

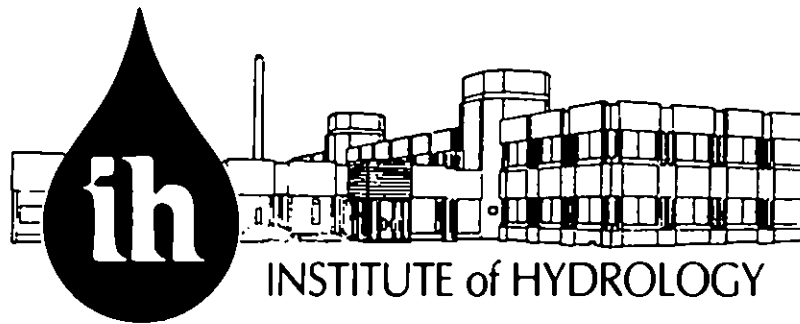


1989/003

INSTITUTE of HYDROLOGY

Ryall House Farm, Upton Hydrological Investigation

July 1989



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1. Introduction

Hills Aggregates Ltd (HAL) have submitted an application to extract sand and gravel from an area of some 30 ha at Ryall House Farm near Ryall in Worcestershire. The local residents at Saxons Lode, some 500 to 750m south-east of the site, have expressed concern that their water supplies, which are obtained from wells and boreholes, might be affected by the proposed development.

The Institute of Hydrology (IH), a component organisation of the Natural Environment Research Council, was commissioned by HAL to examine the possible effects of the development on the surrounding hydrological regime, with special reference to the Saxon Lode area.

In order to examine the potential impact of the proposed development on the wells and boreholes in the Saxon Lode area it is necessary to establish (a) whether the deposits underlying the site are in hydraulic connection with those at Saxon Lode, and, (b), if interconnected, the contribution of groundwater from the site area to the abstraction at Saxon Lode.

The area was included in a well survey undertaken by Malvern District Council in 1984. This survey obtained information on well depths, water levels, and water quality. However, as only one of the local well owners was prepared to allow this information to be released, the potential impact of the development on the abstraction at Saxon Lode cannot as yet be examined in detail.

2. Sources of information

This desk study has been based mainly on the following sources of information:

- Site Investigation Results supporting the Application for Planning Permission (C and C Mineral Planning Services for HAL)

- Geological Maps for Sheet SO 83 NE (Ripple) at 1:10000 produced in 1982 and Sheet 216 (Tewksbury) at 1:50000 produced in 1988, together with the associated memoirs

National Well Records, British Geological Survey, Wallingford.

In addition, a visit was made to the site on 10 May 1989, during which discussions were held with one of the local well owners and the Environmental Officer for Malverns District Council.

3. Site description

The application covers an area of 29.25 ha south-east of Ryall between the A38 and the River Severn. The site is generally flat and has an elevation of about 20m OD. It is currently used for agriculture and will be restored to the same use, although this will not include landfill.

The River Severn is some 8m lower than the site. The summer water level of the River Severn has an elevation of 8.27 m OD and the 100 year flood level is about 13.56m OD. It is not in direct hydraulic connection with the gravel deposits underlying the site since the base of these deposits occurs at about 15m OD.

The net working area will be 22.19 ha. A barren strip will be left adjacent to the River Severn. Extraction will take place in nine stages over a 7-year period.

A silt pond with a capacity of 9540 m³ will be created during the first phase at the southern boundary. All water removed prior to extraction during each stage will be transferred to this lagoon and subsequent ponds to infiltrate into the underlying deposits. Any dewatering will be on a closed circuit system.

Rehabilitation measures include the construction of a pond in the southern part of the site for use by the farmer with a maximum level of 14.75m OD. This will be deepened below the base of the gravels and will be connected to the Severn to remove any excess water from the pond. Apart from interception ditches connected to this pond, there are no other artificial drainage measures proposed as part of the site rehabilitation.

4. Well distribution

Wells identified from maps and records are as follows (figure 1):

- a wind pump, presumably drawing from a well, is shown on the site drawings about 150m north of the STWA pumping station

- a single well just north of Ryall Hill some 200m north-west of the development site and within 100m of the Severn. The status of this well is not known.

- three boreholes at the oil storage depot at 450 and 700m south of the site

- two boreholes and three wells at Saxon Lode some 500 to 750m south-east of the site and adjacent to the Severn.

