12. Piltown / Fiddown Source

12.1 Introduction

The objectives of this chapter are:

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

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

12.2 Location and Site Description

Five springs supply public drinking water for the towns of Fiddown and Piltown and the village of Templeorum. They are located in the townlands of Templeorum and Raheen. At the end of the summer, water is sometimes taken from the nearby stream to augment the spring supply.

The location of the springs and stream supplying the Piltown/Fiddown source is shown on Maps 4 and 8. The springs lie in a wooded area at the bottom of a small, steep sided valley. For the purposes of this report, the small stream which occupies this valley will be called the 'Templeorum stream.'

The area owned by Kilkenny County Council, within which the springs are located, is fenced off with wire and barbed wire. Each spring has been deepened and the water now collects in a concrete sump approximately 1 m in diameter. Each sump is covered with a concrete slab, and access is by a metal manhole cover, which is kept locked. Water from the five springs (and periodically from the stream) is fed into a central sump and from here the water is gravity-fed to a plant house in Jamestown where it is fluoridated and chlorinated.

12.3 Summary of Source Details

GSI no.	2311NEW069
Grid ref. (1:25,000)	24774 12553
Townlands	Templeorum and Raheen
Source type	Springs (five), augmented by surface water
Development date*	1930's
Owner	Kilkenny County Council
Elevation (ground level)	80 m OD to 92 m OD.
Depth to rock	<1 m to 3 m
Static water level	Ground level
Discharge summary:	
(i) average consumption**	780 m^3/d
(ii) average overflow*	None

**Anecdotal information from Kilkenny County Council*
***Information taken from consumption data from 1999 to 2000 provided by Kilkenny County Council*

12.4 Methodology

12.4.1 Desk Study

Bedrock geology information was compiled from original 1:10560 (six inch) field sheets and from the GSI bedrock report for the area (Sleeman and McConnell, 1995). Details of the current abstraction rate were obtained from Kilkenny County Council. Data on private groundwater wells in the area were taken from GSI archives and additional information on the source was obtained from a report produced by M.C. O'Sullivan Consulting Engineers (1999) for Kilkenny County Council.

12.4.2 Site Visits and Field Work

- Site visits and fieldwork included walkover surveys undertaken by both the Groundwater (3 days) and Quaternary (1 day) sections of the GSI to further investigate the subsoil and bedrock geology, the hydrogeology, and the vulnerability to contamination.
- Raw water samples were taken on 03/10/00 and 28/06/01 by GSI staff and were submitted for analysis at the EPA laboratories in Kilkenny in accordance with their sampling and transportation guidelines.

12.4.3 Assessment

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

12.5 Topography and Surface Hydrology

The springs of the Piltown/Fiddown source are located between 300-400 m south of the church in Templeorum at an elevation of approximately 90 m. The springs can be found on either side of a stream that rises in the uplands to the north of Templeorum village. The Templeorum stream flows southwards down the slopes of the Southern Kilkenny Uplands for a distance of 2.3 km before reaching the low-lying, generally flat land at the River Suir.

The springs occur on both sides of, and close to, the stream at a point where the slopes suddenly steepen from 0.05 upstream to 0.07 downstream. The width of the valley also becomes constricted at the springs, reducing from approximately 500 m upstream to approximately 100 m downstream.

The local watersheds of the Templeorum stream lie up to 110 m above the level of the springs and occur approximately 2.3 km to the east and 0.5 km to the west of the springs. Both watersheds run approximately north south and converge to a point approximately 2 km north of the springs. Slopes on the valley sides are typically in the order of 0.05 to 0.1.

12.6 Geology and Aquifers

12.6.1 Bedrock

The main bedrock types in the vicinity of the Piltown/Fiddown source comprise the Carrigmaclea Formation and the Kiltorcan Formation. These formations are described in more detail in Chapter 2 of Volume I and their distribution in the vicinity of the Piltown/Fiddown source is shown on Map 8.

The Carrigmaclea Formation underlies the Templeorum surface water catchment upstream of the springs. It consists of a sequence of quartz-cobble conglomerates, pebbly sandstones and cross-stratified sandstones. The formation has been classed as a locally important bedrock aquifer which is moderately productive only in local zones (**Ll**). Fracture flow is expected to be dominant. Flows are expected to be concentrated in fractured and weathered zones. Given common weathering patterns, most flow is thought to be relatively shallow; concentrating in the top 10 m to 30 m of the rock profile. More detail on flow characteristics and aquifer classification criteria can be found in Chapter 4 of Volume I.

