GLIN PUBLIC SUPPLY

GROUNDWATER SOURCE PROTECTION ZONES

Matthew Hudson
Groundwater Section
Geological Survey of Ireland

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‘Note:
Since this report was published, the Glin borehole is no longer in use as a Public Water Supply. However, geological and hydrogeological information included in this report could be beneficial.

Please be aware that some maps have been updated based on improved geoscientific evidence and hydrogeological knowledge. The most up-to-date maps can be found on the Geological Survey Ireland website (https:// www.gsi.ie/en-ie/data-and-maps/Pages/default.aspx).'

GLIN PUBLIC SUPPLY

1. SUMMARY OF WELL DETAILS

Main Borehole (Costelloes Factory)

GSI no.	:	1113NWW197
Grid ref.	:	16600 12178
Owner	:	Limerick Co. Co.
Well type	:	Bored
Elevation (top of casing)	:	52.38 m OD (Poolbeg). Ground level is 52.1 m OD.
Depth	:	63.39 m
Diameter	:	203 mm (8")
Depth-to-rock	:	Rock at surface
Static water level	:	Estimated static water level 45.1 m O.D.(7 m below ground level)
Pumping water level	:	19.65 m O.D. (32.73 m below top of casing after 10 hours continuous pumping) on 18/9/93
Drawdown	:	16 - 22.0 m
Abstraction rate	:	406 m^3/d (3720 gal/hr)
Normal consumption	:	270 - 406 m^3/d (16 hours pumping in winter, 24 hours in summer)
Specific capacity	:	21 m^3/d/m (extrapolated to 1 week)

Pumping test summary:

(i) abstraction rate : 406 m^3/d (17 m^3/d)
(ii) specific capacity : 18m^3/d/m (10 hours)
(iii) transmissivity : 14 m^2/d [7 – 27 m^2/d]

Secondary Borehole (south of the Industrial School)

GSI no.	:	1113NWW199
Grid ref.	:	11364 14668
Owner	:	Limerick Co. Co.
Well type	:	Bored
Elevation (top of casing)	:	46.32 m OD (Poolbeg). Ground level is 45.96 m OD.
Depth	:	40 m (approx.)
Diameter	:	152 mm (6")
Static water level	:	The estimated value is 43.96 m O.D.(2.3 m b.g.l.))
Pumping water level	:	28.15 m O.D.(18.17 m below top of casing on 3/10/95)
Drawdown	:	17.81m (using the extrapolated static water level)
Abstraction rate	:	120 m^3/d (approx. 1100 gal/hr)
Normal consumption	:	90 m^3/d (approx. 20,000 gal/d on average, over approximately 18 hours)
Specific capacity	:	Approx. 6 m^3/d/m (from basic discharge - drawdown values)
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 precise locations and any relevant borehole, chemistry and pumping test data available.

The second stage comprised site visits and fieldwork in the surrounding area. A pumping test was carried out to examine the aquifer characteristics for the major source. 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.

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

3. WELL LOCATIONS AND SITE DESCRIPTIONS

Main Supply
The main bored well is located approximately 1.5 km southeast of Glin, (immediately adjacent to a minor road) next to 'Costello's' wood preparation factory. Water from the well is pumped up to a reservoir which serves Glin. The well casing is not capped, however, the well is surrounded by a concrete enclosure and protected by a wooden cover. (Figure 1).

Secondary Supply
The secondary supply is located approximately 800 metres to the southeast of Glin, immediately behind the old 'Industrial School'. The well casing is not capped but the well is located within a small pumphouse. This supply is only used during the summer months to supplement the main supply.

4. TOPOGRAPHY, SURFACE HYDROLOGY AND LAND USE

The land surrounding the main supply slopes steeply to the west, up to an east-west trending hill (94 m high), and steeply down to the river valley to the east. The land around the secondary supply slopes more gently up to the south (Figure 1).

The River Glencorbry, which is immediately to the east of the main supply, flows northwards and has been straightened downstream of the supply to flow around the window factory. In addition a small stream, approximately 200 metres south of the main supply, flows eastwards through the townland of Ballygiltenan Lower. Several streams of a similar size occur on the eastern side of the River Glencorbry. On visiting the site on 3/10/95 all of these streams were flowing.

Agriculture is the principal land use in the area, with most of the land being used as pasture, particularly around the secondary supply.

