HERBERSTOWN PUBLIC SUPPLY

GROUNDWATER SOURCE PROTECTION ZONES

Jenny Deakin
Groundwater Section
Geological Survey of Ireland

December 1995

HERBERTSTOWN PUBLIC SUPPLY

1. SUMMARY OF WELL DETAILS

GSI no.	:	1413NEW138
Grid ref.	:	16819, 14087
Owner	:	Limerick Co. Co.
Well type	:	Bore
Elevation (top of casing)	:	95.21 m OD (Poolbeg).
Depth	:	66.4 m
Depth of casing	:	27 m ?
Diameter	:	200 mm (8")
Depth-to-rock	:	<1 m
Static water level	:	14.5 m b.g.l.
Pumping water level	:	17.6 m b.g.l. (after 10 hrs continuous pumping)
Drawdown	:	3.1 m
Abstraction rate	:	288 m^3/d (2,640 gal/hr)
Normal consumption	:	273 m^3/d (60,000 gal/d on average, over ~23 hrs)
Specific capacity	:	83 m^3/d/m (extrapolated to 1 week)

Pumping test summary:

(i) abstraction rate	: 306 m^3/d
(ii) specific capacity	: 99 m^3/d/m (10 hours)
(iii) transmissivity	: 100 m^2/d [74–117 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 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, including a pumping test which was carried out on the public supply well to examine the aquifer characteristics. The area encompassing a 1 km radius around the source was also mapped with regard to subsoil and bedrock geology, hydrogeology and vulnerability to contamination.

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

3. WELL LOCATION AND SITE DESCRIPTION

The well is located at the southern end of the village, directly opposite the Co-op shop and stores. It is set back from the road and lies within a roofed, concrete pumphouse which has a well maintained, fenced off enclosure. The casing rises above ground level which helps to reduce direct access to potential contaminants.

4. TOPOGRAPHY, SURFACE HYDROLOGY AND LAND USE

The well lies at 95.21 m OD on a slight ridge between the Camoge River to the west and a smaller stream to the east, both of which flow in a northerly direction. The highest point on the ridge is the hill to the north (113 m OD) where the reservoir is situated, while to the south a smaller hill reaches 107.6 m OD. On a regional basis the ground is hummocky at around the 91.4 m OD (300 ft) contour mark.

Surface drainage is relatively good in the vicinity of the borehole and the ridge, despite the occasional ponding occurring in fields. Drainage ditches are only evident to the east and west of the source in the lower lying areas around the river and stream. A small spring lies to the west of the source from where it flows northwards and westwards towards the Camoge River. There is also a large marshy low lying area to the southeast, which drains into the northerly flowing stream.

Excluding the village and its immediate surround, the land in the area is primarily used for grazing. The field in which the well is located is currently used for cattle grazing and they have worn away the grass around the fence. The old creamery buildings to the north of the village are now used for a chlorine manufacturing plant.

5. GEOLOGY

5.1 Bedrock geology

The area has been mapped in detail by a number of geologists and as there is good bedrock exposure (Fig. 1) there is a high level of confidence inherent in the geology map. Herbertstown village lies within an east-west trending band of intermediate felsic volcanic rocks, which are the oldest volcanics cropping out in the Limerick Syncline. The rocks comprise purple-grey, brown-grey and grey lavas, tuffs and volcaniclastics. To the south, the underlying typically blue-grey, massive Waulsortian bank limestones crop out. The upper beds of these limestones are more cherty than the typical bank limestones and they have been mapped out separately by some geologists as a separate formation; they are referred to here as the Lough Gur cherty limestones. The rocks to the north of the volcanics, known as the Herbertstown Limestones, are younger, and are oolitic shelf limestones with some shale and chert in places. The sequence is orientated east-west and dips to the north at 5–45°. A NNE-SSW fault trends through the small stream valley to the east of the source and there may be associated fracture sets with it. Jointing is common, predominantly vertical, in a north-south trend while there is also a weaker east-west subvertical set.

Based on the depth of the well and simple trigonometry it would appear that the well only penetrates the volcanic sequence. The area is faulted and fractured however, and there may therefore be limestones either faulted in or interbedded with the volcanics at depth.

