BRUREE PUBLIC SUPPLY

GROUNDWATER SOURCE PROTECTION ZONES

Jenny Deakin
Groundwater Section
Geological Survey of Ireland
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1. SUMMARY OF WELL DETAILS

GSI no.	: 1413SWW094
Grid ref.	: 15467 13051
Owner	: Limerick Co. Co.
Well type	: Borehole
Elevation (top of casing)	: 47.14 m OD (Poolbeg). Ground level is AT 47.46 m OD.
Depth	: 91.44 m
Diameter	: 150 mm (6")
Depth-to-rock	: 3 m
Static water level	: 1.24 m below top of casing (b.t.c.)
Pumping water level	: 10.51 m b.t.c. (after 10 hrs continuous pumping)
Drawdown	: 9.27 m
Abstraction rate	: 500 m^3/d (4,580 gal/hr over ~21 hours)
Normal consumption	: 441 m^3/d (on average)
Specific capacity	: 39 m^3/d/m (1 week)

Pumping test summary:

(i) abstraction rate: 413 m^3/d
(ii) specific capacity : 45 m^3/d/m (10 hours)
(iii) transmissivity: 132 m^2/d [54–151 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. A pumping test with recovery was carried out to examine the aquifer characteristics. 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 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 source is the main public supply well for Bruree and it is located to the west of the village, on the northern bank of the river, behind the old mill house. The bore is enclosed by a small brick house with removable felt roof and it is fenced off. The pumphouse is located in the next field. A second council supply, a borehole next to the reservoir at the top of the hill, to the north of the site, is maintained as a backup supply but is rarely used as it has an inadequate yield. A spring lying next to the pump house is now abandoned due to its poor yield. In addition, there are a number of private wells in the vicinity, including the Rockhill Group Water Scheme which supplies the surrounding area to the west of Bruree.

4. TOPOGRAPHY, SURFACE HYDROLOGY AND LAND USE

Bruree lies in the valley of the river Maigue between two elevated areas to the north and south, which rise to 75 m OD (244 ft) and 90 m OD (297 ft), respectively. The ground is relatively flat and low-lying to the east and west. On a broad scale, topography dips gently to the north-northwest.

The river Maigue flows in a northerly direction, although it deviates westwards through Bruree. There are numerous springs occurring to the east and west of the village and small streams from these also trend northwards to drain into the Maigue. Drainage on higher ground is good and there are no drainage ditches.

Excluding the village, the land is primarily used for grazing.

5. GEOLOGY

5.1 Bedrock geology

A borehole log from the public supply gives the geology in the immediate vicinity of the well. The record shows 90 m of interbedded purple green, brown and grey, medium to fine grained, recrystallised sandstones with few siltstone and shale beds, which are characteristic of the Old Red Sandstone. These rocks form part of an easterly younging succession which includes a series of Old Red Sandstones, the Kiltorcan Sandstone, the Mellon House Beds, the Ringmoylan Shales and the Ballysteen Limestones (Fig. 1). A major east-west trending fault, less than 5 m to the north of the well, juxtaposes this succession against a series of sandstones which are part of either the lower Kiltorcan Sandstones or the upper Old Red Sandstones. There are also two large NNE-SSW faults present to the east and west and a second east-west fault further to the south. There are likely to be two series of joints and fractures parallel to the major faults.

5.2 Subsoils geology

The dominant subsoils are light orange-brown clayey, stony deposits, with small sub-angular to angular limestone clasts and they are interpreted to be limestone tills (Fig. 2). A section in the river bank next to the source indicates that the subsoils there are more sandy and silty, with no clay and an abundance of sandstone clasts; these deposits are likely sandstone tills. There is a channel of alluvium present along the course of the river, except in the vicinity of the well where bedrock outcrops in the river bed. There is reported to be more than 9.6 m of sand in a bore to the north west of the area and a small pod of gravel at the top of the southerly hill. The higher areas are generally rock close to the surface with thin limestone tills in places.

5.3 Soils

Soils of the area are primarily derived from a parent material of glacial drift origin, mainly limestone with some shale, sandstone and volcanics and they include members of two of the more common series in Limerick, the Howardstown gleys and the Elton grey brown podzolics. The gleys normally occur in areas with low permeabilities or on wet ground and are found predominantly on the limestone till in the area to the north and northwest of the source. The Elton podzolics are found on the drier hilly areas and to the east and southeast. There is also a small patch of Ballybrood brown podzolics (well drained permeable soils dominantly of sandstone glacial drift origin) lying on the top of the hilly area to the south. The soils are shown on the published soils map of Co. Limerick (Finch and Ryan, 1966).

