

Appendix A


Ecological Assessment

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**HABITAT ASSESSMENT OF
BOG OF THE RING pNHA
AND COMPARISON WITH
PREVIOUS SURVEYS
SEPTEMBER 2006**

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1 INTRODUCTION

TOBIN Consulting Engineers conducted an assessment of the current ecological status of the Bog of the Ring proposed Natural Heritage Area (pNHA). A habitat assessment using the habitat classification scheme devised by Fossitt (2000) was undertaken. Vegetation monitoring using the permanent quadrats that were set up in 1999 (Natural Environmental Consultants, 1999) was carried out, as was an assessment of five of the hedgerows present on the site. This work was undertaken on behalf of Fingal County Council. This follows on from previous assessments made in 1999, 2004 and January 2006 and baseline monitoring programmes set up in 1999. The current ecological status of the site was compared with previous survey work.

1.1 Background

The Bog of the Ring Groundwater Abstraction Scheme commenced abstraction, treatment and supply to the network in July 2003. The Bog of the Ring supply is sourced from 4 No. Production Boreholes, 3 No. of which are located within or directly adjacent to the Bog of the Ring pNHA (Sitecode: 002104), and 1 No. which is located approximately 1 km west.

The Bog of the Ring pNHA, located south-west of Balbriggan, contains pockets of wet and damp ground which supports marsh and wet grassland vegetation. A number of rare plant species have been recorded within the pNHA in the past. Furthermore, the site is used in winter by Golden Plover, Whooper Swan and Short-eared owl. As marshes are few in Co. Dublin, the site is of ecological interest. Although drainage has occurred in the past, pockets of wet areas still persist (NPWS Site Synopsis. See Appendix A.1 for full copy).

An ecological assessment of the pNHA was conducted by Natural Environmental Consultants in 1999, in advance of drilling of the production wells, which was undertaken in the summer of 2000. This assessment was carried out in order to ascertain the ecological status of the wetland at that time and to provide a baseline against which potential impacts of the Groundwater Abstraction Scheme could be measured. Their report concluded that the significance of the Bog of the Ring pNHA had declined as a result of drying out of the habitats and the loss of rare plant species on the site. They considered the pNHA was probably of local ecological significance at that time (Natural Environment Consultants, 1999).

In August 2004, Natural Environmental Consultants carried out a second habitat assessment and repeated the vegetation monitoring set up in 1999. The report concluded that the site had further dried out but that this could be down to a number of factors; short/long term climate change, local drainage and/or water abstraction. The report also stated that more positive management of the site would be required to maintain its local ecological importance (Natural Environmental Consultants, 2004).

In January 2006, TES Consulting Engineers (now part of TOBIN Consulting Engineers) undertook a habitat assessment of the site and concluded that in comparison with the summer 1999 assessment, the main habitat type 'Wet Grassland' did not appear to have declined significantly (TES Consulting Engineers, 2006) but recommended that the monitoring programme established in 1999 be repeated to give a more robust assessment of any change occurring to the ecological status of the site.

2 BASELINE ECOLOGICAL SURVEYS

Natural Environment Consultants undertook a baseline ecological assessment of the Bog of the Ring pNHA in 1999. The following surveys were undertaken as part of this assessment:

- Phase 1 habitat assessment in accordance with the JNCC Phase 1 Habitat Survey Methodology (Anon, 1993),
- Selected hedgerow survey using the Hedgerow Evaluation and Grading System (HEGS) (Clements and Tofts, 1992),
- Detailed description of vegetation of the main habitats within the site following the National Vegetation Classification (NVC) (Rodwell, 1992). Different vegetation types were mapped using aerial photography.
- Setup of a vegetation monitoring programme to monitor changes in vegetation over time. Permanent square 2m x 2m quadrats were installed and percentage cover and abundance values were measured using Braun Blanquet and DAFOR scales.
- Breeding birds observed within the site were recorded. Earlier records were referenced.

In 2004 Natura Environmental Consultants repeated the work carried out in 1999. Since 1999, a new system of classifying habitats found in Ireland had been developed by the Heritage Council (*A Guide to the Habitats of Ireland*, Fossitt 2000). The assessment in 2004 used this system to compare with the classification used in 1999. In addition, Natura made comment on the National Vegetation Classification (NVC) communities present on the site. TES in January, 2006 carried out a habitat assessment based on Fossitt.

3 CURRENT ASSESSMENT

3.1 Habitat Assessment

The habitat assessment was conducted on August 14th and 29th 2006 in accordance with The Heritage Council's Draft methodology, *A Standard Methodology for Habitat Survey and Mapping in Ireland* (Natura, 2002) and habitats were classified according to The Heritage Council's *A Guide to Habitats in Ireland* (Fossitt, 2000). The classification of habitats according to this Guide is primarily based on the combination of plant species that occur in a particular area. The 1999 ecological assessment employed the JNCC Phase 1 Habitat Survey methodology (Anon, 1993). Table 4.1 summarises the habitats currently within the pNHA, with the approximate equivalent 1999 classification. Aerial photography (2000) was employed to aid delineation of habitat types. Plant identification principally follows Webb et al. (1996). Each species recorded was given a DAFOR rating (i.e. D = Dominant, A = Abundant, F = Frequent, O = Occasional, R = Rare; LD = Locally Dominant; LA = Locally Abundant) indicating its abundance within the area under investigation.

For direct comparison with previous reports, the pNHA was subdivided into 7 No. blocks. A description of the habitats and vegetation of each block are presented in Appendix A.2.

3.2 Survey Constraints

The assessment was carried out on two dates in August. It is possible, therefore, that some plant

species may have been overlooked or under-recorded due to seasonal factors. The dense vegetation growth in some areas of the site restricted access and also will have obscured some species growing as an understorey to the tall rank vegetation. The fields in the northern section of block 5 were not visited.

4 HABITAT ASSESSMENT

4.1 Site Description

The Bog of the Ring pNHA is located approximately 4 km southwest of Balbriggan, Co. Dublin, at an approximate elevation of 40 m.O.D. The pNHA covers a linear area approximately 2 km in length and 51 ha in area. A relatively flat low-lying site with impeded drainage and organic rich clay, the site was drained approximately 30 years ago leading to overall drying out of the habitat. However, the area still has pockets of marsh grassland habitat. The construction of the M1 motorway converted approximately 1.5 ha of pNHA habitat to built-up and landscaped habitats, and isolated a sliver of land to the east of the motorway (approximately 1 ha) from the remainder of the pNHA.

Table 4.1 summarises the habitat categories recorded within the pNHA, together with the approximate equivalent 1999 classification. Figure 1 presents the current extent and classification within the pNHA.

Table 4.1. Summary of Habitats, with JNCC approximate equivalent classification.

Habitats (Fossitt, 2000)	Habitats 1999 (Natural Environment Consultants)
Wet Grassland (GS4)	Marshy Grassland
Dry Meadows and Grassy Verges (GS2)	Unimproved Grassland
Improved Agricultural Grassland (GA1)	Improved Grassland
Spoil and Bare Ground (ED2)	Disturbed Ground
Amenity Grassland (GA2)	
Hedgerow (WL1)	Hedge
Treeline (WL2)	
Depositing/Lowland Rivers (FW2)	Watercourse
Drainage Ditch (FW4)	Watercourse

4.2 Wet Grassland (GS4)

This habitat type covers the greatest area within the site and Wet Grassland occurs in all of the blocks except for block 2. This habitat is characterised by an abundant growth of either grass or rush species which make up 50% or more of the plant cover. In blocks 3 and 4, *Phalaris arundinacea* is the dominant species, whereas in blocks 5, 6 and 7 there is more of a mosaic with common rush (*Juncus effusus*) (abundant) and yellow flag (*Iris pseudacorus*) (abundant). Block 5 also shows a noticeable increase in the occurrence of hard rush (*Juncus inflexus*) (abundant). Block 1 has a different mosaic with yellow flag (abundant), meadowsweet (*Filipendula ulmaria*) (locally dominant) and jointed rush (*Juncus articulatus*) (abundant) showing up in the ungrazed area. The grazed section of block 1 shows

a higher percentage of grass species, demonstrating the influence of grazing.

Grazing also has a noticeable effect with a difference in the structure of the vegetation in blocks 3 and 4 (no grazing) and blocks 5, 6 and 7 (cattle grazing). Blocks 3 and 4 are dominated by a rank growth of *Phalaris*. Beneath the *Phalaris* is an understorey of other grass species, most noticeably, fiorin grass (*Agrostis stolonifera*) that forms a mat of vegetation beneath the *Phalaris*. Some scrub growth is also apparent in block 4 with three clumps of willow (*Salix* sp.). Field bindweed (*Convolvulus arvensis*) grows through the tall vegetation in blocks 3 and 4, particularly close to the road. The tall, rank vegetation also creates conditions for lesser stitchwort (*Stellaria graminea*) to grow up through the tussocks of vegetation.

Block 5 is the most closely grazed block and this has produced a mosaic of short grazed grass with hard rush and yellow flag. The grass species are chiefly Yorkshire fog (*Holcus lanatus*), rye-grass (*Lolium perenne*) and rough meadow grass (*Poa trivialis*). Creeping thistle (*Cirsium arvense*) is abundant throughout this block.

Blocks 6 and 7 are similar to block 5 in terms of species composition but the structure is different due to a much lower grazing pressure. The northern section of block 6 has a high density of clumps of yellow flag. The southern section has a higher species mix with tufted hair-grass (*Deschampsia cespitosa*) abundant and *Holcus mollis* occurs.

All of the areas that have the Wet Grassland habitat have scattered mounds with nettle (*Urtica dioica*) or willowherb (*Epilobium* sp.) growing on the mounds, indicating localised enrichment. Blocks 3, 4, 5 and 6 also have spoil mounds from the ditch or stream cleaning operations. These mounds have been colonised by plants such as nettle, creeping thistle, bramble (*Rubus fruticosus* agg.) and cock's foot grass (*Dactylis glomerata*)

Other characteristic wetland species were recorded including water mint (*Mentha aquatica*), silverweed (*Potentilla anserina*), purple loosestrife (*Lythrum salicaria*) and *Glyceria* sp.

4.3 Dry Meadows and Grassy Verges (GS2)

This habitat type occupies small areas on the slightly higher ground adjacent to the Wet Grassland. It occurs in blocks 3, 4, 6 and 7. These areas are dominated by grassland species, particularly Yorkshire fog (abundant) and dog's tail (*Cynosuros cristatus*) (occasional). Where grazing is low or absent, a tussocky vegetation develops consisting of cock's foot (locally frequent) and false oat grass (*Arrhenatherum elatius*) (occasional). Other grass species recorded were fiorin grass, rough meadow grass and red fescue (*Festuca rubra*).

Broadleaved herbs found include sorrel (*Rumex acetosa*), ribwort plantain (*Plantago lanceolata*), vetches (*Vicia* sp.), knapweed (*Centaurea nigra*) and hogweed (*Heracleum sphondylium*).

4.4 Improved Agricultural Grassland (GA1)

Three areas of this habitat type were found within the site, two in block 5 and one in block 6. The

largest area of Improved Agricultural Grassland lies to the north of the ditch that runs through the middle of block 5. The land here appears to be rising away from the ditch perhaps leading to improved drainage of the land. This block is well grazed and has a very short sward. It appears to have been topped recently. In the western section of block 5 is a small field that is dominated by rye-grass. The sward height was about 20 cm suggesting that this field had been cut earlier in the season and had subsequently regrown. The third area is a small field at the eastern end of block 6 and is well grazed.

These areas are characterised by a grassy sward that is dominated by rye-grass with occasional Yorkshire fog. Common rush may be present but is scarce. Buttercups (*Ranunculus* spp.), daisy (*Bellis perennis*), ragwort (*Senecio jacobaea*), creeping thistle and docks (*Rumex* spp.) occur occasionally.

4.5 Spoil and Bare Ground (ED2)

There is only one small area of this habitat type; in the southeastern part of block 6. Spoil has been formed into a level area with some of this spoil formed into screening banks around the area. Some ornamental conifers have been planted on these banks.

4.6 Amenity Grassland (GA2)

The whole of block 2 now makes up this habitat type. In 1999, this area was recorded as disturbed ground. It has subsequently been levelled and seeded to form a sports pitch. It is dominated by a close sward of rye-grass with occasional broadleaved weed species; white clover (*Trifolium repens*), red bartsia (*Odontites vernus*) and docks (*Rumex* sp.)

4.7 Hedgerow (WL1)

Three hedgerows were recorded, one of these was also recorded as part of the hedgerow assessment (see 6. below). The main tree species occurring in these hedgerows are hawthorn (*Crataegus monogyna*), ash (*Fraxinus excelsior*), sycamore (*Acer pseudoplatanus*), elm (*Ulmus procera*) and blackthorn (*Prunus spinosa*). Other tree species include sally (*Salix cinerea*), osier (*S. viminalis*), elder (*Sambucus nigra*) and alder (*Alnus glutinosa*). Some of these trees, particularly ash, can be quite mature and reach over 10m in height. The majority of these hedgerows have not been managed in the recent past and can be up to 12m in height and 6m wide. The shrub component of the hedgerows is dominated by bramble and smaller hawthorn; gorse (*Ulex europeus*) also forms a major component in parts. The ground flora varies from a sparse to more developed composition with the occurrence of woodland plants such as ivy (*Hedera helix*), cow-parsley (*Anthriscus sylvestris*) and ferns, hart's tongue (*Asplenium scolopendrium*) and *Polystichum setiferum*.

4.8 Treeline (WL2)

There are two forms of treeline recorded on this site. One type is planted treelines and these are found around the sports pitches and range in height from approximately 3 m to 7 m. Tree species include ash, oak (*Quercus robur*), silver birch (*Betula pendula*) and alder.

The second type is overgrown hedges that have now reached a height where they no longer are classed as hedgerows. One of these forms the southern boundary of block 6. It has a mix of species including very tall ash (can attain a height of 20m), blackthorn, elder, osier and conifer species. It is growing on a bank and at the base of the bank is a ditch, at the eastern end, the ditch is dry but to the west it holds running water. The bank supports nettle, bramble, horsetails (*Equisetum* sp.), *Angelica sylvestris* and the fern *Polystichum setiferum*. This treeline has an overall height of 10-15m and up to 10m wide.

