CLOUNCAGH PUBLIC SUPPLY

GROUNDWATER SOURCE PROTECTION ZONES

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1. SUMMARY OF WELL DETAILS

GSI no.	: 1113SEW153
Grid ref.	: 13708 13448
Owner	: Limerick Co. Co.
Well type	: Borehole
Elevation (top of casing)	: 81.84 m OD to Poolbeg. Ground level is 82.25 m OD.
Depth	: 45 m
Diameter	: 203 mm (8″)
Depth-to-rock	: 15 m approx.
Static water level	: 4.68 m below top of casing
Pumping water level	: 14.7 m (>24 hours)
Drawdown	: 10.02 m
Current abstraction	: 590 m^3/d (5,400 gal/hr over 24 hrs)
Specific capacity	: 57 m^2/d (1 week)

Pumping test summary:

(i) abstraction rate: 534 m^3/d
(ii) specific capacity : 63 m^2/d
(iii) transmissivity: 68 m^2/d [41–150 m^2/d]

2. METHODOLOGY

There were three stages involved in assessing the area, the first of which was a detailed desk compilation. The subsoil and bedrock geologies were primarily compiled from the original 6" field sheets in the Geological Survey. 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. A pumping test was carried out to examine the aquifer characteristics. Subsequently, the area enclosed by a circle of 1 km radius was mapped with regard to subsoil and bedrock geology, hydrogeology and vulnerability to contamination. A detailed well survey was carried out to obtain basic data and to get an estimate of groundwater gradients in the area. Finally two full suites of chemical analyses were completed on raw water samples in September 1993 and April 1994.

Stage three, the assessment stage, utilised analytical equations to take a more detailed look at the hydrogeology and to delineate a more comprehensive protection zone.

3. WELL LOCATION AND SITE DESCRIPTION

The public supply well in Clouncagh is located behind the buildings in the creamery yard. The wellhead is below ground level beneath a manhole cover and is cemented up to the casing. The creamery is disused and is now owned by the council. An old shallow well was also present in the yard but as it could not sustain the required yield for the creamery, it was abandoned and filled in.

4. TOPOGRAPHY, SURFACE HYDROLOGY AND LAND USE

The land around Clouncagh slopes southward from the top of the Knockaderry hills at 145 m OD to the flatter low lying areas to the south of the well. The source lies at the foot of the hills at approximately 81 m OD.

A small river rises in the hills further to the east and drains away in a southwesterly direction to the south of the source. Drainage ditches are present in the flatter parts of the area below the 300 ft (91.4 m OD) contour and flow direction is generally in a southeasterly direction towards the river. The higher areas are otherwise very well drained.

The land is primarily use for grazing.

5. GEOLOGY

5.1 Bedrock geology

The bedrock geology of the area comprises a number of different rock types, including the Kiltorcan Sandstone, Lower Limestone Shale (Mellon House Beds, Ringmoylan Shales, Ballyvergin Mudstones and Ballymartin Shales) and Ballysteen Limestones (Fig. 1). The hills to the north are Kiltorcan Sandstone and the beds dip gently to the south at angles varying from approximately 10–30°. From geometric calculations it appears that the well penetrates both the Ringmoylan Shales and the Mellon House Beds, and may just reach the Kiltorcan Sandstones. A log from a nearby mineral exploration borehole shows the rocks of the Mellon House Beds to be grey to white sandstones with dark shaly partings which are very weathered with iron staining. A large northeast-southwest fault passes 500 m to the west of the borehole and it is likely that it has a series of fractures and faults associated with it trending in the same direction. The Kiltorcan Sandstone is also reported to be very fractured and brecciated.

5.2 Subsoils

Subsoils in the immediate vicinity of the well comprise mainly limestone till (Fig. 2). Sand and gravel deposits lie to the northwest of the area while to the northeast there is an area of till-with-gravel. Aerial photography highlights a small east-west trending ridge to the south of the source which is likely to be sand and gravel. To the north, bedrock is close to the surface and where there is no outcrop, the covering is a thin deposit with a sandy matrix, some clay and many sub-angular clasts. To the southeast of this, sections in the river bank to the south of the old church expose alluvial sand and gravel, with thin silty layers.

