Thomastown Source

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

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Groundwater Protection Scheme

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Overall conclusions are contained within Volume I.

13. Thomastown Source

13.1 Introduction

The objectives of this chapter are:

- To delineate source protection zones for the Thomastown Water Supply Scheme.
- To outline the principal hydrogeological characteristics of the Thomastown 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 well. 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).

13.2 Location and Site Description

Two wells situated in the townland of Grenan, make up the public drinking water source for Thomastown. Their location is shown on Map 8 and Map 4S. The more northerly well is known as Well 9, or the GAA Grounds well, while the southerly one is known as Well 5, or the Nore Creamery well.

Both wells have separate pump-houses, and both are located outside them. Well 9 is located 35 m to the south east of the pump-house, while Well 5 is situated 9 m south of its pump-house. Both pump-houses have the same dimensions: floored with concrete 0.15 m above the surrounding ground level, 4.6 m wide by 4.6 m deep. Both pump-houses also have tarmac laid all around them and are securely fenced off from the road. Well 5 is contained within this fencing, but Well 9 is not.

Both wells are situated on the west side of the River Nore, above the flood-plain level. Although the two well heads are below ground surface, they appear to be sealed-off and protected from surface runoff. According to County Council staff, neither well has been inundated during recent floods. The discharge from both wells is pumped to a plant house less than 0.5 km to the west, where it is chlorinated and fluoridated before being stored in the adjacent reservoir. The two wells are pumped one hour on, one hour off, 24 hours a day.

13.3 Summary of Source Details

	Well 5, Nore Creamery	**Well 9, GAA Grounds**
GSI no.	2313NEW234	2313NEW236
Grid ref. (1:25,000)	25900 14094	25904 14146
Townland	Grenan	Grenan
Source type	Borehole	Borehole
Drilled	January 1991	December 1990
Owner	Kilkenny County Council	Kilkenny County Council
Elevation (ground level)	20.4 m O.D.	16.2 m O.D.
Depth	67 m	102 m
Depth of casing	63 m	90 m
Diameter	250 mm (10")	300 mm (12")
Depth to rock	12 m	12 m
Static water level	14.4 m O.D. (6.0 m b.g.l.) on 12/02/91	15.5 m O.D. (0.7 m b.g.l.) on 13/02/91
Pumping water level	7.8 m O.D. (12.6 m b.g.l.) on 09/07/01	7.5 m O.D. (8.7 m b.g.l.) on 09/07/01
Maximum drawdown	19.97 m	7.97 m
Consumption	1240 m^3/d	360 m^3/d
Pumping test summary:		
(i) abstraction rate	2232-2246 m^3/d*	*Not available*
(ii) specific capacity	260 $m^3/d/m$	
(iii) transmissivity	700 to 1000 m^2/d	

** Well 5 was tested at various rates in February 1991, the longest test abstracting on average 2240 m^3/d and lasting 10 days.*

13.4 Methodology

13.4.1 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 *et al*, 1994a). Details of the current abstraction rate were obtained from Kilkenny County Council. Drilling and pumping test data for the supply wells were obtained from Brian P. Connor, the consultant involved with their development, while data on private groundwater wells in the area was taken from GSI archives and an unpublished groundwater supply scheme feasibility report prepared by the GSI (Daly, 1984). Historical water quality data was provided the EPA and the County Council.

13.4.2 Site Visits and Field Work

Site visits and fieldwork included walkover surveys undertaken by both the Groundwater (1 day) and Quaternary (1 day) sections of the GSI to further investigate the subsoil and bedrock geology, the hydrogeology and the vulnerability to contamination. Two raw water samples were taken by the GSI on 02/10/2000 and 25/04/2001, and analysed by EPA laboratories in Kilkenny to assess possible sources of contamination at the wells.

13.4.3 Assessment

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

13.5 Topography and Surface Hydrology

Both wells are located less than 1 km south of Thomastown. Well 5 is located 140 m west of the River Nore, while well 9 is located 340 m west of the river (Map 8).

The Nore flows generally south eastwards and forms a broad meander at Thomastown, which encircles the wells in all directions except the south west. This meander occupies the base of a flat, 500 m wide valley which rises sharply on either side. The southern watershed of the Nore rises to an altitude of 252 m O.D., at a distance of 8 km from the wells. The eastern watershed rises to an altitude of 365 m O.D., at a distance of 6.5 km from the wells.

Slopes on the valley bottom are generally in the order of 0.01 (1 in 100), and up to 0.35 (1 in 3) on the valley sides.

There are streamflow gauges on the Nore River at Brownsbarn Bridge, 3.5 km downstream of Thomastown, and at Mount Juliet, 4 km upstream. Low flows[23] at Mount Juliet are in the order of 4 m^3/sec, while those at Brownsbarn are in the order of 4.3 m^3/sec (EPA, 2001).

The natural stream density is low, even on the valley floor. Aside from the Nore itself, only one stream is found in the vicinity of the wells.

13.6 Geology and Aquifers

13.6.1 Bedrock

The main rock types in the vicinity of the Thomastown source are the Maulin Slate, the Carrigmaclea Sandstone and the Kiltorcan Sandstone Formations. Both supply wells are thought to draw most of their water from the Carrigmaclea sandstones. This is shown in cross-section in Figure 13.1, and in plan view in Map 8. These formation are described in more detail in Chapter 2 of Volume I. Aquifer classifications are discussed in Chapter 4 of Volume I.

The Carrigmaclea Formation comprises sandstones and has been classified as a **locally important aquifer** which is **moderately productive only in local zones** (**Ll**). Drilling information from six wells in the vicinity of the supply wells suggests that the main water strikes in the Carrigmaclea sandstones in this area occur in two zones:

- *Within the weathered zone in the top fifteen meters of the bedrock profile*: Initial strikes of 15,000 to 30,000 gph (1640 to 3270 m^3/day) were encountered in this zone in three of the six holes.
- *Close to the contact between the Carrigmaclea sandstone and the underlying Maulin shale, at depths of 60 to 90 m below ground:* A zone of conglomeratic rocks is sometimes associated with this contact and was encountered in three of the six holes drilled. Strikes of over 20,000 gph (2180 m^3/day) were encountered in this material in a test borehole close to production well 9, and over 18,000 gph (1960 m^3/day) in production well 5. No strikes were recorded in the third hole which encountered this material; another test hole for production well 9.

In addition to these two intervals of concentrated groundwater flows, it is apparent from the six well logs that water strikes can occur across the whole thickness of the Carrigmaclea sandstones in the valley floor area. Strikes of 1000 to 1500 gph (110 to 160 m^3/day) were encountered between the upper weathered zone and the basal conglomerate material in four of the six holes in the vicinity of the supply wells. Note also that strikes of 2000 to 2300 gph (220 to 250 m^3/day) were estimated in a hole that penetrated the underlying Maulin Formation slates.

