# MURROE PUBLIC SUPPLY

# GROUNDWATER SOURCE PROTECTION ZONES

**Jenny Deakin**
**Groundwater Section**
**Geological Survey of Ireland**

**December 1995**

# MURROE PUBLIC SUPPLY

## 1. SUMMARY OF WELL DETAILS

| | | |
|---|---|---|
| GSI no. | : | 1715SWW033 |
| Grid ref. | : | 17233, 15638 |
| Owner | : | Limerick Co. Co. |
| Well type | : | 6 springs (with a supplementary borehole) |
| Elevations (Poolbeg) | : | 70.79–73.12 m OD (top of the chambers) |
| Depths | : | 2.4–4.06 m |
| Diameters | : | ~1–4.5 m |
| Depth-to-rock | : | estimated at ~14 m |
| Static water levels | : | ~68.71–71.55 m OD (April 1994) |
| Average total consumption | : | ~560 $m^3$/d (5,130 gal/hr). |

## 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 chamber construction and water chemistry data available.

The second stage comprised site visits and fieldwork. The area encompassing a circle of 1 km radius was mapped with regard to subsoil and bedrock geology, hydrogeology and vulnerability to contamination. Finally, three raw water samples were taken in September 1993, April 1994 and June 1995 for full suites of chemical and bacterial analyses.

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

## 3. WELL LOCATION AND SITE DESCRIPTION

The Murroe public supply comprises 6 springs and a relatively low yielding borehole (Costelloe's well, 180 $m^3$/d) which is used to supplement the springs in dry weather. (This study does not incorporate Costelloe's well as the springs are the main supply and they are fed by a different aquifer to that of the borehole). Five of the springs are located next to the pumphouse, to the north of the village; the site is marked as Leanbomanus springs on the 6 inch sheets and it is fenced off and owned by the County Council. The sixth spring is located in the corner of the field behind the others (i.e. to the west), beside a stream, and it is also fenced off in an enclosure which is owned by the County Council. The six springs are maintained in concrete chambers, and all of them feed into the collection chamber at spring number 5, from where the water is pumped through the pumphouse to the reservoir. (The borehole is situated on the banks of the stream, downstream and further to the west of spring number 6.) The reservoir is located at a height of 122 m OD (400 ft) on the hill to the northeast of the sources.

## 4. TOPOGRAPHY, SURFACE HYDROLOGY AND LAND USE

Murroe lies in the westerly foothills of the Slieve Phelim Mountains. The public supply springs are situated at a break in slope, at elevations of approximately 70.8–73.1 m OD (230–240 ft). The land rises steeply to the north-northeast of the sources to a height of 201 m OD (659 ft), and to a height of approximately 213 m OD (700 ft) to the east-northeast. Between these two peaks there lies a vertical walled, deep valley called Cappercullen Glen, which trends in a southeasterly direction.

There are a number of surface water courses in the area which are all part of the Mulkear catchment. The first is the stream which is located at the field boundary to the north of the five main springs. This is however, dry during the summer months. A second flows into this by the sixth spring and together they flow onwards towards the public supply borehole. A third, larger stream flows down the Cappercullen Glen into three small lakes, before flowing off to the south to join the Mulkear. This stream is marked on the half inch topographic maps as merging into the others. This is not the case at the present time however, and the connection between them is dry. The land in the immediate vicinity of the springs, and in the lower lying areas to the west, is generally quite wet and marshy; elsewhere, in particular on the higher ground, it is relatively dry and there are no drainage ditches.

Most of the land in the immediate area of the sources is owned by Glenstal Abbey, which is now a boarding school. The grounds are generally woodland areas although the school have a small farm and several playing pitches, as well as the residential buildings. Outside of this, the land is primarily used for grazing.