5.3 Soils

The soils of the area are primarily of three main types and can be seen to broadly correlate with the bedrock. The brown earths of the Baggotstown series are present to the north, overlying the Kiltorcan Sandstone, and they are derived from glacial gravels and sands, dominantly of limestone origin with some sandstone, shale and volcanic components. Further to the south, a thin band of the Puckane gleys are present overlying the Lower limestone shales and these are of sandstone-shale glacial drift origins. Finally, the southern parts of the area are covered with the Elton grey-brown podzolics which are of limestone glacial drift origin with some sandstone shale and volcanics. These soils are underlain by the Ballysteen Limestones. The soils are shown on the published soils map of Co. Limerick (Finch and Ryan, 1966).

5.4 Depth-to-rock

Depth-to-bedrock in the area varies from outcrop on the hills to the north, with subsoils becoming thicker further southwards, reaching a depth of at least 17 m. The thickness of deposits in the public supply borehole is estimated to be in the region of 15 m. The Kiltorcan Sandstone crops out on the hills to the north. The depth-to-rock has been contoured but it is based on few data points and may need refining as further borehole records become available (Fig. 2).

6. HYDROGEOLOGY

6.1 Data availability

The following sources of hydrogeological information were used in considering the conceptual model:

- Results of a 10 hour pumping test with recovery carried out as part of the study in July 1993.
- A well survey of the area also carried out as part of the study.
- GSI Mineral exploration records.
- GSI well records.

6.2 Groundwater levels

The static water level in the Clouncagh Public Supply well, taken on 13.7.93, was 77.16 m OD (4.68 m from the top of the casing). It is reasonable to assume that the river to the south of the well is in hydraulic continuity with groundwater; water levels in the streams can therefore be taken as groundwater levels. There are a number of shallow wells and springs in the area.

6.3 Groundwater flow directions and gradients

Groundwater flow direction is from north-northwest to south-southeast, following topography and the direction of dip of bedrock. The gradient varies over the area with the changes in rock type but the estimated average is taken to be 0.02, based on water levels in private wells to the east of the source.

6.4 Meteorology and recharge

Rainfall data for the area are taken from the nearest weather station in Kilmeedy some 3 miles south of Clouncagh, which is situated in a similar topographic location. Mean annual rainfall for the years 1941–1980 was 976 mm. 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/a. Actual evapotranspiration (A.E.) is then calculated by taking 93% of the potential figure, to allow for soil moisture deficits during part of the year. Using these figures, the average annual effective rainfall (E.R.) is taken to be approximately 500 mm per annum.

There are numerous surface streams in the area and the subsoils are generally thick limestone tills; it is assumed therefore that runoff is of the order of 30% and recharge is estimated to be approximately 350 mm.

These calculations are summarised below:

Average annual rainfall	976 mm
Estimated P.E.	510 mm
Estimated A.E. (93% P.E.)	475 mm
Effective rainfall	~500 mm
Recharge (70% E.R.)	~350 mm

6.5 Hydrochemistry and water quality

The hydrochemistry of the groundwater in the source at Clouncagh is indicative of a **hard** water (279–293 mg/l $CaCO_3$), with moderately high alkalinity (270 mg/l $CaCO_3$), which is more typical of a limestone aquifer in which carbonate dissolution is the dominant chemical process. This is may be due to the carbonate limestone bands within the formation or, may be a reflection of the presence of limestone dominated subsoils through which recharge is infiltrating.

There are no problems with the water quality; nitrate, chloride and potassium are all low and there is no evidence of bacterial contamination.

6.6 Aquifer coefficients

Analysis of the pumping test data gave a range of transmissivity values from 42–150 m^2/d, with a best estimate of 68 m^2/d. There are no major recharge or barrier boundaries intercepted by the cone of depression and the well appears to be more than able to sustain the current pumping rate. The specific capacity was calculated as 57 $m^3/d/m$.

6.7 Conceptual model

The aquifer feeding the Clouncagh source is the Mellon House Beds Formation, although the uppermost beds of the Kiltorcan Sandstones are likely to be contributing to the supply. The aquifer may be confined by the overlying Ringmoylan Shales in the vicinity of the well; however, as there is no geological log for the public supply borehole this is not known with certainty. The line of springs through the area just north of the well is likely to correspond with the contact between the Mellon House Beds and the more impermeable Ringmoylan Shales, where groundwater flow is interrupted and is forced to come to surface.