The Kiltorcan Formation, which overlies the Carrigmaclea Formation to the north of the supply wells, has been classified as a **regionally important** fissured bedrock aquifer (**Rf**). The Maulin Formation

[23] *Flow which is equalled or exceeded at least 95% of the time.*

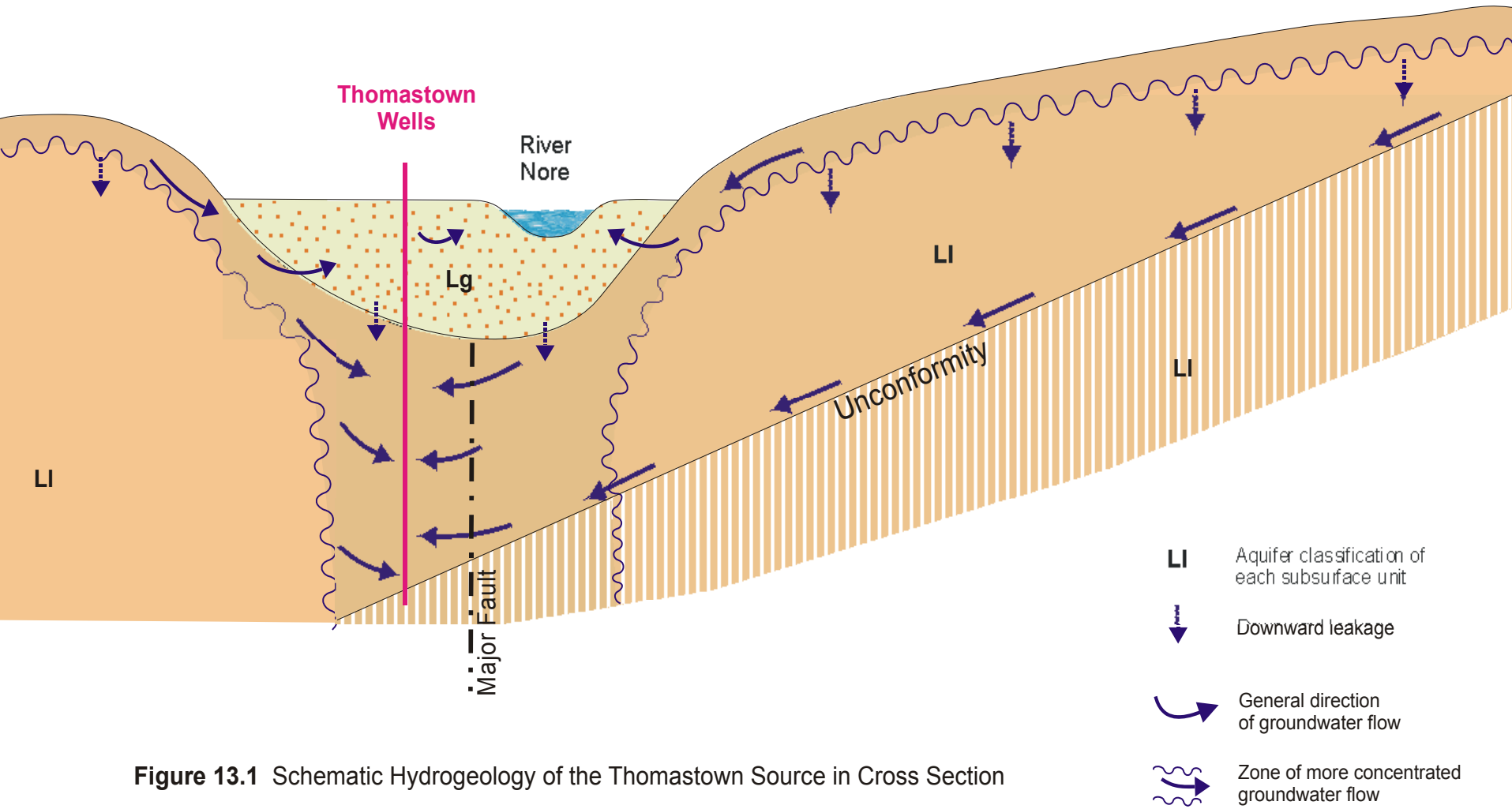


Figure 13.1 Schematic Hydrogeology of the Thomastown Source in Cross Section

underlies the Carrigmaclea sandstones at the wells. It consists of metamorphic rock, and has been classified as a **locally important aquifer** which is **moderately productive only in local zones** (**Ll**).

All three formations have been affected by a north to south trending fault (Map 8 and Map 1S), which appears to have resulted in 400 m of displacement and which is likely to act as a focus for groundwater flow.

The Nore catchment around the source lies on the south-eastern side of a large syncline (downward fold in the rock mass). As a consequence, the rocks dip at 3° to 10° north-westwards into the valley (Figure 13.1).

13.6.2 Subsoil

The main subsoil types are gravel, till and alluvium. These materials are described in more detail in Chapter 3 of Volume I and their distribution in the vicinity of the Thomastown source is shown on Map 2S.

As described in Chapter 4 of Volume I, gravels occur along the Nore valley and are classified as a **Locally important** gravel aquifer (**Lg**). Prior to 1991 the town's water supply was from an infiltration gallery situated in these gravels on the banks of the Nore at Stamps-Park 1 km west of the supply wells. Well records in the area show the gravel to be between 9 and 12 m thick on the valley floor (under the meander which partially encircles the supply wells) but thinning rapidly to less than 3 m at the edge of the Nore floodplain, and further downstream where the river valley narrows.

The till deposits are found on the valley sides, where they form a thin covering which rarely exceeds 3 m. The alluvial deposits are recent, and are found at points along the river bank where flooding is common. Neither deposit is considered to have aquifer potential. Their main significance is in vulnerability and recharge assessments. These issues are described in Sections 13.7 and 13.8.

13.7 Groundwater Vulnerability

13.7.1 Introduction

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 13.6, two groundwater targets occur, one in fractured bedrock and the other in the overlying sands and gravels. Where the sand and gravel aquifer occurs at the surface, the overall vulnerability will be dictated by the vulnerability of groundwater within this aquifer. On the valley sides where the sand and gravel aquifer is absent, vulnerability will be dictated by the overall subsoil permeability and by the depth to bedrock.

13.7.2 Vulnerability in Areas where the Sand and Gravel Aquifer Occurs

Water level information for the six wells in the vicinity of the supply wells indicate that the water table is between 2 and 2.6 m below ground level on the flood plain, and 5.6 to 6.7 m on the lower valley sides.

In unconfined situations, the vulnerability of a sand and gravel aquifer is dictated by the thickness of the unsaturated zone. Where the unsaturated zone is less than 3 m from the land surface, the vulnerability of the aquifer is considered to be 'extreme'. Although the available water level information indicates that in some cases, the water table is less than 3 m from the land surface, it is regarded as generally 'high' rather than 'extreme' vulnerability due to the presence of a silty alluvial layer at the surface. This alluvial layer should serve to somewhat reduce the vulnerability of the groundwater.

13.7.3 Vulnerability in Areas where the Sand and Gravel Aquifer is Absent

In these areas, situated on the valley sides overlooking the site, the groundwater vulnerability is determined by the permeability and thickness of the tills overlying the bedrock.

A large number of outcrops occur on the valley sides and subsoils are thought to be generally less than 3 m thick. 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 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 on the valley sides, a vulnerability classification of 'extreme' has been assigned.

13.7.4 Summary

Groundwater vulnerability is generally 'high' on the valley floor and generally 'extreme' on the valley sides.

Note that the permeability estimations are based on regional-scale evaluations, while depth to rock and water level interpretations are based on the available data cited here. However, permeability, water level and particularly depth to rock can vary over a very small scale. As such, 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).

13.8 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 [24]:

- Annual rainfall: 930 mm (Met Eireann average annual (1961-90) rainfall measured at Kilmurry House in Thomastown.
- Annual actual evapotranspiration (A.E.) losses: 460 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: 470 mm/year, based on average annual rainfall less estimated evapotranspiration.
- Annual runoff losses: 90 mm/year. (20% of potential recharge). This is a typical figure used by the GSI in areas where the till cover is thin, and where drainage densities are low. Note, however, that drilling evidence indicates that groundwater flows occur at a number of depths. The total groundwater recharge will be distributed across these depths. Recharge to the lower levels will therefore be a small fraction of the estimated total groundwater recharge.

