KILCOLEMAN PUBLIC SUPPLY

GROUNDWATER SOURCE PROTECTION ZONES

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1. SUMMARY OF WELL DETAILS

GSI no.	:	1113SEW149	1113SEW039	1113SEW150
Grid ref.	:	13603, 13697	13577, 13664	13574, 13663
Well type	:	Main spring	Second spring	Borehole
Owner	:	Limerick Co. Co.	Limerick Co. Co.	Limerick Co. Co.
Elevation (Poolbeg)	:	56.28 m OD (chamber)	approx. 61 m (chamber)	60.94 m OD (casing)
Depth	:	4.17 m		43 m
Diameter	:	4.8 m		203 mm (8″)
Depth-to-rock	:	~20 m	~27 m	~27 m
Static water level (winter)	:	overflowing		artesian/flowing
Abstraction rate	:			1200 m^3/d (backup)
Average normal consumption	:	1840 m^3/d (all springs and borehole)		2–3 hours in summer
Average spring overflow	:	Variable but none when pumps are in operation		
Total spring output	:	1865–2645 m^3/d (all springs and borehole in summer)		

Borehole pumping test summary:

(i) abstraction rate	: 973 m^3/d
(ii) specific capacity	: 85 m^3/d/m (10 hours)
(iii) transmissivity	: 154 m^2/d [111 – 197 m^2/d]

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 spring flow, water chemistry and construction data available.

The second stage comprised site visits and fieldwork in the surrounding area. A walk-over survey of the surface water catchment area was carried out which enabled an assessment of the bedrock geology, subsoils, hydrogeology and vulnerability to contamination. Two raw water samples were taken for full suites of chemical and bacterial analyses in September 1993 and April 1994.

Stage three, the analytical stage, utilised a water balance, analytical equations and hydrogeological mapping to delineate the catchment area and hence identify the groundwater protection zones.

3. WELL LOCATIONS AND SITE DESCRIPTIONS

The Kilcoleman public supply is primarily a spring system comprising a main spring next to the water works, a second spring located next to a backup borehole across the road, and a third spring (NGR 13583, 13667) between there and the water works. The main spring is a wide diameter shallow well, located to the north of a small east-west trending road on the northerly flank of the Ballingarry ridge, and it is marked on the six inch sheets as Poulalecbaun. It is uncovered but it is situated in a well maintained enclosure which is owned by the County Council. The main spring also has two small suplimentary feeder springs on the same site which are fed into the same collecting chamber. The second spring and the backup borehole are located to the south of the road, further to the west, and are accessed via the driveway of a private property. They are enclosed in a small area which is fenced off and is owned by the County Council. The spring is covered in a collecting chamber and feeds into the water works by gravity feed. The overflow from the backup borehole is also collected in this chamber. The third spring is smaller and is enclosed in a chamber in a fenced off area which is owned by the County Council. There is a fourth spring located to the south-southwest of the others, which is marked on the six inch sheets as Poulnagorm, and although it is piped to the public supply it is not currently used. The Kilcoleman system is linked to the source at Clouncagh and together they provide the water supply for Rathkeale.

4. TOPOGRAPHY, SURFACE HYDROLOGY AND LAND USE

The Kilcoleman spring system is located on the northerly flank of the ENE-WSW trending Ballingarry ridge, at an elevation of approximately 56–61 m OD (~200 ft). The hills rise steeply to a height of 148 m to the south of the sites, while to the north, the land surface is relatively flat, extending out towards north Limerick (Fig. 1).

The drainage in the area is variable with topography. In the higher regions, above the 200 ft contour level, there are no surface streams and the land is very well drained. Moving northwards onto the lower lying flatter areas, surface streams are abundant and the overall drainage is generally poor. The streams drain in a northwesterly direction into the River Deel which flows northwards to the Shannon Estuary.

The land is primarily used for grazing and there are a number of small gravel pits and quarries on the higher areas.

5. GEOLOGY

5.1 Bedrock geology

The bedrock in the area comprises three main rock types: sandstones, shales and limestones. The hills to the south of the sites are composed of the coarse white to yellow sandstones of the Kiltorcan Sandstone which outcrop in places with thin red and purple shales. Further downslope towards the sources, the rock type changes to the thinly interbedded sandstones, shales and muddy limestones of the overlying Mellon House Beds, the Ringmoylan Shales and the Ballymartin shaly limestones (collectively mapped out here as the Lower Limestone shale). The flatter areas to the north of the sources comprise the youngest rocks of the area, the Ballysteen muddy limestones. Elsewhere across the county the Ballysteen limestones have a cleaner series of limestones at the base of the formation and these may also be present here.