The natural groundwater gradient varies over the area with the changes in rock type. A steeper gradient occurs in the Lower Limestone Shales than in the Ballysteen Limestones due to the change in permeabilities. High permeability zones caused by the fracturing and brecciation may also occur.

Recharge to the aquifer is considered to occur most readily in the vicinity of the ridge to the north of the source, where rock is close to surface.

6.8 Aquifer category

The Mellon House Beds Formation is not usually considered to be a regionally important aquifer, based on consideration of the rock lithology – thin sandstones interbedded with shaly horizons – and well yields. The high yield at Clouncagh suggests that permeabilities are increased by fracturing and/or water is being contributed by the uppermost beds of the Kiltorcan Sandstone. The Mellon House Beds Formation is classed as a **locally important aquifer** which is **moderately productive only in local zones**. The Kiltorcan Sandstone however, is a **regionally important aquifer** which is dominated by **fissure flow**.

7. VULNERABILITY

Using the GSI vulnerability mapping guidelines, the areas where rock is greater than 10 m below surface are mapped as having a **probably low** vulnerability. This is the case for most of the area in the vicinity of the source, where the subsoils are primarily limestone till and are of low permeability. The area to the north of the site, in the region of the ridge is classed as **probably extreme** vulnerability as rock is at, or close to the surface. The till-with-gravel and gravel deposits are classed as **probably high**, and these extend over a large proportion of the area to the northeast and northwest. The vulnerability is shown in Figure 3.

The groundwater source at Clouncagh is not considered to be vulnerable to pollution as the limestone till deposits are more than 10 m thick in the vicinity of the borehole, and the aquifer is overlain by low permeability rocks, both of which provide good protection.

8. DELINEATION OF SOURCE PROTECTION AREAS

Source Protection Areas are delineated for a 50% higher output than the current abstraction (i.e. 890 m^3/d) to facilitate an increase in demand and to allow for expansion of the zone of contribution in 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 groundwater recharge.

The Uniform Flow Equation was used to calculate the ZOC. Taking the transmissivity and the hydraulic gradient to be 68 m^2/d and 0.02 respectively, the distance to the down gradient null point (X_L) is calculated as 104 m and the width of the zone of contribution is 655 m. The zone extends northwards to the groundwater divide (Fig. 4).

The final ZOC includes a safety margin, which is delineated by incorporating a ±20° error in the estimated groundwater flow direction. The ZOC, shown in Figure 4, is significantly larger than the area calculated by the Recharge Equation for the increased pumping rate (0.93 km^2; equivalent to a circular area of approximate radius 545 m). This is necessary to take account of uncertainties in the conceptual model. As more data become available, the ZOC can be amended.

8.2 Inner Protection Area

The Inner Protection Area (SI) is the area defined by a 100-day time of travel from any 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 pollution.

The Time of Travel Equation was used to delineate the 100-day time of travel distance. The value for permeability is taken to be 1.7 m/d which is calculated from the pumping test transmissivity. Taking porosity to be 0.02 as an average between the highly permeable Kiltorcan Sandstones and the less permeable Mellon House Beds, and estimating a pumping water gradient of 0.04, the distance required to ensure a 100-day travel time to the well, on the up-gradient side, is 340 m, at the increased pumping rate (Fig. 4).

9. POTENTIAL POLLUTION SOURCES

The area enclosed within the 100-day travel time radius is currently relatively free from danger of bacterial pollution, with the exception of some houses which may have septic tanks. Spillages of milk in the vicinity of the creamery may also prove to be a threat. The remainder of the area within the zone of contribution does not currently pose cause for concern.

10. GROUNDWATER PROTECTION SCHEME

Combining the Source Protection Areas, as described above, with the vulnerability ratings, delineates a total of nine groundwater source protection zones for the Clouncagh source. These are listed here and are shown in Figure 6 (with the exception of the Source Site):

- Source Site / Low SS – L
- Inner Protection Area / Extreme SI – E
- Inner Protection Area / High SI – H
- Inner Protection Area / Moderate SI – M
- Inner Protection Area / Low SI – L
- Outer Protection Area / Extreme SO – E
- Outer Protection Area / High SO – H
- Outer Protection Area / Moderate SO – M
- Outer Protection Area / Low SO – L

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 and the EPA, with assistance from the GSI.