## 5. GEOLOGY

### 5.1 Bedrock geology

The bedrock geology of the area comprises the sandstones and conglomerates of the Old Red Sandstone which is mapped in this area as the Cappaghwhite Formation. The rocks are pale and red sandstones, with interbedded black mudstones and coarse conglomerates which are rich in Silurian clasts. A large fault trends down through Cappercullen Glen; it is considered that the fault continues under the gravels down towards the road. Borehole records from the Glenstal estate (Lynch's drillers) suggest that the sandstone is quartz rich and is greyish in colour.

### 5.2 Subsoils (Quaternary) geology

The subsoils of the area are quite complex. The most common subsoil type is till-with-gravel which is composed of interbedded gravels and tills in varying proportions, although the predominant component would appear to be sands and gravels (Fig. 1). Borehole records from the Glenstal grounds show loose gravels above bedrock, while there is a section in the stream bank along the entrance road showing a sandy till. A new pit located across the road from the springs showed almost 3 m of clean, well sorted sand. Reports from house owners along the easterly side of the road are that the subsoils are generally free-draining, loose sediments. These deposits are banked up around the higher hilly areas and can be clearly defined by their morphology. To the west of the road, in the lower lying area, the land becomes less free-draining and the subsoils comprise mainly tills, some with variable limestone/sandstone clast compositions. The landowner to the west of the sources reported the presence of almost 3 m of a sticky grey-blue clay. There is some peat reported in the higher areas.

### 5.3 Soils

The soils in the area comprise four main types: the brown earths of the Ballyvorheen Series which are derived from sandstone dominated fluvioglacial and outwash material and are found overlying most of the gravels and till-with-gravel; the gleys of the Puckane Series which are derived from glacial drift of predominantly sandstone-shale origin and which are located mainly in the lower lying areas over the tills; the podzols of the Knockaceol Series, derived from sandstone and conglomerate head deposits and found in the higher areas; and the lithosols of the Slievereagh Series which are derived from sandstones and conglomerates and are present in the area between the reservoir and the road. The soils are shown on the published soils map of Co. Limerick (Finch and Ryan, 1966) and so are not reproduced here.

### 5.4 Depth-to-rock

Rock crops out in the higher areas to the east of the sources although there is a thin subsoil cover in places. Boreholes drilled on the Glenstal Abbey grounds to the east of the site have recorded depths in the till-with-gravel of 12.2 m, 14.3 m and 2 m to bedrock (Fig. 1). These thicknesses are common in this deposit type in Co. Limerick as during the ice ages, the glaciers banked up against rock features, such as the Slieve Phelims, and deposited large quantities of loose sediment. The depth of the subsoil cover is unknown around the public supply but it is likely to be quite thick as a Co. Co. borehole drilled at Glenstal Lodge, approximately 370 m from the main springs and along the same topographic contour, was found to be more than 14 m. The depth-to-rock contours are based on few data points and may need refining as further borehole records become available.

## 6. HYDROGEOLOGY

### 6.1 Data availability

The following data sources were used in considering the conceptual model for the Murroe public supply springs:

- The source caretaker's notebook.
- Borehole records from four wells drilled on the Glenstal Estate.
- GSI well records.
- Aerial photographs.

### 6.2 Discharge

The average discharge at the combined Murroe sources is estimated by the County Council to be of the order of 560 $m^3$/d (5,130 gal/h). The five main springs are used alone during the winter months but during the drier weather, their yield reduces somewhat and the sixth spring and borehole are used to supplement the resource. The main collection chamber at the fifth spring has an overflow into the stream but this is only operational during the winter months and there is no estimate available as to the quantity overflowing. The total average discharge is taken to be the average spring discharge as a conservative estimate.

