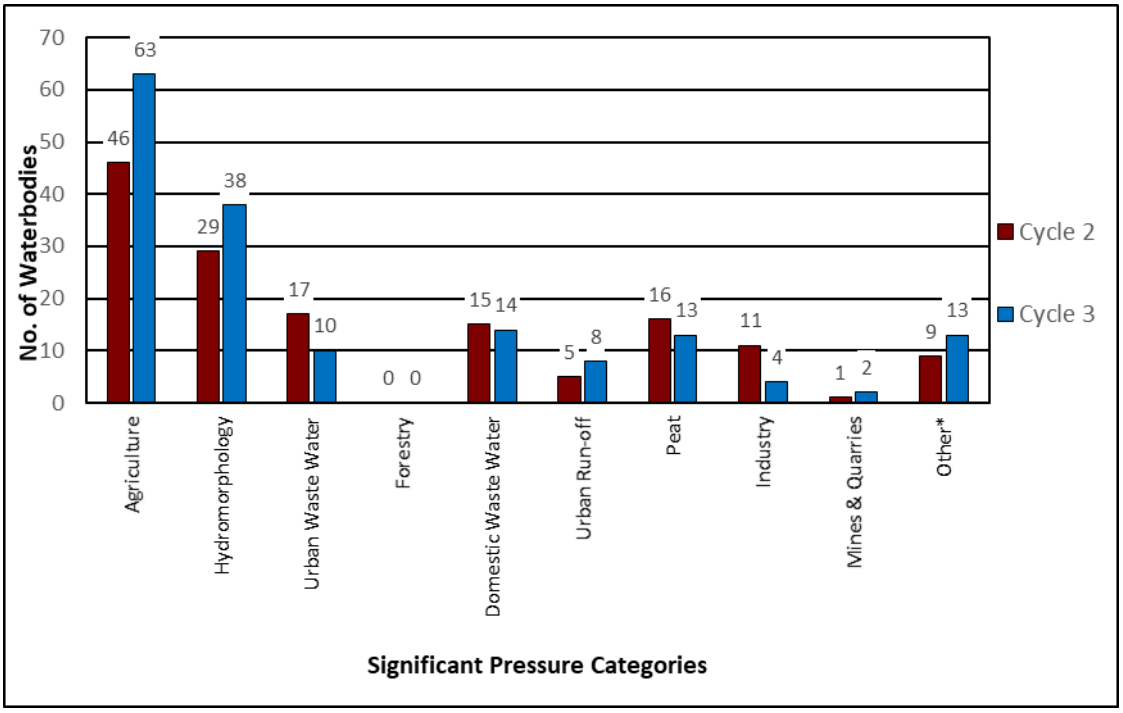
*Other - Acidification, saline intrusion, elevated temperature, litter, microbiological pollution and unknown impacts have all been grouped into the "Other" issues category for the purpose of this report

Figure 13: Significant Issues in *At Risk* High Status Objective Waterbodies

5 Significant pressures in *At Risk* Waterbodies

5.1 All Waterbodies

- Where waterbodies have been classed as *At Risk*, significant pressures have been identified.
- Figure 14 shows a breakdown of the number of *At Risk* waterbodies in each significant pressure category.
- The significant pressure affecting the greatest number of waterbodies is agriculture, followed by hydromorphological pressures, domestic waste water, peat, urban waste water, urban run-off, industry and mines & quarries.
- When comparing Cycle 2 and Cycle 3 the biggest change is an increase of 17 waterbodies where agriculture is a significant pressure from 46 waterbodies in Cycle 2 to 63 waterbodies in Cycle 3. This suggests that agricultural pressures are the primary reason for the overall decline in waterbody status since Cycle 2.
- There has also been an increase in the number of waterbodies impacted by hydromorphological pressures, however, this is more likely associated with detailed assessment by the EPA based on the recently developed Morphological Quality Index tool and associated increasing awareness of hydromorphology rather than new significant hydromorphology pressures since Cycle 2.
- Urban waste water, domestic waste water, peat and industry are all impacting less waterbodies in Cycle 3 than Cycle 2.



*Other – abstractions, aquaculture, atmospheric, anthropogenic pressures, historically polluted sites, waste, water treatment and invasive species have all been grouped into the "Other" pressure category for the purpose of this report

Figure 14: Significant Pressure (All *At Risk* Waterbodies)

5.1.1 Pressure Type

5.1.1.1 Agriculture

- Agriculture is a significant pressure in 51 river waterbodies, five lake waterbodies, one transitional waterbody (Boyne Estuary) and six groundwater bodies in Cycle 3. Phosphorus loss to surface waters from, for example, direct discharges; or runoff from yards, roadways or other compacted surfaces, or runoff from poorly draining soils, remains an issue since Cycle 2. Sediment associated with agricultural activities, including land drainage works, bank erosion from animal access or stream crossings, has also been noted as an issue in this catchment. Organic pollution associated with run-off from farmyards in particular, has also been identified throughout the catchment.

5.1.1.2 Hydromorphology

- Hydromorphology is a significant pressure in 38 river waterbodies. Channelisation is the dominant hydromorphology subcategory in the catchment with 34 river waterbodies within the catchment subject to extensive modification mainly due to drainage schemes. Dams, barriers, lock and weirs were identified as the pressure subcategory in five river waterbodies (Athboy_040, Blackwater (Kells)_120, Crosskeys Stream_010, Stonyford_010 & Stonyford_020). Channelisation was also an issue in all five of these waterbodies. Land drainage was identified as an impact on Boyne_020 river waterbody and three river waterbodies (Blackwater (Kells)_020, Blackwater (Kells)_050 & Blackwater (Kells)_060) are still impacted by embankment schemes.

5.1.1.3 Domestic waste water

- Domestic waste water has been identified as a significant pressure in 10 river waterbodies, three lakes (Acurry, Skeagh Upper & Drumkeery). The significant issues arise from unsuitable domestic waste water treatment systems, especially when they are poorly sited on areas of high pollution impact potential/poorly draining soils or discharging directly into the water bodies. This results in enrichment and organic contamination. Furthermore, some of these locations are located on areas of high susceptibility to phosphate transport via near surface pathways. Domestic waste water has

also been identified as a significant pressure in one groundwater body (Trim) where groundwater contribution of nutrient and other impacts to surface waters were identified as issues.

5.1.1.4 Urban waste water

- Urban waste water agglomerations have been identified as a significant pressure in eight *At Risk* river waterbodies, as well as Ramor lakeand Boyne Estuary (Table 4).
- Bailieborough and Virginia agglomerations are due to be upgraded by2024, and the Drogheda agglomeration is due to be upgraded by 2021. There are no plans on the current Irish Water CIP for the remaining four agglomerations that are impacting seven waterbodies.

Table 4: Waste Water Treatment Agglomerations identified as significant pressures in *At Risk* waterbodies in Cycle 3

Facility name	Facility Type	Waterbody	2013-18 Ecological Status	Irish Water's Expected CIP Completion Date[5]
Drogheda D0041	Agglomeration PE > 10,000	Boyne Estuary	Moderate	2021
Virginia D0255	Agglomeration PE of 2,001 to 10,000	Ramor	Poor	2024
Bailieborough D0085	Agglomeration PE of 2,001 to 10,000	BLACKWATER (KELLS)_020	Poor	2024
Rochfortbridge D0101	Agglomeration PE of 2,001 to 10,000	CASTLEJORDAN_010	Poor	N/A
Collon D0261	Agglomeration PE of 1,001 to 2,000	MATTOCK_010	Moderate	N/A
Mullagh Waste Water Treatment Works D0252	Agglomeration PE of 1,001 to 2,000	MOYNALTY_040	Poor	N/A
Mullagh Waste Water Treatment Works D0252	Agglomeration PE of 1,001 to 2,000	MOYNALTY_050	Moderate	N/A
Mullagh Waste Water Treatment Works D0252	Agglomeration PE of 1,001 to 2,000	MOYNALTY_060	Moderate	N/A
Millview Housing Estate (Milltownpass) A0527	Agglomeration PE < 500	MILLTOWNPASS_010	Poor	N/A
Mullagh Waste Water Treatment Works D0252	Agglomeration PE of 1,001 to 2,000	MULLAGH LOUGH STREAM_010	Poor	N/A

- Urban waste water significant pressures are impacting seven less waterbodies in Cycle 3 than in Cycle 2 (a decrease from 17 to 10 waterbodies impacted). The following Agglomerations were listed as pressures in Cycle 2 but are not on the list of significant pressures in Cycle 3.
    - Slane (D0257)
    - Ballivor (D0254)
    - Longwood (D0250
    - Kildalkey (D0486)
    - Carlanstown (D0488)

[5] Based on Irish Water's Capital Investment Programme (2020-2024) as of February 2021 and may be subject to change.

- Kinnegad (D0104)
- Kells (D0127)
- Edenderry (D0110)
- Dunshauglin (D0138)
- Enfield (D0131)

Millview Housing Estate (Milltownpass) A0527 has been included in the list of significant pressures in Cycle 3 and was not listed in Cycle 2.

5.1.1.5 Extractive industry

- *Peat*
  Peat drainage and extraction remains a significant pressure in 13 river water bodies, a reduction from 16 waterbodies in Cycle 2. The peat pressures have resulted in increased sediment loads in these rivers, which alters habitats, morphology and hydrology. There have also been fluctuations in ammonia concentrations.

5.1.1.6 Urban run-off

- Diffuse urban pressures, caused by misconnections, leaking sewers and runoff from paved and unpaved areas, have been identified as a significant pressure in seven river waterbodies as well as Boyne Estuary Plume Zone coastal waterbody impacted by Navan, Bailieborough, Edenderry, Trim, Rochfortbridge, Summerhill, Killucan and Drogheda urban areas. Elevated concentrations of nutrients and organic pollutants are the significant issues.

5.1.1.7 Industry

- Industry has been identified as a significant pressure in two river water bodies (Knightsbrook_010 & Moynalty_030) and two groundwater bodies (Industrial Facility (P0784-01) & Industrial Facility (P0690-01)). These point source discharges, causing nutrient and organic issues, arise from industrial discharges (Table 5).

Table 5: Breakdown of Cycle 3 Industry Significant Pressures in the Boyne Catchment

Waterbody Code	Waterbody Name	Waterbody Type	Emission Type	Name	Impact
IE_EA_07K020300	KNIGHTSBROOK_010	River	Section 4	N/A*	Nutrient
IE_EA_07M030300	MOYNALTY_030	River	IPC	Wellman International Limited	Nutrient
IE_EA_G_029	Industrial Facility (P0784-01)	Groundwater	IPC	Boylan Print Limited	Chemical & Diminution of quality of associated surface waters for chemical reasons
IE_SH_G_261	Industrial Facility (P0690-01)	Groundwater	IPC	Decotek Automotive Limited	Chemical & Diminution of quality of associated surface waters for chemical reasons

*Name of facility not provided during characterisation

5.1.1.8 Mines & Quarries

- A number of old quarries and backfilled quarries have been identified as a significant pressure impacting the Boyne_040 river waterbody causing morphological impacts in the river channel. Abstraction exceeding available groundwater resource (lowering water table) has also been identifies as an issue in the Bettystown GWB.

5.1.1.9 Other significant pressures

- *Invasive species*
  Invasive fish species have been identified as a significant pressure in Lene lake. IFI noted that invasive roach is now present and native fish biomass has decreased with changes in population dynamics (e.g. food web structure, competition, predation, etc.) being the main driver. Ramor lake has been identified as a zebra mussel lake but the impact type is unknown.

- *Abstraction*
  Abstraction for water supply was identified as a significant pressure in Acurry (Clifferna private water supply) and Bane Noggin Hill (Kells/Oldcastle public water supply) lakes. Altered habitat due to hydrological changes was identified as the issue in Bane Noggin Hill and impact type in Acurry is unknown.

- *Unknown anthropogenic*
  The significant pressures impacting five waterbodies (Blackwater (Longwood)_010, Blackwater (Longwood)_020, Blackwater (Longwood)_040), Blackwater (Kells)_070 & Boyne_150), Trim groundwater body, Boyne Estuary Plume Zone coastal waterbody and Bane Noggin Hill lake waterbody are unknown.

Figure 15 - Figure 19 illustrates the locations of waterbodies for the five most common pressures in order of prevalence (agriculture, hydromorphology, domestic waste water, peat & urban waste water) within the catchment in Cycle 3.

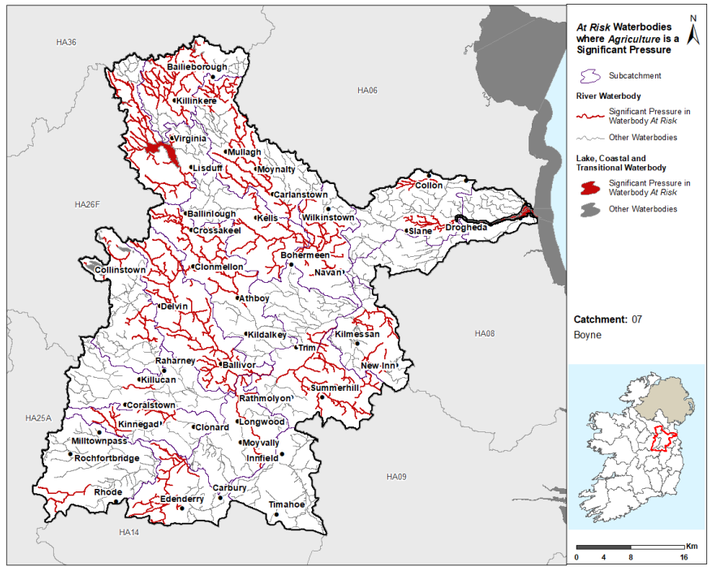


Figure 15: Locations of Waterbodies where Agriculture is a Significant Pressure

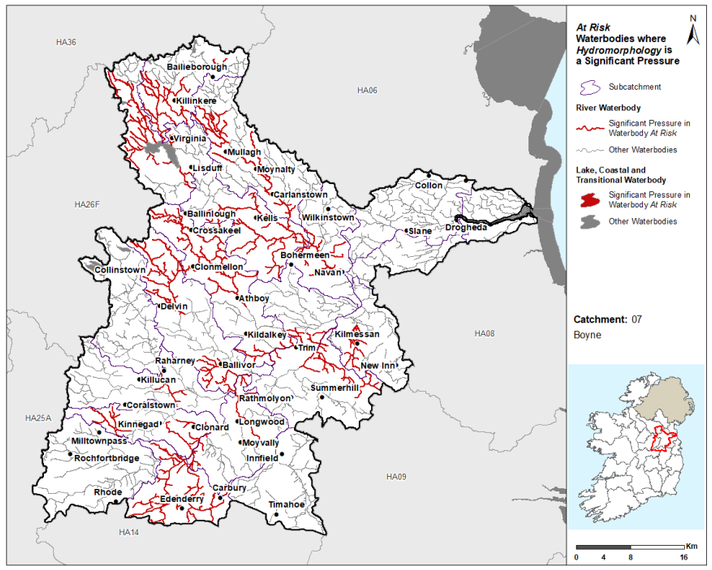


Figure 16: Locations of Waterbodies where Hydromorphology is a Significant Pressure

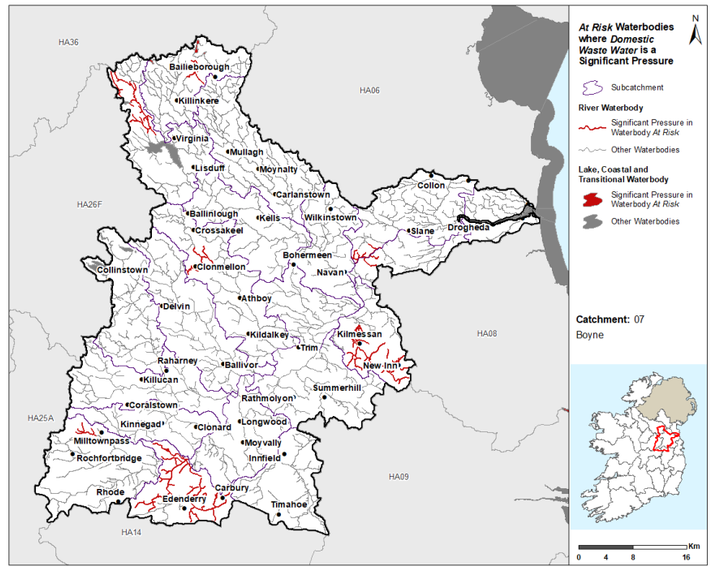


Figure 17: Locations of Waterbodies where Domestic Waste Water is a Significant Pressure

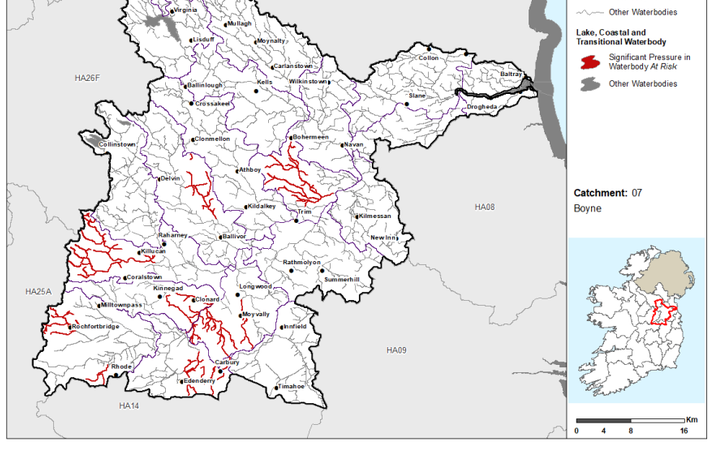


Figure 18: Locations of Waterbodies where Peat is a Significant Pressure

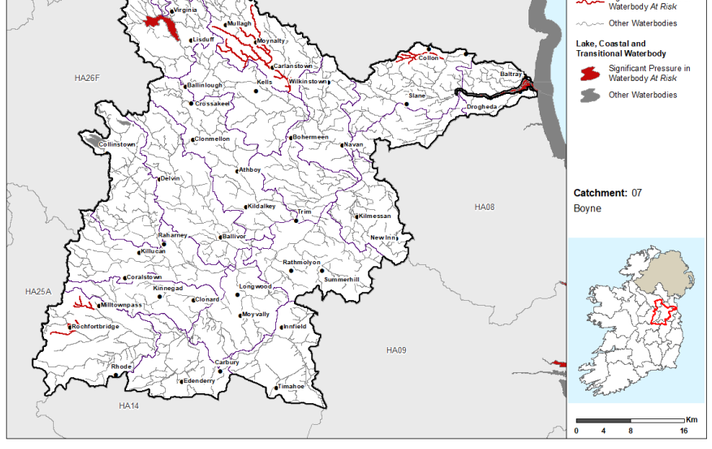
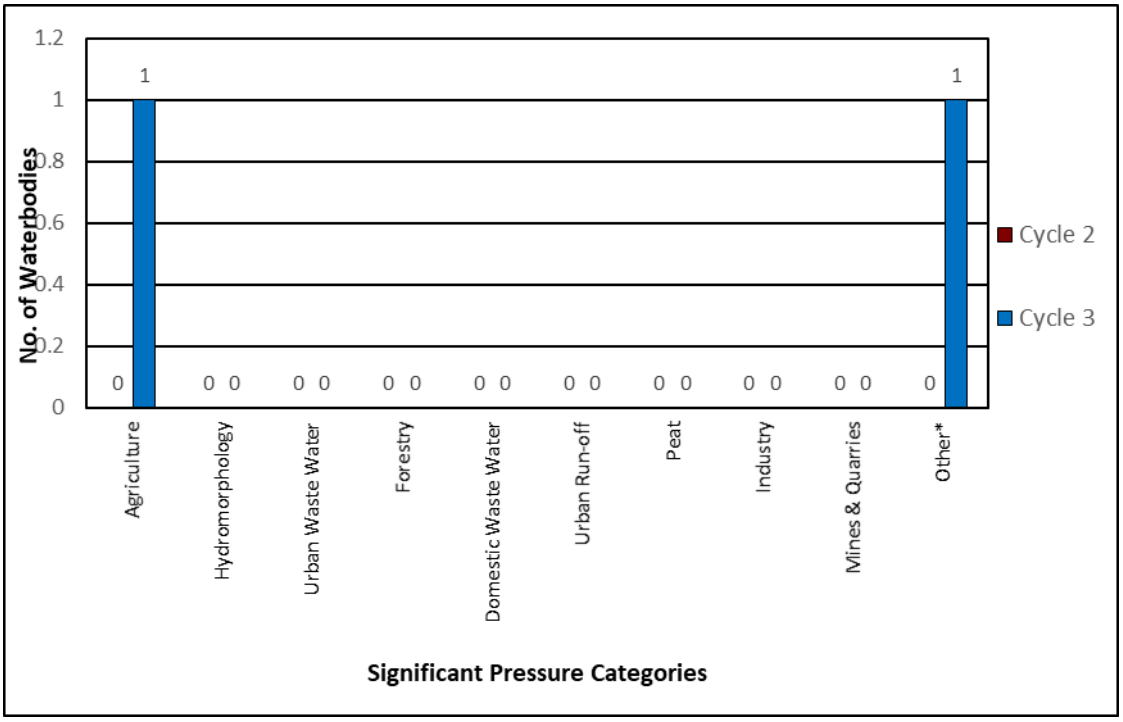


Figure 19: Locations of Waterbodies where Urban Waste Water is a Significant Pressure

5.2 High Status Objective Waterbodies

- Agriculture is also the significant pressure in one (Chapel Lake Stream_010) of the two High Status Objective waterbodies currently *At Risk*. Bane Noggin Hill lake waterbody is impacted by an abstraction (water supply) pressure as well as an unknown pressure type which both fall under the other category in Figure 20.



*Other – abstractions, aquaculture, atmospheric, anthropogenic pressures, historically polluted sites, waste, water treatment and invasive species have all been grouped into the "Other" pressure category for the purpose of this report

Figure 20: Significant Pressure in *At Risk* High Status Objective Waterbodies

6 Source Load Apportionment Modelling (SLAM)

- The EPA has developed Source Load Apportionment Models (SLAM) for both P and N which estimate the proportion of the phosphorus and nitrogen inputs, respectively, to waters in each catchment that comes from each sector as illustrated in Figure 21.

- The main data inputs for the model for agriculture are the 2018 land parcel (LPIS) and animal (AIMs) data from the Department of Agriculture Food and the Marine. The Urban Waste Water (UWW) data comes from Irish Water's discharge monitoring data. The model also calculates the inputs from a range of other sectors, including for example, forestry, septic tanks, peat, urban runoff and atmospheric deposition.

- In the catchment pasture and arable land is responsible for 76% and 16% of the nitrogen load respectively while land in pasture, discharges from urban waste water and diffuse urban sources contribute 40%, 23% and 10% of the phosphorus loadings for the catchment respectively (Figure 17).

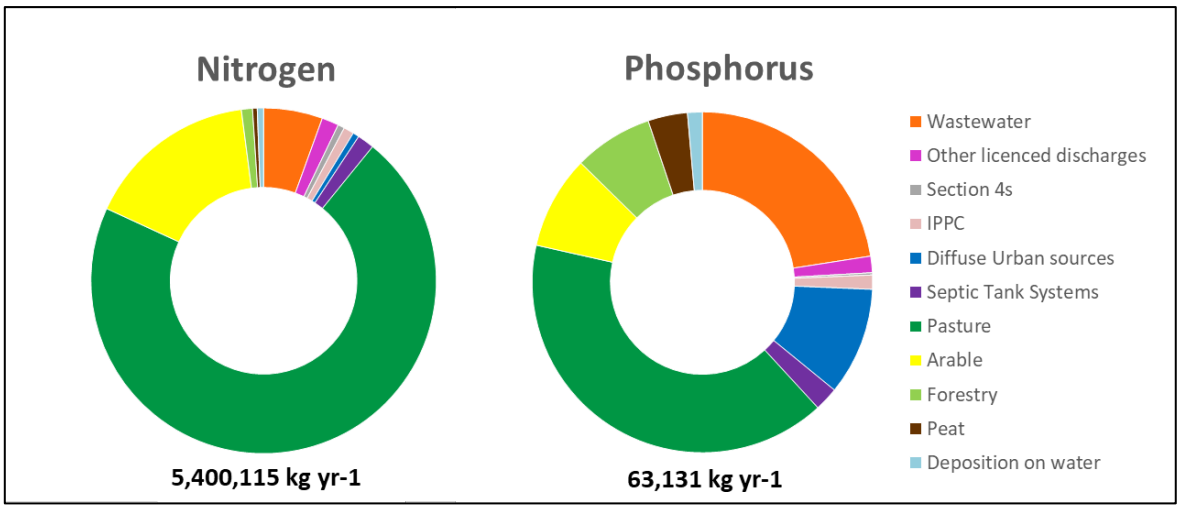


Figure 21: Estimated Proportions of N & P from Each Sector in the Boyne Catchment

7 Load Reduction Assessment

7.1 Nitrogen Load Reduction

- An assessment was undertaken to determine if nitrogen reductions in rivers, streams and lakes are required for Transitional and Coastal (TRACs) waterbodies to achieve their WFD environmental objective. The outcome of the assessment indicated that 10 of the 46 catchments require N reductions in our inland waters to restore some TRAC waterbodies. The assessment report can be found at https://www.catchments.ie/assessment-of-the-catchments-that-need-reductions-in-nitrogen-concentrations-to-achieve-water-quality-objectives.

- The N reduction required in the Boyne Catchment is considered to be high and ranges from 500-2000 t N/yr.

- Source load apportionment modelling indicates that the main sources of N in the catchment are 72% pasture, 16% arable, 6% Urban waste water and 6% from miscellaneous sources.

7.2 Phosphorus / Sediment Load Reduction

- Further modelling work is required to determine if and what P load reductions are required.

Figure 22 highlights areas where agricultural measures for nitrogen, sediment and phosphorus should be targeted. Waterbodies with orange fill are areas where nitrogen measures should be targeted, waterbodies with blue fill are areas where sediment or phosphorus should be targeted and waterbodies with orange and blue hatching highlight areas where multiple measures (phosphorus /sediment and nitrogen) are required. Pollution Impact Potential mapping for both phosphorus and nitrogen in the catchment are provided in Appendix 2.

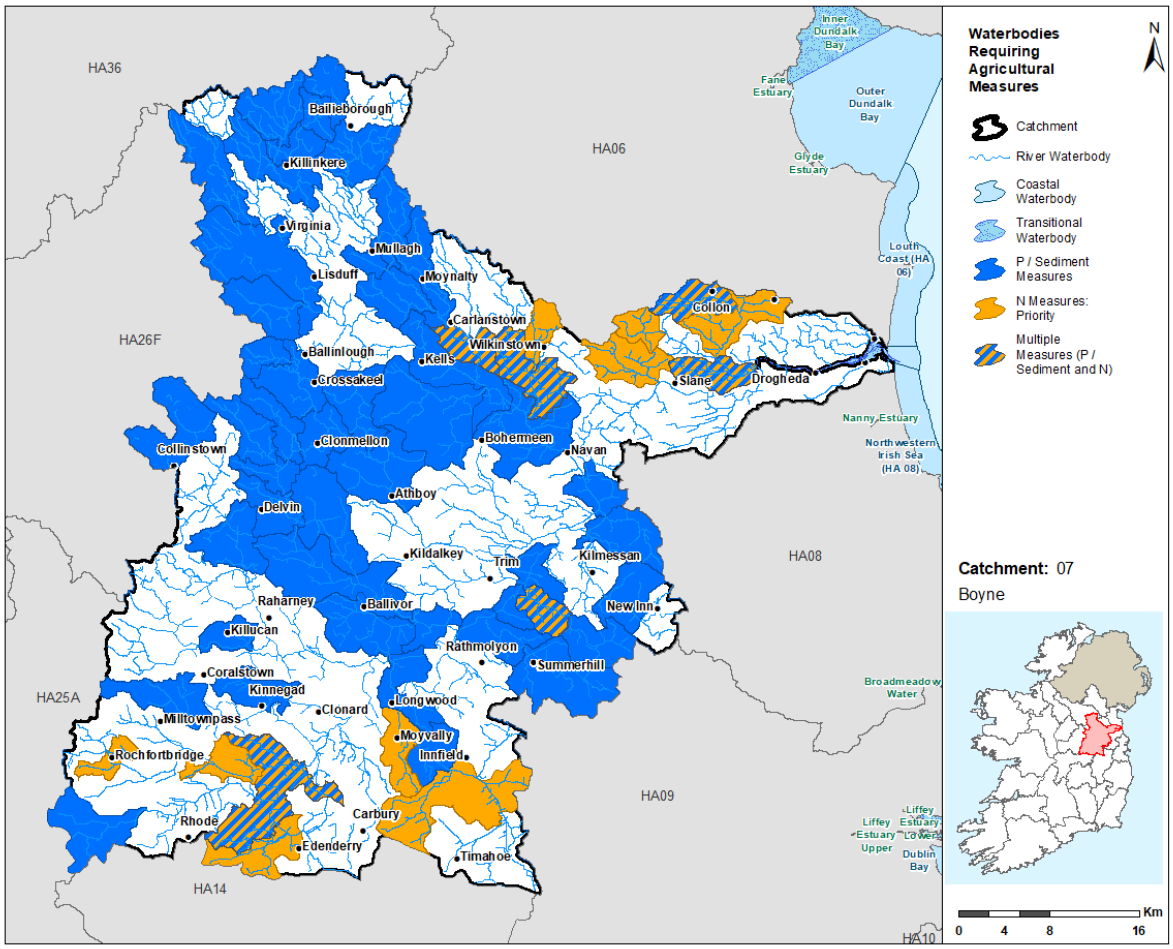


Figure 22: Waterbodies where Agricultural Measures should be Targeted

8 2nd Cycle Areas for Action

8.1 Area for Action Overview

- There were six Areas for Action, comprising of 23 waterbodies, selected for further characterisation and action in the catchment for the 2nd Cycle River Basin Management Plan. The Areas for Action in the catchment are listed in Table 6 and shown in Figure 23. LAWPRO, in conjunction with local authorities and stakeholders from the Midlands and Eastern Regional Operational Committee, have been working in these areas since 2018.

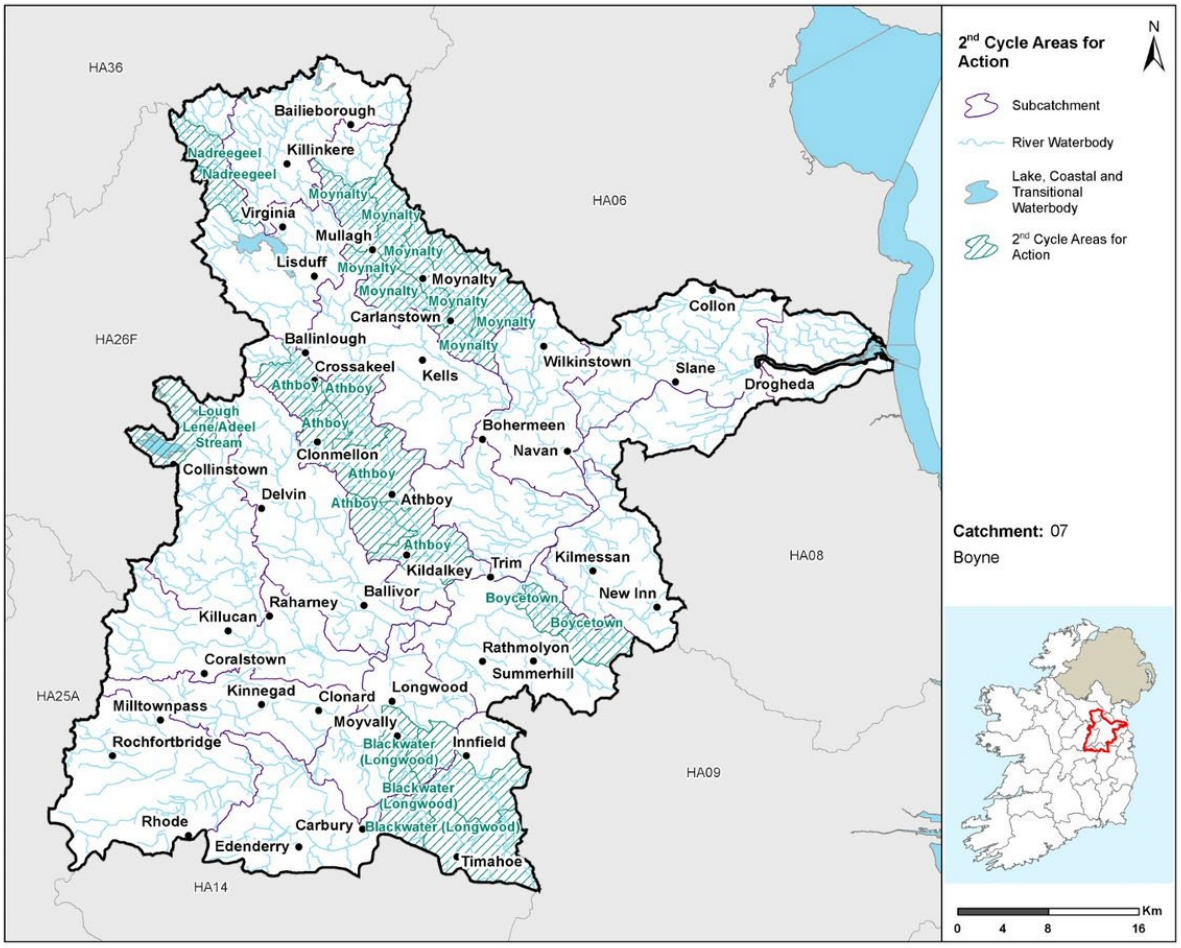


Figure 23: 2nd Cycle Areas for Action Locations

Table 6: 2nd Cycle Areas for Action

2nd Cycle Area for Action	Number of Waterbodies	Sub-catchment	Local Authority	Reason for Selection
Moynalty	8	07_14	Meath	• Salmonid river. • Potential for 'quick wins'. • Possible high nitrate areas which would help with TraC water nitrate reduction requirement. • Four deteriorated water bodies.
Lough Lene	1	07_7	Westmeath	• Headwaters to Lough Lene which has heritage values and is a popular designated bathing location. • Deteriorated waterbody. • Lough Lene failed to meet protected area objective for drinking water.
Boycetown	2	07_20	Meath	• Build on work completed by Meath County Council – stream walks completed on the lower portion: ~80 cattle access points were identified. • Two deteriorated water bodies.
Athboy	6	07_13	Meath	• Headwater tributaries to the Boyne main channel. • Long term challenge - five of the six water bodies are *At Risk*. • Building on work completed by Meath County

2nd Cycle Area for Action	Number of Waterbodies	Sub-catchment	Local Authority	Reason for Selection
				Council to reduce nutrient concentrations in the river waterbody. • One deteriorated water body.
Nadreegeel	2	07_10	Cavan	• Cavan/Monaghan lakes scenario project. • Headwaters to Nadreegeel Lough. • Potential 'quick win'. • Building on existing work completed by Cavan Co Co. • Will provide insight into question regarding river monitoring stations downstream of failing lakes. • A group water scheme here abstracts immediately upstream. • Public water abstraction. • One deteriorated waterbody.
BLACKWATER (LONGWOOD)	4	07_16 07_6	Kildare Meath	• Building on work completed by Kildare County Council. • Opportunity to address spikes in ammonia from peat. • Headwaters of Blackwater (Longwood). • Opportunity to work with Bord naMona (BnM) and Office of Public Works (OPW).

8.2 Status Change in 2nd Cycle Areas for Action

- For Cycle 3, of the 23 waterbodies in the 2nd Cycle Areas for Action, there are 11 waterbodies at Moderate Status, eight waterbodies at Poor Status and four waterbodies where status has not been assigned.

- There is an overall improvement in the status of one of the 2nd cycle Areas for Action waterbodies across the catchment.[6]

- Of the 19 waterbodies within the 2nd Cycle Areas for Action which had status assigned, 10 experienced no change in status between Cycle 2 and Cycle 3, five waterbodies (Boycetown_020, Lough Lene-Adeel Stream_010, Moynalty_050, Moynalty_060 & Nadreegeal) experienced an improvement and four river waterbodies (Athboy_040, Moynalty_020, Mullagh Lough Stream_010 & Nadreegeel Lough Stream_020) was subject to deterioration in status (Figure 24). The waterbody improvements were across Boycetown, Lough Lene/ Adeel Stream, Moynalty and Nadreegal Areas for Action. The waterbody which experienced decline were in Athboy, Moynalty and Nadreegal Areas for Action.

[6] Status class change cannot be calculated for waterbodies where status has not been assigned in either Cycle 2 or 3 and therefore these waterbodies are not represented in Figure 18. Percentage displayed in the chart below are in relation to the total number of waterbodies with status assigned in both cycles, as opposed to total number of all waterbodies.

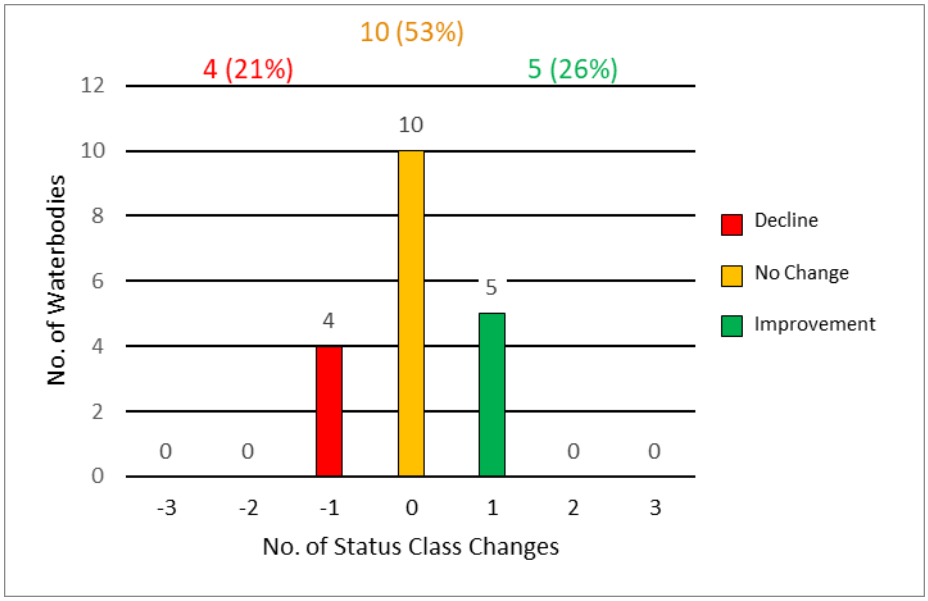


Figure 24: 2nd Cycle Area for Action Waterbody Status Class Changes between Cycle 2 and Cycle 3

8.3 Waterbody Risk in 2nd Cycle Areas for Action

- For the 23 waterbodies in the 2nd Cycle Areas for Action, 19 (83%) of these are currently *At Risk* and four (17%) in *Review*.
- For the 22 river waterbodies, 18 (82%) are *At Risk* and four (18%) are in *Review.*
- The only lake waterbody (Nadreegal) in a 2nd Cycle Area for Action is *At Risk*.
- The largest proportion of *At Risk* waterbodies are found in river waterbodies, accounting for 18 (95%) of 19 *At Risk* waterbodies. Figure 25 gives an overview of the breakdown of risk across waterbody types for both Cycle 2 and Cycle 3 in 2nd Cycle Areas for Action.
- Overall there is a decrease from 20 to 19 *At Risk* waterbodies in 2nd Cycle Areas for Action between Cycle 2 and Cycle 3. Athboy_060 river waterbody was previously *At Risk* but is now in *Review.*

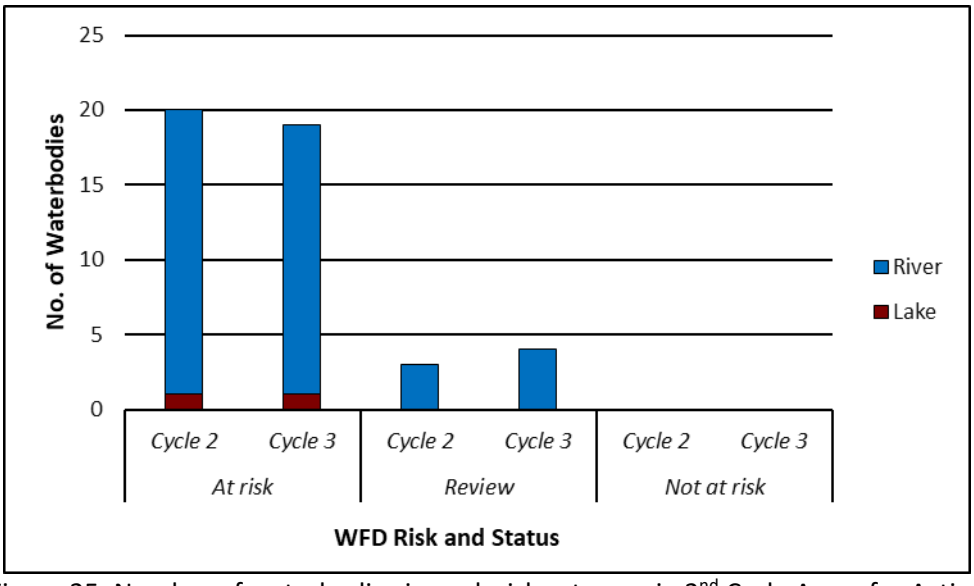
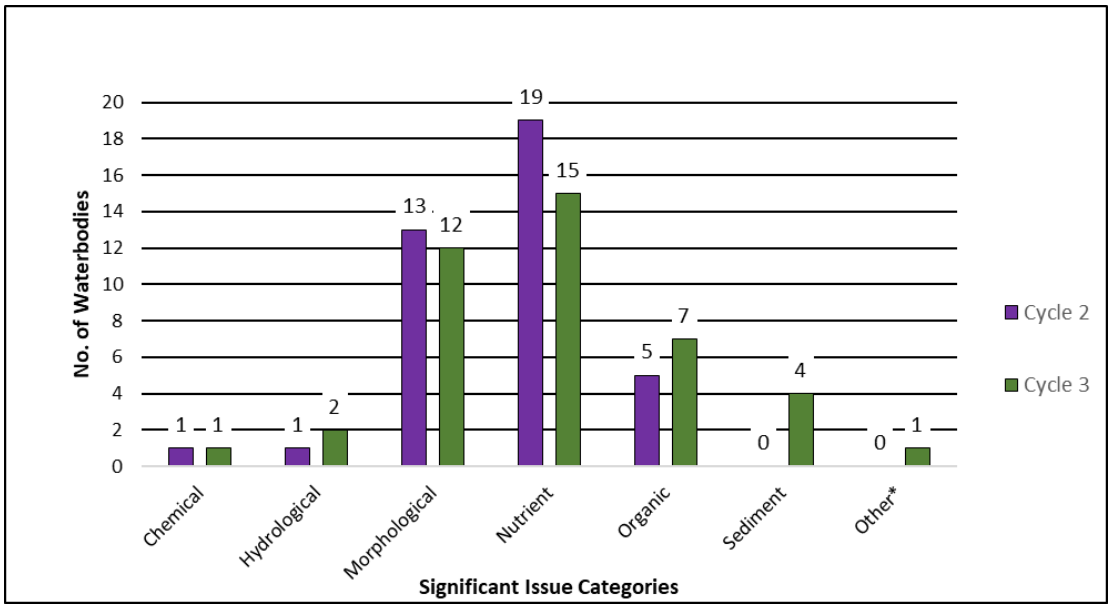


Figure 25: Number of waterbodies in each risk category in 2nd Cycle Areas for Action

8.4 Significant Issues in 2nd Cycle Areas for Action

- Based on the EPA assessment for Cycle 3, the significant issue in the 2nd Cycle Areas for Action is nutrient pollution impacting 15 waterbodies (Figure 26). This is followed by morphological issues which are impacting 12 waterbodies, organic pollution impacting seven waterbodies and sediment impacting four waterbodies.
- The number of 2nd Cycle Areas for Action waterbodies associated with nutrient and morphological significant issues have reduced from 19 to 15 and 13 to 12, respectively, between Cycle 2 and Cycle 3. Sediment is now deemed to be impacting four waterbodies where it was not deemed an issue in any waterbodies in Cycle 2.



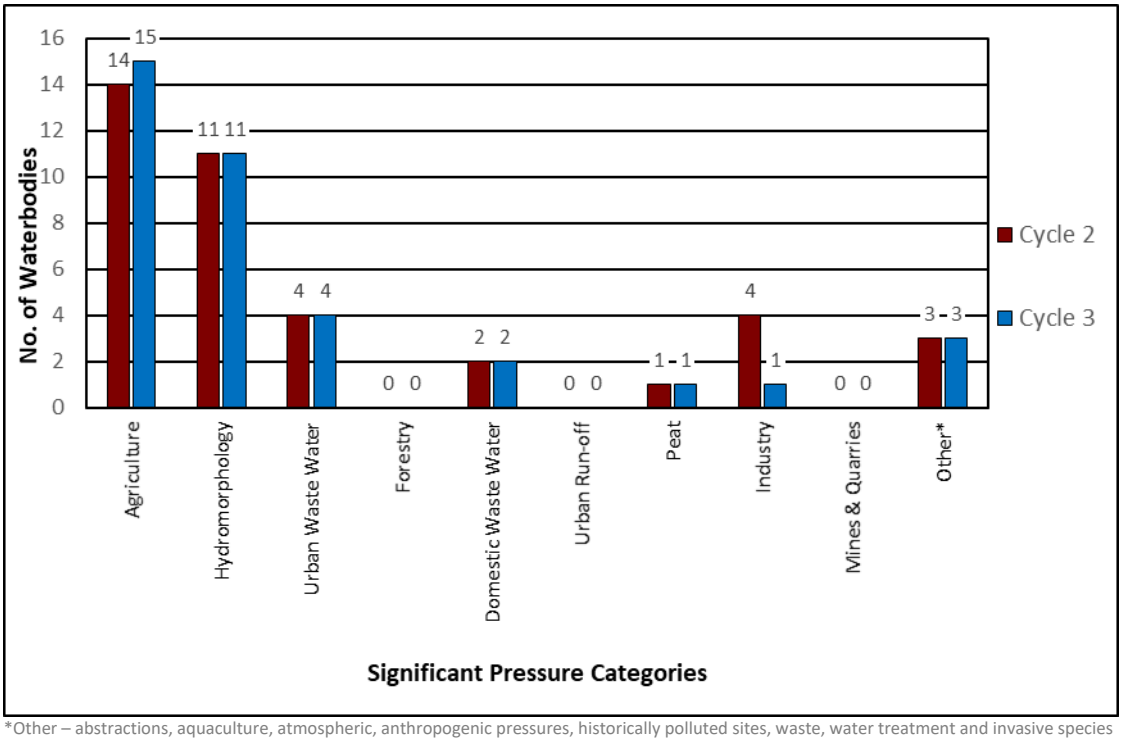
*Other - Acidification, saline intrusion, elevated temperature, litter, microbiological pollution and unknown impacts have all been grouped into the "Other" issues category for the purpose of this report

Figure 26: Significant Issues across all 2nd Cycle Areas for Action Waterbodies

8.5 Significant Pressure in 2nd Cycle Areas for Action

- For Cycle 3, in 2nd Cycle Areas for Action waterbodies, the dominant significant pressures are:
  - Agriculture - 15 waterbodies impacted in Cycle 3, compared to 14 in Cycle 2.
  - Hydromorphology – 11 waterbodies remain impacted in Cycle 3.
  - Urban Waste Water – four waterbodies remain impacted in Cycle 3.
  - Domestic Waste Water - two waterbodies (Athboy_030 & Nadreegeel Lough Stream_020) remain impacted in Cycle 3.
  - Industry - one waterbody (Moynalty_030) is impacted in Cycle 3 compared to four waterbodies impacted in Cycle 2.
  - Peat – one waterbody (Blackwater (Longwood)_040) remains impacted in Cycle 3.
  - Other - In three waterbodies, Blackwater (Longwood)_010, Blackwater (Longwood)_020 & Blackwater (Longwood)_040) the significant pressure type is unknown, as was the case in Cycle 2.

- When comparing the significant pressures in the 2nd Cycle Areas for Action between Cycle 2 and 3 there has been there has been no change in the number of waterbodies affected by each significant pressure category in the catchment with the exception of agriculture and industry pressures which increased by one and decreased by three respectively.



*Other – abstractions, aquaculture, atmospheric, anthropogenic pressures, historically polluted sites, waste, water treatment and invasive species have all been grouped into the "Other" pressure category for the purpose of this report

Figure 27: Significant Pressures in 2nd Cycle Area for Action Waterbodies

9 3rd Cycle Recommended Areas for Action

9.1 Recommended Areas for Action Overview

- For the 3rd Cycle Draft River Basin Management Plan Areas for Action have been extended out to not only include Prioritised Areas for Action undertaken by LAWPRO which focussed on restoring waterbodies, but to also include restoration work undertaken by all agencies under Areas for Restoration. In addition, protection work is included under Areas for Protection and research, pilot schemes and community initiatives are included under Catchment Projects. The aim of the 3rd Cycle Plan is to capture all activity that is working to restore, improve and/or protect waterbodies.

- The Recommended 3rd Cycle Areas for Action list will be included in the Draft River Basin Management Plan and will be finalised after the consultation period.

- There are 23 Areas for Action, comprising of 108 waterbodies, recommended for further characterisation and action in the catchment for the 3rd Cycle River Basin Management Plan. 75 of the 108 waterbodies in the 3rd Cycle Areas for Action are *At Risk*, 20 are in *Review* and 13 are *Not At Risk.* The 23 Areas for Action consist of one Area for Protection, 20 Areas for Restoration and two Areas for Catchment Projects. LAWPRO are the proposed lead organisation in 13 Areas for Action, Meath County Council are the proposed lead in six Recommended Areas for Action. NFGWS, IFI and Offaly County Council have each been proposed to lead one Recommended Areas for Action. GSI, EPA and Irish Water are the proposed joint leads in the Bettystown Catchment Research Project. The Recommended Areas for Action in the catchment are listed in Table 7 and shown in Figure 28. The reason for selecting each waterbody in a Recommended Area for Action is provided in Appendix 3.

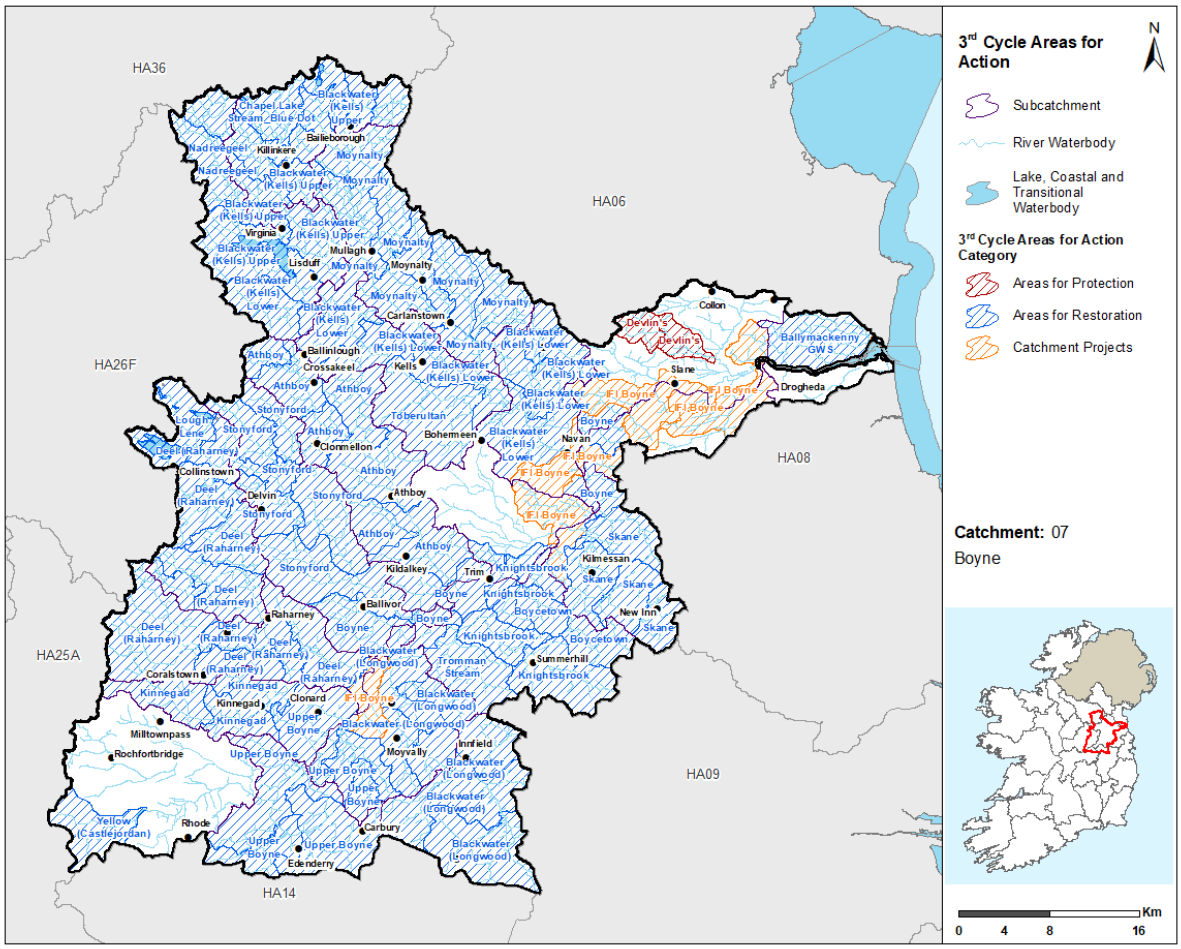


Figure 28: 3rd Cycle Recommended Areas for Action Locations

Table 7: 3rd Cycle Recommended Areas for Action Breakdown

3rd Cycle Recommended Areas for Action	Number of Waterbodies	Recommended Areas for Action Category	Recommended Areas for Action Sub-category	Lead Organisation
Athboy	7	Restoration	Prioritised Areas for Action LAWPRO	LAWPRO
Moynalty	9	Restoration	Prioritised Areas for Action LAWPRO	LAWPRO
Blackwater (Kells) Upper	13	Restoration	Prioritised Areas for Action LAWPRO	LAWPRO
Blackwater (Kells) Lower	8	Restoration	Prioritised Areas for Action LAWPRO	LAWPRO
Blackwater (Longwood)	7	Restoration	Prioritised Areas for Action LAWPRO	LAWPRO
Boycetown	2	Restoration	Prioritised Areas for Action LAWPRO	LAWPRO
Upper Boyne	6	Restoration	Prioritised Areas for Action LAWPRO	LAWPRO
IFI Boyne	7	Catchment Projects	Public Body Research	IFI
Boyne	5	Restoration	LA Areas for Restoration Local Authorities	Meath County Council
Knightsbrook	5	Restoration	Prioritised Areas for Action LAWPRO	LAWPRO

3rd Cycle Recommended Areas for Action	Number of Waterbodies	Recommended Areas for Action Category	Recommended Areas for Action Sub-category	Lead Organisation
Deel (Raharney)	10	Restoration	Prioritised Areas for Action LAWPRO	LAWPRO
Chapel Lake Stream_Blue Dot	1	Restoration	Blue Dot Areas for Action LAWPRO and Others	LAWPRO
Stonyford	6	Restoration	LA Areas for Restoration Local Authorities	Meath County Council
Devlin's	2	Protection	LA Areas for Protection Local Authorities	Meath County Council
Kinnegad	3	Restoration	Prioritised Areas for Action LAWPRO	LAWPRO
Lough Lene	5	Restoration	Prioritised Areas for Action LAWPRO	LAWPRO
Nadreegeel	3	Restoration	Prioritised Areas for Action LAWPRO	LAWPRO
Skane	4	Restoration	LA Areas for Restoration Local Authorities	Meath County Council
Tromman Stream	1	Restoration	LA Areas for Restoration Local Authorities	Meath County Council
Toberultan	1	Restoration	LA Areas for Restoration Local Authorities	Meath County Council
Ballymackenny GWS	1	Restoration	Public Health Areas for Restoration NFGWS, IW, HSE, LAs, SFPA	NFGWS
Yellow (Castlejordan)	1	Restoration	LA Areas for Restoration Local Authorities	Offaly County Council
Bettystown GW	1	Catchment Projects	Public Body Research	GSI and EPA and IW

10 Catchment Summary

- Of the 116 river waterbodies, 75 are *At Risk* of not meeting their WFD objectives.
- Seven out of 11 lake waterbodies are *At Risk* of not meeting their WFD objectives.
- Boyne Estuary transitional waterbody is *At Risk* and impacted by eutrophication. Agriculture and the Drogheda WWTP are the significant pressures.
- One coastal waterbody (Boyne Estuary Plume Zone) out of the three in the catchment are *At Risk*.
- There are nine *At Risk* groundwater bodies out of 41 groundwater bodies.
- There has been an overall deterioration across the catchment with 93 waterbodies *At Risk* in Cycle 3 compared to 81 waterbodies *At Risk* in Cycle 2.
- The main significant issues are impacts from nutrient pollution, followed by morphological impacts, organic pollution, sediment and hydrological impacts.
- The main significant pressures are agricultural pressures followed by hydromorphological pressures, domestic waste water, peat and urban waste water pressures.
- The main impacts and pressures driving the change between Cycle 2 and Cycle 3 are increases in waterbodies impacted by nutrient pollution particularly from agricultural sources. There has also been a notable increase in hydromorphological issues, however, this is likely due to an increase in awareness and an improved evidence-base around hydromorphological pressures rather than new pressures.
- There was an overall improvement in the 2nd Cycle Areas for Action since Cycle 2. 20 waterbodies were *At Risk* in Cycle 2 and 19 waterbodies are *At Risk* in Cycle 3. These

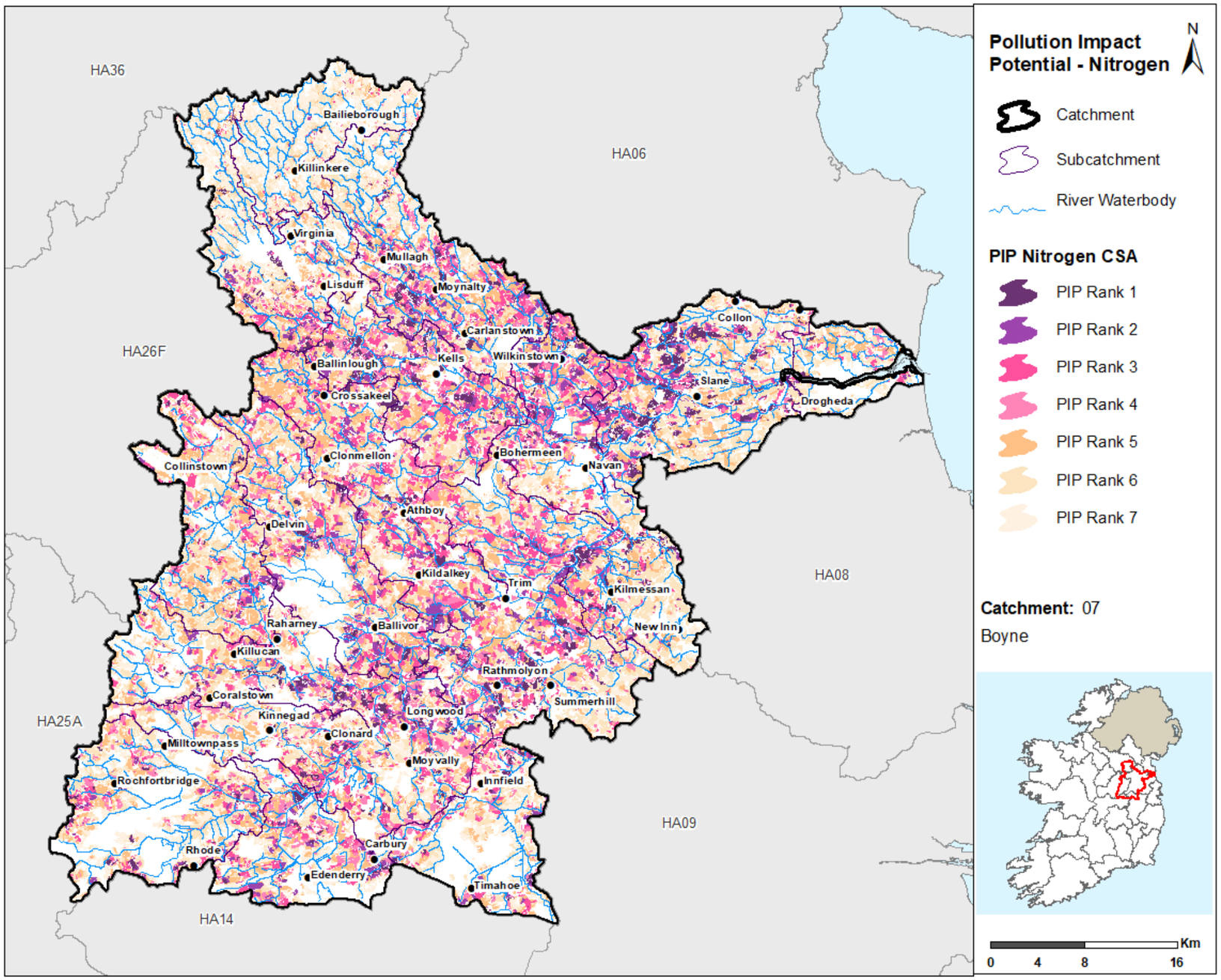
improvements have occurred in waterbodies where forestry was a significant pressure in Cycle 2 but are no longer a significant pressure in Cycle 3.

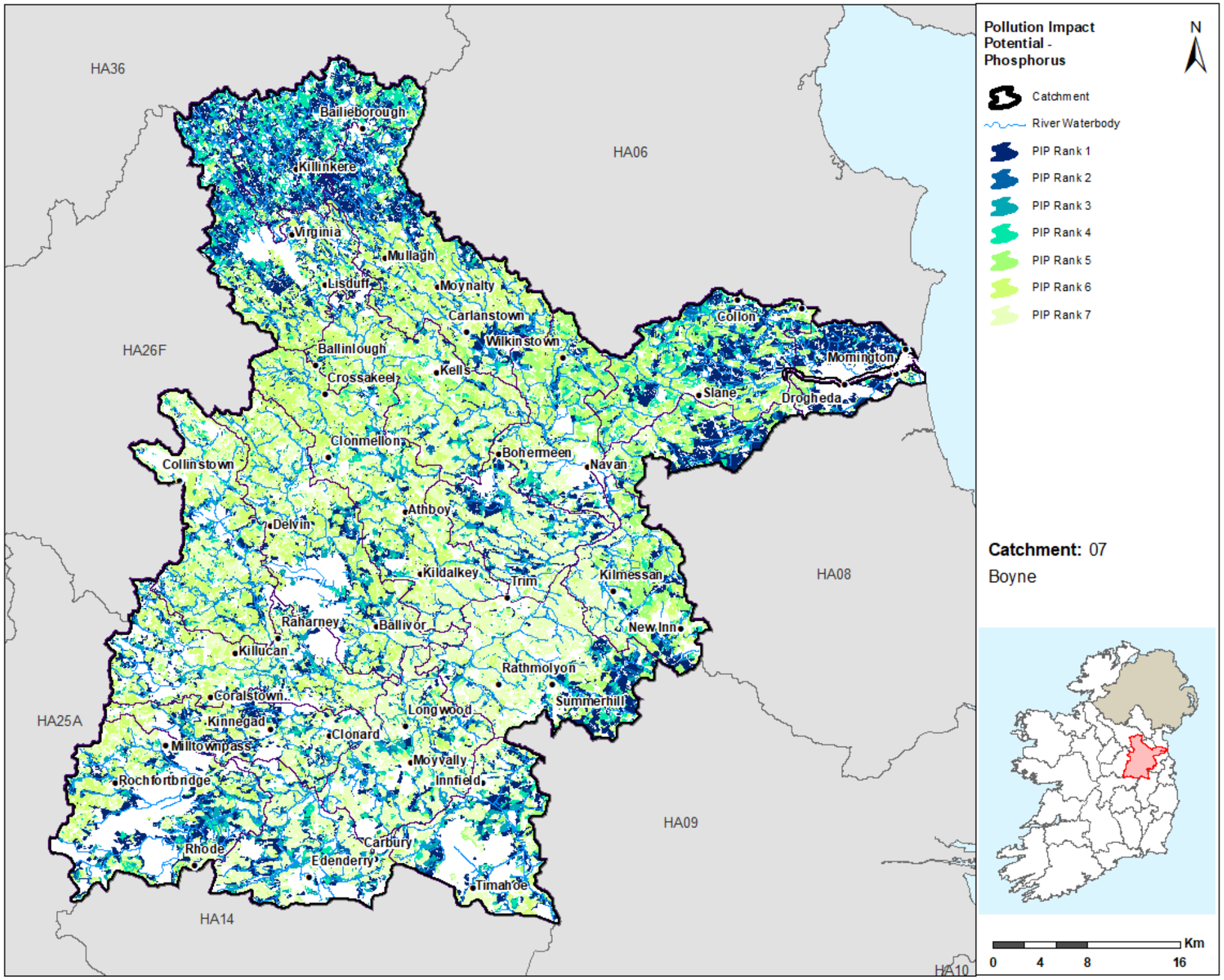
- There are 23 3rd Cycle Recommended Areas for Action for Cycle 3. They comprise of 108 waterbodies with 75 waterbodies *At Risk*, 20 in *Review* and 13 *Not At Risk*.