An overgrown hedge on the northern side of block 7 has now been classed as a treeline. It is dominated by ash and hawthorn, and again, some of the ash have grown into mature trees. Alder and elder also occur. Bramble dominates the understorey and in places the bramble has expanded out in to the field itself. The overall height of this hedge is 10m and width is 4m, although where the bramble spills out onto the field, it is considerably wider.

4.9 Depositing/lowland river (FW2)

A small stream occurs on site and flows in a west east direction. It runs through the middle of block 6 and continues on to form the southern boundary of blocks 2, 3 and 4. It has been cleaned out in the recent past and the spoil has been put on the adjacent field. In general, the stream is 2-3m wide with steep sided banks. There is little water depth, at most 10cm with only a moderate water flow. Vegetation growth varies. In the most part there is no vegetation but some sections are almost choked with the growth of *Phalaris* or fool's water cress (*Apium nodiflorum*). The substrate is chiefly muddy silt and is the chief basis for this stream being classed in the depositing/lowland river habitat type.

4.10 Drainage Ditch (FW4)

One main drainage ditch was recorded, running through the middle of block 5. This ditch was 2-2.5m wide and water depth was up to 50cm deep with a slow flow west to east. Vegetation recorded in this ditch included *Chara* sp., duckweed (*Lemna minor*), bur reed (*Sparganium erectum*), curled pondweed (*Potamogeton crispus*) and fool's water-cress. This ditch has been cleaned out in the recent past and the spoil placed on the adjacent field. The ditch bottom substrate was silty mud.

A number of secondary ditches were present on the site but held no water and considerable vegetation growth suggesting that they only hold water during the wettest periods of the year. Particularly noticeable were the ditches running parallel to the road that runs through the middle of the site. The ditch that runs beneath the hedge that forms the eastern boundary of the northern part of block 6 had bare mud in the bottom indicating that it does hold water for longer in the year. It also had fool's water cress and celery-leaved buttercup (*Ranunculus sceleratus*) growing on the bare mud.

5 VEGETATION MONITORING

The permanent 2x2m quadrats established in 1999 by Natural Environmental Consultants, were re-surveyed. These quadrats were also surveyed in 2004 by Natura Environmental Consultants who added an additional quadrat and took GPS readings to aid with finding the quadrats in the future.

Thirteen quadrats were located within the fields and three stream/ditch side quadrats have been established. The GPS readings for all of the quadrats are given in Appendix A.3.

The quadrats were located using the GPS co-ordinates given in Natura Environmental Consultant's 2004 report. In three cases, the original wooden marker posts were re-located. The GPS reading and the wooden marker posts were taken to form the southwest corner of the 2x2m quadrat with exception of quadrat 11, where a water monitoring borehole was located alongside the wooden post. In this instance the post was taken to mark the northeast corner of the quadrat.

The vegetation was recorded using the Braun-Blanquet scale for the field quadrats. The stream/ditch side quadrats recorded both aquatic and bankside vegetation using the DAFOR scale. Appendix A.4 gives the raw data recorded for these quadrats.

In line with Natura's 2004 report, Sorensen's co-efficient of similarity (Magurran 2004) was calculated in order to compare the results obtained in this survey with the previous surveys. Table 5.1 below shows the values calculated.

Table 5.1 Calculated Sorensen's co-efficient of similarity

Quadrat number	Similarity 1999-2004	Similarity 2004-2006	Similarity 1999-2006
1	55	62	59
2	50	25	40
5	60	60	44
6	77	62	67
7	33	67	67
8	40	60	53
9	62	67	52
10	47	60	50
11	18	40	25
12	47	91	56
13	100	75	71
14	46	80	80
15 aquatic	0	0	25
bank	32	22	32
16 aquatic	66	0	0
bank	58	32	43
17 aquatic	50	29	44
bank	48	35	48

There is an obvious difference in the values obtained for the terrestrial quadrats (1-14) and the stream/ditch quadrats (15, 16 and 17).

For the terrestrial quadrats, the similarity between 2004 and 2006 is generally high, with values ranging between 25 and 91, although only two values fall below 50, giving the indication of only a

small change between 2004 and 2006. The overall similarity between 1999 and 2006 varies from 25 to 80, indicating that a greater degree of change has occurred over the seven years between surveys.

The quadrats along the watercourses show little similarity.

6 HEDGEROWS

Five hedgerows were evaluated in 1999 and revisited in 2004 and again in this study. The results and comments from 1999 and 2004 are reproduced in table 6.1 along with comments from this year's study. All five hedgerows are intact and provide good wildlife habitat. No management of these hedges has taken place since 2004.

Table 6.1 Hedgerow assessment

Hedge no.	Local ecological Value (1999)	Comments in 1999	Revisited in 2004	Revisited in 2006
H1	Moderate	Dense overgrown willow hedge with elder. Associated ditch. Good cover for birds	Hedge still present and unchanged.	Overgrown hawthorn hedge. Has fine specimens of osier and elder trees
H2	Moderate	Unmanaged hawthorn hedge >4m high with mature ash trees. Associated small stream flowing east. Shaded banks with woodland flora.	Hedge still present and unchanged. This hedge is not part of the existing NHA boundary, so could perhaps be dropped from any later surveys.	Hedge still present. An area of blackthorn scrub has now developed into the field in front of this hedge creating a scrub thicket that is good cover for birds
H3	Moderate	Overgrown hawthorn hedge >4m high with ash and sycamore trees and many climbing plants. Associated drainage ditch 2m wide with steep banks. Diverse ground flora.	This hedge spans two sides of the road and appears to be unchanged. There was no water in the streams at their base. There was a large dung heap close to the southern part of the hedge which may be polluting the	Hedge appears to have changed little. Ditch was dry at the time of recording. The spoil banks on the field are now beginning to scrub over creating almost a double hedge effect.

			stream.	
H4	High	Unmanaged hawthorn hedge over a wide ditch. Mature ash trees. Good diversity of woody species. Associated ditch with shaded woodland flora, ivy and ferns. Good cover for wildlife.	This hedge is still intact with a variety of tree species still present. There may be more <i>Rubus</i> now, which is forming a wide band in front of the hedge. This is probably due to lack of grazing pressure on the site.	This hedge again is little changed. As in 2004, the bramble growth into the field is an obvious feature.
H5	High	Unmanaged mixed hedge along a drainage ditch. Mature standard ash trees. Good diversity of shrubs and climbers. Associated ditch with flowing water. Steep banks with shaded ground flora	This hedge is still present but the flow of water in the ditch recorded in 1999 is non-existent now.	This hedge is still present and is a good mix of species.

7 RARE PLANTS

No specific search for rare plants was undertaken. Only two of the species mentioned in the 1999 report were recorded;

Teasel (*Dipsacus fullonum*). Recorded in blocks 1, 2 and 4

Celery leaved buttercup (*Ranunculus sceleratus*). Only recorded from the southern end of the ditch that forms the eastern boundary of the northern part of block 6.

8 DISCUSSION

8.1 Habitat Classification

TES Consulting Engineers (2006) concluded that there was very little difference in the types of habitat classification and their extent between the study carried out by Natural Environmental Consultants in 1999 and TES in January 2006. This current study also concurs with this conclusion. The extent of 'Wet Grassland (GS4)' has remained relatively constant; on this basis the ecological status of the site is unchanged. Figure 1 shows the extent of habitats recorded in August 2006.

There are some minor differences between the two studies. A small area at the western end of block 7 has now been classed as 'Dry Meadows and Grass Verges (GS2)' rather than 'Improved Agricultural Grassland (GA1)'. The January 2006 survey recorded several 'Hedgerows (WL1)' and some of these have now been classed as 'Treelines (WL2)'. Both of these differences probably reflect individual surveyors' interpretation of the classification as set out in Fossitt (2000) rather than a real difference. The northeastern section of block 5 was not visited in August 2006 and some of the 'Hedgerows (WL2)' previously noted in this section have not been recorded.

In January 2006, the stream was classed as 'Eroding/Upland river (FW1)' whereas this study places it in the 'Depositing/Lowland river (FW2)' class. The classification has been determined chiefly by the nature of the substrate, with gravel recorded in January and silt in August. This possibly reflects different rainfall and hence stream flow patterns between summer and winter and the low summer flows encourage silt deposition. It may also be a result of cleaning regimes and the gravel substrate being exposed following late summer/autumn cleaning of the ditch.

8.2 Vegetation monitoring

The differing values for the calculated Sorensen's co-efficient of similarity suggest that there is little change between 2004 and 2006 for the terrestrial quadrats, whereas comparison of the results from 1999 and 2006 do indicate a greater change. The raw data indicates that there is no single reason for the change shown but that there are different reasons for differing quadrats.

Quadrat 2 in block 1 is grazed by horses. Horses are selective graziers and can affect species composition. The 2006 survey also took place at a time when this area had been heavily grazed and some plant species may have been grazed so hard that they were difficult to find.

In general, the quadrats in blocks 3 and 4 are showing the effects of the abandonment of management as these areas are now rank and have not been cut or grazed for a number of years

Block 5 (quadrats 9 and 10) generally shows an increase in the abundance of grasses indicating that this area is drier now.

There are two quadrats in the southern part of block 6, quadrats 11 and 12. Quadrat 12 still contains the main species including *Juncus effusus* and *Agrostis stolonifera*, both species of wet conditions but does show a reduction in the number of species present. Quadrat 11 shows a great increase in the abundance of *Juncus effusus*, with none being recorded in 1999 but having a Braun-Blanquet cover

value of 5 (greater than 75% of the quadrat) in 2004 and 2006. This quadrat is next to one of the monitoring boreholes which is marked by a number of fence posts. Cattle may well have been attracted to this area and may have lead to an increase in trampling (and poaching in the wet periods of the year) leading to an artificially high increase in *Juncus effusus*

Quadrat 13 (in block 7) and quadrat 14 (the northern section of block 6) both show an increase in *Agrostis stolonifera* and *Juncus effusus* and a decrease in the diversity of species in the quadrat. The increase in *Juncus* may be at the expense of other species. *Juncus*, in particular, is a plant that likes wet, waterlogged winter conditions and drier summer conditions. This suggests that this section of the site is not showing increased signs of drying out.

The results from the quadrats on and adjacent to the watercourses show little similarity with previous years. This is probably down to the watercourses having been cleaned out in recent times, setting the process of succession back and changing the vegetation. The watercourses are also probably prone to wide fluctuations in water levels, again influencing the nature of the vegetation depending on the water level conditions in the preceding weeks before the survey.

8.3 Hedgerows

All of the hedgerows surveyed in the previous years are still present on the site and appear to have received no management in the intervening years. Bramble continues to dominate the understorey.

9 SUMMARY

The area of Wet Grassland (GS4) remains unchanged in comparison with the surveys carried out in 1999 and 2004.

The monitoring of the vegetation in the permanent quadrats shows that blocks 6 and 7 in the west of the site appear to be little changed. Blocks 3 and 4 are changing to a more rank vegetation but this is due to the area not being managed through grazing or cutting. The vegetation in block 5 is indicating that this area is become drier, whereas block 1 does retain its wetland vegetation.

10 RECOMMENDATIONS

The habitat classification system used in this assessment and in the TES assessment in January 2006 is Fossitt (2000). This is a very 'broad' system of classification and focuses on the main species. The National Vegetation Classification (NVC) devised by Rodwell is more detailed and records plant species in terms of communities and sub-communities and would be more suitable for recording any changes to the vegetation at Bog of the Ring. For comparison with previous surveys, Fossitt's classification should be used alongside the NVC surveys. Future surveys should be conducted every three years in order to record any changes occurring.

The monitoring of the permanent 2x2m quadrats continues to provide greater detail on any change taking place and this monitoring should be repeated every three years. The GPS readings for the

quadrats greatly aid relocating the quadrats.

The hedgerow assessment provides little information on the state of the wetland and this part of the monitoring could be dropped.

Blocks 5 and 6 would greatly benefit from the re-introduction of light levels of grazing.

11 BIBLIOGRAPHY

Anon. 1993. *Phase I Habitat Survey: A technique for environmental audit*. Joint Nature Conservation Committee. Peterborough

Fossitt, J.A. 2000. *A Guide to Habitats in Ireland*. The Heritage Council, Kilkenny, Ireland.

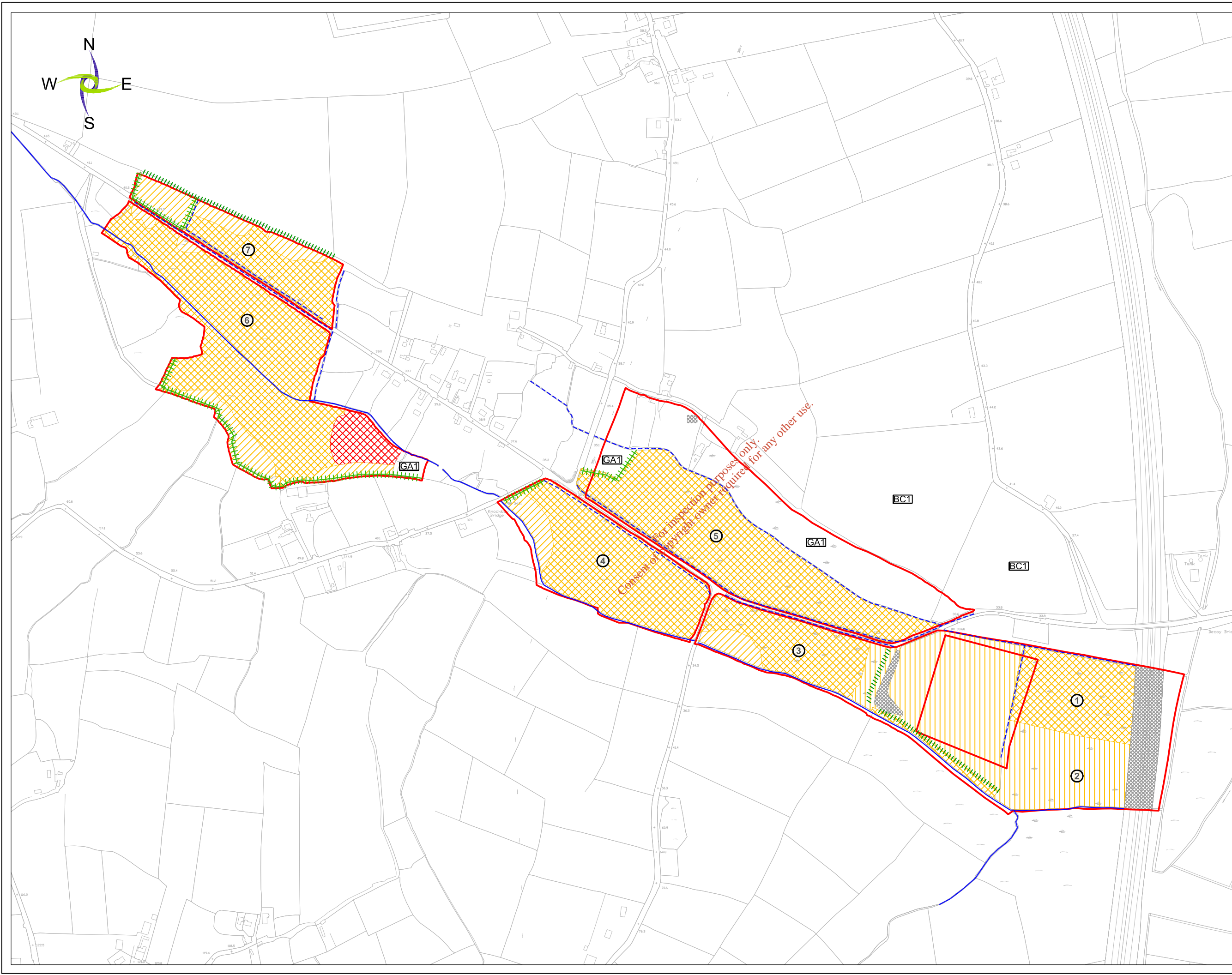
Natura Environmental Consultants. 2002. *A Standard Methodology for Habitat Survey and Mapping in Ireland*. The Heritage Council. Draft.