The boundary between the Carrigmaclea and the lower units of the Kiltorcan Formation is mapped some 200 m to 300 m to the south of the springs. The Kiltorcan Formation as a whole is a regionally important aquifer, but lower permeability shales, mudstones and siltstones are predominant close to the boundary with the Carrigmaclea Formation (Daly, 1994). The presence of shales, mudstones and siltstones may explain the sudden change in topography to the south of the springs.

The springs are located on the southern limb of a large 'anticline' (upward fold in the rock mass). Bedrock units dip gently at 5^o to 20^o southwards. Associated with this fold is a large north-south trending fault, mapped some 400 m from the springs. Other, similar faults may also occur within the Templeorum sub-catchment, but have not yet been identified. The main significance of the fold structure is that the Carrigmaclea Formation will occur below the springs to considerable depths underground and that this formation, in conjunction with north-south trending fractures, will be the main influence on groundwater flow to the springs.

12.6.2 Subsoil

The main subsoil type in the surrounding area is till. However, bedrock is close to the surface (generally less than 3 m) over much of the surface water catchment of the Templeorum stream. The till is described in more detail in Chapter 3 of Volume I and its distribution in the vicinity of the Piltown/Fiddown source is shown on Map 2S.

There are no subsoil materials classified as aquifers in the Templeorum area. The main significance of the subsoil material, therefore, is in vulnerability and recharge assessments. These issues are described in Sections 12.7 and 12.8.

12.7 Groundwater Vulnerability

The concept of vulnerability is discussed in Chapter 5 of Volume I. In essence, groundwater vulnerability is dictated by the nature and thickness of the material overlying the main groundwater 'target'. As discussed in Section 12.6, the main groundwater resource at the Piltown springs occurs within fractured bedrock. Consequently, the target is taken from the top of the bedrock formation and considerations of groundwater vulnerability concern the permeability of the whole subsoil profile and the depth to bedrock.

The subsoil in the immediate vicinity of the springs is thought to be between 1 m and 3 m thick. This thickness persists along the river valley. Once away from the valley floor, the till thins and over the remainder of the zone of contribution the bedrock is mapped as being close to the ground surface; generally within 1 m of ground level. This interpretation is based on the presence, across the surface water catchment to the north of the springs, of at least 12 rock outcroppings (4 of which are in excess of 200 m long) and 2 boreholes with reported depths to rock of 1 m to 2 m.

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 subsoil permeability becomes increasingly variable and increasingly influenced by the presence of 'bypass flow' mechanisms such as cracks in the subsoil. Accordingly, on the basis of the general depth to bedrock in the area, a vulnerability classification of 'extreme' has been assigned for the whole Templeorum sub-catchment.

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

12.8 Rainfall, Evaporation and Recharge

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

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

- Annual rainfall: 1080 mm, data from Met Éireann average annual (1961-90) rainfall records, measured at Mullinavat Garda Station.
- Annual evapotranspiration losses: 480 mm. Potential evaporation (P.E.) is estimated to be 500 mm yr^{-1} (Met Éireann, 1996). Actual evapotranspiration (A.E.) is assumed to be 95 % of P.E. (Daly, 1994).
- Potential recharge: 600 mm/year, based on average annual rainfall less estimated evapotranspiration.

12.9 Groundwater levels

There are few groundwater level data available for the area around the source. There are, however, water level data from August 1971 (GSI well records) for 3 domestic wells in Ashtown and Oldcourt townlands in the surface water catchment upgradient of the springs. In addition, the springs themselves provide groundwater level information. Available data are summarised below:

Distance upstream of springs	**Water Levels measured in August 1971**			**Distance to Templeorum Stream.**
	m below ground	m OD	m above stream.	
0 km (springs)	0 m	90 mOD	0 m to 18 m.	50 m to 210 m
1.1 km	10.2 m	161 mOD	0.5 m	70 m
1.6 km	7.2 m	191 mOD	23 m	370 m
2 km	23.5	182 mOD	22 m	850 m

Though the data are sparse, there is a suggestion that:

- The aquifer is unconfined over most of the sub-catchment to the north of the springs.
- Groundwater can discharge both into the stream and into the springs.
- Net groundwater flow directions are <u>unlikely</u> to be northwards.
- Thickest unsaturated zones occur at higher elevations and most recharge is likely to occur towards the head of the surface water sub-catchment.

12.10 Groundwater Flow Direction and Gradients

The aquifer on which the surface water sub-catchment lies is not regarded as being highly productive (refer to Section 12.6.1). As such, the water table in the area is generally assumed to be a slightly subdued reflection of topography. The overall flow direction will therefore vary within the sub—catchment, but is expected to be generally southwards. This is inference supported by available water level data.

