

S.37

File With

SECTION 131 FORM

Appeal No

ABP— 322154-25

Defer Re O/H

☐

Having considered the contents of the submission dated/received

22/4/25

from Kilkenny West Group Water Scheme Cooperative Society Ltd

I recommend that section 131 of the Planning and Development Act, 2000 be/not be invoked at this stage for the following reason(s):

No new planning issues

Section 131 not to be invoked at this stage.

☒

Section 131 to be invoked — allow 2/4 weeks for reply.

☐

Signed

Daniel O'Connor

Date

25/4/25

EO

Signed

Date

SEO/SAO

M

Please prepare BP — Section 131 notice enclosing a copy of the attached submission.

To

Task No

Allow 2/3/4 weeks

BP

Signed

Date

EO

Signed

Date

AA



Planning Appeal Online Observation

D. O'Connor

Online Reference
NPA-OBS-004520

Online Observation Details

Contact Name
Alexander Sheehan

Lodgement Date
21/04/2025 23:10:56

Case Number / Description
322154

Payment Details

Payment Method
Online Payment

Cardholder Name
Alexander Sheehan

Payment Amount
€50.00

Processing Section

S.131 Consideration Required

☒ Yes — See attached 131 Form

☐ N/A — Invalid

Signed

Daniel O'Connor

EO

Date

25/4/25

Digital B040

Fee Refund Requisition

Please Arrange a Refund of Fee of

€

Lodgement No

LDG—

Reason for Refund

Documents Returned to Observer

☐ Yes

☐ No

Request Emailed to Senior Executive Officer for Approval

☐ Yes

☐ No

Signed

EO

Date

Finance Section

Payment Reference

ch_3RGSYGB1CW0EN5FC02OB5zrJ

Checked Against Fee Income Online

EO/AA (Accounts Section)

Amount

€

Refund Date

Authorised By (1)

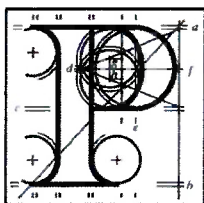
SEO (Finance)

Authorised By (2)

Chief Officer/Director of Corporate Affairs/SAO/Board Member

Date

Date



An
Bord
Pleanála

Observation on a Planning Appeal: Form.

Your details

1. Observer's details (person making the observation)

If you are making the observation, write your full name and address.

If you are an agent completing the observation for someone else, write the observer's details:

Your full details:

(a) Name

Kilkenny West Group Water Scheme Cooperative
society ltd.

(b) Address

33 Collaire court, Callan, Co. Kilkenny, R95P974

Agent's details

2. Agent's details

If you are an agent and are acting for someone else **on this observation**, please **also** write your details below.

If you are not using an agent, please write "Not applicable" below.

(a) Agent's name

Alexander Sheehan

(b) Agent's address

33 Collaire court, Callan, Co. Kilkenny R95P974

Postal address for letters

3. During the appeal process we will post information and items to you **or** to your agent. For this observation, who should we write to? (Please tick ✓ one box only.)

You (the observer) at the address in Part 1

☐

The agent at the address in Part 2

☒

Details about the proposed development

4. Please provide details about the appeal you wish to make an observation on. If you want, you can include a copy of the planning authority's decision as the observation details.

(a) Planning authority

(for example: Ballytown City Council)

Kilkenny County Council

(b) An Bord Pleanála appeal case number (if available)

(for example: ABP-300000-19)

PL10.322154

(c) Planning authority register reference number

(for example: 18/0123)

25/60003

(d) Location of proposed development

(for example: 1 Main Street, Baile Fearainn, Co Abhaile)

Townlands of Acragar, Ballyconra, Ballycuddihy, Ballyroe, Ballyroe (Grace), Ballyroe (Maher), Baunaniska, Boherkyle, Briskalagh, Brittas, Clone, Coolnapisha, Curraghduff,, Freshford, Freshford Lots, Graigueswood, Grange, Huntstown, Kilmanagh, Knockeenglass, Knockown, Moatpark, Monabrika, Monavadaroe, Moneenaun, Oldtown,, Oldtownhill, Parksgrove, Picketstown, Rathealy, Sart, Sweethill, Tobernapeastia, Tullaroan, Upperwood Demesne, Co. Kilkenny.

Observation details

5. Please describe the grounds of your observation (planning reasons and arguments). You can type or write them in the space below or you can attach them separately.

Grounds of Observation

Groundwater Vulnerability of the Zone of Contribution (ZOC):

The proposed wind turbine development is situated within zones of high to extreme groundwater vulnerability.

Turbines T01 and T02, as well as spoil management and borrow pits, are located in areas where pollutants could easily infiltrate groundwater.

Ballycallan GWS (part of the rationalised Kilkenny West Group Scheme) relies on a karstified limestone aquifer, which is particularly susceptible to contamination due to its rapid, unfiltered water flow.

Lack of Geotechnical Investigation at Turbine T07:

No test pit was dug at the Turbine T07 site, meaning there is no baseline information on soil permeability, stability, or contamination potential.

T07 is near important groundwater recharge areas, and the lack of data increases uncertainty about environmental and structural safety.

Aquifer Sensitivity:

The GWS aquifer is a karst limestone system overlain by highly permeable sand/gravel deposits, both of which lack filtration. Surface pollutants can rapidly reach the community's water supply, posing an immediate risk to public health.

Interaction with the Tullaroan Stream:

The Tullaroan Stream, 40 meters from the borehole, plays a direct role in local groundwater recharge.

Construction and watercourse crossings risk introducing pollutants into the interconnected surface and groundwater system.

5. Please describe the grounds of your observation (planning reasons and arguments). You can type or write them in the space below or you can attach them separately.

Borrow Pits and Spoil Areas:

Proposed excavation and spoil management in extremely vulnerable areas may expose bedrock and soils with minimal natural protection.

This raises the risk of pollutants rapidly reaching the aquifer and the GWS borehole.

Insufficiency of Mitigation Measures:

Standard mitigation such as silt fences and spill kits are inadequate for protecting such a sensitive hydrogeological environment.

The absence of baseline geotechnical data, particularly at T07, further limits the effectiveness of any proposed pollution control.

Conclusion:

The observation concludes that the proposed development poses substantial and immediate risks to the Ballycallan GWS water supply. The lack of proper investigation, especially for Turbine T07, and the vulnerability of the underlying aquifer system are key concerns. The development area's proximity to recharge zones and the Tullaroan Stream adds to the risk of contamination, prompting the recommendation for the planning appeal case reference number: PL10.322154 be refused.

Attached in support of this observation on the appeal of case number PL10.322154 is a copy of the submission made by Kilkenny West Group Water Scheme on Kilkenny County Council file number 2560003

Supporting materials

6. If you wish, you can include supporting materials with your observation.

Supporting materials include:

- photographs,
- plans,
- surveys,
- drawings,
- digital videos or DVDs,
- technical guidance, or
- other supporting materials.

Fee

7. You **must** make sure that the correct **fee** is included with your observation. You can find out the correct fee to include in our [Fees and Charges Guide](#) on our website.

This document has been awarded a Plain English mark by NALA.

Last updated: April 2019.



Kilkenny West Group Water Scheme Co-operative
Society Ltd.

**PLANNING OBSERVATION
ON PROPOSED WIND
TURBINE DEVELOPMENT:
CONCERNS FOR
BALLYCALLAN GROUP
WATER SCHEME (GWS)**

Submitted by: Kilkenny West GWS Cooperative
Society Ltd.

Planning Application: 2560003 (Kilkenny County Council)

Kilkenny West Group Water
Scheme Co-operative Society Ltd.
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Planning Observation on Proposed Wind Turbine Development: Concerns for Ballycallan Group Water Scheme (GWS)

Submitted by: Kilkenny West GWS Cooperative Society Ltd.

Introduction

Kilkenny West Group Water Scheme (GWS) Cooperative Society Ltd., the governing body for the Ballycallan Group Water Scheme, submits this observation to highlight significant concerns regarding the proposed wind turbine development near the Ballycallan GWS, which provides essential water to over 320 residents and community facilities in Kilmanagh. This observation addresses critical risks to groundwater quality and sustainability posed by the development's proximity to high-sensitivity groundwater zones and raises concerns about inadequate geotechnical investigation for certain turbine sites.

Key Concerns and Observations

1. Groundwater Vulnerability of Ballycallan GWS Zone of Contribution (ZOC)

The proposed development area lies within zones of high to extreme groundwater vulnerability, with particularly sensitive areas mapped for turbine installation, spoil management, and borrow pits. Geological Survey Ireland (GSI) vulnerability maps confirm that Turbines T01 and T02, as well as associated infrastructure, are positioned in zones where pollutants could readily reach the groundwater.

The reliance of Ballycallan GWS on a karstified limestone aquifer, with its rapid and unfiltered water flow through fractured rock, makes any contaminants introduced at the surface a serious risk to groundwater quality. Given the importance of this aquifer for the community's water supply, any disruption within this ZOC could have immediate impacts on water quality and safety for residents.

2. Inadequate Testing for Turbine T07 Site

We note with concern that no test pit was dug for the proposed site of Turbine T07, an omission that leaves a significant gap in the understanding of the soil and subsoil conditions at this location. Test pits provide essential data on the permeability, stability, and contamination potential of the subsoil, all of which are critical for assessing potential impacts on groundwater in sensitive zones.

Without a test pit, there is no baseline for soil composition, contamination risk, or depth to bedrock at the T07 location. This absence of data is particularly concerning given that Turbine T07 is situated near groundwater recharge areas that are crucial for maintaining the quality and flow of the Ballycallan GWS water supply. The lack of geotechnical investigation at this site

increases uncertainty about the structural and environmental suitability of the T07 location, as well as the efficacy of any proposed mitigation measures.

3. Sensitivity of Aquifer Characteristics

Ballycallan GWS relies on a karst limestone aquifer overlain by sand/gravel deposits, both of which are highly permeable and lack natural filtration layers. This aquifer type, characterized by rapid, unfiltered groundwater flow, is especially vulnerable to surface pollutants. Any contaminants introduced by construction, material leachate, or accidental spills could quickly reach the borehole, potentially compromising the water quality for the entire community.

The permeability of the karst landscape, combined with the uninvestigated soil conditions at Turbine T07, raises significant concerns about the uncontrolled movement of contaminants into groundwater recharge areas.

4. Surface Water and Groundwater Interaction with the Tullaroan Stream

The Tullaroan Stream is located approximately 40 meters from the Ballycallan GWS borehole, contributing directly to the local groundwater recharge system. Construction activities near this stream—including the proposed watercourse crossings—pose additional contamination risks. The planned activities risk introducing sediments and pollutants into this interconnected water system, affecting both surface water and the underlying aquifer.

Given the close relationship between surface and groundwater flows in this area, any disturbances or contaminants introduced near the stream could compromise the water quality within Ballycallan GWS's recharge zones.

5. Borrow Pits and Spoil Areas as Contamination Sources

The development proposes borrow pits and spoil areas in zones classified as extremely vulnerable to contamination, requiring excavation that exposes soils and bedrock with minimal natural barriers to contamination. If pollutants from these areas enter the groundwater, they could be transmitted rapidly through the karst aquifer, affecting the GWS borehole.

The potential for contamination is further compounded by the proximity of high-risk sites like T07, where untested soil and subsoil characteristics introduce additional uncertainties regarding the containment of pollutants.

6. Limitations of Proposed Mitigation Measures

While the development proposal includes standard mitigation methods, such as silt fences and spill kits, these may not sufficiently address the sensitivity of the groundwater system surrounding Ballycallan GWS. The lack of baseline geotechnical data, especially at T07, adds to the difficulty in predicting or controlling pollutant spread in this high-risk area.

Conclusion

The proposed wind turbine development near Ballycallan GWS poses substantial risks to the aquifer and, consequently, to the community's water supply. The omission of a test pit at Turbine T07 is a critical oversight, leaving the development's potential impacts on groundwater quality and the ZOC insufficiently assessed. The inherent vulnerability of the karst limestone

aquifer, combined with the lack of soil data at T07, presents an elevated risk that has not been adequately mitigated by the current proposal.

Kilkenny West GWS Cooperative Society Ltd. respectfully submits that further geotechnical investigations and more rigorous assessments are necessary to ensure that the proposed development does not compromise the water quality of the Ballycallan GWS.

Submitted by:

Chairman:

Kilkenny West GWS Cooperative Society Ltd.

Secretary:

Kilkenny West GWS Cooperative Society Ltd.



Roinn Cumarsáide, Gnómhaithe
ar son na hAeráide & Comhshaoli
Department of Communications,
Climate Action & Environment



Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

Geological Survey Ireland

**Establishment of Groundwater Zones of Contribution
Ballycallan Muintir Group Water Scheme, Co. Kilkeny
May 2018**

**Prepared by:
Aisling Whelan**

Geological Survey Ireland
(Monica Lee, Caoimhe Hickey, Taly Hunter Williams, Sophie O'Connor)

And with assistance from:

Ballycallan Muintir Group Water Scheme



Acknowledgements

Joe Delaney (Ballycallan Muintir GWS)

Roisín Dowd Smith

Franco Devitor (EPS)

Document Information

Project title: Establishment of Groundwater Zone of Contribution

Current Document version 2.0

Date

Prepared By	Date	Comment
A. Whelan	25/09/2017	

Reviewed By	Date	Comment
Monica Lee	09/10/2017	

Approved By	Date	Comment
Monica Lee	18/05/2018	

Version History

Ver. No.	Ver. Date	Comment	Revised By
1.0	25/09/2017		Aisling Whelan
2.0	03/05/2018		Aisling Whelan



Project description

Since the 1980s, the Geological Survey of Ireland (GSI) has undertaken a considerable amount of work developing Groundwater Protection Schemes throughout the country. Groundwater Source Protection Zones are the surface and subsurface areas surrounding a groundwater source, i.e. a well, wellfield or spring, in which water and contaminants may enter groundwater and move towards the source. Knowledge of where the water is coming from is critical when trying to interpret water quality data at the groundwater source. The 'Zone of Contribution' (ZOC) also provides an area in which to focus further investigation and is an area where protective measures can be introduced to maintain or improve the quality of groundwater.

This report has been prepared for the Ballycallan Muintir Group Water Scheme as part of the Rural Water Programme funding initiative of grants towards specific source protection works on Group Water Schemes (DECLG Circular L5/13 and Explanatory Memorandum).

The report has been prepared in the format developed during an earlier pilot project "Establishment of Zones of Contribution" which was undertaken by the Geological Survey of Ireland (GSI), in collaboration with the National Federation of Group Water Schemes (NFGWS), and with support from the National Rural Water Services Committee (NRWSC).

The methodology undertaken by the GSI included: liaising with the GWS and NFGWS to facilitate data collection, a desk study, a site visit to inspect the supply, the local area, and to record groundwater level(s). The data was then analysed and interpreted in order to delineate the ZOC.

The maps produced are based largely on the readily available information in the area, a field walkover survey, and on mapping techniques which use inferences and judgements based on experience at other sites. As such, the maps cannot claim to be definitively accurate across the whole area covered, and should not be used as the sole basis for site-specific decisions, which will usually require the collection of additional site-specific data.

The report and maps are hosted on the GSI website (www.gsi.ie). A glossary of acronyms and terms used in this report is included in the Appendices.



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1. Overview: Groundwater, groundwater protection and groundwater supplies

Groundwater is an important natural resource in Ireland. It originates from rainfall that soaks into the ground. If the ground is permeable, the rainfall will filter down until it reaches the main body of groundwater, which is usually within either the bedrock, or a sand/gravel deposit. If the bedrock or sand/gravel deposit can hold enough groundwater and allow enough flow to supply a useful abstraction, it is referred to as an aquifer.

In Irish bedrock aquifers, groundwater predominantly flows through interconnected fractures, fissures, joints and bedding planes, which can be envisaged as a 'pipe network', of various sizes, with varying degrees of interconnectivity. The speed of flow through this network is relatively fast, delivering groundwater, and a large proportion of the contaminants present in the groundwater, to its destination e.g. borehole, spring, river and sea.

In sand/gravel aquifers, the groundwater flows in the interconnected pore spaces between the sand/gravel grains. Generally, this is equivalent to a filter system that may physically filter out contaminants to varying degrees, depending on the nature of the spaces and grains. It also slows down the speed of flow giving more time for pathogens to die off before they reach their destination e.g. borehole, spring, river and sea.

Further filtration of contaminants may occur where the aquifers are protected by the overlying soil and subsoil; thick, impermeable clay soil and subsoil provide good protection while thin gravel will provide limited protection. Therefore variation in subsoil type and thickness is important when characterising the 'vulnerability' of groundwater to contamination.

The karst limestone aquifers provide significant and important groundwater supplies in Ireland. Karst landscapes develop in rocks that are readily dissolved by water e.g. limestone (composed of calcium carbonate). Consequently, conduit, fissure and cave systems develop underground. Groundwater typically travels very fast in karst aquifers,



which has a significant impact on the water quality; neither filtration nor pathogen die-off are associated with these aquifers.

The interaction between abstraction and geology is shown in Diagram 1. In this scenario, a borehole is pumping groundwater from the bedrock aquifer. As the water is abstracted through the well, the original water table (a) is drawn down to level (b), where it induces a drawdown curve of the natural water table (c). The shape of this curve depends on the properties of the aquifer, for example, if the borehole is intersecting an aquifer with few fractures that are poorly interconnected, the groundwater from that system will soon be exhausted, and therefore the pumping will have to pull from deeper depths to maintain supply, which results in the steep, deep drawdown curve. Alternatively, if the borehole is intersecting an aquifer with a large number of well-connected groundwater-filled fractures, the abstraction will be met by pulling water from farther away, at a shallower depth, resulting in a shallow, wide drawdown curve.

By knowing the rate of abstraction (output), how much rainfall there is (input), and by assessing the geological elements outlined above (nature of the bedrock fractures or sand/gravel deposit; how permeable the soil and subsoil are) to determine what happens in between input and output, the catchment area, or 'Zone of Contribution' (ZOC), to any groundwater water supply can be determined.

Ballycallan Muintir GWS (NFGWS ref. no. kk31) is supplied by a borehole abstracting groundwater that flows through fractures in a poorly productive bedrock aquifer, enlarged fractures (conduits) in a regionally important karstified bedrock aquifer and also possibly groundwater from a regionally important sand and gravel aquifer overlying the bedrock. The GWS abstracts an average of 165 m³/day.



¹ Geological Survey of Ireland, 2000.

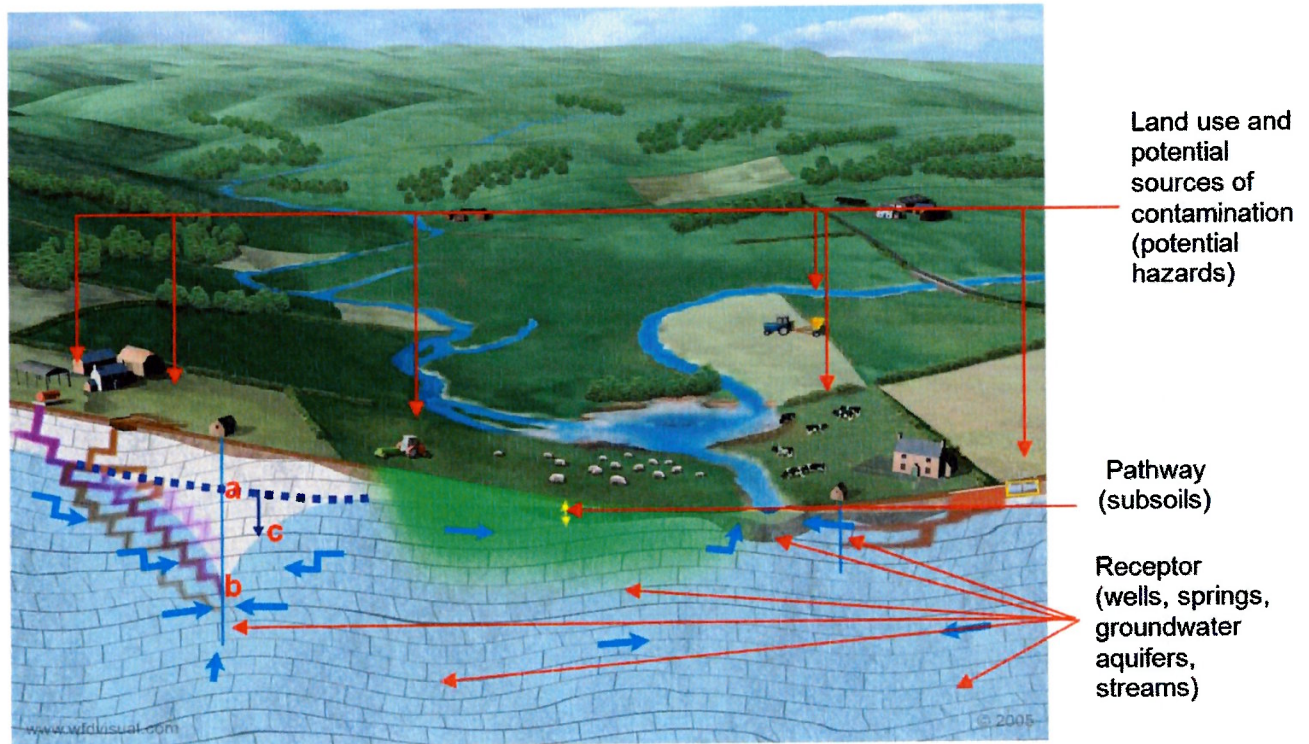


Diagram 1. Rural Landscape highlighting the Interaction between Surface Water, Groundwater and Potential Hazards

2. Location, Site Description, Supply Details and Wellhead Protection

The zone of contribution (ZOC) for the Ballycallan Muintir Group Water Scheme (GWS) has been delineated according to the principles and methodologies set out in 'Groundwater Protection Schemes'¹ and in the GSI/EPA/IGI Training course on Groundwater SPZ Delineation.

