

Glenmore Source

**Extracted from:
County Kilkenny Groundwater Protection Scheme,
Volume II: Source Protection Zones (Draft. May 2002)**

County Kilkenny

Groundwater Protection Scheme

Volume II: Source Protection Zones

(Draft. May 2002)

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Table of Contents

Sections 1 to 6 are contained within Volume I. They comprise an overall introduction, classifications of aquifers and vulnerability, and overall conclusions.

7. GROUNDWATER QUALITY.....	4
7.1 INTRODUCTION	4
7.2 SCOPE	4
7.3 METHODOLOGY	9
7.4 GROUNDWATER OCCURRENCE AND EXPLOITATION IN COUNTY KILKENNY	11
7.5 INDICATORS OF GROUNDWATER CONTAMINATION	12
7.6 GENERAL GROUNDWATER QUALITY ASSESSMENT OF SUPPLY SOURCES	20
7.7 APPRAISAL OF WATER QUALITY ISSUES AT SPECIFIC SUPPLY SOURCES	21
7.8 CONCLUSIONS.....	21
7.9 RECOMMENDATIONS	22
7.10 ACKNOWLEDGEMENTS.....	23
8. BENNETTSBRIDGE SOURCE	24
8.1 INTRODUCTION	24
8.2 LOCATION AND SITE DESCRIPTION	24
8.3 SUMMARY OF SOURCE DETAILS	25
8.4 METHODOLOGY	25
8.5 TOPOGRAPHY AND SURFACE HYDROLOGY	26
8.6 GEOLOGY AND AQUIFERS	26
8.7 GROUNDWATER VULNERABILITY	27
8.8 RAINFALL, EVAPORATION AND RECHARGE	28
8.9 GROUNDWATER LEVELS	29
8.10 GROUNDWATER FLOW DIRECTIONS AND GRADIENTS	29
8.11 WATER QUALITY	30
8.12 AQUIFER PARAMETERS	31
8.13 CONCEPTUAL MODEL.....	32
8.14 DELINEATION OF SOURCE PROTECTION AREAS.....	32
8.15 LAND USE AND POTENTIAL POLLUTION SOURCES	34
8.16 CONCLUSIONS AND RECOMMENDATIONS.....	35
9. CALLAN SOURCE	36
9.1 INTRODUCTION	36
9.2 LOCATION AND SITE DESCRIPTION	36
9.3 SUMMARY OF SOURCE DETAILS	36
9.4 METHODOLOGY	37
9.5 TOPOGRAPHY AND SURFACE HYDROLOGY	37
9.6 GEOLOGY AND AQUIFERS.....	38
9.7 GROUNDWATER VULNERABILITY	39
9.8 RAINFALL, EVAPORATION AND RECHARGE	39
9.9 GROUNDWATER DISCHARGE AND GROUNDWATER LEVELS	40
9.10 GROUNDWATER FLOW DIRECTIONS AND GRADIENTS	40
9.11 HYDROCHEMISTRY AND WATER QUALITY	41
9.12 AQUIFER PARAMETERS	42
9.13 CONCEPTUAL MODEL.....	42
9.14 DELINEATION OF SOURCE PROTECTION AREAS.....	43
9.15 GROUNDWATER PROTECTION ZONES	44
9.16 LAND USE AND POTENTIAL POLLUTION SOURCES	44
9.17 CONCLUSIONS AND RECOMMENDATIONS.....	45
10. GLENMORE SOURCE	46
10.1 INTRODUCTION.....	46
10.2 LOCATION AND SITE DESCRIPTION.....	46
10.3 SUMMARY OF SOURCE DETAILS.....	47

10.4	METHODOLOGY.....	47
10.5	TOPOGRAPHY AND SURFACE HYDROLOGY	48
10.6	GEOLOGY AND AQUIFERS	48
10.7	GROUNDWATER VULNERABILITY.....	49
10.8	RAINFALL, EVAPORATION AND RECHARGE.....	49
10.9	GROUNDWATER LEVELS.....	50
10.10	GROUNDWATER FLOW DIRECTIONS AND GRADIENTS.....	50
10.11	HYDROCHEMISTRY AND WATER QUALITY.....	50
10.12	AQUIFER PARAMETERS	51
10.13	CONCEPTUAL MODEL.....	52
10.14	DELINEATION OF SOURCE PROTECTION AREAS.....	52
10.15	GROUNDWATER PROTECTION ZONES	54
10.16	LAND USE AND POTENTIAL POLLUTION SOURCES	54
10.17	CONCLUSIONS AND RECOMMENDATIONS.....	55
11.	PAULSTOWN SOURCE	56
11.1	INTRODUCTION.....	56
11.2	LOCATION AND SITE DESCRIPTION.....	56
11.3	SUMMARY OF SOURCE DETAILS.....	56
11.4	METHODOLOGY.....	56
11.5	TOPOGRAPHY AND SURFACE HYDROLOGY	57
11.6	GEOLOGY AND AQUIFERS	57
11.7	GROUNDWATER VULNERABILITY.....	59
11.8	RAINFALL, EVAPORATION AND RECHARGE.....	60
11.9	GROUNDWATER LEVELS.....	61
11.10	GROUNDWATER FLOW DIRECTIONS AND GRADIENTS.....	61
11.11	HYDROCHEMISTRY AND WATER QUALITY.....	61
11.12	AQUIFER PARAMETERS	62
11.13	CONCEPTUAL MODEL.....	63
11.14	DELINEATION OF SOURCE PROTECTION AREAS.....	63
11.15	GROUNDWATER PROTECTION ZONES	65
11.16	LAND USE AND POTENTIAL POLLUTION SOURCES	66
11.17	CONCLUSIONS AND RECOMMENDATIONS.....	66
12.	PILTOWN / FIDDOWN SOURCE.....	67
12.1	INTRODUCTION.....	67
12.2	LOCATION AND SITE DESCRIPTION.....	67
12.3	SUMMARY OF SOURCE DETAILS.....	67
12.4	METHODOLOGY.....	68
12.5	TOPOGRAPHY AND SURFACE HYDROLOGY	68
12.6	GEOLOGY AND AQUIFERS	68
12.7	GROUNDWATER VULNERABILITY.....	69
12.8	RAINFALL, EVAPORATION AND RECHARGE.....	70
12.9	GROUNDWATER LEVELS.....	70
12.10	GROUNDWATER FLOW DIRECTION AND GRADIENTS.....	70
12.11	HYDROCHEMISTRY AND WATER QUALITY.....	71
12.12	AQUIFER PARAMETERS	72
12.13	CONCEPTUAL MODEL.....	72
12.14	DELINEATION OF SOURCE PROTECTION AREAS.....	73
12.15	GROUNDWATER PROTECTION ZONES	75
12.16	LAND USE AND POTENTIAL POLLUTION SOURCES	75
12.17	CONCLUSIONS AND RECOMMENDATIONS.....	76
13.	THOMASTOWN SOURCE.....	77
13.1	INTRODUCTION.....	77
13.2	LOCATION AND SITE DESCRIPTION.....	77
13.3	SUMMARY OF SOURCE DETAILS.....	78
13.4	METHODOLOGY.....	78
13.5	TOPOGRAPHY AND SURFACE HYDROLOGY	79
13.6	GEOLOGY AND AQUIFERS	79

13.7	GROUNDWATER VULNERABILITY.....	80
13.8	RAINFALL, EVAPORATION AND RECHARGE.....	81
13.9	GROUNDWATER LEVELS.....	82
13.10	GROUNDWATER FLOW DIRECTIONS AND GRADIENTS.....	82
13.11	HYDROCHEMISTRY AND WATER QUALITY.....	83
13.12	AQUIFER PARAMETERS.....	83
13.13	CONCEPTUAL MODEL.....	84
13.14	DELINEATION OF SOURCE PROTECTION AREAS.....	85
13.15	GROUNDWATER PROTECTION ZONES.....	86
13.16	LAND USE AND POTENTIAL POLLUTION SOURCES.....	87
13.17	CONCLUSIONS AND RECOMMENDATIONS.....	87
14.	URLINGFORD/JOHNSTOWN SOURCE.....	88
14.1	INTRODUCTION.....	88
14.2	LOCATION AND SITE DESCRIPTION.....	88
14.3	SUMMARY OF SOURCE DETAILS.....	88
14.4	METHODOLOGY.....	89
14.5	TOPOGRAPHY AND SURFACE HYDROLOGY.....	89
14.6	GEOLOGY AND AQUIFERS.....	89
14.7	GROUNDWATER VULNERABILITY.....	90
14.8	RAINFALL, EVAPORATION AND RECHARGE.....	91
14.9	GROUNDWATER LEVELS.....	92
14.10	GROUNDWATER FLOW DIRECTIONS AND GRADIENTS.....	92
14.11	HYDROCHEMISTRY AND WATER QUALITY.....	92
14.12	AQUIFER PARAMETERS.....	93
14.13	CONCEPTUAL MODEL.....	93
14.14	DELINEATION OF SOURCE PROTECTION AREAS.....	94
14.15	GROUNDWATER PROTECTION ZONES.....	95
14.16	LAND USE AND POTENTIAL POLLUTION SOURCES.....	95
14.17	CONCLUSIONS AND RECOMMENDATIONS.....	96
15.	GRAIGUENAMANAGH.....	98
15.1	INTRODUCTION.....	98
15.2	LOCATION AND SITE DESCRIPTION.....	98
15.3	SUMMARY OF SOURCE DETAILS.....	98
15.4	METHODOLOGY.....	98
15.5	TOPOGRAPHY AND SURFACE HYDROLOGY.....	99
15.6	GEOLOGY AND AQUIFERS.....	99
15.7	GROUNDWATER VULNERABILITY.....	99
15.8	RAINFALL, EVAPORATION AND RECHARGE.....	100
15.9	GROUNDWATER LEVELS.....	100
15.10	GROUNDWATER FLOW DIRECTIONS AND GRADIENTS.....	100
15.11	HYDROCHEMISTRY AND WATER QUALITY.....	100
15.12	AQUIFER PARAMETERS.....	100
15.13	CONCEPTUAL MODEL.....	100
15.14	DELINEATION OF SOURCE PROTECTION AREAS.....	101
15.15	GROUNDWATER PROTECTION ZONES.....	102
15.16	LAND USE AND POTENTIAL POLLUTION SOURCES.....	102
15.17	CONCLUSIONS AND RECOMMENDATIONS.....	102
16.	GROUP SCHEME, DOMESTIC AND INDUSTRIAL GROUNDWATER SUPPLIES.....	1
	REFERENCES.....	2

APPENDIX IV: Discussion of the key indicators of domestic and agricultural contamination of groundwater

APPENDIX V: Laboratory analytical results

APPENDIX VI: Summary of trends in water quality over time for selected supply sources in Kilkenny

Overall conclusions are contained within Volume I.

10. Glenmore Source

10.1 Introduction

The objectives of this chapter are:

- To delineate source protection zones for the Glenmore Water Supply Scheme.
- To outline the principal hydrogeological characteristics of the Glenmore area.
- To assist Kilkenny County Council in protecting the water supply from contamination.

The protection zones are delineated to help prioritise certain areas around the source in terms of pollution risk to the spring. This prioritisation is intended to provide a guide in the planning and regulation of development and human activities. The implications of these protection zones are further outlined in ‘Groundwater Protection Schemes’ (DELG/EPA/GSI, 1999).

10.2 Location and Site Description

The location of the Glenmore spring source is shown on Map 8. The well-house for the supply lies in Weatherstown townland some 2 km to the north of Glenmore. Flow from the source is gravity fed into the well-house, where it is chlorinated and then gravity-fed down to Glenmore. The location of the source itself is less obvious than that of the well-house. On the basis of the configuration of pipework to the well-house, Council staff have indicated that the spring is located by the side of the road some 125 m north of the well-house, below a small crescent-shaped, natural cutting in the road-side bank. The source may be associated with a Holy Well spring, which lies less than 100 m downslope and on the opposite side of the road from this cutting.

The well-house is located alongside a small stream, and excess flow from the spring is discharged to the stream via an overflow pipe, 15 m downstream of the well-house and 1 m above the stream bed. Another pipe enters the stream 2 m upstream of the well-house and 0.3 m above the stream bed, but this only discharges when the supply to the village is turned off, or when flow conditions are particularly high.

Reportedly, no protective structures have been built around the spring itself, so it is likely to be vulnerable to infiltration inundation by roadside runoff. The well-house chlorination tank is known to have been inundated by the adjacent stream at least once in the past year.

10.3 Summary of Source Details

	Weatherstown Spring
GSI no.	2611NWW094
Grid ref. (1:25,000)	26539 12460
Townland	Weatherstown
Source type	Spring
Development date	1930's
Owner	Kilkenny County Council
Elevation (ground level)	80 to 85 m OD
Depth to rock	Less than 3 m
Static water level	At surface
Discharge summary:	
(i) average consumption*	20 m ³ /d
(ii) measured overflow**	210 m ³ /d, 130 m ³ /d, 60 m ³ /d
(iii) Estimated total discharge***	230 m ³ /d to 90 m ³ /d

* Figure taken from a report produced by M.C. O'Sullivan Consulting Engineers (1999) for Kilkenny County Council.

**Measurements were taken by GSI staff on 12/4/00, 31/5/00 and 3/10/00 respectively (refer to Section 10.4.2).

***The higher of the two values is taken from estimated consumption added to the highest measured overflow. The lower value is taken from the dry weather yield cited in by M.C. O'Sullivan Consulting Engineers (1999).

10.4 Methodology

10.4.1 Desk Study

Bedrock geology information was compiled from original 1:10560 (six inch) field sheets and from the GSI bedrock report for the area (Tietzsch-Tyler and Sleeman, 1994b). Details of the current abstraction rate were obtained from a report produced by M.C. O'Sullivan Consulting Engineers (1999) for Kilkenny County Council (refer to Section 10.3). Data on private groundwater wells in the area were taken from GSI archives and additional information on the source was obtained from anecdotal information supplied by Kilkenny County Council staff. Data on existing water quality were obtained from the County Council/Health Board (treated waters).

10.4.2 Site Visits and Field Work

- Site visits and fieldwork included walkover surveys undertaken by both the Groundwater (3 days) and Quaternary (1 day) sections of the GSI to further investigate the subsoil and bedrock geology, the hydrogeology, and the vulnerability to contamination.
- A raw water sample was taken on 04/10/00 by GSI staff and was submitted for analysis at the EPA laboratories in Kilkenny in accordance with their sampling and transportation guidelines. Additional samples could not be taken because of restrictions during the Foot and Mouth crisis of 2001.
- Measurements of the overflow from the spring were taken by GSI staff on 12/4/00, 31/5/00 and 3/10/00. The overflow is piped to the adjacent stream and measurements were made by timing the filling of a 13.5 litre vessel from this pipe. Each measurement comprises an average of at least 3 individual readings.

10.4.3 Assessment

Analytical equations and hydrogeological mapping were utilised to delineate protection zones around the source.

10.5 Topography and Surface Hydrology

The Glenmore source is located 3.5 km west of the River Barrow, and 2 km north of Glenmore Village (see Map 8). A small stream flows within 20 m of the source, and it continues down to Glenmore where it joins the Glenmore River and flows into the Barrow 2 km east of Glenmore.

The spring occurs on the floor of a narrow NW-SE trending valley. Where the spring emerges, the valley floor lies at 80 m to 90 m OD and is just under 1 km wide. The stream which occupies the valley originates in steep hills which rise to over 200 m O.D some 1.5 km to the north-west of the spring. These hills form part of the catchment divide between the Nore and the Barrow river basins. Closer to the spring, the watersheds of the valley lie at approximately 100 m OD.

Slopes are approximately 0.1 (1 in 10) on the steeper valley sides in the north of the catchment, and approximately 0.05 (1 in 20) on the valley sides in the vicinity of the Glenmore source.

There is a streamflow gauge on the Glenmore River at Glenmore. Low flows¹¹ at this station are of the order of 0.023 m³/sec (EPA, 2001).

10.6 Geology and Aquifers

10.6.1 Bedrock

The main rock types in the vicinity of the Glenmore source are the Oaklands and Ballylane Formations. These formation are described in more detail in Chapters 2 and 4 of Volume I and their distribution in the vicinity of the Glenmore source is shown on Map 8.

In Section 4.6 of Volume I, the Oaklands Formation is classified as a **locally important aquifer** which is **moderately productive only in local zones (LI)**, while the Ballylane Formation is classified as a **poor aquifer** which is **generally unproductive except for local zones (PI)**. Fracture flow is expected to be dominant in these aquifers. Flows are expected to be concentrated in fractured and weathered zones. Given common weathering patterns, most flow is thought to be relatively shallow; concentrating in the top 10 m to 30 m of the rock profile. More detail on flow characteristics and aquifer classification criteria can be found in Volume I.

The structural geology of both these formations is related. In the Glenmore area, the rocks have been folded into a SW-NE trending syncline (downward fold in the rock mass). The axis of the syncline runs just to the south of the spring, and fracturing is likely to be associated with it. A NE-SW trending fault line is mapped close to the spring. This fault may be associated with more extensive weathering and fracturing and may therefore be a focus for groundwater flow to the spring (refer to Map 8).

The rocks of both formations dip towards the axis of the syncline at between 40° and 80°.

10.6.2 Subsoil

The main subsoil type is glacial till. This material is described in more detail in Chapter 3 of Volume I and its distribution in the vicinity of the Glenmore source is shown on Map 2S.

There are no subsoil materials classified as aquifers in the Glenmore area. The main significance of the subsoil materials, therefore, is in vulnerability and recharge assessments. These issues are described in Sections 10.7 and 10.8.

¹¹Flow which is equalled or exceeded at least 95% of the time.

10.7 Groundwater Vulnerability

The concept of vulnerability is discussed in Chapter 5 of Volume I. In essence, however, groundwater vulnerability is dictated by the nature and thickness of the material overlying the main groundwater 'target'. As discussed in Section 10.6, the main groundwater resource occurs within fractured bedrock. Consequently, the target is taken from the top of the bedrock formations, and considerations of groundwater vulnerability concern the permeability of the whole subsoil profile and the depth to bedrock.

The subsoil in the immediate vicinity of the Glenmore source is thought to be generally less than 3 m thick. This interpretation is based on the presence, across the surface water sub-catchment to the north of the source, of at least 11 rock outcroppings (2 of which are in excess of 200 m long). No relevant borehole data is available to the GSI.

At subsoil thicknesses of less than 3 m, bulk permeability becomes less relevant in mapping vulnerability across wide areas (as opposed to specific sites), because the permeability becomes increasingly variable and increasingly influenced by the presence of 'bypass flow' mechanisms such as cracks in the subsoil. Accordingly, on the basis of the general depth to bedrock in the area, a vulnerability classification of 'extreme' has been assigned for the whole sub-catchment to the north of the spring.

The permeability estimations are based on regional-scale evaluations. Depth to rock interpretations are based on the available data cited here. However, permeability and particularly depth to rock can vary over a very small scale. Consequently, the vulnerability mapping provided will not be able to anticipate all the natural variation that occurs in an area. The mapping is intended only as a guide to land use planning and hazard surveys, and is not a substitute for site investigation for specific developments. Classifications may change as a result of investigations such as trial hole assessments for on-site domestic wastewater treatment systems. The potential for discrepancies between large scale vulnerability mapping and site-specific data has been anticipated and addressed in the development of groundwater protection responses (site suitability guidelines) for specific hazards. More detail can be found in 'Groundwater Protection Schemes' (DELG/EPA/GSI, 1999).

10.8 Rainfall, Evaporation and Recharge

The term 'recharge' refers to the amount of water replenishing the groundwater flow system. Recharge is generally estimated on an annual basis, and is assumed to consist of an input (i.e. annual rainfall) less water losses (i.e. annual evapotranspiration and runoff). The estimation of recharge is critical in source protection delineation as it largely dictates the size of the zone of contribution.

In areas where point recharge from sinking streams, etc, is discounted, the main parameters involved in recharge rate estimation are annual rainfall, annual evapotranspiration, and annual runoff:

- Annual rainfall: 1080 mm, data from Met Éireann average annual (1961-90) rainfall records, measured at Mullinavat Garda Station.
- Annual evapotranspiration losses: 480 mm. This figure ('actual evapotranspiration') was calculated assuming 95% of the country-wide potential evapotranspiration data presented in the "Agroclimatic Atlas of Ireland" (Collins and Cummins, 1996). Local measurements of actual evapotranspiration are not available.
- Potential recharge: 600 mm/year, based on average annual rainfall less estimated evapotranspiration.
- Annual runoff losses: 480 mm/year (80% of potential recharge). This estimation is based on the fact that, due to the poor nature of the aquifer and generally steep slopes, only a small proportion of the potential recharge will enter groundwater. Quantifying the precise proportion which enters groundwater is difficult, and an estimation of 20% has been used, based on work at the Piltown source (refer to Section 12.13). Given the thin subsoils

(thinner subsoils normally allow more groundwater recharge), it is thought that this estimation is conservative and at the lower reasonable limit of groundwater recharge.

