

ATHBOY PUBLIC SUPPLY

GROUNDWATER SOURCE PROTECTION ZONES

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ATHBOY PUBLIC SUPPLY

1. LOCATION AND SITE DESCRIPTION

This main public supply source for Athboy and its surrounds is located on the Trim Road 1.2 km south of the village, on the eastern bank of the Athboy River. The Production Well (61m deep), drilled in 1985, is approximately 7.5 metres from the river bank and is completed 1 metre below ground level, with two manholes covering the well. The well is located beside the pump house and both are fenced off (see sketch, page 9). There is no backup supply for this production well at present, but surface water is pumped from the River Tully, a tributary of the Athboy River, to supplement the water supply from the well. The surface water intake point is overgrown. The Athboy groundwater is chlorinated in the pump house before being pumped to the Hill of Ward reservoir, which has a capacity of 100,000 gallons.

In 1995 an unsuccessful trial well was drilled in the old quarry adjacent to the Hill of Ward. In June 1995 a GSI observation borehole 58.8 m deep was drilled approximately 17 m from the production well (see site sketch). In May 1996 two trial boreholes were drilled by Dunnes Water Services Ltd. close to Athboy, the first at the Hill of Ward and the second in the Council yard at Athboy. The yields of these wells were estimated to be less than 40m³/d. The Hill of Ward borehole was backfilled immediately after drilling.

2. WELL DETAILS

GSI no.:	2625NW001
Grid ref.:	27249 26327
Owner:	Meath Co. Co.
Well type:	Borehole
Elevation (top of casing):	63.83m OD (Poolbeg). Ground level is 64.80m OD.
Depth:	61m
Depth of casing:	11m
Diameter:	200 mm (8")
Depth-to-rock:	6.5m
Static water level:	3.75m b.g.l. (10-10-95)
Pumping water level:	4.85m b.g.l. (after 12 hrs continuous pumping)
Drawdown:	1.10m (after 12 hrs continuous pumping)
Pumping rate:	1080m ³ /d (9,900 gal/hr)
Normal consumption:	1080m ³ /d (240,000gal/d on average, over 24 hrs)
Pumping test summary:	
(i) abstraction rate:	1080m ³ /d
(ii) specific capacity:	980m ³ /d/m (12 hours); 800m ³ /d/m (extrapolated to 1 week)
(iii) transmissivity:	100 - 1000m ² /d

3. METHODOLOGY

The assessment involved three stages: (a) detailed desk study, (b) site visits and fieldwork, and (c) analysis of the data. The desk study included compilation of the geology from all available data sources. Basic public supply well details were obtained from County Council personnel, including all relevant borehole, chemistry and pumping test data available.

The second stage comprised site visits and fieldwork in the area. A GSI observation borehole 58.8 m deep (Athboy D/H 104) was drilled near the production well. A twelve hour pumping test was carried out to examine the aquifer characteristics. The area within 1km radius (later extended to 1.5 km

upgradient) was surveyed with regard to geology, hydrogeology, vulnerability to pollution and current pollution loading. Raw water samples were taken in March, June, and September 1995 and January 1996 for full suites of chemical and bacterial analyses. Conductivity measurements were taken at regular intervals throughout the study.

The assessment stage utilised analytical equations and hydrogeological mapping to delineate protection zones.

4. TOPOGRAPHY, DRAINAGE AND LAND USE

The Athboy source is located beside the Athboy River (Tremblestown River), a tributary of the River Boyne. The topography is slightly undulating, ranging from to 64 m OD (210 ft) to 73 m OD (240 ft).

The Athboy River flows in a south-southeasterly direction, with numerous small streams draining the area. Drainage is good and there is an absence of drainage ditches.

Agriculture is the principal land use activity in the area, with most of the land around the source being used primarily for tillage and pasture. The field around the well was in tillage during 1994-6.

5. GEOLOGY

5.1 Bedrock geology

A borehole log (61 m) for the Athboy production well indicates 54.5 m of black limestone with shale bands. The upper 4.5 m were reported to be highly broken. The GSI observation borehole (58.8 m deep) encountered 47.9 m of dark grey to black limestone and shales. The limestone was not regarded as highly broken or fractured and fracturing decreased with depth. No cavities were encountered, although the drilling circulation was lost between 38 m and 48 m below ground, suggesting higher permeabilities in this zone although the core did not indicate excessive fracturing at this depth. Volcanic tuff bands were met at 36.3 m and 44 m depth. The bedrock geology is shown in Figure 1.

5.2 Quaternary (subsoils) geology

Three types of Quaternary deposits are present in the vicinity of the Athboy source (Figure 2).

Along the river, to the west of the well, is a narrow strip of alluvium varying in width from 10 m to 75 m across. The alluvium is generally sandy in texture and 1 m – 2 m deep, generally thinning away from the river. Some gravel lenses occur within the alluvium.

To the northwest of the well, stretching beyond Athboy town, is an area of fluvio-glacial gravels, generally less than 3 m deep, overlying till. The gravels are well sorted but poorly bedded, and were deposited as part of an outwash system during deglaciation. The gravels are pebble to cobble grade, mostly of Carboniferous limestone, with a sandy matrix. Sand lenses and interbeds are common.

East of the well and flanking the alluvial deposits to the south is an extensive area of limestone-dominated till which is gravelly to stony or sandy in texture, with fairly high proportions of clay present. The till is interpreted as a melt-out till deposited towards the end of the last glacial period.

5.3 Soils

Information is taken from the soils map of County Meath (Finch *et al*, 1983). The soils of the area are primarily derived from a parent material of river alluvium. The soils are very immature with poor profile development. The Great Soil Group is the Boyne Alluvium Complex. The lithological composition of this alluvium is mainly limestone and shale.

Away from the river the soils are derived from the limestone and shale dominated tills. The dominant soils in the north are the Grey Brown Podzolic Group, the Rathowen Soil Series. These soils are well to moderately drained and are best suited to grassland.

5.4 Depth to rock

Depth to rock in the public supply borehole is 6.5 metres and in the GSI observation borehole, 10.9 metres of clays, sand and gravels were encountered. Outcrop on the Hill of Ward indicates that the hill is rock cored although there is a some overlying thin cover. A Council trial well indicated 1.2 metres of subsoil. Other rock outcrops occur at quarries in Mullaghstones and Mitchelstown.

To the west the subsoils are on average much thicker (generally around 5 metres) than to the east and northeast. The depth to rock is very variable throughout the area. In Figure 3 the depth-to-rock contours are shown but are based on limited data points and may need refining as further records become available (see). The well drilled in the Council yard (a disused gravel pit) indicated 8.8 metres of clay, sand and gravels.

6. HYDROGEOLOGY

6.1 Data availability

Hydrogeological data for the Athboy area are reasonably good, although lacking in the area of interest around the public supply. A 12 hour pumping test with a recovery test was carried out in October 1995 and a survey of wells and pollution sources was conducted around the source (Figure 4.). Water levels from private wells were collected and a water table map drawn to determine the groundwater flow direction. Some of these water level readings were used with caution as the well heads were not all accurately levelled in and some dug wells may be tapping a perched water table within the till. Most of the wells in the vicinity of the production well are disused shallow dug wells.

The production well was drilled and tested in March 1985, after a geophysical survey in 1984 suggested the valley of the Athboy River was infilled with alluvial sands and gravels (7-10 m thick) overlying limestone bedrock. A short report on the drilling and testing was prepared by K.T. Cullen.

The two trial boreholes drilled by Dunnes Water Services, at the Hill of Ward and in the Council yard at Athboy, yielded less than 40m³/d.

The hydrogeological survey data collected during the course of this project is shown in Figure 4.

The GSI drilled a monitoring borehole (June 1995) with an open hole diameter of 75.7mm (47.6mm core) and 60mm plastic pipes were installed in the borehole. The bottom pipes were slotted to allow water entry. The core is stored in the GSI core store. This well is labelled GSI OW No.1.

6.2 Groundwater levels

Groundwater is generally less than 5 m from surface. The static water level in the production well on 10/10/95, following overnight recovery, was 3.75 m b.g.l. (60.95 m OD), and in the observation well 3.60 m b.g.l. (60.84 m OD).

The pumping water level in the production well on 9/10/95 was 4.90 m b.g.l. and 3.92 m b.g.l. in the observation well.

6.3 Groundwater flow directions and gradients

Regional groundwater flow is generally southwards, but locally it depends on topography, moving in all directions to the Athboy River. It is inferred that the river is in hydraulic continuity with the water table, at least near the well, as the pumping water level in the well is equivalent to the river level. The exact flow direction is difficult to assess due to the relative flat lying ground near the well.

Groundwater gradients in the general area may range from approximately 0.015 to 0.022. The steep gradients occur from the Hill of Ward, while along the river the gradients are quite shallow.

6.4 Rainfall, Evaporation and Recharge

Rainfall data for the area are taken from the nearest rainfall station in Athboy, 1 km northwest. Mean annual rainfall as recorded by Met Eireann for 1951 - 1980 was 839 mm. Potential evapotranspiration (P.E.) is estimated from a Met Eireann contoured map as 500 mm/yr. Actual evapotranspiration (A.E.) is estimated at 475 mm (95% of P.E.) allowing for soil moisture deficits for part of the year.

Using the above figures the effective rainfall (E.R.) is taken as approximately 364 mm/yr. As there are no drainage ditches or streams in the immediate area of the source and the subsoils are generally thin and free draining, a high proportion of the effective rainfall infiltrates to the water table. Estimating run-off to be around 10%, the actual recharge to the aquifer is estimated to be 328 mm/yr.

These calculations are summarised below:

Average annual rainfall	839 mm
Estimated P.E.	500 mm
Estimated A.E. (95% P.E.)	475 mm
Effective rainfall	364 mm
Recharge (90% E.R.)	328 mm

6.5 Hydrochemistry and Water Quality

The hydrochemical analyses of groundwater at the Athboy source indicate a very hard water (345-380 mg/l CaCO₃), with a high alkalinity (255-360 mg/l CaCO₃). Conductivities are also high, ranging from 500-790 µS/cm. (Table 1). This groundwater can be classed as a calcium bicarbonate water. The groundwater analyses are included in the Appendices.

The water quality at Athboy is generally excellent with no bacterial contamination except for occasional small numbers of background Coliforms, and all the major cations, anions and trace elements are within the Irish Drinking Water Standards. Nitrates range between 9-20mg/l which are higher than background levels for County Meath.

6.6 Aquifer coefficients

Analysis of the 1995 pumping test indicated an apparent transmissivity of around 1000 m²/d. The specific capacity calculated was 980 m³/d/m after 12 hours pumping. After an initial drawdown in the well of 0.90 metres during the first minute, drawdown was only 0.2 metres over the next 10 hours.

However, analysis of the original 72 hour pumping test (1985) with a pumping rate of 1385 m³/d and a drawdown of 7.3 metres indicated a transmissivity of around 100-230 m²/d and a specific capacity of 190 m³/d/m. These figures are much lower than those obtained from the 12 hour test, apparently because of the higher pumping rate. More comprehensive tests would be needed to confirm the sustainable maximum yield of the well. The pumping test data are in the Appendices.

The specific yield of 0.075 was calculated from data from the observation well and indicates that the aquifer is unconfined. This value is high for a bedrock aquifer and is thus a composite value which probably relates only to the upper broken part of the bedrock aquifer.

Table 1. Conductivity readings from the Athboy Source

Date	Production Well		River	
	Conductivity	Temperature	Conductivity	Temperature
	($\mu\text{S/cm}$)	($^{\circ}\text{C}$)	($\mu\text{S/cm}$)	($^{\circ}\text{C}$)
*16-3-95	784	6.6		
+24-3-95	492	8.5		
15-5-95	561	10.2		
+13-6-95	572	10.3		
13-9-95	598	12.4		
+27-9-95	579	11.4		
10-10-95	582 - 594	11 - 12.1	586 - 605	12.9 - 13.4
2-11-95	590	12	555	10.1
30-11-95	562	10.9	445	8.5
+10-1-96	617	10.3		
26-2-96	618	9.7	630	6.3
2-4-96	635	10	641	8.8
3-5-96	626	8.9	632	7.4

* Reading taken using a different conductivity meter

+ Full Analyses

6.7 Conceptual Model

The aquifer feeding the Athboy source is the Calp Limestone. This is overlain by up to 11 metres of highly permeable sands and gravels, therefore the aquifer is considered to be unconfined. Permeabilities within the bedrock are increased by joints and fractures. When drilling the production well a major inflow of groundwater was recorded in broken limestone at 10m depth (54.8 m O.D).