General information from BGS records on the boreholes at the oil depot, SO 83/8a and b and SO 83/9 (SO 83 NE/2 and SO 83 NE/3 in figure 1), is as

follows:

	83/8 a and b	83/9
Depth	21.3	50.2
Water level	2.4 (14.7)	6.1
Water struck	nk	12.2
Casing	18.3	6.1
Yield gph	270	400
Drilled	1938	1958

Boreholes 83/8a and b are about 0.5m apart. The aquifer is reported as red marls (MMG) from 15 to 21m+, with open hole from 18 to 21m. Borehole 83/9 penetrated confined sandstones (Arden Sandstone?) to 15.2m+. It is believed that these wells are no longer in regular use.

Details of the wells and boreholes at Saxon Lode could not be obtained, except for the well belonging to Mr Horton at Saxon Lode House. They all provide local domestic supplies. The well at Saxon Lode House is believed to be the deepest well, some 10.7 to 12.2m deep, and has a rest water level of 8 to 9.5m bgl.

5. Geology

The general geology of the area north of Ripple is shown in figure 1.

The sand and gravel deposits at the site belong to the Third (Main) Terrace, which has a base at about 15m OD. These overlie the Mercia Mudstone Group (MMG, or Keuper Marl).

Second Terrace deposits form a bench about 300m wide extending south from Saxon Lode. The wells at Saxon Lode are all situated on the Second Terrace deposits. The top of this terrace is marked by a change of slope just east of Saxon Lode at an elevation of about 15m OD, and marks the boundary between the Second and Third Terraces.

The Second Terrace deposits extend beneath the river alluvium, which occurs mainly on the west of the river in the Upper Ham area. A narrow band of alluvium passes along the rear gardens of the houses at Saxon Lode.

The MMG consists of mudstones and siltstones. There are two major northerly trending faults bordering the site, such that the site lies on an upthrown block (or horst) affecting the MMG. A thin sandstone to siltstone band some 3 to 5m thick, the Arden Sandstone, occurs within the MMG and may form the main source for water supplies from the MMG in this area. The geological map indicates a possible outlier of Arden Sandstone along an east-west trending syncline just east of Saxon Lode.

About 5m of red mudstones belonging to the MMG sequence is exposed along the bluff between the River Severn and the site. This bluff becomes less prominent southwards until it passes beneath the Second Terrace at about Saxon Lode. It may continue south towards Uckinghall as a low, buried bluff marking the junction between the Second and Third Terrace.

6. Hydrogeology

6.1 SITE AREA

The site is located on Third Terrace deposits. The mineral investigation studies included the following:

- three resistivity soundings
- 25 investigation boreholes
- 8 trial pits, with 15 grain size analyses

The hydrogeological information provided from these investigations is rather limited. Nonetheless, an attempt has been made to define the hydrogeology of the site as shown in figure 2.

(a) Aquifer Base.

The MMG forms the base of the aquifer. This is encountered at depths of between 3 and 4.5m bgl. The elevation of the base varies from about 15 to 20m. Areas having an aquifer base at an elevation of more than 17m would appear to be dry. This includes most of the western part of the site, the northern area around boreholes 1, 2, and 5, the south eastern area around boreholes 17 and 19, together with isolated areas at boreholes 12 and 24. There would appear to be 'buried valleys' passing north from borehole 7 through borehole 4 and south through borehole 21.

(b) Aquifer Thickness.

About 50% of the borehole sites are reported as dry. This may be partly the result of drilling effects, but would appear to be due mainly to the presence of clays, particularly down the western side of the site, and to variations in the elevation of the base of the aquifer. The saturated thickness elsewhere ranges from 0.1m at the edges of the dry areas to about 2.2m in the buried valleys.

(c) Water Levels.

Depths to water level range from 2 to about 4.5m. The water level data do not provide a consistent pattern. However, it would appear that the main directions of groundwater flow are from the area around boreholes 23, 11 and

25 north-west through borehole 4, south through borehole 21 and north-east through trial pit 7. Rainfall is indicated as the main source of recharge.

(d) Aquifer Characteristics

There is no information on aquifer characteristics and reliable estimates of the amount of groundwater flow or groundwater in storage cannot be made. The deposits of the Third Terrace are likely to be somewhat compacted and the use of grain size data to estimate permeabilities may be misleading in such a situation.