[24] *Estimations used in this report have generally been rounded off to two significant figures*

These calculations are summarised below:

Average annual rainfall (R)	930 mm
Estimated A.E.	460 mm
Potential Recharge (R – A.E.)	470 mm
Runoff losses (RO)	20%
Estimated recharge to upper groundwater flow zones (R-A.E.) x (1-R.O)	380 mm

13.9 Groundwater levels

Measurement of water levels was not directly possible at the 2 wells, but auto-recorder levels were obtained from the County Council. Typical results were as follows:

Date	Level in River (m OD)*		Pumping **	Level in Pumping Well 5 (m OD)	Level in Pumping Well 9 (m OD)
	Mount Juliet	Brownsbarn			
12/03/97	21.7	7.9	Pump off	14.6	16.4
			Pump on	8.1	7.5
09/07/01	21.4	7.5	Pump off	11.9	15.0
			Pump on	7.8	7.5

**Data from OPW. Brownsbarn lies 6.8 km downstream (measured along the river channel) while Mount Juliet lies 5.4 km upstream.*

***It should be noted that both wells are pumped 24 hours a day on a one hour off, one hour on basis.*

13.10 Groundwater Flow Directions and Gradients

A diagrammatic representation of the various components of flow is presented in Figure 13.1.

Due to the range of aquifer types in the Thomastown area, the groundwater flow directions are somewhat complex. Information from the logs of the supply wells suggest that flows occur within the subsoil gravels, and across the whole profile of the Carrigmaclea sandstone aquifer. In the gravels along the river and the top few tens of meters of weathered rock, water is likely to follow relatively short flowpaths, recharging in the hills to the west and east of the Nore, before discharging into the river. Thus, the water table in the area is assumed to be controlled by topography, with a good hydraulic connection between the river and the groundwater (see Figure 13.1).

The deeper component of groundwater flow at the base of the Carrigmaclea sandstones is likely to be controlled primarily by the dip of the rocks, with a proportion of flow drawn from the western side of the Nore valley and towards the supply wells (refer to Figure 13.1).

Gradients on the valley sides have been estimated at 0.01 from water level data collected during development of the supply scheme in the 1980's. However, less data are available for the valley floor, and groundwater gradients in this area are difficult to calculate because different gradients are likely in the different flow systems. Nevertheless, it is clear from permeability and topography data that gradients on the valley floor will be much lower than those on the valley sides. The gradient of the river channel between Mount Juliet and Brownsbarn is 0.001 (refer to Section 13.9) and this is likely to represent a lower limit for the groundwater gradient. A figure of 0.005 (in between the river gradient and the groundwater gradient on the valley sides) has been selected as generally representative of groundwater gradients on the valley floor.

Note that gradients close to the pumping wells are likely to increase.

13.11 Hydrochemistry and Water Quality

Data on recent trends in water quality at the Thomastown wells are summarised graphically in Figures 13.2 and 13.3, and the source data can also be found in Appendix V.

The following key points have been identified from the data:

- Data from analysis in eight samples from the two supply wells indicate a 'moderately hard' to 'very hard' (>350-151 mg/l $CaCO_3$) calcium-bicarbonate hydrochemical signature. Daly, 1994 reports that these levels of hardness are common in sandstones in Kilkenny where they are overlain by thick subsoils.
- For Well 5 (Nore Creamery), only total coliforms exceeded the European maximum admissible concentration. This occurred at low levels (8 counts/100 ml) in one of the three raw water[25] analyses available. Note that small concentrations of total coliforms can originate in the natural environment and are not necessarily proof that faecal contamination has occurred.
- For Well 9 (GAA grounds), in the five analyses available, manganese (one occasion in 1993), lead (one occasion in 1993), and faecal coliforms (two occasions in October 2000) exceeded the European maximum admissible concentration. Note that the levels of faecal coliforms were low (1 count / 100 ml) and may have originated from the sample vessel or sample handling.
- In terms of the remaining contaminant indicators studied, levels of nitrate, phosphate and chloride were close to GSI guide limits in Well 9 (GAA grounds). It is likely, therefore, that the waters are affected by releases of organic waste and/or inorganic fertiliser such as agricultural landspreading, or seepage from sewerage systems.
- Given the presence of casing at depths of 63 m and 90 m in the supply wells (refer to section 13.3) it is unlikely that contaminants are being introduced down the side of the well bore. Consequently, the contaminant indicators suggest that, within the aquifer itself, surface water and/or shallow groundwaters are mixing with the deeper groundwaters which supply the wells.

The regional hydrochemistry of the Maulin (**Ll**), Carrigmaclea (**Ll**) and Kiltorcan (**Rf**) aquifer systems is discussed in Chapter 4 of Volume I.

13.12 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. The data used in this section are based on pumping tests undertaken by the consultant Brian P. Connor in February 1991 (results provided by Brian P. Connor).

Well 5 (Nore creamery): A constant discharge test in February 1991 at 2240 m^3/day for 10 days gave a final drawdown of 8.62 m, and a specific capacity of 260 m^3/day/m. Water levels in a well just 2 m from Well 5 were observed throughout the discharge and subsequent recovery. Analysis of the drawdown in both the pumping and observation wells provided a transmissivity estimate of approximately 1000 m^2/d. The well penetrates through the whole saturated thickness of the aquifer (from 12 m below ground to 67 m below ground). An overall bulk permeability of 18 m/day has been derived from the transmissivity and saturated thickness estimates.

Specific capacity estimates are available for six wells (including Well 5) in the Carrigmaclea sandstones in Grenan and Dangan townlands. Estimates ranged from 16 to 260 m^3/day/m, and exceeded 190 m^3/day/m in three of the six wells. These specific capacities are generally significantly higher that the levels normally associated with the Carrigmaclea sandstones and it may be that the

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

fault described in Section 13.6 has increased specific capacities and transmissivities in the vicinity of the valley floor. Consequently, though the transmissivity derived from data for Well 5 is much higher than would normally be expected for Carrigmaclea sandstones, it is thought to represent a realistic 'worst case' (in terms of the need for groundwater protection) for the formation in the vicinity of the fault. Transmissivities on the valley sides are expected to be generally lower, probably by at least an order of magnitude.

Storativity values estimated from this 1991 pump test data are in the order of 1.6×10^{-3}.

Pump test data have not currently been made available for well 9 (GAA grounds).

A porosity of 0.025 has been assumed for the aquifer on the valley floor. This is at the upper end of the typical range used by the GSI for bedrock aquifers (0.025 to 0.01) and reflects the belief that the aquifer is densely fractured in the vicinity of the fault zone which runs along the valley floor.