These calculations are summarised below¹²:

Average annual rainfall (R)	1080 mm
Estimated A.E.	480 mm
Potential Recharge (R – A.E.)	600 mm
Runoff losses factor (RO)	80%
Estimated Actual Recharge (R-A.E.)*(1-R.O)	120 mm

10.9 Groundwater levels

The GSI database has no records within the surface water sub-catchment upstream of the Glenmore source. However, the fact that the source is a spring suggests water levels are close to ground surface in the vicinity. Further, the generally poor nature of the aquifers in the sub-catchment suggests that that water tables will be generally close to ground levels across most of the area. This is supported by visual evidence of field drainage in the vicinity of the source.

Given the thin subsoils, it is likely that groundwater within the upper, weathered portion of the aquifer is generally unconfined.

10.10 Groundwater Flow Directions and Gradients

In the absence of borehole data, and given the aquifer conditions (refer to Sections 10.6 and 10.9), the water table in the area is assumed to reflect topography, with groundwater flowing south westwards to the spring from the watersheds in Rickardsland and Weatherstown townlands. The Glenmore source, and the associated Holy Well spring, both lie on the eastern side of the stream and it is thought unlikely that significant groundwater flows will pass underneath the stream from the sub-catchment watersheds to the west. It is likely that the spring is formed at the intersection of a large mapped fault (refer to Section 10.6) and the surface water stream. Flows in large fault zones may occur deeper than in the upper weathered zone alone. However, given the generally poor nature of the aquifer, it is assumed that even flows within the fault will not cross underneath the surface watershed in Weatherstown townland.

Groundwater gradients are difficult to calculate because of the limited well water level data available. However, assuming that water levels are close to the ground surface, it is thought that hydraulic gradients will be similar to, but slightly less than, topographic gradients. Accordingly, a hydraulic gradient of 0.05 (1 in 20) is considered to represent a reasonable, if conservative, estimate of hydraulic gradient in the vicinity of the Glenmore source.

10.11 Hydrochemistry and Water Quality

Data on recent trends in water quality at the Glenmore source are summarised graphically in Figure 10.1, and the original data can be found in Appendix V.

The following key points have been identified from the data:

- Three analyses of hardness were available. Results indicate a ‘moderately soft’ to ‘moderately hard’ water (91 to 144 mg/l CaCO₃). This is considered typical of the non-limestone rocks in the Southern Uplands of Kilkenny; particularly in areas where the subsoil cover is thin. Naturally soft waters are often associated with problems due to low pH, and M.C. O’Sullivan Consulting Engineers (1999) indicate that the water in the source is acidic and likely to attack and tuberculate the cast iron network in the distribution system.

¹²Estimations rounded off to two significant figures.

- Some 34 chemical and 24 bacteriological analyses (one of which was from a raw¹³ water sample) have been obtained, and results are depicted in Figure 10.1. The dominant features are elevated nitrate and elevated faecal coliforms. Of the 34 nitrates results, 32 analyses reported concentrations in excess of the guide level of 25 mg/l NO₃, with 6 results close to or in excess of 50 mg/l NO₃. Of the faecal coliforms, most were in excess of 1 count/100 ml. In addition, one of the four available ammonia results is in excess of the guide level of 0.15 mg/l, while all 15 chloride results are close to the guide level of 25 mg/l to 30 mg/l. This combination of results suggests that contamination from organic wastes is occurring in groundwaters feeding the spring. It is likely that the organic wastes comprise domestic wastewater treatment systems (including 'septic tanks') and/or landspreading of animal wastes. In addition, the presence of consistently elevated nitrate concentrations mean that inorganic fertilisers cannot be ruled-out as a contributory hazard.

Faecal coliform and ammonia are usually readily attenuated in the soil/subsoil. Therefore, the occurrence of high ammonia and high faecal coliforms in groundwater would often suggest that contamination is occurring from underground point hazards (such as septic tank systems) rather than from hazards at the ground surface (e.g. landspreading). However, given the generally thin subsoils near the Glenmore source (rock at or close to surface in places), it is likely that the natural attenuation capacity is limited and it is possible that faecal coliforms and ammonia are able to reach groundwater from hazards at the ground surface. In addition, spring sources often have high faecal coliforms as a result of wildfowl activity or surface water inundation. Thus, even though faecal coliforms and ammonia are elevated in some of the available samples, it is not possible to isolate the main organic waste hazard at the Glenmore source using water quality data alone. Further assessments are provided in Section 10.16.

10.12 Aquifer Parameters

The main aquifer parameters of significance are permeability and porosity. Together with groundwater gradients, these parameters are used to estimate the extent of the inner source protection area in Section 10.14.3.

The data used in this section are mainly estimations based on our understanding of the likely flow-regimes in the Oaklands and Ballylane aquifer systems. No pump-test data were available in the immediate vicinity of the Glenmore source, but well grant scheme pump tests for each of the formations were used to assist in the assessment. Well 2611NWW092 is situated in the Ballylane Formation, 1.5 km north-west of spring, while well 2611NWW091 is located in the Oaklands Formation, 7 km to the north-east of the spring.

In 2611NWW092, a constant discharge test in 1998 at 22 m³/day for 6 hours gave a final drawdown of 9.2 m, and a very low specific capacity of 2.4 m³/day/m. Analysis of the data from this test using the Logan method (Misstear 1998) provided a transmissivity estimate of 5.4 m²/d.

In 2611NWW091 a discharge test at 30 m³/day for 4 hours gave a final drawdown of 6.1 m, and a low specific capacity of 4.9 m³/day/m. Analysis of the data from this test using the Logan method provided a transmissivity estimate of 9 m²/d.

The estimated bulk permeability of the aquifer feeding groundwater to the Glenmore source is 0.9 m/day. This has been derived by dividing the higher of the two transmissivity estimates (9 m²/d) by the lower limit of assumed aquifer thickness (10 m). It is thought that this value therefore represents a conservative, but reasonable, estimate of bulk permeability.

Bulk porosity is assumed to be in the order of 0.01. This is at the lower end of the typical range used by the GSI for bedrock aquifers (0.025 to 0.01) and reflects the possibility that the aquifer is not densely fractured near the spring.

¹³ Raw water samples are taken prior to treatment. Assessments are aimed at identifying contamination hazards rather than direct human health issues.

10.13 Conceptual Model

This section provides a qualitative overview of the geological framework, recharge, flow and discharge patterns across the aquifer contributing groundwater to the source. It represents a summary of the main inferences drawn in previous sections, and provides a foundation upon which the quantitative analyses required for delineating source protection areas can be drawn.

- The source at Glenmore is a low yielding spring, discharging a few hundred cubic metres per day. The source lies within the surface water sub-catchment of a small, un-named stream to the north of Glenmore, which drains into the River Barrow.
- The spring occurs at the downstream limit of a poor (PI) aquifer, and may be associated with a zone where a large, mapped fault intersects the stream.
- Subsoils are dominated by tills which are expected to be less than 3 m thick across most of the surface water sub-catchment upstream of the spring.
- The aquifer is thought to be unconfined in the area and flow to the springs is controlled by fracturing and weathering patterns within the rock mass. Most groundwater flow is thought to be relatively shallow; concentrating in the top 10 m to 30 m of the rock profile and in the mapped fault zone. The flow is therefore likely to follow local variations in topography, but will generally be south westwards.
- Recharge to the spring is likely to originate as rainfall on the eastern half of the surface water sub-catchment upstream of the spring. Given the poor nature of the aquifer, most effective rainfall will divert to surface water and it is assumed that only 20% of the effective rainfall (i.e. 120 mm/year) which falls on the eastern half of the sub-catchment will enter groundwater and flow to the spring.
- The nature of the aquifer is such that groundwater residence times and groundwater flow paths are believed to be short. Even flows within the large mapped fault are not expected to cross underneath surface watersheds, or underneath the stream which runs close to the spring.
- Due to their low bulk permeabilities, groundwater gradients in the aquifer are probably similar to topographic gradients, and are estimated to be up to 0.05 (1 in 20).

10.14 Delineation of Source Protection Areas

10.14.1 Introduction

This section delineates the areas around the source that are believed to contribute groundwater to the source, and that therefore require protection. The areas are delineated on the basis of the conceptualisation of the groundwater flow pattern as described in Section 10.13.

Two source protection areas are delineated:

- Inner Protection Area (SI), designed to give protection from microbial pollution;
- Outer Protection Area (SO), encompassing the remainder of the zone of contribution (ZOC) of the source.

10.14.2 Outer Protection Area

The Outer Protection Area (SO) is bounded by the complete catchment area to the source, i.e. the zone of contribution (ZOC), and is defined as the area required to support an abstraction from long-term recharge. The ZOC is controlled primarily by (a) the groundwater flow direction and gradient, (b) the rock permeability and (c) the recharge in the area. The ZOC is delineated using both analytical modelling and the results of hydrogeological mapping and conceptualisation. Given the limited amount of calibration data available, a full groundwater numerical model was not undertaken.

The larger the total discharge at a source, the larger the ZOC will be in order to balance recharge with discharge. In order to be conservative, therefore, the largest measured discharge (230 m³/day) was used as the basis for estimating the extent of the ZOC.

Given that groundwater flow in the area is expected to follow topography, the ZOC is likely to coincide, or lie within, the physical constraints of the surface water sub-catchment upstream of the spring. These constraints are outlined below:

- **Northern boundary:** Catchment divide between the Nore and the Barrow in Ballyvoulera townland, approximately 1.5 km north of the Glenmore spring.
- **Southern boundary:** This boundary is downgradient of the spring. In theory, springs will draw no water from areas downgradient of their location. However, irregularities caused by the dominance of fracture flow within the aquifer and by the relationship between surface water and groundwater mean that this may not strictly apply at Glenmore. In order to account for some of these irregularities, the southern boundary has been placed at an arbitrary distance of 100 m downgradient of the spring.
- **Western boundary:** The stream running down the centre of the valley.
- **Eastern boundary:** Watershed running from Ballyvoulera southwards through Weatherstown and into Rickardsland South. This watershed lies 350 m to the east of the spring at its closest point. It has been mapped using a combination of Ordnance Survey contour information, field walkovers, and areal photograph interpretation.

The area defined by the boundaries described above is 0.7 km². A water balance should provide a cross-check on whether lands outside the boundaries are supplying groundwater to the spring. Calculations are as follows:

Recharge area required to sustain discharge = Discharge ÷ average annual depth of recharge.

Recharge area required to sustain discharge = (230 × 365) ÷ 0.12

Recharge area required to sustain discharge = 0.7 km²

Thus, there appears to be a good balance between the recharge area required, and the area which lies within the physical constraints of the surface water sub-catchment upstream of the spring. Though the discharge and recharge figures quoted in these calculations are both estimates, they have both been selected to be conservative in the context of requiring a large area to balance recharge with discharge. The agreement between the water balance and physical constraints is therefore taken to suggest that the physical constraints outlined above provide a reasonable basis for the delineation of the ZOC at the Glenmore source. The ZOC (i.e the extent of the SO, or ‘Outer Protection Area’) is depicted on Map 10.

10.14.3 Inner Protection Area

The Inner Protection Area (SI) is the area defined by a 100 day time of travel (TOT) to the source from a point below the water table and it is delineated to protect against the effects of potentially contaminating activities which may have an immediate influence on water quality at the source, in particular from microbial contamination.

Estimations of the extent of this area cannot be made by hydrogeological mapping and conceptualisation methods alone. Analytical modelling was therefore used to estimate the extent of this zone upgradient of the well.

Subject to certain assumptions and conditions, Darcy’s Law can be used to approximate groundwater flow velocities, as follows:

$$\text{Velocity} = \text{groundwater gradient} \times \text{permeability} \div \text{porosity}$$

Using the estimates derived in Sections 10.10 and 10.12 for gradient, permeability, and porosity (0.05, 0.9 m/day, and 0.01 respectively), the equation gives a velocity of 4.5 m/day. This could be treated as a ‘reasonable worst case estimate’. In other words, though some very rapid flow paths may occur, it is

thought that most groundwater will move up to 450 m in 100 days. Accordingly, the boundary of the SI has been delineated 450 m upgradient of the springs (refer to Map 10).

10.15 Groundwater Protection Zones

The groundwater protection zones are obtained by integrating the source protection areas and vulnerability categories – giving a possible total of 8 source protection zones (see the matrix in the table below). In practice, this is done by superimposing the vulnerability map on the source protection area map. Each zone is represented by a code, e.g. **SI/H**, which represents an Inner Source Protection area where the groundwater is highly vulnerable to contamination. All of the hydrogeological settings represented by the zones may not be present around any given source. Just two groundwater protection zones are present around the Glenmore source (see Map 10), as shown in the matrix below.

Matrix of Source Protection Zones

VULNERABILITY RATING	SOURCE PROTECTION	
	<i>Inner</i>	<i>Outer</i>
<i>Extreme (E)</i>	SI/E	SO/E
<i>High (H)</i>	<i>not present</i>	<i>not present</i>
<i>Moderate (M)</i>	<i>not present</i>	<i>not present</i>
<i>Low (L)</i>	<i>not present</i>	<i>not present</i>

The appropriate responses imposing restrictions on development are presented in the document ‘Groundwater Protection Schemes’ (DELG/EPA/GSI, 1999).

10.16 Land Use and Potential Pollution Sources

Agriculture in the area mainly comprises pasture and there are a number of farms in the area. Glenmore itself is a village of just over 100 people, and with a number of small commercial enterprises, one of which contains a petrol pump.

On the basis of the available water quality analyses, the main hazards within the ZOC are considered to be effluent from on-site wastewater treatment systems (including ‘septic tanks’), and agricultural landspreading of organic and inorganic fertiliser. However, the full range of contaminants were not examined and other potential hazards include fuel storage, roadside spillages, pesticide application, and farmyards.

The nitrate concentrations are consistently elevated and merit some additional consideration. Some broad, ‘back-of-the-envelope’ estimations of the number of domestic wastewater treatment systems required to produce the measured nitrogen loading in the spring are provided below:

- Typical nitrogen concentration in spring flow: 10 mg/l N
- Typical ‘background’ nitrogen concentration¹⁴: 3 mg/l N
- Estimated additional contribution of nitrogen from human activities in the ZOC: $10 - 3 = 7$ mg/l N
- Minimum estimated total spring flow: 90,000 l/day.
- Estimated minimum nitrogen loading in spring: $90,000 \times 7 \div 1000,000 \approx 0.6$ kg/day N.
- Estimated ‘natural’ nitrogen loading in recharge waters¹⁵: 0.1 mg/l N @ 90,000 l/day \rightarrow 0.009 kg/day N.

¹⁴ Taken as the typical concentration in Piltown spring, which lies in a similar hydrogeological and climatological environment.

¹⁵ Loading estimates taken from EPA, 2000. The figures assume no denitrification and subsequent attenuation of nitrogen will occur in the subsurface.

- *Estimated additional loading from human activities in the ZOC = $0.6 - 0.009 \approx 0.6$ kg/day N.*
- *Assuming all additional loading is derived from septic tanks, the population equivalent of the additional septic tank loading: $0.6 \text{ kg/day N @ } 50 \text{ mg N/l/person @ } 180 \text{ l effluent/person/day} \approx 70 \text{ people}$.*

In other words, it is estimated that the waste from at least 70 people living in the ZOC would be required to balance all the nitrogen loading observed in the spring waters. The ZOC is estimated to be 0.7 km^2 , and 100 people within this area comprises a density of 1 person/hectare. Note that the ZOC crosses the townlands of Weatherstown, Busherstown and Rickardsland South, but does not incorporate Glenmore village itself. Note also that the calculations have used the minimum estimated spring flow ($90 \text{ m}^3/\text{day}$) and have assumed that all the nitrogen from the septic tanks is converted to nitrate. In practice, some of the nitrogen will not become mobile in the subsurface, and there is evidence that average springflows are greater than $90 \text{ m}^3/\text{day}$. Consequently, the population density suggested by these ‘back-of-the-envelope’ estimations comprises a minimum number required to balance the observed nitrogen concentrations if septic effluent were the only influence on nitrate concentrations at the source.

If the actual population density is significantly lower than 1 person/hectare, the water quality data suggests that agricultural landspreading of organic wastes and inorganic fertilisers will require consideration as a significant influence on nitrate concentrations in the Glenmore spring.

10.17 Conclusions and Recommendations

- ◆ The source at Glenmore is a low yielding spring, which is located in a poor aquifer.
- ◆ Groundwater below the zone of contribution to the supply is generally ‘extremely’ vulnerable to contamination. However, future site-specific investigations may indicate that localised patches of lower vulnerability also occur.
- ◆ The protection zones delineated in this chapter are based on our current understanding of groundwater conditions and on the available data. Additional data obtained in the future may indicate that amendments to the boundaries are necessary.
- ◆ It is recommended that:
 - chemical and bacteriological analyses of raw water as well as treated water be carried out regularly. Given some of the raw water quality issues at the source, a monthly frequency has been recommended in Section 7.9. This high frequency is required because of the elevated nitrate and bacterial levels in the source. The chemical analyses should include all major ions - calcium, magnesium, sodium, potassium, ammonium, bicarbonate, sulphate, chloride, and especially nitrate. More occasional analyses of other parameters such as pesticides and hydrocarbons is also recommended;
 - care should be taken in allowing any activities or developments which might significantly increase nitrate levels;
 - the spring should be located and its vulnerability to surface runoff assessed; for example, in the context of animal fouling or chemical spills along the adjacent road. If the spring is intended for long term use, a protective structure would help minimise the risk;
 - the potential hazards in the ZOC should be located and assessed.

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Appendix IV: Discussion Of the Key Indicators of Domestic and Agricultural Contamination of Groundwater

A.1 Introduction

This appendix is adapted from Daly, 1996.

There has been a tendency in analysing groundwater samples to test for a limited number of constituents. A "full" or "complete" analysis, which includes all the major anions and cations, is generally recommended for routine monitoring and for assessing pollution incidents. This enables (i) a check on the reliability of the analysis (by doing an ionic balance), (ii) a proper assessment of the water chemistry and quality and (iii) a possible indication of the source of contamination. A listing of recommended and optional parameters are given in Table A1. It is also important that the water samples taken for analysis have not been chlorinated - this is a difficulty in some local authority areas where water take-off points prior to chlorination have not been installed.

The following parameters are good contamination indicators: E.coli, nitrate, ammonia, potassium, chloride, iron, manganese and trace organics.

TABLE A1

Recommended Parameters		
Appearance	Calcium (Ca)	Nitrate (NO ₃)*
Sediment	Magnesium (Mg)	Ammonia (NH ₄ and NH ₃)*
pH (lab)	Sodium (Na)	Iron (Fe)*
Electrical Conductivity (EC)*	Potassium (K)*	Manganese (Mn)*
Total Hardness	Chloride (Cl)*	
General coliform	Sulphate (SO ₄)*	
E. coli *	Alkalinity	
Optional Parameters (depending on local circumstances or reasons for sampling)		
Fluoride (F)	Fatty acids *	Zinc (Zn)
Orthophosphate	Trace organics *	Copper (Cu)
Nitrite (NO ₂)*	TOC *	Lead (Pb)
B.O.D.*	Boron (B) *	Other metals
Dissolved Oxygen *	Cadmium (Cd)	
* good indicators of contamination		

A.2 Faecal Bacteria and Viruses

E. coli is the parameter tested as an indicator of the presence of faecal bacteria and perhaps viruses; constituents which pose a significant risk to human health. The most common health problem arising from the presence of faecal bacteria in groundwater is diarrhoea, but typhoid fever, infectious hepatitis and gastrointestinal infections can also occur. Although *E. coli* bacteria are an excellent indicator of pollution, they can come from different sources - septic tank effluent, farmyard waste, landfill sites, birds. The faecal coliform : faecal streptococci ratio has been suggested as a tentative

indicator to distinguish between animal and human waste sources (Henry *et al.*, 1987). However, researchers in Virginia Tech (Reneau, 1996) cautioned against the use of this technique.

Viruses are a particular cause for concern as they survive longer in groundwater than indicator bacteria (Gerba and Bitton, 1984).

The published data on elimination of bacteria and viruses in groundwater has been compiled by Pekdeger and Matthess (1983), who show that in different investigations 99.9% elimination of *E. coli* occurred after 10-15 days. The mean of the evaluated investigations was 25 days. They show that 99.9% elimination of various viruses occurred after 16-120 days, with a mean of 35 days for Polio-, Hepatitis, and Enteroviruses. According to Armon and Kott (1994), pathogenic bacteria can survive for more than ten days under adverse conditions and up to 100 days under favourable conditions; enteroviruses can survive from about 25 days up to 170 days in soils.