5.4 Depth-to-rock

Outcrop on both hills indicate that rock is close to the surface, although there is a degree of thin cover. Depth-to-rock in the public supply borehole is 3 m and this is likely to be the case in the rest of the valley. To the east and west, the subsoils are less than 5 m thick on average, but are thinner in places (local farmers, pers. comm.), with the exception of the southeasterly area where depths of more than 20 m are reached. A borehole to the west of the river indicates a thickness of almost 10 m. Further to the south away from the hill, the deposits become substantially thicker reaching up to 80 m in places. 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

Hydrogeological data for the Bruree area are reasonably good, although are lacking in the area around the public supply:

- A 10 hour pumping test with four hour recovery which was carried out as part of the study in July 1993.
- Temperature and electrical conductivity measurements taken in the borehole and the river during the pumping test.
- A Geoex (a hydrogeological consulting firm) report, dated 1980, which was commissioned by the County Council to review the groundwater resources of the region.
- GSI well data.

6.2 Groundwater levels

Groundwater is generally close to the surface, being less than 5 m below surface, except in the elevated areas; a well on the hill to the south of the well is estimated to have a water level deeper than 10 m. The static water level taken in the public supply well on 17/8/93, following overnight recovery, was 45.9 m OD (1.24 m below the top of the casing). It is reasonable to assume that the river is in hydraulic continuity with groundwater and the water level is therefore taken as that of groundwater. There are also a number of springs and shallow wells in the area. The unsaturated zone, therefore, is generally thin ranging from 0–5 m thick, except in the region of the hills where it is likely to reach more than 10 m.

6.3 Groundwater flow directions and gradients

Groundwater flow, from the regional viewpoint, is generally towards the north, but at a more local scale, it is influenced by topography and converges from all directions into the river valley. Flow directions are difficult to assess due to the presence of the major east-west fault. It is expected that this fault zone is a zone of relatively moderate transmissivity, as is generally the case in Ireland with east-west trending faults, but that it is more permeable than the surrounding rock (refer to the next section). There will also be a groundwater divide, reflecting topography, on top of the hill to the north of the site.

The groundwater gradient from the higher areas to the river valley is estimated to be approximately 0.04.

6.4 Meteorology

Rainfall data for the area are taken from the nearest weather station which is located in Kilmallock, 4 miles to the east-southeast. Mean annual rainfall, as recorded by the Meteorological Service, for the years 1951–1980 was 941 mm. Potential evapotranspiration (P.E.) is estimated from a regional Meteorological Service contoured map, and a ranking scheme with all the other sources, as 470 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 504 mm per annum.

As there are no drainage ditches or streams in the immediate area of the supply and the subsoils are relatively free draining and generally thin, a high proportion of the effective rainfall infiltrates to the water table. Estimating run off to be of the order of 15%, recharge to the aquifer is taken to be approximately 430 mm/a.

These calculations are summarised below:

Average annual rainfall	941 mm
Estimated P.E.	470 mm
Estimated A.E. (93% P.E.)	437 mm
Effective rainfall	504 mm
Recharge (85% E.R.)	~430 mm

6.5 Hydrochemistry and water quality

The hydrochemical analyses of groundwater at the source in Bruree indicate a **hard** water (285–340 mg/l; $CaCO_3$), with moderately high alkalinity (280–295 mg/l; $CaCO_3$). Electrical conductivities are also high at 640–

760 μS/cm. The analyses indicate that although the water does have a sandstone signature, there is also an influence by carbonate dissolution processes. Groundwater mixing is likely to be occurring.

The water quality in the Bruree Source is variable. Chloride levels are generally greater than 33 mg/l, although they reached as high as 42 mg/l in August 1993. Nitrate is generally low in the C3 analyses, ranging from 10–17 mg/l (NO_3) although a concentration of 24.5 mg/l (NO_3) was recorded during the project. These slightly elevated and variable parameters may be indicative of contamination occurring at times.