### 6.3 Groundwater levels

Groundwater levels will vary over the area depending upon topography, and the permeability of the subsoils and bedrock. The static water levels in the five main springs in April 1994 were approximately 71.55 m OD (1.07–1.12 m below the tops of the chambers). The water level in spring number 6 on the same date was 68.71 m OD (2.08 m below the top of the chamber). Water levels for the boreholes drilled on the Glenstal Estate were obtained from the driller but the dates of measurement are not known. They were as follows (Fig. 1 for locations):

1. County Council borehole drilled at Glenstal Lodge, ~75 m OD (5.49 m below ground level);
2. Glenstal Abbey borehole drilled by the tennis courts, 7.6 m below ground level which is approximately the height of water in the adjacent lake;
3. Glenstal Abbey borehole drilled at the white gate, 5.6 m below the top of the casing (Nov. 1995) which is approximately 4.5 m below the level of the adjacent stream;
4. Glenstal Abbey borehole drilled behind the laboratories, ~104 m OD (12.2 m below ground level).

There are a number of springs in the area, in particular in the vicinity of the lakes which are only evident when the water levels are low. The four lakes along the line of the fault have been artificially developed using weirs to retain the spring water, and it is likely that only the top lake which lies on the Old Red Sandstone is representative of groundwater levels.

### 6.4 Groundwater flow directions

Groundwater in the area will generally flow perpendicular to the topographic contours in a southwesterly direction. It is considered that the large fault in Cappercullen has an important role to play in the hydrogeologic regime; groundwater will be focused into the upper regions of the glen from both sides, before flowing off in a southwesterly direction. There will be a groundwater divide at the tops of both hills beyond which groundwater

will flow in the other direction. The flow patterns are not known with certainty and so a gradient cannot be calculated.

### 6.5 Meteorology and recharge

Rainfall data for the area are taken from the weather station in Murroe. Mean annual rainfall, as recorded by the Meteorological Service, for the years 1941–1980 was 969 mm. Potential evapotranspiration (P.E.) is estimated from a regional Meteorological Service contoured map, and a ranking scheme with all the other sources, as 520 mm per annum. 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 485 mm per annum.

Drainage within the area is fairly good but the stream and lakes which occur within the recharge area to the springs will direct a certain proportion of rainfall away from the aquifer. Estimating run off to be of the order of 25%, the average recharge to the aquifer is taken to be ~365 mm per annum.

These calculations are summarised below:

| | |
|---|---|
| Average annual rainfall | 969 mm |
| Estimated P.E. | 520 mm |
| Estimated A.E. (93% P.E.) | 484 mm |
| Effective rainfall | 485 mm |
| Recharge (75% E.R.) | ~365 mm |

### 6.6 Hydrochemistry and water quality

The hydrochemical analyses of groundwater at the source in Murroe indicate that it is a **hard** water (262–268 mg/l; $CaCO_3$), with moderately high alkalinity (219–237 mg/l; $CaCO_3$). Conductivities are in the range 520–730 μS/cm, averaging at approximately 560 μS/cm. These analyses are indicative of a calcium bicarbonate type water which may either be a carbonate rich sandstone or which may lie at the softer end of the limestone carbonate water scale. The hardness values would be more typical of the sandstones in Co. Limerick but values this low may also occur in limestones.

The water quality at the source is variable. Nitrate varied from 5.8–28.3 mg/l and was higher than the guide level in four ($n$ = 9) samples suggesting that contamination may be occurring at times. Chloride reached 39 mg/l and 40.5 mg/l in two of the analyses and this may also be indicative of contamination. The analyses from the State Laboratory, taken on raw water samples, show no evidence of faecal coliforms although there was a count of 44 total coliforms/100 ml in the June analysis. Fluoride is also quite high on occasion at 950 μg/l. It should be noted that the County Council borehole which was drilled at Glenstal Lodge was abandoned due to the presence of *E. coli*., and high iron and silt.

### 6.7 Conceptual model

The aquifer which is supplying the Murroe springs is the large area of till-with-gravel in the grounds of Glenstal Abbey. The permeabilities of the subsoils will be variable with the changes in clay content, but from the borehole records in the grounds, the permeable soil cover, and the lack of surface water drainage, it would appear that there is quite a high proportion of high permeability sands and gravels throughout.