Given that the springs occur on both sides of the valley floor and at a constriction in the valley sides, and given that groundwater flow within the aquifer is expected to concentrate at shallow depths, it is likely that;

- most groundwater will be forced to the surface and discharge into either the springs or surface water upstream of the springs, and that
- groundwater flow to the springs will occur from both the eastern and western sides of the valley.

Groundwater gradients are difficult to calculate because of the limited water level data available for wells in the Carrigmaclea Formation near the springs, and because gradients will vary locally with topography. However, assuming that groundwater will generally flow along very short flowpaths of a few tens or hundreds of metres, gradients of 0.003, 0.03, and 0.06 have been estimated between the wells identified in Section 12.9 and the nearest portion of the stream. These gradients compare with topographic gradients of 0.05 (on the valley floor) to 0.1 (on the valley sides).

On the basis of a comparison of topographic and water level information, a figure of 0.05 has been taken as a typical (but 'reasonably conservative') groundwater gradient below the Templeorum surface water sub-catchment upstream of the springs.

12.11 Hydrochemistry and Water Quality

Data on recent trends in water quality at the Piltown source are summarised graphically in Figure 12.1, and the source data can be found in Appendix V.

The following key points have been identified from the data:

- Only one analysis of hardness was available. The groundwater sample indicates a 'moderately soft water' of 53 mg/l $CaCO_3$. This is considered typical of the non-limestone rocks in the Southern Uplands of Kilkenny; particularly in areas where the subsoil cover is thin. Naturally soft waters are often associated with problems due to low pH, and M.C. O'Sullivan Consulting Engineers (1999) indicate that the water in the source is acidic and likely to attack and tuberculate the cast iron network in the distribution system.
- Of the two available raw water analyses of combined discharge from the springs, faecal coliforms were in excess of the European maximum admissible concentration for drinking water (MAC).[18]
- Aside from coliforms, no other indicators of agricultural or domestic groundwater contamination were reported above GSI guide levels in the available samples. Note, however, that nitrate levels, typically in the order of 13 mg/l, were reported at 20 mg/l in the most recent sample analysis available. Though below indicator guide levels, this most recent result is slightly elevated and would be worthy of note if it proved to be part of a rising trend in nitrate concentrations.

A sample of the stream water was taken on the 28/6/01. Results are presented in Table 12.1. The main feature to note is that there are large differences in the amount of coliforms, ammonium and chloride between groundwater and surface water samples, but that concentrations of most other parameters are very similar. The similarities suggest that groundwater residence times within the aquifer are very short (more likely to be a few months than a few tens of years) and/or that there is a close hydraulic connection between surface water and groundwater in the sub-catchment updradient of the springs. The lower concentrations of coliforms and ammonium in the groundwater sample might reflect the partial protection afforded by the thin subsoils. However, chloride is not readily attenuated by subsoils, and the elevated chloride concentration in the stream (if correct) suggests that organic wastes are being discharged directly to the stream. It may be that these wastes are the source of the bacteria and ammonium found in the surface water sample.

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

Table 12.1: Selected EPA Laboratory Analyses at the Piltown/Fiddown Source

Parameter	**Results of Laboratory Analyses of *Untreated* Water Samples**	
	Sample from combined spring discharge (28/6/01)	Sample taken from the stream in the vicinity of the springs. (28/6/01)
Temperature °C (field[19])	11.4 °C	13.7 °C
Conductivity µS/cm (lab,field)	198, 176	198, 188
pH (lab, field)	6.6, 6.2	7, 7.3
Alkalinity (mg/l HCO_3)	37	38
Calcium (mg/l)	19	20
Magnesium (mg/l)	5.9	5.5
Chloride (mg/l)	14	882
Sulphate (mg/l SO_4)	9.6	8
Sodium (mg/l)	9.3	8.4
Potassium (mg/l)	2.6	2.6
Nitrate (mg/l NO_3)[20]	19.9	15.1
Ammonium (mg/l NH_4)	0.006	0.014
Iron (mg/l)	<0.05	<0.05
Manganese (mg/l)	0.003	0.002
Faecal coliforms per 100 ml	7	1120
Total coliforms per 100 ml	172	>2419

12.12 Aquifer Parameters

In unconfined aquifers where the influence on gradients of seasonal variations in recharge is expected to be limited, the main aquifer parameters of significance are permeability and porosity. Together with groundwater gradients, these parameters are used to estimate the extent of the inner source protection area in Section 12.14.3.