13.13 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 conceptual model is depicted schematically in Figure 13.1

- The supply wells are drilled into fractured sandstones of the Carrigmaclea Formation. Water strikes occurred at intervals across the whole thickness of this formation during drilling of the two supply wells, but were largest in the upper weathered portion (top 5 to 15 m of the rock) and at the unconformity at the base of the formation (60 to 90 m below ground). Transmissivity and specific capacity data in the vicinity suggests that the transmissivity of the sandstones is significantly enhanced (1000 m^2/d) on the valley floor in the vicinity of the wells. This is probably related to increased fracturing near a large fault.
- In the Nore valley, the bedrock units are overlain by gravel, which is greater than 10 m thick at the centre of the valley, thinning rapidly to less than 3 m close to the valley sides. There is evidence that this material is very free-draining and highly permeable, and prior to the development of the two wells, it was the source of water in Thomastown. The valley sides are mainly covered by tills of less than 3 m thickness. Surface drainage indicators suggest that the valley sides are also free-draining.
- Shallow groundwater flows occur in the gravel aquifer and the weathered portion of the sandstone aquifer. They are controlled by topography/gravity and by the high permeability pathway orientated along the north-south fault on the valley floor. Consequently, most shallow groundwater flows will be derived from the Nore valley sides to the west and south of the wells and will generally migrate towards the river perpendicular to the topographic contours. Recharge rates to the shallow portion of the aquifer are thought to be of the order of 380 mm/year.
- The deeper flows to the wells are concentrated in a geological unconformity at the base of the sandstone aquifer. They are controlled by topography/gravity and by the geological orientation of the base of the sandstone aquifer. This flow pathway is predominantly recharged vertically from shallow flow systems closer to the surface, but also horizontally from the area where the base of the aquifer comes to surface. The mixing of shallow and deep water is supported by the presence of slightly elevated levels of phosphate, nitrate and chloride in the production wells. Consequently, the recharge area for deep groundwater flows will include the recharge area for the shallow flows, but will also extend across to the valley sides to the east of the river where the base of the sandstone aquifer comes to surface. Groundwater close to the base of the aquifer will generally flow perpendicular to the dip of the geological unconformity.
- Gradients within the shallow groundwater component are in the order of 0.01 on the valley sides and assumed to be in the order of 0.005 on the valley floor.

13.14 Delineation of Source Protection Areas

13.14.1 Introduction

This section delineates the areas around the wells that are believed to contribute groundwater to the wells, and that therefore require protection. The areas are delineated on the basis of the conceptualisation of the groundwater flow pattern as described in Section 13.13 and shown in Figure 13.1.

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 wells.

13.14.2 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 pumping rate, (b) the groundwater flow direction and gradient, (c) the rock permeability and (d) 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.

In order to provide a reasonable, but conservative, estimate of the size of the ZOC, a high abstraction estimate of 2,780 m^3/day (1,014,700 m^3/year) was used. This figure was derived from the 1991 pumping test estimate of maximum yield from the Nore Creamery well (2250 m^3/day) and the maximum recorded daily discharge from the GAA grounds well[26] (530 m^3/day).

The boundaries of the analytical model were taken from hydrogeological mapping and the conceptualisation outlined in Section 13.13, and were as follows:

- **Northern boundary:** Nore river.
- **Southern boundary:** Ridge at Knockard - at point where the dip of the unconformity at the base of the Carrigmaclea sandstone swings away from the supply wells.
- **Western boundary:** Grenan ridge, surface water catchment for this stretch of the Nore.
- **Eastern boundary:** That portion of the unconformity between the Maulin and the Carrigmaclea Formations which dips towards the supply wells from the eastern side of the Nore valley. An additional buffer of 30 m was added upslope of the unconformity to allow for surface drains which may supply recharge waters to the unconformity.

These boundaries delineate the physical limits within which the ZOC is likely to occur, and cover an area of 5.7 km^2.

Note that the limits extend onto the far side of the Nore and it is unusual for a ZOC to cross under rivers of this size. The reasons are outlined in Section 13.13, but a water balance can also be used to examine whether the inclusion of the area to the east of the Nore is over-conservative:

West bank recharge rate estimate:	*380 mm/year*
Area of west bank included within the physical constraints:	*2.3 km^2*
Average annual volume of recharge from the west bank:	*2,300,000 × 0.38 = 874,000 m^3/year*
Volume of recharge required to sustain abstraction at Thomastown:	*1,014,700 m^3/year*
Shortfall in required recharge:	*140,700 m^3/year.*

In other words, recharge to the west bank under-estimates the total recharge volume required to balance abstraction by 140,700 m^3/year. This represents a minimum shortfall as the water balance

[26] *Pumping tests data for this well was not provided by the consultants.*

assumes that all groundwater recharge to the west bank will be drawn into the wells and that none will discharge directly to the river.

The area of the eastern bank contained within the physical constraints is 3.4 km^2. Over this area, the shortfall volume equates to a recharge rate of at least 40 mm/year, or more than 11% of the recharge rate estimate described in Section 13.8. Although most groundwater recharge from the eastern bank will discharge to the Nore without reaching the Thomastown wells, it is thought that the amount migrating to deeper levels and crossing under the Nore will be at least 10% and will therefore be sufficient to balance the shortfall in recharge from the western bank.

In summary:

- The recharge on both the western and eastern banks of the Nore are required to balance the abstraction at Thomastown wells, particularly if the rate of abstraction is to be increased in future years.
- The physical constraints are not overly conservative and appear to be generally appropriate to utilise as the boundary of the ZOC.

The ZOC boundary is depicted in Map 10.

13.14.3 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 two wells.

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

$$Velocity = groundwater\ gradient \times permeability \div porosity$$

A permeability of 18 m/day and a porosity of 0.025 was used (refer to Section 13.12). Given that the source comprises pumping wells in a high permeability zone, the natural gradient described in Section 13.10 is likely to increase closer to the wells. The increasing groundwater gradient moving closer to the pumping wells was estimated using the 'Theim' equation and groundwater velocities were predicted accordingly. In essence, though some more rapid flow paths may occur, it is predicted that most groundwater will move up to 400 m towards the wells in 100 days. Accordingly, the boundary of the SI has been delineated in a radius 400 m from each of the wells (refer to Map 10). Where the radii from each well intersect, the intersection has been smoothed-off.

13.15 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. 4 groundwater protection zones are present around the Thomastown source (see Map 10), as shown in the matrix below.

Matrix of Source Protection Zones

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

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

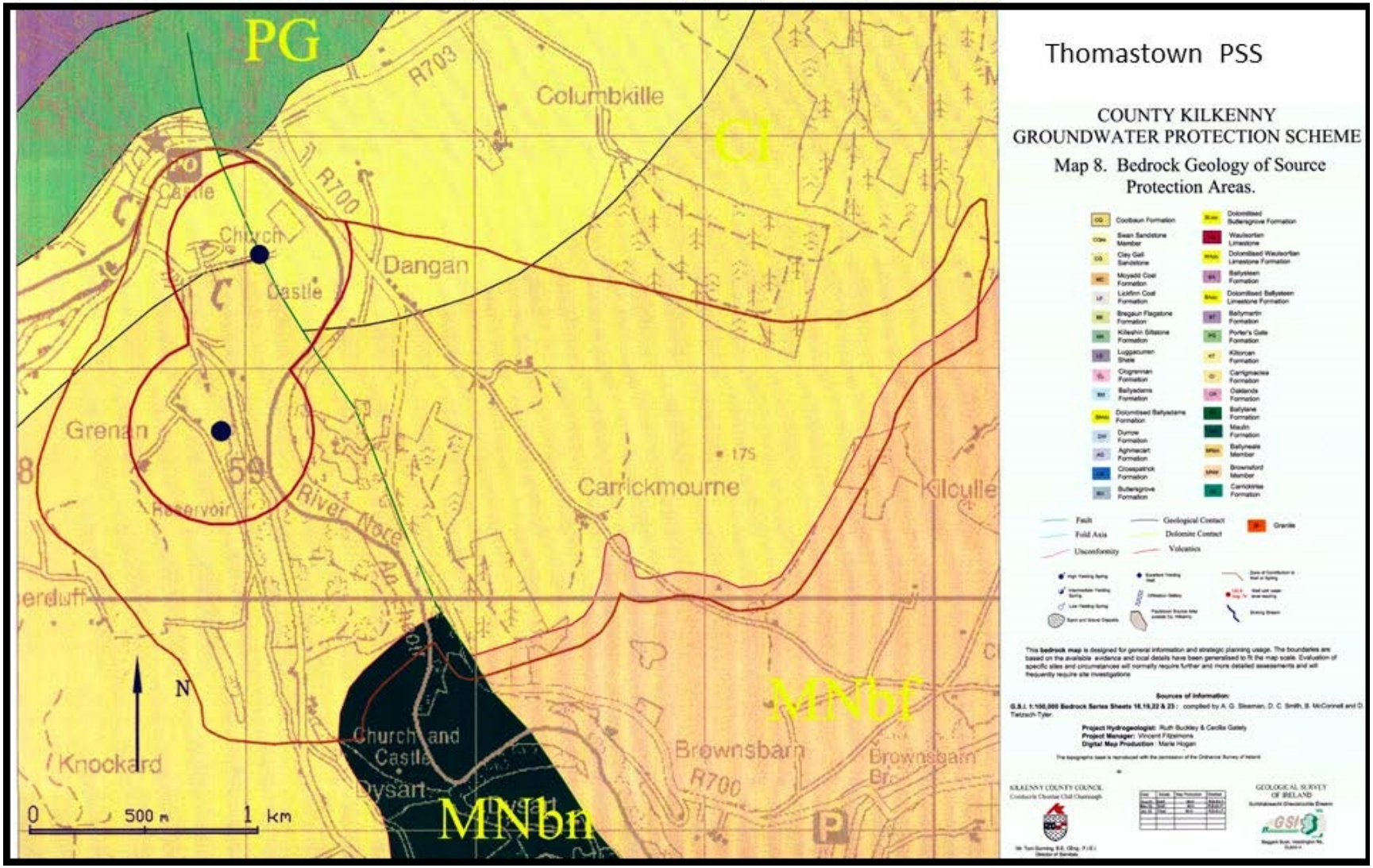
13.16 Land Use and Potential Pollution Sources