It is considered that the large fault running through Cappercullen Glen continues under the till-with-gravel and that it is a high permeability zone; the County Council borehole drilled at Glenstal Lodge in the fault zone had a yield of ~1965 $m^3$/d (18,000 g/hr). The stream running through the upper reaches of the glen flows over the less permeable Old Red Sandstones, where the water table is likely to be relatively close to the surface, until it reaches the gravel deposits in the vicinity of the top lake. From initial observations it would appear that there is less water flowing out of the lake than there is flowing into it and it is likely that this is due to the presence of the gravels overlying the permeable fault at the downstream end of the lake, which will diffuse some of the surface water underground. It is probable that groundwater flow is focused along the buried channel towards Glenstal Lodge. Flow is then further influenced by the boundaries of the permeable deposits, which causes groundwater to be directed towards the springs.

Groundwater levels approximately 50 m downstream of the top lake, at the borehole by the white gate, are significantly lower than the stream. The hydraulic connection between groundwater and the stream is

considered therefore, to be relatively poor in the area of the till-with-gravel (the high permeabilities in the till-with-gravel will keep the water levels low); the springs which occur in the lakes may be a consequence of lenses of less permeable till interrupting the flow regime.

The small stream which used to flow to the north of the springs is likely to be effected by the pumping regime at the springs. The landowner to the north of spring number 6 indicated that several small springs on his land, on the northern side of the stream channel, were also effected when the sixth spring was brought into operation.

### 6.8 Aquifer category

The gravels at Murroe are considered to be a **locally important sand and gravel aquifer**. Till-with-gravel deposits are not usually classed as locally important aquifers, as generally the extent and hydraulic connection between the sand and gravel lenses is not known. In this case however, there is a significant proportion of sand and gravel with a thickness of more than 10 m, and the additional recharge focused into the aquifer via Cappercullen Glen, the deposit is more than capable of sustaining a supply for the local community.

The Old Red Sandstones are classed as a **locally important aquifer** which is **moderately productive only in local zones**.

## 7. VULNERABILITY

Using the GSI vulnerability mapping guidelines, most of the area around the Murroe source is regarded as being **probably highly** vulnerable to contamination, due to the presence of the high permeability till-with-gravel deposits. The water table however, is less than 3 m below surface in the relatively low lying, wet area in the vicinity of the springs and these are mapped as having a **probably extreme** vulnerability. Further up-slope, rock comes close to surface and this area is also designated as having a **probably extreme** vulnerability. The area to the west of the source is of **probably low** vulnerability as the low permeability till deposits are more than 10 m thick. The vulnerability categories are shown in Figure 2.

## 8. DELINEATION OF SOURCE PROTECTION AREAS

Source Protection Areas are delineated for the estimated total spring output (i.e. 560 $m^3/d$).

### 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 zone of contribution for the Murroe springs is primarily controlled by the Cappercullen Glen, the extent of the till-with-gravel deposit, and the likely groundwater flow directions (Fig. 3). The glen acts as a feeder channel which will focus recharge to the aquifer and therefore its catchment area is included in the ZOC. The northern boundary of the zone is delineated using the groundwater divide at the top of the hill and the likely groundwater flow directions from there to the sources.

The boundaries of the ZOC as shown delineate an area which is 2–3 times bigger than that calculated by the Recharge Equation (0.56 $km^2$, equivalent to a circular area of approximate radius 420 m) as being necessary to sustain the spring discharge. The equation however, is based on average conditions. The summer and winter zones of contribution to the Murroe springs are likely to be significantly different as the aquifer is relatively small and the resources are dependent upon recharge; the summer ZOC will be much larger than the winter ZOC. The delineated zone is considered to be larger than the summer ZOC and will therefore incorporate an additional safety margin to allow for uncertainties.

### 8.2 Inner Protection Area

The Inner Protection Area (SI) is the area defined by a 100-day time of travel distance 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 estimate the 100-day time of travel distance to the source. In view of the lack of definitive hydrogeological information however, conservative estimates were used for each of the relevant aquifer coefficients. Taking the permeability as 50 m/d and the hydraulic gradient as 0.004, and assigning a porosity value of 0.07, the 100-day time of travel radius, for the increased pumping rate, is calculated as approximately 285 m (Fig. 3). The radius will only be valid within the ZOC and so the shape of the area is amended accordingly.

