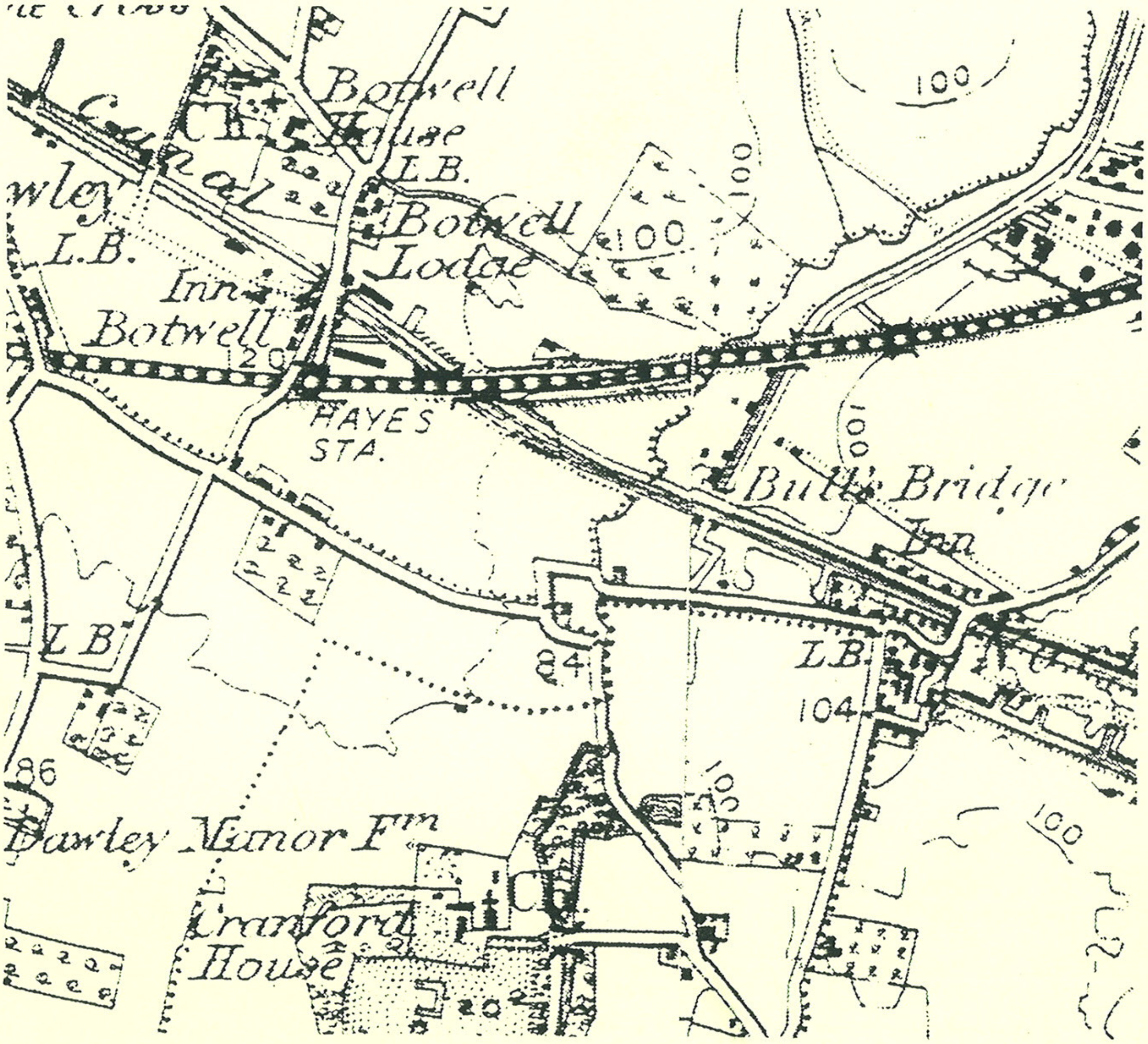
**Bull's Bridge Power Station, Hayes,
London Borough of Hillingdon**