Natura Environmental Consultants. 2004 *Bog of the Ring. Ecological monitoring programme Year 1:2004*. For Fingal County Council

Natural Environmental Consultants. 1999. *Bog of the Ring: Baseline Ecological Surveys 1999*. For Fingal County Council.

Rodwell, J.S. (ed.) 1992. *British Plant Communities. Volume 3. Grasslands and montane communities*. Cambridge University Press.

TES Consulting Engineers. 2006. *Habitat Assessment of Bog of the Ring pNHA*. For Fingal County Council



- LEGEND**
- BOG OF THE RING PROPOSED NATURAL HERITAGE AREA BOUNDARY (SITE CODE: 001204)
 - WET GRASSLAND (GS4)
 - DRY MEADOWS AND GRASSY VERGES (GS2)
 - AMENITY GRASSLAND (IMPROVED) (GA2)
 - SPOIL AND BARE GROUND (ED2)
 - BUILDINGS AND ARTIFICIAL SURFACES (BL3)
 - 5 BLOCK NUMBERS
 - BC1 ARABLE CROPS (BC1)
 - GA1 IMPROVED AGRICULTURAL GRASSLAND (GA1)
 - DEPOSITING / LOWLAND RIVERS (FW2)
 - DRAINAGE DITCH (FW4)
 - HEDGEROWS (WL1)
 - TREELINE (WL2)

- NOTES**
1. FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING
 2. ALL DRAWINGS TO BE CHECKED BY THE CONTRACTOR ON SITE
 3. ENGINEER TO BE INFORMED BY THE CONTRACTOR OF ANY DISCREPANCIES BEFORE ANY WORK COMMENCES
 4. ALL LEVELS SHOWN RELATE TO ORDNANCE SURVEY DATUM AT MALIN HEAD

-50m 0 50m 100m 150m

Issue	Date	Description	By	Chkd.

Client:
FINGAL COUNTY COUNCIL

Project:
**GROUNDWATER MONITORING
BOG OF THE RING**

Title:
HABITAT ASSESSMENT

Scale:
1:7500

Prepared by: Michael Nolan Checked: Lisa Dowling Date: Sept. 2006

Project Director:

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Drawing No.: **FIGURE 1** Issue: **0**

APPENDIX A.1: NPWS SITE SYNOPSIS

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SITE NAME: BOG OF THE RING

SITE CODE: 001204

Bog of the Ring is situated approximately 5 km south-west of Balbriggan. It is a flat low-lying area with impeded drainage, showing signs of peat development in its upper horizons. The site was drained about thirty years ago, but still contains pockets of wet and damp ground where marsh vegetation occurs.

The greater part of the surface is covered by Yellow Iris (*Iris pseudacorus*) and Rough Meadow-grass (*Poa trivialis*), with Soft Rush (*Juncus effusus*) and Meadowsweet (*Filipendula ulmaria*) being common. Other species which occur in this dryish habitat are Great Willowherb (*Epilobium hirsutum*), Field Horsetail (*Equisetum arvense*), Angelica (*Angelica sylvestris*), Reed Canary-grass (*Phalaris arundinacea*), Purple-loosestrife (*Lythrum salicaria*) and Heath Spotted Orchid (*Dactylorhiza maculata*).

In the wetter areas, such as drainage ditches, species which have been recorded in the past include Frogbit (*Hydrocharis morsus-ranae*), Bladderworts (*Utricularia vulgaris* and *U. neglecta*), Lesser Marshwort (*Apium inundatum*), the scarce starwort (*Callitriche obtusangula*), Common Water Crowfoot (*Ranunculus aquatilis*), Unbranched Bur-reed (*Sparganium emersum*) and the stonewort *Chara hispida*. Other marshy places allow Great Yellow-cress (*Rorippa amphibium*) to grow, with Early Marsh-orchid (*Dactylorhiza incarnata*), Water purslane (*Lythrum portula*), Wild Celery (*Apium graveolens*), Bur-marigolds (*Bidens cernua* and *B. tripartita*) and Lesser Water-parsnip (*Berula erecta*).

The site is used in winter by Golden Plover, Whooper Swan (occasionally) and Short-eared Owl. Breeding species include Snipe, Skylark, Meadow Pipit, Reed Bunting, Stonechat and Sedge Warbler.

Marshes are few in County Dublin and therefore the site is of interest. Although attempts at drainage have been made in the past, isolated wet areas still exist and the site could be considerably improved by raising the water table.

The construction of Balbriggan by-pass is an immediate threat and may alter the hydrology of the site.

**APPENDIX A.2: VEGETATION DESCRIPTION OF EACH BLOCK
(2006)**

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Block 1

Three quarters of this area is unmanaged. It is dominated by meadowsweet (*Filipendula ulmaria*). Yellow flag (*Iris pseudacorus*) occurs in abundant clumps, patches of water mint (*Mentha aquatica*) can be locally frequent as can silverweed (*Potentilla anserina*). Fiorin grass (*Agrostis stolonifera*) occurs throughout the entire block and is classified as occasional. Towards the eastern side of the block, stands of jointed rush (*Juncus articulatus*) become prevalent and classed as abundant. There are occasional mounds that are slightly higher than the surrounding field layer. These mounds are dominated by nettle (*Urtica dioica*) or willowherb (*Epilobium hirsutum*), suggesting localised enrichment and that these mounds may be formed from old hay bales.

The northwestern quarter of the block has been fenced off and is horse grazed. The horse grazing has produced a very tight, grassy sward. Clumps of meadowsweet still occur but not in the same density as in the rest of this block.

Teasel (*Dipsacus fullonum*) was found growing close to the boundary with block 2. A single Irish Hare was seen in this block.

Block 2

This whole block is now managed as a sports field. It has a closely mown sward of rye-grass (*Lolium perenne*) which dominates the area. Some weed species have colonised occasional gaps within the sward. Typically, these are white clover (*Trifolium repens*), red bartsia (*Odontites vernus*) and docks (*Rumex* sp.). A triangle of waste ground to the west of this block holds some teasel plants.

Block 3

An area of grassland that is unmanaged producing rank vegetation that is dominated by *Phalaris arundinacea*. Scattered throughout the block are clumps of nettles, patches of common rush (*Juncus effusus*) and patches of yellow flag. Other species that form occasional patches are meadowsweet, hard rush (*J. inflexus*) and *Glyceria*. Purple loosestrife (*Lythrum salicaria*) indicates areas that do hold water to an extent. Lesser stitchwort (*Stellaria graminea*) is found growing through some of the clumps of tall rank vegetation.

Towards the western end of this block, the ground rises slightly and the stands of *Phalaris* are replaced by common rush and a more grassy vegetation including Yorkshire fog (*Holcus lanatus*) and false oat grass (*Arrhenatherum elatius*).

A line of spoil mounds runs alongside the stream on the southern edge of this block. This spoil has, presumably, been produced by cleaning out the stream. The mounds have been colonised by nettle, willowherb and bramble (*Rubus fruticosus* agg.).

Block 4

Block 4 is very similar to block 3. It is another area of unmanaged grassland that is dominated by tall rank vegetation, notably *Phalaris arundinacea* and common rush. Again, clumps of yellow flag are abundant. Through the northern part of this block, the vegetation becomes even more rank and field bindweed (*Convolvulus arvensis*) and nettle are abundant. Three clumps of willow (*Salix* sp.) are found in the eastern end of the block, further indicating the lack of management.

Spoil mounds, with bramble, nettle, willowherb and some hogweed (*Heracleum sphondylium*), are found along the southern edge, parallel to the stream.

The western end of the block rises slightly as it nears a minor road. The drier conditions within this section are indicated by the presence of Yorkshire fog and tufted hair-grass (*Deschampsia cespitosa*). Common rush is now more abundant than *Phalaris*.

Block 5

This block is split in two by a ditch. Both sections of the block are cattle grazed. The northern part was not visited but appears to be improved grassland with little in the way of broadleaved species. It is well managed and has been topped recently. Cattle were present in the field at the time of recording.

The southern section is 'rougher' and has not been topped. Again, cattle were present in the block at the time of recording. This area has close grazed grass, chiefly rye-grass and Yorkshire fog, interspersed with abundant clumps of yellow flag and hard rush. Creeping thistle (*Cirsium arvense*) is abundant throughout this southern section of the block and particularly on the spoil mounds running in parallel to the stream that runs through the middle of this block.

A small field at the western end of this block is managed by cutting for hay/silage and the sward is dominated by rye-grass. The hedge growing around this field is hedge 1 in the hedgerow assessment.

Block 6

One of the two blocks lying to the west of the higher patch ground that splits the site in two. A stream splits this block into a northern and a southern section.

Much of this block is cattle grazed but is not topped. Levels of stock grazing are not high, producing an area with a lightly grazed grassland component interspersed with clumps of taller, coarser vegetation. The grassland species are chiefly Yorkshire fog, fiorin grass and rough meadow grass (*Poa trivialis*). The clumps of coarser vegetation are tussocks of common rush and tufted hair grass. Patches of nettle and creeping thistle are frequent. Yellow flag is also abundant in the northern section, less so in the south.

An area of bare ground and spoil lies in the eastern part of the southern section and appears to be an area of hard standing for lorries. An attempt has been made to provide screening bunds with conifers planted on banks. A small field of improved grassland lies to the east of this area.

The land rises along the southern boundary of the block and gives rise to a dry grassland type which is heavily grazed.

Block 7

This is a similar area to block 6 but is more heavily grazed, the main difference being that *Phalaris* is

dominant in this block, along with common rush. Clumps of nettle are abundant particularly around the edges of the field indicating localised enrichment, some of these clumps are growing on spoil from cleaning out the ditches.

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**APPENDIX A.3: GPS READINGS FOR THE PERMANENT 2X2M
QUADRATS**

From Natura Environment Consultants (2004)

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Block	Quadrat number	Irish Grid Ref. 2004
1	1	IO 18459 59957
	2	IO 18408 59988
3	5	IO 17952 60050
	6	IO 17798 60094
4	7	IO 17651 60147
	8	IO 17560 60231
	16	IO 17691 60082
5	9	IO 17976 60159
	10	IO 17628 60327
	17	IO 17990 60179
6	11	IO 16957 60488
	12	IO 16886 60495
	14	IO 16822 60746
	15	IO 16764 60698
	13	IO 16870 60805
7	13b	IO 16822 60851

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**APPENDIX A.4: FIELD DATA FOR THE PERMANENT 2X2M
QUADRATS (2006)**

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Plant species cover for the 13 terrestrial quadrats was measured using the Braun Blanquet Cover-Abundance Scale:

5 = any number with cover more than $\frac{3}{4}$ of the 2x2m quadrat (>75%)

4 = any number with $\frac{1}{2}$ to $\frac{3}{4}$ cover (50-75%)

3 = any number with $\frac{1}{4}$ to $\frac{1}{2}$ cover (25-50%)

2 = any number with $\frac{1}{20}$ to $\frac{1}{4}$ cover (5-25%)

1 = numerous but less than $\frac{1}{20}$ cover or scattered cover up to $\frac{1}{20}$ (5%)

+ = few, with small cover

r = solitary, with small cover

The DAFOR scale was used for the three quadrats along the watercourses:

D = Dominant

A = Abundant

F = Frequent

O = Occasional

R = Rare

This follows the methods used in the baseline monitoring established by Natural Consultants (1999).