Groundwater flow is influenced by topography. A groundwater mound can be deduced along the top of the ridge at the Hill of Ward. The groundwater flow to the source is therefore from the north-northeast.

In the production well, the upper 10.5 metres (6 m of sand and gravel, overlying broken limestone) were lined with 200mm steel casing. The well is open hole to a depth of 61 metres (3.8 m O.D.) The main inflow into the well is at the base of the steel casing, which prevents inflow from the subsoils.

Raw water samples from the well analysed in March 1985 indicated that the groundwater from the well was of excellent quality. There has been no significant change in the hydrochemistry, although the nitrates were much higher (40 mg/l as NO_3). The chemical analysis from the river was similar, suggesting they are interconnected, although the differences in some parameters indicate that the river water is not being pumped directly into supply. Further comparative analyses are required to establish the degree of connection between the river and the supply well.

The 1985 pumping test indicated a maximum yield of $1385\text{m}^3/\text{d}$ with a drawdown of 7.3m (pumping level of 11.2m b.g.l). Increasing the pumping rate lowered the water level to the pump intake at 30m. The 1995 test showed a drawdown of 1.1 m with a pumping level of 5.0m b.g.l., for a discharge of $1080\text{m}^3/\text{d}$. The comparison suggests increasing the pumping rate above $1080\text{m}^3/\text{d}$ produces disproportionate increases in drawdown, as the more permeable upper zones are dewatered.

6.8 Aquifer category

The aquifer supplying the Athboy source is the Calp Limestone and the overlying alluvial sand and gravel deposits, which may be receiving additional recharge from the river. In this area this aquifer is classed as a **locally important aquifer which is generally moderately productive (Lm)**.

7. GROUNDWATER VULNERABILITY

Most of the catchment area for the Athboy source is mapped as highly vulnerable to pollution. The subsoils are generally highly permeable, subject to detailed investigation. However, since a significant proportion of flow to the well may be from the river, the vulnerability of the source to pollution may be less important than the river water quality.

Areas where rock is less than 3 m below surface are mapped as ‘extreme vulnerability’; areas around the Hill of Ward and Mullaghstones fall into this category. The remaining area, including all of the Inner protection Area (SI) is classified as ‘highly vulnerable’ due to the high permeability of the subsoil and/or the shallow cover. The vulnerability zones are shown on Figure 5.

8. DELINEATION OF SOURCE PROTECTION AREAS

Source protection areas are delineated for the output currently abstracted (1080 m³/d), and allows for expansion of the zone of contribution during dry weather by including a buffer zone.

8.1 Inner Source Protection Area (SI)

The Inner Protection Area is the area defined by a 100 day time of travel to the source and is drawn 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.

As a result of the inferred highly permeable zone close to the surface (upper 10 metres) in the vicinity of the source, high aquifer coefficients are used to determine the 100 day time of travel distance.

Using the following aquifer coefficients: permeability (k) = 30 m/d, porosity = 0.075, and hydraulic gradient (i) = 0.02, the 100 day time of travel distance to the well is estimated to be approximately 800 metres (Figure 6). The actual 100 day time of travel distance may be more or less than this, depending on the true parameter values used and the amount of recharge induced from the river.

8.2 Outer Protection Area (SO)

The Outer Protection Area includes the remainder of the catchment area to the source, (or zone of contribution (ZOC)), and is defined by the area required to support abstraction from long-term recharge. The zone of contribution at Athboy is derived from hydrogeological mapping techniques and is controlled primarily by the groundwater divide to the northeast of the source (Hill of Ward) and by the groundwater flow direction. The zone of contribution is shown in Figure 6.

The size of the zone of contribution is based largely on the Recharge Equation. If average annual recharge is 328 mm, the area needed to supply 1080 m³/d is 1.2 km². The null point or down gradient boundary of the ZOC (beyond which water does not contribute to the well) extends to the Athboy River. A buffer (safety margin) is included in the final ZOC by incorporating a ±20° error margin in the inferred groundwater flow direction.

9. GROUNDWATER SOURCE PROTECTION ZONES

Combining the Inner and Outer Source Protection Areas with the vulnerability ratings produces three Groundwater Source Protection Zones (Figure 7), listed in order of decreasing degree of protection required:

- Inner Protection Area / High (SI/H)
- Outer Protection Area / Extreme (SO/E)
- Outer Protection Area / High (SO/H)

10. POTENTIAL POLLUTION SOURCES

As the pumping well is drawing water from the Athboy River, the primary threat to the Athboy source is the quality of the river water upstream of the source, which may be affected in particular, by septic tanks and/or leaky sewers (if present) in the village. This may also account for the slightly elevated background levels of nitrates.

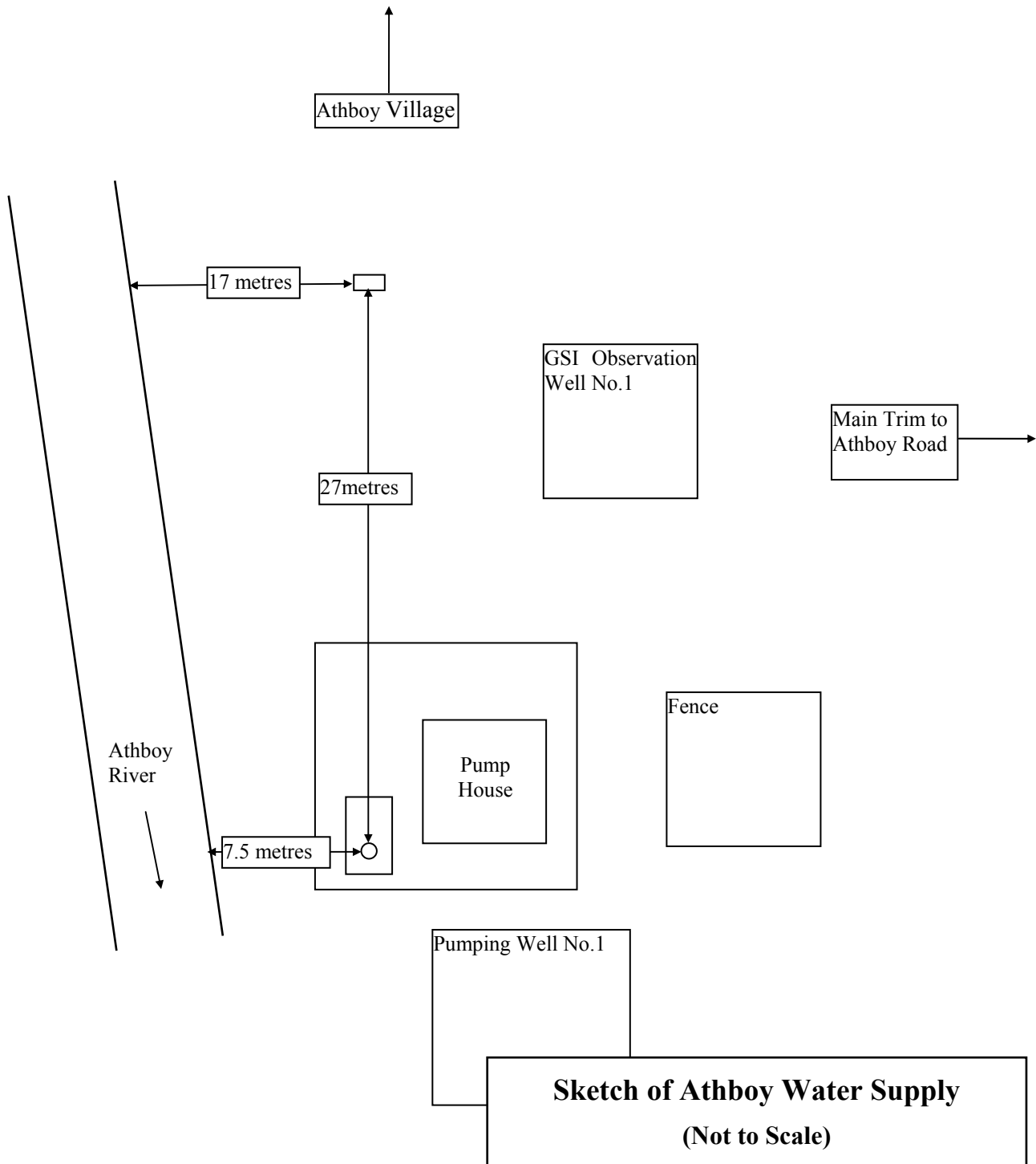
A small number of houses and farmyards exist around the well. One farmyard in particular, located approximately 500 metres up-gradient of the well, stores silage and has cattle feeding yards which would pose a significant risk to the well if the present farmyard management deteriorated. The commercial vehicle test centre in Athboy is located within the Outer Protection area, and spillages of hydrocarbons could pose a significant risk to the Athboy source.

11. CONCLUSIONS AND RECOMMENDATIONS

Overall the source at Athboy is a very good well which should be able to support an increased yield. The water analyses indicated no serious water quality problems at this source, but the ZOC is highly vulnerable to pollution due to the shallow thickness and permeability of the subsoils.

The Council are recommended to monitor the raw water from the source and the river, to control and monitor potentially polluting activities within the source protection zones, particularly the farmyard uphill from the well and the commercial vehicle test centre, and to control activities along the river.

The borehole drilled in May 1996 in the Council yard in Athboy should be secured and locked or backfilled, to prevent pollutants entering the groundwater system.



Appendix 1

Pump Test Data

PUMPING TEST DATA SHEET

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Location : ATHBOY

Borehole name : PW No. 1

Date : 19-03-85

Test : Drawdown data from PW No. 1

Duration : 72 hrs.

Weather : Wet

Height of datum point above ground level : 1m

Well depth : 61m

Date	Time	Time since pumping began (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m ³ /d	Temperature C	Remarks
19/03/85		0	3.89	0			
		1	7.89	4			
		1.5	8.07	4.18			
		2	8.5	4.61			
		2.5	8.68	4.79			
		3	8.88	4.99			
		4	9.2	5.31			
		4.5	9.33	5.44			
		5	9.5	5.61			
		6	9.77	5.88	1650		
		7	9.7	5.81			
		8	9.84	5.95			
		9	9.98	6.09	2415		
		10	10.1	6.21			
		12	13.02	9.13			
		14	12.89	9			
		16	21	17.11			cut down
		30	10.5	6.61	1575		
		35	10.5	6.61			
		40	10.57	6.68			
		45	10.64	6.75			
		50	10.82	6.93			
		55	10.88	6.99			
		60	10.92	7.03			
		75	10.98	7.09			
		90	11.04	7.15			
		105	11.1	7.21			
		120	11.11	7.22	1625		
		150	11.3	7.41			
		180	11.45	7.56	1650		
		210	11.49	7.6			
		240	11.55	7.66	1610		
		300	11.2	7.31			
		360	11.01	7.12			
		420	10.72	6.83	1500		
		720	10.9	7.01	1500		
		1200	11.2	3.31	1500		
		1440	14.47	6.4	1500		
		1560	18.31	9.81	1520		
		1680	10.75	2.07	1370		
		1800	10.66	1.78	1400		
		1920	10.78	1.58	1365		
		2040	10.83	1.5	1365		
		2160	10.92	1.42	1365		
		2520	10.87	1.1	1400		
		3240	11.1	1.4	1365		
		3600	11.25	1.41	1365		
		3960	11.09	1.11	1365		
22/03/85		4320	11.2	1.1	1400		

