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Archaeological Borehole Investigations at
Castle Mills Car Park, Piccadilly, York

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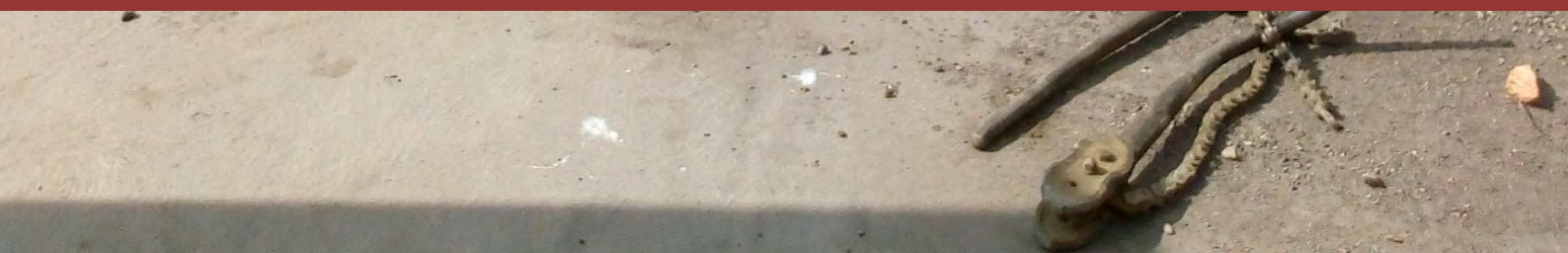
Report 2018/105 April 2019



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Abbreviations

AOD – Above Ordnance Datum

BGL – Below Ground Level

CBM – Ceramic Building Material

YAT – York Archaeological Trust

PGL – Present Ground Level

NON-TECHNICAL SUMMARY

Between the 23rd July and the 25th July 2018 York Archaeological Trust conducted an evaluation comprising monitoring and logging of boreholes at Castle Mills Car Park, Piccadilly, York (SE 60652 51415). The work was undertaken for City of York Council to meet requirements laid out in planning consent agreed by City of York Council (17/01499/FUL). The work was based on a Written Scheme of Investigation produced by YAT (Appendix 9). The works involved a programme of four boreholes and the installation of three instrumented water monitoring points and one instrumented water quality sensor that were observed over a seven month period.

This report compiles the results of the seven months of water quality monitoring previously summarised in two interim reports on the Site Investigation (SI) works and the three-month interim hydrology report, and represents the final report on the programme of borehole survey, water quality and hydrology monitoring outlined in the Written Scheme of Investigation (WSI).

KEY PROJECT INFORMATION

Project Name	Castle Mills Car Park, Piccadilly, York
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3	CJ/MS/AJ	24/04/19	AJ	24/04/19	IDM	24/04/19

1 INTRODUCTION

Between the 23rd July and the 25th July 2018 YAT conducted an evaluation comprising monitoring and logging of boreholes at Castle Mills Car Park, Piccadilly, York (SE 60652 51415) (Figure 1).

The work was undertaken for City of York Council to meet requirements laid out in planning consent agreed by City of York Council (17/01499/FUL). The work was based on a WSI produced by YAT. The works involved the excavation and recording of four lightweight windowless dynamic rig drilled boreholes, designated as water monitoring points, using data gathering as part of a six month monitoring programme for analysis of water quality and hydrology.

The aim of the borehole survey was to characterise the hydrology and soil conditions of the site and to provide a baseline model for comparison with further monitoring points that will be installed and monitored during and after the forthcoming redevelopment of the site. This will create a data set that will aid in understanding the impact of piled developments on waterlogged soil horizons.

This report details the archaeological deposition data gathered from the borehole logs, the two previous interim reports and the full seven month scheme of water monitoring.

2 METHODOLOGY

The methodology followed the WSI (Appendix 9).

A total of four windowless sample boreholes were excavated (Figure 2):

No.	Easting	Northing	AOD height (m) PGL
1	460660.45	451450.01	9.29
2	460648.12	451430.77	9.33
3	460649.98	451430.43	9.32
4	460642.60	451408.13	9.32

The positioning of the boreholes has been designed for optimal coverage across the site, and to reduce risk of damage during construction. The locations of the boreholes were plotted by GPS to an accuracy of no less than 100mm.

Prior to the commencement of drilling, WS01 was initiated with a hand dug starter pit excavated to a depth of 1m to mitigate the presence of unexpected services and other obstacles close to the surface. For three of the boreholes the concrete ground surface had to be cut to a depth of around 0.15m with a concrete cutter, making the excavation of the starter impractical.

The windowless sample boreholes were notionally excavated to a depth of 10m BGL, however this was curtailed in WS01 when the top of undisturbed natural deposits were reached at 8m BGL, and in WS02 when an obstruction at 8m BGL halted excavations. Plastic sleeves containing the drilled out cores, measuring 1m in length and 8” to 6” in width, were opened

on site. The cores were subsequently cleaned, digitally photographed with an appropriate scale, and recorded by the onsite archaeologist. Changes in the strata of the archaeological deposition were described and their depths recorded on pro forma record sheets following the standard YAT single context methodology and were related to the Ordnance Datum.

A total of eight environmental samples for General Biological Analysis (GBA) were collected from boreholes WS01, WS03 and WS04 when deposits which contained potential organic material were encountered. Three sealed samples were also taken for triaxial analysis from boreholes WS01, WS03 and WS04. No samples were taken from WS02 as the deposits smelled strongly of hydro carbons and it was believed that some contamination was present. The aroma of hydro carbons was also present in boreholes WS01 and WS03; however samples were able to be taken far enough below to avoid potential contamination. The depths of samples taken were recorded on standardised pro forma sheets, as well as the presence, depth and description of each deposit. The results of the sample analysis are discussed in Appendix 8.

3 LOCATION, GEOLOGY & TOPOGRAPHY

The site covered approximately 2,675m^2 and was located at Castle Mills, Piccadilly, York. The site was formerly occupied by Castle Mills car park, a single storey brick building. Prior to the evaluation this building was demolished to ground level, with the concrete floors and wall foundations still extant. The site was bounded to the west by the River Foss, to the east by Piccadilly and to the south and north by the Postern Gate Travelodge and Ryedale House respectively.

The underlying geology of the site is sandstone of the Sherwood Sandstone Group with superficial deposits of alluvial silt, clay, sand and gravel (www.bgs.ac.uk). The present ground level is relatively flat at around 9.30m AOD. Archaeological investigation has shown that natural glacial deposits slope down toward the River Foss from a ridge of high ground on Piccadilly.

4 ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

The Piccadilly area has been subject to numerous archaeological interventions since the 1980s. The following overview of the current archaeological knowledge of the site and surrounding area has been taken from the WSI (YAT 2018) and from YAT report 2018/56 (Jackson 2018).

The topography and regime of the River Foss

The importance of York's waterfronts and their potential to provide information about areas of the city once the focus for trade and commerce has long been recognised. The work of York Archaeological Trust since 1972 has shown that excavation of waterfront sites can reveal evidence for 'the economic basis of the city's life throughout its history' (Addyman et al 1988, 1). During the extensive 1981-2 watching brief on the area now occupied by the Coppergate Centre on the west bank of the River Foss the ancient course of the river was found along with revetments, installations, ship fragments, and traces of the water defences of York Castle. Further excavations at the site of the former ABD Cinema, 22 Piccadilly, defined an earlier river channel and associated 11th century riverside revetments (Addyman et al 1988, 8).

The Castle Mills site is situated on ground at the confluence of the Rivers Ouse and Foss close to the point where these rivers penetrate the York Morraine. This historic fluvial morphology of the lower River Foss is not well understood. What little information there is comes from borehole records and excavations carried out along the south-west side of Piccadilly, Coppergate and more recently the Hungate area; all of which demonstrate a complex landscape morphology which is the product of both natural geological processes and large-scale alterations caused by human agency throughout historic periods.