### 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), and is designed to maintain good wellhead sanitary protection. The fenced off enclosures around the springs at Murroe, which are owned by the County Council, are designated the Source Site Areas.

## 9. GROUNDWATER PROTECTION SCHEME

Combining the Source Protection Areas, as described above, with the vulnerability ratings, delineates a total of five groundwater source protection zones for the Murroe springs. These are listed here and are shown in Figure 4 (with the exception of the Source Site):

- Source Site / Extreme (SS – E)
- Inner Protection Area / Extreme (SI – E)
- Inner Protection Area / High (SI – H)
- Outer Protection Area / Extreme (SO – E)
- Outer Protection Area / High (SO – H)

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.

## 10. POTENTIAL CONTAMINATION SOURCES

The village is not expected to pose a serious threat to the source as, for the most part, it is located outside the source protection area and there is a sewerage scheme in operation. There is a farmyard located directly across the road from the source and during the last site visit in November 1995, the owner was digging a 3 m pit which may be used for a slatted unit and may therefore pose a significant contamination threat to the springs in the future. The County Council borehole at the Lodge showed evidence of bacterial pollution; the source of this may be the Glenstal farm, but is more likely to be a leaky sewer or poorly located septic tank at the Lodge. Part of Glenstal Abbey and the adjoining school are also located within the ZOC and there may be a number of septic tanks.

## 11. CONCLUSIONS AND RECOMMENDATIONS

Overall the springs at Murroe are a reasonably high yielding group of springs which are being supplied by a till-with-gravel aquifer to the east. The aquifer is receiving additional recharge from a surface water stream running through the Cappercullen glen. Groundwater is highly vulnerable to contamination and this is being highlighted by the currently variable water quality. The main threats are the agricultural practices within the zone of contribution, and possibly any leakage occurring from the septic tanks/sewerage line.

The Council should carefully control and monitor the farm management practices at the farm across the road from the springs, in particular with respect to the new pit which has just been dug out. This may be the source of the occasional high nitrate and chloride occurring in the public supply water which indicate that contamination is occurring at times. In addition, the Council should control and monitor potentially contaminating activities being carried out within the ZOC, in particular at Glenstal. If the Council require more water for the Murroe public supply they should invstigate the source of E. coli in the borehole at Glenstal Lodge and then provided it is local and the problem can be solved, they should drill again along the line of the fault, on the Limerick road.