5. GEOLOGY

5.1 Bedrock geology

Both wells are located in Namurian gritstones and shales (as shown in Figure 1). These consist of coarse, compact, green - grey gritstones and black, flaggy, iron rich shales. Because of the complex nature of these beds no distinction is made between individual units. The Namurian grits and shales in the vicinity of the main supply dip between 20 - 40 degrees to the south east, elsewhere the dip direction is more variable. Two small faults are indicated on six-inch GSI geological maps and these are shown in Figure 1, however no evidence was seen for these faults in the field.

5.2 Quaternary (subsoils) geology

The subsoils are shown in Figure 2. In the immediate vicinity of the main supply and on the higher ground to the west, the bedrock is close to the surface. Other areas of rock close to surface occur on the upland areas to the east of the Glencorbry River and in several river and stream sections. Between these areas of rock close to

surface and the river, the bedrock is covered by till with gravel of variable thickness (greater than 10 metres in parts). Sections in this till are rare, although a good section is present on the east bank of the river, opposite the window factory. The till matrix at this section is variable, with a clay matrix at the base of the section and a sandy matrix towards the top of the section. The upper 2-3 metres of the section are very gravelly and abundant gritstone and shale clasts are present. Several gravel pits are marked to the south of Glin on the original Quaternary maps.

5.3 Soils

The soils in the area around both supplies consist of Kilfergus Brown Earths. Kilrush Gleys occur to the east of the river. Both of these soils are derived from glacial deposits of shale and sandstone origin.

5.4 Depth-to-rock

In general the depth to bedrock ranges from less than 3 metres to the west of the main supply and to the east of the river (on higher ground) to greater than 10 metres in the low lying areas along the river valley. Small outcrops occur near the top of the hill overlooking the main supply.

Bedrock is close to surface at at the main supply, however depth to bedrock data from other wells in the area and from subsoil sections, indicate a variable depth to bedrock in the vicinity of the wells. Depth to bedrock contours are shown in Figure 3.

6. HYDROGEOLOGY

6.1 Data availability

Hydrogeological data for the Glin area are poor, particularly in the area around the public supplies. A well survey was conducted during the site visit on the 3/10/95, and four wells were discovered. Two of these wells are upgradient of the main public supply well and provide useful information regarding groundwater gradients. Although records of other wells exist for the area around the well, most of these are not located accurately (only to within the nearest townland). A 10 hour pumping test with a 10 hour recovery was carried out in September 1993 on the main public supply well.

6.2 Groundwater levels

The static water levels measured in the four wells on the 3/10/95 are shown below and on Figure 4.

Grid Ref	Location	Approx. Height a O.D.	Static Water Level m O.D.
11412 14612	100m south east of the main supply	58.0 m	50.1 m
11358 14613	On top of the hill, above both supplies	88.4 m	68.1 m
11384 14687	Kilfergus, north of the secondary supply	39.7 m	37.1 m
11406 14671	Kilfergus, east of the secondary supply	39.6 m	30.4 m

These static water levels have been used to calculate groundwater gradients and to help estimate static water levels in each of the public supply wells.

Water levels in the main supply well were recorded at 33.46 m O.D. (18.64 m below the top of the casing) prior to the pumping test on 8/9/93 and at 35.44 m O.D. (16.66 m below the top of the casing) after the 10 hour recovery test. In both cases the water level in the wells were still rising at the end of the recovery test.
Using the pumping test graphs and the existing water level data, the static water level in the main pumping well is estimated at approximately 45.1 m O.D. (7 m b.g.l.), while that in the secondary supply is estimated at approximately 44.0 m O.D. (2.3 m b.g.l.)

6.3 Groundwater flow directions and gradients

Groundwater flow from the regional viewpoint, is generally towards the north-east, but at a more local scale, it is influenced by topography. The local groundwater flow directions are eastwards to the main supply and northwards to the secondary supply.

The estimated natural gradient (based on the limited data available) eastwards towards the main supply is 0.05, while the gradient northwards to the secondary supply is estimated as 0.04.

6.4 Meteorology and recharge

Rainfall data for the area are taken from the nearest similarly located weather station at Glin. Mean annual rainfall, as recorded by the Meteorological Service, for the years 1951 - 1980 was 1099 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 sequence with all the other sources, as 525 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, so A.E. is estimated as 490 mm/yr. Using these figures the effective rainfall (E.R.) is taken to be approximately 610 mm/yr.

The presence of thin free draining soils, moderately 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. However, several perennial streams are present near to the well suggesting that runoff is also significant. Although the proportion of effective rainfall infiltrating to the water table is not known with certainty it is assumed that 75% is a realistic estimate and that the actual annual recharge in the area is therefore 460 mm.