Evidence from the Piccadilly areas, largely derived from small-scale keyhole excavations carried out by YAT in the early 1990's, has provided valuable evidence about the topographical development of the River Foss and its waterfront areas. Archaeological evidence from around the proposal site shows that the ground level on the eastern Foss bank has been increased since the Roman period through land reclamation. At 50 Piccadilly, approximately 65m north of the proposal site, natural was identified at 1.20m AOD and a borehole watching brief at 38 Piccadilly identified natural at approximately 9m BGL – a depth of approximately 1.65m AOD. A borehole survey conducted on the proposal site in 1992 identified natural at around 2.40m AOD.

Roman period

The archaeological evidence for Roman activity in the area to the south-east of the River Foss is relatively sparse compared to that of the fortress area, 485m to the north-west of the proposed development site; however the area does seem to have been utilised throughout the Roman period (McComish 2007).

Evidence for Roman use of the Foss as a navigation comes from 1951-52 excavations for the construction of the Telephone Exchange building in Garden Place, Hungate, where walls and piles interpreted as a Roman wharf and the buried former course of the river were discovered (RCHMY I, 64). In the Piccadilly area, evidence for riverbank activity on the east bank of the Foss comes from excavations at numbers 38, 40 and 50 Piccadilly. A line of stone pillars beneath the Tax Offices on Piccadilly was interpreted as possible evidence for a Roman riverside jetty (Ottaway 1993, 69), whilst excavations at 38 and 50 Piccadilly suggest there was significant occupation and river front land use during the late 2nd-3rd centuries in the vicinity of the site, comprising evidence for management of riverside, dumped occupation material and evidence of possible industrial activity. Evidence of structural activity at 41 Piccadilly (YAT 1992b) in the form of post-pads, post-holes, a pebble floor surface, gullies and pits indicates the possibility of late 4th century and 5th century occupation along this section of the river.

A series of Roman dump deposits were recorded at 41 Piccadilly (YAT 1992b), the earliest of which was recorded at 7.41m AOD. At 50 Piccadilly (YAT 1992c) deposits dating to between the late 2nd century and 3rd century were encountered, raising the ground level to around 4.5m AOD. The deposits were shown to have been dumped close to the river edge, with the tip lines running from east to west. The raising of the ground surface was subsequently consolidated by a cobble surface, which was later sealed by an organic build-up. Roman deposits containing preserved wood, charcoal and organics were tentatively identified during the borehole survey on the same site (Reeves 2017) at around 5m AOD. During the Roman period through to the medieval period the study site lay within the course of the River Foss, and evidence from the borehole survey in 1992 (YAT 2000) showed that there is potential for

thick alluvial deposits along the western part of the site. However, the evidence of Roman land reclamation at 50 Piccadilly indicates that there is potential for Roman deposits extending into the north-east part of the study site, though this is speculative.

Anglian

As yet, no evidence of wharves or intensive occupation has been found along the eastern bank of the River Foss; however evidence from sites suggests the presence of other activity along the river bank. At 22 Piccadilly, Anglian pottery, probably of early-mid 9th century date was recovered from two trenches, one of which was associated with a wicker fence running parallel to the river. Silt accumulations above these levels indicate the area was prone to flooding. Further evidence came from 38 Piccadilly where a sherd of Badorf ware was recovered some 8m below modern street level beneath a substantial accumulation of probable 11th century alluvial silt. At 17-21 Piccadilly a 9th century relief-band amphora fragment was recovered from around 5m below the modern street level at around 5.7m AOD (AY 7/2, 196-197).

Anglo-Scandinavian

The site lies within an extensive area of Anglo-Scandinavian activity to the south-east of the former Roman fortress. Evidence of craft and trade activity was recorded at Dixon Lane/George Street in 2007 and excavations along Walmgate suggest that it was an important thoroughfare during this period, with a substantial suburb developing in the area. A number of sites along Piccadilly have revealed traces of Anglo-Scandinavian activity such as bone working evidence from excavations at 38, 50 and 84 Piccadilly (AY 8/4, 469-472). Artefacts dating from this period have been found at 41 Piccadilly (YAT 1992b); a glass bead and a small amount of pottery were recovered from a series of clay dumps which raised the ground level by 0.5m. Most significantly a pit dating to the very end of the Anglo-Scandinavian period was found to contain waste material from bone comb manufacture. Within the study site, occupation deposits dating to this period were recorded from a depth of 2.90m AOD, and a significant amount of residual Anglian and Anglo-Scandinavian artefacts were recovered; including pottery, a metal pin, part of a quern stone, worked antler and a spindle whorl.

Medieval activity

The landscape of the River Foss was drastically altered by the damming of the southern end of the river at Castle Mills by William the Conqueror to exploit its waters to feed the moat of the Norman Castle at York (VCHY 1961, 509-510). The resulting body of water was called the *Stagnum Regis,* the King's pool. Much of the area to the west of Piccadilly was flooded by the creation of the Fishpool and this is reflected in the results of excavations on and in the immediate vicinity of the study site. Borehole evidence from Ryedale House (YAT 2000), to the immediate north of the study site, suggests that alluvial deposits accumulated across the site during the medieval period and it wasn't until the late medieval period that the first reclamation of land took place. On the proposed development site (YAT 1992a) silts containing pottery dating to the 14th and 15th centuries were recorded at 4.70m AOD, immediately above alluvial deposits, indicating that the King's Fishpool was allowed to silt up during the later medieval period.

However, results from 50 Piccadilly (YAT 1992c), indicate that the edge of the Fishpool did not extend as far east as previously thought, and along that part of the River Foss the pool ran more parallel with the river. A sequence of 14th century deposits were recorded on the site which included highly organic material, suggesting alternating episodes of flooding and dry periods when domestic dump deposits accumulated. A substantial timber revetment was constructed during this period, comprising of large horizontal timbers, woven wicker work and timber uprights. Wicker and clay layers were deposited to the east of the revetment, possibly forming a lining. In the 15th century substantial horizontal planking was added to the revetment with thick clay. After the ground was level the area was continually used for the dumping of domestic waste into the post-medieval period and the ground level was considerably raised during this time.

Post-medieval

Canalisation of the River Foss began in the late 18th century, the first stretch from Castle Mills to Monk Bridge being opened in 1794. The modern street named Piccadilly runs from Pavement across the River Foss and along its east bank to the east end of Castle Mills Bridge. A lane or open space existed at the south end by 1610 and was widened and re-named Piccadilly after the London street in c.1840. It was extended north to Pavement in 1912 (RCHMY 5, 199).

Much of the land is built over land that was formerly covered by the King's Pool of the River Foss. Close to the banks of the river mixed dumps and deposits dating to the 18th and 19th centuries were encountered on the study site at 7.20m AOD (YAT 1992a). Similar deposits were recorded at 50 Piccadilly (YAT 1992c), 41 Piccadilly (YAT 1992b) and at Ryedale House (YAT 2000).

The gradual development of the post-medieval landscape can be traced through the historic maps of which there is a sequence available dating from the 17th century. On Speed's map of 1610 the King's Fishpool can be seen extending across the western portion of the site, with an open space and possible lane running north-south to the east. Richard's map of 1685 showed the Fish pool covering the western portion of site, but also bounded plots of open land, presumably used for commercial horticulture.

Modern

Hargrove's map of 1818 showed the narrowing of the River Foss, and the site clearly lay outside the confine of the river. The land on which the site is located is open and undeveloped, though a stream or drain is shown running north-south, crossing the northeast corner of the site, towards the southern edge. A lane or track is illustrated to the east of the site, and is potentially the precursor to Piccadilly. Baines' 1822 map showed that the site was still on unoccupied land, surrounded by gardens and orchards, suggesting that the site was prone to flooding.