The main dip of the beds is in a northerly direction at an average angle of approximately 10°. A large NNE–SSW fault runs right across the area in the region of the springs and there is likely to be some associated fracturing. Some minor folding has also occurred.

5.2 Subsoils (Quaternary) geology

The subsoils in the area comprise primarily limestone tills, with some sands and gravels (see Fig. 1). The tills are present over most of the area, with exception of the higher parts of the hills where rock is close to surface and some areas just north of the ridge where there are sand and gravel deposits present. Sections in the deposits in the drier areas south of the 200 ft contour suggest that they are of a sandy composition with little clay. Moving north of this line where the drainage becomes poorer, the tills appear more clayey and less permeable than in the higher regions.

The subsoils can be interpreted as part of a dead ice environment which would have been present as the ice was retreating in a northerly direction. In this environment at the ice margin, the chaotic loose sandy deposits interspersed with the tills would have been laid down. The area is mapped as primarily till but the deposits are relatively thick (refer to next section), and it is quite possible that there is a greater extent of gravels present than the map would suggest. A borehole record for example to the northeast of the Main Spring indicates that beneath 1.5 m of till there is a 14 m thick sand and gravel deposit.

5.3 Soils

The soils which lie to the north of the 200 ft contour, and which are present over most of the area, are the poorly drained gleys of the Howardstown Series. Soils of the Elton grey-brown podzolics are common in the hilly areas and these are generally well to moderately well drained. Both of these soil types are derived from glacial deposits of limestone, sandstone and shale composition. On the higher regions of the ridge, the soils present are the podzols of the Knockaceol and Doonglara Series which are both derived in areas where rock is close to surface or where there is a thin cover of slope deposits. The soils are well leached and are derived in areas of high rainfall or where there is an acidic parent material, e.g. sandstones. These soils may also have iron pans present at depth. To the west of the ridge the final series of soils present are those of the Slievereagh lithosols, which are derived in areas where rock is at surface. The soils in this area correspond well to the subsoils mapped in the area and are shown on the published soils map of Co. Limerick (Finch and Ryan, 1966).

5.4 Depth-to-rock

Outcrop on the ridge indicates that rock is close to surface in the upland areas on the hill slopes (Fig. 1). The subsoils are thicker to the north of the hills, reaching approximately 25 m thick to the northeast of the Main Spring (taken from borehole records). Depth-to-bedrock in the immediate vicinity of the Main Spring is not known, although it is estimated that it may be as much as 20 m based on nearby borehole records at the same topographic height. A thickness of 27 m of subsoils is recorded in the public supply backup borehole. It may be assumed therefore, that there is a substantial thickness of subsoils to the north of the ridge which is typical in ice marginal areas where extensive deposition takes place. 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 hydrogeological data for the Kilcoleman area were used in considering the conceptual model:

- The source caretaker’s notebook.
- GSI well records.
- GSI mineral exploration reports for the area.
- A well survey carried out in the summer of 1994, as part of the study.
- Results of a 10 hour drawdown test with two full recovery tests (one before and one after the drawdown test) which were carried out as part of the study on the back-up borehole in July 1993.

6.2 Spring discharge

Discharge values for the springs are estimated using average monthly abstraction figures for 1993 and the average time pumped per day (20.26 hours) over the year. Council staff have indicated that while the pumps are on there is no overflow from the springs at any time of the year. Overflow when the pumps are off during the winter period however, is substantially greater than that during the summer. In addition, during the summer months the springs are supplmented by the borehole for a few hours each day.

It is assumed therefore, for the purposes of calculating the total annual discharge from the aquifer, that during the summer period (taken as 6 months), the total quantity of water discharging at the spring is the amount abstracted for public supply (1865 m^3/d). This is based on the fact that the borehole is required to abstract water from storage during dry weather. During the winter period (6 months), the spring discharge is higher, the total amount required to meet the demand is obtainable in a shorter time, and the springs will then overflow for the remainder. Based on the total number of hours pumped during the year (data from the Council), the required supply is abstracted in 16.5 hours in the winter period and the total discharge over a 24 hour period is therefore approximately 2645 m^3/d. The average annual total discharge of the springs is therefore approximately 2250 m^3/d.

