ARCHAEOLOGICAL EXCAVATION AT BOURN BROOK, SELLY OAK, BIRMINGHAM

James Goad, Katie Head and Angus Crawford

Illustrated by Carolyn Hunt

14th September 2004
Revised 10th November 2004

Historic Environment and Archaeology Service,
Worcestershire County Council,
Woodbury,
University College Worcester,
Henwick Grove,
Worcester WR2 6AJ

Project 2482
Report 1253
BSMR 20726

Contents

Part 1 Project summary **1**

Part 2 Detailed report

1. **Background** **2**
1.1 Reasons for the project 2
1.2 Project parameters 2
1.3 Aims 2
2. **Methods** **2**
2.1 Documentary search 2
2.2 Fieldwork 3
2.2.1 Fieldwork strategy 3
2.2.2 Structural analysis 3
2.3 Artefacts 4
2.3.1 Artefact recovery policy 4
2.3.2 Method of analysis 4
2.3.3 Artefactual analysis 4
2.4 Environment 4
2.4.1 Fieldwork and sampling policy 4
2.4.2 Plant macrofossil and general environmental analysis 4
2.4.3 Pollen analysis 5
2.5 The methods in retrospect 5
3. **Topographical and archaeological context** **5**
4. **Description** **6**
4.1 Discussion of the artefacts 7
4.1.1 Post-medieval 7
4.1.2 Modern 7
4.1.3 Significance 7
5. **Environmental Results** **8**
5.1 Pollen samples 8
5.1.1 Monolith 1a 8
5.1.2 Monolith 2a 8
5.1.3 Monolith 3a 9
5.2 Plant macrofossil samples 9
5.2.1 Monolith 1a: 22-27cm 9
5.2.2 Context 042 10
6. **Significance** **11**
7. **Discussion** **11**
7.1 Phase 1 Natural deposits 11
7.2 Prehistoric 11
7.3 Roman 11
7.4 Medieval 11
7.5 Post-medieval to modern 13
7.6 Research frameworks 13
8. **Publication summary** **14**
9. **The archive** **14**
10. **Acknowledgements** **15**
11. **Personnel** **15**
12. **Bibliography** **15**
13. **Abbreviations** **17**

Archaeological excavation at Bourn Brook, Selly Oak, Birmingham

James Goad, Katie Head and Angus Crawford

Part 1 Project summary

An archaeological excavation was undertaken at Bourn Brook, Selly Oak, Birmingham (NGR SP 0408 8316). It was undertaken on behalf of Arthur Amos Associates as agents to Sainsbury's Supermarkets Ltd. The client intends to site a floodwater storage area adjacent to the Bourn Brook as part of a supermarket development of the area, for which a planning application has been submitted (reference number S/04932/00/OUT). The excavation followed an evaluation and earthwork survey in 2001 that identified former courses of the Bourn Brook as well as an additional watercourse south of the Brook which served fish ponds and a watermill on the east side of the Worcester to Birmingham Canal.

The excavation aimed to determine the sequence of deposition over the area of the Bourn Brook floodplain. The excavation was also carried out to locate, excavate and record any archaeological features or structures and retrieve palaeoenvironmental evidence from within the depositional sequence. The excavation succeeded in identifying a former course of the Bourn Brook, as well as phases of a previously detected watercourse (leat) to the south of it. A sequence of alluvial deposition was recorded across the floodplain, as well as occasional archaeological features such as pits containing dumped industrial waste from the post-medieval and modern periods.

Radiocarbon dating was used to determine the dating of the relict watercourses detected across the floodplain during the excavation. Deposits in both channels were dated to the late medieval period (15th and 16th centuries), indicating possible late medieval origins for the leat as well as the for the fishponds and the Bourn Brook Mills that it served.

Part 2 Detailed report

1. Background

1.1 Reasons for the project

An archaeological excavation was undertaken at Bourn Brook, Selly Oak, Birmingham (BSMR 20726), on behalf of Arthur Amos Associates acting as agents to Sainbury's Supermarkets Ltd. The client intends to construct a floodwater storage area adjacent to the Brook and has submitted a planning application to Birmingham City Council (reference S/04932/00/OUT), who considered that a site of archaeological interest was affected (BSMR 20726).

1.2 Project parameters

The project conforms to the *Standard and guidance for archaeological excavation* (IFA 1999). The project also conforms to a brief prepared by Birmingham City Council (BCC 2003) and for which a project proposal (including detailed specification) was produced (HEAS 2003).

1.3 Aims

The aims of the project were to excavate a trench across the floodplain of the Bourn Brook, from the edge of the floodplain to as near to the present stream as possible. This excavation intended to define and date the sequences of deposition, record any archaeological features or structures within this sequence and retrieve palaeoenvironmental information from the deposits present.

2. Methods

2.1 Documentary search

Prior to fieldwork commencing the results of previous projects relating to the site (HEAS 2000; Patrick 2001) were collected. In addition the following sources were also consulted:

Cartographic sources

- A Plan of the Intended Navigable Canal from the town of Birmingham in to the Severn, unknown, 1790
- Netherton in the Parish of Dudley and County of Worcester to the Worcester and Birmingham Canal at Selly Oak in the Parish of Northfield in the said county, John Snape, 1792
- Map of the Worcester and Birmingham Canal, 1828
- Sale of Selly Oak, Rodway, 1833
- Northfield Tithe Map, 1840
- Conjectural map of Selly Oak, anonymous, 1850
- Map of Birmingham and Environs, Blood, 1857

- Map of Edgebaston Parish, Robins, 1877
- Ordnance Survey map, 1:2500, 1884
- Ordnance Survey map, 1:2500 1890
- Ordnance Survey map, 1:2500, 1916 and 1917
- Ordnance Survey map, 1:2500, 1945
- Ordnance Survey, 1:1250, 1965

Documentary sources

- Barfield and Hodder 1981, 1987 and 1989
- HEAS 2000
- Patrick 2001

2.2 Fieldwork

2.2.1 Fieldwork strategy

A detailed specification has been prepared by the Service (HEAS 2003). Fieldwork was undertaken between 10th and 19th May 2003.

One trench, amounting to around 175m² in area, was excavated in the floodplain of the Bourn Brook. The location of the trench is indicated in Figures 1 and 2. The trench extended from the southern edge of the floodplain to approximately 4m from the edge of the brook.

The trench was excavated using a 360º wheeled excavator, employing a toothless bucket and under archaeological supervision. The depth of the trench extended to the natural sands or gravels in order to obtain a clear picture of the sequence of deposition throughout the floodplain. Subsequent excavation was undertaken by hand. Clean surfaces were inspected and selected deposits were excavated to retrieve artefactual material, as well as to obtain environmental bulk samples and monoliths. Deposits were recorded according to standard Service practice (CAS 1995).

The northern 20-25m of the trench, closest to the brook, was subject to some very heavy flooding. The extent of the water inundation caused some problems early on. In the flooded area the very base of the trench was not possible to clean, though the sections were recorded and the requisite environmental samples were taken.

On completion of excavation, trenches were reinstated by replacing the excavated material.

2.2.2 Structural analysis

All fieldwork records were checked and cross-referenced. Analysis was effected through a combination of structural, artefactual and ecofactual evidence, allied to the information derived from other sources.

Two contexts (base of monolith 1a: 22-27cm and monolith 3a: 20-25cm) were processed for plant macrofossils in order to obtain material for radiocarbon dating. The sediments were sieved through a 300mm mesh and the residue dried, then examined under a low power EMT stereo light microscope. Only wood fragments and twigs were identified which were

submitted for AMS dating to the University of Waikato Radiocarbon Dating Laboratory, New Zealand and calibrated using OxCal v3.9 (Bronk Ramsey 2003).

2.3 Artefacts

2.3.1 Artefact recovery policy

All artefacts from the area of evaluation were retrieved by hand and retained in accordance with the service manual (CAS 1995 as amended).

2.3.2 Method of analysis

All hand retrieved finds were examined. A primary record was made of all finds on a Microsoft Access 2000 database. Artefacts were identified, quantified and dated.

Pottery was examined under x20 magnification and recorded by fabric type and form according to the fabric reference series maintained by the service (Hurst and Rees 1992).

2.3.3 Artefactual analysis

A summary of the artefacts recovered can be seen in Table 2. The assemblage retrieved from the programme of archaeological work consisted of hand retrieved, unstratified material. The group ranged from the post-medieval to modern periods.

Pottery formed 90% of the assemblage. Sherds were identified and grouped by fabric (see Table 2). The majority of sherds were undiagnostic but could be dated to between the 18th – 20th centuries on the basis of fabric type.

Other finds consisted of a clay pipe bowl and two shards of bottle glass all dating from the 19th century.

2.4 Environment

2.4.1 Fieldwork and sampling policy

The environmental sampling policy was as defined in the County Archaeological Service Recording System (1995, as amended). Samples were taken for environmental analysis and AMS dating. The samples consisted of three monoliths, primarily used for pollen analysis, and seven spit samples (5cm blocks) for plant macrofossil investigations. Further monoliths were taken by Terra Nova to evaluate the geoarchaeology of the site in order to clarify the origins of the deposits and help assess the archaeological potential of the site. The work by Terra Nova gave greater assurance that the pollen core analysis was valuable. The Terra Nova report is included in Appendix 2.

2.4.2 Plant macrofossil and general environmental analysis

For each of the samples a sub-sample of 1 litre was processed by the wash-over technique as follows. The sub-sample was broken up in a bowl of water to separate the light organic remains from the mineral fraction and heavier reside. The water, with the light organic faction was decanted onto a 300mμ sieve and the residue washed through a 1mm sieve. The remainder of the bulk sample was retained for further analysis.

The residues were fully sorted by eye and the abundance of each category of environmental remains estimated. The flots were scanned using a low power EMT stereo light microscope and plant remains identified using modern reference collections maintained by the Service, and seed identification manual (Beijerinck 1947). Nomenclature for the plant remains follows the Flora of the British Isles, 3rd edition (Clapham *et al* 1989).

2.4.3 **Pollen analysis**

For pollen analysis, where possible, samples were selected at 8cm intervals down the core, and 2cm^3 of sediment was measured volumetrically. The samples were soaked for 24 hours and then boiled in tetra-Sodium Pyrophosphate for 1 hour, sieved through a 120 μm mesh and onto a 10 μm mesh, and the residue collected. Due to the silicaceous nature of the sediments, the samples were processed using Hydrofluoric Acid digestion, being placed in a hot water bath for 1 hour. Where obvious large silicaceous material was still present, selected samples were also swirled on a watch glass to separate any remaining organic from inorganic material. Where certain samples were more organic, they were acetolysed for 2.5 mins to break down the cellulose material. Finally the pollen pellet was stained with Safranine, washed in alcohol to dehydrate the sample, and preserved in Silicon Oil.

As samples were low in organic content, pollen grains were counted to a total of 250 land pollen grains on a GS binocular polarising microscope at 400x magnification. Identification was aided by using the pollen reference manual (Moore *et al* 1991). Nomenclature for pollen follows Stace (1997) and Bennett (1994). The pollen diagram was constructed using TILIA, TILIA.GRAPH, and TGView 1.6.2 software (Grimm 1990; 2004).

2.5 The methods in retrospect

The methods adopted allow a high degree of confidence that the aims of the project have been achieved.

3. Topographical and archaeological context

The excavation took place in an area south of the Bourn Brook. This area of land is composed of boulder clay, with a band of Upper Mottled Sandstone to the south (Geological Survey of England and Wales 1924). The present watercourse flows eastwards, forming the northern boundary of the site, with the area of the floodplain rising approximately 25m from the edge of the current brook, where there is a slight rise in the gravel terrace. The Bourn Brook appears to have been divided into two channels from by the time of the earliest maps such as the Tithe map (Figure 5). The two channels appear to rejoin around 350m east of the Worcester to Birmingham canal. The modern brook follows the course of the northern channel, whilst the southern channel appears to have been a man-made mill leat (HEAS 2000). The site is bordered to the east by the Worcester and Birmingham canal, to the south and south-east by the A38 and the site of the old Birmingham Battery and Metal Company Works and to the west by Harborne Lane and its associated housing and retail developments.

The course of the Bourn Brook is known for its concentrations of burnt mounds. These are prehistoric features comprised of charcoal-rich soils and matrixes of heat-shattered stone. Often there are central pits, thought to be a water tank into which the stones were placed to either create a sauna or cook (Barfield and Hodder 1989). A number of these sites have been excavated along the course of the brook, with the nearest (BSMR 1682) being on the north side of the brook near Vincent Drive (HEAS 2000). An archaeological evaluation in 2001 failed to locate any traces of such structures within the development area (Patrick 2001).