5.2 Subsoils (Quaternary) geology

The subsoils in the immediate vicinity of the source are predominantly limestone tills although there are also areas of alluvium alongside the surface water courses (Fig. 2). The alluvial deposits are expected to be composed largely of fine silts, judging by the overlying soils (refer to next section). The tills are mainly clayey; a section to the north of the site in a quarry face showed a silty clayey dark brown deposit with very angular stones. The higher areas generally have rock close to the surface with thin limestone tills in places.

5.3 Soils

There are three main soil types in the area. The dominant soils are from one of the more common series in Limerick, the Elton grey-brown podzolics, which are derived from a parent material of glacial drift origin, mainly limestone with some shale, sandstone and volcanics. To the south of the source, the soils from the Derk brown earths series are present which are derived from a glacial drift of predominantly volcanic origin. Both soil types are fairly free draining. The third group of soils present, the Camoge Series, are found to the north overlying the alluvium and these are normally derived from fine textured alluvial deposits. 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

Subsoil cover over most of the area is thin at less than 1 m and there is a good deal of outcrop exposed. Bedrock is evident in the bed of the small stream to the east while to the west of the source the limestone tills thicken moving towards the Camoge River. Depth-to-bedrock in the public supply source is 0.9 m below ground level. The depth-to-rock has been contoured for ease of incorporation into the vulnerability map but it is based on few data points and the regional scale map, and may need refining as further borehole records become available (Fig. 2).

6. HYDROGEOLOGY

6.1 Data availability

Hydrogeological data for the Herbertstown area are generally lacking with the exception of a 10 hour drawdown test with nearly five hours recovery, which was carried out in August 1993. There are also figures taken in June 1995 for the height of water above sea level in the river and stream, and a riverbed section from the Office of Public Works. The general principles of groundwater flow are applied.

6.2 Groundwater levels

The groundwater level taken in the public supply well on 12/8/93, following overnight recovery, was 14.49 m b.g.l. (80.72 m OD). The static water level when the borehole was drilled in 1972 was 12.5 m b.g.l. (82.71 m OD). The height of water in the river taken at Cloghansoun Bridge on 29/6/95 was 69.83 m OD, while that taken at the bridge over the small stream to the east of the source on the same date was 81.32 m OD.

The unsaturated zone in the region of the ridge is therefore likely to be more than 15 m thick becoming thinner moving towards the surface water courses to the east and west.

6.3 Groundwater flow directions and gradients

Taking the higher static water level in the public supply borehole, i.e. when it was initially drilled, gives a gradient of 0.0015 in an easterly direction towards the stream, and a steeper gradient of 0.022 towards the river to the west. However, if the lower static water level from 1993 is considered, groundwater flow direction would appear to be from east to west with a gradient of 0.008.

6.4 Meteorology and recharge

Rainfall data for the area are taken from the nearest weather station at Hospital which is similar to Herbertstown in terms of topography, height above sea level and distance from the coast. Mean annual rainfall, as recorded by the Meteorological Service for the years 1951–1980, was 920 mm. Potential evapotranspiration (P.E.) is estimated from a regional Meteorological Service contoured map and a ranking scheme with all the other sources as 480 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 475 mm per annum.

Although the clayey tills and fine textured alluvial deposits are of relatively low permeability, in the immediate vicinity of the supply they are generally thin or absent and there are no drainage ditches or streams. A high proportion of the effective rainfall therefore infiltrates to the water table. Estimating run off to be of the order of 15%, recharge to the aquifer is taken to be 425 mm per annum.

These calculations are summarised below:

Average annual rainfall	920 mm
Estimated P.E.	480 mm
Estimated A.E. (93% P.E.)	446 mm
Effective rainfall	~475 mm
Recharge (85% E.R.)	~405 mm

6.5 Hydrochemistry and water quality

Comprehensive hydrochemical analyses of groundwater at the source in Herbertstown are lacking as it was not incorporated in the project sampling programme and the County Council monitoring regime does not include the major anions and cations. Conductivities are relatively high, normally ranging between 500 and 650 μS/cm, which would suggest an influence by carbonate dissolution processes. This may however, be an influence of either the limestone dominated subsoil cover or perhaps limestone bedrock, or may be a consequence of the water quality. More comprehensive hydrochemical analyses would have assisted in the assessment.

Groundwater quality in the Herbertstown Source is often poor and the source has been contaminated on a number of occasions when samples have been taken. Nitrate is the indicator parameter with concentrations ranging from 44 to 59 mg/l (as NO_3; *n*=5). Chloride is also relatively high, reaching 36 mg/l in one of the two samples analysed by the County Council between 1991 and 1993 inclusive. This is significantly higher than background levels and is also suggestive of contamination occurring at times. There are no total or faecal coliforms recorded but the samples taken were from the consumers tap and the water was therefore chlorinated.