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Quadrat no.	Plant Species	Braun-Blanquet value
Block 1, quadrat 1	<i>Carex</i> sp.	4
	<i>Iris pseudacorus</i>	3
	<i>Potentilla anserina</i>	2
	<i>Holcus lanatus</i>	+
	<i>Poa trivialis</i>	+
	<i>Juncus articulatus</i>	+

Quadrat no.	Plant Species	Braun-Blanquet value
Block 1, quadrat 2	<i>Holcus lanatus.</i>	4
	<i>Iris pseudacorus</i>	3
	<i>Filipendula ulmaria</i>	2
	<i>Carex</i> sp.	+

Quadrat no.	Plant Species	Braun-Blanquet value
Block 3, quadrat 5	<i>Holcus lanatus.</i>	3
	<i>Agrostis stolonifera</i>	2
	<i>Phalaris arundinacea</i>	2
	<i>Holcus mollis</i>	1

Quadrat no.	Plant Species	Braun-Blanquet value
Block 3, quadrat 6	<i>Arrhenatherum elatius.</i>	4
	<i>Filipendula ulmaria</i>	2
	<i>Lathyrus palustris</i>	2
	<i>Holcus lanatus</i>	2
	<i>Agrostis stolonifera</i>	1
	<i>Potentilla anserina</i>	1
	<i>Stellaria graminea</i>	+

Quadrat no.	Plant Species	Braun-Blanquet value
Block 4, quadrat 7	<i>Filipendula ulmaria.</i>	4
	<i>Agrostis stolonifera</i>	3
	<i>Holcus lanatus</i>	2
	<i>Arrhenatherum elatius.</i>	1
	<i>Equisetum palustre</i>	1
	<i>Holcus mollis</i>	+
	<i>Ranunculus repens</i>	+

Quadrat no.	Plant Species	Braun-Blanquet value
Block 4, quadrat 8	<i>Phalaris arundinacea</i>	4
	<i>Convolvulus arvensis</i>	4
	<i>Holcus lanatus</i>	2
	<i>Equisetum palustre</i>	+
	<i>Agrostis stolonifera</i>	+

Quadrat no.	Plant Species	Braun-Blanquet value
Block 5, quadrat 9	<i>Iris pseudacorus</i>	4
	<i>Agrostis stolonifera</i>	3
	<i>Holcus lanatus</i>	3
	<i>Poa trivialis</i>	2
	<i>Potentilla anserina</i>	2
	<i>Trifolium repens</i>	2
	<i>Lolium perenne</i>	1
	<i>Ranunculus repens</i>	+
	<i>Cirsium arvense</i>	+
	<i>Lathyrus palustris</i>	+

Quadrat no.	Plant Species	Braun-Blanquet value
Block 5, quadrat 10	<i>Agrostis stolonifera</i>	4
	<i>Juncus effusus</i>	3
	<i>Poa trivialis</i>	3
	<i>Holcus lanatus</i>	3
	<i>Arrhenatherum elatius.</i>	2
	<i>Trifolium repens</i>	1
	<i>Filipendula ulmaria</i>	+
	<i>Cirsium arvense</i>	+
	<i>Lathyrus sp.</i>	+
	<i>Stellaria graminea</i>	+
	<i>Taraxacum officinale agg.</i>	+
	<i>Equisetum palustre</i>	+

Quadrat no.	Plant Species	Braun-Blanquet value
Block 6, quadrat 11	<i>Juncus effusus</i>	5
	<i>Arrhenatherum elatius</i>	3
	<i>Agrostis stolonifera</i>	1
	<i>Urtica dioica</i>	1

Quadrat no.	Plant Species	Braun-Blanquet value
Block 6, quadrat 12	<i>Juncus effusus</i>	4
	<i>Agrostis stolonifera</i>	3
	<i>Holcus lanatus</i>	2
	<i>Alopecurus pratensis</i>	2
	<i>Holcus mollis</i>	2
	<i>Poa trivialis</i>	1

Quadrat no.	Plant Species	Braun-Blanquet value
Block 7, quadrat 13	<i>Juncus effusus</i>	3
	<i>Holcus lanatus</i>	3
	<i>Agrostis stolonifera</i>	2
	<i>Alopecurus pratensis</i>	1
	<i>Urtica dioica</i>	1
	<i>Poa trivialis</i>	1
	<i>Iris pseudacorus</i>	+

Quadrat no.	Plant Species	Braun-Blanquet value
Block 7, quadrat 13b	<i>Juncus effusus</i>	4
	<i>Iris pseudacorus</i>	3
	<i>Agrostis stolonifera</i>	3
	<i>Alopecurus pratensis</i>	2

Quadrat no.	Plant Species	Braun-Blanquet value
Block 6, quadrat 14	<i>Juncus effusus</i>	5
	<i>Agrostis stolonifera</i>	3
	<i>Holcus lanatus</i>	2
	<i>Poa trivialis</i>	1
	<i>Holcus mollis</i>	+

Quadrat no.	Plant Species	DAFOR value
Block 6, quadrat 15	Aquatic vegetation	
	<i>Nasturtium officinale</i>	F
	<i>Rumex crispus</i>	R
	<i>Epilobium hirsutum</i>	R
	Bankside vegetation	
	<i>Agrostis stolonifera</i>	A
	<i>Rubus fruticosus</i> agg	F
	<i>Arrhenatherum elatius</i>	O
	<i>Sparganium</i> sp	R

	<i>Holcus lanatus</i>	R
	<i>Sonchus sp</i>	R

Quadrat no.	Plant Species	DAFOR value
Block 4, quadrat 16	Aquatic vegetation	
	<i>Nasturtium officinale</i>	R
	<i>Agrostis stolonifera</i>	R
	Bankside vegetation	
	<i>Urtica dioica</i>	A
	<i>Convolvulus arvensis</i>	A
	<i>Poa trivialis</i>	F
	<i>Phalaris arundinacea</i>	F
	<i>Arrhenatherum elatius</i>	F
	<i>Filipendula ulmaria</i>	O
	<i>Rumex obtusifolius</i>	O
	<i>Cirsium vulgare</i>	R
	<i>Cirsium arvense</i>	R

Quadrat no.	Plant Species	DAFOR value
Block 5, quadrat 17	Aquatic vegetation	
	<i>Lemna minor</i>	A
	Filamentous algae	A
	<i>Nasturtium officinale</i>	O
	<i>Polygonum bistorta</i>	R
	<i>Mentha aquatica</i>	R
	Bankside vegetation	
	<i>Filipendula ulmaria</i>	A
	<i>Carex sp.</i>	O
	<i>Trifolium repens</i>	O
	<i>Agrostis stolonifera</i>	O
	<i>Cirsium arvense</i>	R
	<i>Epilobium hirsutum</i>	R
	<i>Galium palustre</i>	R
	<i>Convolvulus arvensis</i>	R

Appendix B

Borehole Logs

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WELL LOG

Well Ident PW1	Description Bog of the Ring	Location Decoy Bridge
Drill. Method		Drill. Dates
Easting	Northing	Elevation
Meas. Pt. Elev.		

*All diameters in mm
All depths in metres*

Water Level (mOD)	Level-Date	Vertical 450.0	Horizontal 50.0
--------------------------	-------------------	--------------------------	---------------------------

Depth [m]	Hole	Annulus	Casing	Screen	Lithology	Elev. [m]
5	750				Fill material	-5
	4.6					
10					Black BOULDER CLAY	-10
15		Gravel Pack			Clayey GRAVEL	-15
					INFLOW	-17
						-19
25	600				Clayey Gravel	-25
30			30	27		-30
35					Soft, brown weathered LIMESTONE	-35
			250		INFLOW	-36.6
						-38
						-39.5
40					Soft, brown weathered LIMESTONE	-40
	42.7				Solid, grey LIMESTONE	-42.7
45						-45
						-47.2
50						-50
55					Solid, grey LIMESTONE	-55
60	375					-60
65					COMMENTS 400 mm steel casing withdrawn from 42m to 27m, to allow inflow from the gravels.	-65
70						-70
75	75		75	73		-75
80						-80

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WELL LOG

Well Ident PW2	Description Bog of the Ring	Location Balrickard
Drill. Method		Drill. Dates
Easting	Northing	Elevation
<i>All diameters in mm All depths in metres</i>		

Water Level (mOD)	Level-Date	Vertical 450.0	Horizontal 50.0
--------------------------	-------------------	--------------------------	---------------------------

Depth [m]	Hole	Annulus	Casing	Screen	Lithology	Elev. [m]
5	750 6.1				Blue, sticky BOULDER CLAY	-5
10	600				Clayey GRAVEL	-10
15						-15
20	18.3			16		-20
25		Gravel Pack	300		Solid, dark grey LIMESTONE	-25
30						-30
35						-35
40						-40
45					Soft, weathered, shaley LIMESTONE	-45
46					INFLOW	-46
50	425		52	52	Soft, weathered, shaley LIMESTONE	-50
55						-55
60					Solid, dark grey LIMESTONE	-60
65		Borehole collapsed				-65
66					INFLOW	-66
67.5						-67.5
70					Solid, dark grey LIMESTONE	-70
75					Comments: 450 mm steel casing set to 18.6m Borehole collapsed to 52m due to soft rock and large inflows.	-75
80	79.3		79.3			-80

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WELL LOG

Well Ident PW3	Description Bog of the Ring	Location Knockboy
Drill. Method		Drill. Dates
Easting	Northing	Elevation
<i>All diameters in mm All depths in metres</i>		

Water Level (mOD)	Level-Date	Vertical 350.0	Horizontal 50.0
--------------------------	-------------------	--------------------------	---------------------------

Depth [m]	Hole	Annulus	Casing	Screen	Lithology	Elev. [m]
750						-5
5	6.1				Gravelly BOULDER CLAY	
10						-10
15	600			14	Sandy, clayey GRAVEL	-15
					INFLOW	
					Sandy, clayey GRAVEL	
20						-20
25	24.4	Gravel Pack	300			-25
30					Soft, Black shaley LIMESTONE	-30
35					COMMENTS: 450 mm steel casing set to 24.4m	-35
40	425					-40
45						-45
					INFLOW - Cavity - collapsing.	
50					Soft, black shaley LIMESTONE	-50
55	53		53	53		-55
60						-60

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WELL LOG

Well Ident PW4	Description Bog of the Ring	Location Curragh East
Drill. Method		Drill. Dates
Easting	Northing	Elevation
<i>All diameters in mm All depths in metres</i>		

Water Level (mOD)	Level-Date	Vertical 510.0	Horizontal 50.0
--------------------------	-------------------	--------------------------	---------------------------

Depth [m]	Hole	Annulus	Casing	Screen	Lithology	Elev. [m]
750	5.2				Brown, BOULDER CLAY	
10					9.1 10 12 INFLOW	-10
600					Sandy, clayey GRAVEL	-20
20					24.4 Soft weathered brown LIMESTONE	
24.4					28 29.5 30.5 INFLOW	-30
30				36	Solid, grey, LIMESTONE	-40
40					42.7 44 46 Soft, weathered grey LIMESTONE INFLOW	
50		Gravel Pack	250		Soft, weathered, grey LIMESTONE	-50
60	425				54.9 Solid, grey LIMESTONE	-60
70					60.96 Weathered grey LIMESTONE	-70
80					67.1 Weathered, brown LIMESTONE	-80
90	91.4		91.4	89	76.2 Grey & brown LIMESTONE	-90
					88.4 Solid grey LIMESTONE	
					91.4	

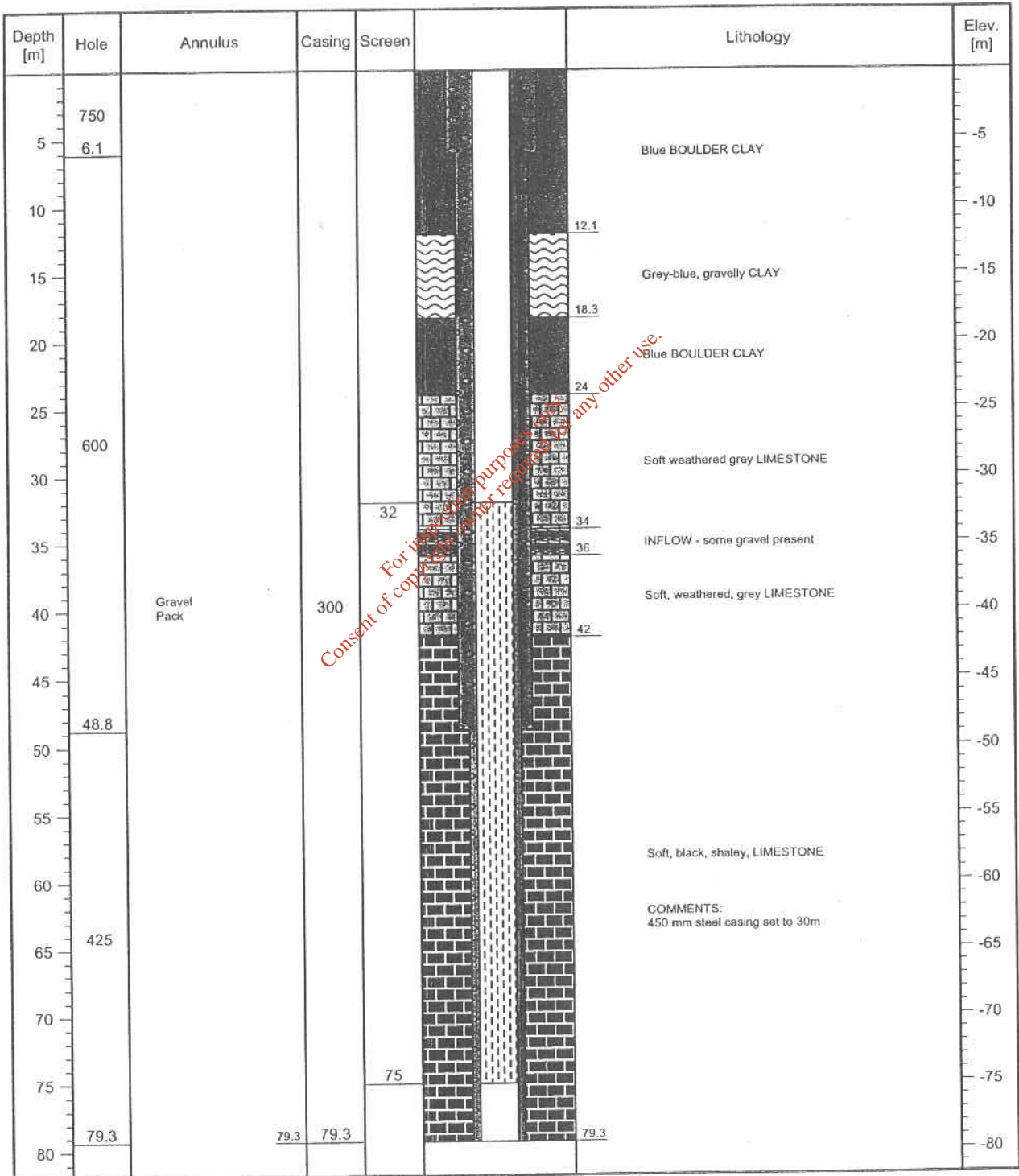
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COMMENTS:
450mm steel casing set to 24.4m

WELL LOG

Well Ident PW5	Description Bog of the Ring	Location Killougher
Drill. Method		Drill. Dates
Easting	Northing	Elevation
<i>All diameters in mm All depths in metres</i>		

Water Level (mOD)	Level-Date	Vertical 450.0	Horizontal 50.0
--------------------------	-------------------	--------------------------	---------------------------



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WELL LOG

Well Ident 1872/OW1	Description Deep Piezometer	Location Bog of the Ring
Drill. Method		Drill. Dates
Easting	Northing	Elevation
Meas. Pt. Elev.		