Pumping the back-up borehole reduces the discharge at the springs, showing that that they are in hydraulic continuity.

6.3 Groundwater levels

Groundwater levels in the higher part of the area are generally close to surface (usually less than 3 m below ground level). In the vicinity of the springs, the groundwater in the Kiltorcan Sandstone is under artesian pressure and the potentiometric surface (an imaginary surface whose height above the aquifer depends on the pressure in the aquifer) is above ground level except in the vicinity of the springs, where it is drawn down to ground level. Consequently, some of the boreholes in the area, including the public supply backup, are recorded as overflowing.

6.4 Groundwater flow directions and gradients

Groundwater flow direction follows topography, flowing down-slope in a northerly direction from a groundwater divide at the top of the ridge. The groundwater gradient is estimated to be in the range 0.03–0.04; this is steeper than expected in this rock unit, however it probably results from the drawdown effect of the springs.

6.5 Meteorology and recharge

Rainfall data for the area are taken from the nearest, most representative weather station which is located in Kilmeedy. Mean annual rainfall, as recorded by the Meteorological Service, for the years 1941–1980 was 976 mm. Long-term potential evapotranspiration (P.E.) is estimated from a regional Meteorological Service contoured map, and a ranking scheme with all the other sources, as 500 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 effective rainfall (E.R.) is taken to be approximately 425 mm for 1993.

The subsoil deposits, where present, are highly permeable in the higher parts of the ridge, i.e. south of the 200 ft contour, and there is a marked absence of surface streams. A high proportion of the effective rainfall must therefore be infiltrating to the water table in these regions, probably in the region of 90%. In the lower areas where the aquifer is overlain by lower permeabilty rocks (refer to section 6.8), the subsoils are much thicker and there is an abundance of surface water courses, it is likely that a much lower percentage (approx. 10%) infiltrates. Recharge to the aquifer therefore is taken to be 51 mm/a in the low lying regions and 460 mm/a in the higher areas.

These calculations are summarised below:

Annual rainfall	976 mm
Estimated P.E.	500 mm
Estimated A.E. (93% P.E.)	465 mm
Effective rainfall	511 mm
Recharge (10 and 90% E.R.)	~51 and 460 mm

6.6 Hydrochemistry and water quality

The hydrochemical analyses of groundwater at the Kilcoleman sources are indicative of a **moderately hard** to **hard** water (244–292 mg/l; $CaCO_3$), with moderate alkalinity (224–261 mg/l; $CaCO_3$). The conductivities are variable although generally range from 500–700 μS/cm. In Co. Limerick, these values are typical of sandstone groundwaters which have a carbonate influence. This is often attributable to the overlying limestone rich subsoils, through which recharge infiltrates.

The routine analyses carried out by the Council for the purposes of the EC regulations are of limited use in assessing the water quality of the Kilcoleman supply, as the samples are taken from private residences in Rathkeale, and the town supply includes water taken from the Clouncagh source. From the two full analyses taken for the project, it would appear that the water quality is generally quite good, with low nitrate and chloride. *E. coli.* was present in one of the samples, but as a count of just 2/100 ml was obtained, and the Main Spring is not covered, this may be a very localised contamination source caused in the vicinity of the open well. The combined analyses for the Rathkeale supply however, have shown *E. coli* as high as ≥100, conductivities of 1264 μS/cm and chloride as high as 40 mg/l. Note that the Poulnagorm spring is no longer used as a consequence of the presence of *E. coli*.

6.7 Aquifer coefficients

The pumping test on the borehole provided transmissivities in the range 111–197 m^2/d with 154 m^2/d being the best estimate. Recovery to the top of the casing, following 16.5 hours pumping and with 12.7 m drawdown, took place in just over 15 minutes; this suggests that the potentiometric surface is several metres above ground level. The test graphs were fairly uniform and are not indicative of any major recharge or barrier boundaries. The specific capacity is in the region of 77 m^3/d/m.