Ballycallan Muintir GWS is supplied from a borehole located at the eastern end of the village of Kilmanagh, Co. Kilkenny (**Figure 1**). The borehole is located in a small fenced off grassed area in the corner of the village GAA grounds and beside the road. The site is just 40 m west of a bridge which crosses the Tullaroan Stream (**Diagram 2**).

¹ DELG/EPA/GSI, 1999



The scheme serves a population of 320, mostly for domestic and agricultural use but also for use by the village school, graveyard and parish hall/curates house. Average usage is approximately 165 m³/d². Individual metering was installed on all connections c. 10 years ago to assist in leak detection.

The scheme pumps to a 455 m³ (100,000 gallon) capacity reservoir in Knockeenglass (to the east of Kilmanagh) from where it feeds into the distribution network. The pumping regime is in response to the water levels in the reservoir tank. The pump is set to operate at c. 15.5 m³/hr³, and pumps for an average of c.10.5 hours per day⁴. The reservoir holds up to c. 2.5 days supply.

Treatment comprises chlorination followed by filtration. The raw water is pumped to the reservoir site at Knockeenglass where it is treated prior to be stored in the reservoir for onward distribution to the network.

The borehole is located in an above ground, concrete block built chamber fitted with a metal lid (**Photo 1**). The outer steel casing extends c. 25 mm above the concrete base of the chamber. The chamber was observed to be dry during the site visit on 10/7/17 suggesting potentially contaminated surface water cannot enter the chamber. The top of the well casing is fitted with a sheet of plastic (**Photo 2**) which is secured in place and prevents dust, insects or vermin entering the borehole. Overall well head protection for this borehole is very good. The location of the original trial well on the site is not known but it is understood it was decommissioned by Fogarty Well Drilling Ltd. under the direction of GES Ltd.

² Based on daily flow rates during 2016 (taken from EPS monthly Operational Reports)

³ Pers. comm. Franco Devitor, EPS 10/7/17

⁴ Based on the average abstraction of 165 m³/day reported by EPS during 2016



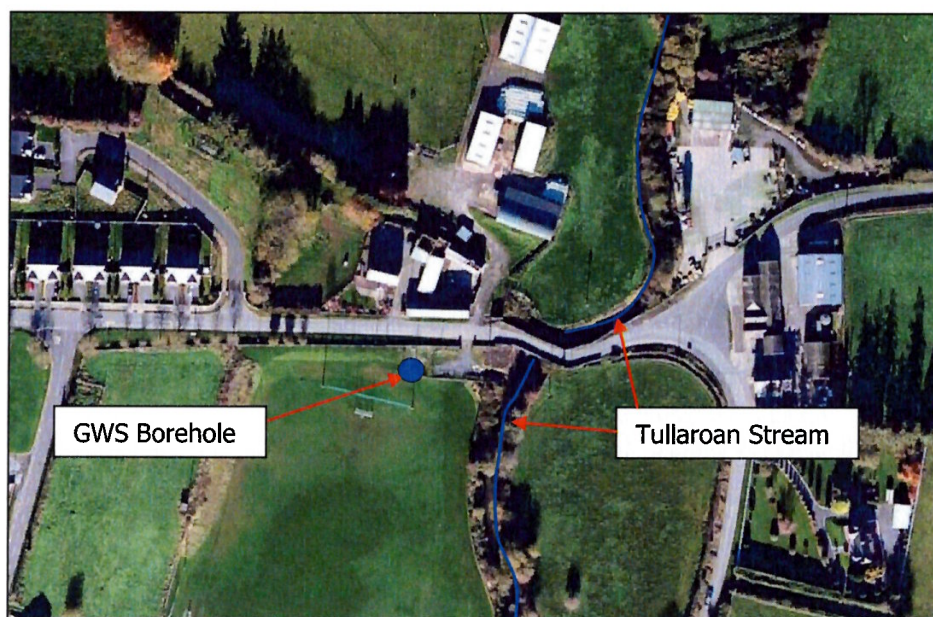


Diagram 2 Aerial photo showing location of GWS abstraction point



Photo 1 Ballycallan Muintir GWS borehole chamber



Photo 2 Ballycallan Muintir GWS borehole wellhead within chamber

Summary details are presented in **Table 1**.

Table 1. Water Supply Details

NFGWS No. kk31	Ballycallan Muintir GWS Borehole
Grid reference	ITM: E639288 N652320
Townland	Kilmanagh
Source type	Borehole
Drilled	August /September 2007
Drilling Contractor	Padraig Briody & Sons
Owner	Ballycallan Muintir GWS
Elevation in metres above Ordnance Datum	c. 105 m aOD (Estimated from OSI 1:30,000 Scale Map)
Total depth (m)	108 m (350 ft)
Construction details (Appendix 4)	300 mm dia. outer steel casing from 0 - 15 m; 200 mm dia. pvc well string installed full length of borehole (assumed that screened section extends from c. 21 - 108 m); Cement grout installed in annulus from 20 m to ground level. (Note: 250 mm dia. black 'Wavin' pipe is also visible at surface between the 300 mm steel and 200 mm pvc casing but no record of this on log)
Depth to rock in metres below ground level	15
Inflow zones (water strikes) mbgl (Appendix 4)	6-12 ('water' - but this zone is sealed off) 12 - 15 (22.7 m ³ /hr in cobbles - but this zone is sealed off) 24 - 25 ('small' water strike) 36 - 42 (4.5 m ³ /hr) 100 - 108 ('big water' strike from clay & sand filled cavity)
Static water level (SWL) (m bgl)	22.68 (during site visit on 10/7/2017, the pump was not running but uncertainty as to whether this is a static level) (Static water level recorded as 15.57 at start 7 day pumping test on nearby trial well, TW1, on 17/1/2005)
Pumping water level (PWL) (m bgl)	Not available for abstraction well but water level at end 7 day test on trial well, TW1, was 20.85 on 24/1/05 (18.7 m ³ /hr)
Pump intake depth (m bgl)	Unconfirmed
Current abstraction rate (GWS)	117– 255 m ³ /day (average 165 m ³ /day) ⁵
Number of Connections	120
Reported yield (m ³ /d)	Not available (limited data from short 5hr pumping test undertaken in 2004 suggests abstraction well was pumped at 21 m ³ /hr with stable drawdown of 3 m; yield of trial well, TW1, was reported as 20 m ³ /hr ⁶)
Specific Capacity (m ³ /d/m)	168 (estimated from limited data from 2008 5-hr pumping test) ⁷ 65 (approximate estimate only from 2016 monitoring data ⁸)
Transmissivity (m ² /d)	Insufficient pumping test data to calculate for abstraction well. (value of 59 m ² /day was obtained from analysis (Cooper Jacob method) of 7 day pumping test on nearby trial well TW1) ⁹

⁵ (based on daily outflows from reservoir recorded in EPS monthly operational reports for 2016

⁶ GES, 2005.

⁷ 5-hr pumping test in 2008 was undertaken at max. pumping rate of c. 21 m³/hr (Appendix 5)

⁸ Based on average minimum and average maximum water levels above probe recorded in EPS monthly operational reports from 2016 (see Appendix 6) and using a pumping rate of 15.5 m³/hr.



3. Physical Characteristics and Hydrogeological Considerations

3.1. Physical characteristics of the area

An overview of the relevant information on rainfall, land use, topography, hydrology and geology for the area around the GWS is provided in Table 2.

Table 2. Physical Characteristics of the Area of Interest

	GWS Well	Description/Comments
Topography		The borehole is located in the south-eastern foothills of the Slieve Donagh Plateau close to the valley floor of the Tullaroan Stream. The stream lies just 40 m to the east. The borehole is situated at an elevation of c. 105 m OD. Upland areas rise to 293 mOD and 228 mOD northwest and northeast of the borehole respectively.
Land use		The borehole is situated in Kilmannagh village. Outside of the village the land is predominantly used as pasture with one off housing and occasional farm yards.
Surface Hydrology (Figure 1 & Figure 2)		The Tullaroan Stream is located c. 40 m to the east where it flows in a southerly direction. Regionally, smaller streams drain the high ground to the west and east and flow towards the Tullaroan Stream. A manmade mill race which discharges to the Tullaroan Stream is located c. 40 m north of the borehole.
Topsoil http://gis.epa.ie/envision		The soils at the borehole are mapped as shallow and well-drained. To the west they are mapped mainly as deep and poorly drained. To the east of the stream soils are deep and well drained and deep and poorly drained, transitioning to shallow well and drained towards the hilltop at Ballykeefe.
Subsoil (Figure 3) www.gsi.ie/mapping		The borehole is located within a strip of high permeability sand and gravels that extend north along the valley floor. Low permeability alluvium deposits overlie the sands and gravel along the Tullaroan Stream. Low permeability sandstone and shale till overlie the lateral extents of the sands and gravels and are also mapped on the hill slopes to the east and west of the borehole with subsoils absent on the hilltops.
Groundwater Vulnerability (Figure 4) www.gsi.ie/mapping		The area around the borehole is mapped as High vulnerability and this is associated with the sand/gravel deposits. Further east and west the vulnerability is Low where low permeability till overlies the sand/gravels. Areas of Moderate vulnerability are mapped further west and east again. Vulnerability increases to Extreme on the hilltops to the east and west (See Appendix 1).
Geology (Figure 5) www.gsi.ie/mapping		The borehole is drilled into shale bedrock. The bottom of the borehole seems to have intercepted limestone bedrock which underlies the shale.
Aquifer Classification (Figure 6) www.gsi.ie/mapping		The shale is classified as a Poor aquifer (PI) – bedrock which is generally unproductive except for local zones. The deeper limestone is classified as a Regionally Important Karstified aquifer (Rkd). The sands and gravels overlying the bedrock are classified as a regionally important gravel aquifer (Rg)
Groundwater Body (GWB) www.wfdireland.ie		Ballingarry and Kilkenny GWB's - both categorised as having "good" status. (www.gsi.ie/Programmes/Groundwater/Projects/Groundwater+Body+Descriptions)
Recharge Coefficient (Appendix 2)	7.5 - 85% (range)	In general there will be low recharge rates (7.5-15%) to the underlying sand/gravel and bedrock due to mainly low to moderate vulnerability setting with low permeability subsoils.
Recharge (mm/yr) www.gsi.ie/mapping	100 (cap)	Recharge rates will increase to 85% in the uphill areas where subsoils are absent and vulnerability extreme. However, the PI aquifer cannot accept all of the available recharge and there is a maximum recharge capacity of 100 mm/yr.

⁹ All available pumping test data for the abstraction well and nearby trial well (since decommissioned) is included in Appendix 5



3.2. Hydrochemistry and water quality

12 monthly treated sample results for 2016 and one untreated raw sample result were used to assess the hydrochemistry and water quality for Ballycallan Muintir GWS. All available water quality data are presented in **Appendix 3**.

The data are summarised in **Table 3**, where they have been compared to the drinking water limits (DWL) from the Drinking Water Regulations (S.I. No. 122 of 2014) and/or threshold values (TV) from the European Communities Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010).

Table 3. Key Hydrochemistry and Water Quality values in untreated water sample

Parameter	No. of samples	Result	Drinking Water Limit (DWL) or Threshold Value (TV)
Total Hardness (mg/l as CaCO ₃)	1	255.1	[-]
Electrical Conductivity (µS/cm)	1	502	800 (TV), 2,500 (DWL)
Total Coliforms (MPN ¹⁰ /100 ml)	1	0	0 (DWL)
Faecal Coliforms (<i>E. Coli</i>) (MPN/100 ml)	1	0	0 (DWL)
Nitrate (mg/l NO ₃)	1	<2.2	50 (DWL) 37.5 (TV)
Chloride (mg/l)	1	12.33	250 (DWL), 24 (TV)
Ammonium (mg/l NH ₄)	1	0.14	0.3 (DWL), 0.225 [0.175 as N] (TV)
Iron (µg/l)	1	39	200 (DWL)
Manganese (µg/l)	1	398	50 (DWL)
Zinc	1	299	75 (TV)
Potassium:sodium ratio	1	0.11	0.4 (indicator)

¹⁰ MPN is most probable number



Table 4. Key Hydrochemistry and Water Quality values in treated water samples

Parameter	No. of samples	Min	Max	Average	Drinking Water Limit (DWL) or Threshold Value (TV)
Electrical Conductivity ($\mu\text{S/cm}$)	5	529	573	553	800 (TV), 2,500 (DWL)
Total Coliforms (MPN ¹¹ /100 ml)	12	<1	<1	<1	0 (DWL)
Faecal Coliforms (<i>E. Coli</i>) (MPN/100 ml)	12	<1	<1	<1	0 (DWL)
Nitrate (mg/l NO_3)	12	<0.890	<0.890	<0.890	50 (DWL) 37.5 (TV)
Chloride (mg/l)	1	17.074 (one sample result only)			250 (DWL), 24 (TV)
Ammonium (mg/l NH_4)	5	0.065	0.037	0.024	0.3 (DWL), 0.225 [0.175 as N] (TV)
Iron ($\mu\text{g/l}$)	12	<7.2	<7.2	<7.2	200 (DWL)
Manganese ($\mu\text{g/l}$)	12	<0.7	22.3	9.50	50 (DWL)

Available data indicate the water is 'hard' which is typical of most groundwater in Ireland, particularly in limestone regions. The pH of the raw sample is approximately neutral. The range of conductivity values for the treated samples and raw sample is relatively small, suggesting a relatively stable groundwater system where rainfall percolates relatively slowly down through to groundwater in the bedrock.

Nitrate concentrations were very low and below the detection limit for all samples. Ammonium concentrations, while above the detection limit, were below the TVs and DWLs in all samples. Ammonia can be found in higher concentrations in groundwater from shale rock than from other types of rock. The nitrate and ammonium concentrations indicate reducing conditions, that is, groundwater with low oxygen levels.

Iron concentrations were below the DWL in the raw and treated water samples. The manganese concentration in the raw water sample was eight times the DWL, although the concentrations in all the treated water samples were below the DWL. While the treatment plant is not specifically designed to remove manganese, the chlorination and filtration processes appear to be reducing manganese concentrations in the treated water. A GWS customer reported dark brown slime in a filter on their supply in recent times. Elevated manganese deposits can result in the coating of pipework with a black slime so this

¹¹ MPN is most probable number



customer report may be related to elevated manganese. In response to the black slime observed by a customer, it is understood the GWS propose to clean the distribution pipework using the ice-pigging method in the near future. It is understood that the pump in the borehole was last replaced c. 5 years ago but it appears there was no issue with clogging or slime build-up on the pump. Elevated manganese can sometimes cause clogging of a borehole which can lead to reduced well yield over time. Manganese can be naturally elevated in groundwater from some types of rocks in Ireland. Elevated concentrations can also be an indicator of contamination or due to corrosion of galvanised steel pipework. The concentration of zinc exceeded the GTV and this, together with the elevated manganese, could indicate corrosion of steel pipework. However, iron would also be expected to be high if corrosion was occurring but this is not the case. Additionally elevated zinc in groundwater can also be naturally occurring due to minerals in the rock.

Faecal coliforms and *Clostridium perfringens* were not present in the raw water sample or any of the treated water samples. This indicates the water treatment system was performing well although with only one raw sample result available, no further conclusions can be made. Therefore, while the bacteriological quality was good in that sample it would be useful to obtain further raw water samples to get a better overall picture of the bacteriological quality of the raw water.

The full chemical analysis undertaken as part of this study did not show any other naturally-occurring elements dissolved into the groundwater at concentrations that would cause concern for human health.

In summary the water quality at the Ballycallan Muintir GWS borehole is impacted by elevated manganese and zinc concentrations (which may or may not be naturally occurring). The treatment process appears to be effectively reducing manganese concentrations to below the drinking water standard. (There is no drinking water limit for zinc but high concentrations (>3 mg/l) can cause an unpleasant appearance and taste). The relatively low nitrate, ammonium and iron concentrations and absence of bacterial contamination probably reflects the good well head protection and how the borehole was constructed to seal off shallow groundwater and abstract only deeper groundwater. In general shallow groundwater tends to be of poorer quality than deeper groundwater.



4 Zone of Contribution

4.1 Conceptual Model

The current understanding of the geological and hydrogeological setting is given as follows and as shown schematically in **Diagram 3**.

The Ballycallan GWS is supplied by one borehole that abstracts groundwater from the underlying shale and limestone bedrock and possibly from the overlying sand and gravel deposits as well.

Rainfall falling in the area will replenish the groundwater in the sands/gravels and the shale and limestone bedrock. The rainfall will percolate through the soils/subsoils and down into the spaces between the sand and gravel grains and into the fissures and fractures in the bedrock. The subsoils overlying the sand/gravel and bedrock are classified as having a low permeability, thus allowing a low proportion of rainfall to percolate downwards. Where subsoils are absent in the upland area over the bedrock a greater proportion of rainfall will percolate downwards. Unlike the limestone bedrock the shale bedrock is poorly fractured and has a limited ability to accept all of the potential recharge.

The large body of sands and gravels overlying the bedrock in this area is extensive and is classified as an aquifer itself. The groundwater in the sands/gravels will flow in the spaces between the grains until it reaches a point of discharge such as the Tullaroan Stream. Some groundwater will percolate deeper into the underlying shale or limestone bedrock. The GWS borehole was constructed to seal off any water from the sands and gravels but some groundwater in the sand and gravel may seep downwards into the shale rock and make its way into the GWS borehole.

Once the downward percolating rainfall reaches the top of the shale bedrock, the majority of it will move along the top of the bedrock, which is likely to be more weathered and therefore have interconnected fractures and fissures (i.e. more flow paths), until it reaches the Tullaroan Stream. In the underlying limestone bedrock, groundwater is more likely to



flow through enlarged fractures (caused by dissolution of the limestone rock). This enlarging of fractures makes the limestone more permeable (and thus a more productive aquifer) than the overlying shale and thus it can accept of all the downward percolating rainfall.

The first type of bedrock beneath ground at the borehole is shale and this is classified as a Poor Aquifer (PI) which is generally unproductive except for local zones. The productive groundwater zones within this rock are likely to be related to zones of fissuring and fracturing within the rock. The drilling log for the GWS borehole recorded water inflows at depths of 24-25 m and 36-42 m which is where the rock is fractured.

Underlying the poor aquifer is limestone bedrock which is classified as a Regionally Important Karstified aquifer. The drilling log indicates most of the water coming into the GWS borehole is from a sand filled cavity at 100-108 m. Cavities like this are usually found in karst limestone aquifers which suggests that the bottom of the borehole intercepted the top of the underlying karst limestone aquifer. The limestone outcrops to the southeast of the borehole on the other side of the Tullaroan Stream and this is the area where the limestone aquifer will be replenished by rainfall.

The groundwater hydraulic gradient in the sand/gravel and bedrock will reflect the moderately steeply sloping land around the borehole and is likely to be around 0.05.

The lower lying area around the borehole is classified as having a Low (L) and Moderate (M) vulnerability to contamination. The sand and gravel aquifer in the vicinity of the borehole is classified as High vulnerability. Vulnerability increases to High and Extreme (E/X) in the upland areas to the northwest and east. The borehole is located within the village of Kilmanagh which has a number of properties which are not on mains sewerage and have their own septic tanks. The percolation area for a small housing development is located c. 80 m northwest of the borehole. There are also a small number of farmyards within the village and a creamery is located across the river to the east of the borehole. Outside of the village the land is predominantly used for cattle grazing (dairy) with some tillage and once-off housing and occasional farms.



The delineation of the boundaries for the zones of contribution includes a safety margin for some variability in groundwater flow direction and for seasonal variability in abstraction rates and water level.



