ARDAGH PUBLIC SUPPLY

GROUNDWATER SOURCE PROTECTION ZONES

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1. SUMMARY OF WELL DETAILS

GSI no.	:	1113SEW151
Grid ref.	:	12730 13977
Owner	:	Limerick Co. Co.
Well type	:	Dug
Elevation (top of casing)	:	Approx. 88.5 m OD (Poolbeg).
Depth	:	3.15 m
Depth of lining	:	3.15 m
Diameter	:	0.9 m
Depth-to-rock	:	greater than 3 m
Static water level	:	87.1 m O.D. (1.4 m below top of casing on 29/10/93)
Pumping water level	:	85.84 m O.D. (2.66 m below top of casing on 18/9/93)
Drawdown	:	1.26 m
Abstraction rate	:	327 m^3/d (3000 gal/hr)
Normal consumption	:	245 m^3/d (approx. 54,000 gal/d on average, over approximately 18 hours)
Specific capacity	:	160 m^3/d/m (this is an approximate value from general pumping data)
Pumping test summary:	:	No pumping test was carried out.

2. METHODOLOGY

There were three stages involved in assessing the area, a detailed desk study, site visits and fieldwork, and analysis of the data. The desk study was conducted in the Geological Survey where the subsoil and bedrock geologies were compiled from the original 6" field sheets. Basic public supply well details were recorded by County Council personnel in the form of a questionnaire which included a precise location and any relevant borehole, chemistry and pumping test data available.

The second stage comprised site visits and fieldwork in the surrounding area. Subsequently, the area encompassing a circle of 1 km radius was mapped with regard to subsoil and bedrock geology, hydrogeology and vulnerability to contamination. Finally, two raw water samples were taken in September 1993 and April 1994 for a full suite of chemical and bacterial analyses. A pumping test was not carried out at this location.

Stage three, the assessment stage, utilised analytical equations and hydrogeological mapping to delineate protection zones.

3. WELL LOCATION AND SITE DESCRIPTION

The dug well supplying Ardagh is located approximately 1.2 kilometres northwest of Ardagh, immediately to the north of a stream, off the main Newcastle to Foynes road (see Figure 1.). The well is protected by a steel cover which is 70 cm higher than ground level. A pumphouse is located next to the well and both the well and the pumphouse are fenced off.

4. TOPOGRAPHY, SURFACE HYDROLOGY AND LAND USE

The well is located at the bottom of a NW-SE trending valley. The land slopes gently upwards to the north of the well at first and then more steeply above the 400 ft contour. The areas immediately to the north and south of the public supply are also marked by a distinctive undulating topography which is characteristic of gravel-rich subsoil deposits.

The most significant hydrological feature in the area is an eastward flowing stream, immediately to the south of the well. Several smaller streams and rises are marked on 6" scale topographic maps in the area, however, on visiting the site in October (3/10/95) all of these streams were dry.

Agriculture is the principal activity in the area, with most of the land being used as pasture. The two fields on either side of the well were being used as pasture at the time of the site visit (3/10/95). Reeds and marsh grasses were growing in the fields immediately to the north of the well.

5. GEOLOGY

5.1 Bedrock geology

The well is located near the unconformity of the Namurian Clare Shale to the west and the Visean Muddy Shelf Limestone to the east (as shown in Figure 1). The Muddy Shelf Limestones consist of undifferentiated black limestones and shales which dip predominantly to the north west, (45° - 60°). These rocks are unconformably overlain by the Namurian Clare Shale, which consists of a series of olive and black pyritic and fossiliferous shales.

5.2 Quaternary (subsoils) geology

The subsoils are shown in Figure 2. A significant extent of "till with gravels" occurs in a north-south trending deposit up to 1 km wide, in the vicinity of the well. Several sections of clean sand occur within the till, (150 m north of Rathronan rectory for example). However, in view of the mode of deposition of the gravels and general information for the area it is probable that they are poorly sorted and silty. The proportion of gravel in "till with gravel" can be variable. In this instance the free draining nature of the area and the presence of sand sections suggests that gravel is the dominant lithology. Large areas of rock close to surface have been mapped to the west and north of this till. Small areas of alluvium, till and gravel are also present.