6.8 Conceptual model

The Kiltorcan Sandstone, augmented by the Mellon House Beds, is considered to be the source of water for the Kilcoleman public supply. Recharge occurs mainly in the upland areas to the south, where the subsoil is thin and free-draining. Groundwater in the sandstone flows northwards and becomes confined beneath, initially, the till and then further northwards under the Ringmoylan Shales and the Ballymartin shaly limestones.

Artesian overflow from the bored well and the springs themselves indicate that the potentiometric surface (an imaginary surface whose height above the aquifer depends on the pressure in the aquifer) is above ground level.

It is probable that there are some localised flows to the springs in gravelly lenses/layers in the till. Also, permeable zones must be present in the till beneath the springs to enable groundwater to flow from the Kiltorcan Sandstone and the Mellon House Beds to the surface. The outlet for artesian groundwater provided by the springs are having the effect of drawing water from the areas to the south-east and the south-west as well as the south.

As the NNE-SSW fault is likely to be a high permeability zone, may have a significant impact on groundwater flow in the area: i) by drawing water from the area surrounding the fault; ii) by providing a permeable route towards the springs (the main spring is located above the fault zone); iii) by providing a vertical route for groundwater in the Kiltorcan Sandstone to flow upwards through the low permeability Ringmoylan Shales and Ballymartin shaly limestones to the main spring. The width of this zone is not known.

6.9 Aquifer category

The Kiltorcan Sandstone is classed as a **regionally important aquifer** which is dominated by **fissure flow**. The Mellon House beds and the Ballysteen Limestones are considered to be **locally important / generally moderately productive only in local zones**, while the Ballymartin Muddy Limestones are **poor / generally unproductive except for local zones** and the Ringmoylan Shales are **poor / generally unproductive**.

7. VULNERABILITY

Using the GSI vulnerability mapping guidelines, the groundwater in the low-lying area south of the 200 ft contour is considered to be of **low vulnerability** as there is a thick cover of relatively low permeabilty subsoils. North of this line the subsoil cover thins and the matrix becomes more sandy, and consequently, this area is mapped as having a **high vulnerability**. Rock crops out towards the top of the ridge to give an area of **extreme vulnerability**. The vulnerability categories are shown in Figure 3.

8. DELINEATION OF SOURCE PROTECTION AREAS

The Source Protection Areas are delineated for the total groundwater abstraction at Kilcoleman, i.e. all springs currently in operation and the borehole.

8.1 Outer Protection Area

The Outer Protection Area (SO) includes the complete catchment area to the supply, 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 ZOC is controlled primarily by the groundwater divide at the top of the hill, beyond which groundwater will flow in the opposite direction. The eastern and western boundaries are more tentative and are based on the likely groundwater flow direction and the size given by the Recharge Equation. The zone is widened to the west of the spring to incorporate the area which is likely to be influenced by the permeable fault zone. The Recharge

Equation estimates that the area required to collect enough recharge to sustain the discharge at the springs and the borehole, on an annual basis, is in the region of 2.1 km^2. This is equivalent to a circular area of approximate radius 800 m. The area delineated is slightly larger than this and will therefore incorporate an additional safety margin.

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. Taking the permeability (k) as 4.0 m/d and a hydraulic gradient (i) as 0.035, and assigning a porosity (η) value of 0.025, the 100-day time of travel distance is calculated as approximately 560 m (Fig. 4). This distance will be greater in the vicinity of the fault, as the permeability is higher in the fault zone. Arbitrary boundaries to take account of this are delineated by increasing the distance along the fault to 660 m and taking a width of 100 m each side of the fault (Fig. 4).

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 which are owned by the County Council, are designated the Source Site Areas, although in the case of the borehole and the 2nd spring the area is too small.

9. GROUNDWATER PROTECTION SCHEME

Combining the Source Protection Areas, as described above, with the vulnerability ratings, delineates a total of seven groundwater source protection zones for the Kilcoleman source. These are listed here and are shown in Figure 5 (with the exception of the Source Site):

- Source Site / Low (SS – L)
- 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.

10. POTENTIAL POLLUTION SOURCES

The current primary threats to the public supply at Kilcoleman are the farms to the south of the source within the zone of contribution, in particular to the immediate southeast of the main spring, and on the higher areas where the subsoil cover is both thin and permeable. In addition, the enclosure around the borehole and 2nd spring is quite small and in wet weather surface runoff, contaminated by cattle faeces, is present around the fence. The spring is reasonably well sealed in a collection chamber but the borehole may be at risk.