Bacteria can move considerable distances in the subsurface, given the right conditions. In a sand and gravel aquifer, coliform bacteria were isolated 100 ft from the source 35 hours after the sewage was introduced (as reported in Hagedorn *et al.*, 1981). They can travel several kilometres in karstic aquifers. In Ireland, research at Sligo RTC involved examining in detail the impact of septic tank systems at three locations with different site conditions (Henry, 1990; summarised in Daly, Thorn and Henry, 1993). Piezometers were installed down-gradient; the distances of the furthest piezometers were 8 m, 10 m and 9.5 m, respectively. Unsurprisingly, high faecal bacteria counts were obtained in the piezometers at the two sites with soakage pits, one with limestone bedrock at a shallow depth where the highest count (max. 14 000 cfu's per 1000 ml) and the second where sand/gravel over limestone was present (max 3 000 cfu's per 100 ml). At the third site, a percolation area was installed at 1.0 m b.g.l; the subsoils between the percolation pipes and the fractured bedrock consisted of 1.5 m sandy loam over 3.5 m of poorly sorted gravel; the water table was 3.5 b.g.l. (So this site would satisfy the water table and depth to rock requirements of S.R.6:1991, and most likely the percolation test requirement.) Yet, the maximum faecal coliform bacteria count was 300 cfus per 100 ml. Faecal streptococci were present in all three piezometers. It is highly likely that wells located 30 m down gradient of the drainage fields would be polluted by faecal bacteria.

As viruses are smaller than bacteria, they are not readily filtered out as effluent moves through the ground. The main means of attenuation is by adsorption on clay particles. Viruses can travel considerable distances underground, depths as great as 67 m and horizontal migrations as far as 400 m have been reported (as reported in US EPA, 1987). The possible presence of viruses in groundwater as a result of pollution by septic tank systems is a matter of concern because of their mobility and the fact that indicator bacteria such as faecal coliforms have been found not to correlate with the presence of viruses in groundwater samples (US EPA, 1987).

The natural environment, in particular the soils and subsoils, can be effective in removing bacteria and viruses by predation, filtration and absorption. There are two high risk situations: (i) where permeable sands and gravels with a shallow water table are present; and (ii) where fractured rock, particularly limestone, is present close to the ground surface. The presence of clayey gravels, tills, and peat will, in many instances, hinder the vertical migration of microbes, although preferential flow paths, such as cracks in clayey materials, can allow rapid movement and bypassing of the subsoil.

A.3 Nitrate

Nitrate is one of the most common contaminants identified in groundwater and increasing concentrations have been recorded in many developed countries. The consumption of nitrate rich water by young children may give rise to a condition known as methaemoglobinaemia (blue baby syndrome). The formation of carcinogenic nitrosamines is also a possible health hazard and epidemiological studies have indicated a positive correlation between nitrate consumption in drinking

water and the incidence of gastric cancer. However, the correlation is not proven according to some experts (Wild and Cameron, 1980). The EC MAC for drinking water is 50mg/l.

The nitrate ion is not adsorbed on clay or organic matter. It is highly mobile and under wet conditions is easily leached out of the rooting zone and through soil and permeable subsoil. As the normal concentrations in uncontaminated groundwater is low (less than 5 mg/l), nitrate can be a good indicator of contamination by fertilisers and waste organic matter.

In the past there has been a tendency in Ireland to assume that the presence of high nitrates in well water indicated an impact by inorganic fertilisers. This assumption has frequently been wrong, as examination of other constituents in the water showed that organic wastes - usually farmyard waste, probably soiled water - were the source. The nitrate concentrations in wells with a low abstraction rate - domestic and farm wells - can readily be influenced by soiled water seeping underground in the vicinity of the farmyard or from the spraying of soiled water on adjoining land. Even septic tank effluent can raise the nitrate levels; if a septic tank system is in the zone of contribution of a well, a four-fold dilution of the nitrogen in the effluent is needed to bring the concentration of nitrate below the EU MAC (as the EU limit is 50 mg/l as NO_3 or 11.3 mg/l as N and assuming that the N concentration in septic tank effluent is 45 mg/l).

The recently produced draft county reports by the EPA on nitrate in groundwater show high levels of nitrate in a significant number of public and group scheme supplies, particularly in south and southern counties and in counties with intensive agriculture, such as Carlow and Louth. This suggests that diffuse sources – landspreading of fertilisers – is having an impact on groundwater.

In assessing regional groundwater quality and, in particular the nitrate levels in groundwater, it is important that:

- (i) conclusions should not be drawn using data only from private wells, which are frequently located near potential point pollution sources and from which only a small quantity of groundwater is abstracted;
- (ii) account should be taken of the complete chemistry of the sample and not just nitrate, as well as the presence of *E. coli*;
- (iii) account should be taken of not only the land-use in the area but also the location of point pollution sources;
- (iv) account should be taken of the regional hydrogeology and the relationship of this to the well itself. For instance, shallow wells generally show higher nitrate concentrations than deeper wells, low permeability sediments can cause denitrification, knowledge on the groundwater flow direction is needed to assess the influence of land-use.

A.4 Ammonia

Ammonia has a low mobility in soil and subsoil and its presence at concentrations greater than 0.1 mg/l in groundwater indicates a nearby waste source and/or vulnerable conditions. The EU MAC is 0.3 mg/l.

A.5 Potassium

Potassium (K) is relatively immobile in soil and subsoil. Consequently the spreading of manure, slurry and inorganic fertilisers is unlikely to significantly increase the potassium concentrations in groundwater. In most areas in Ireland, the background potassium levels in groundwater are less than 3.0 mg/l. Higher concentrations are found occasionally where the rock contains potassium e.g. certain granites and sandstones. The background potassium:sodium ratio in most Irish groundwaters is less than 0.4 and often 0.3. The K:Na ratio of soiled water and other wastes derived from plant organic

matter is considerably greater than 0.4, whereas the ratio in septic tank effluent is less than 0.2. Consequently a K:Na ratio greater than 0.4 can be used to indicate contamination by plant organic matter - usually in farmyards, occasionally landfill sites (from the breakdown of paper). However, a K:Na ratio lower than 0.4 does not indicate that farmyard wastes are **not** the source of contamination (or that a septic tank is the cause), as K is less mobile than Na. (Phosphorus is increasingly a significant pollutant and cause of eutrophication in surface water. It is not a problem in groundwater as it usually is not mobile in soil and subsoil).

A.6 Chloride

The principle source of chloride in uncontaminated groundwater is rainfall and so in any region, depending on the distance from the sea and evapotranspiration, chloride levels in groundwater will be fairly constant. Chloride, like nitrate, is a mobile anion. Also, it is a constituent of organic wastes. Consequently, levels appreciably above background levels (12-15 mg/l in Co. Offaly, for instance) have been taken to indicate contamination by organic wastes such as septic tank systems. While this is probably broadly correct, Sherwood (1991) has pointed out that chloride can also be derived from potassium fertilisers.

A.7 Iron and manganese

Although they are present under natural conditions in groundwater in some areas, they can also be good indicators of contamination by organic wastes. Effluent from the wastes cause deoxygenation in the ground which results in dissolution of iron (Fe) and manganese (Mn) from the soil, subsoil and bedrock into groundwater. With reoxygenation in the well or water supply system the Fe and Mn precipitate. High Mn concentrations can be a good indicator of pollution by silage effluent. However, it can also be caused by other high BOD wastes such as milk, landfill leachate and perhaps soiled water and septic tank effluent.

Box A1 Warning/trigger Levels for Certain Contaminants

As human activities have had some impact on a high proportion of the groundwater in Ireland, there are few areas where the groundwater is in a pristine, completely natural condition. Consequently, most groundwater is contaminated to some degree although it is usually not polluted. In the view of the GSI, assessments of the degree of contamination of groundwater can be beneficial as an addition to examining whether the water is polluted or not. This type of assessment can indicate where appreciable impacts are occurring. It can act as a warning that either the situation could worsen and so needs regular monitoring and careful land-use planning, or that there may be periods when the source is polluted and poses a risk to human health and as a consequence needs regular monitoring. Consequently, thresholds for certain parameters can be used to help indicate situations where additional monitoring and/or source protection studies and/or hazard surveys may be appropriate to identify or prevent more significant water quality problems.

Parameter	Threshold mg/l	EU MAC mg/l
Nitrate	25	50
Potassium	4	12
Chloride	30 (except near sea)	250
Ammonia	0.15	0.3
K/Na ratio	0.3-0.4	
Faecal bacteria	0	0

Box A2 Summary : Assessing a Problem Area

Let us assume that you are examining an area with potential groundwater contamination problems and that you have taken samples in nearby wells. How can the analyses be assessed?

E. coli present ⇒ organic waste source nearby (except in karst areas), usually either a septic tank system or farmyard.

E. coli absent ⇒ either not polluted by organic waste or bacteria have not survived due to attenuation or time of travel to well greater than 100 days.

Nitrate > 25 mg/l ⇒ either inorganic fertiliser or organic waste source; check other parameters.

Ammonia > 0.15 mg/l ⇒ source is nearby organic waste; fertiliser is not an issue.

Potassium (K) > 5.0 mg/l ⇒ source is probably organic waste.

K/Na ratio > 0.4 (0.3, in many areas) ⇒ Farmyard waste rather than septic tank effluent is the source. If < 0.3, no conclusion is possible.

Chloride > 30 mg/l ⇒ organic waste source. However this does not apply in the vicinity of the coast (within 20 km at least).

In conclusion, faecal bacteria, nitrate, ammonia, high K/Na ratio and chloride indicate contamination by organic waste. However, only the high K/Na helps distinguish between septic tank effluent and farmyard wastes. So in many instances, while the analyses can show potential problems, other information is needed to complete the assessment.

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Appendix V: Laboratory analytical results

EPA Regional Water Laboratory, Kilkenny. Monitoring Data for County Kilkenny Groundwaters 1993 to 1999.

Source	Sampling Date	Sampling Time	To	Ref No	Sampling Location	Taken By	Lab No	EPARef	Stn Grid Ref	Water Supply	Public/Group/Private	Temperature	Odour 1/2/3	Colour Hazen	pH	Conductivity µS/cm	Turbidity NTU	TOC mg/l C	Ammonia mg/l N	
Spring at Paulstown Castle	29/04/1992	11:38:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		1648	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	9.1	1	5	7.3	623			0.03	
Spring at Paulstown Castle	01/07/1992	15:55:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		2681	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	11.4	1	5	7.4	640			0.02	
Spring at Paulstown Castle	20/08/1992	15:15:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		3737	KIK46	S 660 570	Gowran/Goresbr./P-town	Public		1	5	7.2	600			0.02	
Spring at Paulstown Castle	18/11/1992	13:29:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		5086	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	9.8	2	5	7.4	623			0.02	
Spring at Paulstown Castle	10/03/1993	16:00:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		1017	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	9.6	1	5	7.3	660			0.01	
Borehole at Castletomer Yarns	02/06/1993		Kilkenny Co. Co.	KK00300	Tap in yard at Castletomer Yarns	J. Keohane	2269		25360 17330	Castletomer Yarns	Private			1	15	7.5	570	1	< 1	0.01
Spring at Paulstown Castle	02/06/1993		Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle	J. Keohane	2270	KIK46	S 660 570	Gowran/Goresbr./P-town	Public		1	5	7.2	696	0.4	5.7	0.01	
Borehole at Rathcash	02/06/1993		Kilkenny Co. Co.	KK02000	Joe Pykes house, Rathcash, Clara.	J. Keohane	2271	KIK55	25870 15510	Rathcash	Group		1	5	7.3	682	0.2	< 1	0.01	
Springs at Bausheenmore	02/06/1993		Kilkenny Co. Co.	KK00500	At source (springs at Bausheenmore)	J. Keohane	2272	KIK39	25520 14690		Private		1	5	7.3	814	0.35	0.9	0.01	
Spring at Westcourt	02/06/1993		Kilkenny Co. Co.	KK00800	Spring at Earlsland, Westcourt, Callan	J. Keohane	2273	KIK91	S 407 442	Callan	Public		1	5	7.3	718	0.2	0.5	0.01	
Borehole at Galmoy	03/06/1993	11:25:00	Kilkenny Co. Co.	KK00200	Leahy's House, Galmoy	P.Mullins	2292	KIK17	23020 17120	Galmoy	Group	10	1	5	7.4	790	0.2	< 1	0.01	
Galmoy 35	03/06/1993	11:47:00	Kilkenny Co. Co.		M. Phelan	P.Mullins	2293				Private	10	1	5	7.4	792	0.15	< 1	0.01	
Galmoy 37	03/06/1993	12:02:00	Kilkenny Co. Co.		Mr. Tom Maher's House	P.Mullins	2294				Private	11	1	5	7.4	769	0.2		0.01	
Galmoy 25	03/06/1993	12:15:00	Kilkenny Co. Co.		Hennessy's at House	P.Mullins	2295				Private	10	1	5	7.3	894	0.25	0.2	0.01	
Galmoy 202	03/06/1993	12:55:00	Kilkenny Co. Co.		Phelans	P.Mullins	2296				Private	11	1	5	7.4	755	0.3	< 1	0.01	
Borehole at Bawnmore	03/06/1993	16:00:00	Kilkenny Co. Co.	KK00100	Phelan's house, Bawnmore	P.Mullins	2297	KIK50	22580 16610	Bawnmore	Group	12	1	5	7.3	820	0.2	0.14	0.01	
Spring at Clomantagh	10/06/1993	11:40:00	Kilkenny Co. Co.	KK00900	Beside Nuenna river, 50m SE of roac	P.Mullins+J.Keohane	2395		23520 16320		Private		1	5	7.3	664	0.3		0.01	
Spring at Clomantagh	10/06/1993	11:50:00	Kilkenny Co. Co.	KK00900	Beside Nuenna river, 50m SE of roac	P.Mullins+J.Keohane	2396		23520 16320		Private		1	5	7.3	677	0.35		0.01	
Borehole at Dunmore	10/06/1993	12:28:00	Kilkenny Co. Co.	KK00700	C. Murray's house, Dunmore.	P.Mullins+J.Keohane	2397		24910 16200	Dunmore	Group		1	5	7.4	676	0.2		0.01	
Spring Toberpatrick Urlingford	15/06/1993	10:45:00	Kilkenny Co. Co.	KK01500	In chamber at source	C. Murray	2417	KIK34	23000 16350	Urlingford/Johnstownr	Public		1	5	7.2	781	0.3	1.6	0.01	
Borehole at Kilmanagh	15/06/1993	12:00:00	Kilkenny Co. Co.	KK01400	In pumphouse	C. Murray	2418	KIK45	23930 15250	Kilmanagh/Ballycuddihy	Group		1	5	7.5	659	0.3		0.01	
Borehole at Dunmore S/G	15/06/1993	14:30:00	Kilkenny Co. Co.	KK01000	Canteen at Dunmore Sand & Gravel	C. Murray	2419	KIK53	25000 16020	Dunmore Sand & Gravel	Private		1	5	7.4	643	1.2	0.4	0.01	
Borehole at Kilkenny Mar	15/06/1993	15:00:00	Kilkenny Co. Co.	KK01300	Cattle holding shed	C. Murray	2420		25070 15670	Kilkenny Mart	Private		1	5	7.6	691	0.2	0.4	0.01	
Borehole at Windgar	01/07/1993		Kilkenny Co. Co.	KK01900	Overflow from borehole	C. Murray	2769		24200 13580	Farm supply	Private		1	5	7.2	382	1.5		0.37	
Spring at Paulstown Castle	05/08/1993	15:55:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		3294	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	11.6	1	5	7.3	680			0.01	
Galmoy	08/11/1993	11:15:00	Kilkenny Co. Co.		Leahy's House (A 82)	P.Mullins	4754			Galmoy	Group	8	1	5	7.3	806	0.09		0.01	
Galmoy	08/11/1993	11:45:00	Kilkenny Co. Co.		Parochial House	P.Mullins	4755			Galmoy	Private	9	1	5	7.3	725	0.09		0.01	
Galmoy	08/11/1993	12:20:00	Kilkenny Co. Co.		Phelans, original (A 35)	P.Mullins	4756			Galmoy	Private	8	1	5	7.1	996	0.21		0.01	
Galmoy	08/11/1993	12:40:00	Kilkenny Co. Co.		Brophy's (A 25)	P.Mullins	4757			Galmoy	Private	9	1	5	7.4	849	0.15			
Galmoy	08/11/1993	13:50:00	Kilkenny Co. Co.		Phelans (A 24)	P.Mullins	4758			Galmoy	Private	9	1	5	7.4	874	0.19		< 0.01	
Galmoy	08/11/1993	13:55:00	Kilkenny Co. Co.		Hennessy's	P.Mullins	4759			Galmoy	Private	9								
Galmoy	08/11/1993	14:44:00	Kilkenny Co. Co.		Gannons (A 36)	P.Mullins	4760			Galmoy	Private	9	1	5	7.3	864	0.13		< 0.01	
Galmoy	08/11/1993	14:52:00	Kilkenny Co. Co.		Maher's (A 37)	P.Mullins	4761			Galmoy	Private	9	1	5	7.3	816	0.14		< 0.01	
Borehole at Bawnmore	08/11/1993	15:15:00	Kilkenny Co. Co.	KK00100	Phelan's house, Bawnmore	P.Mullins	4762	KIK50	22580 16610	Bawnmore	Group	9	1	5	7.3	829	0.1		< 0.01	
Galmoy	08/11/1993	15:45:00	Kilkenny Co. Co.		Dan Phelan (A 202)	P.Mullins	4763			Galmoy	Private	9	1	5	7.3	739	0.07		< 0.01	
Spring Toberpatrick Urlingford	09/11/1993	11:45:00	Kilkenny Co. Co.	KK01500	In chamber at source	P. Mullins	4776	KIK34	23000 16350	Urlingford/Johnstownr	Public	10	2	< 5	7.3	808	0.22		0.01	
Borehole at Castletomer Yarns	09/11/1993	12:35:00	Kilkenny Co. Co.	KK00300	Tap in yard at Castletomer Yarns	P. Mullins	4777		25360 17330	Castletomer Yarns	Private	10	2	5	7.6	568	3.5		0.01	
Spring at Paulstown Castle	09/11/1993	14:40:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle	P. Mullins	4778	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	11	2	< 5	7.4	648	0.24		0.01	
Borehole at Clara	09/11/1993	15:15:00	Kilkenny Co. Co.	KK00400	At pumphouse	P. Mullins	4779	KIK41	25770 15530	Clara	Group	10	1	< 5	7.4	677	0.17	67.3	0.01	
Spring at Westcourt	09/11/1993	16:00:00	Kilkenny Co. Co.	KK00800	Spring at Earlsland, Westcourt, Callan	P. Mullins	4780	KIK91	S 407 442	Callan	Public	10	1	< 5	7.3	722	0.21		0.01	
Borehole at Dunmore	10/11/1993	10:30:00	Kilkenny Co. Co.	KK00700	C. Murray's house, Dunmore.	C.Murray	4796		24910 16200	Dunmore	Group	8.4	1	5	7.5	702	0.1		0.01	
Borehole at Dunmore S/G	10/11/1993	10:55:00	Kilkenny Co. Co.	KK01000	Canteen at Dunmore Sand & Gravel	C.Murray	4797	KIK53	25000 16020	Dunmore Sand & Gravel	Private	8.1	1	< 5	7.6	635	0.7		0.01	
Borehole at Kilkenny Mar	10/11/1993	11:15:00	Kilkenny Co. Co.	KK01300	Cattle holding shed	C.Murray	4798		25070 15670	Kilkenny Mart	Private	4.9	2	< 5	8	690	0.14		0.01	
Borehole at Kilmanagh	10/11/1993	12:22:00	Kilkenny Co. Co.	KK01400	In pumphouse	C.Murray	4799	KIK45	23930 15250	Kilmanagh/Ballycuddihy	Group	10	2	< 5	7.7	644	0.33		0.01	
Springs at Bausheenmore	10/11/1993	14:30:00	Kilkenny Co. Co.	KK00500	At source (springs at Bausheenmore)	C.Murray	4800	KIK39	25520 14690		Private	10.2	1	< 5	7.4	812	0.23		0.01	
Borehole No.9, Thomastown	10/11/1993	15:10:00	Kilkenny Co. Co.	KK01600	At pumphouse	C.Murray	4801	KIK32	25890 14160	Thomastown	Public	11	2	< 5	7.4	798	0.15		0.01	
Borehole at Windgar	10/11/1993	15:50:00	Kilkenny Co. Co.	KK01900	Overflow from borehole	C.Murray	4802		24200 13580	Farm supply	Private	10.8	1	< 5	7.5	375	0.32		0.01	
Borehole at Avonmore Dairy	11/11/1993	11:30:00	Kilkenny Co. Co.	KK01200	Holding tank on roof	C.Murray	4803			Avonmore Kilkenny City	Private		2	5	7.8	621	0.11		0.01	
Rathcash, Clifden,Co. Kilkenny	08/12/1993	09:45:00	Kilkenny Co. Co.		Joe Pykes	J.Keohane	5212			Rathcash	Group		1	5	7.4	711	0.17		< 0.01	
Spring at Paulstown Castle	10/11/1994	11:25:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		5072	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	9.8	1	5	7.1	680			0.08	
Graigue, Callan.	12/01/1995		Kilkenny Co. Co.		James Robinsons well	James Robinson	212			Proposed Supply for James Robinson	Private				< 5	7.6	528	14		
Spring at Paulstown Castle	23/01/1995	15:45:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		255	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	9.5		5		680			0.01	
Spring at Paulstown Castle	16/10/1995	15:23:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		4410	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	11.8	1	5	7.3	595			< 0.01	
Borehole at Castletomer Yarns	08/01/1996	11:10:00	Kilkenny Co. Co.	KK00300	Tap in yard at Castletomer Yarns	C. Murray	74		25360 17330	Castletomer Yarns	Private	11.6	2	20	7.4	583	5.5	2	< 0.01	
Borehole at Dunmore	08/01/1996	11:30:00	Kilkenny Co. Co.	KK00700	C. Murray's house, Dunmore.	C. Murray	75		24910 16200	Dunmore	Group	8	1	5	7.3	615	0.2	3.4	< 0.01	
Borehole at Dunmore S/G	08/01/1996	12:00:00	Kilkenny																	

EPA Regional Water Laboratory, Kilkenny. Monitoring Data for County Kilkenny Groundwaters 1993 to 1999.