In the early Roman period a series of forts were constructed to the north of the study area at Metchley (BSMR 2005 and 20140). Investigations revealed extensive evidence for an ancillary civilian settlement and trackway extending west from the fort (Jones 1999). A Roman road running from Gloucester, through Worcester and Droitwich is thought to join Rynild Street in Selly Oak (Hetherington and Whitehouse 1969). The area was thought to have a length of Roman Road running through it but no trace of such a feature was located in the 2001 evaluation (Patrick 2001).

In the Domesday Book of 1086 Selly Oak was recorded as being a sub-manor of the manor of Northfield or Weoley. Two water mills and one fishery are recorded within the manor in

1272-1273 and 1338. By 1368, when Selly Oak was a tithing of the chief manor of Weoley or Dudley, there were three mills, one fishery and two fishponds (VCH III, 194-7). Two post-medieval mills are shown outside the study area on the 19th century mapping of Selly Oak. These may have medieval predecessors. Harborne mill (BSMR 3205) is located to the west of Harborne Lane whilst the Bourn Brook Mills (BSMR 3206) were located to the east of the canal with a series of fish ponds. The Bourn Brook Mills were associated with the metal industry from the beginning of the 18th century. The string possibility exists for earlier mill complexes on the site or in the vicinity of their location (HEAS 2000). The leat serving the latter mill crosses the study area (HEAS 2000). The 2001 evaluation located relict watercourses, amongst them the man-made leat in Trenches K and J. Former silted up courses of the Bourn Brook were also detected during the trenching (Patrick 2001).

According to the 1840 tithe map and the 1884 Ordnance Survey map (Figures 5 and 7 respectively), the Bourn Brook flowed west to east under Harborne Lane and into the study area, where it divided into two channels. The water flowed into the surviving northern channel over a weir while the southern channel flowed south-eastwards before turning to flow east approximately parallel with the northern channel. This southern channel then flowed under the canal and later the railway before flowing into a series of fishponds and the millpond of the Bournbrook Mill. The fishponds became boating lakes in the late 19th century before being filled in 1908, making the southern channel redundant. The 1916 Ordnance Survey map (Figure 8) shows the channel as a redundant earthwork. A map from the Lapal Canal Trust from around the same time shows the central area of the channel backfilled and the area being used as allotments. The site at this time was owned by the Birmingham Battery and Metal Company. This ownership would explain the provenance of the industrial waste found in the backfill of the southern watercourse (HEAS 2000).

The 19th century mapping of the area (Figures 5-7) shows it was used primarily as agricultural land. By the 20th century this land seems to have become used more for allotments, as the Selly Oak area generally had become largely developed owing in part to the proliferation of local industry. The Elan Valley aqueduct was constructed across the site in the early 20th century, running from the north-east to south-west. This would have caused a great deal of ground disturbance in the study area and is just about visible as a low earthwork (HEAS 2000).

4. Description

The contexts listed are presented in Table 8 (Appendix 2), with Tables 2 and 3a summarising the artefacts recovered. Appendix 1 contains the pollen diagram and Tables 3-7, which list the environmental remains studied. The radiocarbon dating is shown in Table 1. The trenches and features recorded are shown in Figures 1-8. Appendix 3 contains the main body of the Terra Nova geoarchaeology report.

4.1 Carbon 14 dating

4.1.1 Monolith 1a: 22-27cm

The base of the monolith was sampled in order to obtain material for AMS dating (Tables 1, 3, and 5). Wood fragments dated to between 1410 cal AD and 1530 cal AD (425 ± 39 ^{14}C BP), at 95% (2σ) probability (University of Waikato 2004).

4.1.2 Context 42

Spit 5: 20-25cm: sample 7

Twigs sampled at this point dated to between 1430 cal AD and 1530 cal AD (395 ± 39 ^{14}C BP), at 95% (2σ) probability (University of Waikato 2004); (Table 1).

Table 1: *Radiocarbon results for selected samples*

Sample	Material	Laboratory code	$\delta^{13}C$ ‰	Radiocarbon age BP	Calibrated age (2σ)
Monolith 1a, 22-27cm	Wood	Wk15265	-28.4	425 ± 39	1410-1530AD
Monolith 3a, 20-25cm	Twigs	Wk15266	-28.8	395 ± 39	1430-1530AD

4.2 Discussion of the artefacts

The discussion below is a summary of the finds and associated location or contexts by period. Where possible, *terminus post quem* dates have been allocated based on the evidence recorded and the importance of individual finds commented upon as necessary.

4.2.1 Post-medieval

Only four sherds of post-medieval pottery were recovered on site. These were all identified as post-medieval red sandy ware (fabric 78) and, while undiagnostic in form, they can be loosely dated to between the 17th to 18th century.

4.2.2 Modern

The modern ceramic assemblage consisted of 23 sherds. All were identified as modern stone china (fabric 85) except for a single sherd of Nottingham stoneware (fabric 81.3). While the sherd of Nottingham stoneware may have originated from a flagon the modern stone china originated from a wide range of domestic kitchen forms. These included 19 sherds from willow pattern ware plates and a teapot neck.

4.2.3 Significance

The artefacts assemblage from this site is suggestive of only minimal cultural activity on site during the post-medieval to modern period. There was no artefactual evidence for cultural activity prior to this period. The small number of finds, and the large proportion of sherds of domestic wares suggest only general household refuse discard during the 18th to 20th centuries.

Table 2: *Quantification of the assemblage*

Type	Total	Weight (g)	Date
Bottle glass	2	14	19th century
Clay pipe bowl	1	8	Post 1850
Modern pottery	23	190	19th -20th century
Post-medieval pottery	4	127	17th –18th century

Table 3a: *Quantification of pottery fabrics*

Fabric name	Fabric	Total	Weight (g)
Red sandy ware	78	4	127
Nottingham stoneware	81.3	1	12
Modern stone china	85	22	178

5. Environmental results

5.1 Pollen samples

5.1.1 Monolith 1a

Depth 20cm

The pollen assemblage from within this leat fill (Table 5) was dominated by grasses (Poaceae). Other herbs were present in low numbers, with dandelion (*Taraxacum officinale)* the primary taxon, a coloniser of damp grassland or meadowland, or in some cases waysides and cultivated ground. There were additional wetland species including meadowsweet (*Filipendula)* and sedge (Cyperaceae), reflecting the immediate river area. Both chamomile (*Anthemis* type) and mugwort (*Artemisia)* were also present, colonisers of waste places, although *Anthemis* type (chamomile) can also be associated with arable land. Alder (*Alnus)* dominated the arboreal assemblage. Other trees and shrubs were present in much lower numbers but included birch (*Betula)*, pine (*Pinus)*, oak (*Quercus)*, willow (*Salix)*, ivy (*Hedera)*, holly (*Ilex)*), and a number of hazel (*Corylus)* grains. Fern spores were present, being dominated by *Pterosida* (mon) indet, although interestingly, a marshland fern (*Thelypteris palustris)* was also recorded, often associated with alder carr or woodland.

Depth 12cm

Higher within the profile, grasses (Poaceae) remained dominant, while dandelion (*Taraxacum officinale)* was still the most important of the minor herbs. Single examples of bur-marigold (*Bidens* type), common sorrel (*Rumex acetosa)*, and knotgrass (*Polygonum)* also appeared. The former most probably associated with dandelion, both being meadowland or damp grassland species. The latter two taxa are suggestive of waste ground in this case rather than arable land. Regarding trees and shrubs, alder (*Alnus)* was still dominant but had become associated with higher numbers of hazel (*Corylus)*, most probably colonising the river's edge.

5.1.2 Monolith 2a

Local pollen zones

BB1: 52-35cm

As with the first monolith this was also taken from the leat (Table 6 and pollen diagram). This zone was characterised by a domination of grasses (Poaceae indet). This zone also saw the beginnings of a steady expansion in the wetland or meadowland species, dandelion (*Taraxacum officinale)*, with others such as buttercup (*Ranunculus)* and meadowsweet (*Filipendula)*. Hazel *(Corylus)* and alder (*Alnus)* were the dominant arboreal species, with occasional other taxa such as birch (*Betula)* and pine (*Pinus)*. Spores were low, ferns *Pterosida* (mon) indet being the major taxon and beginning a gradual rise. By the middle of zone BB1, species diversity for herbs generally improved. Grasses (Poaceae indet) values had fallen slightly, while alder (*Alnus)* increased. Wetland and damp-loving herbs were also recorded and included buttercup (*Ranunculus)*, tormentil (*Potentilla)*, meadowsweet (*Filipendula)*, and teasel (Dipsacaceae). Both cornflower (*Centaurea* type) and chamomile (*Anthemis* type) were also present, both colonisers of waste places, the former including a weed of cultivated land (*C. cyanus)*. Towards the end of the zone, there was a slight increase in oak (*Quercus)* and willow (*Salix)*. Both Apiaceae and Rosaceae also became apparent at this point.

BB2: 35-23cm

Zone BB2 was characterised by a continual increase in dandelion (*Taraxacum officinale)*, while other herbs were minimal. Common sorrel (*Rumex acetosa)* also made its first appearance within this profile, together with wetland herbs buttercup (*Ranunculus)*, meadowsweet (*Filipendula)*, and bur-marigold (*Bidens* type). Towards the end of zone BB2, grasses (Poaceae indet) began to rise slightly, although this taxon had remained dominant throughout this and the former zone. Arboreal species remained steady, with the exception of pine (*Pinus)*, which disappeared at this point.

BB3: 23-4cm

Zone BB3 saw a fall in dandelion (*Taraxacum officinale)* and an increase in grasses (Poaceae indet). Other taxa values remained the same, with the exception of a fall in hazel (*Corylus)*. This zone was also characterised by a marked increase in spores, primarily fern (*Pterosida* (mon) indet), but also polypody fern (*Polypodium)* and moss (*Sphagnum)*. By the middle of the zone, dandelion peaked once more, returning to former values. Alder (*Alnus)* and hazel (*Corylus)* increased, while other trees and shrubs were present in low numbers, with only birch (*Betula)*, lime (*Tilia)*, willow (*Salix)*, and holly (*Ilex)*, present. There was also one example of heather (*Calluna vulgaris)*, most probably colonising the woodland understorey distant from the catchment. By the end of the zone, grasses once again increased in number, and as before, were mirrored by a notable fall in alder and hazel. Other arboreal species remained as before, with the addition of pine (*Pinus)* and oak (*Quercus)*. Other herbs increased slightly and included a dominance of meadowsweet (*Filipendula)*, together with examples of chamomile (*Anthemis type)*, and buttercup (*Ranunculus)*.

5.1.3 Monolith 3a

Depth 12cm

Evidence for alder carr *(Alnus)* was notably high, but grasses (Poaceae indet) were still dominant (Table 7). Other arboreal species comprised mainly hazel (*Corylus)*, as well as minimal numbers of birch (*Betula)*, pine (*Pinus)*, oak (*Quercus)*, lime (*Tilia)*, willow (*Salix)*, ivy (*Hedera)*, and guelder rose (*Viburnum)*. Few other herbs were present, the principal taxon being dandelion (*Taraxacum officinale)*. Other wetland herbs included meadowsweet (*Filipendula)* and buttercup (*Ranunculus)*.

Depth 4cm

Evidence for grassland (Poaceae indet) increased markedly, while trees and shrubs remained at former values. Dandelion (*Taraxacum officinale)* fell in number. The most interesting addition to the herb pollen suite however, was the introduction of ribwort plantain (*Plantago lanceolata)*, often associated with cultivated or waste ground. An interpretation of a waste area was supported by the presence of mugwort (*Artemisia vulgaris)*. Cultivation or at least human interference cannot be ruled out however, as the plant macrofossil assemblage included charred grass grains.

5.2 Plant macrofossil samples

5.2.1 Monolith 1a: 22-27cm

The material taken for carbon-14 dating was also used to extract environmental material for analysis. Environmental evidence was minimal, comprising small amounts of charcoal, waterlogged seeds, and a variety of wood, twig, and root fragments, as well as moderate amounts of unidentifiable plant material. The plant macrofossils consisted of just two examples of campion (*Silene* sp), and one of fat hen (*Chenopodium album)*, both often found colonising open and waste ground.

5.2.2 **Context 42**

Spit 5: 20-25cm: sample 7

On the east facing section (opposite side to Monolith 1a), five spit samples were taken relating to Monolith 3a (Figure 4), which was used for pollen spot samples. With regard to all spit samples, there was very limited environmental evidence (Tables 3 and 4). At the base of the section, only occasional insect remains, charcoal fragments, and a variety of plant and woody material were recorded.

Spit 4: 15-20cm: sample 6

This sample was also limited in its environmental value, the residues comprising occasional charcoal, waterlogged seeds, and twigs, as well as larger quantities of root material. Only three seeds were found, those of fat hen (*Chenopodium album)* and Caryophyllaceae, the former often found colonising waste ground.