11. CONCLUSIONS AND RECOMMENDATIONS

Overall the public supply at Kilcoleman is a high yielding group of springs and supplementary borehole. The springs are considered to be situated in a low vulnerability area but as they are surrounded by low permeability subsoils, overland surface runoff may be causing the sporadic problems with bacterial contamination. (It is considered unlikely that the contamination is coming from the Clouncagh supply as it is very well protected with low permeability bedrock and thick subsoil cover overlying the aquifer – refer to Section 6.6.) Further comprehensive analyses on the Kilcoleman supply alone should be carried out to help in assessing the contamination problem.

They main spring and the borehole should be properly covered and sealed to minimise bacterial contamination by overland flow. It is recommended that the Council control and monitor potentially polluting activities being carried out in the lowlying area in the vicinity of the springs, in particular at the farm immediately to the southeast of the main spring. The Council should consider purchasing a larger area around the borehole and 2nd spring, and surrounding the enclosure with a wall rather than a fence as walls appear to be less appealing to cattle.

FIG. 1 GEOLOGY

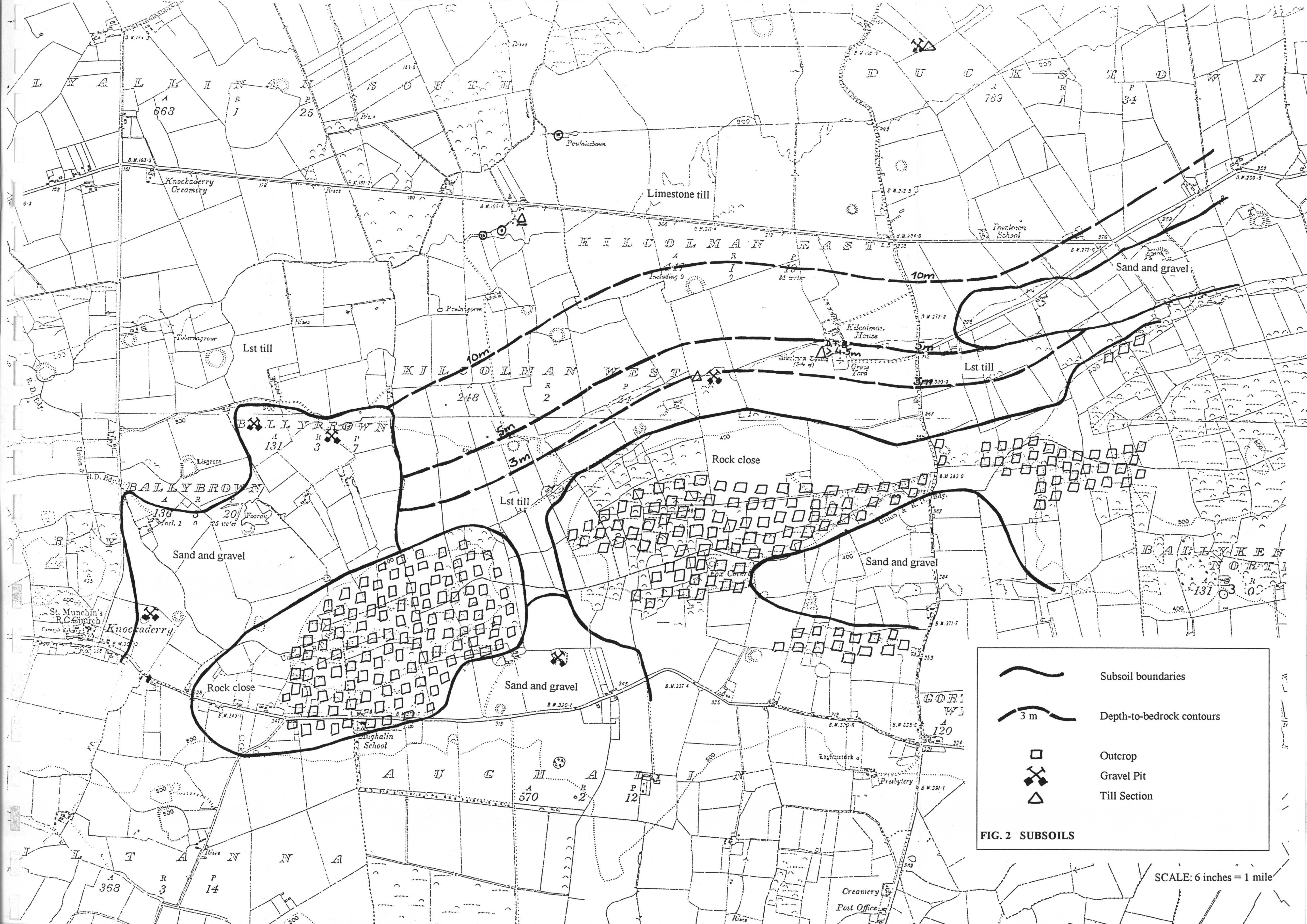

FIG. 2 SUBSOILS

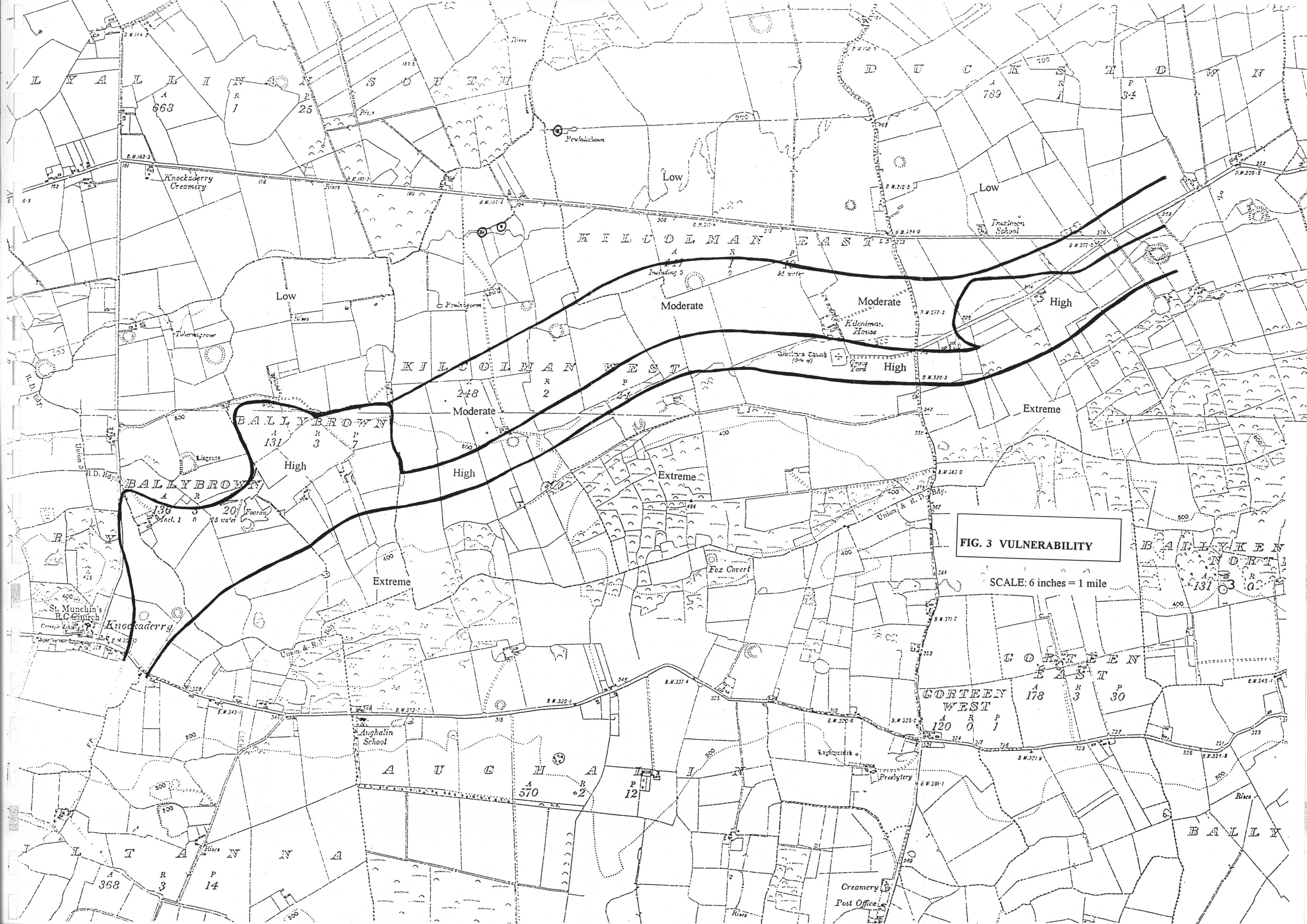

FIG. 3 VULNERABILITY

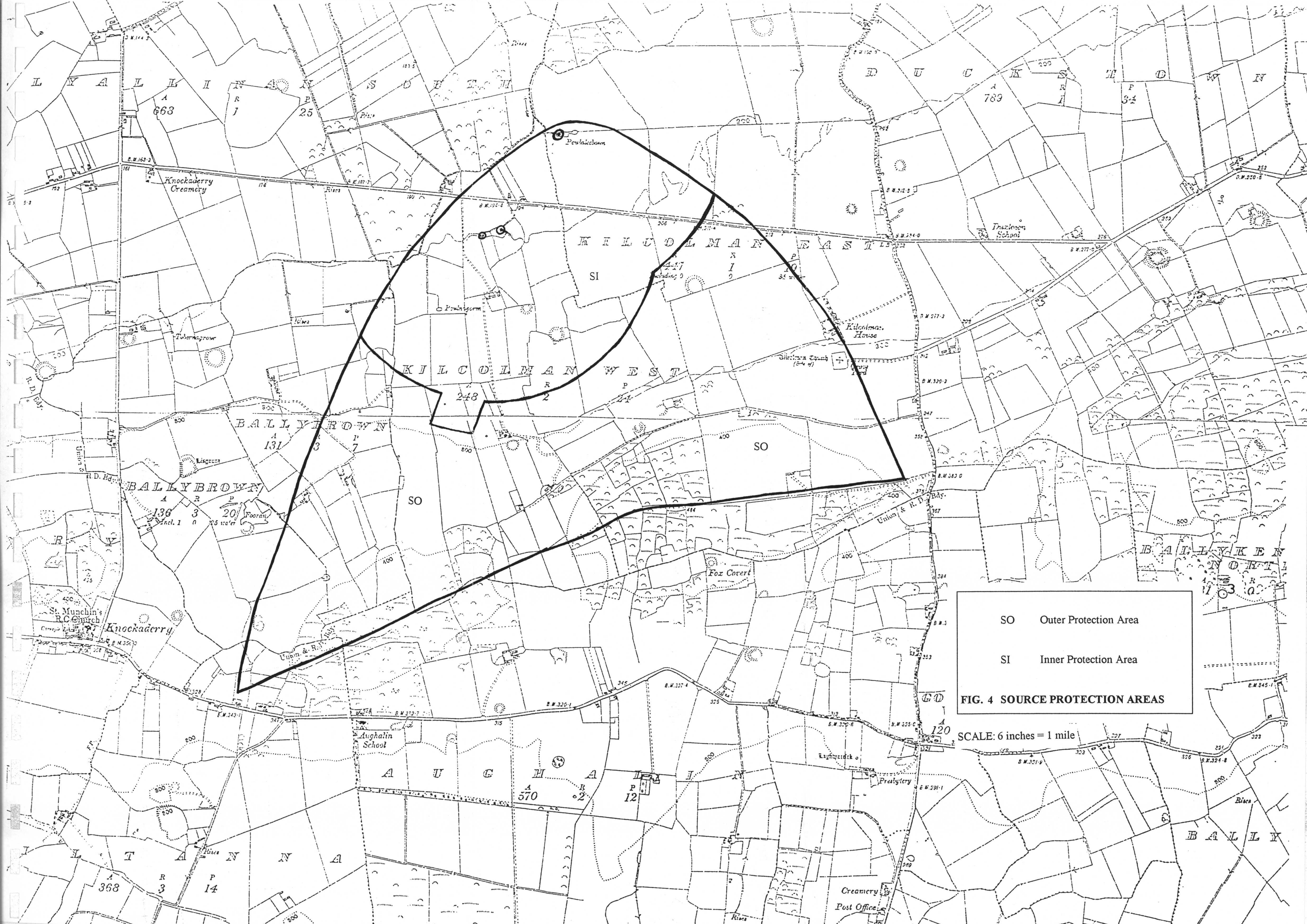

FIG. 4 SOURCE PROTECTION AREAS

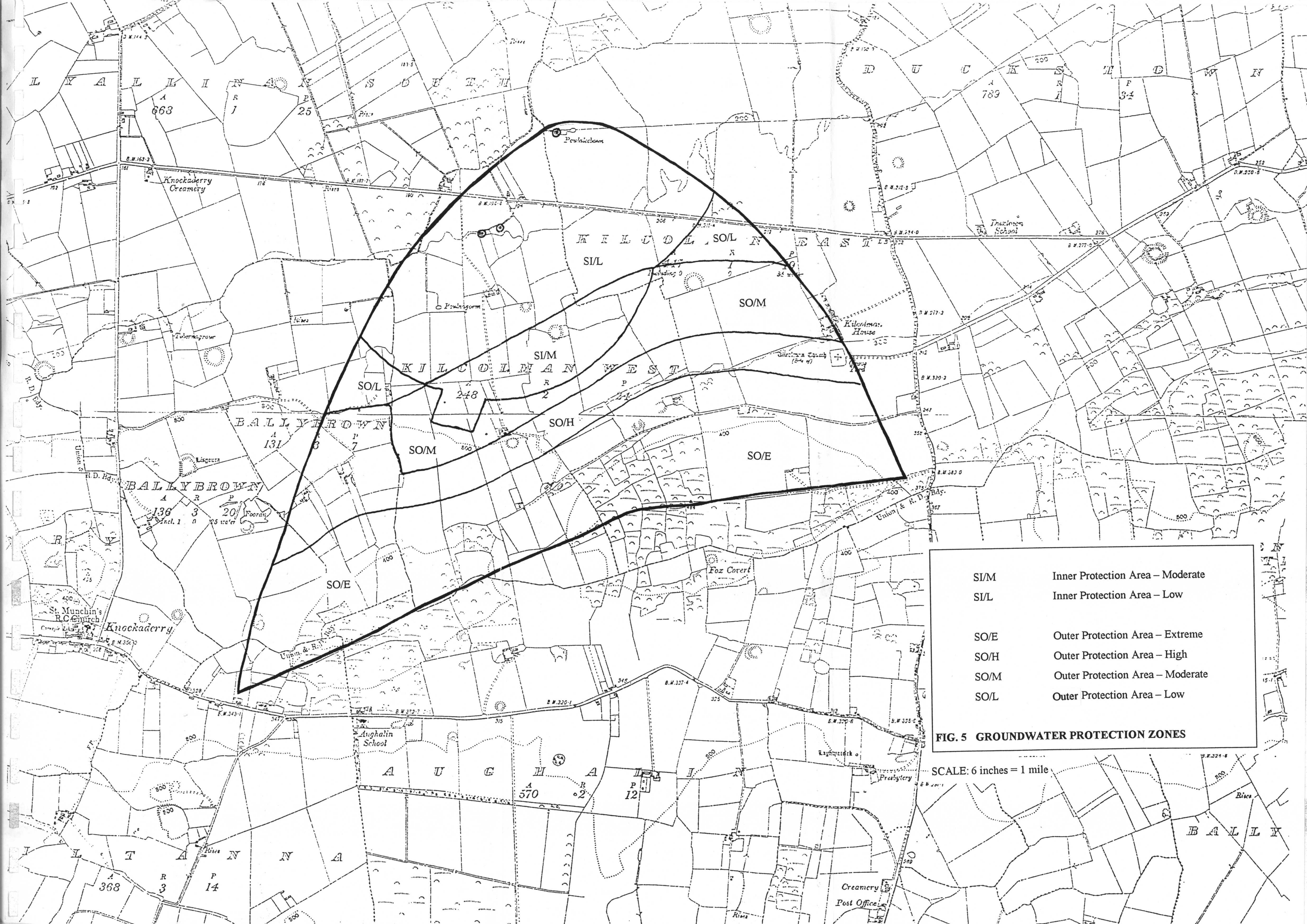

FIG. 5 GROUNDWATER PROTECTION ZONES