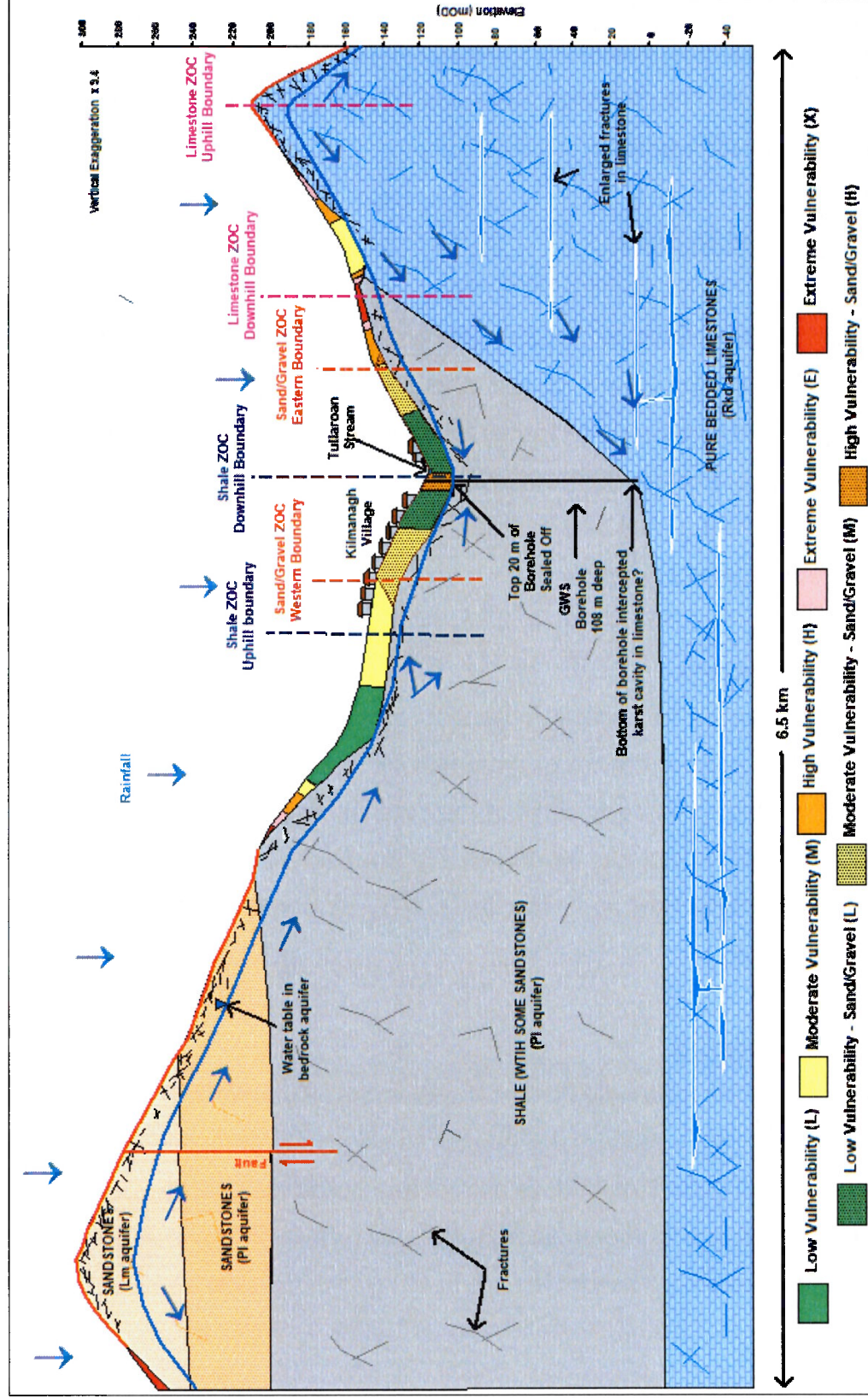


Diagram 3 Conceptual model of groundwater flow

4.2. Boundaries

The Zone of Contributions (ZOC) delineated for Ballycallan Muintir GWS is based mainly on a combination of hydrogeological mapping and inferences, and geological boundaries. The borehole abstracts from the underlying shale and limestone bedrock and it is thought that it might also abstract from the overlying sands and gravel aquifer. Therefore three ZOCs have been delineated for each aquifer as follows:

ZOC over Limestone Bedrock

The ZOC is based on the area where the limestone outcrops to the southeast of the borehole. The **Southeastern boundary** is based on topography and extends to the top of Ballykeefe Hill. It is assumed that groundwater on the other side of the hill will flow to the south. The **Eastern boundary** is also based on topography and assumes that groundwater to the east of this boundary will flow eastwards. The **Northern boundary** is based on the mapped boundary between the shale and the limestone bedrock. A buffer of 100 m was included to account for uncertainty in the mapped boundary.

ZOC over Shale Bedrock

The **Western (or uphill) boundary** is based on topography and extends uphill to a small, flat area c. 810 m to the west-northwest of the borehole. The **Eastern (or downhill) boundary** was extended an arbitrary 30 m downhill of the borehole to capture any groundwater being pumped back to the borehole. The **Northern** and **Southern boundaries** were based on inferred groundwater flow lines and water balance calculations to capture enough rainfall to support the abstraction.

ZOC over Sands/Gravels

The ZOC is based on the mapped extent of the sand/gravel aquifer in the vicinity of the borehole. Sometimes rivers and streams can act as barriers to groundwater flow but in this case it is assumed that Tullaroan Stream does not act as a barrier to groundwater flow and that groundwater is drawn into the borehole from the sand/gravel on the other side of the stream. The **Eastern** and **Western boundaries** are based on the mapped lateral extent of the



sand/gravel and include a 100 m buffer to account for uncertainty in the mapping. The **Northern** and **Southern boundaries** are based on topography and inferred groundwater flow lines.

4.3. Recharge & Water Balance

The recharge and water balance calculations are used to support the hydrogeological mapping and to confirm that the ZOCs delineated are big enough to supply the quantity of water at the source.

Based on bulk flow readings for 2016, the GWS well abstracts between 117 m³/day and 255 m³/day. A rate of 383 m³/day was used for water balance calculations, which is based on the maximum daily rate during 2016 plus a factor of safety of 50% to allow for the expansion of the ZOC area during dry periods as well as to accommodate uncertainty in groundwater flow direction.

Shale ZOC

Assuming a recharge of c. 100 mm/yr over the shale bedrock, then the delineated area of this ZOC of 0.4 km² can support an estimated abstraction rate of approximately 110 m³/day.

Limestone ZOC

The recharge rate over the limestone ZOC ranges from 93 mm/yr to 527 mm/yr. Assuming a bulk recharge rate of c. 310 mm/yr, then the delineated area of this ZOC of 0.9 km² can support an estimated abstraction rate of approximately 764 m³/day.

Sand/Gravel ZOC

Assuming a recharge of c. 50 mm/yr over the sand/gravel aquifer, then the delineated area of the ZOC of 0.4 km² can support an estimated abstraction rate of approximately 55 m³/day.

The calculations above show the ZOCs delineated using hydrogeological mapping and topography are together somewhat larger than required to capture enough rainfall to support a



total conservative abstraction of 383 m³/day. However a conservative approach has been taken to account for uncertainty with ZOC boundaries and as to whether the borehole abstracts from the sand/gravel aquifer or not.

5. Conclusions

The Ballycallan Muintir GWS is supplied by a borehole from which an average of 165 m³/d is pumped over c. 10 hours per day from a poorly productive shale aquifer and the top of a regionally important karstified limestone aquifer beneath. It is also thought that the borehole may abstract some groundwater from the overlying sand/gravel deposits but there is some uncertainty as to whether this occurs.

Rainfall infiltrates to the groundwater by percolating through the till subsoils into the sand/gravel aquifer and into the shale and limestone bedrock beneath. However, unlike the sand/gravel and limestone aquifers, not all of this rainfall can percolate downwards into the shale bedrock as it is a poor aquifer and not very permeable.

Because the borehole abstracts from three different aquifers and they are located in different areas in the vicinity of the borehole three different ZOCs have been delineated - the first for the limestone aquifer where it outcrops to the southeast of the borehole; the second for the shale bedrock in the vicinity of the borehole and the third for the sand/gravel aquifer in the vicinity of the borehole. The ZOCs encompass areas of 0.9 km², 0.4 km² and 0.4 km² respectively. Groundwater flows through fissures and fractures in the shale, through enlarged fractures (conduits) in the karstified limestone and in the spaces between the grains in the sand/gravel aquifer.

The available water quality data (bacteriological and chemical), while limited, suggests water quality from the borehole is good with the exception of elevated manganese and zinc concentrations which are most likely to be naturally occurring. The groundwater vulnerability within the ZOCs is Low (26%) and Moderate (29%) in the vicinity of the borehole but increases to High (13%) and Extreme (32%) further uphill to the northwest and northeast.



The maps produced are based largely on the readily available information in the area, a field walkover survey, and on mapping techniques which use inferences and judgements based on experience at other sites. As such, the maps cannot claim to be definitively accurate across the whole area covered, and should not be used as the sole basis for site-specific decisions, which will usually require the collection of additional site-specific data.



6. Recommendations

Essential:

- A regular survey of water quality parameters of untreated water that would include coliforms (total and faecal), pH, alkalinity, hardness, electrical conductivity, nitrate, ammonia, chloride, iron, manganese, potassium and sodium. As zinc concentrations were elevated in the raw water sample it may also be useful to include metals such as aluminium, antimony, arsenic, barium, cadmium, copper, lead, nickel and zinc. This survey should be taken on a monthly basis for the first year and should incorporate samples following a variety of wet and dry rainfall conditions in the preceding week. The results should be shared with the GSI. The need for future monitoring can be determined on the basis of these results, and in discussion with a hydrogeologist.
- Continue monitoring monthly minimum and maximum water levels above the pressure transducer probe (as reported by EPS on a monthly basis). However, the depth of the pressure transducer probe in the borehole should be measured accurately (in meters below top of the 200 mm diameter pvc casing at the well head) so that the accurate depth to the water level within the borehole can be known. The monthly minimum and maximum water levels should then also be reported as meters below top of casing (in addition to meters above the probe).

Desirable:

- Identify and map all potential contaminant hazards and activities within the ZOC. Any risks of contamination to the supply can be assessed by comparing these to the delineated ZOCs and groundwater vulnerability map (Figure 4). This, in conjunction with regular raw water quality monitoring, will assist in identifying and possibly solving any water quality issues with the supply. This is of particular interest given the close proximity of Kilmanagh Village.



- Undertake a survey of other wells in the area to obtain water level measurements. The water levels in the sand/gravel, shale and limestone aquifers would be expected to be different so this could assist in establishing if the borehole abstracts from the sand/gravel, shale and/or limestone aquifers and in refining the boundaries.
- Prepare a monthly graph of recorded water levels from the SCADA system (with corresponding pumping rate if possible) so that any changes or trends in water levels can be easily viewed. The water levels should be presented as meters below top of casing (in addition to meters above the probe).
- Consider undertaking a pumping test in the form of a step and a longer term constant rate test. A step test is a type of pumping test which measures the performance/efficiency of a well. Repeating this test (for example every 3-5 years) is a useful way of assessing changes in well performance (and yield) over time. There is some suggestion from the limited pumping test data from 2008 and SCADA water level data for 2016 that there has been a reduction in well performance over this period. During the longer term test water levels in nearby wells could be monitored at the same time and this could assist in establishing if the borehole abstracts from the limestone, shale and /or sand and gravels and in refining the boundaries. A pumping test should be undertaken based on the advice and under the supervision of a hydrogeologist.
- If the untreated water quality results indicate that there is a risk of microbial contamination, a Cryptosporidium risk assessment for the source should be considered. This should be considered in consultation with a hydrogeologist.

Other:

- The following EPA guidelines may serve as future useful reference documents for the GWS:
 - EPA Guidance on Landspreading of Organic Waste¹²

¹² http://www.epa.ie/pubs/advice/waste/waste/EPA_landspread_organic_waste_guide.pdf



- EPA Drinking Water Advice Note No. 7: Source Protection and Catchment Management to Protect Groundwater Sources. Of particular interest would be Section 4.1 – Step 2 – Hazard Mapping¹³.
- EPA Drinking Water Advice Note No. 8: Developing Drinking Water Safety Plans. This document contains checklists for hazards which would assist in hazard mapping within the ZOC¹⁴.
- EPA Drinking Water Advice Note No. 14. Borehole Construction and Wellhead Protection¹⁵

7. References

DELG/EPA/GSI, 1999. Groundwater Protection Schemes. Dept. of the Environment & Local Government; Environmental Protection Agency; Geological Survey of Ireland.

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EPA (2004) Guidance on Landspreading of Organic Waste.

EPA (2011) Drinking Water Advice Note No. 7: Source Protection and Catchment Management to Protect Groundwater Sources.

EPA (2011) Drinking Water Advice Note No. 8: Developing Drinking Water Safety Plans.

EPA (2013) Drinking Water Advice Note No. 14. Borehole Construction and Wellhead Protection

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Hunter Williams, N.H., Misstear, B.D., Daly, D. and Lee, M. (2013) Development of a national groundwater recharge map for the Republic of Ireland. Quarterly Journal of Engineering Geology and Hydrogeology. Vol. 46, No. 4, pp. 493-506.

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<http://www.igi.ie/publications/codes-guidelines.htm>

¹³ http://www.epa.ie/pubs/advice/drinkingwater/epadrinkingwateradvisenote-advisenoteno7.html#UpNP_eJ9KEp

¹⁴ <http://www.epa.ie/pubs/advice/drinkingwater/epadrinkingwateradvisenote-advisenoteno8.html#UpNQf-J9KEo>

¹⁵ <http://www.epa.ie/pubs/advice/drinkingwater/advisenote14.html#UpNR8eJ9KEo>



Figures



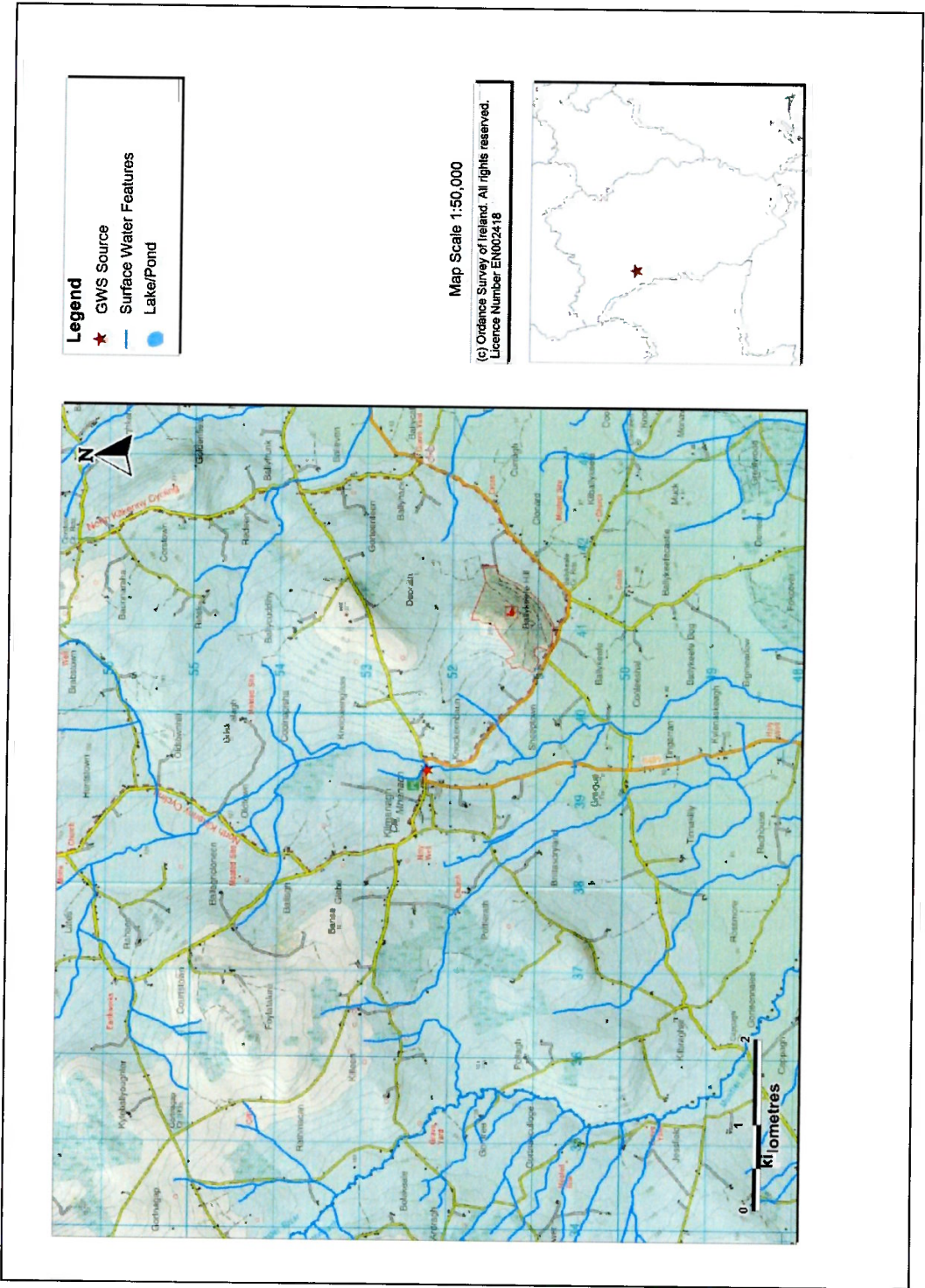


Figure 1 Location Map (OSI 1:50,000 scale for main map)