5.3 Soils

The soils in the area around the public supply are a combination of Elton series (Grey Brown Podzolics) to the east of the public supply and Ashgrove series (Brown Earths, generally well drained with a loamy texture) to the west of the public supply. Both soils are derived predominantly from limestone and limestone till.

5.4 Depth-to-rock

In general the depth to bedrock ranges from less than 3 metres to the north and west of the public supply to greater than 3 metres in the lower lying area immediately surrounding the supply, and to the east. Information on the thickness of the tills in particular is poor, however the undulating topography and available evidence suggest a thickness greater than 5 metres over much of the area. The accurate determination of the 5 metre contour is not relevant in determining the vulnerability of moderately permeable till and is not included. The depth to bedrock at the well location is at least 3 metres. Depth to bedrock contours are shown in Figure 3.

6. HYDROGEOLOGY

6.1 Data availability

Hydrogeological data for the Ardagh area are very poor, particularly for the area around the public supply. A well survey was conducted during the site visit on the 3/10/95, and no new wells were discovered. An existing group water scheme well is present 150 metres west of the supply but this is on the other side of the stream. Details are available from another well, 1 km to the north of the public supply, in Ballyvoghan townland. No pumping test was carried out at this supply.

6.2 Groundwater levels

Although groundwater level data for the area are poor, certain observations can be made. The water table is close to the surface in the immediate vicinity of the well, (less than 2 metres at the well), and at the ground

surface during winter (as observed by the water caretaker). The presence of reeds and other marsh grasses around the well also suggests a water table near to the surface. The pumping water level in the well was recorded at 85.8 m O.D. (2.66 m below the top of the casing) on 25/10/95 and at 85.6 m O.D. (2.9 m below the top of the casing on the 3/10/95). The well at Ballyvoghan is at an approximate elevation of 115.0 m O.D., and had a static water level of 111.0 m O.D. on the 18/8/1969.

The level of the water in the stream immediately south of the well was calculated to be 4.17 m below the top of the well casing (at least 2 metres below the estimated static water level in the well). The well overflows during the winter months (according to the water caretaker).

6.3 Groundwater flow directions and gradients

Although the water table is likely to be a subdued reflection of topography in general, the presence of the spring suggests a substantial flow from the north. Assuming the gradient is constant an approximate value can be calculated from the well level at Ballyvoghan and the public supply. This gradient is 0.025, however, the actual gradient will be steeper in the vicinity of Ballyvoghan and shallower in area to the south.

6.4 Meteorology and recharge

Rainfall data for the area is estimated from the nearest similarly located weather station. Approximate mean annual rainfall, as recorded by the Meteorological Service, for the years 1951 - 1980 was 1100 mm, at an elevation of 20 m O.D. Potential Evapotranspiration (P.E.) is estimated from a regional Meteorological Service contoured map, and a ranking scheme with all the other sources, as 510 mm/yr. Actual evapotranspiration (A.E.) is then calculated by taking 93% of the potential figure, to allow for soil moisture deficits for part of the year (A.E. = 474 mm/yr). Using these figures the effective rainfall (E.R.) is taken to be approximately 626 mm/yr.

The presence of thin free draining soils, permeable till with gravels and rock close to surface over the area suggests that a high proportion of effective rainfall is infiltrating to the water table. Although the proportion of effective rainfall infiltrating to the water table is not known with certainty it is assumed that 80% is a realistic figure and that actual annual recharge in the area is therefore approx. 500 mm.

These calculations are summarised below:

Average annual rainfall	1100 mm
Estimated P.E.	510 mm
Estimated A.E. (93% P.E.)	474 mm
Effective rainfall	626 mm
Recharge (90% E.R.)	500 mm

6.5 Hydrochemistry and water quality

Samples of (chlorinated) groundwater from the public supply are analysed regularly by the County Council at various private residences in and around Ardagh. In addition, raw water samples were taken from the well on the 9/15/93 and 4/27/94 and an on-site analysis was also performed.

The chemical analysis at Ardagh indicates a **hard** water (366 - 379 mg/l CaCo3) with a high alkalinity (340 - 356 mg/l). Conductivity values are also relatively high (700 - 900 µS/cm) and have reached 1071 µS/cm (on 23/08/93). Chloride levels are generally between 30 - 40 mg/l and E.Coli are occasionally present.. Concentrations of ammonia, nitrates and potassium are all low. There are no iron problems at this well.