These calculations are summarised below:

Average annual rainfall	1099 mm
Estimated P.E.	525 mm
Estimated A.E. (93% P.E.)	490 mm
Effective rainfall	610 mm
Recharge (75% E.R.)	460 mm

6.5 Hydrochemistry and water quality

Raw water from the main supply was sampled and analysed on the 15/9/93 and on the 2/4/94 and a range of parameters were measured at the well head during the pumping test. In addition regular checks are carried out on treated water for both supplies.

The hydrochemical analyses of groundwater at the main source in Glin indicate a **slightly hard** water (approx. 130 mg/l ($CaCO_3$)), with a moderate alkalinity (180 - 215 mg/l ($CaCO_3$)). Conductivities were between 430 - 722 μS/cm. The hardness and alkalinity values in these analyses are similar to other values from the Namurian in Limerick.

Analysis of treated water for the main supply shows that all the major cations, anions and trace elements are within EU limits except for ammonia on 27/4/94 which was present at 0.304 mg/l (slightly over the maximum allowable concentration of 0.3 mg/l). The more comprehensive raw water analysis from the main supply indicates that both iron and manganese can exceed allowable concentrations, for example; Fe 0.202 mg/l and Mn 0.218 mg/l on 9/15/93 . The reducing conditions and the presence of Fe^{2+} would suggest a shale source for the iron. Oxidised iron and manganese are readily visible in exposures of Namurian shale in the area.

Analysis for the secondary supply are not as comprehensive as for the main supply, however available council analysis found bacterial contamination on 12/10/92 and high nitrites (0.12 mg/l) on 28/04/92. Full chemical analyses of raw water samples are necessary to enable a more comprehensive assessment.

6.6 Aquifer coefficients

The pumping test analyses for the main supply provided a transmissivity of 14 m²/d from the drawdown test and 7 m²/d - 17 m²/d from the recovery test. An average figure of 14 m²/d is taken as the best estimate. The specific capacity calculated was 21 m^3/d/m after 10 hours pumping.

6.7 Conceptual model

The aquifer feeding the Glin source is composed of Namurian shales and gritstones. The bedrock is composed of gritstones and shales and has a fissure permeability only, associated with joints and fractures. The aquifer is overlain by 0 to greater than 10 metres of till with gravels. As the gravels are highly permeable, the aquifer can be considered to be unconfined.

It is assumed that the water table mirrors topography and so there is a groundwater mound beneath the hill to the west of the main supply (this is supported by groundwater level data, Figure 4). Groundwater is probably concentrated in the uppermost weathered zone of the bedrock and in the gritstone beds. Groundwater level data suggest that at least the lower part of the perennial stream to the south is being fed by baseflow during the summer months. Similarly, groundwater is also believed to discharge to the Glencorbry River.

Natural groundwater flow to the secondary supply is northwards from the groundwater mound.

6.8 Aquifer category

The Namurian shales and gritstones are classed as a **poor** aquifer which is **generally unproductive except for local zones**.

7. VULNERABILITY

Using the GSI vulnerability mapping guidelines, areas where rock is less than 3 m below surface are mapped as having a 'probably extreme vulnerability' and the area to the west of the main supply falls into this category. Other areas of 'probably extreme vulnerability' are present to the south and east of the supplies.

The 3 metre contours are interpreted using general trends across the country, aerial photographs and the available data points. A large area to the east of the river is covered by 3-10 metres of subsoil, however the permeability of this subsoil results in this area being classified as 'probably highly vulnerable'. Evidence from wells in this area suggest that the depth to bedrock may be greater than 10 metres in places. The vulnerability zones are shown on Figure 5.

Although depth to bedrock information is not available around the immediate vicinity of the secondary supply groundwater in this area is likely to be high - extremely vulnerable to pollution due to the relatively thin, highly permeable subsoils overlying the area.

8. DELINEATION OF SOURCE PROTECTION AREAS

Source protection areas for the main supply are delineated for the higher output of 507 m^3/d, reflecting summer abstraction and allowing for an expansion of the zone of contribution during dry weather (represented by a 25% increase in discharge). A value of 112 m^3/d is used for the delineation of zones around the secondary supply allowing for an expansion of the zone of contribution during dry weather.

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 practical zones of contribution for both wells at Glin are derived from hydrogeological mapping techniques. The

combined ZOC to the two wells is controlled primarily by the recharge mound to the west, the river and stream boundaries to the east and south and the proposed groundwater flow directions.