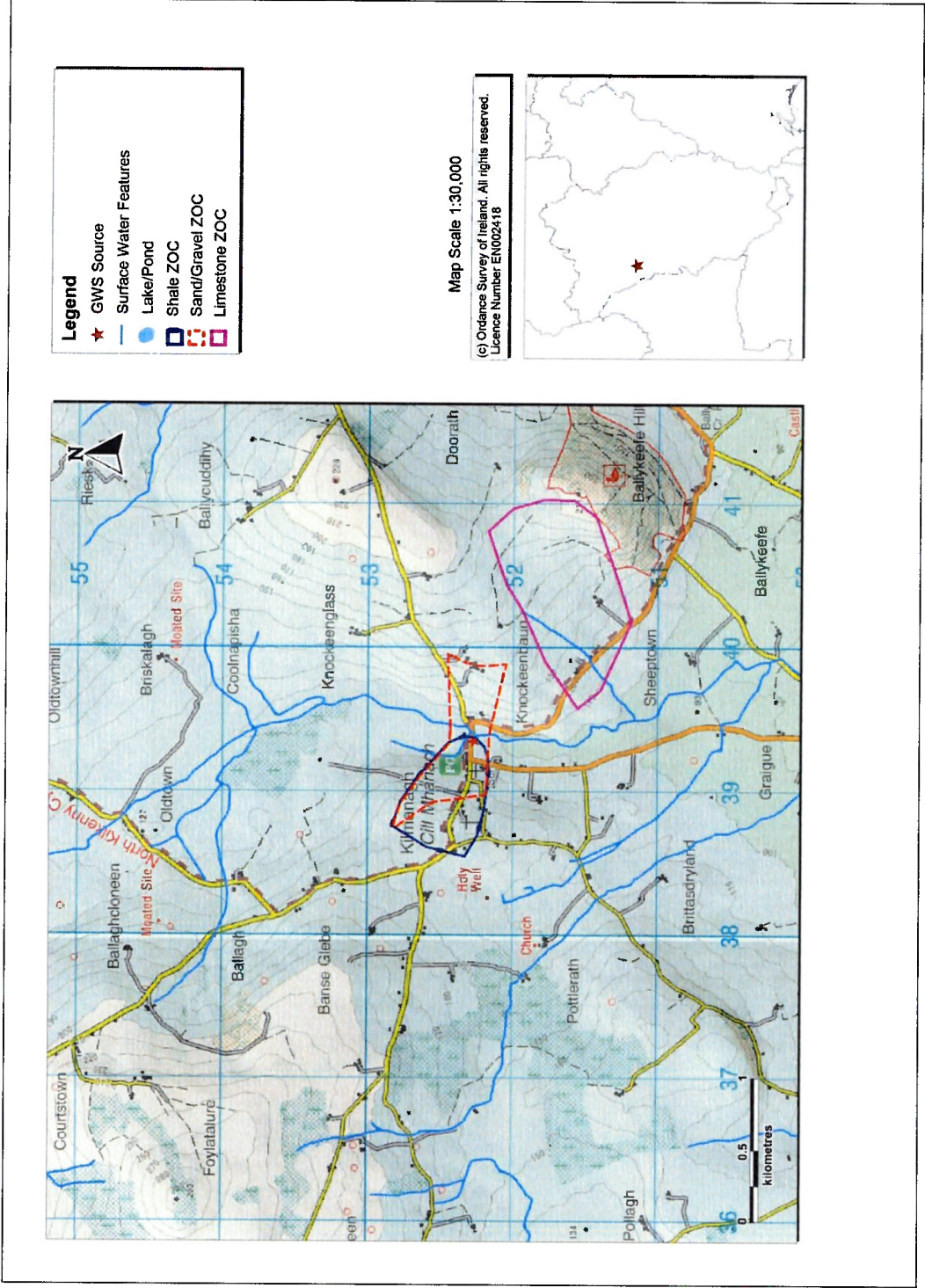


Figure 2 Topography and hydrology

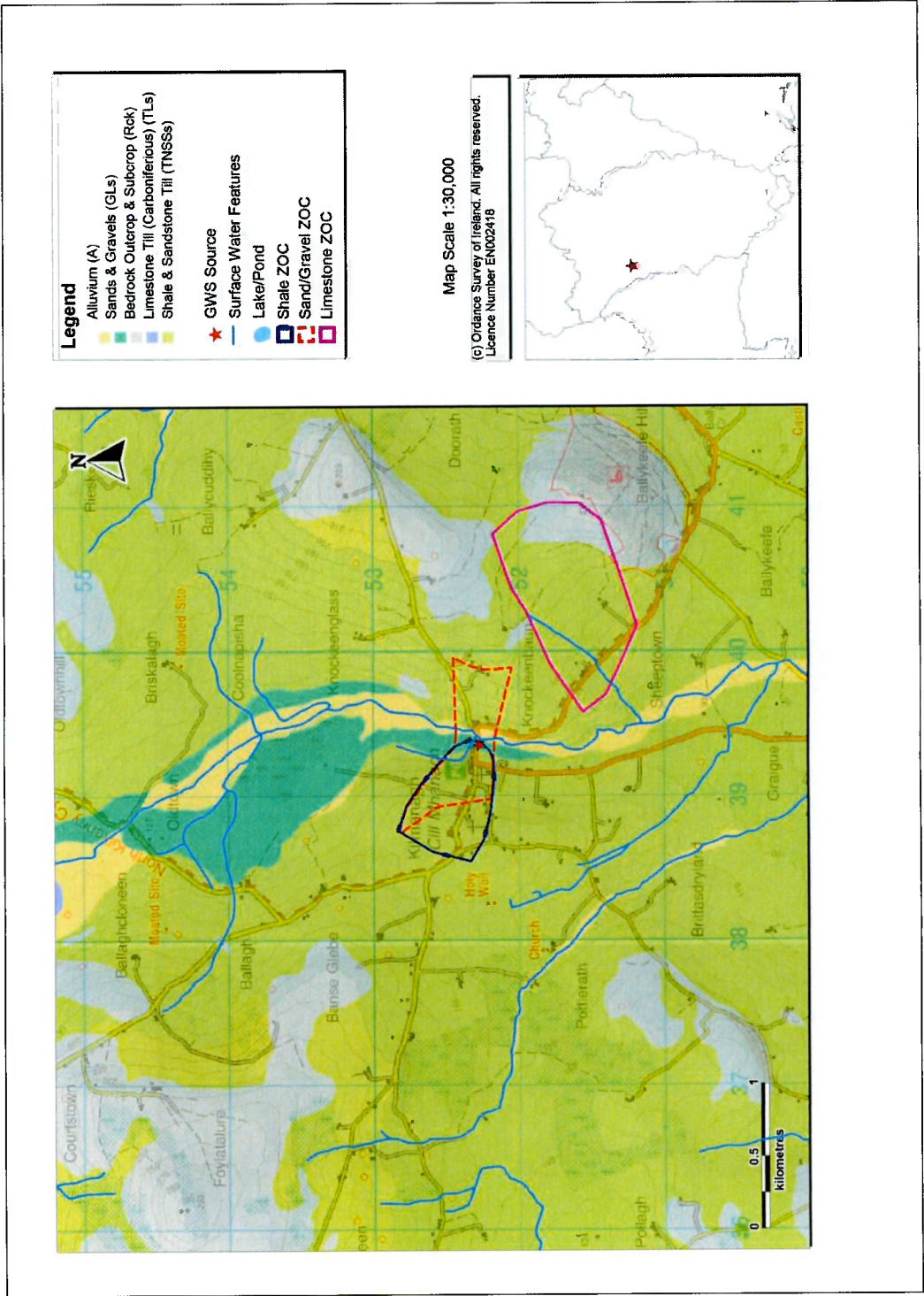


Figure 3 Subsoils

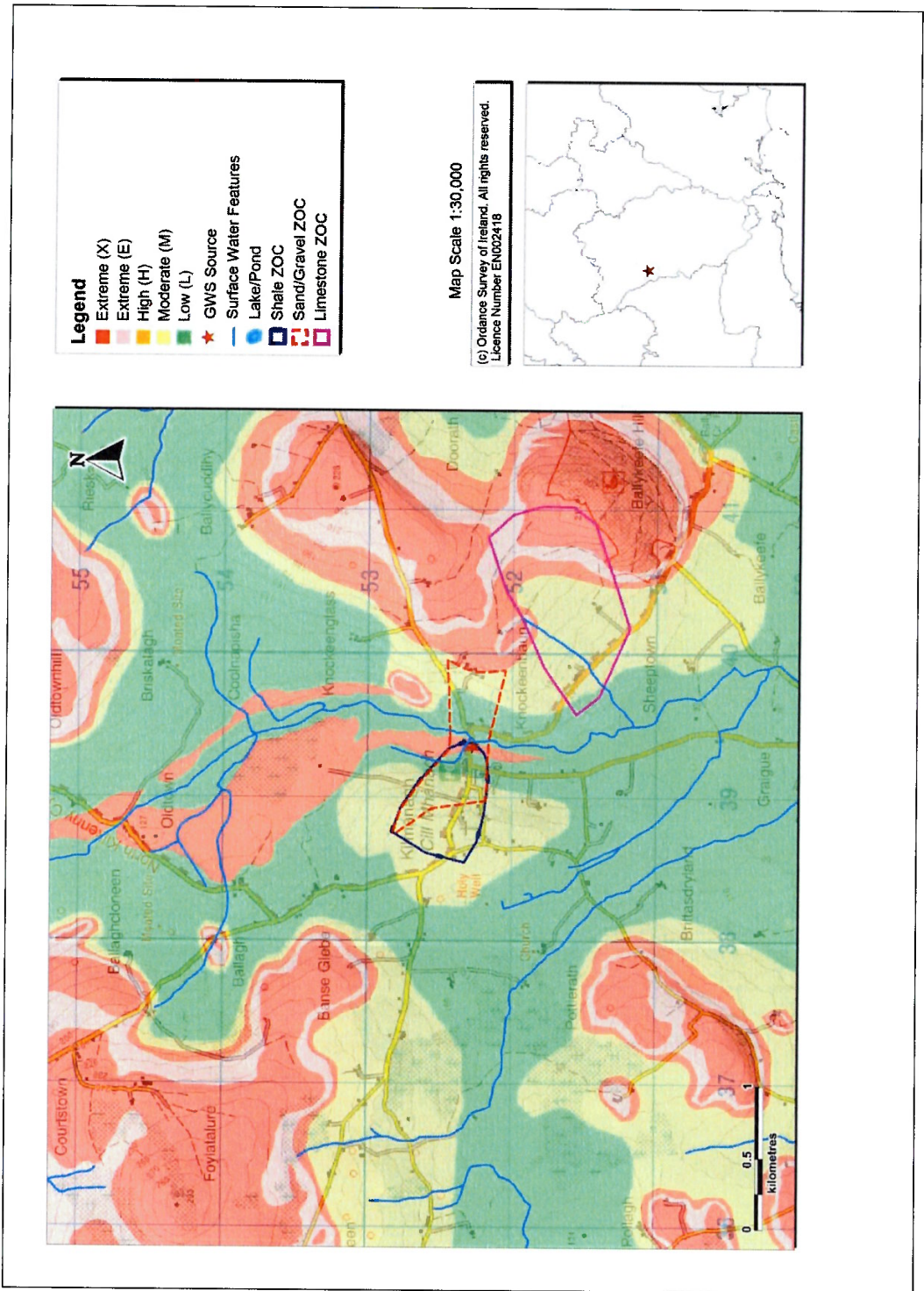


Figure 4 Groundwater Vulnerability Map

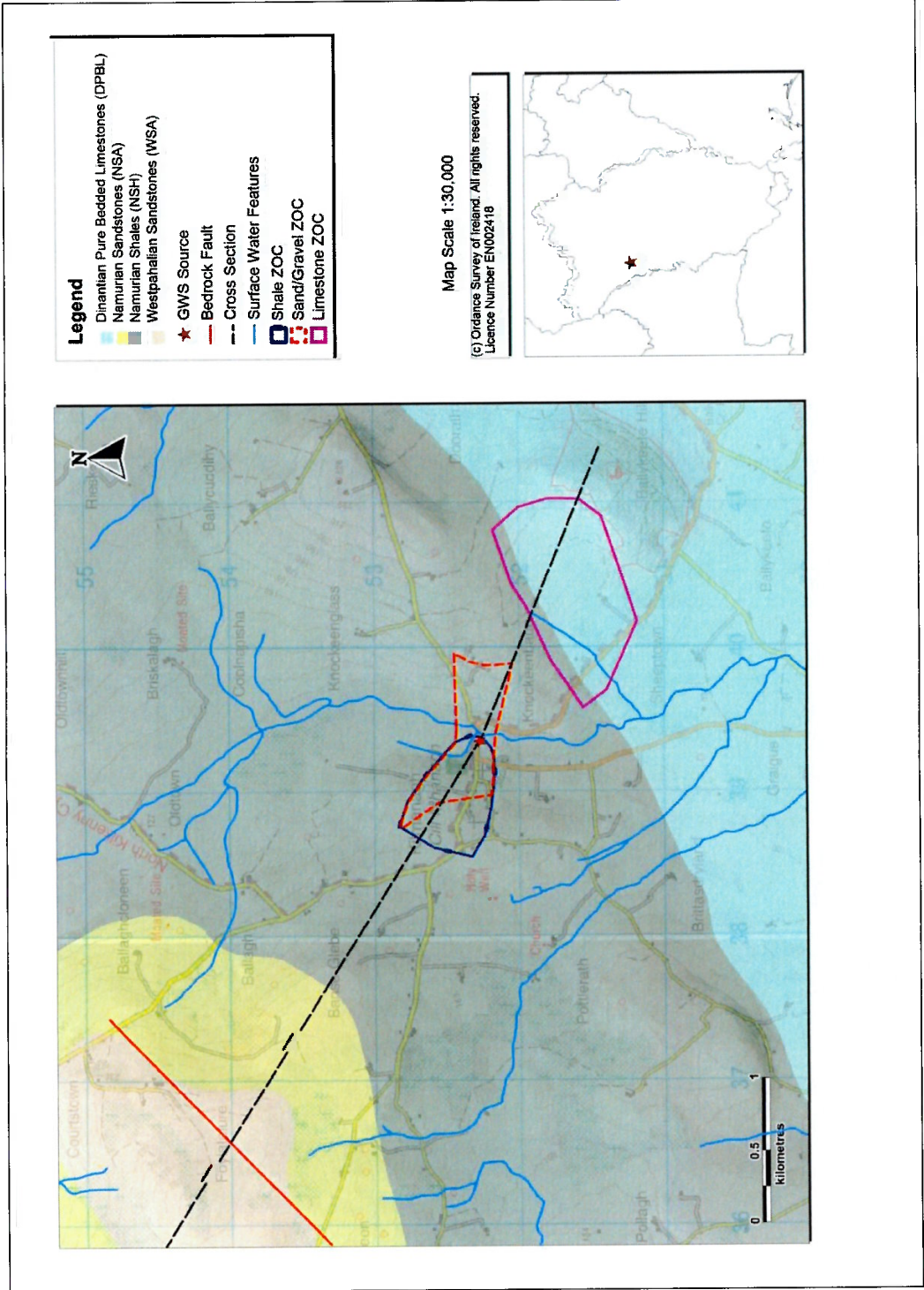


Figure 5 Rock Unit Group Map

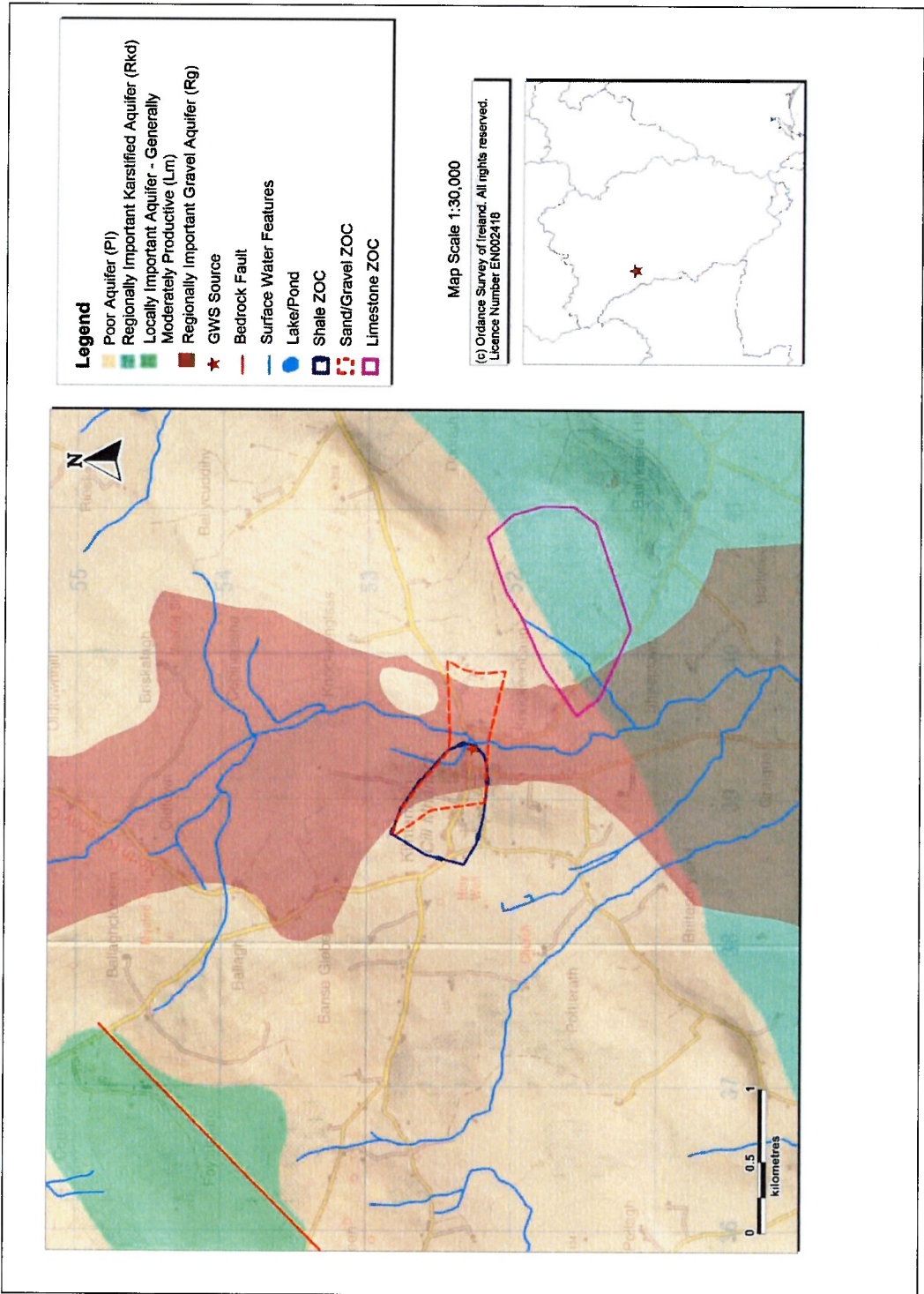


Figure 6 Aquifer Map

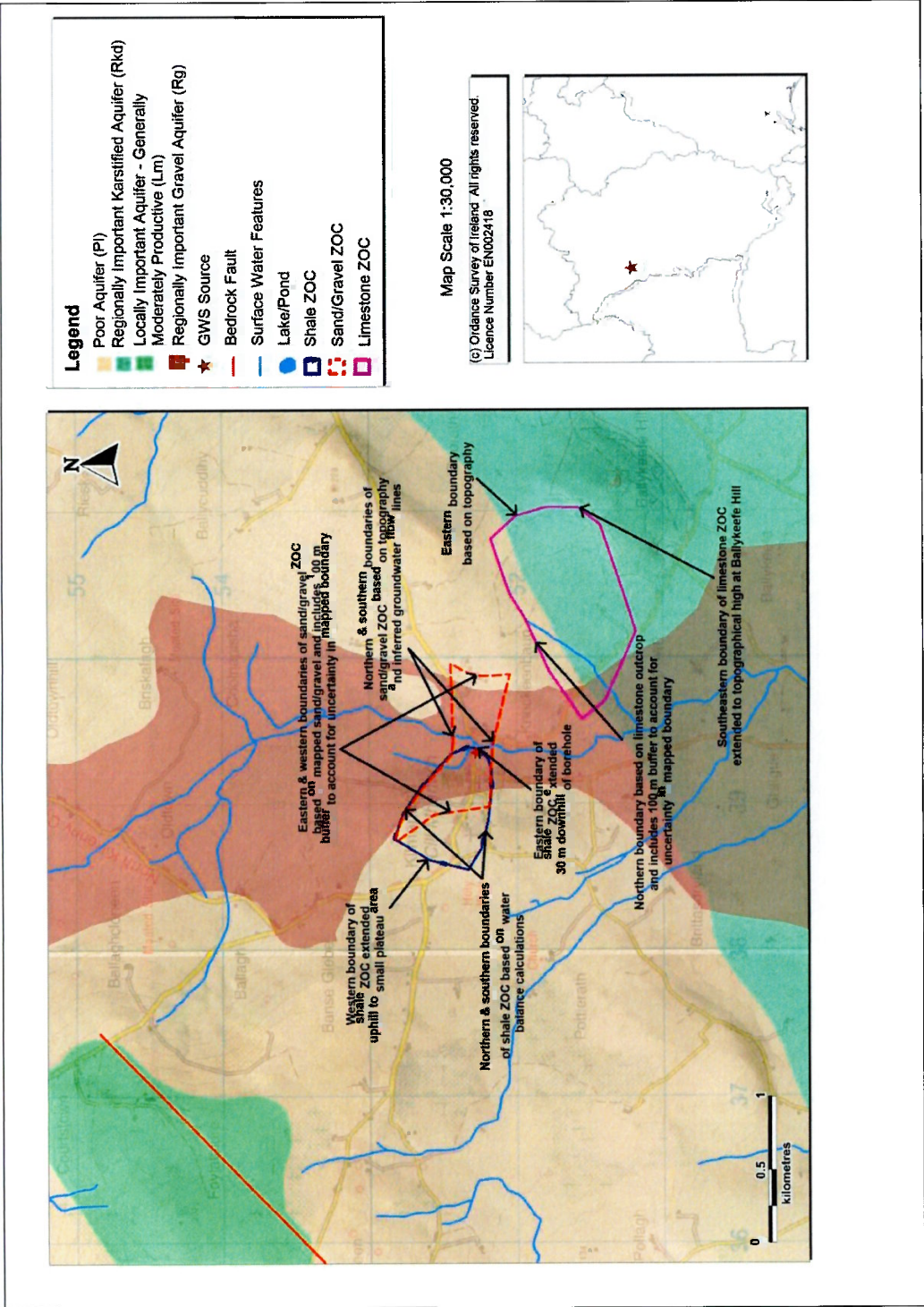


Figure 7 ZOC boundaries

Appendix 1

Groundwater Vulnerability



Introduction

The term 'vulnerability' is used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities (DELG *et al.*, 1999). The vulnerability of groundwater depends on:

- the time of travel of infiltrating water (and contaminants)
- the relative quantity of contaminants that can reach the groundwater
- the contaminant attenuation capacity of the geological materials through which the water and contaminants infiltrate.

All groundwater is hydrologically connected to the land surface; the effectiveness of this connection determines the relative vulnerability to contamination. Groundwater that readily and quickly receives water (and contaminants) from the land surface is 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:

- the type and permeability of the subsoils that overlie the groundwater
- the thickness of the unsaturated zone through which the contaminant moves
- the recharge type – whether point or diffuse.

In other words, vulnerability is based on evaluating the relevant hydrogeological characteristics of the protecting geological layers along the pathway, and the possibility of bypassing these layers. In summary, the entire land surface is divided into four vulnerability categories: **Extreme**, **High**, **Moderate** and **Low**, based on the geological and hydrogeological characteristics. Further details of the hydrogeological basis for vulnerability assessment can be found in 'Groundwater Protection Schemes' (DELG *et al.*, 1999).

The Groundwater Vulnerability Map shows the vulnerability of the first groundwater encountered, in either sand/gravel or bedrock aquifers, by contaminants released at depths of 1-2 m below the ground surface. Where the water-table in bedrock aquifers is below the top of the bedrock, the target needing protection is the water-table. However, where the aquifer is fully saturated, the target is the top of the bedrock. The vulnerability map aims to be a guide to the likelihood of groundwater contamination, if a pollution event were to occur. It does not replace the need for site investigation. Note also that the characteristics of individual contaminants are not considered.

Except where point recharge occurs (*e.g.* at swallow holes), the groundwater vulnerability depends on the type, permeability and thickness of the subsoil.

The groundwater vulnerability map is derived by combining the permeability and depth to bedrock maps, using the three subsoil permeability categories: high, moderate and low; and four depths to rock categories: <3m, 3–5m, 5–10m and >10m. The resulting vulnerability classifications are shown below.

Vulnerability mapping guidelines (adapted from DELG *et al.*, 1999)

Thickness of Overlying Subsoils	Hydrogeological Requirements for Vulnerability Categories				
	Diffuse Recharge			Point Recharge	Unsaturated Zone
	Subsoil permeability and type				
	High permeability (sand/gravel)	moderate permeability (sand/subsoil)	low permeability (clayey subsoil, clay, peat)	(swallow holes, losing streams)	(sand & gravel aquifers <u>only</u>)
0–3 m	Extreme	Extreme	Extreme	Extreme (30 m radius)	Extreme
3–5 m	High	High	High	N/A	High
5–10 m	High	High	Moderate	N/A	High
>10 m	High	Moderate	Low	N/A	High

Notes: (i) N/A = not applicable.
(ii) Release point of contaminants is assumed to be 1–2 m below ground surface.
(iii) Permeability classifications relate to the engineering behaviour as described by BS5930.
(iv) Outcrop and shallow subsoil (*i.e.* generally <1.0 m) areas are shown as a sub-category of extreme vulnerability (amended from Deakin and Dally (1999) and DELG/EPA/GSIa (1999))



Sources of Vulnerability Data

Specific vulnerability field mapping and assessment of previously collected data were carried out as part of this project. Fieldwork focused on assessing the permeability of the different subsoil deposit types so that they could be subdivided into the three permeability categories. This involved:

- Describing selected exposures/sections according to the British Standard Institute *Code of Practice for Site Investigations* (BS 5930:1999).
- Collection of subsoil samples for laboratory particle size analyses
- Assessing the recharge characteristics of selected sites using natural and artificial drainage, vegetation and other recharge indicators.

The following additional sources of data were used to assess the vulnerability and produce the map:

- Subsoils Map (EPA/Teagasc Subsoil Map, 2006), which is the basis for the main permeability boundaries. 'Clean' sands and gravels are usually high permeability. Alluvium deposits are either moderate or low permeability.
- Depth to bedrock map, compiled by the mapping team for the current project in the Geological Survey of Ireland, using data compiled from GSI, consultant and county council reports, along with purpose-drilled auger holes
- Geological Survey of Ireland Bedrock Geology Map
- Geological Survey of Ireland well and karst database, which supplied information on well yields and depth to bedrock, as well as locations of point recharge.
- General Soils Map of Ireland (Gardiner and Radford, 1980). This gives additional, indirect information on subsoil permeability in the areas mapped by Teagasc as 'till'.

Thickness of the Unsaturated Zone

The thickness of the unsaturated zone, or the depth of ground free of intermittent or permanent saturation, is only relevant in vulnerability mapping over unconfined sand and gravel aquifers. As described in Table 6.1, the critical unsaturated zone thickness is 3m; unconfined gravels with unsaturated zones thicker than 3m are classed as having a 'high' vulnerability, while those with unsaturated zones thinner than 3m are classed as having an 'extreme' vulnerability.



Appendix 2

Groundwater Recharge



Introduction

The term 'recharge' refers to the amount of water replenishing the groundwater flow system. The recharge rate is generally estimated on an annual basis, and is assumed to consist of the rainfall input (i.e. annual rainfall) minus water loss prior to entry into the groundwater system (i.e. annual evapotranspiration and runoff). The estimation of a realistic recharge rate is critical in source protection delineation, as this dictates the size of the zone of contribution to the source (i.e. the outer Source Protection Area).

The main parameters involved in the estimation of recharge are: annual rainfall; annual evapotranspiration; and a recharge coefficient (Table 1). The recharge coefficient is estimated using Hunter Williams et al (2013), which is based on Guidance Document GW5 (Groundwater Working Group 2005).