No tests of permeability and porosity have been undertaken in the sub-catchment upgradient of the spring. Some data is available, however, for well 2311NEW068, which is approximately 1.8 km to the south-east of the springs and is located in the Carrigmaclea Formation. Pumping test data from this well gave a specific capacity of 5 m^3/d/m, a transmissivity of 7 m^2/d and a permeability of 0.7 m/d. These local-scale estimates tend to agree with regional-scale aquifer permeability and specific capacity estimates of 1 m/day and 2 m^3/d/m to 10 m^3/d/m respectively (from Daly 1992). Accordingly, a typical permeability of 0.7 to 1 m/day has been assumed for the aquifer upgradient of the springs.

A porosity of 0.01 is assumed as being applicable to this aquifer. This is at the lower limit of the typical range used by the GSI for bedrock aquifers (0.025 to 0.01) and reflects the possibility that the aquifer is not densely fractured near the springs.

12.13 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

[19] *Field measurements undertaken by GSI staff.*
[20] *Parameter reported as Total Oxidised Nitrogen. GSI has assumed nitrate is the only significant contributor of oxidised nitrogen.*

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 springs lie at the base of a steep slope and at the point where the valley becomes more constrained downstream. Their location is believed to be topographically controlled, although this topography may be itself controlled by changes in rock type and by faulting.
- The springs and the Templeorum surface water sub-catchment upstream of the springs overlie the 'Locally important' (Ll) Carrigmaclea sandstones aquifer. Subsoils are dominated by tills which are expected to be less than 3 m thick across most of the area upstream of the springs.
- The aquifer is unconfined in the area, and flow to the springs is controlled by fracturing and weathering patterns within the rock mass. As a consequence, the potential for contaminant attenuation within the bedrock will be limited and flows will be locally variable both in terms of velocity and orientation. Most groundwater flow is thought to be relatively shallow; concentrating in the top 10 m to 30 m of the rock profile. The flow is therefore likely to follow local variations in topography, but will generally be southwards.
- Recharge is likely to occur across both sides of the Templeorum sub-catchment upstream of the springs.
- The nature of the aquifer, and of water quality in the spring and stream is such that groundwater residence times and groundwater flow paths are believed to be short. Flows would not usually be expected to cross underneath surface watersheds, and the distance between recharge and discharge areas is unlikely to exceed a few hundred metres.
- Most groundwater flow within the Templeorum surface water sub-catchment upstream of the springs is likely to discharge to surface water at, or upstream of, the springs. The proportion of groundwater flow leaving the sub-catchment below the springs is thought to be insignificant. No long term streamflow data is available for the Templeorum sub-catchment, However, very broad estimates can be made on the basis of estimated potential recharge (i.e. soil moisture excess) and estimates of the area of the sub-catchment. If the estimates of potential recharge in Section 12.8 were broadly correct, the average combined surface water and springflow at the mouth of the Templeorum sub-catchment would be in the order of 5300 m^3/day. Assuming an average daily total discharge of 780 m^3/day at the springs, this would suggest that springflow accounts for approximately 15% of the total flow from the sub-catchment, and that the proportion of effective rainfall infiltrating to groundwater is at least 15%.

12.14 Delineation of Source Protection Areas

12.14.1 Introduction

This section delineates the area around the source that is believed to contribute groundwater to the source, and that therefore requires protection. The area is delineated on the basis of the conceptualisation of the groundwater flow pattern as described in Section 12.13.

Two source protection areas are delineated:

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

12.14.2 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 abstraction rate, (b) the recharge in the area (c) the groundwater flow direction and gradient, (d) the rock permeability. The ZOC was delineated using the results of hydrogeological mapping and flow system conceptualisation.

The average abstraction rate for the Piltown/Fiddown source was calculated using monthly abstraction records from January 1999 to December 2000 obtained from Kilkenny County Council. The abstraction rates were relatively constant, ranging from 763 m^3/day to 846 m^3/day, with an average of 780 m^3/d.

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

- **Northern boundary**: This is the area of the intersection between the eastern and western watersheds of the Templeorum surface water sub-catchment.
- **Southern boundary:** This boundary is downgradient of the springs. In theory, springs will draw no water from areas downgradient of their location. However, irregularities caused by the dominance of fracture flow within the aquifer and by the relationship between surface water and groundwater mean that this may not strictly apply at the Piltown/Fiddown source. In order to account for some of these irregularities, the southern boundary has been placed at an arbitrary distance of 100 m downgradient of the springs.
- **Western boundary:** Groundwater is thought to flow to the springs from both sides of the Templeorum sub-catchment. The western boundary is defined by the surface water divide of the Templeorum stream. Given that groundwater in the catchment is thought to flow generally southwards, only the portion of this watershed which lies to the north of the springs has been included. This portion has been linked to the southern boundary by drawing a line between the two boundaries which intersects the intervening topographic contours at right angles. It has been assumed that groundwater on the watershed will broadly follow the same pattern.
- **Eastern boundary:** This boundary is defined by the watershed dividing the Templeorum stream and its neighbour to the east. Again, only the portion of this watershed which lies to the north of the springs has been included, and this portion has been linked to the southern boundary by drawing a line between the two boundaries which intersects the intervening topographic contours at right angles.