11. CONCLUSIONS AND RECOMMENDATIONS

Overall the source at Clouncagh is a high yielding well which has a relatively high specific capacity and currently has limited potential for further development. It is likely that a much greater abstraction could be obtained if the borehole was deepened, as it would reach the underlying Kiltorcan Sandstone which is a Regionally Important aquifer.

The groundwater in the vicinity of the well is of low vulnerability as it is protected by the overlying thick low permeability subsoil deposits and probably by low permeability bedrock. This is reflected in the chemical and bacterial analyses which are indicative of a good quality groundwater. The recharge area to the north of the source however, is classed as extreme vulnerability and good aquifer management in this zone will be necessary in the future to prevent contamination occurring.

The County Council should conduct their own, more detailed pollution surveys in the given protection zones to investigate the current source(s) of groundwater contamination and to prevent its deterioration.

It is recommended as a general policy, that a comprehensive suite of hydrochemical and water quality analyses, including all the major anions and cations, be carried out on a more regular basis (at least twice a year) to monitor changes in groundwater quality and to forecast any further deterioration.

Kiltorcan Sandstone

Kiltorcan Sandstone

Kiltorcan Sandstone

Lower Limestone Shale

Lower Limestone Shale

Lower Limestone Shale
(Mellon House Beds, Ringmoylan Shales,
Ballymartin Shaly Limestone and Lwr. Ballysteen Limestone)

Ballysteen limestone

Ballysteen limestone

Public supply well

Fault

Geological contact

FIG. 1 GEOLOGY

SCALE: 6 inches = 1 mile

Subsoil boundaries

3 m — Depth-to-bedrock contours

Outcrop

Gravel pit (used or disused)