Spit 3: 10-15cm: sample 5

Again, the environmental assemblage was similar to the lower samples, comprising only limited insect, charcoal, and waterlogged remains, with larger quantities of unidentifiable vegetative and woody matter. There were just two species of waterlogged seed, raspberry (*Rubus* cf *idaeus)* and common sorrel (*Rumex acetosa)*, the latter often found growing amongst grassland or open clearings in woodland. The appearance of raspberry suggests that waste or scrub colonised areas slightly removed from the river edge, although it cannot be discounted that the seeds were washed in from elsewhere.

Spit 2: 5-10cm: sample 4

The categories of environmental remains were more diverse than lower levels, with additions of occasional large mammal bone fragments, charred plant macrofossils and increased evidence of charcoal. The charred remains consisted of just one fragmented unidentified berry. Waterlogged seeds increased in species diversity and included raspberry (*Rubus* cf *idaeus)*, raspberry/bramble (*Rubus idaeus/caesius/fruticosus)*, common sorrel (*Rumex acetosa)*, and common nettle (*Urtica dioica)*. The presence of raspberry/bramble is difficult to interpret and may have equally been growing amongst woodland, scrub, dry grassland or fen carr. Due to the river location it may have colonised the wetter areas of the floodplain, possibly in conjunction with common nettle. It appears that all species, with the exception of raspberry, were most probably growing on damp grassland areas beside the river. It is possible that raspberry and bramble were growing at the site itself rather than being transported from upstream, as evidence of these species are found within the upper three samples.

Spit 1: 0-5cm: sample 3

At the top of the section, species numbers increased still further, the waterlogged assemblage being dominated by curled/sharp dock (*Rumex* cf *crispus/conglomeratus)*. Other species included a few seeds of raspberry/bramble *(Rubus idaeus/caesius/fruticosus)*, common sorrel (*Rumex acetosa)*, grasses (Gramineae sp indet), and bulrush (cf *Schoenoplectus lacustris*). Occasional charred remains survived, represented by just two grass grains (Gramineae sp indet). Other remains were comparable to former levels with the addition of occasional mollusc shell fragments. The abundance of curled/sharp dock suggests that there were damp grassy areas or general waste ground within the raspberry/bramble scrub. The presence of bulrush is obvious evidence of the wetland location.

Evidence of charcoal was found in all samples, together with very limited seed remains in some samples, including an unidentified charred berry. It is therefore possible that human activity was occurring at the site, but as preservation was poor, little detailed interpretation

could be made. On the basis of the above results, the final two spit samples taken from the east facing section were not processed.

6. Significance

The environmental record tends to be most complete within the pollen record, as preservation of the plant macrofossil remains is poor. There appears to be evidence of human activity, highlighted primarily by the presence of charcoal, which is dated to the late medieval period (15^{th} to 16^{th} century).

7. Discussion

7.1 Phase 1 Natural deposits

Natural deposits were encountered along the length of the trench, from the northern end of the trench adjacent to the Brook to its southern extent. The trench was excavated down to the top of the natural layer of river gravels.

The natural deposits and geoarchaeological information are as described in the Terra Nova report (Appendix 3).

7.2 Prehistoric

The geoarchaeology suggests that the majority of samples analysed are of early Holocene age. However, these samples were taken further along the southern portion of the trench and amongst the natural strata, some distance from the relict palaeochannels. However, there were no features or artefacts found in the trench or in the finds assemblage that point to prehistoric activity in the study area.

7.3 Roman

There were no artefacts or features dating from this period. There was no trace of any road that might have served the Metchley Roman forts, which existed north of the brook and to the north east of the study area. There was no evidence from the trench that suggested that the area had been settled on.

7.4 Medieval

Although no artefactual material was recovered from the excavation dating to this period, the palaeochannels proved to contain deposited material dating from the latter part of this period. The former course of the Bourn Brook and the known artificial channel or leat around 20m to the south showed very similar date ranges. The leat is shown on various historical maps (Figures 5-8) but its origins can now be confirmed. It would seem certain that the phase of activity which saw the palaeochannels adopt the form shown on the historical maps occurred at the same time. The northern course of the Bourn Brook has been straightened, judging by its appearance on the maps (Figures 5-8). The palaeochannel sample at the northern end of the trench (monolith 3a) would appear to be from a relict section of the former course of the brook. The management of the water system for the fishponds and the Bourn Brook Mills would have required the construction of not only the leat, but also the management of the existing brook. This was achieved via straightening of the naturally meandering watercourse in order to allow water flow to be controlled into the mill leat and prevent flooding, or breaching, of the brook in to the leat. The leat itself was located in the trench quite close to the small rise in the river terrace gravels. It's quite likely that the channel follows this terrace along its length until it reached the fishponds and the Bourn Brook mill. Mills are often situated on the edge of terraces in order for their structures to remain dry enough and to

prevent flooding of the water wheel etc, whilst still being able to exploit the water source (Woodiwiss pers comm).

The leat was probably, like the straightening of the brook, constructed in the period just prior to the 1410-1530 AD date range given by the carbon-14 dating. The sample taken from the bases were a deposit that had naturally silted into the channel and not been removed during cleaning episodes. These deposits in the relict courses do not date the construction of the channels themselves, but it seems highly likely that the leat and the brook realignment are late medieval activities. It's unlikely that new and large scale construction projects like this would have occurred in the mid 14th century or any date immediately thereafter, given the Black Death and the subsequent shortage of labour. A late 14th or early 15th century date would seem more likely for new constructions given the subsequent recovery in population numbers. The leat appears to have been in existence from its probable construction around this time until it was partly backfilled between 1884 and 1916 (Figures 8 and 9). The length of its existence therefore is a very significant, given that it was used for around 600 years. In section, the leat appeared to have been re-cut at least once (Figure 4), indicating different phases of use. The date of the mill leat also has strong implications for the date of the Bourn Brook mill. Currently dated to the 18th century and tied in with the establishment of the local metal industry, it would seem that a medieval predecessor to the mill did indeed exist, as has been previously suggested (HEAS 2000).

At first, it was believed that the samples from the two former watercourses (monoliths 1a and 3a) would be prehistoric in date. The radiocarbon ages now indicate a medieval date, both sequences dating to between the 15th and 16th centuries. Bourn Brook is a typical floodplain site, particularly well characterised by the pollen suite. The pollen sequence from the three monoliths demonstrates an open damp grassland environment indicated by wetland or meadowland type herbs such as dandelion (*Taraxacum officinale)*, meadowsweet (*Filipendula)*, buttercup (*Ranunculus)*, and bur-marigold (*Bidens* type). The river edge itself would have been colonised by alder (*Alnus)*, or a mixture of alder and hazel (*Corylus)*. The limited numbers of other arboreal species suggests that mixed woodland distant from the site was also present, most probably colonising the drier landscape away from the immediate floodplain. Although the plant macrofossil evidence was limited, species, which could not be detected within the pollen record, were found. This is particularly true of *Rubus* sp, which was most probably growing at the site. Like the pollen sequence, many of the plant macrofossils species suggest a floodplain landscape comprising a mosaic of wetter grassland colonised by herbs such as curled/sharp dock (*Rumex* cf *crispus/conglomeratus)* and common sorrel (*Rumex acetosa)*, as well as slightly drier, waste ground or scrubland colonised by raspberry (*Rubus* cf *idaeus)* and raspberry/bramble (*Rubus idaeus/caesius/fruticosus).* The only hint of human activity from the pollen assemblages is the presence of ribwort plantain (*Plantago lanceolata)*, which due to its medieval date, most probably represents cultivated or formerly cultivated, land, or alternatively colonised waste scrubland. However, in context 42, at the base of the former Bourn Brook there is an increase in macrofossil remains indicative of human activity (most probably domestic waste), such as fragmented animal bone and charcoal, and charred grass grains towards the top of the organic deposit.

Overall the pollen sequences provide a detailed description of a typical, relatively open grassy (most probably meadowland) floodplain environment. There are subtle fluctuations in pollen reflecting alder carr, grassland and in particular dandelion vegetation. As dandelion is a plant of damp meadowland, wasteland or cultivated ground, slight peaks in pollen may indicate periods of more intensive grassland management in the vicinity (resulting in a more species diverse vegetation), or disturbance resulting from cultivation or more intensive occupation within the river catchment.

Comparison with other sites in the region

A number of floodplain sites have been investigated for pollen and plant macrofossil remains in the midlands. In Leominster, Herefordshire (Head forthcoming) for example, the Romano British site of Mill Street provided an insight into the vegetation of the area, comparable to Bourn Brook. Mill Street produced a picture of alder or mixed alder/hazel woodland

colonising the river's edge. This would have been combined with a mosaic of damp and drier grassland, characterised by herbs similar to those found at Bourn Brook.

With regard to the pollen and plant macrofossil record, Bourn Brook is comparable to the Bronze Age to Romano-British sequence at Beckford, along the Carrant Brook Valley, Worcestershire (Greig and Colledge 1988), where there was evidence of alder carr and other wetland herbs within the environmental record. The peaty nature of these deposits however, provided better conditions for survival of macrofossil remains, and hence a more comprehensive environmental record survived. Well-preserved charred cereal waste indicated increased agricultural activity.

There is also a good environmental record of meadowland at a number of medieval sites, either representing the meadowland itself, which is possibly the case at Bourn Brook, or indicating hay products brought in from a meadowland site elsewhere. At the urban 13th century medieval site of Shrewsbury Abbey for example, evidence of hay waste was found, with pollen and seed records including species such as tormentil (*Potentilla erecta*) and cornflower (*Centaurea cyanus*); (Greig 2002). These hay meadow plants are assumed to have been brought in with other products such as foodstuffs during the medieval period. These were probably growing around the site, as they do not colonise urban areas easily (Greig 2002).

One particularly important medieval/post-medieval site in Birmingham however, is that of Smithfield Market section of the Birmingham Moat site, where pollen and plant macrofossil remains were analysed from the moat fill (Greig 1980). This sequence gives an insight into the rural landscape of the area, which comprised thickets or hedgerows, some arable land including cornfields and possibly the cultivation of hops or hemp, as well as some pasture and heathland. Preservation conditions within the moat however, were very different from Bourn Brook, with good preservation of pollen and plant macrofossils within the clays and silts (Greig 1980), and excellent preservation of the insect remains within the peats (Osbourne 1980).

7.5 Post-medieval to modern

Features and artefacts from the post-medieval to modern periods were recovered from areas along the whole trench. A moderate quantity of pottery was recovered from the machined material. This consisted of pottery that dated loosely from the 17th century onwards, with 20th century china as part of the assemblage. There were a number of pits present within the trench that were filled with an abundance of industrial waste and modern brick fragments. These probably date to the period when the Birmingham Battery and Metal Company was established on the site from the 19th century. The greatest quantity of waste deposit was nearest the factory over the "hill" to the south of the site, but obviously there had been dumping further north over the floodplain area too.

The environmental evidence hinted at minimal evidence for agricultural activity. The historic maps show the area to have been used for allotments in the 19th century. This might be the only time the area was used for cultivation.

7.6 Research frameworks

The Bourn Brook excavation has revealed the date of palaeochannels in this part of the floodplain. In addition to this the environmental study has, despite the poor preservation of environmental remains, indicated a slightly mixed wetland environment. This environment has been subject to probable human activity although never been directly settled on. The information provided by this excavation will be useful to compare to future studies in other urban floodplain environments. Interesting comparisons can be made to the Birmingham Smithfield Market site in establishing the past rural environment.

The dating of the straightening of the Bourn Brook and the construction of the mill leat suggests that the site of the Bourn Brook mill was medieval in origin. It is significant for Selly Oak that a mill or mills existed in roughly the same location for around 500-600 years. Any future opportunity to discover the location of the medieval predecessor to the post-medieval mill would be useful in confirming this phase of late medieval activity in Selly Oak. The excavation will inform the local and regional research cycles.

8. Publication summary

The Service has a professional obligation to publish the results of archaeological projects within a reasonable period of time. To this end, the Service intends to use this summary as the basis for publication through local or regional journals. The client is requested to consider the content of this section as being acceptable for such publication.

An archaeological excavation was undertaken on behalf of Arthur Amos Associates at Bourn Brook, Selly Oak, Birmingham (NGR SP 0408 8316: BSMR 20726). The excavation succeeded in locating a former course of the Bourn Brook, which seems to have been created due to artificial straightening, as well as phases of a mill leat further to the south of the present brook. Deposits from these relict water channels were radiocarbon dated to the 15th and 16th century. The phases of activity which saw the re-designing of the Bourn Brook and the construction of the mill leat would seem to be contemporary given the closeness of the carbon-14 dates and the purpose for which this water management system was intended.