Table 1. Recharge coefficients for different hydrogeological settings.

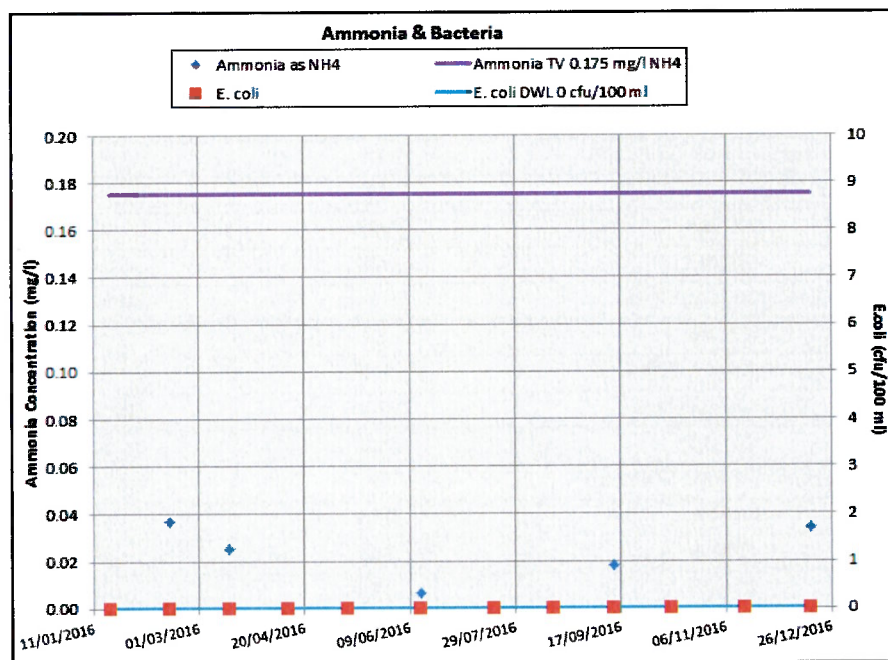
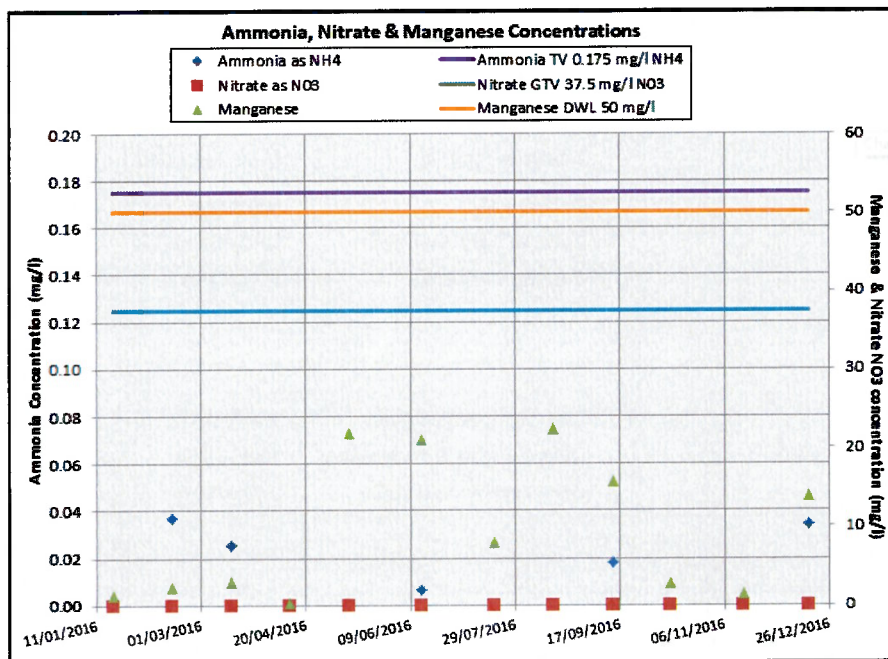
Groundwater vulnerability category	Hydrogeological setting	Recharge coefficient (RC)		
		Min (%)	Inner Range	Max (%)
Extreme (X or E)	1.i	30	80-90	100
	1.ii	50	80-90	100
	1.iii	15	35-50	70
	1.iv	45	50-70	80
	1.v	5	15-30	50
	1.vi	50	80-90	100
	1.vii	1	15-30	50
High (H)	2.i	50	80-90	100
	2.ii	50	80-90	100
	2.iii	15	35-50	70
	2.iv	15	35-50	70
	2.v	35	50-70	80
	2.vi	10	15-30	50
	2.vii	1	20-30	40
	2.viii	1	5-15	20
Moderate (M)	3.i	35	50-70	80
	3.ii	10	15-30	50
	3.iii	1	10-20	30
	3.iv	1	3-5	10
Low (L)	4.i	1	5-10	20
	4.ii	1	3-5	10

The recharge coefficients in this table are summarised in a paper by Hunter Williams *et al.* (2013) in the Quarterly Journal of Engineering Geology and Hydrogeology. Aquifer recharge acceptance capacity is generally limited in LI aquifers (200 mm/yr) and PI and PU aquifers (100 mm/yr). Made ground has recharge coefficient of 20%.

Appendix 3

Water Quality Results







Independent Analytical Supplies

Test Report

Lab Report Number: 4280J01

Analysis Number: 99A/105328

Customer ID: BALC.GW1

Analysis Type: Misc. Tests (99A)

Contact Name: JOE DELANEY

Delivery By: IAS Collection Chargeable

Company Name: NATIONAL FED GWS

Sample Card Number: NFGWS/BALL/2

Address:
BALLYCALLAN MUINTIR
BALLYCUDDIHY
KILMANAGH
KILKENNY

Sample Condition: Acceptable

Sample Type: Water

Date Sample Received: 19/06/2017

Sample Reference: BALLY CALLAN MUINTIR GWS

Date Analysis Commenced: 19/06/2017

Sample Description: T10.20 RAW

Date Certificate Issued: 27/06/2017

Parameter	Method	Result	Unit
Aluminium	ICP-MS	<20	ug/l
Alkalinity	Konelab Aquakem SOP2064	305.75	mg/l
Arsenic*	ICP-MS	<10	ug/l
Barium*	ICP-MS	<10	ug/l
Biochemical Oxygen Demand	Oxygen Meter SOP 2006	<1	mg/l
Calcium	ICP-MS	62.1	mg/l
Cadmium	ICP-MS	<20	ug/l
Chloride	Konelab Aquakem SOP 2065	12.33	mg/l
Colour	Konelab Aquakem SOP 2063	1.5	Pt Co
Conductivity	Electrometry SOP 2076	502	µS/cm 20°C
Chromium	ICP-MS	<20	ug/l
Copper	ICP-MS	<20	ug/l
E. Coli*	Quanti-tray SOP 2090	0	MPN/100ml
Iron	ICP-MS	39	ug/l
Fluoride*	Konelab Aquakem SOP 2069	0.12	mg/l
Total Hardness	Ca & Mg Hardness	255.1	mg/l CaCO3
Potassium	ICP-MS	3.93	mg/l
Clostridium Perfringens*	Membrane Filtration SOP 2093	0	cfu/100 ml
Magnesium	ICP-MS	24.3	mg/l
Manganese	ICPMS	398	ug/l
Sodium	ICP-MS	35.3	mg/l
Ammonium	Konelab Aquakem SOP 2057	0.14	mg/l NH4
Nickel	ICP-MS	<20	ug/l
Nitrite	Konelab Aquakem SOP 2059	0.03	mg/l NO2
Nitrate	Konelab Aquakem SOP 2060	<2.2	mg/l NO3
P Orthophosphate	Konelab Aquakem SOP 206 1	<0.01	mg/l P

* = not INAB Accredited ^ = Subcontracted

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IAS LABORATORIES, Unit 4 Bagenalstown Bus. Park, Bagenalstown, Co. Carlow,



Independent Analytical Supplies

Test Report

Lab Report Number: 4280J01	Analysis Number: 99A/105328
-----------------------------------	------------------------------------

Customer ID:	BALC.GW1	Analysis Type:	Misc. Tests (99A)
Contact Name:	JOE DELANEY	Delivery By:	IAS Collection Chargable
Company Name:	NATIONAL FED GWS	Sample Card Number:	NFGWS/BALL/2
Address:	BALLYCALLAN MUINTIR BALLYCUDDIHY KILMANAGH KILKENNY	Sample Condition:	Acceptable
Sample Type:	Water	Date Sample Received:	19/06/2017
Sample Reference:	BALLYCADLLAN MUINTIR GWS	Date Analysis Commenced:	19/06/2017
Sample Description:	T10.20 RAW	Date Certificate Issued:	27/06/2017

Parameter	Method	Result	Unit
Dissolved Oxygen*	Oxygen Meter SOP 2006	2.35	mg/l O2
Lead	ICP-MS	<20	ug/l
pH	Electrometry SOP 2004	7.2	pH units
Silica**	Subcontracted	12.4	mg/l
Sulphate	Konelab Aquakem SOP 2062	12.03	mg/l SO4
Strontium*	ICP-MS	<10	ug/l
Total Coliforms*	Quanti-tray SOP 2090	0	MPN/100ml
Total Organic Carbon*	Oxidation & Colourimetry	0.7	mg/l
Turbidity	Turbidimetric SOP 2022	<0.02	NTU
Zinc	ICP-MS	299	ug/l

Signed: Wendy McCall
Wendy McCall - Laboratory Manager

Date: 27/06/2017

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IAS LABORATORIES

Independent Analytical Supplies

Test Report

Lab Report Number: 4280J02	Analysis Number: 99A/105329
----------------------------	-----------------------------

Customer ID:	BALC.GW1	Analysis Type:	Misc. Tests (99A)
Contact Name:	JOE DELANEY	Delivery By:	IAS Collection Chargeable
Company Name:	NATIONAL FED GWS	Sample Card Number :	NFGWS/BALL/2
Address:	BALLYCALLAN MUINTIR BALLYCUDDIHY KILMANAGH KILKENNY	Sample Condition:	Acceptable
Sample Type:	Collection	Date Sample Received:	19/06/2017
Sample Reference:	BALLYCADLLAN MUINTIR GWS	Date Analysis Commenced:	19/06/2017
Sample Description:	COLLECTION	Date Certificate Issued:	20/06/2017

Parameter	Method	Result	Unit
Collection		-	

Signed: Wendy McCallDate: 20/06/2017

Wendy McCall - Laboratory Manager

^ = Subcontracted

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Opinions and interpretations expressed herein are outside the scope of INAB accreditation.

IAS LABORATORIES, Unit 4 Bagenalstown Bus. Park, Bagenalstown, Co. Carlow,

Ballycallan Muintir GWS - Treated Water Results (taken from EPS Monthly Operational Reports)													
Parameter	Units	19/01/2016	16/02/2016	15/03/2016	12/04/2016	10/05/2016	14/06/2016	19/07/2016	16/08/2016	14/09/2016	11/10/2016	15/11/2016	16/12/2016
Ammonia as NH ₄	mg/l	-	0.037	0.025	-	-	< 0.013	-	-	0.018	-	-	0.034
Chlorine, Free Onsite	mg/l	0.300	0.280	0.170	0.190	-	-	-	-	-	-	-	-
Colour True	Hazen	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Conductivity @ 20°C	uS/cm @20°C	-	561	547.0	-	-	554.0	-	-	529.0	-	-	573.0
Iron	ug/l	< 7.20	< 7.20	< 7.20	< 7.20	< 7.20	< 7.20	< 7.20	< 7.20	< 7.20	< 7.20	< 7.20	< 7.20
Manganese	ug/l	1.28	2.31	3.00	< 0.70	21.83	21.09	7.94	22.30	15.78	2.80	1.37	13.94
Nitrite as NO ₂	mg/l	< 0.016	< 0.066	< 0.066	< 0.066	< 0.066	< 0.066	0.067	< 0.066	< 0.066	< 0.066	< 0.066	< 0.066
Nitrate as NO ₃	mg/l	< 8.954	< 8.900	< 8.900	< 8.900	< 8.900	< 8.900	< 8.900	< 8.900	< 8.900	< 8.900	< 8.900	< 8.900
Odour	N/A	-	0	Slight Musty	-	-	0	-	-	0	-	-	0
Taste (Nature)	N/A	-	0	Musty	-	-	0	-	-	0	-	-	0
pH	pH Unit	7.22	7.45	7.28	7.34	7.31	7.31	7.42	7.34	7.54	7.09	7.17	7.39
Total Organic Carbon	mg/l	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500	1.260	< 0.500	0.510	1.570
Turbidity	NTU	< 0.10	< 0.10	0.27	0.47	0.40	0.43	0.33	0.66	0.25	0.50	0.64	0.45
Coliforms	MPN/100ml	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
E. coli	MPN/100ml	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloroethane	ug/l	-	< 5.00	-	-	-	-	-	-	-	-	-	-
Aluminium, Total	ug/l	-	< 5.00	-	-	-	-	-	-	-	-	-	-
Antimony	ug/l	-	0.04	-	-	-	-	-	-	-	-	-	-
Arsenic	ug/l	-	0.37	-	-	-	-	-	-	-	-	-	-
Benzene	ug/l	-	< 0.50	-	-	-	-	-	-	-	-	-	-
Boron	ug/l	-	< 50.00	-	-	-	-	-	-	-	-	-	-
Bromate as BrO ₃	ug/l	-	0.60	-	-	-	-	-	-	-	-	-	-
Cadmium	ug/l	-	0.19	-	-	-	-	-	-	-	-	-	-
Chloride	mg/l	-	17.074	-	-	-	-	-	-	-	-	-	-
Chromium	ug/l	-	1.20	-	-	-	-	-	-	-	-	-	-
Copper	ug/l	-	2.52	-	-	-	-	-	-	-	-	-	-
Cyanide, Total	ug/l	-	1.30	-	-	-	-	-	-	-	-	-	-
Fluoride	mg/l	-	< 0.2	-	-	-	-	-	-	-	-	-	-
Lead	ug/l	-	3.57	-	-	-	-	-	-	-	-	-	-
Mercury	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Nickel	ug/l	-	0.47	-	-	-	-	-	-	-	-	-	-
Odour	N/A	-	0	-	-	-	-	-	-	-	-	-	-
Taste	N/A	-	0	-	-	-	-	-	-	-	-	-	-
Selenium	ug/l	-	0.16	-	-	-	-	-	-	-	-	-	-
Sodium	mg/l	-	37.789	-	-	-	-	-	-	-	-	-	-
Sulphate	mg/l	-	< 20.000	-	-	-	-	-	-	-	-	-	-
Tetrachloroethene	ug/l	-	< 0.60	-	-	-	-	-	-	-	-	-	-
Trichloroethene	ug/l	-	< 0.60	-	-	-	-	-	-	-	-	-	-
Pesticides Total	ug/l	-	0.00	-	-	-	-	-	-	-	-	-	-
Clostridium perfringens	cfu/100ml	-	< 1	-	-	-	-	-	-	-	-	-	-
Faecal Enterococci	MPN/100ml	-	< 1.0	-	-	-	-	-	-	-	-	-	-
TVC @ 22°C	cfu/ml	-	< 1	-	-	-	-	-	-	-	-	-	-
Dieldrin	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
p,p'-DDT	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Aldrin	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Alpha BHC	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Beta BHC	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Gamma BHC	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Chlorothalonil	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Dichlobenil	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Alpha-Endosulphan	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Endosulphan-beta	ug/l	-	< 0.02	-	-	-	-	-	-	-	-	-	-
Endrin	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Hexachlorobenzene	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Heptachlor	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Heptachlor Epoxide	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Isodrin	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Alachlor	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Heptachlor-endo-epoxide	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Heptachlor-exo-epoxide	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Malathion	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Chlorfenvinphos	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Diflufenican	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Propetamphos	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Fluoranthene	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Benzo(b)fluoranthene	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Benzo(k)fluoranthene	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Benzo(a)pyrene	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Benzo(ghi)perylene	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Ideno (123cd) pyrene	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Anthracene	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Total PAH 6 Constituents	ug/l	-	< 0.01	-	-	-	-	-	-	-	-	-	-
Chloroform	ug/l	-	< 0.90	-	-	-	-	-	-	-	-	-	-
Bromodichloromethane	ug/l	-	< 0.90	-	-	-	-	-	-	-	-	-	-

Appendix 4

Borehole Logs



Patrick Briody & Sons Ltd.**DRILLING LOG****AQUADRILL SERVICES****Well Drilling & Site Investigation Contractors**

Consultant/Engineer EPS
 Client Kilberry Co. Co. Kilnash stone
 Borehole Reference No. Sheet 1 of 2
 Borehole Location Kilnash GAA Pitch.

The Grove,
 Rathangan, Co. Kildare.
 Tel (045) 524360
 Fax (045) 524785
 e-mail: info@briodydrilling.com

Date of Drilling	Depth (from - to) Mtrs/Ft.	Actual Drilling Diametre	Drilling Conditions / Water Strike
29-8-07	Mobilised to site	@ 11-30am	site
	not completed	started drilling @ 2pm	
	0 - 2	375mm	boulder clay
	2 - 6	"	Sand.
	6 - 12	"	Sandy gravel with water
30-8-07	12 - 15	"	large cobbles angular with big water. 5000 gals
	15 - 17	"	weathered bedrock.
	casing sealed most of water out		
	17 - 24	300mm	light grey bedrock ch
	24 - 25	"	fractured small water.
	25 - 30	"	light grey bedrock.
	30 - 36	"	change to dark colour
	36 - 42	"	V fractured but clean
		with	water 1000 gals
	42 - 48	300mm	soft black limestone.

Total Depth of Well.....
 Estimated Yield.....
 Depth to Rock.....
 Steel Casing Installed.....
 P.V.C. Casing/Screen Installed.....
 Other Remarks.....

 Lead Driller..... Drilling Rig.....
 Engineer Approval.....

Schematic View

Patrick Briody & Sons Ltd.

DRILLING LOG

AQUADRI LLSERVICES

Well Drilling & Site Investigation Contractors

Consultant/Engineer... EPS.

The Grove,
Rathangan, Co. Kildare.

Client... Kilmaragh schene

Tel (045) 524360

Fax (045) 524785

Borehole Reference No. Sheet... 2 of 2

e-mail: info@briodydrilling.com

Borehole Location... Kilmaragh GAA Pitch.

Date of Drilling	Depth from - to)Mtrs/Ft.	Actual Drilling Diametre	Drilling Conditions / Water Strike
30-8-07	48 - 54	300mm	still fractured & soft
	54 - 60	"	more competent
31-8-07	60 - 72	"	competent bedrock
	72 - 78	"	more weathered
	78 - 90	"	reasonable good
	90 - 96	"	more weathered
	96 - 100	"	✓ weathered clay filled
	100 - 108	"	✓ weathered & broken with clay & sand filled cavity with big water.
			direct link to test hole.
	Airlifted for 2 hours		core reasonably good
3-8-07	Installed 108m of P.V.C. then installed 10 ton of peg gravel & back to 21m		
	1m layer of sand then cement from 20m		
	added back to surface using 1/2 ton of cement added on lockable lid.		

Total Depth of Well... 108m

Estimated Yield... 8000 gph

Depth to Rock... 15m

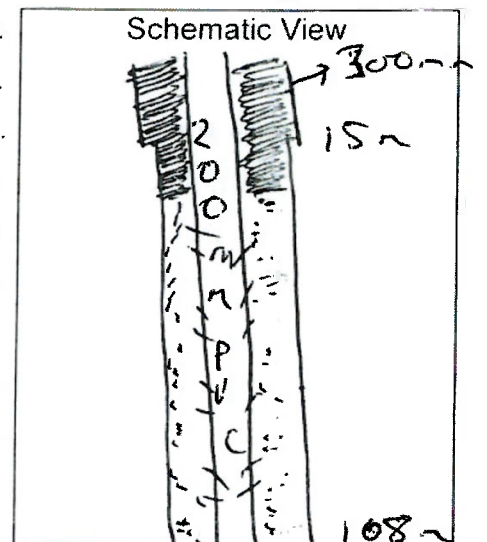
Steel Casing Installed... 15m x 300mm

P.V.C. Casing/Screen Installed... 108m x 200mm

Other Remarks.....

Lead Driller... Chris Baul Drilling Rig... Knebel

Engineer Approval.....



Patrick Briody & Sons Ltd.

DRILLING LOG

AQUADRILL SERVICES

Ballycollan

Well Drilling & Site Investigation Contractors

Consultant/Engineer T.J. O'Connell Assoc.

Client Kilnashan Camp Water Scheme

Borehole Reference No. BH1 Sheet 1 of 1

Borehole Location Beside GAA pitch

The Grove,
Rathangan,
Co. Kildare.

Tel (045) 524360

Fax (045) 524785

e-mail: info@briodydrilling.com

No 0109

Date of Drilling	Depth (from - to) mtrs/ft.	Actual Drilling Diametre	Drilling Conditions / Water Strike
19 20-10-04	0 - 55'	12"	Overburden compacted clayey Gravel
	55 - 60	12"	Soft bedrock
	60 - 80	8"	light grey bedrock
	80 - 81	8"	Small cavity some water
	120 - 140	8"	U Fractured more water 500 gph
	160 - 180	8"	U Fractured
	240 - 260	8"	Clay filled cavity water 1200 gph
	310 - 315	8"	Sand & clay filled big water
	315 - 350	8"	U broken weathered
	1 1/2 hr air lifting		lockable lid

Total Depth of Well 350'

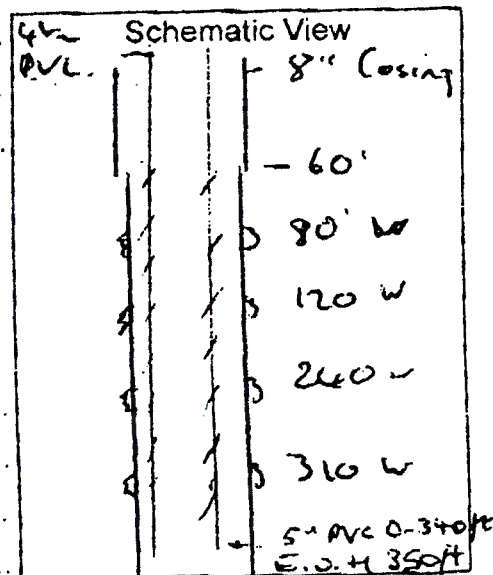
Estimated Yield 5000 gph/hr

Depth to Rock 55'

Steel Casing Installed 60' of 8" Casing

P.V.C. Casing/Screen Installed 340' of P.V.C.