GEOARCHAEOLOGICAL INVESTIGATION

TQ 105793



OXFORD ARCHAEOLOGICAL UNIT

May 1998

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GEOARCHAEOLOGICAL INVESTIGATION

1 INTRODUCTION

1.1 Planning background

The investigation was undertaken by the Dr. Martin R. Bates on 8/9th April 1998, in advance of the redevelopment of the former Bull's Bridge Power Station site, Hayes, Middlesex. The investigation was carried out in accordance with a Written Scheme of Investigation (WSI) provided by the Oxford Archaeological Unit (OAU), in response to guidelines prepared by English Heritage on behalf of the London Borough of Hillingdon Planning Authority.

An archaeological desk-top assessment prepared by the OAU (OAU 1998) concluded that the archaeological impact of the development would be insignificant over most of the site. However, the Yeading Brook was identified as having some potential for the survival of palaeoenvironmental remains. The present study is in response to the proposed construction of a new bridge across the brook. Piling for the foundations will cause deep ground disturbance in two small areas on either bank.

1.2 Site location and description

The site occupies a roughly triangular area *c.*11 ha in extent, located at TQ 105 793, between the Grand Union Canal to the south and the London (Paddington) to Bristol Railway to the north. The Yeading Brook and the A312 Hayes by-pass, both cross the site from north to south. The Yeading Brook runs *c.*3 m below the level of the Power Station site, as a result of raising of the surrounding ground level.

2 BACKGROUND

2.1 Regional geology and archaeology

The site lies in an area of the Thames Floodplain dominated by sediments deposited by the eastwards flowing Thames and assigned to the Lynch Hill Gravel (Gibbard, 1985). However, the surface of the Lynch Hill Gravel within this area is noted to be highly degraded and within the site area further complexities exist due to the presence of a small Thames tributary (Yeading) that is associated with a distinctive sequence of sediments defined as the Crane Valley Gravel (Gibbard, 1985). The Yeading is presently a south flowing tributary of the Thames.

The Lynch Hill Gravel is commonly ascribed to the Saalian Complex and Bridgland (1994) assigns these sediments to Oxygen Isotope Stage 8 (although the possibility exists that the basal part of this sequence may belong to Oxygen Isotope Stage 10). This suggests that the Lynch Hill Gravel was deposited between 350 and 250 ka B.P[1]. The age of the Crane Valley Gravel cannot at present be determined.

Archaeological material is common in the Lynch Hill Gravel (Gibbard, 1985). For example, upstream of the study area important sites such as Cannoncourt Farm and Baker's Farm have been correlated with these gravel units. In most cases artefacts from the gravels will consist of artefacts in secondary context that may have been subject to considerable reworking.

[1] ka B.P. – thousands of years before present.

3 AIMS AND OBJECTIVES

This project was commissioned in order to evaluate the geological stratigraphy, and assess the palaeoenvironmental potential of, the alluvial deposits on the site of the proposed bridge footings, (Drawing Number 6001, Site Layout and Drainage, Bull's Bridge, Hayes. December 1997. Powell Tolner & Associates. Consultant Engineers). The aims of the project, as stated in the WSI, were as follows:

- To assess the palaeoenvironmental and archaeological potential of alluvial deposits associated with the Yeading Brook, in the area of the new bridge.

- To establish the geological sequence in the vicinity of the Yeading Brook

- In the event that deposits with environmental potential were encountered, to establish, so far as reasonably possible, the likely date of the deposits and the survival of specific environmental indicators.

4 METHODOLOGY

4.1 General methodology

Standard geotechnical borehole data can be utilized by geoarchaeological and palaeoenvironmental specialists to model the development of past landscapes and to determine the spatial extent and three-dimensional sub-surface architectures of archaeologically and palaeoenvironmentally important sequences (Barham and Bates 1994). Data quality and recovery from geotechnical boreholes varies, depending on the skill and training of the drillers in the field, the geotechnical brief, sampling design and time availability set by the engineers.

Geotechnical investigation measures parameters that differ significantly from parameters required by geoarchaeologists attempting to model the evolution of past landscapes and predict sub-surface archaeological horizons. Hence standard geotechnical borehole logs may contain minimal information regarding specific sedimentological properties of the sequence (commonly surface heights above Ordnance Datum are missing from many reports).

