

MOUNTLUCAS GROUP WATER SCHEME

GROUNDWATER SOURCE PROTECTION ZONES

(DRAFT)

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4. TOPOGRAPHY, SURFACE HYDROLOGY AND LAND USE

The well is located 200 metres to the south of the Philipstown River. The land slopes gently upwards to the south of the well to a height of 95 metres. This higher ground is well drained and is used as pasture and arable land. Areas of peat bog lie to the west and east of the well drained land, these areas are poorly drained, as is the area of land immediately bordering the river (this area is liable to flooding in winter). Two small seasonal streams are marked on 1/2" scale topographic maps, at the margins of the bog areas, these streams are shown on Figure 1.

5. GEOLOGY

5.1 Bedrock geology

The underlying geology of the area is the Edenderry Limestone (as shown in Figure 1). This is a pale grey-light blue oolitic limestone (composed of small spherical grains). The limestone is poorly exposed in the area, however where visible it is well jointed, the larger joints being vertical rather than horizontal. The beds dip approximately 10° to the west.

5.2 Quaternary (subsoils) geology

The subsoils are shown in Figure 2. A large area of sandy till covers the limestone immediately to the south of the well, coinciding with an area of well drained land. The till was exposed in the trial pits excavated 130 metres SSE of the well as part of a planning application. In addition other smaller sections, mainly in ditches and embankments were exposed around the fields south of the well. The till is composed predominantly of fine sand (approx 70%) with subrounded to subangular clasts of limestone up to 400 mm in size. Silt was also present within the till together with a small percent of clay.

5.3 Depth-to-rock

The deepest trial pit within the till reached a depth of 3.3 metres, when bedrock was reached (according to the landowner). Other sections in the till greater than 1 metre were not present in the area south of the well, however it is probable that the hill is rock cored, with a thin (3-5m) cover of till. The depth of the peat either side of the till is unknown, as is the presence of any underlying subsoil. Rock outcrops occur to the north of the river on top of the hill.

Due to the absence of data, depth to bedrock contours have not been drawn.

6. HYDROGEOLOGY

6.1 Data availability

Hydrogeological data for the Mountlucas area are very poor, including the area around the group water scheme. A well survey was conducted during the site visit on the 31/7/96, two shallow handpump wells were found and dipped, the location of these wells is shown on Figure 1.

6.2 Groundwater levels

Although groundwater level data for the area are poor, certain observations can be made. The water table is close to the surface in the immediate vicinity of the well, (less than 2 metres at the well), and at the ground surface during winter (there is a significant overflow from the well in winter). The pumping water level in the well was estimated at 74.72 m O.D. (1.48 m below the top of the casing) on 31/7/96. The trial pit (3.3 m deep) and the handpump well 80 metres SSE of the well (4.7m deep) were both dry on the 31/7/96, indicating that the till is unsaturated during the summer months and therefore that most of groundwater flow to the well is within the underlying limestone. The sandy till is likely to be saturated for part of the winter months.

6.3 Groundwater flow directions and gradients

The water table is likely to be a subdued reflection of topography in general, with groundwater flowing NNE towards the Philipstown River. Groundwater flow directions will vary between winter and summer months.

During the winter months, water levels will be relatively high and a recharge mound is likely to coincide with the topographic rise to the south of the well. Although a major component of flow will be towards the river, groundwater flow will also radiate outwards from the recharge mound and discharge into the seasonal streams to the east and west of the topographic rise. The dry streams during the summer and the dry handpump well SSW of the GWS allow the calculation of an approximate summer groundwater gradient. This gradient is estimated to be 0.005.

During the summer months groundwater levels drop, the seasonal streams are dry and groundwater flow is likely to be northwards towards the Philipstown River.

6.4 Meteorology and recharge

Rainfall data for the area are taken from a contoured rainfall map of Offaly (Burns, 1993) based on data from the Meteorological Service. For the years 1951 - 1980 the mean annual rainfall for the area was 850 mm. Evaporation data for the area are taken from a national contoured map as recorded by the Meteorological Service. Potential evapotranspiration (P.E.) is estimated as 475 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 450 mm/yr. Using these figures the effective rainfall (E.R.) is taken to be approximately 400 mm/yr.