Source	Sampling Date	Sampling Time	o-Phosphate mg/l P	Nitrate mg/l N	Nitrite mg/l N	Chloride mg/l Cl	Ca Hardness mg/l CaCO ₃	Alkalinity mg/l CaCO ₃	TCS	Total Coliforms per 100 ml	FCS	Fecal Coliforms per 100 ml	Sulphate mg/l SO ₄	Dry Residue mg/l	Sus_Solids mg/l	Magnesium mg/l Mg	Total Hardness mg/l CaCO ₃	Sodium mg/l Na	Potassium mg/l K	Aluminium mg/l Al	Iron mg/l Fe	Manganese mg/l Mn	Copper mg/l Cu	Zinc mg/l Zn	Chromium mg/l Cr	Lead mg/l Pb
Spring at Paulstown Castle	29/04/1992	11:38:00	0.04	6		29				78		44	2		5						< 0.05	< 0.02	< 0.03	< 0.01		
Spring at Paulstown Castle	01/07/1992	15:55:00	0.01	5		28				13		999			5						< 0.04	< 0.02	< 0.03	0.01		
Spring at Paulstown Castle	20/08/1992	15:15:00	0.02	4.3		28									5											
Spring at Paulstown Castle	18/11/1992	13:29:00	0.03	4.6		28				340		280			5											
Spring at Paulstown Castle	10/03/1993	16:00:00	0.02	6.8		38				20		5			5											
Borehole at Castlecomer Yarns	02/06/1993		0.05	0.1	0.006	20				999		999	7			23.8	242	33.1	1.4		0.011	0.009	< 0.001	0.015	< 0.001	< 0.001
Spring at Paulstown Castle	02/06/1993		0.06	8.2	0.005	30		305		999		999	< 1			12.3	355	9.1	3.2		0.051	0.006	< 0.001	< 0.005	< 0.001	< 0.001
Borehole at Rathcash	02/06/1993		0.08	7.2	0.001	24		317		15		1				22.3	359	8.4	1.5		0.033	0.004	< 0.001	0.02	< 0.001	< 0.001
Springs at Bausheenmore	02/06/1993		0.08	6.1	0.006	41		401		999		999	< 1			33.3	425	9.3	4.3		0.077	0.017	< 0.001	0.018	< 0.001	< 0.001
Spring at Westcourt	02/06/1993		0.05	3.8	0.002	24		370		64		21	< 1			27.8	383	9.8	1.2		0.012	< 0.005	< 0.001	< 0.005	< 0.001	< 0.001
Borehole at Galmoy	03/06/1993	11:25:00	0.01	9.4	0.002	29		350		999		999	4			83.2	399	17.1	2.7	0.027	0.026	< 0.005	0.063	0.036	< 0.001	0.011
Galmoy 35	03/06/1993	11:47:00	0.01	10	0.003	28		350		999		999	9			96.8	393	22.8	6.5	0.006	0.022	< 0.005	0.079	0.021	< 0.001	0.001
Galmoy 37	03/06/1993	12:02:00	0.01	5.7	0.002	21		379		999		999	3			84.8	393	20.2	2.2	0.02	0.015	< 0.005	0.111	0.05	< 0.001	0.005
Galmoy 25	03/06/1993	12:15:00	0.007	12	0.003	22		383		275		28	25			80	433	37.9	11.7	0.009	0.036	< 0.005	0.439	0.278	< 0.001	0.016
Galmoy 202	03/06/1993	12:55:00	0.005	5.7	0.003	22		359		20		18	7			58.8	375	26.2	10	0.019	0.021	0.012	0.151	0.027	< 0.001	< 0.001
Borehole at Bawnmore	03/06/1993	16:00:00	0.01	6	0.002	26		398		1		1	8			102	419	21.8	5.4	0.005	0.015	< 0.005	0.068	0.03	< 0.001	< 0.001
Spring at Clomantagh	10/06/1993	11:40:00	0.007	6.1	0.004	22		297		230			< 1			14.1	359	7.5	1.6		0.032	0.009	< 0.001	< 0.005	< 0.001	0.003
Spring at Clomantagh	10/06/1993	11:50:00	0.02	6.5	0.003	23		318		162			< 1			14.3	369	7.6	1.6		0.037	0.008	0.001	< 0.005	< 0.001	< 0.001
Borehole at Dunmore	10/06/1993	12:28:00	0.004	14	0.001	27		251		999		999	2			7.5	354	8.3	0.8		0.031	< 0.005	0.009	< 0.005	< 0.001	< 0.001
Spring Toberpatrick Urlingford	15/06/1993	10:45:00	0.01	7.6	0.005	27		383		34		15	8			22.2	400	9.1	4.7				0.004		< 0.001	
Borehole at Kilmanagh	15/06/1993	12:00:00	0.01	4.5	0.001	19		328		175		116	7			18.9	345	8.5	1.1			0.009			< 0.001	
Borehole at Dunmore S/G	15/06/1993	14:30:00	0.01	0.2	0.006	18		313		999		999	24			19.3	333	11.3	1				0.039		< 0.001	
Borehole at Kilkenny Mar	15/06/1993	15:00:00	0.01	6.3	0.002	18		296		43		20	32			20.8	355	11	1.5				0.03		< 0.001	
Borehole at Windgap	01/07/1993		0.02	1.6	0.001	14		137		999		999	< 1		Not Vis.	20	177	6.9	1.1		0.17	0.014		0.01		
Spring at Paulstown Castle	05/08/1993	15:55:00	0.02	6		27				85					5						0.019	< 0.005		0.025		
Galmoy	08/11/1993	11:15:00	< 0.01	10.2		34	309	389					8			30.6	435	8.6	1.1		0.041	< 0.005	< 0.001	0.031	0.0005	< 0.001
Galmoy	08/11/1993	11:45:00	< 0.01	4.4		20	247	378		999		999	11			35.9	395	11.5	1.7		0.03	< 0.005	< 0.001	0.021	0.0004	< 0.001
Galmoy	08/11/1993	12:20:00	< 0.01	5.3		59	384	470		6		999	10			27.4	497	18.6	10.3		0.036	< 0.005	0.006	0.034	0.0004	0.003
Galmoy	08/11/1993	12:40:00	0.003	7.2	0.01	24	300	437		24		999	14			38.1	457	12.7	1.8		0.055	0.002	< 0.001	0.062	0.0005	< 0.001
Galmoy	08/11/1993	13:50:00	0.004	15.1		34.6	288	387		999		999	14			38.7	448	13.4	9		0.032	< 0.005	0.014	0.178	0.0005	< 0.001
Galmoy	08/11/1993	13:55:00								50		7														
Galmoy	08/11/1993	14:44:00	0.008	12.7		28.7	342	415		100		2	8			24.5	443	13.9	9.1		0.044	0.016	< 0.001	0.681	0.0003	< 0.001
Galmoy	08/11/1993	14:52:00	0.007	8.8		26	309	416		999		999	7			32.4	443	8.6	1.4		0.051	< 0.005	0.002	0.026	0.0004	< 0.001
Borehole at Bawnmore	08/11/1993	15:15:00	< 0.01	6		27.6	315	434		1		1	9			33.6	454	9	2.2		0.025	< 0.005	0.005	0.015	0.0004	< 0.001
Galmoy	08/11/1993	15:45:00	0.006	6.4		18.3	305	389		999		999	6			22.6	398	8.7	2.7		0.038	< 0.005	0.008	0.017	0.0004	< 0.001
Spring Toberpatrick Urlingford	09/11/1993	11:45:00	0.01	8.5		27		395		100		21	8				403									
Borehole at Castlecomer Yarns	09/11/1993	12:35:00	0.01	0.2		19		278		1		999	12				229									
Spring at Paulstown Castle	09/11/1993	14:40:00	0.01	5.8		26		296		33		18	8				314									
Borehole at Clara	09/11/1993	15:15:00	0.01	6.8		21		325		167		2	8				340									
Spring at Westcourt	09/11/1993	16:00:00	0.01	4.3		24		370		4		3	5				368									
Borehole at Dunmore	10/11/1993	10:30:00	0.01	13.6		22		296		999		999	< 1			7.3	320	9.2	0.8		0.041	< 0.005	0.001	0.035		< 0.001
Borehole at Dunmore S/G	10/11/1993	10:55:00	0.01	0.1		17		297		84		27	12			17.5	300	12	0.9		0.106	0.229	0.003	0.043		< 0.001
Borehole at Kilkenny Mar	10/11/1993	11:15:00	0.01	6.6		18		307		8		6	19			19	324	12	1.3		0.087	0.013	0.003	0.487		< 0.001
Borehole at Kilmanagh	10/11/1993	12:22:00	0.01	5		19		293		8		2	< 1			16.2	300	9.3	0.9		< 0.005	0.001	0.001	0.06		< 0.001
Springs at Bausheenmore	10/11/1993	14:30:00	0.01	6.5		30		100		100		< 1				34	381	10.1	3.5		0.009	0.001	< 0.001	0.052		< 0.001
Borehole No.9, Thomastown	10/11/1993	15:10:00	0.02	7.3		41		999		999		999	2			25.4	350	18	3.5		0.017	0.002	0.002	0.565		0.001
Borehole at Windgap	10/11/1993	15:50:00	0.02	1.7		12		173		9		5	2			17	173	8	1		0.016	0.001	< 0.001	0.075		< 0.001
Borehole at Avonmore Dairy	11/11/1993	11:30:00	0.3	6.5		31		230		999		999	15			10.6	265	16.9	6.7		0.04	0.003	0.002	0.178		< 0.001
Rathcash, Clifden, Co. Kilkenny	08/12/1993	09:45:00	0.011	6	0.001	23		334		999		999	8			27.8	358	8.5	1.2		0.01	0.006	0.004	0.084		0.003
Spring at Paulstown Castle	10/11/1994	11:25:00	< 0.01	5.3		29				420		170			5											
Graigie, Callan.	12/01/1995							244								27.4	238	14.1	0.7		1.06	0.09	0.01	0.166		
Spring at Paulstown Castle	23/01/1995	15:45:00	0.01	7		25				500		290			5											
Spring at Paulstown Castle	16/10/1995	15:23:00	0.016	4		22				150		72			5											
Borehole at Castlecomer Yarns	08/01/1996	11:10:00		0.05	0.006	18.5		304		999		999	22			20.2	321	18.6	0.9		0.116	0.434		< 0.02		
Borehole at Dunmore	08/01/1996	11:30:00	< 0.001	9.5	< 0.003	20.9		257		999		999	20			6.1	338	7.7	0.8		< 0.06	< 0.02		< 0.02		
Borehole at Dunmore S/G	08/01/1996	12:00:00	< 0.001	< 0.01	0.004	19.3		311				999	36			17.5	355	11.2	0.9		< 0.06	0.15		< 0.02		
Borehole at Kilkenny Mar	08/01/1996	12:15:00	< 0.001	5.9	< 0.003	19.7		312		5		999	40			18.3	389	10.2	1.3		< 0.06	< 0.02		< 0.02		
Borehole at Clara	08/01/1996	12:55:00	0.01	6.9	< 0.003	22.3		340		65		2	18			19.9	409	8.1	1.4		&					

EPA Regional Water Laboratory, Kilkenny. Monitoring Data for County Kilkenny Groundwaters 1993 to 1999.

Source	Sampling Date	Sampling Time	Cadmium mg/l Cd	Mercury mg/l Hg	Nickel mg/l Ni	Fluoride mg/l F	OMCTSiloxane µg/l	Comments1	Comments2	Comments3
Spring at Paulstown Castle	29/04/1992	11:38:00								
Spring at Paulstown Castle	01/07/1992	15:55:00								
Spring at Paulstown Castle	20/08/1992	15:15:00								
Spring at Paulstown Castle	18/11/1992	13:29:00								
Spring at Paulstown Castle	10/03/1993	16:00:00								
Borehole at Castlecómer Yarns	02/06/1993		< 0.0001					Copy to Castlecómer Yarns Ltd.		
Spring at Paulstown Castle	02/06/1993		< 0.0001							
Borehole at Rathcash	02/06/1993		< 0.0001					Copy to Rathcash G.W.S.		
Springs at Bausheenmore	02/06/1993		< 0.0001							
Spring at Westcourt	02/06/1993		< 0.0001							
Borehole at Galmoy	03/06/1993	11:25:00	< 0.0001		0.007					
Galmoy 35	03/06/1993	11:47:00	0.0001		0.001					
Galmoy 37	03/06/1993	12:02:00	0.0001		< 0.001					
Galmoy 25	03/06/1993	12:15:00	0.0001		0.005					
Galmoy 202	03/06/1993	12:55:00	0.0001		< 0.001					
Borehole at Bawnmore	03/06/1993	16:00:00	0.0001		< 0.001					
Spring at Clomantagh	10/06/1993	11:40:00	< 0.0001							
Spring at Clomantagh	10/06/1993	11:50:00	< 0.0001							
Borehole at Dunmore	10/06/1993	12:28:00	< 0.0001							
Spring Toberpatrick Urlingford	15/06/1993	10:45:00	< 0.0001							
Borehole at Kilmanagh	15/06/1993	12:00:00	< 0.0001							
Borehole at Dunmore S/G	15/06/1993	14:30:00	< 0.0001							
Borehole at Kilkenny Mar	15/06/1993	15:00:00	< 0.0001							
Borehole at Windgap	01/07/1993									
Spring at Paulstown Castle	05/08/1993	15:55:00								
Galmoy	08/11/1993	11:15:00	< 0.0001		< 0.001					
Galmoy	08/11/1993	11:45:00	< 0.0001		< 0.001					
Galmoy	08/11/1993	12:20:00	< 0.0001		< 0.001					
Galmoy	08/11/1993	12:40:00	< 0.0001		< 0.001					
Galmoy	08/11/1993	13:50:00	< 0.0001		< 0.001					
Galmoy	08/11/1993	13:55:00						Taken after well was pumped for approximately 1 1/2 hours.		
Galmoy	08/11/1993	14:44:00	< 0.0001		< 0.001					
Galmoy	08/11/1993	14:52:00	< 0.0001		< 0.001					
Borehole at Bawnmore	08/11/1993	15:15:00	< 0.0001		< 0.001					
Galmoy	08/11/1993	15:45:00	< 0.0001		< 0.001					
Spring Toberpatrick Urlingford	09/11/1993	11:45:00								
Borehole at Castlecómer Yarns	09/11/1993	12:35:00								
Spring at Paulstown Castle	09/11/1993	14:40:00								
Borehole at Clara	09/11/1993	15:15:00						167 Total Coliforms, 5 obvious coliform colonies, 162 probably	coliform colonies.	
Spring at Westcourt	09/11/1993	16:00:00								
Borehole at Dunmore	10/11/1993	10:30:00	< 0.0001							
Borehole at Dunmore S/G	10/11/1993	10:55:00	< 0.0001							
Borehole at Kilkenny Mar	10/11/1993	11:15:00	< 0.0001							
Borehole at Kilmanagh	10/11/1993	12:22:00	< 0.0001					Copy to Mr. Liam Delaney.		
Springs at Bausheenmore	10/11/1993	14:30:00	< 0.0001							
Borehole No.9, Thomastown	10/11/1993	15:10:00	< 0.0001							
Borehole at Windgap	10/11/1993	15:50:00	< 0.0001							
Borehole at Avonmore Dairy	11/11/1993	11:30:00	< 0.0001					Chlorinated sample		
Rathcash, Clifden, Co. Kilkenny	08/12/1993	09:45:00	< 0.0001							
Spring at Paulstown Castle	10/11/1994	11:25:00								
Graigue, Callan.	12/01/1995		< 0.0003					High iron and elevated manganese levels leading to high turbidity.		
Spring at Paulstown Castle	23/01/1995	15:45:00						Interference < mixed background colonies (non-coliform) on Total	Coliform plate.	
Spring at Paulstown Castle	16/10/1995	15:23:00						Interference from background colonies on Total Coliform plate.		
Borehole at Castlecómer Yarns	08/01/1996	11:10:00								
Borehole at Dunmore	08/01/1996	11:30:00								
Borehole at Dunmore S/G	08/01/1996	12:00:00						Total Coliform plate overgrown with non-coliforms.		
Borehole at Kilkenny Mar	08/01/1996	12:15:00								
Borehole at Clara	08/01/1996	12:55:00						Copy to: Paddy Coogan, Clifden, Clara, Co. Kilkenny		
Borehole at Rathcash	08/01/1996	13:10:00						Copy to: Mr. Joe Pyke, Rathcash, Clifden, Co. Kilkenny.		
Spring at Paulstown Castle	08/01/1996	14:40:00								
Spring at Clomantagh	09/01/1996	10:40:00							Spring in farmyard, sample taken at surface.	
Spring Toberpatrick Urlingford	09/01/1996	11:05:00								
Borehole at Bawnmore	09/01/1996	11:30:00								

EPA Regional Water Laboratory, Kilkenny. Monitoring Data for County Kilkenny Groundwaters 1993 to 1999.