6.6 Aquifer coefficients

As no pumping test was carried out at this location, hydrogeological data on the nature of the till with gravels are very limited. The aquifer is considered to have similar characteristics to a somewhat silty, poorly sorted gravel aquifer.

6.7 Conceptual Model

The (unconfined) aquifer feeding the Ardagh source is “till with gravels”, though it is considered that the gravels are the dominant lithology. Sections of clean sand occur within the till suggesting that this deposit is highly permeable in places. The underlying bedrock deposits are of low permeability.

Groundwater is considered to be flowing in the gravels from the area north of the spring. The boundaries of the “till with gravel” deposit are likely to be a factor in focusing groundwater southwards towards the spring. Also, tills in the gravels are probably complicating and influencing groundwater flow.

The relatively high electrical conductivity values appear to be the result of contamination, however ammonia, nitrate and potassium values are all low. The elevated chloride values can be explained by the addition of chloride from precipitation

6.8 Aquifer category

This “till with gravel” deposit would not be classified as an aquifer under the GSI guidelines, however, as it supplies sufficient water for the Ardagh public supply, it is classified as a **locally important aquifer** (intergranular flow) which is **generally moderately productive**. The Namurian Clare Shales are classified as a poor aquifer (generally unproductive) and the Visean Muddy Shelf Limestones are classified as a locally important aquifer which is generally unproductive except for local zones.

7. VULNERABILITY

The source at Ardagh is regarded as being high to extremely vulnerable to pollution. Using the GSI vulnerability mapping guidelines, areas where rock outcrops at the surface are mapped as having extreme vulnerability. Areas where rock is less than 3 m below surface are mapped as having a ‘probably extreme vulnerability’ and a large proportion of the area west and north of the source falls into this category. Groundwater is also extremely vulnerable in sand and gravel aquifers where the water table is less than 3 metres below the surface (this is the case in the area to the north of the public supply). The 3 metre depth to bedrock contours are interpreted using the general trends across the country, aerial photographs and the available data points. Although information on depth to bedrock over the area are limited, subsoils are highly permeable over much of the area around the well, and the water table is close to the surface. In addition the majority of the remaining area contributing to the well has rock close to surface.

The 5 metre contours are not produced as practically all of the subsoil is moderately to highly permeable, where greater than 10 metres is required to change the vulnerability classification. The vulnerability zones are shown on Figure 4.

8. DELINEATION OF SOURCE PROTECTION AREAS

Source protection areas are delineated for a higher output (327 m^3/d) than is currently abstracted, to facilitate an increase in demand of 33% and to allow for expansion of the zone of contribution in dry weather. 33% represents an increase in pumping from 18 up to 24 hours.

8.1 Outer Protection Area

The Outer Protection Area (SO) includes the complete catchment area to the source, i.e. the zone of contribution (ZOC), and it is delineated as the area required to support an abstraction from long-term recharge.

The most accurate zone of contribution at Ardagh is derived from hydrogeological mapping techniques and is controlled primarily by the major stream immediately to the south of the supply, by the groundwater flow directions to the stream and by the limited extent of the till with gravels. The size of the zone of contribution is based largely on the Recharge Equation. Taking the average annual recharge to be 500 mm as previously indicated, the area required to supply the increased pumping rate of 327 m^3/d, is calculated to be 0.24 km^2 ; this is equivalent to a circular area of an approximate radius of 275 m. This area does not take account of overflow from the well in winter. A buffer (safety margin) is included in the zone of contribution by incorporating a ±20% error margin in the estimated groundwater flow direction. The zone of contribution is shown in Figure 5.

The zone is significantly larger (approx. 80%) than that calculated by the recharge equation. However, this allows for the water overflow and the uncertainties due to the lack of hydrogeological data.

8.2 Inner Protection Area

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

Using the following aquifer coefficients: permeability (k) = 25 m/d, effective porosity = 0.08, and groundwater gradient (I) = 0.015, the 100 day time of travel distance to the well is estimated at 470m (see Figure 5). It is emphasised, however, that there are no data to enable the aquifer coefficients to be calculated for this source, consequently the boundary to this zone is uncertain.