The presence of thin free draining soils, permeable till and rock close to surface over the area suggests that a high proportion of effective rainfall is infiltrating to the water table. Although the proportion of effective rainfall infiltrating to the water table is not known with certainty, it is assumed that 90% is a realistic figure and that actual annual recharge in the area is therefore approx. 360 mm.

These calculations are summarised below:

Average annual rainfall	850 mm
Estimated P.E.	475 mm
Estimated A.E. (93% P.E.)	450 mm
Effective rainfall	400 mm
Recharge (90% E.R.)	360 mm

6.5 Hydrochemistry and water quality

Samples of groundwater from the public supply are analysed regularly by the County Council at various private residences supplied by the group water scheme and at the well. Seven samples are available for analyses. from 1992 to 1995, one of these is a comprehensive analyses. This water supply is not chlorinated.

The chemical analysis at Mountlucas indicates a **slightly hard** (101 - 150 mg/l CaCO₃) to **moderately hard** water (151-250 mg/l CaCO₃), with a moderate alkalinity (168 mg/l). Conductivity values are typical of groundwater from limestones and limestone tills (570 - 740 µS/cm), as are the pH values (7.1 - 7.4). Chloride levels are slightly elevated (20-25 mg/l) and may be indicative of contamination (up to 38 mg/l on the 10/11/92). From a total of 18 water samples tested for faecal coliforms, between 19/5/93 and 28/5/96, 8 were polluted. Concentrations of ammonia, nitrates and potassium are all normal and there are no iron problems at this well. The analyses suggest that the well is occasionally polluted by organic waste, probably from farmyard or a septic tank.

6.6 Aquifer coefficients

Hydrogeological data on the nature of the limestone (and the till) around the source is poor. In the absence of data the permeability of the upper few metres of weathered limestone is estimated to be in the range 10-20 m/d. The effective porosity of the limestone is also estimated, at 0.02 (2%).

6.7 Conceptual Model

The aquifer feeding the Mountlucas source is the Edenderry Limestone. Groundwater flow is likely to be concentrated in the upper few metres of fissured and weathered limestone. The limestone is overlain to the south by approximately 3-5 metres of sandy till, therefore the aquifer can be considered to be unconfined. The available groundwater level data suggests that the till is predominantly unsaturated during the summer months.

Although data is poor, the water table is expected to be a subdued reflection of topography, higher in the south and decreasing towards the river. The static water level in the well is higher than the Philipstown River to the north, also suggesting groundwater flows northwards towards the river.

A recharge mound is assumed to coincide with the topographic rise to the south of the well during the winter, with a component of groundwater flowing into the seasonal streams to the SW and SE of the source. In addition groundwater levels are at the surface in the vicinity of the well during the winter. Consequently, the water discharging from the well is derived from an area to the south.

During the summer months the water table drops, the seasonal streams are dry and groundwater flow is predominantly northwards, towards the Philipstown River.

A topographic divide is present approximately 1 km to the south of the well. In the absence of data a groundwater divide is assumed to coincide with this feature.

The till has a sandy matrix suggesting that this deposit is moderately permeable. Water levels are at the surface at the well during the winter and the well overflows considerably. It is likely that the till south of the well is saturated to some degree during the winter months and during this time may contribute to the well discharge.

6.8 Aquifer category

This limestone is classified as a **locally important aquifer** which is **generally moderately productive**.

7. VULNERABILITY

The source at Mountlucas is regarded as being highly vulnerable to pollution. Areas where rock is less than 3 m below surface are mapped as having a 'probably extreme vulnerability'. The available evidence suggests that the till is slightly thicker than 3 m, resulting in a 'probably high' vulnerability.

According to the local caretaker overflow from the well responds quickly to rainfall events. This suggests that groundwater throughflow to the well is relatively quick and that the source is vulnerable.

Although the till is very sandy, a permeability test (conforming to SR6 guidelines) produced a 'T' value = 12.6. This figure, and the presence of silt in the till, suggest that this subsoil has a moderate permeability. Consequently the groundwater in the area to the south of the well is given the vulnerability classification of 'probably high'.