The area constrained by these limits is approximately 3.2 km^2 . The ZOC is taken as comprising the whole of the area constrained within these boundaries and is depicted on Map 10.

12.14.3 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. It is delineated to help planners minimise the risk to groundwater from potentially contaminating activities which may have an immediate influence on water quality at the source; particularly those related to microbial contamination.

Estimations of the extent of this area could not be made by hydrogeological mapping and conceptualisation methods alone. Analytical modelling was used to estimate groundwater flow velocities and the extent of the Inner Protection Area upgradient of the spring. Subject to certain assumptions and conditions, Darcy's Law can be used to approximate groundwater flow velocities, as follows:

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

Using the estimates derived in Sections 12.10 and 0 for gradient, permeability, and porosity (0.05, 0.7 - 1 m/day, and 0.01 respectively), the equation gives a velocity of 3 m/day. This can be treated as a 'reasonable worst case estimate'. In other words, though some very rapid flow paths may occur, it is thought that most groundwater will move up to 300 m in 100 days. Accordingly, the boundary of the SI has been delineated 300 m upgradient of the springs (Map 8).

12.15 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, superimposing the vulnerability map on the source protection area map does this. Each zone is represented by a code, e.g. **SI/H**, which represents an Inner Source Protection area where the groundwater is highly vulnerable to contamination. All of the hydrogeological settings represented by the zones may not be present around any given source. Just two groundwater protection zones are present around the Piltown/Fiddown source, as shown in the matrix below.

Matrix of Source Protection Zones for Piltown/Fiddown source

VULNERABILITY RATING	SOURCE PROTECTION	
	Inner	***Outer***
Extreme (E)	SI/E	*SO/E*
High (H)	*not present*	*not present*
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).

12.16 Land Use and Potential Pollution Sources

The main land use in the area is agricultural, comprising pasture with some tillage. Templeorum is a small village of 150 people and lies within the ZOC of the spring. The village is reportedly not sewered.

The main hazards within the ZOC are considered to be effluent from on-site wastewater treatment systems (including 'septic tanks'), agricultural landspreading of organic and inorganic fertiliser, and direct discharges of wastes to surface water. Other potential hazards include fuel storage, roadside spillages, pesticide application, and farmyards.

Though the nitrate concentrations in the springs have generally been quite low, the most recent analysis available reported a slightly elevated concentration of 20 mg/l. Given that the catchment is small, with limited potential for dilution of contaminants, the total loading of nitrogen from the village effluent may become significant. Some broad, 'back-of-the-envelope' estimations of the septic nitrate loading from domestic wastewater treatment systems in comparison with the measured nitrate loading are provided below:

- *Estimated average water flow in catchment: 5,300,000 litres/day (proportion of springflow is estimated at 15% of this total).*
- *Estimated nitrogen loading from wastewater systems[21]:0.009 kg/day/person @ 150 people → 1.4 kg/day N.*
- *Estimated 'natural' nitrogen loading: 0.1 mg/l N @ 5,300,000 litres/day → 0.5 kg/day N.*
- *Estimated total wastewater and 'natural' nitrogen loading: 1.4 + 0.5 ≈ 1.9 kg/day N.*
- *Measured nitrogen concentration in catchment runoff[22]: 3.4 mg/l N in the stream and 4.5 mg/l N in the springs.*

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

[22] *From EPA laboratory analyses. Refer to Table 12.1.*

- *Estimated nitrogen loading in catchment runoff: 5,300,000 × ((3.4 × 0.85) + (4.5 × 0.15)) ≈ 19 kg/day N.*

Though the estimations are very approximate, it seems that the domestic wastewater effluent from 150 people (~ 2 kg/day N), combined with the natural loading from rainwater, is insufficient to account for the total nitrogen loading in surface and groundwaters leaving the sub-catchment (~ 20 kg/day N). One conclusion which could be drawn is that, if nitrogen concentrations require remedial action in the future, hazards other than domestic wastewater treatment systems (e.g. landspreading of organic and inorganic fertiliser, and direct discharges to surface water) may need to be targeted.