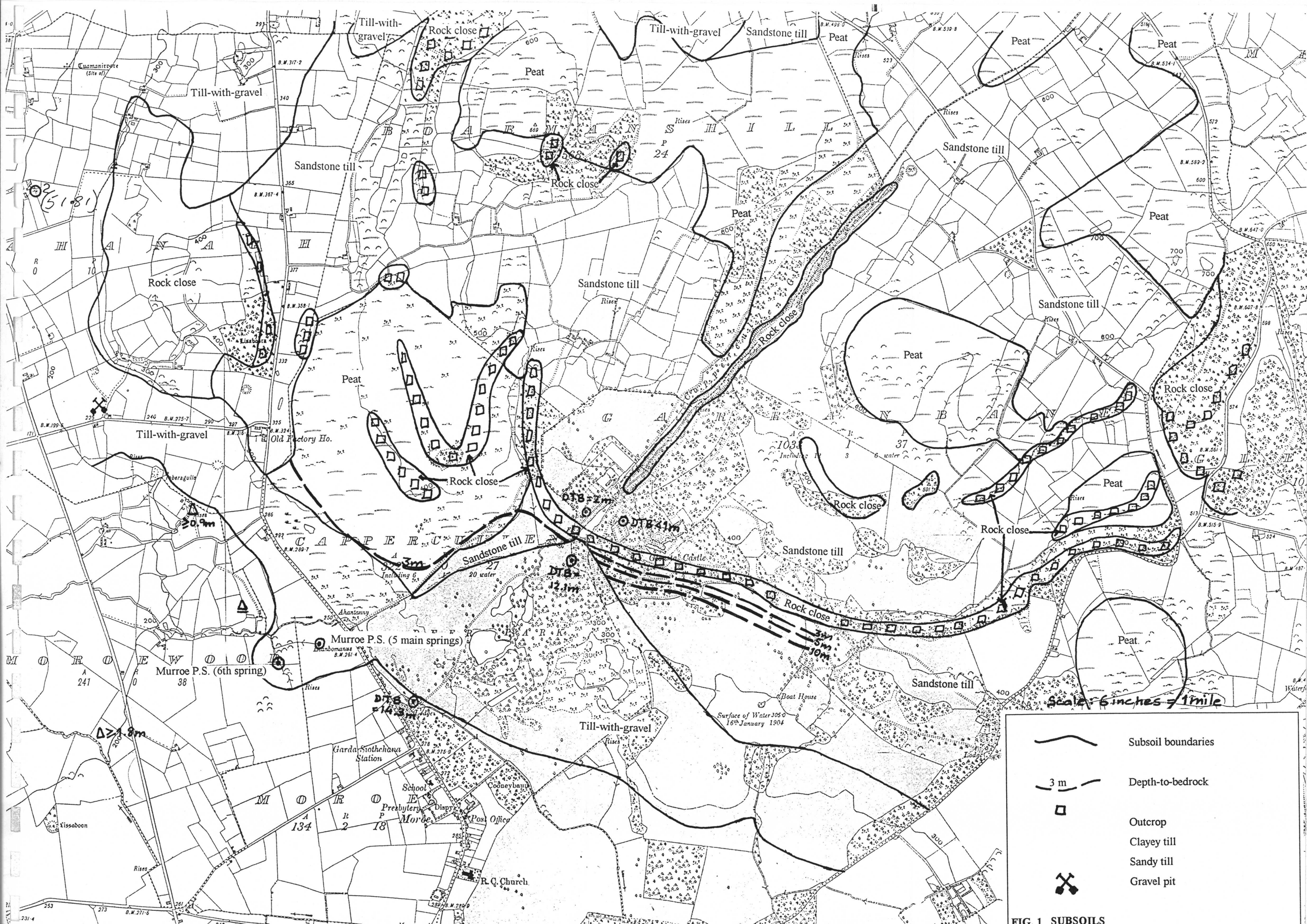



**FIG. 1 SUBSOILS**

Tuamanintrote (Site of)

B.M.317·2

B O A R M A N S H I L L

Rises

Extreme

Old Factory Ho.