PUMPING TEST DATA SHEET

Location : ATHBOY

Borehole name : PW No. 1

Date: 22-03-85

Test : Recovery data from PW No. 1

Duration : 40 minutes

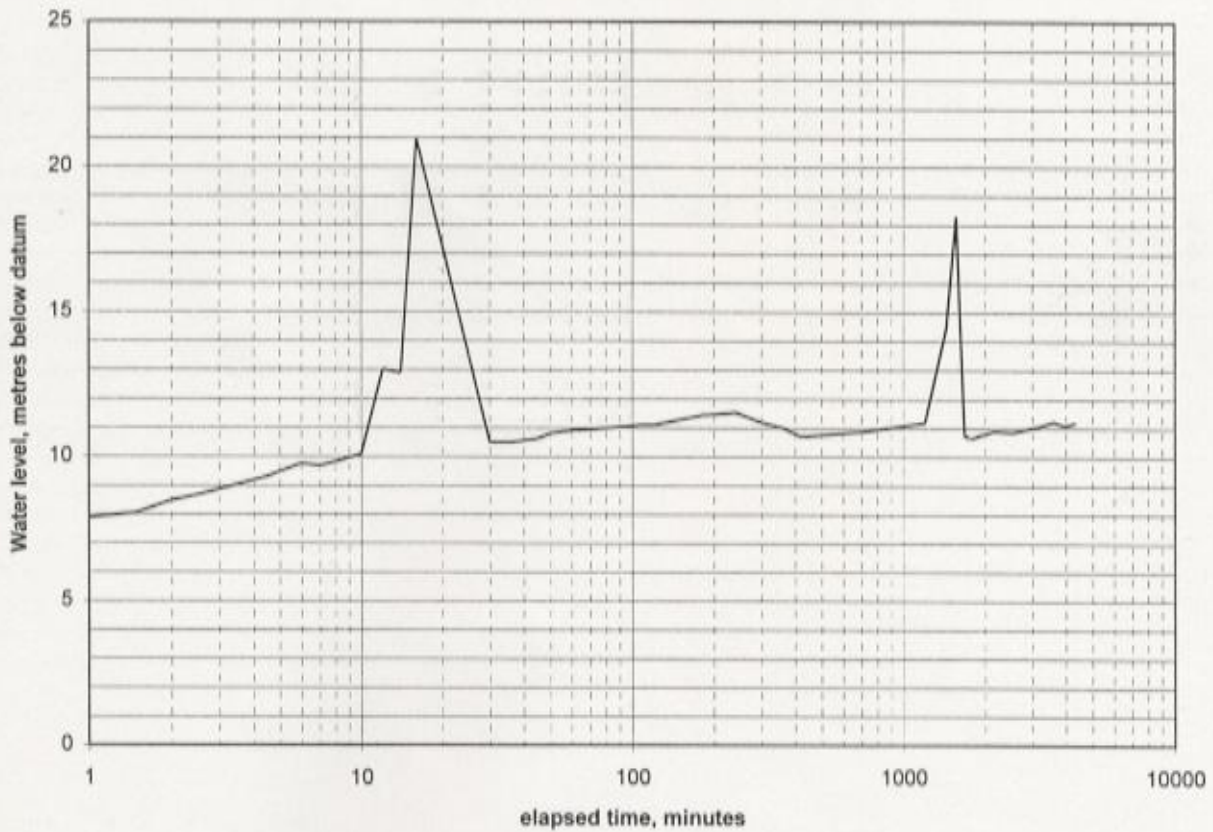
Weather : Wet

Height of datum point above ground level : 1m

Well depth : 61m

Date	Time	Time since pumping ended (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m ³ /d	Temperature C	Remarks
22/03/85		0	11.2	7.31			
		1	4.4	0.51			
		2	4.37	0.48			
		4	4.63	0.74			
		7	4.63	0.74			
		26	4.56	0.67			
		40	4.54	0.65			

Athboy Pumping Test, PW No. 1, 19-22 March 1985



PUMPING TEST DATA SHEET

Location : **ATHBOY**

Borehole name : **PW No.1**

Date : **10-10-95**

Test : **Drawdown Data from PW No.1**

Weather :

Duration : **12hrs.**

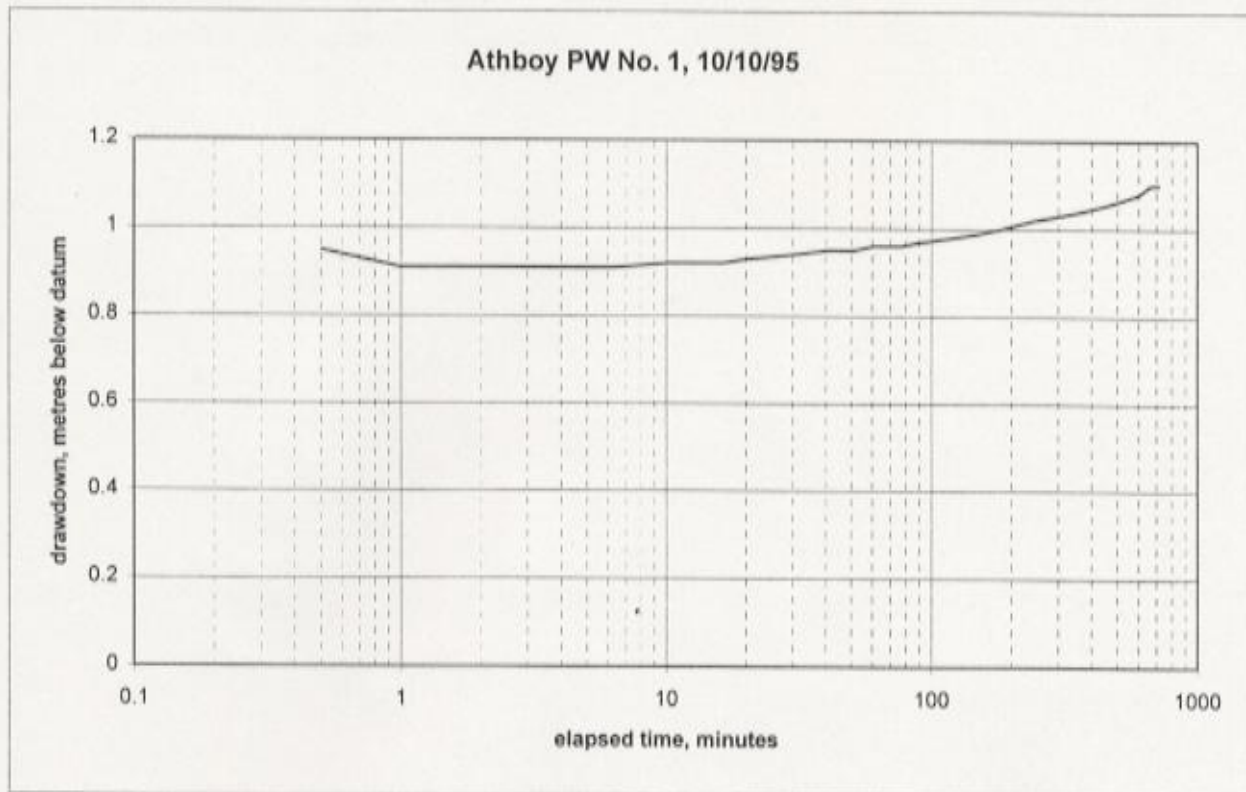
Well depth : **61m.**

Depth of Pump :

Height of datum point above ground level :

Datum Point :

Date	Time	Time since pumping began (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m ³ /d	Temperature C	Conductivity uS/cm @20 C
10-10-95	07:00	0	3.85	0			
		0.5	4.8	0.95			
		1	4.76	0.91			
		1.5	4.76	0.91			
		2	4.76	0.91			
		3.5	4.76	0.91			
		6	4.76	0.91			
		10	4.77	0.92		11.9	585
		16	4.77	0.92		12	588
		20	4.78	0.93			
		30	4.79	0.94		12	586
		40	4.8	0.95			
		50	4.8	0.95			
	08:00	60	4.81	0.96		12.1	589
		75	4.81	0.96			
		90	4.82	0.97		12.1	593
	09:00	120	4.83	0.98		11.9	584
		150	4.84	0.99			
	10:00	180	4.85	1		12	586
		210	4.86	1.01			
		240	4.87	1.02		11	584
		300	4.88	1.03		11.7	586
		360	4.89	1.04			
	14:00	420	4.9	1.05		11.7	594
		480	4.91	1.06		11.6	582
	16:00	540	4.92	1.07		11.7	586
		600	4.93	1.08			
	18:00	660	4.95	1.1			
		720	4.95	1.1			



PUMPING TEST DATA SHEET

Location : ATHBOY

Borehole name : OW No.1

Date : 09-10-95

Test : Recovery Data from OW No.1

Duration : 4hrs.

Weather :

Distance from Pumping Well : 17m

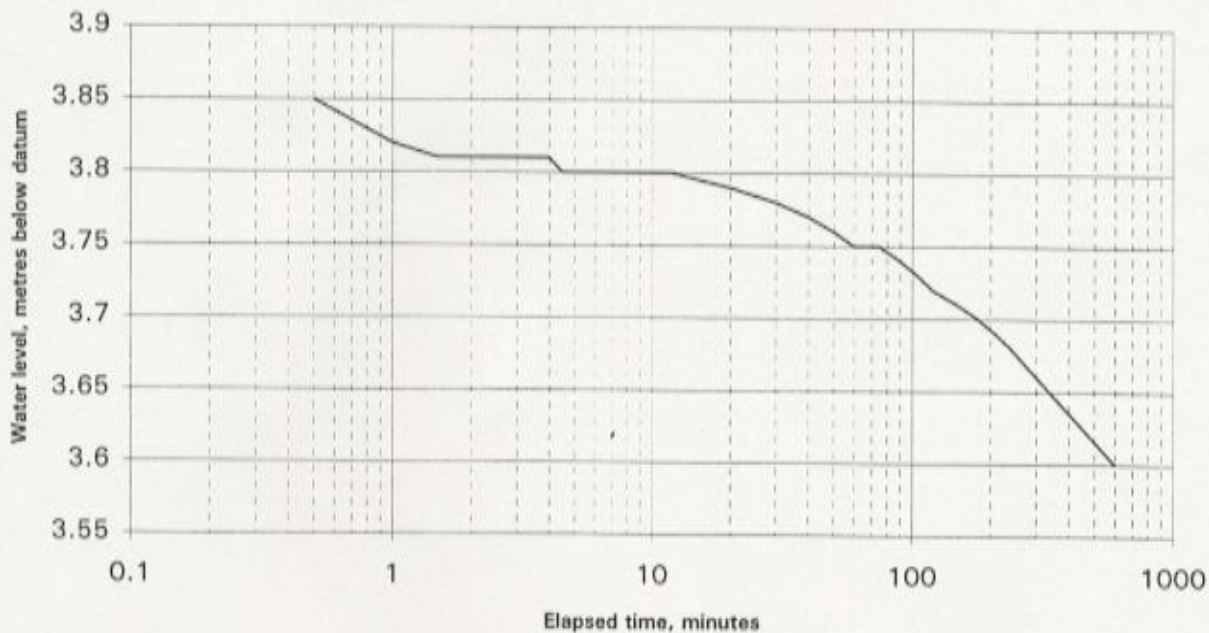
Well depth : 58.8m

Height of datum point above ground level : 0m

Datum Point : top of casing

Date	Time	Time since pumping ended (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m ³ /d	Temperature C	Conductivity uS/cm @20 C
09-10-95	09:00	0	3.92	0.32			
		0.5	3.85	0.25			
		1	3.82	0.22			
		1.5	3.81	0.21			
		2	3.81	0.21			
		2.5	3.81	0.21			
		3	3.81	0.21			
		3.5	3.81	0.21			
		4	3.81	0.21			
		4.5	3.8	0.2			
		5	3.8	0.2			
		6	3.8	0.2			
		7	3.8	0.2			
		8	3.8	0.2			
		9	3.8	0.2			
		10	3.8	0.2			
		12	3.8	0.2			
		20	3.79	0.19			
		30	3.78	0.18			
		40	3.77	0.17			
		50	3.76	0.16			
	10:00	60	3.75	0.15			
		75	3.75	0.15			
		90	3.74	0.14			
		105	3.73	0.13			
	11:00	120	3.72	0.12			
	11:30	150	3.71	0.11			
	12:00	180	3.7	0.1			
	12:30	210	3.69	0.09			
	13:00	240	3.68	0.08			
	19:00	600	3.6	0			

Athboy recovery test OW No. 1, 10 October '95



PUMPING TEST DATA SHEET

Location : ATHBOY

Borehole name : OW No.1

Date : 10-10-95

Test : Drawdown Data from OW No.1 while PW No.1 is pumping.

Duration : 12hrs.