Agriculture in the area comprises mainly pasture. Thomastown itself is a town of over 3,000 people, with a number of small commercial enterprises, including two petrol service stations. Much of the development lies on the opposite bank of the Nore, but housing and small industrial enterprises occur 40-50 m upgradient of the supply wells. The housing is sewered.

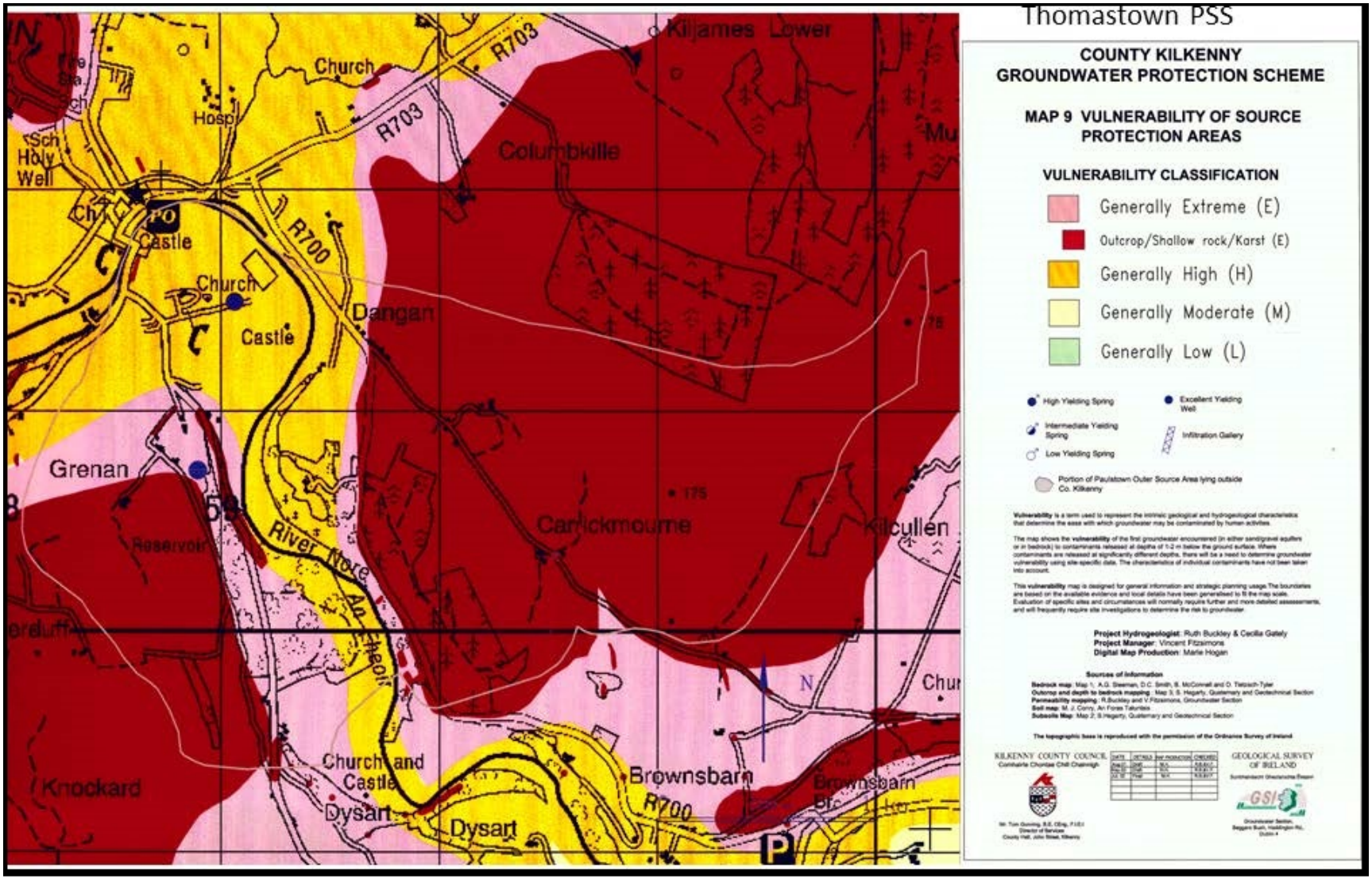
There is no evidence of significant contamination in the wells. There is, however, evidence that inorganic fertilisers and/or organic wastes have influenced water quality to some degree at the GAA Grounds well. Based on general land use, these influences may be linked to sewer leakage from the nearby housing.

13.17 Conclusions and Recommendations

- Wells 5 and 9 are excellent yielding wells, which draw from a mixture of deep, old groundwater and shallow, young groundwater.
- Most of the area in the ZOC is 'highly' to 'extremely' vulnerable to contamination.
- 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 should be carried out regularly, in addition to analysis of treated samples. Given the raw water quality issues at Well 9 (GAA Grounds), a quarterly frequency has been recommended in Section 7.9. 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. In order to detect separate contamination hazards at each well, it is recommended that the two wells be sampled separately;
  - given the proximity of commercial and industrial enterprises close to the wells, analysis of parameters specific to operations at these enterprises (e.g. oils and hydrocarbons) might be appropriate;
  - care should be taken in allowing any activities or developments which might significantly increase nitrate levels;
  - the potential hazards in the ZOC should be located and assessed, particularly in relation to agricultural activities, handling of wastes by commercial activities close to the supplies, and sewer integrity.