Toberagulla

C A P P E R C U L L E N

Glenstal Castle

High

D E E R P A R K

Moderate

Boat House

Surface of Water 305·0
16th January 1904

T O R O E W O O D

Garbomanus B.M.251·4

Garda Siothchana Station

M O R O E

Morbe

School

Presbytery

Dispy

Post Office

Cooneybaun

R.C. Church

Lissadoon

Ahantanny

Lodge

B.M.534·1

B.M.589·2

B.M.647·0

B.M.607·8

B.M.306·7

B.M.371·0

B.M.275·7

B.M.199·6

B.M.358·1

B.M.367·4

B.M.532·8

B.M.498·0

FIG. 2 VULNERABILITY

Scale: 6 inches = 1 mile

SO

SO

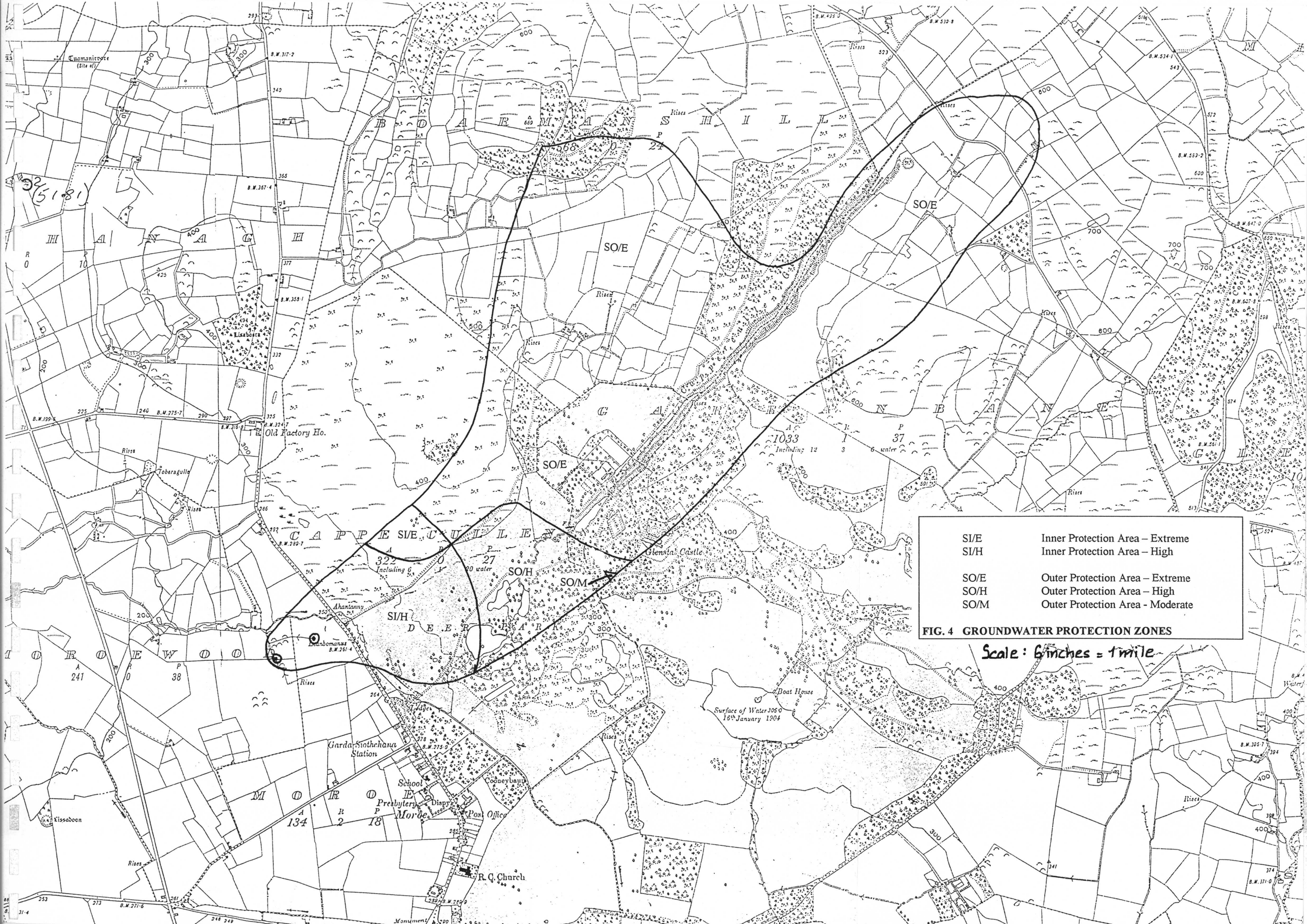
SO

SI

| | |
|---|---|
| SO | Outer Protection Area |
| SI | Inner Protection Area |

**FIG. 3 SOURCE PROTECTION AREAS**

Scale: 6 inches = 1 mile




| | |
|---|---|
| SI/E | Inner Protection Area – Extreme |
| SI/H | Inner Protection Area – High |
| SO/E | Outer Protection Area – Extreme |
| SO/H | Outer Protection Area – High |
| SO/M | Outer Protection Area - Moderate |

**FIG. 4 GROUNDWATER PROTECTION ZONES**