Weather : Fine

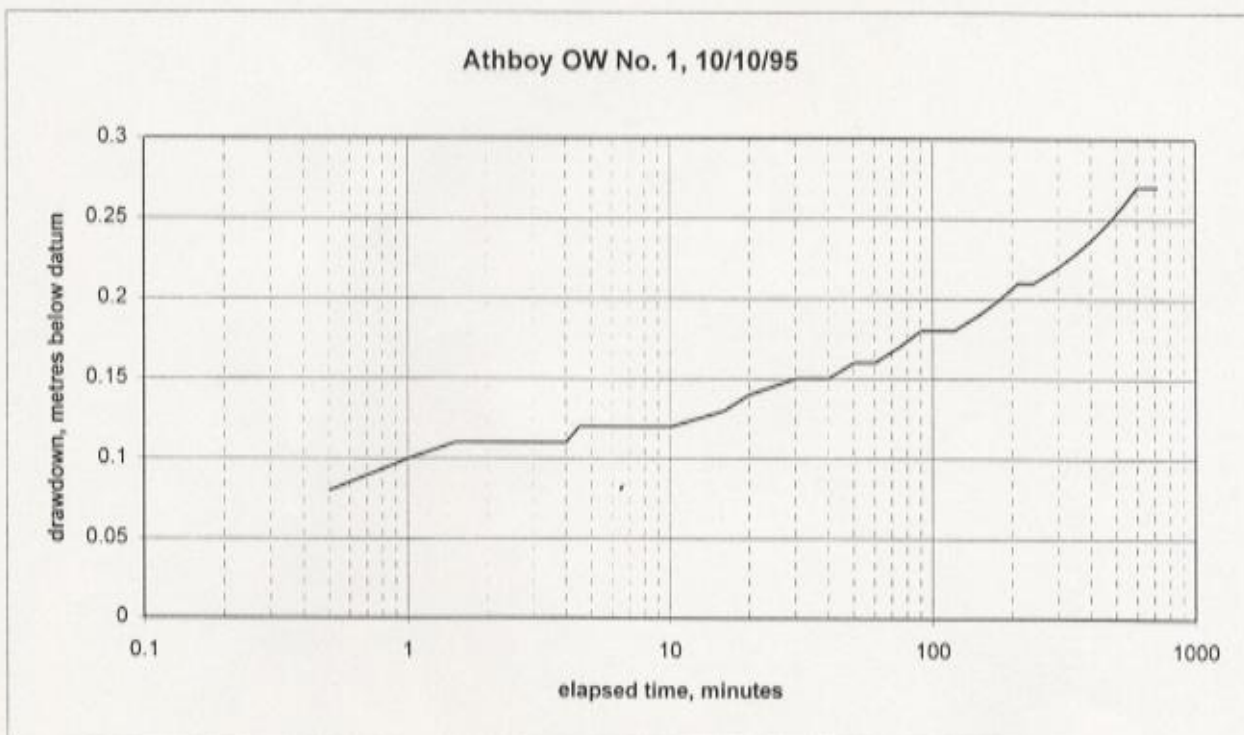
Distance from Pumping Well : 17m

Well depth : 58.8m

Height of datum point above ground level : 0m

Datum Point : top of casing

Date	Time	Time since pumping began (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m ³ /d	Temperature C	Conductivity uS/cm @20 C
10-10-95	07:00	0	3.6	0			
		0.5	3.68	0.08			
		1	3.7	0.1			
		1.5	3.71	0.11			
		2	3.71	0.11			
		2.5	3.71	0.11			
		3	3.71	0.11			
		3.5	3.71	0.11			
		4	3.71	0.11			
		4.5	3.72	0.12			
		10	3.72	0.12			
		16	3.73	0.13			
		20	3.74	0.14			
		30	3.75	0.15			
		40	3.75	0.15			
		50	3.76	0.16			
	08:00	60	3.76	0.16			
		75	3.77	0.17			
		90	3.78	0.18			
	09:00	120	3.78	0.18			
		150	3.79	0.19			
	10:00	180	3.8	0.2			
		210	3.81	0.21			
	11:00	240	3.81	0.21			
		300	3.82	0.22			
		360	3.83	0.23			
	14:00	420	3.84	0.24			
	15:00	480	3.85	0.25			
	16:00	540	3.86	0.26			
	17:00	600	3.87	0.27			
	18:00	660	3.87	0.27			
	19:00	720	3.87	0.27			



Location : ATHBOY

Borehole name : PW No.1

Date : 03-07-96

Test : Drawdown Data from PW No.1.

Duration : 96hrs

Weather : Fine

Height of datum point above ground level : 1m.

Well depth : 61m.

Date	Time	Time since pumping began (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m ³ /d	Temperature C	Remarks
03-07-96	11:30	0	4.12	0			Step 1
		0.5	4.28	0.16			
		1	4.3	0.18			
		1.5	4.29	0.17			
		2	4.31	0.19			
		2.5	4.32	0.2			
		3	4.32	0.2			
		3.5	4.33	0.21			
		4	4.33	0.21			
		4.5	4.34	0.22			
		5	4.34	0.22	1229		
		6	4.34	0.22			
		7	4.34	0.22			
		8	4.34	0.22			
		9	4.34	0.22			
		10	4.35	0.23	1229		
		12	4.35	0.23			
		14	4.35	0.23			
		16	4.35	0.23	1229		
		18	4.35	0.23			
		20	4.35	0.23			
		22	4.36	0.24			
		24	4.36	0.24			
		26	4.36	0.24	1229		
		28	4.36	0.24			
		30	4.37	0.25			
		35	4.37	0.25			
		40	4.37	0.25			
		45	4.37	0.25			
		50	4.38	0.26	1229		
		55	4.38	0.26			
	12:30	60	4.38	0.26			
		75	4.39	0.27			
		90	4.4	0.28			Step 2
		90.5	5.1	0.98			
		91	5.19	1.07			
		91.5	5.25	1.13			
		92	5.28	1.16			
		92.5	5.3	1.18			
		93	5.31	1.19			
		93.5	5.32	1.2			
		94	5.33	1.21			
		94.5	5.33	1.21			
		95	5.34	1.22	2884		
		96	5.34	1.22			
		97	5.35	1.23			
		98	5.35	1.23			
		99	5.35	1.23	2884		
		100	5.36	1.24			
		102	5.37	1.25			
		104	5.37	1.25			
		106	5.37	1.25			
		108	5.38	1.26			
		110	5.38	1.26			
		112	5.39	1.27			
		114	5.4	1.28			
		116	5.4	1.28			
		118	5.4	1.28			

Location : ATHBOY

Borehole name : PW No.1

Date : 03-07-96

Test : Drawdown Data from PW No.1.

Duration : 96hrs

Weather : Fine

Height of datum point above ground level : 1m.

Well depth : 61m.

Date	Time	Time since pumping began (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m ³ /d	Temperature C	Remarks
	13:30	120	5.41	1.29	2884		
		125	5.41	1.29			
		130	5.42	1.3			
		135	5.42	1.3			
		140	5.43	1.31	2884		
		145	5.44	1.32			
		150	5.44	1.32	2884		
		165	5.46	1.34			
	14:30	180	5.48	1.36			Step 3
		180.5	5.61	1.49			
		181	5.73	1.61			
		181.5	5.75	1.63			
		182	5.79	1.67			
		182.5	5.81	1.69	3388		
		183	5.83	1.71			
		183.5	5.83	1.71			
		184	5.83	1.71			
		184.5	5.84	1.72			
		185	5.84	1.72			
		186	5.84	1.72			
		187	5.85	1.73			
		188	5.85	1.73			
		189	5.85	1.73			
		190	5.86	1.74	3388		
		192	5.86	1.74			
		194	5.86	1.74			
		196	5.86	1.74	3388		
		198	5.87	1.75			
		200	5.87	1.75			
		202	5.87	1.75			
		204	5.88	1.76			
		206	5.88	1.76			
		208	5.89	1.77			
		210	5.89	1.77			
		215	5.89	1.77			
		220	5.9	1.78			
		225	5.9	1.78			
		230	5.91	1.79			
		235	5.92	1.8			
	15:30	240	5.92	1.8			
		255	5.94	1.82	3388		
		270	5.96	1.84			
		285	5.97	1.85			
	16:30	300	6	1.88			
		330	6.02	1.9			
	17:30	360	6.04	1.92			
		390	6.07	1.95	3388		
		420	6.1	1.98			
	18:30	480	6.15	2.03	3388		
	20:30	540	6.19	2.07	3216		
	21:30	600	6.22	2.1	3216		
	22:30	660	6.27	2.15	3216		
	23:30	720	6.31	2.19	3216		
04-07-96	00:30	780	6.35	2.23	3216		
	02:30	900	6.42	2.3	3216		
	04:30	1020	6.5	2.38	3216		
	06:30	1140	6.56	2.44	3216		
	08:30	1260	6.63	2.51	3216		

Location : ATHBOY

Borehole name : PW No.1

Date : 03-07-96

Test : Drawdown Data from PW No.1.

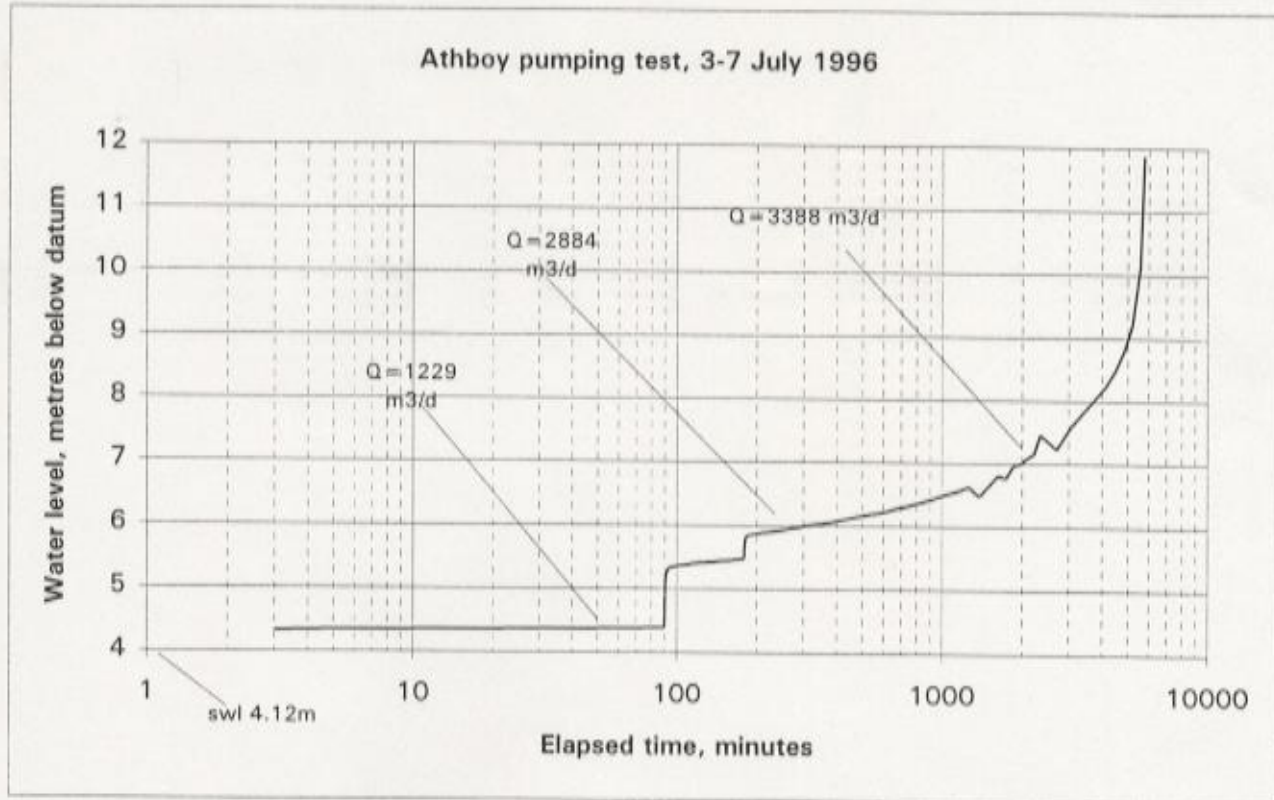
Duration : 96hrs

Weather : Fine

Height of datum point above ground level : 1m.

Well depth : 61m.