PG
CI
MNbl
MNbn
R703
R700
Columbkille
Dangan
Castle
Church
Grenan
Carrickmourne
Kilculle
River Nore
Reservoir
Knockard
Church and Castle
Dysart
Brownsbarn
Brownsbarn Br
N
0
500 m
1 km
Thomastown PSS
COUNTY KILKENNY
GROUNDWATER PROTECTION SCHEME
Map 8. Bedrock Geology of Source Protection Areas.
Coolbaun Formation
Swan Sandstone Member
Clay Gall Sandstone
Moyadd Coal Formation
Lickfinn Coal Formation
Bregaun Flagstone Formation
Killeshin Siltstone Formation
Loggacurren Shale
Clogrennan Formation
Ballyadams Formation
Dolomitised Ballyadams Formation
Durrow Formation
Aghmacart Formation
Crosspatrick Formation
Butlersgrove Formation
Dolomitised Butlersgrove Formation
Waulsortian Limestone
Dolomitised Waulsortian Limestone Formation
Ballyteen Formation
Dolomitised Ballyteen Limestone Formation
Ballymartin Formation
Porter's Gate Formation
Kiltorcan Formation
Carrigmaclea Formation
Oaklands Formation
Ballylane Formation
Maulin Formation
Ballyneale Member
Brownsford Member
Carrickstee Formation
Fault
Fold Axis
Unconformity
Geological Contact
Dolomite Contact
Volcanics
Granite
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 16,19,22 & 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
KILKENNY COUNTY COUNCIL
GEOLOGICAL SURVEY OF IRELAND

Thomastown 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 either sand/gravel aquifers or in bedrock) to contaminants released at depths of 1-2 m below the ground surface. Where contaminants are released at significantly different depths, there will be a need to determine groundwater vulnerability using site-specific data. The characteristics of individual contaminants have not been taken into account.

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 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 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. Sleeman, D.C. Smith, B. McConnell and O. Tietzsch-Tyler
Outcrop and depth to bedrock mapping : Map 3, S. Hegarty, Quaternary and Geotechnical Section
Permeability mapping : R.Buckley and V.Fitzsimons, Groundwater Section
Soil map: M. J. Conry, An Foras Taluntais
Subsoils Map: Map 2, S.Hegarty, Quaternary and Geotechnical Section

KILKENNY COUNTY COUNCIL
Comhairle Chontae Chill Chainnigh

DATE	DETAILS	INITIALS	CHECKED
Aug-03	GWP	BLG	KB/LEG
May-04	Draft	BLG	KB/BLG
Jul-04	Final	MH	KB/BLG

GEOLOGICAL SURVEY OF IRELAND
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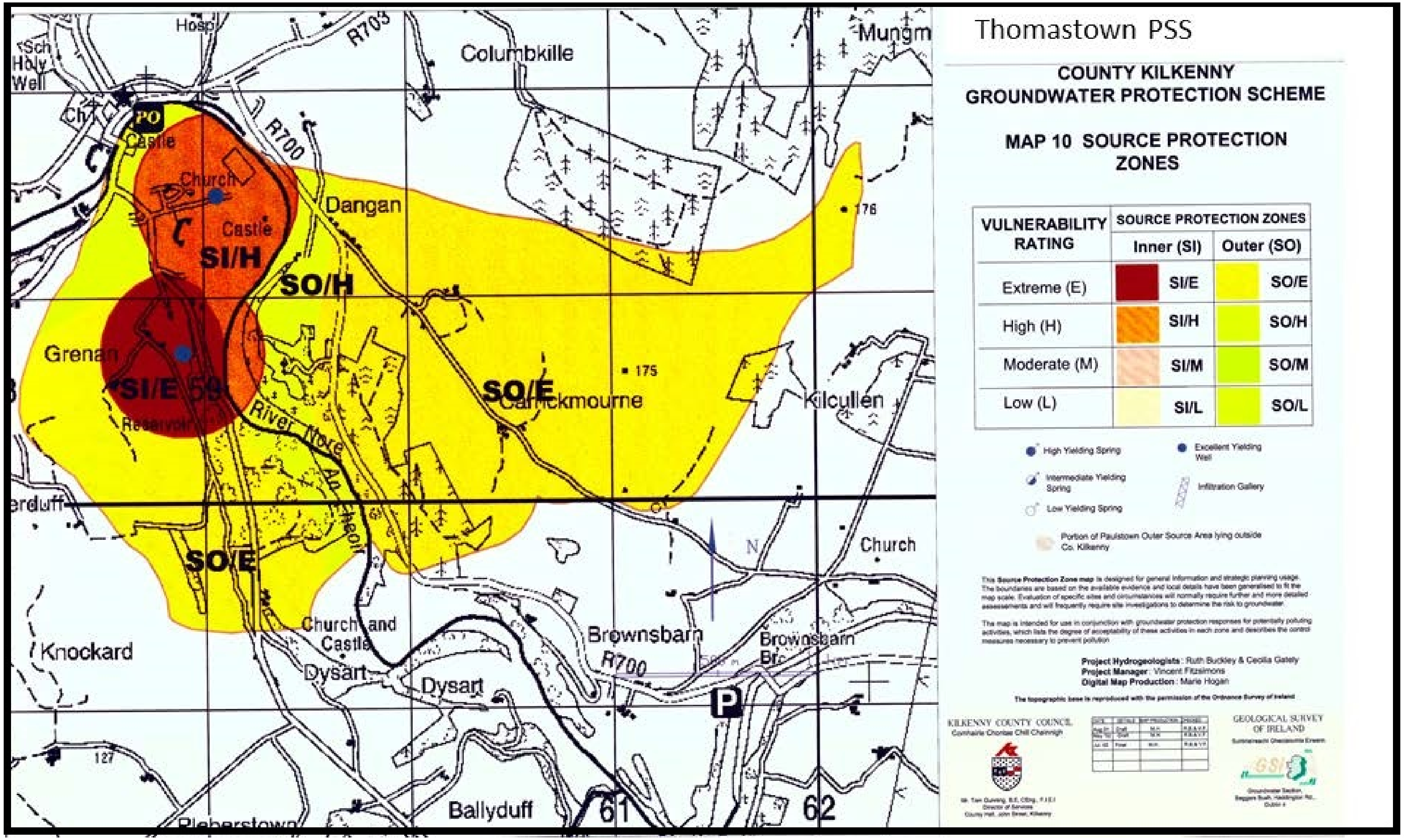
Director of Services
County Hall, John Street, Kilkenny

Groundwater Section,
Beggars Bush, Haddington Rd.,
Dublin 4


Thomastown 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
Excellent Yielding Well
Intermediate Yielding Spring
Infiltration Gallery
Low Yielding Spring
Portion of Paulstown Outer Source Area lying outside Co. Kilkenny
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 generalised to fit the map scale. Evaluation of specific sites and circumstances will normally require further and more detailed assessements 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 lists the degree of acceptability of these activities in each zone and describes the control measures necessary to prevent pollution.
Project Hydrogeologists: Ruth Buckley & Cecilia Gately
Project Manager: Vincent Fitzsimons
Digital Map Production: Marie Hogan
The topographic base is reproduced with the permission of the Ordnance Survey of Ireland
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GEOLOGICAL SURVEY OF IRELAND
SI/H
SO/H
SI/E
SO/E
SO/E
Columbkille
Dangan
Grenan
Carrickmourne
Kilcullen
Church
Brownsbarn
Knockard
Dysart
Ballyduff
River Nore
R700
R703
61
62

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

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 ($N0_3$)*
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 ($S0_4$)*	
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 ($N0_2$)*	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; entertoviruses 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 streptocci 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 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 suggest 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 cation. 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.

A.8 References

Armon, R. and Kott, Y., 1994. The health dimension of groundwater contamination. In: Zoller, U. (Editor), Groundwater Contamination and Control. Published by Marcel, Dekker, Inc., pp71-86.

Daly, D. 1996. Groundwater in Ireland. Course notes for Higher Diploma in Environmental Engineering, UCC.