The dating of the leat and the alteration of the Bourn Brook lends substantial weight to the probability of the Bourn Brook mill in Selly Oak having one or more medieval ancestors. The fishponds that the leat drained into would also have to be of late medieval date.

The trench exposed alluvial deposition across a large part of the brook's floodplain. A series of environmental samples were taken from the palaeochannels. Monolith samples were taken from the former watercourses, mainly for pollen analysis. Pollen preservation was sufficient to produce a detailed sequence of vegetation change corresponding to periods of deposition of organic material within the channels. Macrofossil remains were, however, poorly preserved, providing limited information on the nature of the surrounding environment. The pollen results reflect a typical floodplain site characterised by an open, damp grassland environment, with alder carr woodland along the river edge and mixed woodland distant from the site, probably on the drier landscape beyond the floodplain. There were some signs of periods of woodland clearance and expansion of grassland and ferns, but only limited evidence of human activity, particularly arable agriculture, except for the appearance of occasional charred grass grains and plants associated human disturbance (plantain and mugwort) towards the top of one sequence.

The results of the environmental sampling picture the study area to be a typical wetland environment, which shows little substantial evidence of having ever been agricultural. However, human activity has been located in the material extracted from the former course of the Bourn Brook, which lay parallel to the existing brook. The presence of small pieces of animal bone and charred grass seeds within the palaeochannel deposit indicates human activity. Following radiocarbon dating, such activity appears to have taken place in the late medieval period. Ribwort plantain pollen was found in the former brook, which indicates possible agricultural activity, as the plant occupies cultivated, or formerly cultivated, land. The environmental evidence points to settlement activity in the general environs of the brook and its floodplain, which might have colonized drier land around the edges of the area. The evidence of cultivation in the study area is therefore vague in any period prior to the 19th century, when the land was apportioned for allotments.

9. The archive

The archive consists of:

3	Fieldwork progress records AS2
4	Photographic records AS3
66	Digital Images
2	Context finds sheets AS8
3	Scale drawings

The project archive is intended to be placed at:

Birmingham City Museum and Art Gallery

10. Acknowledgements

The Service would like to thank the following for their kind assistance in the successful conclusion of this project, Sainsbury's Supermarkets Ltd, Arthur Amos Associates, Dr Mike Hodder (Birmingham City Council) and Terra Nova.

11. Personnel

The fieldwork was led by James Goad. The report preparation was led by James Goad and Liz Pearson. The project managers responsible for the quality of the project were Simon Griffin and Simon Woodiwiss. Fieldwork was undertaken by James Goad, Marc Steinmetzer, Alvaro Mora-Ottamano, Liz Pearson, Katie Head, Angus Crawford and Andrew Brown, finds analysis by Angus Crawford, environmental analysis by Liz Pearson and Katie Head, with additional environmental analysis undertaken by Richard Payne of Terra Nova.

12. Bibliography

Barfield, L and Hodder, M, 1981 Birmingham's Bronze Age, *Current Archaeology*, 7 (7): 198-200

Barfield, L and Hodder, M, 1987 Burnt mounds as saunas: an exercise in archaeological interpretation, *Antiquity*, 61 (233): 370-379

Barfield, L and Hodder, M, 1989 Burnt mounds in the West Midlands: surveys and excavations, In: A. Gibson (ed), *Midlands Prehistory: some recent and current researches into the prehistory of central England*, 5-13, BAR British Series 204, Oxford

BCC, 2003 *Brief for an archaeological excavation at the former Battery Site, Selly Oak, Birmingham*, Birmingham City Council Planning dated 10th November 2003

Beijerinck, W, 1947 *Zadenatlas der Nederlandsche Flora*, Wagoningen

Bennett, K.D, 1994 *Annotated catalogue of pollen and pteridophyte spore types of the British Isles*, unpublished report

Bronk Ramsey 2003 OxCal v3.9 radiocarbon calibration program

CAS, 1995 (as amended) *Manual of Service practice: fieldwork recording manual*, County Archaeological Service, Hereford and Worcester County Council, report, **399**

Clapham, A R, Tutin, T G and Moore D M, 1989 *Flora of the British Isles*, (3rd edition), Cambridge University Press

Deeks, A, Griffin, L, and Head, K, 2004 *Archaeological evaluation at Newport Street, Worcester, Worcestershire* Historic Environment and Archaeology Service, Worcestershire County Council, report, **1237**

Greig, J, 2002 The 13th-18th century plant remains, in N Baker (ed), *Shrewsbury Abbey: Studies in the archaeology and history of an urban abbey*, Shropshire Archaeological and Historical Society Monograph Series, **2**, 163-178

Greig J R 1980 The plant remains, 66-72. In: Watts L Birmingham moat, its history, topography and destruction. *Trans, Birmingham and Warwickshire Archaeol. Soc. (for 1978-9)*, 89: 1-71, England, West Midlands

Greig, J R A, and Colledge, S, 1988 *The prehistoric and early medieval waterlogged plant remains from multi-period Beckford sites 5006 and 5007 (Worcestershire) and what they show of the surroundings then*, English Heritage Ancient Monuments Laboratory Rep **54/88**

Grimm, E C, 1990 TILIA and TILIA.GRAPH. PC spreadsheet and graphics software for pollen data. *INQUA working group on data-handling methods, Newsletter 4*: 5-7

Grimm, E C, 2004 TGView 1.6.2

Head K, forthcoming *Pollen evidence from an excavation at Mill Street, Leominster, Herefordshire*

HEAS, 2003 *Proposal for an archaeological excavation at The Sainsbury's Site, Selly Oak, Birmingham*, Historic Environment and Archaeology Service, Worcestershire County Council, unpublished document dated 17th November 2003, **P2482**

HEAS 2000 Archaeology and built heritage, in an Environmental Impact Assessment submitted in support of a planning application (reference S/04932/00/OUT) for Sainsbury's Supermarkets Ltd submitted to Birmingham City Council

Hetherington, R J and Whitehouse, D B 1969 The Roman road between Gloucester and Birmingham, north of the Lickey Hills, *Trans and proc Birmingham Archaeol Soc, 83, 180-187*

Hurst, J D, and Rees, H, 1992 Pottery fabrics; a multi-period series for the County of Hereford and Worcester, in Woodiwiss, S G (ed), *Iron Age and Roman salt production and the medieval town of Droitwich*, CBA Res Rep, **81**

IFA, 1999 *Standard and guidance for archaeological excavation*, Institute of Field Archaeologists

Jones, A 1999 *University Hospital Birmingham* NHS Trust, *Archaeological Evaluation Area C*, Birmingham University Field Archaeology Unit internal report 617.01

Moore, P D, Webb, J A and Collinson, M E 1991 *Pollen analysis*, (2nd edition), Blackwell Scientific Publications, Oxford

Osbourne, P J, 1980 Report of the insects from two organic deposits on the Smithfield Market site, Birmingham, 63-66. In: Watts L Birmingham moat, its history, topography and destruction. *Trans, Birmingham and Warwickshire Archaeol. Soc. (for 1978-9)*, 89: 1-71, England, West Midlands

Patrick, C 2001 *Evaluation at Selly Oak, Birmingham* Worcestershire County Council Archaeology Service, report **933**

Stace C, 1997 *New flora of the British Isles*, 2nd edition, Cambridge University Press, Cambridge

University of Waikato Radiocarbon Dating Laboratory 2004 *Report on Radiocarbon Age Determination for Wk 15265, Wk 15266*, unpublished report

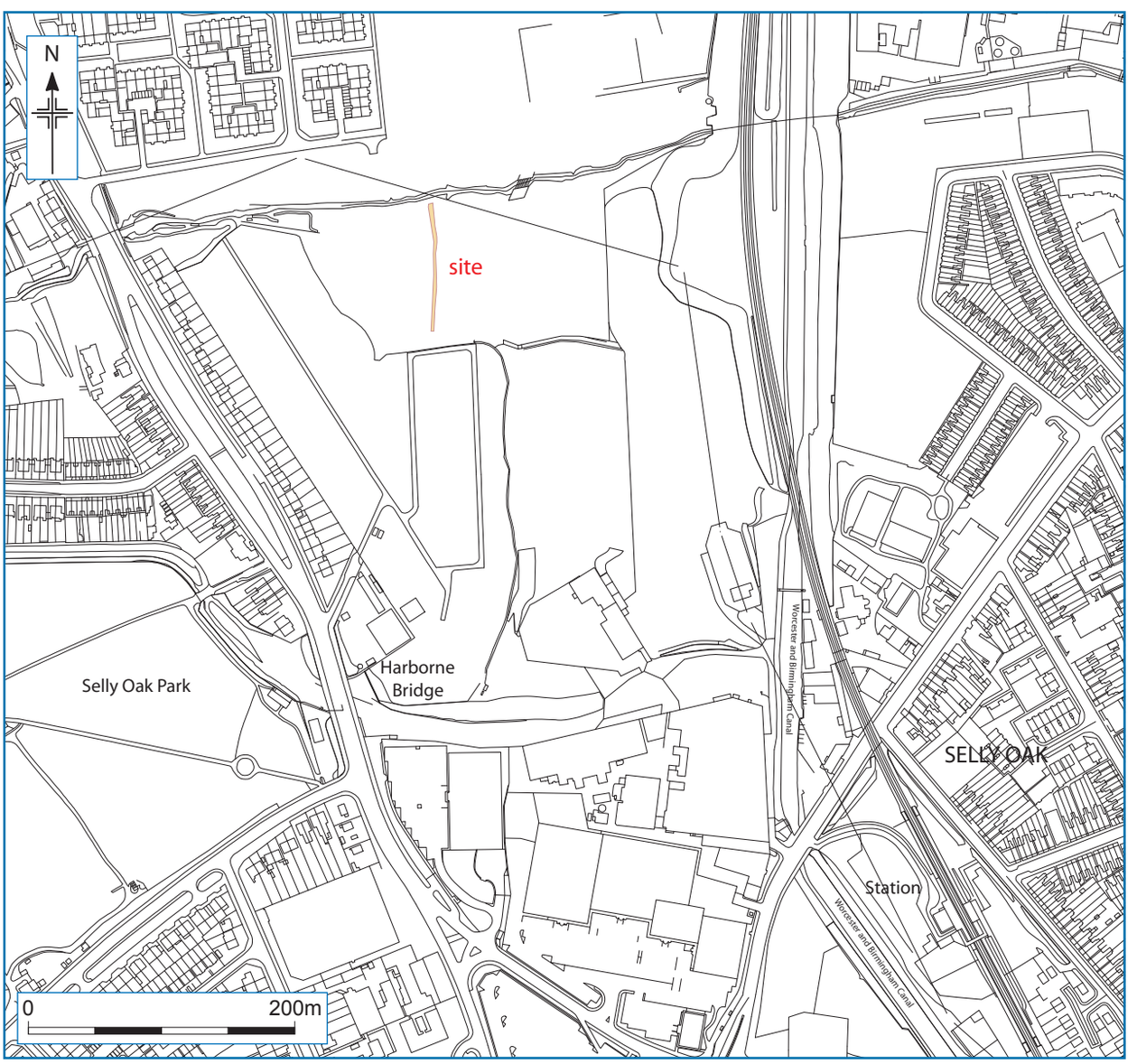
VCH III, Page, W (ed) 1913 *Victoria History of the County of Worcestershire* **III**

13. Abbreviations

BCC	Birmingham City Council
BSB	Break of slope to the base
BSMR	Numbers prefixed with "BSMR" are the primary numbers used by the Birmingham Sites and Monuments Record
BST	Break of slope from the top
CBM	Ceramic, brick and mortar
NMR	National Monuments Record.
SMR	Sites and Monuments Record.