Appendix 1
High ecological status objective waterbodies

Waterbody Name	Waterbody Type	Waterbody Code	Status 2013-2018
Bane Noggin Hill	Lake	IE_EA_07_270	Good
Chapel Lake Stream_010	River	IE_EA_07C050700	Good
Northwestern Irish Sea (HA 08)	Coastal	IE_EA_020_0000	High

Appendix 2
Pollution Impact Potential Mapping




HA36
HA06
HA26F
HA08
HA25A
HA09
HA14
HA10
Ballieborough
Killinkere
Virginia
Mullagh
Lisduff
Moynalty
Carlanstown
Wilkinstown
Ballinlough
Kells
Crossakeel
Collon
Mornington
Slane
Drogheda
Clonmellon
Bohermeen
Navan
Collinstown
Athboy
Delvin
Kildalkey
Trim
Kilmessan
Raharney
Ballivor
New Inn
Killucan
Rathmolyon
Summerhill
Coralstown
Kinnegad
Longwood
Clonard
Multyfarnham
Moyvally
Rochfortbridge
Innfield
Carbury
Rhode
Edenderry
Timahoe
Pollution Impact Potential - Phosphorus
N
Catchment
River Waterbody
PIP Rank 1
PIP Rank 2
PIP Rank 3
PIP Rank 4
PIP Rank 5
PIP Rank 6
PIP Rank 7
Catchment: 07
Boyne
Km
0
4
8
16

Appendix 3
Summary information on all waterbodies in the Boyne Catchment

Subcatchment Code	Waterbody Code	Waterbody Name	Waterbody Type	Risk 10-15	Risk 13-18	Status 10-15	Status 13-18	High Ecological Status Objective Waterbody	Significant Pressures	Recommended Area for Action Name	Recommended Areas for Action (reasons for selection)
	IE_07_AWB_GCMLW	Grand Canal Main Line (Boyne)	River		Not at risk	Good	Good	No			
	IE_07_AWB_RCMLE	Royal Canal Main Line (Boyne)	River		Not at risk	Good	Good	No			
07_13	IE_EA_07A010020	ATHBOY_010	River	Not at risk	At risk	Good	Moderate	No	Ag, Hymo	Athboy	deteriorated WB, headwaters of existing PAA - expand PAA to include. 2027 EO Ag; hymo significant pressures
07_13	IE_EA_07A010050	ATHBOY_020	River	At risk	At risk	Moderate	Moderate	No	Ag, Hymo	Athboy	existing PAA - Further characterisation yet to commence. Not meeting protected area objective. Ag and hymo significant pressures. 2027 EO
07_13	IE_EA_07A010070	ATHBOY_030	River	At risk	At risk	Moderate	Moderate	No	Ag, DWW, Hymo	Athboy	existing PAA - Further characterisation yet to commence Not meeting protected area objective. Ag, DWWTS and hymo significant pressures. 2027 EO
07_13	IE_EA_07A010100	ATHBOY_040	River	At risk	At risk	Moderate	Poor	No	Ag, Hymo	Athboy	existing PAA - Further characterisation yet to commence. Not meeting protected area objective. Ag and hymo significant pressures. 2027 EO
07_13	IE_EA_07A010300	ATHBOY_050	River	At risk	At risk	Moderate	Moderate	No	Ag, Hymo	Athboy	existing PAA - Further characterisation yet to commence. Not meeting protected area objective. Ag and hymo significant pressures. 2027 EO
07_13	IE_EA_07A010500	ATHBOY_060	River	At risk	Review	Moderate	Moderate	No		Athboy	existing PAA - Further characterisation yet to commence. Not meeting protected area objective. UWW and hymo significant pressures. 2027 EO
07_14	IE_EA_07A200940	AGHNANEANE_or_HERMITAGE_010	River	Review	Review	Unassigned	Unassigned	No		Moynalty	Existing PAA - unassigned WB to undertake further characterisation in 3rd cycle

07_5	IE_EA_07B010100	BLACKWATER (KELLS)_010	River	Not at risk	Not at risk	Good	Good	No		Blackwater (Kells) Upper	Included under SC approach alongside M&E suggestions
07_5	IE_EA_07B010170	BLACKWATER (KELLS)_020	River	At risk	At risk	Moderate	Poor	No	Hymo, UR, UWW	Blackwater (Kells) Upper	Included under SC approach alongside M&E suggestions
07_5	IE_EA_07B010280	BLACKWATER (KELLS)_030	River	At risk	At risk	Poor	Poor	No	Ag	Blackwater (Kells) Upper	Included under SC approach alongside M&E suggestions
07_5	IE_EA_07B010420	BLACKWATER (KELLS)_040	River	At risk	At risk	Moderate	Moderate	No	Ag, DWW	Blackwater (Kells) Upper	Included under SC approach alongside M&E suggestions
07_5	IE_EA_07B010500	BLACKWATER (KELLS)_050	River	Not at risk	At risk	Good	Poor	No	Ag, Hymo	Blackwater (Kells) Upper	Included under SC approach alongside M&E suggestions
07_5	IE_EA_07B010600	BLACKWATER (KELLS)_060	River	Not at risk	At risk	Good	Moderate	No	Ag, Hymo	Blackwater (Kells) Upper	Included under SC approach alongside M&E suggestions
07_5	IE_EA_07B010800	BLACKWATER (KELLS)_070	River	Review	At risk	Moderate	Moderate	No	Hymo, Other	Blackwater (Kells) Upper	Included under SC approach alongside M&E suggestions
07_10	IE_EA_07B011000	BLACKWATER (KELLS)_080	River	At risk	At risk	Poor	Moderate	No	Ag, Hymo	Blackwater (Kells) Upper	At Risk River Blackwater Moderate Status
07_8	IE_EA_07B011100	BLACKWATER (KELLS)_090	River	At risk	Not at risk	Moderate	Good	No		Blackwater (Kells) Lower	To complete sub catchment
07_8	IE_EA_07B011200	BLACKWATER (KELLS)_100	River	At risk	At risk	Moderate	Moderate	No	Hymo	Blackwater (Kells) Lower	At Risk to complete sub catchment 2027 EO hymo significant pressure
07_8	IE_EA_07B011500	BLACKWATER (KELLS)_110	River	At risk	At risk	Poor	Moderate	No	Ag, Hymo	Blackwater (Kells) Lower	At Risk to complete sub catchment 2027 EO UWWT, hymo significant pressures
07_18	IE_EA_07B011800	BLACKWATER (KELLS)_120	River	At risk	At risk	Moderate	Poor	No	Ag, Hymo, UR	Blackwater (Kells) Lower	IW Treatment & Management: Turbidity & nutrients. EPA Pesticide Act and Watch list - Watch. Pesticide issue but also nutrient/ sediment; treatment and management issues with this. 2027 EO Ag significant pressure
07_6	IE_EA_07B020060	BLACKWATER (LONGWOOD)_010	River	At risk	At risk	Poor	Poor	No	Other	Blackwater (Longwood)	existing PAA - Further characterisation to commence Anthropogenic Pressures 2027 EO
07_6	IE_EA_07B020100	BLACKWATER (LONGWOOD)_020	River	At risk	At risk	Moderate	Moderate	No	Other	Blackwater (Longwood)	existing PAA - Further characterisation to commence Anthropogenic Pressures 2027 EO
07_16	IE_EA_07B020200	BLACKWATER (LONGWOOD)_030	River	At risk	At risk	Unassigned	Unassigned	No	Ag	Blackwater (Longwood)	Existing PAA - unassigned WB. Further characteisiation to commence. Ag and UWW Significant pressures Poor drainage - beyond 2027 EO
07_16	IE_EA_07B020300	BLACKWATER (LONGWOOD)_040	River	At risk	At risk	Moderate	Moderate	No	Other, Peat	Blackwater (Longwood)	Existing PAA - Further characterisation to commence Anthropogenic and Peat Pressures 2027 EO

07_16	IE_EA_07B020600	BLACKWATER (LONGWOOD)_050	River	At risk	At risk	Moderate	Moderate	No	Ag, Hymo	Blackwater (Longwood)	Expand PAA to include - same trib. Multi-pressures: agriculture, hydromorphology and UWWT. 2027 EO
07_20	IE_EA_07B030200	BOYCETOWN_010	River	At risk	At risk	Poor	Poor	No	Ag, Hymo	Boycetown	Existing PAA. Transition strategy to be developed.
07_20	IE_EA_07B030300	BOYCETOWN_020	River	At risk	At risk	Poor	Moderate	No	Ag, Hymo	Boycetown	Existing PAA. Transition strategy to be developed.
07_4	IE_EA_07B040200	BOYNE_010	River	At risk	At risk	Moderate	Moderate	No	DWW, Hymo, Peat	Upper Boyne	DWW, hymo, peat signficant pressures Fish ONM 2027 EO Was not inlcuded in 2nd cycle Proposed by KE Biological rating Q4 last achieved in 2009. Has remained at Q3-4 for each subsequent assesment. Likely to be a more difficult waterbody to make progress in as water quality is influenced by peat. IFI Research
07_4	IE_EA_07B040300	BOYNE_020	River	At risk	At risk	Moderate	Moderate	No	Ag, Hymo, UR	Upper Boyne	DWW, hymo,URO, UWW signficant pressures Fish ONM 2027 EO Was not inlcuded in 2nd cycle Proposed by OY 1. Human Health (PWS at Trim) 2. Salmonid River 3.Headwaters, 4. Building on improvements IFI Research
07_4	IE_EA_07B040400	BOYNE_030	River	Not at risk	At risk	Good	Moderate	No	Ag, DWW, Hymo	Upper Boyne	IFI research Ag, DWW, hymo signficant pressures Fish ONM 2027 EO Added to complete subcatchment.
07_16, 07_2	IE_EA_07B040600	BOYNE_040	River	At risk	At risk	Moderate	Moderate	No	Hymo, M+Q, Peat	Upper Boyne	Add to Upper Boyne IFI research Hymo, MQ, Peat signficant pressures Fish ONM 2027 EO
07_16, 07_9	IE_EA_07B040800	BOYNE_050	River	Not at risk	Not at risk	Good	Good	No		IFI Boyne	IFI are starting a new project in the Boyne catchment in 2021, this is part of a larger national climate change mitigation project. The Boyne catchment has been selected as one of the index catchments in the project (with funding from OPW) and will be part of the

											national river water temperature monitoring network. IFI will also examine impacts of drought and other climate related issues impacting fish species in the catchment. The waterbodies have not been identified as yet where loggers and fieldwork will be placed has not been identified but research work is at the catchment rather than the sub-catchment scale, therefore multiple waterbodies were selected.
07_12, 07_16	IE_EA_07B040900	BOYNE_060	River	At risk	At risk	Moderate	Good	No	Ag, Hymo	Boyne	IFI are starting a new project in the Boyne catchment in 2021, this is part of a larger national climate change mitigation project. The Boyne catchment has been selected as one of the index catchments in the project (with funding from OPW) and will be part of the national river water temperature monitoring network. IFI will also examine impacts of drought and other climate related issues impacting fish species in the catchment. The waterbodies have not been identified as yet where loggers and fieldwork will be placed has not been identified but research work is at the catchment rather than the sub-catchment scale, therefore multiple waterbodies were selected. MH to take lead following discussions
07_12, 07_20	IE_EA_07B041000	BOYNE_070	River	Not at risk	At risk	Good	Moderate	No	Ag	Boyne	IFI are starting a new project in the Boyne catchment in 2021, this is part of a larger national climate change mitigation project. The Boyne catchment has been selected as one of the index catchments in the project (with funding from OPW) and will be part of the national river water temperature monitoring network. IFI will also examine impacts of drought and other climate related issues impacting fish species in the catchment. The waterbodies have not been identified as yet where loggers and fieldwork will be placed has not been identified but research work is at the catchment rather than the sub-catchment scale, therefore multiple waterbodies were selected. MH to take lead following discussions
07_13, 07_20	IE_EA_07B041200	BOYNE_080	River	At risk	At risk	Moderate	Moderate	No	Hymo	Boyne	IFI are starting a new project in the Boyne catchment in 2021, this is part of a larger national climate change mitigation project. The Boyne catchment has been selected as one of the index catchments in the project (with funding from OPW) and will be part of the national river water temperature monitoring network. IFI will also examine impacts of

											drought and other climate related issues impacting fish species in the catchment. The waterbodies have not been identified as yet where loggers and fieldwork will be placed has not been identified but research work is at the catchment rather than the sub-catchment scale, therefore multiple waterbodies were selected. MH to take lead following discussions
07_20, 07_3	IE_EA_07B041400	BOYNE_090	River	At risk	At risk	Moderate	Moderate	No	Hymo, UR	Knightsbrook	URO, hymo significant pressures SAC and Fish ONM IFI research To complete subcatchment
07_20, 07_3	IE_EA_07B041500	BOYNE_100	River	At risk	At risk	Moderate	Moderate	No	Ag, Hymo	Knightsbrook	Ag, hymo significant pressures SAC and Fish ONM DWPA 2027 EO IFI research To complete subcatchment
07_19, 07_3	IE_EA_07B041600	BOYNE_110	River	Review	Review	Unassigned	Unassigned	No		IFI Boyne	IFI are starting a new project in the Boyne catchment in 2021, this is part of a larger national climate change mitigation project. The Boyne catchment has been selected as one of the index catchments in the project (with funding from OPW) and will be part of the national river water temperature monitoring network. IFI will also examine impacts of drought and other climate related issues impacting fish species in the catchment. The waterbodies have not been identified as yet where loggers and fieldwork will be placed has not been identified but research work is at the catchment rather than the sub-catchment scale, therefore multiple waterbodies were selected.
07_18, 07_19	IE_EA_07B041700	BOYNE_120	River	At risk	Review	Moderate	Good	No		Boyne	Boyne Navagation/ Eel Weirs 20 Structures, Migration - Salmon/ River lamprey IFI research
07_1, 07_18	IE_EA_07B041810	BOYNE_130	River	Not at risk	Not at risk	Unassigned	Unassigned	No		IFI Boyne	IFI are starting a new project in the Boyne catchment in 2021, this is part of a larger national climate change mitigation project. The Boyne catchment has been selected as one of the index catchments in the project (with funding from OPW) and will be part of the national river water temperature monitoring network. IFI will also examine impacts of drought and other climate related issues impacting fish species in the catchment. The waterbodies have not been identified as yet where loggers and fieldwork will be placed has

											not been identified but research work is at the catchment rather than the sub-catchment scale, therefore multiple waterbodies were selected.
07_1, 07_18	IE_EA_07B041900	BOYNE_140	River	Not at risk	Review	Unassigned	Unassigned	No		IFI Boyne	IFI are starting a new project in the Boyne catchment in 2021, this is part of a larger national climate change mitigation project. The Boyne catchment has been selected as one of the index catchments in the project (with funding from OPW) and will be part of the national river water temperature monitoring network. IFI will also examine impacts of drought and other climate related issues impacting fish species in the catchment. The waterbodies have not been identified as yet where loggers and fieldwork will be placed has not been identified but research work is at the catchment rather than the sub-catchment scale, therefore multiple waterbodies were selected.
07_1, 07_15	IE_EA_07B042010	BOYNE_150	River	At risk	At risk	Moderate	Moderate	No	DWW, Other	Boyne	IFI are starting a new project in the Boyne catchment in 2021, this is part of a larger national climate change mitigation project. The Boyne catchment has been selected as one of the index catchments in the project (with funding from OPW) and will be part of the national river water temperature monitoring network. IFI will also examine impacts of drought and other climate related issues impacting fish species in the catchment. The waterbodies have not been identified as yet where loggers and fieldwork will be placed has not been identified but research work is at the catchment rather than the sub-catchment scale, therefore multiple waterbodies were selected.
07_1, 07_15	IE_EA_07B042100	BOYNE_160	River	At risk	Review	Moderate	Good	No		IFI Boyne	IFI are starting a new project in the Boyne catchment in 2021, this is part of a larger national climate change mitigation project. The Boyne catchment has been selected as one of the index catchments in the project (with funding from OPW) and will be part of the national river water temperature monitoring network. IFI will also examine impacts of drought and other climate related issues impacting fish species in the catchment. The waterbodies have not been identified as yet where loggers and fieldwork will be placed has not been identified but research work is at the catchment rather than the sub-catchment scale, therefore multiple waterbodies were selected.
07_1, 07_15	IE_EA_07B042150	BOYNE_170	River	Not at risk	Review	Good	Good	No		IFI Boyne	IFI are starting a new project in the Boyne catchment in 2021, this is part of a larger national climate change mitigation project. The

											Boyne catchment has been selected as one of the index catchments in the project (with funding from OPW) and will be part of the national river water temperature monitoring network. IFI will also examine impacts of drought and other climate related issues impacting fish species in the catchment. The waterbodies have not been identified as yet where loggers and fieldwork will be placed has not been identified but research work is at the catchment rather than the sub-catchment scale, therefore multiple waterbodies were selected.
07_1, 07_15	IE_EA_07B042200	Boyne_180	River	Not at risk	Not at risk	Good	Good	No		IFI Boyne	IFI are starting a new project in the Boyne catchment in 2021, this is part of a larger national climate change mitigation project. The Boyne catchment has been selected as one of the index catchments in the project (with funding from OPW) and will be part of the national river water temperature monitoring network. IFI will also examine impacts of drought and other climate related issues impacting fish species in the catchment. The waterbodies have not been identified as yet where loggers and fieldwork will be placed has not been identified but research work is at the catchment rather than the sub-catchment scale, therefore multiple waterbodies were selected.
07_9	IE_EA_07B340940	BALLYHAW_010	River	Review	Review	Unassigned	Unassigned	No		Deel (Raharney)	Add to complete sub catchment
07_3	IE_EA_07C010100	CLADY (MEATH)_010	River	At risk	At risk	Unassigned	Unassigned	No	Peat		
07_3	IE_EA_07C010260	CLADY (MEATH)_020	River	At risk	At risk	Poor	Poor	No	Peat		
07_10	IE_EA_07C020930	CROSS WATER_010	River	At risk	At risk	Moderate	Moderate	No	Ag	Blackwater (Kells) Lower	EPA proposed. At risk headwater.
07_15	IE_EA_07C030930	CASTLEPARKS_010	River	Review	Review	Unassigned	Unassigned	No			
07_11	IE_EA_07C040050	CASTLEJORDAN_010	River	At risk	At risk	Poor	Poor	No	Peat, UR, UWW		
07_11	IE_EA_07C040100	CASTLEJORDAN_020	River	At risk	Review	Moderate	Good	No			
07_11	IE_EA_07C040190	CASTLEJORDAN_030	River	Not at risk	Not at risk	Good	Good	No			
07_5	IE_EA_07C050700	CHAPEL LAKE STREAM_010	River	Not at risk	At risk	High	Good	Yes	Ag	Chapel Lake Stream_Blue Dot	Blue Dot headwater of Blackwater (Kells) recommended PAA
07_12	IE_EA_07C070055	CROSSKEYS STREAM_010	River	Not at risk	At risk	Good	Moderate	No	Ag, Hymo	Stonyford	At Risk WB SAC not meeting objective To complete sub-catchment MH to consider in conjunction with Stonyford WBs
07_11	IE_EA_07C080190	CASTLETOWN TARA STREAM_010	River	At risk	At risk	Unassigned	Unassigned	No	Peat		
07_6	IE_EA_07C220690	CLONCURRY_010	River	Review	Review	Unassigned	Unassigned	No		Blackwater (Longwood)	Expand PAA Unassigned WB feeding Blackwater (Longwood) _020

07_7	IE_EA_07D010070	DEEL (RAHARNEY)_010	River	Not at risk	Not at risk	Good	Good	No		Deel (Raharney)	Split sub-catchment 07_7 into Lough Lene (plus lakes) and the Adeel stream PAA and the Deel (Ratharney) PAA. Include headwaters. NPWS IE0002120 - Lough Bane and Lough Glass SAC. Austropotamobius pallipes. Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.
07_7	IE_EA_07D010080	DEEL (RAHARNEY)_020	River	Review	Review	Unassigned	Unassigned	No		Deel (Raharney)	unassigned WB. Include in sub catchment.
07_7	IE_EA_07D010200	DEEL (RAHARNEY)_030	River	Not at risk	At risk	Good	Moderate	No	Ag	Deel (Raharney)	SAC ONM Ag significant pressure 2027 EO Deteriorated WB; SAC NMO; Ag only significant pressure
07_7	IE_EA_07D010300	DEEL (RAHARNEY)_040	River	Not at risk	Not at risk	Good	Good	No		Deel (Raharney)	complete sub catchment
07_9	IE_EA_07D010400	DEEL (RAHARNEY)_050	River	At risk	At risk	Moderate	Moderate	No	Hymo	Deel (Raharney)	SAC ONM Hydromorphology significant pressure 2027 EO Inlcude in sub catchment
07_9	IE_EA_07D010600	DEEL (RAHARNEY)_060	River	At risk	Review	Moderate	Good	No		Deel (Raharney)	complete sub catchment
07_15	IE_EA_07D020140	DEVLIN'S_010	River	At risk	Not at risk	Moderate	Good	No		Devlin's	Catchment improved to Good Status following Meath CC efforts in 1st cycle (investigative surveys, farm surveys, engagement, enforcement and cross reporting to address identified pollutant sources from farms and OSWWTSs) and Council is familiar with the pressures in catchment and well placed for future inspections/surveys to try to maintain Good Status.
07_15	IE_EA_07D020300	DEVLIN'S_020	River	Not at risk	Not at risk	Good	Good	No		Devlin's	Catchment improved to Good Status following Meath CC efforts in 1st cycle (investigative surveys, farm surveys, engagement, enforcement and cross reporting to address identified pollutant sources from farms and OSWWTSs) and Council is familiar with the pressures in catchment and well placed for future inspections/surveys to try to maintain Good Status.
07_12	IE_EA_07D060030	D'ARCY'S CROSSROADS STREAM_010	River	At risk	At risk	Moderate	Moderate	No	Ag, Hymo	Stonyford	At Risk WB SAC not meeting objective To complete sub-catchment MH to consider in conjunction with Stonyford WBs
07_18	IE_EA_07D490060	DEMAILESTOWN_010	River	Review	Review	Unassigned	Unassigned	No		Blackwater (Kells) Lower	Add to PAA following inclusion at ROC

07_16	IE_EA_07G020400	GLASH_010	River	At risk	At risk	Poor	Poor	No	Peat	Upper Boyne	
07_16	IE_EA_07G020600	GLASH_020	River	At risk	At risk	Moderate	Moderate	No	Peat	Upper Boyne	
07_2	IE_EA_07K010060	KINNEGAD_010	River	At risk	At risk	Moderate	Moderate	No	Ag, Hymo	Kinnegad	Proposed by MH At risk WB 2027 EO Ag, Hymo
07_2	IE_EA_07K010100	KINNEGAD_020	River	At risk	Review	Moderate	Moderate	No		Kinnegad	Proposed by MH At risk WB 2027 EO Peat harvesting
07_2	IE_EA_07K010200	KINNEGAD_030	River	At risk	At risk	Moderate	Moderate	No	Ag	Kinnegad	Proposed by MH At risk WB 2027 EO Ag, UWWTP
07_20	IE_EA_07K020300	KNIGHTSBROOK_010	River	At risk	At risk	Poor	Poor	No	Ag, Ind, UR	Knightsbrook	Ag, industry, URO significant pressures Ag poor drainage - beyond 2027 EO Proposed by MH Previous investigations, farm and DWWTS work by Meath CC, poorly drained soils in upper half of catchment. Known to have poor water quality upstream of Summerhill. Similar to reasoning on Broadmeadow, perhaps LAWPRO investigations and approach with ASSAP can bring some new tools to bear.
07_20	IE_EA_07K020400	KNIGHTSBROOK_020	River	Not at risk	At risk	Good	Moderate	No	Ag	Knightsbrook	Ag significant pressure Ag poor drainage - beyond 2027 EO Proposed by MH Previous investigations, farm and DWWTS work by Meath CC, poorly drained soils in upper half of catchment. Known to have poor water quality upstream of Summerhill. Similar to reasoning on Broadmeadow, perhaps LAWPRO investigations and approach with ASSAP can bring some new tools to bear.
07_20	IE_EA_07K020500	KNIGHTSBROOK_030	River	At risk	At risk	Poor	Poor	No	Ag, Hymo	Knightsbrook	Ag, hymo significant pressures 2027 EO to complete sub catchment
07_7	IE_EA_07K330580	KILLYNAN_010	River	Review	Review	Unassigned	Unassigned	No		Deel (Raharney)	complete sub catchment Unassinged WB
07_13	IE_EA_07K410830	KNOCKSHANGAN_010	River	Review	Review	Unassigned	Unassigned	No		Athboy	Existing PAA - unassigned WB to undertake further characteisation in 3rd cycle Trib feeding Athboy_060
07_10	IE_EA_07L010100	LISLEA_010	River	Not at risk	Not at risk	Good	Good	No		Blackwater (Kells) Upper	Included under SC approach alongside M&E suggestions
07_7	IE_EA_07L030040	Lough Lene-Adeel Stream_010	River	At risk	At risk	Poor	Moderate	No	Ag	Lough Lene	Existing PAA; WB fed by L Lene; Ben Loughs, Bane Noggin Hill Expand PAA Ag significant pressure 2027 EO

											NPWS IE0002120 - Lough Bane and Lough Glass SAC. Austropotamobius pallipes. Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.
07_15	IE_EA_07M010100	MATTOCK_010	River	At risk	At risk	Moderate	Moderate	No	Ag, UWW		
07_15	IE_EA_07M010220	MATTOCK_020	River	Review	Review	Good	Good	No			
07_15	IE_EA_07M010300	MATTOCK_030	River	At risk	At risk	Unassigned	Unassigned	No	Ag		
07_14	IE_EA_07M030070	MOYNALTY_010	River	Not at risk	At risk	Good	Good	No	Ag	Moynalty	deteriorated WB in sub-catchment - expand PAA Ag significant pressure 2027 EO
07_14	IE_EA_07M030100	MOYNALTY_020	River	At risk	At risk	Moderate	Poor	No	Hymo	Moynalty	existing PAA proposed to transition in 2022 Hymo significant pressure 2027 EO
07_14	IE_EA_07M030300	MOYNALTY_030	River	At risk	At risk	Poor	Poor	No	Ag, Ind	Moynalty	existing PAA proposed to transition in 2022 Ag, Industry significant pressures Ag poor drainage - beyond 2027
07_14	IE_EA_07M030700	MOYNALTY_040	River	At risk	At risk	Poor	Poor	No	Ag, UWW	Moynalty	existing PAA proposed to transition in 2022 Ag, Industry, UWW significant pressures 2027 EO
07_14	IE_EA_07M030800	MOYNALTY_050	River	At risk	At risk	Poor	Moderate	No	Ag, Hymo, UWW	Moynalty	existing PAA proposed to transition in 2022 Ag,Hymo,Ind,UWW significant pressures Ag poor drainage - beyond 2027
07_14	IE_EA_07M030900	MOYNALTY_060	River	At risk	At risk	Poor	Moderate	No	Ag, Hymo, UWW	Moynalty	existing PAA proposed to transition in 2022 Ag,Hymo,UWW significant pressures 2027 EO
07_11	IE_EA_07M040400	MILLTOWNPASS_010	River	At risk	At risk	Moderate	Poor	No	DWW, UWW		
07_14	IE_EA_07M060400	MULLAGH LOUGH STREAM_010	River	At risk	At risk	Moderate	Poor	No	Ag, Hymo, UWW	Moynalty	existing PAA proposed to transition in 2022 Ag,Hymo,UWW significant pressures 2027 EO
07_10	IE_EA_07N010100	NADREEGEEL LOUGH STREAM_010	River	Not at risk	Not at risk	Good	Good	No		Nadreegeel	Expansion of existing PAA
07_10	IE_EA_07N010500	NADREEGEEL LOUGH STREAM_020	River	At risk	At risk	Moderate	Poor	No	Ag, DWW, Hymo	Nadreegeel	Existing PAA - requires further characterisation
07_9	IE_EA_07R010090	RIVERSTOWN_010	River	At risk	At risk	Moderate	Moderate	No	Other, Peat	Deel (Raharney)	At risk to extend Deel (Rathharney) to include. Peat and Waste significant pressures. 2027 EO
07_9	IE_EA_07R010200	RIVERSTOWN_020	River	At risk	At risk	Moderate	Moderate	No	Ag, Peat, UR	Deel (Raharney)	At risk to extend Deel (Rathharney) to include. Ag, Peat and URO significant pressures. 2027 EO
07_16	IE_EA_07R020680	RATHCORE STREAM_010	River	Review	Review	Unassigned	Unassigned	No		Blackwater (Longwood)	Expand PAA; Unassigned WB feeding BL _050
07_1	IE_EA_07R030640	Roughgrange (Main channel)_010	River	Review	Review	Unassigned	Unassigned	No			
07_11	IE_EA_07R040300	ROCHFORTBRIDGE STREAM_010	River	At risk	At risk	Moderate	Moderate	No	Peat		

07_14	IE_EA_07R320900	REASK_010	River	Review	Review	Unassigned	Unassigned	No		Moynalty	Existing PAA - unassigned to undertake further characterisation in 3rd cycle
07_19	IE_EA_07S010150	SKANE_010	River	At risk	At risk	Unassigned	Unassigned	No	DWW	Skane	MCC has done survey work in upper Skane in 2019 and previous years. Identified misconnection from residential estate in Dunshaughlin to headwaters still to be resolved. Improvements that might have been expected several years ago when Castletown Tara WWTP replaced old Dunshaughlin WWTP have not been fully realised due to other catchment pressures. Cattle access issues and some poorly drained soils. Some significance as feeder / spawning stream for Boyne salmon population.
07_19	IE_EA_07S010300	SKANE_020	River	At risk	At risk	Poor	Poor	No	Ag, DWW	Skane	MCC has done survey work in upper Skane in 2019 and previous years. Identified misconnection from residential estate in Dunshaughlin to headwaters still to be resolved. Improvements that might have been expected several years ago when Castletown Tara WWTP replaced old Dunshaughlin WWTP have not been fully realised due to other catchment pressures. Cattle access issues and some poorly drained soils. Some significance as feeder / spawning stream for Boyne salmon population.
07_19	IE_EA_07S010510	SKANE_030	River	At risk	At risk	Poor	Poor	No	DWW, Hymo	Skane	MCC has done survey work in upper Skane in 2019 and previous years. Identified misconnection from residential estate in Dunshaughlin to headwaters still to be resolved. Improvements that might have been expected several years ago when Castletown Tara WWTP replaced old Dunshaughlin WWTP have not been fully realised due to other catchment pressures. Cattle access issues and some poorly drained soils. Some significance as feeder / spawning stream for Boyne salmon population.
07_19	IE_EA_07S010600	SKANE_040	River	At risk	At risk	Poor	Poor	No	Ag	Skane	MCC has done survey work in upper Skane in 2019 and previous years. Identified misconnection from residential estate in Dunshaughlin to headwaters still to be resolved. Improvements that might have been expected several years ago when Castletown Tara WWTP replaced old Dunshaughlin WWTP have not been fully realised due to other catchment pressures. Cattle access issues and some poorly drained soils. Some significance as feeder / spawning stream for Boyne salmon population.
07_12	IE_EA_07S020065	STONYFORD_010	River	Not at risk	At risk	Good	Moderate	No	Ag, Hymo	Stonyford	Proposed by WH for LAWPRO Deteriorated WB LAWPRO propose for LA as MH propose to work in downstream WB

07_12	IE_EA_07S020075	STONYFORD_020	River	Not at risk	At risk	Good	Moderate	No	Ag, Hymo	Stonyford	Proposed by WH for LAWPRO Deteriorated WB LAWPRO propose for LA as MH propose to work in downstream WB
07_12	IE_EA_07S020100	STONYFORD_030	River	Not at risk	At risk	Good	Moderate	No	Ag, Peat	Stonyford	Proposed by WH for LAWPRO LAWPRO propose for LA as MH propose to work in downstream WB Proposed by MH for MH Dropped in status in 2018 EPA biological surveys, previously Q4 sites. Meath CC hasn't targeted this catchment for surveys in recent years as it was one of the better areas, so Meath CC stream surveys and follow up farm inspections could be very beneficial. Not an extensive area for poorly drained soils. Potentially a tributary with positive influence on Boyne. (Should also get 2 phys-chem monitoring sites re-instated onto WFD Operational programme). Border catchment with Westmeath.
07_12	IE_EA_07S020400	STONYFORD_040	River	Not at risk	At risk	Good	Moderate	No	Ag	Stonyford	Proposed by MH for MH Dropped in status in 2018 EPA biological surveys, previously Q4 sites. Meath CC hasn't targeted this catchment for surveys in recent years as it was one of the better areas, so Meath CC stream surveys and follow up farm inspections could be very beneficial. Not an extensive area for poorly drained soils. Potentially a tributary with positive influence on Boyne. (Should also get 2 phys-chem monitoring sites re-instated onto WFD Operational programme). Border catchment with Westmeath.
07_17	IE_EA_07S320550	STAGRENNAN_010	River	Review	Review	Unassigned	Unassigned	No			
07_20	IE_EA_07T010400	TROMMAN STREAM_010	River	Review	Not at risk	Unassigned	Unassigned	No		Tromman Stream	Part of Knightsbrook subcatchment - separate tributary to the Knightsbrook and feeds into Boyne_070. Unassigned but used to be monitored. Only taking on as unassigned.
07_8	IE_EA_07T180970	TOBERULTAN_010	River	Review	At risk	Unassigned	Unassigned	No	Ag, Hymo	Toberultan	Catchment is not assigned a status currently, Meath CC has requested EPA to add to biological monitoring programme as it's a large catchment area without monitoring. Preliminary work by MCC in 2019 indicates problems in catchment and below Good Status. Large area, no farm surveys previously by MCC so investigative and farm surveys definitely warranted.
07_17	IE_EA_07T270880	TULLYESKAR_010	River	Review	Review	Unassigned	Unassigned	No		Ballymackenny GWS	NFGWS would like to highlight that the Ballymackenny GWS groundwater Zone of Contribution is situated within the Tullyesker_010 and therefore would like to propose its inclusion for selection as a PAA.

07_18	IE_EA_07Y010800	YELLOW (Blackwater Kells)_010	River	Review	Review	Unassigned	Unassigned	No		Blackwater (Kells) Lower	to complete sub-catchment
07_18	IE_EA_07Y011100	YELLOW (Blackwater Kells)_020	River	At risk	At risk	Poor	Poor	No	Ag	Blackwater (Kells) Lower	At risk WB
07_11	IE_EA_07Y020070	YELLOW (CASTLEJORDAN)_010	River	At risk	At risk	Moderate	Moderate	No	Ag	Yellow (Castlejordan)	At risk WB 2027 EO Ag significant pressure
07_11	IE_EA_07Y020100	YELLOW (CASTLEJORDAN)_020	River	Not at risk	Not at risk	Good	Good	No			
07_11	IE_EA_07Y020300	YELLOW (CASTLEJORDAN)_030	River	Not at risk	Not at risk	Good	Good	No			
07_7	IE_EA_07_178	Glass	Lake	Review	Review	Unassigned	Unassigned	No			
07_7	IE_EA_07_190	Doo WH	Lake	Review	Review	Unassigned	Unassigned	No			
07_7	IE_EA_07_223	Ben	Lake	Review	Review	Unassigned	Unassigned	No		Lough Lene	3 unassigned lakes to complete sub-catchment; feeder stream in existing Lough Lene-Adeel stream PAA. Characterisation of lakes
07_5	IE_EA_07_242	Acurry	Lake	At risk	At risk	Poor	Poor	No	Ag, DWW, Other	Blackwater (Kells) Upper	Poor status lake, At Risk - included under Blackwater (Kells) recommended PAA
07_7	IE_EA_07_258	Annagh-White	Lake	Not at risk	Not at risk	Good	Good	No		Lough Lene	Lake within existing PAA boundary. Protect function
07_5	IE_EA_07_267	Skeagh Upper	Lake	At risk	At risk	Bad	Poor	No	Ag, DWW	Blackwater (Kells) Upper	Poor status lake, At Risk - included under Blackwater (Kells) recommended PAA
07_5	IE_EA_07_268	Drumkeery	Lake	At risk	At risk	Bad	Poor	No	Ag, DWW	Blackwater (Kells) Upper	Poor status lake, At Risk - included under Blackwater (Kells) recommended PAA
07_7	IE_EA_07_270	Bane Noggin Hill	Lake	Not at risk	At risk	High	Good	Yes	Other	Lough Lene	Proposed by MH lake within existing PAA - L.Lene, Restore Blue Dot - failing Biol + failing fish + Chemical SW Status; L. Bane is on Blue Dot programme as it was High Status in 2010-2015, drinking water source, limited number of pressures, nutrients generally low. Appears that Fish status is issue in regaining High Status. Limited development in area, and recognised as important public drinking water source. Border with Westmeath. 2027 EO IFI
07_10, 26F_3	IE_EA_07_273	Nadreegeal	Lake	At risk	At risk	Poor	Moderate	No	Ag	Nadreegeel	Expansion of existing PAA
07_7	IE_EA_07_274	Lene	Lake	Not at risk	At risk	Good	Moderate	No	Other	Lough Lene	Lake itself was not included in 2nd cycle PAA. To include in 3rd cycle. Protected Area WB not meeting objective. Invasive species significant pressure. 2027 EO Proposed by WH Active community groups; Municipal DW supply; Bathing Water; deteriorated WB

07_10, 07_5	IE_EA_07_275	Ramor	Lake	At risk	At risk	Bad	Poor	No	Ag, Other, UWW	Blackwater (Kells) Upper	Lough Ramor Poor Status drinking water source Pressures urban wastewater, Agriculture & Industry. Additional comments: Focus on Blackwater Kells and Lough Ramor.
06_14, 07_17	IE_EA_010_0000	Boyne Estuary Plume Zone	Coastal	Review	At risk	Good	Moderate	No	Other, UR		
07_17, 08_1, 08_2, 08_5, 08_6, 09_17	IE_EA_020_0000	Northwestern Irish Sea (HA 08)	Coastal	Review	Not at risk	Good	High	Yes			
06_14, 07_17	IE_NB_025_0000	Louth Coast (HA 06)	Coastal	Not at risk	Review	Unassigned	Unassigned	No			
07_1, 07_15, 07_17	IE_EA_010_0100	Boyne Estuary	Transitional	At risk	At risk	Moderate	Moderate	No	Ag, UWW		
07_11, 07_12, 07_13, 07_14, 07_18, 07_2, 07_3, 07_4, 07_7, 07_8, 07_9, 14_14, 25A_10, 25A_3, 25A_7, 26F_6, 26F_7, 26F_9	IE_EA_G_001	Athboy	Groundwater	Review	At risk	Good	Good	No	Ag		
07_1, 07_11, 07_12, 07_13, 07_15, 07_16, 07_17, 07_18, 07_19, 07_2, 07_20, 07_3, 07_4, 07_6, 07_9, 08_3, 08_4, 08_5, 09_10, 09_3, 09_7, 09_9, 14_14, 14_16, 14_3	IE_EA_G_002	Trim	Groundwater	At risk	At risk	Good	Good	No	Ag, DWW, Other		
06_3, 06_7, 07_10, 07_13, 07_14, 07_5, 07_8, 26F_3, 26F_6, 36_11, 36_16, 36_9	IE_EA_G_006	Bailieborough	Groundwater	Review	Not at risk	Good	Good	No			
07_20, 07_6, 08_3, 09_1, 09_10, 09_11, 09_14, 09_15, 09_16, 09_17, 09_3, 09_4, 09_5, 09_6, 09_7, 09_9, 14_16	IE_EA_G_008	Dublin	Groundwater	Not at risk	Review	Good	Good	No			

06_14, 06_15, 06_3, 06_4, 07_14, 07_15, 07_17, 07_18, 07_8	IE_EA_G_010	Wilkinstown	Groundwater	At risk	Not at risk	Good	Good	No			
07_19, 08_1, 08_2, 08_3, 08_4, 08_6, 09_10	IE_EA_G_014	Lusk-Bog of the Ring	Groundwater	Not at risk	Review	Good	Good	No			
06_3, 07_14, 07_18, 07_8	IE_EA_G_015	Moynalty	Groundwater	Not at risk	Not at risk	Good	Good	No			
07_1, 07_17, 08_4, 08_5	IE_EA_G_016	Bettystown	Groundwater	At risk	At risk	Poor	Poor	No	Ag, M+Q	Bettystown GW	The GWB has deteriorated in status due to abstraction pressures. These are likely to be represened in other areas of the country in the future. GSI are conducting research (together with EPA hydrometrics and IW) into the absraction pressures and groundwater resources in this GWB. A PAA status would allow this already existing work to be highlighted via the WFD process. Deteriorated waterbody; GWB has deteriorated in status due to abstraction pressures. Build on existing programmes and community group initiatives.
07_16, 07_20	IE_EA_G_018	Longwood	Groundwater	Not at risk	Not at risk	Good	Good	No			
07_19, 07_20, 09_10, 09_3	IE_EA_G_019	Moynalvy	Groundwater	Review	Not at risk	Good	Good	No			
07_1, 07_19, 08_4, 08_5	IE_EA_G_020	Realtage	Groundwater	Review	Not at risk	Good	Good	No			
07_1, 07_15, 07_17, 08_4, 08_5	IE_EA_G_021	Donore	Groundwater	Review	Not at risk	Good	Good	No			
06_14, 07_1, 07_15, 07_17, 08_5	IE_EA_G_025	Drogheda	Groundwater	Review	Not at risk	Good	Good	No			
07_1, 07_19, 08_4	IE_EA_G_028	Hill of Tara	Groundwater	Review	Not at risk	Good	Good	No			
07_17	IE_EA_G_029	Industrial Facility (P0784-01)	Groundwater	At risk	At risk	Poor	Poor	No	Ind		
07_19, 07_20, 08_3, 09_10	IE_EA_G_031	Dunshaughlin	Groundwater	Not at risk	Not at risk	Good	Good	No			
07_16, 07_2, 07_4	IE_EA_G_044	Kilrathmurry Gravels	Groundwater	Review	Not at risk	Good	Good	No			
07_20	IE_EA_G_066	Waste Facility (W0010-02)	Groundwater	At risk	At risk	Poor	Good	No	Other		

07_2, 07_9	IE_EA_G_072	GWDTE-Mount Hevey Bog (SAC002342)	Groundwater	Review	Not at risk	Good	Good	No			
07_10, 07_14, 07_8	IE_EA_G_073	GWDTE-Killyconny Bog (Cloghbally) (SAC000006)	Groundwater	Review	Not at risk	Good	Good	No			
07_11, 14_14, 25A_3	IE_EA_G_074	GWDTE-Raheenmore Bog (SAC000582)	Groundwater	Review	Not at risk	Good	Good	No			
07_12, 07_13	IE_EA_G_075	GWDTE-Newtown Lough Fen (SAC002299)	Groundwater	Not at risk	Not at risk	Good	Good	No			
07_9, 25A_10	IE_EA_G_083	Waste Facility (W0071-02)	Groundwater	At risk	Not at risk	Poor	Good	No			
07_14	IE_EA_G_090	Waste Facility (W0091-01)	Groundwater	Not at risk	Not at risk	Good	Good	No			
07_12, 07_16, 07_20, 07_9	IE_EA_G_094	Longwood Gravels	Groundwater	Not at risk	Not at risk	Good	Good	No			
07_20, 09_3	IE_EA_G_095	Summerhills Gravels	Groundwater	Not at risk	Not at risk	Good	Good	No			
06_1, 06_15, 06_3, 06_4, 06_7, 07_14	IE_NB_G_018	Ardee	Groundwater	Review	At risk	Good	Good	No	Ag		
03_5, 03_6, 06_5, 06_7, 06_8, 07_10, 07_5, 26C_2, 26C_4, 26C_6, 26F_3, 26F_6, 26F_7, 36_10, 36_11, 36_12, 36_14, 36_16, 36_17, 36_18, 36_19, 36_21, 36_3, 36_4, 36_5, 36_8, 36_9	IE_NW_G_061	Cavan	Groundwater	Review	Not at risk	Good	Good	No			
07_4, 14_1, 14_11, 14_14, 14_16, 14_17, 14_20, 14_3	IE_SE_G_048	Cushina	Groundwater	Not at risk	Not at risk	Good	Good	No			
07_11, 14_14, 25A_3, 25A_4	IE_SE_G_049	Daingean	Groundwater	Not at risk	Review	Good	Good	No			
07_6, 09_11, 09_7, 14_16, 14_17, 14_18, 14_3	IE_SE_G_077	Kildare	Groundwater	Not at risk	Not at risk	Good	Good	No			
07_11, 07_4, 14_14, 14_20, 14_3, 25A_4	IE_SE_G_116	Rhode	Groundwater	Not at risk	Not at risk	Good	Good	No			

07_4, 14_1, 14_11, 14_12, 14_14, 14_16, 14_17, 14_18, 14_2, 14_20, 14_3, 15_10, 15_7, 25A_4	IE_SE_G_153	Bagenalstown Upper	Groundwater	Review	Review	Good	Good	No			
07_12, 07_7, 25A_10, 26F_6, 26F_7, 26F_9	IE_SH_G_077	Derravarragh	Groundwater	At risk	At risk	Good	Good	No	Ag		
07_11, 14_14, 14_15, 14_20, 25A_11, 25A_12, 25A_2, 25A_3, 25A_4, 25A_5, 25A_6, 25B_1, 25B_3	IE_SH_G_103	Geashill	Groundwater	Not at risk	Not at risk	Good	Good	No			
07_10, 07_12, 07_13, 07_7, 07_9, 25A_10, 25A_8, 25A_9, 25B_2, 26C_1, 26C_6, 26C_7, 26E_1, 26E_4, 26E_6, 26F_1, 26F_10, 26F_2, 26F_3, 26F_4, 26F_5, 26F_6, 26F_7, 26F_8, 26F_9, 26G_1, 26G_2, 26G_3, 36_18, 36_8, 36_9	IE_SH_G_110	Inny	Groundwater	Review	Not at risk	Good	Good	No			
07_7, 26F_6, 26F_7	IE_SH_G_238	Tynagh Gravels	Groundwater	Review	At risk	Good	Good	No	Ag		
07_11, 07_2, 07_9, 25A_1, 25A_10, 25A_11, 25A_2, 25A_3, 25A_5, 25A_7, 25A_8, 25A_9, 25B_1, 25B_2, 25B_4, 26F_1, 26F_2, 26F_4, 26F_5, 26G_1, 26G_3	IE_SH_G_240	Clara	Groundwater	Not at risk	Not at risk	Good	Good	No			
07_11, 25A_3, 25A_7, 25A_9	IE_SH_G_242	Kilbeggan Gravels	Groundwater	Review	Not at risk	Good	Good	No			

07_7, 26F_9	IE_SH_G_261	Industrial Facility (P0690-01)	Groundwater	At risk	At risk	Poor	Poor	No	Ind		
03_1, 03_5, 06_1, 06_10, 06_11, 06_12, 06_13, 06_14, 06_15, 06_2, 06_3, 06_4, 06_5, 06_6, 06_7, 06_8, 06_9, 07_14, 07_15, 07_17, 07_18, 07_5, 36_12, 36_16	IEGBNI_NB_G_019	Louth	Groundwater	Review	Not at risk	Good	Good	No			

Ag: Agriculture

DWW: Domestic Waste Water

For: Forestry

Hymo: Hydromorphology

Ind: Industry

M+Q: Mines and Quarries

Peat: Peat Drainage and Extraction

UR: Urban Run-off

UWW: Urban Waste Water

Note: Significant Pressures for *Review* water bodies have not been included as they will need to be confirmed as part of an Investigative Assessment.

Athboy GWB: Summary of Initial Characterisation.

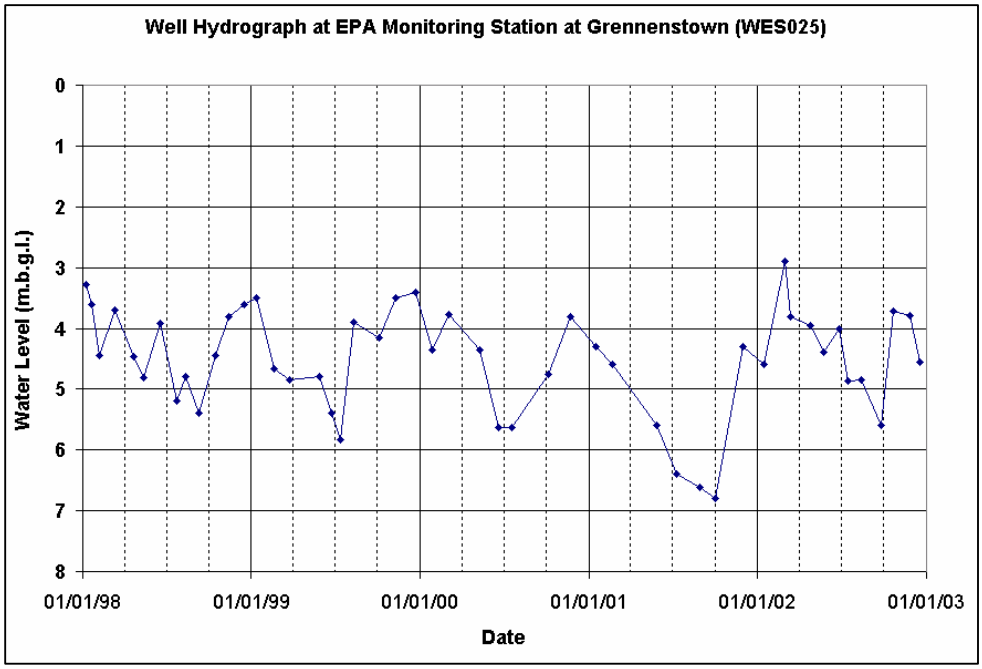
Hydrometric Area Local Authority	Associated surface water bodies	Associated terrestrial ecosystems	Area (km^2)
Meath Co Co Westmeath Co. Co. Offaly Co Co. Hydrometric Area 07	Rivers: Yellow, Stonyford, Rochfordbridge, Riverstown, Milltownpass, Kinnegad, Deel, Castlejordan, Blackwater, Athboy Loughs: Yellow, White, Stillafiddler, Reynella, Newtown, Doolin, Freekan, Cunninghams, Crowinstown, Croboy, Cloran, Bracklin, Black Ballyhealy	Raheenmore Bog (SAC - 582), Mount Hevey Bog (SAC - 1584), Molerick Bog (1582), Girley Bog (1580), Jamestown Bog (1324), Wooddown Bog (694) & Lough Shesk (556)	964

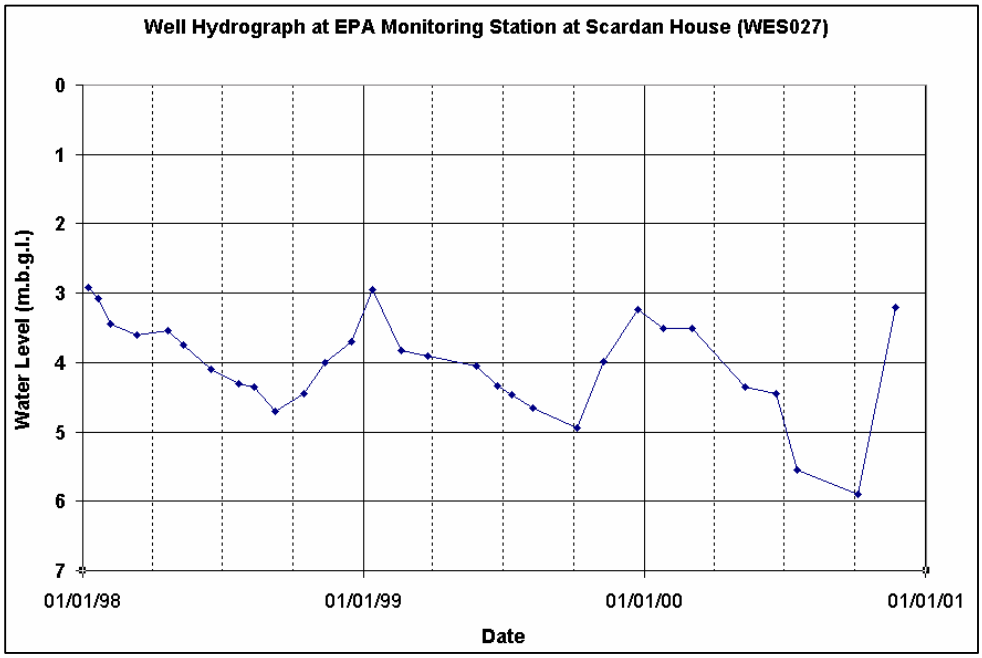
Topography		This large GWB extends from Navan in the northeast to Tyrrellspass and Rochfortbridge in Westmeath. The area is typical of the midlands of Ireland with little relief. There are some isolated hills which rarely rise above 150 m OD. In general the elevation falls from northwest to southeast, reflected in the overall drainage pattern. The region shows a distinctive topography, a typical product of the last glaciation. The land surface is undulating, with large hummocks of glacial drift, deposited under the ice as moraines.
Geology and Aquifers	Aquifer type(s)	Mostly **Ll:** Locally important aquifer, moderately productive only in local zones Small amounts of **Pl:** Poor aquifer, generally unproductive except for local zones (~1.2%) **Lm:** Locally important aquifer, generally moderately productive (~2%)
	Main aquifer lithologies	Dinantian Upper Impure Limestones Dinantian Pure Unbedded Limestones Dinantian Lower Impure Limestones Dinantian Early Sandstones, Shales and Limestones
	Key structures.	
	Key properties	Pumping test analyses from Ballivor WS provided apparent transmissivities of 10 - 200 m^2/d from the 12-hour pumping test and from recovery tests. A value of 50 m^2/d is taken as the most reasonable figure of apparent transmissivity based on test results from other wells in the region. A pumping test at a factory in Ballivor provided an apparent transmissivity of around $30m^2/d$. The drilling encountered 28 m of till overlying deeply weathered and broken limestone bedrock. The main groundwater inflow l was met at 51m depth. The aquifer remained confined during the pumping test. (Cullen 1985) Analysis of a 72-hour pumping test at Athboy WS indicated transmissivities around 100-230 m^2/d. Higher figures were estimated from a 12-hour test in 1996; a higher permeability zone may have been developed close to the surface, possibly along the interface of the broken limestone bedrock and the overlying sands and gravels.
	Thickness	In a large limestone aquifer such as this the bedrock is high heterogeneous and the depth to which major groundwater flows are encountered varies even over short distances. In general in a locally important aquifer such as this the majority of groundwater flow is expected to occur in an upper broken and weathered zone, which is considered to be about 3m thick. Additional flows are commonly found in the upper 10m where groundwater flows along fracture networks. Occasionally deeper isolated groundwater flows are found in cavities which may have been layers or pure limestone solutionally enlarged by karstification. The examples below give a details description of the rock profile in a number of locations. A borehole log (61m) for the Athboy borehole indicates 54.5 m of black limestone with shale bands. The upper 4.5 m were reported to be highly broken. A GSI observation borehole 58.8 m deep (Athboy D/H 104) was drilled approximately 17 m from the supply well, and encountered 47.9 m of dark gray to black limestone and shale. The limestone was not regarded as highly broken or fractured and fracturing decreased with depth. No cavities were encountered, although the return water during the drilling was lost between 38m and 48m below ground level, which would suggest higher permeabilities in this zone although the core did not indicate excessive fracturing at this depth. A GSI observation borehole 63 m deep (Ballivor D/H 105) was drilled approximately 25m from the production wells and encountered limestone at 7 m. The limestones are dark gray to black in colour with alternating thin beds of black calcareous shales (1-5cm thick). The limestones were not regarded as highly fractured although the recovered core was very broken due to the brittle nature of the rock. Several of the fractures have been infilled with calcite ranging in thickness from 1-2cm generally. A vein 30cm thick was encountered from 14.4m to 14.7m, which contained small cavities or vugs. There was no evidence of alteration such as dolomitisation.
Overlying Strata	Lithologies	There is a varied subsoil cover overlying this aquifer. The dominant subsoil type is till, in most cases this is derived from limestone clasts, although in the northern area of the body there are till derived from Lower Paleozoic rocks. In addition to till there are also numerous deposits of gravels and in other places Peat. Subsoil mapping in Co. Meath indicates there are many gravel deposits overlying the aquifer. The gravel deposits form hummocky hills and also eskers, which are seen through out the area.
	Thickness	Thick till covers most of this area although a high degree of variability is expected over such a large area. Subsoil thickness has not yet been adequately mapped in Westmeath. There are quarries within this groundwater body where the aquifer will be exposed, e.g. at River Dale, Co. Westmeath.

	% Area aquifer near surface	The percentage of the area where the aquifer is close to the surface is quite low.
	Vulnerability	Vulnerability mapping is available only for the area within Meath and Offaly, where the vulnerability is mostly Moderate but with significant areas of both higher and lower vulnerability.
Recharge	Main recharge mechanisms	Diffuse recharge appears to be the dominant process for water to reach the aquifer. The slope and the thickness and permeability of the soil and subsoil will determine the amount of recharge reaching the aquifer. Due to the generally low permeability of the aquifer a high proportion of the recharge will then discharge rapidly to surface water courses via the upper weathered layers of the aquifer, effectively reducing the available groundwater resources in the aquifer. In certain areas of the aquifer the surface drainage system appears to be disjointed, a typical sign of a karstic environment, with rivers disappearing underground in swallow holes or caves and reappearing as springs. It is likely in these areas that point recharge occurs. The gravel deposits overlying the aquifer may also influence the drainage pattern; a more detailed understanding is not possible until subsoil mapping is available for the areas of interest e.g. around Delvin, Co. Westmeath.
	Est. recharge rates	*[Information to be added at a later date]*
Discharge	Springs and large known abstractions	**GSI Source Reports** – Athboy & Ballivor Public Supplies **EPA GW Abstraction Register** – *Name (Abstraction (m^3/d))* Clonmellon (94-Spring), BNM at Derrygreenagh (27), Clonard GWS (20), Riversdale Concrete (18), Raharney WS (14), Ballinbrackey Housing (7), Lewinstown GWS (7), Cloneycavan, Robinstown, Kilwarden, Clonard, Rossan, Granstown (Spring), Grennanstown.
	Main discharge mechanisms	This GWB discharges to the overlying rivers and streams. In some instances there may be discharge to the adjacent Trim GWB to the east. Discharge to rivers will be in the form of baseflow. Dry Weather Flows (DWF) are moderate to low. This suggests the aquifer is not maintaining a large baseflow in the summer months. This is typical of karstic and fissured aquifers where the low storativity cannot maintain a large baseflow throughout dry summer months. There is direct discharge of groundwater to the surface at springs, 7 of which are recorded in the GSI karst database, and many others tend to be located along the banks of rivers.
	Hydrochemical Signature	Data collected by the EPA for this GWB shows the water is generally Hard (250-350 mg/l CaCO3) with high Electrical Conductivity (600-700 µS/cm). The Durov diagram attached shows the waters have a calcium bicarbonate signature and the water has alkalinity values of over 250 mg/l.
Groundwater Flow Paths		The specific yield data from various pumping tests in the area indicates that the aquifer is unconfined. Groundwater flow in the aquifer will generally take place in the upper 3 to 5 m of the bedrock where there has been weathering. In some local areas there may be the development of deeper flow through a network of connected fractures and fissures. In some instances these fractures be come enlarged by solution to form karstic conduits, which can transport large quantities of water at high speeds. A calculation of the drainage density for the entire area is 0.662 km/km^2. This is considered to be indicative of a moderately good aquifer. The typical groundwater flow path length is estimated at 0.75 km. The three EPA water level monitoring station located around Sion Hill, north of Kilucan, show the variation in the depth of the water table between the river and the hill. The highest gauge shows the water table around 8 m below ground, the next borehole shows it around 5 m below ground and close the river the water table is less than 2 m below the surface. This indicates a hydraulic gradient of 0.05 on the hill and 0.005 on the flood plain.
Groundwater & surface water interactions		In karstic areas there is a direct link between the surface and groundwater systems. There is evidence that in some areas of this GWB the limestone is karstified. Springs, swallow holes and caves are three typical karstic features present where groundwater and surface water are directly linked. The area contains numerous surface water bodies, which are considered as protected areas and to differing extents are dependent on groundwater. One site at Lough Shesk, near Clonmellon on the Meath/Westmeath border is worth special consideration. The hummocky nature of the terrain in this area produces frequent springs and seepages, rich in lime. Consequently, a series of base-rich marshes have developed in the poorly drained hollows, generally linked with three larger lakes, i.e. Lough Shesk, Freehan Lough and Newtown Lough. This site has been rated as of national importance. There is no other place in the county where the full sequence of stages in the open water/peat bog transition is so well illustrated within a compact area. The main threat to the site lies in drainage of the wetland areas, either directly or by means of dredging of the adjacent river systems or lowering the water table by over abstraction.
Conceptual model	This large GWB extends from Navan in the northeast to Tyrrellspass and Rochfortbridge in Westmeath. The area is low-lying; some isolated hills rarely rise above 150 m OD. The GWB boundary is defined to the south and west by the topographic boundary with other RBDs. To the north the boundary is at the contact with the Lower Paleozoic rocks and to the east the boundary coincides with the change in aquifer classification of the Calp from an Ll aquifer to an Lm aquifer. The GWB is composed primarily of moderate permeability rocks, although localized zones of enhanced permeability do occur. Groundwater flow will mainly occur laterally through the upper weathered zone of the aquifer. Below this, flow occurs along fractures, faults and karstic conduits. Recharge occurs diffusely through the subsoils and via outcrops and in some local areas direct recharge may be possible where via sinking streams. The aquifers are generally unconfined, but may be locally confined where the subsoil is thicker and/or less permeable. Regional groundwater flow is from northwest to southeast, but locally, groundwater discharges to the streams and rivers crossing the aquifer. In general groundwater flow paths will be less than a kilometre from recharge to discharge point; longer groundwater flow paths may develop where there is a higher degree of karstification. Groundwater discharges to the numerous small streams crossing the aquifer, and to the springs and seeps. There may also be some discharge to the Trim GWB to the east of this body.	