The logs do, however, provide a data source that, taken in conjunction with i) other known stratigraphic data, ii) a knowledge of processes likely to have operated in the area and iii) a knowledge of geomorphological principles, can yield useful archaeologically predictive information. In particular, trends in grain size, patterns of mottling, zones of rooting, sub-fossil assemblages and the nature of contacts between individual units can all provide data on completeness of sequences, location of palaeolandsurfaces, patterns of sedimentation and the location of unconformities and zones of erosion/reworking. The identification of such features is of critical importance in defining the archaeological and palaeoenvironmental potential of an area.

In this study a large database from previous ground investigations was available for study. However, in all cases surface datums were absent.

Although prospecting through borehole investigation will only exceptionally provide direct proof of archaeological sites or materials buried at depth (e.g. recovery of medieval metalwork and a mesolithic core axe from gravels drilled during the Dover A20 Road and Sewer Scheme - Bates and Barham 1993). It can, however, when used in careful consideration with known stratigraphic data and the application of radiometric dating methods (Smart 1991), provide a chronostratigraphic model for the major identified sedimentological units, a model for sequence development, and indications of the presence of buried landsurfaces and contexts likely to represent environments previously occupied by humans (Barham and Bates 1994).

4.2 Site methodology

Two boreholes were drilled by Strata Investigation under the supervision of the geoarchaeological specialist (Dr. M.Bates). A shell and auger percussion drill rig was used, which was suitable for the recovery of undisturbed U4/U100 core samples. On-site supervision and recording resulted in the production of the basic stratigraphic framework. Sampling of the soft sediments was undertaken by the use of a U4/U100 core sampler taking 450 mm x 100 mm undisturbed core samples of key stratigraphic units. Where possible the shoe sample was also retained for possible future analysis. Individual cores, where available, were extruded, sectioned, cleaned and recorded. Descriptions from individual cores were integrated into the main stratigraphical description from the borehole.

All descriptions used in the logging of the sediments follow those used by the former Geoarchaeological Service Facility at University College London and in conventional use by Quaternary geologists in the UK.

5 RESULTS

5.1 Borehole locations

Two boreholes were drilled to a maximum depth of 8.0 m (BH1). The boreholes were located on the western and eastern edges of the Yeading Brook on the alignment of the proposed new bridge. Contamination by hydrocarbons was noted in both boreholes.

5.1.1 *Table 1: Borehole 1* (Fig. 2)

Depth below ground surface (m)	**Stratigraphic description**
0.00 – 0.20	Topsoil.
	---abrupt contact---
0.20 – 0.80	Loose, unconsolidated concrete.
	---diffuse contact---
0.80 – 3.65	Mid-grey clay-silt with common chalk, flint and red brick/tile fragments. Clasts are matrix supported with clasts 1-6 cm in size and predominantly sub-angular in shape. Common black organic fragments present. Strong odor of hydrocarbons. Wood fragments noted. Stiff and structureless. Sediments become organic rich with depth while clast size tends to decrease to *c.* 1-2 cm.
	---not observed---
3.65 – 3.90	Dark brown organic silt containing common roots and some possible coarse sand grains. Unit is structureless and compact. Charcoal and coal fragments are common (typically <0.5 cm). Common small flint chips and very coarse sand grains are present. Occasional red ceramic fragments noted and large, sub-angular flint clasts (<4 cm).
	---diffuse contact---
3.90 – 4.30	Mid-grey clay-silt containing common black flecks and yellowish-brown mottles. Charcoal and/or coal fragments are common in places. Occasional sub-rounded flint clasts (<5 cm) are present. Roots noted. Unit is plastic and pliable.
	---diffuse contact---
4.30 – 5.00	Mid-grey clay with common reddish-brown mottles (mottling decreases with depth). Slightly blocky structure and empty root canals (<1 mm width). Occasional angular to sub-angular flint clasts. Dense and compact.
	---sharp contact---
5.00 -	Mid-brown clay. Dense and compact. Bluish-grey mottles in places. Blocky structure noted occasionally. Small fragments of septarian nodules noted.
	---base of borehole 8.0 m---
Samples taken:	
U4 ① 3.65 – 4.10 m	Bulk ② 4.10-4.15 m
U4 ③ 4.15 – 4.60 m	Bulk ④ 4.60-4.65 m
U4 ⑤ 4.65 – 5.20 m	Bulk ⑥ 5.20–5.25 m