Appendix 2: Sample Descriptions

Please refer to bound copy



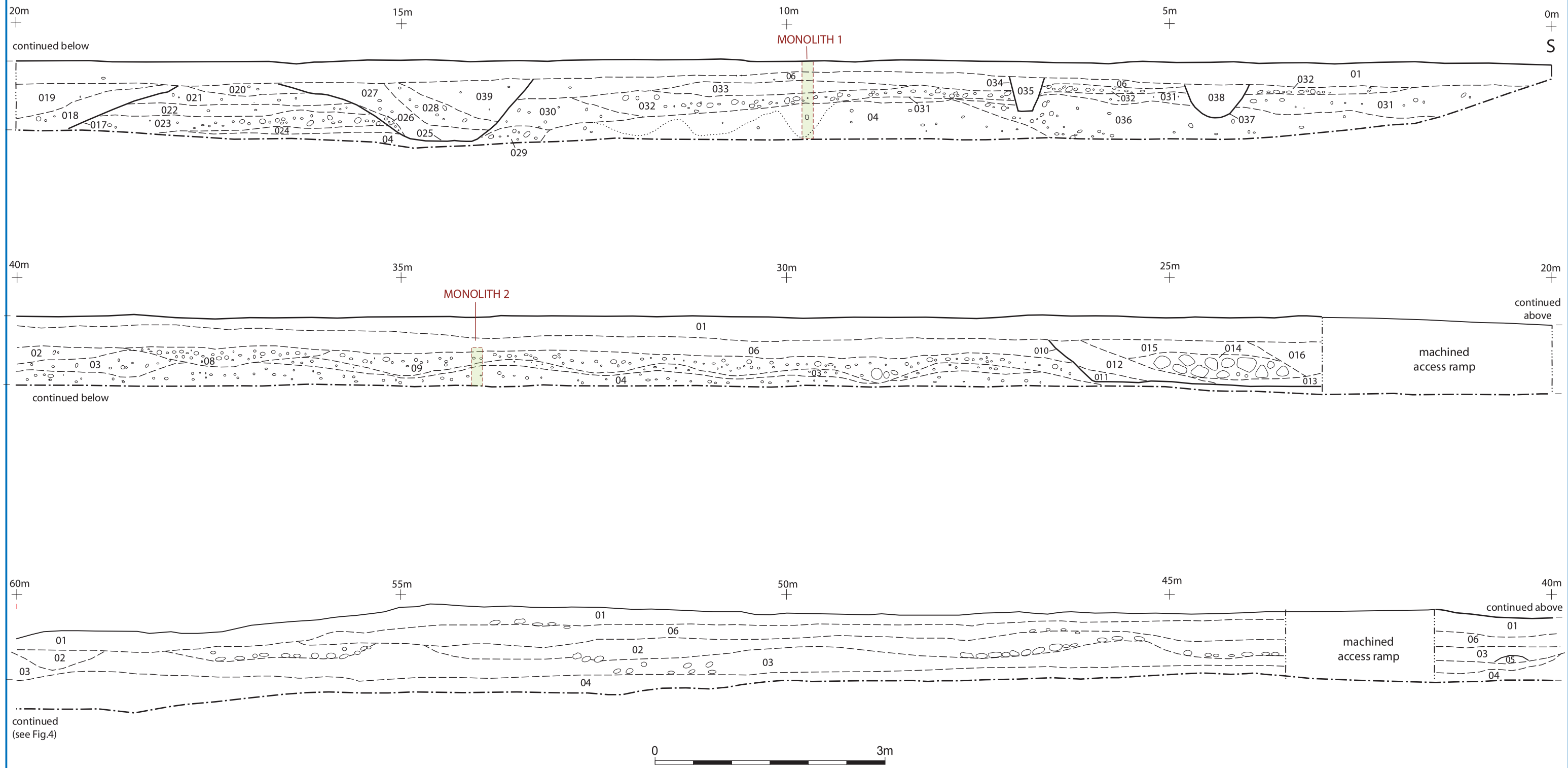
Location of the site. *Figure 1*

1:5000

Trench location plan.

Figure 2

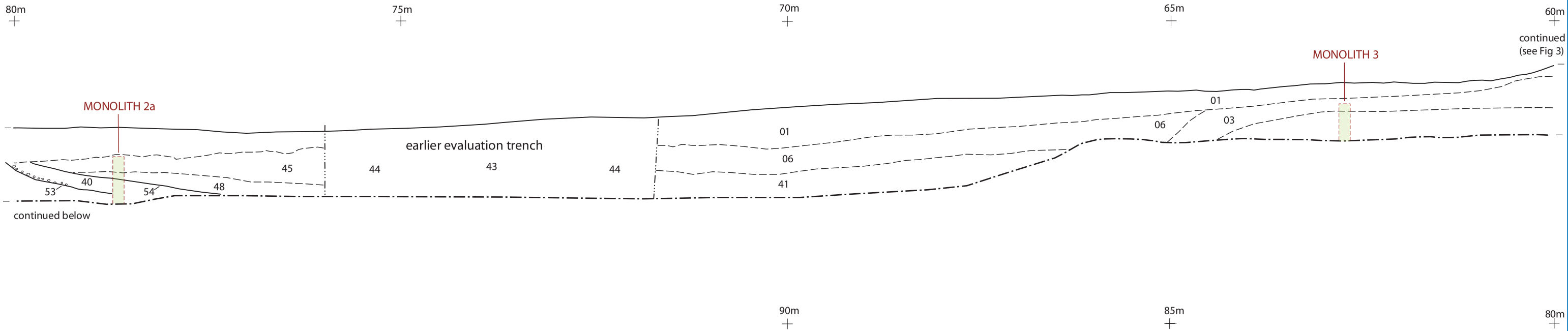
WEST-FACING SECTION



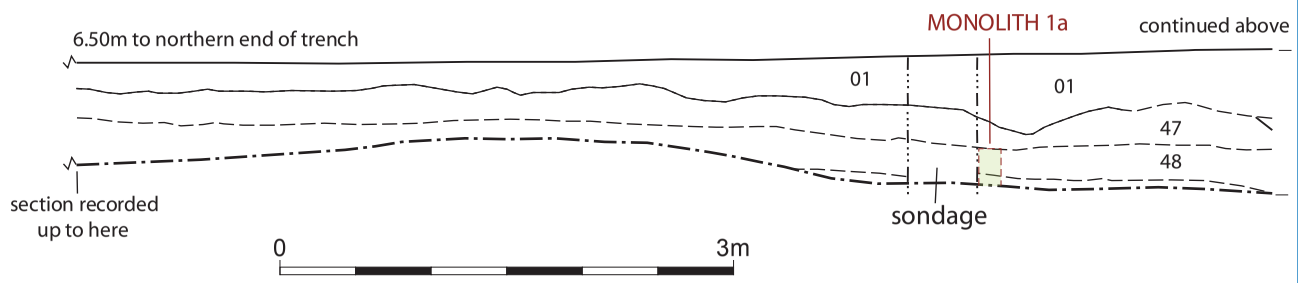
West-facing section.