Attachments	Four Borehole Hydrographs measured at EPA Stations within the GWB
Instrumentation	Stream gauge: 07002, 07006, 07008, 07014, 07015, 07023, 07028, 07029, 07030, 07031, 07032, 07036, 07044, 07045, 07049, 07050, 07051, and 07052. **Borehole Hydrograph:** GRENNENSTOWN (Dillon) (WES025) Scardan House (WES027) The following hydrographs are not plotted, as there is very little data available. Sionhill (WES031), Borrow (WES032) **EPA Representative Monitoring boreholes:** Clonard GWS (MEA093) O'Conner (Parke) (MEA107), Lewinstown GWS (WES007), Granston (WES026)
Information Sources	Cullen K T (1985) *Report on the Drilling and Testing of a Water Well at N.E.C. Ltd*. Report to N.E.C. Ltd. Geraghty M, Farrelly I, Claringbold K, Jordan C, Meehan R, & Hudson M, 1997. *Geology of Monaghan-Carlingford. A geological description to accompany the Bedrock Geology 1:100,000 Scale Map Series, Sheet 8/9, Monaghan-Carlingford.* Geological Survey of Ireland. 60 p. Morris J H, Somerville I D & MacDermot C V (2002). *Geology of Longford-Roscommon.* A Geological Description to Accompany the Bedrock Geology 1:100,000 Bedrock Series Sheet 12. Geological Survey of Ireland, 121pp. McConnell B, Philcox M & Geraghty M, 2001. *Geology of Meath: A geological description to accompany the bedrock geology 1:100,000 scale map series, Sheet 13, Meath*. Geological Survey of Ireland. 77 p. McConnell B, Philcox M, Sleeman A G, Stanley G, Flegg A M, Daly E P & Warren W P. 1994. *A Geological description to accompany the Bedrock Geology 1:100,000 Scale Map Series, Sheet 16, Kildare-Wicklow*. Geological Survey of Ireland, 70 pp. Kelly C & Fitzsimons V. (2002) *County Kildare Groundwater Protection Scheme*. Report to Kildare County Council. Geological Survey of Ireland 55pp Woods L, Meehan R & Wright G R, 1998. *County Meath Groundwater Protection Scheme*. Report to Meath County Council. Geological Survey of Ireland. 54 p. Daly D, Cronin C, Coxon C & Burns S J 1998. *County Offaly Groundwater Protection Scheme*. Report to Offaly County Council & Geological Survey of Ireland, 57pp.
Disclaimer	Note that all calculation and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae

Formation Name	**Code**	**Description**	**Rock Unit Group**	**Aquifer Classification**
Agglomerate	Va	Lm	Basalts & other Volcanic rocks	Lm
Ballysteen Formation	BA	Fossiliferous dark-grey muddy limestone	Dinantian Lower Impure Limestones	Ll
Basalt	Vb	Lm	Basalts & other Volcanic rocks	Lm
Derravaragh Cherts	DV	Very cherty limestone	Dinantian Upper Impure Limestones	Lm
Edenderry Oolite Member	AWed	Oolitic limestone	Dinantian Pure Bedded Limestones	Lm
Liscarton Formation	LC	`Laminated Beds & Muddy Limestones	Dinantian (early) Sandstones, Shales and Limestones	Ll
Lower Palaeozoic rocks	LP	Undifferentiated	Ordovician Metasediments	Pl
Lucan Formation	LU	Dark limestone & shale (Calp") "	Dinantian Upper Impure Limestones	Ll
Meath Formation (`Pale Beds)	ME	Pale grainstone	Dinantian (early) Sandstones, Shales and Limestones	Ll
Moathill Formation (`Shaly Pales)	MH	Mudstone, calcarenite & calc. sandstone	Dinantian (early) Sandstones, Shales and Limestones	Ll
Mudbank Limestones	mk	Massive grey micritic limestone	Dinantian Pure Unbedded Limestones	Ll
Old Red Sandstone	ORS	Red conglomerate, sandstone, mudstone	Devonian Old Red Sandstones	Ll
Stackallan Member (`Micrite Unit)	MEst	Micrite, mudstone and dolomite	Dinantian Pure Bedded Limestones	Lm
Tober Colleen Formation	TC	Calcareous shale, limestone conglomerate	Dinantian Upper Impure Limestones	Pl
Visean limestones, undifferentiated	VIS	Undifferentiated limestone	Dinantian Upper Impure Limestones	Ll
Volcanics (in Carboniferous)	V	Lm	Basalts & other Volcanic rocks	Lm
Waulsortian Limestones	WA	Massive unbedded lime-mudstone	Dinantian Pure Unbedded Limestones	Ll


Well Hydrograph at EPA Monitoring Station at Grennenstown (WES025)
Water Level (m.b.g.l.)
0
1
2
3
4
5
6
7
8
01/01/98
01/01/99
01/01/00
01/01/01
01/01/02
01/01/03
Date


Well Hydrograph at EPA Monitoring Station at Scardan House (WES027)
Water Level (m.b.g.l.)
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2
3
4
5
6
7
01/01/98
01/01/99
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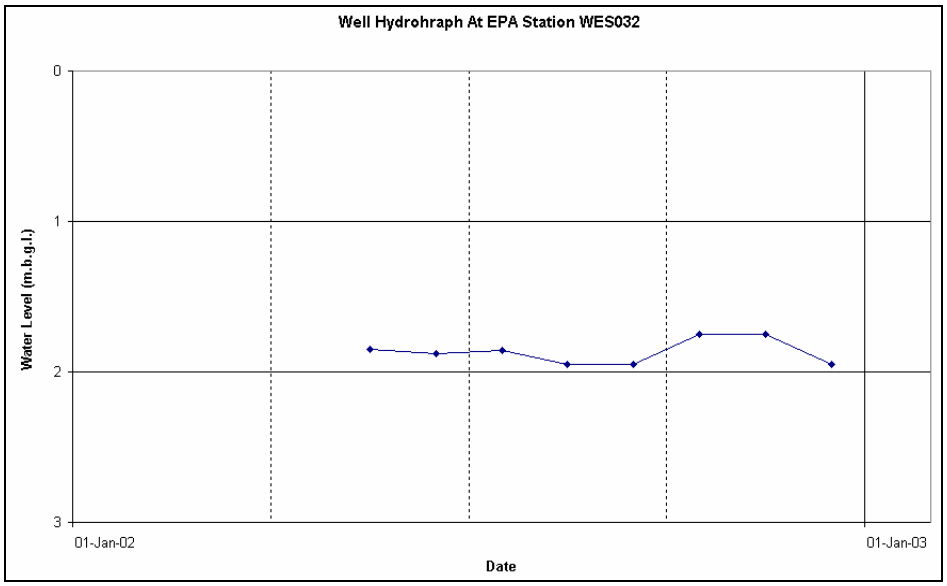
01/01/01
Date


Well Hydrohraph At EPA Station WES032
Water Level (m.b.g.l.)
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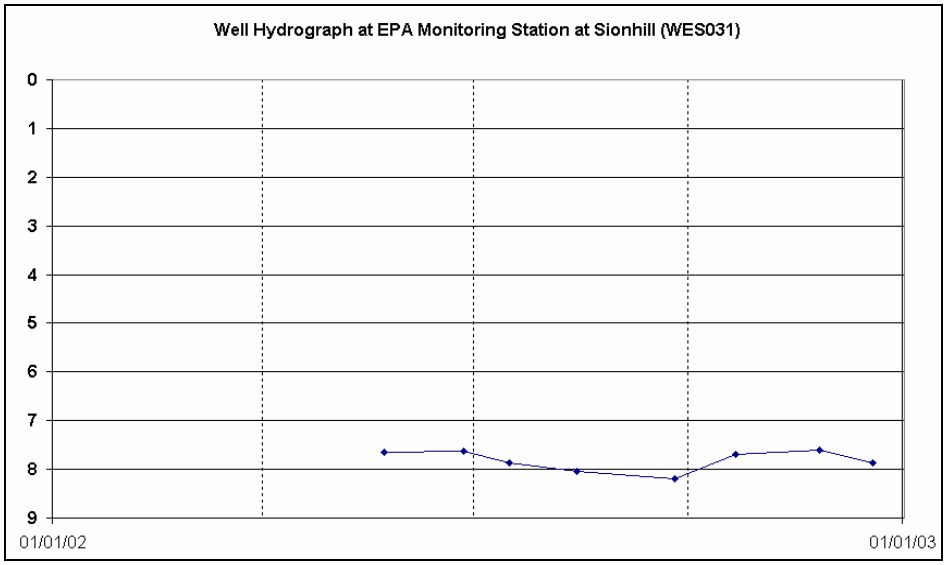
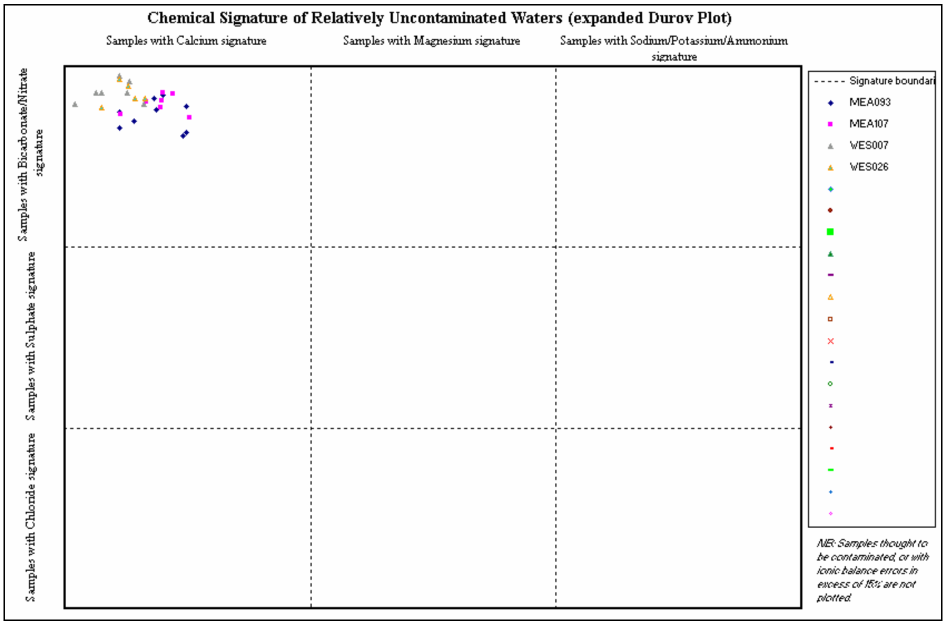
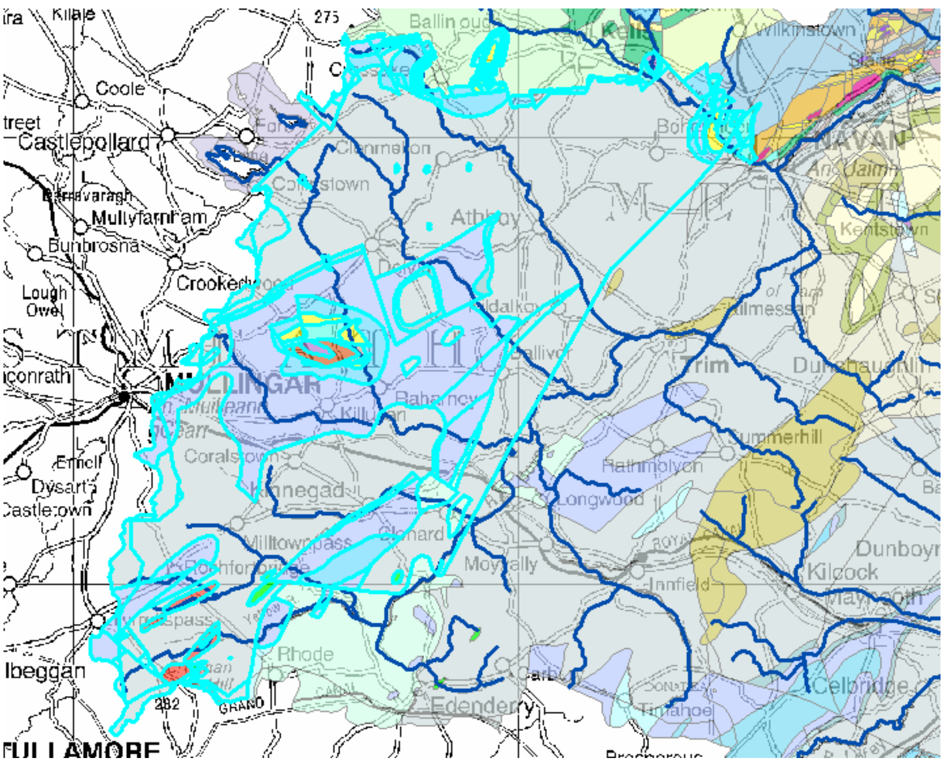
2
3
01-Jan-02
01-Jan-03
Date


Well Hydrograph at EPA Monitoring Station at Sionhill (WES031)
0
1
2
3
4
5
6
7
8
9
01/01/02
01/01/03


Chemical Signature of Relatively Uncontaminated Waters (expanded Durov Plot)
Samples with Calcium signature
Samples with Magnesium signature
Samples with Sodium/Potassium/Ammonium signature
Samples with Bicarbonate/Nitrate signature
Samples with Sulphate signature
Samples with Chloride signature
Signature boundari
MEA093
MEA107
WES007
WES026
NB: Samples thought to be contaminated, or with ionic balance errors in excess of 15% are not plotted.

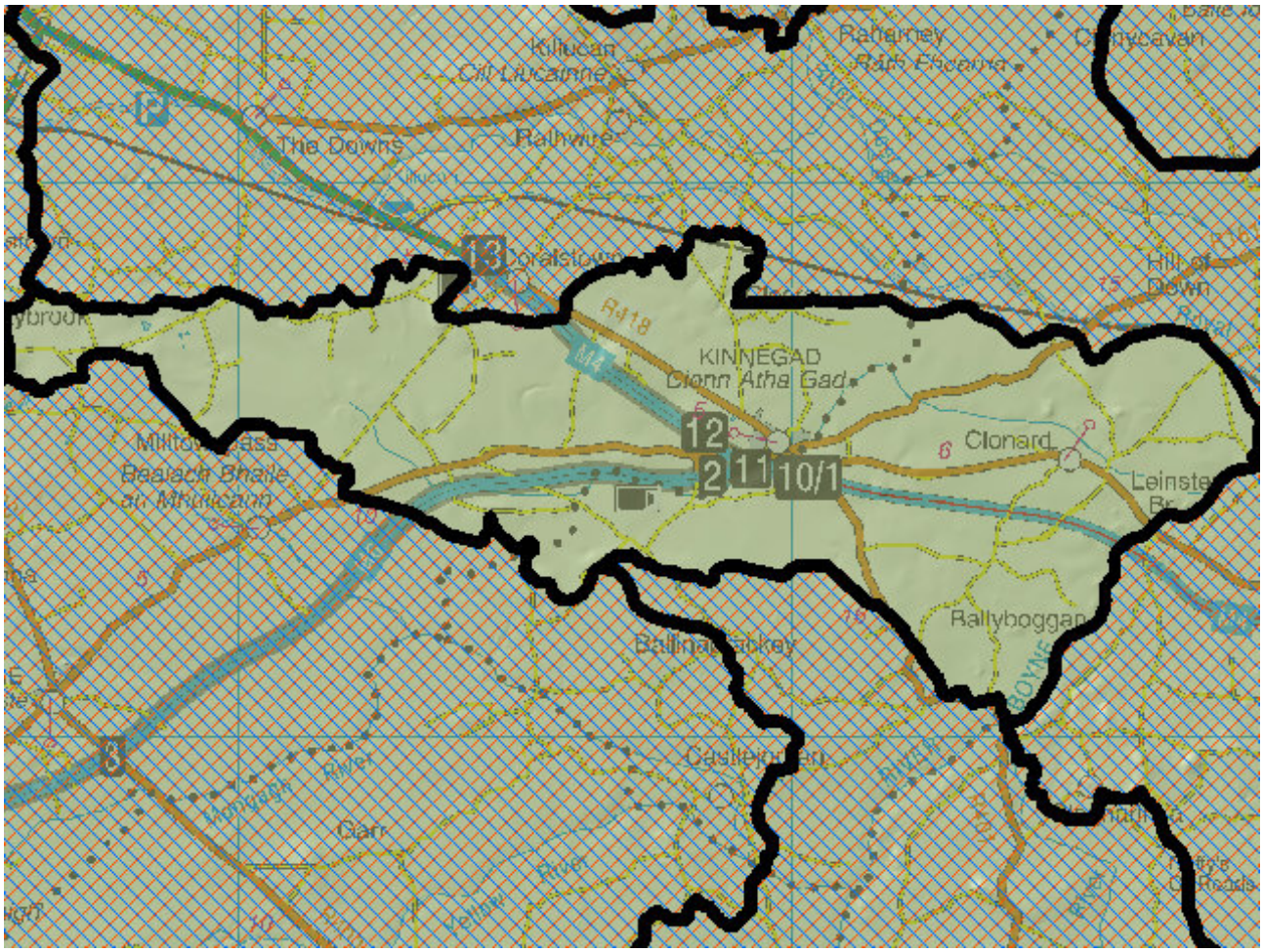

Killale
Coole
Castlepollard
Mullyfarnham
Bunbrosna
Lough Owel
Crookedwood
Athboy
Clonmellon
Collinstown
Wilkinstown
NAVAN
Kentstown
MULLINGAR
Killucan
Coralstown
Kinnegad
Milltownpass
Clonard
Moynalty
Rochfortbridge
Rhode
Edenderry
Longwood
Rathmolyon
Summerhill
Trim
Dunboyne
Kilcock
Maynooth
Celbridge
Innfield
Tyrrellspass
Kilbeggan
TULLAMORE
Dysart
Castletown
Emell
275
282

WFD Cycle 2

Catchment Boyne

Subcatchment Boyne_SC_030

Code 07_2

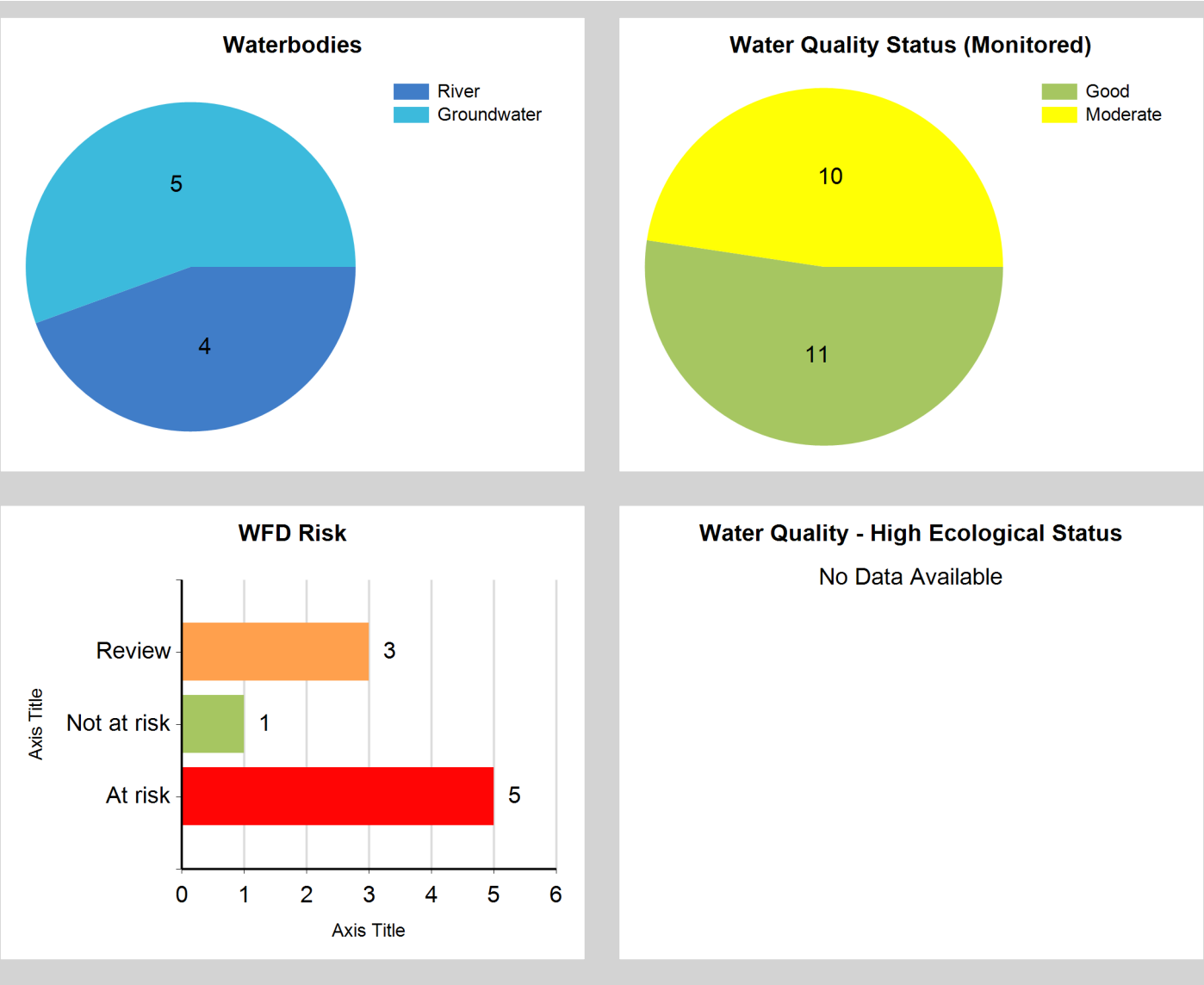


Generated on: 19 Dec 2018

Assessment Purpose

This assessment has been produced as part of the national characterisation programme undertaken for the second cycle of Water Framework Directive river basin management planning. It has been led by the EPA, with input from Local Authorities and other public bodies, and with support from RPS consultants.

The characterisation assessments are automatically generated from the information stored in the WFD Application. They are based on information available to the end of 2015 but may be subject to change until the final 2018-21 river basin management plan is published. Users should ensure that they have the most up to date information by downloading the latest assessment before use.

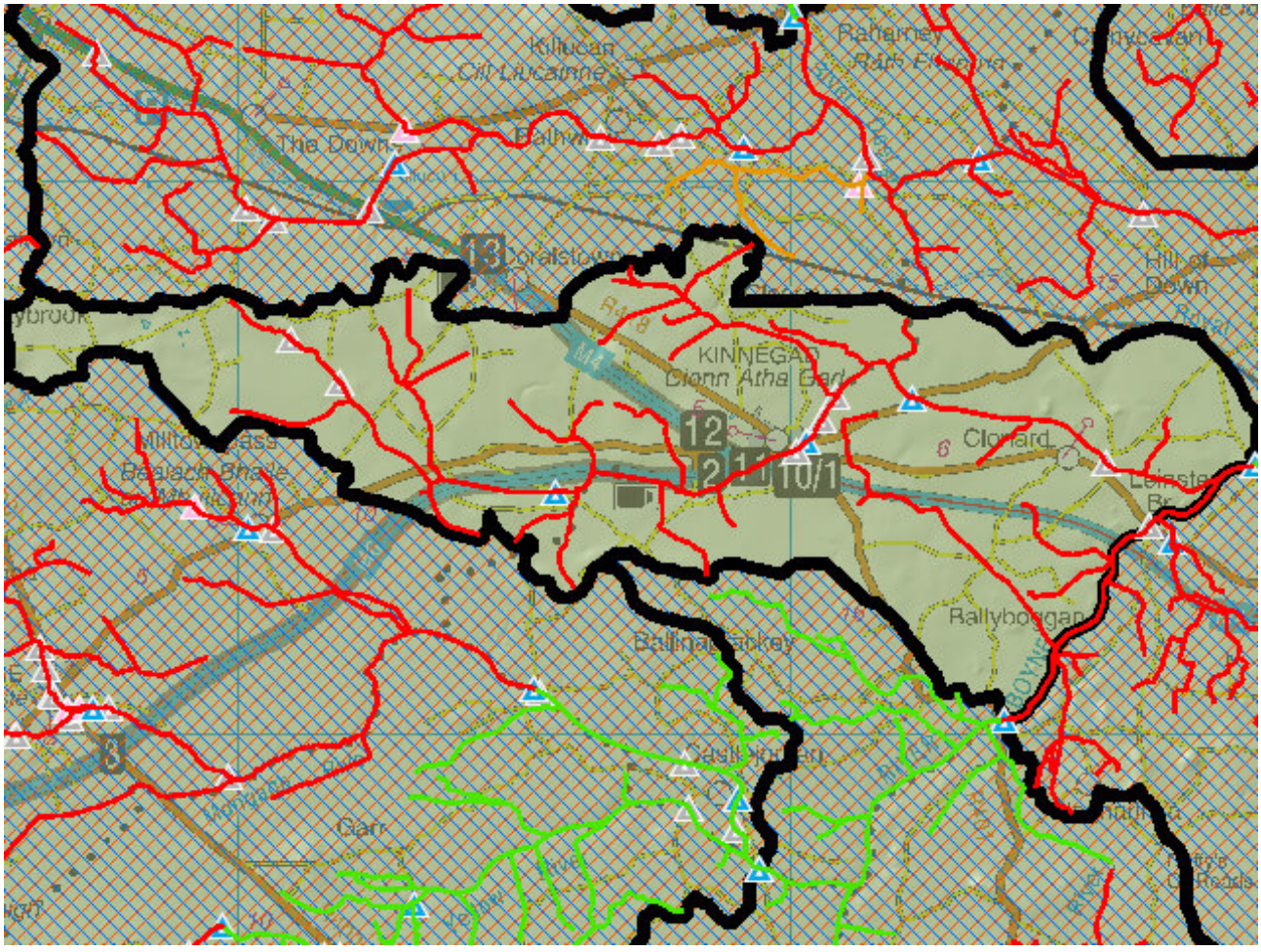


Evaluation of PrioritySubcatchment Issues

All four river water bodies in this subcatchment are AT RISK: Kinnegad_010 due to Moderate biological status; Kinnegad_020, Kinnegad_030 and Boyne_040 due to Moderate biological status and elevated phosphate and ammonia. Biological status was driven by invertebrate status for all water bodies.

Peat harvesting and agriculture on peaty soils is present throughout the subcatchment and are likely to be the significant pressures in all water bodies particularly with regard to elevated ammonia concentrations (and in addition, siltation issues within Kinnegad_010). Urban waste water treatment may also be impacting Kinnegad_030 whereas quarry activities and channelisation are likely to be additional pressures within Boyne_040.

Map Subcatchment Risk Map

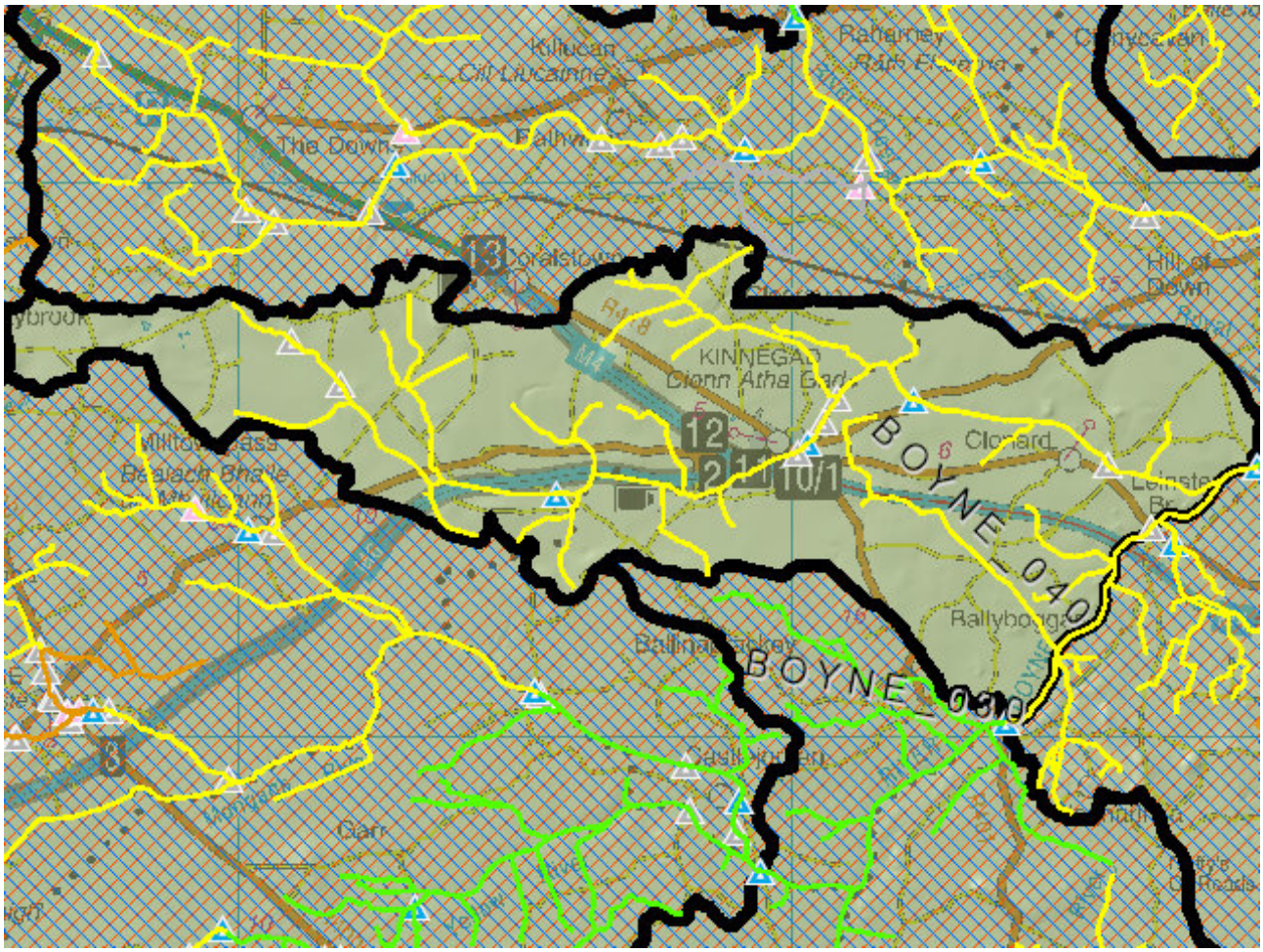


River And Lake Waterbodies: WFD Risk

The following river and lake waterbodies are in the subcatchment.

Code	Name	Type	WFD Risk	Significant Pressure
IE_EA_07B040600	BOYNE_040	River	At risk	Yes
IE_EA_07K010060	KINNEGAD_010	River	At risk	Yes
IE_EA_07K010100	KINNEGAD_020	River	At risk	Yes
IE_EA_07K010200	KINNEGAD_030	River	At risk	Yes

Map Subcatchment Water Quality Status Map



River And Lake Waterbodies: Water Quality Status

The water quality status of river and lake waterbodies in the subcatchment is as follows.

Code	Name	Type	2007-09	2010-12	2010-15
IE_EA_07B040600	BOYNE_040	River	Moderate	Moderate	Moderate
IE_EA_07K010060	KINNEGAD_010	River	Good	Moderate	Moderate
IE_EA_07K010100	KINNEGAD_020	River	Unassigned	Moderate	Moderate
IE_EA_07K010200	KINNEGAD_030	River	Moderate	Moderate	Moderate

Potentially Dependent Transitional and Coastal Waterbodies

The Transitional and Coastal waterbodies listed below intersect spatially with river and lake waterbodies in the subcatchment …

Code	Name	Type	Local Authority	WFD Risk

Potentially Dependent Groundwater Waterbodies

The groundwaters listed below interset spatially with river and lake waterbodies in the subcatchment …

Code	Name	Type	Local Authority	WFD Risk
IE_EA_G_001	Athboy	Groundwater	Westmeath County Council	Review
IE_EA_G_002	Trim	Groundwater	Meath County Council	At risk
IE_EA_G_044	Kilrathmurry Gravels	Groundwater	Kildare County Council	Review
IE_EA_G_072	GWDTE-Mount Hevey Bog (SAC002342)	Groundwater	Westmeath County Council	Review
IE_SH_G_240	Clara	Groundwater	Offaly County Council	Not at risk

Protected Areas intersecting River and Lake Waterbodies

The Protected Areas listed below intersect spatially with river and lake waterbodies in the subcatchment …

Code	Name	Type	Waterbody Name	Association Type
IE0002342	Mount Hevey Bog SAC	SAC	KINNEGAD_030	Overlapping / partly within Protected Area
IEPA5D0004	River Boyne	Salmonid	BOYNE_040	Overlapping / partly within Protected Area

Pressures

Below is a list of all significant pressures identified in the subcatchment.

Code	Name	WFD Risk	Pressure Category	Pressure Sub Category
IE_EA_07B040600	BOYNE_040	At risk	Extractive Industry	Peat - Harvesting
IE_EA_07B040600	BOYNE_040	At risk	Extractive Industry	Quarries
IE_EA_07B040600	BOYNE_040	At risk	Hydromorphology	Channelisation
IE_EA_07K010060	KINNEGAD_010	At risk	Agriculture	Pasture
IE_EA_07K010060	KINNEGAD_010	At risk	Hydromorphology	Channelisation
IE_EA_07K010100	KINNEGAD_020	At risk	Extractive Industry	Peat - Harvesting
IE_EA_07K010200	KINNEGAD_030	At risk	Agriculture	Pasture
IE_EA_07K010200	KINNEGAD_030	At risk	Urban Waste Water	Agglomeration PE of 2,001 to 10,000
IE_EA_G_002	Trim	At risk	Agriculture	Agriculture
IE_EA_G_002	Trim	At risk	Domestic Waste Water	Waste Water discharge
IE_EA_G_001	Athboy	Review	Anthropogenic Pressures	Unknown
IE_EA_G_044	Kilrathmurry Gravels	Review	Anthropogenic Pressures	Unknown
IE_EA_G_072	GWDTE-Mount Hevey Bog (SAC002342)	Review	Anthropogenic Pressures	Unknown

Further Characterisation Actions

The following further characterisation actions have been identified. These are necessary to help understand more fully issues in the subcatchment and their likely cause.

Code	Name	Action	Responsible Organisation
IE_EA_07K010100	KINNEGAD_020	IA1 Provision of Information	Environmental Protection Agency
IE_EA_07K010060	KINNEGAD_010	IA7 Multiple Sources in Multiple Areas	Westmeath County Council
IE_EA_07K010200	KINNEGAD_030	IA1 Provision of Information	Environmental Protection Agency
IE_EA_07B040600	BOYNE_040	IA1 Provision of Information	Environmental Protection Agency
IE_EA_07K010200	KINNEGAD_030	IA1 Provision of Information	Irish Water

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1. Introduction

1.1 General

This groundwater protection scheme was commissioned by Meath County Council and was prepared in the Groundwater Section of the Geological Survey of Ireland (GSI). The project was undertaken in two parts. Part 1 involved the mapping of the Quaternary subsoils, which was carried out by Robert Meehan of the GSI Quaternary Section from 1993 to 1996. This included compiling the Subsoils and Depth to Bedrock maps and accompanying reports. Part 2 (January 1995 to July 1996) involved compiling all the geological and hydrogeological data to produce a suite of maps (Geology, Hydrogeological Data, Aquifers, Groundwater Vulnerability and Groundwater Protection maps) and this report. Seven major groundwater sources in County Meath (Slane, Curragha, Athboy, Dunshaughlin, Dunboyne, Ballivor and Nobber) were selected for detailed investigations and source protection zones were delineated for each source. Accompanying source reports and maps have been produced for the seven sources.

1.2 Objectives and Methodology

This report briefly describes the geology, hydrogeology, aquifers, groundwater quality, and groundwater vulnerability of County Meath, and the groundwater protection scheme proposed for the county. This scheme will assist in the rational planning of future development in County Meath.

The main objective of the project was to collect, compile and assess all the data (geological and hydrogeological) available for the county. The data have been compiled on 1:25,000 scale maps and entered into a computer database. Some additional hydrogeological data were collected, mainly on water quality and aquifer coefficients. Finally a suite of environmental geology maps (1 : 63,360) were produced to accompany this report. These maps are as follows:

Primary Data Maps
- Bedrock Geology Map
- Subsoils Map
- Depth to Bedrock Map
- Hydrogeological Data Map

Derived or Interpretative Maps
- Aquifer Map
- Groundwater Vulnerability Map

Land Use Planning Map
- Groundwater Protection Map

These maps have been produced using all data available to the GSI at the beginning of 1996. Site specific investigations were not conducted for this project, thus the resulting maps are general regional maps and should not be used for site specific work, for which detailed site investigations should be conducted, as required. In areas were information was poor or not available, relevant data from adjacent counties were used.

1.3 Location

County Meath is bounded to the east by the Irish Sea and County Dublin, to the south by Counties Kildare and Offaly, to the west by County Westmeath and on the north by Counties Cavan, Monaghan and Louth. The county comprises an area of 2345 km^2.

1.4 Topography, Surface Hydrology and Land Use

The topography is generally flat to undulating with elevation generally around 60 to 100 metres above sea level, but ranging from 15 metres along the Boyne valley to around 200-300 metres along the tops of ridges (Slieve na Calliagh, north of Slane and north of Moynalty).

The surface water drainage of County Meath is dominated by the River Boyne, which drains more than half the county. The Boyne's most important tributaries are (downstream of Navan) the Kells Blackwater, Moynalty, Mattock and Devlin rivers, and (upstream of Navan) the Enfield Blackwater, Athboy, Boycetown, Castlejordan, Clady, Deel, Kinnegad, Knightsbrook, Riverstown, Skane, Stonyford, and Yellow rivers. Other significant rivers in Meath are the Dee, Nanny, Inny, Glyde, Liffey, Tolka, Broad Meadow, and Delvin. The catchment divides are shown on Map 1. Several of the rivers also drain adjoining counties.

Agriculture is the dominant land use activity in Meath, particularly livestock farming and tillage.

1.5 Rainfall and Evapotranspiration

The average annual rainfall for Meath is 846mm, based on the 1951-1980 average monthly data provided by Met Eireann. The rainfall is lower along the coast (750mm) and increases in upland areas of the northwest to over 1000mm.

Average potential evapotranspiration (P.E.) for the nearest station, Dublin Airport, is 550mm per year. Potential evapotranspiration for County Meath was estimated from a regional Met Eireann contoured map, and ranges from 500 to 550mm/year. Actual evapotranspiration (A.E.) is estimated as a percentage (95%) of the potential evapotranspiration for the area, as 475 to 522mm/year, to allow for soil moisture deficits during the year.

The effective rainfall (rainfall minus actual evapotranspiration) is taken to be approximately 350mm per year, ranging from 230 mm along the coast to around 500mm in the west of the county.

2. The Groundwater Protection Scheme

– A Means of Preventing Contamination

2.1 Introduction

2.1.1 Groundwater Protection – A Priority Issue for Local Authorities

The protection of groundwater quality from the impact of human activities is a high priority for land-use planners and water resources managers. This situation has arisen because:

- groundwater is an important source of water supply;
- human activities are posing increasing risks to groundwater quality as there is widespread disposal of domestic, agricultural and industrial effluents to the ground and the volumes of waste are increasing;
- groundwater provides the baseflow to surface water systems, most of which are used for water supply and recreational purposes. In many rivers, more than 50% of the annual flow is derived from groundwater and more significantly, in low flow periods in summer, more than 90% is groundwater. If groundwater becomes contaminated the rivers can also be affected and so the protection of groundwater resources is an important aspect of sustaining surface water quality;
- groundwater generally moves slowly through the ground and so the impact of human activities can last for a relatively long time;
- polluted drinking water is a health hazard and once contamination has occurred, drilling of new wells is expensive and in some cases not practical. Consequently "prevention is better than cure";
- groundwater may be difficult to clean up, even when the source of pollution is removed;
- unlike surface water where flow is in defined channels, groundwater is present everywhere;
- EU policies and national regulations are requiring that pollution must be prevented as part of sustainable groundwater quality management.

2.1.2 The Threat to Groundwater

The main threat to groundwater is posed by point contamination sources - farmyard wastes (silage effluent and soiled water mainly), septic tank effluent, sinking streams and to a lesser extent leakages, spillages, pesticides used for non-agricultural purposes and leachate from waste disposal sites (Daly, 1994). Diffuse sources such as fertilizers do not yet seem to be causing significant large-scale contamination problems and are unlikely to cause the same degree of problem in Ireland as in many European countries. However, intensive arable farming and landspreading of piggery and hatchery wastes pose a risk to groundwater in some areas.

2.1.3 Groundwater Protection through Land Use Planning

There are a number of ways of preventing contamination, such as improved well siting, design and construction and better design and management of potential contamination sources. However, one of the most effective ways is utilising groundwater protection schemes as part of the planning process.

Land-use planning, using either planning, environmental impact assessment, integrated pollution control or water pollution legislation, is the main method used in Ireland for balancing the need to protect the environment with the need for development. However, land-use planning is a dynamic process with social, economic and environmental interests and impacts, influencing to varying degrees the use of land and water. In a rural area, farming, housing, industry, tourism, conservation, waste disposal, water supply, etc., are potentially interactive and conflicting and may compete for priority. How does groundwater and groundwater pollution prevention fit into this complex and difficult situation, particularly as it is a resource that is underground and for many people is "out of sight, out of mind"? Groundwater protection schemes are an essential means of enabling planning authorities to

take account of both geological and hydrogeological factors in locating potentially polluting developments; consequently they are now an essential means of preventing groundwater pollution.

2.1.4 Environmental Principles

As a means of protecting the environment, the following principles are now generally recommended and are part of Irish environmental policy:

- the principle of sustainable development, which is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs";
- the precautionary approach, which means giving preference to risk-averse decisions and avoiding irreversible actions;
- the principle that environmental protection should be an integral part of the development process;
- the "polluter pays" principle, which requires that the environmental cost should be incorporated in any development proposals.

These principles provide the basic philosophy for the groundwater protection scheme proposed for County Limerick. Also, the concept of risk and the requirement to take account of the risk of contamination to groundwater from potentially polluting activities have been integrated into the groundwater protection scheme.

2.1.5 Risk and Risk Management - A Framework for Groundwater Protection Schemes

Risk can be defined as the likelihood or expected frequency of a specified adverse consequence. Applied to groundwater, it expresses the likelihood of contamination arising from potentially polluting sources or activities (called the **hazard**). A Royal Society (London) Study Group (1992) formally defined an **environmental hazard** as “an event, or continuing process, which if realised, will lead to circumstances having the potential to degrade, directly or indirectly, the quality of the environment”. Consequently, a hazard presents a risk when it is likely to affect something of value (the **target**, which in this case is groundwater). It is the combination of the probability of the hazard occurring and its consequences that is the basis of **risk assessment**.

RISK = PROBABILITY OF AN EVENT × CONSEQUENTIAL DAMAGE

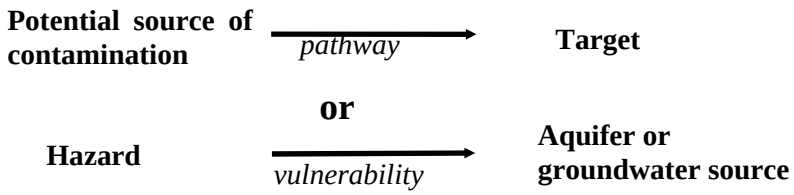
There are three key stages in risk analysis: risk **estimation**, risk **evaluation** and risk **management.** These are highlighted by the following questions.

What can go wrong? *Hazard identification and identification of outcomes* How likely is it to go wrong? *Estimation of probability of these outcomes or estimation of vulnerability* What would happen if it did go wrong? *Consequence analysis*	**risk estimation**
Is the risk acceptable and can it be reduced?	**risk evaluation**
What decisions arise from risk estimation and risk evaluation? What control measures are needed to minimise the risk?	**risk management**

Protection, like risk, is a relative concept in the sense that there is an implied degree of protection (absolute protection is not possible). An increasing level of protection is equivalent to reducing the risk of damage to the protected quantity, e.g. groundwater. Moreover, choosing the appropriate level of protection, necessarily involves placing a relative value on the protected quantity.

Groundwater protection schemes are usually based on the concepts of groundwater contamination risk and risk management. In the past, these concepts were in the background, often implicit, sometimes intuitive factors. However, with the language and thought-processes associated with risk and risk

assessment becoming more common, relating a groundwater protection scheme to these concepts allows consistent application of a protection policy and encourages a rigorous and systematic approach. The conventional source-pathway-target model for environmental management can be applied to groundwater risk management:

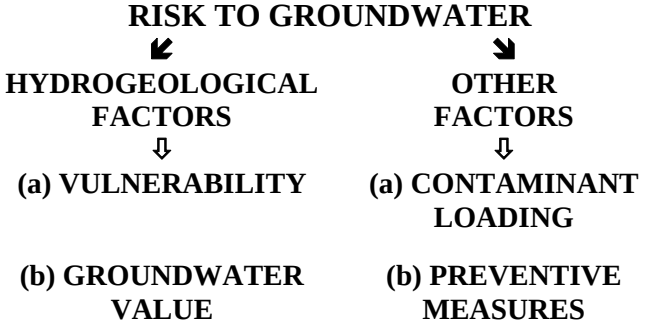


The GSI uses the following terminology and definitions.

The **risk** of contamination of groundwater depends on three elements:
(i) the **hazard** provided by a potentially polluting activity;
(ii) the **vulnerability** of groundwater to contamination;
(iii) the potential **consequences** of a contamination event.

Risk management is based on analysis of these elements followed by a **response** to the risk. This response includes the assessment and selection of solutions and the **implementation of measures** to prevent or minimise the consequences and probability of a contamination event.

The **hazard** depends on the potential **contaminant loading**. The natural **vulnerability** of the groundwater dictates the **likelihood of contamination** if a contamination event occurs. The **consequences** to the target depend on the **value** of the groundwater, which is normally indicated by the aquifer category (regionally important, locally important or poor) and the proximity to an important groundwater abstraction source (e.g. a public supply well). **Preventive measures** may include: control of land-use practices and in particular directing developments towards lower risk areas; building codes that take account of the vulnerability and value of the groundwater; lining of landfill sites; installation of monitoring networks; specific operational practices. Consequently, assessing the risk of contamination to groundwater is complex. It encompasses geological and hydrogeological factors - (a) the vulnerability to contamination and (b) the relative importance or value of the groundwater resource, - and factors that relate to the potentially polluting activity - (a) the contaminant loading and (b) the preventive measures.



A conceptual model of the relationship between these factors is given in Figure 2.1, where septic tank effluent is taken as the hazard.

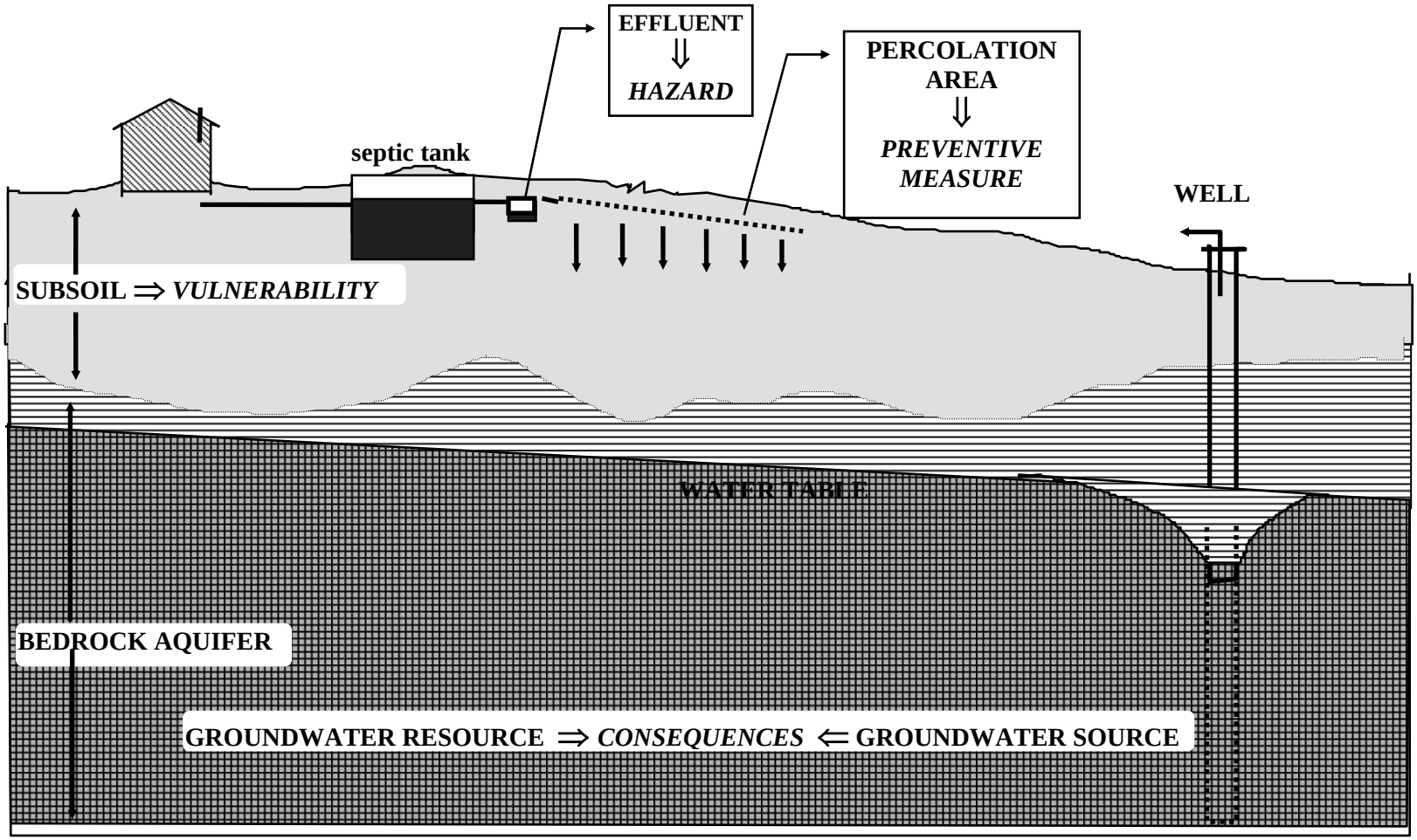


Figure 2.1 A Conceptual Model of the Elements of Risk and Risk Management

The groundwater protection scheme outlined here integrates these factors and in the process serves to focus attention on the higher risk areas and activities, and provides a logical structure within which contaminant control measures can be selected.

Exposure of groundwater to hazard can sometimes be reduced by engineering measures (such as geomembrane liners beneath landfills). However, in most cases, a significant element of the total exposure to hazard will depend on the natural geological and hydrogeological conditions, which define the vulnerability or the sensitivity of the groundwater to contamination. Engineering measures may be required in some situations to reduce the risk further.

2.1.6 Objectives of the Groundwater Protection Scheme

The overall aim of the groundwater protection scheme is to preserve the quality of groundwater, particulary for drinking purposes, for the benefit of present and future generations.

The objectives, which are interrelated, are as follows:

- to assist the statutory authorities in meeting their responsibilities for the protection and conservation of groundwater resources
- to provide geological and hydrogeological information for the planning process, so that potentially polluting developments can be located and controlled in an environmentally acceptable way
- to integrate the factors associated with groundwater contamination risk, to focus attention on the higher risk areas and activities, and provide a logical structure within which contamination control measures can be selected

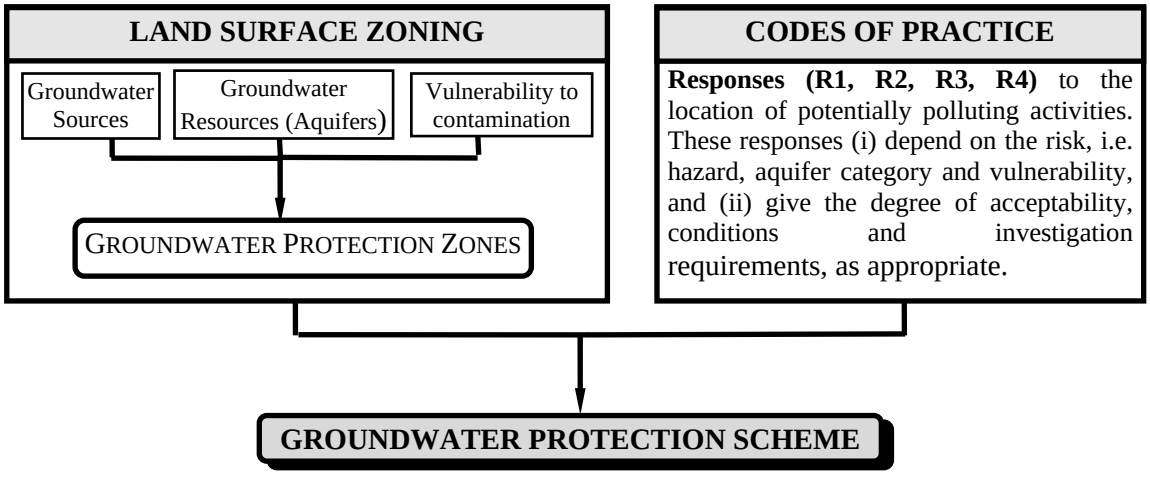
The scheme is not intended to have any statutory authority now or in the future; rather it should provide a framework for decision-making and guidelines for the statutory authorities in carrying out their functions. As groundwater protection decisions are often complex, sometimes requiring detailed geological and hydrogeological information, the scheme is not prescriptive and needs to be qualified by site-specific considerations.

2.2 How A Groundwater Protection Scheme Works

There are **two main components** of the groundwater protection scheme (Figure 2.2):

- **Land surface zoning**, which encompasses the hydrogeological elements of risk**.**
- **Codes of practice for potentially polluting activities** which encompasses both the contaminant loading element of risk and planning/preventative measures as a response to the risk**.**

Figure 2.2. Summary of Components of a Groundwater Protection Scheme



Land surface zoning provides the general framework for a groundwater protection scheme. The outcome is a map, which divides any chosen area into a number of groundwater protection zones according to the degree of protection required. The quality and level of sophistication of the land surface zoning map usually depends on the data and resources (time, money and staff) available, and on the degree of hydrogeological analysis used. Delineation of protection zones based on adequate hydrogeological information and analysis is recommended as a defensible basis for planning decisions.

There are three main hydrogeological elements to land surface zoning:

- Division of the entire land surface according to the **vulnerability** of the underlying groundwater to contamination. This requires production of a vulnerability map showing four vulnerability categories.
- Delineation of **areas surrounding** individual **groundwater sources** (usually public supply sources); these are termed source protection areas.
- Delineation of areas according to the value of the groundwater resources or **aquifer category**; these are termed resource protection areas.

These three elements are integrated together to give maps showing **groundwater protection zones**.

The location and management of potentially polluting activities in each groundwater protection zone is by means of a **code of practice** for each activity or group of activities, which describes (i) the degree of acceptability of each activity, (ii) the conditions to be applied and, in some instances, (iii) the investigations that may be necessary prior to decision-making.

While the two components – maps showing the zones and the control measures – are different, they are incorporated together and closely interlinked in the scheme.

2.3 Land Surface Zoning for Groundwater Protection

2.3.1 Groundwater Vulnerability Categories

Vulnerability is a term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities.

The vulnerability of groundwater depends on the time of travel of infiltrating water (and contaminants), on the relative quantity of contaminants that can reach the groundwater and on the contaminant attenuation capacity of the geological materials through which the water and contaminants infiltrate. As all groundwater is hydrologically connected to the land surface, it is the effectiveness of this connection that determines the relative vulnerability to contamination. Groundwater that readily and quickly receives water (and contaminants) from the land surface is considered to be more vulnerable than groundwater that receives water (and contaminants) more slowly and in lower quantities. The travel time, attenuation capacity and quantity of contaminants are a function of the following natural geological and hydrogeological attributes of any area:

(i) the subsoils that overlie the groundwater;
(ii) the recharge type - whether point or diffuse; and
(iii) the thickness of the unsaturated zone through which the contaminant moves.

In general, little attenuation of contaminants occurs in the bedrock in Ireland because flow is almost wholly via fissures. Consequently, the subsoils - sands, gravels, glacial tills (or boulder clays), peat, lake and alluvial silts and clays, - are the single most important natural feature in influencing groundwater vulnerability and groundwater contamination prevention. Groundwater is most at risk

where the subsoils are absent or thin and, in areas of karstic limestone, where surface streams sink underground at swallow holes.

The geological and hydrogeological characteristics can be examined and mapped, thereby providing a groundwater vulnerability assessment for any area or site. Four groundwater vulnerability categories are used by the GSI - **extreme**, **high**, **moderate** and **low**. The hydrogeological basis for these categories is summarised in Table 2.1 and further details can be obtained from the GSI. The ratings are not scientifically precise; they are based on pragmatic judgements, experience and limited technical and scientific information. However, provided the limitations are appreciated, vulnerability assessments are an essential element when considering the location of potentially polluting activities. As groundwater is considered to be present everywhere in Ireland, the vulnerability concept is applied to the entire land surface. The ranking of vulnerability does not take into consideration the biologically-active soil zone, as contaminants from point sources are usually applied below this zone, often at depths of at least 1m.

Table 2.1. Vulnerability Mapping Guidelines

Vulnerability Rating	Hydrogeological Requirements				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Recharge Type
	high permeability (*sand/gravel*)	moderate permeability (*sandy till*)	low permeability (*clayey till, clay, peat*)	(*sand & gravel* aquifers only)	
Extreme	0 - 3.0 m	0 - 3.0 m	0 - 3.0 m	0 - 3.0 m	point (<30 m radius)
High	>3.0 m	3.0 - 10.0 m	3.0 - 5.0 m	>3.0 m	diffuse
Moderate	N/A	>10.0 m	5.0 - 10.0	N/A	diffuse
Low	N/A	N/A	>10.0 m	N/A	diffuse

Notes: i) N/A = not applicable.
ii) Precise permeability values cannot be given at present.
iii) Release point of contaminants is assumed to be 1-2 m below ground surface.

(from Daly and Warren, 1997)

Vulnerability maps are an important part of groundwater protection schemes and are an essential element in decision-making on the location of potentially polluting activities. Firstly, the vulnerability rating for any area indicates, and is a measure of, the likelihood of contamination. Secondly, the vulnerability map assists in ensuring that the groundwater protection scheme is not unnecessarily restrictive on human economic activity. Thirdly, the vulnerability map helps in the choice of preventative engineering measures and enables major developments, which have a significant potential to contaminate, to be located in areas of relatively low vulnerability and therefore of relatively low risk, from a groundwater point of view.

In summary, the entire land surface is divided into four vulnerability categories - extreme (**E**), high (**H**), moderate (**M**) and low (**L**) - based on the geological and hydrogeological factors described above and this subdivision is shown on a groundwater vulnerability map. The map shows the vulnerability of the first groundwater encountered (in either sand/gravel aquifers or in bedrock) to contaminants released at depths of 1-2 m below the ground surface. Where contaminants are released at significantly different depths, there will be a need to determine groundwater vulnerability using site-specific data. The characteristics of individual contaminants have not been taken into account.

2.3.2 Groundwater Source Protection Zones

Groundwater sources, particularly public, group scheme and industrial supplies, are of critical importance in any region. Consequently, the objective of source protection zones is to provide an

additional element of protection, by placing tighter controls on activities within all or part of the zone of contribution (ZOC) of the source.

There are two main elements to source protection land surface zoning:

- Areas surrounding individual groundwater sources; these are termed Source Protection Areas (SPAs)
- Division of the SPAs on the basis of the vulnerability of the underlying groundwater to contamination.

These elements are integrated to give the Source Protection Zones.

2.3.2.1 Delineation of Source Protection Areas

Three source protection areas are recommended for delineation:

- Source Site (**SS**)
- Inner Protection Area (**SI**)
- Outer Protection Area (**SO**), encompassing the source catchment area or zone of contribution.

The orientation, shape and size of the Source Site is based on practical, non-technical considerations.

In delineating the Inner and Outer Protection areas, there are two broad approaches: first, using arbitrary fixed radii, which do not incorporate hydrogeological considerations; and secondly, a scientific approach using hydrogeological information and analysis, in particular the hydrogeological characteristics of the aquifer, the direction of groundwater flow, the pumping rate and the recharge.

Where the hydrogeological information is poor and/or where time and resources are limited, the simple zonation approach using the arbitrary fixed radius method is a good first step that requires little technical expertise. However, it can both over- and under-protect. It usually over-protects on the downgradient side of the source and may under-protect on the upgradient side, particularly in karst areas. It is particularly inappropriate in the case of springs where there is no part of the downgradient side in the zone of contribution. Also, the lack of a scientific basis reduces its defensibility as a method.

There are several hydrogeological methods for delineating SPAs. They vary in complexity, cost and the level of data and hydrogeological analysis required. Four methods, in order of increasing technical sophistication, are used by the GSI:

(i) calculated fixed radius
(ii) analytical methods
(iii) hydrogeological mapping
(iv) numerical modelling, using FLOWPATH.

Each method has limitations. Even with relatively good hydrogeological data, the heterogeneity of Irish aquifers will generally prevent the delineation of definitive SPA boundaries. Consequently, the boundaries must be seen as a guide for decision-making, which can be reappraised in the light of new knowledge or changed circumstances.

2.3.2.2 Source Site (SS)

This is the innermost protection area, which includes the source and usually the operational activities associated with water supply. It should be under the ownership and control of the local authority. The area should be fenced off and the boundaries should be at least 10m from the source. All potentially polluting activities not directly related to the production of drinking water should be prohibited and care should be taken that the operational activities do not cause contamination (e.g. runoff from paved areas, storage of fuel and chemicals).

2.3.2.3 Inner Protection Area (SI)

This zone is designed to protect against the effects of human activities that might have an immediate effect on the source and, in particular, against microbial pollution. The area is defined by a 100-day time of travel (TOT) from any point below the water table to the source. (The TOT varies significantly between regulatory agencies in different countries. The 100-day limit is chosen for Ireland as a relatively conservative limit to allow for the heterogeneous nature of Irish aquifers and to reduce the risk of pollution from bacteria and viruses, which in some circumstances can live longer than 50 days in groundwater.) In karst areas where conduit flow is dominant, the TOT approach is not applicable, as there are large variations in permeability, high flow velocities and a low level of predictability.

If it is necessary to use the arbitrary fixed radius method, a distance of 300m is chosen. A semi-circular area is used for springs. The distance may be increased for sources in karst (cavernous) aquifers and reduced in granular aquifers and around low yielding sources.

2.3.2.4 Outer Protection Area (SO)

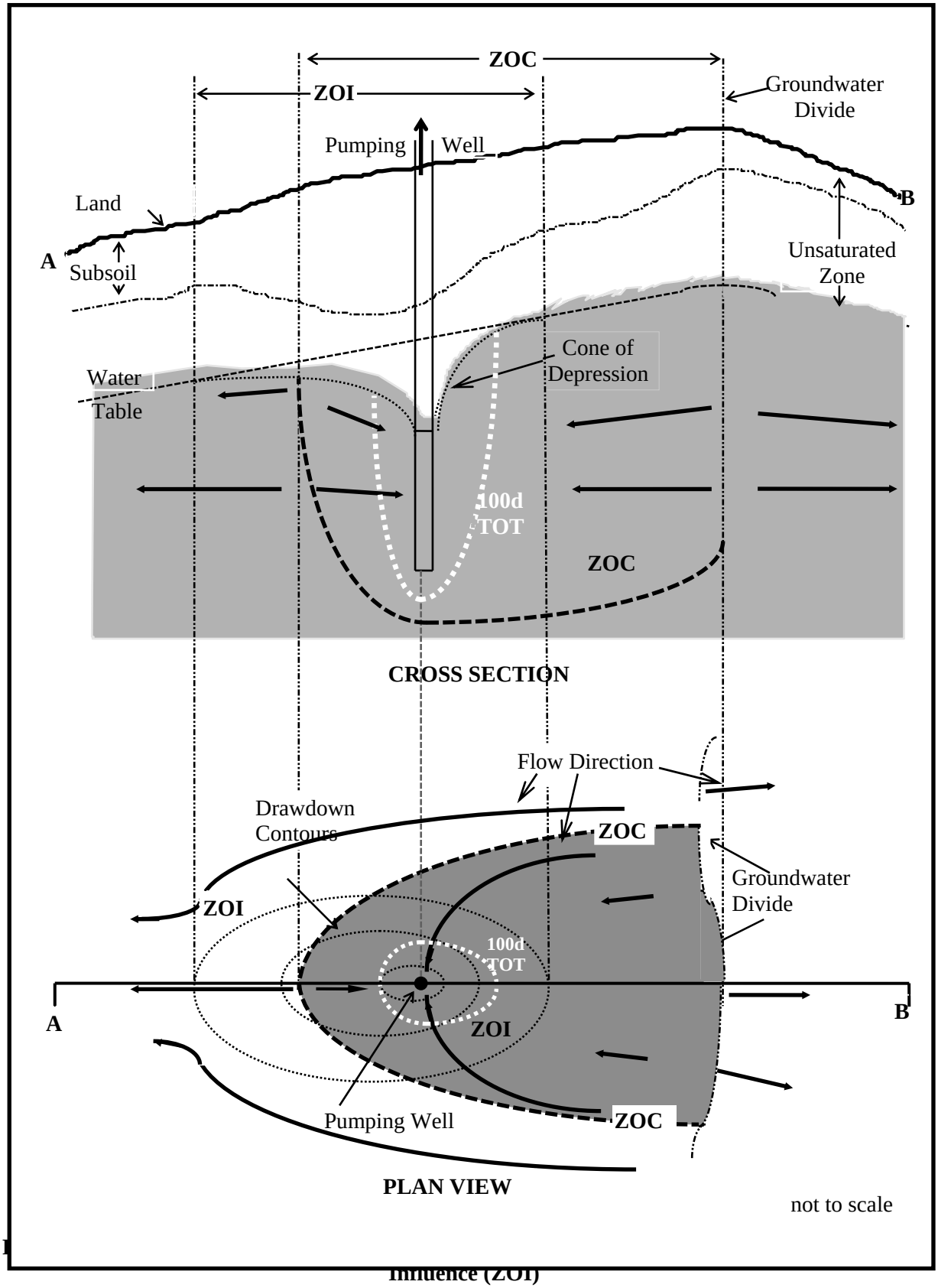
This zone covers the zone of contribution (ZOC) (or complete catchment area) of the groundwater source. It is defined as the area needed to support an abstraction from long-term groundwater recharge (the proportion of effective rainfall that infiltrates to the water table). The abstraction rate used in delineating the zone will depend on the views of the source owner. The GSI currently increases the maximum daily abstraction rate by 50% to allow for possible future increases in abstraction and for expansion of the ZOC in dry periods. In order to take account of the heterogeneity of many Irish aquifers and possible errors in estimating the groundwater flow direction, a 20° variation in the flow direction is frequently included as a safety margin in delineating the ZOC. A conceptual model of the ZOC (or outer protection area) and the 100-day TOT boundary (or inner protection area) is given in Figure 2.3.

If the arbitrary fixed radius method is used, a distance of 1000m is chosen with, in some instances, variations in karst aquifers and around springs and low-yielding wells.

The boundaries of the SPAs are based on the horizontal flow of water to the source and, in the case particularly of the Inner Protection area (SI), on the time of travel in the aquifer. Consequently, the vertical movement of a water particle or contaminant from the land surface to the water table is not taken into account. This vertical movement is a critical factor in contaminant attenuation, contaminant flow velocities and in dictating the likelihood of contamination. It can be taken into account by mapping the groundwater vulnerability to contamination.

2.3.2.5 Delineation of Source Protection Zones

The matrix in Table 2.2 below gives the result of integrating the two elements of land surface zoning (source protection areas and vulnerability categories) – a possible total of 12 source protection zones. In practice, the source protection zones are obtained by superimposing the vulnerability map on the source protection area map. Each zone is represented by a code e.g. **SO/H**, which represents an Outer Source Protection area where the groundwater is highly vulnerable to contamination. All of the hydrogeological settings represented by the zones may not be present around each local authority source.



Influence (ZOI)

(adapted from U.S. EPA, 1987)

Table 2.2. Matrix of Source Protection Zones

VULNERABILITY RATING	SOURCE PROTECTION		
	Site	***Inner***	***Outer***
Extreme (E)	SS/E	SI/E	SO/E
High (H)	SS/H	SI/H	SO/H
Moderate (M)	SS/M	SI/M	SO/M
Low (L)	SS/L	SI/L	SO/L

2.3.3 Groundwater Resource Protection Zones

For any region, the area outside the source protection areas can be subdivided, based on the value of the resource and the hydrogeological characteristics, into eight resource protection areas.

Regionally Important (R) Aquifers

(i) Karstified aquifers (where conduit flow is dominant) (**Rc**)
(ii) Fissured bedrock aquifers (**Rf**)
(iii) Extensive sand/gravel **(Rg)**

Locally Important (L) Aquifers

(i) Sand/gravel (**Lg**)
(ii) Bedrock which is Generally Moderately Productive (**Lm**)
(iii) Bedrock which is Moderately Productive only in Local Zones (**Ll**)

Poor (P) Aquifers

(i) Bedrock which is Generally Unproductive except for Local Zones (**Pl**)
(ii) Bedrock which is Generally Unproductive (**Pu**)

These aquifer categories are shown on an aquifer map, which can be used not only as an element of the groundwater protection scheme but also for groundwater development purposes.

The matrix in Table 2.3 below gives the result of integrating the two regional elements of land surface zoning (vulnerability categories and resource protection areas) – a possible total of 24 resource protection zones. In practice this is achieved by superimposing the vulnerability map on the aquifer map. Each zone is represented by a code e.g. **Rf/M**, which represents areas of regionally important fissured aquifers where the groundwater is moderately vulnerable to contamination. In land surface zoning for groundwater protection purposes, regionally important sand/gravel (**Rg**) and fissured aquifers (**Rf**) are zoned together, as are locally important sand/gravel (**Lg**) and bedrock which is moderately productive (**Lm**). All of the hydrogeological settings represented by the zones may not be present in each local authority area.

Table 2.3. Matrix of Groundwater Resource Protection Zones

VULNERABILITY RATING	RESOURCE PROTECTION ZONES					
	Regionally Important Aquifers (R)		Locally Important Aquifers (L)		Poor Aquifers (P)	
	Rc	**Rf/Rg**	**Lm/Lg**	**Ll**	**Pl**	**Pu**
Extreme (E)	Rc/E	Rf/E	Lm/E	Ll/E	Pl/E	Pu/E
High (H)	Rc/H	Rf/H	Lm/H	Ll/H	Pl/H	Pu/H
Moderate (M)	Rc/M	Rf/M	Lm/M	Ll/M	Pl/M	Pu/M
Low (L)	Rc/L	Rf/L	Lm/L	Ll/L	Pl/L	Pu/L

2.4 Groundwater Protection Response Matrices

The **Groundwater Protection Response Matrices** set out the recommended response to a certain type of development. The level of response depends on the different elements of risk - the vulnerability, the value of the groundwater (with sources being more valuable then resources and regionally important aquifers more valuable than locally important and so on) and the contaminant loading. By consulting a Response Matrix, it can be seen (a) whether such a development is likely to be acceptable on that site, (b) what kind of further investigations may be necessary to reach a final decision, and (c) what planning or licensing conditions may be necessary for that development. The response matrices do not necessarily restrict development, but are a means of ensuring that good environmental practices are followed.