6.6 Aquifer characteristics

The pumping test analyses provided transmissivities ranging from 74–117 m^2/d with 100 m^2/d being the best estimate. The shapes of the graphs did not indicate any major recharge or barrier boundaries (Fig. 3). A 10 hour specific capacity of 99 m^3/d/m was calculated, while the long-term value is estimated at 83 m^3/d/m.

The fracturing and jointing in the area may provide high transmissivity zones in a north-south direction.

6.7 Conceptual model

The aquifer feeding the Herbertstown source is the volcanic rocks; it is not clear whether the lavas or the tuffs are the dominant source of groundwater as they are interbedded. There is also a possibility that there may be interbedded limestones at depth or that limestones have been faulted into place in the vicinity of the borehole. From the surface geology there is no evidence for this but this possibility should not be dismissed as the electrical conductivity analyses suggest a hard water which has been influenced by carbonate dissolution (refer to Section 6.5). The aquifer is generally overlain by thin, if any, deposits and it is considered to be unconfined.

It is assumed that both the stream and the river are in hydraulic continuity with the water table as neither run dry in the summer months and the small stream has also exposed outcropping bedrock. It is likely, based on the static water levels in the public supply borehole, that at least for most of the year, there is a groundwater mound present in the region of the ridge with flow moving in all directions away from it. The borehole is located close to the high point of the mound but the location of the latter will vary depending upon seasonal climatic conditions and the pumping regime. It is possible that during dry years the mound is absent and groundwater flow is from east to west.

6.8 Aquifer category

Considering these volcanic rocks in terms of well yields, specific capacities, lithology and structure over the county, they are classed as a **locally important aquifer** which is **generally moderately productive**.

7. VULNERABILITY

Using the GSI vulnerability mapping guidelines, the source at Herbertstown is regarded as being extremely vulnerable to pollution. There are a number of areas where rock crops out at surface and these are mapped as having **extreme** vulnerability. Areas where rock is less than 3 m below surface are mapped as having a **probably extreme** vulnerability and most of the area in question falls into this category. The 3 m contours are based on the general trends across the county as there are few locally available data points, and they infer the presence of two small areas of high vulnerability to the north and west of the source which are not likely to be of consequence in the Zone of Contribution. The vulnerability categories are shown in Figure 4.

8. DELINEATION OF SOURCE PROTECTION AREAS

Source protection areas are delineated for a 50% higher output (410 m^3/d) than is currently abstracted, to facilitate an increase in demand and to allow for non-average conditions.

8.1 Outer Protection Area

The Outer Protection Area (SO) is delineated as the area within which all groundwater may reach the well, also known as the zone of contribution, and it is designed to protect the source from chemical and trace organic pollution. As the borehole is located near the high point of a groundwater mound, groundwater will be drawn into it from all sides during pumping. The most practical zone of contribution at Herbertstown is therefore a circular area. The size of the zone of contribution is then based on the Recharge Equation. The area required to collect enough recharge, at the rate of 405 mm/a, to sustain the increased discharge at the source on an annual basis, is estimated to be 0.37 km^2, or a circular area of radius 345 m (Fig. 5).

8.2 Inner Protection Area

The Inner Protection Area (SI) is the area within which it will take groundwater 100 days or less to reach the pumping well and it is intended to protect the source from bacterial pollution. The Volumetric Flow Equation was felt to be most useful in this instance as the presence of the groundwater mound means that a method requiring a gradient would be unsuitable. Taking the aquifer thickness as approximately 52 m, i.e. the saturated thickness in the borehole, and assigning a porosity value of 0.02, the 100 day time of travel radius, for the increased pumping rate, is calculated as approximately 112 m (Fig. 5).

8.3 Source Site

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

The Source Protection Areas are in effect, inclusive of buffer zones in order to remain with a conservative stance; the areas for the current pumping regime are likely to be smaller.

9. GROUNDWATER PROTECTION SCHEME

Combining the Source Protection Areas, as described above, with the vulnerability ratings, delineates a total of four groundwater source protection zones for the Herbertstown source. 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 (SS/E)
- Inner Protection Area / Extreme (SI/E)
- 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. Suffice it to say that the area falls primarily into the **Locally Important aquifers** which are **generally moderately productive**, and with a vulnerability rating of mainly extreme to high, it will encompass two main protection zones: Lm/E and Lm/H.