*All diameters in mm
All depths in metres*

Water Level (mOD)	Level-Date	Vertical 240.0	Horizontal 40.0
--------------------------	-------------------	--------------------------	---------------------------

Depth [m]	Hole	Annulus	Casing	Screen	Lithology	Elev. [m]
2	300		1		Medium brown CLAY with occasional pebbles	-2
4						-4
6	6.1				Softer brown CLAY	-6
8					Brown BOULDER CLAY	-8
10					CLAY with some gravel	-10
12						-12
14						-14
16	200	Gravel Pack			SAND and GRAVEL deposits	-16
18						-18
20						-20
22			50			-22
24						-24
26	25.6					-26
28						-28
30					Tight Blue CLAY	-30
32			32			-32
34	150		33		Fractured LIMESTONE bedrock	-34
36						-36
38		Gravel Pack		37.3	Solid LIMESTONE	-38
40					Comments: Estimated yield of 1000gph+ 150mm Steel casing set to 30m & slotted from 10.7 to 16.8m	-40
42	43.3		43.3	43.3		-42

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WELL LOG

Well Ident 1872/OW1 S	Description Shallow Piezometer	Location Bog of the Ring	
Drill. Method		Drill. Dates	
Easting	Northing	Elevation	Meas. Pt. Elev.

*All diameters in mm
All depths in metres*

Water Level (mOD)	Level-Date	Vertical 200.0	Horizontal 40.0
--------------------------	-------------------	--------------------------	---------------------------

Depth [m]	Hole	Annulus	Casing	Screen	Lithology	Elev. [m]
		Bentonite seal	1			
2					Medium brown CLAY with occasional pebbles	-2
300						-4
4						-6
6	6.1				Softer brown CLAY	-6
						-8
8					Brown BOULDER CLAY	-8
						-10
10					CLAY with some gravel	-10
						-12
12						-14
14						-16
16	200	Gravel Pack	50		SAND & GRAVEL deposits	-16
18						-18
20						-20
22						-22
24						-24
26	25.6					-26
				26.3		-28
28						-28
30	150				Tight blue CLAY	-30
						-32
32	32.3		32.3	32.3		-32
						-34
34						-34
36						-36

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COMMENTS:
150mm Steel casing set to 30m & slotted from 10.7m to 16.7m.

WELL LOG

Well Ident 1872/OW2	Description Deep Piezometer	Location Bog of the Ring
Drill. Method		Drill. Dates
Easting	Northing	Elevation
Meas. Pt. Elev.		

*All diameters in mm
All depths in metres*

Water Level (mOD)	Level-Date	Vertical 200.0	Horizontal 40.0
--------------------------	-------------------	--------------------------	---------------------------

Depth [m]	Hole	Annulus	Casing	Screen	Lithology	Elev. [m]
2		Bentonite seal				-2
300		1			Medium brown CLAY with occasional pebbles	-4
6	6.1					-6
7.62						-7.62
10		Gravel Pack				-10
12					Clayey GRAVEL	-12
14	200					-14
16						-16
18						-18
19.2						-19.2
20		Bentonite seal			Blue BOULDER CLAY	-20
20.7		20				-20.7
21		21				-21
23.8						-23.8
24						-24
26					Solid grey LIMESTONE	-26
28		Gravel Pack				-28
30	150				Comments: Estimated yield of 400gph. 150mm Steel casing set to 23.8m & slotted from 12.2m to 18.3m.	-30
30.5						-30.5
32						-32
34						-34
36						-36

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WELL LOG

Well Ident 1872/OW2	Description Deep Piezometer	Location Bog of the Ring	
Drill. Method		Drill. Dates	
Easting	Northing	Elevation	Meas. Pt. Elev.

*All diameters in mm
All depths in metres*

Water Level (mOD)	Level-Date	Vertical 200.0	Horizontal 40.0
--------------------------	-------------------	--------------------------	---------------------------

Depth [m]	Hole	Annulus	Casing	Screen	Lithology	Elev. [m]
38						-38
40						-40
42						-42
44						-44
46						-46
48						-48
50						-50
52						-52
54						-54
56						-56
58						-58
60						-60
62						-62
64						-64
66						-66
68						-68
70						-70
72						-72

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WELL LOG

Well Ident 1872/OW2 S	Description Shallow Piezometer	Location Bog of the Ring
Drill. Method		Drill. Dates
Easting	Northing	Elevation
		Meas. Pt. Elev.

*All diameters in mm
All depths in metres*

Water Level (mOD)	Level-Date	Vertical 150.0	Horizontal 40.0
--------------------------	-------------------	--------------------------	---------------------------

Depth [m]	Hole	Annulus	Casing	Screen	Lithology	Elev. [m]
		Bentonite seal	1			
2						-2
300					Medium brown CLAY with occasional pebbles	-4
4						-6
6	6.1					-6
8						-8
10			50			-10
12		Gravel Pack			Clayey GRAVEL	-12
200						-14
14				14.7		-14
16						-16
18						-18
20						-20
20.7	20.7		20.7	20.7	Blue BOULDER CLAY	-20.7
22						-22
24						-24
26						-26

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COMMENTS:
150mm steel casing set to 20.7m and slotted from 12.2 to 18.3m.

WELL LOG

Well Ident 1872/OW3	Description Deep Piezometer	Location Bog of the Ring
Drill. Method		Drill. Dates
Easting	Northing	Elevation
<i>All diameters in mm All depths in metres</i>		

Water Level (mOD)	Level-Date	Vertical 250.0	Horizontal 40.0
--------------------------	-------------------	--------------------------	---------------------------

Depth [m]	Hole	Annulus	Casing	Screen	Lithology	Elev. [m]
2			1			-2
4	300				Medium brown CLAY	-4
6	6.1	Gravel Pack				-6
8					Sandy, Gravelly CLAY	-8
10	200		9.5			-10
12	12.2		10.5			-12
14						-14
16						-16
18						-18
20						-20
22			50			-22
24					Grey/blue LIMESTONE	-24
26						-26
28	150	Gravel Pack				-28
30						-30
32						-32
34						-34
36						-36
38				36.6		-38
40						-40
42	42.7		42.7	42.7		-42
44						-44

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COMMENTS:
150mm Steel casing set to 12.2m
& slotted from 6.1 to 9.1m.

WELL LOG

Well Ident 1872/OW3 S	Description Shallow Piezometer	Location Bog of the Ring
Drill. Method		Drill. Dates
Easting	Northing	Elevation
Meas. Pt. Elev.		

*All diameters in mm
All depths in metres*

Water Level (mOD)	Level-Date	Vertical 65.0	Horizontal 40.0
-------------------	------------	------------------	--------------------

Depth [m]	Hole	Annulus	Casing	Screen	Lithology	Elev. [m]
1		Bentonite seal	1			-1
2						-2
3	300				Medium brown CLAY	-3
4				3.75		-4
5			50			-5
6	6.1	Gravel Pack				-6
7						-7
8	200				Sandy, Gravelly CLAY	-8
9						-9
10	9.75		9.75	9.75		-10
11						-11

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COMMENTS:
150mm Steel casing set to 12.2 and slotted from 6.1 to 9.1m.

WELL LOG

Well Ident 1872/TW4A	Description Bedrock Observation Well	Location Bog of the Ring
Drill. Method		Drill. Dates
Easting	Northing	Elevation
		Meas. Pt. Elev.

*All diameters in mm
All depths in metres*

Water Level (mOD)	Level-Date	Vertical 480.0	Horizontal 50.0
--------------------------	-------------------	--------------------------	---------------------------

Depth (m)	Hole	Annulus	Casing	Screen	Lithology	Elev. (m)
5		200mm Steel Casing			Medium brown CLAY with abundant pebbles	-5
		6.1				6.1
10					Coarse gravelly CLAY	-10
						12.2
15	300					-15
20		150mm Steel Casing			Stiff brown BOULDER CLAY	-20
25						26
					Coarse limestone GRAVEL	28.9
30	30.48				Broken top of LIMESTONE bedrock	-30
						30.5
						31.5
					Black shaley LIMESTONE	33.5
35					Grey brown LIMESTONE	-35
		36.6				36.6
40					Soft brown LIMESTONE with Water	-40
						42.7
45					Blue LIMESTONE	-45
50						51.8
					Soft brown LIMESTONE with Water	54.9
55						-55
60	200				Bluish brown LIMESTONE	-60
65						70.1
70					Medium grey LIMESTONE	-70
						76.6
75					Grey blue LIMESTONE with brown patches	-75
80						85.3
85	85.3				COMMENTS: No Piezometer pipe installed in this borehole.	-85

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WELL LOG

Well Ident 1872/OW5	Description Deep Piezometer	Location Bog of the Ring
Drill. Method		Drill. Dates
Easting	Northing	Elevation
		Meas. Pt. Elev.

*All diameters in mm
All depths in metres*

Water Level (mOD)	Level-Date	Vertical 300.0	Horizontal 50.0
--------------------------	-------------------	--------------------------	---------------------------

Depth [m]	Hole	Annulus	Casing	Screen	Lithology	Elev. [m]
300					BOULDER CLAY	-5
5	6.1			6.1		
10					Soft CLAY with some hard bands	-10
15						-15
20		BACKFILL				-20
25			50			-25
200					Soft, black CLAY with some hard bands	-30
30						-35
35						-40
40			39 40	39.6		-40
45		Gravel Pack		42.8	Very soft, black SHALEY LIMESTONE	-45
48.8	48.8		48.8	48.8	COMMENTS: 150mm Steel casing set to 45m.	-50

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WELL LOG

Well Ident 1872/OW5A	Description Shallow Piezometer	Location Bog of the Ring
Drill. Method		Drill. Dates
Easting	Northing	Elevation
		Meas. Pt. Elev.

*All diameters in mm
All depths in metres*

Water Level (mOD)	Level-Date	Vertical 100.0	Horizontal 40.0
--------------------------	-------------------	--------------------------	---------------------------

Depth [m]	Hole	Annulus	Casing	Screen	Lithology	Elev. [m]
1		Bentonite seal	1			-1
2						-2
3						-3
4					Brown BOULDER CLAY	-4
5						-5
6						-6
7						-7
8					Medium brown CLAY with occasional pebbles	-8
9	200		50			-9
10		Gravel Pack			Gravelly CLAY with some water	-10
11						-11
12				12.3		-12
13						-13
14					Sticky brown CLAY	-14
15					Comments: Estimated yield of 300gph. 150mm steel casing set to 18.3m and slotted from 9.1 to 10.7m.	-15
16						-16
17						-17
18						-18

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WELL LOG

Well Ident 1872/OW7	Description Deep Piezometer	Location Bog of the Ring
Drill. Method		Drill. Dates
Easting	Northing	Elevation
<i>All diameters in mm All depths in metres</i>		

Water Level (mOD)	Level-Date	Vertical 400.0	Horizontal 40.0
--------------------------	-------------------	--------------------------	---------------------------

Depth [m]	Hole	Annulus	Casing	Screen	Lithology	Elev. [m]
300						
5	6.1					-5
200	9.14					-10
10					Medium brown CLAY	
15						-15
20	150					-20
25		BACKFILL				-25
30	31.32					-30
35			50		GRAVEL deposits with clay	-35
40						-40
45						-45
50	137.5		51 52		Blue CLAY	-50
55						-55
60		Gravel Pack			Black LIMESTONE	-60
65				64		-65
70	70.1		70.1	70.1		-70

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COMMENTS:
137.5mm steel casing set to 56.1m by ODEX.

WELL LOG

Well Ident 1872/OW8	Description Deep Piezometer	Location Bog of the Ring	
Drill. Method		Drill. Dates	
Easting	Northing	Elevation	Meas. Pt. Elev.