Date	Time	Time since pumping began (min.)	Water level below datum (metres)	Drawdown (metres)	Discharge m ³ /d	Temperature C	Remarks
	10:30	1380	6.48	2.36	3388		
	14:30	1620	6.81	2.69	3216		
	16:30	1740	6.77	2.65	3388		
	18:30	1860	6.97	2.85	3216		
	20:30	1980	7	2.88	3216		
	22:30	2100	7.1	2.98	3388		
05-07-96	00:30	2220	7.16	3.04	3216		
	02:30	2340	7.46	3.34	3216		
	08:30	2700	7.23	3.11	3216		
	14:30	3060	7.59	3.47	3047		
	20:30	3420	7.83	3.71	3216		
06-07-96	02:30	3780	8.04	3.92	3216		
	08:30	4140	8.23	4.11	3216		
	14:30	4500	8.48	4.36	3216		
	20:30	4860	8.81	4.69	3216		
07-07-96	02:30	5220	9.22	5.1	3047		
	08:30	5580	10.12	6	3047		
	11:30	5760	11.87	7.75	2884		



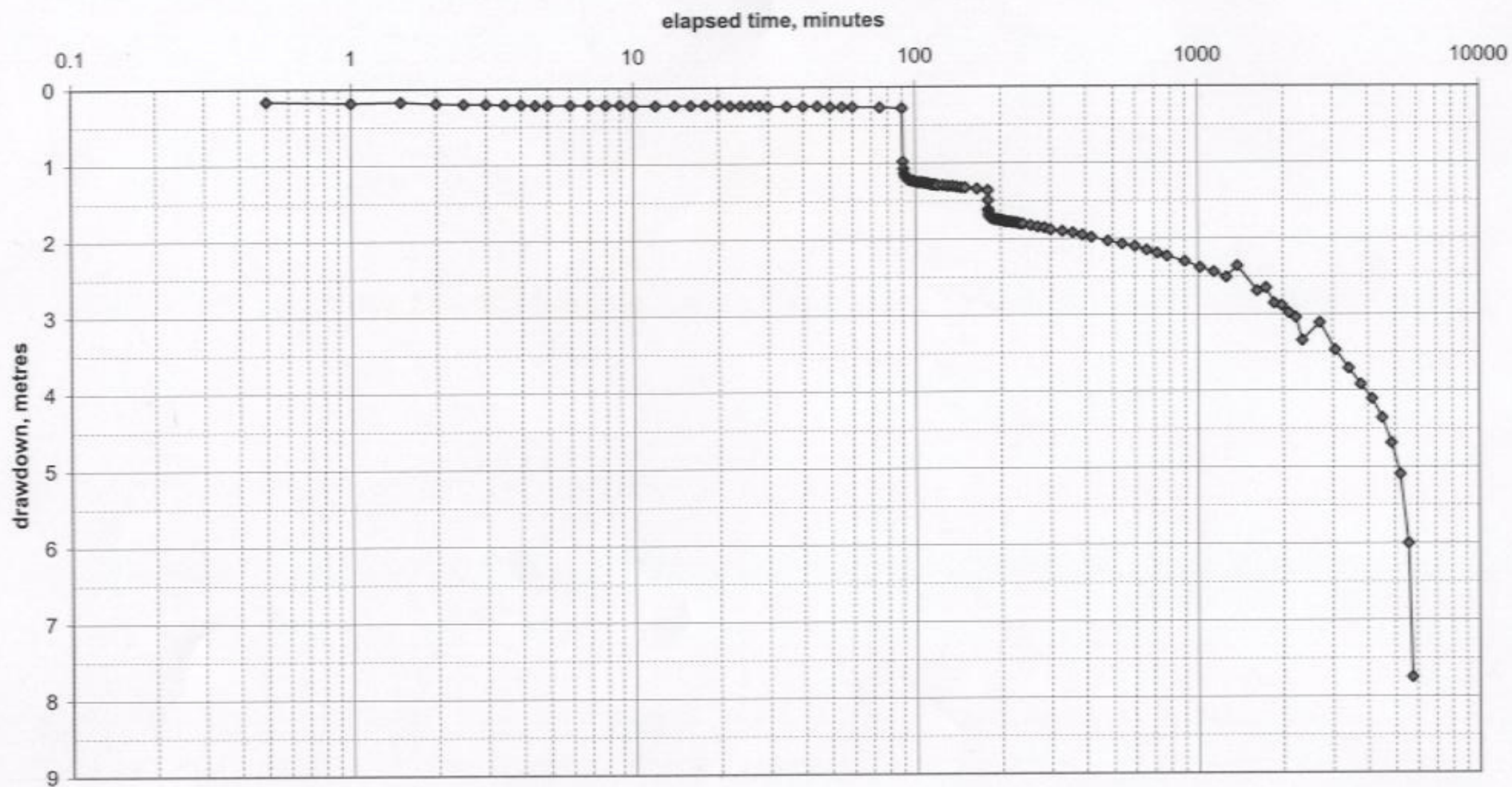
Groundwater Quality Analyses

Groundwater Source :		Athboy					
Sample Location :		PW No.1	Athboy R.	PW No.1	PW No.1	PW No.1	PW No.1
Date :		22/03/85	22/03/85	24/03/95	13/06/95	27/09/95	10/01/96
Parameters	Units						
Alkalinity	mg/l	310	296	358	358	254	306
Aluminium	mg/l			<0.02	<0.02	<0.02	<0.02
Ammonium	mg/l	0.1	0.26				
Ammonium as Nitrogen	mg/l			<0.01	<0.01	<0.015	<0.015
Arsenic	mg/l			<0.25		<0.05	<0.05
Barium	mg/l			0.078	0.088	0.09	0.076
Bicarbonate	mg/l	378	361				
Boron	mg/l			0.032	<0.02	0.035	0.031
Cadmium	mg/l			<0.025	<0.025	<0.005	<0.005
Calcium	mg/l	136	138	143	138	139	136.4
Calcium Hardness	mg/l			357	345	347	340
Total Hardness	mg/l			395	387	395	377
Chloride	mg/l	24	22	21.2	21.1	21.3	19.8
Chromium	mg/l			<0.025	<0.025	<0.005	<0.005
Copper	mg/l			<0.01	<0.01	0.005	<0.005
Cyanide	mg/l			<0.01	<0.01	<0.01	<0.01
Electrical Conductivity	mg/l	0.62	0.64	0.723	0.794	0.638	0.708
Fluoride	mg/l			<0.25	<0.25	<0.25	<0.25
Iron (total)	mg/l		0.1	0.011	<0.01	0.007	<0.005
Lead	mg/l			0.24	<0.25	<0.02	<0.02
Magnesium	mg/l	6	9	9	10.3	11.5	8.838
Magnesium Hardness	mg/l			37	42	47	36
Manganese	mg/l			<0.005	<0.005	<0.005	<0.005
Mercury	mg/l					<0.02	<0.02
Nickel	mg/l			<0.05	<0.05	<0.01	<0.01
Nitrate	mg/l	39.9	31	14.8	13.9	8.9	19.9
Nitrite	mg/l	<0.01	0.38	<0.01	<0.01	<0.1	<0.1
pH		7.4	7.9	7.2	7.3	7.2	7.1
Phosphate	mg/l			<0.5	<0.5	<0.5	<0.5
Phosphorus	mg/l			0.444	<0.25	<0.025	<0.25
Potassium	mg/l	1.3	2.3	1.5	2.2	2.457	1.527
Selenium	mg/l					<0.05	<0.05
Silver	mg/l			<0.01	<0.01	<0.005	<0.005
Sodium	mg/l	7	7	7.8	9.2	10.83	8.75
Strontium	mg/l			0.725	0.747	0.778	0.737
Sulphate	mg/l	25.5	56	21.6	50.9	52.7	24.4
Temperature	C			8.5	10.3	11.6	10.6
Total dissolved solids	mg/l			562	590	492	505
Zinc	mg/l			0.02	0.037	0.012	0.016
Total Coliforms	/100 ml	0	0	0	2	0	0
E. coli	/100 ml	0	0	0	0	0	0

Groundwater Quality Analyses

Groundwater Source :		Athboy					
Sample Location :		PW No1	Athboy R.	PW No.1	PW No.1	PW No.1	PW No.1
Date :		22/03/85	22/03/85	24/03/95	13/06/95	27/09/95	10/01/96
Parameters	Units						
Alkalinity	mg/l	310	296	358	358	254	306
Aluminium	mg/l			<0.02	<0.02	<0.02	<0.02
Ammonium	mg/l	0.1	0.26				
Ammonium as Nitrogen	mg/l			<0.01	<0.01	<0.015	<0.015
Arsenic	mg/l			<0.25		<0.05	<0.05
Barium	mg/l			0.078	0.088	0.09	0.076
Bicarbonate	mg/l	378	361				
Boron	mg/l			0.032	<0.02	0.035	0.031
Cadmium	mg/l			<0.025	<0.025	<0.005	<0.005
Calcium	mg/l	136	138	143	138	139	136.4
Calcium Hardness	mg/l			357	345	347	340
Total Hardness	mg/l			395	387	395	377
Chloride	mg/l	24	22	21.2	21.1	21.3	19.8
Chromium	mg/l			<0.025	<0.025	<0.005	<0.005
Copper	mg/l			<0.01	<0.01	0.005	<0.005
Cyanide	mg/l			<0.01	<0.01	<0.01	<0.01
Electrical Conductivity	mg/l	0.62	0.64	0.723	0.794	0.638	0.708
Fluoride	mg/l			<0.25	<0.25	<0.25	<0.25
Iron (total)	mg/l		0.1	0.011	<0.01	0.007	<0.005
Lead	mg/l			0.24	<0.25	<0.02	<0.02
Magnesium	mg/l	6	9	9	10.3	11.5	8.838
Magnesium Hardness	mg/l			37	42	47	36
Manganese	mg/l			<0.005	<0.005	<0.005	<0.005
Mercury	mg/l					<0.02	<0.02
Nickel	mg/l			<0.05	<0.05	<0.01	<0.01
Nitrate	mg/l	39.9	31	14.8	13.9	8.9	19.9
Nitrite	mg/l	<0.01	0.38	<0.01	<0.01	<0.1	<0.1
pH		7.4	7.9	7.2	7.3	7.2	7.1
Phosphate	mg/l			<0.5	<0.5	<0.5	<0.5
Phosphorus	mg/l			0.444	<0.25	<0.025	<0.25
Potassium	mg/l	1.3	2.3	1.5	2.2	2.457	1.527
Selenium	mg/l					<0.05	<0.05
Silver	mg/l			<0.01	<0.01	<0.005	<0.005
Sodium	mg/l	7	7	7.8	9.2	10.83	8.75
Strontium	mg/l			0.725	0.747	0.778	0.737
Sulphate	mg/l	25.5	56	21.6	50.9	52.7	24.4
Temperature	C			8.5	10.3	11.6	10.6
Total dissolved solids	mg/l			562	590	492	505
Zinc	mg/l			0.02	0.037	0.012	0.016
Total Coliforms	/100 ml	0	0	0	2	0	0
E. coli	/100 ml	0	0	0	0	0	0

Athboy WSS, pumping test 3-7 July 1996
Drawdown in Pumped Well PW1



PUMPING TEST DATA SHEET

Location : **ATHBOY**

Borehole name : **PW No.1**

Date : **03-07-96**

Test : Drawdown Data from PW No.1.

Duration Time : 96hrs

Weather : Fine

Distance from Pumping Well :

Well depth : 61m.

Height of datum point above ground level : 1m.