The stratigraphy represented in the borehole can be subdivided into the following sediment groups:

- Fill and made ground (0.00 – 3.65 m).
- Organic sediments (3.65 – 3.90 m).
- Clay-silt sediments (3.90 – 4.30 m).
- Mottled clays (4.30 m – base of borehole).

These sediments are predominantly poorly stratified and organic material is poorly preserved. No bone or shell fragments were noted during the recording.

5.1.2 *Table2: Borehole 2* (Fig. 2)

Depth below ground surface (m)	**Stratigraphic description**
0.00 – 0.20	Topsoil.
	---abrupt contact---
0.20 – 1.80	Greyish-brown silt with some sand. Common flint and brick clasts and large concrete fragments. Loose and unconsolidated. With depth unit becomes black and organic rich with common gravel clasts. Slate, tile and coal are present. Occasional chalk clasts and patches of blue-grey clay-silt are present. Unit is poorly sorted.
	---not observed---
1.80 – 3.40	As above but increase in clay-silt content. Unit becomes more compact and cohesive.
	---not observed---
3.40 – 4.05	Black, loose ash and coal rubble. Coarse and unconsolidated. Occasional rounded flint clasts (<2 cm). With depth unit becomes slightly more compact.
	---not observed---
4.05 – 4.90	Mid to dark-grey clay-silt with common black (reduced organics?) flecks. Unit is dense and compact. Yellowish-brown mottles noted towards top of unit. Occasional rounded flint clasts present (<3 cm).
	---not observed---
4.90 – 6.80	Dark yellowish-brown to mid bluish-grey, matrix supported flint gravel. Clasts are <0.5 cm to >3 cm in size and sub-rounded to sub-angular in shape. Very dense and compact. Matrix consists of silt with some coarse sand. Gravel clasts increase in size with depth to >20 cm. Unit has a strong odor of hydrocarbons.
	---not observed---
6.80 -	Dark brown clay. Dense and compact. Some possible evidence of blocky structure. Occasional blue-grey patches noted. Occasional fragments of fractured septarian nodules.
	---base of borehole 7.0 m---
Samples taken:	
U4 ① 3.90 – 4.35 m	Bulk ② 4.35-4.40 m
U4 ③ 4.90 – 5.35 m	Bulk ④ 5.35-5.40 m
	Bulk ⑤ 5.50-6.00 m

The stratigraphy represented in the borehole can be subdivided into the following sediment groups:

- Fill and made ground (0.00 – 4.05 m).
- Clay-silt sediments (4.05 – 4.90 m).
- Matrix supported gravels (4.90 – 6.80 m).
- Mottled clays (6.80 m – base of borehole).

These sediments are predominantly poorly stratified and organic material is poorly preserved. No bone or shell fragments were noted during the recording.

The stratigraphy represented in the borehole can be subdivided into the following sediment groups:

- Fill and made ground (0.00 – 4.05 m).
- Clay-silt sediments (4.05 – 4.90 m).
- Matrix supported gravels (4.90 – 6.80 m).
- Mottled clays (6.80 m – base of borehole).

These sediments are predominantly poorly stratified and organic material is poorly preserved. No bone or shell fragments were noted during the recording.

5 DISCUSSION

The evidence obtained from the investigation of the borehole samples indicates that three major types of naturally deposited sediments can be identified below the made ground units. These sediment types are typical of those expected in the Thames valley gravel areas. Table 3 attempts to integrate the evidence from the two boreholes and define the archaeological and palaeoenvironmental potential of the sediments.

Table 3: Summarized stratigraphic information, inferred environments of deposition and archaeological and palaeoenvironmental potential of Boreholes 1 and 2.