*All diameters in mm
All depths in metres*

Water Level (mOD)	Level-Date	Vertical 300.0	Horizontal 50.0
-------------------	------------	-------------------	--------------------

Depth [m]	Hole	Annulus	Casing	Screen	Lithology	Elev. [m]
300						-5
5	6.1					
200						-10
10	12.2					
15		BACKFILL			medium brown gravelly CLAY	-15
20						-20
25	175		50			-25
30			30.5 31.5			-30
35	36.6					-35
40		Gravel Pack			Black shaley LIMESTONE.	-40
45	150			42.8	COMMENTS: 150mm steel casing set to 38.4m.	-45
50	48.8		48.8	48.8		-50

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Completed Well Design

Trial Well No.7

Client : Dublin Co.Co
 Project : Groundwater Development
 Location : Walshestown
 County : North County Dublin
 Date : May 1993
 Driller : O'Donohoe Bros.
 Aquifer : Limestone
 Output : 500 m³/day
 Specific Capacity : m³/day/m
 National Grid : East
 Co - ordinates : North

Remarks

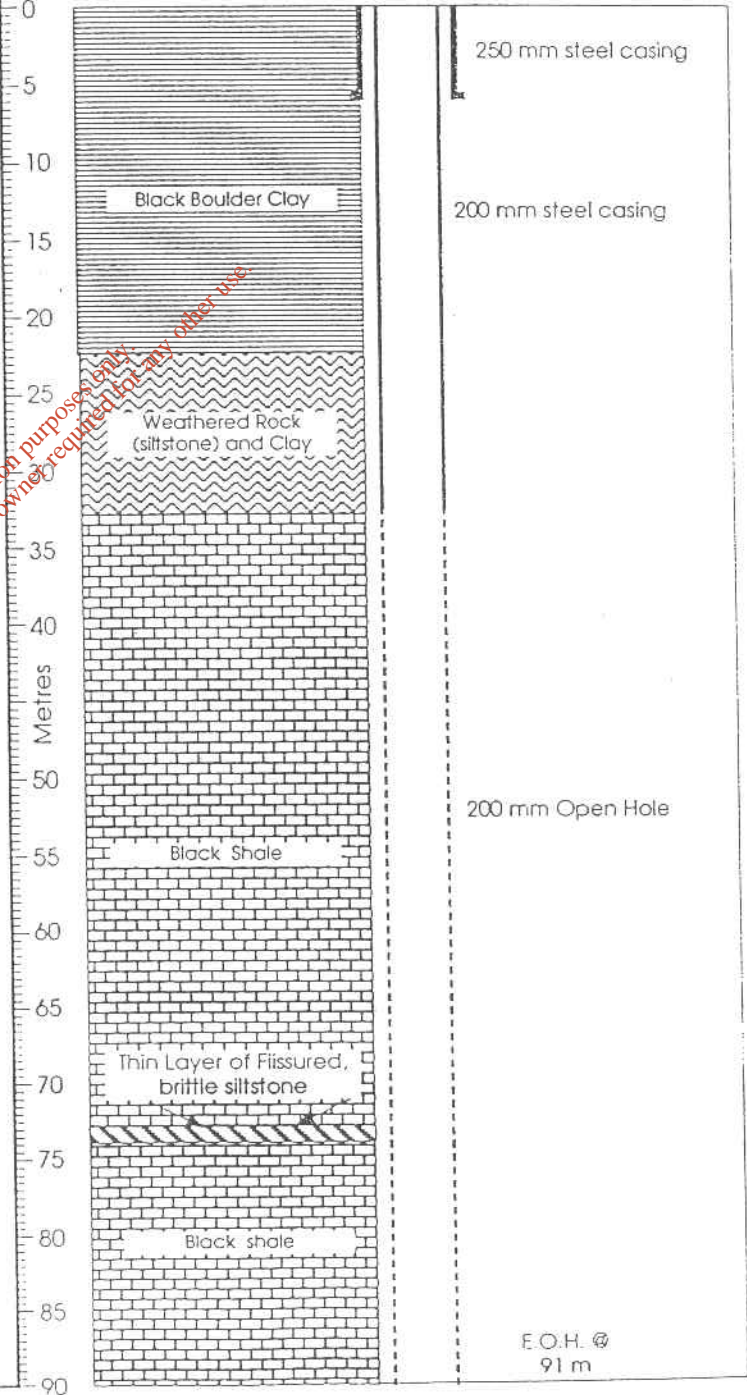
SWL. 11/5/93

Water level at end of pumping test at 575 m³/day

	Grout	Water Levels	Water Entry	Water Loss	Diameter (mm)							
					Casing	Casing 200	Casing	Casing 250	Screen	Screen	Open Hole 200	Open Hole
0												
5												
10												
15												
20												
25												
30												
35												
40												
45												
50												
55												
60												
65												
70												
75												
80												
85												
90												

Geology

Construction Details



E.O.H. @ 91 m

Completed Well Design

TRIAL WELL NO.10

Client : P.H. McCarthy & Ptnrs
 Project : Bog of the Ring RWSS

Location : Balrickard

County : Dublin

Date : January 1994

Driller : O'Donohoe Bros

Aquifer : Limestone

Output : 1100 m³/day

Specific Capacity : m³/day/m

National Grid : East

Co - ordinates : North

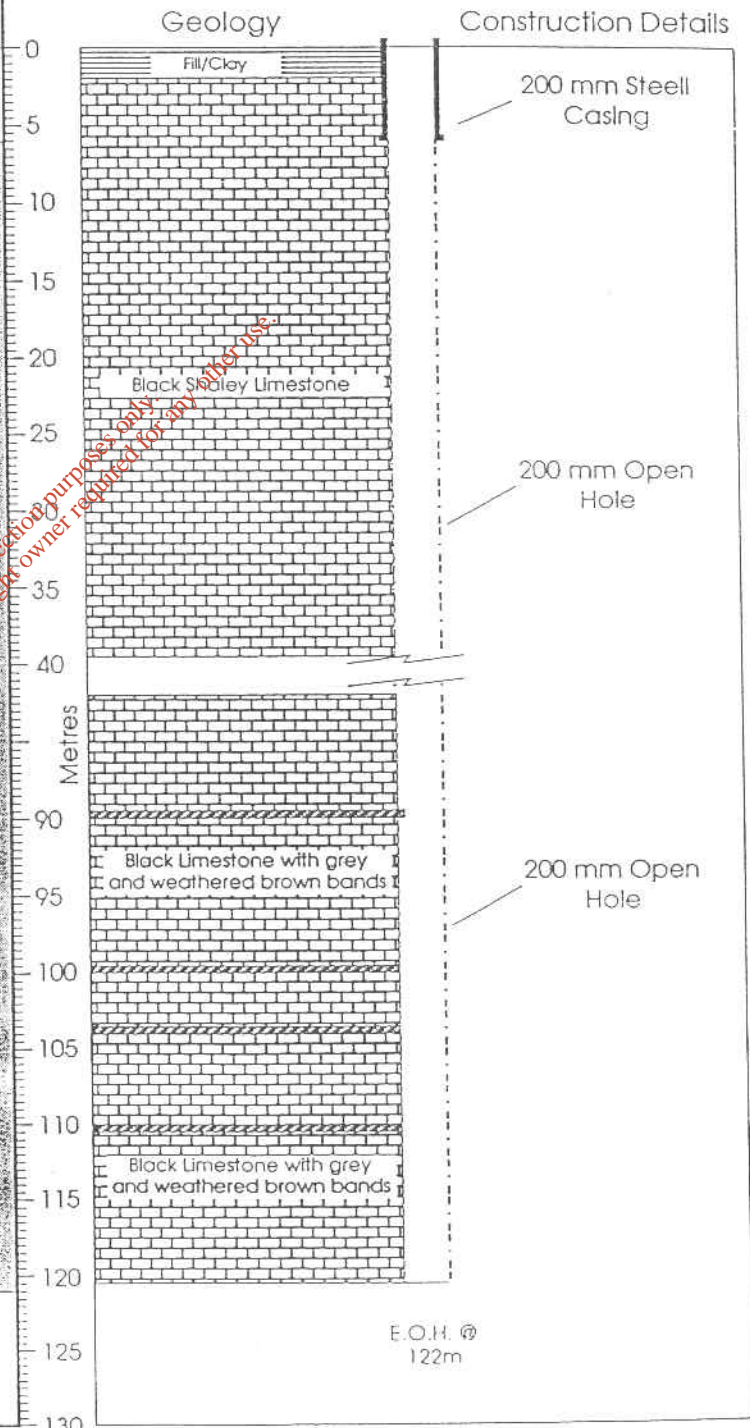
Remarks

The depth of this borehole extended to 122 m due to its elevation

The yield of the well was estimated to be 20 m³/day at 85 metres. All the water entered in the last 30 metres which had bands of weathered limestone.

Water level at end of Pumping Test
 Q = 1149 m³/day

	Grout	Water Levels	Water Entry	Water Loss	Diameter (mm)							
					Casing	Casing	Casing	Casing	Screen	Screen	Open Hole	Open Hole
						200						200

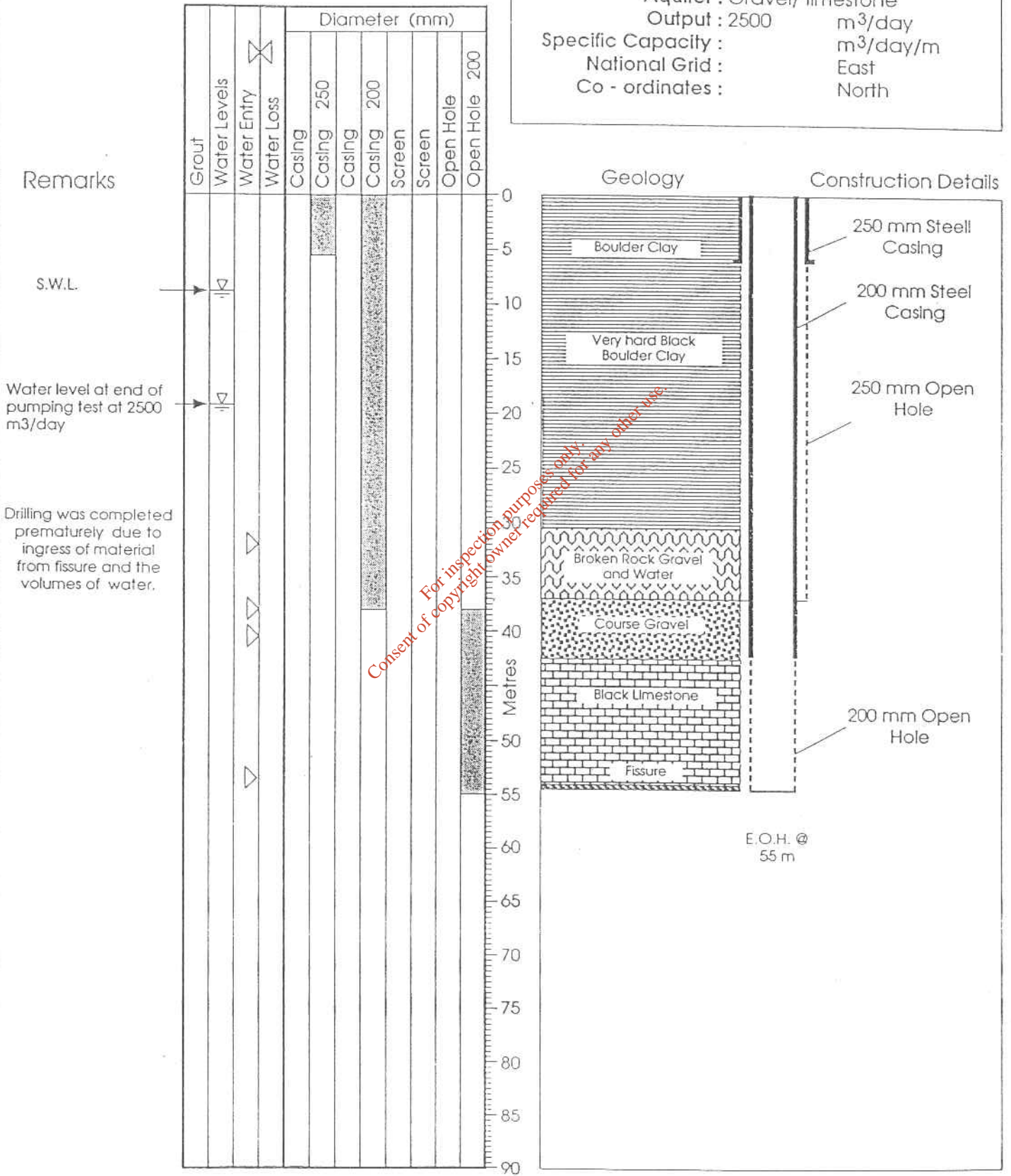


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Completed Well Design

TRIAL WELL NO.12

Client : P.H. McCarthy & Ptnrs
 Project : Bog of the Ring RWSS
 Location : Killougher
 County : Dublin
 Date : February 1994
 Driller : O'Donohoe Bros
 Aquifer : Gravel/ limestone
 Output : 2500 m³/day
 Specific Capacity : m³/day/m
 National Grid : East
 Co - ordinates : North



Completed Well Design

TRIAL WELL NO.13

Client : P.H. McCarthy & Ptnrs
 Project : Bog of the Ring RWSS
 Location : Commons
 County : Dublin
 Date : March 1994
 Driller : O'Donohoe Bros
 Aquifer : Limestone
 Output : 1200 m³/day
 Specific Capacity : m³/day/m
 National Grid : East
 Co - ordinates : North