8.3 Source Site

In addition to the Inner and Outer Areas there is a third protection area, the Source Site (SS), which is delineated as the area in the immediate vicinity of the source (minimum 10 m radius) in order to maintain good wellhead sanitary protection. The fenced off enclosure around the source at Ardagh is designated the Source Site Area.

9. GROUNDWATER PROTECTION SCHEME

Combining the Source Protection Areas, as described above, with the vulnerability ratings produces four groundwater protection zones for the source at Ardagh. These are listed here in order of decreasing degree of protection required and are shown in Figure 6 (with the exception of the Source Site):

- Source Site / High
- Inner Protection Area / Extreme
- Outer Protection Area / Extreme
- Outer Protection Area / High

It is not within the scope of this report to delineate the protection zones in the surrounding area and this is dealt with at the regional resource protection scale.

The accompanying code of practice imposing restrictions on developments will follow when discussions as to the degree of restriction necessary in each protection zone have been carried out between the Council, the EPA and the GSI.

10. POTENTIAL POLLUTION SOURCES

There is at times a possible contamination problem with the supply as indicated by the presence of occasional E.Coli. and high conductivity levels. The high calcium (132 - 136 mg/l), alkalinity and conductivity values may be related to water percolation through the overlying limestone rich soils and subsoils.

While several farms are present to the north of the supply, distances to the well exceed 600 metres. No major pollution sources are present in the immediate vicinity of the supply. The slightly elevated chloride levels are difficult to explain as other indicators of pollution such as nitrates, ammonia and sulphates are at normal levels. Chloride levels may be partially explained by higher levels from precipitation.

11. CONCLUSIONS AND RECOMMENDATIONS

Overall, the source at Ardagh is a reasonably good yielding well although it is not known whether it would support an increased yield. The supply is high - extremely vulnerable to pollution due to the thickness and permeability of the subsoils in the immediate vicinity of the supply and the proximity of the water table to the

surface. The water analyses showed occasional faecal bacteria and elevated values of chloride, although other indicators of pollution were not present.

It is recommended that the Council monitor the raw water from Ardagh public supply to examine the effects of any potentially polluting activities near to the well and to keep a check on bacterial contamination and elevated values of chloride and conductivity. In addition it is recommended that the council control and monitor potentially polluting activities in the delineated groundwater source protection zones.

SCALE 6 Inches = 1 Mile

Clare Shales

Muddy Shelf Limestones

Clare Shales

Muddy Shelf Limestones

Geological boundary (unconformity)