Source	Sampling Date	Sampling Time	To	Ref No	Sampling Location	Taken By	Lab No	EPAREf	Stn Grid Ref	Water Supply	Public/Group/Private	Temperature	Odour 1/2/3	Colour Hazen	pH	Conductivity µS/cm	Turbidity NTU	TOC mg/l C	Ammonia mg/l N
Borehole at Galmoy	09/01/1996	12:40:00	Kilkenny Co. Co.	KK00200	Leahy's House, Galmoy	C. Murray	92	KIK17	23020 17120	Galmoy	Group	8.6	1	5	7.3	779	0.1	1.8	<0.01
Borehole at Kilmanagh	09/01/1996	14:20:00	Kilkenny Co. Co.	KK01400	In pumphouse	C. Murray	93	KIK45	23930 15250	Kilmanagh/Ballycuddihy	Group	8.2	1	5	7.6	645	0.1	2.3	0.021
Spring at Westcourt	09/01/1996	15:10:00	Kilkenny Co. Co.	KK00800	Spring at Earlsland, Westcourt, Callan	C. Murray	94	KIK91	S 407 442	Callan	Public	11.1	1	5	7.3	704	0.1	2.9	<0.01
Borehole at Windgap	09/01/1996	15:40:00	Kilkenny Co. Co.	KK01900	Overflow from borehole	C. Murray	95		24200 13580	Farm supply	Private	11	1	5	7.4	380	0.2	<0.12	0.023
Spring at Carrigeen,	15/01/1996	13:00:00	Kilkenny Co. Co.		Keoghans Field, Threecastles	J. Jennings	135						2	15	8	1045			0.03
Belview	27/02/1996	14:15:00	Kilkenny County Council		Well No.2 for proposed new water supply	Brian Connor	763			Belview proposec				5	6.8	351			<0.01
Belview	29/02/1996	11:45:00	Kilkenny County Council		Well No.2 for proposed new water supply	Brian Connor	822			Belview proposec			1	5	6.7	359			<0.01
Belview No. 2	07/03/1996	16:00:00	Kilkenny Co Co		Belview Proposed water supply Well No. 2	Brian Connor	973						1	5	6.7	365			
Belview No. 2	14/03/1996	11:00:00	Kilkenny Co Co		Belview Proposed water supply Well No. 2	Brian Connor	1050						1	5	6.7	357			<0.01
Belview No. 2	23/03/1996	14:10:00	Kilkenny Co Co		Belview Proposed water supply Well No. 2	Brian Connor	1157						1	5	6.4	290			<0.01
Belview No. 1	25/03/1996	15:00:00	Kilkenny Co Co		Belview Proposed water supply Well No. 1	Brian Connor	1130						1	5	6.5	290	0.67		<0.01
Belview No. 1	27/03/1996	13:00:00	Kilkenny Co Co		Belview Proposed water supply Well No. 1	Brian Connor	1173						1	5	6.4	289			<0.01
Dunmore Wells	02/07/1996	10:10:00	Kilkenny Co. Co.		Readymix	C. Murray	2536						1	5	7.5	651		0.15	<0.01
Dunmore Wells	02/07/1996	10:15:00	Kilkenny Co. Co.		Leahy's	C. Murray	2537						1	10	8.3	413		<0.12	<0.01
Dunmore Wells	02/07/1996	10:15:00	Kilkenny Co. Co.		O'Dwyers	C. Murray	2538						2	5	7.5	513		<0.12	0.03
Dunmore Wells	02/07/1996	10:35:00	Kilkenny Co. Co.		Tom Langtons	C. Murray	2539						1	10	7.9	350		<0.12	0.02
Dunmore Wells	02/07/1996	10:55:00	Kilkenny Co. Co.		McDermotts	C. Murray	2540						1	10	7.4	599	0.69		<0.01
Dunmore Wells	02/07/1996	11:10:00	Kilkenny Co. Co.		Nolans	C. Murray	2541						1	5	7.3	841	0.61		<0.01
Dunmore Wells	02/07/1996	11:30:00	Kilkenny Co. Co.		O'Neill's	C. Murray	2542						1	10	7.4	700	0.15		<0.01
Dunmore Wells	02/07/1996	11:45:00	Kilkenny Co. Co.		Fitzpatrick's	C. Murray	2543						1	5	7.4	737	0.53		<0.01
Dunmore Wells	02/07/1996	12:10:00	Kilkenny Co. Co.		Canteen in Landfill Site	C. Murray	2544						1	15	7.4	563	2.07		0.05
Dunmore Wells	02/07/1996	12:35:00	Kilkenny Co. Co.		Holohan's	C. Murray	2545						2	15	7.4	633	1.94		0.42
Dunmore Wells	02/07/1996	12:45:00	Kilkenny Co. Co.		Murphy's/Stacks	C. Murray	2546						2	50	7.5	689		<0.12	0.013
Belview	02/10/1996	11:10:00	Kilkenny Co. Co.		Well No. 3.	Brian Connor	3853						1	5	6.6	554	0.26		<0.01
Belview	03/10/1996	10:30:00	Kilkenny Co. Co.		Well No. 3.	Brian Connor	3873						1	5	6.4	565	0.2		
Bellview Water Supply	08/10/1996	10:30:00	Kilkenny Co. Co.		Well No. 3.	B. O'Connor	3971						1	5	6.5	551			<0.01
Spring at Paulstown Castle	09/01/1997	12:17:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle	P. Mullins	106	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	9.3	1	<5	7.3	613	0.23	1.9	<0.01
Thomastown	10/01/1997	10:17:00	Kilkenny Co. Co.		Borehole No. 5	P. Mullins	111		S 589 411			9.6	1	<5	7.1	439	0.09	1.3	<0.01
Borehole No.9, Thomastown	10/01/1997	10:05:00	Kilkenny Co. Co.	KK01600	At pumphouse	P. Mullins	112	KIK32	25890 14160	Thomastown	Public	9.4	1	<5	7.3	721	0.11	1.5	
Borehole at Dunmore	13/01/1997		Kilkenny Co. Co.	KK00700	C. Murray,s house, Dunmore.	C. Murray	216		24910 16200	Dunmore	Group								
Spring at Paulstown Castle	17/02/1997	11:30:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle	C. Murray	726	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	10.3	1	<5	7.3	607		0.6	<0.1
Springs at Bausheenmore	17/02/1997	12:30:00	Kilkenny Co. Co.	KK00500	At source (springs at Bausheenmore	C. Murray	727	KIK39	25520 14690		Private	10.5	1	<5	7.3	767		<1	<0.1
Spring at Westcourt	17/02/1997	14:05:00	Kilkenny Co. Co.	KK00800	Spring at Earlsland, Westcourt, Callan	C. Murray	728	KIK91	S 407 442	Callan	Public	11.3	1	<5	7.3	702		<1	<0.1
Dunmore	09/05/1997		Kilkenny Co. Co.		Doyle's	M. Daly	1936				Private		1				0.53		2
Dunmore	09/05/1997		Kilkenny Co. Co.		Holohan's	M. Daly	1937				Private		3				1.8		0.5
Dunmore	09/05/1997		Kilkenny Co. Co.		No. 8 Stack	M. Daly	1938				Private		3				0.1		<0.01
Dunmore	09/05/1997		Kilkenny Co. Co.		Well in landfill site	M. Daly	1939				Private		2						17.6
Dunmore	09/05/1997		Kilkenny Co. Co.		Unused Borehole, Doyle's Field	M. Daly	1940				Private		2				5.4		12.1
Dunmore	12/05/1997	10:45:00	Kilkenny Co. Co.		Readymix	C. Murray	1944					10.2	1	5	7.7	631	0.65	0.22	1.5
Dunmore	12/05/1997	10:55:00	Kilkenny Co. Co.		O'Dwyers	C. Murray	1945					10.8	2	15	7.6	473	3.8	0.09	0.05
Dunmore	12/05/1997	11:05:00	Kilkenny Co. Co.		Langtons	C. Murray	1946					9.7	1	15	8	352	12	0.08	0.04
Dunmore	12/05/1997	11:15:00	Kilkenny Co. Co.		Bergin's	C. Murray	1947					9.8	2	5	7.4	656	0.42	0.33	<0.01
Dunmore	12/05/1997	11:25:00	Kilkenny Co. Co.		McDermott's	C. Murray	1948					10.8	2	5	7.3	615		0.39	<0.01
Dunmore	12/05/1997	12:00:00	Kilkenny Co. Co.		Nolans	C. Murray	1949					10.8	2	5	7.3	794	0.19	0.64	<0.01
Dunmore	12/05/1997	12:15:00	Kilkenny Co. Co.		O'Neill's	C. Murray	1950					10.9	1	5	7.4	700	0.42	0.09	<0.01
Dunmore	12/05/1997	12:30:00	Kilkenny Co. Co.		Fitzpatricks	C. Murray	1951					10.4	2	5	7.3	736	0.21	0.43	<0.01
Dunmore	12/05/1997	15:30:00	Kilkenny Co. Co.		Doyle's	C. Murray	1952					10.7	2	5	7.2	816	0.11	0.67	1.41
Dunmore	12/05/1997	15:45:00	Kilkenny Co. Co.		Holohan's	C. Murray	1953					12	2		7.3	640	69	1.88	0.33
Dunmore	12/05/1997	15:55:00	Kilkenny Co. Co.		Stacks/Murphys	C. Murray	1954					11.5	3		7.7	665	16	0.26	<0.01
Dunmore	12/05/1997	14:35:00	Kilkenny Co. Co.		Canteen at landfill site.	C. Murray	1955			Canteen at landfill	private	11.5	3		7.9	1.8	100		110
Dunmore	12/05/1997	14:50:00	Kilkenny Co. Co.		New Bore at landfill site.	C. Murray	1956					12.4	2		7.2	994	6.1	7.2	0.5
Dunmore	12/05/1997	15:10:00	Kilkenny Co. Co.		Roches Pit, new cell	C. Murray	1957					10.8	2	5	7.3	653	1.2	0.64	<0.01

EPA Regional Water Laboratory, Kilkenny. Monitoring Data for County Kilkenny Groundwaters 1993 to 1999.

Source	Sampling Date	Sampling Time	o-Phosphate mg/l P	Nitrate mg/l N	Nitrite mg/l N	Chloride mg/l Cl	Ca Hardness mg/l CaCO ₃	Alkalinity mg/l CaCO ₃	TCS	Total Coliforms per 100 ml	FCS	Fecal Coliforms per 100 ml	Sulphate mg/l SO ₄	Dry Residue mg/l	Sus_Solids mg/l	Magnesium mg/l Mg	Total Hardness mg/l CaCO ₃	Sodium mg/l Na	Potassium mg/l K	Aluminium mg/l Al	Iron mg/l Fe	Manganese mg/l Mn	Copper mg/l Cu	Zinc mg/l Zn	Chromium mg/l Cr	Lead mg/l Pb
Borehole at Galmoy	09/01/1996	12:40:00	0.002	9.6	< 0.003	27.7		364		999		999	20			31.8		7.9	0.8		< 0.06	< 0.02		0.061		
Borehole at Kilmanagh	09/01/1996	14:20:00	0.099	3.5	< 0.003	20.4		327	>=	15	>=	2	11			18.4		9.1	0.9		< 0.06	< 0.02		0.035		
Spring at Westcourt	09/01/1996	15:10:00	0.02	3.6	< 0.003	24.1		365		52		64	15			29.2		9.5	0.9		< 0.06	< 0.02		0.028		
Borehole at Windgap	09/01/1996	15:40:00	0.122	1.8	< 0.003	16		164		999		999	4			19.2		6.9	1		< 0.06	< 0.02		0.03		
Spring at Carrigeen	15/01/1996	13:00:00	0.1	36.2	0.014	44		183					25													
Belview	27/02/1996	14:15:00	< 0.02	3.7	< 0.004	28		97		999		999					103									
Belview	29/02/1996	11:45:00	< 0.02	4.1	< 0.004	32.7		81		999		999					83									
Belview No. 2	07/03/1996	16:00:00						114		1		999					116				< 0.06	< 0.02		0.08		
Belview No. 2	14/03/1996	11:00:00	< 0.02	4.5	< 0.004	28		97		14		9									< 0.06	< 0.02		0.026		
Belview No. 2	23/03/1996	14:10:00	< 0.02	6.7	< 0.004	26		77		2		999														
Belview No. 1	25/03/1996	15:00:00	< 0.02	6.8	0.004	28		49		999		999									< 0.06	< 0.02		0.314		
Belview No. 1	27/03/1996	13:00:00	< 0.02	6.7	< 0.004	28		64		1		999														
Dunmore Wells	02/07/1996	10:10:00	< 0.02	< 0.1	0.004	20		317		999		999	29													
Dunmore Wells	02/07/1996	10:15:00	< 0.02	1.5	0.007	16		191	>=	3		999	11													
Dunmore Wells	02/07/1996	10:15:00	< 0.02	< 0.1	0.009	18				999		999	14													
Dunmore Wells	02/07/1996	10:35:00	< 0.02	< 0.1	0.003	13		164	>	80		999	4													
Dunmore Wells	02/07/1996	10:55:00	< 0.02	6.5	0.001	19		283	>=	3		6	15													
Dunmore Wells	02/07/1996	11:10:00	0.22	12	0.002	37		352	>	80		15	25													
Dunmore Wells	02/07/1996	11:30:00	< 0.02	7.4	0.002	28		323		999		999	15													
Dunmore Wells	02/07/1996	11:45:00	0.14	9.2	0.002	28		330	>	80	>	60	16													
Dunmore Wells	02/07/1996	12:10:00	0.03	2.6	0.041	22		250	>	80		6	25													
Dunmore Wells	02/07/1996	12:35:00	0.09	< 0.1	0.015	19		322		2		999	20													
Dunmore Wells	02/07/1996	12:45:00	< 0.02	< 0.1	0.005	21		323	>=	68		999	30													
Belview	02/10/1996	11:10:00	< 0.02	19.3	0.003	43				999		999				21.3		22.5	2.6		0.12	0.033		0.184		
Belview	03/10/1996	10:30:00								1		999				21.3		23.3	2.8		0.087	0.034	0.112			
Bellview Water Supply	08/10/1996	10:30:00	0.01	22	0.004	41		68	>=	2		999				21.3		22.8	2.8		0.087	0.029		0.074		
Spring at Paulstown Castle	09/01/1997	12:17:00	0.01	7	0.001	28		252		21		1	19													
Thomastown	10/01/1997	10:17:00	0.01	4.4	< 0.004	23	248			999		999														
Borehole No.9, Thomastown	10/01/1997	10:05:00	0.03	5.7	< 0.004	39	248			999		999														
Borehole at Dunmore	13/01/1997																									
Spring at Paulstown Castle	17/02/1997	11:30:00	< 0.02	6.4	0.01	22		245		200		22				11.5		8.7	2.6							
Springs at Bausheenmore	17/02/1997	12:30:00	< 0.02	7.1	< 0.004	26		345	>	80		50				29.5		8.7	3.6							
Spring at Westcourt	17/02/1997	14:05:00	< 0.02	4.8	0.011	20		329		3		2				23.3		8.3	0.9							
Dunmore	09/05/1997		< 0.02	11.2	< 0.004	45																				
Dunmore	09/05/1997		0.19	< 0.1	0.005	18																				
Dunmore	09/05/1997		< 0.02	< 0.1	< 0.003	21																				
Dunmore	09/05/1997		0.87	11.3	2	295																				
Dunmore	09/05/1997		0.08	3.3	0.1	29																				
Dunmore	12/05/1997	10:45:00	0.01	0.232	0.004	20				15		999														
Dunmore	12/05/1997	10:55:00	0.05	0.15	0.003	16			>=	37		6														
Dunmore	12/05/1997	11:05:00	0.01	0.16	0.004	13				999		999														
Dunmore	12/05/1997	11:15:00	< 0.02	16.2	0.007	23			>=	6		999														
Dunmore	12/05/1997	11:25:00	< 0.02	7.5	0.003	20			>=	13		999														
Dunmore	12/05/1997	12:00:00	0.17	12	0.004	30			>=	210		999														
Dunmore	12/05/1997	12:15:00	0.01	8.2	0.003	27						999														
Dunmore	12/05/1997	12:30:00	0.165	10.1	0.003	26				750		300														
Dunmore	12/05/1997	15:30:00	0.015	1.3	0.031	44			>	80		4														
Dunmore	12/05/1997	15:45:00	0.11	0.15	0.019	18																				
Dunmore	12/05/1997	15:55:00	< 0.02	0.18	2.2	19			>=	16		999														
Dunmore	12/05/1997	14:35:00	3	5.6	3.8	353			>	2000	>	2000														
Dunmore	12/05/1997	14:50:00	0.5	0.9	0.41	31					>	600														
Dunmore	12/05/1997	15:10:00	< 0.02	11	0.002	19			>=	9		999														

EPA Regional Water Laboratory, Kilkenny. Monitoring Data for County Kilkenny Groundwaters 1993 to 1999.

Source	Sampling Date	Sampling Time	Cadmium mg/l Cd	Mercury mg/l Hg	Nickel mg/l Ni	Fluoride mg/l F	OMCTSiloxane µg/l	Comments1	Comments2	Comments3
Borehole at Galmoy	09/01/1996	12:40:00								
Borehole at Kilmanagh	09/01/1996	14:20:00								
Spring at Westcourt	09/01/1996	15:10:00								
Borehole at Windgap	09/01/1996	15:40:00								
Spring at Carrigeen,	15/01/1996	13:00:00						Very high Nitrate.	High Conductivity and chloride.	
Belview	27/02/1996	14:15:00						Sample taken after pumping for 1 hour.		
Belview	29/02/1996	11:45:00								
Belview No. 2	07/03/1996	16:00:00						Sample delivered to the laboratory on 8/3/96 by Finbar Coughlan.		
Belview No. 2	14/03/1996	11:00:00								
Belview No. 2	23/03/1996	14:10:00								
Belview No. 1	25/03/1996	15:00:00								
Belview No. 1	27/03/1996	13:00:00								
Dunmore Wells	02/07/1996	10:10:00								
Dunmore Wells	02/07/1996	10:15:00								
Dunmore Wells	02/07/1996	10:15:00								
Dunmore Wells	02/07/1996	10:35:00								
Dunmore Wells	02/07/1996	10:55:00								
Dunmore Wells	02/07/1996	11:10:00								
Dunmore Wells	02/07/1996	11:30:00								
Dunmore Wells	02/07/1996	11:45:00								
Dunmore Wells	02/07/1996	12:10:00								
Dunmore Wells	02/07/1996	12:35:00								
Dunmore Wells	02/07/1996	12:45:00								
Belview	02/10/1996	11:10:00						Calcium Hardness = 152 mg/l CaCO3	Very high nitrate.	
Belview	03/10/1996	10:30:00						Calcium Hardness = 144 mg/l CaCO3		
Bellview Water Supply	08/10/1996	10:30:00						Calcium Hardness = 144 mg/l CaCO3	Interference from background colonies on Total Coliform plate.	Very high Nitrate.
Spring at Paulstown Castle	09/01/1997	12:17:00						See GC/MS Purge & Trap analyses on separate sheet.		
Thomastown	10/01/1997	10:17:00								
Borehole No.9, Thomastown	10/01/1997	10:05:00						See GC/MS Purge & Trap analyses on separate sheet.	Octamethylcyclotetrasiloxane < 0.2 ug/l.	
Borehole at Dunmore	13/01/1997							Sample for GC/MS Purge & Trap analyses only. Results on separate sheet.	Octamethylcyclotetrasiloxane 0.7 ug/l.	
Spring at Paulstown Castle	17/02/1997	11:30:00						Octamethylcyclotetrasiloxane = 0.3 ug/l.		
Springs at Bausheenmore	17/02/1997	12:30:00						Octamethylcyclotetrasiloxane = 1.7 ug/l.	K/Na Ratio = 0.41	
Spring at Westcourt	17/02/1997	14:05:00						Octamethylcyclotetrasiloxane = 1.4 ug/l.		
Dunmore	09/05/1997							Very high ammonia.	Sample taken after land-fill leachate escaped to groundwater.	Approximate ammonia concentration.
Dunmore	09/05/1997							Strong odour and high ammonia.	Sample taken after land-fill leachate escaped to groundwater.	Approximate ammonia concentration.
Dunmore	09/05/1997							Odour of sulphide.	Sample taken after land-fill leachate escaped to groundwater.	Approximate ammonia concentration.
Dunmore	09/05/1997							Very high TOC, ammonia and nitrite results < serious contamination.	Sample taken after land-fill leachate escaped to groundwater.	Approximate ammonia concentration.
Dunmore	09/05/1997							Very high ammonia and high nitrite.	Sample taken after land-fill leachate escaped to groundwater.	Approximate ammonia concentration.
Dunmore	12/05/1997	10:45:00						Ammonia >1.5 mg/l as N.	Sample taken after leachate at landfill site escaped to groundwater	Amended report, ammonia is >1.5 and not <1.5 as reported on 15/5/97.
Dunmore	12/05/1997	10:55:00							Sample taken after leachate at landfill site escaped to groundwater	
Dunmore	12/05/1997	11:05:00							Sample taken after leachate at landfill site escaped to groundwater	No coliforms detected but possible interference from suspended solids.
Dunmore	12/05/1997	11:15:00							Sample taken after leachate at landfill site escaped to groundwater	
Dunmore	12/05/1997	11:25:00							Sample taken after leachate at landfill site escaped to groundwater	
Dunmore	12/05/1997	12:00:00							Sample taken after leachate at landfill site escaped to groundwater	Interference from suspended solids on the total coliform test.
Dunmore	12/05/1997	12:15:00							Sample taken after leachate at landfill site escaped to groundwater	Background interference on the total coliform test.
Dunmore	12/05/1997	12:30:00							Sample taken after leachate at landfill site escaped to groundwater	Very high coliform levels (total and faecal).
Dunmore	12/05/1997	15:30:00						High ammonia and nitrite concentrations.	Sample taken after leachate at landfill site escaped to groundwater	
Dunmore	12/05/1997	15:45:00						Very turbid. High ammonia indicative of pollution.	Sample taken after leachate at landfill site escaped to groundwater	Interference from suspended solids on the coliform tests (total & faecal).
Dunmore	12/05/1997	15:55:00						Very turbid. High nitrite. Odour detected.	Sample taken after leachate at landfill site escaped to groundwater	Background interference on the total coliform test.
Dunmore	12/05/1997	14:35:00						Turbidity > 100 NTU and ammonia > 110 mg/l N. Very high coliform levels.	Sample taken after leachate at landfill site escaped to groundwater	
Dunmore	12/05/1997	14:50:00						High ammonia and nitrite levels.	Sample taken after leachate at landfill site escaped to groundwater	Interference on the total coliform test.
Dunmore	12/05/1997	15:10:00							Sample taken after leachate at landfill site escaped to groundwater	Interference on the total coliform test.

EPA Regional Water Laboratory, Kilkenny. Monitoring Data for County Kilkenny Groundwaters 1993 to 1999.