By 1852 the site had started to become developed, with a timber yard present in the southern part of the site. In 1892 the site is empty apart from a 'crane'; however trade directories from around the time indicate that agricultural implements were made on or near the site. By 1907 small narrow plots containing commercial premises had appeared along this stretch of the River Foss; trade directories from the 19th and 20th centuries suggest possible businesses include an umbrella repairer, a timber merchants and Anglo-American Oil Co. Ltd. By the

1920's two garages had been set up on or close by to the site, as well as a foundry to the north and an iron works to the south.

5 RESULTS

Deposits identified within each of the boreholes were assigned context numbers which corresponded with the borehole reference number; windowless sample borehole WS01 commenced with context 100 onwards, WS02 commenced with context 200 onwards and so on. These contexts were then allocated to a broad phase of activity across the site (Figure 4). Due to the paucity of finds recovered, it should be noted that the designations of these phases are tentative and rely on observations by the experienced attendant archaeologist.

Full descriptions of these deposits and their phase designations can be found in the context table which forms Appendix 1 of this report.

5.1 WS01

Phase 1 Natural (Contexts 123 and 124) (Plate 1)

Natural glacial deposits of boulder clay and sand were identified at 7.58m BGL (1.71m AOD).

Phase 2 Alluvial clay and organic deposits (Contexts 112-122) (Plate 2)

A series of alluvial clay and organic rich deposits were encountered in WS01 at 3.73m BGL (5.56m AOD). The clays were dark grey or grey brown in colour (115, 120, 121), and were predominantly rich in organic material (116, 119, 122). Animal bone was present in 112, and flecks of charcoal were present in 113 and 118. Additional deposits included dark grey, almost black coarse clayey sand with mussel shell and small rounded pebble inclusions (114), and a dark grey brown silty clay, with fragments of degraded wood (117). No dateable material was recovered.

Phase 4 Post-medieval (Contexts 110 and 111)

Sealing the Phase 2 deposits were contexts 110 and 111, encountered at 2.61m BGL (6.68m AOD). Context 111 was an organic dark blue grey clayey silt with charcoal flecks and fragments of CBM, while context 110 consisted of an organic blue grey clay with lenses of mid-brown grey clay. CBM fragments were also present within this deposit. The Phase 4 deposits appear to represent a period of post-medieval land reclamation, in which clay deposits were dumped to build up the level of the ground in this area.

Phase 5 Later post-medieval to modern (Contexts 100-109) (Plate 3)

A series of silts and clays with an increasingly gritty content (104-109) were encountered at 1.21m BGL (8.08m AOD). An increase in the amount of CBM observed in these deposits when compared to those of Phase 4 may be seen as an indication of a later post-medieval date. 16th-18th century brick was present in 108. Above these deposits was a series of modern concrete, hardcore and clinker deposits (100, 101, 103) between 0 - 1.21m BGL (8.08 - 9.29m AOD), with a soft silty clay (102) between contexts 101 and 103.

5.2 WS02

Phase 1 Natural

WS02 did not reach deep enough to encounter natural deposits.

Phase 2 Alluvial clay and organic deposits (Contexts 222-223)

Alluvial clays and organic rich deposits were encountered in WS02 at 6.97m BGL (2.36m AOD). The clays were dark grey with charcoal inclusions. No dateable material was recovered.

Phase 3 Medieval (Contexts 217-221) (Plate 4)

Soft organic dark grey, black and brown clays and silty clays were identified at 5.31m BGL (4.02m AOD). These deposits, containing fragments of charcoal and mussel shells, are likely to date from the medieval period, when this area was part of the King's Fishpool.

Phase 4 Post-medieval (Contexts 208-216) (Plate 5)

Post-medieval activity in this borehole consisted of a series of soft organic dark grey or brown sands and clays, identified at 1.75m BGL (7.58m AOD). A sherd of 18th century Nottingham-type pottery was present in deposit 212, indicating that land reclamation was still being undertaken in the later post-medieval period.

Phase 5 Later post-medieval to modern (Contexts 200-207) (Plate 6)

Above the post-medieval deposits were a series of redeposited grey and orange brown clays with charcoal, brick and mortar fragments (203, 204, 207) and brick rubble and clinker deposits (201, 202, 205). These were encountered at 0.14m BGL (9.19m AOD) and were sealed by modern concrete present at 0m BGL (9.33m AOD).

5.3 WS03

Phase 1 Natural

WS03 did not reach deep enough to encounter natural deposits.

Phase 2 Alluvial clay and organic deposits (Contexts 320-326) (Plate 7)

Alluvial clays and organic rich deposits were encountered in WS03 at 6.71m BGL (2.61m AOD). The deposits consisted of mid-dark grey clay and silty clays with charcoal, CBM and sandstone inclusions. A fragment of leather was present in context 325.

Phase 3 Medieval (Contexts 317-319) (Plate 8)

Soft organic dark grey, black and brown clays and silty clays were identified at 4.86m BGL (4.46m AOD). These deposits, containing root material, are potentially part of the King's Fishpool.

Phase 4 Post-medieval (Contexts 309-316)

Post-medieval activity in this borehole consisted of a series of soft organic dark grey or light brown sandy clays, silty clays and clays, identified at 1.8m BGL (7.52m AOD).

Phase 5 Later post-medieval to modern (Contexts 300-308)

Above the post-medieval deposits were a series of redeposited grey and orange brown clays, silts and sands with CBM, charcoal and mortar fragments (302, 304-305, 307-308) and mortar and clinker deposits (301, 303, 306). These were encountered at 0.16m BGL (9.16m AOD) and were sealed by modern concrete present at 0m BGL (9.32m AOD).

5.4 WS04

Phase 1 Natural (Context 433)

The natural glacial deposit of grey brown boulder clay was identified at 9.78m BGL (-0.46m AOD).

Phase 2 Alluvial clay and organic deposits (Contexts 424-426, 428-432) (Plate 9)

A series of alluvial clay and organic rich deposits were encountered in WS04 at 6.68m BGL (2.64m AOD). The clays were dark grey or grey brown in colour, and were predominantly rich in organic material (429, 431, 432). Fish bones were present in 429 and 431, and degraded wood was present in 432. No dateable material was recovered.

Phase 3 Medieval (Contexts 416-423) (Plate 10)

Soft organic grey brown silty clay and clay deposits containing CBM, degraded roots and wood were identified at 4.76m BGL (4.56m AOD). A wooden stake with a tapered end was encountered at 5m BGL (418) (4.32 AOD) and degraded wood or wattle, with a possible small stake, was seen at 4.66m BGL (416) (4.66m AOD). These deposits may indicate an area of revetments at the edge of the fish pool in the medieval period.

Phase 4 Post-medieval (Contexts 408-415, 427) (Plate 11)

Sealing the medieval fish pool deposits was a series of grey, brown and black silty clays, clays and sandy clays, encountered at 1.42m BGL (7.9m AOD). These deposits contained mortar fragments, shells, charcoal and wood, with burnt bone and iron staining present in 408. As seen in the earlier boreholes, the Phase 4 deposits appear to represent a period of post-medieval land reclamation, in which clay deposits were dumped to build up the level of the ground in this area.

Phase 5 Later post-medieval to modern (Contexts 400-407)

A series of silts and clays with an increasingly high frequency of CBM, mortar and limestone fragments (402, 404, 406-407) were encountered at 0.21m BGL (9.11m AOD). Between these deposits was a dry organic brown lens of degraded plant and wood matter (405) and a garden soil with frequent roots (403). Above this series of deposits was modern concrete and made ground (400-401) between 0 - 0.21m BGL (9.11 - 9.32m AOD).