BH1 stratigraphy	BH2 stratigraphy	Inferred environment of deposition	Archaeological potential	Palaeo-environmental potential
Fill/Made Ground (0.00 - 3.65 m)	Fill/Made Ground (0.00 - 4.05 m)	-	Low (occasional reworked artefacts associated with dumping)	None
Organic sediments (3.65 – 3.90 m)	-	Low energy wetland supporting active plant growth adjacent to slow moving river course	Moderate (occasional artefacts may occur in *in situ* contexts in floodplain situations)	Moderate (organic content suggests pollen and diatoms may be present in addition to some plant macrofossils and insects)
Clay-silts (3.90 – 4.30 m)	Clay-silts (4.05 – 4.90 m)	Low energy wetland subject to rapid sedimentation	Moderate (occasional artefacts may occur in *in situ* contexts in floodplain situations)	Low (unit probably hostile to plant macro/micro fossil preservation – no carbonate fossils noted)
-	Gravel (4.90 – 6.80 m)	High energy braided channel environment	Low (artefacts are likely to have been reworked)	Low (material will have been reworked)
Mottled Clay (4.30 m -)	Mottled Clay (6.90 m –)	Marine basin	None	None

Made ground deposits exist in both boreholes to a depth of *c*.3.5 m - 4.0 m. These consist of sediments containing a wide range of inclusions including slate, tile, ceramic fragments, coal and charcoal. These deposits may contain stratified sequences dating to the post-medieval period

Sediments below the made ground consist of an organic rich unit (Borehole 1, 3.65-3.90 m) and clay-silt units (Borehole 1, 3.90-4.30 m and Borehole 2, 4.05-4.90 m). These deposits are interpreted as floodplain sediments deposited adjacent to a relatively slow moving watercourse or on the floodplain of a river at some distance from the active channel (i.e. alluvium). No dating evidence was obtained from these deposits but it is probable that they are of Holocene age. Locally *in situ* archaeological material may occur within these sequences. No archaeological material was recovered during the site investigation. Microfossils (pollen/diatoms) may be present within the organic rich upper part of the sequence in Borehole 1.

The gravel unit present in Borehole 2 suggests deposition under high energy braided channel conditions. Deposits of this type are typically laid down under cold climate periglacial conditions. It is not possible to determine whether these gravels belong to the Lynch Hill Gravel or to the Crane Valley Gravel.

The underlying sediments are attributed to the London Clay. Where gravel is absent in Borehole 1 the upper surface of the London Clay appears weathered and a palaeosol may be present developed in the top of this Tertiary sediment.

On the basis of the evidence obtained in this study it is unlikely that significant palaeoenvironmental remains are preserved within the area of impact (that will result from bridge construction). Archaeological material may be present within the clay-silt units or resting on/cut into the London Clay surface adjacent to Borehole 1.

6 CONCLUSIONS

Because of the absence of height datums for the boreholes and test pits excavated during previous ground investigations it has not been possible to directly relate the sequences recovered in Boreholes 1 and 2 with the remaining stratigraphical information from the site. However, it should be noted that the previous site investigations showed that a basic sequence consisting of made ground/alluvium/gravel/London Clay existed across the site. In places the alluvium and/or the gravel was missing. No apparent pattern to the distribution of alluvium or gravel could be discerned from a study of this data (it should be noted that in places sequences are likely to have been artificially truncated). The study of Boreholes 1 and 2 confirms the general sequence order determined by the previous studies. The key points to emerge from the recent borehole investigation are listed:

- Made ground exists to a depth of c.3.5 m to 4.0 m.
- Sediments, that would be classified as alluvium, are present both east and west of the proposed river crossing.
- Coarse fluvial gravels are present east of the river crossing.
- London Clay bedrock underlies the sequences and this surface appears to dip from west to east.
- The upper surface of the London Clay, west of the proposed river crossing, possibly represents a buried landsurface.
- Only limited palaeoenvironmental potential is assigned to the deposits recovered from the boreholes (considerable evidence exists for possible contamination of the sediments by rooting and intrusion (possibly during road, bridge or viaduct construction).
- No archaeological remains were recovered in the boreholes and only moderate archaeological potential is assigned to elements of these sediment.