Till section

Gravel section

Clayey gravel section

Head section

FIG. 2 SUBSOILS

SCALE: 6 inches = 1 mile

Rock close

Rock close

Rock close

Lst till

Lst till

Lst till

Lst till

Gravel

Gravel

Gravel

Gravel

Alluvial sand

3m

5m

10m

Fox Covert

Augha lin School

Clonamarkaun

Clouncagh

R.C.Church

Carnegie Library

Creamery

Post Office

Rock

Ford

Knocknamacapreen

Liable to Floods

AUGHALIN A 570 R 2 P 12

CORTEEN WEST A 120 R 0 P 1

CORTEEN EAST A 178 R 3 P 30

BALLYKENNEDY SOUTH A 323 R 2 P 36

BALLYKENNEDY NORTH A 131 R 3 P 0

CLONCAGH A 307 R 0 P 14

CLOGHBAN A 415 R 0 P 38 Including 0 16 water

BALLYBEGGANE A 284 R 0 P 24 Including 0 0 38 water

TIERNAHILLA A 435 R 0 P 15

Extreme

Moderate

Moderate

Extreme

High

High

Low

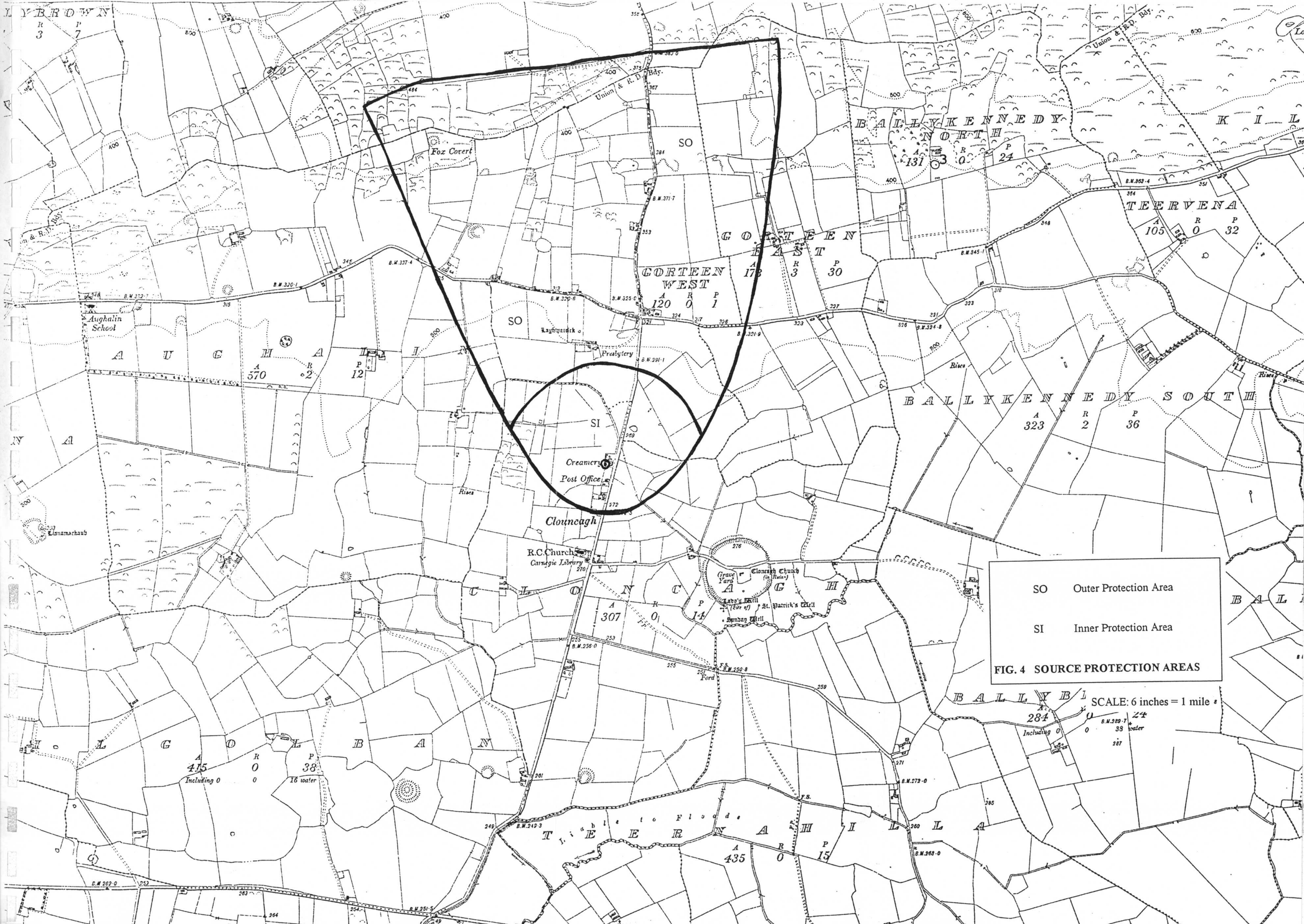
Low

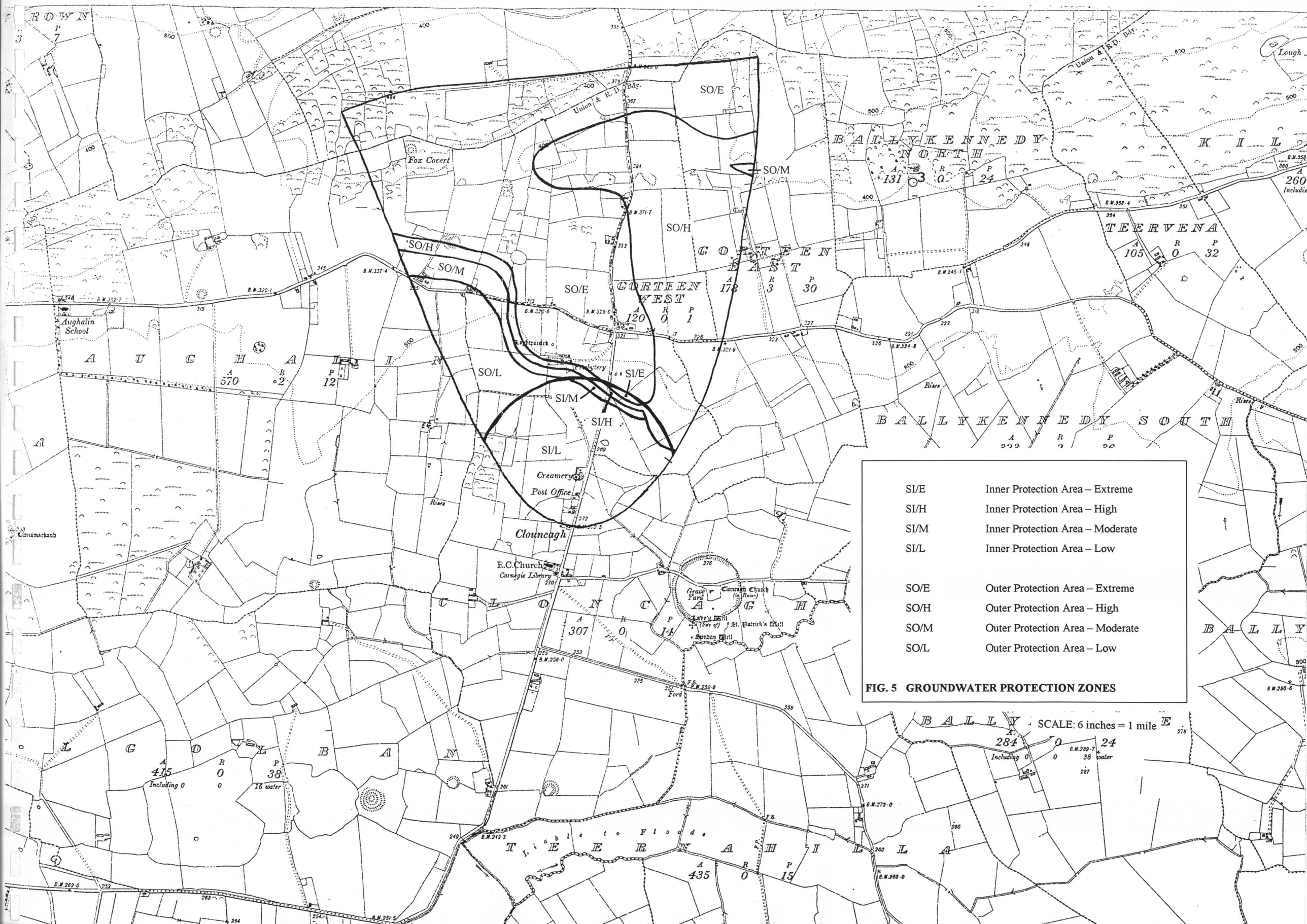
High

High

FIG. 3 VULNERABILITY

SCALE: 6 inches = 1 mile


SO
SI
Fox Covert
Union & R.D. Bdy.
Aughalin School
Raghtpatrick