The vulnerability zones are shown on Figure 3.

8. DELINEATION OF SOURCE PROTECTION AREAS

The source protection area is delineated for a higher output than is currently abstracted, to take into account the overflow from the source during the winter months. Having spoken to the local GWS caretaker the best estimate of winter overflow is a rate of approximately 3000 gph (330 m³/d) for 10 weeks during the winter. Ideally more accurate measurements of the overflow would be required in order to delineate the ZOC. The estimated overflow from the well has been combined with the well yield to produce an average well discharge of 165 m³/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 recharge (see Figure 4).

The most accurate zone of contribution for the Mountlucas GWS is derived from hydrogeological mapping techniques and is controlled primarily by the proposed recharge mound to the south of the supply and by the groundwater flow direction to the Philipstown River. The size of the zone of contribution is based largely on the Recharge Equation.

Taking the average annual recharge to be 360 mm as previously indicated, the area required to supply the estimated average well discharge of 165 m³/d, is calculated to be 0.167 km²; this is equivalent to a circular area with a radius of 230 m.

Based on the conceptual model outlined above, the groundwater discharging from the well during the winter months is derived from an area to the south of the well. However, groundwater levels are drawn down slightly by the well during the summer, consequently the ZOC is enlarged slightly to take in an area immediately north of the well. The boundaries of the ZOC are a best estimate based on the data available.

A buffer (safety margin) is included in the zone of contribution by incorporating a ±20% error margin in the estimated groundwater flow direction. The zone of contribution is shown in Figure 5.

Although the proposed ZOC is larger than the area required this allows for the expansion of the ZOC during dry periods, and for uncertainties such as; the estimation of water overflow from the well, and the general lack of hydrogeological data.

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.

A range of values for permeability, between 10 and 20 m/d, were used to estimate the 100 day time of travel zone distance to the well. Using an effective porosity = 0.02, and a groundwater gradient = 0.005, the 100 day time of travel distance to the well is estimated at between 250 and 500 m. The more conservative distance is taken (see Figure 4). It is emphasised, however, that there are no data to enable the aquifer coefficients to be calculated for this source, consequently the boundary to this zone is uncertain.

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 Mountlucas is designated the Source Site Area.

9. GROUNDWATER PROTECTION SCHEME

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

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

Several potential sources of pollution exist within a short distance upgradient of the well. A farmyard 50 m to the south of the well is used to store sillage and hay and there may also be a cattle pen in the yard. The house immediately south of the well has a septic tank nearby and two new houses south of Clonarrow House also have septic tanks. Some of the fields to the south of the well are used as arable land which usually involves the application of fertilizers.