The general information provided by the site investigation surveys indicates that the Third Terrace deposits form a thin aquifer of limited extent and contain only limited volumes of groundwater in storage. Only the southern part (about 10 ha) of the site has a flow southwards. However, there is no information on the groundwater conditions within the Third Terrace deposits between the site and Saxon Lode and whether this flow contributes supplies to Saxon Lode cannot be determined.

The oil depot boreholes suggest that the MMG is confined and forms a separate system to the Third Terrace deposits.

6.2 SAXON LODE

The wells at Saxon Lode are situated on the Second Terrace deposits. These deposits form an important aquifer with high permeabilities and are recharged by the River Severn. The water level in the well at Saxon Lode House is generally consistent with the water level of the Severn.

It is uncertain whether the boreholes at Saxon Lode penetrate the MMG. They are believed to be more recent than the wells and may be of a similar depth but of a smaller diameter for more modern pumps. If so, then these may also obtain their supply from the Second Terrace deposits, since it would probably have been unnecessary to have drilled into the MMG to obtain a sufficient supply for domestic use.

The most northerly borehole at Saxon Lode is located at the junction between the alluvium and Third Terrace at the southern end of the bedrock bluff bordering the Severn. This particular borehole therefore could obtain a supply from the MMG rather than the unconsolidated deposits.

6.3 HYDRAULIC INTERCONNECTION

The base of the Third Terrace occurs at an elevation of about 15m, which is also the elevation of the top of the Second Terrace. This suggests that the Second Terrace at Saxon Lode could abut MMG rather than Third Terrace deposits and that direct hydraulic connection between the Third and Second Terraces will be limited.

The site investigations have also identified a zone about 150m wide bordering the River Severn consisting mainly of clays which are essentially dry. Whether this zone extends south to follow the contact between the Third and Second Terrace (at about 15m OD) is not known, but, if present, it would also form a hydraulic barrier separating the site from the Second Terrace in the Saxon Lode area.

7. Conclusions and recommendations

Preliminary Conclusions

Without the information on the wells and boreholes at Saxon Lode we cannot be entirely certain that they will be unaffected by the proposed development. Nonetheless, the available information for the general area indicates that they are unlikely to be affected due to the following conditions:

the wells are likely to derive their supply from the Second Terrace deposits. These are recharged by the River Severn and do not appear to be in direct hydraulic connection with the Third Terrace deposits underlying the development site. The boreholes may draw supplies from the MMG but this seems to form a separate system and would not be affected by the development.

- the potential contribution of groundwater derived from the site area to the wells at Saxon Lode is unlikely to be significant as the aquifer underlying the site is thin and has limited storage. Only groundwater from the southern part of the site flows southwards. Whether this flow connects with the wells at Saxon Lode is uncertain since there is no information on the Third Terrace deposits between the site and Saxon Lode, but this seems unlikely.

during the extraction phase water abstracted during dewatering will be transferred to silt ponds in the southern part of the development area and should sustain the southerly flow of groundwater, although the silt will eventually restrict infiltration.

- landfill is not proposed and there should be no impact on the groundwater quality.

Recommendations

A more detailed assessment of the likely impact of the development on the wells at Saxon Lode will require additional information. This should include the following:

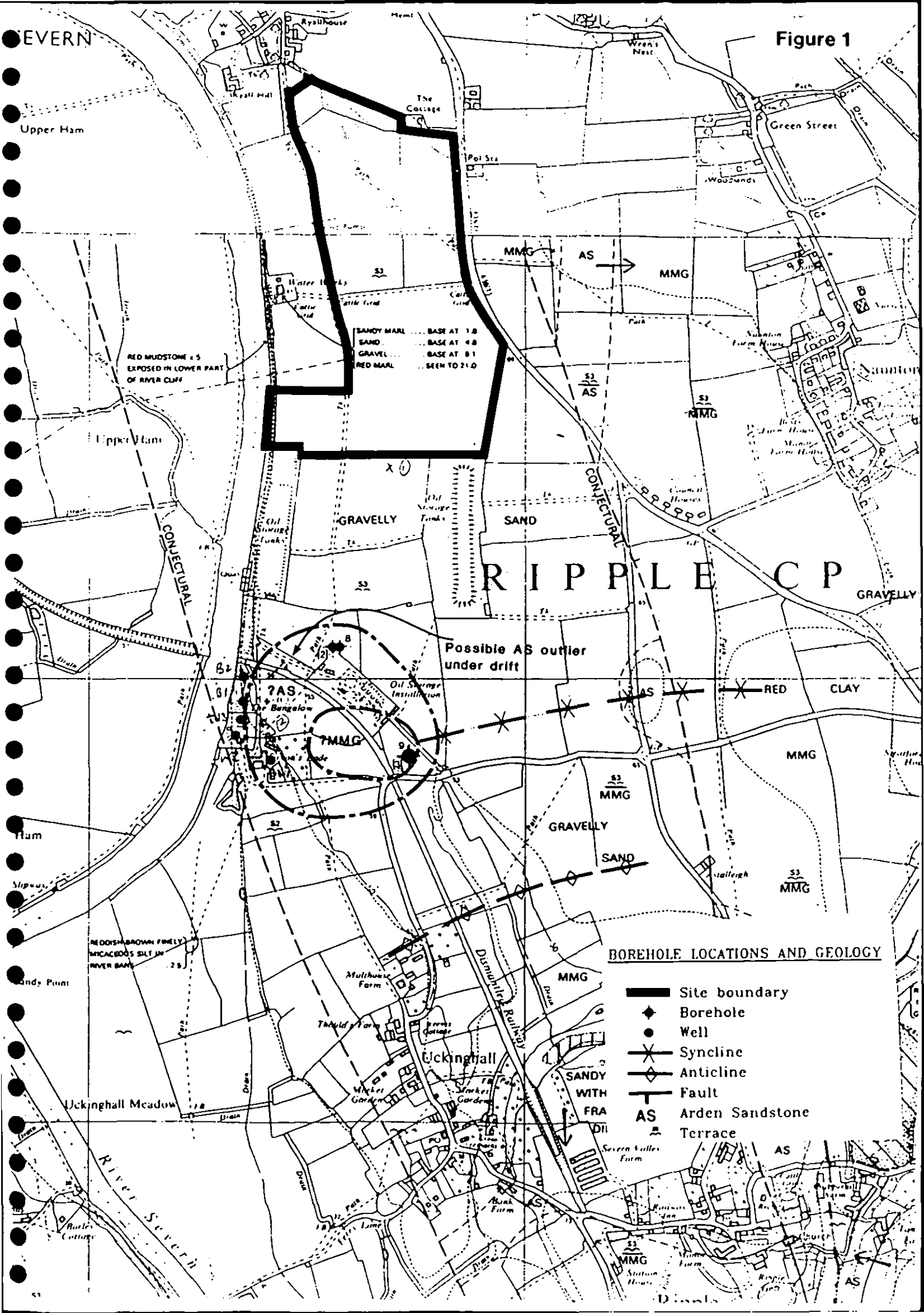
- * well and borehole information for the Saxon Lode area
- * monitor water levels in the wells and boreholes at Saxon Lode to provide information on background water level changes caused by natural events

- obtain water samples from each well and borehole, from the river and from groundwater at the site for chemical analysis to help establish the sources of recharge and interconnection

- install piezometers between the site and Saxon Lode to measure any decline in water level resulting from the development and to provide information on the directions of groundwater flow

- install a line of piezometers across the boundary between the Third and Second Terrace just east of Saxon Lode to provide more direct evidence of whether there is a hydraulic connection between the deposits underlying the site and those believed to supply the wells.

Figure 1



EVERN

Upper Ham

Upper Ham

Ham

Sandy Point

Jekinghall Meadow

River South

RED MUDSTONE c. 5
EXPOSED IN LOWER PART
OF RIVER CLIFF

SANDY MARL BASE AT 1.8
SAND BASE AT 4.8
GRAVEL BASE AT 8.1
RED MARL SEEN TO 21.0

GRAVELLY

SAND

RIPPLE CP

GRAVELLY

Possible AS outlier
under drift

RED CLAY

GRAVELLY

SAND

BOREHOLE LOCATIONS AND GEOLOGY

- Site boundary
- ◆ Borehole
- Well
- ✕ Syncline
- ◊ Anticline
- Fault
- AS Arden Sandstone Terrace