12.17 Conclusions and Recommendations

- The springs at Piltown/Fiddown lie on a locally important aquifer (Ll).
- Groundwater in the area of the zone of contribution to the supply is generally 'extremely' vulnerable to contamination. However, future site-specific investigations may indicate that localised patches of lower vulnerability also occur.
- The protection zones delineated in this chapter are based on our current understanding of groundwater conditions and on the available data. Additional data obtained in the future may indicate that amendments to the boundaries are necessary.
- The spring supply is augmented with surface water in the summer. Existing treatment methods are focussed on bacteria and may not be sufficient in the event of chemical spillages into the stream.
- It is recommended that:
  - chemical and bacteriological analyses of raw water as well as treated water be carried out regularly. Given some of the raw water quality issues at the source, a monthly frequency has been recommended in Section 7.9. 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;
  - the potential hazards in the ZOC should be located and assessed;
  - the use of borehole supplies be examined to minimise requirements for surface water augmentation. The aquifer is categorised as 'Ll' and, as such, is expected to be moderately productive only in local zones, like the one exploited by Thomastown wells (refer to Section 13). Away from these local zones, yields from <u>individual</u> wells are not expected to exceed a few tens of cubic metres per day and adequate supplies would probably require the development of a small wellfield. Consequently, exploratory drilling would benefit from some preparatory studies (perhaps including a geophysical survey) into the potential existence of productive zones in the Templeorum sub-catchment and, in the context of a wellfield, into the potential area of land and number of wells required;
  - there is some evidence of direct discharges to surface water. If the stream water is to continue to be used to augment supply, a zone of land use restrictions might be considered on each side of the stream for the purposes of protecting surface water.
  - planning permission for new developments in the ZOC be considered in the context of the additional nitrogen and phosphorous loading from septic effluent.

AppendixIV: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.

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Appendix V:Laboratory analytical results

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

Source	Sampling Date	Sampling Time	To	Ref No	Sampling Location	Taken By	Lab No	EPARef	Stn Grid Ref	Water Supply	Public/Group/Private	Temperature	Odour 1/2/3	Colour Hazen	pH	Conductivity µS/cm	Turbidity NTU	TOC mg/l C	Ammonia mg/l N
Spring at Paulstown Castle	29/04/1992	11:38:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		1648	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	9.1	1	5	7.3	623			0.03
Spring at Paulstown Castle	01/07/1992	15:55:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		2681	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	11.4	1	5	7.4	640			0.02
Spring at Paulstown Castle	20/08/1992	15:15:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		3737	KIK46	S 660 570	Gowran/Goresbr./P-town	Public		1	5	7.2	600			0.02
Spring at Paulstown Castle	18/11/1992	13:29:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		5086	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	9.8	2	5	7.4	623			0.02
Spring at Paulstown Castle	10/03/1993	16:00:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle		1017	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	9.6	1	5	7.3	660			0.01
Borehole at 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 Mart	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 Mart	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 Mart	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		

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								

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

Source	Sampling Date	Sampling Time	To	Ref No	Sampling Location	Taken By	Lab No	EPARef	Stn Grid Ref	Water Supply	Public/Group/Private	Temperature	Odour 1/2/3	Colour Hazen	pH	Conductivity µS/cm	Turbidity NTU	TOC mg/l C	Ammonia mg/l N
Borehole at Galmoy	09/01/1996	12:40:00	Kilkenny Co. Co.	KK00200	Leahy's House, Galmoy	C. Murray	92	KIK17	23020 17120	Galmoy	Group	8.6	1	5	7.3	779	0.1	1.8	< 0.01
Borehole at Kilmanagh	09/01/1996	14:20:00	Kilkenny Co. Co.	KK01400	In pumphouse	C. Murray	93	KIK45	23930 15250	Kilmanagh/Ballycuddihy	Group	8.2	1	5	7.6	645	0.1	2.3	0.021
Spring at Westcourt	09/01/1996	15:10:00	Kilkenny Co. Co.	KK00800	Spring at Earlsland, Westcourt, Callan	C. Murray	94	KIK91	S 407 442	Callan	Public	11.1	1	5	7.3	704	0.1	2.9	< 0.01
Borehole at Windgap	09/01/1996	15:40:00	Kilkenny Co. Co.	KK01900	Overflow from borehole	C. Murray	95		24200 13580	Farm supply	Private	11	1	5	7.4	380	0.2	< 0.12	0.023
Spring at Carrigeen,	15/01/1996	13:00:00	Kilkenny Co. Co.		Keoghans Field, Threecastles	J. Jennings	135						2	15	8	1045			0.03
Belview	27/02/1996	14:15:00	Kilkenny County Council		Well No.2 for proposed new water supply	Brian Connor	763			Belview proposed				5	6.8	351			< 0.01
Belview	29/02/1996	11:45:00	Kilkenny County Council		Well No.2 for proposed new water supply	Brian Connor	822			Belview 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														