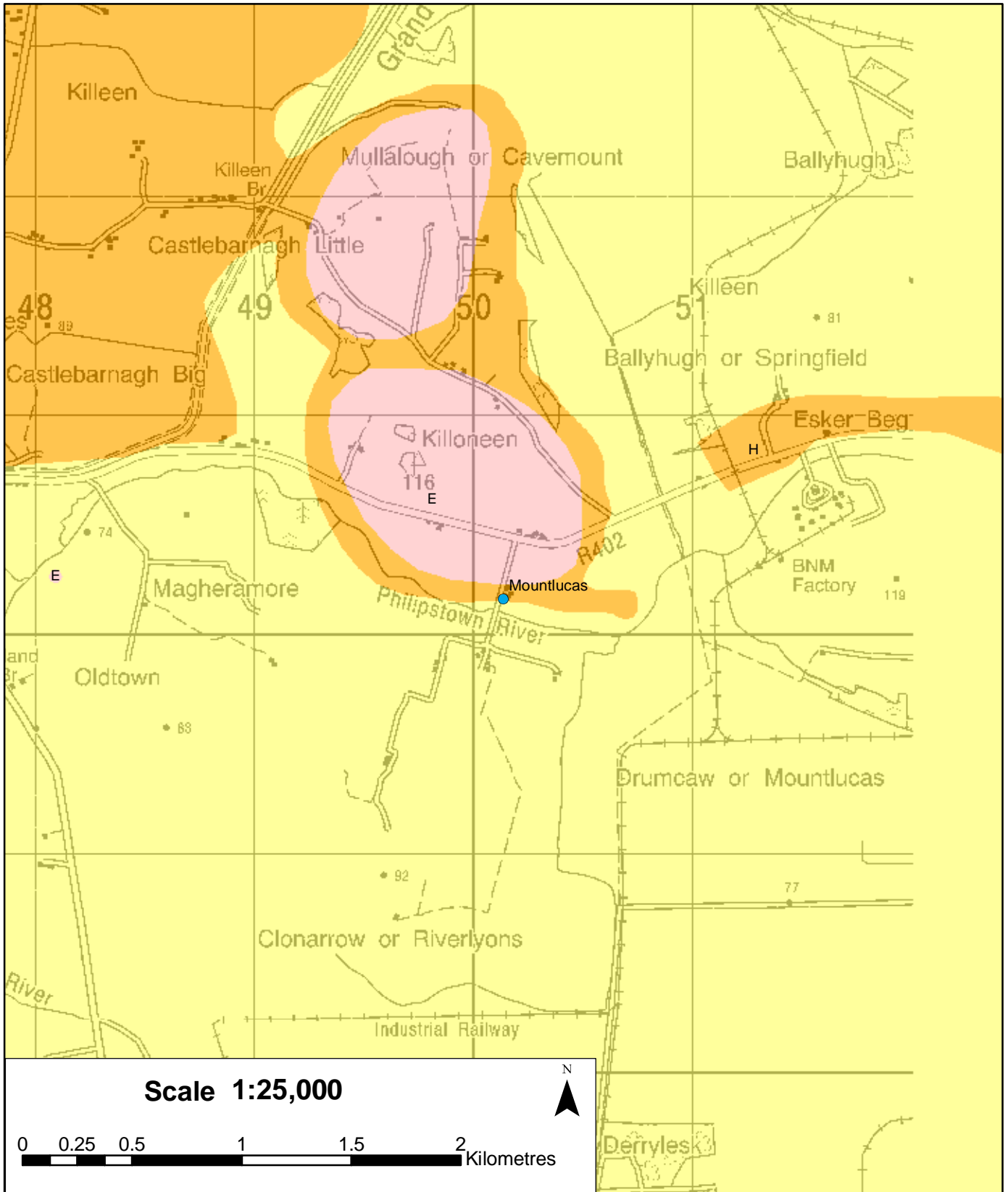
11. CONCLUSIONS AND RECOMMENDATIONS

Overall the source at Mountlucas is a moderately good yielding well which may support an increased yield (particularly during the winter months). The supply is highly vulnerable to pollution due to; the thickness and permeability of the subsoils in the immediate vicinity of the supply, the proximity of the water table to the surface near the well and the apparent rapid throughflow to the well.

The chemical and bacteriological analyses suggest that the well is occasionally polluted by organic waste, probably from a nearby farmyard or septic tank system.

It is recommended that the raw water from the Mountlucas supply should be analysed regularly (chemically and microbiologically) in order to examine the effects of any potentially polluting activities near to the well. In addition it is recommended that the potentially polluting activities and monitor in the delineated groundwater source protection zones should be controlled and monitored.

At present the source is not chlorinated; in view of the likely vulnerability of the area upgradient of the source, the location of potential pollution sources, and the evidence of occasional pollution, it is recommended that the source be disinfected.



