BALLYROHAN PUBLIC SUPPLY

GROUNDWATER SOURCE PROTECTION ZONES

(DRAFT)

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BALLYROHAN PUBLIC SUPPLY

1. SUMMARY OF WELL DETAILS

GSI no.	:	2011SEW003
Grid ref.	:	21958 11090
Owner	:	Waterford Co. Co.
Well type	:	Bored
Elevation (top of casing)	:	122.61 m OD (Poolbeg).
Depth	:	38 m
Depth of casing	:	unknown
Diameter	:	203 mm (8")
Depth-to-rock	:	Rock close to surface
Static water level	:	115.3 m O.D. (7.28 m b.g.l.) on 21/8/92 121.8 m O.D. (0.75 m b.g.l.) on 18/1/96
Pumping water level	:	108.9 m O.D. (13.71m b.g.l.) on 21/8/92 119.3 m O.D. (3.25 m b.g.l.) on 18/1/96
Drawdown	:	6.43 m on 21/8/92 2.50 m on 18/1/96
Abstraction rate	:	330 m^3/d (3000 gal/hr)
Normal consumption	:	145 m^3/d (32,000 gal/d on average, over 10 hrs)

Pumping test summary:

(i) abstraction rate : 255 m^3/d
(ii) specific capacity : 15 m^3/d/m (drawdown extrapolated to 1 week)
(iii) transmissivity : 20 m^2/d [7–40 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 borehole, chemistry and pumping test data available.

The second stage comprised site visits and fieldwork in the surrounding area. A two hour recovery test was followed by a two hour pumping test in August 1992 in order to examine the aquifer characteristics. Subsequently, field work was carried out in the area encompassing a circle of 1 km radius in order to examine subsoil and bedrock geology, hydrogeology, vulnerability to pollution and current pollution loading. Finally, two raw water samples were taken in September 1992 and June 1993 for full suites of chemical and bacterial analyses.

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

3. WELL LOCATION AND SITE DESCRIPTION

The source is the main public supply well for Ballymacarbry and it is located 1.5 km south of Ballymacarbry, in the townland of Ballyrohan, just off the main Dungarvan to Clonmel road (Figure 1). The well is in a small pumphouse and a small area around the pumphouse is paved and fenced off.

A second council supply was drilled in sand and gravel in the village of Ballymacarbry, however the quality of water is poor so this well is only used in emergencies (Area Engineer, pers. comm.).

4. TOPOGRAPHY, SURFACE HYDROLOGY AND LAND USE

The well lies in a small north-south trending valley which joins the larger, east-west trending Nier River valley 2 km to the north. The well is at a height of 122 m O.D. and the land rises steeply to the west, south and south east of the well, up to a height of 240 m O.D. .

The well is located 16 metres to the east of a stream which flows northwards into the River Nier. Another stream flows north-westwards and joins the main stream 30 metres to the north of the well. Both streams are perennial. Several springs and small streams can be observed 500m - 1km to the south of the supply.

The land use in the area is primarily grazing.

5. GEOLOGY

5.1 Bedrock geology

The public supply is located in the Ballytrasna Formation (Old Red Sandstone). The formation consists predominantly of compact purple siltstones and mudstones, with minor sandstone units. Outcrops occur immediately behind the pumphouse and in the stream closest to the well where thinly bedded siltstones are exposed.The thickness of bedding (10 cm to 1m) and the dip (see Figure 1) are variable in the area to the south of the well.

5.2 Quaternary (subsoils) geology

The subsoils in the area surrounding the well are poorly exposed, however in general the stream valleys appear to have rock close to the surface with thin sandstone till covering most of the remaining area (Figure 2). Where exposed, the till is red - brown in colour with a sandy matrix and poorly sorted subangular to subrounded mudstone clasts. A small area of till containing dominantly chert clasts is indicated immediately to the south of the well on G.S.I. Quaternary maps, however evidence for this is not clearly visible in the field.

5.3 Depth-to-rock

Outcrops can be seen on the hill behind the source and in and around the streams in the vicinity indicate that the depth to rock is less than 3 metres over much of the area around the public supply. Evidence from Quaternary mapping in the general area suggests that the depth to bedrock in the remaining areas is generally between 3 and 5 m. Rock is close to surface in the immediate vicinity of

the well as indicated by nearby outcrops. Outcrops and proposed depth to bedrock contours are shown on Figure 2. The depth-to-rock has been contoured for ease of incorporation into the vulnerability map but it is based on few data points and may need refining as further borehole records become available.