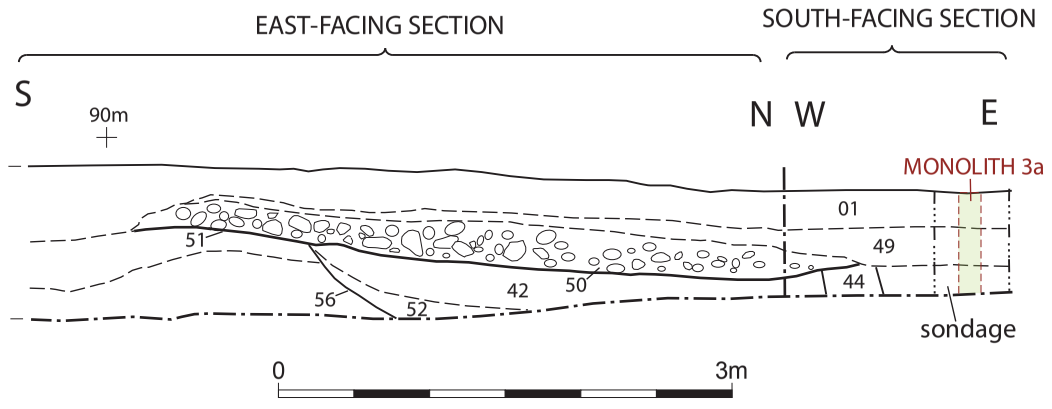
Figure 3

WEST-FACING SECTION



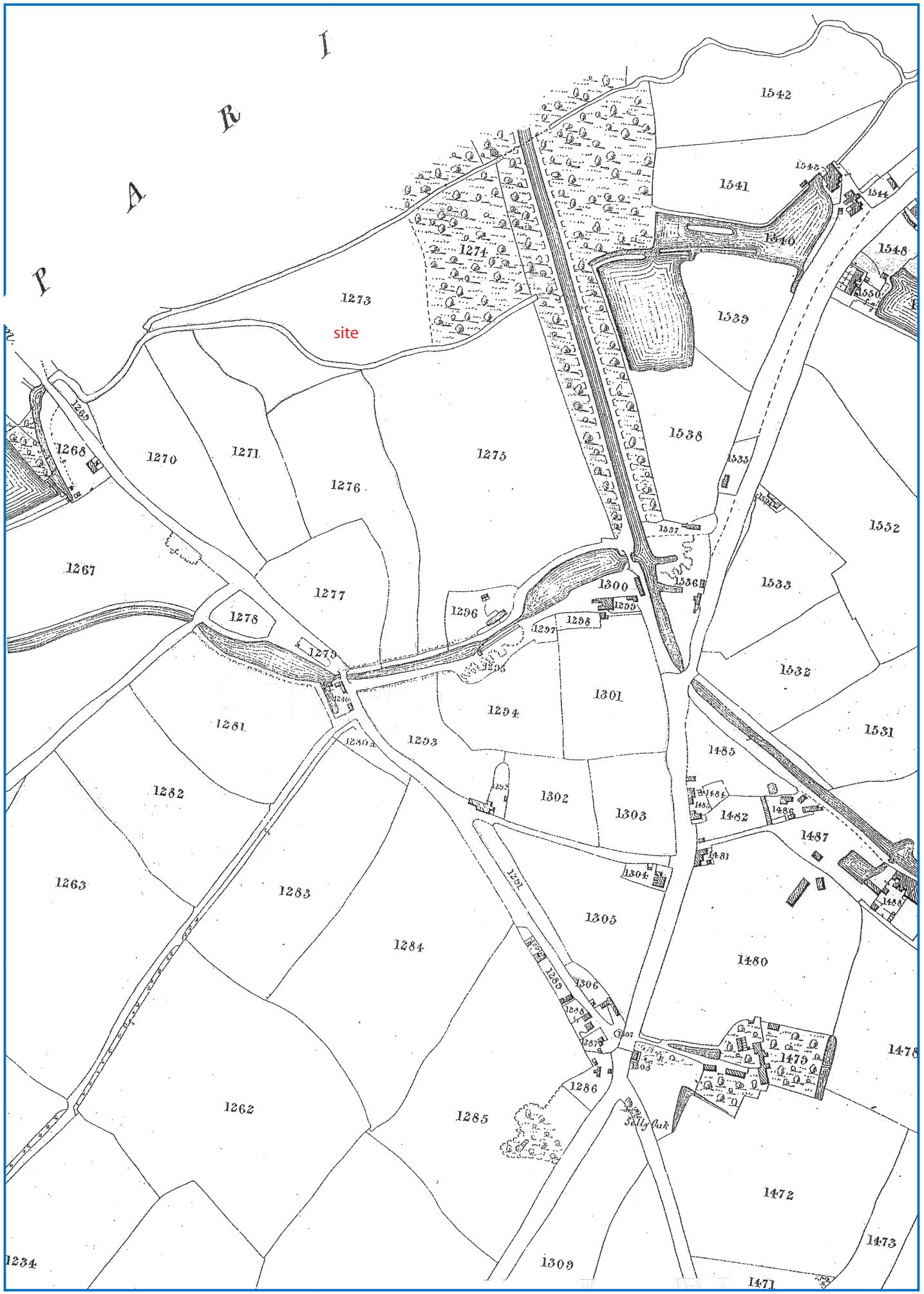
N



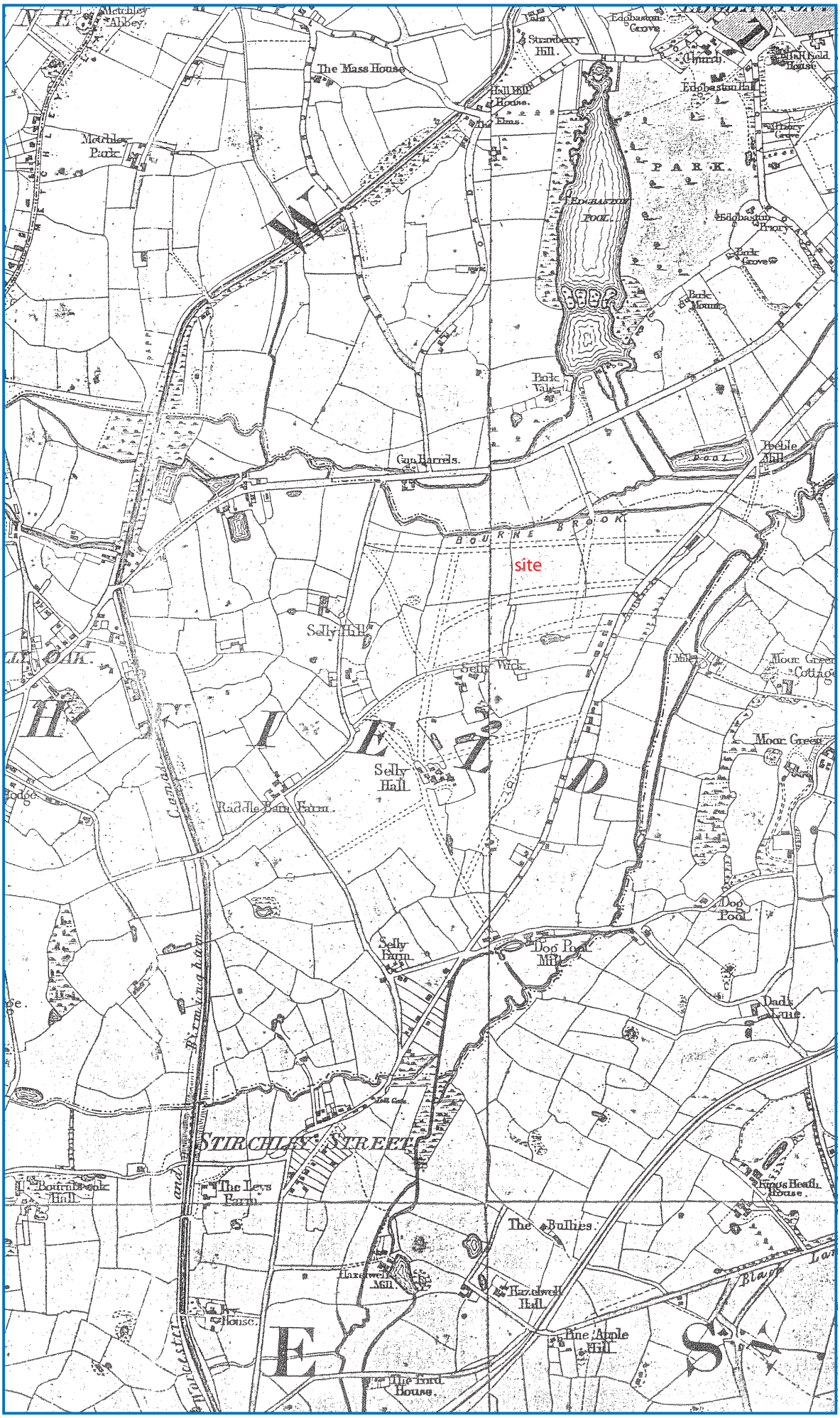


West-facing section, east-facing and south-facing sections.

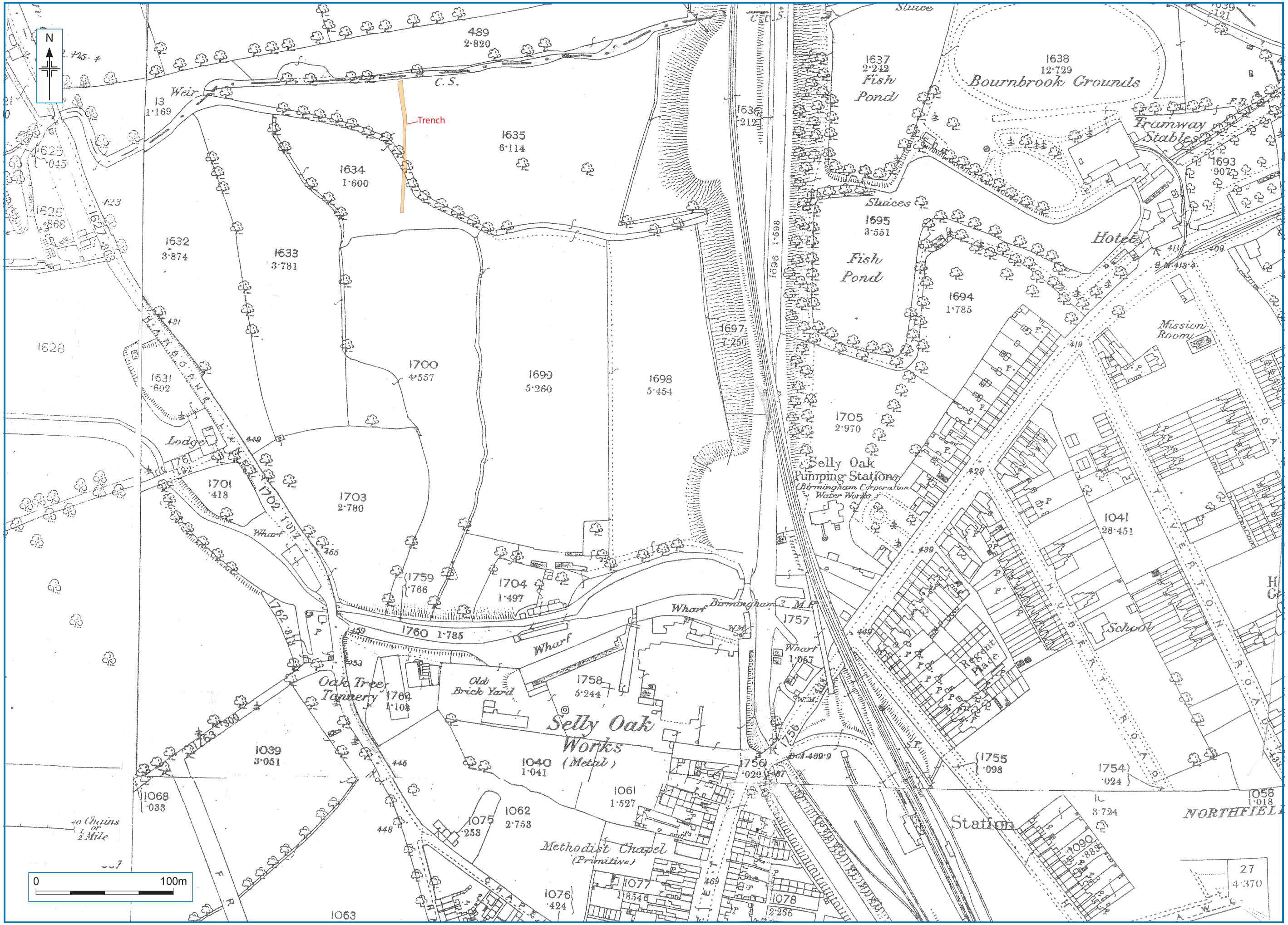
Figure 4



Extract from Northfield Tithe Map, 1840. *Figure 5*



Extract from Blood's map of Birmingham and environs (1857). *Figure 6*



Exstract from 1st edition Ordnance Survey map, 1884.

Figure 7

Exstract from Ordnance Survey map, 1916.

Figure 8

Plate 1: North end of trench

Plate 2: Monolith samples 1A and 2A in east section of trench

Plate 3: Section of stone-filled former watercourse

Plate 4: North section of trench showing earlier watercourse at base of section

Plate 5: North west corner of trench showing stone-filled former watercourse and area of sondage where environmental samples were taken, including monolith no. 3A

Appendix 1 Pollen tables and diagram

Fig 1: Percentage pollen diagram for Monolith 2a, Bourn Brook, Selly Oak, Birmingham

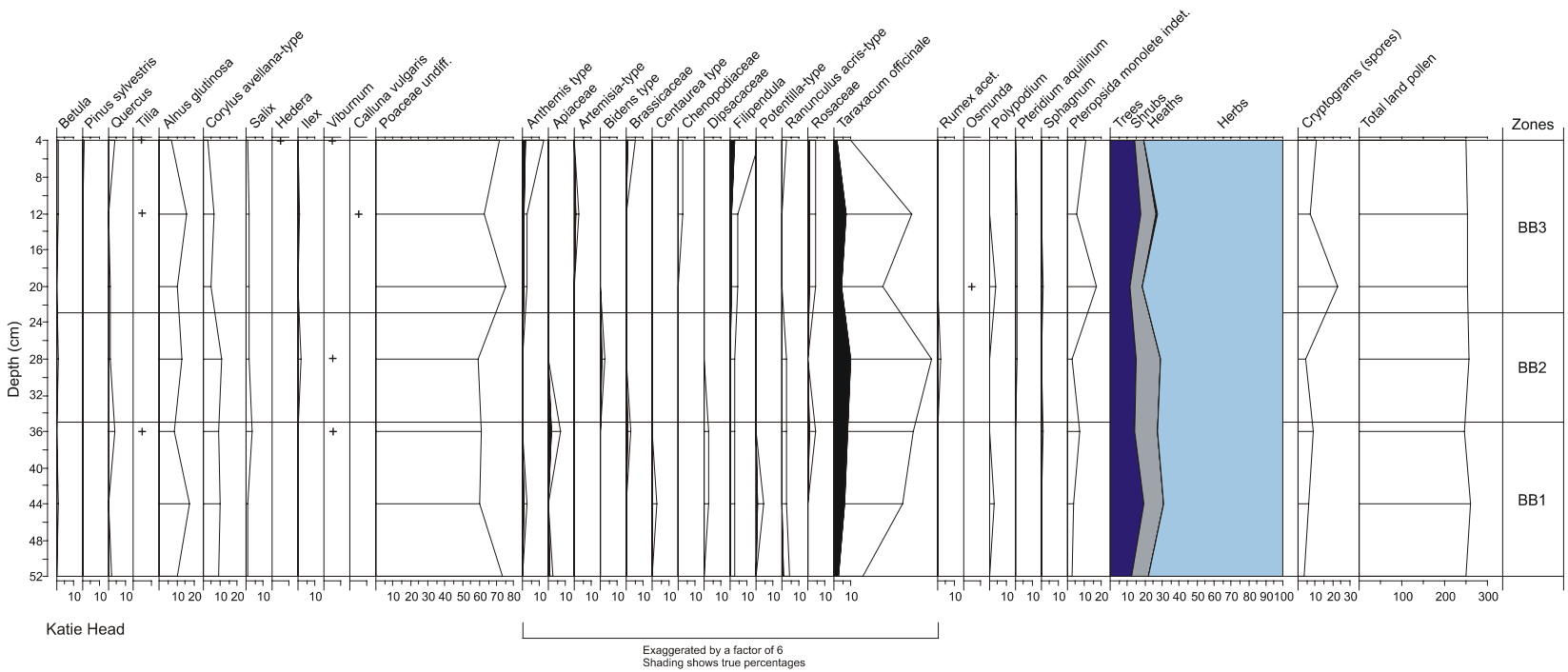


Table 3: Environmental summary for selected contexts (Key: occ = occasional; mod = moderate; abt = abundant)

Context	Sample	large mammal	mollusc	insect	charcoal	charred plant	waterlogged plant	other	Comment
042	3		occ	occ	occ	occ	occ	abt	unident veg; mod roots; occ woddy material; abt mineral matter
042	4	occ		occ	mod	occ	occ	abt	oots; occ twigs; mod woody material; abt mineral matter
042	5			occ	occ		occ	mod	roots; occ twigs; occ woody material; abt mineral matter
042	6				occ		occ	mod	roots; occ twigs; abt mineral matter
042	7			occ	occ			mod	roots; occ twigs; occ woody material; abt mineral matter
Monolith 1a	22-27cm				occ		occ	occ	wood frags,twigs,roots; mod unident veg;abt mineral matter

Table 4: Plant remains from selected contexts

Latin name	Family	Common name	Habitat	042 (sample 3)	042 (sample 4)	042 (sample 5)	042 (sample 6)	042 (sample 7)	Monolith 1a
Charred plant remains									
Gramineae sp indet grain	Gramineae	grass	AF	1					
unidentified berry	unidentified				1				
Waterlogged plant remains									
Silene sp	Caryophyllaceae	campion	CDE						2
Caryophyllaceae sp indet	Caryophyllaceae						1		
Chenopodium album	Chenopodiaceae	fat hen	AB				2		1
Rubus cf *idaeus*	Rosaceae	raspberry	CD		1	1			
Rubus idaeus/caesius/fruticosus	Rosaceae	raspberry/bramble etc	CD	3	1				
Rumex acetosa	Polygonaceae	common sorrel	CD	1	3	1			
Rumex cf *crispus/conglomeratus*	Polygonaceae	curled/sharp dock	ABCD	12					
Urtica dioica	Urticaceae	common nettle	CD		2				
cf *Schoenoplectus lacustris*	Cyperaceae	bulrush	E	1					
Gramineae sp indet grain (wa)	Gramineae	grass	ABCDE	2					
unidentified twig/bud fragments	unidentified				1	1	1	1	1
unidentified seed	unidentified				1	1			
unidentified root fragments	unidentified			2	3	2	2	2	1
unidentified wood	unidentified			1	2	1			1

fragments									
unidentified	unidentified			3					2

A = cultivated ground; B = disturbed ground; C = woodlands, hedgerows, scrub, etc; D = grasslands, meadows, heathland; E = aquatic/wet habitats; F = cultivar