Vulnerability Categories

- E - Extreme
- H - High
- M - Moderate
- Spring

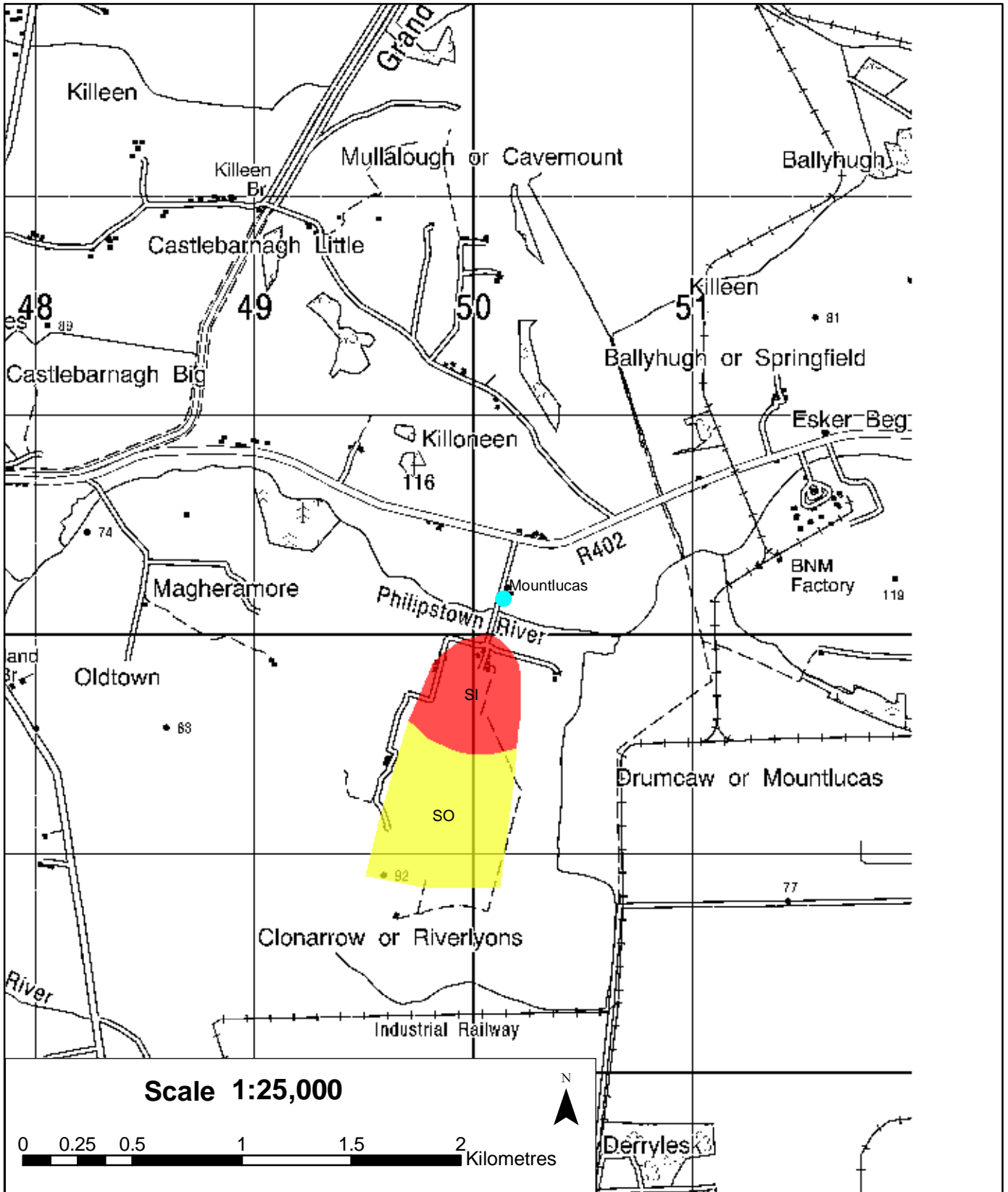
This Source Protection Area map is designed for general information and strategic planning usage. The boundaries are based on the available evidence and local details have been generalised to fit the map scale. Evaluation of specific sites and circumstances will normally require further and more detailed assessments and will frequently require site investigations to determine the risk to groundwater.

The map is intended for use in conjunction with groundwater protection responses for potentially polluting activities, which lists the degree of acceptability of these activities in each zone and describes the control measures necessary to prevent pollution.