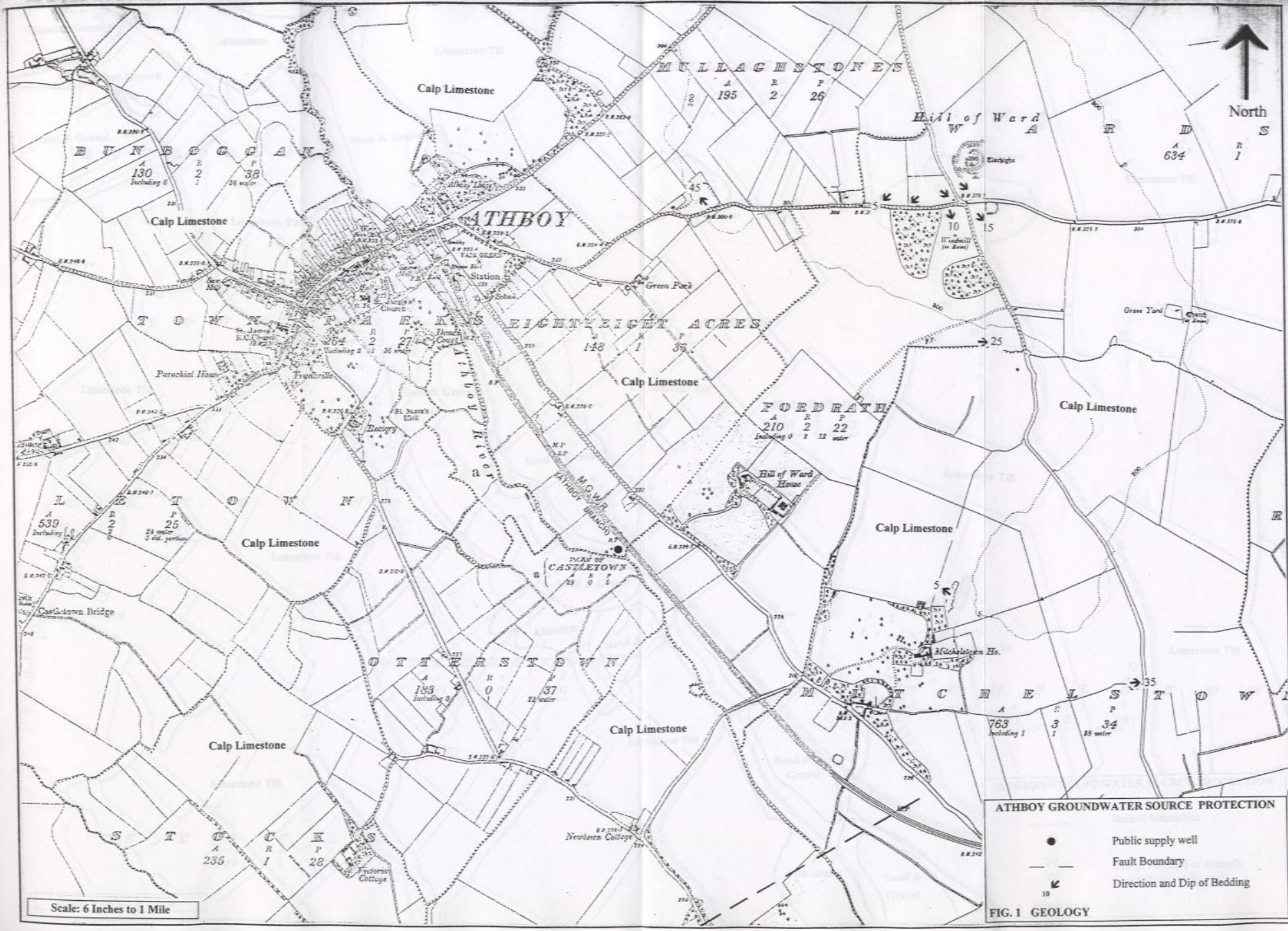
Datum Point : ?

Date	Time	Time since pumping began/ended	Water level below datum (metres)	Drawdown (metres)	Discharge m3/d	Temperature C				
03-07-96	11:30	0	4.12	0			Step 1			
		0.5	4.28	0.16						
		1	4.3	0.18						
		1.5	4.29	0.17						
		2	4.31	0.19						
		2.5	4.32	0.2						
		3	4.32	0.2						
		3.5	4.33	0.21						
		4	4.33	0.21						
		4.5	4.34	0.22						
		5	4.34	0.22		1229				
		6	4.34	0.22						
		7	4.34	0.22						
		8	4.34	0.22						
		9	4.34	0.22						
		10	4.35	0.23		1229				
		12	4.35	0.23						
		14	4.35	0.23						
		16	4.35	0.23		1229				
		18	4.35	0.23						
		20	4.35	0.23						
		22	4.36	0.24						
		24	4.36	0.24						
		26	4.36	0.24		1229				
		28	4.36	0.24						
		30	4.37	0.25						
		35	4.37	0.25						
		40	4.37	0.25						
		45	4.37	0.25						
		50	4.38	0.26		1229				
		55	4.38	0.26						
			12:30	60	4.38	0.26				Step 2
				75	4.39	0.27				
				90	4.4	0.28				
				90.5	5.1	0.98				
				91	5.19	1.07				
				91.5	5.25	1.13				
				92	5.28	1.16				
				92.5	5.3	1.18				
				93	5.31	1.19				
				93.5	5.32	1.2				
				94	5.33	1.21				
				94.5	5.33	1.21				
				95	5.34	1.22			2884	
				96	5.34	1.22				
				97	5.35	1.23				
				98	5.35	1.23				
				99	5.35	1.23			2884	
				100	5.36	1.24				
				102	5.37	1.25				
				104	5.37	1.25				
		106	5.37	1.25						
		108	5.38	1.26						
		110	5.38	1.26						
		112	5.39	1.27						
114	5.4	1.28								
116	5.4	1.28								
	13:30	118	5.4	1.28						
		120	5.41	1.29		2884				
		125	5.41	1.29						
		130	5.42	1.3						
		135	5.42	1.3						
		140	5.43	1.31	2884					

Date	Time	Time since pumping began/ended	Water level below datum (metres)	Drawdown (metres)	Discharge m3/d	Temperature C	
		145	5.44	1.32			
		150	5.44	1.32	2884		
		165	5.46	1.34			
	14:30	180	5.48	1.36			Step 3
		180.5	5.61	1.49			
		181	5.73	1.61			
		181.5	5.75	1.63			
		182	5.79	1.67			
		182.5	5.81	1.69	3388		
		183	5.83	1.71			
		183.5	5.83	1.71			
		184	5.83	1.71			
		184.5	5.84	1.72			
		185	5.84	1.72			
		186	5.84	1.72			
		187	5.85	1.73			
		188	5.85	1.73			
		189	5.85	1.73			
		190	5.86	1.74	3388		
		192	5.86	1.74			
		194	5.86	1.74			
		196	5.86	1.74	3388		
		198	5.87	1.75			
		200	5.87	1.75			
		202	5.87	1.75			
		204	5.88	1.76			
		206	5.88	1.76			
		208	5.89	1.77			
		210	5.89	1.77			
		215	5.89	1.77			
		220	5.9	1.78			
		225	5.9	1.78			
		230	5.91	1.79			
		235	5.92	1.8			
	15:30	240	5.92	1.8			
		255	5.94	1.82	3388		
		270	5.96	1.84			
		285	5.97	1.85			
	16:30	300	6	1.88			
		330	6.02	1.9			
	17:30	360	6.04	1.92			
		390	6.07	1.95	3388		
	18:30	420	6.1	1.98			
	19:30	480	6.15	2.03	3388		
	20:30	540	6.19	2.07	3216		
	21:30	600	6.22	2.1	3216		
	22:30	660	6.27	2.15	3216		
	23:30	720	6.31	2.19	3216		
04-07-96	00:30	780	6.35	2.23	3216		
	02:30	900	6.42	2.3	3216		
	04:30	1020	6.5	2.36	3216		
	06:30	1140	6.56	2.44	3216		
	08:30	1260	6.63	2.51	3216		
	10:30	1380	6.48	2.36	3388		
	14:30	1620	6.81	2.69	3216		
	16:30	1740	6.77	2.65	3388		
	18:30	1860	6.97	2.85	3216		
	20:30	1980	7	2.88	3216		
	22:30	2100	7.1	2.98	3388		
05-07-96	00:30	2220	7.16	3.04	3216		
	02:30	2340	7.46	3.34	3216		
	08:30	2700	7.23	3.11	3216		
	14:30	3060	7.59	3.47	3047		
	20:30	3420	7.83	3.71	3216		
06-07-96	02:30	3780	8.04	3.92	3216		
	08:30	4140	8.23	4.11	3216		
	14:30	4500	8.48	4.36	3216		
	20:30	4860	8.81	4.69	3216		
07-07-96	02:30	5220	9.22	5.1	3047		
	08:30	5580	10.12	6	3047		
	11:30	5760	11.87	7.75	2884		