Source	Sampling Date	Sampling Time	To	Ref No	Sampling Location	Taken By	Lab No	EPARef	Stn Grid Ref	Water Supply	Public/Group/Private	Temperature	Odour 1/2/3	Colour Hazen	pH	Conductivity µS/cm	Turbidity NTU	TOC mg/l C	Ammonia mg/l N
Borehole at Dunmore	18/06/1997	11:45:00	Kilkenny Co. Co.	KK00700	C. Murray,s house, Dunmore.	C. Murray	2630		24910 16200	Dunmore	Group	15		15	7.4	604			< 0.01
Dunmore	08/07/1997	14:50:00	Kilkenny Co. Co.		Stacks	M. Daly	2973						2	60	7.6	659	7.5		< 0.01
Dunmore	08/07/1997	15:00:00	Kilkenny Co. Co.		Holohans	M. Daly	2974						1		7.3	639	72		0.4
Borehole at Kilmanagh	01/09/1997	10:24:00	Kilkenny Co. Co.	KK01400	In pumphouse	P. Mullins	3796	KIK45	23930 15250	Kilmanagh/Ballycuddihy	Group	14.4	1	< 5	7.5	641	0.26	0.4	< 0.01
Spring at Westcourt	01/09/1997	11:17:00	Kilkenny Co. Co.	KK00800	Spring at Earlsland, Westcourt, Callan	P. Mullins	3797	KIK91	S 407 442	Callan	Public	11.9	1	< 5	7.3	701	0.14	0.28	< 0.01
Borehole at Windgap	01/09/1997	11:54:00	Kilkenny Co. Co.	KK01900	Overflow from borehole	P. Mullins	3798		24200 13580	Farm supply	Private	11.3	1	< 5	7.3	386	0.39	0.07	< 0.01
Springs at Bausheenmore	01/09/1997	13:36:00	Kilkenny Co. Co.	KK00500	At source (springs at Bausheenmore)	P. Mullins	3799	KIK39	25520 14690		Private	11.9	1	20	7.4	717	2.6	3.3	< 0.01
Borehole at Dunmore S/G	01/09/1997	14:17:00	Kilkenny Co. Co.	KK01000	Canteen at Dunmore Sand & Gravel	P. Mullins	3800	KIK53	25000 16020	Dunmore Sand & Gravel	Private	13.6	1	5	7.7	645	1	0.41	< 0.01
Borehole at Dunmore	01/09/1997	14:26:00	Kilkenny Co. Co.	KK00700	C. Murray,s house, Dunmore.	P. Mullins	3801		24910 16200	Dunmore	Group	16	1	< 5	7.4	643	0.14	0.34	< 0.01
Borehole at Kilkenny Mar	01/09/1997	15:13:00	Kilkenny Co. Co.	KK01300	Cattle holding shed	P. Mullins	3802		25070 15670	Kilkenny Mart	Private	16.7	1	60	8.4	130	27	3.2	0.03
Borehole at Galmoy	27/08/1997	11:19:00	Kilkenny Co. Co.	KK00200	Leahy's House, Galmoy	P. Mullins	3743	KIK17	23020 17120	Galmoy	Group	14.3	1	5	7.6	763	0.15	0.55	< 0.01
Borehole at Bawnmore	27/08/1997	11:39:00	Kilkenny Co. Co.	KK00100	Phelan's house, Bawnmore	P. Mullins	3744	KIK50	22580 16610	Bawnmore	Group	15.4	1	5	7.3	826	0.08	1.04	< 0.01
Spring Toberpatrick Urlingford	27/08/1997	12:05:00	Kilkenny Co. Co.	KK01500	In chamber at source	P. Mullins	3745	KIK34	23000 16350	Urlingford/Johnstown	Public	11.1	1	5	7.2	743	0.12	2.47	< 0.01
Spring at Clomantagh	27/08/1997	12:20:00	Kilkenny Co. Co.	KK00900	Beside Nuenna river, 50m SE of road	P. Mullins	3746		23520 16320		Private	12.4	1	5	7.4	638	1.6	1.01	< 0.01
Borehole at Castlecomer Yarns	27/08/1997	14:00:00	Kilkenny Co. Co.	KK00300	Tap in yard at Castlecomer Yarns	P. Mullins	3747		25360 17330	Castlecomer Yarns	Private	12	1	5	7.4	600	5.8	0.56	0.033
Spring at Paulstown Castle	27/08/1997	14:51:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle	P. Mullins	3748	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	11.9	1	5	7.3	636	0.72	1.13	< 0.01
Borehole at Rathcash	27/08/1997	15:12:00	Kilkenny Co. Co.	KK02000	Joe Pykes house, Rathcash, Clara.	P. Mullins	3749	KIK55	25870 15510	Rathcash	Group	16.9	1	5	7.4	709	0.07	0.49	< 0.01
Borehole at Clara	27/08/1997	15:30:00	Kilkenny Co. Co.	KK00400	At pumphouse	P. Mullins	3750	KIK41	25770 15530	Clara	Group	16.3	1	5	7.4	673	0.06	0.59	< 0.01
Dunmore	03/03/1998	11:10:00	Kilkenny Co. Co.		1. Billy O'Dwyers	C. Murray	1116			1. Billy O'Dwyers		9.8	1	10	7.6	473	3.7	0.03	0.073
Dunmore Group Scheme	19/05/1998	11:45:00	Kilkenny Co. Co.			P. Mullins	2330					17.6	1	5	7.44	636			
	19/05/1998	11:55:00	Kilkenny Co. Co.		Readymix	P. Mullins	2331					14.8	1	< 5	7.59	648			
Borehole at Windgap	09/02/1999	09:30:00	Kilkenny Co. Co.	KK01900	Overflow from borehole	Redmond Bergir	815		24200 13580	Farm supply	Private			5	7.3	330	< 0.1		< 0.2
Spring at Clomantagh	17/02/1999	10:40:00	Kilkenny Co. Co.	KK00900	Beside Nuenna river, 50m SE of road	C. Murray	998		23520 16320		Private	10	1	5	7.3	669	0.6	4	
Spring Toberpatrick Urlingford	17/02/1999	11:00:00	Kilkenny Co. Co.	KK01500	In chamber at source	C. Murray	999	KIK34	23000 16350	Urlingford/Johnstown	Public	9.2	1	5	7.3	747	0.2	4.3	
Borehole at Bawnmore	17/02/1999	11:30:00	Kilkenny Co. Co.	KK00100	Phelan's house, Bawnmore	C. Murray	1000	KIK50	22580 16610	Bawnmore	Group	7	1	5	7.1	881	< 0.1	4.5	
Borehole at Galmoy	17/02/1999	12:00:00	Kilkenny Co. Co.	KK00200	Leahy's House, Galmoy	C. Murray	1001	KIK17	23020 17120	Galmoy	Group			5	7.3	776	0.4	2.1	
Borehole at Castlecomer Yarns	17/02/1999	12:50:00	Kilkenny Co. Co.	KK00300	Tap in yard at Castlecomer Yarns	C. Murray	1002		25360 17330	Castlecomer Yarns	Private	10.5	1	40	7.4	535	11.6	2	
Borehole at Dunmore	17/02/1999	14:05:00	Kilkenny Co. Co.	KK00700	C. Murray,s house, Dunmore.	C. Murray	1003		24910 16200	Dunmore	Group	7.7	1	5	7.3	663	< 0.1	1.7	< 0.2
Borehole at Kilkenny Mar	17/02/1999	15:00:00	Kilkenny Co. Co.	KK01300	Cattle holding shed	C. Murray	1004		25070 15670	Kilkenny Mart	Private	9.7	1	10	7.9	690	1.5	1.8	< 0.2
Borehole at Kilmanagh	17/02/1999	16:00:00	Kilkenny Co. Co.	KK01400	In pumphouse	C. Murray	1005	KIK45	23930 15250	Kilmanagh/Ballycuddihy	Group	7.3	1	5	7.6	658	< 0.1	3.9	< 0.2
Spring at Westcourt	14/04/1999	10:47:00	Kilkenny Co. Co.	KK00800	Spring at Earlsland, Westcourt, Callan	P. Mullins	1889	KIK91	S 407 442	Callan	Public	9.8	1	< 5	7.5	699	< 0.1		< 0.01
Borehole at Windgap	14/04/1999	11:14:00	Kilkenny Co. Co.	KK01900	Overflow from borehole	P. Mullins	1890		24200 13580	Farm supply	Private	10.5	1	< 5	7.3	388	0.2		< 0.01
Springs at Bausheenmore	14/04/1999	12:12:00	Kilkenny Co. Co.	KK00500	At source (springs at Bausheenmore)	P. Mullins	1891	KIK39	25520 14690		Private	9.6	1	< 5	7.4	772	0.2		< 0.01
Borehole at Rathcash	14/04/1999	14:00:00	Kilkenny Co. Co.	KK02000	Joe Pykes house, Rathcash, Clara.	P. Mullins	1892	KIK55	25870 15510	Rathcash	Group	9.4	1	< 5	7.3	722	< 0.1		< 0.01
Borehole at Clara	14/04/1999	14:18:00	Kilkenny Co. Co.	KK00400	At pumphouse	P. Mullins	1893	KIK41	25770 15530	Clara	Group	9.6	1	< 5	7.3	695	< 0.1		< 0.01
	07/09/1999	10:20:00	Kilkenny Co. Co.		Kenny's Well, Kilkenny City	T. Doherty	4410												
Bennettsbridge	29/03/2000	14:16:00	Kilkenny Co. Co.		New well - feeding the infiltration gallery	P. Mullins	1688			Bennettsbridge	Public	10.6	1	< 5	7.6	727			< 0.003
Borehole at Kilmanagh	27/09/2000	10:30:00	Kilkenny Co. Co.	KK01400	In pumphouse	C. Murray	5048	KIK45	23930 15250	Kilmanagh/Ballycuddihy	Group	13.8			7.3	664	0.1		< 0.003
Borehole at Windgap	27/09/2000	12:10:00	Kilkenny Co. Co.	KK01900	Overflow from borehole	C. Murray	5049		24200 13580	Farm supply	Private	11.5			7.3	388	0.6		< 0.003
Borehole No.9, Thomastown	27/09/2000	14:15:00	Kilkenny Co. Co.	KK01600	At pumphouse	C. Murray	5050	KIK32	25890 14160	Thomastown	Public	13.3			7.2	758	0.2		< 0.003
Springs at Bausheenmore	27/09/2000	14:50:00	Kilkenny Co. Co.	KK00500	At source (springs at Bausheenmore)	C. Murray	5051	KIK39	25520 14690		Private	11			7.1	787	0.6		0.005
Spring at Paulstown Castle	27/09/2000	15:40:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle	C. Murray	5052	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	11.1			7.1	656	0.4		0.016
Spring at Clomantagh	26/09/2000	10:20:00	Kilkenny Co. Co.	KK00900	Beside Nuenna river, 50m SE of road	C. Murray	5026		23520 16320		Private	11.4	1	15	7.4	282			0.083
Spring Toberpatrick Urlingford	26/09/2000	10:40:00	Kilkenny Co. Co.	KK01500	In chamber at source	C. Murray	5027	KIK34	23000 16350	Urlingford/Johnstown	Public	10.3	1	5	7.2	813			< 0.003
Borehole at Bawnmore	26/09/2000	11:05:00	Kilkenny Co. Co.	KK00100	Phelan's house, Bawnmore	C. Murray	5028	KIK50	22580 16610	Bawnmore	Group	13.5	1	5	7.3	863			< 0.003
Borehole at Galmoy	26/09/2000	12:15:00	Kilkenny Co. Co.	KK00200	Leahy's House, Galmoy	C. Murray	5029	KIK17	23020 17120	Galmoy	Group	14.7	1	5	7.4	789			< 0.003
Borehole at Castlecomer Yarns	26/09/2000	14:00:00	Kilkenny Co. Co.	KK00300	Tap in yard at Castlecomer Yarns	C. Murray	5030		25360 17330	Castlecomer Yarns	Private	12.2	1	20	7.5	578			0.036
Borehole at Dunmore	26/09/2000	14:25:00	Kilkenny Co. Co.	KK00700	C. Murray,s house, Dunmore.	C. Murray	5031		24910 16200	Dunmore	Group	14.7	1	5	7.4	668			< 0.003
Borehole at Dunmore S/G	26/09/2000	14:40:00	Kilkenny Co. Co.	KK01000	Canteen at Dunmore Sand & Gravel	C. Murray	5032	KIK53	25000 16020	Dunmore Sand & Gravel	Private	12.4	1	5	7.6	660			< 0.003
Borehole at Kilkenny Mar	26/09/2000	14:55:00	Kilkenny Co. Co.	KK01300	Cattle holding shed	C. Murray	5033		25070 15670	Kilkenny Mart	Private	14.6	1	5	7.6	708			< 0.003
Borehole at Clara	26/09/2000	15:35:00	Kilkenny Co. Co.	KK00400	At pumphouse	C. Murray	5034	KIK41	25770 15530	Clara	Group	11.6	1	5	7.4	667			< 0.003
Kiloshau/Barna	03/10/2000	11:15:00	Kilkenny Co. Co./G.S.I.		GWS06	M. Daly	5218							7		663			0.015
Tubrid Lower	03/10/2000	11:40:00	Kilkenny Co. Co./G.S.I.		GWS14	M. Daly	5219								7.2	766			0.012
Balief Clomantagh	03/10/2000	12:00:00	Kilkenny Co. Co./G.S.I.		GWS03	M. Daly	5220								7.3	794			0.007
Graine/Craddockstown	03/10/2000	12:30:00	Kilkenny Co. Co./G.S.I.		GWS07	M. Daly	5221								7.4	727			0.006
Pilltown (PWS07)	03/10/2000	09:45:00	Kilkenny Co. Co./G.S.I.			Ruth Buckley	5222								6.5	184			0.01
Tullahought (GWS16)	03/10/2000	10:30:00	Kilkenny Co. Co./G.S.I.			Ruth Buckley	5223								6.3	194			0.007
Hugginstown (GWS10)	03/10/2000	11:30:00	Kilkenny Co. Co./G.S.I.			Ruth Buckley	5224								6.7	448			0.005
Ahenure (PWS09)	03/10/2000	14:15:00	Kilkenny Co. Co./G.S.I.			Ruth Buckley	5225								7.3	743			0.005

EPA Regional Water Laboratory, Kilkenny. Monitoring Data for County Kilkenny Groundwaters 1993 to 1999.

Source	Sampling Date	Sampling Time	o-Phosphate mg/l P	Nitrate mg/l N	Nitrite mg/l N	Chloride mg/l Cl	Ca Hardness mg/l CaCO ₃	Alkalinity mg/l CaCO ₃	TCS	Total Coliforms per 100 ml	FCS	Fecal Coliforms per 100 ml	Sulphate mg/l SO ₄	Dry Residue mg/l	Sus_Solids mg/l	Magnesium mg/l Mg	Total Hardness mg/l CaCO ₃	Sodium mg/l Na	Potassium mg/l K	Aluminium mg/l Al	Iron mg/l Fe	Manganese mg/l Mn	Copper mg/l Cu	Zinc mg/l Zn	Chromium mg/l Cr	Lead mg/l Pb
Borehole at Dunmore	18/06/1997	11:45:00	< 0.02	10		19.7		240		999		999														
Dunmore	08/07/1997	14:50:00	< 0.02	< 0.1	0.003	20				100	<	100			Visible	19.5		10.2	0.6							
Dunmore	08/07/1997	15:00:00	0.1	< 0.1	0.016	19			<	200	<	100			Visible	10.3		15.2	0.4							
Borehole at Kilmanagh	01/09/1997	10:24:00	< 0.02	4.6	< 0.004	17	270	287	>	100	>	100	7													
Spring at Westcourt	01/09/1997	11:17:00	< 0.02	4.3	< 0.004	22	262	310		15		5	12													
Borehole at Windgap	01/09/1997	11:54:00	0.02	2.1	< 0.004	15	144	151		6		2	4													
Springs at Bausheenmore	01/09/1997	13:36:00	0.04	5.6	0.004	26	270	304	>	100	>	100	17													
Borehole at Dunmore S/G	01/09/1997	14:17:00	< 0.02	< 0.1	< 0.004	21	252			480		9	36													
Borehole at Dunmore	01/09/1997	14:26:00	< 0.02	10.6	< 0.004	19	272	272		2		999	20													
Borehole at Kilkenny Mar	01/09/1997	15:13:00	0.09	0.5	0.018	3	64		>	160	>	120	<1.5													
Borehole at Galmoy	27/08/1997	11:19:00	< 0.02	16.1	< 0.004	20	228	298		1		999	19													
Borehole at Bawnmore	27/08/1997	11:39:00	< 0.02	11	< 0.004	23	316	363	>	80		7	17													
Spring Toberpatrick Urlingford	27/08/1997	12:05:00	< 0.02	8.1	< 0.004	22	292	332		51		9	17													
Spring at Clomantagh	27/08/1997	12:20:00	< 0.02	7.4	0.001	18	236	276	>	160	>	120	10													
Borehole at Castlecomer Yarn	27/08/1997	14:00:00	< 0.02	0.13	0.004	20	144	262		999		999	25													
Spring at Paulstown Castle	27/08/1997	14:51:00	< 0.02	7	< 0.004	25	232	256	>	160	>	120	17													
Borehole at Rathcash	27/08/1997	15:12:00	< 0.02	6.2	< 0.004	24	212	314		999		999	15													
Borehole at Clara	27/08/1997	15:30:00	0.02	8.7	< 0.004	21	272	283		29		18	13													
Dunmore	03/03/1998	11:10:00	< 0.02			17.6		206	<	40	<	1														
Dunmore Group Scheme	19/05/1998	11:45:00	0.011	9.4		19				999		999														
	19/05/1998	11:55:00	0.011	0.4		22				12		999														
Borehole at Windgap	09/02/1999	09:30:00	0.05	2	< 0.003	13.3	93	148		999		999	6.1			13.9		7.2								
Spring at Clomantagh	17/02/1999	10:40:00	< 0.04	6.1	< 0.003	15.4		299		10		2	9.5		Not Vis.											
Spring Toberpatrick Urlingford	17/02/1999	11:00:00	< 0.04	5.7	< 0.003	17.5		340		13		1	10.1		Not Vis.											
Borehole at Bawnmore	17/02/1999	11:30:00	< 0.04	7.9	< 0.003	17.9		416		999		999	11.2		Not Vis.											
Borehole at Galmoy	17/02/1999	12:00:00	< 0.04	11.5	< 0.003	24.5		317		29		999	13.3		Not Vis.											
Borehole at Castlecomer Yarn	17/02/1999	12:50:00	< 0.04	0.6	< 0.003	16.7		241		999		999	18.4		Not Vis.											
Borehole at Dunmore	17/02/1999	14:05:00		8.9	< 0.003	21.3	303	262		999		999	15.1		Not Vis.	4.5		9	0.9							
Borehole at Kilkenny Mar	17/02/1999	15:00:00	< 0.04	6.6	< 0.003	18.8	273	270		9		999	37.9		Not Vis.	14.1		11.2	1.3							
Borehole at Kilmanagh	17/02/1999	16:00:00	< 0.04	4	< 0.003	15.2	276	308		999		999	9.7		Not Vis.	12		9.2	0.8							
Spring at Westcourt	14/04/1999	10:47:00	< 0.04	4.2	< 0.004	20	288	330		1		1	11.4			24.2		8.9	0.6							
Borehole at Windgap	14/04/1999	11:14:00	< 0.04	2.2	< 0.004	13	138	174		999		999	5.6			17.9		6.6	0.7							
Springs at Bausheenmore	14/04/1999	12:12:00	< 0.04	5.7	< 0.004	23	272	360		74		2	15			30.5		8.3	2.3							
Borehole at Rathcash	14/04/1999	14:00:00	< 0.04	6.7	< 0.004	21	286	326		999		999	14			22.3		7.9	0.8							
Borehole at Clara	14/04/1999	14:18:00	< 0.04	8.5	< 0.004	19	288	318		45		2	12.8			17.1		7.8	1							
	07/09/1999	10:20:00								999		999														
Bennettsbridge	29/03/2000	14:16:00	< 0.006	5.1		22				999		999			Not Vis.											
Borehole at Kilmanagh	27/09/2000	10:30:00	< 0.006	3.7	< 0.001	14	288		>=	43		999	13			15	349	11	1.2		< 0.06	< 0.02		0.026		
Borehole at Windgap	27/09/2000	12:10:00	0.019	2.4	< 0.001	14	143					999	9.1			15	204	7.9	1.4		< 0.06	< 0.02		0.024		
Borehole No.9, Thomastown	27/09/2000	14:15:00	0.032	5.8	< 0.001	31	293			8		1	19			22	383	18	3.5		< 0.06	< 0.02		0.138		
Springs at Bausheenmore	27/09/2000	14:50:00	0.014	6	< 0.001	23	308		>	80	>	60	20			30	431	10	3.9		< 0.06	< 0.02		0.022		
Spring at Paulstown Castle	27/09/2000	15:40:00	0.008	4.7	0.007	23	290		>	80	>	60	18			11	335	11	3.4		< 0.06	< 0.02		0.021		
Spring at Clomantagh	26/09/2000	10:20:00	0.012	1.5	0.007	6.9	83		>	80	>	60	7.8			2.4	92.8	6	6.5		0.086	< 0.02		0.189		
Spring Toberpatrick Urlingford	26/09/2000	10:40:00	0.009	7.1	0.011	20	338		>	80	>	60	15			19	416	9.4	5		0.106	< 0.02		0.48		
Borehole at Bawnmore	26/09/2000	11:05:00	< 0.006	6.7	< 0.001	18	348		>=	50		28	16			30	471	8.1	3.4		0.114	< 0.02		0.421		
Borehole at Galmoy	26/09/2000	12:15:00	< 0.006	8.2	< 0.001	21	305			999		999	18			27	416	9.6	1.4		0.082	< 0.02		0.258		
Borehole at Castlecomer Yarn	26/09/2000	14:00:00	0.077	1.1	0.003	17	150			7		999	25			17	220	43	1.7		0.664	0.536		0.152		
Borehole at Dunmore	26/09/2000	14:25:00	< 0.006	8.9	< 0.001	23	308			21	<	1	18			3.1	320	9.9	1.4		< 0.06	< 0.02		0.102		
Borehole at Dunmore S/G	26/09/2000	14:40:00	< 0.006	0.67	0.002	19	278		>=	44		999	38			14	294	12	1.4		0.063	0.273		0.076		
Borehole at Kilkenny Mar	26/09/2000	14:55:00	< 0.006	6.2	< 0.001	18	295			47		3	39			16	360	12	1.9		< 0.06	< 0.02		0.151		
Borehole at Clara	26/09/2000	15:35:00	0.03	5.9	< 0.001	18	275			5		999	16			16	340	9.7	1.9		< 0.06	< 0.02		0.068		
Kiloshau/Barna	03/10/2000	11:15:00	0.023	5.9	< 0.001	14	360	305	>	80	>	80	7.8			10.4	402	6.9	2.1	< 0.05	0.075	0.01	0.004	0.262	0.012	< 0.001
Tubrid Lower	03/10/2000	11:40:00	0.009	8.5	< 0.001	18	413	353		7		1	10.6			15.5	476	7.7	0.6	< 0.05	0.097	0.003	0.005	0.463	0.034	< 0.001
Balief Clomantagh	03/10/2000	12:00:00	0.01	8.5	0.01	18	427	383		62		58	9.6			14.2	485	9.4	5	< 0.05	0.078	0.005	0.005	0.343	0.028	< 0.001
Graine/Craddockstown	03/10/2000	12:30:00	0.007	5.2	< 0.01	15	321	362		999		999	10.7			37.1	7.4	< 0.3		< 0.05	< 0.05	0.002	0.009	0.208	0.019	< 0.001
Pilltown (PWS07)	03/10/2000	09:45:00	0.03	2.9	0.003	14.3	40	53		28		999	4.9			3.1	52.7	8	1.4	< 0.05	< 0.05	0.002	< 0.001	0.124	0.009	< 0.001
Tullahought (GWS16)	03/10/2000	10:30:00	0.027	7.1	< 0.001	17	35	26		2		999	9.8			5.5	57.6	11.4	< 0.3	< 0.05	< 0.05	0.002	0.011	0.084	0.005	< 0.001
Hugginstown (GWS10)	03/10/2000	11:30:00	0.026	4.3	< 0.001	15	193	176	>	80	>	60	14.5			8.4	227	10.5	5.9	< 0.05	< 0.05	< 0.001	0.011	0.071	0.006	< 0.001
Ahenure (PWS09)	03/10/2000	14:15:00	< 0.006	2.6	< 0.001	19	348	347		14		999	16.5			28.3	464	8.8	1.7	< 0.05	< 0.05	0.739	0.009	0.051	0.007	< 0.001