6. HYDROGEOLOGY

6.1 Data availability

Hydrogeological data for the area around Ballyrohan are poor. A brief well survey was conducted during the site visit on the 18/1/96, however no wells could be found in the area around the public supply. Although records of two wells exist for the wider area around the well, the location of these were not determined accurately (only a townland name is available). A 2 hour recovery test was followed by a 2 hour pumping test in August 1992, the duration of test was restricted because of demand for water at that time. A longer test would have been more preferable.

6.2 Groundwater levels

Groundwater levels in the area are variable, depending on the time of year. The static water level in the public supply on the 18/1/96 was 121.8 m O.D. (0.75 m b.g.l.) whereas the static water level on the 21/8/92 was 115.3 m O.D. (7.28 m b.g.l.). The low water level in summer is considered to be the result of the dewatering of the aquifer and therefore does not represent the natural static level. A number of small springs are present 500 to 1000m to the south of the well, these are assumed to be seasonal.

6.3 Groundwater flow directions and gradients

Groundwater flow to the well is likely to be dominated by flow from the hill immediately to the south which acts as a recharge mound. Due to the lack of groundwater level data it is not possible to obtain an accurate groundwater gradient. However, an approximate gradient (0.07) is proposed, based on the gradient of the perennial streams adjacent to the source.

6.4 Meteorology and recharge

Rainfall and evaporation data for the area are taken from national contoured maps as recorded by the Meteorological Service. For the years 1951 - 1980 the mean annual rainfall for the area was 1280 mm. Potential evapotranspiration (P.E.) is estimated as 510 mm/yr. Actual evapotranspiration (A.E.) is then calculated by taking 95% of the potential figure, to allow for soil moisture deficits for part of the year, so A.E. is estimated as 485 mm/yr. Using these figures the effective rainfall (E.R.) is taken to be approximately 795 mm/yr.

Several perennial streams are present in the area, the bedrock has a relatively low permeability and topography is steep in the vicinity of the well. This suggests that a significant proportion of potential recharge is rejected as surface runoff. Although the proportion of effective rainfall infiltrating to the water table is not known with certainty, it is assumed that 60% is a realistic estimate, consequently the actual annual recharge in the area is therefore approximately 480 mm.

These calculations are summarised below:

Average annual rainfall	1280 mm
Estimated P.E.	510 mm
Estimated A.E. (95% P.E.)	485 mm
Effective rainfall	795 mm
Recharge (60% E.R.)	480 mm

6.5 Hydrochemistry and water quality

Two raw water samples were taken for chemical and bacterial analysis. The hydrochemical analyses indicate a **'slightly hard'** water (115 - 119 mg/l) with a relatively low alkalinity (89 mg/l $CaCO_3$). These values are typical of the Ballytrasna Formation. Conductivities were also relatively low (240 - 290 µS/cm). All the major cations, anions and trace elements are within EC limits, except for faecal coliforms (2 per 100 ml). No comprehensive well head analyses were performed, however the temperature and conductivity of the groundwater measured on 18/1/96 were 10.5°C and 382 µS/cm. The temperature and conductivity of the stream adjacent to the well were also measured on the same visit and were 9.4°C and 218 µS/cm.

6.6 Aquifer coefficients

The pumping test analyses provided transmissivities of 7 m^2/d from the 2 hour pumping test and 18 m^2/d from the 2 hour recovery test. However both these tests were very short. A transmissivity of 40 m^2/d is suggested by an examination of the specific capacity of the supply during the pumping test. A value of 20 m^2/d is taken as the most reasonable figure. This figure proved to be the most realistic when the source was modelled.

The specific capacity calculated from the pumping test was 34 $m^3/d/m$ after 2 hours pumping. When the drawdown data was extrapolated to 1 week a figure of 15 $m^3/d/m$ was obtained. More comprehensive pumping tests would be needed to confirm the sustainable maximum yield of the supply.

The main problems with the supply are that sand is drawn into the well and the well yield in summer is inadequate due to increased demand and/or poor yield.

6.7 Conceptual model

The aquifer feeding the Ballyrohan source is the Ballytrasna Formation. This is overlain by 0 to 5 metres of sandy till that is moderately permeable, therefore the aquifer can be considered to be unconfined.

Groundwater flow is influenced by topography and a groundwater mound is present to the south of the supply; groundwater therefore flows northwards to the supply.

The two streams adjacent to the supply are perennial, therefore groundwater will flow into these steams all year round. However, the static water level in the area immediately surrounding the source is lower than the nearby streams during the summer months (5m below the level of the nearest stream). Together with the relatively low permeability of the bedrock (approx. 0.5 m/d) and low specific yield, this suggests that the water levels in the vicinity of the source are a reflection of the aquifer being dewatered by the public supply.