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

The current primary threat to the public supply at Herbertstown is the village itself as there is no sewerage scheme and there is therefore a concentration of septic tanks in a small area adjacent to the source. Cattle in the adjoining field also tend to gather round the County Council enclosure to scratch on the barbed wire fence, thus causing a potential risk of bacterial pollution from their faeces. In addition there is a fertiliser storage facility across the road from the supply. One or more of these may be the cause of the high nitrate and the elevated chloride concentrations.

11. CONCLUSIONS AND RECOMMENDATIONS

Overall the source at Herbertstown is a moderate yielding well which would have good potential for further development as far as available resources are concerned. The source is however, extremely vulnerable to pollution as rock is close to surface and there are numerous places where bedrock crops out. There are a number of sources of pollution within the zone of contribution to the well and this, with the extreme vulnerability, is reflected in the water quality. The water analyses show exceedances of the nitrate MAC, and chloride, when measured, is also significantly higher than background levels suggesting that contamination is occurring at times. The causes of this may be either the septic tanks in the village, the fertiliser storage facility across the road, or both.

The Council should consider installing a sewerage scheme in Herbertstown to remove the possibility of contamination by septic tank effluent. Full detailed chemical and bacteriological analyses should be carried out on the raw water from the source as these would be helpful in assessing the water quality problem. In the future, the Council should consider maintaining stone walls around source enclosures instead of fences, as they appear to be less appealing to cattle, hence avoiding unnecessary risks of bacterial pollution.