Remarks

S.W.L

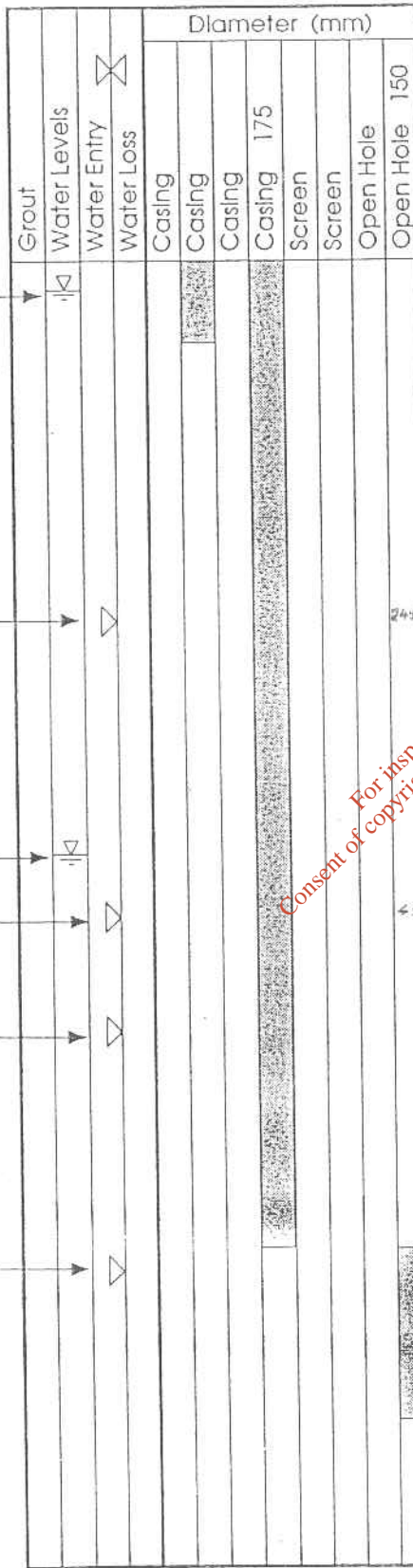
Minor Water Inflow

Water level at end of pumping test at 1200 m³/d

Water inflow

Water inflow

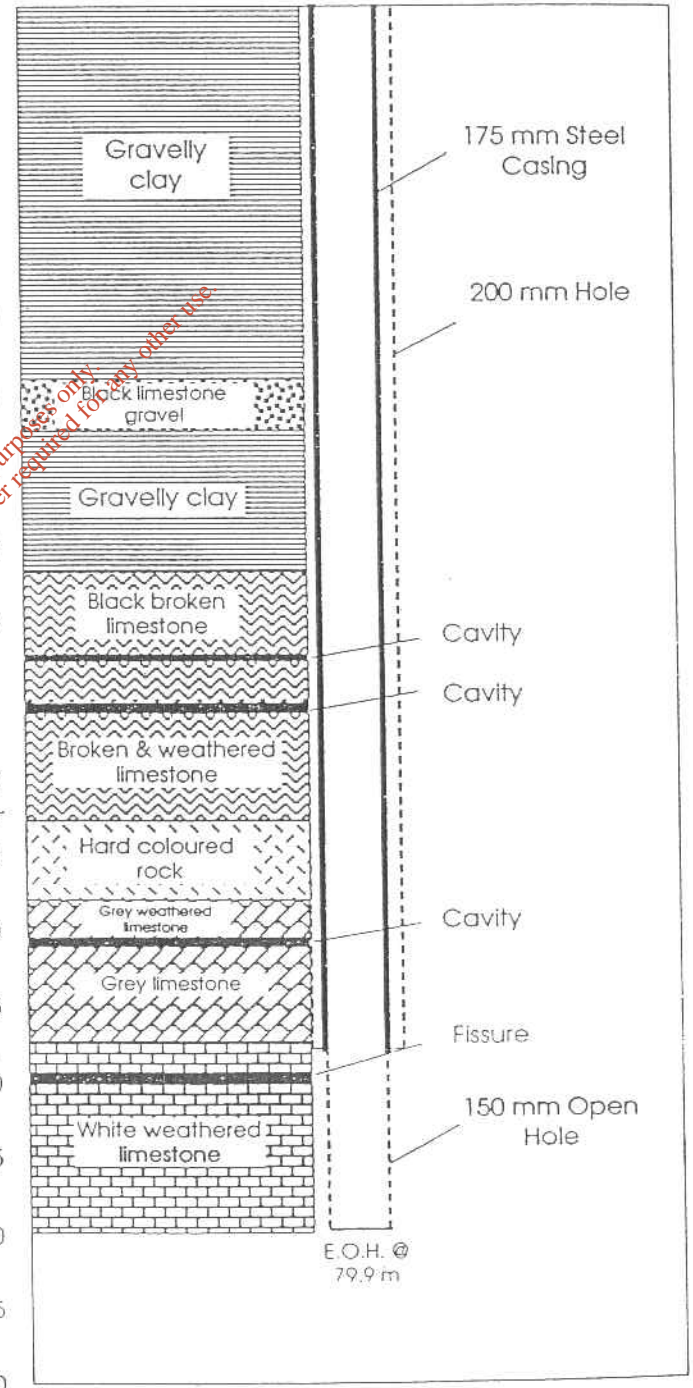
Water inflow



Geology

Construction Details

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Completed Well Design

TRIAL WELL NO. 14

Client : P.H. McCarthy & Ptnrs
 Project : Bog of the Ring RWSS
 Location : Matt Lane, Ring.
 County : Dublin
 Date : March 1994
 Driller : O'Donohoe Bros
 Aquifer : Grey wacke/Limestone
 Output : ~ 300 m³/day
 Specific Capacity : m³/day/m
 National Grid : East
 Co - ordinates : North

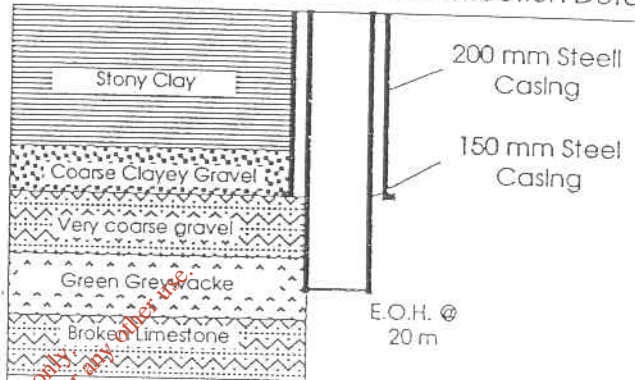
Remarks

Drilling was completed prematurely due to unstable conditions.

	Grout	Water Levels	Water Entry	Water Loss	Diameter (mm)														
					Casing	Casing 200	Casing	Casing 150	Screen	Screen	Open Hole	Open Hole							
0																			
5																			
10			▽																
15			▽																
20			▽																
25																			
30																			
35																			
40																			
45																			
50																			
55																			
60																			
65																			
70																			
75																			
80																			
85																			
90																			

Geology

Construction Details

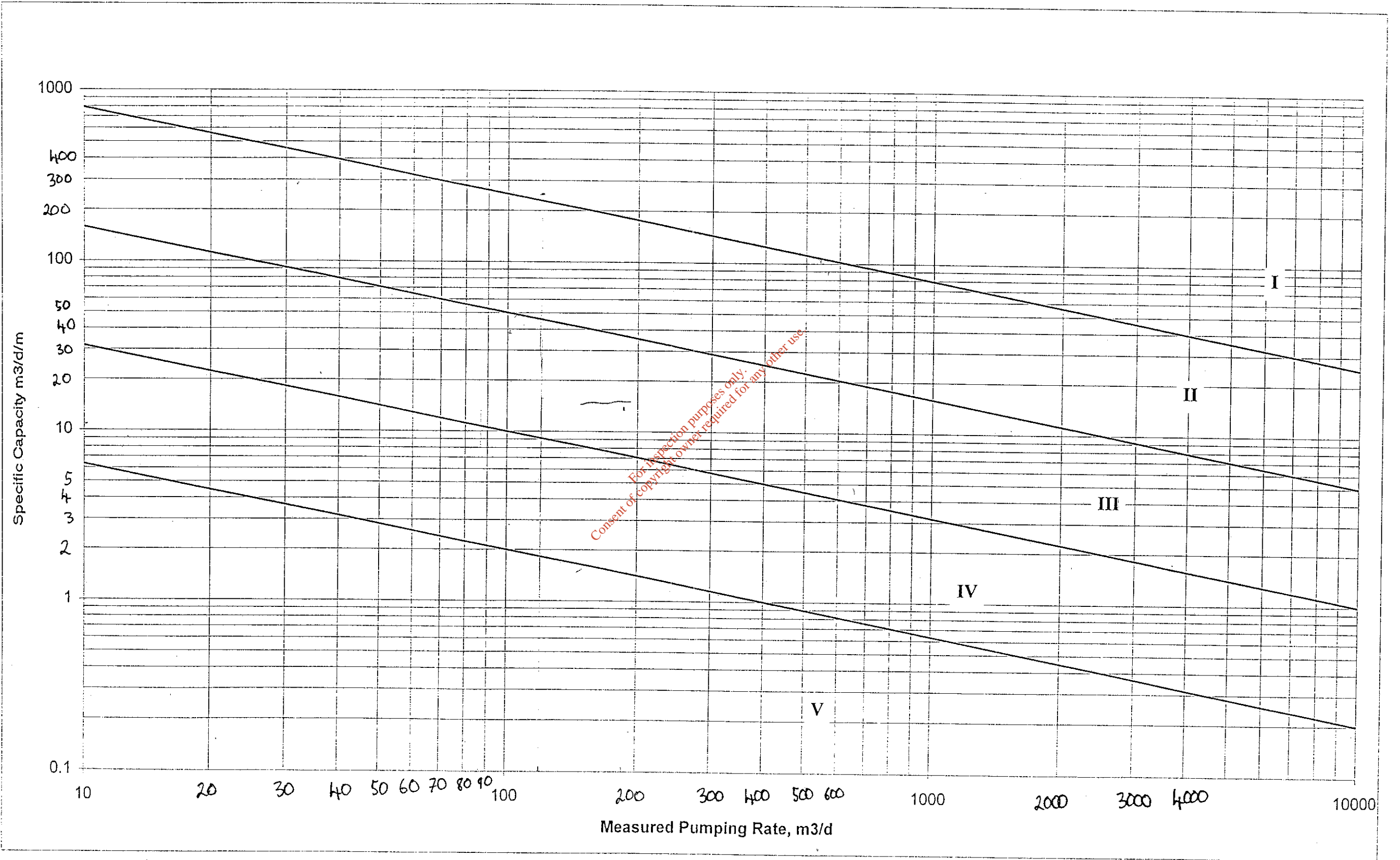


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Appendix C

Borehole Productivity Classification Scheme (Devised by Geological Survey of Ireland)

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Appendix D

Meteorological Data

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	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05	Sep-05	Oct-05	Nov-05	Dec-05	Jan-06	Feb-06	Mar-06	Apr-06	May-06	Jun-06	Jul-06	Aug-06
1		0	2.2	0	0.1	3.6	0	0	14.3	0.3	3.1	0.4	0.7	0	0.4	4.8	11.6	0	0	0	3.8	0.1	0	0	0.1
2		0.3	1.9	0.1	0	0	0.1	0.5	0	5.8	1.3	0.2	0	0	0	3.3	21.4	0	0	0	9	1.8	0	0.3	0
3		0.1	5.4	0.8	0.4	0	0	0.1	0	22	1.6	2.2	0	0.1	0	6.7	10.9	0.3	0	0.6	0.4	0	0	0	0
4		0	11.7	0	0.1	1.8	2.1	0.5	1.4	0	0.5	1.3	2.3	4.5	0	4.3	1.4	0	0	0	3	0	3.5	0.4	
5		0	0	0	0.3	1	0	0	0.7	0.2	0	8.8	0	0.1	0	1.4	0.1	0.2	0	0.1	0	0	0	0	0
6		0	0.8	0.9	1.4	0	10.8	0	11	4.4	0	0.6	0	0	0	1.8	0	0.1	0	1	0.6	0.5	0	0	2.7
7		0	1.3	0.1	0	22.5	0	0	1.9	0.5	0	0.1	0	0.1	0	6.3	14.5	0	3.9	6.7	2.4	0	0	0	0
8		0.1	0.5	0.4	1	3.2	0.9	0	0	1	0	0.6	0	0.7	2.6	8.8	1.4	2.9	0	4.5	0.8	13.6	0	6.1	4.1
9		0.1	0	0.2	0	0.3	1.8	0	1.2	0.3	0	0.9	0	17.5	0	1	0.5	0.6	0	1.3	0.9	0	0	0.7	0.2
10		4.7	0	0	0.6	0.8	1.4	0	0.1	0	0	0	0	0	6.2	4.4	0	6.2	0	0.8	0	0	0	0.1	0.6
11		0.6	0	0	0.3	1.1	2.8	0.9	0.3	0	0	0	0	0	15	0.9	0	0.2	1.8	11.3	3.3	0	0.1	0	1
12		1.8	0	0.7	0	0.7	3.7	0	3.1	0	0	0	0	0	0.8	0	0	0	3.4	0.6	0.5	16.7	0	0	0
13		0.7	3.7	0	0	0	1.2	0	0.5	0	0	0	3.6	0.3	0	0	0	0.3	6	2.8	0.1	0.2	0	0	0
14		0.7	3.3	0	0.6	0	0	4.2	5.5	0	0.1	0	0	0.1	0.1	0	0	0	9.7	0.1	0	6.3	0	0	0
15		0.4	0	0	4.6	1.4	0	0.1	0.3	0	2.1	0	0	14	0.2	0.1	0	2.5	0.9	3.7	0.1	13.5	0	0	10
16		4.1	1.8	0.1	1.4	0.4	0	0	0	0.3	3.1	0	0	1.3	0.1	0	0.2	0.8	0.1	1.4	0	0.1	0	0	0.7
17	0.8	0	0.7	1.5	3.2	4.4	0.2	0	13.2	0	0	0	0	0	0.4	0	0	0.3	0	1.2	4.6	5.6	0	0	0.4
18	32.8	5	0	16.7	8.9	3.9	0.2	0	3.8	1.7	0	0.1	7.2	0	0.8	0	1.4	0	0	5.6	4.9	8	0	0	4.2
19	18.3	2.1	1.4	0	0.1	3.3	0	0	0.5	0.2	0	0	0.3	0.7	10.2	0	0	0	0.2	0	0	4.3	0.2	0.2	18.5
20	1	1.1	19	11.7	0.9	1.8	0	0.2	0.4	1.6	0	0	0	0.2	6	0	0	1.5	0.2	0.6	0	2.4	1.4	0	0
21	0	0	3.1	3.2	3.7	2.3	3.7	4.8	0	0.3	0	1.2	2.5	0	11.4	0	0.6	0	0.8	1.4	0	22.9	1.3	0.1	0.1
22	10	1.5	10.2	0	4	9.5	3.8	0.1	0.1	0.8	0	0	0.6	0	0	0	0	0	1.3	0	0.2	1.9	0	0	0.1
23	18	2.4	6	0.1	0.7	0	3.8	4	2.7	7.6	0	2.2	1.2	1.4	15	0	0	0	4.7	0.3	0.2	5.5	0	0	1
24	1.4	0	0.3	0.9	3.1	0	1.8	0.3	0.1	11.3	7.9	0.1	3.1	5.1	14.3	0.3	0	0	3.4	10.7	0.5	3.7	1	0	0
25	2.6	0.6	0.3	1.4	2.9	1	1	0	2.9	3.8	0	0	2.2	0.7	4.4	0.8	0	0	0	5.8	0.1	0.9	0	0	3.9
26	0.3	0.3	0.1	0.8	0	0.5	0.1	0.1	0.6	0.4	0	0	0.1	4.5	0.3	0	0.5	0	0	1.9	0.1	8	1.8	0	1
27	0.2	0.1	14.7	0.8	4.1	0	2.6	0	4.3	1.5	0	0	0	0.1	0	0	0.8	0.5	0.1	1.4	0	0.7	1.1	0	1.7
28	0.3	0.2	19	0	0	0	0	0.5	0.4	0	1.9	32.6	0	1.5	0.5	0	0.7	0	1.2	1.1	0	0.2	0.1	1.3	2
29	1.4	12.5	12.6	0	0	0.2		2.9	0	0	8.1	24.3	1.8	1.9	6	1.6	1.9	0		6.5	0	0.1	6.3	1.2	1.1
30	0	7.4	0.2	0.7	1.3	0.1		0	2.3	1.7	1.5	6.2	0	1	1	0.2	4.8	0		0.7	7.9	0	5.2	3.5	3.6
31	0		0		1.3	0.2		0.8		1.5		1.6	0.5		6		0.3	0		3.2		0		1.2	0.2
Total		46.8	120.2	41.1	45	64	42	20	71.6	67.2	31.2	83.4	26.1	55.8	101.8	46.7	73	16.4	37.7	69.7	41.1	116.9	26.5	18.2	57.6
30Yr Av		50.7	55.1	56	49.9	70.5	66.7	69.7	64.7	75.6	69.4	50.4	53.8	50.7	55.1	56	49.9	70.5	66.7	69.7	64.7	75.6	69.4	50.4	53.8

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Appendix E

Groundwater Source Protection Zones, Geological Survey of Ireland, January 2005)

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Bog of the Ring

Groundwater Source Protection Zones

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Bog of the Ring Public Water Supply Wells: Groundwater Protection Zones

1: Introduction

The objectives of the report are as follows:

- To delineate source protection zones for the four Bog of the Ring public supply wells.
- To outline the principal hydrogeological characteristics of the Bog of the Ring area.
- To assist Fingal County Council in protecting the water supply from contamination.
- To assist Fingal County Council in estimating groundwater resources.