EPA Regional Water Laboratory, Kilkenny. Monitoring Data for County Kilkenny Groundwaters 1993 to 1999.

Source	Sampling Date	Sampling Time	Cadmium mg/l Cd	Mercury mg/l Hg	Nickel mg/l Ni	Fluoride mg/l F	OMCTSiloxane µg/l	Comments1	Comments2	Comments3
Borehole at Dunmore	18/06/1997	11:45:00								
Dunmore	08/07/1997	14:50:00						Total Coliforms present. Accurate count not possible due to	Suspended Solids.	
Dunmore	08/07/1997	15:00:00						Total Coliforms present. Accurate count not possible due to	Suspended Solids.	
Borehole at Kilmanagh	01/09/1997	10:24:00								
Spring at Westcourt	01/09/1997	11:17:00								
Borehole at Windgap	01/09/1997	11:54:00								
Springs at Bausheenmore	01/09/1997	13:36:00								
Borehole at Dunmore S/G	01/09/1997	14:17:00								
Borehole at Dunmore	01/09/1997	14:26:00								
Borehole at Kilkenny Mar	01/09/1997	15:13:00								
Borehole at Galmoy	27/08/1997	11:19:00								
Borehole at Bawnmore	27/08/1997	11:39:00								
Spring Toberpatrick Urlingford	27/08/1997	12:05:00								
Spring at Clomantagh	27/08/1997	12:20:00								
Borehole at Castlecomer Yarns	27/08/1997	14:00:00								
Spring at Paulstown Castle	27/08/1997	14:51:00								
Borehole at Rathcash	27/08/1997	15:12:00								
Borehole at Clara	27/08/1997	15:30:00								
Dunmore	03/03/1998	11:10:00								
Dunmore Group Scheme	19/05/1998	11:45:00								
	19/05/1998	11:55:00								
Borehole at Windgap	09/02/1999	09:30:00						Sodium and calcium for guide only.		
Spring at Clomantagh	17/02/1999	10:40:00				< 0.1				
Spring Toberpatrick Urlingford	17/02/1999	11:00:00				< 0.1				
Borehole at Bawnmore	17/02/1999	11:30:00				< 0.1				
Borehole at Galmoy	17/02/1999	12:00:00				< 0.1				
Borehole at Castlecomer Yarns	17/02/1999	12:50:00				< 0.1				
Borehole at Dunmore	17/02/1999	14:05:00				< 0.1				
Borehole at Kilkenny Mar	17/02/1999	15:00:00				< 0.1				
Borehole at Kilmanagh	17/02/1999	16:00:00				< 0.1				
Spring at Westcourt	14/04/1999	10:47:00				< 0.1				
Borehole at Windgap	14/04/1999	11:14:00				< 0.1				
Springs at Bausheenmore	14/04/1999	12:12:00				< 0.1				
Borehole at Rathcash	14/04/1999	14:00:00				< 0.1				
Borehole at Clara	14/04/1999	14:18:00				< 0.1				
	07/09/1999	10:20:00						Sample for bacteriological analyses only.		
Bennettsbridge	29/03/2000	14:16:00						This is a sample from a new well that feeds the old infiltration gallery for	Bennettsbridge water supply.	
Borehole at Kilmanagh	27/09/2000	10:30:00					3.2		VOC analysis results on separate sheet.	
Borehole at Windgap	27/09/2000	12:10:00					2.1	Total Coliforms not reported.	VOC analysis results on separate sheet.	
Borehole No.9, Thomastown	27/09/2000	14:15:00					1.8		VOC analysis results on separate sheet.	
Springs at Bausheenmore	27/09/2000	14:50:00								
Spring at Paulstown Castle	27/09/2000	15:40:00					10.3		VOC analysis results on separate sheet.	
Spring at Clomantagh	26/09/2000	10:20:00					0.6		VOC analysis results on separate sheet.	
Spring Toberpatrick Urlingford	26/09/2000	10:40:00					1.7		VOC analysis results on separate sheet.	
Borehole at Bawnmore	26/09/2000	11:05:00					0.7	Background interference on Total Coliform plate.	VOC analysis results on separate sheet.	
Borehole at Galmoy	26/09/2000	12:15:00					2.4		VOC analysis results on separate sheet.	
Borehole at Castlecomer Yarns	26/09/2000	14:00:00					0.6		VOC analysis results on separate sheet.	
Borehole at Dunmore	26/09/2000	14:25:00					1.1	Small underdeveloped colonies on Total Coliform plate.	VOC analysis results on separate sheet.	
Borehole at Dunmore S/G	26/09/2000	14:40:00					2.2	Background interference on Total Coliform plate.	VOC analysis results on separate sheet.	
Borehole at Kilkenny Mar	26/09/2000	14:55:00					1.3		VOC analysis results on separate sheet.	
Borehole at Clara	26/09/2000	15:35:00					2.9		VOC analysis results on separate sheet.	
Kiloshau/Barna	03/10/2000	11:15:00	< 0.0001	< 0.0001	0.008	< 0.1		Samples as part of Kilkenny Groundwater Protection Scheme.		
Tubrid Lower	03/10/2000	11:40:00	< 0.0001	< 0.0001	0.015	< 0.1		Samples as part of Kilkenny Groundwater Protection Scheme.		
Balief Clomantagh	03/10/2000	12:00:00	< 0.0001	< 0.0001	0.012	< 0.1		Samples as part of Kilkenny Groundwater Protection Scheme.		
Graine/Craddockstown	03/10/2000	12:30:00	< 0.0001	< 0.0001	0.007	< 0.1		Samples as part of Kilkenny Groundwater Protection Scheme.		
Pilltown (PWS07)	03/10/2000	09:45:00	< 0.0001	< 0.0001	0.004	< 0.1		Samples as part of Kilkenny Groundwater Protection Scheme.		
Tullahought (GWS16)	03/10/2000	10:30:00	< 0.0001	< 0.0001	0.002	< 0.1		Samples as part of Kilkenny Groundwater Protection Scheme.		
Hugginstown (GWS10)	03/10/2000	11:30:00	< 0.0001	< 0.0001	0.002	< 0.1		Samples as part of Kilkenny Groundwater Protection Scheme.		
Ahenure (PWS09)	03/10/2000	14:15:00	< 0.0001	< 0.0001	0.024	< 0.1		Samples as part of Kilkenny Groundwater Protection Scheme.		

EPA Regional Water Laboratory, Kilkenny. Monitoring Data for County Kilkenny Groundwaters 1993 to 1999.

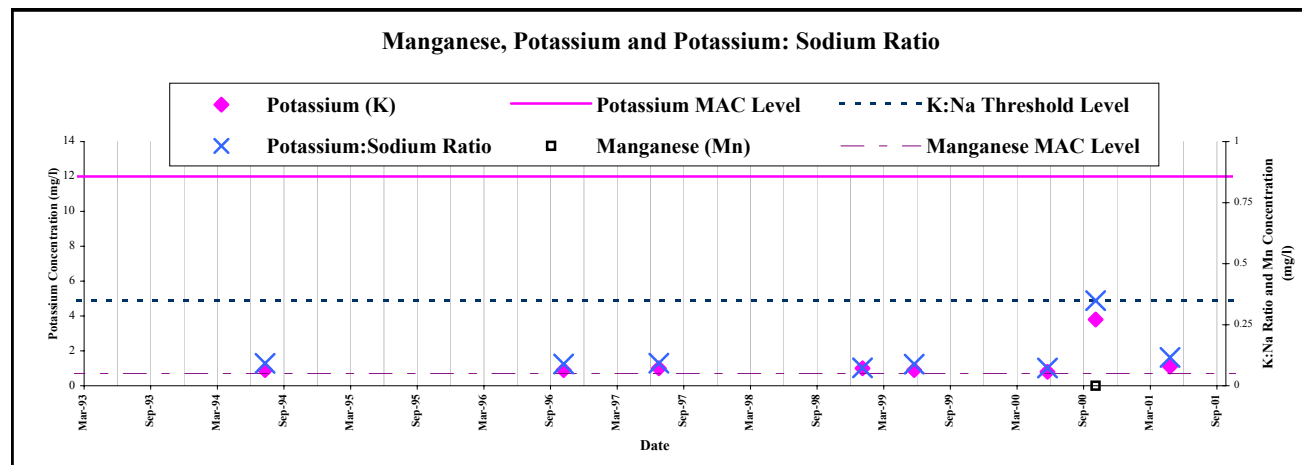
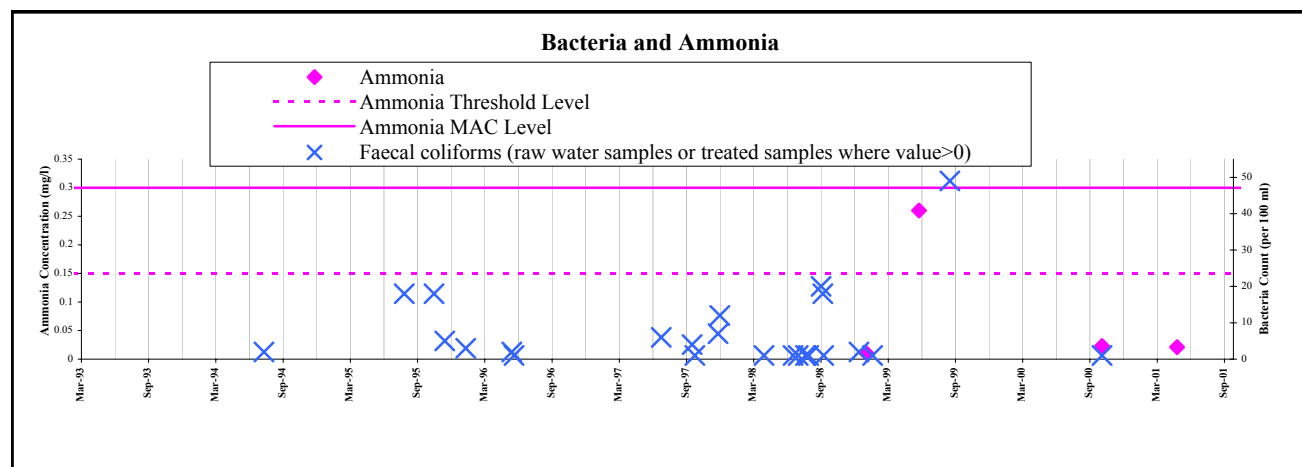
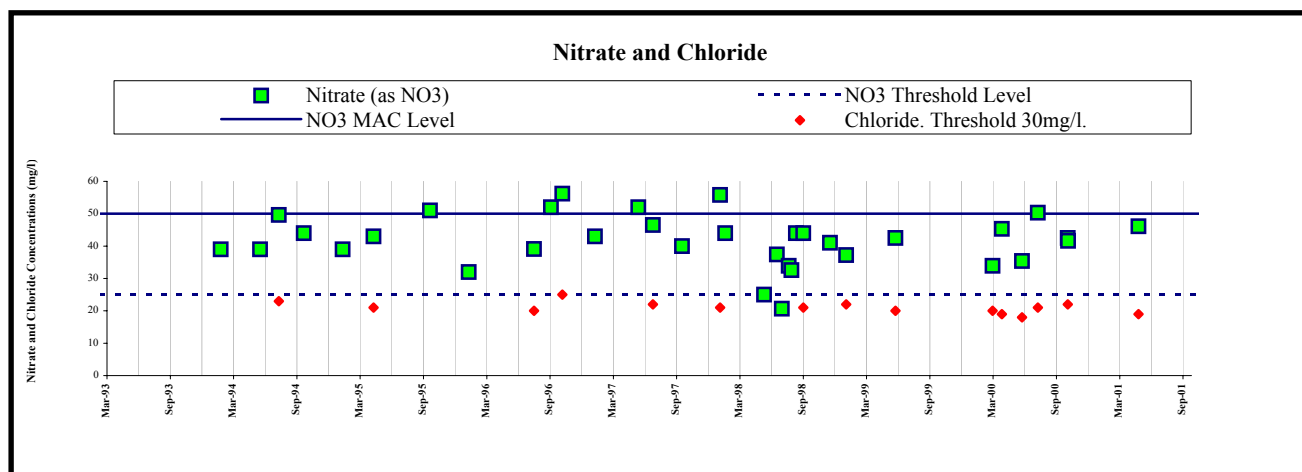
Source	Sampling Date	Sampling Time	To	Ref No	Sampling Location	Taken By	Lab No	EPAREf	Stn Grid Ref	Water Supply	Public/Group/Private	Temperature	Odour 1/2/3	Colour Hazen	pH	Conductivity μS/cm	Turbidity NTU	TOC mg/l C	Ammonia mg/l N
Callan (PWS06)	03/10/2000	15:00:00	Kilkenny Co. Co./G.S.I.			Ruth Buckley	5226								7.3	705			0.004
Windgap (GWS17)	03/10/2000	12:45:00	Kilkenny Co. Co./G.S.I.			Ruth Buckley	5227								6.7	267			0.007
Highrath (GWS11)	04/10/2000	12:00:00	Kilkenny Co. Co./G.S.I.		Highrath (GWS11)	M. Daly	5260						1	5	7.1	999			0.024
Maddoxtown (GWS12)	04/10/2000	12:30:00	Kilkenny Co. Co./G.S.I.		Maddoxtown (GWS12)	M. Daly	5261						1	5	7.2	931			0.022
Glenmore Spring (PWS02-1)	04/10/2000	11:10:00	Kilkenny Co. Co./G.S.I.		Glenmore Spring (PWS02-1)	Ruth Buckley	5266							5	6.4	259			0.018
Glenmore Spring (PWS02-2)	04/10/2000	13:25:00	Kilkenny Co. Co./G.S.I.		Glenmore Spring (PWS02-2)	Ruth Buckley	5267												
Cuffesgrange No. 1 (GWS13)	02/10/2000	11:00:00	Kilkenny Co. Co./G.S.I.		Cuffesgrange No. 1 (GWS13)	M. Daly	5094						1	5	7.3	772			0.011
Ballymack (GWS02)	02/10/2000	11:20:00	Kilkenny Co. Co./G.S.I.		Ballymack (GWS02)	M. Daly	5095						1	5	7.2	800			0.004
Newtown Kells (GWS04)	02/10/2000	11:45:00	Kilkenny Co. Co./G.S.I.		Newtown Kells (GWS04)	M. Daly	5096						1	5	7.3	789			0.007
Caherlesk Goolaghmore	02/10/2000	12:20:00	Kilkenny Co. Co./G.S.I.		Caherlesk Goolaghmore	M. Daly	5097						1	5	6.8	459			0.008
Paulstown (PWS7)	04/10/2000	10:30:00	Kilkenny Co. Co./G.S.I.		Paulstown (PWS7)	V. Fitzsimons	5262						1	5	7.3	676			0.016
Tullaroan (PWS5)	04/10/2000	11:30:00	Kilkenny Co. Co./G.S.I.		Tullaroan (PWS5)	V. Fitzsimons	5263						1	5	7.5	616			0.004
Urlingford (PWS5-S)	04/10/2000	12:30:00	Kilkenny Co. Co./G.S.I.		Urlingford (PWS5-S)	V. Fitzsimons	5264						1	5	7.2	803			0.007
Urlingford (PWS5-R)	04/10/2000	12:40:00	Kilkenny Co. Co./G.S.I.		Urlingford (PWS5-R)	V. Fitzsimons	5265							10	7.3	825			0.094
Thomastown BH1 (PWS01-1)	02/10/2000	10:30:00	Kilkenny Co. Co./G.S.I.		Thomastown BH1 (PWS01-1)	Ruth Buckley	5114							5	7	466			0.003
Thomastown BH2 (PWS01-2)	02/10/2000	10:50:00	Kilkenny Co. Co./G.S.I.		Thomastown BH2 (PWS01-2)	Ruth Buckley	5115							5	7.3	748			< 0.003
Bennettsbridge BH (PWS04-B)	02/10/2000	12:10:00	Kilkenny Co. Co./G.S.I.		Bennettsbridge BH (PWS04-B)	Ruth Buckley	5116							5	7.3	721			< 0.003
Bennettsbridge River (PWS04-R)	02/10/2000	12:15:00	Kilkenny Co. Co./G.S.I.		Bennettsbridge River (PWS04-R)	Ruth Buckley	5117							175	8	447			0.022
Bennettsbridge Gravel (PWS04-G)	02/10/2000	12:25:00	Kilkenny Co. Co./G.S.I.		Bennettsbridge Gravel (PWS04-G)	Ruth Buckley	5118							20	7.5	563			0.006
Bennettsbridge Mixed (PWS04-M)	02/10/2000	12:50:00	Kilkenny Co. Co./G.S.I.		Bennettsbridge Mixed (PWS04-M)	Ruth Buckley	5119						1	5	7.4	681			< 0.003
Kilree Stoneyford (GWS08)	02/10/2000	15:00:00	Kilkenny Co. Co./G.S.I.		Kilree Stoneyford (GWS08)	Ruth Buckley	5120						1	5	7.1	866			< 0.003
Spring at Clomantagh	12/02/2001	11:00:00	Kilkenny Co. Co. □	KK00900	Beside Nuenna river, 50m SE of roac		633		23520 16320		Private	9.7			7.2	615	1.4		0.007