Appendix 2

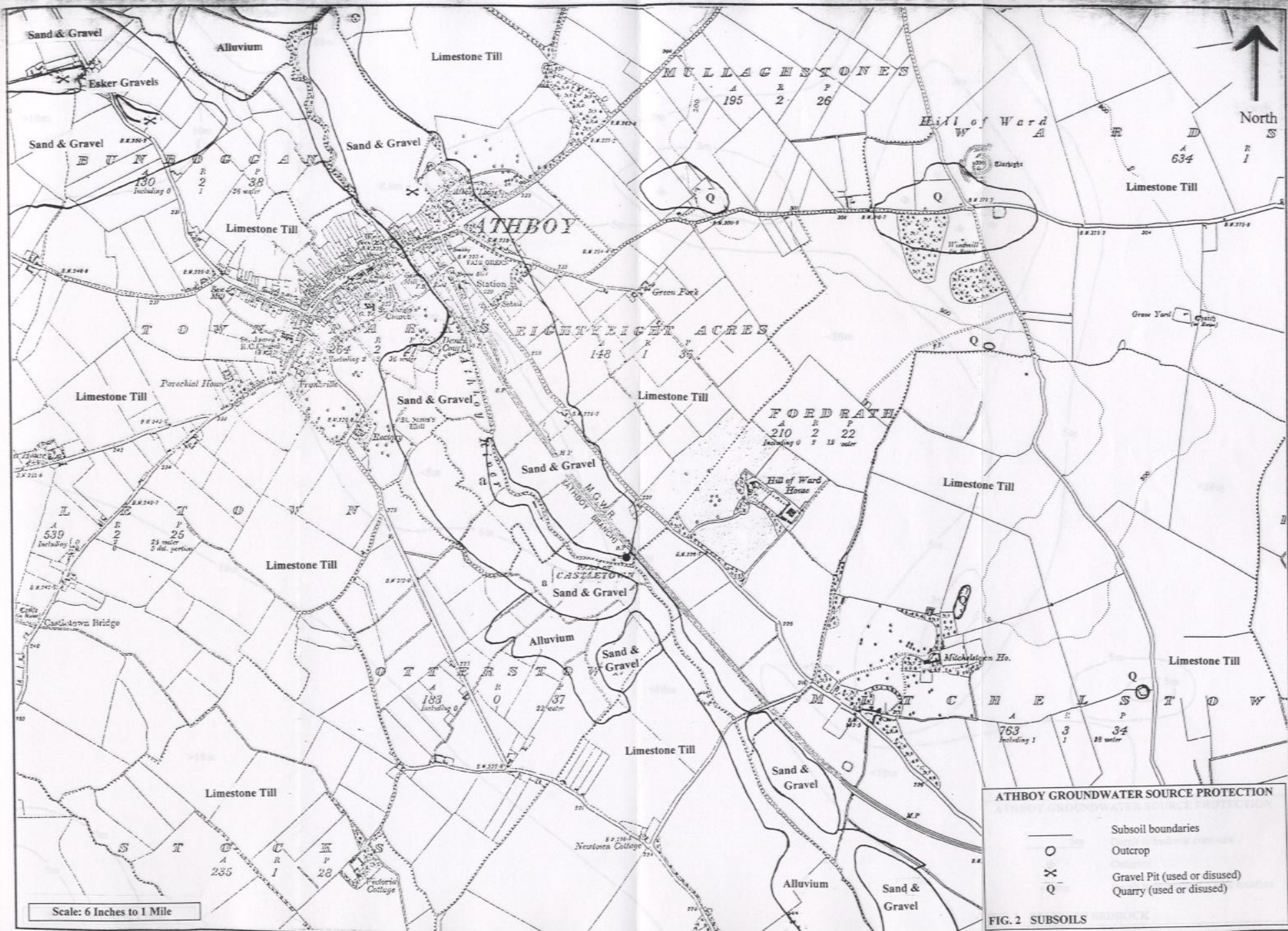
Maps



ATHBOY GROUNDWATER SOURCE PROTECTION

- Public supply well
- - - Fault Boundary
- ↙ Direction and Dip of Bedding

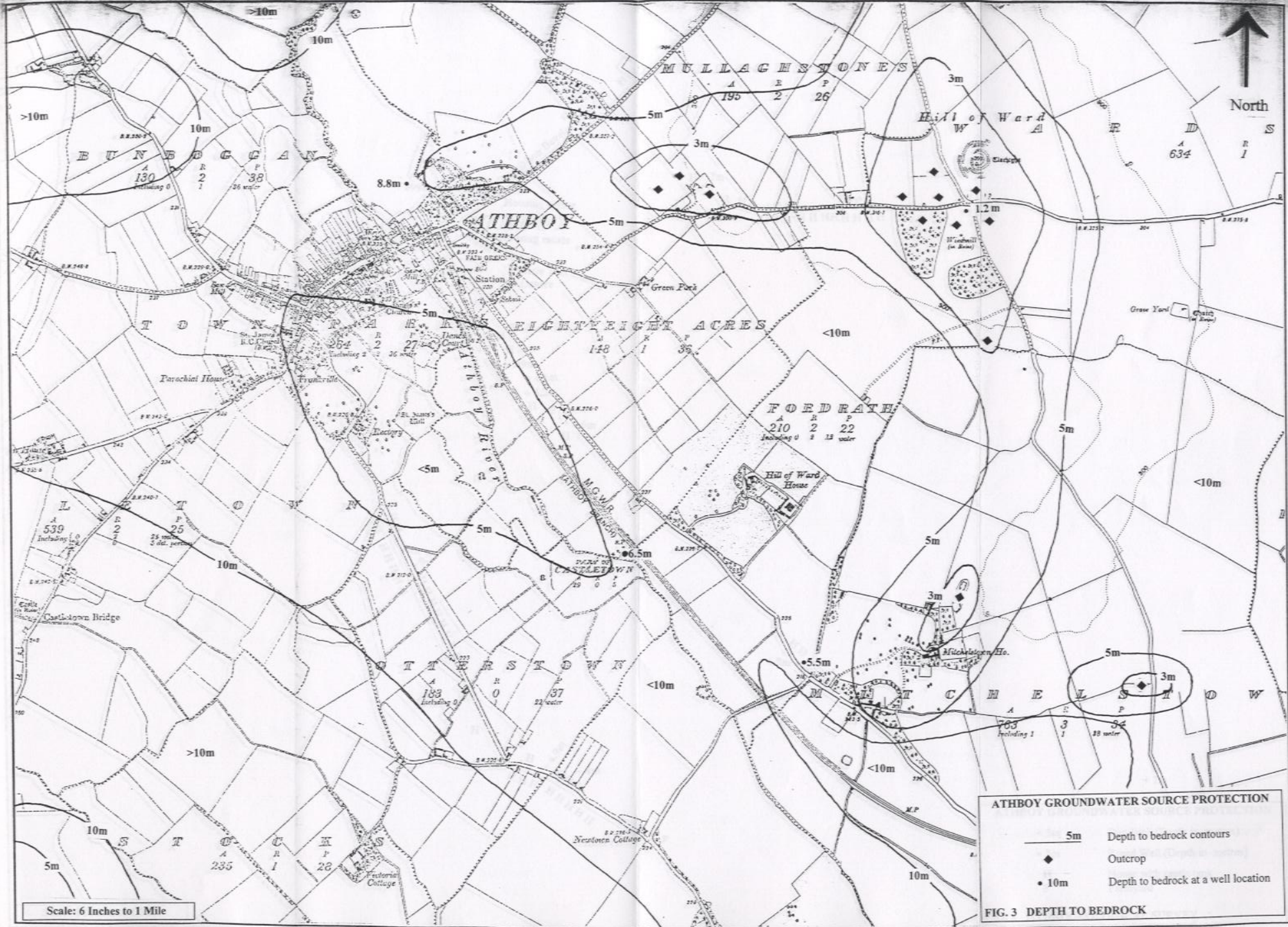
FIG. 1 GEOLOGY



ATHBOY GROUNDWATER SOURCE PROTECTION

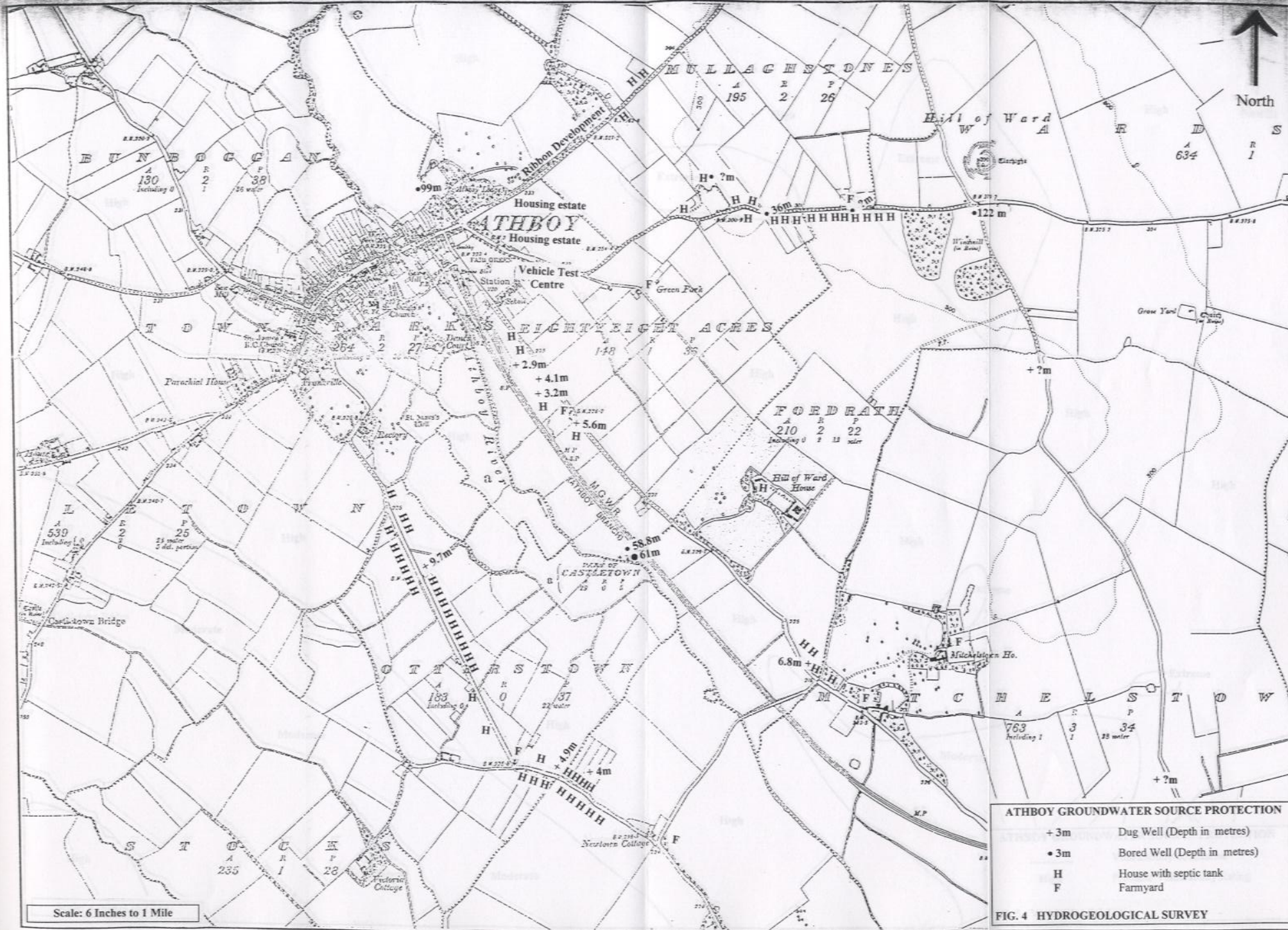
— Subsoil boundaries
 O Outcrop
 X Gravel Pit (used or disused)
 Q Quarry (used or disused)