Table 5: Pollen results from Monolith 1a

CONTEXT: Mono 1	**12cm**	**20cm**
Species counts		
Trees		
Betula	3	5
Pinus		1
Quercus	7	3
Tilia	3	2
Alnus	32	40
Shrubs		
Corylus	23	13
Salix	7	4
Hedera		1
Ilex		1
Viburnum		
Heaths		
Calluna vulgaris		
Vaccinium type		
Herbs		
Poaceae	164	158
Cyperaceae		2
Apiaceae		1
Anthemis type		2
Artemisia vulgaris		1
Bidens type	1	
Brassicaceae	1	1
Caltha type		
Caryophyllaceae		1
Chenopodiaceae		
Cirsium type		
Dipsacaceae		
Filipendula		1
Plantago lanceolata		
Plantago major/media		
Plantago type		
Polygonum	1	
Potentilla		
Ranunculus		
Rosaceae	1	3
Rumex acetosa	1	
Taraxacum officinale	12	9
Urtica dioica		
TOTAL LAND POLLEN	**256**	**249**
Spores		
Thelypteris palustris		1
Sphagnum	1	
Polypodium	4	5
Pteridium	3	2
Pterosida (mon) indet	13	14

Table 6: Pollen remains from Monolith 2a

CONTEXT: Mono 2	**4cm**	**12cm**	**20cm**	**28cm**	**36cm**	**44cm**	**52cm**
Species counts							
Trees							
Betula	4	4	1	4	2	3	1
Pinus	4					2	1
Quercus	9		4	3	10	2	5
Tilia	1	1			1		
Alnus	17	39	25	32	21	44	25
Shrubs							
Corylus	8	17	11	27	23	26	22
Salix	3	4	5	4	8	2	1
Hedera	2						
Ilex		3		4			1
Viburnum	1			1	2		
Heaths							
Calluna vulgaris		1					
Vaccinium type							
Herbs							
Poaceae	177	159	190	152	151	155	183
Cyperaceae							
Apiaceae					3		1
Anthemis type	5	1	1			1	
Artemisia vulgaris		1					
Bidens type				1			
Brassicaceae	2				1		
Caltha type							
Caryophyllaceae							
cf. *Centaurea*						1	
Chenopodiaceae	1	1					
Cirsium type							
Dipsacaceae					1	1	
Filipendula	7	2	2	1	1	1	1
Plantago lanceolata							
Plantago major/media							
Plantago type							
Polygonum							
Potentilla						2	
Ranunculus	1		2	1	1	1	2
Rosaceae	2	2			2		
Rumex acetosa				1			
Taraxacum officinale	4	19	12	24	19	17	7
TOTAL LAND POLLEN	**248**	**254**	**253**	**255**	**246**	**258**	**250**
Spores							
Osmunda			1				
Sphagnum			4	1	3		
Polypodium		1	9	1	1	7	1
Pteridium		2	2	2			
Pterosida (mon) indet	27	15	43	7	19	10	7

Table 7: Pollen remains from Monolith 3a

CONTEXT: Mono 3	**4cm**	**12cm**
Species counts		
Trees		
Betula	1	1
Pinus		1
Quercus	2	3
Tilia	1	3
Alnus	52	69
Shrubs		
Corylus	12	16
Salix	1	2
Hedera	1	3
Ilex		
Viburnum		1
Heaths		
Calluna vulgaris		
Vaccinium type		
Herbs		
Poaceae	170	144
Cyperaceae		
Apiaceae		
Anthemis type		
Artemisia vulgaris	1	
Bidens type		
Brassicaceae		1
Caltha type		
Caryophyllaceae		
Chenopodiaceae	1	
Cirsium type		
Dipsacaceae		
Filipendula	2	2
Plantago lanceolata	1	
Plantago major/media		
Plantago type		
Polygonum		
Potentilla		
Ranunculus		2
Rosaceae	1	
Rumex acetosa		
Taraxacum officinale	6	13
TOTAL LAND POLLEN	**252**	**261**
Spores		
Sphagnum		
Polypodium		2
Pteridium	4	
Pterosida (mon) indet	12	11

Appendix 2 Trench descriptions

Table 8

Trench 1

Site area: Bourn Brook

Maximum dimensions: Length: 88.50m Width: 2.0-2.5m Depth: 0.90-1.20m

Orientation: North-South

Main deposit description

Context	Classification	Description	Depth below ground surface (b.g.s) – top and bottom of deposits
1	Topsoil	Loose mid brown silty sand with occasional small and rounded stones	0.0-0.40m
2	Layer	Pale greenish grey clay with occasional charcoal flecks	0.32-0.55m
3	Layer	Pale greenish grey sandy clay with occasional patches of dark red staining. A large band of rounded stones concentrated in a band at the top of the layer	0.10-0.45m
4	Layer	Red and pale grey clay sand with occasional patches of dark red staining. Occasional small rounded stone inclusions, increasing in frequency towards base of deposit	0.20-0.80m
5	Small deposit existing within layer 3	Dark greyish brown sandy clay with occasional charcoal flecks and small rounded stones	0.50-0.60m
6	Layer	Reddish brown silty clay with occasional charcoal flecks	0.30-0.65m
7	Layer	Loose pale yellow sand mixed with pale grey sandy clay with dark red mottling	0.35-0.50m
8	Layer	Silty light grey green silty clay with moderate small and medium-sized rounded stones	0.40-0.60m
9	Layer	Mid to dark grey silty clay with moderate small and medium-sized rounded stones	0.45-0.75m
10	Cut of modern/post-medieval intrusion – pit containing large	BST-Gradual	0.30-0.85m

	amount of dumped industrial waste	Sides-Slightly convex BSB-Gradual Base-Flat	
11	Fill of pit cut 10 – primary fill	Dark grey silty clay with occasional charcoal flecks and small rounded stones	0.70-0.85m
12	Pit fill of pit cut 10	Mid brownish grey silty clay with occasional coal lumps	0.30-0.65m
13	Pit fill of pit cut 10	Dark grey silty clay	0.75-0.90m
14	Pit fill of pit cut 10	Mid grey silty clay. Abundant industrial waste inclusions in the form of large, irregular pieces of slag.	0.48-0.80m
15	Pit fill of pit cut 10	Mid pinkish brown sand	0.30-0.45m
16	Pit fill of pit cut 10	Mid grey brown clayey sand	0.35-0.80m
17	Cut of modern intrusion – possible pit	BST-Gradual Sides-Slightly convex BSB-Unknown Base-Unknown	0.30m-
18	Primary fill of pit 17	Mid pink brown sand with occasional flecks of charcoal and small rounded stone inclusions	0.60m-
19	Secondary fill of pit cut 17	Mid grey silty clay. Occasional CBM and small to medium-sized rounded stones	0.30-0.75m
20	Layer	Light yellowish grey sandy clay. Occasional CBM and small to medium-sized rounded stones	0.30-0.45m
21	Layer	Mid grey-brown silty clay with occasional small to medium-sized stone inclusions	0.30-0.55m
22	Layer	Light greyish-yellow silty clay with occasional small to medium-sized stones	0.55-0.70m
23	Layer	Light grey blue silty clay with moderate small to medium-sized stone inclusions	0.70-0.95m
24	Layer	Light grey silty sand with occasional small to medium-sized rounded stones	0.85-0.90m

		small to medium-sized rounded stones	
25	Cut of pit or ditch – pattern of fills suggests a series of silting episodes occurring from the north side of the ditch, indicating possible earthwork located there	BST-Gradual Sides-Convex BSB-Gradual Base-Flat	0.28-1.05m
26	Fill of 25 – small area of stony material on north side of feature	Mid grey silty clay with occasional small to medium-sized rounded stones	0.70-0.85m
27	Fill of 25	Mid brownish red silty clay with occasional charcoal flecks and small to medium-sized	0.30-0.70m
28	Fill of 25	Mid yellow sandy clay with occasional small to medium-sized rounded stones	0.30-0.50m
29	Layer, cut by pit/ditch 25	Light yellow grey silty clay with moderate stone inclusion (small to medium sized and rounded)	0.85m-
30	Layer, cut by pit/ditch 25	Mid yellow silty clay with occasional small to medium rounded stones	0.50-0.90m
31	Layer	Light grey silty sand with occasional rounded stones	0.35-0.70m
32	Layer	Light grey blue silty sand with moderate	0.40-0.70m
33	Layer	Mid grey silty sand	0.30-0.50m
34	Land drain – running east to west	BST-Sharp Sides-Straight BSB-Sharp Base-Flat	0.20-0.65m
35	Fill of drain 34	Mid red-brown silty clay with occasional charcoal and rounded stones	0.20-0.65m
36	Layer	Mid yellowy red silty clay with occasional rounded stone inclusions	0.50m-
37	Pit, filled by 38	BST-Sharp Sides-Concave BSB-Imperceptible	0.28-0.70m

		Base-Concave	
38	Fill of 37	Dark brown red silty clay with moderate CBM inclusions and occasional rounded stones.	0.28-0.70m
39	Fill of ditch/pit 25	Mid brown red silty clay. Last fill of feature 25	0.25-0.80m
40	Primary fill of possible leat watercourse	Soft mid brownish grey sandy silt with occasional small sub-rounded stones mainly linig the base of the deposit	0.70-1.0m
41	Layer		0.85m-
42	Fill of old Bourn Brook palaeochannel	Soft brownish grey sandy silt. Moderate small to large tree roots growing through it	0.60m-
43	Mixed backfill of old evaluation trench 44	Mixed clay and silt material along with clumps of grass and pieces of pasty wrapper etc	0.0m-
44	Edge of former evaluation trench		0.0m-
45	Fill of possible re-cut of leat watercourse	Soft light reddish brown silty clay	0.25-0.65m
46	Fill of possible re-cut of leat watercourse – primary fill of re-cut	Soft light greyish brown silty sand	0.60-0.80m
47	Layer	Soft mid reddish brown silty sand	0.35-0.60m
48	Layer	Soft mid reddish brown silty sand	0.60-0.85m
49	Layer, overlies stone dump 50	Layer of red brown sand at north end of trench	0.25-0.50m
50	Layer/fill – probable dump of large stones along the former course of the Bourn Brook palaeochannel	Layer of abundant medium and large rounded stones (like cobbles) dumped along the course of the palaeochannel. Stones are set in a matrix of soft dark blackish grey clay silt with occasional charcoal flecks	0.30-0.60m
51	Possible cut for stone dump 50		0.30-0.60m
52	Primary fill of palaeochannel 56 adjacent to Bourn Brook	Soft light orangey brown silty sand	0.50m-
53	Original cut for possible man-made leat	BST-Unknown (probably truncated by ploughing)	0.40m-

	watercourse, filled by 40	ploughing) Sides-Irregular BSB-Unknown Base-Unknown	
54	Re-cut of leat, filled by 45 and 46	BST-Unknown (probably truncated by ploughing) Sides-Concave BSB-Unknown Base-Unknown	0.40m-
55	Layer	Soft mid brownish grey silty sand	0.80m-
56	Former palaeochannel	BST-Gradual Sides-Concave BSB-Unknown Base-Unknown	0.50m-

Appendix 3 Terra Nova report

TERRA NOVA

The Geoarchaeology of Deposits at Selly Oak, Birmingham

23 July 2004

Terra Nova Ltd.
Llwynfedwen, Libanus, Brecon, LD3 8NN, Great Britain
Tel/fax 01874 636345 Mobile 0797 11 66 380
E-mail: terra@celtic.co.uk

The Geoarchaeology of Deposits at Selly Oak, Birmingham

23 July 2004

Summary

A geoarchaeological study was carried out in order to clarify the origin of deposits at Selly Oak, Birmingham. The site lies in shallow river valley through which the course of the Bourn Brook now runs, adjacent to the former premises of the Birmingham Battery and Metal Company. The deposits consisted of Devensian sands and gravels overlain by fluvial glacial sediments, which in turn were overlain by modern archaeological deposits and topsoil.

Terra Nova

Llwynfedwen, Libanus, Brecon, LD3 8NN, Great Britain
Tel/fax 01874 636345 Mobile 0797 11 66 380
e-mail: terra@celtic.co.uk

Table of Contents

Text

Aims 1
Scope of Report 1
Background 2
Method 4
Observations 5
Discussion 8
Conclusions 9
Further Study 10
Bibliography 11

Appendices

Appendix 1: The Meaning of Magnetic Susceptibility xii
Appendix 2: Sample Descriptions xiii

Aims

This report aimed to evaluate the geoarchaeology of a site at Selly Oak, Birmingham in order to clarify the origins of the deposits and help assess the archaeological potential of the site.

Scope of Report

This report is the result of the laboratory examination and analysis of 6 monoliths taken from the site at Selly Oak, Birmingham. The records are necessarily brief and only a small amount of preliminary analysis has been carried out in the laboratory in order to identify the potential of the deposits and construct a provisional geoarchaeological interpretation.

Background

Location

The site is located at NGR SP 0420 8300 just to the north of the junction between the A4040 and the A38.