2: Location, Site Description and Well Head Protection

Four boreholes are used for the Bog of the Ring Public Water Supply. The boreholes are located in a roughly WNW-ESE line along the Bog Road, in the Townlands of Ring Commons and Killougher. Three of the boreholes are within 1 km of each other, with the fourth borehole about 1.5 km further to the west. Currently, all four boreholes are active, and supply a combined volume of around 3,500 m³/d. Table 1 provides a summary of the wells, including the name, drilled date and their general location. In addition to the wells listed in Table 1, another production borehole, PW1, was drilled just to the east of the M1. However, this has been omitted from the network due to silting.

Table 1: Summary of the locations of the wells at Bog of the Ring

Borehole	Date Drilled	General Location
PW2	2000	Bog road, at junction with road to Balrickard
PW3	2000	Bog road, at junction with road to Curragh Bridge
PW4	2000	Bog road, west of PW3
PW5	2000	Sharp bend in road in Killougher Townland

The sanitary protection of the boreholes appears satisfactory. They are located on concrete platforms approximately 5 m x 5 m that are elevated above the surrounding ground, and securely fenced-off behind 2 m railings (Figure 1). The boreholes are fully covered by small (1.2 m high) ‘cabins’, while the pump control equipment is housed in a separate cabinet. Pressure transducers record water levels automatically, and these data, together with pumping rate data, are transmitted continuously to the pumping station computer. The pumping station is situated on the Bog Road, just to the east of the M1.

At least one observation borehole is located near every well. Production wells 2 and 4 have two observation wells. The observation boreholes are generally between 80-400 m from the production wells, although the one next to PW4 is only 10 m away.



Figure 1: Production well 2 (PW2), showing the concrete platform, railings, well-head protection cabin and pump-control housing.

3: Summary of Well Details

Available pumping test and abstraction data include:

- 48-144 hour pumping tests on 8 trial wells (TWs 1, 4, 7, 8, 9, 10, 12 and 13) was carried out in 1984 and in 1993/94 (K.T. Cullen, 1985; K.T. Cullen & Co., 1994);
- 72-hour pumping tests carried out at Production wells (PWs 2, 3 and 5) in June 2000 (K.T. Cullen & Co., 2000);
- 7 day combined abstraction tests from PWs 1, 2 and 3, and then from PWs 4 and 5 in July 2000. The tests were sequential (K.T. Cullen & Co., 2000). The well groups were pumped simultaneously and water levels were monitored in these and the associated observation wells, as well as in shallow piezometers installed in the bog;
- Daily pumping volumes from Fingal Co. Co. for PWs 2, 3, 4 and 5 from 13/10/2003 to present. The wells have been pumped since July 2004, but these data are not available. Water level data are available from May 2004.

The locations of the production wells (PWs) are shown on all the maps in this report. The locations of the trial wells, observation wells and bog standpipes are shown in Figure A.1 (in the Appendix).

Table 2, below, provides a summary of the wells' details.

Table 2: Summary of well details

Well Details	Well Name				
	PW1 ¹	PW2	PW3	PW4	PW5
GSI Well Number	-	2925NE W090	2925NE W091	2925NE W092	2925NE W093
Grid Reference	318659, 260160	317758, 260160	317429, 260377	317007, 260696	315685, 261356
Location	Ring	Ring Commons	Ring Commons	Ring Commons	Killougher
Well type	Bored	Bored	Bored	Bored	Bored
Owner	Fingal Co. Co.	Fingal Co. Co.	Fingal Co. Co.	Fingal Co. Co.	Fingal Co. Co.
Elevation (ground level) (mAOD)	32.5	34.261	35.507	37.089	55.085
Depth of borehole (m)	75	52	53	91.4	79.3
Diameter of hole (mm)	600/375	600/425	600/425	600/425	600/425
Diameter of casing/ screen (mm)	250	300	300	250	300
Screened interval (mbgl)	27-73	16-52	14-53	36-89	32-75
Screened length (m)	46	36	39	53	43
Depth to rock (m)	36.6	13.4	18.3	24.4	24.0
Bedrock Unit	Mullaghfin Fmn	Loughshinny Fmn	Loughshinny Fmn	Loughshinny Fmn	Loughshinny Fmn
Static water level (mbgl) ²	N/A	0 (artesian)	0.37	2.85	7.86
Static water level (mAOD) ²	N/A	34.26	34.96	33.23	46.62
Pumping water level (mbgl) ³	-	13.26	14.56	16.13	16.32
Pumping water level (mAOD) ³	-	21	20.4	17.1	30.3
Average Current Abstraction (m ³ /d) ⁴	0	1057	1048	336	1043
Maximum Drawdown ^a (m) ⁵	0	>13.26	>14.56	>16.13	>16.32
Specific Capacity ^{6, b} (m ³ /d/m)	N/A	285	195	N/A	253

Notes:

1. PW1 is not in use as a production well
2. Static water levels refer to June 2000 measurements.
3. Pumping water level refers to 31st July 2004.
4. Pumping rates since April 2004.
5. Pumping water level is still declining slightly (summer 2004).
6. Specific capacities during 24-hour tests in June 2000.

4: Methodology

4.1 Desk Study

Trial, Production and Observation borehole details such as depth, depth to bedrock, construction, abstraction figures, along with geological and hydrogeological information were obtained from GSI records, County Council personnel and hydrogeological reports by KTC/ WYG (K.T. Cullen & Co., now part of White Young Green) and P.H. McCarthy. Data from the IGSL report for RPS-MCOS were also assessed (IGSL, 2004).

^a drawdown = static water level – pumping water level

^b specific capacity = abstraction divided by the drawdown. It is an indicator of both the efficiency of the well under varying pumping rates, and indirectly of the capacity of an aquifer to transmit water to the well.

4.2 Site visits and fieldwork

The fieldwork undertaken for this project included carrying out depth-to-rock augering, subsoil sampling and vulnerability mapping. Two rotary-cored drill holes were drilled to try to establish the presence/ absence of gravel deposits along the Matt River and in the area east of Gibbonstown Reservoir. Elevations above sea level were computed at selected borehole and surface water locations by static GPS surveying using a Leica System 5000. Some basic surface water chemistry data were collected. Field walkovers were also carried out to investigate the subsoil geology, the hydrogeology and vulnerability to contamination.

4.3 Assessment

Analyses incorporated field studies, data collected previously, and numerical modelling to delineate protection zones around the public supply wells.

5: Topography, Surface Water Hydrology and Land Use

The locations of the Bog of the Ring boreholes are shown on Figure 2 (and subsequent maps). PWs 2, 3 and 4 are situated in the centre of the very flat-lying Bog of the Ring, at elevations ranging from 34.26 mAOD to 37.09 mAOD. PW5 is located about 1500 m further WNW on slightly higher ground (55.09 mAOD). As can be seen, the boreholes lie along the Bog road in a WNW-ESE trending line. This orientation is determined by the bedrock geology; more resistant Namurian Sandstones occupy the hills to the south of the valley and bog area, and Ordovician Volcanics occupy the slightly higher ground to the north of the Bog. Underlying the valley and the Bog are softer and more easily eroded and weathered shaly limestones.

As described, the topography has a WNW-ESE 'grain' owing to the underlying geology. The topography to the southwest of the boreholes is hilly and ground elevation rises steeply to 176 mAOD at Knockbrack Hill. Many streams emerge at springs on the flanks of Knockbrack Hill, flowing generally northwards to the stream that drains through the Bog, westwards to the Delvin River, or eastwards to the Matt River. The Bog of the Ring is situated in a very low gradient (0.003-0.006), flat-bottomed valley. Streams drain from west-northwest to east-southeast along the valley, through the bog, to the Matt River. Gradients are similarly gentle along the Matt River, with the ground sloping northwards at gradients of <0.003. The Matt River flows northwards from around Hedgestown, to Stephenstown. It then flows northeast to the coast at Balbriggan. Approximately 2 km east of the Matt River, the ground rises to just under 100 mAOD at Salmon. Streams drain westwards to the Matt River. Northeast of the valley, the ground rises gently and is flat to gently undulating, with elevations ranging from 50-70 mAOD. In this area, streams generally emerge as seeps and drainage ditches and flow eastwards along a shallow valley which slopes eastwards at about 0.008 to join the Matt River near Folkstown Little. Just west of Killougher, streams drain westwards to the Delvin River, which flows through Naul. Along the Delvin River, ground elevation decreases in a northeasterly direction at about 1:200.

Agriculture is the main activity in the area. The bog area around the boreholes is used (in summer) for grazing cattle. Sheep are also grazed nearby. On higher ground away from the bog, the land use is a mixture of pasture and tillage. In Hazardstown, there are orchards. Main summer crops in the area are wheat and root vegetables. Although the entire area has mains drinking water, houses near the wells are serviced by individual septic tank systems.

6: Geology

6.1 Introduction

This section briefly describes the relevant characteristics of the geological materials that underlie the Bog of the Ring and surrounding area. This provides a framework for the assessment of groundwater flow and source protection zones that will follow in later sections.

Bedrock information was taken from a variety of sources including:

- GSI publication on the bedrock geology of the region (McConnell *et al.*, 2001)
- Hydrogeological reports and borehole logs from KTC/ WYG (1985, 1994, 2000).

Subsoils information derives from

- Quaternary mapping undertaken by the GSI (O'Connor, 1998);
- Teagasc subsoils mapping (Meehan, 2004);
- Permeability mapping by GSI field personnel in July and August 2004;
- Sixty auger holes and two rotary holes drilled by the GSI (July and August 2004);
- Site investigation data, including geotechnical descriptions and tests (e.g., particle size analyses, triaxial permeability, falling head) (IGSL, 2004; Benson & Partners, 2001; OCSC, 2003, Glover Site Investigations Ltd, 2000).

6.2 Bedrock Geology

The Bog of the Ring production wells (PWs 2-5) are located in the Loughshinny Formation, which is a shaly limestone, with bands of brown limestone (which is presumed to be dolomitised) recorded in some of the boreholes. The non-pumping PW1 penetrates the Mullaghfin Formation, which is a pure, well-bedded limestone.

The shaly limestone rocks that the majority of the boreholes are drilled into are commonly known as 'Calp' limestones. They are laterally interbedded with pure limestones, and underlie younger (Namurian age) rocks that are generally non-calcareous shales and sandstones.

In this part of Co. Dublin, the Carboniferous rock units (see Table 3) are folded into a gentle syncline (bowl-shaped fold), whose axis is roughly WNW-ESE. The Namurian shales and sandstones occupy the core of the fold, and are found in the south of the study area under the higher ground of Knockbrack Hill. The Calp Limestones are found under the low-lying ground in the centre of the study area in a WNW-ESE band about 500-800 m wide.

Significantly older Lower Palaeozoic rocks are faulted against the Loughshinny Formation to the north of the Bog area. The WNW-ESE trending fault zone is not a continuous line, but is cross-cut and offset by roughly N-S faults that also cut across the younger limestones and Namurian rocks.

Descriptions of rock units and details of the overall relationship between the Lower Palaeozoic and Carboniferous rocks are derived from a GSI report on the area (McConnell *et al.*, 2001).

The individual bedrock units are described in Table 3, and their distribution is shown in Figure 2 and Map 1. A cross-section is shown in Figure 3.

Table 3: Bedrock Geology of the Bog of the Ring area

Age		Geological Name	Geological Description	Maximum thickness (m)
CARBONIFEROUS	Upper	Walshestown Formation (WL)	Shales, thin sandstones/ siltstones, occasional thin limestones	>200
		Balrickard Formation (BC)	Coarse micaceous sandstone with shale interbeds	75-100
	Lower	Loughshinny Formation (LO)	Layered dark grey micrite and calcarenite (fine – coarse-grained limestone) and shale	100-150
		Naul Formation (NA)	Calcarenite and calcisiltite (coarse – medium-grained limestone) with minor chert and thin shales	100
		Mullaghfin Formation (MF)	Layered, pale grey peloidal calcarenite (coarse-grained limestone)	210
		Holmpatrick Formation (HO)	Well-bedded grainstone-packstone and micrite (coarse – fine-grained limestone)	80-90
		Malahide Formation (ML)	Layered argillaceous biohermal (muddy and fossiliferous) limestone	300-1200
		mudbank limestone (mk)	Unbedded grey micritic (fine-grained) limestone	?
SILURIAN - ORDOVICIAN (LOWER PALAEOZOIC)		Denhamstown Formation (DD)	Greywacke (layered and poorly-sorted) sandstone and siltstone	?
		Skerries Formation (SS)	Laminated blue-grey siltstone, sandstone	>350
		Balbriggan Formation (GB)	Variably-coloured mudstone	~500
		Belcamp Formation (BP)	Andesite (volcanic rock), pillow breccia, mudstone and tuff	>1600
		Clashford Formation (CF)	Mudstone and siltstone, andesite	>100
		Herbertstown Formation (HB)	Andesite, tuff and mudstone	>300
		Snowtown Formation (SW)	Banded grey mudstone and siltstone	200
		Fourknocks Formation (FK)	Banded red and green mudstone and siltstone	?