FIG. 2 SUBSOILS

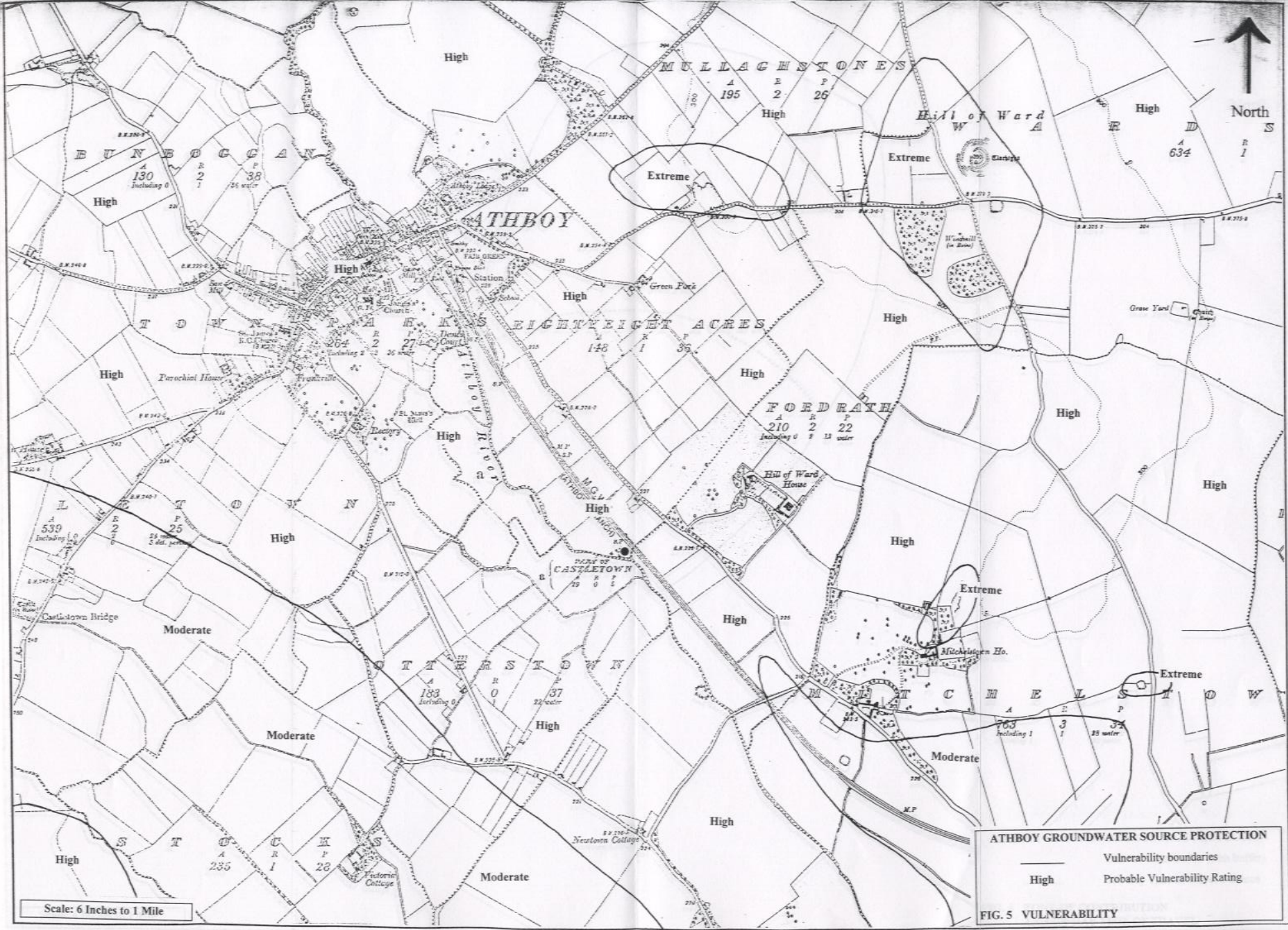


Scale: 6 Inches to 1 Mile

FIG. 3 DEPTH TO BEDROCK

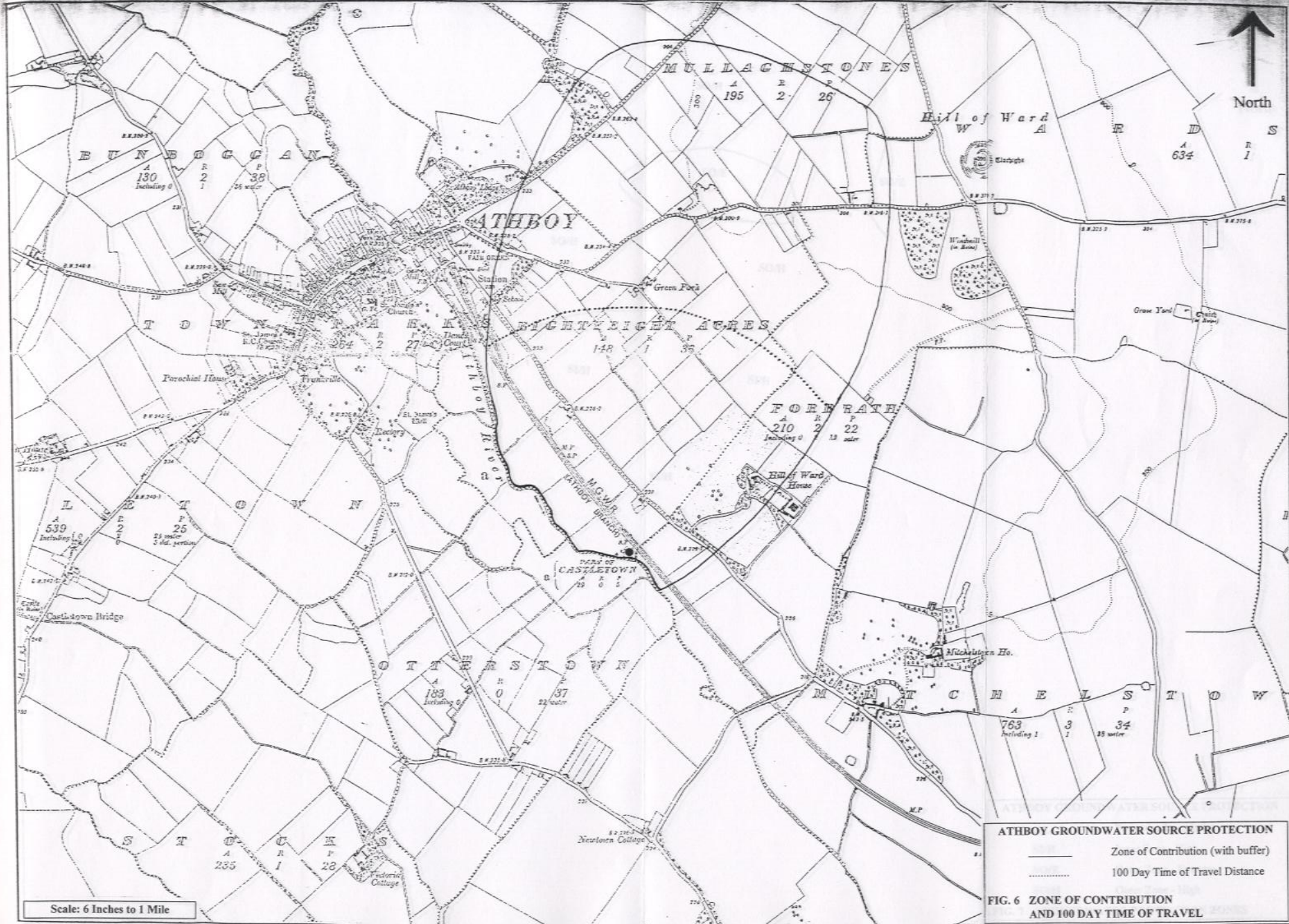


Scale: 6 Inches to 1 Mile



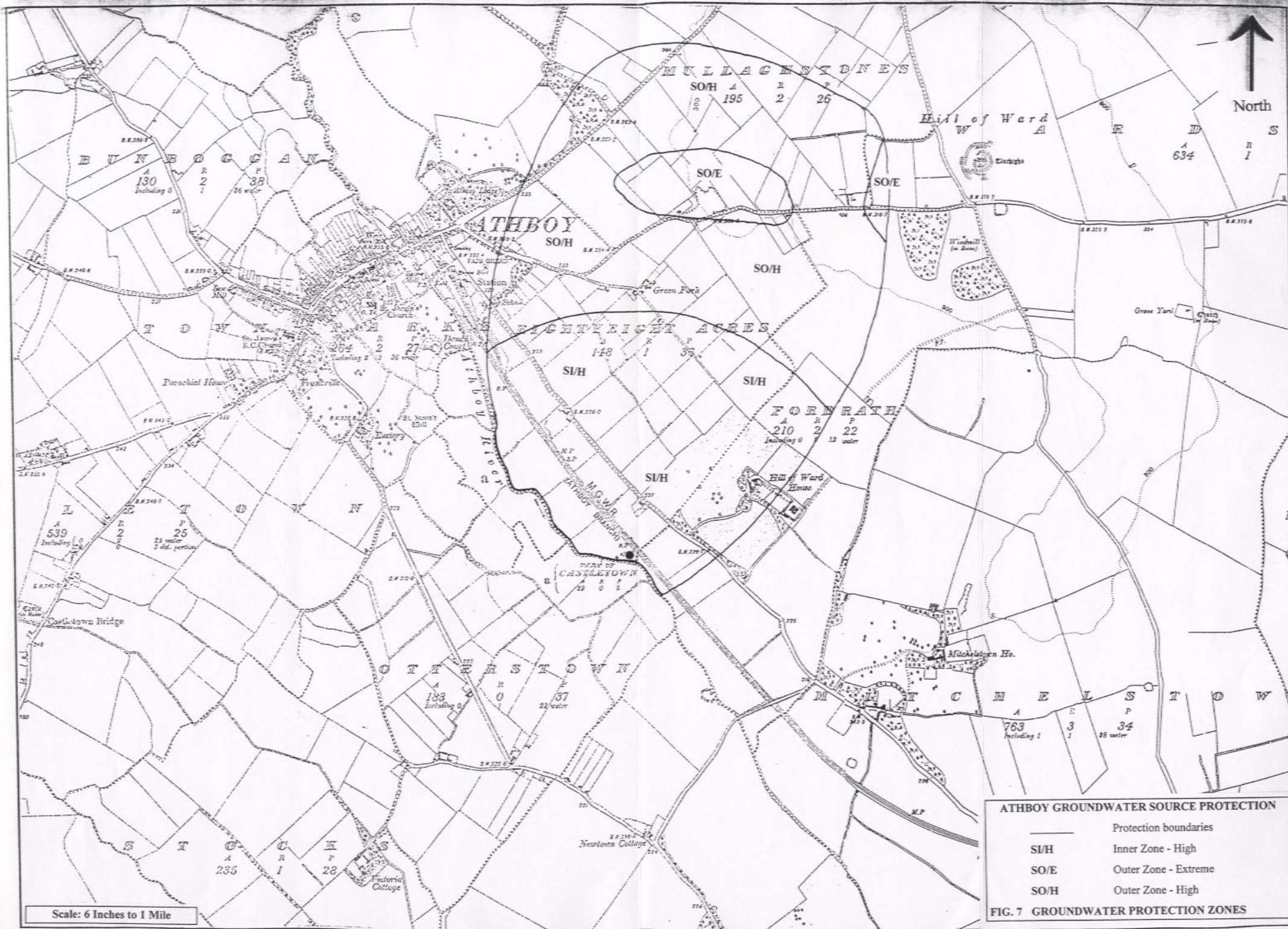
Scale: 6 Inches to 1 Mile

ATHBOY GROUNDWATER SOURCE PROTECTION
 — Vulnerability boundaries
 High Probable Vulnerability Rating
FIG. 5 VULNERABILITY

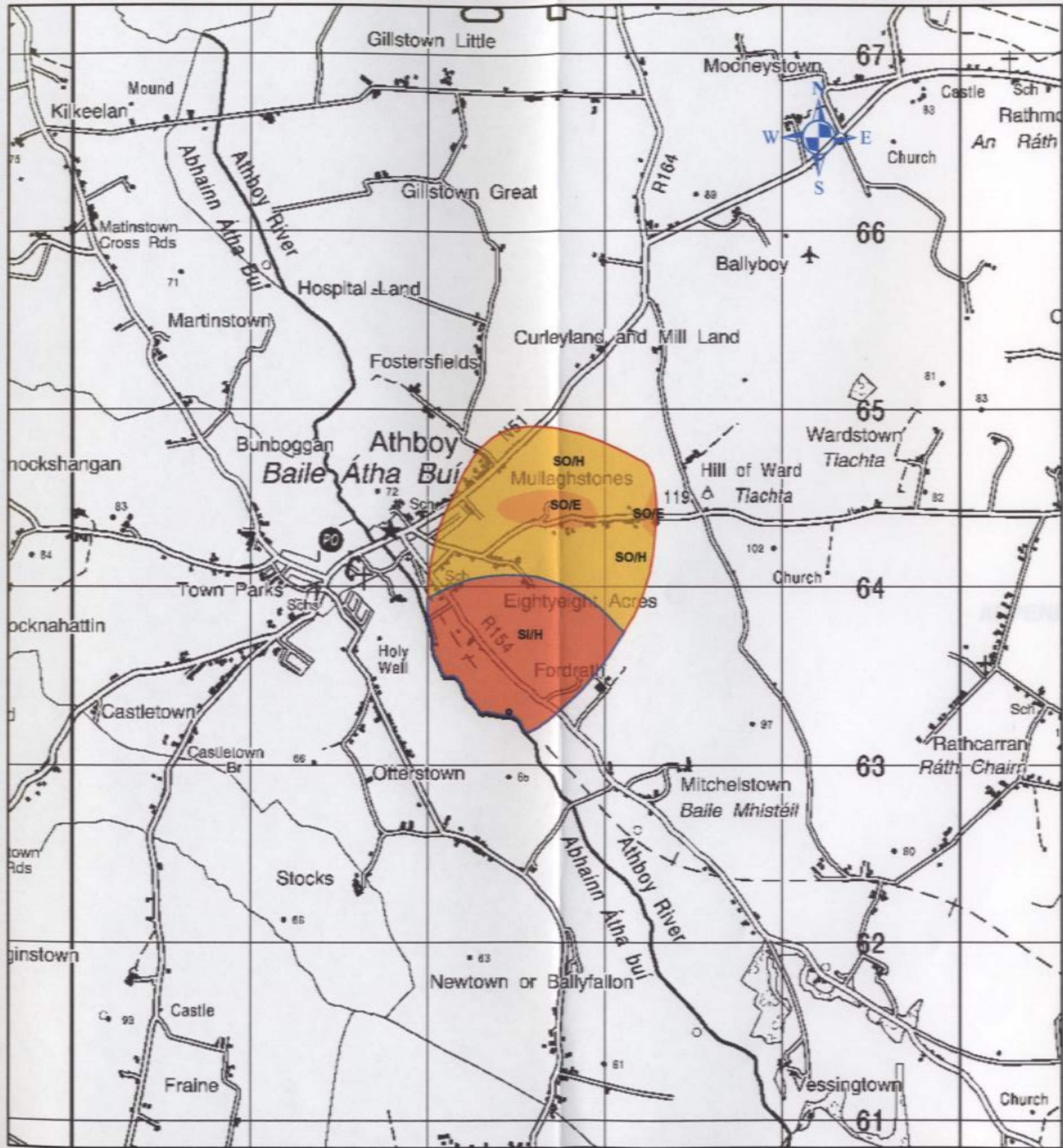


Scale: 6 Inches to 1 Mile

North



Scale: 6 Inches to 1 Mile



COUNTY MEATH GROUNDWATER PROTECTION SCHEME SOURCE PROTECTION ZONES

Vulnerability Rating	Source Protection Zones	
	Inner (SI)	Outer (SO)
Extreme (E)	SI/E	SO/E
High (H)	SI/H	SO/H
Moderate (M)	SI/M	SO/M
Low (L)	SI/L	SO/L

- Zone of Contribution of Wells (SO)
- Inner protection area (SI)
- County Boundary
- Public Supply Well

Project Hydrogeologist: Coran Kelly
Project Manager: Geoff Wright
Digital Map Production: Silvia Caloca

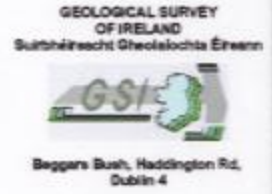
This Source Protection Zone map is designed for general information and strategic planning usage. The boundaries are based on the available evidence and local details have been generalised to fit the map scale. Evaluation of specific sites and circumstances will normally require further and more detailed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

The topographic base is reproduced with the permission of the Ordnance Survey of Ireland



DATE	DETAIL	APPROVED BY	ISSUED



Athboy

Scale 1:25,000