Estimation of the size of the combined zone of contribution is largely based on the Recharge Equation. Taking the average annual recharge to be 460 mm as previously indicated, the area required to supply the increased pumping rates of 507 m^3/d and 112 m^3/d is calculated to be 0.5 km^2, this area is equivalent to a circular area with a radius of 400 m. A buffer (safety margin) is included in the final zone of contribution by incorporating a ±20% error margin in the estimated groundwater flow direction.

The combined zone of contribution to both sources is shown on Figure 6.

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 for the main supply: permeability (k) = 0.27 m/d and effective porosity = 0.01, the 100 day time of travel distance to the well is 270m (see Figure 6).

If a similar value for permeability and effective porosity are used for the secondary supply the 100 day travel time distance to the well is 216 m.

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. Both sources at Glin have poor protection in the source site area and this is cause for concern.

9. GROUNDWATER PROTECTION SCHEME

Combining the Source Protection Areas, as described above, with the vulnerability ratings produces five groundwater protection zones for the public supply wells at Glin. 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 / Extreme
- Inner Protection Area / Extreme
- Inner Protection Area / High
- 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 will be dealt elsewhere under resource protection.

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

Two significant industrial sites are present in the area near the main supply. A small wood processing factory is located immediately adjacent to the main supply (within 10 metres). A large factory making plastic and aluminium windows is located approx. 200 metres further down river (outside of the ZOC). Apart from these factories a small number of houses and farmyards are present in the general area of the wells.

The wood processing factory is less than 10 metres away from the well (within the source site area) and as the bedrock is close to the surface in this area this factory poses a significant risk to the well; in particular, from septic tank effluent and fron any fungicides used in the factory.

The presence of elevated nitrite levels and occasional faecal bacteria in the secondary supply are likely to be the result of poor wellhead protection as the adjacent area is used for cattle grazing.

11. CONCLUSIONS AND RECOMMENDATIONS

Overall the main source at Glin is a moderate yielding well (with a higher yield than normally present in this rock unit), which is unlikely to be able to support a significant increase in yield. The source is high-extremely vulnerable to pollution due to the shallow thickness and the permeability of the subsoils in the immediate vicinity of the supply. The water analyses showed no major anomalies in the major and minor ion concentrations or faecal bacteria, except for one instance of high ammonia, which may be due to a septic tank in the area (possibly from the wood processing factory) The proximity of the source to this factory is a serious cause for concern.

The high values of iron and manganese, while not detrimental to health, may cause problems in the long term due to encrustation of the rising main and pump, and discoloration of the water supply.

The secondary supply is a relatively poor yielding well which is also unlikely to be capable of any significant increase in yield. There are some instances of minor bacterial and nitrite pollution, probably as a result of cattle grazing immediately around the well.

It is recommended that the County Council should monitor the raw water from both supplies to examine the effects of the potentially polluting activities near to the well. It is strongly recommended that Council staff should check for the use of wood preservatives at this factory and , if necessary, check for the presence of these chemicals in the water supply. In addition it is recommended that the council control and monitor polluting activities being carried out on the delineated groundwater source protection zones, particularly in the factory adjacent to the main supply and in the source site area around the secondary supply.

SCALE 6 Inches = 1 Mile

Public supply well

Possible Geological Fault

45° Dip of Bedding

FIG. 1 GEOLOGY

Namurian grits and shales

Namurian grits and shales

Namurian grits and shales

Namurian grits and shales

GLIN

KILLACOLLA (Barker)

DEMESNE

BALLYGILTENAN NORTH

BALLYGILTENAN LOWER

TULLYGLASS

INARD

KILLEANY MORE

KILLERGUS

Glin Castle

Industrial School

Reservoir, (The Board of Management Glin District School)

Rathmay

Waterfall

Waterfall

SCALE 6 Inches = 1 Mile

Gravel

Till-with-gravel

Rock close

Alluvium

Rock close

Till-with-gravel

Till-with-gravel

Rock close

Till-with-gravel

Rock close

Subsoil boundaries

Outcrop
Till section
Gravelly till section
Gravel section
Gravel pit (used or disused)