Four levels of response (**R**) to the risk of a potentially polluting activity are recommended for the Irish situation:

R1 Acceptable subject to normal good practice.

R2$^{a,b,c,...}$ Acceptable in principle, subject to conditions in note a,b,c, etc. (The number and content of the notes may vary depending on the zone and the activity).

R3$^{m,n,o,...}$ Not acceptable in principle; some exceptions may be allowed subject to the conditions in note m,n,o, etc.

R4 Not acceptable

2.5 Integration of Groundwater Protection Zones and Response Matrices

The integration of the groundwater protection zones and the response matrix is the final stage in the production of the groundwater protection scheme. The approach is illustrated for a hypothetical potentially polluting activity in the matrix in Table 2.4 below:

Table 2.4. Groundwater Protection Scheme Matrix for Activity X

VULNERABILITY RATING	SOURCE PROTECTION			RESOURCE PROTECTION						
				Regionally Imp.		Locally Imp.		Poor Aquifers		
	Site	*Inner*	*Outer*	*Rk*	*Rf/Rg*	*Lm/Lg*	*Ll*	*Pl*	*Pu*	
Extreme (E)	R4	R4	R4	R4	R4	R3^{m}	R2^{d}	R2^{c}	R2^{b}	↓
High (H)	R4	R4	R4	R4	R3^{m}	R3^{n}	R2^{c}	R2^{b}	R2^{a}	↓
Moderate (M)	R4	R4	R3^{m}	R3^{m}	R2^{d}	R2^{c}	R2^{b}	R2^{a}	R1	↓
Low (L)	R4	R3^{m}	R3^{o}	R2^{d}	R2^{c}	R2^{b}	R2^{a}	R1	R1	↓
	→	→	→	→	→	→	→	→	→	

(Arrows (→ ↓) indicate directions of decreasing risk)

The matrix encompasses both the geological/hydrogeological and the contaminant loading aspects of risk assessment. In general, the arrows (→ ↓) indicate directions of decreasing risk, with the ↓ arrow showing the decreasing **likelihood of contamination** and the → arrow showing the direction of **decreasing consequence**. The **contaminant loading** aspect of risk is indicated by the activity type in the table title.

The **response** to the risk of groundwater contamination is given by the response category allocated to each zone and by the site investigations and/or controls and/or protective measures described in notes a,b,c,d,m n and o.

In deciding on the response decision, it is useful to differentiate between potentially polluting developments that already exist prior to implementation of a groundwater protection scheme and proposed new activities. For existing developments, the first step is to carry out a survey of the area and prepare an inventory. This is followed by site inspections in high risk situations, and monitoring

and operational modifications, perhaps even closure, as deemed necessary. New potential sources of contamination can be controlled at the planning stage. In all cases the control measures and response category depend on the potential contaminant loading, the groundwater vulnerability and the groundwater value.

Decisions on the response category and the code of practice for potentially polluting developments are the responsibility of the statutory authorities, in particular, the local authorities and the EPA; although it is advisable that the decisions should follow from a multi-disciplinary assessment process involving hydrogeologists.

At present, codes of practice have not been completed for any potentially polluting activity. Draft codes have been produced for landfills, septic tank systems and landspreading of agricultural wastes; only the landfill code of practice is readily available (from the EPA). Preparation of codes of practice requires the involvement and, in most instances, the agreement of the local authority. As a means of illustrating the use of the scheme and the relationship between the groundwater protection zones and the codes of practice, draft codes of practice are given in the following sectioins

2.6 Draft Response Matrix for Landfills

Table 2.5 gives a Response Matrix for landfills (from EPA, 1996) and this is followed by the specific responses to the proposed location of a landfill in each groundwater protection zone.

Table 2.5. Groundwater Protection Scheme Matrix for Landfills

VULNERABILITY RATING	SOURCE PROTECTION			RESOURCE PROTECTION						
				Regionally Imp.		Locally Imp.		Poor Aquifers		
	Site	*Inner*	*Outer*	*Rc*	*Rf/Rg*	*Lm/Lg*	*Ll*	*Pl*	*Pu*	
Extreme (E)	R4	R4	R4	R4	R4	R4	$R2^4$	$R2^4$	$R2^2$	↓
High (H)	R4	R4	R4	R4	R4	$R3^2$	$R2^4$	$R2^4$	$R2^2$	↓
Moderate (M)	R4	R4	R4	R4	$R3^2$	$R2^5$	$R2^3$	$R2^3$	$R2^1$	↓
Low (L)	R4	R4	$R3^1$	$R3^1$	$R3^1$	$R2^1$	$R2^1$	$R2^1$	$R2^1$	↓
	→	→	→	→	→	→	→	→	→	

(Arrows (→ ↓) indicate directions of decreasing risk)

- To reduce the risk to groundwater, it is recommended that landfills taking domestic/municipal waste be located in, or as near as possible, to the zone in the bottom right hand corner of the matrix.
- The engineering measures used must be consistent with the requirements of the national licensing authority (EPA).
- Landfills will normally only be permitted as outlined below.

$R2^1$ Acceptable.
Engineering measures may be necessary to provide adequate containment.
Engineering measures are likely to be necessary in order to protect surface water.

$R2^2$ Acceptable.
Engineering measures are likely to be necessary to provide adequate containment.
There may not be a sufficient thickness of subsoil on-site for cover material and bunds.

R2[3] Acceptable.
Engineering measures are likely to be necessary to provide adequate containment.
Special attention should be given to checking for the presence of high permeability zones.

R2[4] Acceptable.
Engineering measures are likely to be necessary to provide adequate containment.
Special attention should be given to checking for the presence of high permeability zones. If such zones are present, the landfill should not be allowed unless special precautions are taken to minimise the risk of leachate movement in the zones and unless the risk of contamination of existing sources is low. Also, the location of future wells down-gradient of the site in these zones should be discouraged.
There may not be a sufficient thickness of subsoil on-site for cover material and bunds.

R2[5] Acceptable.
Engineering measures are likely to be necessary to provide adequate containment.
Special attention should be given to existing wells down-gradient of the site and of the projected future development of the aquifer.

R3[1] Not generally acceptable, unless it can be shown that:
(i) the groundwater in the aquifer is confined, or
(ii) it is not practicable to find a site in a lower risk area.

R3[2] Not generally acceptable, unless it is not practicable to find a site in a lower risk area.

R4 Not acceptable.

Landfills on or near regionally important (major) aquifers should only be considered where no reasonable alternative can be found, and in the following instances:

- Where the hydraulic gradient (relative to the leachate level at the base of the landfill) is upwards for a substantial proportion of each year (confined aquifer situation).
- Where a map showing a regionally important (major) aquifer includes low permeability zones or units which cannot be delineated using existing geological and hydrogeological information but which can be found by site investigations. Location of a landfill site on such a unit may be acceptable provided leakage to the permeable zones or units is insignificant.
- Where the waste is classified as inert and waste acceptance procedures are employed in accordance with the proposal for an EU Directive on Landfill of Waste.

2.7 Draft Response Matrix for Septic Tank Systems

Table 2.6 gives a draft Response Matrix for septic tank systems and Table 2.7 gives the specific responses to the proposed location of a septic tank system in each groundwater protection zone.

Table 2.6. Draft Groundwater Protection Scheme Matrix for Septic Tank Systems

VULNERABILITY RATING	SOURCE PROTECTION			RESOURCE PROTECTION						
				Regionally Imp		Locally Imp.		Poor Aquifers		
	Site	*Inner*	*Outer*	*Rc*	*Rf/Rg*	*Lm/Lg*	*Ll*	*Pl*	*Pu*	
Extreme (E)	**R4**	**R3[1]**	**R3[3]**	**R3[3]**	**R2[2]**	**R2[2]**	**R2[1]**	**R2[1]**	**R2[1]**	↓
High (H)	**R4**	**R3[2]**	**R2[7]**	**R2[4]**	**R1**	**R1**	**R1**	**R1**	**R1**	↓
Moderate (M)	**R4**	**R2[9]**	**R2[6]**	**R2[3]**	**R1**	**R1**	**R1**	**R1**	**R1**	↓
Low (L)	**R4**	**R2[8]**	**R2[5]**	**R2[3]**	**R1**	**R1**	**R1**	**R1**	**R1**	↓
	→	→	→	→	→	→	→	→	→	

(Arrows (→ ↓) indicate directions of decreasing risk)

2.8 Information and Mapping Requirements for Land Surface Zoning

The **groundwater resources protection zone map** is the regional land-use planning map, and therefore is the critical and most useful map for the County Council. It is the ultimate or final map as it is obtained by combining the **aquifer** and **vulnerability maps.** The **aquifer map** boundaries, in turn, are based on the **bedrock map** boundaries and the **aquifer categories** are obtained from an assessment of the available **hydrogeological data**. The **vulnerability map** is based on the **subsoils map**, together with an assessment of relevant **hydrogeological data**, in particular indications of permeability and karstification. This is illustrated in Figure 2.4.

Similarily, the **source protection zone maps** result from combining **vulnerability** and **source protection area maps**. The **source protection areas** are based largely on assessments of **hydrogeological data**, but are usually influenced by the **geology**. This is illustrated in Figure 2.5.

The conceptual frameworks for groundwater resource and source protection shown in Figures 2.4 and 2.5 provide the structure for the remainder of this report:

- Chapter 3 Bedrock geology
- Chapter 4 Subsoils geology
- Chapter 5 Hydrogeology and aquifer classification
- Chapter 6 Hydrochemistry and water quality
- Chapter 7 Groundwater vulnerability
- Chapter 8 Groundwater protection

2.9 Flexibility, Limitations and Uncertainty

The Groundwater Protection Scheme is only as good as the information which is used in its compilation - geological mapping, hydrogeological assessment, etc. - and these are subject to revision as new information is produced. Therefore the scheme must be flexible and allow for regular revision.

Uncertainty is an inherent element in drawing geological boundaries and there is a degree of generalisation because of the map scales used. Therefore the scheme is not intended to give sufficient information for site-specific decisions. Also, where site specific data received by the County Council in the future are at variance with the maps, this does not undermine the scheme, but rather provides an opportunity to improve the scheme. In essence a Groundwater Protection Scheme is a tool which helps Council officials to respond to relevant development proposals and is a means of showing that the County Council is undertaking its responsibility for preventing groundwater contamination in a practical and reasonable manner.

2.10 Conclusions

- Groundwater protection schemes are an essential means of enabling local authorities to take account of (i) the potential risks to groundwater resources and sources and (ii) geological and hydrogeological factors, when considering the location of potentially polluting developments; consequently, they are now an essential means of preventing groundwater contamination.

- If planning decisions based on a groundwater protection scheme are to be readily defensible, it is important that the scheme should be founded on hydrogeological concepts and on a sufficient degree of geological and hydrogeological information.

- Groundwater protection schemes should not be seen as a panacea for solving all groundwater contamination problems. In practice their use needs a realistic and flexible approach. The maps have limitations because they generalise (with the degree of generalisation depending on data availability) variable and complex geological and hydrogeological conditions. Consequently, the

proposed scheme is not prescriptive and needs to be qualified by site-specific considerations and investigations. The investigation requirements depend mainly on the degree of hazard provided by the contaminant loading and, to a lesser extent, on the availability of hydrogeological data.

♦ The scheme has the following benefits and uses:

- it provides a hierarchy of levels of risk and, in the process, assists in setting priorities for technical resources and investigations;
- it contributes to the search for a balance of interests between groundwater protection issues and other special and economic factors;
- it can be adapted to include risk to surface water;
- it acts as a guide and provides a 'first-off' warning system before site visits and investigations are made;
- it shows generally suitable and unsuitable areas for potentially hazardous developments such as landfill sites and piggeries;
- by controlling developments and enabling the location of certain potentially hazardous activities in lower risk areas, it helps ensure that the pollution acts are not contravened;
- it can be used in preparing Emergency Plans, assessing environmental impact statements and the implications of EU directives, planning and undertaking groundwater monitoring networks and in locating water supplies.

♦ The groundwater protection scheme outlined in this report will be a valuable tool and a practical means in helping to achieve the objective of sustainable water quality management, as required by national and EU policies. Effective use of the scheme achieves this objective because it provides:

- geological and hydrogeological information and knowledge as a basis for decision-making and land-use planning;
- a framework and policy which enables groundwater to be protected from the impacts of human activities;
- codes of practice for the location and control of potentially polluting activities.

Table 2.7. Responses to the Proposed Location of a Septic Tank System

(draft, subject to change)

Response Code	Acceptability, Conditions or Exceptions
R1	**Acceptable**, subject to normal good practice (i.e. compliance with S.R.6 : 1991).
R2[1]	**Probably acceptable**, subject to compliance with S.R.6:1991. Particular attention should be given to the depth of subsoil in situations where there are nearby wells and springs.
R2[2]	**Probably acceptable**, subject to compliance with S.R.6:1991. Special attention should be given to the depth of subsoil over bedrock and to the thickness of the unsaturated zone in free-draining areas.
R2[3]	**Probably acceptable**, subject to compliance with S.R.6:1991. Special attention should be give to the location of karst features, such as swallow holes and collapse features. Percolation areas should not be located within 15 m of such features.
R2[4]	**Probably acceptable**, subject to compliance with S.R.6:1991. Particular attention should be given to (i) the depth of subsoil over bedrock, (ii) in free-draining areas, the thickness of the unsaturated zone, (iii) Percolation areas should not be located within 15 m of karst features.
R2[5]	**Probably acceptable**, subject to: (i) compliance with S.R.6:1991, and (ii) provision of evidence *(e.g. from nearby wells)* on the type and depth of subsoil to confirm that the site is not in a higher risk zone that precludes the location of septic tank systems.
R2[6]	**Probably acceptable**, subject to: (i) compliance with S.R.6:1991; (ii) provision of evidence *(e.g. from nearby wells)* on the type and depth of subsoil to confirm that the site is not in a higher risk zone; (iii) taking account of the number of existing houses so that the problem of significant contamination by nitrate does not arise.
R2[7]	**Probably acceptable**, subject to: (i) compliance with S.R.6:1991; (ii) provision of evidence *(e.g. from nearby wells)* on the type and depth of subsoil to confirm that the site is not in a higher risk zone; (iii) taking account of the number of existing houses so that the problem of significant contamination by nitrate does not arise. Engineered preventive measures, such as on-site treatment systems, may be advisable to reduce the risks in some situations (*for instance, where the site is close to the limits of the zone – close to extreme vulnerability or the SI zone boundary*).
R2[8]	**Probably acceptable**, subject to: (i) compliance with S.R.6:1991; (ii) provision of evidence *(e.g. from nearby wells)* on the type and depth of subsoil to confirm that the site is not in a higher risk zone; (iii) that surface ponding of effluent and/or shallow contaminated groundwater does not pose a significant risk to the source (*this would apply particularly where the site is up-gradient of the source and/or the well casing has not been grouted and sealed*).
R2[9]	**Probably acceptable**, subject to: (i) compliance with S.R.6:1991; (ii) provision of evidence *(e.g. from nearby wells)* on the type and depth of subsoil to confirm that the site is not in a higher risk zone; (iii) taking account of the number of existing houses so that the problem of significant contamination by nitrate does not arise; (iv) an assessment that surface ponding of effluent and/or shallow contaminated groundwater does not pose a significant risk to the source (*this would apply particularly where the site is up-gradient of the source and/or the well casing has not been grouted and sealed*).
R3[1]	**Not generally acceptable**, unless it is shown by investigation and assessment that the risk to groundwater is reduced by the hydrogeological situation at the site (e.g. *if the site is in a lower risk zone where septic tank systems are acceptable subject to compliance with S.R.6:1991). (On-site treatment systems should not be seen as an alternative.)*
R3[2]	**Not generally acceptable**, unless it is shown by investigation and assessment that the risk to groundwater is reduced by the hydrogeological situation at the site *(e.g. if the site is in a lower risk zone or the subsoil thickness is substantially greater than 3 m or, in the case of sands/gravels, the unsaturated zone is substantially greater than 3 m*) or alternatively can be significantly reduced by the use of engineered preventive measures, such as on-site treatment systems. Compliance with S.R.6:1991 or appropriate Agrement Certificate is essential.
R3[3]	**Not generally acceptable**, unless it is shown by investigation and assessment that the risk to groundwater is reduced by the hydrogeological situation at the site *(e.g. if the site is in a lower risk zone*) or alternatively can be significantly reduced by the use of engineered preventive measures, such as on-site treatment systems. Compliance with S.R.6:1991 or appropriate Agrement Certificate is essential.
R4	Not acceptable

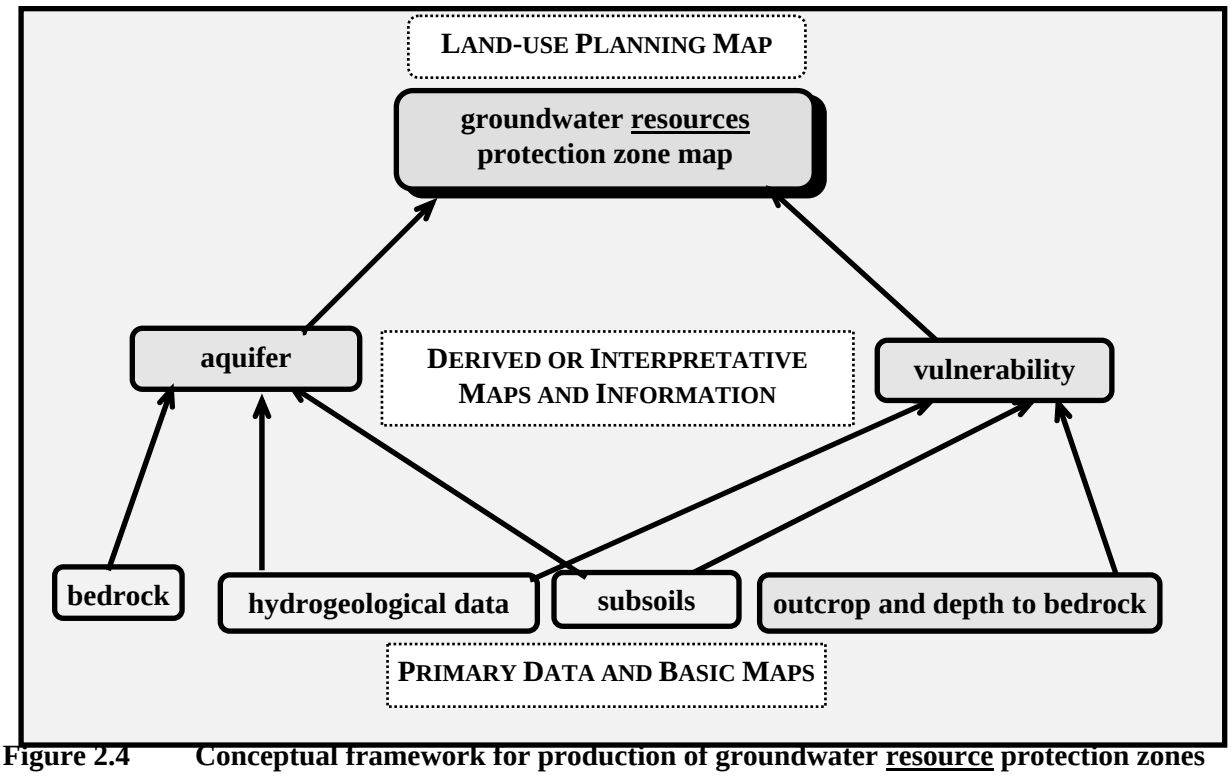


Figure 2.4 Conceptual framework for production of groundwater resource protection zones

(indicating information needs and links)

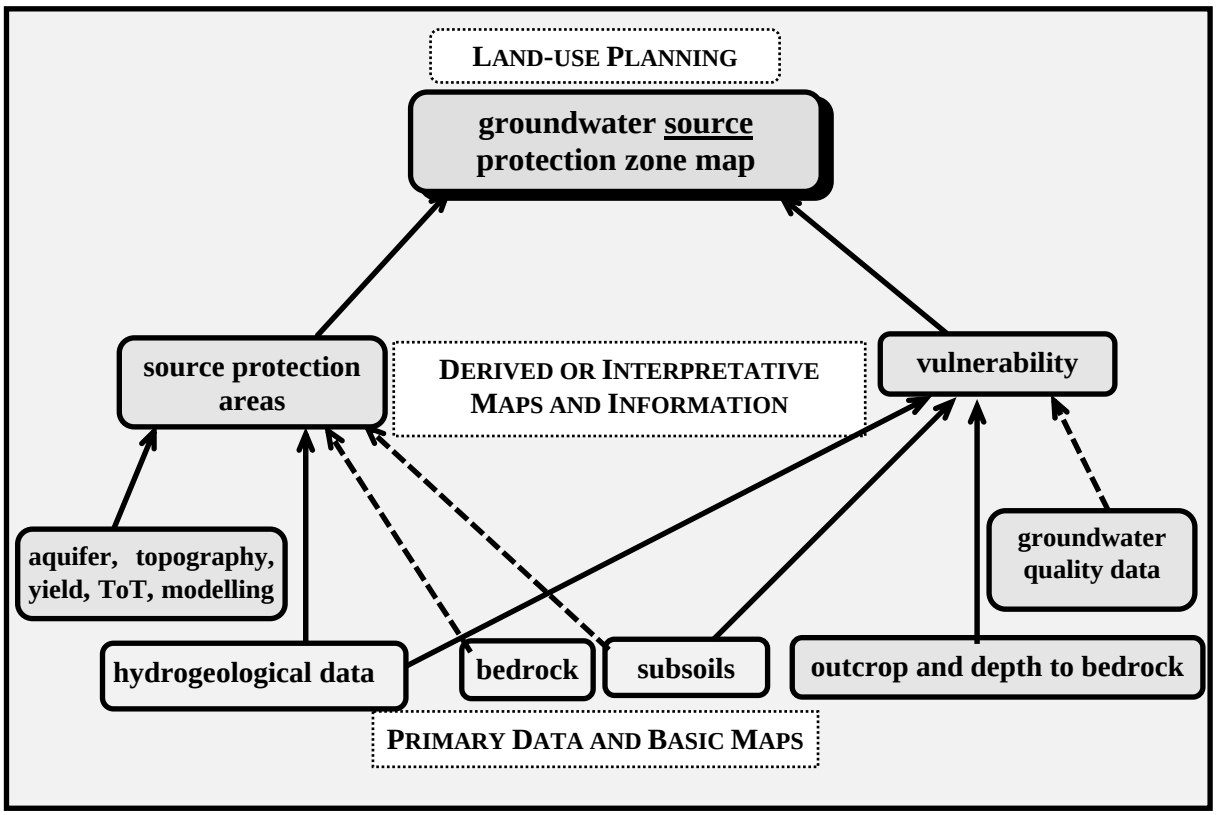


Figure 2.5 Conceptual framework for production of groundwater source protection zones

(indicating information needs and links)

3. Bedrock Geology

3.1 Introduction

The bedrock geology of County Meath is comprised of rocks that range in age from the Lower Palaeozoic to the Mesozoic (500 to 205 million years old). The rocks can be divided into four main groups: Ordovician and Silurian shales, greywackes and volcanics; Lower Carboniferous limestones and shales; Upper Carboniferous (Namurian) sandstones and shales; and Permian/Triassic sandstones.

South Meath consists of an accumulation of Lower Carboniferous deep water muddy limestones, an extension of the Dublin Basin. This basin is bounded to the north by older Lower Palaeozoic rocks of the Longford-Down Inlier and to the east by the Balbriggan Inlier. Shallow water clean limestones of equivalent age are found south of Drogheda and around Lough Sheelin.

In the north of Meath, the Kingscourt Outlier is a smaller Basin/Platform consisting of Lower Carboniferous shallow water limestones and clastic rocks. The Kingcourt Outlier, like the Dublin Basin, rests unconformably on the surrounding Lower Palaeozoic rocks. Upper Carboniferous rocks of Namurian age are found overlying these limestones south of Kingscourt, around Summerhill, Trim and Slane.

The youngest rocks in Meath are Permian and Triassic sandstones, which are found around Kingscourt and rest unconformably on the Namurian.

As a result of limited bedrock outcrop in many areas, the geological boundaries are uncertain, in particular the boundary between the Lower Palaeozoic and the Carboniferous rocks. The orientations of many of the faults are also speculative/conceptual and this must be remembered when interpreting the Geology and Aquifer maps.

The bedrock geology is presented in Map 2 (E & W). A brief summary of the bedrock geology is given below, in conventional geological order, i.e. beginning with the oldest rocks. The formal geological formation names have been used, to facilitate comparison with the GSI bedrock maps (Sheets 13 and 16).

3.2 Lower Palaeozoic Rocks

The oldest rocks in Co. Meath are Ordovician and Silurian in age (500 - 410 million years) and belong to the Lower Palaeozoic era. These rocks occur in the Longford-Down Inlier, northeast from Slane - Newtown, Navan - Castletown, and in the northwest around Kells, Slieve na Calliagh, Moynalty and to the west of Kilmainhamwood. The second main area is to the east, the Balbriggan Inlier around Gormanstown, Bellewstown and Ardcath.

The Lower Palaeozoic rocks represent a complex geological history and comprise a wide range of rock types including greywackes (turbidites), volcaniclastic sediments, lavas, shales, mudstones and cherts. During the Ordovician the Iapetus Ocean began to close and volcanoes formed adjacent to the continental margins, giving rise to a complex suite of volcanic and deep water sediments. During the Devonian to early Carboniferous periods the two continents collided and the accumulated sediments were squeezed up to form a chain of mountains (Caledonian Orogeny). The Navan-Silvermines Fault is thought to represent the Iapetus Suture along which the two continents collided.

These rocks are highly folded and faulted by several phases of deformation. The rocks have also been metamorphosed on a regional scale transforming the original shales and sandstones and giving the rocks their pervasive fabric or cleavage which allows these rocks to be instantly recognisable.

The Lower Palaeozoic rocks in northwest Meath have not been comprehensively mapped since the last century. They are predominantly grey to green, thin bedded to massive greywackes and shales and are undifferentiated on the Geology map.

The Lower Palaeozoic rocks of the Longford-Down Inlier have been divided into several blocks or tracts (Vaughan 1991), usually separated by faults. The Silurian blocks are Clontail Tract, Salterstown Tract and Rathkenny Tract north of the suture and the Clogherhead Tract south of the suture. The Ordovician is divided into 3 groups, Mellifont Abbey Group, Grangegeeth Group and Slane Group.

In the Balbriggan Inlier (Murphy 1984) the Silurian in the northern sector is divided into 3 formations: Kennetstown Formation, Clatterstown Formation and Denhamstown Formation.

The Ordovician rocks are classified into three formations in the north: Carnes Formation, Hilltown Formation, Prioryland Formation, and three in the southern sector: Clashford House Formation, Herbertstown Formation and Fourknocks Formation.

Table 1 gives brief descriptions of the Ordovician, Silurian and Devonian rocks, taken from PhD. theses by Vaughan (1991) and Murphy (1984).

3.3 Lower Carboniferous

During the Lower Carboniferous there occurred a transgression of the sea which resulted in the deposition of limestones. These rocks lie unconformably upon the Lower Palaeozoic rocks. Deposition was very complex with local variations whose lack of lateral continuity has resulted in many local stratigraphical units.

3.3.1 Basal Clastics (Red Beds)

The Lower Palaeozoic rocks on the northern side of Slieve na Calliagh are unconformably overlain by a variable thickness (0-5m) of Red Beds. These consist of red sandstones, siltstones and mudstones with conglomerates. On the Geology Map these rocks are not differentiated from the Navan Beds except near Slieve na Calliagh.

3.3.2 Navan Group

The Navan Group comprises: the Red Beds, the Mixed Beds, the Pale Beds and the Shaly Pales (Philcox 1984), which are not differentiated on the Geology Map.

The Red Beds (fluviatile or alluvial plain) form the basal unit (up to 45m) consisting of red clastics which fine upwards from coarse grits and conglomerates to laminated sandstones and siltstones.

The Mixed Beds comprise the Laminated Beds (dark laminated siltstones, mudstones and shales, which are partially marine) and the Muddy Limestone (dark fine grained, well bedded argillaceous and crinoidal limestone, indicating a rapid transition from periodically clastic to fully marine carbonate sedimentation.)

The Pale Beds (200m) comprised pale to grey argillaceous carbonate-cemented sandstones, silts and shales with pelletal, oolitic and bioclastic calcarenites. The Stackallan Member (60-100m), a pale to dark grey, generally massive fine grained micritic limestone, defines the base of the Pale Beds. The uppermost 0-8m of the unit is often dolomitised and recrystallised.

The Shaly Pales (100-110m) consist of bioclastic sandstones, shales and siltstones; grey sandstones and calcarenites and dark shales.

In the Kingscourt area the Rockfield Sandstone Member (maximum 70m thick) occurs at the base of the Shaly Pales, and is a fairly uniform medium to coarse grained sandstone with some muddy sandstone with thin shales. Above the Rockfield Sandstone are sandy bioclastic limestones.

3.3.3 Argillaceous Bioclastic Limestone (ABL)

The ABL (250-280m) comprises dark grey, well bedded, strongly crinoidal shaly limestones and mudstones, which become increasingly crinoidal and paler upwards.

3.3.4 Waulsortian Reef Limestone

The Waulsortian Limestone (50-200m) comprises massive pale grey biomicrites formed as mounds of calcareous mud in deep to moderate water depths.

In northwest Meath near Oldcastle the limestone sequence is much thinner (Brand & Emo 1985) and the Waulsortian is absent.

In the Kingscourt area the equivalent to the Waulsortian is the Kilbride Limestone which is thickly bedded, coarse grained crinoidal limestone with thin shale partings. On the Geology Map the Kilbride Limestone is included in the ABL.

At Navan the ABL and the Waulsortian are absent due to erosion. Overlying the erosion surface is a Boulder Conglomerate 50m thick at the base of the Calp. The Tobercolleen Limestone is also absent from the Navan area.

3.3.5 Tobercolleen Limestone

The Tobercolleen (or lower Calp basin limestone) is deep basinal, (85m thick) predominantly (>90%) black, terrigenous mudstone and calcareous shales and often bioturbated.

3.3.6 Calp Limestone

These are basinal sediments consisting of dark grey, fine grained, graded limestones (bioclastic calcarenites), interbedded with black calcareous mudstones and shales. The thickness of the limestone beds, grain size, colour and the proportion of shale vary widely. Towards the top of the Calp the basinal limestones are often interbedded with shallower water oolites or graded crinoidal calcarenites and calcirudites of turbiditic origin, which become more frequent towards the basin margins. Occasional thin sandy limestones can also be encountered. Lateral variations occur within the Calp Limestone between basin-edge successions and its finer-grained basin-centre equivalents.

3.3.7 Derravaragh Limestone

These limestones are a lithological variation of the Calp Limestone and are silicified thick bedded limestones, with chert nodules and shaly layers. South of Slieve na Calliagh the Calp Limestone is overlain by or passes into the Derravaragh Limestone (Personal Communication, D. Smith, GSI).

3.3.8 Shallow Water Limestone

Shelves of clean limestone occur in the extreme north (Kingscourt) and east (Lower Boyne Valley and Naul) areas. North of Slieve na Calliagh shallower and coarser, cleaner, turbiditic limestones also occur. These shallow water limestones are laterally equivalent to the deep water Calp Limestone.

These platform limestones are over 850 m thick and comprise four formations (not differentiated on the Geology Map):

The Crufty Formation (maximum 60m thick) includes intertidal and shallow subtidal micrites, sandstones shales and peloidal packstones. In some places it is extensively dolomitised.

The Holmpatrick Formation (maximum 480m thick) is dominated by coarse grained crinoidal limestones and is heavily dolomitised.

The Mullaghfin Formation (maximum 80m thick) is similar to the Holmpatrick Formation but has horizons of micritic limestone and mudbanks. Evidence exists for some palaeokarstic features *(Bridge Farm quarry, Nobber and Barley Hill quarry, Ardagh).*

The Deer Park Formation (maximum 100m thick) consists of medium grey, thickly bedded crinoidal limestones, dark grey to black, cherty thinly bedded argillaceous wackestone and packstones and massive pale grey, crinoidal limestones (P. Strogen *et al* 1995).

These limestones also occur south of Drogheda (Pickard *et al* 1992 & 1994) and platform sedimentation occurred across the lower Boyne Valley. They are overlain by basinal limestones and shales of the Calp. The basal part of the Calp consists of coarse conglomerates and graded calcarenites which fine upwards, to be succeeded by shale-dominated limestones.

3.3.9 Edenderry Limestone

These limestones are a lithological variation of the platform limestones which formed on high energy shallow water shelves. They are poorly bedded, medium to coarse grained oolitic (spherical grains) limestones. Some of the oolites appear to have been transported away from the shelf edge, which may explain their occurrence within the Calp at Castlerickard Bridge, near Longwood.

3.4 Namurian

The conformable Namurian shales and sandstones (Pro-Delta environment) occur around Summerhill, SE of Slane, near Trim and in the Kingscourt area. There is an almost complete succession of Namurian rocks in the Kingscourt Outlier, but the younger sandstones are not preserved elsewhere in Meath.

The Summerhill Syncline (Nevill, 1957) is divided into the Lower Shale Series (600 m of alternating dark thinly bedded shales and black argillaceous limestones, some graded greywackes and occasional thin sandstone beds), the Upper Black Shale Series (approximately 75 m of soft black shales) and the Moynalvy Sandstone Beds (approximately 90 m of fine grained olive green sandstones occurring around Garadice, Moynalvy and Woodtown). These are not differentiated on the Geology Map.

South of Slane the Namurian is dominated by shales.

In the Kingscourt area the Namurian consists of up to 500m of alternating, thick shale-dominated units, and thick sandstone-dominated units, each named and dated (Jackson 1965) which are not differentiated on the Geology Map:

The Ardagh Shale (80 metres of black shales with clay ironstone nodules) and the Ardagh Sandstone, (70 metres of massive micaceous sandstones with sandy shales). These sandstones are seen in two swallow holes (near Barley Hill House) at the junction with the underlying shales and Visean limestone).

The Barley Hill Grits include the Carrickleck Sandstone (60 metres of buff coloured and often pebbly sandstone, highly weathered and friable; the sandstone thins northwards), and the Carrickleck Shale (85 metres). Above the Carrickleck Shale are two more sandstones separated by shale (25metres in all) with a dolerite sill (Barley Hill Sill, 3 metres thick) near the base.

The Rathe Sandstones, Clontrain Grit (generally white in colour) the Corratober Grits and Shales, Corratober Brick-Shale, Corrybracken Sandstones and the Cabra Sandstones and Shales all have alternating sequences of white, grey and red sandstones or siltstones, with grey to black shales, carbonaceous shales, clay ironstone bands and thin traces of coal seams (Jackson 1965).

3.5 Permian

These rocks are limited to the Kingscourt area and lie unconformably upon the Upper Carboniferous. These terrestrial desert sediments are generally red due to iron oxidation under tropical conditions. The basal Permian rocks are latterly impersistent and typically 90 metres thick. The Upper Permian rocks of the Kingscourt Gypsum Formation (Visscher 1971) consist of:

Basal Conglomerate Member, (absent in the east), 0-18m thick, with a gypsum matrix

Lower Mudstone Member, 2-25m of grey mudstones, shales and laminated siltstones occasionally calcareous

Lower Gypsum Member, 20-35m of shales and evaporites including Gypsum; the gypsum is white or grey and forms massive beds near the top of the sequence

Middle Mudstone Member, 6-12m of micaceous red shales

Upper Gypsum Member, 6-10m of red mudstones with massive pink gypsum beds and red siltstones

Upper Mudstone Member, 26-35m of red mudstones and clays with gypsum lenses over a metre thick at the top

3.6 Triassic

The Permian rocks are succeeded conformably by at least 500 metres of Triassic red bed sequences of the Kingscourt Sandstone Formation (Visscher 1971) which is comprised of four Members: the basal Siltstone Member (80-100m) with alternating siltstones and fine sandstones, and the Lower (70-100m), Middle (2-30m),and Upper (>270m) sandstone members of fine red sandstones with laminations. In all members red is the dominant colour although green and grey bands occur, and individual sandstone beds are thick. The sandstones are uniform in grain size with only occasional coarser or shaly units. The four members are not differentiated on the Geology Map.

4. Quaternary (Subsoils) Geology

4.1 The Quaternary Period

The Quaternary Period is the most recent period of geological time, generally taken to cover the last 1.65 million years. It is subdivided into two epochs which are the Pleistocene (1.65 million to 10,000 years ago) and the Holocene (10,000 years ago to the present). The Holocene, in Ireland, is the post-glacial period. Most of the subsoil sediments in Ireland were deposited during the last 130,000 years.

Quaternary sediments differ from earlier sediments in being generally unlithified. Most Quaternary sediments owe their genesis in one way or another to the action or melting of ice. Ireland was covered by ice for long periods in the last 130,000 years, just as many high latitude regions are nowadays. The last glaciation occurred between 63,000 years ago and 10,000 years ago, and had a huge influence on both the landscape and the underlying geology of the country. Since 10,000 years ago the action of modern rivers and the infilling of lakes, along with the formation of peat bogs, have been the main natural processes affecting both our landscape and geology.

4.2 Glaciation In Ireland

There is direct evidence in Ireland of no more than two glacial periods. There may have been others, but the destructive power of ice sheets has removed any earlier evidence. Ireland has, though, a very rich legacy of glacial deposits and landforms relating to the most recent glaciation. Over 90% of Ireland is covered by deposits from this period.

The most recent glaciation lasted for about 63,000 years and ended only 10,000 years ago, when our climate warmed again. The maximum extent of the ice occurred sometime between 20,000 and 22,000 years ago, when it covered the whole country apart from a limited area in the southwest around west Limerick and north Kerry. In other areas only the highest mountain peaks stuck up above the ice. This ice was moving all the time, under its own weight, rather like wet concrete.

As ice moves, pieces of rock and soil over which it flows become attached to its base, and may become incorporated into the lower layers of the ice, making the base of the ice very abrasive. It can then rapidly erode the underlying material. In this way the substrate is eroded, picked up and transported by the ice. When the ice melts, the material is deposited as one of the many landforms caused by glacial ice. Thus rocks can be carried far away from their source and left as ‘erratics’, either at the surface or incorporated into the subsoil.

4.3 Glacial Deposits in County Meath

Many of the Quaternary deposits in County Meath were laid down during the last glaciation affecting Ireland. County Meath was completely smothered by the ice sheet, which moved in a general southeasterly direction. The deposits remaining from this glaciation are varied in their sedimentology and their landforms. County Meath has a very varied suite of landforms which, together with their sedimentology, gives hints as to the events which took place during the last glaciation in the county.

Eight main genetic types of sediment were recognised during the Quaternary mapping:

- tills
- esker sands and gravels
- alluvium
- head
- glacio-fluvial sands and gravels
- glacio-lacustrine deposits
- peat
- marine deposits

Bedrock at or close to the surface, was also mapped.

Till (commonly 'Boulder Clay') is sediment deposited by or from glacier ice, which is the principal depositional agent, but gravity and, in some cases, water, also play a part. Tills are often overconsolidated, or tightly packed, unsorted, unbedded, include many different particle and clast (stone) sizes, and commonly have sharp, angular clasts. On the GSI's 1:25,000 maps tills are categorised according to their dominant lithological component, e.g. Lower Carboniferous limestone till or Lower Palaeozoic shale till. The texture of the till must be taken into account, as this determines its permeability. Thus tills may be described as gravelly, sandy, silty or clayey till.

Within different till types, a wide variety of permeabilities are possible. In this project, generalisations were made to classify the tills as stony, bouldery, gravelly, sandy, silty, clayey, etc. On the maps fourteen different till textures have been recorded. Those examined in the field only, *i.e.* that were not sampled and sieved, were classified according to the dominant particle size observed (surrounding drainage was also taken into account). Most were recorded as stony, gravelly, sandy, silty or clayey, and only in cases where a bi-modal particle size distribution was extremely obvious were they given a dual label *i.e.* stony sandy till, gravelly clayey till. Where exposure was exceptionally poor the till was classified as 'undifferentiated'. Those labelled in the field and those that were sampled and sieved were classified thus:

- Undifferentiated: Applied to deposits observed only in the field, as sieving always resulted in a particle size classification.
- Clayey: >30% silt/clay **or** >20% silt/clay and <30% sand (clasts <50%); in both cases where field observations recorded the till as **clayey**.
- Silty: >30% silt/clay **or** >20% silt/clay and <30% sand (clasts <50%); in both cases where field observations recorded the till as **silty**.
- Sandy: >40% sand **or** >30% sand and <20% silt/clay; in both cases where field observations recorded the till as **sandy**.
- Gravelly/Stony >55% clasts **and** <45% sand, silt and clay (with none dominant), where field observations recorded the till as gravelly/stony. (In the case of gravelly and stony tills, field observations are very important.)
- Sandy Gravelly: >50% clasts **and** >30% sand. (Field observations again important.)
- Silty Gravelly: >50% clasts **and** >30% silt/clay, where the matrix was recorded in the field as silt.
- Sandy Silty: >30% sand **and** >30% silt/clay, where the matrix was recorded in the field as very silty.
- Gravelly Clayey: >50% clasts **and** >25% silt/clay, where the matrix was recorded in the field as clayey and the till 'gravelly'.
- Stony Sandy: >50% clasts **and** >30% sand, where the till was recorded in the field as 'stony'.
- Clayey Stony: >50% clasts **and** >25% silt/clay, where the matrix was recorded in the field as clayey and the till 'stony'.
- Stony Silty: >50% clasts **and** >25% silt/clay, where the matrix was recorded in the field as silty and the till 'stony'.
- Bouldery: >55% clasts **and** where the till was recorded in the field as 'bouldery'.

Till is the most extensive Quaternary deposit occurring within the county. Seven till types occur:

Till derived from Lower Palaeozoic rocks is found in two major areas in the county: (i) to the north of Navan, (i) in the Bellewstown/Gormanston area. This till is generally orange/brown in colour, matrix-dominated and clayey, resulting in relatively poor drainage characteristics.

Till derived from Lower Carboniferous limestone is the most dominant till type found within the county, cropping out over the majority of the area south of Navan, and in a southwest-northeast trending strip northeast of Kells. The till is usually matrix dominated, but may be very stony in the areas of Calp limestone in the south of the county. Generally the deposit has a brown colour, and enjoys better drainage than the till derived from Lower Palaeozoic rocks, despite the wide range of textures seen.

Till derived from Upper Carboniferous (Namurian) rocks is found in relatively small areas throughout the county, the largest three being (i) northeast of Nobber, (ii) southwest of Donore and (iii) southwest of Warrenstown. This till is generally dark brown in colour, matrix-dominated and clayey, with quite poor drainage characteristics. A limited area of till derived from weathered Namurian sandstone occurs in the extreme north of the county around Ardagh, where it is sandy and quite well drained.

Till derived from chert occurs in two small areas: (i) to the south of Drumone, on the ridges immediately north of Lough Bane; and (ii) southwest of Trim, north of the confluence of the Boyne and Deel rivers. These tills are stony, with varying matrix textures, and quite well drained.

Till derived from Triassic sandstone occupies an area of less than two square kilometres in the extreme north of the county just east of Kingscourt. This till is red in colour, and is quite clayey despite being derived chiefly from sandstone. This is due to the influence of the surrounding (clayey) Lower Palaeozoic tills.

Till derived from Basic Igneous rocks occurs southeast of the Carrickdexter Escarpment just west of Slane. This till is quite stony, and is well drained due to its shallow depth.

Irish Sea Till is found east of a line joining Drogheda and Duleek. This till is very clayey and its colour varies across the area. South of this area the outwash gravels around Bettystown/Gormanston are underlain by the same till between 5m depth and bedrock.

Glacio-fluvial sands and gravels are different from tills in that they are deposited by running water only. The gravels are usually stratified (layered) and pebbles are usually rounded. Glacio-fluvial deposits are usually loosely packed. Due to the huge amounts of water produced by the melting of the ice sheet which covered most of Ireland at the end of the last glacial period, these deposits are very common in Ireland. They represent the stagnation and decay of the ice sheets. On the maps they are represented as ‘sands and gravels’ and are also categorised according to their dominant rock type *e.g.* Lower Carboniferous limestone sands and gravels. They give rise to a variety of different landforms, including ‘kames’, ‘moraines’ and, in some cases, ‘drumlins’.

Sands and gravels are quite widespread across the county, and abundant in many of the hummocky areas below 120m altitude. The largest expanses of gravel occur along the Blackwater and Boyne Valleys, around Castletown, west of Drumone, west of Summerhill and north of Gormanston.

Esker sands and gravels are laid down by glacial meltwaters in tunnels and crevasses in stationary or retreating ice sheets, and are seen on land as long, narrow, sinuous ridges. They commonly include rounded boulders and cobbles. Clasts are usually much larger overall than in other glacio-fluvial deposits. Sand may or may not be present. The esker alignment usually corresponds closely with the ice flow direction. The gravels are usually bedded, the beds often slumping towards the flank of the esker, indicating collapse as the confining ice walls melted.

Esker sands and gravels are quite common, especially in the southern two-thirds of the county. The most extensive esker systems occur around Murrens, west of Kells, in Castletown and in the Trim/Summerhill region.

Glacio-lacustrine deposits were deposited into a large number of meltwater-fed lakes during and shortly after deglaciation. Deposits consist of sorted gravel, sand, silt and clay. They are found normally in wide flat plains, or in small depressions in the landscape. The deposits have different permeabilities depending on the dominant grain size. Deltas, which are formed as sediment is deposited at a river mouth on entry into a glacial lake, usually contain interbedded sands and gravels which dip lakeward. These are left as gravel and sand hills when the ice disappears and the lake drains away. Lacustrine basins, which are distal parts of the lake system, usually contain finer sediments, such as clays and silts. The differentiation of the dominant grain sizes within lacustrine sediments is imperative as such a wide variety of grain size combinations is possible, each resulting in a different permeability.

Glacio-lacustrine silts and clays are usually found around and beneath the county’s most extensive peat bogs, and are also common in the interdrumlin hollows in the north of the county.

Alluvium is a post-glacial deposit and may consist of gravel, sand, silt or clay in a variety of mixes and usually includes a fairly high percentage of organic material (10%-30%). Alluvium is mapped only on modern river floodplains. The alluvial deposits are usually bedded, consisting of many complex strata of waterlain material left both by the flooding of rivers over their floodplains and the meandering of rivers across their valleys.

Alluvium is present along most of the major rivers in the county (Boyne, Blackwater, Nanny, Dee, Tolka, Deel, Stonyford, Athboy, Moynalty, Kilmainham, Upper Inny) albeit discontinuously.

Peat is also a post-glacial deposit, consisting mostly of partially decomposed vegetation which has accumulated and compacted in marshes, ponds and lakes carved out and left by Quaternary ice sheets. In Ireland, peat usually overlies badly drained glacio-lacustrine silts and clays. In the last few centuries, much of the peat has been cut away for fuel. Both cutover and intact bog were mapped, provided that the peat in all cases attains a thickness of at least one metre.

The most extensive peat bogs occur west of Ballivor, south of Athboy, south of Kinnegad, at Fletcherstown and at Tullaghanstown west of Navan.

Head is a sediment deposited during the severe cold climate (similar to present-day tundra) which occurred during and shortly after deglaciation. In these conditions, the frozen ground thaws in spring and becomes very mobile and a slow flow of shattered fragments of rock, also resulting from the intensely cold conditions, occurs from higher to lower ground. Head deposits are most common where the bedrock is very friable, for example in areas underlain by shale. The deposit varies in texture from being very flaky to very muddy, depending on the lithology of the local bedrock.

Head is found on the slopes of the Lower Palaeozoic ridges to the north and east of the county, and on the ridges cored by Namurian rocks to the south of the county (*e.g.* Warrenstown).

Marine deposits are found along the coast and usually take the form of beaches, spits and bars. These deposits are continually reworked by the sea today. Beach sands and gravels are the most common deposits *e.g.* at Bettystown.

Bedrock at or close to (within 1 metre of) the surface was also mapped, according to the type and lithology of the rock. The most extensive bedrock outcrops in the county occur on the crests and flanks of the Lower Palaeozoic ridges to the north of the county *e.g.* Slieve na Calliagh.

5. Hydrogeology & Aquifer Classification

5.1 Introduction

Groundwater is a very important resource and provides about 20% of the public water supply in County Meath. 28% is taken from major rivers and 17% from lakes. The remaining 35% is obtained from other local Authorities: Drogheda Corporation (which extracts from the River Boyne to supply east Meath), Dublin County Council (extracts from the River Liffey at Lexlip), Westmeath County Council and Cavan County Council.

Meath County Council operates 14 major groundwater supplies and 51 minor groundwater supplies, some of which supply only a few houses each. Groundwater from all the major supplies and 17 minor supplies (Table 5.1) were sampled for chemical and bacteriological analyses. The following minor supplies were not sampled due to their very small demand:

Table 5.1 Minor County Council Supplies

Minor County Council boreholes (*A)		Minor County Council Supplies (*B)	
Anneville	Donore	Ballinabrackey	Moylough
Balfeaghan	Julianstown	Baltrasna	Mullaghroy
Ballymacad	Knockmark	Baxter	Mullaghteelin
Bective	Leggagh	Belper	Rathkeenan
Carnaross	Moat	Collestown	Ross Road
Castlepole	Oakley Park	Crowpark	Ross
Clonlyon	Ross	Croboy	Toberultan
Cookstown		Danestown	
Crossdrum		Dean Hill	
Cross Guns		Mitchelstown	

The locations of the minor sources listed (A) in the above table, have been verified and these wells are still in operation. The sources listed in (B) have not been verified.

There are also many private abstractions of groundwater for industrial, domestic and farming purposes. Well data have been compiled from a variety of sources including GSI surveys, water well drillers, consultants' reports and the Council. The data are unevenly dispersed throughout the county and vary in quality from very poor to good.

Many wells have not been adequately tested to obtain reliable information on the specific aquifer characteristics. The well records are incomplete, and many private wells are not recorded. Some of the data are out of date, especially where boreholes have now replaced old shallow dug wells.

5.2 Aquifer Classification

The rocks in Co. Meath have been classified into three main bedrock aquifer categories, with each category being sub-divided into two or three sub-classes:

1. **Regionally Important Aquifers**
   (i) Groundwater flow mainly in Karst conduits (enlarged by solution) (**Rk**)
   (i) Groundwater flow mainly in fissures/fractures in the rock (**Rf**)
2. **Locally Important Aquifers**
   (i) Generally moderately productive (**Lm**)
   (i) Moderately productive only in local zones (**Ll**)
3. **Poor Aquifers**
   (i) Generally unproductive except for local zones (**Pl**)
   (i) Generally unproductive (**Pu**)

The Quaternary deposits of sands and gravels are classified as aquifers where they are sufficiently extensive (greater than 1km^2) and have a saturated thickness of at least 5m. Sand and gravel aquifers are classified into Regionally or Locally important:

1. **Regionally Important Aquifers:** Greater than 10km^2 in extent (**Rg**)
2. **Locally Important Aquifers:** Less than 10km^2 in extent (**Lg**)

5.3 Regionally Important Aquifers

The Shallow Water Limestones are the only rocks in Co. Meath which fall into the regionally important category and are classified as having both karst flow dominant (Rk on the map) and fissure flow dominant (Rf on the map) in different areas. These rocks are found in the east just south of Drogheda, in the north from around Ardagh to Nobber, and in the west around Lough Sheelin.

These limestones are pale grey, thickly bedded, fine to coarse grained limestones with abundant fragments of crinoids and coral fossils. The lower part of the rock succession is often dolomitised and karstified, which can be seen where drift cover is absent. These limestones have a moderate to good secondary permeability and the development of joints and fissures by solutional processes and the dolomitisation and decalcification have increased the available storage of the limestones. The greater the degree of solution within the limestones, the greater the likelihood of karstic features and thus karstic groundwater flow patterns. The permeability of the resulting solution features may have been reduced by later (Quaternary) infilling with sands, silts and clays.

5.3.1 Regionally Important Aquifers - karst flow dominant (Rk)

The shallow water limestones in the Kingscourt Outlier around Ardagh to Nobber are classified as having karst flow dominant (Rk on the map). This classification is based on evidence from County Monaghan, where there is extensive karstification of this limestone unit; swallow holes, caves, collapse features and springs have been observed (Personal Communication, M. Burke). These limestones in County Meath have been extensively covered by Quaternary subsoils and karst features have not been located except for two swallow holes which were noted by John Jackson (1955) just south of Barley Hill House, Ardagh, where dark grey micaceous shales overlie dolomitised clean limestones. Evidence for some palaeokarstic features are also reported at Bridge Farm quarry, Nobber and Barley Hill quarry, Ardagh.

The well records show two locations with “excellent” well yields in excess of 1000m^3/d (at Meath Hill and Rolagh). The Meath Hill well was artesian with an overflow rate of 600m^3/d, and the specific capacity was 550m^3/d/m. A third “good” well was located north of Nobber (270m^3/d) and the specific capacity was 38m^3/d/m, while the apparent transmissivity was 50-60 m^2/d.

Based on the geology, evidence for karstication and the occurrence of high yielding wells, these shallow water limestones are classified as a Regionally Important Aquifer - karst flow dominant (Rk on the map).

5.3.2 Regionally Important Aquifers - fissure flow dominant (Rf)

The remainder of the shallow water limestones which are found in east Meath, just south of Drogheda, and in the west around Lough Sheelin, are classified as having fissure flow dominant (Rf on the map), as the evidence available at present does not indicate extensive development of karst.

The presence of fissuring within these limestones at Drogheda is shown in boreholes at Drybridge, Co. Louth, (drilled as part of the investigation by the North East Regional Development Organisation (NERDO) in 1981), where 8m out of the 16m of borehole which was calliper logged had a diameter greater than the drill bit size. Trial wells at Mell, County Louth also showed cavities up to 10% of the total rock penetrated. The porosity is estimated at 5% at Mell Quarries and 10% at Platin Quarry (NERDO 1981).

Recent borehole records from the site investigation for the Northern Motorway in these limestones have recorded cavities/fissures with a vertical depth up to 3m (BMA 1995). Evidence from the Platin Quarries in Co. Meath also suggests karstic solution of fissures has developed within this limestone.

The GSI manuscript maps record karstic features at Ross Quarry, near Lough Sheelin, Co. Meath. George Du Noyer illustrates deep hollows and trenches in the surface of the limestone at Ross Quarry, which were later infilled with stiff brown clay and overlain by a gravelly limestone till. This illustration (on the cover of this report) may represent a buried or infilled karst system, which is no longer in operation.

From the well records six locations indicate well yields in excess of 100m^3/d. The highest yield was at Platin Quarry, with a present pumping rate of 3,600m^3/d. A sand filled fissure was encountered in Production Well No.2 between -17m O.D, and -19m O.D. The specific capacity at the end of the pumping test was 230m^3/d/m, while the transmissivity ranged from 80-150 m^2/d.

Based on the geology, evidence for fissure flow and the presence of ‘good’ wells, these shallow water limestones are classified as a Regionally Important Aquifer - fissure flow dominant (Rf on the map).

5.4 Locally Important Aquifers

Locally important aquifers cover approximately half of Meath and are mainly located in the south.

5.4.1 Locally Important Aquifers - generally moderately productive (Lm)

5.4.1.1 Permian & Triassic

These rocks outcrop within the Kingscourt Outlier in the north of Co. Meath. The Permian and Triassic are a very significant aquifer in Northern Ireland due to the high yields. As a result of their small areal extent (<25Km^2) in the Republic they are classified as only “Locally important and generally moderately productive” (Lm on the map).

They generally consist of red shales, siltstones and sandstones. There is little hydrogeological information available for these rocks in Co. Meath. An investigation at Knocknacran Mine, Co. Monaghan by Geoffrey Walton (1982) indicated transmissivities in the range of 20-200m^2/d.

The North East Regional Development Organisation (NERDO) drilled at Mullantra, Kingscourt in 1981 to investigate the potential of the Triassic sandstone. The sandstone was very friable and liable to collapse. The well yielded 915m^3/d with a specific capacity of 23-33m^3/d/m. Transmissivity was calculated at 48m^2/d. The aquifer is locally confined by 48 metres of till at this location. Recent drilling (1994-1996) east of Kingscourt in Countries Cavan, (Corgarry) Monaghan (Descart) and Meath for the Kingscourt water supply, indicated estimated yields between <10 to >1000m^3/d. The high yielding wells which were tested indicated specific capacities of 110m^3/d/m. One of the wells encountered a grey to white rock unit which may be gypsum (calcium sulphate). The Triassic sandstones also contain very muddy and silty units which can give very poor yielding supplies. During

the pumping tests, steady state conditions were not obtained (Personal Communication, K. O'Dwyer, K.T. Cullen & Co.).

The highly weathered Permian and Triassic sandstones are capable of transmitting large volumes of groundwater, although the interbedded mudstones can act as barriers to groundwater movement. Karstic features have been developed in the gypsum units (revealed by mining) and can transmit groundwater. The quality of water from the gypsum units could be unacceptable for drinking as a result of the very high sulphate concentrations that would be expected.

Based upon the lithologies and hydrogeological data available the Permian and Triassic rocks have been classified as "Locally important aquifers - generally moderately productive" (Lm on the Map).

5.4.1.2 Namurian Sandstone

The Namurian succession found in the Kingscourt Outlier is younger than the successions found elsewhere in Meath and is composed of thick alternating sequences of sandstones with shales. These sandstones are poorly cemented and often very weathered which increases their permeabilities.

Recent drilling (1994-1996) in the Namurian east of Kingscourt in County Meath, for the Kingscourt water supply, encountered yields estimated between 200 to 800m^3/d from four trial wells. These high yielding wells indicate the potential of these sandstones for groundwater development. The pumping tests which were conducted on these trial wells provided specific capacities from 40 - 85m^3/d/m. During the pumping tests, steady state conditions were not obtained (Personal Communication, K. O'Dwyer, K.T. Cullen & Co.).

The Council well at Kilmainham provided a discharge of 240m^3/d with a transmissivity in the order of 15-30m^2/d and a specific capacity of 6m^3/d/m.

The results of the drilling have established the potential of these rocks as an aquifer and on this basis the Namurian rocks of the Kingscourt Outlier have been classified as "Locally important aquifers - generally moderately productive" (Lm on the Map).

5.4.1.3 Calp Limestone

The Calp limestone occur over much of the county, particularly in the south. They are composed of dark grey to black, fine grained, well bedded limestones and shales.

The base of the Calp succession consists of coarse grained, cleaner limestones with occasional thin shale bands and often sandstone units are present. Where these variations are encountered especially where secondary permeability is well developed due to the faulting of the rocks, well yields are often much higher than would be expected for the Calp limestones. The lower Calp limestone may also be dolomitised in certain areas.

The base of the Calp limestone succession is more productive than the top but not enough geological information is available to divide the Calp limestone. Basal Calp limestone is found for example at Curragha, and at Kilmoon where the underlying Lower Palaeozoic rocks were encountered.

The upper Calp limestone are deeper basinal limestones and are dominantly fine grained black shales with limestones. The higher shale content ensures a much lower permeability and results in a lower yield. The cleaner limestone units are also found closer to the basin margins where they have slumped into the deeper water sediments.

In Co. Dublin, the proposed Powerstown Landfill site (County Fingal), located on Calp limestone was classified as "Locally important aquifer, moderately productive only in local zones" (Ll) by the consultant to An Bord Pleanala. The site investigations undertaken are site specific and cannot be applied to the entire Calp limestones of Counties Dublin and Meath. This classification of the Calp (Ll) concurs with the GSI's views for the Calp limestones in County Dublin.

In County Offaly the hydrogeological data has also resulted in the Calp limestones being classified as a "Locally important aquifer moderately productive only in local zones" (Ll). There are areas of higher productivity which would be classified as a "Locally important aquifer - generally moderately

productive" (Lm). The data are insufficient to delineate these areas and the Ll classification has been retained for the entire Calp in Offaly (Personal Communication D. Daly).

The well records for County Meath show 33 sites with wells in Calp yielding greater than $100m^3/d$. 22 are classified as "good" wells and the remaining 11 as "excellent" wells ($>400m^3/d$). There are also many "moderate" and "poor" wells located within the Calp limestone. Yields are often as low as $10m^3/d$. These wells are often domestic supplies and occasionally council supplies but generally have not been tested to establish their potential output. Examples of Council wells drilled with estimated moderate and low yields are as follows:

Location	Depth (metres)	Lithology	Yield (m^3/d)
Hill of Tara	73	Limestone	44
Dunshaughlin (Tower)	300	Black limestone & shales	50
Curragha (Ballymack)	122	Black limestone & shales	55
Athboy	122	Black limestone & shales	30

Typical specific capacities range 5 - $150m^3/d/m$ and transmissivities range 20-$1000m^2/d$.

The seven largest County Council groundwater supplies (Slane, Curragha, Athboy, Dunshaughlin, Dunboyne, Ballivor and Nobber) all abstract from the Calp Limestone. These sources were subjected to 12 hour pumping test and short recovery tests and the results are given in Table 5.2 below.

Table 5.2 Pumping Test Results in Co. Meath

Location	Pumping Rate m^3/d	Specific Capacity $m^3/d/m$	Transmissivity m^2/d	Specific Yield
Slane	PWNo.1 = 780 PWNo.2 = 1640	60 - 65 130 - 135	70 - 130 150 - 200	0.002
Curragha	PWNo.2 = 1320	130	60 - 130	0.002
Athboy	1080	800 - 980	100 - 1000	0.075
Dunshaughlin	810	40 - 47	100-300	0.0004
Dunboyne	PWNo.1 = 115 PWNo.2 = 175 PWNo.3 = 335 PWNo.4 = 535	10 - 15 5 - 10 80 30 - 35	10 - 50 10 - 50 60 - 150 30 - 100	0.001 - 0.04
Ballivor	PWNo.2 = 265	8 - 15	10 - 200	0.01 - 0.02
Nobber	175	20 - 30	20-40	0.002

High yielding wells have also been located at Enfield, Longwood, Summerhill, Kilmoon, Batterstown, Ballivor (NEC), Ballivor (Kilmurry), Ratoath, and Nobber (College Proteins).

In Meath the high number of "excellent" and "good" wells, which includes many of the Council's major groundwater supplies, has led to the conclusion that the Calp Limestone is an important aquifer and it has been classified as "Locally important aquifer - generally moderately productive" (Lm on the map). The general hydrogeological data indicates a lot of local variation including the variability in the well yields and aquifer coefficients which depend on the groundwater flow paths through the fractures and fissures. The aquifer coefficients vary depending on the depth below ground level. In general higher values are obtained in the zone close to the surface and decrease with depth. The main groundwater flows are concentrated in the upper fractured and weathered zone and along fracture/fault lines.

The overlying Quaternary deposits often consist of thick limestone tills which can act as a confining layer thus producing artesian supplies, for example at Kilmoon, Dunshaughlin and Longwood. The present data is insufficient to delineate possible zones of confinement.

5.4.1.4 Derravaragh Limestone

The Derravaragh Limestone are silicified limestones and is a lithological variation within the Calp Limestone. These limestones are located in west County Meath south of Oldcastle. There are no hydrogeological data available except for the large spring located in gravels at Lough Bane pump house. This spring has a discharge of approximately 2,500m^3/d.

The Derravaragh Limestones are classified with the Calp Limestone as a "Locally important aquifer - generally moderately productive" (Lm on the map).

5.4.1.5 Edenderry Limestone

The Edenderry Limestones are oolitic limestones which are a lithological variation within the Shallow Water Limestones. These limestones are located in southwest Meath south of Kinnegad. There are no hydrogeological data available for these limestones in Meath. In Offaly they are classified as locally important (Lm) and this is being applied in Co. Meath.

5.4.2 Locally Important Aquifers - moderately productive only in local zones (Ll)

These aquifers in general have a low permeability, but they have the potential to provide high yields where favourable geological conditions occur.

5.4.2.1 Navan Group

The Navan Beds consist of a range of lithologies including basal conglomerates, sandstones, siltstones, shales, muddy limestones and cleaner limestones.

Within the Navan Beds some of the lithologies are occasionally dolomitised and fractured. The coarse grained limestones (Meath Formation or Pale Beds) are often dolomitised and recrystallised. The dolomite is often associated with fracturing and void creation. Indicators of primary palaeokarst can occur in the Micrite Unit of the Pale beds (M. Fleming 1996). Several boreholes in Co. Meath {1439-2 Athboy, 1439-4 Athboy, 91-3347-1 Woodtown, Kil-1 Kilallon, CK-2 Crossakeel, and in the J-Series (NW of Navan) J-58, J-60, J-56, J-83 (6.8m cavity), J-27, J-68, and J-30} indicate alteration due to dolomitisation. The Meath Formation or Pale Beds are the most likely to have cavity systems, voids and fractures developed (M. Fleming 1996).

Karstification and sub-aerial erosion occurred at the end of the Courceyan. This is shown by an unconformity at Navan, where a channel over 100m deep and probably over a kilometre wide has been cut into the underlying limestones. This allowed karstification to varying depths in particular of the Navan beds.

Three "excellent" wells (550-1650m3/d) are located within the Navan beds: at Moynalty, Castletown and Mountainstown. Specific capacities range from 45-200m^3/d/m. Tara Mine (Navan) is located on Navan Beds and hydrogeological information from the dewatering of the mine indicates very low transmissivities and yields in this area. Despite the presence of high yielding wells the Navan Beds are thus classified as only "Locally important aquifers - moderately productive only in local zones" (Ll on the map). This is the result of the very variable lithologies within the Navan Beds which produce the very variable yields.

5.4.2.2 Waulsortian Limestone

The Waulsortian bank or reef limestones are comprised of almost unbedded pale grey, very fine grained limestones which formed as massive mounds of lime mud. These limestones originally had very open structures with a large cavity volume. These cavities may or may not have been later infilled

with calcite. Clean limestones such as the Waulsortian are highly susceptible to dissolution and karstification which involves the enlargement of the primary openings.