The public supply may be drawing some water from the nearby streams during the summer, however the available pumping test data and measurements of conductivity and temperature do not allow this to be verified. Controlled measurements of conductivity and temperature are needed during the summer to confirm the relationship between the public supply and the adjacent stream.

6.8 Aquifer category

The Ballytrasna Formation is classed as a **locally important** aquifer which is **moderately productive only in local zones.**

7. VULNERABILITY

The source at Ballyrohan is regarded as being high to extremely vulnerable to pollution. Subsoils are moderately permeable and less than 5 m thick throughout most of the area and rock outcrops are common in the stream valleys. The well at Ballyrohan may be drawing some water from the adjacent streams during the summer; as a result an area 30 m wide along the streams next to the well (in the upgradient direction) is classified as extremely vulnerable.

The vulnerability is shown in Figure 3.

8. DELINEATION OF SOURCE PROTECTION AREAS

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 recharge. The most accurate zone of contribution at Ballyrohan is derived from hydrogeological mapping techniques and is controlled primarily by the groundwater flow direction and by the streams to the south-west and south-east. Numerical modelling of the groundwater system was also undertaken to assist in the delineation of the source protection areas.

A groundwater divide is present 1.5 km to the south of the source, however because of the relatively low yield of the well, the low permeability of the bedrock and the presence of several springs between the well and the divide, the ZOC is not extended this distance.

The zone of contribution is shown in Figure 4. The size of the zone of contribution is based largely on the Recharge Equation, however in addition the area of the ZOC immediately surrounding the well has been enlarged because the aquifer is dewatered during the summer. Taking the average annual recharge to be 477 mm as previously indicated, the area required to supply an increased pumping rate of 200 m^3/d, is calculated to be 0.15 km^2 (the pumping rate is increased in order to produce a conservative ZOC). This is equivalent to a circular area with a radius of 220 m. A conservative null point (the distance down gradient after which water is not contributing to the well) of 50m is also taken as a result of the dewatering of the aquifer around the public supply. A buffer (safety margin) is included in the final zone of contribution by incorporating a ±20% error margin in the estimated groundwater flow direction.

8.2 Inner protection area

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

Using the following aquifer coefficients: permeability (k) = 0.5 m/d and porosity = 0.01, the 100 day time of travel distance to the well is calculated to be approximately 350 metres (Figure 4). This relatively large distance is a reflection of the low porosity of the bedrock and the high hydraulic gradient.

In order to protect the public supply from contamination which may be drawn into the well from the adjacent streams, the inner protection zone is extended along these streams in the upgradient direction.

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 enclosure around the source at Ballyrohan is designated the Source Site Area.

9. GROUNDWATER PROTECTION SCHEME

Combining the Source Protection Areas, as described above, with the vulnerability ratings produces four groundwater protection zones for the source at Ballyrohan. These are listed here in order of decreasing degree of protection required and are shown in Figure 5 (with the exception of the Source Site):

- Source Site / Extreme
- Inner Protection Area / Extreme
- Outer Protection Area / Extreme
- Outer Protection Area / High

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, the EPA and the GSI.

10. POTENTIAL POLLUTION SOURCES

The current primary threat to the public supply at Ballyrohan is the quality of the water in the stream adjacent to the source, which if polluted may affect the water quality in the public supply. Several farms are present upgradient of the source, however most of these are more than 500 m distant. Pollutants in the stream may account for the elevated levels of bacteria found in the supply.

11. CONCLUSIONS AND RECOMMENDATIONS

Overall the source at Ballyrohan is a moderate yielding well which may be drawing some water from the adjacent stream during the summer months. The water analyses showed some E.coli content, however in general the water quality is good. The area around the supply (including the nearby stream) is high to extremely vulnerable to pollution and the public supply may be affected by the water quality in the stream. The presence of E.coli may be due to pollutants in the nearby stream and/or grazing animals in the vicinity of the well.

It is recommended that the Council try to ascertain whether the public supply is drawing water from the stream (by taking controlled conductivity and temperature measurements during the summer). If this is the case then it will be necessary to monitor the stream water more closely in addition to controlling and monitoring potentially polluting activities within the ZOC of the source. In the event of a pollution scare occurring in the stream, upstream of the well, the well should be turned off to try and prevent the drawing in of possible contaminants into the aquifer.