5.5 Water Monitoring

The water monitoring and hydrological analysis is discussed in detail in Appendix 7.

5.6 Palaeoecology

The results of the scheme of environmental sampling are discussed in greater detail in Appendices 6 and 8. The samples demonstrate preserved organic material is present at the site, although in relatively poor condition and has perhaps deteriorated due to historic fluctuations in the water table (Appendix 8)

6 SUMMARY

This phase of boreholes at Castle Mills adds to the information provided by the earlier phase of boreholes on the site in 1992. The pattern of deposition observed across both phases was very similar, with the exception of the dateable material in the Phase 2 alluvial clay and organic deposits, from which one piece of medieval CBM and leather were retrieved. Similar

deposits were dated to pre-1069 AD in the earlier phase of works. However, a borehole survey of the NCP car park to the north dated alluvial deposits to the Roman period.

The following summary provides a guide to the deposit sequence as encountered during this phase of works.

Natural (Phase 1)

Natural deposits were identified at 7.58m BGL in WS01 and at 9.78m BGL in WS04. The drop in the level of the natural between WS04 and WS01 indicates that it slopes down toward the River Foss.

Alluvial clay and organic deposits (Phase 2)

Alluvial and organic deposits were encountered between 3.73m BGL in WS01 and 6.97m BGL in WS02. The depth of these deposits in WS02 and WS03 indicates a potential deep area of flooding or an earlier pool, as neither of these boreholes reached natural deposits.

Medieval fish pool silts (Phase 3)

The soft organic silts within this phase were identified at 5.31m BGL in WS02, 4.86m BGL in WS03 and 4.76m BGL in WS04. No silty deposits were seen within WS01. These deposits are thought to relate to the silting up of the King's Pool during the later medieval period. The wooden stake and possible wattle seen in WS04 suggest that, as seen at 50 Piccadilly, there were alternating episodes of flooding and dry periods, enough to construct possible revetments along the River Foss.

Post-medieval (Phase 4)

Post-medieval deposits with increasing amounts of CBM were encountered between 1.42-2.61m BGL. These deposits appear to represent a period of post-medieval land reclamation, in which clay deposits were dumped to build up the level of the ground in this area.

Later post-medieval to modern (Phase 5)

Made ground deposits from the later post-medieval to modern periods were present between 0-2.61m BGL. These demonstrate the urbanisation of this area during these periods.

Groundwater and Deposit Monitoring

Based on the results from the geochemical sampling exercise and groundwater monitoring program, the sub-surface deposits below 2.4 m BGL) remain waterlogged, anoxic and highly reducing. The primary influences on the water levels are from natural groundwater flow through the site as well as rainwater, with levels closest to the river Foss almost static (due to the canalization of the Foss impeding water movement) whilst greater fluctuations are observed in the deposits furthest away from the river Foss. As almost all of the development area is hard paved or concreted over, effective recharge can only be achieved primarily via continued groundwater movement through the sub-surface deposits. Any activity that physically isolates the site from its surroundings – for example, contiguous sheet piling – should be avoided. See Appendix 7 for the full report on the scheme of groundwater monitoring.

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PLATES

Plate 1 Natural deposits in WS01, contexts 123 and 124. Scale 0.5m

Plate 2 Alluvial deposits in WS01, contexts 116-118 (L-R). Scale 0.5m

Plate 3 Modern deposits in WS01, contexts 103-106 (L-R). Scale 0.5m

Plate 4 Medieval fish pool deposits in WS02, contexts 217-220 (L-R). Scale 0.5m

Plate 5 Post-medieval made ground in WS02, contexts 212-213. Scale 0.5m

Plate 6 Modern deposits in WS02, contexts 201-204 (L-R). Scale 0.5m

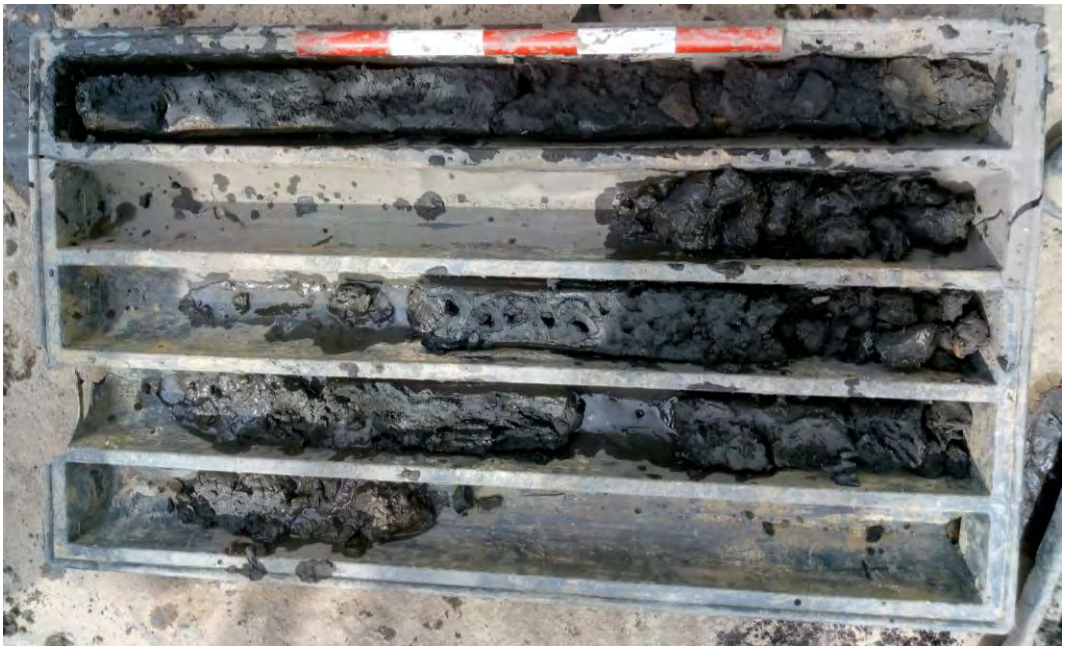


Plate 7 Alluvial deposits in WS03, contexts 324-326. Scale 0.5m

Plate 8 Medieval fish pool silts in WS03, context 317. Scale 0.5m

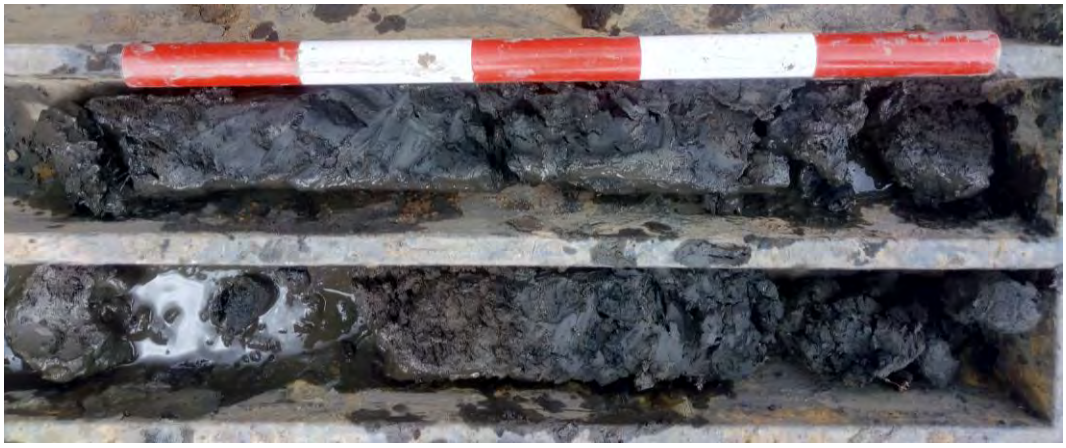


Plate 9 Alluvial deposits in WS04, contexts 425-426. Scale 0.5m

Plate 10 Medieval fish pool deposits in WS04, contexts 418-419. Scale 0.5m

Plate 11 Post-medieval made ground deposits in WS04, contexts 413-414. Scale 0.5m