Daly, D., Thorn, R. and Henry, H., 1993. Septic tank systems and groundwater in Ireland. Geological Survey Report Series RS 93/1, 30pp.

Gerba, C.P. and Bitton, G., 1984. Microbial pollutants : their survival and transport pattern to groundwater. In : G.Bitton and C.P. Gerba (Editors), Groundwater Pollution Microbiology, Wiley - Intersciences Publishers, pp 65-88.

Hagedorn, C., McCoy, E.L. and Rahe, T. M. 1981. The potential for ground water contamination form septic tank effluents. Journal of Environmental Quality, volume 10, no. 1, p1-8.

Henry, H. (1990). An Evaluation of Septic Tank Effluent Movement in Soil and Groundwater Systems. Ph.D. Thesis. Sligo Regional Technical College. National Council for Education Awards - Dublin.

Reneau, R.B. 1996. Personal communication. Virginia Polytechnic Institute and State University.

Sherwood, M., 1991. Personal communication, Environmental Protection Agency.

US EPA. 1987. Guidelines for delineation of wellhead protection areas. Office of Ground-water Protection, U.S. Environmental Protection Agency.

Wild, A. and Cameron, K.C., 1980. Nitrate leaching through soil and environmental considerations with special reference to recent work in the United Kingdom. Soil Nitrogen - Fertilizer or Pollutant, IAEA Publishers, Vienna, pp 289-306.

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 Castlecomer Yarns	02/06/1993		Kilkenny Co. Co.	KK00300	Tap in yard at Castlecomer Yarns	J. Keohane	2269		25360 17330	Castlecomer 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 road	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 road	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/Johnstown	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 Windgap	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/Johnstown	Public	10	2	< 5	7.3	808	0.22		0.01
Borehole at Castlecomer Yarns	09/11/1993	12:35:00	Kilkenny Co. Co.	KK00300	Tap in yard at Castlecomer Yarns	P. Mullins	4777		25360 17330	Castlecomer 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 Windgap	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 Castlecomer Yarns	08/01/1996	11:10:00	Kilkenny Co. Co.	KK00300	Tap in yard at Castlecomer Yarns	C. Murray	74		25360 17330	Castlecomer 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 Co. Co.	KK01000	Canteen at Dunmore Sand & Gravel	C. Murray	76	KIK53	25000 16020	Dunmore Sand & Gravel	Private	10.1	2	5	7.7	627	1.6	2.2	< 0.01
Borehole at Kilkenny Mar	08/01/1996	12:15:00	Kilkenny Co. Co.	KK01300	Cattle holding shed	C. Murray	77		25070 15670	Kilkenny Mart	Private	9.5	1	5	7.9	690	0.2	2.4	< 0.01
Borehole at Clara	08/01/1996	12:55:00	Kilkenny Co. Co.	KK00400	At pumphouse	C. Murray	78	KIK41	25770 15530	Clara	Group	11	1	5	7.3	696	0.2	4.5	< 0.01
Borehole at Rathcash	08/01/1996	13:10:00	Kilkenny Co. Co.	KK02000	Joe Pykes house, Rathcash, Clara.	C. Murray	79	KIK55	25870 15510	Rathcash	Group	8.7	2	5	7.4	708	0.1		< 0.01
Spring at Paulstown Castle	08/01/1996	14:40:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle	C. Murray	80	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	10.6	1	5	7.2	623		5.5	< 0.01
Spring at Clomantagh	09/01/1996	10:40:00	Kilkenny Co. Co.	KK00900	Beside Nuenna river, 50m SE of road	C. Murray	89		23520 16320		Private	9.8	1	60	7.3	467	38		0.026
Spring Toberpatrick Urlingford	09/01/1996	11:05:00	Kilkenny Co. Co.	KK01500	In chamber at source	C. Murray	90	KIK34	23000 16350	Urlingford/Johnstown	Public	9.7	1	5	7.3	712	1.7	8	< 0.01
Borehole at Bawnmore	09/01/1996	11:30:00	Kilkenny Co. Co.	KK00100	Phelan's house, Bawnmore	C. Murray	91	KIK50	22580 16610	Bawnmore	Group	8.5	1	5	7.2	835	0.1	3	< 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 CaCO3	Alkalinity mg/l CaCO3	TCS	Total Coliforms per 100 ml	FCS	Fecal Coliforms per 100 ml	Sulphate mg/l SO4	Dry Residue mg/l	Sus_ Solids mg/l	Magnesium mg/l Mg	Total Hardness mg/l CaCO3	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						0.011	0.009	< 0.001	0.015		
Borehole at Castlecomer Yarns	02/06/1993		0.05	0.1	0.006	20				999		999	7			23.8	242	33.1	1.4		9.2	0.797		0.017	< 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	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											
Graigue, 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		< 0.06	< 0.02		< 0.02		
Borehole at Rathcash	08/01/1996	13:10:00	0.001	5.1	< 0.003	23.6		360		999		999	18			25	427	7.6	1.1		< 0.06	< 0.02		0.024		
Spring at Paulstown Castle	08/01/1996	14:40:00	< 0.01	8	< 0.003			259	>	80	>	60				7.9	333	8	2.7		0.082	< 0.02		< 0.02		
Spring at Clomantagh	09/01/1996	10:40:00	0.06	5.8	0.032	15.6		195	>	200	>	100	7		Visible	4.2		6.5	1		0.93	0.14		0.115		
Spring Toberpatrick Urlingford	09/01/1996	11:05:00	0.037	11.1	< 0.003	23.1		317	>=	32		3	15			18.9		8.5	4.2		< 0.06	< 0.02		0.077		
Borehole at Bawnmore	09/01/1996	11:30:00	0.013	5.1	< 0.003	23.6		443		999		999	18			37.9		8.6	2.3		< 0.06	< 0.02		0.039		

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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 Castlecomer Yarns	02/06/1993		< 0.0001					Copy to Castlecomer 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 Castlecomer 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 Castlecomer 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, Ratcash, 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								

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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 Counci		Well No.2 for proposed new water supply	Brian Connor	763			Belview proposed				5	6.8	351			< 0.01
Belview	29/02/1996	11:45:00	Kilkenny County Counci		Well No.2 for proposed new water supply	Brian Connor	822			Belview proposed			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 Landfdill 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
Bellview	02/10/1996	11:10:00	Kilkenny Co. Co.		Well No. 3.	Brian Connor	3853						1	5	6.6	554	0.26		< 0.01
Bellview	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

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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 CaCO3	Alkalinity mg/l CaCO3	TCS	Total Coliforms per 100 ml	FCS	Fecal Coliforms per 100 ml	Sulphate mg/l SO4	Dry Residue mg/l	Sus_ Solids mg/l	Magnesium mg/l Mg	Total Hardness mg/l CaCO3	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													
Bellview	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		
Bellview	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														

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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								
Bellview	02/10/1996	11:10:00						Calcium Hardness = 152 mg/l CaCO3	Very high nitrate.	
Bellview	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 ammmonia.	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 indicitave 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.

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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 shec	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 Bergin	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		1	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 shec	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 shec	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
Kiloshaun/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

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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 CaCO3	Alkalinity mg/l CaCO3	TCS	Total Coliforms per 100 ml	FCS	Fecal Coliforms per 100 ml	Sulphate mg/l SO4	Dry Residue mg/l	Sus_ Solids mg/l	Magnesium mg/l Mg	Total Hardness mg/l CaCO3	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 Yarns	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 Yarns	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 Yarns	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		
Kiloshaun/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

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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.	
Kiloshaun/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.		