6.6 Aquifer coefficients

The pumping test analyses provided transmissivities ranging from 54–151 m^2/d with 132 m^2/d appearing to be the best estimate. The pumping test graphs (GSI files) indicate that the well was sustained by a nearby recharge boundary during the test. The specific capacity calculated was 45 m^3/d/m after 10 hours pumping.

6.7 Conceptual model

The aquifer feeding the Bruree public supply is considered to be the sandstones, but recharge from the river is likely to be induced during pumping. The sandstones are of moderate permeability but the fault is a higher transmissivity zone. Groundwater will therefore flow from the divide at the top of the hill, towards the river and, during pumping at least, will be intercepted by the more permeable fault zone.

The recharge boundary encountered during the pumping test is likely to be the river. Temperature measurements taken in the borehole and the river during the test showed that the groundwater was a few degrees higher (13.5–14.5°C) than normal groundwater temperature (10–11.5°C) although was still slightly lower than the river water (15.8–16.2°C). This is possibly due to mixing between the groundwater and river water; this is also supported by the hydrochemistry analyses.

6.8 Aquifer category

Considering the Old Red Sandstone in terms of well yields, specific capacities, lithology and structure over the county, they are classed as **locally important aquifers** which are **generally moderately productive only in local zones**. The Mellon House Beds and the Ballysteen Limestones are also classed as **locally important aquifers** which are **generally moderately productive only in local zones**, while the Ringmoylan Shales are a **poor aquifer** which is **generally unproductive**.

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 most of the area in question falls into this category. The 3 m contours are based on the general trend across the county, and on the available data points. 5 m depth-to-rock contours are interpreted to the east and west of the source, creating areas of **probably high** vulnerability. To the southeast of the source, subsoils are much thicker (a borehole with a depth-to-rock of 27.4 m is recorded) and a 10 m contour is included, hence bringing the vulnerability classification down to **probably low** vulnerability. The vulnerability zones are shown in Figure 3.

8. DELINEATION OF SOURCE PROTECTION AREAS

Source Protection Areas are delineated for a 50% higher output than the current abstraction (i.e. 660 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 boundaries of the zone of contribution are influenced by the assumption that the fault is a high transmissivity zone. The northern boundary is extended, up the hill to the north of the source, to the groundwater divide. The eastern boundary is delineated by the change in lithologies of the bedrock, i.e. the contact with the less permeable muddy limestones of the Ballysteen Formation. (The contact with the Ballysteen

Limestones is taken rather than the Ringmoylan Shales, to allow for error in the geology map). The total size of the ZOC is then based on the Recharge Equation which estimates that the area required to supply the increased pumping rate of 660 m^3/d, is calculated to be 0.56 km^2 (560230 m^2), equivalent to a circular area of approximate radius 425 m (Fig. 4). Note that an additional safety margin is incorporated as a significant proportion of the supply is likely to be contributed by the river and the ZOC will, therefore, be smaller than delineated.

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 estimate the 100-day travel time distance to the source. Taking permeability to be in the region of 0.4 m/d, assigning a porosity value of 0.015, and estimating a pumping water gradient of 0.07, the distance required to ensure a 100 day travel time to the well, at the current pumping rate, is approximately 200 m (Fig. 4). This area is extended along the fault zone by 100 m to allow for the higher transmissivity in that area.

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 enclosure around the source at Bruree, which is owned by the County Council, is designated the Source Site Area.

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 Ballyagran source. These are listed here 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
- Outer Protection Area / Moderate SO – M

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 threat to the public supply at Bruree is the quality of the water in the river upstream of the source, which may be affected in particular, by septic tanks and/or leaky sewers (if present) in the village. This may account for the slightly elevated background levels of chloride and nitrate. Part of the village is also located within the zone of contribution.

11. CONCLUSIONS AND RECOMMENDATIONS

Overall the source at Bruree is a reasonable yielding well which is likely to be taking a significant proportion of its water from the river Maigue. The vulnerability of the source to contamination, although it is extreme, is less important than the river water quality. The County Council water analyses showed some anomalies in the chloride, nitrate and potassium concentrations and it is possible that there may be slight contamination at times which may be coming either from the village or from agricultural contaminants leaching into the river. Further analyses on the raw water should be carried out to fully assses potential problems.