Plate 12Made ground and garden soil in WS04, contexts 403-404. Scale 0.5m

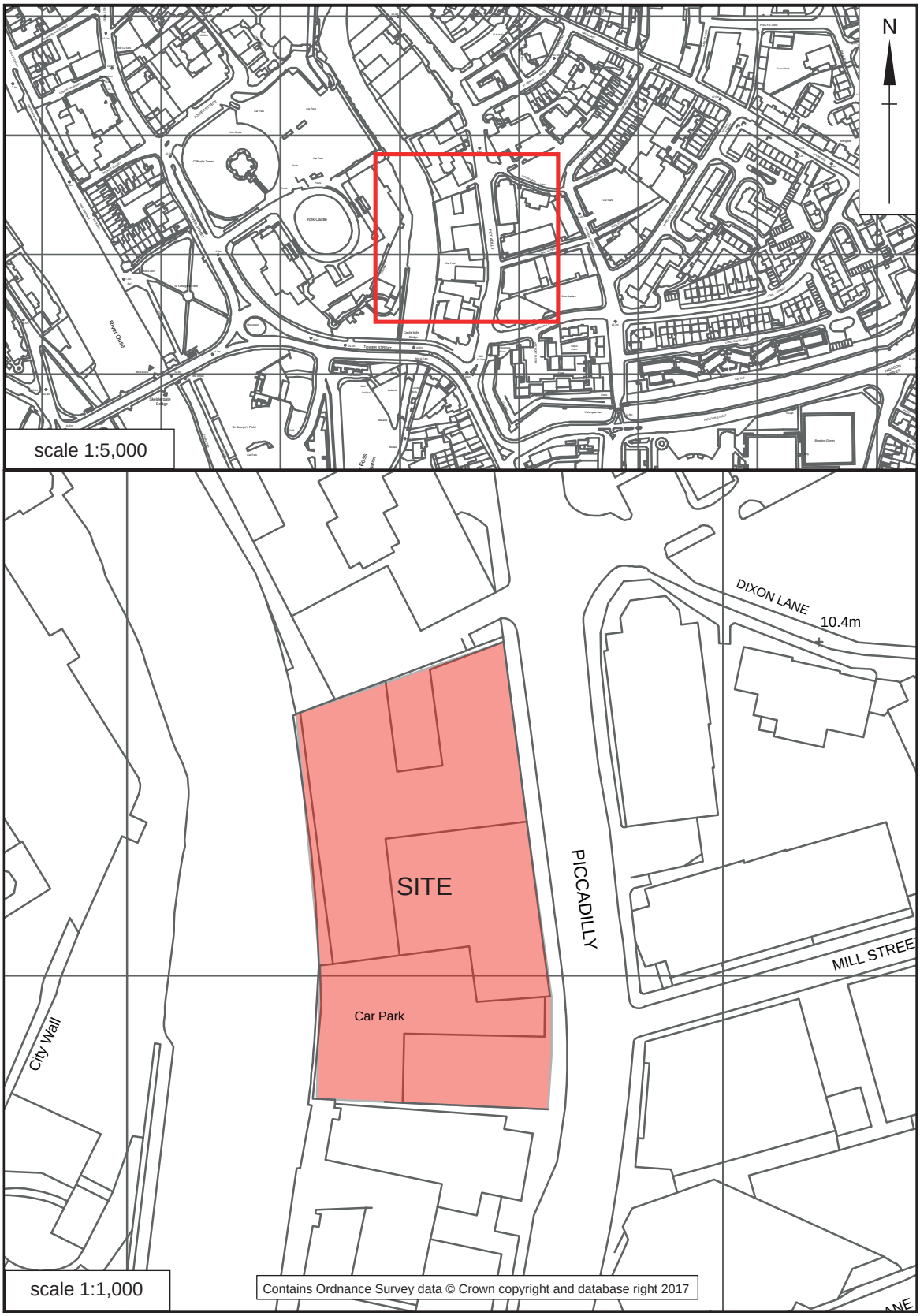
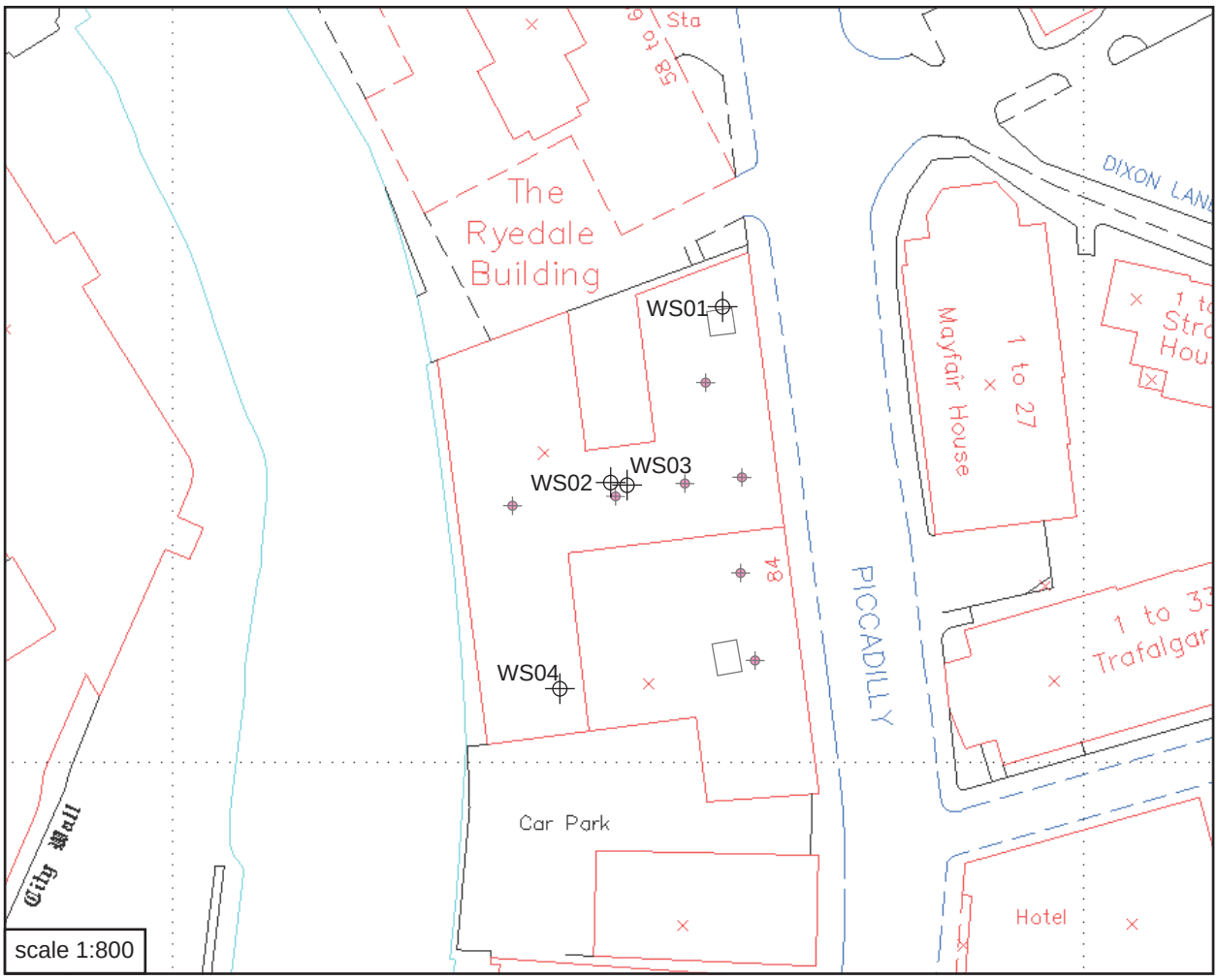