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 Mart	01/09/1997	15:13:00	Kilkenny Co. Co.	KK01300	Cattle holding shed	P. Mullins	3802		25070 15670	Kilkenny Mart	Private	16.7	1	60	8.4	130	27	3.2	0.03
Borehole at Galmoy	27/08/1997	11:19:00	Kilkenny Co. Co.	KK00200	Leahy's House, Galmoy	P. Mullins	3743	KIK17	23020 17120	Galmoy	Group	14.3	1	5	7.6	763	0.15	0.55	< 0.01
Borehole at Bawnmore	27/08/1997	11:39:00	Kilkenny Co. Co.	KK00100	Phelan's house, Bawnmore	P. Mullins	3744	KIK50	22580 16610	Bawnmore	Group	15.4	1	5	7.3	826	0.08	1.04	< 0.01
Spring Toberpatrick Urlingford	27/08/1997	12:05:00	Kilkenny Co. Co.	KK01500	In chamber at source	P. Mullins	3745	KIK34	23000 16350	Urlingford/Johnstown	Public	11.1	1	5	7.2	743	0.12	2.47	< 0.01
Spring at Clomantagh	27/08/1997	12:20:00	Kilkenny Co. Co.	KK00900	Beside Nuenna river, 50m SE of road	P. Mullins	3746		23520 16320		Private	12.4	1	5	7.4	638	1.6	1.01	< 0.01
Borehole at Castlecomer Yarns	27/08/1997	14:00:00	Kilkenny Co. Co.	KK00300	Tap in yard at Castlecomer Yarns	P. Mullins	3747		25360 17330	Castlecomer Yarns	Private	12	1	5	7.4	600	5.8	0.56	0.033
Spring at Paulstown Castle	27/08/1997	14:51:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle	P. Mullins	3748	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	11.9	1	5	7.3	636	0.72	1.13	< 0.01
Borehole at Rathcash	27/08/1997	15:12:00	Kilkenny Co. Co.	KK02000	Joe Pykes house, Rathcash, Clara.	P. Mullins	3749	KIK55	25870 15510	Rathcash	Group	16.9	1	5	7.4	709	0.07	0.49	< 0.01
Borehole at Clara	27/08/1997	15:30:00	Kilkenny Co. Co.	KK00400	At pumphouse	P. Mullins	3750	KIK41	25770 15530	Clara	Group	16.3	1	5	7.4	673	0.06	0.59	< 0.01
Dunmore	03/03/1998	11:10:00	Kilkenny Co. Co.		1. Billy O'Dwyers	C. Murray	1116			1. Billy O'Dwyers		9.8	1	10	7.6	473	3.7	0.03	0.073
Dunmore Group Scheme	19/05/1998	11:45:00	Kilkenny Co. Co.			P. Mullins	2330					17.6	1	5	7.44	636			
	19/05/1998	11:55:00	Kilkenny Co. Co.		Readymix	P. Mullins	2331					14.8	1	< 5	7.59	648			
Borehole at Windgap	09/02/1999	09:30:00	Kilkenny Co. Co.	KK01900	Overflow from borehole	Redmond 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 Mart	17/02/1999	15:00:00	Kilkenny Co. Co.	KK01300	Cattle holding shed	C. Murray	1004		25070 15670	Kilkenny Mart	Private	9.7	1	10	7.9	690	1.5	1.8	< 0.2
Borehole at Kilmanagh	17/02/1999	16:00:00	Kilkenny Co. Co.	KK01400	In pumphouse	C. Murray	1005	KIK45	23930 15250	Kilmanagh/Ballycuddihy	Group	7.3	1	5	7.6	658	< 0.1	3.9	< 0.2
Spring at Westcourt	14/04/1999	10:47:00	Kilkenny Co. Co.	KK00800	Spring at Earlsland, Westcourt, Callan	P. Mullins	1889	KIK91	S 407 442	Callan	Public	9.8	1	< 5	7.5	699	< 0.1		< 0.01
Borehole at Windgap	14/04/1999	11:14:00	Kilkenny Co. Co.	KK01900	Overflow from borehole	P. Mullins	1890		24200 13580	Farm supply	Private	10.5	1	< 5	7.3	388	0.2		< 0.01
Springs at Bausheenmore	14/04/1999	12:12:00	Kilkenny Co. Co.	KK00500	At source (springs at Bausheenmore)	P. Mullins	1891	KIK39	25520 14690		Private	9.6	1	< 5	7.4	772	0.2		< 0.01
Borehole at Rathcash	14/04/1999	14:00:00	Kilkenny Co. Co.	KK02000	Joe Pykes house, Rathcash, Clara.	P. Mullins	1892	KIK55	25870 15510	Rathcash	Group	9.4	1	< 5	7.3	722	< 0.1		< 0.01