Presbytery
Creamery
Post Office
Clouncagh
R.C.Church
Carnegie Library
Grave Yard
Clouncagh Church (in Ruins)
Lady's Well (Site of)
St. Patrick's Well
Sunday Well
Ford
Rises
Tidal to Flood
Lisnamachaub
AUGHALIN
A 570 R 2 P 12
CLONCAGH
A 307 R 0 P 14
HOLGOLBAN
A 415 R 0 P 38
Including 0 0 16 water
TEERNAHILLA
A 435 R 0 P 15
GORTEEN WEST
A 120 R 0 P 1
GORTEEN EAST
A 173 R 3 P 30
BALLYKENNEDY NORTH
A 131 R 3 P 24
TEERVENA
A 105 R 0 P 32
BALLYKENNEDY SOUTH
A 323 R 2 P 36
BALLYBL
A 284 R 0 P 24
Including 0 0 38 water
SO Outer Protection Area
SI Inner Protection Area
FIG. 4 SOURCE PROTECTION AREAS
SCALE: 6 inches = 1 mile



SI/E	Inner Protection Area – Extreme
SI/H	Inner Protection Area – High
SI/M	Inner Protection Area – Moderate
SI/L	Inner Protection Area – Low
SO/E	Outer Protection Area – Extreme
SO/H	Outer Protection Area – High
SO/M	Outer Protection Area – Moderate
SO/L	Outer Protection Area – Low

FIG. 5 GROUNDWATER PROTECTION ZONES

SCALE: 6 inches = 1 mile