FIG. 2 SUBSOILS

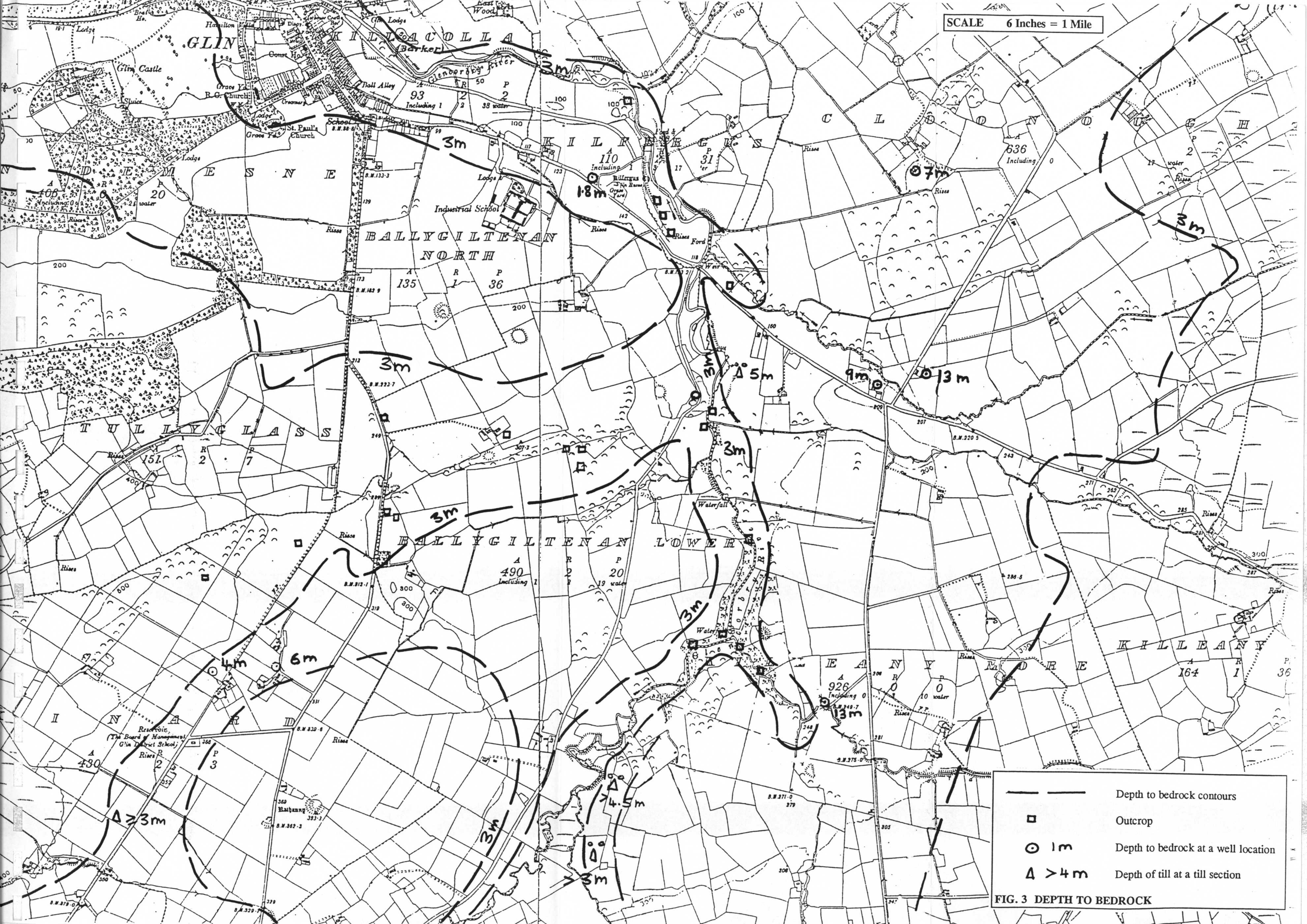

FIG. 3 DEPTH TO BEDROCK

SCALE 6 Inches = 1 Mile

Natural groundwater flow direction

Public supply well

⊙ 39 m Water level measured on 3/10/95 (m above O.D.)

FIG. 4 WATER LEVELS AND NATURAL GROUNDWATER FLOW DIRECTIONS

FIG. 5 VULNERABILITY

SCALE 6 Inches = 1 Mile

Extreme

Extreme

High

High

Extreme

Extreme

High

Extreme

Combined zone of contribution

100 day time of travel zone

FIG.6 RECOMMENDED ZONE OF CONTRIBUTION WITH BUFFER

SCALE 6 Inches = 1 Mile

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

FIG. 7 GROUNDWATER PROTECTION ZONES