Project Hydrogeologist: Coran Kelly
 Project Manager: Donal Daly
 Digital Map Production: Antonio Manna

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LEGEND

- SI Inner Protection Zone**
- SO Outer Protection Zone**
- Spring**

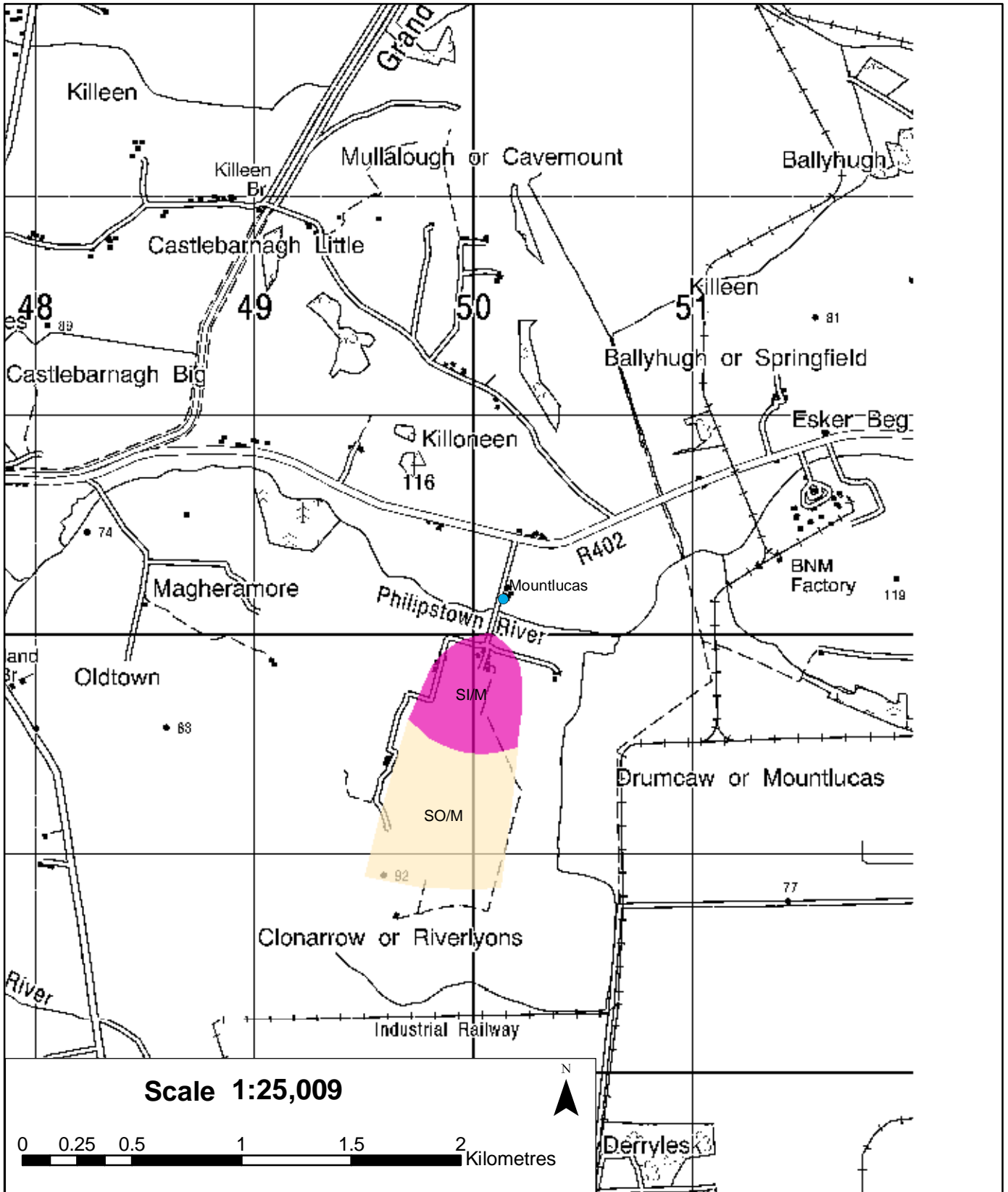
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SOURCE PROTECTION ZONES

VULNERABILITY RATING	SOURCE PROTECTION ZONES	
	Inner SI	Outer SI
Extreme (E)	SI/E	SO/E
High (H)	SI/H	SO/H
Moderate (M)	SI/M	Not Present
Low(L)	Not Present	Not Present

● Spring

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