It is recommended that the Council monitor the river water closely and try to control and monitor potentially polluting activities being carried out near the river banks upstream of the source. In the event of a pollution scare occurring in the river upstream, the public supply well should be turned off to prevent drawing in possible contaminants into the aquifer fissures between the river and the source.

FIG. 1 GEOLOGY

FIG. 2 SUBSOILS

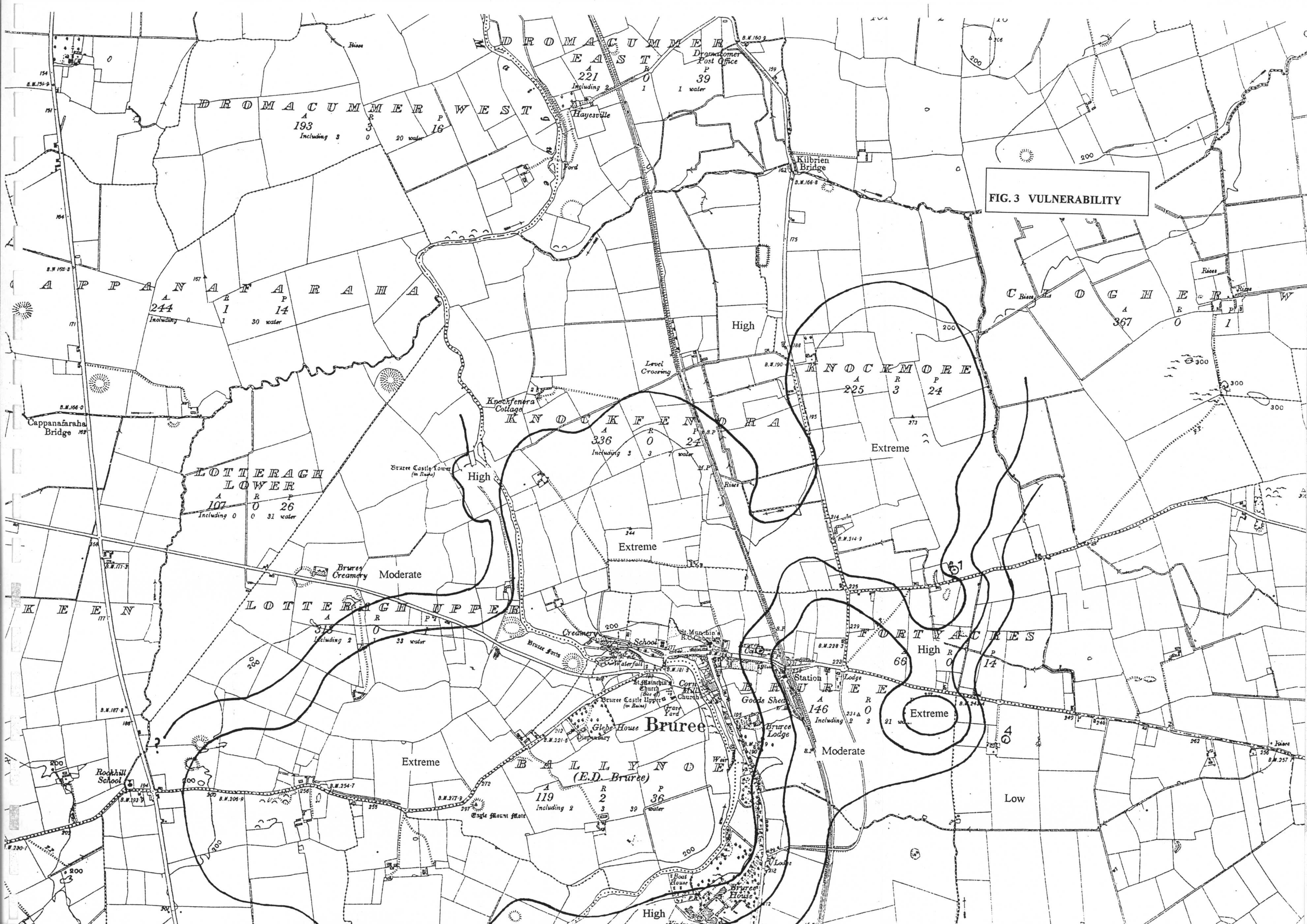

FIG. 3 VULNERABILITY

FIG. 4 SOURCE PROTECTION AREAS

FIG. 5 GROUNDWATER PROTECTION ZONES