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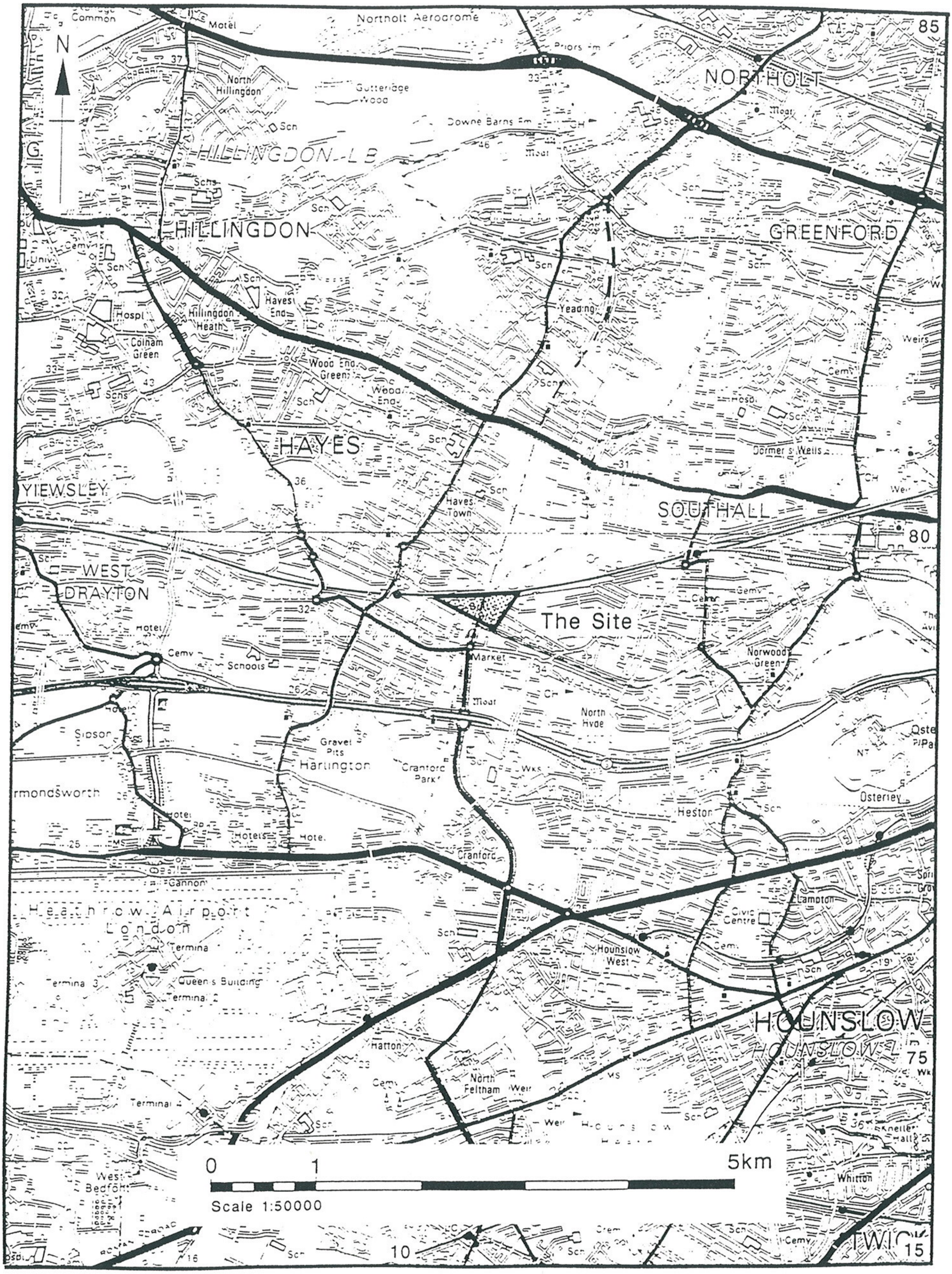