It may be possible to reduce the sand influx into the well by reducing the pumping rate and pumping for longer periods of time. Sand can be drawn into wells when groundwater velocities are high and flow is turbulent. Reducing the pumping rate will reduce the drawdown in the well and therefore reduce velocity.

12. ACKNOWLEDGEMENTS

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FIG. 1 GEOLOGY

FIG. 2 SUBSOILS AND DEPTH TO BEDROCK

FIG. 3 VULNERABILITY

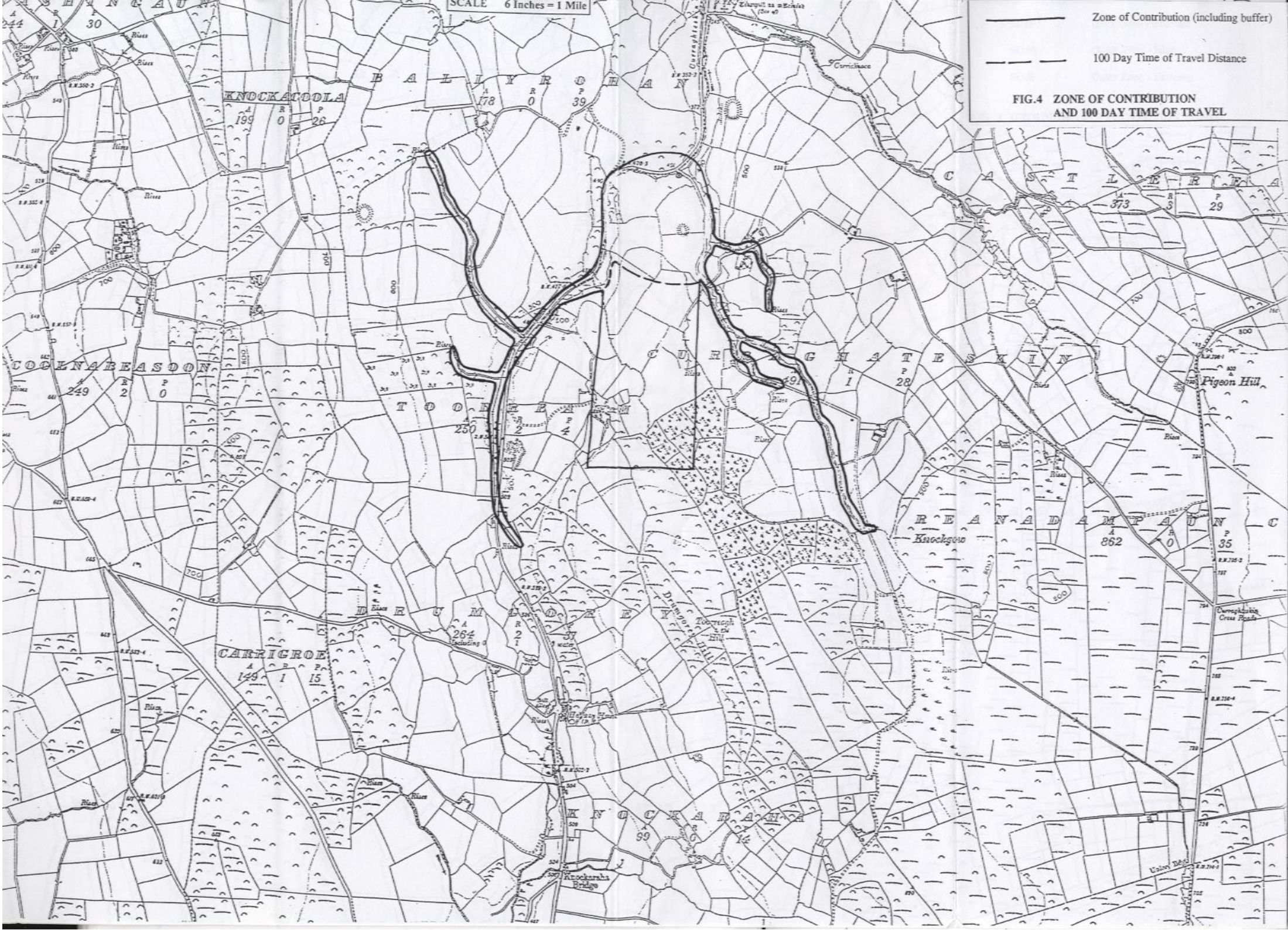

FIG.4 ZONE OF CONTRIBUTION AND 100 DAY TIME OF TRAVEL

FIG. 5 GROUNDWATER PROTECTION ZONES