Borehole at Clara	14/04/1999	14:18:00	Kilkenny Co. Co.	KK00400	At pumphouse	P. Mullins	1893	KIK41	25770 15530	Clara	Group	9.6	1	< 5	7.3	695	< 0.1		< 0.01
	07/09/1999	10:20:00	Kilkenny Co. Co.		Kenny's Well, Kilkenny City	T. Doherty	4410												
Bennettsbridge	29/03/2000	14:16:00	Kilkenny Co. Co.		New well - feeding the infiltration gallery	P. Mullins	1688			Bennettsbridge	Public	10.6	1	< 5	7.6	727			< 0.003
Borehole at Kilmanagh	27/09/2000	10:30:00	Kilkenny Co. Co.	KK01400	In pumphouse	C. Murray	5048	KIK45	23930 15250	Kilmanagh/Ballycuddihy	Group	13.8			7.3	664	0.1		< 0.003
Borehole at Windgap	27/09/2000	12:10:00	Kilkenny Co. Co.	KK01900	Overflow from borehole	C. Murray	5049		24200 13580	Farm supply	Private	11.5			7.3	388	0.6		< 0.003
Borehole No.9, Thomastown	27/09/2000	14:15:00	Kilkenny Co. Co.	KK01600	At pumphouse	C. Murray	5050	KIK32	25890 14160	Thomastown	Public	13.3			7.2	758	0.2		< 0.003
Springs at Bausheenmore	27/09/2000	14:50:00	Kilkenny Co. Co.	KK00500	At source (springs at Bausheenmore)	C. Murray	5051	KIK39	25520 14690		Private	11			7.1	787	0.6		0.005
Spring at Paulstown Castle	27/09/2000	15:40:00	Kilkenny Co. Co.	KK00600	Spring at Paulstown Castle	C. Murray	5052	KIK46	S 660 570	Gowran/Goresbr./P-town	Public	11.1			7.1	656	0.4		0.016
Spring at Clomantagh	26/09/2000	10:20:00	Kilkenny Co. Co.	KK00900	Beside Nuenna river, 50m SE of road	C. Murray	5026		23520 16320		Private	11.4	1	15	7.4	282			0.083
Spring Toberpatrick Urlingford	26/09/2000	10:40:00	Kilkenny Co. Co.	KK01500	In chamber at source	C. Murray	5027	KIK34	23000 16350	Urlingford/Johnstown	Public	10.3	1	5	7.2	813			< 0.003
Borehole at Bawnmore	26/09/2000	11:05:00	Kilkenny Co. Co.	KK00100	Phelan's house, Bawnmore	C. Murray	5028	KIK50	22580 16610	Bawnmore	Group	13.5	1	5	7.3	863			< 0.003
Borehole at Galmoy	26/09/2000	12:15:00	Kilkenny Co. Co.	KK00200	Leahy's House, Galmoy	C. Murray	5029	KIK17	23020 17120	Galmoy	Group	14.7	1	5	7.4	789			< 0.003
Borehole at Castlecomer Yarns	26/09/2000	14:00:00	Kilkenny Co. Co.	KK00300	Tap in yard at Castlecomer Yarns	C. Murray	5030		25360 17330	Castlecomer Yarns	Private	12.2	1	20	7.5	578			0.036
Borehole at Dunmore	26/09/2000	14:25:00	Kilkenny Co. Co.	KK00700	C. Murray,s house, Dunmore.	C. Murray	5031		24910 16200	Dunmore	Group	14.7	1	5	7.4	668			< 0.003
Borehole at Dunmore S/G	26/09/2000	14:40:00	Kilkenny Co. Co.	KK01000	Canteen at Dunmore Sand & Gravel	C. Murray	5032	KIK53	25000 16020	Dunmore Sand & Gravel	Private	12.4	1	5	7.6	660			< 0.003
Borehole at Kilkenny Mart	26/09/2000	14:55:00	Kilkenny Co. Co.	KK01300	Cattle holding shed	C. Murray	5033		25070 15670	Kilkenny Mart	Private	14.6	1	5	7.6	708			< 0.003
Borehole at Clara	26/09/2000	15:35:00	Kilkenny Co. Co.	KK00400	At pumphouse	C. Murray	5034	KIK41	25770 15530	Clara	Group	11.6	1	5	7.4	667			< 0.003
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

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
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 12.1-Piltown Springs (Combined discharge)
Key indicators of Agricultural and Domestic GroundwaterContamination.