FIG. 1 GEOLOGY

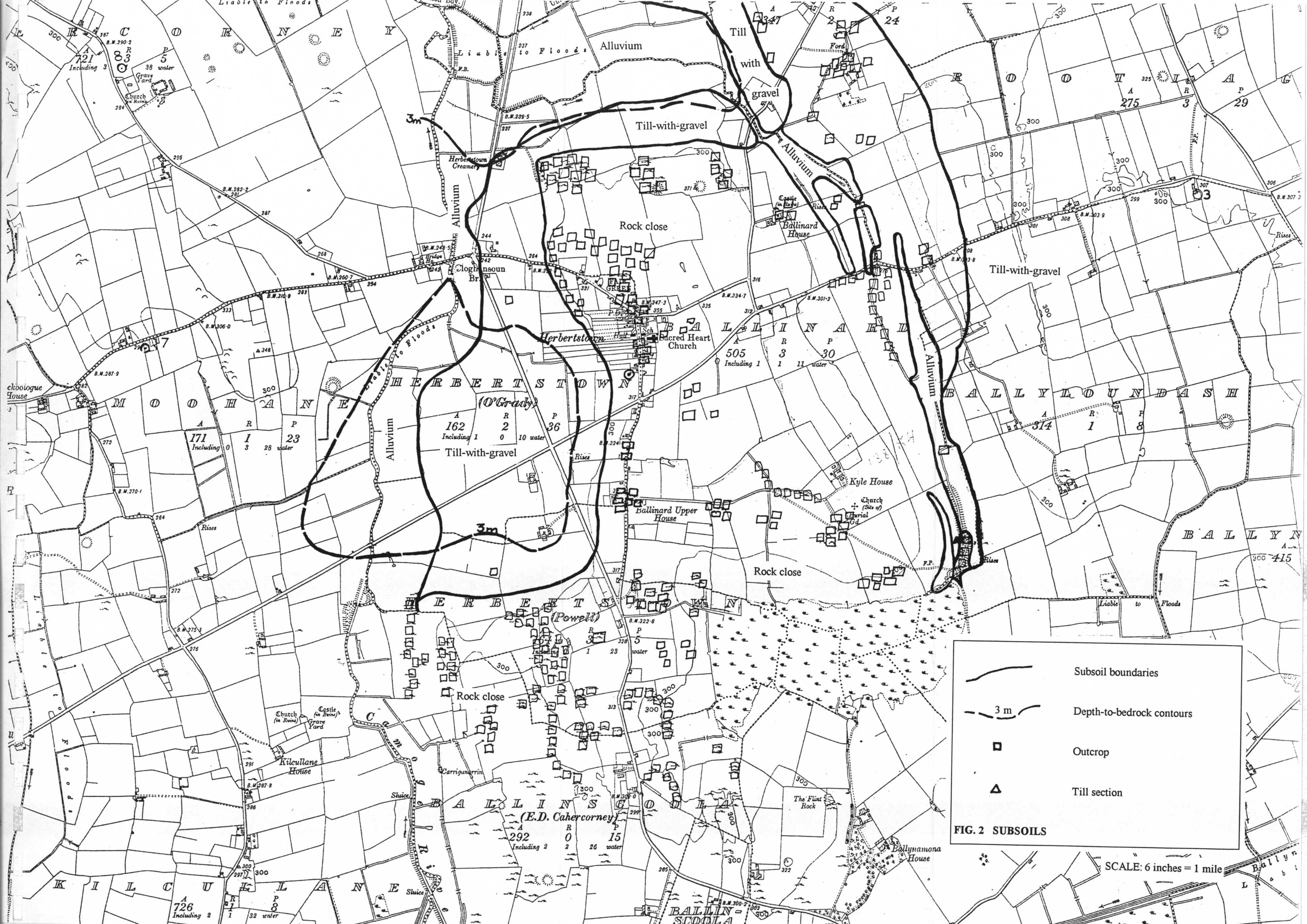

FIG. 2 SUBSOILS

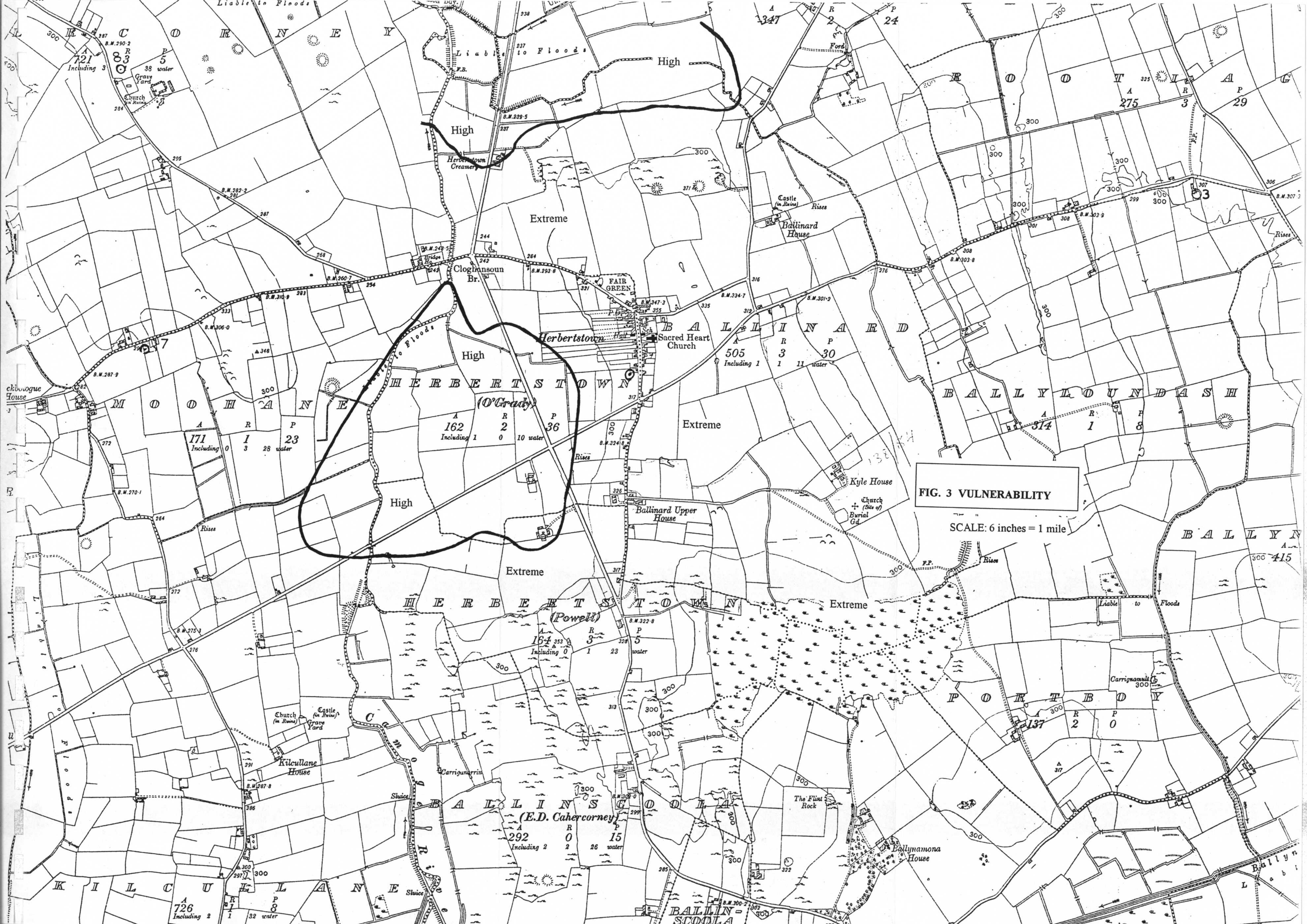