The Waulsortian can also be extensively dolomitised which is often joint or fault controlled. Dolomitisation increases the porosity of limestones by up to 15%. Dolomitisation and karstification are usually local and unpredictable, which gives the limestones a greater potential to provide high yielding wells, but frequently gives very low yields (<20m^3/d).

There is very limited evidence of dolomitisation and karstification within the Waulsortian of Co. Meath, other than the warm springs. Two warm springs in particular are located in the south near Longwood: St Gorman's Spring and Ardanew Spring.

The Geothermal Project undertaken by Minerex Ltd. in 1983 found that Waulsortian reef limestones tended to have groundwater circulation, whether it was cold or warm water. As part of the Geothermal Project two boreholes were drilled adjacent to St Gorman's Spring to a depth of 13m. The first borehole, 2m from the spring encountered very broken Waulsortian limestone and a cavity which was connected to the spring. The second borehole, 12m from the spring also encountered fractured limestone. Both boreholes responded rapidly to the abstraction of water from the spring and to fluctuation in the pumping rate (1300-1800m^3/d). The temperature ranged from 20.9-21.3^oC and the conductivity from 570-585µS/cm.

The well records indicate seven "good" wells (100-400m^3/d) which are all located around the Longwood and Summerhill areas. Specific capacities range from 5-140m^3/d/m and transmissivities from 30 to 40 m^2/d.

The Waulsortian has the potential of being highly dolomitised and karstified, but with the lack of good evidence it is classified as a "Locally important aquifer - moderately productive only in local zones" (Ll on the map).

5.5 Poor Aquifers

These aquifers are characterised by very low permeabilities and transmissivities and are therefore generally very low yielding. Consequently groundwater movement is relatively slow and is often restricted to shallow flow paths near the surface, along fracture zones or through slightly more permeable units. The water table is usually close to ground level and closely mirrors the topography. Well yields are often very low (<40m^3/d), though sufficient for domestic usage, and occasional high yields may be encountered.

5.5.1 Poor Aquifers - generally unproductive except for local zones (Pl)

5.5.1.1 Namurian Shale

The Namurian rocks in north Meath have been classified as locally important aquifers (section 4.3.1.2), while the remainder of the Namurian successions in the south are classified as poor aquifers. These rocks are predominantly composed of siltstones, mudstones and shales with only occasional sandstones. The sandstones possess slightly higher permeabilities and yields, owing to their greater ability to fracture than the shaly units.

Wells are in generally very low yielding, although higher yields have been recorded from Warrenstown and Summerhill with 545m^3/d and 110m^3/d respectively.

The Namurian successions in south Meath are classified as a "Poor aquifer - generally unproductive except for local zones" (Pl on the map).

5.5.1.2 Argillaceous Bioclastic Limestone

This succession is dominated by fine grained argillaceous or muddy limestones and shales. These rocks contain substantial amounts of clayey material and are thus not susceptible to solution or

karstification. There is no primary permeability and limited secondary permeability which restricts groundwater storage and movement.

Well yields are typically low (10-40m^3/d), with occasional higher yields up to 100m^3/d. These limestones are classified as a "Poor aquifer - generally unproductive except for local zones" (Pl on the map).

5.5.1.3 Lower Palaeozoic Rocks

The Lower Palaeozoic Rocks consist of greywackes, sandstones, siltstones, and mudstones with interbedded volcanic rocks. These rocks are generally fine grained and have been intensively folded, faulted and altered. This complex geological history has resulted in these lithologies having a very low permeability. Groundwater is restricted to the shallow weathered zone at the surface or along fault and fracture zones.

Within these rocks five high yielding wells have been located of which two are termed "excellent" (over 400m^3/d). The highest yielding well (610m^3/d) is located near Kilmainham. The transmissivity is 20-40m^2/d and the specific capacity 16m^3/d/m. This unusually high yield is possibly related to the close proximity to the major Kingscourt fault zone.

Two high yielding wells have been located in the Slane succession, just to the north of Slane village, which consists of basaltic lavas, tuffs and sandstones. The high yields are probably related to the presence of the volcanic units and fractures.

Other units in which "good" wells have been located are the Rathkenny succession (northeast of Slane village) and Clatterstown succession (south of Bellewstown). Again these higher than normal yields are likely to be associated with faults.

The units which can be distinguished as having the potential for higher yields are Grangegeeth, Canes, Hilltown, Clashford House and Herbertstown together with Slane, Rathkenny and Clatterstown and the zone along the Kingscourt fault These are classified as "Poor aquifers - generally unproductive except for local zones" (Pl on the map).

The remainder of the Lower Palaeozoic rocks are classified as "Poor aquifers - generally unproductive" (Pu on the map, see section 4.5.2.2).

5.5.2 Poor Aquifers - generally unproductive (Pu).

5.5.2.1 Tobercolleen Limestone

The Tobercolleen consists entirely of thinly bedded mudstones and as a result this lithology has a very low permeability.

Well data for this unit are very poor and yields are generally less than 40m^3/d. These rocks are classified as a "Poor aquifer - generally unproductive" (Pu on the map).

5.5.2.2 Lower Palaeozoic Rocks

These Lower Palaeozoic Rocks (Contail, Salterstown, Clogherhead, Kennetstown, Denhamstown, Mellifont Abbey, Prioryland and Fourknocks successions) generally consist of siltstones and mudstones with minor greywackes and sandstones. These rocks are very fine grained, have been intensively folded, faulted and altered and have a very low permeability. Groundwater is restricted to the shallow weathered zone at the surface or along fault and fracture zones.

Well data for these geological units are very poor and yields are generally less than 40m^3/d and are classified as a "Poor aquifer - generally unproductive" (Pu on the map).

5.5.2.3 Igneous Rocks

There are small outcrops of Pre-Carboniferous intrusive igneous rocks and Carboniferous volcanics. No hydrogeological data are available for these rocks, but they are classified on the basis of their lithology as "Poor aquifers - generally unproductive" (Pu on the map)

5.6 Sand & Gravel Aquifers

Nine areas have been designated as locally important sand & gravel aquifers in Meath. Seven of these are termed "potential" local aquifers as there are no known water supplies currently developed in them and their confirmation must await further investigation. The sand & gravel aquifers are unconfined and are assumed to be in hydraulic continuity with the underlying bedrock aquifer.

Table 5.3 Sand & Gravel Aquifers in Co. Meath

Deposit	Description	Estimated thickness
Known Sand & Gravel Aquifers		
Mosney/Balloy Gravels	Interbedded outwash gravels	10 - 20m
Meath Hill Gravels	Clean, coarse morainic gravels	15 - 20m
Potential Sand & Gravel Aquifers		
Ballinter	Clean, coarse morainic & outwash gravels	8 - 15m
Summerhill	Clean, coarse morainic & esker gravels	10m
Tobertynan	Very clean delta gravels & sand	11m
Longwood	Clean, coarse morainic & outwash gravels	10m
Drumone	Clean, coarse esker & fan gravels	5 - 15m
Blackwater/Inny Valley	Clean, coarse outwash & fan gravels & sand	10 - 12m
Kingscourt Valley	Clean, coarse outwash gravels	5 - 12m

Drilling investigations in the Mosney/Balloy gravels indicated an average yield of 250-300m^3/d with a specific capacity of 28m^3/d/m. The estimated transmissivity is around 40m^2/d, which is rather low and may be due to the very complex sequence of interbedded clays, sands and gravels which vary latterally in this area.

A private group scheme well at Meath Hill yields 1000m^3/d from clean sands & gravels and the top 6m of the underlying shallow water limestones.

The sand & gravel aquifers are classified as "Locally important" (**Lg** on the map), since none of the deposits has an areal extent greater than 10 Km^2.

Table 5.4 High Yielding Wells & Specific Capacities in Co. Meath.

Rock Unit	Well Number (>400m^3/d)			Well Number (100-400m^3/d)			
		Yield	Specific Capacity		Yield	Specific Capacity	Aquifer Category
Triassic	-			-			**Lm**
Permian	-			-			**Lm**
Namurian	2629SE064 2629SE065 2629SE066 2629SE067 2629SE069	850 1000 900 900 650	32 110	2629SE068	c200		**Lm**
Namurian	2629SE024 2925SW357 2629SE064	1850 545 1000		2629SE012 2629SE052 2627NE059 2627NE020 2623NE144	240 240 330 110	7	**Pl**
Calp Limestone	2925SW101-103 2925SW364 2923NW388-390,404 2925SW098,105 355 2625NW001 2625SW013,014 2625SW036 2625SW010 2623NW022 2623NE108 2927SW012-015	c1850 490 125-655 c700 1360 575 545 545 1000 1745 1000	60-160 23,7 10 - 230 38,24,48 185, 980 30, 100 68 68 28 100 70-200	2925SE003 2925SW139 2925SW394 2923NW447 2923NW385 2923NW276 2923NW484 2923NW257 2923NW038 2925SW395 2925SW122 2925SW136 2623NE100 2625NE046 2627NE055-056 2625SW085-086 2625SW090 2625SW088 2625SW011 2625SW012 2627NE067 2627NE123	110 105 260 195 110 220 350 130 130 110 195 140 240 220 175 245 110 110 180 240 230 230 270 330	13 12 22 11 35 5 30 12 10 40	**Lm**
Shallow Water Limestones	2627NE126 2629SE053	1600 1000		2627NE042	270	34	**Rk**
	2927SE047-048	3600		2925NW043 2925NW045 2925NW070 2925NW071 2927SE039	130 140 110 100 160		**Rf**
Waulsortian				2623NE087 2623NE259 2623NE096 2623NE101 2623NE102 2623NE291 2623NW023	110 110 370 130 195 110 245	 40 5 12 140	**Ll**
Navan Beds	2627NW001 2627SE058-059 2627NE057	980 220,550 1650	220 44,55 95				**Ll**
Lower Palaeozoics	2627NE060 2927SW037	610 430	17	2927SW031 2927SW046 2925NE075	115 130 220	8	**Pl**
Gravels	2629SE053	1000		2925NE005	295	30	**Lg**

6. Hydrochemistry & Groundwater Quality

6.1 Introduction

"Hydrochemistry" refers to the chemical composition of the water and "groundwater quality" refers to the chemical, physical and microbiological characteristics, relative to a standard. The standard used for groundwater is the drinking water standard required by the EC (Quality of Water Intended for Human Consumption) Regulations S.I. No. 81 of 1988. These regulations give formal effect in Irish law to the 1980 EC Directive on Quality of Water for Human Consumption (80/778/EEC) and apply to all water intended for human consumption or used in food production (except mineral waters), whether in their natural state or after treatment. The Irish standards (Appendix BII) are used here, although there are some differences from the EC standards

Groundwater analyses were collected and compiled to determine the general hydrochemistry and overall water quality currently occurring in County Meath. Groundwater analyses were available for a variety of sources over the past number of years, resulting from sampling by the County Council. These analyses were not used in this study as the samples were of treated water, rather than raw water and often the samples were from combined surface and groundwater sources, rather than individual groundwater supplies.

A regular groundwater sampling programme was established. A total of 99 raw water samples were collected during 1995 and 1996 from groundwater supplies throughout the county. The sampling programme was conducted approximately every three months (March, June, September 1995 and January 1996) which allowed seasonal variations in the hydrochemistry and water quality to be assessed. A full chemical analysis including all major cations, anions and important metals was carried out by the State Laboratory on all the samples. Bacteriological analyses (Coliforms and *E.coli*) were conducted by the County Council Laboratory staff in Liscarton, Navan. The samples were delivered to Liscarton within six hours from the time of sampling. The results of the analyses are tabulated in Appendix BI.

Duplicate samples were taken from several wells, during each sampling period, to ensure quality control. The differences between duplicate analyses were generally within acceptable ranges.

In order to verify the quality of the data obtained, major ion balances have been calculated:

$$\text{Balance (\%)} = \frac{\Sigma \text{ (Cations, meq/l)} - \Sigma\text{(Anions, meq/l)}}{\Sigma\text{(Cations, meq/l)} + \Sigma\text{(Anions, meq/l)}} \text{ x100}$$

A charge balance error of ±5% is usually taken as acceptable. There were five samples with an error outside this range, of which four were within ±10% and were considered reasonable. One sample (ME953006) from Dunshaughlin has an ionic balance of 21.8% which is not acceptable.

6.2 Hydrochemistry

The groundwater in County Meath is predominantly a calcium bicarbonate water, a direct result of the predominant rock type, limestone and the overlying limestone tills.

Groundwater in County Meath is generally hard (251-350mg/l $CaCO_3$) to very hard (>350mg/l $CaCO_3$). Softer waters occur in areas where the underlying bedrock is not limestone, such as the Namurian shales and sandstones and the Lower Palaeozoic shales and grits.

6.2.1 Seasonal changes in hydrochemistry

In the majority of the sources sampled, the total hardness, calcium, conductivity, nitrate and total dissolved solids (TDS) were higher during the winter sampling periods and the total alkalinity was often lower. This may be explained by the naturally higher amounts of recharge entering the aquifers in the winter, resulting in greater amounts of dissolution of the limestone. The higher water tables may also influence this process which also implies fairly slow groundwater movement to allow the dissolution to occur. However during the winter groundwater flow rates may be very rapid, due to the higher quantities of recharge, which would allow greater amounts of dilution of the above parameters. The higher level of nitrate may be a direct result of runoff from farmyards and fields during heavy rainfall.

Where the total hardness is less than the total alkalinity, cation exchange may be occurring, with the replacement of Ca^{2+} and Mg^{2+} ions by Na^{+} ions, thus reducing the hardness of the groundwater. This may be occurring at Lobinstown and Enfield. Further analyses would be required to confirm this.

The magnesium/calcium ratio in limestone waters can be used to indicate possible dolomitisation where calcium ions have been replaced by magnesium ions. A ratio greater than 0.3 (when the parameters are expressed as meq/l) indicates this or it may indicate contamination. Waters from the Lower Palaeozoic and Namurian rocks often have a high Mg/Ca ratio due to the naturally low concentration of calcium ions in these rocks. Two limestone sources indicate high ratios (Ballair and Ballivor), but there is no other evidence to confirm dolomitisation at these locations.

6.3 Groundwater Quality

During the groundwater monitoring programme, raw water samples were collected from 34 sites: 16 major County Council boreholes, 14 minor County Council boreholes and the springs at Lough Bane. The major supplies were sampled four times, (every three months) and the minor supplies were sampled twice (March and September 1995). Three additional sites were only sampled once (March 1995). The boreholes which were sampled are listed in Table 6.1.

Table 6.1 Wells Sampled in County Meath

Major County Council Boreholes	Minor County Council Boreholes	Additional Minor Sites
Dunboyne PW1, PW2, PW3. & PW6	Batterstown	Carrickleck
Dunshaughlin PW1 & *PW2	Dunsany	Yellow Furze
Slane: combined sample PW1 + PW2	Castletown	Balloy
Curragha PW2	Lobinstown	
Athboy	Newtown	
Nobber	Bellewstown	
Kilmainhamwood	Deanhill	
Moynalty	Ballair	
Trim	Carnacross	
Ballivor	Clonard	
Enfield	Clonycavan	
Summerhill	Robinstown	
Longwood	Rathmoylan	
Kilmessan	Agher	

*PW2 at Dunshaughlin is located at the County Council Offices

Parameters such as E. *coli*, potassium (K), chloride (Cl), nitrate ($N0_3$) and ammonia (NH_3) are good contamination indicators. The potassium/sodium (K/Na) ratio is also a useful indicator of local contamination by vegetative organic matter.

Background levels for potassium, chloride and nitrate (as $N0_3$) in Meath are 1, 10 and 2 mg/l respectively. It has been shown elsewhere in Ireland that concentrations of these parameters of 3-4 times their background level indicate significant contamination. Thus the threshold levels are: potassium (3-4mg/l), chloride (30-40mg/l) and nitrate (6-8mg/l as $N0_3$). Samples which have parameters above the threshold may also have abnormal levels of some other parameters such as total hardness, total dissolved solids, manganese, etc. and frequently contain E. *coli* (Daly & Woods 1994).

These threshold levels of the above parameters can be used to distinguish between uncontaminated groundwaters and those showing some chemical evidence of contamination, indicating significant human influence on the groundwater quality. Groundwater with one or more parameters exceeding the MAC can be classified as polluted, unless the elevated parameters are naturally occurring. In County Meath high levels of iron and manganese, sometimes above the MAC, occur naturally in the groundwater. These groundwaters are not classified as polluted but require treatment to reduce their levels below the MAC for use as drinking water.

The sources sampled in Meath have been classified depending on their water quality.

Class 1 Sources showing no evidence of contamination, which includes groundwaters which have naturally high levels of some parameters (eg. iron and manganese).

Class 2 Sources which show elevated levels of chloride, potassium or nitrate indicating significant contamination, or parameters above the recommended guide levels.

Class 3 Sources in which one or more parameters exceed the MAC.

27 % of the samples are classified as Class 1, 32% as Class 2 and the remaining 41% of samples as Class 3.

Approximately half of the samples show elevated levels of iron and manganese, which occur under natural conditions.

Eight of the wells sampled indicated contamination with E. *coli*, and six of these sources also showed chemical indications of contamination. A further 14 sites contained background coliforms. A total of 21 sources indicated some contamination in the form of elevated indicator parameters, although only seven were above the MAC.

The large number of sources which indicate contamination highlight the need for the protection of all the sources.

Eight sites (Newtown, Deanhill, Ballair, Clonycavan, Robinstown, Lough Bane, Dunboyne gallery and Trim) contained E. *coli* which indicates contamination by human or animal wastes. Robinstown also showed high potassium and manganese, the K/Na ratio is >0.4 and thus indicates contamination by plant organic matter such as farmyards.

Several sources have shown occasional high levels of particular parameters. Clonard has high ammonia together with high iron and manganese. High ammonia usually indicates a nearby waste source and/or vulnerable conditions. Rathmoylan and Nobber showed high levels of lead, Kilmessan indicated high nitrite, Clonycavan high zinc and Agher high fluoride. Further sampling is required at these sites to determine if these occasional high values are a major problem or just anomalies.

The remainder of the samples which have concentrations of iron and manganese above the MAC are the result of natural groundwater conditions. These sources are as follows: Kilmainham and Deanhill (Namurian), Clonycavan, Robinstown and Agher (Waulsortian), Curragha, Dunshaughlin, Ballivor, Longwood, Summerhill, Enfield, Clonard, Batterstown and Dunboyne (Calp Limestones).

6.3.1 Iron & Manganese

Iron and manganese are very abundant elements, but are usually only found in low concentration in groundwater. When found in excessive quantities, they can form precipitates which can clog wells, screens, pumps and rock fractures, thus reducing the yield of the well.

The problem of high iron and manganese is common throughout Ireland. Dark, fine grained, pyritic shaly rocks such as the Calp Limestone are the most likely to have naturally reducing conditions. These lithologies are also rich in organic matter, iron, manganese and sulphate. The high concentrations of iron and manganese in the groundwater occur mainly through the chemical process of ion exchange under reducing conditions. (Deakin 1995).

The pumping of groundwater from a borehole allows oxygen to be introduced into the aquifer, allowing iron and manganese to be precipitated from solution. Wells with high iron and manganese levels should be pumped at lower pumping rates to keep the drawdown as small as possible, reducing the potential for oxidation. Contamination of the groundwater, for example by silage effluent or nitrate, which tends to produce reducing conditions, can also increase the amount of iron and manganese entering into solution.

6.4 Conclusions

Groundwater pollution is not a major problem in County Meath, although some contamination has been indicated at some sources. Often the boreholes are located too close to potential pollution sources such as septic tanks or farmyards, or streams in which the water quality is poor.

The main concerns are the presence of bacteria (Total Coliforms and E. *coli*) in several of the sources sampled. E. *coli* is used to indicate contamination by human or animal waste. It is recommended that all the groundwater sources be sampled regularly and the sources which are frequently contaminated with bacteria be investigated to determine the actual source of pollution.

7. Groundwater Vulnerability

7.1 Introduction

Groundwater Vulnerability is a term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater resources may be contaminated by human activities at a given location (Daly and Warren 1994).

The Vulnerability Map (Maps 5(E) & 5(W)) shows the vulnerability to contamination of the underlying groundwater and not of the aquifer or of a particular groundwater source. The vulnerability rating is irrespective of the possible type and concentration of human pollutants, which is dealt with by the groundwater protection matrices.

The Vulnerability Map thus delineates areas with approximately the same natural protection from potential pollution sources. The maps are interpretative and should not be used for site specific studies; actual vulnerability at any given site should be confirmed by field investigations.

7.2 Vulnerability Classification

The vulnerability classification scheme for County Meath is outlined in Table 7.1.

Table 7.1 Vulnerability Classification Scheme.

Vulnerability Rating	Hydrogeological Setting
Extreme	Locations where rock is at the ground surface. Locations where the subsoil is known to be <3m thick from sections or borehole records. In the vicinity of karst features.
Probably Extreme	Areas interpreted to have < 3m of subsoil overlying bedrock.
High	Locations where high permeability subsoil is known to be >3m thick from sections or borehole records. Locations where intermediate permeability subsoil is known to be 3-10m thick from sections or borehole records. Locations where low permeability subsoil is known to be 3-5m thick from sections or borehole records.
Probably High	Areas of high permeability subsoil interpreted to be >3m thick. Areas of intermediate permeability subsoil interpreted to be 3-10m thick. Areas of low permeability subsoil interpreted to be 3-5m thick.
Moderate	Locations where intermediate permeability subsoil is known to be >10m thick from sections or borehole records. Locations where low permeability subsoil is known to be 5-10m thick from sections or borehole records.
Probably Moderate	Areas of intermediate permeability subsoil interpreted to be >10m thick. Areas of low permeability subsoil interpreted to be 5-10m thick.
Low	Locations where low permeability subsoil is known to be >10m thick from sections or borehole records.
Probably Low	Areas of low permeability subsoil interpreted to be >10m thick.

7.3 Vulnerability Assessment

The Vulnerability Maps are compiled from point sources of data, which were then extrapolated over the land surface to provide areal characterisation. The thickness, composition and permeability of the natural subsoil deposits are very variable, even over short distances. For the purpose of this scheme the vulnerability mapping involves a large degree of generalisation: areas being classified, for example, as areas of moderate vulnerability, could include small areas with either a higher or lower vulnerability rating. The vulnerability ratings are denoted as 'probable' except close to actual data points, and are shown on the map with symbols.

The main characteristics controlling vulnerability are:

- the type and permeability of the subsoil
- the thickness of the subsoil and the unsaturated zone
- the attenuation capacity of the subsoil
- the hydrogeology

The information available on the topsoils and their attenuation capacity is not detailed enough to aid in the vulnerability assessment. The attenuation capacity of the topsoils depends on the type of pollutant and is not used to assess the vulnerability rating.

There is relatively detailed subsoil information for County Meath due to the reconnaissance mapping, drilling, trial pitting, augering and grain size analyses. This has allowed the vulnerability to be compiled at the scale of 1:25,000.

7.3.1 Subsoils

The type and thickness of the subsoils are very important in determining the vulnerability of groundwater to pollution. The higher the clay content, the lower the permeability and the thicker the deposit, the lower the resulting vulnerability. The subsoils have been classified depending on their general permeability:

- Limestone-derived tills are considered to be of intermediate permeability due to their gravelly nature.
- The Permian and Triassic sandstone-derived tills also have an intermediate permeability due to their sandy texture.
- All Lower Palaeozoic-derived tills are assumed to have a high clay content and therefore a low permeability.
- The Namurian-derived till is considered to have a low permeability, although there are areas which are sandy.
- All sand & gravel deposits are assumed to have high permeability.
- Till-with-gravel is assumed to have intermediate permeability.
- All lake deposits are assumed to be thin and the permeability of the underlying deposit is taken into account.
- Alluvial deposits are very variable in terms of permeability and are considered to have a high permeability.
- Peat deposits in Meath are all classified as raised bogs and are considered to have a low permeability.
- Marine deposits are classed as intermediate to high permeability.

The depth to bedrock map was contoured using 3m, 5m, and 10m contours to assist compilation of the vulnerability map. Data points plotted with a locational accuracy of +/-100m were used in the actual contouring and less accurate data points were used within their limitations to assess the general thickness over an area.

7.3.2 Groundwater Vulnerability in County Meath

The county has been classified into four main categories; probably extreme, probably high, probably moderate, and probably low. Within these areas, points of known vulnerability are denoted using symbols.

A large proportion of the county is classed as either probably high or probably moderate, with smaller areas of probably extreme and probably low The large areas of probably extreme vulnerability are generally a direct result of bedrock being exposed at or close to the ground surface and are commonly found in the upland areas of the county. The large areas of probably moderate vulnerability are due to the relatively thick cover of low to intermediate permeability tills.

It is emphasised that the boundaries on the vulnerability map are based on the available data and local details have been generalised to fit the map scale. Evaluation of specific sites and circumstances will normally require further and more detailed assessments, and will frequently require site investigations in order to assess the risk to groundwater. A combination of detailed mapping of the subsoils, assessment of surface drainage and permeability measurements would reduce the area of high vulnerability and would probably reduce the area of extreme vulnerability. However, the vulnerability maps are a good basis for decision-making in the short and medium term.

8. Groundwater Protection Zones

8.1 Groundwater Resource Protection

The Groundwater Protection Map (Maps 8(E) and 8(W)) deals with protection of the aquifers based on their resource potential and vulnerability. The county is delineated into protection zones (24 for bedrock aquifers, with an additional zone for sand & gravel aquifers) with decreasing risk and protection measures, ranging from regionally important aquifers with karst flow with extreme vulnerability (Rk/E), which requires the highest degree of protection, to poor aquifers of low vulnerability (Pu/L), which need the least protection measures. The zones are presented in Table 8.1

Table 8.1 Groundwater Resource Protection Zones

AQUIFER		VULNERABILITY	PROTECTION ZONE
Regionally Important	karst flow	Extreme	Rk/E
		High	Rk/H
		Moderate	Rk/M
		Low	Rk/L
	fissure flow	Extreme	Rf/E
		High	Rf/H
		Moderate	Rf/M
		Low	Rf/L
Locally Important	generally moderately productive	Extreme	Lm/E
		High	Lm/H
		Moderate	Lm/M
		Low	Lm/L
	moderately productive only in local zones	Extreme	Ll/E
		High	Ll/H
		Moderate	Ll/M
		Low	Ll/L
Poor	generally unproductive except for local zones	Extreme	Pl/E
		High	Pl/H
		Moderate	Pl/M
		Low	Pl/L
	generally unproductive	Extreme	Pu/E
		High	Pu/H
		Moderate	Pu/M
		Low	Pu/L
Unconsolidated Aquifers			
locally important	sand & gravel	High	Lg/H

8.2 Groundwater Source Protection

The source protection areas are designed to protect groundwater abstractions by employing varying levels of restrictions on human activities. Three zones are delineated for each source (Slane, Curragha, Athboy, Dunshaughlin, Dunboyne, Ballivor and Nobber):

- the Source Site (SS)
- the Inner Protection area (SI)
- the Outer Protection area (SO)

The Source Site is the area immediately around the source. It should have a minimum radius of 10 metres, which should be owned by the Council and fenced off to ensure complete protection.

The Inner Protection Area (SI) is the area defined by a 100 day time of travel to the and it is delineated to protect against the effects of potentially contaminating activities which may have an immediate influence on water quality at the source, in particular from microbial contamination.

The Outer Protection Area (SO) includes the remainder of the complete catchment area to the source, i.e. the zone of contribution (ZOC), and it is delineated as the area required to support an abstraction from long-term recharge.

The matrix in Table 8.2 gives the results of integrating the three elements of land zoning (vulnerability categories, source protection areas and resource protection areas, a total of 12 and 24 zones respectively). Each zone is represented by a code e.g. **SO/M** which represents an outer source protection area, where the groundwater is moderately vulnerable to contamination.

Table 8.2 Matrix of Groundwater Protection Zones

VULNERABILITY RATING	SOURCE PROTECTION			RESOURCE PROTECTION					
				Regionally Important		Locally Important		Poor Aquifers	
	Site	Inner	Outer	Rk	Rf / Rg	Lm / Lg	ll	Pl	Pu
Extreme (E)	SS/E	SI/E	SO/E	Rk/E	Rf/E	Lm/E	Ll/E	Pl/E	Pu/E
High (H)	SS/H	SI/H	SO/H	Rk/H	Rf/H	Lm/H	Ll/H	Pl/H	Pu/H
Moderate (M)	SS/M	SI/M	SO/M	Rk/M	Rf/M	Lm/M	Ll/M	Pl/M	Pu/M
Low (L)	SS/L	SI/L	SO/L	Rk/L	Rf/L	Lm/L	Ll/L	Pl/L	Pu/L

8.3 Groundwater Protection Response Matrix

The control of groundwater contamination sources is by the use of a response matrix which lists the degree of acceptability of potentially polluting activities for each zone and describes the recommended controls for both existing and new activities. It is shown by a level of response or restriction, which is applied to each activity. The control measures are divided into four levels of response based upon the likely acceptability:

R1 Acceptable subject to statutory regulations and normal good practice.
$R2^{a,b,c,...}$ Acceptable in principle, subject to conditions in note a,b,c, etc.
$R3^{m,n,o,...}$ Not acceptable in principle; some exception may be allowed subject to conditions in note m,n,o, etc.
R4 Not acceptable.

These levels of response can be applied to specific activities or to groups of activities (D. Daly 1995).

The final step in the groundwater protection scheme is to integrate the protection zones and the response matrix. The matrix combines both the geological/hydrogeological and the contaminant loading aspects of risk assessment. A response category is given for each zone.

The response matrices are being drawn up by the Environmental Protection Agency, Geological Survey of Ireland and the Department of the Environment and Local Government, for use in conjunction with the groundwater protection maps.

Thegroundwater protection maps were compiled on a regional scale and are very complex. These maps should not be used as a substitute for site investigations, which will still often be necessary in order to make decisions on specific sites.

8.4 Groundwater Source Protection Reports and Maps

The techniques used to delineate source protection zones (section 2.3.2) have been applied to seven public supply wells in County Meath: Slane, Curragha, Athboy, Dunshaughlin, Dunboyne, Ballivor and Nobber. These have been produced as separate source reports.

9. Conclusions

Groundwater is an important resource in Co. Meath, providing 20% of the total public water supply used by the county. In addition to this many private houses, farms and companies also use groundwater from either their own wells or private group scheme boreholes. The aquifers of Meath are not fully developed, providing the potential for future groundwater development as the need for water continues to increases. Even at present the supply of public water does not met the requirements, especially during the summer months when water rationing measures are in force, particularly in east Meath.

The groundwater quality in Co. Meath is generally considered to be good with few parameters exceeding the MAC (Maximum admissible concentration) set by the EU for drinking water. The groundwater can be classed as a calcium bicarbonate water, which is typically regarded as very hard. Approximately half of the sources sampled showed elevated levels of iron and manganese, often above the MAC. These high levels occur naturally in the groundwater and this is a common problem throughout Ireland. The high concentrations of iron and manganese are directly related to the geology and generally found in groundwaters from the Calp Limestone. These groundwaters are not regarded as polluted but do require treatment to reduce the levels below the MAC before use as drinking water.

Groundwater pollution at present is not a major problem in County Meath, although there are some groundwater sources which have indicated some contamination. Often these groundwater sources are located too close to potential pollution sources such as septic tanks, farmyards or streams in which the water quality is poor.

The vulnerability of groundwater to pollution is determined by the subsoil type and its thickness. A significant proportion of Meath is regarded as extreme or highly vulnerable as a direct result of thin subsoils or the presence of highly permeable deposits and the water quality is related to the vulnerability of the area.

The Groundwater Protection Map and the associated Groundwater Protection Response Matrices, currently under development by the GSI, EPA and DoELG, will help the Council to make better informed decisions on planning applications. Specific site investigations should be used to determine that no adverse effects to the groundwater will occur as a result of a given proposed development.

This report and the accompanying maps should also assist the Council:

- in seeking additional sources of groundwater which will be least vulnerable to contamination
- in managing its water resources
- in planning for emergency responses to pollution incidents
- in responding to unusual water shortages (droughts)
- in outline geotechnical appraisals, e.g. for new roads or sewerage schemes

10. Recommendations

- The preparation of this scheme involved the compilation of raw data from a variety of sources. In some cases the raw data was very sparse and of very poor quality, which resulted in problems in devising the proposed scheme for Meath. The Council should ensure that in future data is collected and recorded in a standard format, which would be easily accessible for future county projects. This would also help in future revisions of the groundwater protection scheme. All geotechnical reports, consultancy reports, drilling logs with location maps and all hydrochemical analyses should be sent to the Groundwater Section of the GSI. This data can then be entered into the national database.

- Regular monitoring of all the groundwater sources should be conducted on the raw water as well as on the treated water. The groundwater should be analysed using indicator parameters for contamination, and any sources which are frequently contaminated with bacteria should be investigated to determine the actual source of pollution. This sampling programme can also be used to monitor the effects of potentially polluting activities and any changes in the water quality can be recorded.

  The minimum parameters to be analysed for are: Coliforms and E. *coli*, nitrate, potassium, chloride and conductivity levels and these should be conducted on a regular basis, while a complete analysis should be conducted at least twice a year. The monthly monitoring of conductivity levels should be maintained as a first indication of any water quality problems. The data collected from all the wells are showing an increase in the conductivity levels. Further monitoring of these wells is required to establish the causes and control the results.

- It is recommended that the Council control and monitor potentially polluting activities being carried out on the delineated groundwater source protection zones.

- The production wells and adjacent observation wells should all be adequately secured from the public and from potential vandalism. These wells should be securely fenced off and the area around each well should be properly maintained. Any trial wells which will not be used should be infilled and plugged with cement to prevent the entry of contaminants into the aquifer.

- The completion of well heads below ground level is not recommended unless necessary due to particular site conditions. Wells completed below ground level should be contained in a sealed manhole which will prevent the entry of surface water.

- Further investigation work should be conducted at each major source to establish the amount of recharge which is induced from the adjacent river, in order to refine the protection zones. The groundwater quality is often dependant on the river water quality as they are hydraulically connected, thus the catchment to the rivers should be delineated and all potential polluting activities within the river catchment should be monitored, particularly farmyard activities upgradient from the well and all industrial and commercial developments.

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Water Chapter

Appendix 8D

Off Site Well Monitoring

Off-Site Groundwater Level Trends

The location of the offsite Groundwater Monitoring Wells was shown on Figure 8.8.

Graphs 8.D.1, 2 and 3 present the applicant's monitoring data for the routine, long-term groundwater level monitoring results, in the off-site monitoring wells listed in Table 8.12 of the main body of the Water Chapter.

In the short term, groundwater levels in most of the wells exhibit the expected natural annual cyclical pattern, with winter rainfall/recharge bringing about a rise in groundwater levels, which subsequently recedes during the drier summer and autumn months. This seasonal range is generally low, being less than 3m. A low value of 3m for the seasonal ranges suggests that, in general, the rock is not supplying water through bedrock fissures or fractures connected to the surface.

Some of the on-site wells (ONGW1, ONGW3 and ONGW8) show no discernible seasonal change in groundwater levels throughout the year.

The dataset shows that groundwater levels have declined in a small number of third-party wells.

A decline in groundwater levels is not apparent in wells in the Waulsortian limestones to the southwest of the limestone quarry.

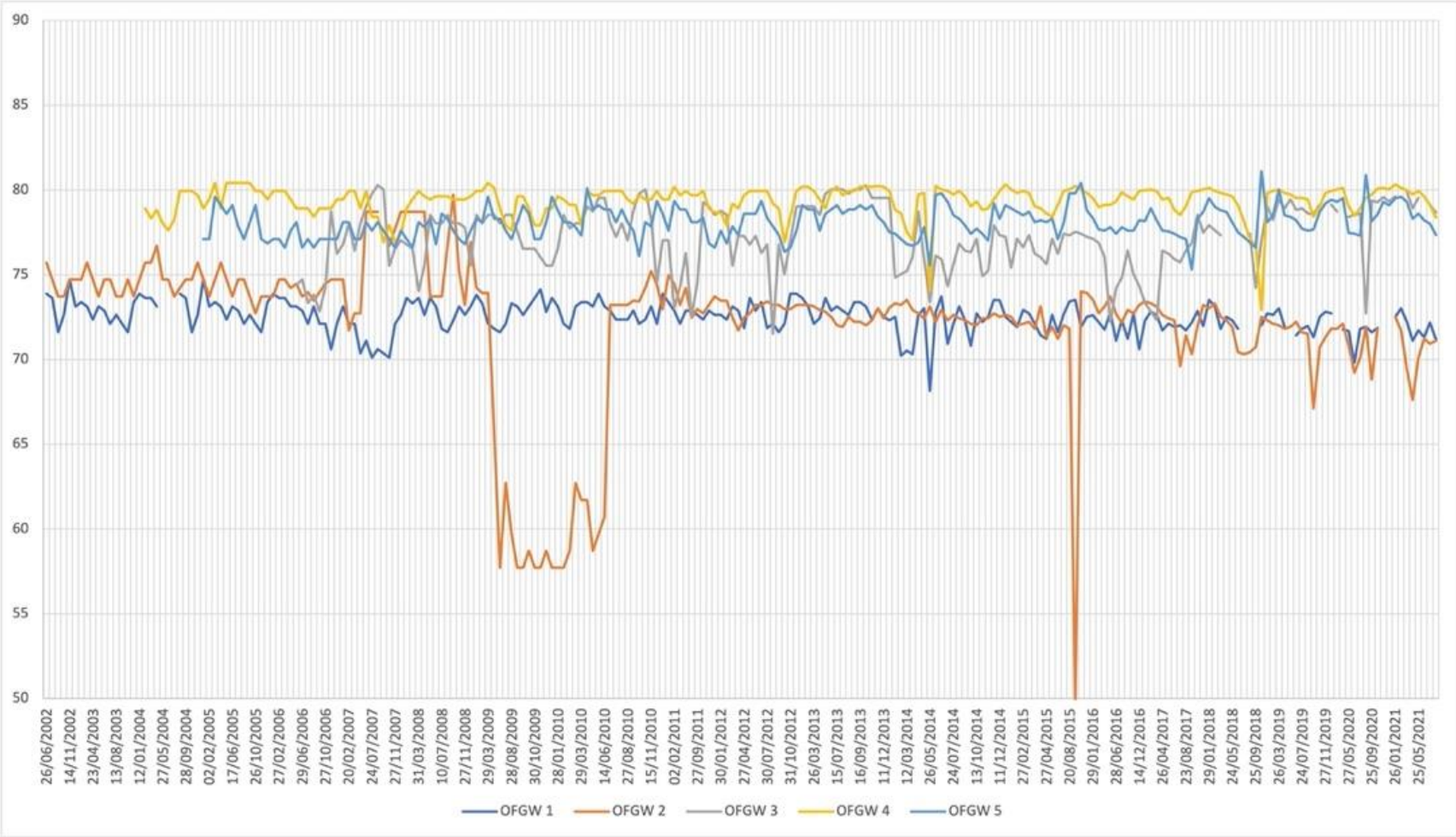
Bedrock quarrying commenced in the early 2000's. However, the groundwater level response trendlines show declines in a subset of wells since 2012.

The limestone quarry has an effect on long-term groundwater levels in the private wells closest to the eastern boundary of the limestone quarry, with a reduction of 2-3m evident. When the elevations of the well water levels are considered, the decline is occurring in the wells taking water from close to ground level. Therefore, the influence of climate cannot be ruled out. In addition, the influence of the removal of hydraulic storage in the wider area subsoils may be a factor. Permitting continuation of quarrying in the application area will not change or cause impact to those wells.

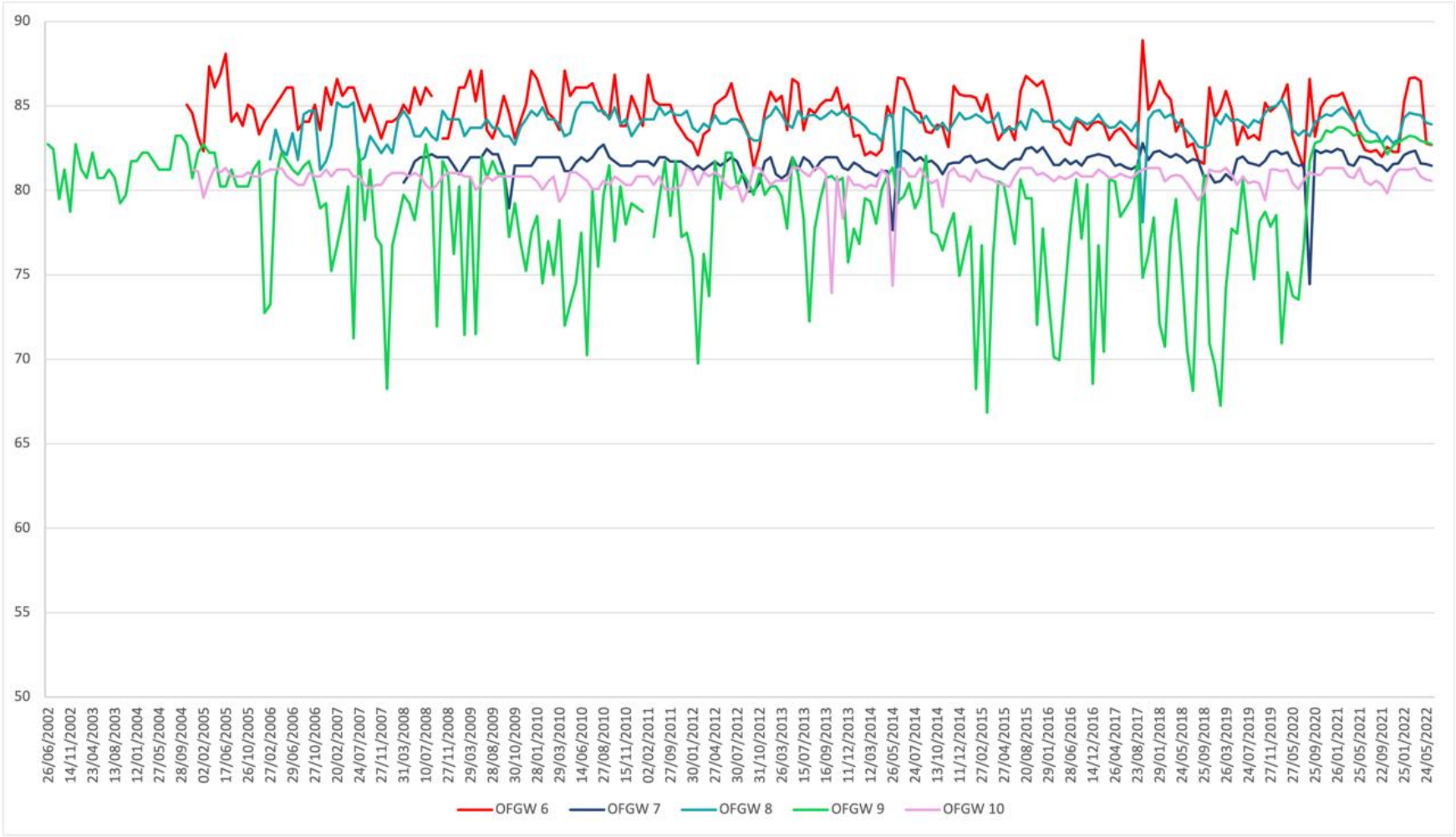
The long-term reduction in groundwater levels is clear in some of the wells penetrating the narrow Tober Colleen shale formation.

Long-term data at OFGW8 and OFGW10 would suggest that the Ballysteen aquifer to the south has not been impacted by dewatering.

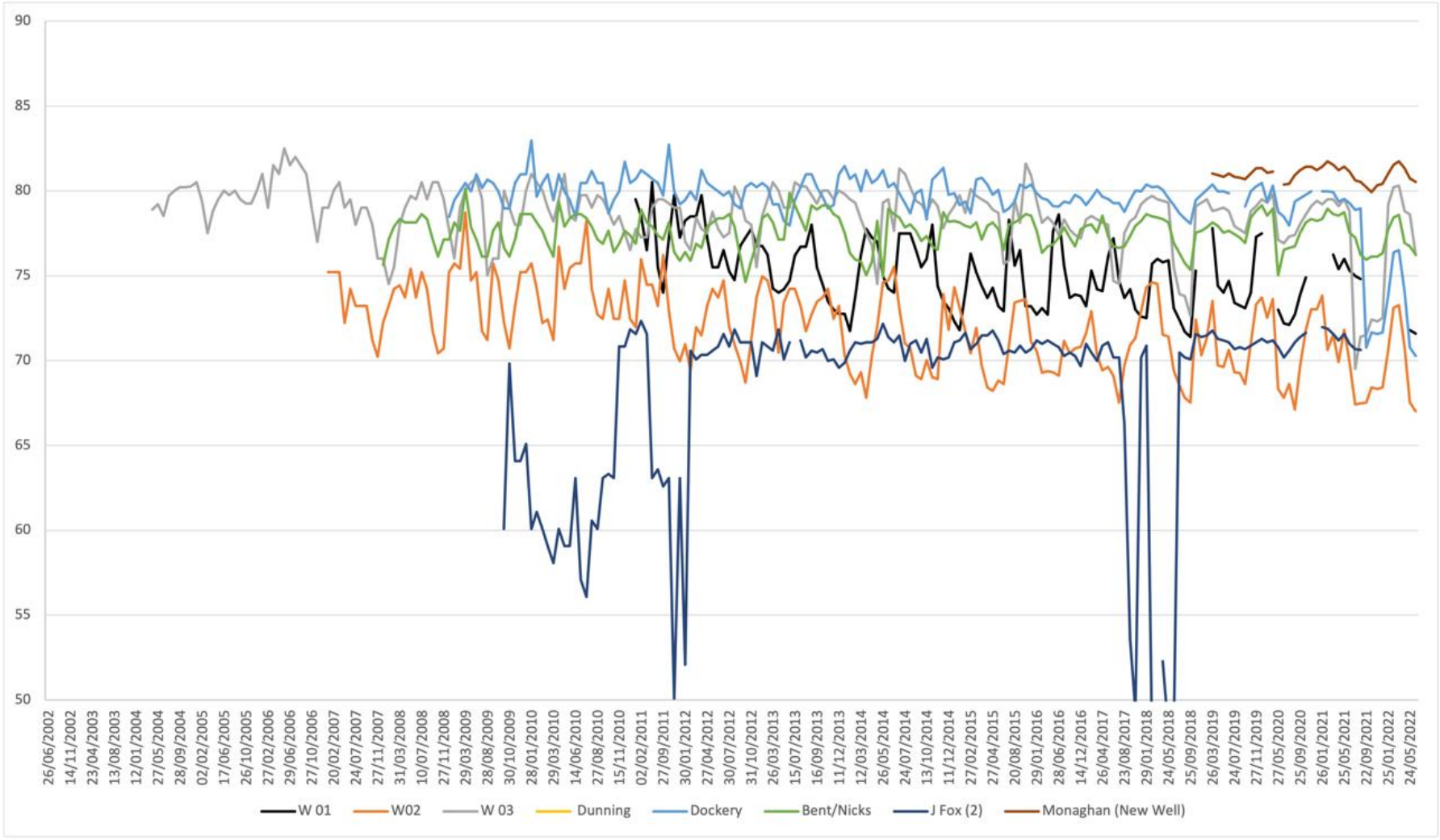
Graph Error! No text of specified style in document.**.D.1 – Monthly groundwater levels (mOD) recorded off-site at OFGW1-5 between 2002 – 2021**



Graph Error! No text of specified style in document.**.D.2 – Monthly groundwater levels (mOD) recorded off-site at OFGW6-10 between 2002 – 2021**



Graph Error! No text of specified style in document.**.D.3 – Monthly groundwater levels (mOD) recorded off-site at other points between 2002 – 2021**



Water Chapter

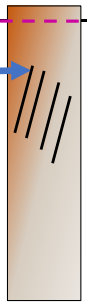
Appendix 8E

Production Well Logs

Drilling ID:	**ONGW18S (PW 1 2022)**
Site:	Breedon Group Quarry @ Kinnegad, Co Meath
Site Location:	Townland = Killaskillen
Hydro-G Project Ref:	21-P30 Kinnegad Breedon
APPROX NGR (ITM)	657010, 743175 i.e. close to PBH9 (Apex 2022)

Client:	Breedon Group
Date Drilled:	22/02/2022
Drilled By:	P Briody & Sons ltd. (Aidan Drilling)
Method:	Symetrix Shoe on the end of steel advanced with drill string & Compressed Air flush with Atlas Compco Stand alone compressor.
Logged By:	Dr. Pamela Bartley
BH Location on Site:	Northern Stockpile area. West Side. Apex Specified Drill Target Zone PBH9 (Apex DWG AGP21195_03, February 2022 Report).
BH GL Elevation (m OD)	~70m OD
BH Drilled Depth (m)	~9m
BH BASE Elevation (m OD)	~61m OD
Proposed Deepest Bench Elevation in Future (m OD)	10m OD
Proposed Bench Depth at this location of the site	10m OD. An adjacent SI MW ONGW14 (2021) is drilled to 10m OD. That MW drilling forund 'a lot' of water in the top meters and this ONGW18 is being drilled to test that water in the top few metres under the floor of this area.

Important Note: This is a BH Log created from Observations during drilling with a Water Well Drilling Rig rather than Rotary CORE. This log is a description by a hydrogeologist with hydrology, hydrogeological and civil engineering expertise. For Geological Detail, refer to descriptions by the geologists for the site and the Land Soils and Geology Section.

Depth (m bgl)	Elevation (m OD)	Description	Colour	Water Strike (m bgl)	Drill Diameter	Installation Details		Notes
0	70	Broken floor	Blue	100 to 150 m3/d	8" Steel to 8m bgl		8" Symetrix drilling to 9m bgl	Curent permitted Level 70m OD
1	69							
2	68							
3	67	Solid Waulsortian Limestone	Navy	No More Water				
4	66							
5	65							
6	64							
7	63							
8	62	GRAVELLY CLAY	BEIGE	SMALL Water here				Note, 9m of steel pulled back after drilling, out of the solid bedrock, Manually slotted with Angle Grinder on site to give 6 long slots going from 1.6m to 3.3m bgl, reinserted with just 8m in the ground, just sitting in the GRAVELLY CLAY. There is some water in this GRAVELLY CLAY, only SOME.
9	61	Solid Limestone	Navy	NONE = DRY				
END BH @ 9m bgl = 61m OD								

2022 Application Area Proposes to bring the floor from ~70m OD to 10m OD in this area

Notes:

To Be PUMP TESTED March 2022 (Driller estimation of yield @ 0 - 2m bgl = 100m3/d)

Water Levels:	1.14m bcl (0.76m bgl) 23/3/22	1.1m bcl (0.72m bgl) 21/4/22

Drilling ID:	**ONGW18D (PW2 2022)**
Site:	Breedon Group Quarry @ Kinnegad, Co Meath
Site Location:	Townland = Killaskillen
Hydro-G Project Ref:	21-P30 Kinnegad Breedon
National Grid Co-ordinates:	657075, 743120 i.e. close to PBH9 (Apex 2022)

Client:	Breedon Group
Date Drilled:	23/02/2022
Drilled By:	P Briody & Sons ltd. (Aidan Drilling)
Method:	DTH Hammer & Compressed Air flush with Atlas Compco Stand alone compressor.
Logged By:	Dr. Pamela Bartley
BH Location on Site:	Northern Stockpile area. WEST SIDE. Apex Specified Drill Target Zone PBH9 (Apex DWG AGP21195_03, February 2022 Report).
BH GL Elevation (m OD)	~70m OD
BH BASE Elevation (m OD)	~5m OD
Proposed Deepest Bench Elevation in Future (m OD)	10m OD
Proposed Bench Depth at this location of the site	10m OD. An adjacent SI MW ONGW14 (2021) is drilled to 10m OD. That MW drilling forund 'a lot' of water in the top meters and this ONGW19 is being drilled to test that water in the top few metres under the floor of this area. ONGW19 is complementary to ONGW18, adj, and these two BHs will be used to test the 'water is floor water' conceptual undesrstanding.

Important Note: This is a BH Log created from Observations during drilling with a Water Well Drilling Rig rather than Rotary CORE. This log is a description by a hydrogeologist with hydrology, hydrogeological and civil engineering expertise. For Geological Detail, refer to descriptions by the geologists for the site and the Land Soils and Geology Section.

Depth (m bgl)	Elevation (m OD)	Description	Colour	Water Strike (m bgl)	Drill Diameter	Installation Details		Notes
0	70							Curent permitted Level in the working floor = 70m OD
1	69	Broken Floor 0 - 2m bgl	Blue	100 to 150 m3/d	10" to 3m bgl		10" STEEL to 3m bgl	Water here is floor water, cracked rock floor, machines, rainfall
2	68							
3	67							Installed 12m of 6" steel with stabilisers
4	66							Tremie pipe cement grout the annulus
5	65							
6	64				8" drilled to 12m bgl		6" Steel from 0m bgl to 12m bgl	Should take 27bags cement at 75litres pet mix with 5bags cement. But it took 36bags. Therefore, good seal on all the cracks in the floor.
7	63							
8	62							
9	61							
10	60	Solid Limestone to 19m bgl	NAVY					
11	59							
12	58							
13	57							
14	56							
15	55			DRY (1 day after cementing out upper floor water)				
16	54							
17	53							
18	52							
19	51	CLAY 1m deep	CREAM	<0.5m3/d				
20	50							
21	49							
22	48							
23	47							
24	46							
25	45	Solid Limestone	Navy	DRY				
26	44							
27	43							
28	42							
29	41							
30	40							
31	39	CLAY 1m deep	CREAM	<0.5m3/d				
32	38							
33	37							
34	36							
35	35							
36	34							
37	33							
38	32							
39	31							
40	30	Solid Limestone	Navy		6" Drilling 12m to 65m bgl		Open Hole bedrock to 65m	
41	29							
42	28							
43	27							
44	26							
45	25							
46	24							
47	23							
48	22	CLAY 1m deep	CREAM					
49	21			DRY				
50	20							
51	19							
52	18							
53	17							
54	16							
55	15							
56	14							
57	13	Solid Limestone	Navy					Developed 30mins and measured 9m3/d in the btm of the hole = all the contributions from the clay bands.... But... also, a possibility that yesterday's cement didn't hold around the base of the steel after 65m drilling today. That is ok, the main deal was to explore dry drilling beneath the 12m band = achieved that today.
58	12							
59	11							
60	10							
61	9							
62	8							
63	7							
64	6							
65	5							

CEMENT GROUT PUMPED FROM 12m to 0m bgl DAY 1, with accelerator, left overnight.

2022 Application Area Proposes to bring the floor from ~70m OD to 10m OD in this area

Notes:

Adjacent PW1 (ONGW18) will be pump tested. Aim of this BH was to attempt to seal off floor water.

Water Levels:	1.14m bcl PW2 (0.46m bgl) 11am 23/3/22	1.32m bcl 21/4/22

Drilling ID:	**ONGW19 (PW3 2022)**
Site:	Breedon Group Quarry @ Kinnegad, Co Meath
Site Location:	Townland = Killaskillen
Hydro-G Project Ref:	21-P30 Kinnegad Breedon
National Grid Co-ordinates:	ITM 657250, 743240 APPROX i.e. APEX's PBH10 (2022)

Client:	Breedon Group
Date Drilled:	25/02/2022
Drilled By:	P Briody & Sons ltd. (Aidan Drilling)
Method:	DTH Hammer & Compressed Air flush with Atlas Compco Stand alone compressor.
Logged By:	Dr. Pamela Bartley
BH Location on Site:	Northern Stockpile area. EAST SIDE. Apex Specified Drill Target Zone PBH 10 (Apex DWG AGP21195_03, February 2022 Report).
BH GL Elevation (m OD)	~70m OD
BH BASE Elevation (m OD)	~5m OD
Proposed Deepest Bench Elevation in Future (m OD)	10m OD
Proposed Bench Depth at this location of the site	10m OD. An adjacent SI MW ONGW14 (2021) is drilled to 10m OD. That MW drilling forund 'a lot' of water in the top meters and this ONGW19 is being drilled to test that water in the top few metres under the floor of this area. ONGW19 is complementary to ONGW18, adj, and these two BHs will be used to test the 'water is floor water' conceptual undesrstanding.

Important Note: This is a BH Log created from Observations during drilling with a Water Well Drilling Rig rather than Rotary CORE. This log is a description by a hydrogeologist with hydrology, hydrogeological and civil engineering expertise. For Geological Detail, refer to descriptions by the geologists for the site and the Land Soils and Geology Section.

Depth (m bgl)	Elevation (m OD)	Description	Colour	Water Strike (m bgl)	Drill Diameter	Installation Details	Notes
0	70	FILL 0 to 1 m bgl	Blue			10" STEEL to 3m bgl	Curent permitted Level in the working floor = 70m OD
1	69						
2	68						NO WATER HERE. NO CLAYS NO WATER
3	67						
4	66						
5	65						
6	64						
7	63						
8	62						
9	61						
10	60						
11	59						
12	58						
13	57						
14	56						
15	55						
16	54						
17	53						
18	52						
19	51						
20	50						
21	49						
22	48						
23	47						
24	46						
25	45						
26	44						
27	43						
28	42						
29	41						
30	40						
31	39						
32	38						
33	37						
34	36	Solid Limestone to 65m bgl	NAVY	NONE	8" to 65m bgl	OPEN HOLE to 65m bgl	
35	35						
36	34						
37	33						
38	32						
39	31						
40	30						
41	29						
42	28						
43	27						
44	26						
45	25						
46	24						
47	23						
48	22						
49	21						
50	20						
51	19						
52	18						
53	17						
54	16						
55	15						
56	14						
57	13						
58	12						
59	11						
60	10						
61	9						
62	8						
63	7						
64	6						
65	5						

2022 Application Area Proposes to bring the floor from ~70m OD to 10m OD in this area

Notes:

Pump Tested May 2022

Water Levels:	0.86m bcl PW3 4.30pm 23/3/22	PW3 = 1.01m bcl (top of steel) 21/4/22

Water Chapter

Appendix 8F

Mathematical Analysis of Site Investigation Tests

Pump Tests on the Production Wells

Hickey Pumps Ltd. were commissioned by Dr. Pamela Bartley to install the appropriate submersible pump and associated pump test infrastructure. Flow rates were measured using an in-line magmeter. Stilling tubes were installed temporarily to facilitate manual groundwater level readings using a dip meter; groundwater levels were also monitored continuously through the use of submerged pressure transducers. Pumps, control valves and pumping rates were calibrated in advance of each test.

Production Well Logs were presented in Appendix E.

The drilling experience and principal findings of the Production Well Site Investigations and constructions were described in Section 8.5.4 of the main body of the Water Chapter.

This Appendix presents the Pump Test Methodology, the reactions of the hydrogeological system and the analysis for hydraulic parameters.

Production Well locations are shown on Figure 8.7, of the Figure Series accompanying the Water Chapter.

8.1.1.1 ONGW18S Step Test

A 6" 11 kW Grundfos MS402 submersible pump was installed at a depth of 8.5 m in ONGW18S on 15th March 2022 to a facilitate a 10-day pumping test. The pump is capable of pumping ~20m3/hr, equivalent to 456m3/d, for the head of the installation.
The first phase of testing was completed purely to try to get an understanding of the water bearing zones. This test commenced on 22nd March 2022. The initial test run was a step test consisting of 4 no. 30 minute concurrent pumping test periods with each at progressively increasing rates.
Starting groundwater level was 1.46 mbtoc; saturated thickness at start of test was 7.4 m. The steps were pumped as follows:

- 30 minutes at 5 m^3/hr (120 m^3/d) = no drawdown; followed by
- 30 minutes at 10 m^3/hr (240 m^3/d) = 0.06 m drawdown (1.52 mbtoc), followed by
- 30 minutes at 15 m^3/hr (360 m^3/d) = 0.12 m drawdown (1.58 mbtoc), followed by
- 30 minutes at 19 m^3/hr (456 m^3/d) = 0.20 m drawdown (1.66 mbtoc).

From the manually recorded response to pumping it quickly became apparent that the response of the drawdown was linear and at the almost the same rate regardless of the abstraction rate. This meant that water being pumped was from shallow water stored in the floor of the application area in broken rock and was not hydraulically connected to an underlying groundwater aquifer. As such step testing analysis provided no mathematical results of benefit to the assessment. The results were useful because they enabled a correct direction for the future testing. The final 'step' of the initial testing was allowed to run into a constant discharge pumping test at 19m3/hr. However, @ 1140 minutes (19 hours) at 19 m^3/hr (461 m^3/d) the drawdown increased rapidly. Water level in the BH drew down from 3.38m to 6.4m within 5 minutes. There was danger of the water level approaching the pump inlet and this is to be avoided. The pump was turned off and the well allowed to recover.
This change in response suggests that groundwater level had dropped below the base of the broken rock layer and was now attempting to abstract water from the competent bedrock, and there was not 19m3/hr in that rock. The base of this broken rock 'reservoir' of water seems end c. 4.0m bgl.

As stated, the drawdown response throughout each stage was a straight line which suggests a finite reservoir of water is being emptied, and that it is either not being recharged, or it is being recharged

only at a very slow rate. The response in groundwater levels throughout the test was measured at ONGW14, located approximately 10 m away. Groundwater levels here were largely in equilibrium with those in the pumping test well at the end of the constant rate discharge test.

8.1.1.2 ONGW18S Constant Rate Discharge & Recovery Test

A constant discharge rate pumping test was repeated at ONGW18S on 24th March 2022.

ONGW14, situated approximately 10 m away from ONGW18D was used as an observation well during the well testing period. Groundwater response to pumping was recorded using datalogger pressure transducers in all surrounding wells. Data from the observation well was used to calculate aquifer properties.

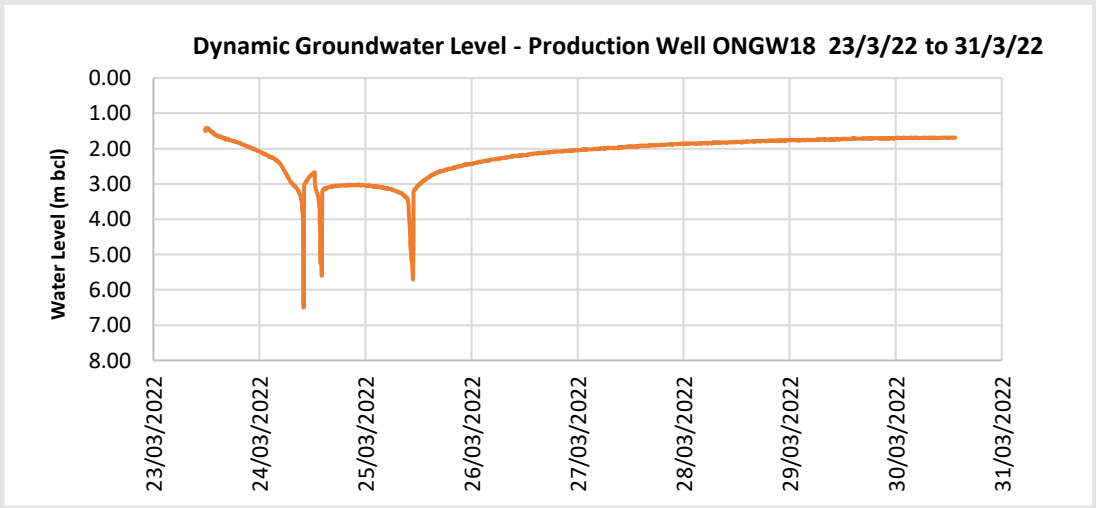
The step test was repeated using four 60 minute steps with pumping rates increasing from 5 to ~20m^3/hr. Overall, drawdown was again minimal (0.12 m). After considering the minimal cumulative drawdown achieved during the initial step test it was decided to undertake a constant discharge test until such a point that the reservoir of water held directly beneath the quarry floor was exhausted. On the 24th of March groundwater levels in the well began to decline rapidly towards the pump intake just below 6 m (bctoc), pumping ceased and groundwater within the well casing recovered instantaneously back up to 3 mbtoc. Once groundwater reached 3 mbtoc groundwater began to recovery slowly for a period of 2.5 hrs.

Pumping recommenced at the initial discharge rate of ~20m^3/hr (12:12pm), once again groundwater levels declined rapidly towards the pump intake. In an attempt to stabilise groundwater levels in the well the discharge rate was lowered to 5 m^3/hr. Water levels in the well appeared to stabilise and the pump was left running overnight. The following morning (25/03/22 09:30) water level in the well began to decline to the point when rapid drawdown was observed for a second time.

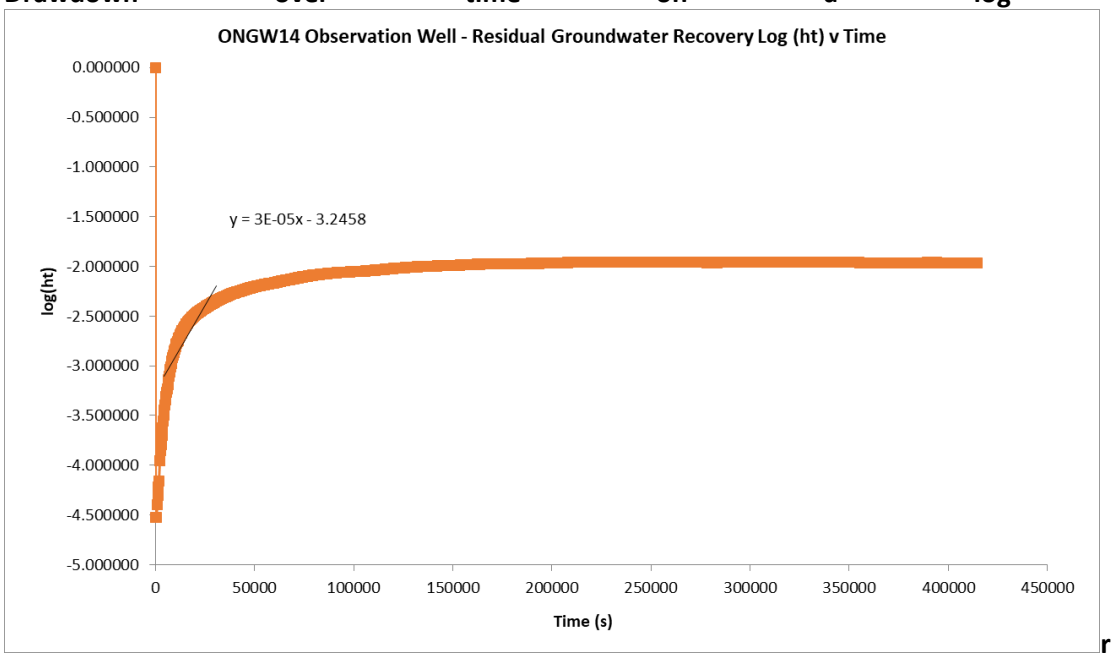
Again, the pump was stopped when water levels began to rapidly decline towards the pump intake. Upon cessation of pumping groundwater instantaneously entered the well annulus and water levels quickly recovered from approximately 6 mbtoc to 3 mbtoc. During this period water was noted to be cascading from the upper screened section and falling into the well, which would infer that the source of water appears to be perched.