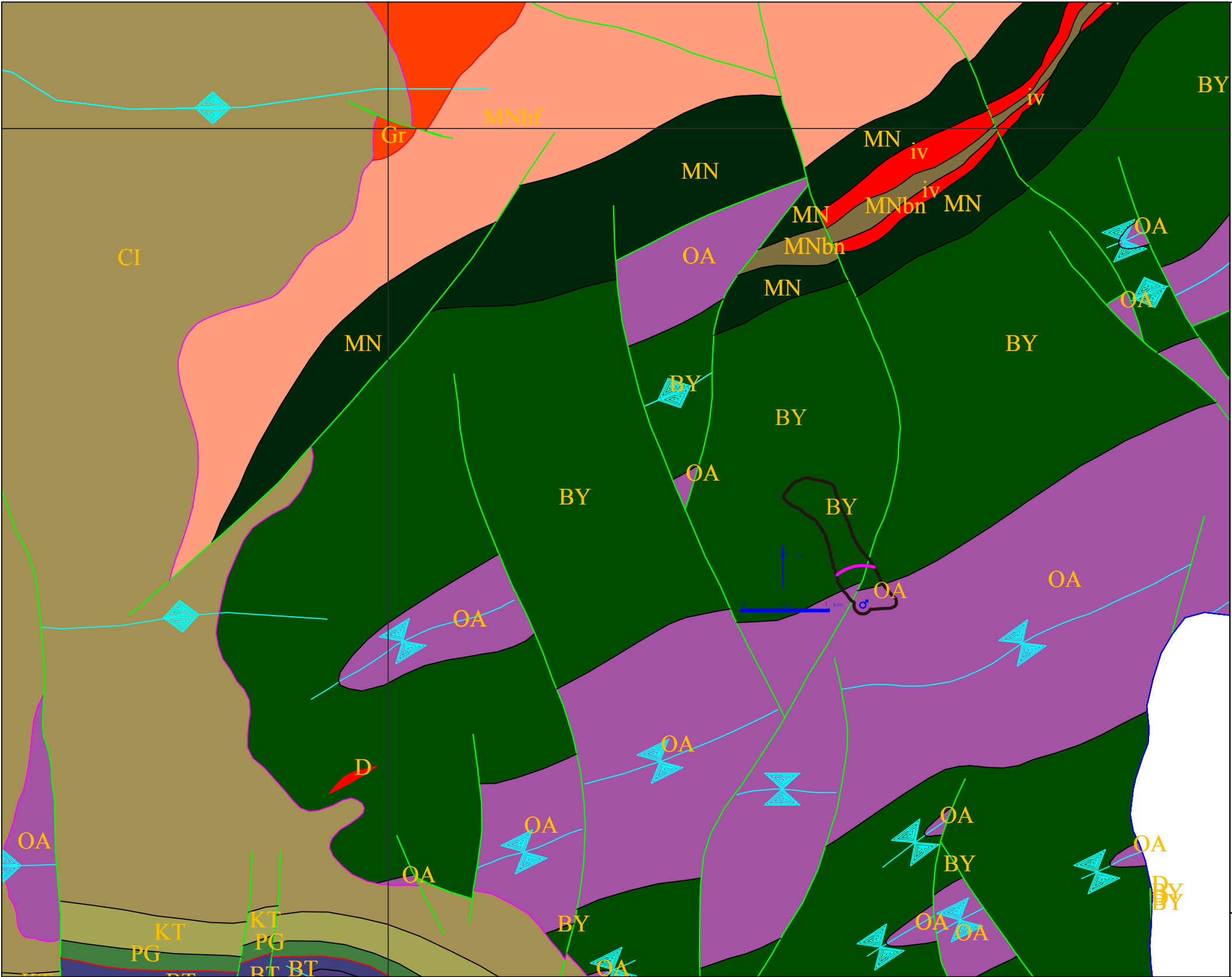
EPA Regional Water Laboratory, Kilkenny. Monitoring Data for County Kilkenny Groundwaters 1993 to 1999.

Source	Sampling Date	Sampling Time	o-Phosphate mg/l P	Nitrate mg/l N	Nitrite mg/l N	Chloride mg/l Cl	Ca Hardness mg/l CaCO ₃	Alkalinity mg/l CaCO ₃	TCS	Total Coliforms per 100 ml	FCS	Fecal Coliforms per 100 ml	Sulphate mg/l SO ₄	Dry Residue mg/l	Sus_Solids mg/l	Magnesium mg/l Mg	Total Hardness mg/l CaCO ₃	Sodium mg/l Na	Potassium mg/l K	Aluminium mg/l Al	Iron mg/l Fe	Manganese mg/l Mn	Copper mg/l Cu	Zinc mg/l Zn	Chromium mg/l Cr	Lead mg/l Pb
Callan (PWS06)	03/10/2000	15:00:00	0.006	4.1	< 0.001	19	334	336		24		10	11.6			25.1	437	10.1	0.9	< 0.05	< 0.05	0.0014	< 0.001	0.046	0.004	< 0.001
Windgap (GWS17)	03/10/2000	12:45:00	0.062	9.6	< 0.001	15	99.7	64		1		999	6.8			2.8	75.5	7.8	< 0.3	< 0.05	< 0.05	< 0.001	< 0.001	0.039	0.003	< 0.001
Highrath (GWS11)	04/10/2000	12:00:00	0.023	5.3	0.003	49	443	436	>	80	>	60	13.5			30	566	11	5.6	< 0.05	< 0.05	0.003	0.004	0.027	0.024	< 0.001
Maddoxtown (GWS12)	04/10/2000	12:30:00	0.015	11.7	< 0.001	25	383	404		17		4	18.6			29.1	502	11.1	3.3	< 0.05	< 0.05	< 0.001	< 0.001	0.003	0.021	< 0.001
Glenmore Spring (PWS02-1)	04/10/2000	11:10:00	< 0.006	9.6	0.001	22	44	38		45		1	12.8			11.5	91.3	10.9	3.8	< 0.05	< 0.05	< 0.001	< 0.001	0.02	0.003	< 0.001
Glenmore Spring (PWS02-2)	04/10/2000	13:25:00								36		1														
Cuffesgrange No. 1 (GWS13)	02/10/2000	11:00:00	0.02	4.2	0.009	19	362	362	>	80		29	13.1			25	464	11.2	3.6	< 0.05	< 0.05	< 0.001	0.005	0.037	0.005	< 0.001
Ballymack (GWS02)	02/10/2000	11:20:00	< 0.006	6.4	< 0.001	23	345	365		52		7	13.9			36.2	494	11.7	1.5	< 0.05	< 0.05	< 0.001	< 0.001	0.035	0.005	< 0.001
Newtown Kells (GWS04)	02/10/2000	11:45:00	0.006	5.6	< 0.001	26	359	367	>	80		7	13			29.2	479	12.5	1.5	< 0.05	< 0.05	< 0.001	0.004	0.049	0.003	< 0.001
Caherlesk Goolaghmore	02/10/2000	12:20:00	0.008	5.3	< 0.001	19	197	178		51		8	10			15.5	260	9.2	2.3	< 0.05	< 0.05	< 0.001	0.003	0.046	0.004	< 0.001
Paulstown (PWS7)	04/10/2000	10:30:00	0.008	5.7	0.008	22	330	286	>	80	>	60	12.8			11.5	377	10.9	3.8	< 0.05	< 0.05	< 0.001	< 0.001	0.014	0.016	< 0.001
Tullaroan (PWS5)	04/10/2000	11:30:00	< 0.006	2.9	< 0.001	14	301	284		999		999	7.4			10	342	8.2	1.4	< 0.05	< 0.05	< 0.001	< 0.001	< 0.001	0.015	< 0.001
Urlingford (PWS5-S)	04/10/2000	12:30:00	0.006	8	0.002	18	377	369	>	80	>	60	10.7			18.5	453	8	5.9	< 0.05	< 0.05	< 0.001	< 0.001	< 0.001	0.012	< 0.001
Urlingford (PWS5-R)	04/10/2000	12:40:00	0.039	7.2	0.056	19	375	375		1080		370	15.9			13.5	430	10.8	1.1	< 0.05	< 0.05	< 0.001	< 0.001	0.013	0.021	< 0.001
Thomastown BH1 (PWS01-1)	02/10/2000	10:30:00	0.012	4.9	< 0.001	18	186	105		8		999	10.4			15.5	249	11	1.3	< 0.05	< 0.05	< 0.001	0.005	0.05	0.004	< 0.001
Thomastown BH2 (PWS01-2)	02/10/2000	10:50:00	0.037	6.2	< 0.001	30	325	320		6		1	16			22.5	417	17.6	3.3	< 0.05	< 0.05	0.001	0.013	0.046	0.006	< 0.001
Bennettsbridge BH (PWS04-B)	02/10/2000	12:10:00	< 0.006	4.3	0.002	24	320	317		17		999	28.5			25.4	424	16.1	2.3	< 0.05	< 0.05	0.004	< 0.001	0.034	0.002	< 0.001
Bennettsbridge River (PWS04-R)	02/10/2000	12:15:00	0.083	2.1	0.014	16	223	185		42000		5600	15.8			7.8	255	10.3	4.4	0.119	0.279	0.02	0.003	0.037	0.004	< 0.001
Bennettsbridge Gravel (PWS04-G)	02/10/2000	12:25:00	0.05	1.1	0.051	22	260	253	>=	76		4	21.2			10.1	301	18.3	3.8	< 0.05	< 0.05	0.066	0.037	0.042	0.005	< 0.001
Bennettsbridge Mixed (PWS04-M)	02/10/2000	12:50:00	0.02	4.5	0.009	23	311	291		104		5	23			19.2	390	16.7	3.3	< 0.05	< 0.05	0.025	0.002	0.046	0.006	< 0.001
Kilree Stoneyford (GWS08)	02/10/2000	15:00:00	0.131	15.4	< 0.001	19	397	370	>	80		60	11.3			29.9	520	11.4	3	< 0.05	< 0.05	< 0.001	0.008	0.039	0.002	< 0.001
Spring at Clomantagh	12/02/2001	11:00:00	0.015	4.1	0.002	14	305	270		15		12	34.9			6.5	331	5.5	1.3		< 0.01	< 0.02		0.031		

Appendix VI: Summary of trends in water quality over time for selected supply sources in Kilkenny

Figure 10.1- Glenmore Spring
Key indicators of Agricultural and Domestic Groundwater Contamination.





COUNTY KILKENNY
GROUNDWATER PROTECTION SCHEME

Map 8. Bedrock Geology of Source
Protection Areas.

- | | | | |
|------|----------------------------------|------|---|
| CQ | Coolbaun Formation | BUdo | Dolomitised Butlersgrove Formation |
| CQss | Swan Sandstone Member | WA | Waulsortian Limestone |
| CG | Clay Gall Sandstone | WAdo | Dolomitised Waulsortian Limestone Formation |
| MC | Moyadd Coal Formation | BA | Ballysteen Formation |
| LF | Lickfinn Coal Formation | BAdo | Dolomitised Ballysteen Limestone Formation |
| BE | Bregaun Flagstone Formation | BT | Ballymartin Formation |
| KN | Killeshin Siltstone Formation | PG | Porter's Gate Formation |
| LS | Luggacurren Shale | KT | Kiltorcan Formation |
| CL | Clogrennan Formation | CI | Carrigmaclea Formation |
| BM | Ballyadams Formation | OA | Oaklands Formation |
| BMdo | Dolomitised Ballyadams Formation | BT | Ballylane Formation |
| DW | Durrow Formation | MA | Maulin Formation |
| AG | Aghmacart Formation | MNbn | Ballyneale Member |
| CS | Crosspatrick Formation | MNbf | Brownsford Member |
| BU | Butlersgrove Formation | CK | Carricktriss Formation |

- | | | | |
|------------------------------|--|----|--|
| Fault | Geological Contact | Gr | Granite |
| Fold Axis | Dolomite Contact | | |
| Unconformity | Volcanics | | |
| High Yielding Spring | Excellent Yielding Well | | Zone of Contribution to Well or Spring |
| Intermediate Yielding Spring | Infiltration Gallery | | Well with water level reading |
| Low Yielding Spring | Paulstown Source Area outside Co. Kilkenny | | Sinking Stream |
| Sand and Gravel Deposits | | | |

This **bedrock map** is designed for general information and strategic planning usage. The boundaries are based on the available evidence and local details have been generalised to fit the map scale. Evaluation of specific sites and circumstances will normally require further and more detailed assessments and will frequently require site investigations

Sources of information:
G.S.I. 1:100,000 Bedrock Series Sheets 18,19,22 & 23 : compiled by A. G. Sleeman, D. C. Smith, B. McConnell and D. Tietzsch-Tyler.

Project Hydrogeologist: Ruth Buckley & Cecilia Gately
Project Manager: Vincent Fitzsimons
Digital Map Production: Marie Hogan

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KILKENNY COUNTY COUNCIL
Comhairle Chontae Chill
Choirneigh



Mr. Tom Gunning, B.E., CEng., F.I.E.I.
Director of Services
County Hall, John Street, Kilkenny

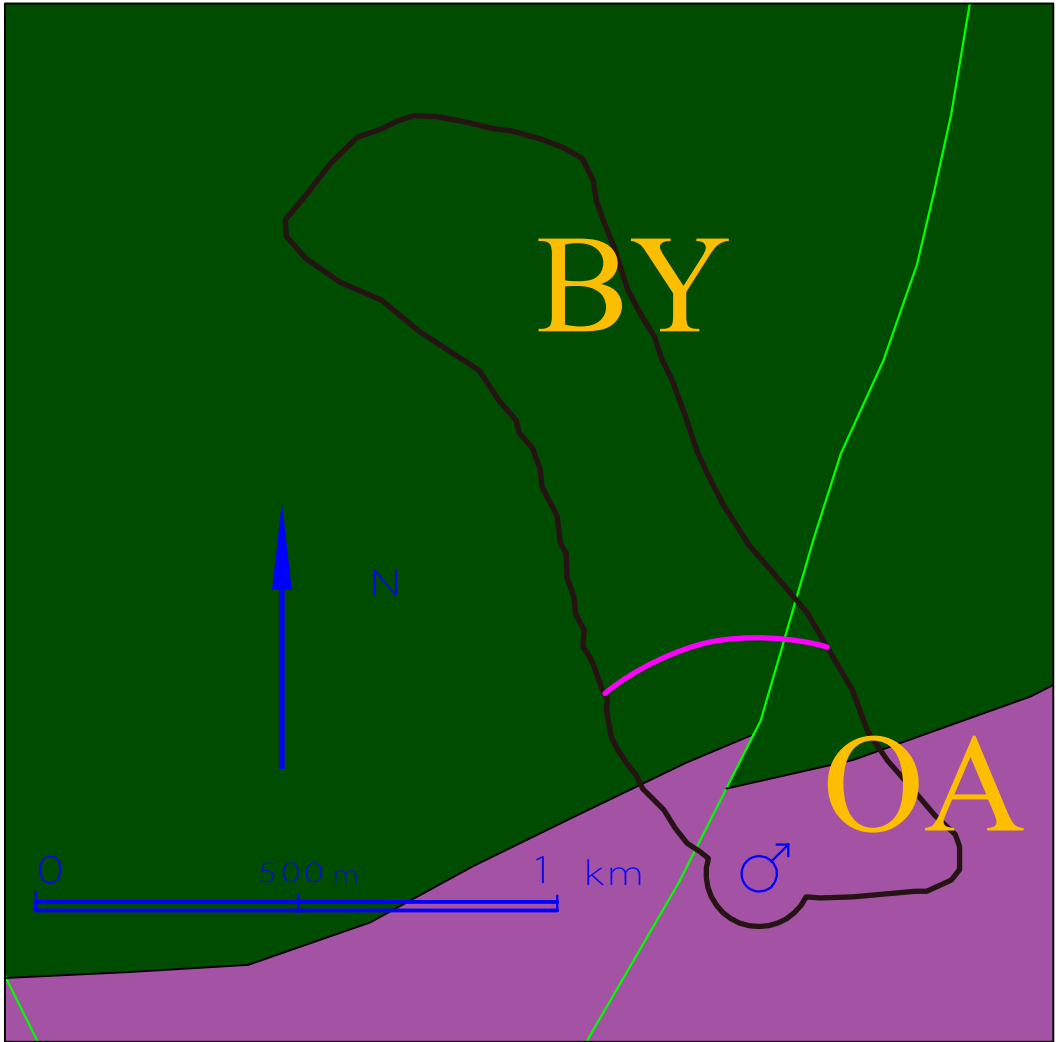
Date	Details	Map Production	Checklist
Aug 01	Draft	M.H.	S.B.A.V.F.
Mar 02	Draft	M.H.	S.B.A.V.F.
Jul 02	Final	M.H.	S.B.A.V.F.

GEOLOGICAL SURVEY
OF IRELAND
Suirbhíreacht Gheolaitochta Éireann



Beggars Bush, Haddington Rd.,
Dublin 4

Glenmore



Glenmore PSS

Glenmore PSS

COUNTY KILKENNY GROUNDWATER PROTECTION SCHEME

MAP 9 VULNERABILITY OF SOURCE PROTECTION AREAS

VULNERABILITY CLASSIFICATION

- Generally Extreme (E)
- Outcrop/Shallow rock/Karst (E)
- Generally High (H)
- Generally Moderate (M)
- Generally Low (L)

- High Yielding Spring
- Excellent Yielding Well
- Intermediate Yielding Spring
- Infiltration Gallery
- Low Yielding Spring
- Portion of Paulstown Outer Source Area lying outside Co. Kilkenny

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

The map shows the vulnerability of the first groundwater encountered (in other words ground water) or is indicated by contemporary research at depths of 2.0 m below the ground surface. Where vulnerability is assessed at significantly different depths, there will be a need to determine groundwater vulnerability using site specific data. The characteristics of individual contaminants have not been taken into account.

This vulnerability map is designed for general information and strategic planning usage. The boundaries are based on the available evidence and local details have been generated to fit the map scale. Evaluation of specific sites and circumstances will normally require further and more detailed assessment, and will frequently require site investigations to determine the risk to groundwater.

Project Hydrogeologist: Ruth Buckley & Cecilia Gately
Project Manager: Vincent Fitzsimons
Digital Map Production: Marie Hogan

Sources of Information

Bedrock map: Map 1: A.G. Stearns, D.C. Smith, B. McConnell and D. Trenchard Taylor
Quaternary and depth to bedrock mapping: Map 1: S. Hegarty, Quaternary and Geotechnical Section
Permeability mapping: R. Buckley and V. Fitzsimons, Groundwater Section
Soil map: 1:25,000, 6th Edition, 1990
Borehole map: Map 2: S. Hegarty, Quaternary and Geotechnical Section

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KILKENNY COUNTY COUNCIL
Containing Ordnance Survey Data



Mr. Tom Barry, E.E. O'Connell, F.E.D.
County Hall, John Street, Kilkenny

DATE	REVISION	DESCRIPTION
1999	1	Initial map
2001	2	Revised map
2003	3	Revised map
2005	4	Revised map
2007	5	Revised map
2009	6	Revised map
2011	7	Revised map
2013	8	Revised map
2015	9	Revised map
2017	10	Revised map
2019	11	Revised map
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2207	105	Revised map
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2607	305	Revised map
2609	306	Revised map
2611	307	Revised map
2613	308	Revised map
2615	309	Revised map
2617	310	Revised map
2619	311	Revised map
2621	312	Revised map
2623	313	Revised map
2625	314	Revised map
2627	315	Revised map
2629	316	Revised map
2631	317	Revised map
2633	318	Revised map
2635	319	Revised map
2637	320	Revised map
2639	321	Revised map
2641	322	Revised map
2643	323	Revised map
2645	324	Revised map
2647	325	Revised map
2649	326	Revised map
2651	327	Revised map
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2681	342	Revised map
2683	343	Re

Glenmore PSS

COUNTY KILKENNY GROUNDWATER PROTECTION SCHEME

MAP 10 SOURCE PROTECTION ZONES

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

- High Yielding Spring
- Intermediate Yielding Spring
- Low Yielding Spring
- Portion of Paulstown Outer Source Area lying outside Co. Kilkenny
- Excellent Yielding Well
- Infiltration Gallery

This Source Protection Zone map is designed for general information and strategic planning usage. The boundaries are based on the available evidence and local details have been generated to fit the map scale. Evaluation of specific sites and circumstances will normally require further and more detailed assessments and will frequently require site investigations to determine the risk to groundwater. The map is intended for use in conjunction with groundwater protection responses for potentially polluting activities, which take the degree of acceptability of those activities in each zone and describes the control measures necessary to prevent pollution.

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Project Manager: Vincent Fitzmaurice
Digital Map Production: Maria Hogan

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KILKENNY COUNTY COUNCIL
c/o Kilkenny Child Care



Mr. Tom Garry, E.E. City, F.I.E.I.
County Hall, John Street, Kilkenny

DATE	BY	REVISION
10/01/01	SG	1
10/01/01	SG	2
10/01/01	SG	3
10/01/01	SG	4
10/01/01	SG	5
10/01/01	SG	6
10/01/01	SG	7
10/01/01	SG	8
10/01/01	SG	9
10/01/01	SG	10

GEOLOGICAL SURVEY
OF IRELAND
Bathymetric Information System



Geological Survey
Bathymetric Information System