Geology

The bedrock in the area of the site consists of Triassic Mercia Mudstone and Sherwood Sandstone (B.G.S. 1980).

Topography

The site lies in an area of land at about 130m OD that slopes gently towards the Bourn Brook to the north.

Land Use

The site lies in an area adjacent to the former premises of the Birmingham Battery and Metal company.

Soils

The site is shown on the "Soil Survey of England and Wales, *sheet 3 Midland and Western England*, 1:250,000" map as unsurveyed, mainly urban and industrial. The soils examined most closely resemble typical stagnogley soils of the Brockhurst 1 association (711b) and stagnogleyic argillic brown earths of the Hodnet association (572c). Stagnogley soils occur widely in the lowlands in Pleistocene deposits. The topsoils can be sandy, loamy or clayey. B horizons may be finer in texture and some have a slowly permeable argillic B (Btg) horizon that contains more clay than those above or below. Argillic brown earths are brown soils with an ordinary argillic B horizon and no sandy or sandy-skeletal layer more than 40cm thick within the upper 80cm. Parent material include late Pleistocene (Devensian) deposits such as loess, till and head and older pervious deposits exposed by erosion during the same period.

Hydrogeology and Hydrology

The site lies on a gently sloping gravel terrace that forms the south side of the valley of the Bourn Brook.

Method

The samples taken for analysis consisted of three monoliths collected in plastic guttering on the day of a site visit, and three monoliths collected later by the excavating archaeologists. Monolith 1 was 90 cm in length and came from the east face of the higher southern end of trench and covered deposits from the ground surface down to the bottom of the trench. Monolith 2 was 50cm in length and came from a point halfway along the east face of the trench. The top of monolith 2 was about 50cm below the ground surface and was positioned to sample the sediments from the sand and gravel base of the trench to just below the layers of modern archaeology. Monolith 3 was 50cm in length and came from the northern end of the trench just above the northern limit of the gravel terrace and covered deposits from near the base of the trench to the bottom of the layers of modern archaeology. Of the three monoliths collected by the excavating archaeologists monolith 1a was 24cm in length and taken from an east facing section at the lower northern end of the trench in the area of a broad palaeochannel. Monolith 2a was 55cm in length, and taken about 6m to the south of monolith 1a from the east facing section in the area of channel deposits believed to belong to a known medieval leat. Monolith 3a was 28cm in length and taken from the west facing section at the northern end of the trench in the area of a palaeochannel close to the Bourn Brook.

Magnetic susceptibility readings were taken every 5cm up the sequence using a Bartington MS2 meter and type F field coil. Sediment descriptions were logged on modified recording sheets after Hodgson (1976).

Observations

The deposits observed within the monoliths consisted of mainly sandy clays over Devensian sands and gravels. The application of 1M HCl to these deposits mainly produced no audible or visible effervescence indicating that they were not calcareous.

Monolith 1

From 0 to 15cm in depth the deposit, context 01 was a medium dark brown sandy clay loam well mixed and rich in archaeological material including ceramics and charcoal. Magnetic susceptibility readings were high ranging from 13 – 55 SI. The lower boundary of this unit was clear to gradual suggesting that this was not a naturally formed top soil since this would normally have had a more diffuse lower boundary.

From 15 to 55cm in depth the deposits (06, 032, 033) consisted of a light to medium grey sandy clay loam which had orange mottles indicating persistent waterlogging. There was no visible structure and there appeared to be no archaeological material. Magnetic susceptibility readings were low ranging from 3 – 10 SI and are consistent with natural background values.

From 55 to 90cm in depth the deposits (04) were a light red brown sand with a few organic root remains. There was some orange mottling, and a purplish tinge to the red brown colour of the deposits is probably the effect of haematite derived from the Triassic bedrock. Magnetic susceptibility readings were all low ranging from 2 – 3 SI.

Monolith 2

From 0 to 8cm in depth the deposits (09) consisted of a dark brown silty loam containing organic root remains. Magnetic susceptibility readings were low ranging from 4 – 7 SI and are consistent with natural background values and the deposit contained no archaeological material. However this unit had a clear lower boundary suggesting that it had not formed completely as a result of natural processes.

From 8 – 20cm in depth the deposits (03) consisted of a medium grey sandy clay loam containing some organic root matter. There was some orange mottling indicating persistent waterlogging. Magnetic susceptibility readings were low ranging from 3 – 4 SI and were consistent with natural background values.

From 20 – 45cm in depth the deposits (04) consisted of a medium grey brown sandy clay with a few organic root remains over a sandy gravel. There was some orange mottling and magnetic susceptibility readings were all low and ranging from 2 – 4 SI.

Monolith 3

From 0 to 5cm the deposits (01) were a medium brown loamy sand well mixed and rich in archaeological material including ceramics and charcoal. Magnetic susceptibility readings were high and ranging from 16 – 65 SI. Their was a clear lower boundary to this unit suggesting that this part of the profile was not a naturally formed top soil since this would normally have had a more diffuse lower boundary.

From 5 to 40cm the deposits (06, 02, 03) consisted of a medium grey sandy clay loam containing organic remains of roots and large cobbles at 20 to 25cm. There was orange mottling and magnetic susceptibility readings were low ranging from 3 – 5 SI.

From 40 to 50cm in depth the deposits (04) consisted of light to medium red brown sand. There was some orange mottling, and a purplish tinge to the red brown colour of the deposits is probably the effect of haematite derived from the Triassic bedrock. Magnetic susceptibility readings were low ranging from 3 – 5 SI.

Monolith 1a

From 0 to 10cm in depth the deposits (48) consisted of a light brown sandy clay loam, there was some orange mottling and evidence of the movement of material from above down root channels. Magnetic susceptibility readings were low ranging from 1 – 3 SI.

From 10 to 24cm in depth the deposits (48) consisted of a medium brown sandy clay loam which became loamy sand at the base, and contained humified organic patches and roots. Magnetic susceptibility readings were very low ranging from 0 – 1 SI.

Monolith 2a

From 0 to 12cm in depth the deposits (45) consisted of a light to medium brown sandy clay loam with some movement of darker material down cracks from above. Magnetic susceptibility readings were fairly low ranging from 2 – 14 SI with the higher values at the top of the unit as a result of the downward movement of material from the topsoil above.

From 12 to 22cm in depth the deposits (46) consisted of a light brown sandy clay loam, and magnetic susceptibility readings were low ranging between 2 – 4 SI.

From 22 to 55cm in depth the deposits (40) consisted of a light to medium brown sandy loam. There was some orange mottling towards the top of this unit indicating persistent waterlogging and the deposit contained a few fragments of charcoal. Magnetic susceptibility readings were fairly low ranging from 3 – 12 SI, the higher values relating to the part of the deposit that contained more orange mottling and fragments of charcoal, suggesting archaeological contamination.

Monolith 3a

From 0 to 20cm in depth the deposit (42) consisted of a dark grey sandy clay loam. There was a slight organic content with orange mottling along root channels. Magnetic susceptibility readings were low with values ranging from 5 - 8 SI.

From 20 to 28cm in depth the deposit (42) consisted of a medium brown sand and gravel with low magnetic susceptibility readings, values ranged from 3 – 6 SI.

Discussion

The samples examined from the monoliths represented a sequence of both natural and archaeological deposits. The bedrock is overlain by Devensian sands and gravels overlain by fluvial glacial deposits, which in turn were overlain by modern archaeological deposits. The monoliths represent a section of deposits that cover the bottom and south side of the valley.

The bedrock in the area of the site consists of Triassic Mercia Mudstone and Sherwood Sandstone and is overlain by deposits of sands and gravels laid down at the periphery of the maximum extent of the ice sheet during the Devensian glaciation. The trench runs north to south across the floodplain on the south side of a river valley in which the course of the Bourn Brook now runs. The sandy nature of the deposits together with layers containing larger rounded cobbles indicate that much of these deposits were laid down in a high energy environment during the Devensian or early Holocene. No archaeological evidence, such as artefact fragments, changes in stratigraphy or magnetic susceptibility readings were found within the deposits. The appearance of bedrock haematite in the samples may indicate a change in the landuse both here and upstream, such as increased erosion of the lower catchment after this part of the valley was cleared of trees.

Over much of the site these high energy fluvial deposits are overlain by a modern topsoil containing large amounts of archaeological and industrial debris. The modern topsoil (01) lies directly over the Devensian and early Holocene deposits, this fairly sharp boundary between the two without any significant subsoils is probably the result of human activity such as deep ploughing. In monolith 2a there was indications of pedogenesis and the movement of darker material rich in archaeological debris down cracks formed by roots and wetting and drying.

Monoliths 1a to 3a were all taken at the lower northern end of the trench through channel deposits interpreted as palaeochannels and a possible medieval leat. Only monolith 2a (45, 46, 40) which was taken through the possible medieval leat contained any charcoal, which is probably the result of reworking and redeposition of deposits from further upstream. The palaeochannels are most likely former courses of the Bourn Brook and some re-cutting and reuse of the palaeochannels is likely to have occurred in antiquity.

Conclusions

The sequence of deposits observed in the monoliths appear to be Devensian silty sands and early Holocene sands and gravels within which are incorporated bands of rounded cobbles which would have been laid down in a high energy environment. Above these sands and gravels a thin soil developed which due to agricultural practices such as deep ploughing followed by more recent industrial development in the area has resulted in a topsoil rich in archaeological and industrial debris above a fairly sharp boundary with the underlying sediments.

Evidence of palaeochannels that are probably former courses of the Bourn Brook together with re-cut channels are located within the floodplain sediments. In the sediments underlying the topsoil no artefacts were found and any fragments of charcoal were usually associated with channels near the valley bottom or were found in ditches cut through the sediments underlying the topsoil. These fragments of charcoal probably represent the reworking and redeposition of sediments further up the valley. There has been a considerable amount of reworking of the sediments therefore evidence survives only poorly.

The site at Selly Oak represents a shallow river valley, over a bedrock not seen in the samples of Triassic Mercia Mudstone and Sherwood Sandstone overlain by Devensian sands and early Holocene sands and gravels. The sands and gravels form a sloping terrace that runs down to the flood plain of the Bourn Brook. Much of the sands and gravels were laid down in a high energy environment that the Bourn Brook in its present state would not have been capable of. The size of some of the cobbles observed in section indicate deposition in a fluvioglacial environment. The evidence of haematite derived from the Triassic bedrock and the layering of the sediments seen as changes in proportions of sand to gravel may indicate increased erosion as a result of clearance or climatic change.

Further Study

Due to the amount of reworking of the sediments and the poor survival of evidence it is felt that no further study would be worthwhile.

Bibliography

British Geological Survey, *East Midlands Sheet Solid Edition, 1:250,000 Series.*

Hodgson, J.M. (1976) *Soil Survey Field Handbook.* The Soil Survey of England and Wales. Harpenden.

Soil Survey of England and Wales, *Sheet 3 Midland and Western England, 1:250,000.*

Appendix 1: The Meaning of Magnetic Susceptibility

Magnetic susceptibility (χ) is a measure of the degree to which a material will become magnetised in the presence of an external magnetic field. The magnetic susceptibility of many natural soils increases slightly towards the surface. This is the Le Borgne effect (Le Borgne, 1955) and is probably caused by slight changes in magnetic mineralogy caused by the greater availability of oxygen at the surface.

Burnt soil material, domestic debris and ceramics typically have high magnetic susceptibilities. Ferrous metals have susceptibilities which are even higher. The degree to which an archaeological or natural deposit is contaminated with these materials can be determined by measuring its susceptibility, either in the field, using a small, portable detector, or under more controlled conditions in the laboratory.

Laboratory instruments also allow us to calculate the frequency dependence (fd) of the susceptibility. This is a measure of the percentage difference between the susceptibility of a sample to magnetic fields which are alternated at two different frequencies, 0.465 and 4.65 KHz – known as low frequency (lf) and high frequency (hf). respectively. Samples containing magnetic minerals of different types show different χ_{fd} values – although the interpretation of these differences is, as yet, a matter of debate. It is thought that very fine magnetic particles, derived from burning and soil formation, alter the magnetic susceptibility of samples in a way which alters with the frequency of the inducing field.

Simple studies of the relationship between particle size, particle type and susceptibility can often help us to understand how the magnetic properties of archaeological deposits arise. Such studies are easily achieved during excavation projects and may prove a valuable part of future excavation practice, especially on urban sites.

The use of magnetic susceptibility measurements is discussed in Walden, J., Oldfield, F., and Smith, J. (1999) *Environmental magnetism: a practical guide*. Quaternary Research Association, technical guide no. 6, London, pp.243.

Le Borgne, E. (1955) *Susceptibilite magnetique anormale du sol superficial.* Annales de Geophysique, **11**, 399-419.