SANDY
WITH
FRA

AS

MMG

AS

AS



SITE AREA : AQUIFER GEOMETRY

- Site boundary
- Trial pit
- Borehole
- Saturated aquifer thickness (m)
- Elevation top of MMG (mOD)
- Dry areas
- General groundwater flow directions
- Topographic contours (mOD)

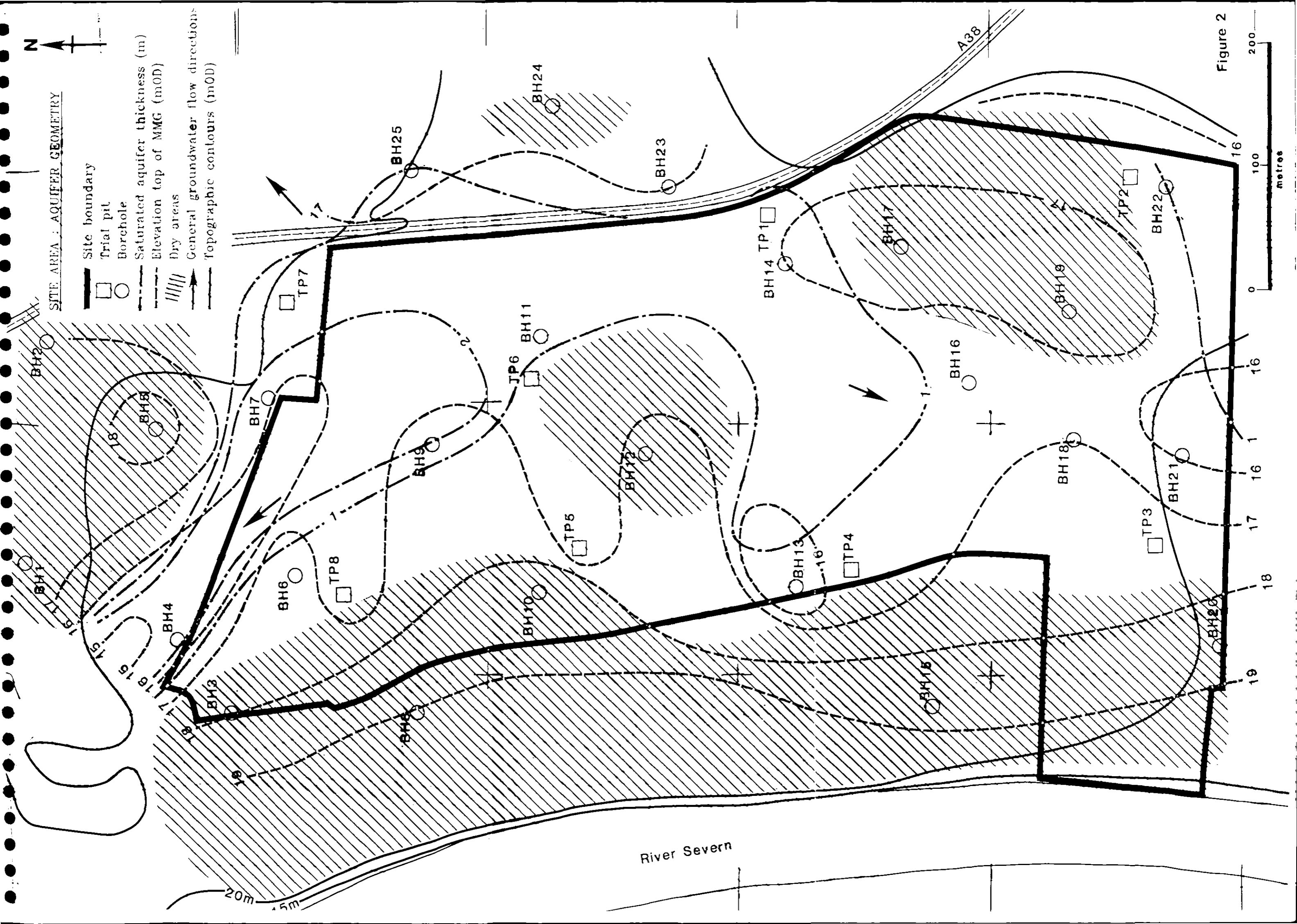


Figure 2

River Severn

20m
15m

0 100 200
metres

The demand for long-term scientific capabilities concerning the resources of the land and its freshwaters is rising sharply as the power of man to change his environment is growing, and with it the scale of his impact. Comprehensive research facilities (laboratories, field studies, computer modelling, instrumentation, remote sensing) are needed to provide solutions to the challenging problems of the modern world in its concern for appropriate and sympathetic management of the fragile systems of the land's surface.