Fig. 01 Location of site



Key

- Previous borehole (YAT 1991.16)
- Previous trenches 8 & 9 (YAT 1991.16)
- Current borehole investigation

Figure 2 Location of Boreholes

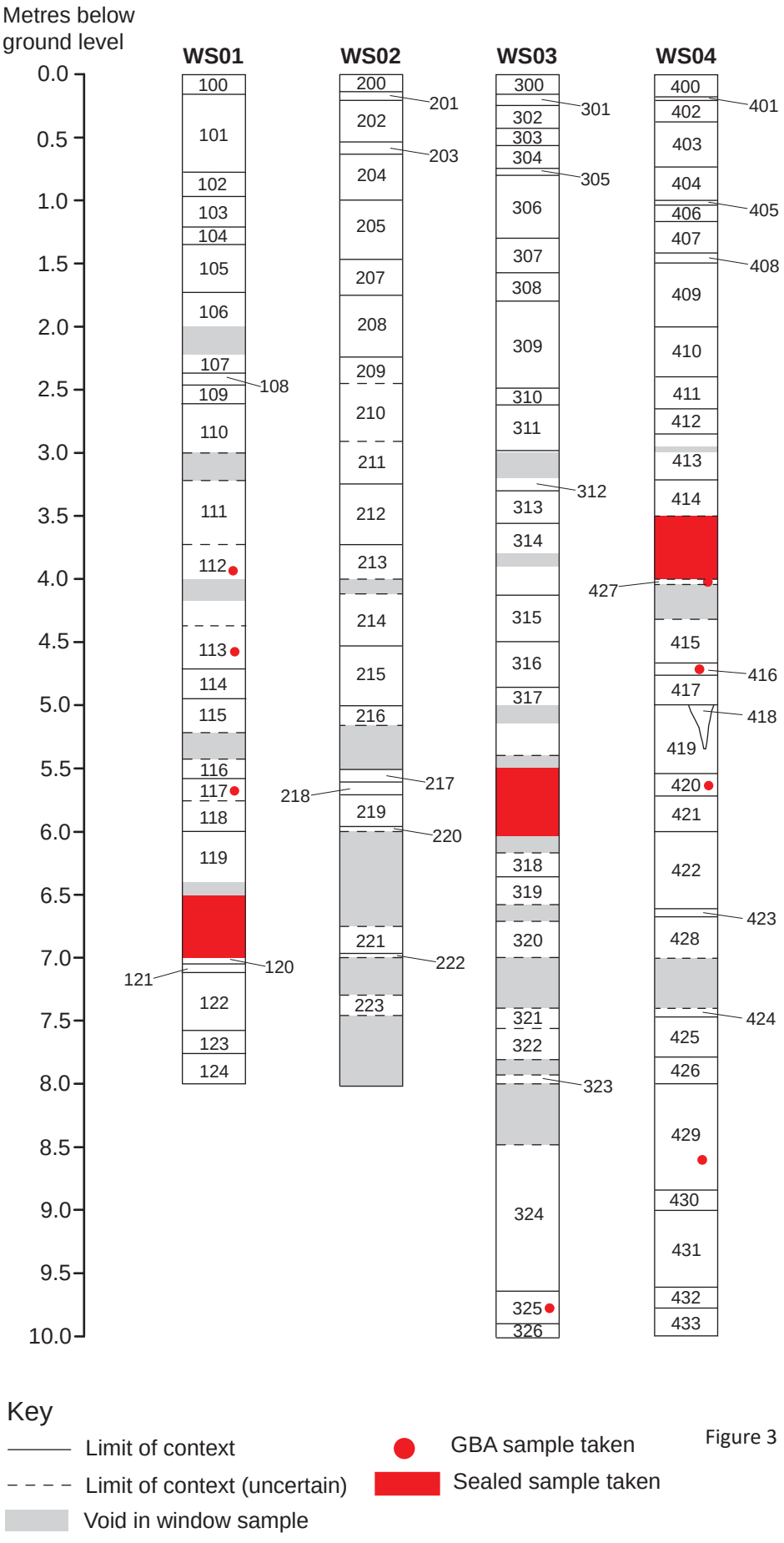


Figure 3 Borehole Profiles

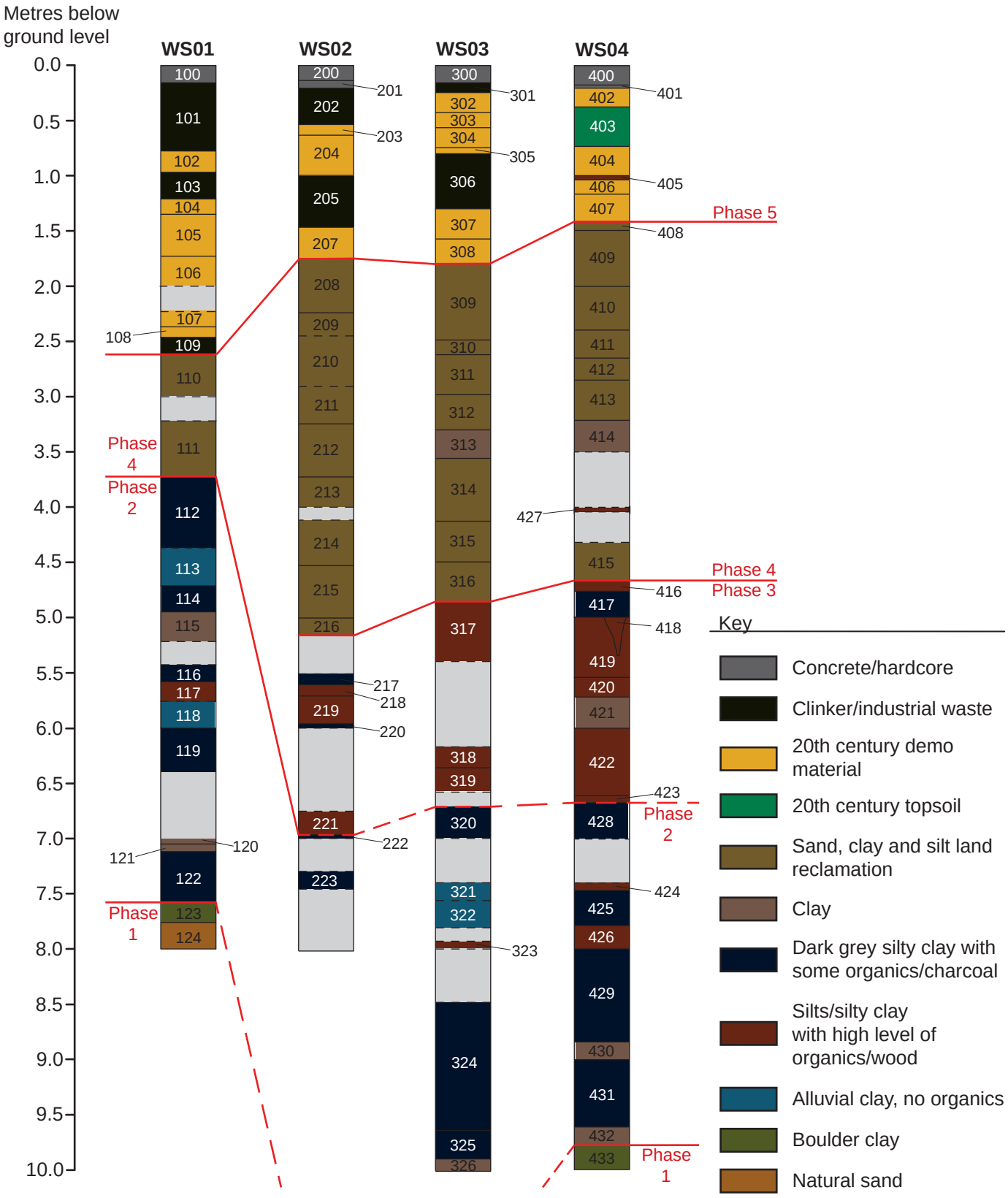