FIG. 3 VULNERABILITY

SCALE: 6 inches = 1 mile

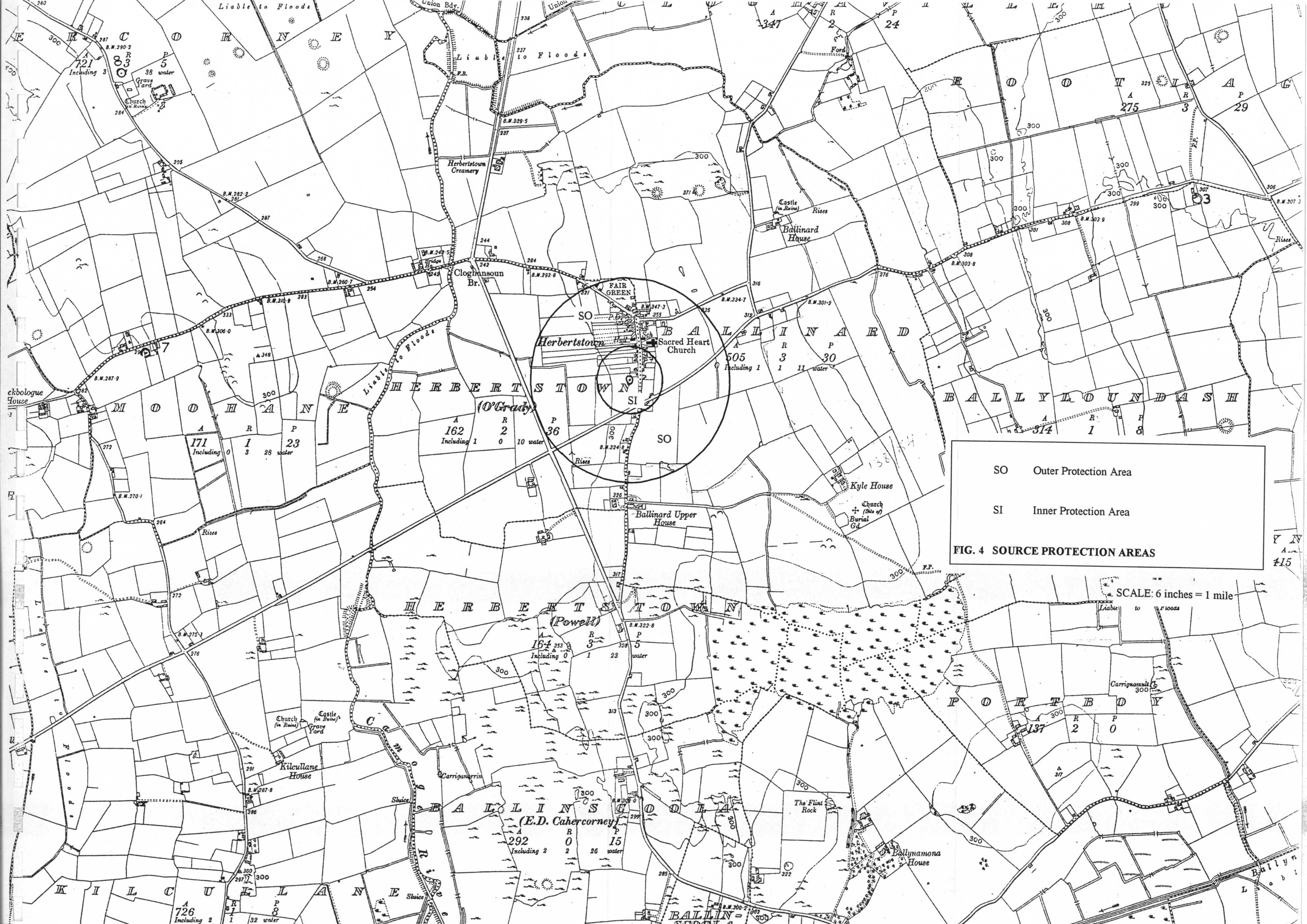