A comparison of ground water level data collected for wells ONGW18 and ONGW14 post-testing revealed that the instantaneous recovery of water levels observed following cessation of pumping in ONGW18 (Graph 8.F.1) was not reflected in the data captured in ONGW14 (Graph 8.F.2). As such it was decided to use the recovery data from the observation well ONGW14 to calculate the hydraulic properties of the underlying formation.

Graph Error! No text of specified style in document.**.F.1 – ONGW18 Constant Discharge Pumping Test Drawdown**



Graph Error! No text of specified style in document.**.F.2 – ONGW14 Constant Discharge Test Drawdown over time on a log scale**



r The

The industry standard equation of the Bouwer Rice (1976) method was used to estimate the hydraulic conductivity of the geological formations exposed in the open-hole section of the well. The rate of flow of ground water into the well when the water level in the well is a distance y lower than the static ground-water table around the well is calculated with the Thiem equation as:

$Q = 2 \pi K L_e (y / \ln (R_e / r_w)$

where: Q = volume rate of flow into well
K = hydraulic conductivity of aquifer surrounding the well
L_e = Length of screened section, perforated or otherwise

y = vertical difference between water level inside well and static water level

By plotting the natural log of water level recovery over time a straight line is then fitted to the initial recovery curve. The gradient of this line is then used to calculate and hydraulic conductivity of the underlying formation.

The Bouwer Rice approach yields a conservative estimate for the hydraulic conductivity of the formation at ONGW18S:

$$K\ (ONGW18S) = 0.0141\ m/d = 1.6 \times 10^{-7}\ m/s$$

Transmissivity is the rate at which water is transmitted through an aquifer under a unit width and a unit hydraulic gradient. The higher the transmissivity, the more prolific the aquifer is considered to be.

$$T = KD$$

where: T = aquifer transmissivity
K = hydraulic conductivity
D = saturated aquifer thickness

As a conservative estimate, this equation yields a Transmissivity of T = 0.1 m^2/d

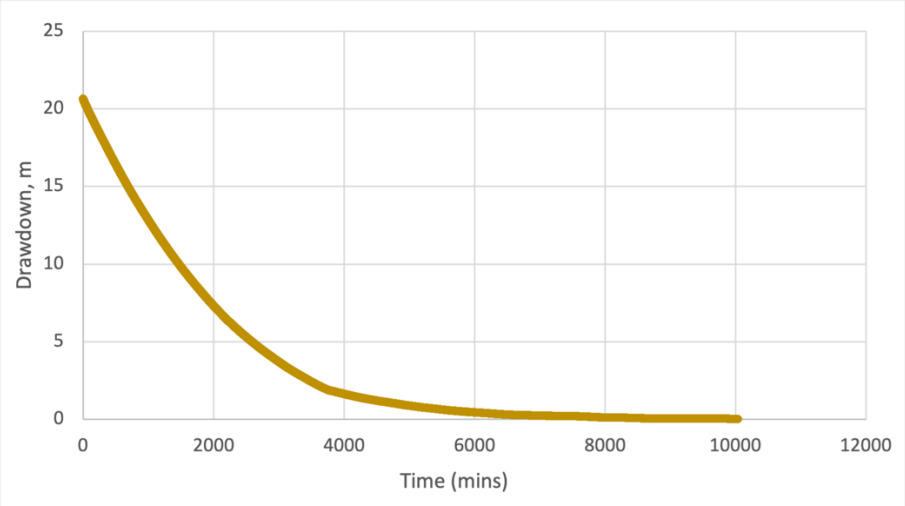
This value should be treated with caution as it likely represents combined permeability across both the competent bedrock formation and broken rock layer.

8.1.1.3 ONGW19 Aquifer Testing

On 4th of May 2022 Envirologic personnel visited the site and performed a modified bail down/recovery test on well ONGW19. This well is on the other side of the floor to ONGW14 and ONGW18S&D. No water strike was encountered during the drilling of the Production Well labelled ONGW19. A Grundfos submersible pump (model SQE 3-55) was installed into the well which has capacity to pump up to 3m^3/h (72m^3/d) at a head of 56m. The intake of the pump was set at 23 m below ground level (bgl). At the start of the test, groundwater level in the well was 1.09 m below top of casing (btoc); saturated thickness at start of test was 22 m. The well was pumped at a constant rate of 3m3/hr. Following commencement of pumping water level in the well dropped within 6 minutes from 1.09 m to 22 m below top of casing. The pump was then switched off and groundwater levels were allowed recover. Recorded drawdown is shown in Graph 8.F.3.

Groundwater levels in ONGW19 took approximately 72 hrs to recover back to pre-pumping levels. This extended recovery reflects the lack of permeability in the bedrock. This is due to the massive nature of the underlying Waulsortian Limestone within which there is little to no connected fracture pathways with flows instead concentrated within small minor discontinuous voids within the mud bank limestone.

Graph Error! No text of specified style in document.**.F.3 – ONGW19 Drawdown following Cessation of Pumping**



The Cooper-Jacob method is suitable for interpretation of pumping test and recovery test data providing certain assumptions are met. In this case the pumping phase did not achieve steady-state drawdown conditions.

Due to the relatively instantaneous withdrawal of water from the well and the prolonged recovery period the pumping phase was treated in theory as a slug removal. The Bouwer Rice (1976) modified slug method was then applied to estimate the hydraulic conductivity of the geological formations exposed in the open-hole section of the well. The rate of flow of ground water into the well when the water level in the well is a distance y lower than the static ground-water table around the well is calculated with the Thiem' equation as:

$$Q = 2 \pi K L_e (y / \ln (R_e / r_w)$$

where:
Q = volume rate of flow into well
K = hydraulic conductivity of aquifer surrounding the well
L_e = Length of screened section, perforated or otherwise
y = vertical difference between water level inside well and static water level

By plotting the natural log of water level recovery Log(ht) over time a straight line is then fitted to the recovery curve, the gradient of this line then is used to calculate hydraulic conductivity of the underlying formation. The Bouwer Rice calculation yields a conservative estimate for the hydraulic conductivity of the bedrock formation underlying ONGW19 as:

K (ONGW19) = 0.0018 m/d = 2 x 10^{-8} m/s
T = 0.04 m^2/d

Using the Geological Survey of Ireland Aquifer Classification System, the extremely low transmissivity value calculated would categorise the underlying rock formation as a 'Poorly Productive Aquifer'.

Results from the aquifer hydraulic testing are summarised in Table 8.F.1.

Table 8-F.1: Summary of aquifer hydraulic properties

Well Ref.	Location	Screen Interval, m	Permeability, m/s	Formation
ONGW12	Adjacent to sandpit near northern settlement pond	4.7 – 10.7 m		Sand MW
ONGW13	West of the main limestone quarry's sump	53.5 – 80.5	7.7×10^{-8} m/s	Waulsortian limestone
ONGW14	Centre of application area	2.6 – 56.6	Not measurable	Waulsortian limestone
ONGW15S	Immediately north of balancing pond	5 - 25	9.2×10^{-10} m/s	Waulsortian limestone
ONGW15D	Immediately north of balancing pond	30 – 80	5.1×10^{-9} m/s	Waulsortian limestone
ONGW16	Northwest of application area, close to boundary of ownership	12.5 - 27.5	1.9×10^{-6} m/s	Tober Colleen shale
ONGW17	North of application area, Adjacent to road overpass	11 – 80	3.0×10^{-6} m/s	Waulsortian limestone (fracture at 20 m)
ONGW18S	6 m from ONGW14	1.6 – 2.6		Broken rock & Waulsortian limestone
ONGW18D	6 m from ONGW14	Open hole: 12 – 60 m		Waulsortian limestone
ONGW19	Application area, Southwest of Balancing Pond	Open hole: X – y m	2×10^{-8}	Waulsortian limestone

Water Chapter

Appendix 8G

Water Quality

Analysis Result Tables
&
Certificates of Analysis

Table 8.G.1 Summary Groundwater Quality Results (refer to Laboratory Certificates of Analysis for full results)

Parameter	Units	ONGW6	ONGW6	ONGW13	ONGW13	ONGW16	ONGW16	ONGW17	ONGW17	Groundwater Regulation Threshold Values (2010, as amended 2016) *
Date		**16/12/21**	**27/04/22**	**16/12/22**	**27/04/22**	**16/12/21**	**27/04/22**	**16/12/21**	**27/04/22**	
Field Temperature	℃	11.6		10.9		10.9		10.9		Not specified
Field Electrical Conductivity	µS/cm	1103		1707		1707		1707		800 - 1875
Lab Electrical Conductivity	µS/cm	964	933	2386	2397	1065	1093	1048	935	
Field pH	pH units	8.7		8.0		8.0		8.0		Not specified
Lab pH	pH units	7.6	7.7	7.6	7.7	7.6	7.7	7.5	7.7	
Field DO	mg/l	9.8		6.5		1.9		6.5		Not specified
Aluminium	µg/l	<1.5	<1.5	6.5	2.0	9.2	16.8	8.3	12.7	
Cadmium	µg/l	0.35	0.11	0.11	<0.03	0.04	<0.03	<0.03	<0.03	3.75
Iron	µg/l	<4.7	1020	<4.7	8990	724	320	150	10.2	Not specified
Manganese	µg/l	531	620	1008	1551	1472	1617	379	111	Not specified
Mercury	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.75
Zinc	µg/l	23.2	26.0	56.7	8.8	35.2	20.2	6.7	7.5	75
Calcium	mg/l	139	141	346	422	294	213	866	416	Not specified
Magnesium	mg/l	14.6	14.4	41.8	53.8	30.1	25.5	32.0	23.0	Not specified
Potassium	mg/l	1.5	2.9	25.4	24.3	17.2	8.8	37.1	37.0	Not specified
Sodium	mg/l	54.5	51.8	82.7	65.4	19.1	18.6	32.9	22.3	150
Total Hardness	mg/l	380	378	1058	1105	571	502	439	396	
Sulphate	mg/l	74	72.5	232	215.3	61.5	61.0	56.1	38.4	187.5
Chloride	mg/l	83.6	79.1	447.8	485.6	97.6	106.9	98.0	75.7	187.5
Nitrate (NO3)	mg/l	0.3	<0.2	0.3	<0.2	<0.2	<0.2	0.4	1.8	37.5
Nitrite (NO2)	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.375 ug/l
Orthophosphate as PO_4	mg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	
Orthophosphate as P	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	Not specified
Ammoniacal Nitrogen as NH_4	mg/l	0.52	0.40	7.26	7.87	0.16	0.13	<0.03	0.04	0.065 to 0.175
Alkalinity (CaCO3)	mg/l	298	330	302	304	440	412	1700	946	Not specified
TOC	mg/l	3	<2	6	34	4	32	3	<2	Not specified
TPH (C5-C35)	µg/l	<10	<10	<10	<10	<10	<10	<10	<10	Not specified
PAH Total	µg/l	<0.195	<0.195	<0.195	<0.195	<0.195	<0.195	<0.195	<0.195	Not specified
Suspended Solids^^	mg/l		<10	1.0	61	3170	1510	4850	1849	Not specified
BOD	mg/l			2		5		2		Not specified
Total coliforms	MPN/ 100 ml			0		0		10		Not specified
Faecal coliforms	MPN/ 100 ml			0		0		10		Not specified

Table 8.G.2 Summary Quarry Water and Surface Water Quality Results (refer to Laboratory Certificates of Analysis for full results)

Parameter	Units	Limestone Quarry Sump		Quarry Discharge, SW1		Kinnegad River Upstream		Surface Water Environmental Quality Standard (EQS, AA)	Groundwater Regulation Threshold Values (2010, as amended 2016) *
Date		**16/12/21**	**27/04/22**	**16/12/21**	**27/04/22**	**16/12/21**	**27/04/22**		
Field Temperature	℃	13.7		11.6		13.7		Not specified	Not specified
Field Electrical Conductivity	µS/cm	974		680		681		Not specified	800 - 1875
Lab. Electrical Conductivity	µS/cm	1178	1256	1386	1076	821	736		
Field pH	pH units	8.8		8.8		8.5		Not specified	Not specified
Lab pH	pH units	7.9	8.2	8.0	7.9	8.1	8.3		
Field DO	mg/l	1.81		9.3		5.2		Not specified	Not specified
Aluminium	µg/l	3.9	11.5	10.9	3.6	5.2	6.7		
Cadmium	µg/l	<0.03	<0.03	<0.03	0.07	<0.03	<0.03	0.08 – 0.25	3.75
Iron	µg/l	<4.7	<4.7	42.0	128.1	166.5	34.5	Not specified	Not specified
Manganese	µg/l	<1.5	<1.5	48.2	196.7	126.4	38.2	Not specified	Not specified
Mercury	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	Not specified	0.75
Phosphorus	µg/l	<5	<5	<5	7	28	8	Not specified	Not specified
Zinc	µg/l	5.4	38.2	2.9	14.7	7.5	4.2	Not specified	75
Calcium	mg/l	138.5	133.6	139.3	124.1	163.9	153.7	Not specified	Not specified
Magnesium	mg/l	15.3	16.7	15.9	12.8	8.3	9.1	Not specified	Not specified
Potassium	mg/l	90.1	126.2	137.6	85.1	2.7	1.6	Not specified	Not specified
Sodium	mg/l	25.0	27.3	42.6	27.5	12.7	9.0	Not specified	150
Total Hardness	mg/l	394	358	387	331	435	387		
Sulphate	mg/l	134.9	94.5	171.9	127.2	57.4	43.2	Not specified	187.5
Chloride	mg/l	119.0	165.9	170.2	111.3	20.0	17.9	Not specified	187.5
Nitrate (NO3)	mg/l	15.5	15.1	5.5	1.4	11.5	9.2	Not specified	37.5
Nitrite (NO2)	mg/l	<0.02	<0.02	<0.02	<0.02	0.08	<0.02	Not specified	0.375 ug/l
Orthophosphate as PO_4	mg/l	<0.03	<0.03	<0.03	<0.03	0.04	<0.03	Not specified	Not specified
Orthophosphate as P	mg/l	<0.01	<0.01	<0.01	<0.01	0.013	0.01	0.035 – 0.075	
Ammoniacal Nitrogen as NH4	mg/l	<0.03	0.04	0.10	0.10	0.15	0.04	Not specified	0.065 to 0.175
Alkalinity (CaCO3)	mg/l	210	258	200	230	352	364	Not specified	Not specified
TOC	mg/l	3	<2	4	<2	13	<2	Not specified	Not specified
EPH (C8-C40)	µg/l	<10	<10	<10	<10	<10	<10	Not specified	Not specified
TPH (C5-C35)	µg/l	<0.195	<0.195	<0.195	<0.195	<0.195	<0.195	Not specified	Not specified
BOD + ATU	mg/l							Not specified	Not specified
Total coliforms	MPN/ 100 ml							Not specified	Not specified
Faecal coliforms	MPN/ 100 ml							Not specified	Not specified
Suspended Solids^^	mg/l		<10		<10		<10	Not specified	Not specified

* Threshold values relevant to an assessment of the general quality of groundwater in a groundwater body in terms of its ability to support human uses has been significantly impaired by pollution. Where this threshold was not stated, that relevant to an assessment of whether groundwater intended for human consumption in drinking water areas is impacted by pollutants and/or is showing a significant and sustained rise in pollutant levels was applied.^ The Irish EPA acknowledge that no laboratory can achieve the TPH and PAH TVs. It is generally accepted that a <LOD result shall suffice to demonstrate no hydrocarbon content in the waters.

- Not Sampled

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78 St Peters Terrace
Howth
Co Dublin
Ireland

Attention :	Pat Breheny
Date :	20th January, 2022
Your reference :	1970
Our reference :	Test Report 21/20341 Batch 1
Location :	Kinnsgad
Date samples received :	20th December, 2021
Status :	Final Report
Issue :	1

Seven samples were received for analysis on 20th December, 2021 of which seven were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Authorised By:

Hayley Prowse
Project Manager

Element Materials Technology Environmental UK Limited
Registered in England and Wales
Registered Office: 3rd Floor Davidson Building, 5 Southampton Street, London WC2E 7HA
Company Registration No: 11371415

Client Name: Envirologic Ltd
Reference: 1970
Location: Kinnsgad
Contact: Pat Breheny
EMT Job No: 21/20341

Report : Liquid

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
$H=H_2SO_4$, Z=ZnAc, N=NaOH, $HN=HN0_3$

EMT Sample No.	1-6	7-12	13-18	19-24	25-30	31-36	37-42				LOD/LOR	Units	Method No.
Sample ID	ONGW6	ONGW13	LQ SUMP	ONGW16	ONGW17	FINAL DISCHARGE	RIVER U/S						
Depth													
COC No / misc													
Containers	V H HN P G	V H HN P G	V H HN P G	V H HN P G	V H HN P G	V H HN P G	V H HN P G						
Sample Date	16/12/2021	16/12/2021	16/12/2021	16/12/2021	16/12/2021	16/12/2021	16/12/2021						
Sample Type	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water						
Batch Number	1	1	1	1	1	1	1						
Date of Receipt	20/12/2021	20/12/2021	20/12/2021	20/12/2021	20/12/2021	20/12/2021	20/12/2021						
Dissolved Aluminium #	<1.5	6.5	3.9	9.2	8.3	10.9	5.2				<1.5	ug/l	TM170/PM14
Dissolved Cadmium #	0.35	0.11	<0.03	0.04	<0.03	<0.03	<0.03				<0.03	ug/l	TM170/PM14
Total Dissolved Iron #	<4.7	<4.7	<4.7	723.7	150.2	42.0	166.5				<4.7	ug/l	TM170/PM14
Dissolved Manganese #	530.8	1008.2 AA	<1.5	1472.4 AA	379.1	48.2	126.4				<1.5	ug/l	TM170/PM14
Dissolved Mercury #	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5				<0.5	ug/l	TM170/PM14
Dissolved Phosphorus #	<5	6	<5	14	<5	<5	28				<5	ug/l	TM170/PM14
Dissolved Zinc #	23.2	56.7	5.4	35.2	6.7	2.9	7.5				<1.5	ug/l	TM170/PM14
Total Calcium	139.0 AB	345.8 AB	138.5 AB	294.0 AB	866.2 AB	139.3 AB	163.9 AB				<0.2	mg/l	TM30/PM14
Total Magnesium	14.6 AB	41.8 AB	15.3 AB	30.1 AB	32.0 AB	15.9 AB	8.3 AB				<0.1	mg/l	TM30/PM14
Total Potassium	1.5 AB	25.4 AB	90.1 AB	17.2 AB	37.1 AB	137.6 AB	2.7 AB				<0.1	mg/l	TM30/PM14
Total Sodium	54.5 AB	82.7 AB	25.0 AB	19.1 AB	32.9 AB	42.6 AB	12.7 AB				<0.1	mg/l	TM30/PM14
Total Hardness Dissolved (as CaCO3)	380	1058 AA	394	571	439	387	435				<1	mg/l	TM30/PM14
PAH MS													
Naphthalene #	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1				<0.1	ug/l	TM4/PM30
Acenaphthylene #	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013				<0.013	ug/l	TM4/PM30
Acenaphthene #	<0.013	<0.013	<0.013	0.023	<0.013	<0.013	<0.013				<0.013	ug/l	TM4/PM30
Fluorene #	<0.014	<0.014	<0.014	0.031	<0.014	<0.014	<0.014				<0.014	ug/l	TM4/PM30
Phenanthrene #	<0.011	<0.011	<0.011	0.056	<0.011	<0.011	<0.011				<0.011	ug/l	TM4/PM30
Anthracene #	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013				<0.013	ug/l	TM4/PM30
Fluoranthene #	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012				<0.012	ug/l	TM4/PM30
Pyrene #	<0.013	<0.013	<0.013	0.013	<0.013	<0.013	<0.013				<0.013	ug/l	TM4/PM30
Benzo(a)anthracene #	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015				<0.015	ug/l	TM4/PM30
Chrysene #	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011				<0.011	ug/l	TM4/PM30
Benzo(bk)fluoranthene #	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018				<0.018	ug/l	TM4/PM30
Benzo(a)pyrene #	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016				<0.016	ug/l	TM4/PM30
Indeno(123cd)pyrene #	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011				<0.011	ug/l	TM4/PM30
Dibenzo(ah)anthracene #	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01				<0.01	ug/l	TM4/PM30
Benzo(ghi)perylene #	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011	<0.011				<0.011	ug/l	TM4/PM30
PAH 16 Total #	<0.195	<0.195	<0.195	<0.195	<0.195	<0.195	<0.195				<0.195	ug/l	TM4/PM30
Benzo(b)fluoranthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01				<0.01	ug/l	TM4/PM30
Benzo(k)fluoranthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01				<0.01	ug/l	TM4/PM30
PAH Surrogate % Recovery	94	82	76	73	80	79	79				<0	%	TM4/PM30
MTBE #	<5	<5	<5	<5	<5	<5	<5				<5	ug/l	TM36/PM12
Benzene #	<5	<5	<5	<5	<5	<5	<5				<5	ug/l	TM36/PM12
Toluene #	<5	<5	<5	<5	<5	<5	<5				<5	ug/l	TM36/PM12
Ethylbenzene #	<5	<5	<5	<5	<5	<5	<5				<5	ug/l	TM36/PM12
m/p-Xylene #	<5	<5	<5	<5	<5	<5	<5				<5	ug/l	TM36/PM12
o-Xylene #	<5	<5	<5	<5	<5	<5	<5				<5	ug/l	TM36/PM12

Please see attached notes for all abbreviations and acronyms

Element Materials Technology

Client Name: Envirologic Ltd
Reference: 1970
Location: Kinnsgad
Contact: Pat Breheny
EMT Job No: 21/20341

Report : Liquid

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
$H=H_2SO_4$, Z=ZnAc, N=NaOH, $HN=HN0_3$

EMT Sample No.	1-6	7-12	13-18	19-24	25-30	31-36	37-42				LOD/LOR	Units	Method No.
Sample ID	ONGW6	ONGW13	LQ SUMP	ONGW16	ONGW17	FINAL DISCHARGE	RIVER U/S						
Depth													
COC No / misc													
Containers	V H HN P G	V H HN P G	V H HN P G	V H HN P G	V H HN P G	V H HN P G	V H HN P G						
Sample Date	16/12/2021	16/12/2021	16/12/2021	16/12/2021	16/12/2021	16/12/2021	16/12/2021						
Sample Type	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water						
Batch Number	1	1	1	1	1	1	1						
Date of Receipt	20/12/2021	20/12/2021	20/12/2021	20/12/2021	20/12/2021	20/12/2021	20/12/2021						
TPH CWG													
Aliphatics													
>C5-C6 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM36/PM12
>C6-C8 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM36/PM12
>C8-C10 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM36/PM12
>C10-C12 #	<5	<5	<5	<5	<5	<5	<5				<5	ug/l	TM5/PM16/PM30
>C12-C16 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM5/PM16/PM30
>C16-C21 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM5/PM16/PM30
>C21-C35 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM5/PM16/PM30
Total aliphatics C5-35 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM5/TM36/PM12/PM16/PM30
Aromatics													
>C5-EC7 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM36/PM12
>EC7-EC8 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM36/PM12
>EC8-EC10 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM36/PM12
>EC10-EC12 #	<5	<5	<5	<5	<5	<5	<5				<5	ug/l	TM5/PM16/PM30
>EC12-EC16 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM5/PM16/PM30
>EC16-EC21 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM5/PM16/PM30
>EC21-EC35 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM5/PM16/PM30
Total aromatics C5-35 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM5/TM36/PM12/PM16/PM30
Total aliphatics and aromatics(C5-35) #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM5/TM36/PM12/PM16/PM30
Sulphate as SO4 #	74.0	232.4	134.9	61.5	56.1	171.9	57.4				<0.5	mg/l	TM38/PM0
Chloride #	83.6	447.8	119.0	97.6	98.0	170.2	20.0				<0.3	mg/l	TM38/PM0
Nitrate as NO3 #	0.3	0.3	15.5	<0.2	0.4	5.5	11.5				<0.2	mg/l	TM38/PM0
Nitrite as NO2 #	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.08				<0.02	mg/l	TM38/PM0
Ortho Phosphate as PO4	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.04				<0.03	mg/l	TM38/PM0
MRP Ortho Phosphate as PO4	<0.06	<0.06	<0.06	<0.06	0.18	<0.06	<0.06				<0.06	mg/l	TM38/PM0
Ammoniacal Nitrogen as NH4 #	0.52	7.26	<0.03	0.16	<0.03	0.10	0.15				<0.03	mg/l	TM38/PM0
Total Alkalinity as CaCO3 #	298	302	210	440	1700	200	352				<1	mg/l	TM75/PM0
Bicarbonate Alkalinity as CaCO3 (water soluble)	298	302	210	440	1700	200	352				<1	mg/l	TM75/PM0
Electrical Conductivity @25C #	964	2386	1178	1085	1048	1386	821				<2	uS/cm	TM76/PM0
pH #	7.63	7.58	7.86	7.56	7.49	8.01	8.07				<0.01	pH units	TM73/PM0
Total Organic Carbon #	3	6	3	4	3	4	13				<2	mg/l	TM60/PM0

Please see attached notes for all abbreviations and acronyms

Client Name: Envirologic Ltd

Reference: 1970

Location: Kinnsgad

Contact: Pat Breheny

Matrix : Liquid

EMT Job No.	Batch	Sample ID	Depth	EMT Sample No.	Analysis	Reason
21/20341	1	ONGW13		7-12	PAH	Sample holding time exceeded
21/20341	1	LQ SUMP		13-18	PAH	Sample holding time exceeded
21/20341	1	ONGW16		19-24	PAH	Sample holding time exceeded
21/20341	1	ONGW17		25-30	PAH	Sample holding time exceeded
21/20341	1	FINAL DISCHARGE		31-36	PAH	Sample holding time exceeded
21/20341	1	RIVER U/S		37-42	PAH	Sample holding time exceeded

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating.

Only analyses which are accredited are recorded as deviating if set criteria are not met.

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

EMT Job No.: 21/20341

SOILS and ASH

Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. Asbestos samples are retained for 6 months.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Limits of detection for analyses carried out on as received samples are not moisture content corrected. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C. Ash samples are dried at 37°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

Sufficient amount of sample must be received to carry out the testing specified. Where an insufficient amount of sample has been received the testing may not meet the requirements of our accredited methods, as such accreditation may be removed.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overesitimate when other sulphides such as Barite (Barium Sulphate) are present.

WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 accreditation applies to surface water and groundwater and usually one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

STACK EMISSIONS

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation for Dioxins and Furans and Dioxin like PCBs has been performed on XAD-2 Resin, only samples which use this resin will be within our MCERTS scope.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

DEVIATING SAMPLES

All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. The temperature of sample receipt is recorded on the confirmation schedules in order that the client can make an informed decision as to whether testing should still be undertaken.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

BLANKS

Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.
Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

REPORTS FROM THE SOUTH AFRICA LABORATORY

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

Measurement Uncertainty

Measurement uncertainty defines the range of values that could reasonably be attributed to the measured quantity. This range of values has not been included within the reported results. Uncertainty expressed as a percentage can be provided upon request.

ABBREVIATIONS and ACRONYMS USED

#	ISO17025 (UKAS Ref No. 4225) accredited - UK.
SA	ISO17025 (SANAS Ref No.T0729) accredited - South Africa
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
>>	Results above calibration range, the result should be considered the minimum value. The actual result could be significantly higher.
*	Analysis subcontracted to an Element Materials Technology approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample
OC	Outside Calibration Range
AA	x5 Dilution

AB	x10 Dilution

EMT Job No: 21/20341

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/SANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM4	Modified USEPA 8270D v5:2014 method for the solvent extraction and determination of PAHs by GC-MS.	PM30	Water samples are extracted with solvent using a magnetic stirrer to create a vortex.				
TM4	Modified USEPA 8270D v5:2014 method for the solvent extraction and determination of PAHs by GC-MS.	PM30	Water samples are extracted with solvent using a magnetic stirrer to create a vortex.	Yes			
TM5	Modified 8015B v2:1996 method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) within the range C8-C40 by GCFID. For waters the solvent extracts dissolved phase plus a sheen if present.	PM16/PM30	Fractionation into aliphatic and aromatic fractions using a Rapid Trace SPE/Water samples are extracted with solvent using a magnetic stirrer to create a vortex.	Yes			
TM5/TM36	please refer to TM5 and TM36 for method details	PM12/PM16/PM30	please refer to PM16/PM30 and PM12 for method details	Yes			
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry): WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP 6010B, Rev.2, Dec.1996; Modified EPA Method 3050B, Rev.2, Dec.1996	PM14	Preparation of waters and leachates for metals by ICP OES/ICP MS. Samples are filtered for Dissolved metals, and remain unfiltered for Total metals then acidified				
TM36	Modified US EPA method 8015B v2:1996. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID. MTBE by GCFID co-elutes with 3-methylpentane if present and therefore can give a false positive. Positive MTBE results will be re-run using GC-MS to double check, when requested.	PM12	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.	Yes			
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993) – All anions comparable to BS ISO 15923-1: 2013I	PM0	No preparation is required.				
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993) – All anions comparable to BS ISO 15923-1: 2013I	PM0	No preparation is required.	Yes			
TM60	TC/TOC analysis of Waters by High Temperature Combustion followed by NDIR detection. Based on the following modified standard methods: USEPA 9060A (2002), APHA SMEWW 5310B:1999 22nd Edition, ASTM D 7573, and USEPA 415.1.	PM0	No preparation is required.	Yes			
TM73	Modified US EPA methods 150.1 (1982) and 9045D Rev. 4 - 2004) and BS1377-3:1990. Determination of pH by Metrohm automated probe analyser.	PM0	No preparation is required.	Yes			

EMT Job No: 21/20341

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/SANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM75	Modified US EPA method 310.1 (1978). Determination of Alkalinity by Metrohm automated titration analyser.	PM0	No preparation is required.				
TM75	Modified US EPA method 310.1 (1978). Determination of Alkalinity by Metrohm automated titration analyser.	PM0	No preparation is required.	Yes			
TM76	Modified US EPA method 120.1 (1982). Determination of Specific Conductance by Metrohm automated probe analyser.	PM0	No preparation is required.	Yes			
TM170	Determination of Trace Metals by ICP-MS (Inductively Coupled Plasma – Mass Spectrometry): Modified USEPA Method 200.8, Rev. 5.4, 1994; Modified EPA Method 6020A, Rev.1, Feb 2007; Modified BS EN ISO 17294-2:2016	PM14	Preparation of waters and leachates for metals by ICP OES/ICP MS. Samples are filtered for Dissolved metals, and remain unfiltered for Total metals then acidified	Yes			

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Envirologic Ltd
78 St Peters Terrace
Howth
Co Dublin
Ireland

Attention :	Pat Breheny
Date :	4th July, 2022
Your reference :	1970
Our reference :	Test Report 22/6853 Batch 1
Location :	Kinnegad
Date samples received :	27th April, 2022
Status :	Final Report
Issue :	1

Seven samples were received for analysis on 27th April, 2022 of which seven were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Authorised By:

Bruce Leslie
Project Manager

Element Materials Technology

Client Name: Envirologic Ltd
Reference: 1970
Location: Kinnegad
Contact: Pat Breheny
EMT Job No: 22/6853

Report : Liquid

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
$H=H_2SO_4$, Z=ZnAc, N=NaOH, $HN=HN0_3$

EMT Sample No.	1-7	8-15	16-22	23-29	30-36	37-43	44-50				LOD/LOR	Units	Method No.
Sample ID	ONGW06	ONGW13	ONGW16	ONGW17	LQ SUMP	FINAL DISCHARGE	RIVER U/S						
Depth													
COC No / misc													
Containers	V H HN P BOD G	V H HN P BOD G	V H HN P BOD G	V H HN P BOD G	V H HN P BOD G	V H HN P BOD G	V H HN P BOD G						
Sample Date	26/04/2022	26/04/2022	26/04/2022	26/04/2022	26/04/2022	26/04/2022	26/04/2022						
Sample Type	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Surface Water	Surface Water						
Batch Number	1	1	1	1	1	1	1						
Date of Receipt	27/04/2022	27/04/2022	27/04/2022	27/04/2022	27/04/2022	27/04/2022	27/04/2022						
Dissolved Aluminium #	<1.5	2.0	16.8	12.7	11.5	3.6	6.7				<1.5	ug/l	TM170/PM14
Dissolved Cadmium #	0.11	<0.03	<0.03	<0.03	<0.03	0.07	<0.03				<0.03	ug/l	TM170/PM14
Total Dissolved Iron #	1020.0	8990.3$_{AB}$	320.1	10.2	<4.7	128.1	34.5				<4.7	ug/l	TM170/PM14
Dissolved Manganese #	619.7	1550.9$_{AA}$	1616.5$_{AA}$	111.3	<1.5	196.7	38.2				<1.5	ug/l	TM170/PM14
Dissolved Mercury #	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5				<0.5	ug/l	TM170/PM14
Dissolved Phosphorus #	59	<5	7	11	<5	7	8				<5	ug/l	TM170/PM14
Dissolved Zinc #	26.0	8.8	20.2	7.5	38.2	14.7	4.2				<1.5	ug/l	TM170/PM14
Total Calcium	140.8$_{AB}$	421.7$_{AB}$	213.1$_{AB}$	415.9$_{AB}$	133.6$_{AB}$	124.1$_{AB}$	153.7$_{AB}$				<0.2	mg/l	TM30/PM14
Total Magnesium	14.4$_{AB}$	53.8$_{AB}$	25.5$_{AB}$	23.0$_{AB}$	16.7$_{AB}$	12.8$_{AB}$	9.1$_{AB}$				<0.1	mg/l	TM30/PM14
Total Potassium	2.9$_{AB}$	24.3$_{AB}$	8.8$_{AB}$	37.0$_{AB}$	126.2$_{AB}$	85.1$_{AB}$	1.6$_{AB}$				<0.1	mg/l	TM30/PM14
Total Sodium	51.8$_{AB}$	65.4$_{AB}$	18.6$_{AB}$	22.3$_{AB}$	27.3$_{AB}$	27.5$_{AB}$	9.0$_{AB}$				<0.1	mg/l	TM30/PM14
Total Hardness Dissolved (as CaCO3)	378	1105$_{AA}$	502	396	358	331	387				<1	mg/l	TM30/PM14
PAH MS													
Naphthalene #	<0.1^{SV}	<0.1^{SV}	<0.1^{SV}	<0.1	<0.1	<0.1^{SV}	<0.1^{SV}				<0.1	ug/l	TM4/PM30
Acenaphthylene #	<0.005^{SV}	<0.005^{SV}	<0.005^{SV}	<0.005	<0.005	<0.005^{SV}	<0.005^{SV}				<0.005	ug/l	TM4/PM30
Acenaphthene #	<0.005^{SV}	<0.005^{SV}	0.071^{SV}	<0.005	<0.005	<0.005^{SV}	<0.005^{SV}				<0.005	ug/l	TM4/PM30
Fluorene #	<0.005^{SV}	<0.005^{SV}	0.056^{SV}	<0.005	<0.005	<0.005^{SV}	<0.005^{SV}				<0.005	ug/l	TM4/PM30
Phenanthrene #	<0.005^{SV}	<0.005^{SV}	0.327^{SV}	<0.005	<0.005	<0.005^{SV}	<0.005^{SV}				<0.005	ug/l	TM4/PM30
Anthracene #	<0.005^{SV}	<0.005^{SV}	<0.005^{SV}	<0.005	<0.005	<0.005^{SV}	<0.005^{SV}				<0.005	ug/l	TM4/PM30
Fluoranthene #	<0.005^{SV}	<0.005^{SV}	0.050^{SV}	<0.005	<0.005	<0.005^{SV}	<0.005^{SV}				<0.005	ug/l	TM4/PM30
Pyrene #	<0.005^{SV}	<0.005^{SV}	0.023^{SV}	<0.005	<0.005	<0.005^{SV}	<0.005^{SV}				<0.005	ug/l	TM4/PM30
Benzo(a)anthracene #	<0.005^{SV}	<0.005^{SV}	<0.005^{SV}	<0.005	<0.005	<0.005^{SV}	<0.005^{SV}				<0.005	ug/l	TM4/PM30
Chrysene #	<0.005^{SV}	<0.005^{SV}	<0.005^{SV}	<0.005	<0.005	<0.005^{SV}	<0.005^{SV}				<0.005	ug/l	TM4/PM30
Benzo(bk)fluoranthene #	<0.008^{SV}	<0.008^{SV}	<0.008^{SV}	<0.008	<0.008	<0.008^{SV}	<0.008^{SV}				<0.008	ug/l	TM4/PM30
Benzo(a)pyrene #	<0.005^{SV}	<0.005^{SV}	<0.005^{SV}	<0.005	<0.005	<0.005^{SV}	<0.005^{SV}				<0.005	ug/l	TM4/PM30
Indeno(123cd)pyrene #	<0.005^{SV}	<0.005^{SV}	<0.005^{SV}	<0.005	<0.005	<0.005^{SV}	<0.005^{SV}				<0.005	ug/l	TM4/PM30
Dibenzo(ah)anthracene #	<0.005^{SV}	<0.005^{SV}	<0.005^{SV}	<0.005	<0.005	<0.005^{SV}	<0.005^{SV}				<0.005	ug/l	TM4/PM30
Benzo(ghi)perylene #	<0.005^{SV}	<0.005^{SV}	<0.005^{SV}	<0.005	<0.005	<0.005^{SV}	<0.005^{SV}				<0.005	ug/l	TM4/PM30
PAH 16 Total #	<0.173	<0.173	0.527	<0.173	<0.173	<0.173	<0.173				<0.173	ug/l	TM4/PM30
Benzo(b)fluoranthene	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008				<0.008	ug/l	TM4/PM30
Benzo(k)fluoranthene	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008				<0.008	ug/l	TM4/PM30
PAH Surrogate % Recovery	53^{SV}	54^{SV}	53^{SV}	79	74	59^{SV}	59^{SV}				<0	%	TM4/PM30
MTBE #	<5	<5	<5	<5	<5	<5	<5				<5	ug/l	TM36/PM12
Benzene #	<5	<5	<5	<5	<5	<5	<5				<5	ug/l	TM36/PM12
Toluene #	<5	<5	<5	<5	<5	<5	<5				<5	ug/l	TM36/PM12
Ethylbenzene #	<5	<5	<5	<5	<5	<5	<5				<5	ug/l	TM36/PM12
m/p-Xylene #	<5	<5	<5	<5	<5	<5	<5				<5	ug/l	TM36/PM12
o-Xylene #	<5	<5	<5	<5	<5	<5	<5				<5	ug/l	TM36/PM12

Please see attached notes for all abbreviations and acronyms

Client Name: Envirologic Ltd
Reference: 1970
Location: Kinnegad
Contact: Pat Breheny
EMT Job No: 22/6853

Report : Liquid

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
$H=H_2SO_4$, Z=ZnAc, N=NaOH, $HN=HN0_3$

EMT Sample No.	1-7	8-15	16-22	23-29	30-36	37-43	44-50				LOD/LOR	Units	Method No.
Sample ID	ONGW06	ONGW13	ONGW16	ONGW17	LQ SUMP	FINAL DISCHARGE	RIVER U/S						
Depth													
COC No / misc													
Containers	V H HN P BOD G	V H HN P BOD G	V H HN P BOD G	V H HN P BOD G	V H HN P BOD G	V H HN P BOD G	V H HN P BOD G						
Sample Date	26/04/2022	26/04/2022	26/04/2022	26/04/2022	26/04/2022	26/04/2022	26/04/2022						
Sample Type	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water	Surface Water	Surface Water						
Batch Number	1	1	1	1	1	1	1						
Date of Receipt	27/04/2022	27/04/2022	27/04/2022	27/04/2022	27/04/2022	27/04/2022	27/04/2022						
TPH CWG													
Aliphatics													
>C5-C6 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM36/PM12
>C6-C8 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM36/PM12
>C8-C10 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM36/PM12
>C10-C12 #	<5	<5	<5	<5	<5	<5	<5				<5	ug/l	TM5/PM16/PM30
>C12-C16 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM5/PM16/PM30
>C16-C21 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM5/PM16/PM30
>C21-C35 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM5/PM16/PM30
Total aliphatics C5-35 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM5/TM36/PM12/PM16/PM30
Aromatics													
>C5-EC7 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM36/PM12
>EC7-EC8 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM36/PM12
>EC8-EC10 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM36/PM12
>EC10-EC12 #	<5	<5	<5	<5	<5	<5	<5				<5	ug/l	TM5/PM16/PM30
>EC12-EC16 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM5/PM16/PM30
>EC16-EC21 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM5/PM16/PM30
>EC21-EC35 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM5/PM16/PM30
Total aromatics C5-35 #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM5/TM36/PM12/PM16/PM30
Total aliphatics and aromatics(C5-35) #	<10	<10	<10	<10	<10	<10	<10				<10	ug/l	TM5/TM36/PM12/PM16/PM30
Sulphate as SO4 #	72.5	215.3	61.0	38.4	94.5	127.2	43.2				<0.5	mg/l	TM38/PM0
Chloride #	79.1	485.6	106.9	75.7	165.9	111.3	17.9				<0.3	mg/l	TM38/PM0
Nitrate as NO3 #	<0.2	<0.2	<0.2	1.8	15.1	1.4	9.2				<0.2	mg/l	TM38/PM0
Nitrite as NO2 #	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02				<0.02	mg/l	TM38/PM0
Ortho Phosphate as PO4	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03				<0.03	mg/l	TM38/PM0
MRP Ortho Phosphate as PO4	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06				<0.06	mg/l	TM38/PM0
Ammoniacal Nitrogen as NH4 #	0.40	7.87	0.13	0.04	0.04	0.10	0.04				<0.03	mg/l	TM38/PM0
Total Alkalinity as CaCO3 #	330	304	412	946	258	230	364				<1	mg/l	TM75/PM0
Bicarbonate Alkalinity as CaCO3 (water soluble)	330	304	412	946	258	230	364				<1	mg/l	TM75/PM0
Electrical Conductivity @25C #	933	2397	1093	935	1256	1076	736				<2	uS/cm	TM76/PM0
pH #	7.72	7.44	7.72	7.69	8.15	7.94	8.28				<0.01	pH units	TM73/PM0
Total Organic Carbon #	<2	34	32	<2	<2	<2	<2				<2	mg/l	TM60/PM0
Total Suspended Solids #	<10	61	1510	1849	<10	<10	<10				<10	mg/l	TM37/PM0

Please see attached notes for all abbreviations and acronyms

Client Name: Envirologic Ltd

Reference: 1970

Location: Kinnegad

Contact: Pat Breheny

Matrix : Liquid

EMT Job No.	Batch	Sample ID	Depth	EMT Sample No.	Analysis	Reason
22/6853	1	ONGW06		1-7	TSS	Sample holding time exceeded
22/6853	1	ONGW13		8-15	TSS	Sample holding time exceeded
22/6853	1	ONGW16		16-22	TSS	Sample holding time exceeded
22/6853	1	ONGW17		23-29	TSS	Sample holding time exceeded
22/6853	1	LQ SUMP		30-36	TSS	Sample holding time exceeded
22/6853	1	FINAL DISCHARGE		37-43	TSS	Sample holding time exceeded
22/6853	1	RIVER U/S		44-50	TSS	Sample holding time exceeded

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating.

Only analyses which are accredited are recorded as deviating if set criteria are not met.

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

EMT Job No.: 22/6853

SOILS and ASH

Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. Asbestos samples are retained for 6 months.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Limits of detection for analyses carried out on as received samples are not moisture content corrected. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C. Ash samples are dried at 37°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

Sufficient amount of sample must be received to carry out the testing specified. Where an insufficient amount of sample has been received the testing may not meet the requirements of our accredited methods, as such accreditation may be removed.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overesitimate when other sulphides such as Barite (Barium Sulphate) are present.

WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 accreditation applies to surface water and groundwater and usually one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

STACK EMISSIONS

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation for Dioxins and Furans and Dioxin like PCBs has been performed on XAD-2 Resin, only samples which use this resin will be within our MCERTS scope.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

DEVIATING SAMPLES

All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. The temperature of sample receipt is recorded on the confirmation schedules in order that the client can make an informed decision as to whether testing should still be undertaken.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

BLANKS

Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.
Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.
Laboratory records are kept for a period of no less than 6 years.

REPORTS FROM THE SOUTH AFRICA LABORATORY

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

Measurement Uncertainty

Measurement uncertainty defines the range of values that could reasonably be attributed to the measured quantity. This range of values has not been included within the reported results. Uncertainty expressed as a percentage can be provided upon request.

Customer Provided Information

Sample ID and depth is information provided by the customer.

ABBREVIATIONS and ACRONYMS USED

#	ISO17025 (UKAS Ref No. 4225) accredited - UK.
SA	ISO17025 (SANAS Ref No.T0729) accredited - South Africa
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
>>	Results above calibration range, the result should be considered the minimum value. The actual result could be significantly higher.
*	Analysis subcontracted to an Element Materials Technology approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample
OC	Outside Calibration Range
AA	x5 Dilution
AB	x10 Dilution

EMT Job No: 22/6853

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/SANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM4	Modified USEPA 8270D v5:2014 method for the solvent extraction and determination of PAHs by GC-MS.	PM30	Water samples are extracted with solvent using a magnetic stirrer to create a vortex.				
TM4	Modified USEPA 8270D v5:2014 method for the solvent extraction and determination of PAHs by GC-MS.	PM30	Water samples are extracted with solvent using a magnetic stirrer to create a vortex.	Yes			
TM5	Modified 8015B v2:1996 method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) within the range C8-C40 by GCFID. For waters the solvent extracts dissolved phase plus a sheen if present.	PM16/PM30	Fractionation into aliphatic and aromatic fractions using a Rapid Trace SPE/Water samples are extracted with solvent using a magnetic stirrer to create a vortex.	Yes			
TM5/TM36	please refer to TM5 and TM36 for method details	PM12/PM16/PM30	please refer to PM16/PM30 and PM12 for method details	Yes			
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry): WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP 6010B, Rev.2, Dec.1996; Modified EPA Method 3050B, Rev.2, Dec.1996	PM14	Preparation of waters and leachates for metals by ICP OES/ICP MS. Samples are filtered for Dissolved metals, and remain unfiltered for Total metals then acidified				
TM36	Modified US EPA method 8015B v2:1996. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID. MTBE by GCFID co-elutes with 3-methylpentane if present and therefore can give a false positive. Positive MTBE results will be re-run using GC-MS to double check, when requested.	PM12	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.	Yes			
TM37	Modified methods - TSS: USEPA 160.2 (1985), EN872:2005 and APHA SMEWW 2540D:1999 22nd Edition; VSS: USEPA 1684 (Jan 2001), USEPA 160.4 (1971) and SMEWW 2540E:1999 22nd Edition. Gravimetric determination of Total Suspended Solids (TSS) and Volatile Suspended Solids (VSS). Sample is filtered through a 1.5um pore size glass fibre filter and the resulting residue is dried and weighed at 105°C for TSS and 550°C for VSS.	PM0	No preparation is required.	Yes			
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993) – All anions comparable to BS ISO 15923-1: 2013I	PM0	No preparation is required.				
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993) – All anions comparable to BS ISO 15923-1: 2013I	PM0	No preparation is required.	Yes			
TM60	TC/TOC analysis of Waters by High Temperature Combustion followed by NDIR detection. Based on the following modified standard methods: USEPA 9060A (2002), APHA SMEWW 5310B:1999 22nd Edition, ASTM D 7573, and USEPA 415.1.	PM0	No preparation is required.	Yes			

EMT Job No: 22/6853

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/SANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM73	Modified US EPA methods 150.1 (1982) and 9045D Rev. 4 - 2004) and BS1377-3:1990. Determination of pH by Metrohm automated probe analyser.	PM0	No preparation is required.	Yes			
TM75	Modified US EPA method 310.1 (1978). Determination of Alkalinity by Metrohm automated titration analyser.	PM0	No preparation is required.				
TM75	Modified US EPA method 310.1 (1978). Determination of Alkalinity by Metrohm automated titration analyser.	PM0	No preparation is required.	Yes			
TM76	Modified US EPA method 120.1 (1982). Determination of Specific Conductance by Metrohm automated probe analyser.	PM0	No preparation is required.	Yes			
TM170	Determination of Trace Metals by ICP-MS (Inductively Coupled Plasma – Mass Spectrometry): Modified USEPA Method 200.8, Rev. 5.4, 1994; Modified EPA Method 6020A, Rev.1, Feb 2007; Modified BS EN ISO 17294-2:2016	PM14	Preparation of waters and leachates for metals by ICP OES/ICP MS. Samples are filtered for Dissolved metals, and remain unfiltered for Total metals then acidified	Yes			

ALS Environmental Ltd
Torrington Avenue
Coventry
CV4 9GU

T: +44 (0)24 7642 1213
F: +44 (0)24 7685 6575
www.alsenvironmental.co.uk

Mr Breheny
Envirologic
Envirologic Ltd.
78 St Peters Terrace
Howth
Dublin D13 HO08
South Dublin

23 December 2021

Test Report: COV/2247633/2021

Dear Mr Breheny

Analysis of your sample(s) received on 16 December 2021 is now complete and we have pleasure in enclosing the appropriate test report(s).

An invoice for the analysis carried out will be sent under separate cover.

Should you have any queries regarding this report(s) or any part of our service, please contact Customer Services on +44 (0)24 7642 1213 who will be happy to discuss your requirements.

If you would like to arrange any further analysis, please contact Customer Services. To arrange container delivery or sample collection, please call the Couriers Department directly on 024 7685 6562.

Thank you for using ALS Environmental Ltd and we look forward to receiving your next samples.

Yours Sincerely,

Signed: 

Name: A. Zunzunegui

Title: Organics Chemistry Manager

UKAS TESTING 1314

bsi ISO 14001 Environmental Management CERTIFIED ISO 45001 Occupational Health and Safety Management CERTIFIED
EMS 675527 OHS 542058

mCERTS THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

Report Summary

ANALYSED BY

Mr Patrick Breheny
Envirologic
Envirologic Ltd.
78 St Peters Terrace
Howth
Dublin
South Dublin
D13 HO08

Date of Issue: **23 December 2021**

Report Number: **COV/2247633/2021** Issue **1**

This issue replaces all previous issues

Job Description: Micro analysis

Job Location: Kinnegad

Number of Samples included in this report **3**

Job Received: **16 December 2021**

Number of Test Results included in this report **12**

Analysis Commenced: **20 December 2021**

Signed: 

Name: **A. Zunzunegui** Date: **23 December 2021**

Title: **Organics Chemistry Manager**

ALS Environmental Ltd was not responsible for sampling unless otherwise stated.

Information on the methods of analysis and performance characteristics are available on request.
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. The results relate only to the items tested and where relevant sampled.
Tests marked 'Not UKAS Accredited' in this Report/Certificate are not included in the UKAS Accreditation Schedule for our laboratory.
This test report is not a statement of conformity to any specification or standard.

Certificate of Analysis

ANALYSED BY

UKAS TESTING 1314

ALS

Report Number:	**COV/2247633/2021**	Issue	**1**
Laboratory Number:	**21170995**	Sample	**1** of **3**

Sample Source:	**Envirologic**
Sample Point Description:	
Sample Description:	**ONGW 13**
Sample Matrix:	**Ground Water**
Sample Date/Time:	**16 December 2021**
Sample Received:	**16 December 2021**
Analysis Complete:	**23 December 2021**

Test Description	Result	Units	Analysis Date	Accreditation		Method
BODS + ATU	2	mg/l O2	23/12/2021	N	S	SUBCON
Total Coliforms (Colilert)	0	mpn/100ml	20/12/2021	N	S	SUBCON
Faecal Coliforms (Colilert)	0	mpn/100ml	20/12/2021	N	S	SUBCON
Total Suspended Solids	1.00	mg/l	20/12/2021	Y	Cov	WAS006

Analyst Comments for 21170995: No Analyst Comment

This issue replaces all previous issues
Accreditation Codes: Y = UKAS / ISO17025 Accredited, N = Not UKAS / ISO17025 Accredited, M = MCERTS.
Analysed at: CHE = Chester(CH5 3US), COV = Coventry(CV4 9GU), OTT = Otterbourne(SO21 2RU), S = Subcontracted, TRB = Subcontracted to Trowbridge(BA14 0XD), WAK = Wakefield(WF5 9TG), F = Data supplied by customer.
For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered.
I/S=Insufficient sample For soil/sludge samples: AR=As received, DW=Dry weight.

Signed: A Zunzunegui

Name: **A. Zunzunegui** Date: **23 December 2021**

Title: **Organics Chemistry Manager**

ALS Environmental Ltd
Torrington Avenue, Coventry, CV4 9GU
Tel:+44 (0)24 7642 1213 Fax:+44 (0)24 7685 6575

Certificate of Analysis

ANALYSED BY

UKAS TESTING 1314

ALS

Report Number:	**COV/2247633/2021**	Issue	**1**
Laboratory Number:	**21170996**	Sample	**2** of **3**

Sample Source:	**Envirologic**
Sample Point Description:	
Sample Description:	**ONGW 16**
Sample Matrix:	**Ground Water**
Sample Date/Time:	**16 December 2021**
Sample Received:	**16 December 2021**
Analysis Complete:	**23 December 2021**

Test Description	Result	Units	Analysis Date	Accreditation		Method
BODS + ATU	5	mg/l O2	23/12/2021	N	S	SUBCON
Total Coliforms (Colilert)	0	mpn/100ml	20/12/2021	N	S	SUBCON
Faecal Coliforms (Colilert)	0	mpn/100ml	20/12/2021	N	S	SUBCON
Total Suspended Solids	3170	mg/l	20/12/2021	Y	Cov	WAS006

Analyst Comments for 21170996: No Analyst Comment

This issue replaces all previous issues
Accreditation Codes: Y = UKAS / ISO17025 Accredited, N = Not UKAS / ISO17025 Accredited, M = MCERTS.
Analysed at: CHE = Chester(CH5 3US), COV = Coventry(CV4 9GU), OTT = Otterbourne(SO21 2RU), S = Subcontracted, TRB = Subcontracted to Trowbridge(BA14 0XD), WAK = Wakefield(WF5 9TG), F = Data supplied by customer.
For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered.
I/S=Insufficient sample For soil/sludge samples: AR=As received, DW=Dry weight.

Signed: 

Name: **A. Zunzunegui** Date: **23 December 2021**

Title: **Organics Chemistry Manager**

Certificate of Analysis

ANALYSED BY

UKAS TESTING 1314

ALS

Report Number:	**COV/2247633/2021**	Issue	**1**
Laboratory Number:	**21170997**	Sample	**3** of **3**

Sample Source:	**Envirologic**
Sample Point Description:	
Sample Description:	**ONGW 17**
Sample Matrix:	**Ground Water**
Sample Date/Time:	**16 December 2021**
Sample Received:	**16 December 2021**
Analysis Complete:	**23 December 2021**

Test Description	Result	Units	Analysis Date	Accreditation		Method
BODS + ATU	2	mg/l O2	23/12/2021	N	S	SUBCON
Total Coliforms (Colilert)	10	mpn/100ml	20/12/2021	N	S	SUBCON
Faecal Coliforms (Colilert)	10	mpn/100ml	20/12/2021	N	S	SUBCON
Total Suspended Solids	4850	mg/l	20/12/2021	Y	Cov	WAS006

Analyst Comments for 21170997: No Analyst Comment

This issue replaces all previous issues
Accreditation Codes: Y = UKAS / ISO17025 Accredited, N = Not UKAS / ISO17025 Accredited, M = MCERTS.
Analysed at: CHE = Chester(CH5 3US), COV = Coventry(CV4 9GU), OTT = Otterbourne(SO21 2RU), S = Subcontracted, TRB = Subcontracted to Trowbridge(BA14 0XD), WAK = Wakefield(WF5 9TG), F = Data supplied by customer.
For Microbiological determinands 0 or ND=Not Detected, For Legionella ND=Not Detected in volume of sample filtered.
I/S=Insufficient sample For soil/sludge samples: AR=As received, DW=Dry weight.

Signed: 

Name: **A. Zunzunegui** Date: **23 December 2021**

Title: **Organics Chemistry Manager**

ALS Environmental Ltd
Torrington Avenue, Coventry, CV4 9GU
Tel:+44 (0)24 7642 1213 Fax:+44 (0)24 7685 6575

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Water Chapter

Appendix 8H

CWSL Site Monitoring Reports

(Selected subset, in the interest of avoiding unnecessary bulk, all reports available at the Water team & Applicant's offices)

Flow & Rainfall Survey

Interim Report 1
Breedon

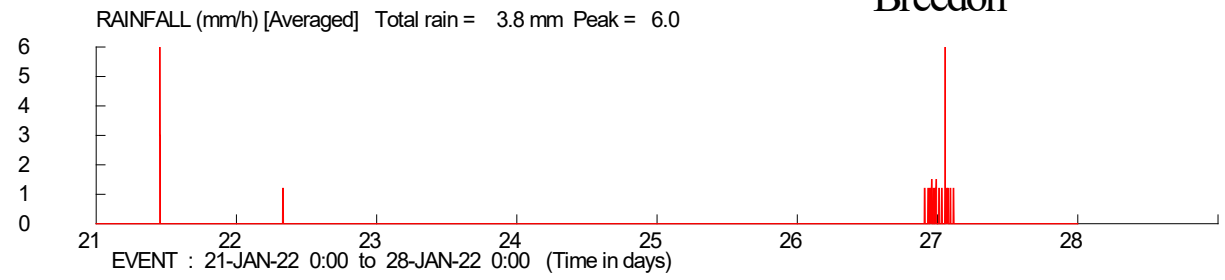
Catchment	Breedon Quarry
Client	Breedon Group
Consultant	N/A
Interim No	1
Rainfall Events Recorded	0

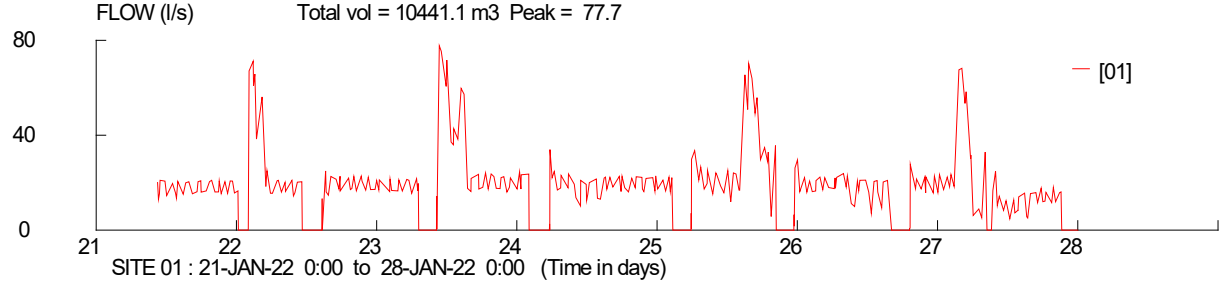
capital water systems ltd.

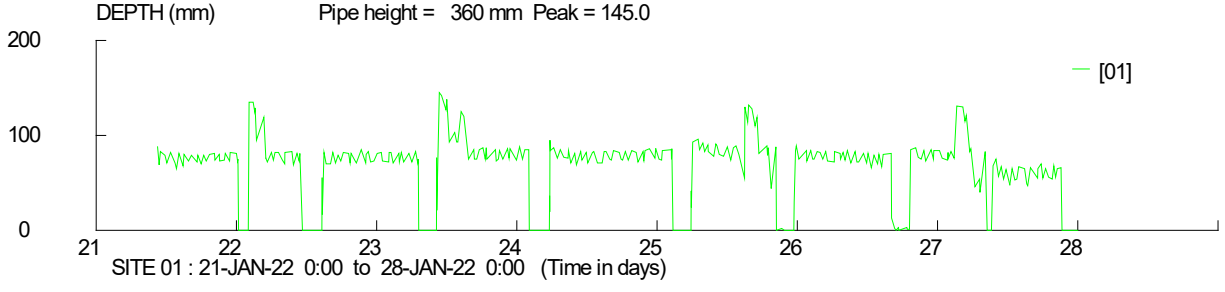
web	www.cwsl.ie
email	info@cwsl.ie
tel.	+353 (090) 6627616

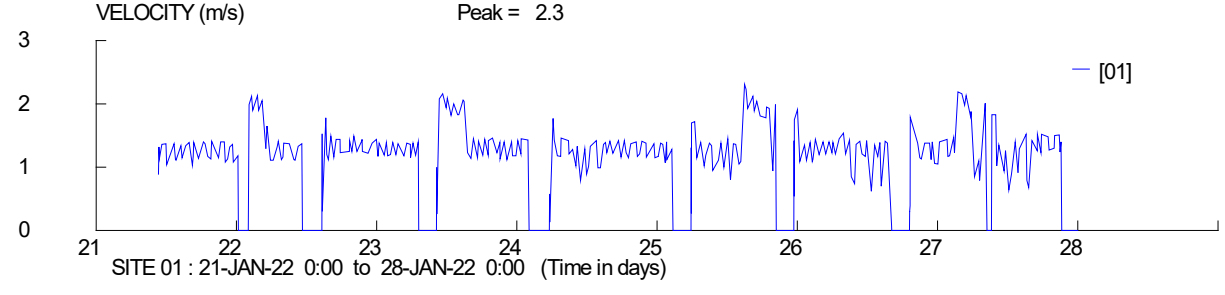
Interim Plots

Breedon


RAINFALL (mm/h) [Averaged] Total rain = 3.8 mm Peak = 6.0
6
5
4
3
2
1
0
21
22
23
24
25
26
27
28
EVENT : 21-JAN-22 0:00 to 28-JAN-22 0:00 (Time in days)


FLOW (l/s)
Total vol = 10441.1 m3 Peak = 77.7
80
40
0
[01]
21
22
23
24
25
26
27
28
SITE 01 : 21-JAN-22 0:00 to 28-JAN-22 0:00 (Time in days)


DEPTH (mm)
Pipe height = 360 mm Peak = 145.0
200
100
0
[01]
21
22
23
24
25
26
27
28
SITE 01 : 21-JAN-22 0:00 to 28-JAN-22 0:00 (Time in days)


VELOCITY (m/s)
Peak = 2.3
3
2
1
0
[01]
21
22
23
24
25
26
27
28
SITE 01 : 21-JAN-22 0:00 to 28-JAN-22 0:00 (Time in days)

Flow & Rainfall Survey

Interim Report 2
Breedon

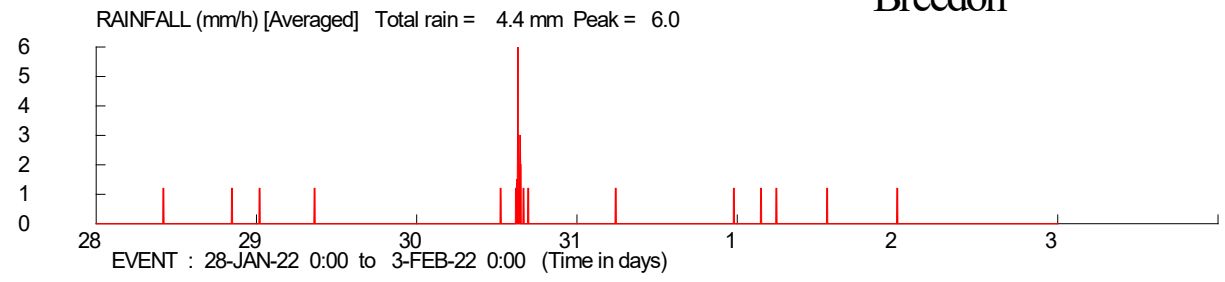
Catchment	Breedon Quarry
Client	Breedon Group
Consultant	N/A
Interim No	2
Rainfall Events Recorded	0

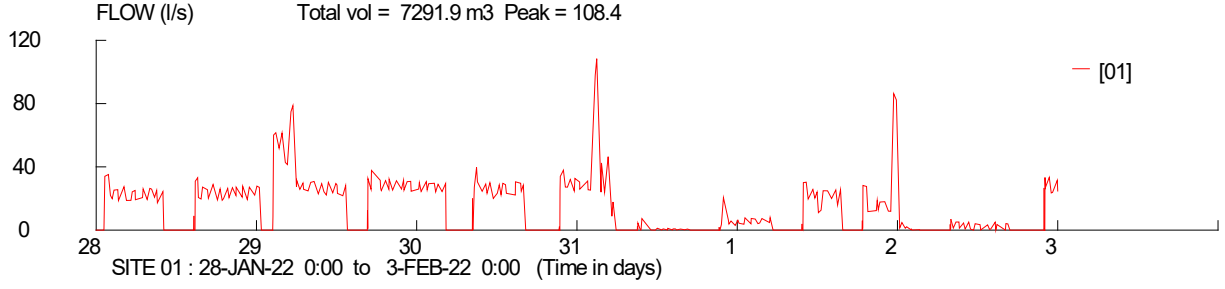
capital water systems ltd.