45° Dip of bedding

FIG. 1 BEDROCK GEOLOGY

SCALE 6 Inches = 1 Mile

Till

Rock close

gravel

Alluvium

Gravel

Rock close

gravel

Till

Rock close

Till

Till-with-gravel

Alluvium

Rock close

Rock close

Till-with-gravel

Peat

gravel

Till-with-gravel

gravel

Alluvium

Subsoil boundaries

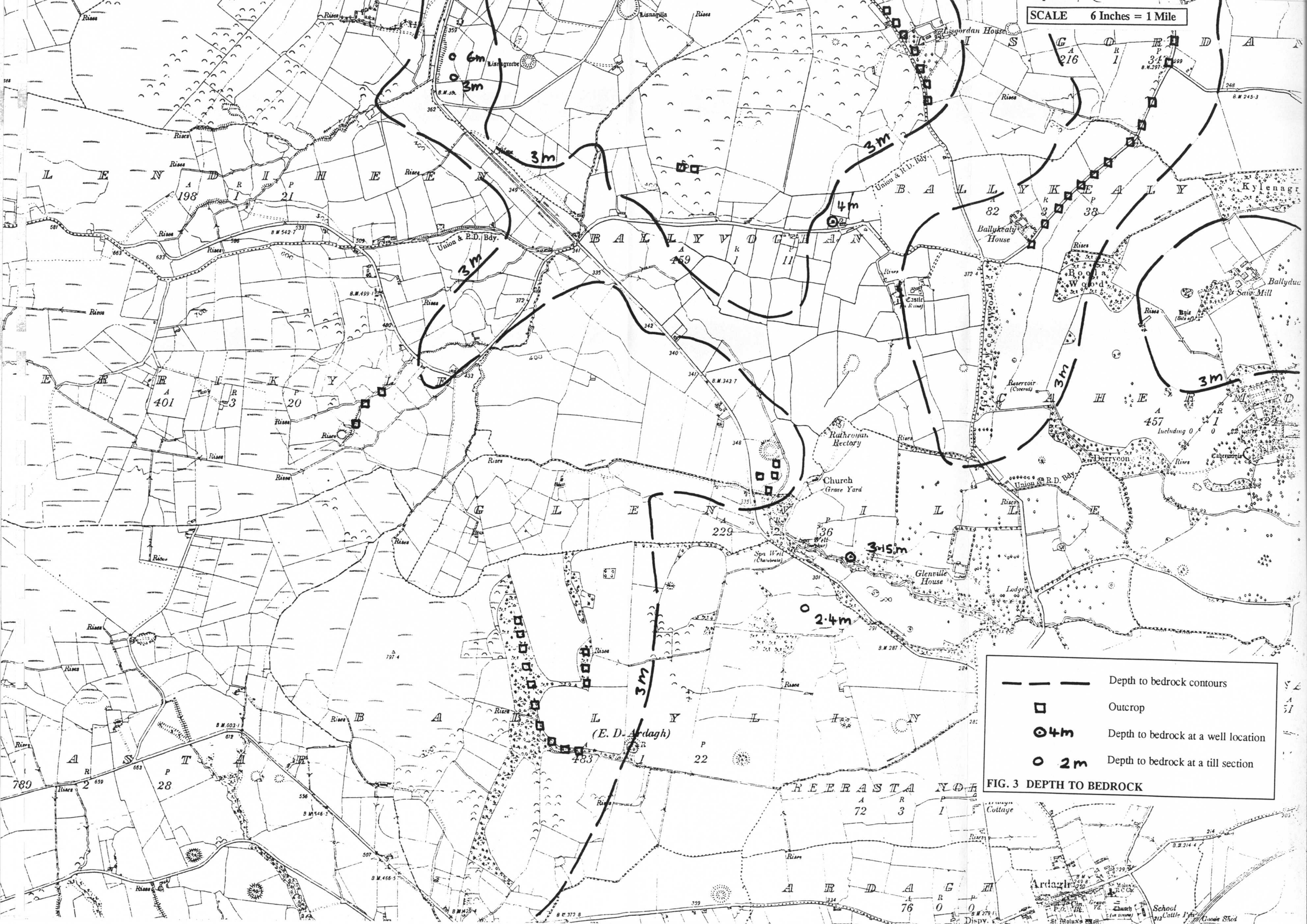
Outcrop

Gravel section

Gravel pit (used or disused)

FIG. 2 SUBSOILS

SCALE 6 Inches = 1 Mile



Depth to bedrock contours

Outcrop

0 4m Depth to bedrock at a well location

0 2m Depth to bedrock at a till section

FIG. 3 DEPTH TO BEDROCK

FIG. 4 VULNERABILITY

High

Extreme

High

Extreme

Extreme

Extreme

High

Extreme

High

Extreme

BALLYKEALY

BALLYVOGHAN

GLEN

BALLYLINN (E. D. Ardagh)

REERASTA NORTH

REERASTA SOUTH

COMMONS

ARDAGH

CROSS

MONASHINNAGH

MINISTER'S-LAND

KILREASH

RATHREAGH

HEFFERNAN

LISKILLEEN (Dickson)

LISKILLEEN (O'Brien)

Kylenagrour

Rathreagh Cottage

Ballyduane

Boolin Wood

Ballykealy House

Castle (in Ruins)

Rathcroman Rectory

Church

Grave Yard

Spa Well (Chalybeate)

Glenville House

Lodge

Reservoir (Covered)

Derrycon

Cahermoyle House

Lucy's Wood

Ardagh Cottage

Ardagh Fort

Ardagh

Ardagh Station

Creamery

School

Dispy.

Union & R.D. Bdy.

SCALE 6 Inches = 1 Mile

Zone of contribution with buffer

100 day time of travel zone

FIG.5 ZONE OF CONTRIBUTION AND 100 DAY TIME OF TRAVEL ZONE

SCALE 6 Inches = 1 Mile

SI/H	Inner Zone - High
SO/H	Outer Zone - High
SO/E	Outer Zone - Extreme

FIG. 6 GROUNDWATER PROTECTION ZONES

SO/H

SO/E

SI/E