FIG. 4 SOURCE PROTECTION AREAS

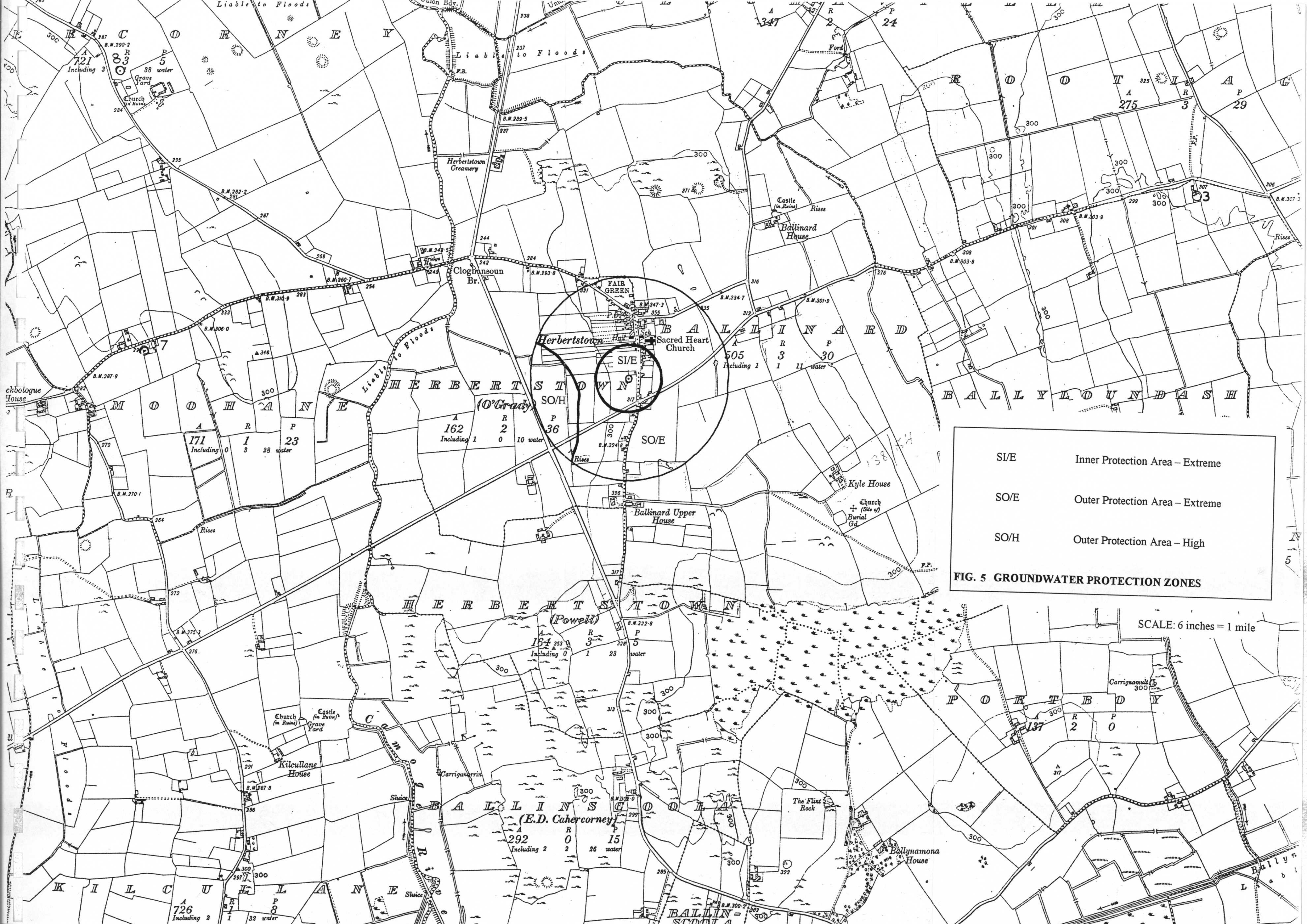

FIG. 5 GROUNDWATER PROTECTION ZONES