Figure 4 Deposit model

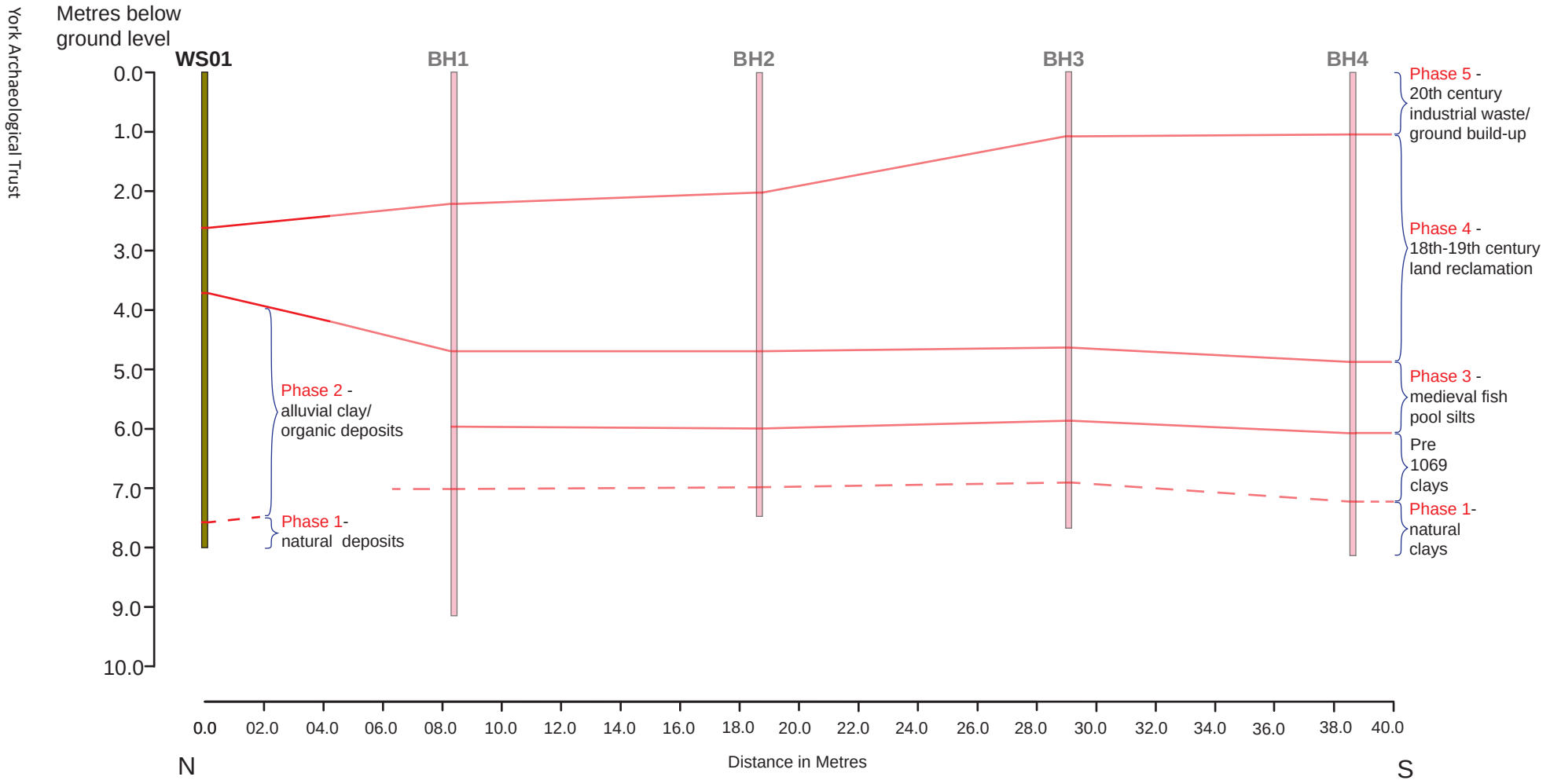


Figure 5. Deposit model on north to south transect using results from YAT 1991 borehole survey

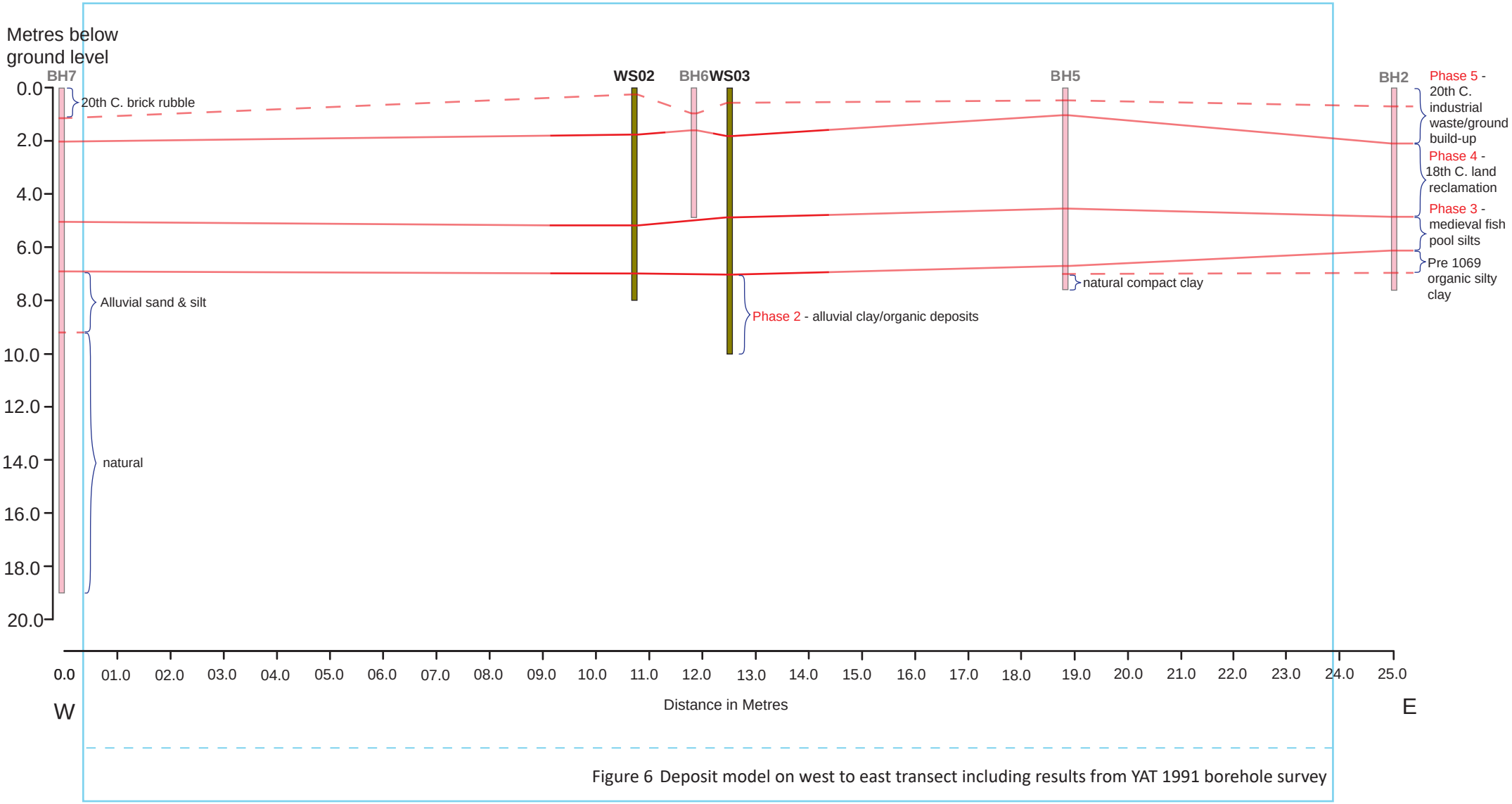


Figure 6 Deposit model on west to east transect including results from YAT 1991 borehole survey