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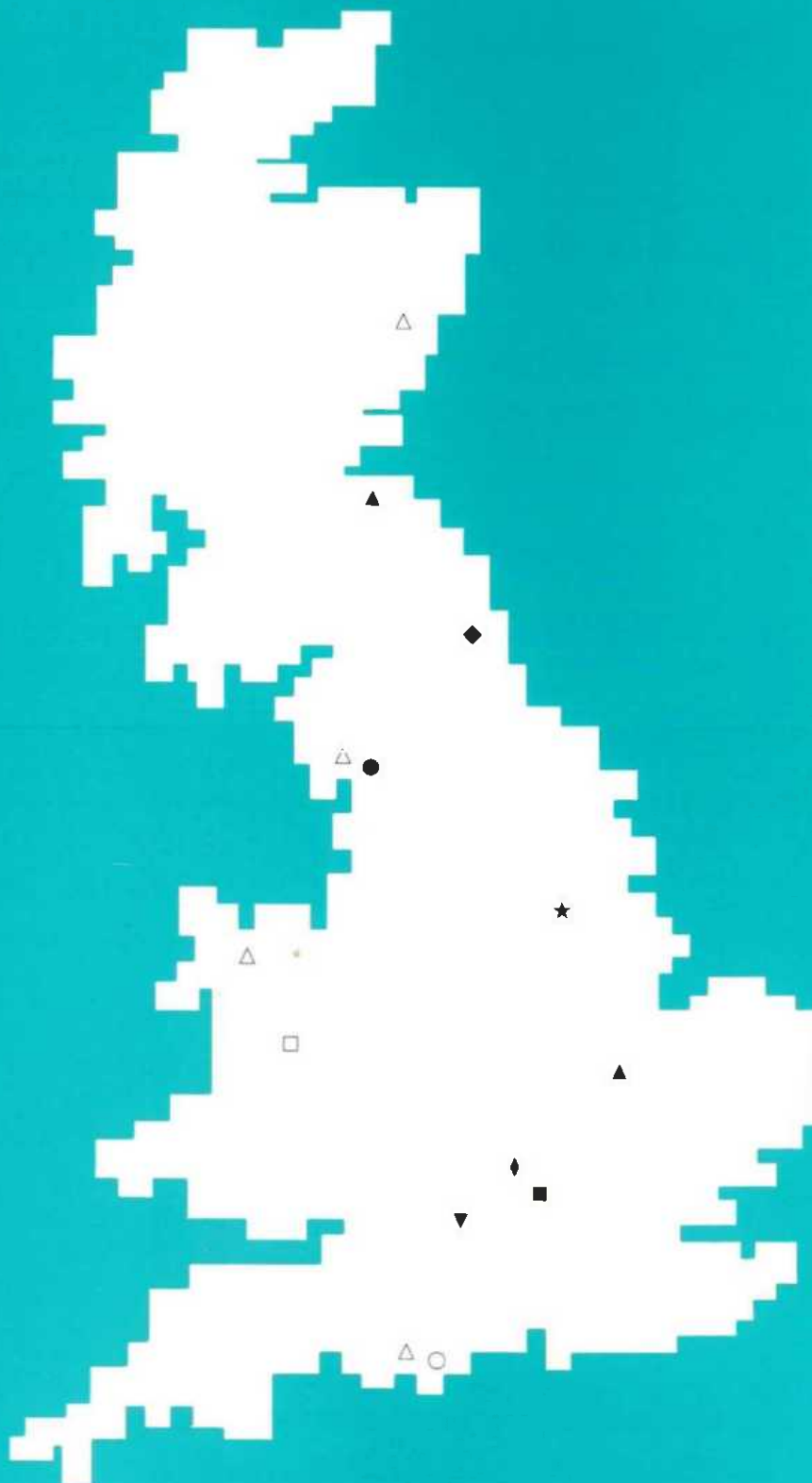
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Environmental Quality and Pollution

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Ecology and Conservation

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