Other Remarks Small water in overburden @ 40' leaking into borehole



Lead Driller Aidan Briody Drilling Rig knobel

Engineer Approval

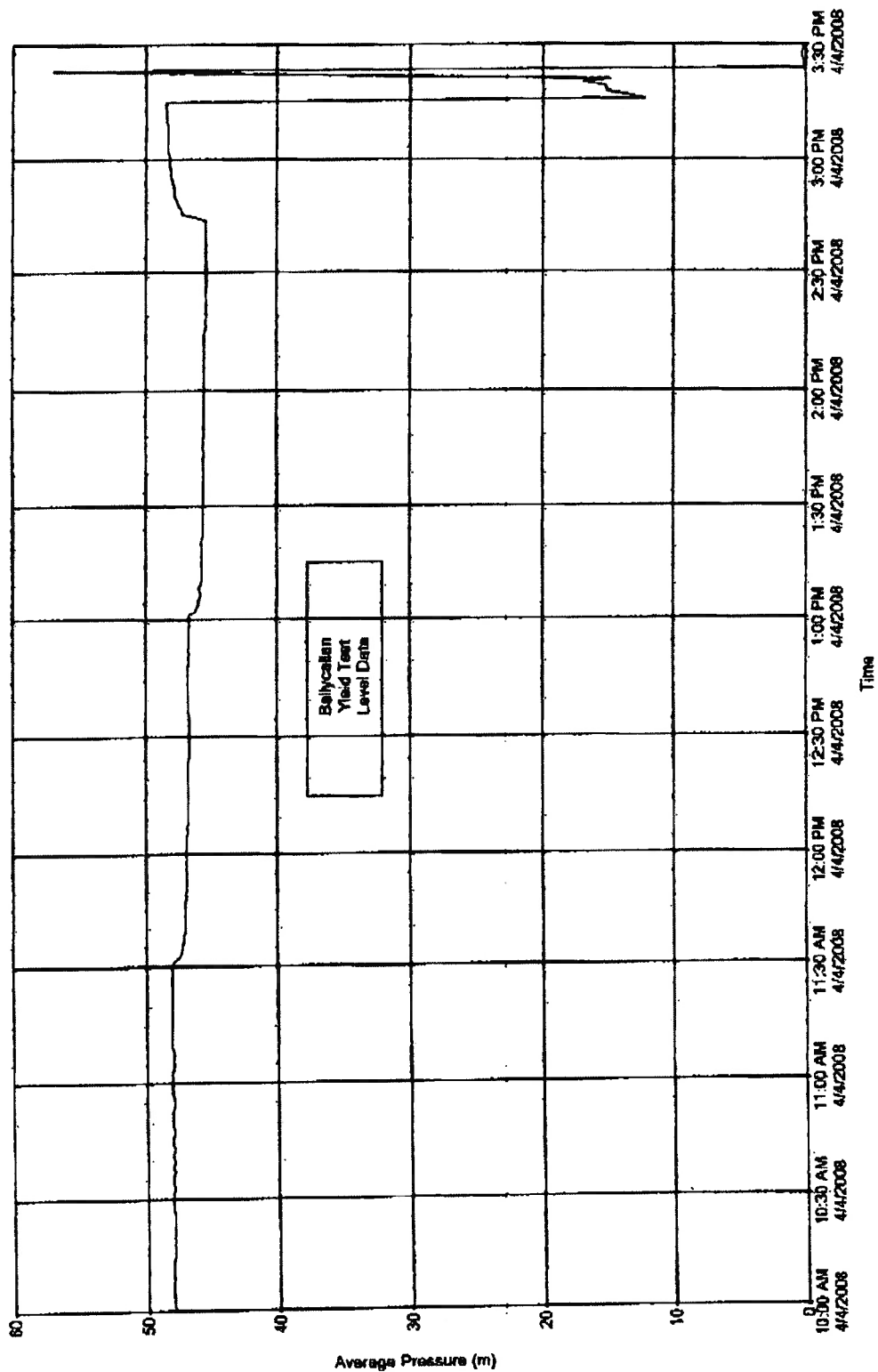
Appendix 5

Pumping Test Data



Ballycallan Muintir GWS Production Well

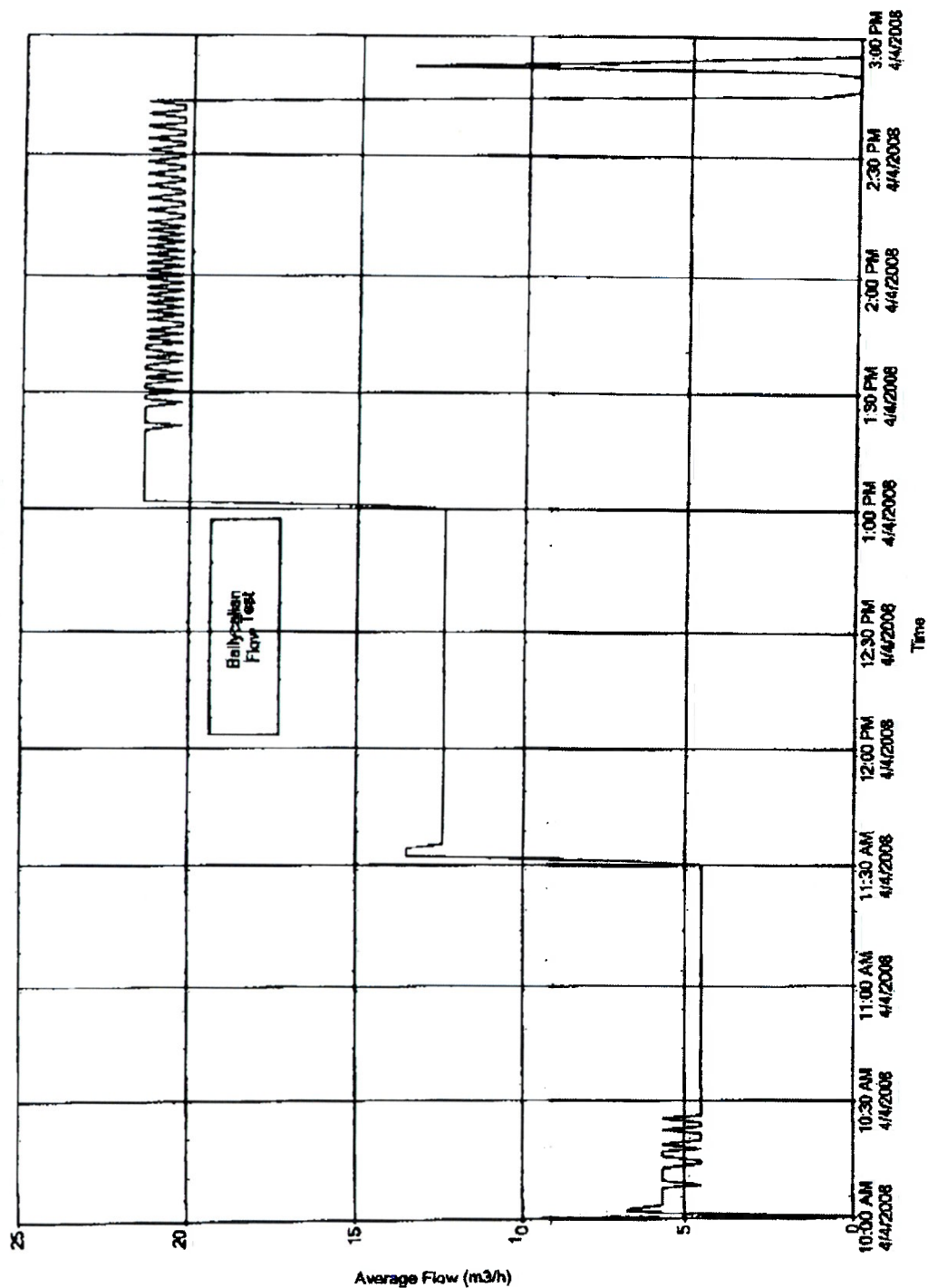
EPS Well Test Level Logger



EPS Well Test Level Logger - Pressure 1 (Average): (m) Min: 0.13 Max: 57.08 Average: 45.31

Ballycallan GWS Muintir Production Well

EPS Well Test Flow Logger



EPS Well Test Flow Logger - Flow 1a (Average): (m3/h) Min: 0.00 Max: 21.37 Average: 12.37 Total: 62.04 (m3)

.Seamus A kelly

.BOREHOLE LOCATION	BALLYCALLAN G.W S	.WELL NO ;T W 1
	KILMANAGH	
.COUNTY	KILKENNY	SHEET TYPE ;START 7 DAY TEST
.DATE	17/01/2006	WEATHER ; SHOWERY
.DIA OF WELL	125mm plastic	DISCHARGE DISTANCE:20 TO STREAM
HEIGHT OF MEASUREMENT ABOVE G.L--0.67m		PURCHASE/ ORDER NO.

Time	Elapsed Time	WELL NO	OBS WELL	METER	FLOW RATE	
11.15am	0	16.24		6556		
	0.5	18.15			5.25 L / S	
	1	18.72				
	1.5	19.06				
	2	19.26				
	2.5	19.36				
	3	19.47				
	3.5	19.54				
	4	19.61				
	4.5	19.67			5.25 L / S	
	5	19.72				
	6	19.78				
	7	19.85				
	8	19.93				
	9	20.2				
	10	20.08			5.23 L / S	
	12	20.16				
	14	20.22				
	16	20.28				
	18	20.34				
	20	20.38			5.22 L / S	
	22	20.42				
	24	20.45				
	26	20.5				
	28	20.54				
	30	20.57			5.22 L / S	
	35	20.61				
	40	20.68				
	45	20.69			5.20 L / S	
	50	20.73				
	55	20.77				
	60	20.8		6575	5.20 L / S	
	75	20.86				
	90	20.92			5.20 L / S	
	105	20.96				
	120	21.01		6594	5.20 L / S	
	150	21.07				
	180	21.13		6613	5.20 L / S	
	210	21.17				
	240	21.2		6631	5.20 L / S	

Seamus A kelly

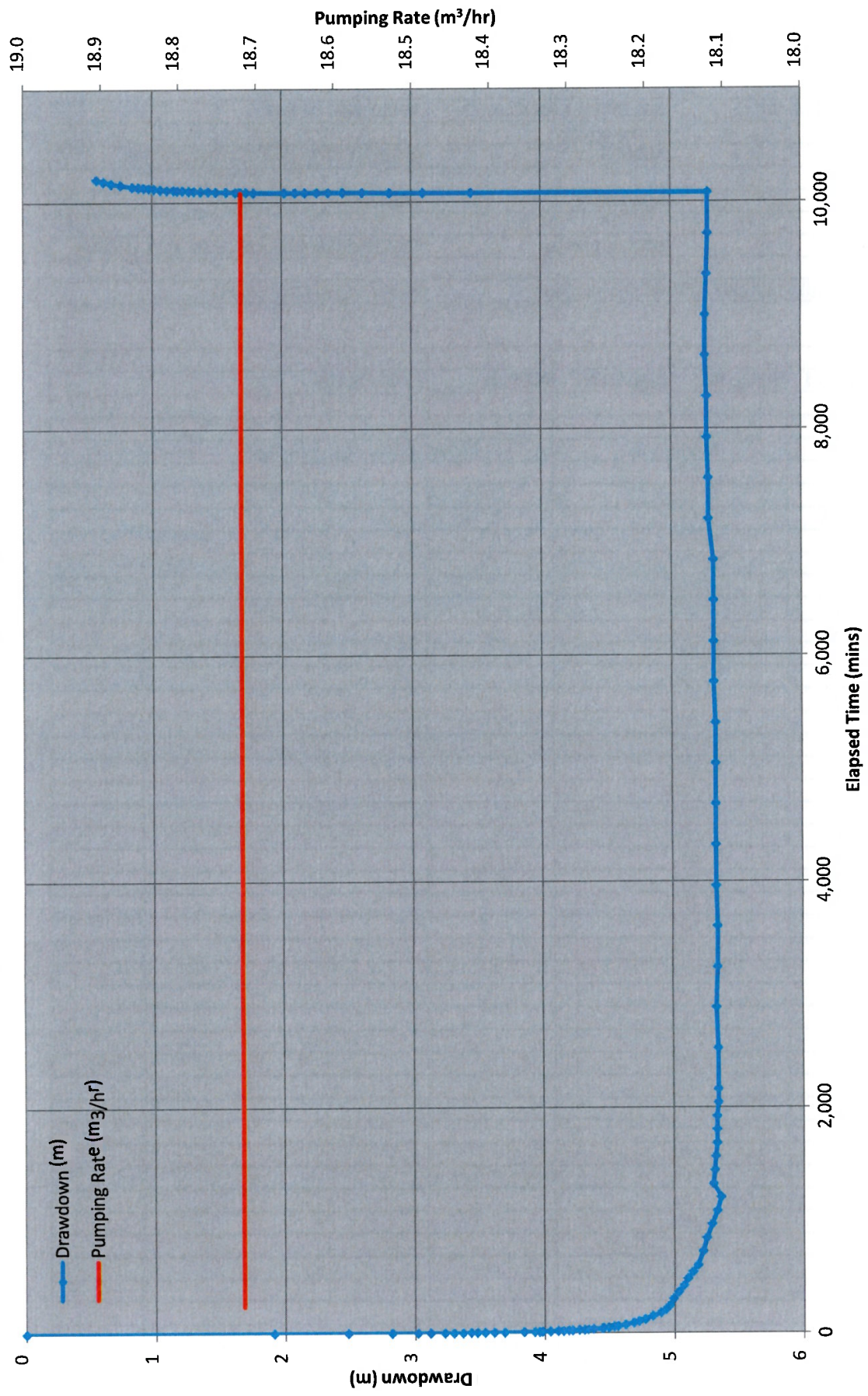
BOREHOLE LOCATION		BALLYCALLAN G.W.S		WELL NO T W 1	
		KILMANAGH			
COUNTY		KI LKENNY		SHEET TYPE:5-168HR	
.DATE		17/01/2005		WEA THER:SHOWERY	
DIA OF WELL		125mm plastic		DISCHARGE DISTANCE:20M	
HEIGHT OF MEASUREMENT ABOVE G.L---0.67n				PURCH ASE/ ORDER NO.	
				DEPTH OF WELL	
	Elapsed				
	Time	WELL NO	OBS WELL	METER	FLOW RATE
TIME	HOURS				
	5	21.23		6650	5.20 L / S
	6	21.27		666 95	5.20 L / S
	7	21.31		6688	5.20 L / S
	8	21.34		6706	520 L / S
	9	21.38		6725	5.20 L / S
	10	21.42		6745	5.20 L / S
	12	21.46		6781	5.20 L / S
	14	21.49		6818	5.20 L / S
	16	21.53		6857	5.20 L / S
	18	21.57		68 94	5.20 L / S
	20	21.6		6931	5.20 L / S
	22	21.54		6967	5.20L / S
	24	21.55		7007	5.20 L / S
	26	21.56		7044	5.20 L / S
	28	21.57		7080	5.20L / S
	30	21.57		71 9	520 L / S
	32	21.57		7154	5.20 L / S
	34	21.58		7 192	5.20 L / S
	36	21.58		7229	520 L / S
	42	21.58		7342	5 20 L / S
	48	21.57		7455	5.20 L / S
	54	21.58		7567	5 20 L / S
	60	21.58		7681	5.20 L / S
	66	21.57		7793	5.20 L / S
	72	21.57		7905	5.20 L / S
	78	27.57		8017	5.20 L / S
	84	27.57		81 30	5.20L / S
	90	21.57		824	5.20 L / S
	96	21.56		8352	5.20 L / S
	102	21.56		8466	5.20 L / S very heavy rain
	108	21.56		8579	5.20 L / S very heavy rain
	114	21.56		8691	5.20 L / S very heavyrain
	120	21.52		8803	5.20 L / S very heavyrain
	126	21.52		8915	5.20 L / S
	132	21.51		9027	5.20 L / S
	138	21. 51		9141	5.20L / S
	144	21. 5		9253	5.20 L / S
	150	21. 5		9365	5.20 L / S
	156	21.51		9478	5.20L / S
	162	21.52		9590	5.20L / S
1 15am	168	21. 52		9701	5.20 L / S

.Seamus A kelly

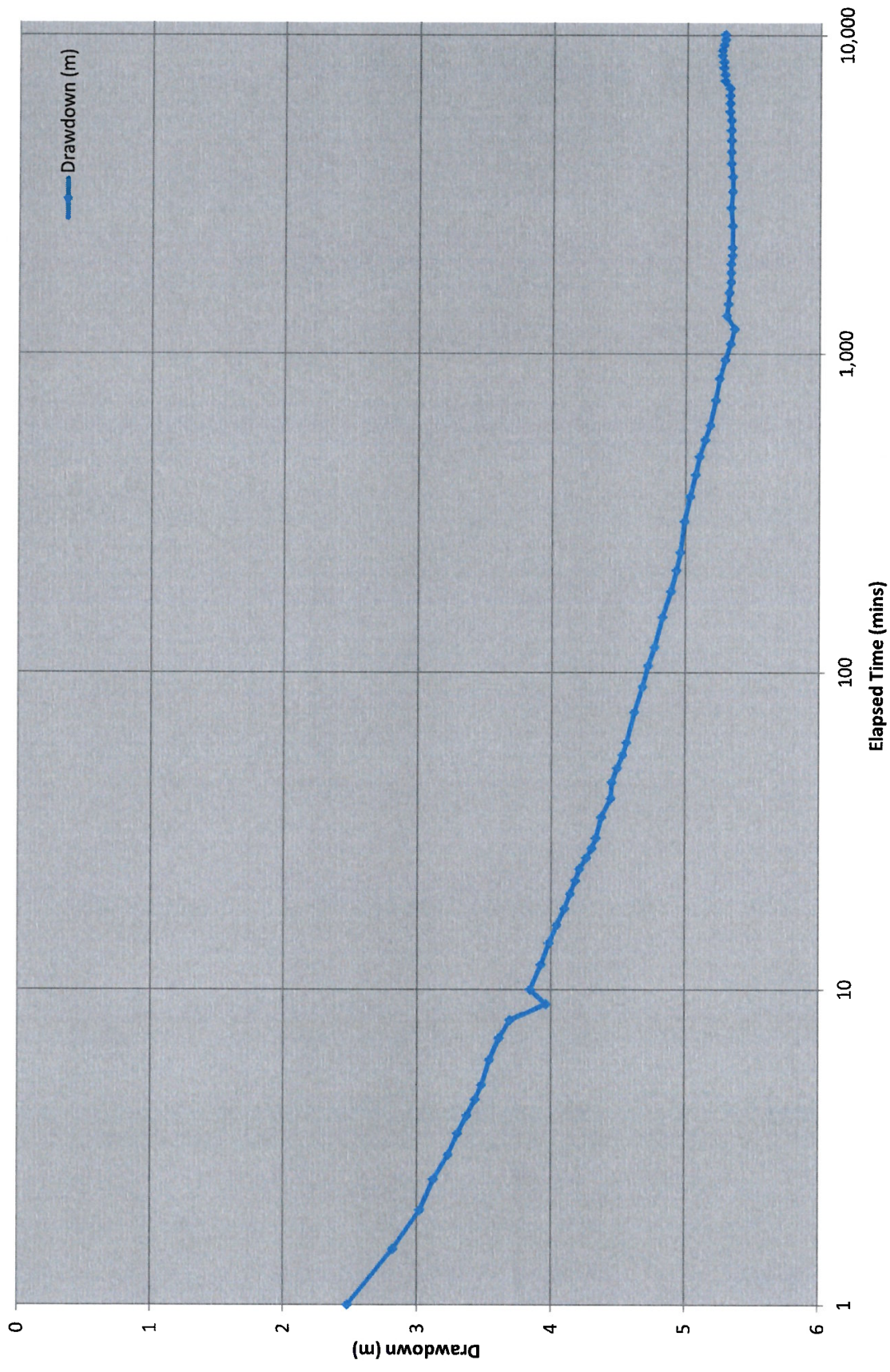
.BOREHOLE LOCATION	BALLYCALLAN G.W S	.WELL NO ;T W 1
	KILMANAGH	
.COUNTY	KILKENNY	SHEET TYPE ;RECOVERY AFTER
		7 DAY TEST
.DATE	24/01/2005	WEATHER ; SHOWERY
.DIA OF WELL	125mm plastic	DISCHARGE DISTANCE:20 TO STREAM
HEIGHT OF MEASUREMENT ABOVE G.L--0.67m		PURCHASE/ ORDER NO.