Figure 1: Site Location Map

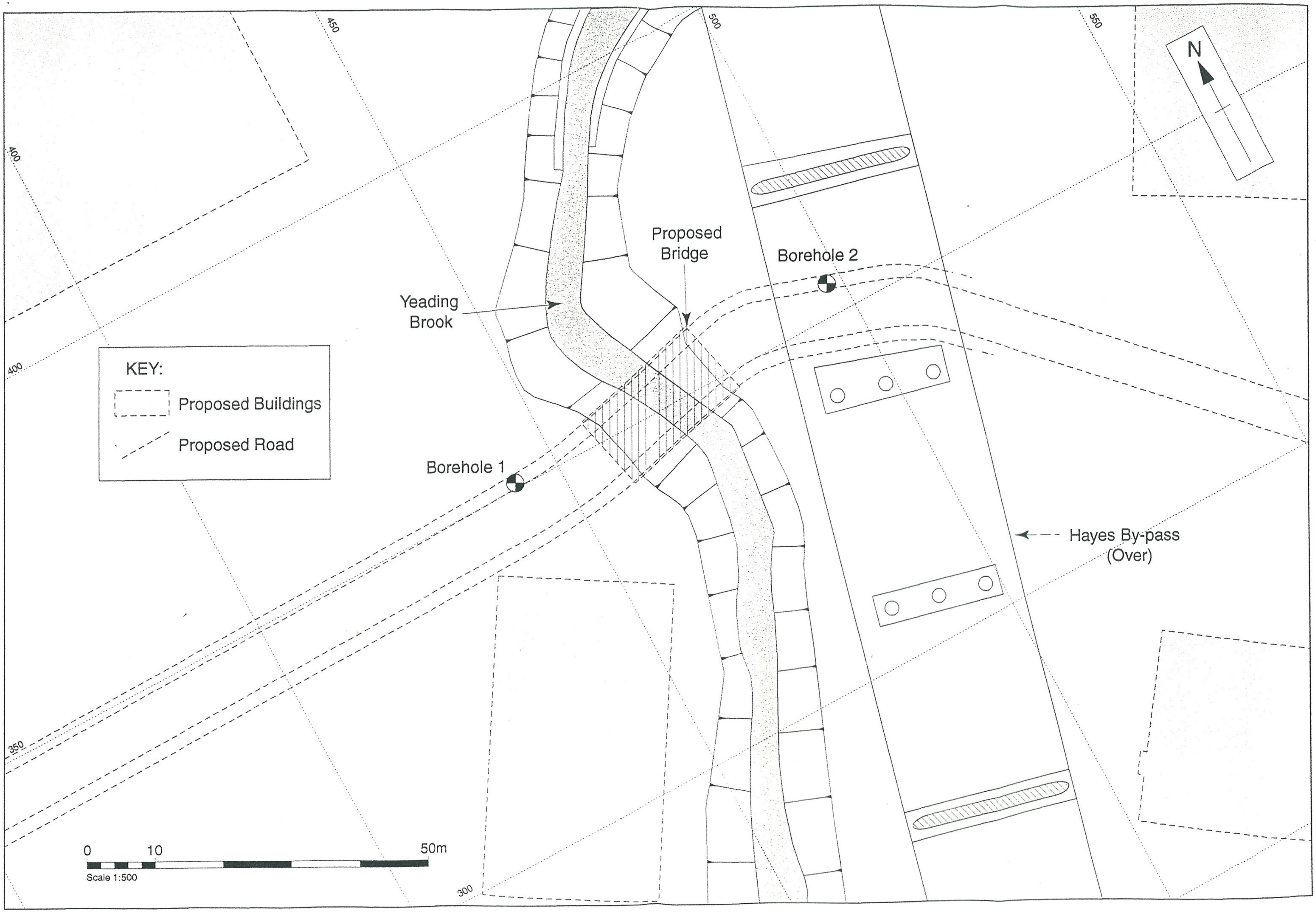

Figure 2: Location of Boreholes 1 and 2

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