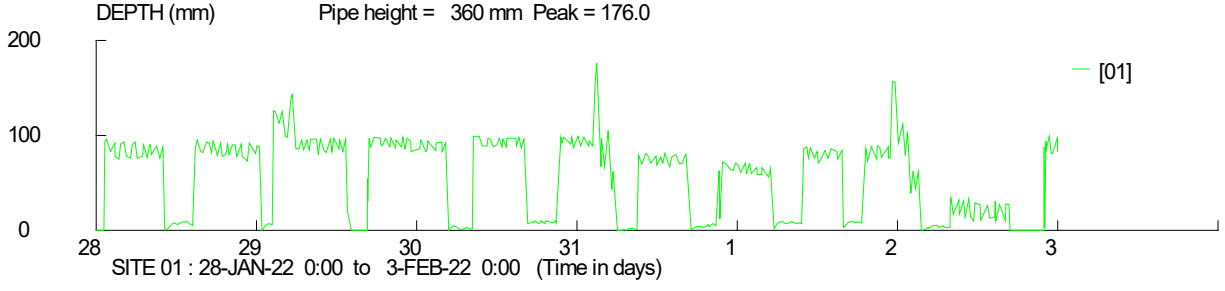
web	www.cwsl.ie
email	info@cwsl.ie
tel.	+353 (090) 6627616

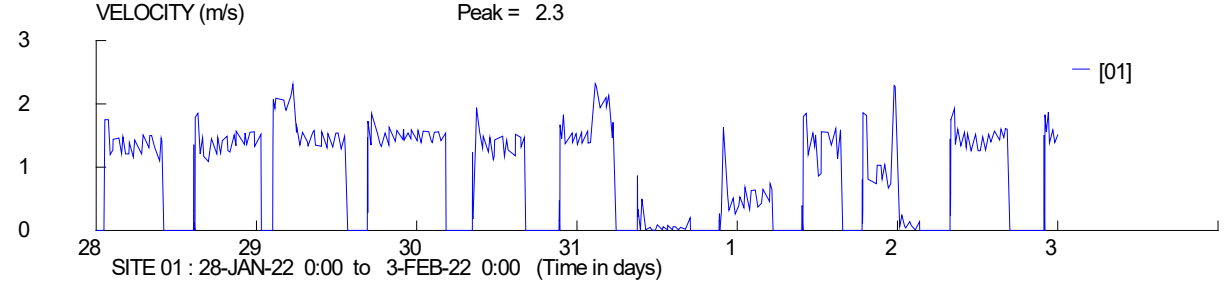
Interim Plots

Breedon


RAINFALL (mm/h) [Averaged] Total rain = 4.4 mm Peak = 6.0
6
5
4
3
2
1
0
28
29
30
31
1
2
3
EVENT : 28-JAN-22 0:00 to 3-FEB-22 0:00 (Time in days)


FLOW (l/s) Total vol = 7291.9 m3 Peak = 108.4
120
80
40
0
[01]
28
29
30
31
1
2
3
SITE 01 : 28-JAN-22 0:00 to 3-FEB-22 0:00 (Time in days)


DEPTH (mm) Pipe height = 360 mm Peak = 176.0
200
100
0
[01]
28
29
30
31
1
2
3
SITE 01 : 28-JAN-22 0:00 to 3-FEB-22 0:00 (Time in days)


VELOCITY (m/s) Peak = 2.3
3
2
1
0
[01]
28
29
30
31
1
2
3
SITE 01 : 28-JAN-22 0:00 to 3-FEB-22 0:00 (Time in days)

Flow & Rainfall Survey

Interim Report 3
Breedon

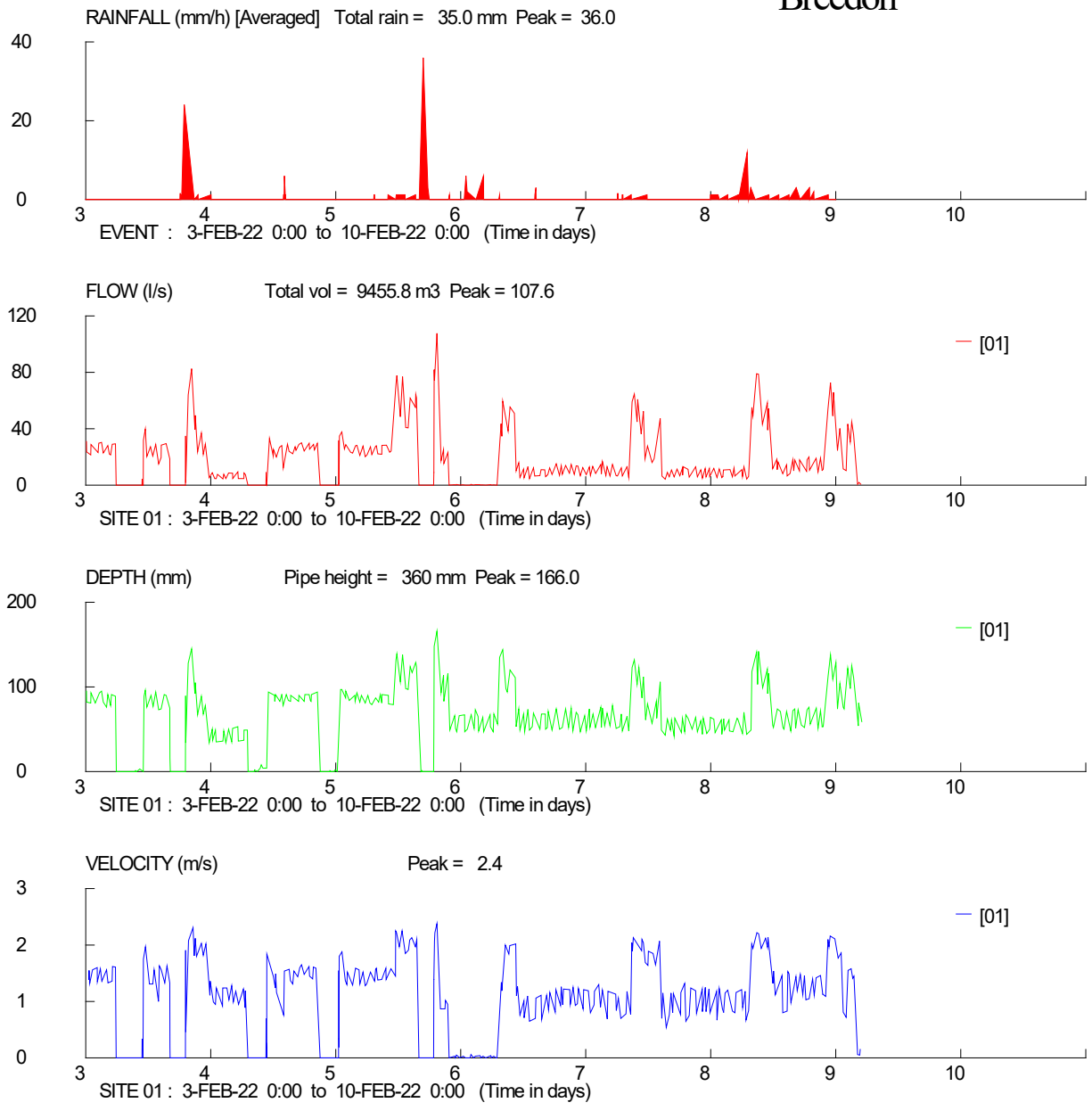
Catchment	Breedon Quarry
Client	Breedon Group
Consultant	N/A
Interim No	3
Rainfall Events Recorded	2- 03/02 & 05/02

capital water systems ltd.

web	www.cwsl.ie
email	info@cwsl.ie
tel.	+353 (090) 6627616

Interim Plots

Breedon


RAINFALL (mm/h) [Averaged] Total rain = 35.0 mm Peak = 36.0
40
20
0
3
4
5
6
7
8
9
10
EVENT : 3-FEB-22 0:00 to 10-FEB-22 0:00 (Time in days)
FLOW (l/s) Total vol = 9455.8 m3 Peak = 107.6
120
80
40
0
[01]
SITE 01 : 3-FEB-22 0:00 to 10-FEB-22 0:00 (Time in days)
DEPTH (mm) Pipe height = 360 mm Peak = 166.0
200
100
0
[01]
SITE 01 : 3-FEB-22 0:00 to 10-FEB-22 0:00 (Time in days)
VELOCITY (m/s) Peak = 2.4
3
2
1
0
[01]
SITE 01 : 3-FEB-22 0:00 to 10-FEB-22 0:00 (Time in days)

Flow & Rainfall Survey

Interim Report 5
Breedon

Catchment	Breedon Quarry
Client	Breedon Group
Consultant	Hydro-G
Interim No	5
Rainfall Events Recorded	2-19/02 & 20/02

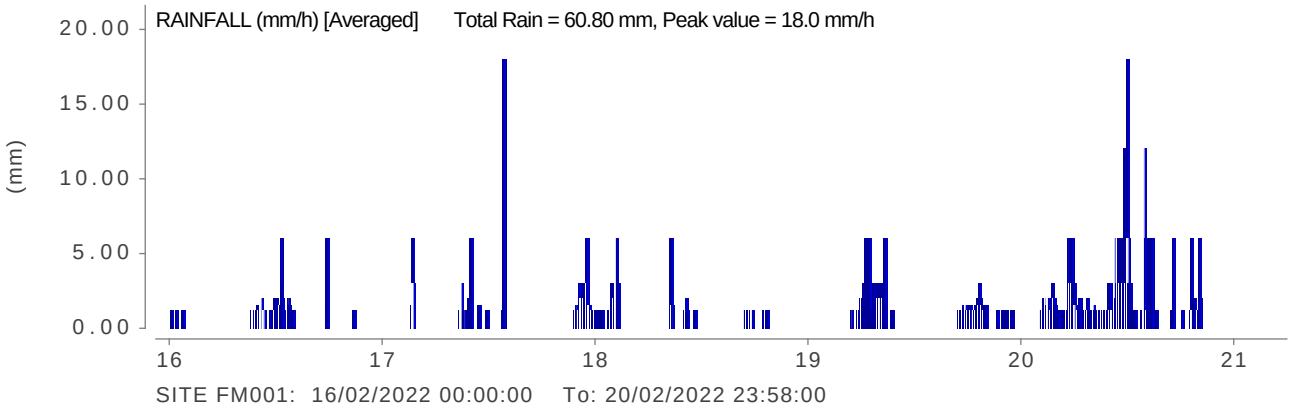
capital water systems ltd.

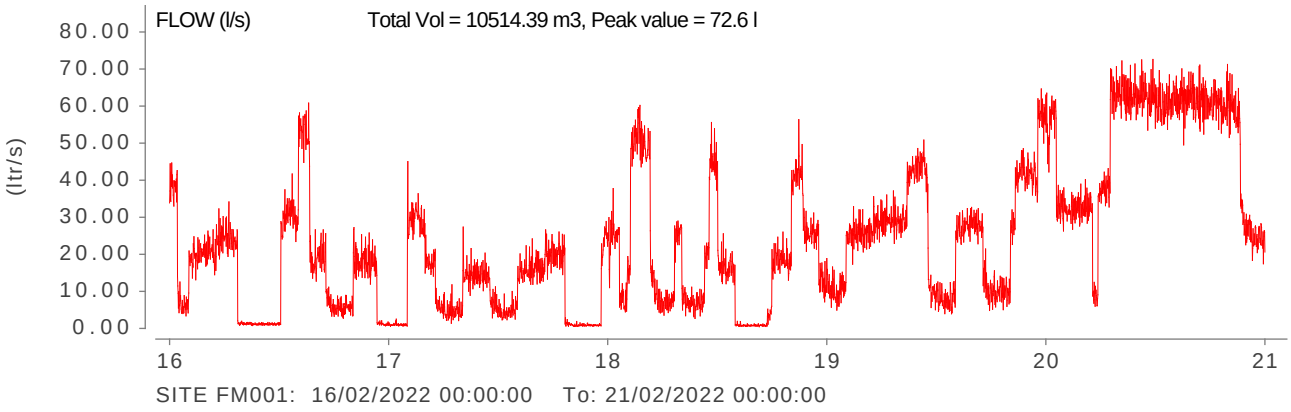
web	www.cwsl.ie
email	info@cwsl.ie
tel.	+353 (090) 6627616

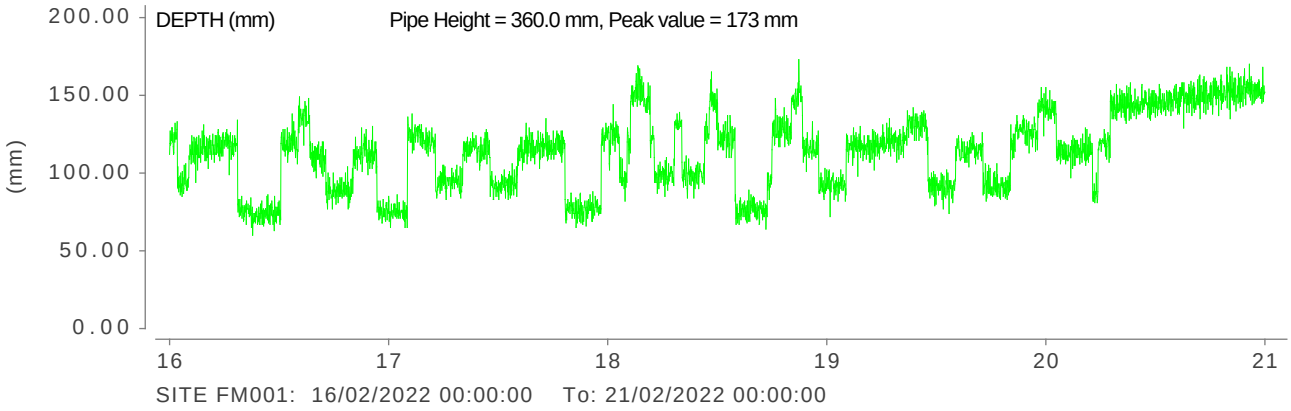
Interim Plots

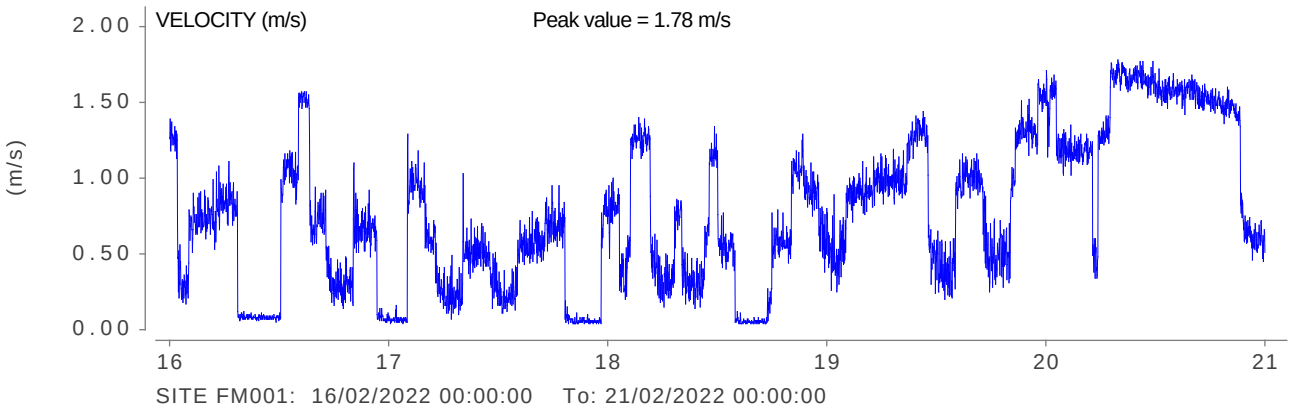
Survey Name	Client	Contractor	Event	Event Start	Event End	Site	Client Ref Id
T45 Breedon	Breedon	CWSL	Weekly Interim Plot	16/02/2022 00:00	21/02/2022 00:00	FM001	

RG01









Flow & Rainfall Survey

Interim Report 4
Breedon

Catchment	Breedon Quarry
Client	Breedon Group
Consultant	Hydro-G
Interim No	4
Rainfall Events Recorded	1 13/02

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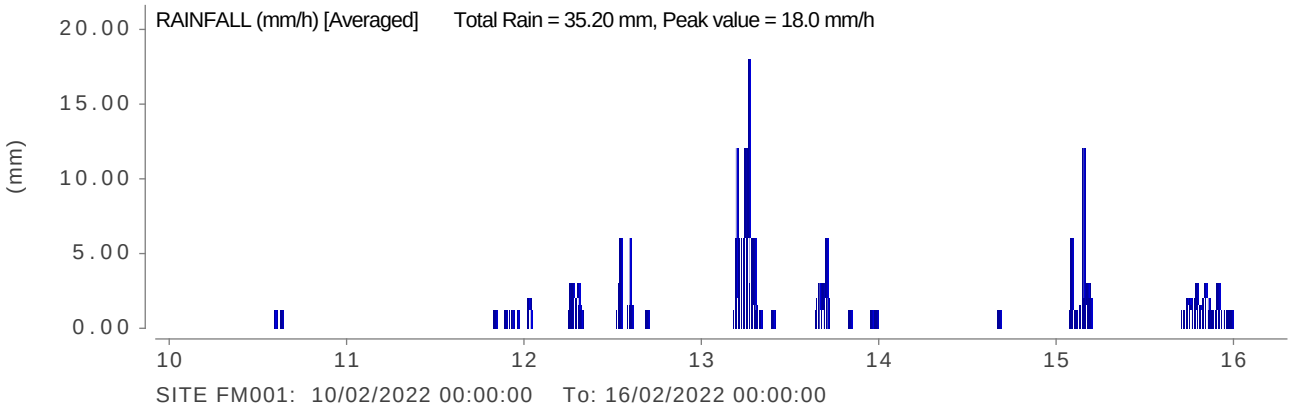
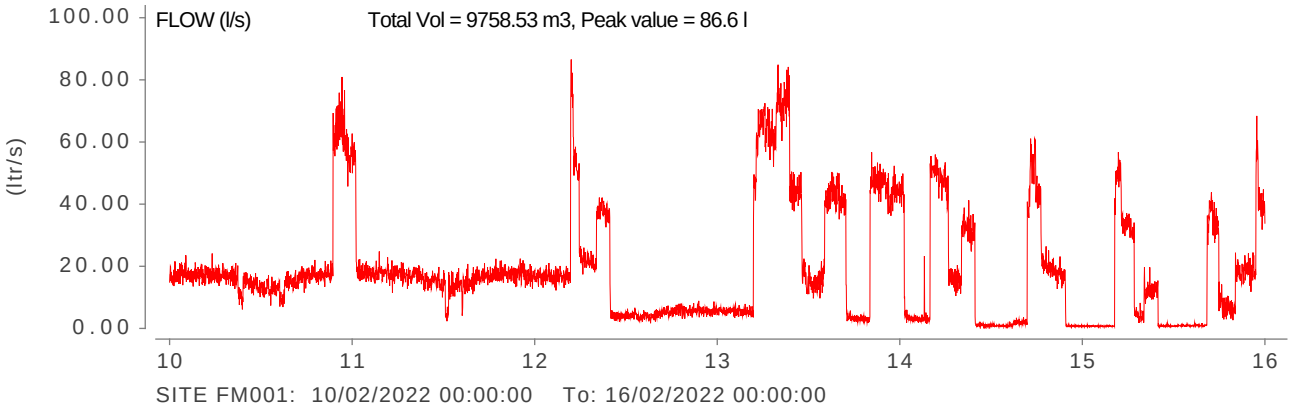
web	www.cwsl.ie
email	info@cwsl.ie
tel.	+353 (090) 6627616

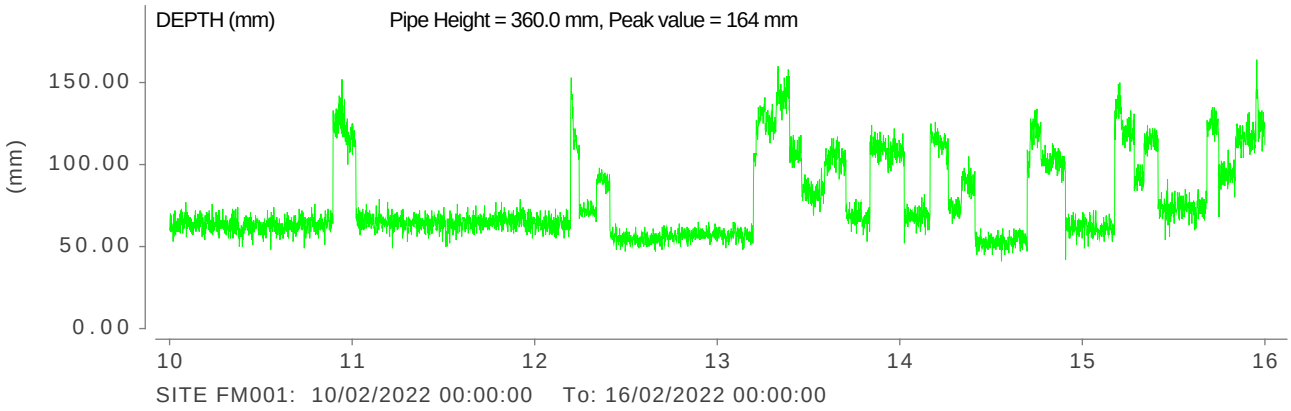
Interim Plots

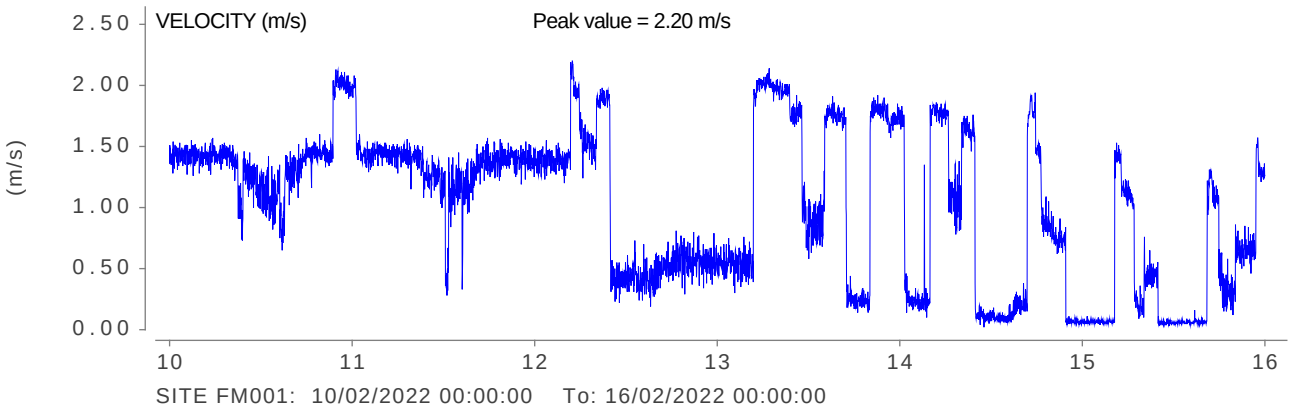
Survey Name	Client	Contractor	Event	Event Start	Event End	Site	Client Ref Id
T45 Breedon	Breedon	CWSL	Event Description	10/02/2022 00:00	16/02/2022 00:00	FM001	

RG01









Flow & Rainfall Survey

Interim Report 6
Breedon

Catchment	Breedon Quarry
Client	Breedon Group
Consultant	Hydro-G
Interim No	6
Rainfall Events Recorded	

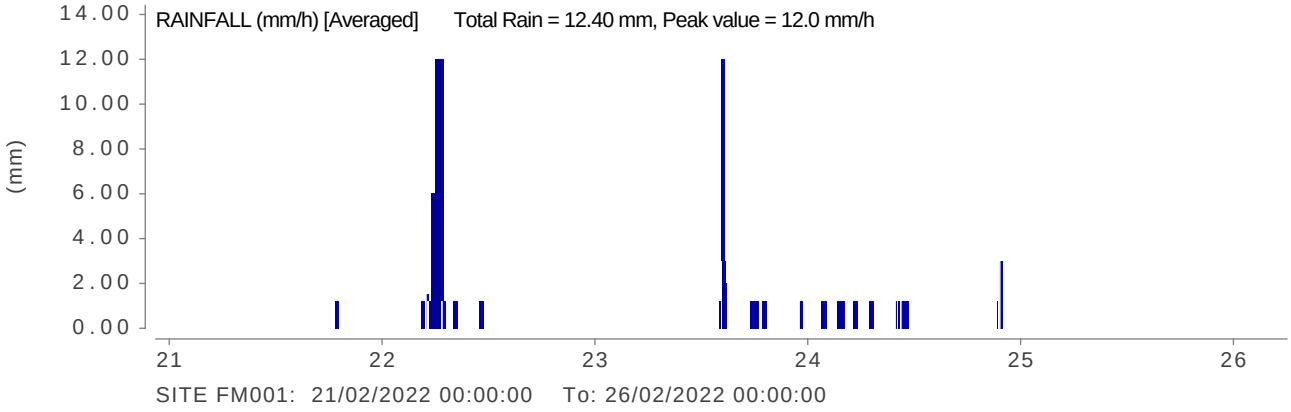
capital water systems ltd.

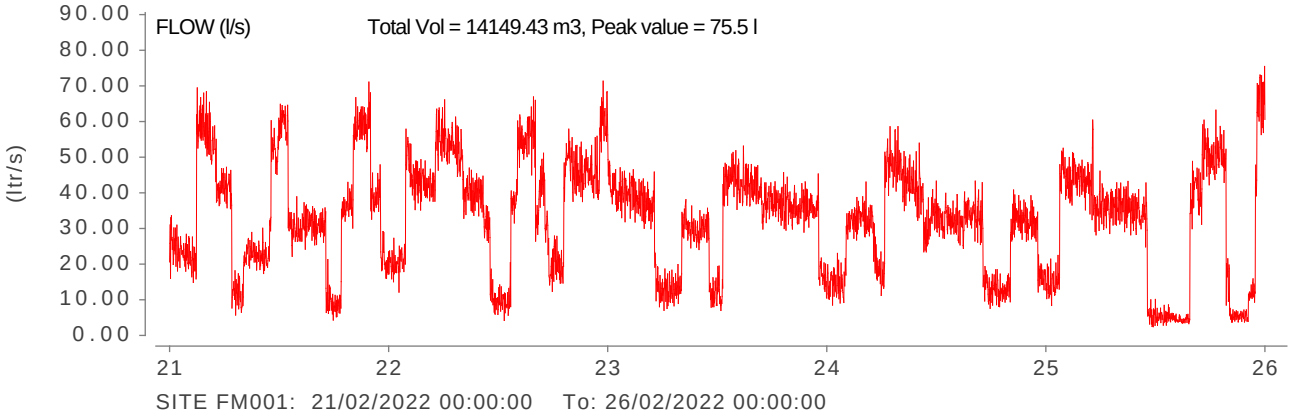
web	www.cwsl.ie
email	info@cwsl.ie
tel.	+353 (090) 6627616

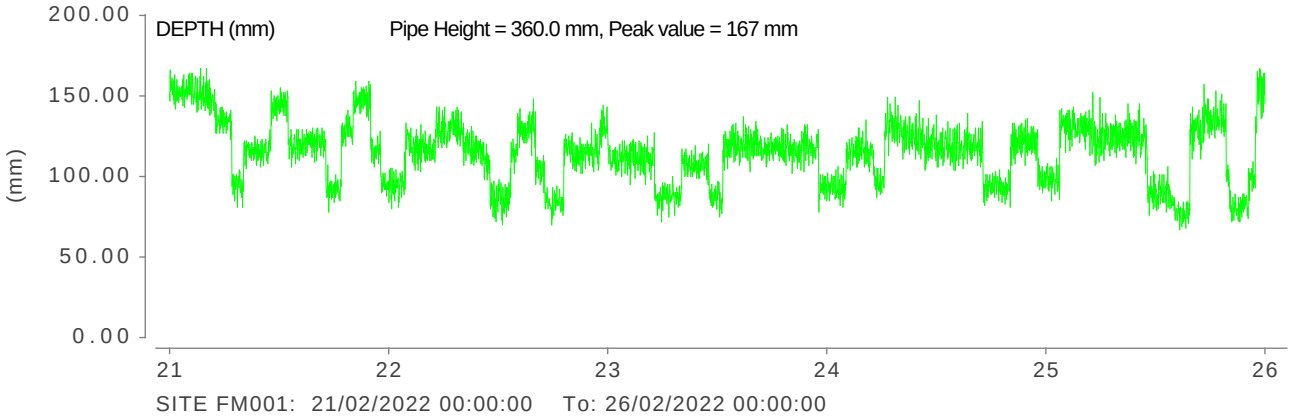
Interim Plots

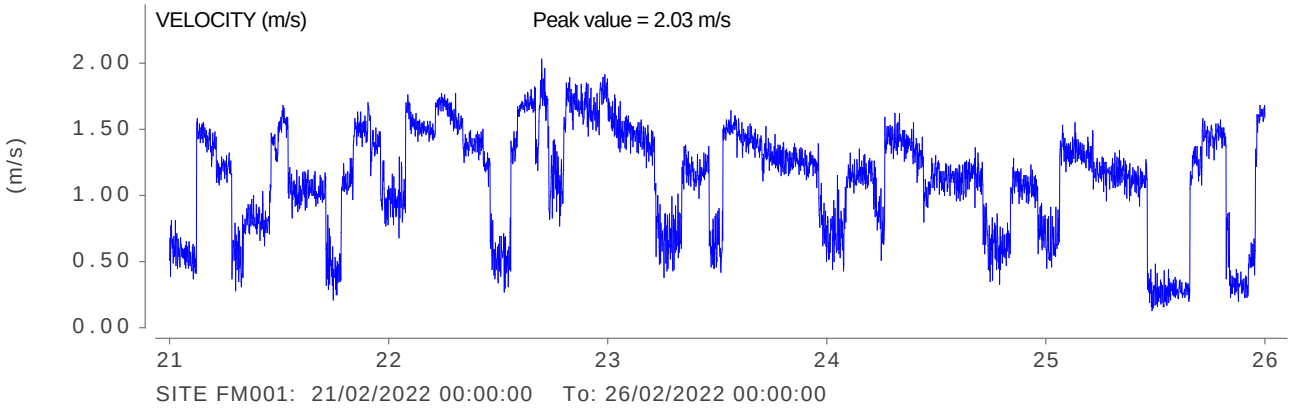
Survey Name	Client	Contractor	Event	Event Start	Event End	Site	Client Ref Id
T45 Breedon	Breedon	CWSL	Event Description	21/02/2022 00:00	26/02/2022 00:00	FM001	

RG01









Flow & Rainfall Survey

Interim Report 7
Breedon

Catchment	Breedon Quarry
Client	Breedon Group
Consultant	Hydro-G
Interim No	7
Rainfall Events Recorded	

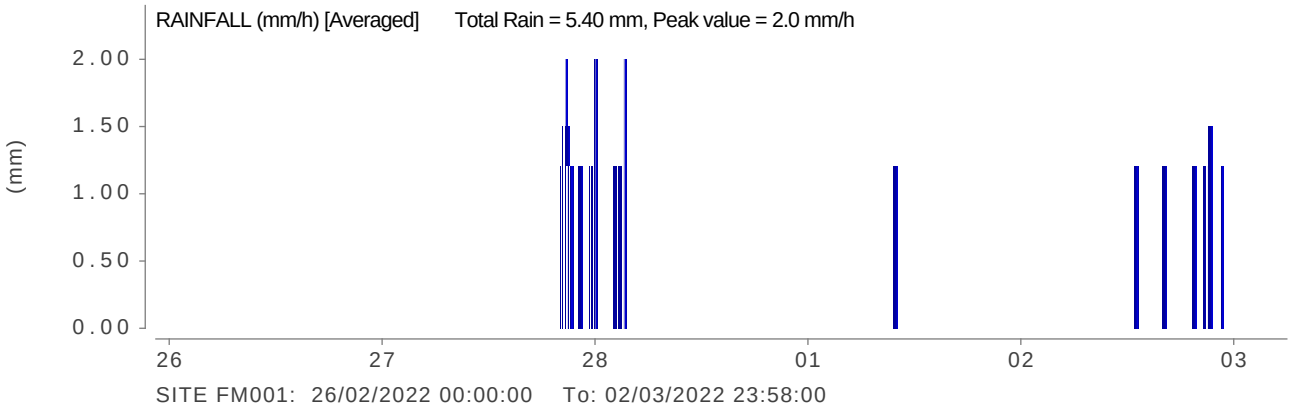
capital water systems ltd.

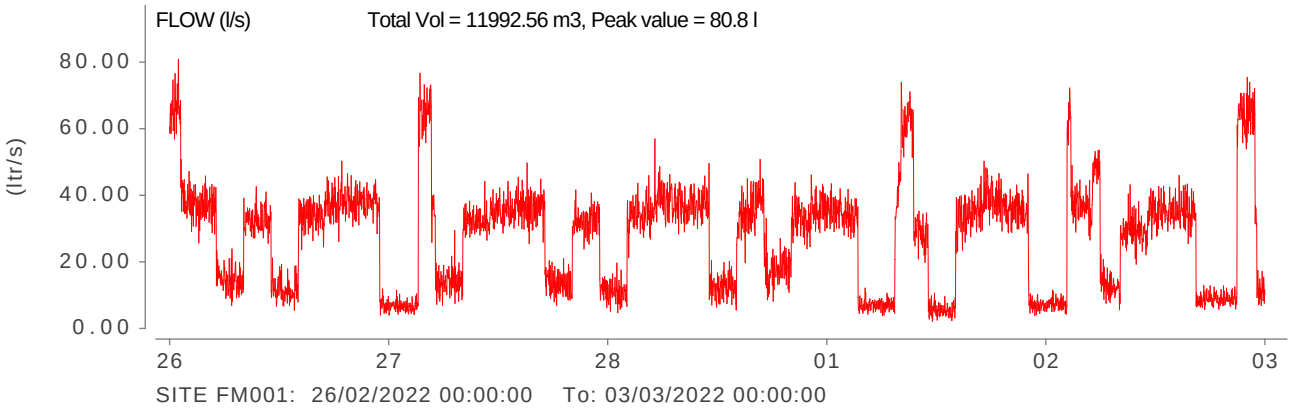
web	www.cwsl.ie
email	info@cwsl.ie
tel.	+353 (090) 6627616

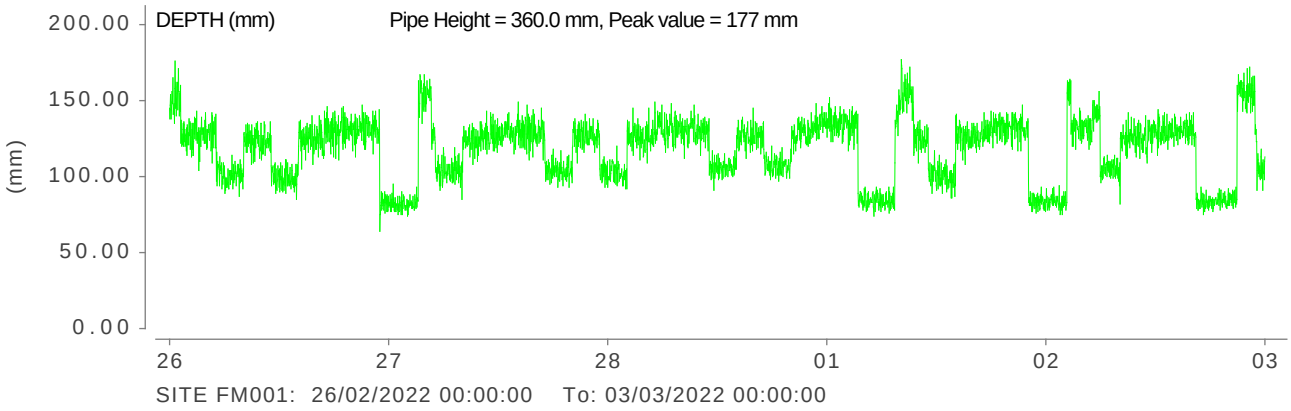
Interim Plots

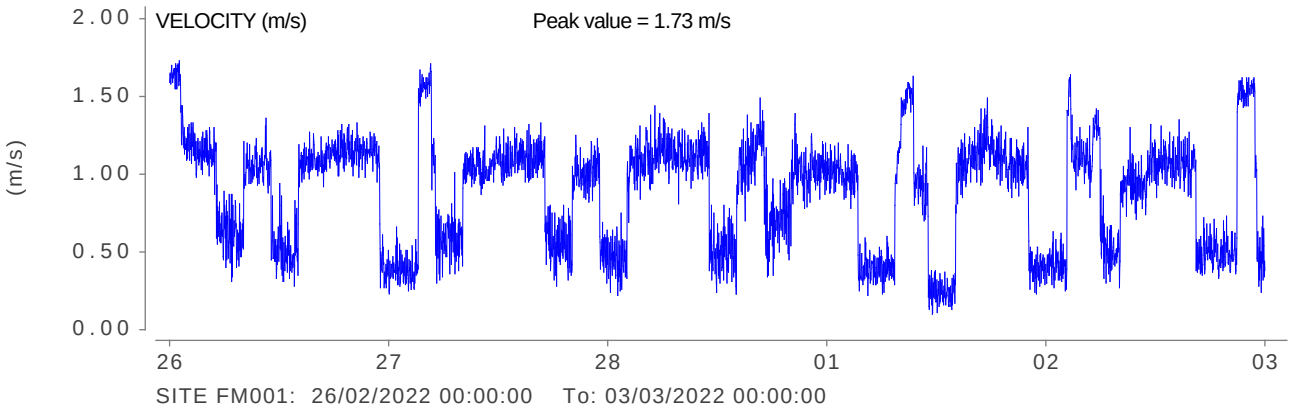
Survey Name	Client	Contractor	Event	Event Start	Event End	Site	Client Ref Id
T45 Breedon	Breedon	CWSL	Event Description	26/02/2022 00:00	03/03/2022 00:00	FM001	

RG01









Flow & Rainfall Survey

Interim Report 8
Breedon

Catchment	Breedon Quarry
Client	Breedon Group
Consultant	Hydro-G
Interim No	8
Rainfall Events Recorded	

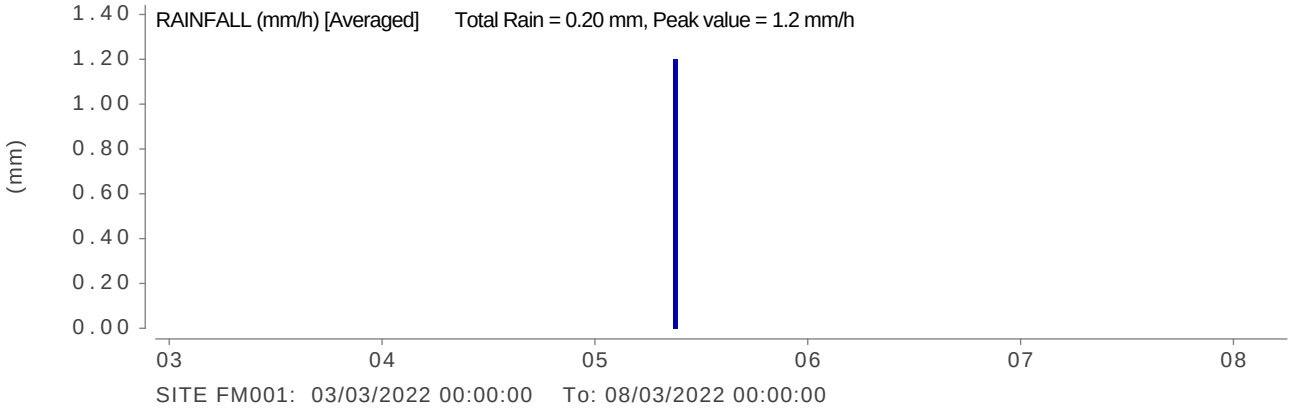
capital water systems ltd.

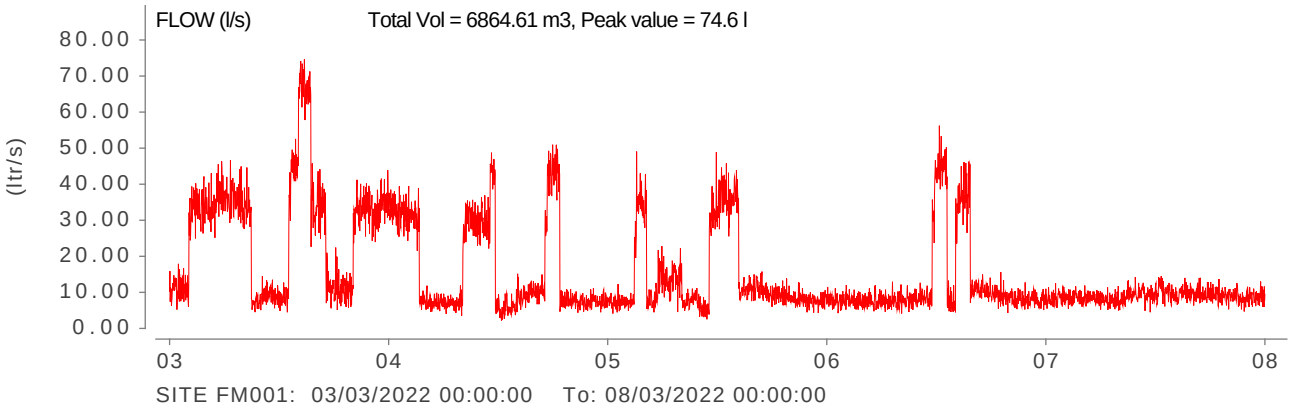
web	www.cwsl.ie
email	info@cwsl.ie
tel.	+353 (090) 6627616

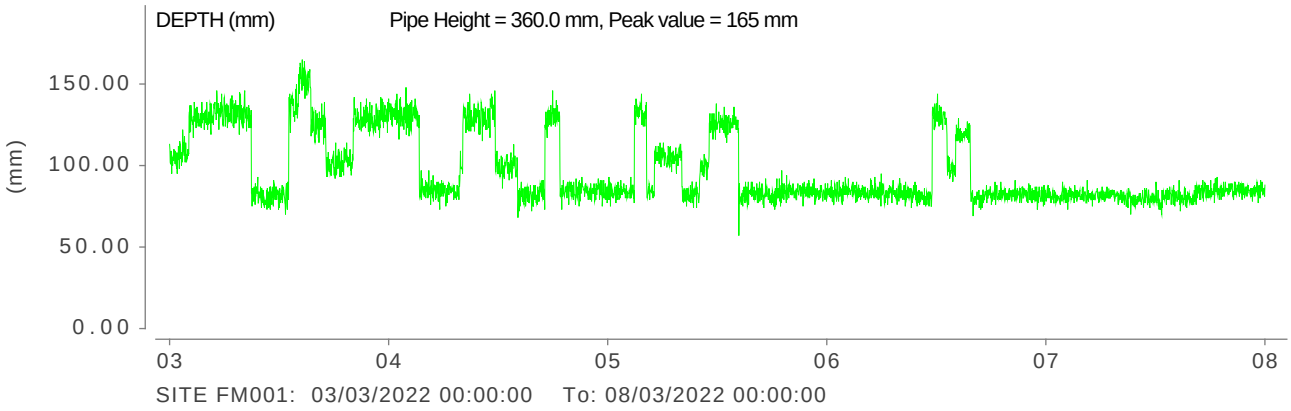
Interim Plots

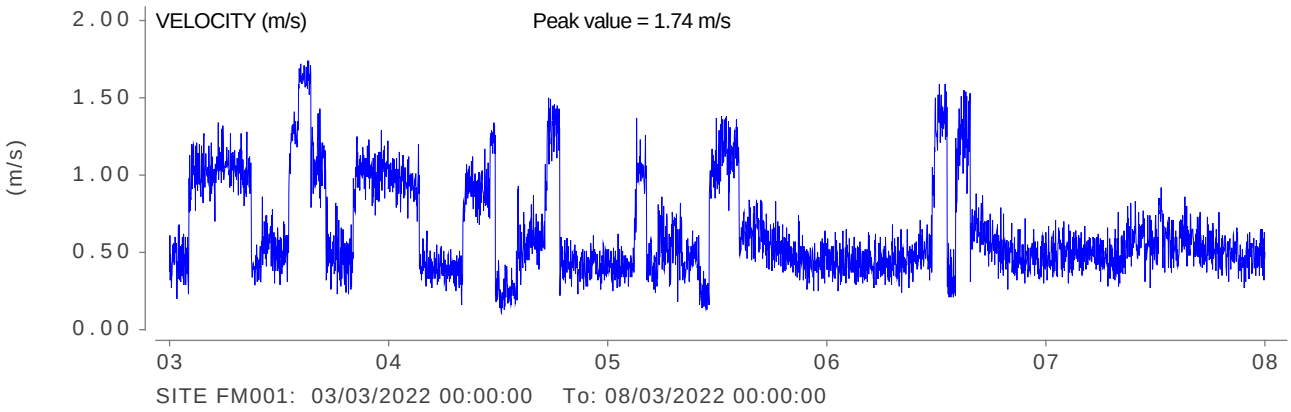
Survey Name	Client	Contractor	Event	Event Start	Event End	Site	Client Ref Id
T45 Breedon	Breedon	CWSL	Event Description	03/03/2022 00:00	08/03/2022 00:00	FM001	

RG01









Flow & Rainfall Survey

Interim Report 9
Breedon

Catchment	Breedon Quarry
Client	Breedon Group
Consultant	Hydro-G
Interim No	9
Rainfall Events Recorded	1-9/03

capital water systems ltd.

web	www.cwsl.ie
email	info@cwsl.ie
tel.	+353 (090) 6627616

Interim Plots

Survey Name	Client	Contractor	Event	Event Start	Event End	Site	Client Ref Id
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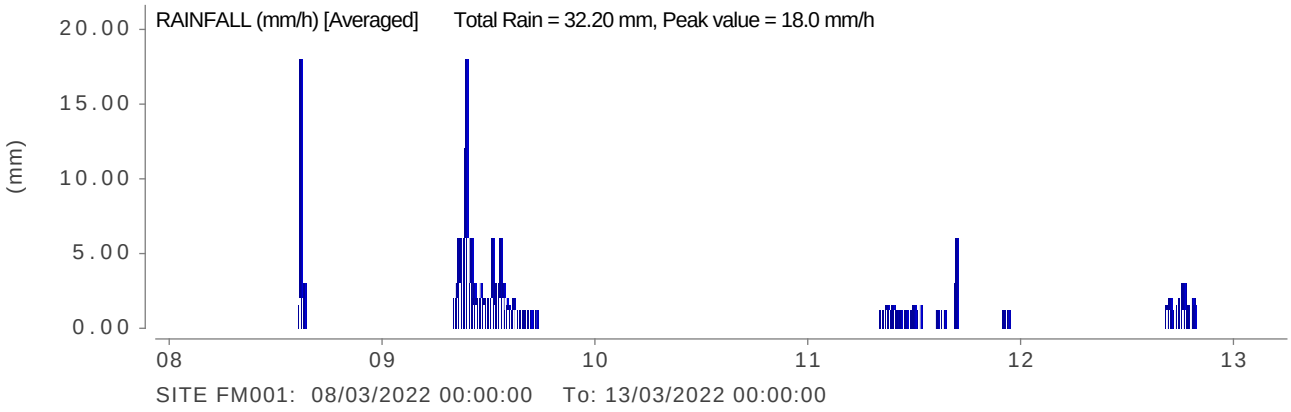
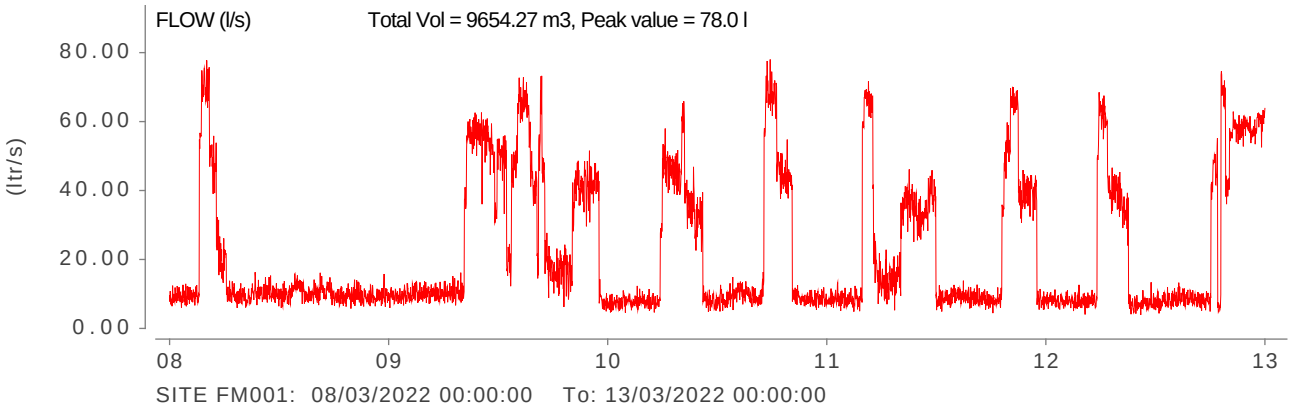
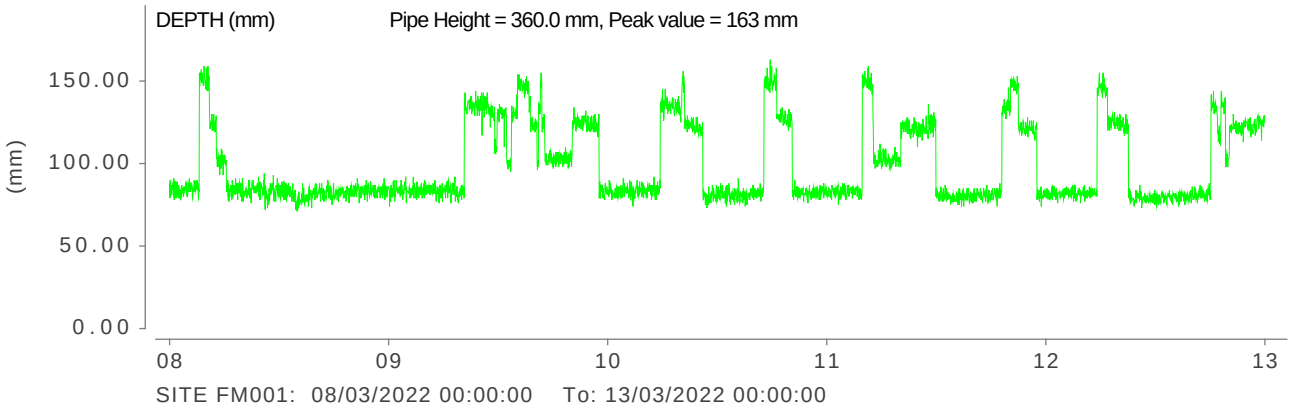
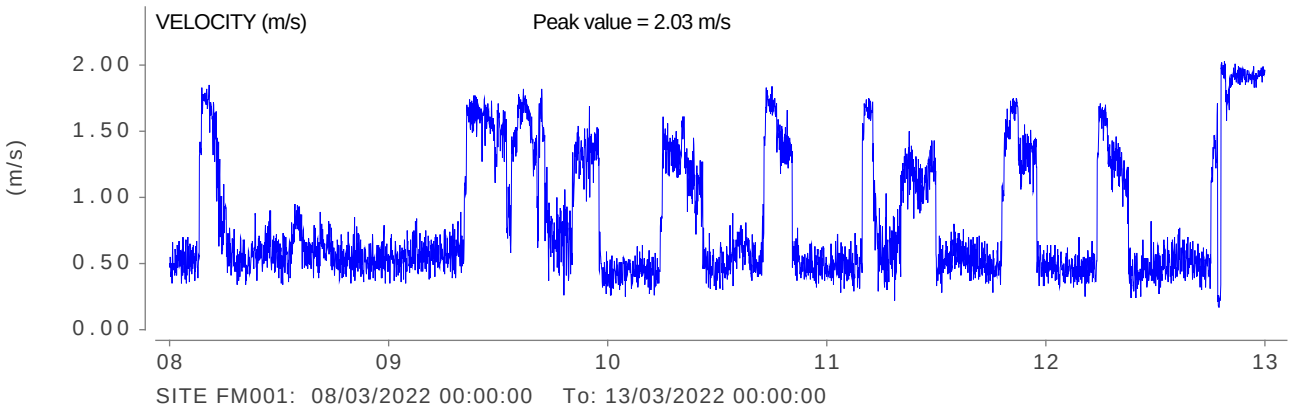








Flow & Rainfall Survey

Interim Report
10 Breedon

Catchment	Breedon Quarry
Client	Breedon Group
Consultant	Hydro-G
Interim No	10
Rainfall Events Recorded	

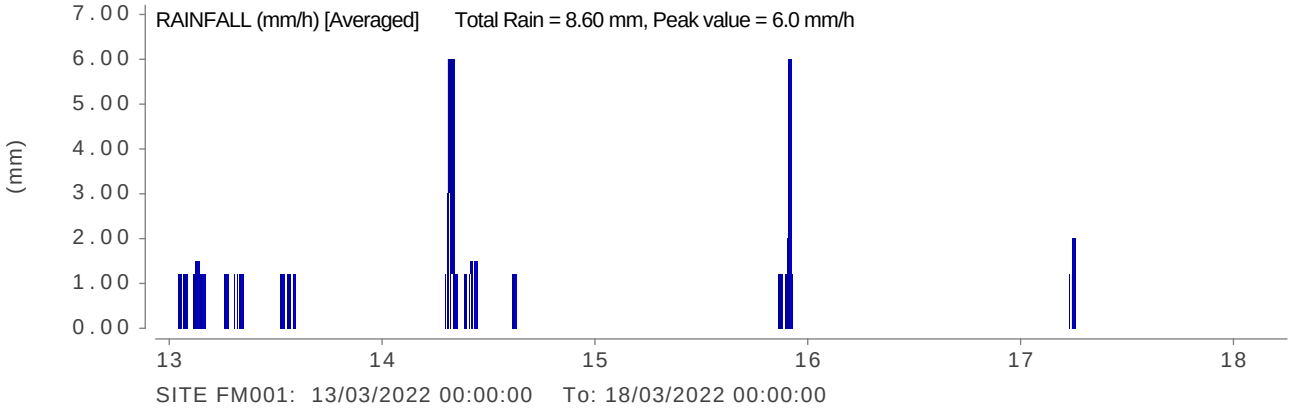
capital water systems ltd.

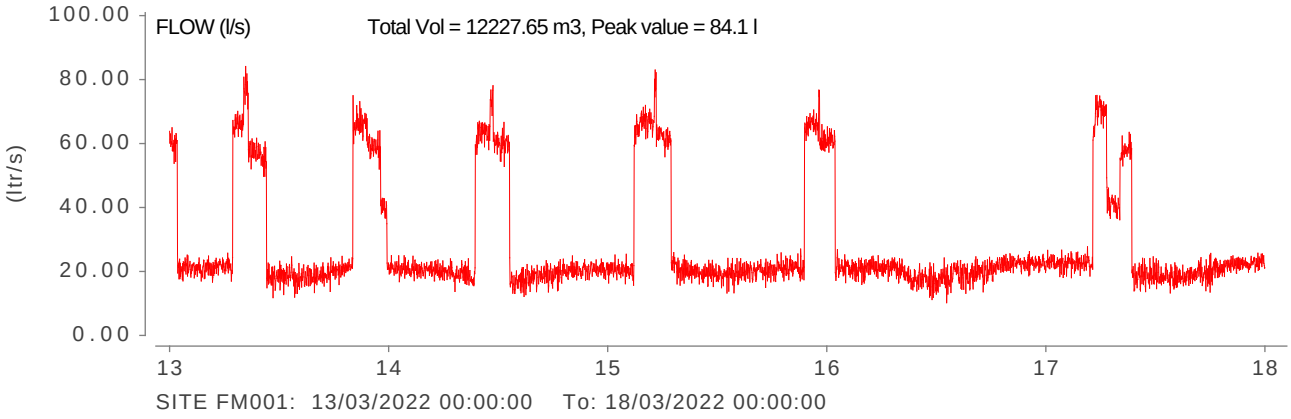
web	www.cwsl.ie
email	info@cwsl.ie
tel.	+353 (090) 6627616

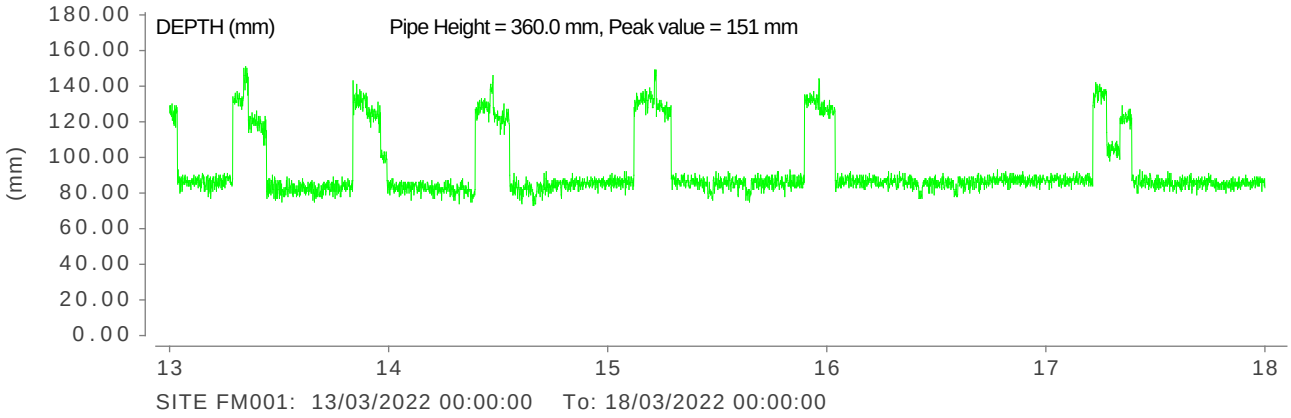
Interim Plots

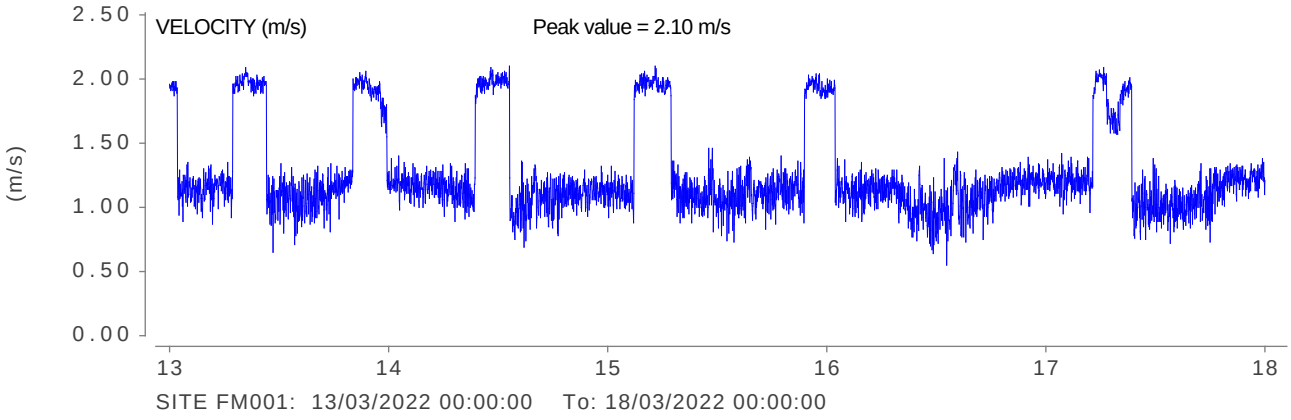
Survey Name	Client	Contractor	Event	Event Start	Event End	Site	Client Ref Id
T45 Breedon	Breedon	CWSL	Event Description	13/03/2022 00:00	18/03/2022 00:00	FM001	

RG01









Flow & Rainfall Survey

Interim Report
11 Breedon

Catchment	Breedon Quarry
Client	Breedon Group
Consultant	Hydro-G
Interim No	11
Rainfall Events Recorded	

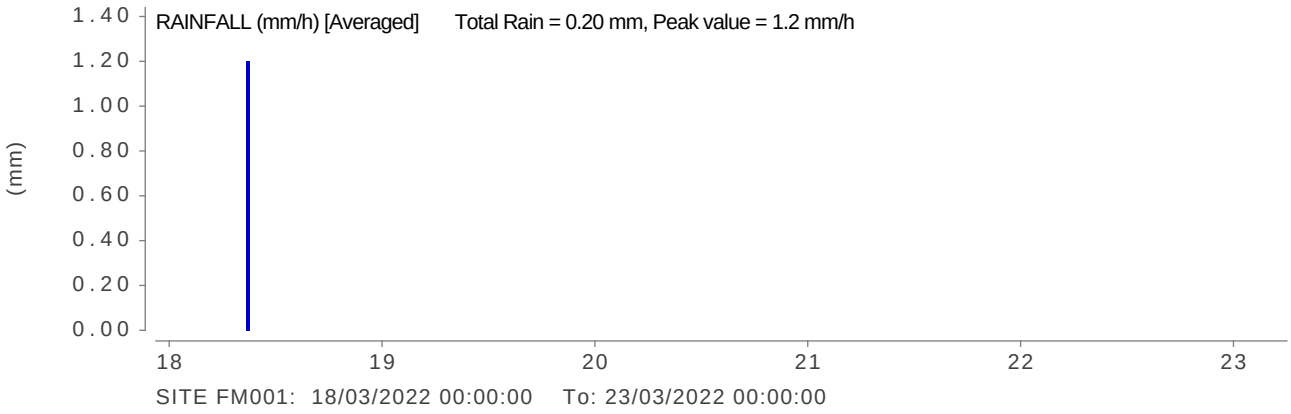
capital water systems ltd.

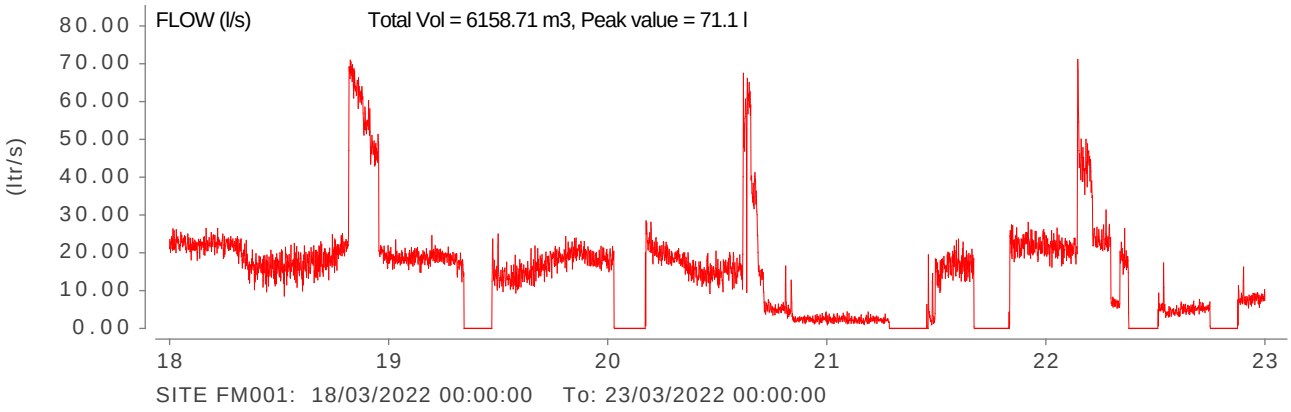
web	www.cwsl.ie
email	info@cwsl.ie
tel.	+353 (090) 6627616

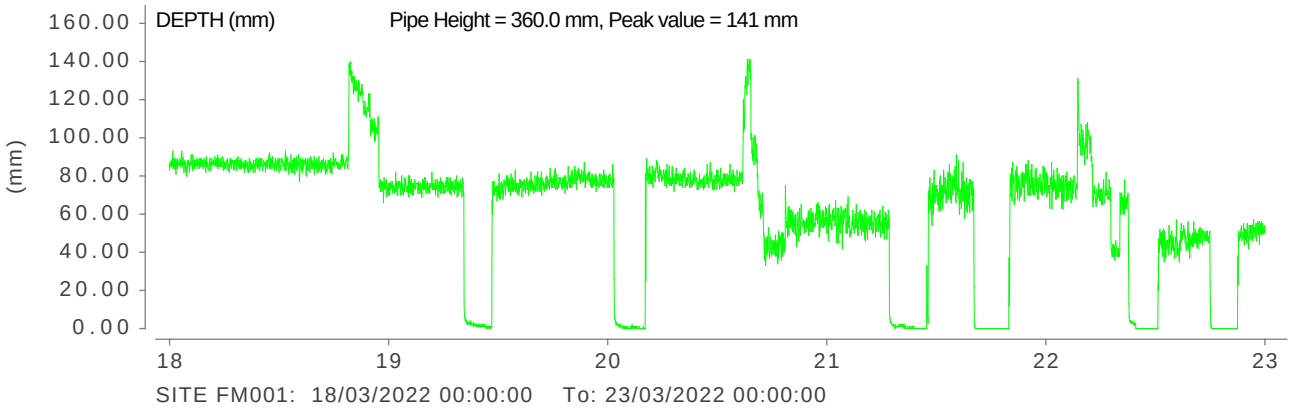
Interim Plots

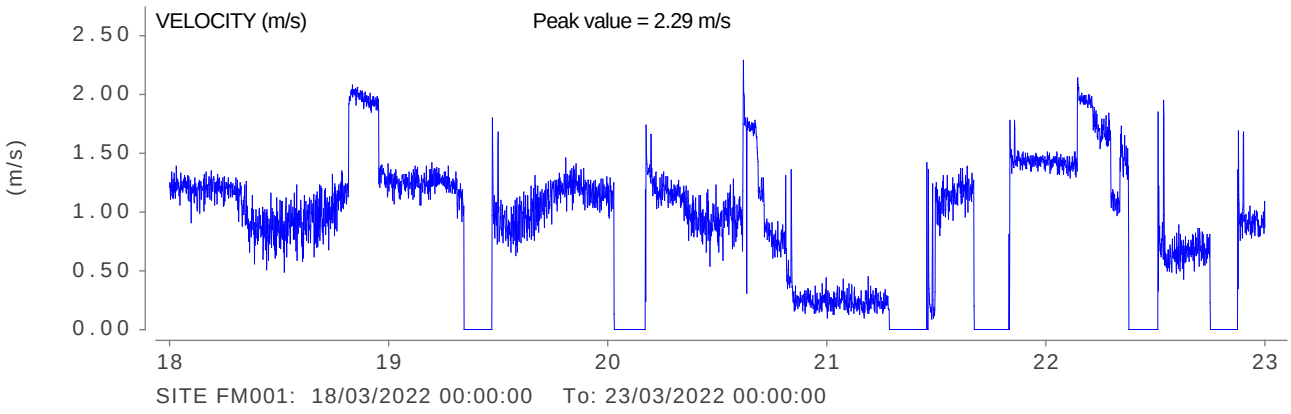
Survey Name	Client	Contractor	Event	Event Start	Event End	Site	Client Ref Id
T45 Breedon	Breedon	CWSL	Event Description	18/03/2022 00:00	23/03/2022 00:00	FM001	

RG01









Flow & Rainfall Survey

Interim Report
12 Breedon

Catchment	Breedon Quarry
Client	Breedon Group
Consultant	Hydro-G
Interim No	12
Rainfall Events Recorded	

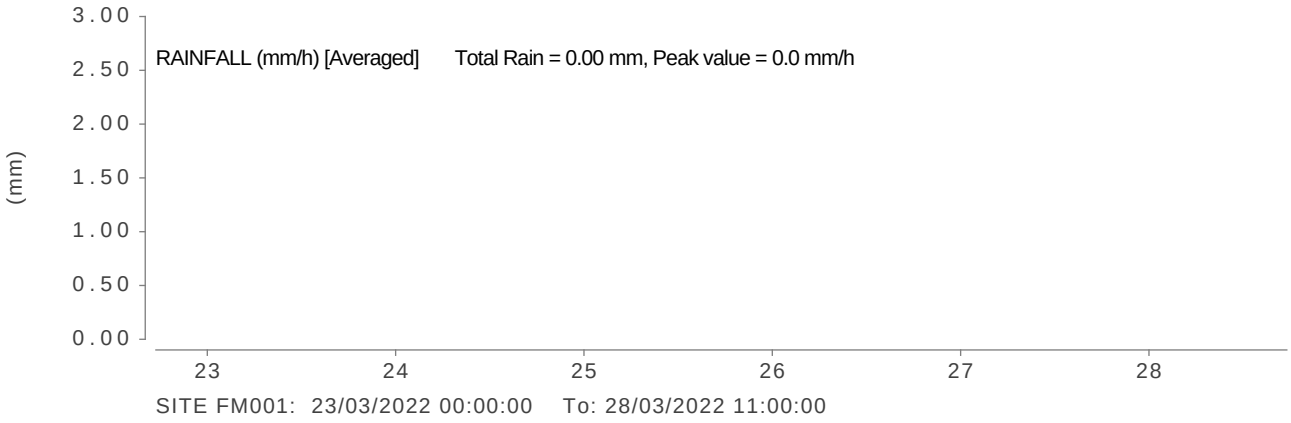
capital water systems ltd.