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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

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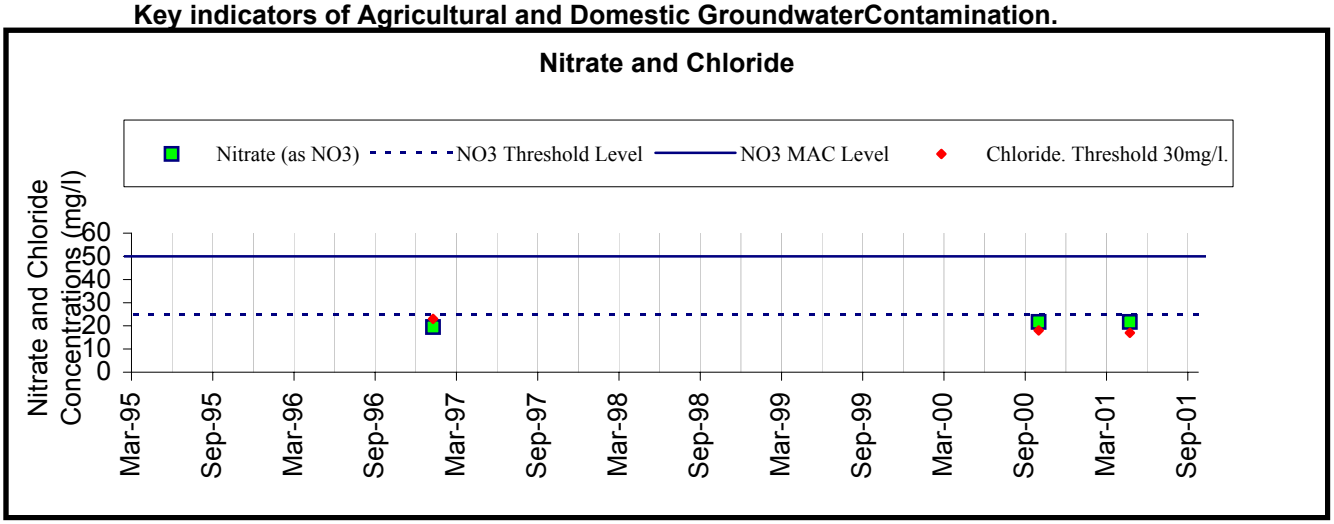
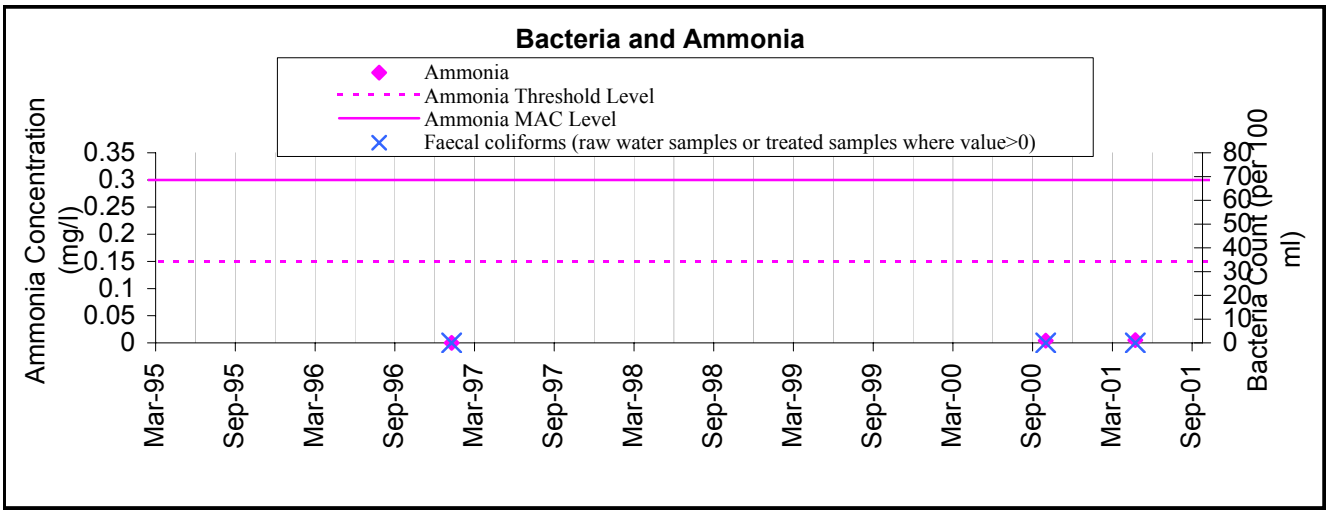
Source	Sampling Date	Sampling Time	o-Phosphate mg/l P	Nitrate mg/l N	Nitrite mg/l N	Chloride mg/l Cl	Ca Hardness mg/l CaCO3	Alkalinity mg/l CaCO3	TCS	Total Coliforms per 100 ml	FCS	Fecal Coliforms per 100 ml	Sulphate mg/l SO4	Dry Residue mg/l	Sus_ Solids mg/l	Magnesium mg/l Mg	Total Hardness mg/l CaCO3	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 13.2-Thomastown (Well 5-Nore Creamery)
Key indicators of Agricultural and Domestic GroundwaterContamination.





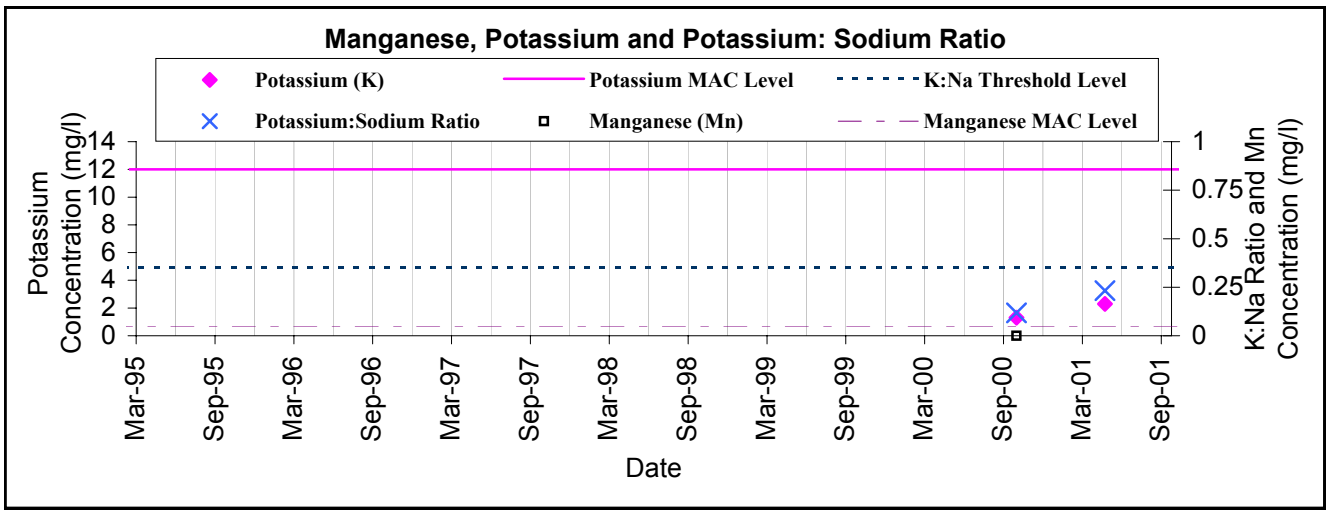


Figure 13.2-Thomastown (Well 9-GAA Grounds)
Key indicators of Agricultural and Domestic GroundwaterContamination.