Time	Elapsed Time	WELL NO	OBS WELL	METER	FLOW RATE	
11.15am	0	21.52				
	0.5	19.7				
	1	19.33				
	1.5	19.07				
	2	18.86				
	2.5	18.71				
	3	18.6				
	3.5	18.51				
	4	18.42				
	4.5	18.34				
	5	18.26				
	6	18.02				
	7	17.96				
	8	17.92				
	9	17.91				
	10	17.88				
	12	17.81				
	14	17.73				
	16	17.67				
	18	17.61				
	20	17.56				
	22	17.52				
	24	17.47				
	26	17.43				
	28	17.4				
	30	17.35				
	35	17.3				
	40	17.25				
	45	17.21				
	50	17.17				
	55	17.13				
	60	17.08				
	75	16.99				
	90	16.92				
	105	16.86				
	120	16.81				
	150					
	180					
	210					
	240					

Ballycallan GWS - TW1 - 7 Day Pumping Test



Ballycallan GWS - TW1 - 7 Day Pumping Test



Appendix 6

Water Level Data



Ballycallan Muintir GWS Water Levels (taken from EPS Monthly Operational Reports)		
Month	Height Water level above pressure transducer probe (m)	
	Minimum	Maximum
Jan-16	16.19	20.76
Feb-16	16.19	20.76
Mar-16	15.05	20.51
Apr-16	14.87	25.34
May-16	14.5	20.98
Jun-16	14.28	19.37
Jul-16	13.92	19.19
Aug-16	12.23	18.16
Sep-16	12.34	17.47
Oct-16	12.27	17.25
Nov-16	12.12	16.92
Dec-16	11.76	17.25

Appendix 7

Acronyms and Glossary



Acronyms

EPA – Environmental Protection Agency
DEHLG – Department of Environment Heritage and Local Government
EU – European Union
GSI – Geological Survey of Ireland
GWB – Groundwater Body
GWD – Groundwater Directive (European Union)
GWS – Group Water Scheme
IGI – Institute of Geologists of Ireland
IG – Irish National Grid Reference
m aOD – metres above Ordnance Datum
m bgl – metres below ground level
TVs – Threshold Values
UV – Ultra-Violet
ZOC – Zone of Contribution
WFD – Water Framework Directive

Glossary of Terms

Aquifer

A subsurface layer or layers of rock, or other geological strata, of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstraction of significant quantities of groundwater (Groundwater Regulations, 2010).

Attenuation

A decrease in pollutant concentrations, flux, or toxicity as a function of physical, chemical and/or biological processes, individually or in combination, in the subsurface environment.

Borehole

A particular type of well - a narrow hole in the ground constructed by a drilling machine in order to gain access to the groundwater system.

Boulder Clay

See 'Till'

Conceptual Hydrogeological Model

A simplified representation or working description of how a real hydrogeological system is believed to behave on the basis of qualitative analysis of desk study information, field observations and field data.

Diffuse Sources

Diffuse sources of pollution are spread over wider geographical areas rather than at individual point locations. Diffuse sources include general land use activities and landspreading of industrial, municipal wastes and agricultural organic and inorganic fertilisers.

Direct Input

An input to groundwater that bypasses the unsaturated zone (e.g. direct injection through a borehole) or is directly in contact with the groundwater table in an aquifer either year round or seasonally.

Doline

Dolines, or enclosed depressions, are relatively shallow bowl or funnel shaped depressions that form in karst landscapes, and serve to funnel or concentrate recharge underground. Their presence indicates that subterranean drainage is in operation.

Dolomitisation

Is a process, whereby the calcite crystals in limestone is replaced by magnesium. This results in an increase in the porosity and permeability of the rock. Dolomitised rocks are a highly weathered, yellow/orange/brown colour and are usually evident in boreholes as loose yellow-brown sand with significant void space and poor core recovery. Dolomitisation often occurs preferentially in both fault zones and purer limestones.



Down-gradient

The direction of decreasing groundwater levels, i.e. flow direction. The area of the groundwater system that has lower groundwater levels than other areas. Opposite of upgradient.

Enclosed Depression

See doline

Fissure

A natural crack in rock which allows rapid water movement.

Groundwater

All water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil (Groundwater Regulations, 2010).

Groundwater Body (GWB)

A volume of groundwater defined as a groundwater management unit for the purposes of reporting to the European Commission under the Water Framework Directive. Groundwater bodies are defined by aquifers capable of providing more than 10 m³/d, on average, or serving more than 50 persons.

Groundwater Recharge

Two definitions: a) the process of rainwater or surface water infiltrating to the groundwater table; b) the volume (amount) of water added to a groundwater system.

Groundwater Resource

An aquifer capable of providing a groundwater supply of more than 10 m³/d as an average or serving more than 50 persons.

Hydraulic Conductivity (also known as 'Permeability')

The rate at which water can move through a unit volume of geological medium under a potential unit hydraulic gradient. The hydraulic conductivity can be influenced by the properties of the fluid, including its density, viscosity and temperature, as well as by the properties of the soil or rock.

Hydraulic Gradient

The change in total head of water with distance; the slope of the groundwater table or the piezometric surface.

Igneous Rock

Igneous rock is formed through the cooling and solidification of magma or lava.

Indirect Input

An input to groundwater where the pollutants infiltrate through soil, subsoil and/or bedrock to the groundwater table.

Input

The direct or indirect introduction of pollutants into groundwater as a result of human activity.

Karst

A distinctive landform characterised by features such as surface collapses, sinking streams, swallow holes, caves, turloughs and dry valleys, and a distinctive groundwater flow regime where drainage is largely underground in solutionally enlarged fissures and conduits.

Karstification

Karstification is the process whereby limestones are slowly dissolved by acidic waters moving through them. This results in the development of an uneven distribution of permeability with the enlargement of certain fissures at the expense of others and the concentration of water flow into these high permeability zones. Karstification results in the progressive development of distinctive karst landforms such as caves, swallow holes, sinking streams, turloughs and dry valleys, and a distinctive groundwater flow regime. It is an important feature of Irish hydrogeology.

Metamorphic Rock

A rock made out of highly altered existing rock. Common types include marble, schist and quartzite.



Pathway

The route which a particle of water and/or chemical or biological substance takes through the environment from a source to a receptor location. Pathways are determined by natural hydrogeological characteristics and the nature of the contaminant, but can also be influenced by the presence of features resulting from human activities (e.g., abandoned ungrouted boreholes which can direct surface water and associated pollutants preferentially to groundwater).

Permeability

A measure of a soil or rock's ability or capacity to transmit water (synonymous with hydraulic conductivity).

Point Source

Any discernible, confined or discrete conveyance from which pollutants are or may be discharged. These may exist in the form of pipes, ditches, channels, tunnels, conduits, containers, and sheds, or may exist as distinct percolation areas, integrated constructed wetlands, or other surface application of pollutants at individual locations. Examples are discharges from waste water works and effluent discharges from industry.

Pollution

The direct or indirect introduction, as a result of human activity, of substances or heat into the air, water or land which may be harmful to human health or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems which result in damage to material property, or which impair or interfere with amenities and other legitimate uses of the environment (Groundwater Regulations, 2010).

Poorly Productive Aquifers (PPAs)

Low-yielding bedrock aquifers that are generally not regarded as important sources of water for public water supply but that nonetheless may be important in terms of providing domestic and small community water supplies and of delivering water and associated pollutants to rivers and lakes via shallow groundwater pathways.

Preferential Flow

A term used to describe water movement along favoured pathways through a geological medium, bypassing other parts of the medium. Examples include pores formed by soil fauna, plant root channels, weathering cracks, fissures and/or fractures.

Saturated Zone

The zone below the water table in an aquifer in which all pores and fissures and fractures are filled with water at a pressure that is greater than atmospheric.

Sedimentary Rock

A rock composed of sediments (sand, silt, clay, calcium carbonate fragments, shell fragments, etc.) that have been buried and lithified (cemented). Common types include sandstone, shale and limestone.

Soil (topsoil)

The uppermost layer of soil in which plants grow.

Spring

A spring is a natural feature where groundwater emerges at the surface. Springs usually occur where the rate of flow of groundwater is too great to remain underground. The position of a spring usually reflects a change in soil or rock type, or a change in slope.

Subsoil

Unlithified (uncemented) geological strata or materials beneath the topsoil and above bedrock. Common types include Till/Boulder Clay, sand/gravel and peat.

Surface Water

An element of water on the land's surface such as a lake, reservoir, stream, river or canal. Can also be part of transitional or coastal waters. (Surface Waters Regulations, 2009.).

Swallow Hole (also known as 'Sinkhole')

The point where concentrated inflows of water sink underground. They are found in karst environments.

Threshold Values (TVs)

Chemical concentration values for substances listed in Schedule 5 of the Groundwater Regulations (2010), which are used for the purpose of chemical status classification of groundwater bodies.



Till (also known as 'Boulder Clay')

Unsorted glacial Sediment deposited directly by the glacier. It is the most common Quaternary deposit in Ireland. Its components may vary from gravel, sands and clays.

Unsaturated Zone

The zone between the land surface and the water table, in which pores, fractures and fissures are only partially filled with water. Also known as the vadose zone.

Up-gradient

The direction of increasing groundwater levels, i.e. the direction from which groundwater is flowing. The area of the groundwater system that has higher groundwater levels than other areas. Opposite of down-gradient.

Vulnerability

The intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities (Fitzsimmons et al, 2003).

Water Table

The uppermost level of saturation in an aquifer at which the pressure is atmospheric. This is the level to which water naturally settles in the cracks, cavities and pore spaces underground. Above the water table, the spaces in the rock or sediments are air-filled. Below the water table, the spaces are filled with water.

Weathering

The breakdown of rocks and minerals at the earth's surface by chemical and physical processes.

Well

A construction into the ground in order to access groundwater. Can be a dug well, which is generally shallow, with a diameter of a metre or more, or a borewell (see 'Borehole'), which is narrower in diameter and generally deeper.

Zone of Contribution (ZOC)

The area surrounding a pumped well or spring that encompasses all areas or features that supply groundwater to the well or spring. It is defined as the area required to support an abstraction and/or overflow (in the case of springs) from long-term groundwater recharge.





Kilkenny County Council

**Rationalisation and Amalgamation of Group Water Schemes
in Co. Kilkenny**

**Ballycallan
Group Water Scheme**

Preliminary Assessment Report

*Revision B
May 2021*



1 0975- Rationalisation & Amalgamation of GWS in Kilkenny

Ballycallan GWS Preliminary Report

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1.0 INTRODUCTION

1.1 Background

Kilkenny County Council have appointed TOBIN Consulting Engineers to carry out the design and project management of the necessary works to enable the amalgamation and rationalisation of a number of group water schemes in Co. Kilkenny. Stage 1 of this appointment involves carrying out assessment of existing documentation, data collection and analysis, and preparation of a preliminary design report on each of the Group Water Schemes (GWS) assessed.

This report will examine if Rationalisation and Amalgamation offers a more sustainable long-term approach to each scheme and what would be envisaged for each scheme to implement such a strategy.

This report will also examine the existing infrastructure at the GWS and assess if any upgrade works are required.

1.2 Definitions

One of the core objectives of the Multi-Annual Rural Water Programme is the amalgamation and/or rationalisation of private group water schemes. Both amalgamation and rationalisation are defined below:

- **Amalgamation** of group water schemes involves the physical interconnection of the water distribution networks of two or more group water schemes where they are in sufficiently close proximity and the topography is favourable for it to be technically and economically viable.
- **Rationalisation** of group water schemes involves an integrated management arrangement of two or more group water schemes, without the physical interconnection of their water distribution networks, it also involves the forming of one new legal structure.

1.3 Group Water Scheme Clusters in Kilkenny

The group water schemes that are part of this project are located in rural Co. Kilkenny (with one located in Co. Carlow). Similar to schemes across the country, these schemes are, for the most part, operated by the community. The schemes part of this project varies in size but would typically be of the order of 50-100 connections, and approximately 5-10km of watermain network. This size of GWS would be considered small in comparison with other parts of the country, which presents challenges in terms of GWS management, operations, and compliance with legislative requirements.

Prior to this study taking place Kilkenny County Council completed a rationalisation/amalgamation feasibility report in 2019. This report divided the schemes into three groups or 'clusters'. The clusters have been numbered 1 to 3.

This report focuses on the Ballycallan Group Water Scheme (GWS) which is part of Cluster 3.

1.3.1 Cluster 3

Cluster 3 is generally located in the southwest of the county, and consists of the following GWSs:

Scheme	Connections	Length of Watermains
Ballycallan	130 Connections • 82 Domestic • 40 House/Land • 5 Land Only • 2 Other • 1 Commercial	15.1km
Castleinch	15 Connections • 15 Domestic	1.2km
Cuffesgrange	56 Connections • 46 Domestic Only • 3 House/Land • 5 Land Only • 2 Other	4.3km
Ballymack	102 Connections • 75 Domestic • 24 House/Land • 2 Land Only • 1 Other	9.3km
Newtown-Ovenstown	58 Connections • 37 Domestic • 11 House/Land • 7 Land Only • 1 Other • 2 Commercial	4.9km
Kilree-Stoneyford	40 Connections • 28 Domestic • 9 House/Land • 3 Land Only	4.7km
Caherleske Coolagh	165 Connections • 87 Domestic • 58 House/Land • 17 Land Only • 1 Other • 2 Commercial	22.8km
Windgap	58 Connections • 48 Domestic • 4 House/Land • 5 Other • 1 Commercial	5.2km

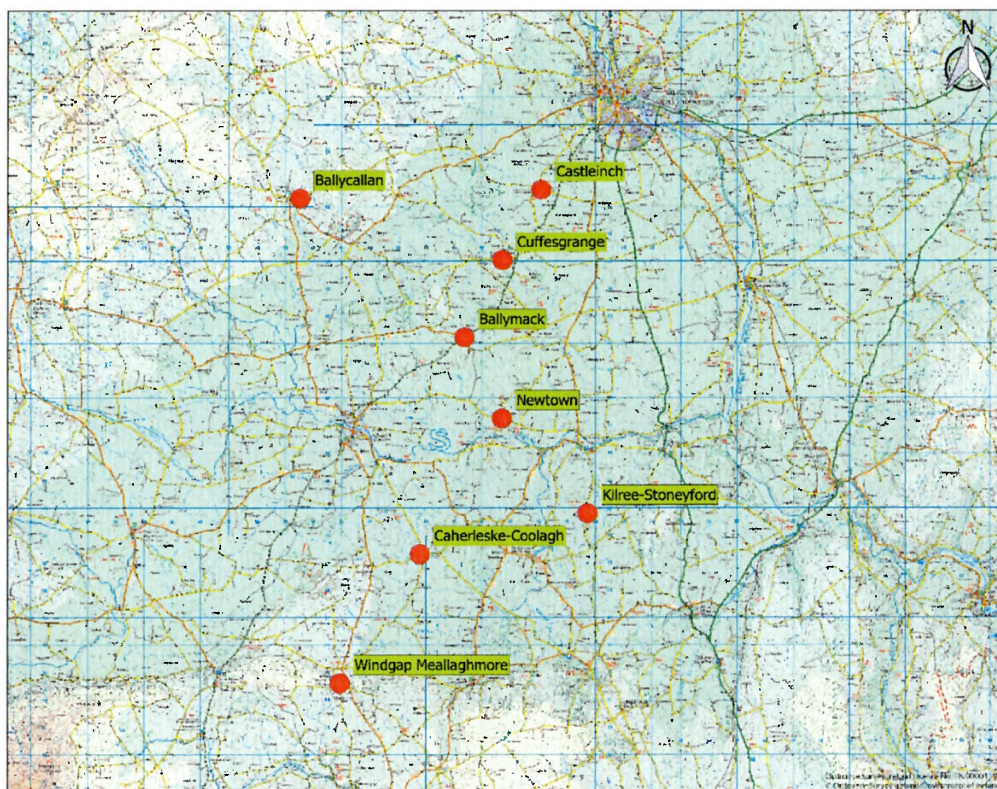


Figure 1.1 - Cluster 3 Location Map

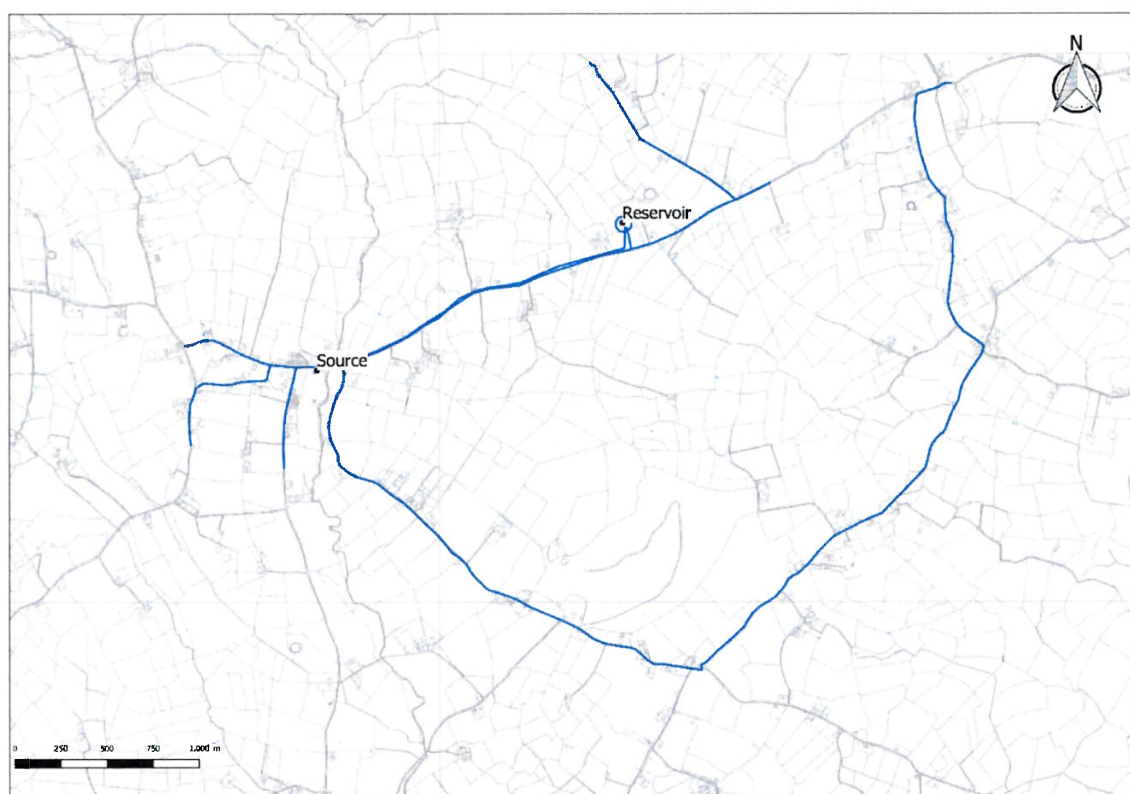


Figure 1.2 – Layout of the Ballycallan GWS Distribution Network

2.0 BALLYCALLAN GWS

The Ballycallan GWS is located 14km west of Kilkenny City, with main water abstraction compound and reservoir located adjacent to the village of Kilmanagh and 5km east of Callan. The GWS compound is located adjacent to the L1009.

The community GWS was established in 1979. The Ballycallan GWS has been set up as a co-operative. In total there are 130 no. connections to the distribution network. This is made up of 82 no. domestic connections, 40 no. house/land connections, 5 no. land only connections, 2 no. other connections and 1 no. commercial connections. The other connections are non-domestic connection and are not associated with agriculture.



Figure 2.1 – Ballycallan GWS Water Abstraction Compound

2.1 Existing Infrastructure

The total length of the distribution network is 15km (15,100m). This network consists of mainly a 4" diameter watermains but there are also 2" and 3" diameter sections of the watermain.

The Ballycallan GWS is supplied by a borehole. The borehole is located in a small fenced off grassed area in the corner of the Kilmanagh village GAA grounds and beside the road. The Kings River flows adjacent to the Ballycallan GWS water abstraction compound.

The top of the borehole is located in an above ground, concrete block-built chamber fitted with a metal lid. This is illustrated in Figure 2.1. The ground level elevation of the borehole is 105m OD. The total depth of the borehole is 108m deep. The daily abstraction rate estimated by the GWS is 290m³/day.

The scheme pumps to a 455m³ (100,000 gallon) capacity reservoir in Knockeenglass (to the east of Kilmanagh village) from where it feeds into the distribution network. This reservoir is illustrated in Figure 2.2. There are water level sensors within the reservoir which control the pumping system. The pump is set to operate at circa 15.5 m³/hr, and pumps for an average of circa 10.5 hours per day. The reservoir has the capacity to hold approximately 2.5 days' supply.

EPS carry out maintenance of the reservoir, water treatment and pumping set-up. Pumping is carried out via a duty/standby pump set-up.