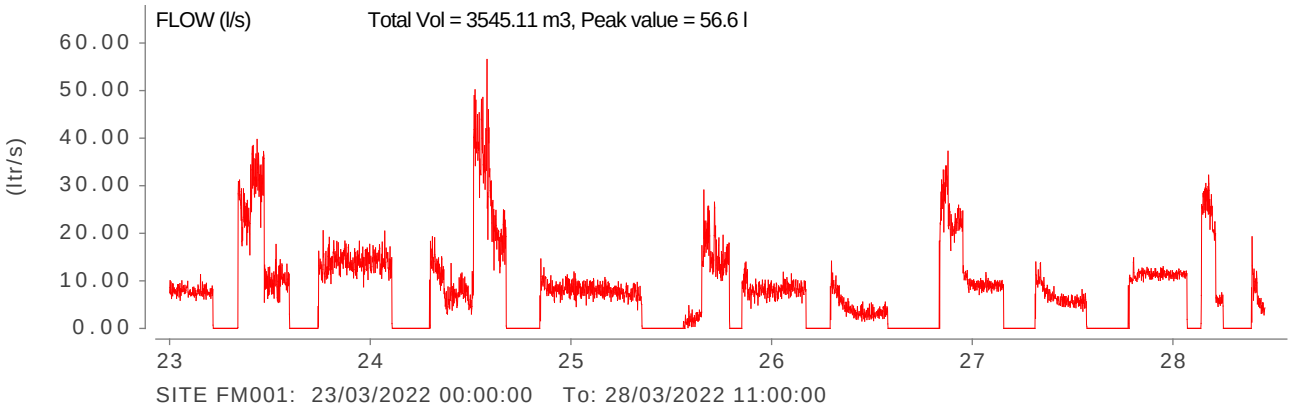
web	www.cwsl.ie
email	info@cwsl.ie
tel.	+353 (090) 6627616

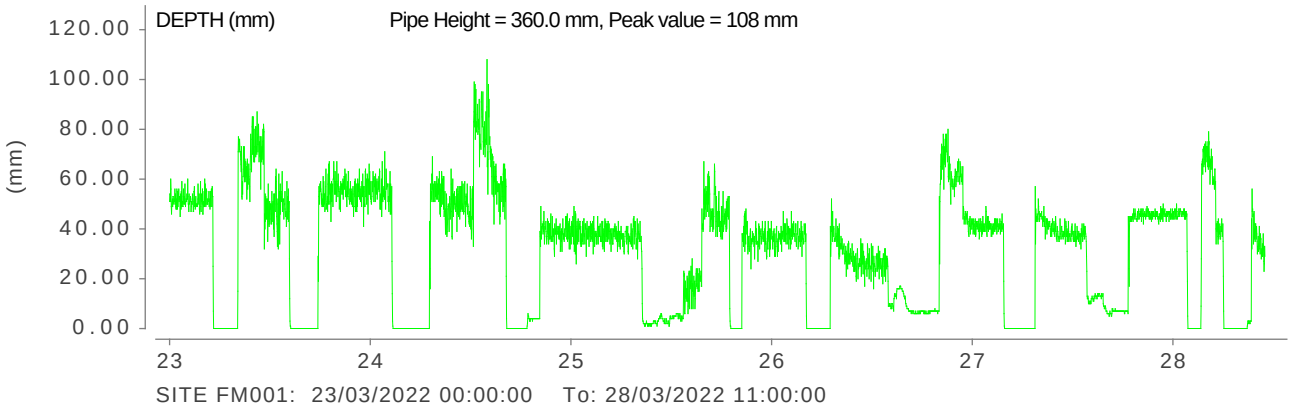
Interim Plots

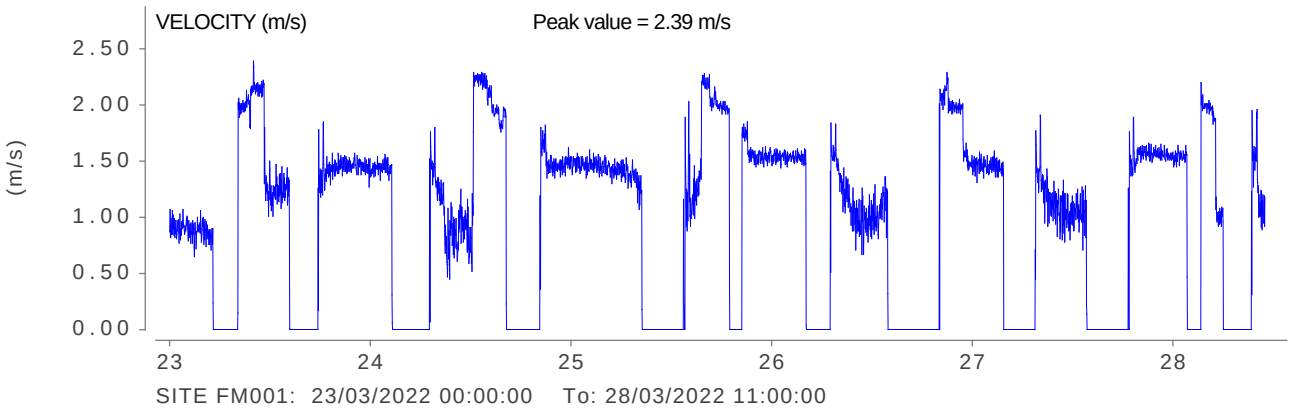
Survey Name	Client	Contractor	Event	Event Start	Event End	Site	Client Ref Id
T45 Breedon	Breedon	CWSL	Event Description	23/03/2022 00:00	28/03/2022 11:00	FM001	

RG01









Flow & Rainfall Survey

Interim Report
13 Breedon

Catchment	Breedon Quarry
Client	Breedon Group
Consultant	Hydro-G
Interim No	13
Rainfall Events Recorded	

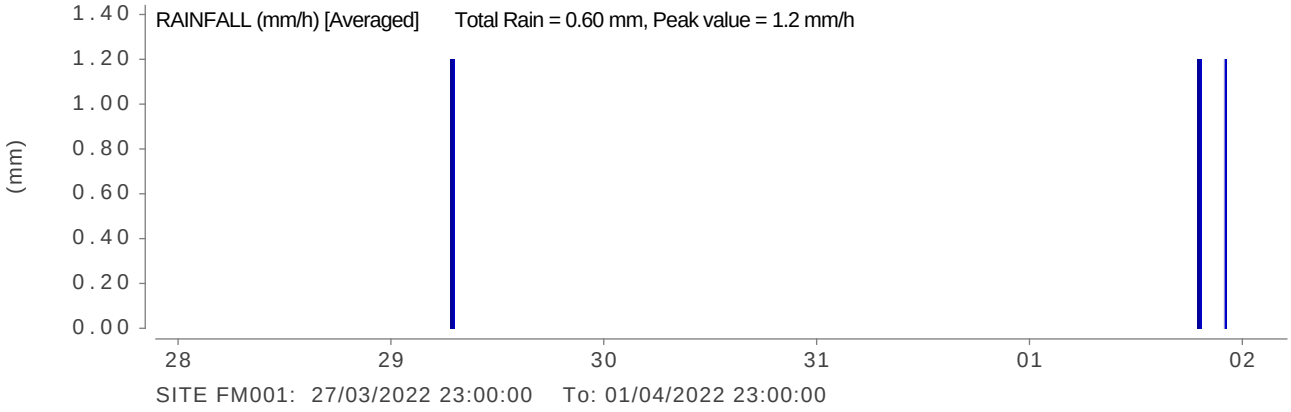
capital water systems ltd.

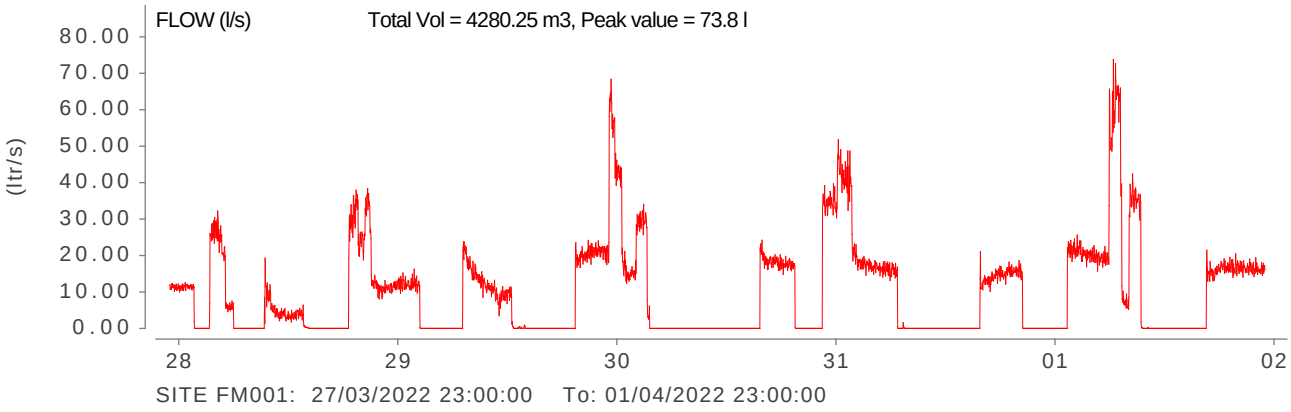
web	www.cwsl.ie
email	info@cwsl.ie
tel.	+353 (090) 6627616

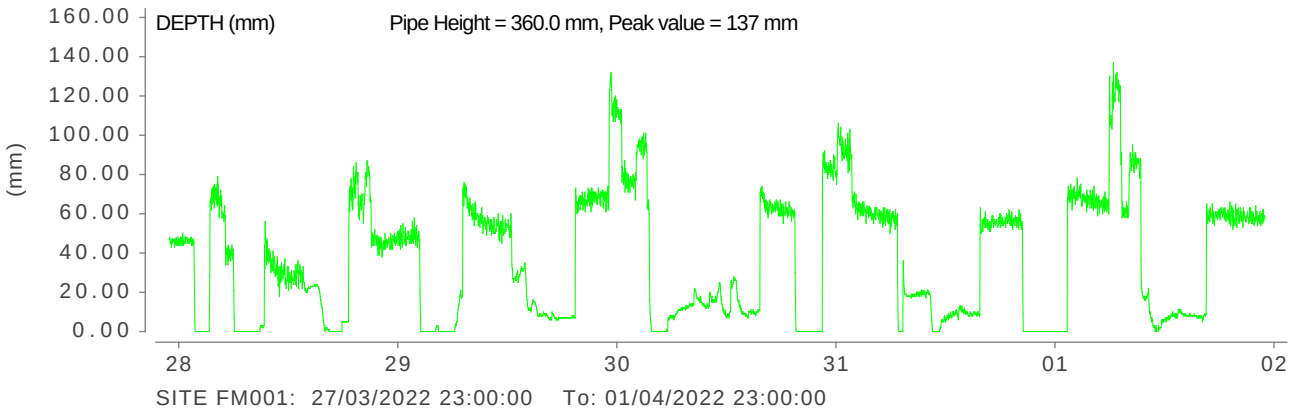
Interim Plots

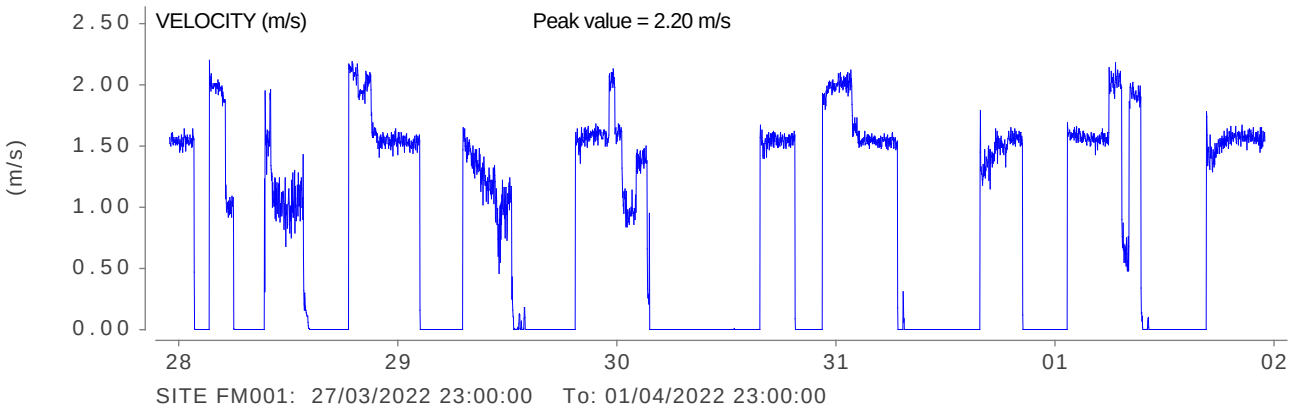
Survey Name	Client	Contractor	Event	Event Start	Event End	Site	Client Ref Id
T45 Breedon	Breedon	CWSL	Event Description	27/03/2022 23:00	01/04/2022 23:00	FM001	

RG01









Flow & Rainfall Survey

Interim Report
14 Breedon

Catchment	Breedon Quarry
Client	Breedon Group
Consultant	Hydro-G
Interim No	14
Rainfall Events Recorded	

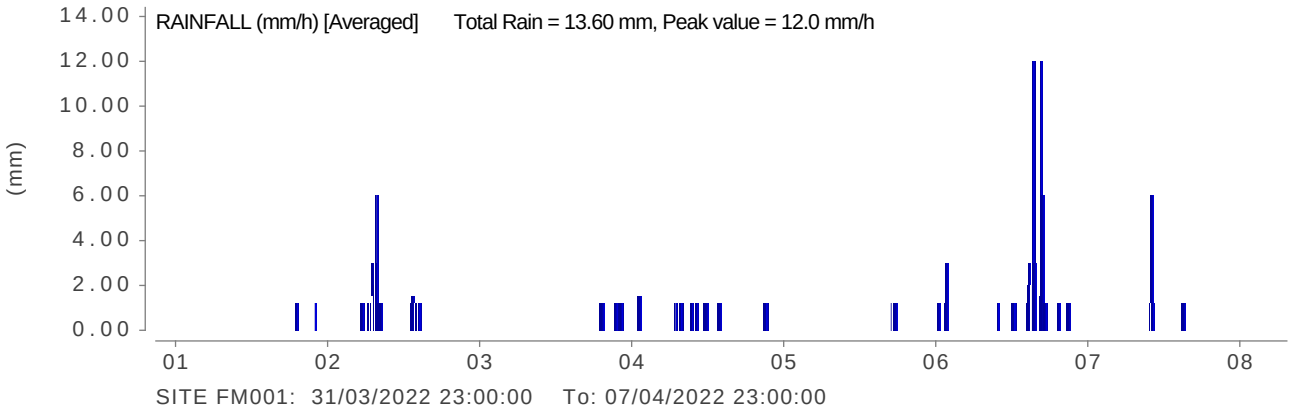
capital water systems ltd.

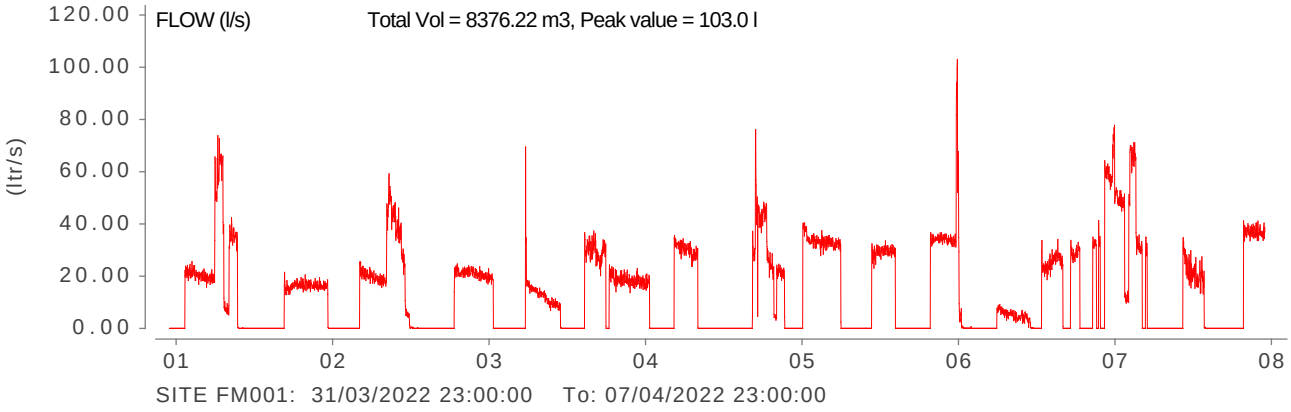
web	www.cwsl.ie
email	info@cwsl.ie
tel.	+353 (090) 6627616

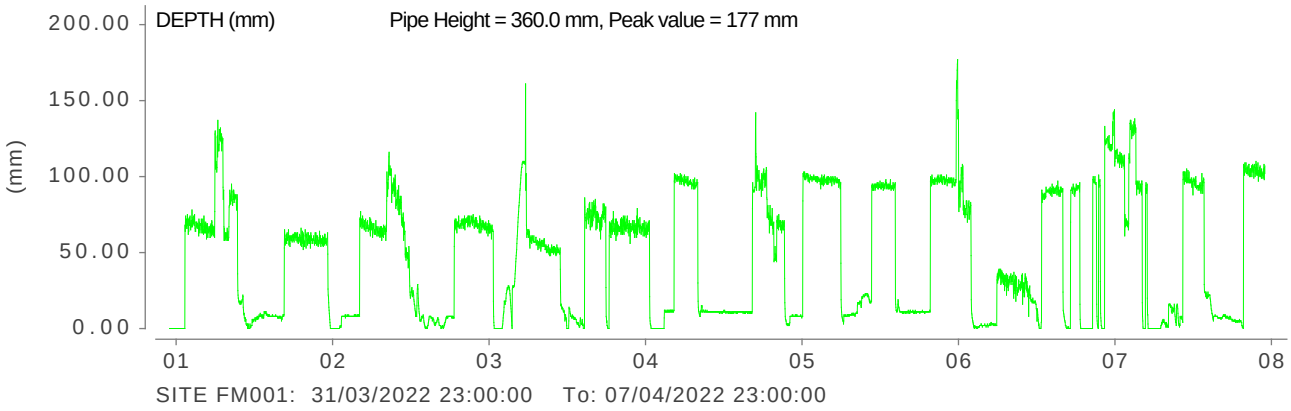
Interim Plots

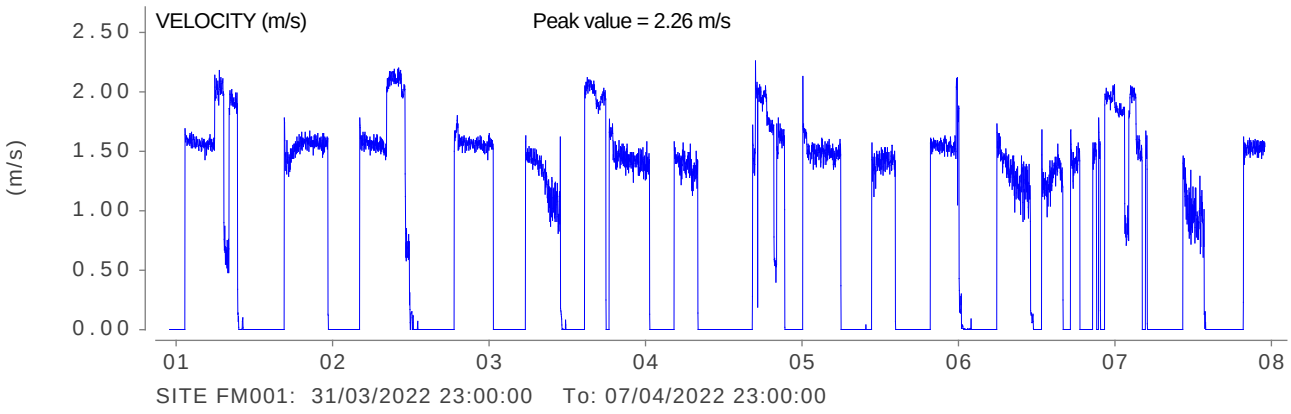
Survey Name	Client	Contractor	Event	Event Start	Event End	Site	Client Ref Id
T45 Breedon	Breedon	CWSL	Event Description	31/03/2022 23:00	07/04/2022 23:00	FM001	

RG01









Water Chapter

Appendix 8I

Hydraulic Capacity Assessment

HYDRAULIC CAPACITY ASSESSMENT

CLIENT:	BREEDON CEMENT IRELAND LTD
LOCATION:	KILLASKILLEN, CO. MEATH
RIVER:	KINNEGAD RIVER
SURVEY COMPLETED	JANUARY 2022
MODEL COMPLETED	APRIL 2022
COMPLETED BY:	ENVIROLOGIC

ENVIROLOGIC
HYDROGEOLOGICAL · HYDROLOGICAL CONSULTING
ROBERTSON HOUSE, UNIT 49 BALDOYLE IND EST, D13
01 8322176 · 087 2024695 · INFO@ENVIROLOGIC.IE

STATEMENT OF AUTHORITY

The field works, model development, hydraulic capacity assessment and report were completed by Envirologic, which is Dr. Colin O'Reilly's company.

Envirologic has key competencies in hydrogeology and hydrology, with expertise in flood assessments and assessment of quarries across a range of diverse hydrogeological conditions across Ireland.

Dr. Colin O'Reilly has a doctorate degree in soil's systems and hydrology. He has over 20 years of professional and field-based experience as a hydrogeologist coupled with a doctorate degree in hydrology, awarded by the Centre for Water Resources Research, School of Architecture, Landscape and Civil Engineering, UCD, while a recipient of a Teagasc Walsh Fellowship. Colin is a current and active member of Engineers Ireland and International Association of Hydrogeologists (Irish Group).

Pat Breheny MSc (Hydrogeology) PGeo. EurGeol. works with Colin O'Reilly in Envirologic. Pat completed the field works for this assessment and developed the model. He has 12 years of post-graduate experience in environmental consultancy having worked extensively in Ireland and the UK, with a background specialising in hydrogeology, hydrology and contaminated land. Patrick holds a Master of Science Degree (MSc) in Hydrogeology which he attained at the University of Leeds, UK. He is a member of the International Association of Hydrogeologists (IAH) and is a Chartered Geologist, as awarded by the Institute of Geologist Ireland (IGI).

Examples of recent relevant projects completed by Envirologic include:

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

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

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

Envirologic holds the required Professional Indemnity Insurances, Employers and Public Liability Insurances.

TABLE OF CONTENTS

1 INTRODUCTION

This hydraulic capacity assessment of the Kinnegad River has been prepared to accompany an EIAR regarding proposed deepening of a 4.13ha area, within an overall landholding of c. 286ha, at an existing facility in Killaskillen, Kinnegad, Co. Meath. The water management regime involves a permitted, Licenced (P0487-07) and controlled discharge of waters to the Kinnegad River on the northern boundary of the facility (SW1).

In order to maintain dry working conditions, rainfall-runoff and groundwater ingress must be removed from the working floor of all quarries. At the site in question, the working floor of the limestone and shale quarries are kept safe for working by sump controls on water levels. Quarry floor sumps are constructed to enable gravity flow of rainfall runoff from the bare rock to the excavated sump. From the floor sump, float switch controls facilitate controlled pumping to water management systems, which are usually positioned at natural ground level elevations on the periphery of the rock working zones and on the outlying boundary of the facility. At the site under consideration, there are a series of attenuation ponds, balancing ponds and settlement lagoons in advance of the licensed discharge point (SW1, IE & IPPC Licence P0487-07) to the Kinnegad River. The discharge point is also controlled by automatic shut off valve, which closes the discharge pipe when the Licensed maximum hourly limit is approached, which is 240 m3/hr. The water management systems also have controls in the form of level sensors in the balancing ponds that can automatically switch off sump pumps.

The work reported here is complimentary to evaluations underway art the site regarding the potential for more waters arising when deepening a 4.13ha of the main limestone quarry area. The entire facility, which includes the limestone quarry and ancillary operations, is licensed to discharge a maximum volume of 6,150m3/d at one discharge point (SW1, IE & IPPC Licence P0487-07) to the Kinnegad River. However, the licence also make provision to ensure that the hydromorphological regime of the river is not overwhelmed and that licensed daily maximum volume cannot be discharged at more than 240m3/hr. That, then, becomes a point of consideration in the hydraulic capacity assessment.

In order to evaluate the site, the technical procedure applied to the evaluation of watercourses is as follows:

1. Assess the risk of flooding from site to river and downstream receptors.
2. Determine the hydraulic capacity of the receiving water to accept additional waters from quarry discharge during flood conditions.
3. Assess whether quarry discharge will increase risk of flooding to downstream receptors.

In order to complete the work, hydrological surveying was performed by Envirologic in January 2022. That field work comprised surveying the physical dimensions and levels in the river. The results were used to create Cross Sections of the Kinnegad River, develop a site-specific flow model and use that model to predict likely future impacts on identified receptors downstream of the facility.

2 SITE DESCRIPTION

2.1 SITE LOCATION

The site is located 1.5 km southwest of Kinnegad (Figure 1) and the Kinnegad River flows, in an easterly direction, along a northern boundary of the facility. The site is easily accessed from the M6 Motorway, from the ‘Kinnegad West (2)’ section.

2.2 SITE LAYOUT

The overall site occupies an area of approximately 286 ha, within which there is a limestone quarry with a footprint of 77ha, a shale quarry, a cement factory and other ancillary operations. There are well established internal access routes, staff buildings, services and a comprehensive network of water management infrastructure. The site operates with permission and under IE & IPPC Licence (P)487-07). The site is proposing additional works, within its limestone quarry, which will involve deepening 4.13ha of the 77ha quarry. The proposed future working area is the northern part of the established limestone quarry. The proposal under consideration at the time of this hydraulic capacity assessment is to bring the floor of the already worked 4.13ha, of the northern part of the limestone quarry, from its current floor elevation of 70m OD to the same permitted floor level of 25ha of the centre of the limestone quarry.

Waters arising on the working floor of the limestone quarry flow by gravity to the floor sump and are pumped from the sump to various parts of the facility for usage. Some water is pumped directly from the sump to the site's 'Balancing Pond', which provides some treatment and hydraulic function. Waters also arise on site from the floor and sump of the shale quarry, rainfall-runoff from hardstanding areas at the cement manufacturing plant and surrounding administration buildings, which has its own balancing and attenuation pond that the site calls the 'Terrace Sump'.

After balancing of all site waters, the balancing ponds forward feed to two large settlement lagoons, which are the final element of the water management infrastructure at the site. The outflow from the settlement lagoons is a single pipe with automatic valve controls. The piped discharge is the primary discharge from the overall site and is referenced as 'SW1' under Condition C.2.1 of the Emissions to Waters Condition of the IE & IPPC Licence P0487-07. The site's discharge enters the Kinnegad River close to the facility's northern site boundary and on the southern bank of the Kinnegad River.

It is noted that there is also another licensed discharge point (SW2) in the Emissions to Waters Condition of the IE & IPPC Licence P0487-07. However, the discharge volume from SW2 is Conditioned as 'Not Limited' because the discharge from SW2 is not associated with quarrying or ancillary activities at the facility. SW2 conveys agricultural land's runoff *via* conventional boundary drains that are ubiquitous throughout Ireland.

3 HYDROLOGICAL SETTING

3.1 SURFACE WATER NETWORK

The Kinnegad River rises 12 km west of the site near Gaybrook and flows in an easterly direction running parallel, and adjacent to, the northern boundary of the facility. The upgradient catchment of the watercourse as it passes the point of discharge is c. 32.5km^2. The upgradient catchment is predominantly low-lying farmland and forested areas. Downstream of the site, the Kinnegad River is culverted below the M4/M6 before proceeding northeast through Kinnegad town. The Kinnegad River outfalls to the River Boyne approximately 12 km downstream of the site near Clonard. There are no hydrometric stations on the Kinnegad River. There are several minor tributaries that drain to the Kinnegad River. They tend to rise in low-lying areas and are fed by a network of open field boundary drains which were installed to improve agricultural drainage. It is assumed that these field drains transmit runoff and shallow subsurface flow only. The tributaries include two streams that flank the western and eastern boundaries of the overall site, referred to on the EPA database as the Baltigeer Stream and the Killaskillen Stream, respectively. Those rivers flow northwards and their catchment areas are small: estimated to be 2.4 and 1.8km^2, respectively.

3.2 DESIGNATED AREAS

The Kinnegad River flows into the River Boyne which is part of the River Boyne and River Blackwater Special Area of Conservation (SAC Site Code: 002299) and River Boyne and River Blackwater Special Protection Area (SPA Site Code: 004232). Those SACs and SPAs are connected to Boyne Estuary and Coast SAC and the Boyne Estuary SPA. The point of licensed discharge from the Breedon site is >13km stream flow length from the point at which the Boyne_030 is mapped as a designated site, which is at Longwood, Co. Meath. Review of EPA HydroTOOL catchments reveals that the catchment area to that point of designation is 436km2. Information for catchments, HydroTOOL maps and flows is presented in Appendix 8.C. HydroTOOL information for Model Node 07_951 suggests a 50%tile flow rate of 3.85 m3/s, which is equivalent to 332,726 m3/d. This suggests that at times of approximate equivalent mean flow at the point of confluence between the Kinnegad River and the Designated Boyne, a maximum permitted discharge of 6,150 m3/d from the Breedon site combined, including all quarries and lands associated with the Breedon operation, represents <2% of the flow in the Designated River. That scale of hydraulic relativity would place the contributions from the Breedon site in the 'little potential for impact' using WFD GW5 (WFD Ireland, 2004).

3.3 WFD CLASSIFICATION

The application site is in the Boyne Catchment (Hydrometric Area 07).

The Kinnegad River, Baltigeer Stream and Killaskillen Stream are part of the Kinnegad_020 catchment. The Kinnegad_020 is mapped by the EPA, for WFD characterisation, as Moderate Status (2013-2018) and 'At Risk' (https://gis.epa.ie/EPAMaps/Water). The Boyne Hydrometric Area 07 (EPA, 2021) 3rd Cycle Catchment Assessment report mentions the Kinnegad_020 river only once and it provides the reason for the 'Under Review' Risk Classification as 'Peat Harvesting'. Section 5.1.1.5 of the Boyne catchment's assessment (EPA, 2021) provides information on pressures caused by the 'Extractive industry' but no quarry is mentioned. EPA (2021) states as follows:

"Peat drainage and extraction remains a significant pressure in 13 river water bodies, a reduction from 16 waterbodies in Cycle 2. The peat pressures have resulted in increased sediment loads in these rivers, which alters habitats, morphology and hydrology. There have also been fluctuations in ammonia concentrations."

Also mentioned, in EPA (2021) for the Boyne catchment's pressures, are those Pressures caused by 'Mines & Quarries', 'Industry' (2 IPPC Licences for other industrial sites are listed as Pressures) and 'Other Significant Pressures'. At no point is the Breedon facility mentioned. It is concluded that the extraction of rock at the application site, or operations in the adjacent quarries and factories, has not impacted the Status or Risk categories of the associated rivers.

4 FLOOD RISK

4.1 HISTORICAL OSI MAPS

The historical 6" OSI maps, dated c.1830 -1840, suggest that the Kinnegad River routing has not been significantly altered in the past 200 years. There are no indicators of flood risk on the overall site. The 6" maps show that a narrow margin along the northern side of the river is prone to winter floods.

The historical OSI 25" maps (dated c.1888 -1913) show minor straightening of the river channel northeast of the site. The 25" maps do not show any indicators of areas adjacent to the river as being prone to flooding.

4.2 OPW FLOOD MAPPING

National Indicative Fluvial Mapping shows that the Kinnegad River may be prone to flooding on its southern side, immediately upstream and downstream of the discharge location (SW1), see Plate 1 below. The image shown in Plate 1 is the mapped 1 in 100-year flood risk (1% AEP) [OPW, https://www.floodinfo.ie/].

Plate 1 National Indicative Fluvial Mapping Output

4.3 CFRAM

There are no CFRAM map tiles for the area. [OPW, https://www.floodinfo.ie/].

4.4 BENEFITTING LAND MAPS

All channels in the area are maintained by the OPW under the Boyne (East) Arterial Drainage Scheme. Drainage properties of lands which extend from the Kinnegad River onto the Breedon site are deemed to have benefitted from these works (Plate 2).

Plate 2 Benefitting Lands

4.5 HISTORICAL FLOOD EVENTS

The OPW database does not contain any records of historical flooding on the Kinnegad River.

5 DISCHARGE

5.1 QUARRY DISCHARGE

The maximum discharge from the site's permitted SW1 discharge point, in the 'Conditions for Emissions: Water', of the IE & IPPC P0487-07 Licence are given as:

1. Maximum daily flow = 6,150 m^3/d (equivalent to 256 m^3/hr or 0.071 m^3/s);
2. Maximum hourly flow = 260 m^3/hr (equivalent to 0.072 m^3/s).

6 HYDRAULIC CAPACITY OF RECEIVING WATERS

Sustainable development requires that the local natural surface water drainage network has adequate capacity to receive and safely transmit the maximum Licensed discharges. The purpose of this hydraulic capacity assessment is to determine the current state of, and available capacity, of the receiving water.

In order to assess the impact posed by discharge from the site, two separate flood risk scenarios have been considered:

(i) Pre-development - The river flows were calculated using natural catchment flood flows as the inflow boundary condition.

(ii) Current – the pre-development simulation was repeated along with the addition of the maximum permitted daily discharge as the inflow boundary condition. This additional flow will be used to assess whether the discharge has an impact on river levels during a Q_{100} flood event.

6.1 RIVER FLOOD FLOW ESTIMATION

The first step in hydraulic capacity assessment is to calculate streamflows that arise in the Kinnegad River during an extreme return period event (Q_{100}). Various formulae used to estimate the Q_{100} river flow are presented below. The most appropriate method was then selected from these.

6.1.1 OPW FSU – Standard 7 Variable Equation

The ungauged method can be used to determine flood flows at the site using catchment characteristics, which are then corrected using a correlation against descriptors for gauged catchments. The median annual maximum flood magnitude, QMED, as outlined in the Flood Studies Update (Nicholson & Bree 2013) is now preferred over the Qbar parameter described in the FSR (1975). The median is less sensitive to large extreme floods and to flood measurement error in general. The estimation method for ungauged locations is based on a regression analysis relating observed QMED to physical catchment descriptors (PCDs) at gauged locations in Ireland, given by the following equation:

$$QMED_{rural} = 1.237x10^{-5} \cdot AREA^{0.937} \cdot BFI_{soil}^{-0.922} \cdot SAAR^{1.306} \cdot FARL^{2.217} \cdot DRAIND^{0.341} \cdot S^{0.185} \cdot (1 + ARTDRAIN2)^{0.408}$$

The PCDs applicable to the subject site are shown in Table 1.

Table 1 Physical catchment descriptors applicable to quarry catchment (standard OPW FSU equation)

PCD	Description	Units	Value
AREA	Catchment area	km^2	32.5
SAAR	Average annual rainfall	mm	908
BFIsoil	Baseflow index derived from soils data		0.70
FARL	Flood attenuation from reservoirs and lakes		1
DRAIND	Ratio of river network to catchment area	Km/km^2	0.802
S_{1085}	Slope of the main stream between the 10 and 85 percentiles	m/km^2	2.56
ARTDRAIN2	Proportion of river network included in drainage schemes		0.76
URBEXT			0
QMED		m^3/s	4.55

A principal of the FSU is the concept of a pivotal site, which is defined as the gauging station that is considered most relevant to a particular flood estimation problem at the subject site and is used to adjust the QMED rural estimate. The FSU portal was used to determine suitable pivotal site for this catchment. In this case the gauging station at Boyne Aqueduct (07007) shall be used. The procedure is to infer an adjustment factor to the QMEDrural estimate by examining the performance of the regression model at the pivotal site. This adjustment factor is derived from the ratio between QMEDurban at the gauging station, and the median annual maxima value which in this instance results in a 16% decrease to QMED:

- QMED at gauging station = 41.93 m3 s-1
- median annual maxima at gauging station / QMED at gauging station = 35.32 / 41.93 = 0.84
- QMEDrural adjusted at site = 4.55 m3 s-1x 0.842 = 3.83 m3 s-1

The QMED value at the site has been downgraded due to a lesser gradient at the gauging station on the Boyne channel (0.70 m/m) when compared to the Kinnegad River as it passes the site (2.56 m/m). Therefore, rather than accepting the adjusted QMED value of 3.83 $m^3\ s^{-1}$ it is considered more appropriate to defer to the original value of 4.55 $m^3\ s^{-1}$. This is part of a conservative approach.

The return-period flood flow (Q_T) is determined by an index flood method, whereby a growth factor as determined from an EV1 distribution plot is applied. In this case:

$$Q_T = QMED \times 2.23$$

$$Q_{100} = 4.55\ m^3/s \times 2.23$$

$$Q_{100} = 10.14\ m^3/s$$

Finally, a climate change growth factor of 20 % is applied:

$$Q_{100} = 8.55 \times 1.2$$

$$Q_{100} = 12.18\ m^3/s$$

6.1.2 OPW FSU - Small Catchments Equation

The updated Flood Studies Update (Nicholson & Bree 2013) presents a revised formula more suited to catchments less than 25 km^2:

$$QMED_{rural} = 2.0951x10^{-5} \cdot AREA^{0.9245} \cdot BFI_{soil}^{-0.9030} \cdot SAAR^{1.2695} \cdot FARL^{2.3163} \cdot S^{0.2513}$$

This yields a $QMED_{rural}$ value of 3.25 m^3/s.

As per the OPW Guidelines, a pivotal site adjustment factor is not applied to the outcome of the small catchments equation. The return-period flood flow (Q_T) is again determined by an index flood method, whereby a growth factor as determined from an EV1 distribution plot is applied. In this case:

$$Q_T = QMED \times 2.23$$

$$Q_{100} = 3.25 \text{ m}^3/\text{s} \times 2.23$$

$$Q_{100} = 7.24 \text{ m}^3/\text{s}$$

Finally, a climate change growth factor of 20 % is applied:

$$Q_{100} = 7.24 \times 1.2$$

$$Q_{100} = 8.69 \text{ m}^3/\text{s}$$

6.1.3 OPW FSU - 3 Variable Method

The FSU 3-variable equation was developed as part of the FSU. It was developed as a 'short cut' equation for the estimation of flow in ungauged catchments.

$$QMED = 0.000302.AREA^{0.829} \cdot SAAR^{0.898} \cdot BFI^{1.539}$$

$$QMED = 1.42 \text{ m}^3/\text{s}$$

Application of the relevant growth factors as per above and 20% climate change adjustment factor results in:

$$Q_{100} = 3.79 \text{ m}^3/\text{s}$$

6.1.4 Flood Studies Report, FSR (NERC 1974)

This is the original FSR method, with the regression coefficient for Ireland. Estimates from this equation should be treated with extreme caution. It is recommended that these equations should be used only for preliminary flood estimates.

$$QBAR = 0.0172.AREA^{0.94} \cdot STMFRQ^{0.27} \cdot S1085^{0.16} \cdot SOIL^{1.23} \cdot RSMD^{1.03} \cdot (1 + LAKE)^{-0.85}$$

Table 2 Calculations of Q_{100} – FSR ungauged catchments

Area, km^2	STMFRQ, jn/km^2	S1085, m/km	SOIL	RSMD	LAKE	Q_{BAR}, m^3/s	Q_{BAR} x 1.96 gf, m^3/s	Q_{100} x 1.47 sfe m^3/s	Q_{100} x cc (1.2), m^3/s
32.5	0.031	2.56	0.35	44.9	0.0	2.19	4.29	6.30	7.56

6.1.5 Institute of Hydrology Report 124 (1994)

Report No. 124 derives an equation to estimate flood flows for small rural catchments (less than 25 km^2). The equation has a standard factorial error (SFE) of 1.65.

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

Table 3 Calculations of Q_{100} using IH124

Area, km^2	SAAR	SOIL	Q_{BAR} m^3/s	Q_{BAR} x 1.96 gf m^3/s	Q_{100} x 1.65 sfe m^3/s	Q_{100} x cc (1.2), m^3/s
32.5	908	0.35	7.09	13.9	22.92	27.51

This method was developed for small catchments (< 25 km^2) in the UK. It's derivation did not include any Irish catchments. The equation tends to overestimate QBAR for the smallest of the UK catchments used.

Without implementing the SFE, the Q_{100} rate plus 20 % climate change factor was reduced to 13.9 m^3/s. This value is generally comparable to results derived from the OPW FSU formula.

6.1.6 Modified IH 124 (Cawley & Cunnane 2003)

$$Qbar_{rural} = 0.000036 (AREA^{0.94} \times SAAR^{1.58} \times SOIL^{1.87})$$

Table 4 Calculations of Q_{100} using modified IH124

Area, km^2	SAAR	SOIL	Q_{BAR}, m^3/s	Q_{BAR} x 1.96 gf m^3/s	Q_{100} x 1.65 sfe m^3/s	Q_{100} x cc (1.2), m^3/s
32.5	908	0.35	6.29	12.3	20.3	24.4

Without implementing the SFE, the Q_{100} rate plus 20% climate change factor was reduced to 12.3 m^3/s. Again, the unadjusted value is closer to the FSU and FSR results above.

6.1.7 TRRL & ADAS

Agricultural Development and Advisory Service (ADAS) , which is a precursor to Transport and Road Research Laboratory (TRRL), is only applicable for catchments smaller than 0.4 km^2. This methodology shall not, therefore, be applied.

6.1.8 Summary of Flood Flow Calculations

Results from the OPW recommended methods are summarised below in Table 5. The results derived are spread across a relatively wide range. The values which appear to be significant underestimates (FSU – 3 variable) and significant overestimates (IH124 and Modified IH124) are omitted.

The standard OPW FSU formula gives the result closest to the average and is selected for use in flood simulations. The OPW FSU formulae were derived using Irish catchments and full datasets from Irish hydrometric gauging stations. The FSU also incorporates catchment descriptors derived from Irish digital elevation models.

Table 5 Summary of calculated flood flows (including 20% climate change factor), m^3/s unless stated

Approach	Q100 in Kinnegad River at SW1, $m^3 s^{-1}$
FSU Standard	12.17
FSU small catchments	8.69
FSU – 3 variable	3.79
FSR 6 – including SFE	7.56
IH124 – including SFE	27.5
Modified IH124 – including SFE	24.4
Mean	14.0

7 HYDRAULIC MODEL

Now that the initial inflow boundary condition has been established the model can be constructed and flood simulations performed through the local river network.

The hydraulic model was compiled using *Flood Modeller Pro* software, which was then used to simulate water levels at different points along the Kinnegad River.

The model consists of 36 cross sections that were surveyed by Envirologic using Trimble RTK VRS technique. Cross section locations are shown in Figure 2 of the Figure Series accompanying this report. The cross sections extended 870m upgradient, immediately downstream of a confluence with a second order. The cross sections terminated 3.3km downstream with the intention of assessing potential increase in flood risk to the primary receptors identified: the M6 motorway, Kinnegad town and Kinnegad WWTP.

Manning's coefficient of 0.03 was applied to open river channel bed sections and a value of 0.045 was applied to riverbanks. The following is a list of the critical culvert structures within the catchments. In total five engineered culverts were surveyed and included in the model as follows:

1 CSN: single spring-arch stone bridge below L8021 (base width = 8.7m; spring = 68.74mOD; soffit = 71.47mOD).

2 CSU: single spring-arch concrete bridge below eastbound M4-M6 (base width = 14.2m; spring = 68.90mOD; soffit = 71.88mOD).

3 CSW: single spring-arch concrete bridge below westbound M4-M6 (base width = 14.8m; spring = 69.06 mOD; soffit = 71.77mOD).

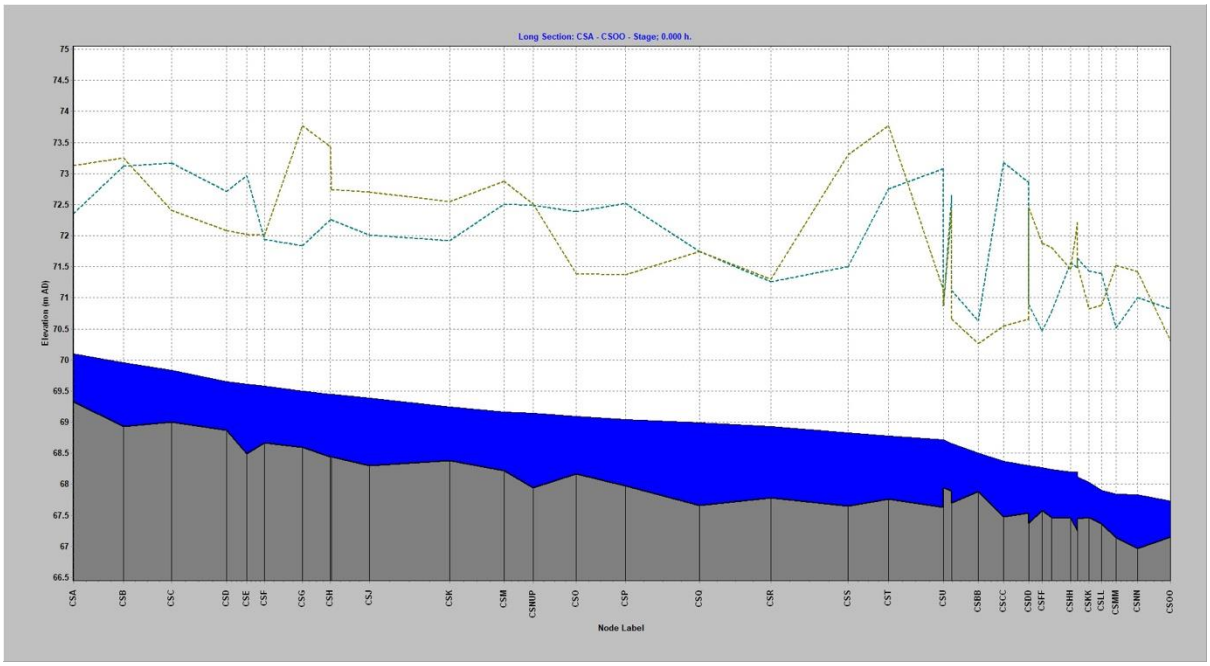
4 CSDD: single spring-arch concrete bridge below R148 (spring = 68.44 mOD; soffit = 71.30 mOD).

5 CSII: twin-box culvert below R401 (soffit = 71.40 mOD).

6 CSNN: twin-box culvert below R161 (soffit = 70.41 mOD).

All other surveyed cross sections in the Kinnegad River were unimpeded open channels. Surveyed surface water levels, for the 25-26th January 2022, are presented in Table 6. Flow for validation of the model's levels was 2.2m³/s. Based on visual estimates this appeared to be a reasonable estimate. Under this flow scenario the predicted river level error was generally less than 80mm. Hence the model is deemed to be valid and accurate. The model output values are not sensitive to flood levels at the downgradient boundary (CSOO). The river passes adjacent to the discharge point (SW1) at CSG.

Plate 3 Longitudinal Profile of Hydraulic Model under validation flows on 25th January 2022 (2.2 m³/s)



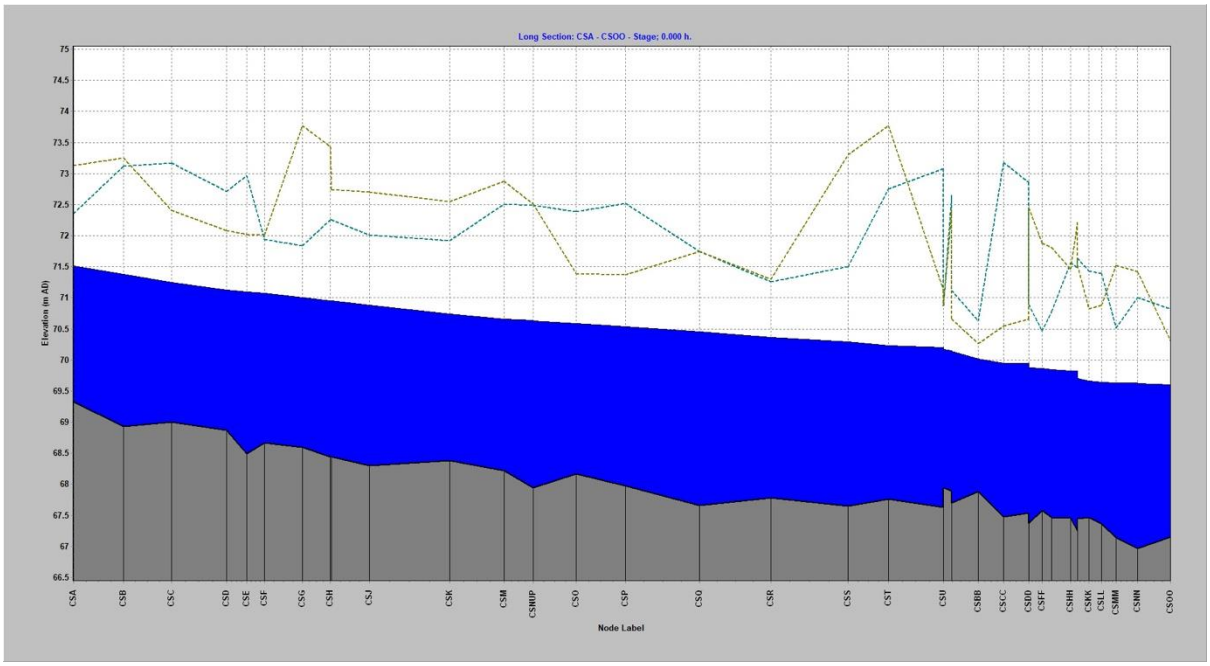
The conveyance capacity of all surveyed cross sections along the stream were assessed for suitability to transmit Q_{100} flood flows, with an allowance included for climate change. The predicted surface water elevations are presented in Table 6.

Table 6 Hydraulic model flow simulation outputs for Kinnegad River

Section	Gradient m/m	Validation, 25th January 2022			Inflow, m^3/s	Q_{100} flood levels, mOD	Inflow, m^3/s	Q_{100} flood flow + max. discharge levels, mOD	Increase in Q_{100} level due to discharge, m
		Observed surface water level, mOD	Envirologic Model Output	Difference, m					
CSA	0.0012	69.96	70.10	-0.144	12.17	71.50	12.17	71.50	0.00
CSB	0.0005	69.72	69.96	-0.239		71.38		71.38	0.00
CSC	0.0003	69.64	69.84	-0.204		71.25		71.25	0.00
CSD	0.0002	69.57	69.66	-0.092		71.12		71.13	0.00
CSE	0.0002	69.56	69.62	-0.065		71.10		71.11	0.01
CSF	0.0002	69.54	69.59	-0.051		71.07		71.08	0.01
CSG	0.0003	69.51	69.52	-0.011		71.10	0.071	71.01	0.01
CSH	0.0002	69.48	69.47	0.011		70.95		70.96	0.01
CSJ	0.0003	69.45	69.41	0.039		70.88		70.88	0.01
CSK	0.0005	69.36	69.26	0.102		70.74		70.75	0.00
CSM	0.0001	69.27	69.18	0.089		70.66		70.66	0.01
CSN	0.0006	69.26	69.16	0.097		70.64		70.64	0.00
CSO	0.0004	69.17	69.11	0.056		70.59		70.59	0.00
CSP	0.0003	69.08	69.06	0.024		70.53		70.54	0.01
CSQ	0.0002	69.03	69.01	0.015		70.46		70.46	0.00
CSR	0.0003	68.98	68.94	0.035		70.37		70.38	0.01
CSS	0.0007	68.89	68.85	0.036		70.29		70.30	0.01
CST	0.0008	68.79	68.79	-0.001		70.23		70.24	0.01
CSU	0.0008	68.64	68.72	-0.083		70.20		70.21	0.01
CSV	0.0009	68.67	68.72	-0.051		70.17		70.18	0.01
CSW	0.0009	68.64	68.67	-0.027		70.15		70.16	0.01
CSAA	0.0023	68.71	68.67	0.038		70.14		70.15	0.01
CSBB	0.0003	68.48	68.52	-0.0041		70.02		70.03	0.01
CSCC	0.0142	68.45	68.39	0.059		69.95		69.95	0.00
CSDD	0.0004	68.32	68.31	0.008		69.95		69.95	0.00
CSEE	0.0001	68.27	68.31	-0.036		69.88		69.88	0.00
CSFF	0.0013	68.27	68.28	-0.013		69.86		69.86	0.00
CSGG	0.0010	68.22	68.25	-0.031		69.85		69.85	0.00
CSHH	0.0004	68.16	68.21	-0.046		69.83		69.83	0.00
CSII	0.0002	68.15	68.21	-0.064		69.82		69.83	0.01
CSJJ	0.0021	68.15	68.12	0.034		69.70		69.70	0.00
CSKK	0.0001	68.06	68.04	0.022		69.66		69.66	0.00
CSLL	0.0013	68.00	67.91	0.089		69.64		69.65	0.01
CSMM	0.0002	67.93	67.85	0.078		69.63		69.63	0.00
CSNN	0.0015	67.92	67.84	0.075		69.63		69.63	0.00
CSOO	0.0001	67.73	67.73	0.00		69.60		69.60	0.00

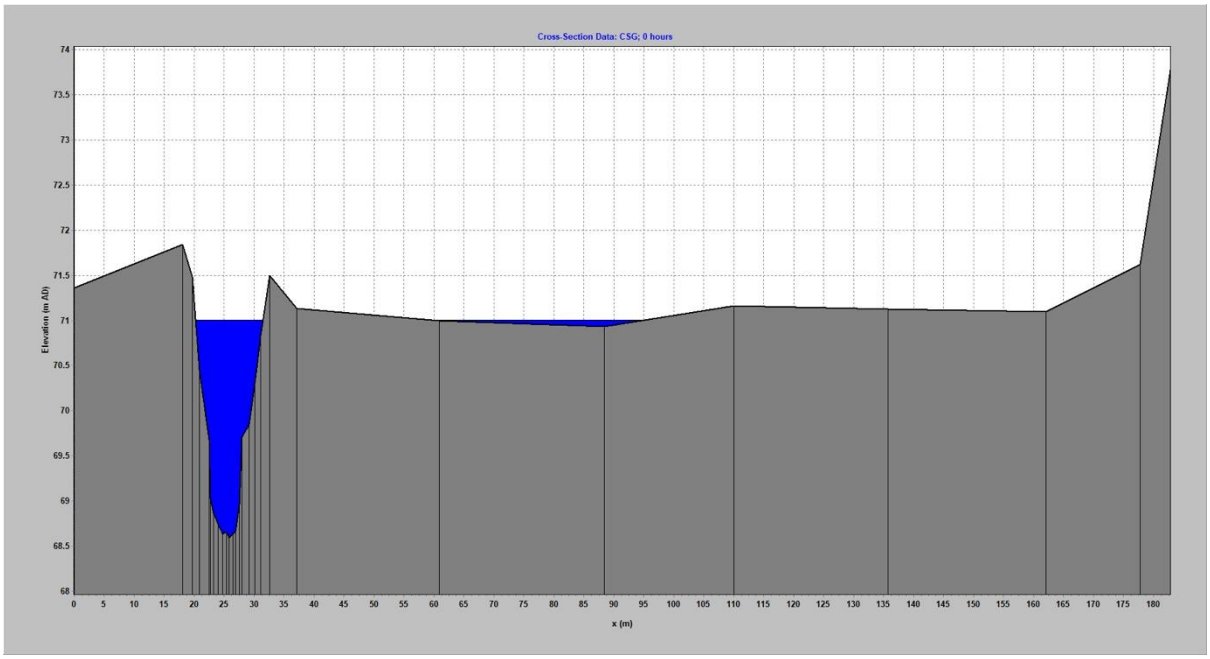
The model simulation was run under steady-state flow conditions. The model output is illustrated as a longitudinal section in Plate 3 which demonstrates that neither the left-hand or right banks of any section were overtopped and that there were no surcharges at any of the bridge structures.

Plate 4 Longitudinal Profile of Hydraulic Model



The simulation results can also be illustrated at each cross section. Plate 4 presents an example of this at CSG, immediately downstream of SW1. The output in Plate 4 shows that the flood flows are withheld within the river channel banks. A small amount of water is shown in the field on the right hand channel side (southern side of river). This is caused by a default setting in the modelling software which assumes the banks are permeable. The sharp incline on the right end of the CSG profile in Plate 4 represents the northern embankment of settlement pond 2.

Plate 5 River Levels at CSG under Q_{100} river flow plus licensed discharge flow conditions



The model outputs presented in Table 6 confirm that introducing the maximum permitted discharge at SW1 under Q_{100} river flow conditions causes an increase of 0.01m (*i.e.,* 1 cm) in river level at approximately half of the surveyed sections. The model provides simulation outputs at 2 decimal places. Therefore, the other half of the cross sections are likely to have increases <1cm. Overall, the results are considered as imperceptible increases in water levels. The simulations confirm that the discharge will not result in an increase in flood risk to the primary downstream receptors, these being the M4/M6 motorway, Kinnegad town and Kinnegad WWTP. Furthermore, there is no increase in flood risk to agricultural lands in the area.

8 DISCUSSION

The purpose of the model was to evaluate the capacity of the Kinnegad River, receiving water. The application of the work was to assess the potential hydraulic impact of the IE & IPPC P0487-07 licence's maximum quarry discharge on the Kinnegad River.

Outputs from the completed hydraulic capacity simulation are as follows:

- The IE & IPPC P0487-07 licence's maximum quarry discharge is 0.6% of the Q_{100} river flow rate *i.e.,* the considered flood flow. This is considered a minor addition to the Kinnegad River in the flood flow condition.
- The licensed maximum discharge results in a 1cm rise, or less, in flood water levels at the 36 cross sections surveyed and modelled by Envirologic. This is considered to be an imperceptible increase in water levels in the flood flow condition.

9 CONCLUSIONS

It is concluded that the addition of the maximum rate of the IE & IPPC Licenced discharge to the Kinnegad River, at SW1, resulted in an imperceptible increase in water levels during a flood event.

The originating catchment area on the site, resulting in the Licensed discharge, naturally lies within the catchment to the Kinnegad River. Therefore, those waters released at SW1 would have entered the Kinnegad River in the pre-development scenario.

There is no necessity to upgrade any structures along the channel downstream of the licensed discharge point.

10 REFERENCES

EPA (2021) 3rd Cycle WFD Draft Catchment Assessment Boyne Catchment Report (HA 07).

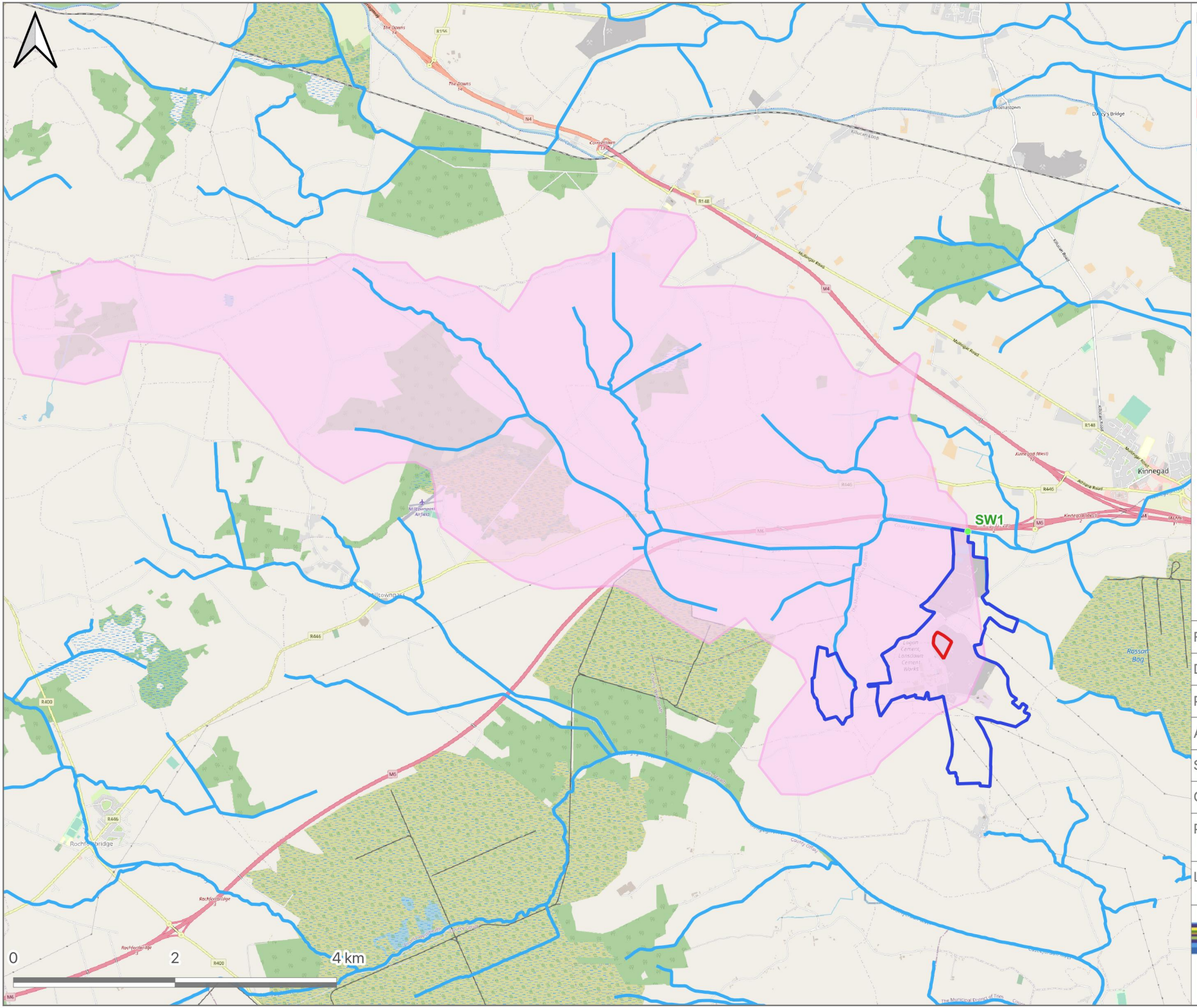
OPW hydrometric flow, levels and mapping (https://www.floodinfo.ie/)

EPA mapping. Status, Risk, hydrometric stations, HydroTOOL model outputs (https://gis.epa.ie/EPAMaps/Water)

FIGURES ACCOMPANYING THIS REPORT

Figure 1 Site Location

Figure 2 Cross Sections



Legend:

- Ownership Boundary
- Application Area
- EPA River Network
- Catchment to Discharge
- SW1 (Licensed Discharge Point)

Figure 1:	Kinnegad River Catchment
Date:	August 2022
Project:	21-P30/1970
Author:	COR
Scale:	1: 60,000
Client:	Breedon
Project:	Hydraulic Capacity Assessment
Location:	Killaskillen, Kinnegad, Co. Meath

Hydro-G

Legend:

- Application Boundary
- Ownership Boundary
- EPA River Network
- Cross Sections Downstream of M4/M6 Motorway
- Cross Sections Upstream of M4/M6 Motorway
- SW1 (Licensed Discharge Point)

Figure 2:	Cross Sections
Date:	August 2022
Project:	21-P30/1970
Author:	COR
Scale:	1: 17,500
Client:	Breedon
Project:	Hydraulic Capacity Assessment
Location:	Killaskillen, Kinnegad, Co. Meath

Hydro-G