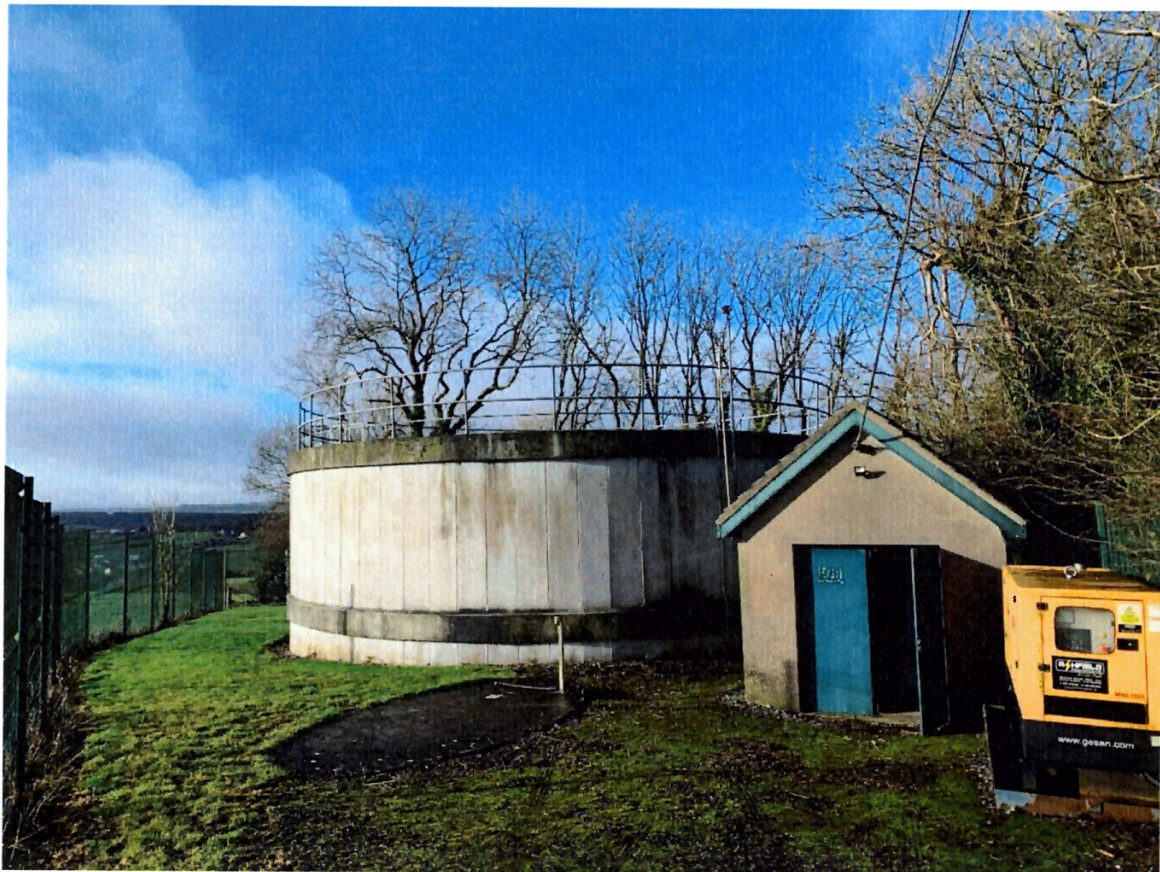


Figure 2.2 Ballycallan GWS chlorine contact tank.

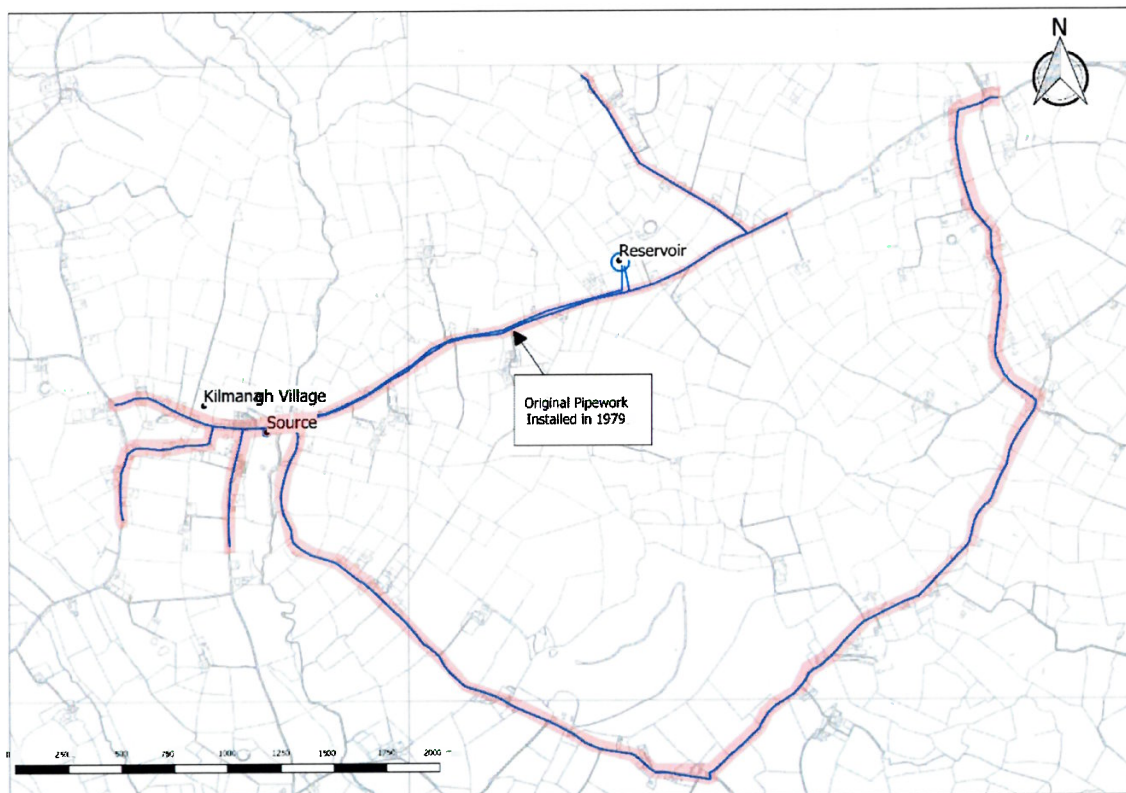


Figure 2.3 – Ballycallan Distribution Network Illustrating Mains Replacement.

Figure 2.3 illustrates the mains network, while repairs have been carried out on the network due to leaks, the majority of the distribution network is the original pipework. This original pipework was installed in 1979.

The pumping equipment is housed within the Ballycallan GWS reservoir compound as shown in Figure 2.1. Water is pumped throughout the network via a duty/standby pump set up.

In total there are 9 bulk meters on the distribution network. The bulk meter data for the flow that leaves the reservoir into the distribution network was made available to TOBIN for this preliminary report. Figure 2.4 illustrates the location of this bulk meter on the distribution network.

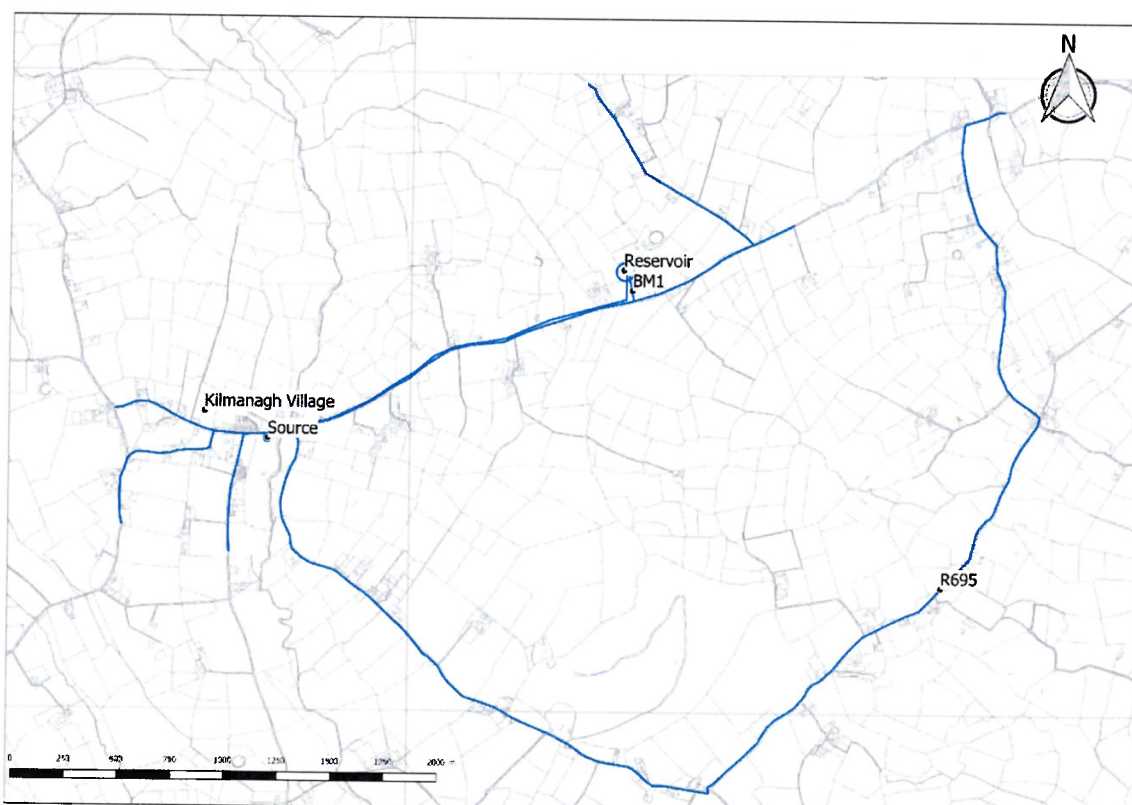


Figure 2.4 – Bulk Meter Locations (Ballycallan GWS)

The following table outlines the bulk meter data available for BM1:

Table 1 - Bulk Meter Data

Bulk Meter Tag	2018 (m ³ /year)	2019 (m ³ /year)	2020 (m ³ /year)
BM1	74,677	67,563	90,403

The data collected for 2020 is for a 12-month period. There was an average monthly flow rate of 7,534 m³/month in 2020.

The data collected for 2019 is for a 12-month period. There was an average monthly flow rate of 5,630 m³/month in 2019.

The data collected for 2018 is for a 12-month period. There was an average monthly flow rate of 6,223 m³/month in 2018.

There are an estimated 13 scour valves/washout hydrants on the distribution network.

There are two air valves on the distribution network.

2.1.1 Water Treatment

The Ballycallan GWS water treatment process includes chlorination followed by filtration.

The chlorination system operates on an automatic pump changeover system. The dosing pumps are arranged in a duty/standby system, and the duty designation is switched between pumps at regular intervals to avoid long periods of inactivity for any dosing pumps.

Minor particle filtration is carried at the Ballycallan GWS.

The Ballycallan GWS have undertaken raw water quality and treated water quality and a detailed log of these tests has been kept. Results of raw water quality testing from 2018 is shown in Appendix 2.

The presence of coliform bacteria and E.Coli have not been indicated in historical treated water quality tests carried out for the GWS. Coliforms were not present in the treated water indicating that the treatment system is working adequately.

Manganese levels in recent raw water quality tests were 330 µg/L. The limit for manganese levels in drinking water is 50 µg/L.

Historically, the GWS have had issues with the presence of manganese in the raw water. The manganese presence has caused issues with the pipework that travels from the borehole outside Kilmanagh village to the reservoir. When manganese is present in the water it can cause the water to turn to a brown/orange and or black colour. The rising main pipework from the source to the reservoir has been professionally cleaned to remove the manganese residue but this is not a permanent fix. As the source of the manganese appears to come from the water source, treatment of the water is required to reduce manganese levels and the effects the manganese is having on the rising main pipework. Effective treatment of manganese concentration is usually carried out by a treatment system incorporating oxidation and filtration of the water.

EPS look after the water treatment system for the Ballycallan GWS. This includes operation and maintenance.

3.0 OVERVIEW OF CAPITAL WORKS IN RELATION TO THE MARWP FRAMEWORK 2019-2021

The Multi-Annual Rural Water Programme (MARWP) 2019-2021, delivers improvements to private domestic water services in areas of rural Ireland where there are no public (Irish Water) water services.

The strategic objective of the Rural Water Programme is to, through various measures, improve the quality, reliability, and efficiency of water services for rural dwellers where Irish Water services are not available.

There are 8 funding measures within the MARWP;

- Source Protection (GWS Sector)
- Public Health Compliance (GWS Sector)
- Enhancement of existing schemes including water conservation
- New Group Water Schemes (GWS)
- Transition of existing GWS and Group Sewerage Schemes (GSS) to the Public Water Sector
- Community Connections (Water and Wastewater)
- Innovation and Research
- Individual Wells (more commonly known as private or household wells) and on-site wastewater treatment systems (more commonly known as septic tanks).

3.1 Overview of Works Carried out under the MARWP

Ballycallan GWS has had bulk meters recently fitted on the distribution network under the current MARWP.

The GWS has undertaken other significant works since the establishment of the rural water programme. This other works included repairing leaks on the distribution network.

4.0 BALLYCALLAN GWS REVIEW

4.1 Source Protection

Routine untreated groundwater monitoring should be continued at the source. The raw water should be tested for coliform bacteria. Nitrate levels in the untreated groundwater should also be continued to be monitored.

Oxidation and filtration treatment of the raw water would reduce the presence of manganese in the water. This would reduce the adverse effects the manganese is having on the infrastructure. This treatment system would be required at the Ballycallan GWS water abstraction compound.

4.2 Treatment Infrastructure

The existing treatment process utilises a chlorination system and filtration, Maintenance of this equipment should be continually maintained to ensure adequate treatment of the raw water is achieved.

No UV treatment is provided. This poses a possible cryptosporidium contamination risk for the GWS. A UV treatment system should be considered by the Ballycallan GWS.

4.3 Water Conservation

Water conservation guidance and action should be continually promoted within the Ballycallan GWS to reduce energy costs and water usage for its members.

Readings of the meters on the GWS should be frequently taken to understand water usage in the network and prevent large water loss due to leakage.

Billings on water usage should be continued to be implemented. Where customers exceed the 160m³/yr allowance, the policy of the GWS is that they are charged per m³ usage above this allowance.

4.4 UFW Figures

Table 1 outlines the water usage and unaccounted for water (UFW) for the Ballycallan GWS for 2020.

According to Irish Water, a sustainable economic level of leakage is estimated to be in the range of 18-22%¹ or below.

¹ <https://www.water.ie/docs/WSSP-Water.pdf>

Table 2 - UFW Calculations

Year	Domestic and non-Domestic Water Usage	Bulk Meter Flows	UFW (%)	Rate/km (m ³ /d/km)
2020	60,939 (m ³ /year)	90,403 (m ³ /year)	32.6	5.35

The calculated UFW (32.6%) for the Ballycallan GWS is above the recommended sustainable economic level of leakage.

4.5 Mains Replacement

The UFW calculated for the Ballycallan GWS, using the bulk meter flow and metered domestic and non-domestic data for 2020, has been calculated as 32.6%. This would indicate that there are major leaks occurring on the distribution network.

To reduce the UFW in the network the pipework that is leaking should be replaced. This can be found with further analysis of the network, such as step testing or leak detection in the network. As the distribution network is nearing the end of its design life, a programme of mains replacement should be implemented with the goal of renewing the entire distribution network. This will further reduce the risk of leaks or burst occurring in the future.

4.1 Physical Amalgamation

Physical amalgamation is the joining of two or more group water schemes through physically connecting its watermains.

Due to the distance between the Ballycallan GWS and its nearest GWS within Cluster 3 (Cuffesgrange GWS – 4.1km away using the L1013 as the route) physical amalgamation of the scheme is not considered as a viable option.

5.0 RECOMMENDATIONS

Overall, the operation, maintenance and management of this scheme appears to be well run. The GWS is heavily reliant on a voluntary committee, specifically one or two members who are responsible for all day to management.

The majority of the distribution network is the original pipework installed in 1979. UFW figures are relatively high (32.6%) for the Ballycallan GWS. This high UFW figure would indicate that there are leaks occurring on the distribution network. A programme of mains replacement should be implemented with the goal of renewing the entire watermain network. This would significantly reduce the UFW figure and further reduce the risk of bursts occurring into the future.

While treated water quality in the network is considered to be of a good quality, the source presents issues with high manganese concentration. The main adverse effect this is having is the corrosion of the pipework infrastructure. Oxidation and filtration of the raw water at the source would reduce manganese levels and reduce the infrastructure corrosion that is occurring.

No UV treatment is carried out for the scheme. UV treatment protects against cryptosporidium bacteria which is a hazardous bacterium when consumed by humans. The installation of a UV treatment should be consider by the GWS.

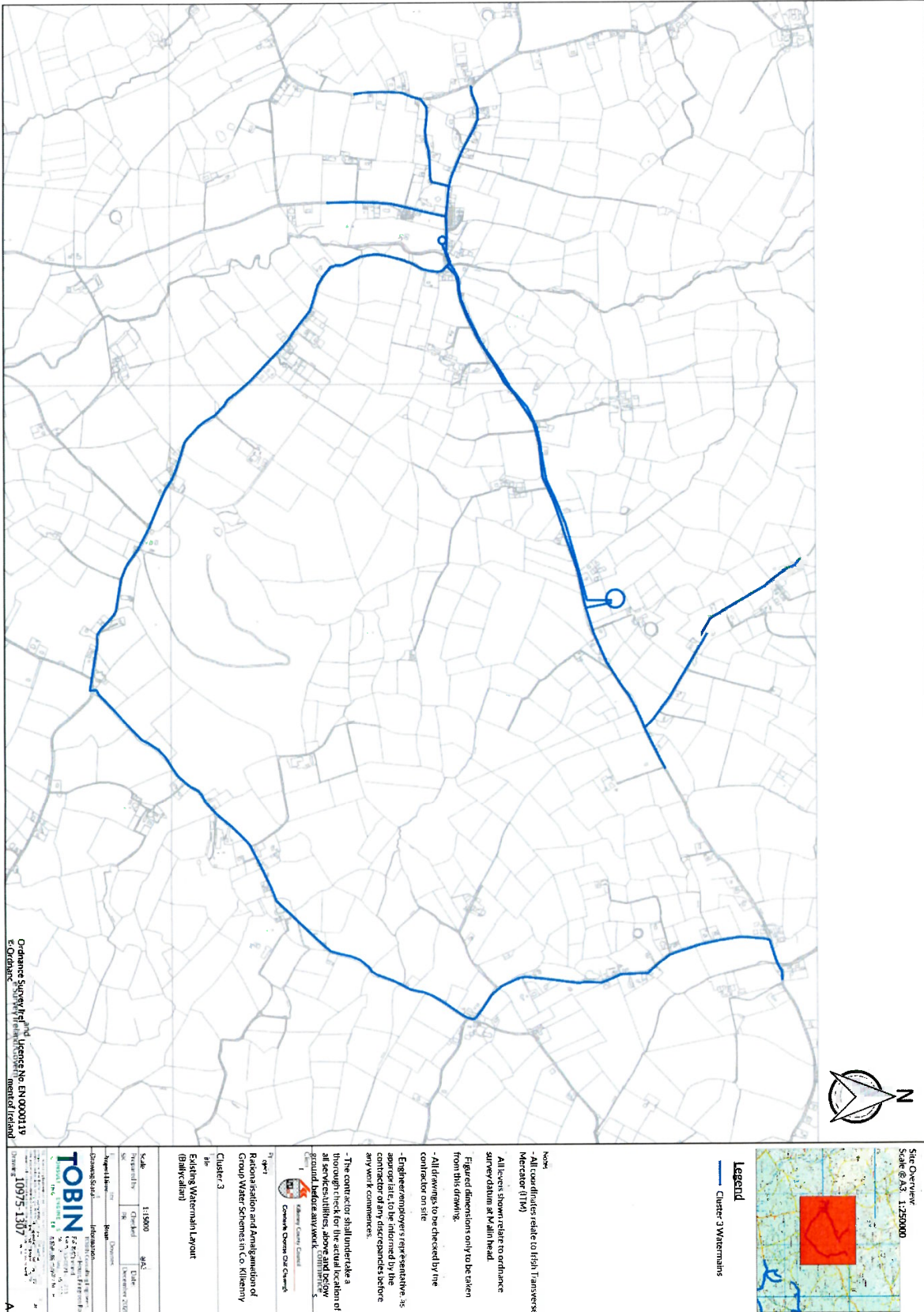
Amalgamation:

Physical Amalgamation of the Ballycallan GWS network is not seen as a viable option. The Ballycallan GWS is made up of 15.1km of varying diameter mains and the closest GWS to this network is the Cuffesgrange GWS. The Cuffesgrange GWS is approximately 4.1km away from the Newtown-Ovenstown GWS and is made up of 4.3km of 4" diameter mains.

Rationalisation:

The main advantage of the rationalisation process is the creation of a single co-operative entity which will incorporate a number of small GWSs leading to a more viable and sustainable scheme with a single management system. Such a system will eliminate the need for several quality assurance, administrative and maintenance structures. In many instances one catchment management plan will also suffice. The opportunity to employ a local manager and introduce a professional management system will dispense with the practice of small GWSs depending solely on the voluntary input of board members to manage the participating schemes separately. A dedicated manager will be available to deal with issues as they arise and to respond promptly to member complaints and system alarms. This in turn will greatly assist in complying with the stringent statutory and regulatory requirements demanded of drinking water supply services – regardless of size. The coming together of GWSs will allow for a more streamlined administrative system with one administrative base being sufficient across the rationalising schemes. GWS telemetric data and other monitoring and alarm systems can report to this one location. A single billing and member relations system and more modern communication technologies can be introduced with the costs distributed over the entire membership. Many operational costs such as accountancy, insurances, and engineering services will see an overall reduction and these costs will be shared over a larger membership base.

Appendix 1



Appendix 2

EPS
 Hacketstown
 Co Carlow

Report Version: 1

Site: Ballycallan
 Sample Description: Ballycallan Raw
 Sample Type: Surface
 Lab Reference Number: 421839

Date of Sampling: 11/12/2018
 Date Sample Received: 11/12/2018

Site / Method Ref.	Analysis Start Date	Parameter	Result	Units	PV Value (Drinking Water Only)
D/D3000#	12/12/2018	Alkalinity CaCO ₃	300.926	mg/l	-
D/D3000#	12/12/2018	Ammonia as NH ₄	0.122	mg/l	-
D/D3000#	12/12/2018	Chloride	15.833	mg/l	-
D/D3011#	11/12/2018	Conductivity @ 20°C	597.0	uS/cm @20°C	-
D/D3000#	12/12/2018	Nitrate as NO ₃	< 8.900	mg/l	-
EW188#*	-	Iron	< 20.0	ug/l	-
EW188#*	-	Magnesium	28.5	mg/L	-
EW188#*	-	Manganese	330	ug/L	-
EW188#*	-	Potassium	4.9	mg/L	-
EW188#*	-	Sodium	44.8	mg/L	-
EW188#*	-	Total Hardness	315	mg/L CaCO ₃	-
D/D1041#	11/12/2018	PH	7.36	pH Unit	-
D/D3054#	12/12/2018	Turbidity	0.14	NTU	-
D/D1201#	11/12/2018	Coliforms	< 1.0	MPN/100ml	-
D/D3221#	11/12/2018	Faecal Coliforms	< 1	cfu/100ml	-

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