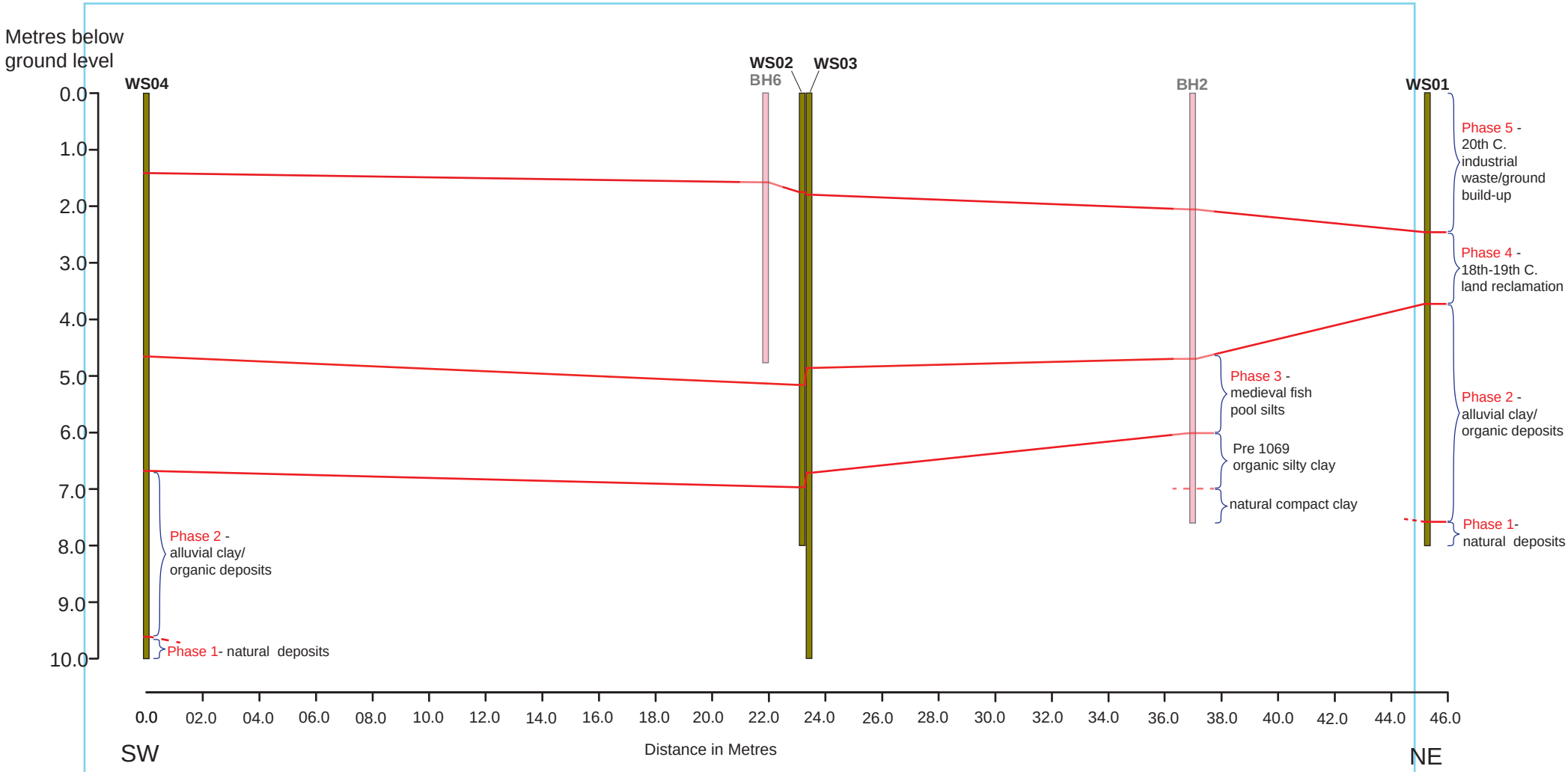


Figure 7 Deposit model on a southwest to northeast transet including results from YAT 1991 borehole survey

APPENDIX 1 – CONTEXT LIST

Context Number	Phase	Depth of deposit (AOD)	Depth of deposit (BGL)	Description
WS01				
100	5	9.29m	0.00m	Concrete and hard-core.
101	5	9.15m	0.14m	Modern made ground. Black ash and clinker deposit with metal and CBM fragments, redeposited organic material and glass.
102	5	8.51m	0.78m	Soft, light brown to mid grey brown, silty clay.
103	5	8.32m	0.97m	Made ground. Black ash and clinker deposit with metal, CBM and glass.
104	5	8.08m	1.21m	Made ground. Loose light grey brown gritty silt with small sub-angular pebbles and CBM.
105	5	7.94m	1.35m	Made ground. Moderate, mid to dark grey clayey silt with sandstone fragments, CBM fragments and mortar.
106	5	7.56m	1.73m	Made ground. Friable, dark grey mottled mid brown clayey silt with frags and flecks of mortar.
107	5	7.07m	2.22m	Made ground. Friable dark grey silty clay with mortar fragments.
108	5	6.92m	2.37m	Made ground. Loose mid brown silty clay with frequent large and medium sized brick fragments.
109	5	6.83m	2.46m	Made ground. Soft, dark grey gritty clay with small pebbles. Hydro carbon smell.
110	4	6.68m	2.61m	Made ground. Soft blue grey clay with 2 lenses of mid brown and grey clay with CBM fragments. Organic material present. Probably redeposited.
111	4	6.07m	3.22m	Soft dark grey silty clay with CBM fragments and charcoal flecks. Organics present. Sandstone fragments either side of deposit.
112	2	5.56m	3.73m	Alluvial deposit. Soft dark grey silty clay with organics and charcoal inclusions & animal bone.
113	2	4.92m	4.37m	Alluvial deposit. Soft, smooth, plasticy, dark grey silty clay. frequent charcoal present
114	2	4.58m	4.71m	Alluvial deposit. Moderate, coarse mid to dark grey, almost black clayey sand with very occasional mussel shell and small to medium rounded pebbles.
115	2	4.34m	4.95m	Alluvial deposit. Soft mid grey brown silty clay, very wet past 5m BGL.
116	2	3.86m	5.43m	Alluvial deposit. Very soft, dark grey to black damp silty clay with organic material.
117	2	3.71m	5.58m	Alluvial deposit. Soft, dark grey brown silty clay with degraded wood present.

Context Number	Phase	Depth of deposit (AOD)	Depth of deposit (BGL)	Description
118	2	3.53m	5.76m	Alluvial deposit. Stiff dark grey clay with frequent charcoal flecks and bone.
119	2	3.29m	6.00m	Alluvial deposit. Very wet and soft dark grey organic rich silty clay. Very small very occasional fragments of CBM.
120	2	2.29m	7.00m	Alluvial deposit. Very soft, dry light grey brown sterile clay.
121	2	2.24m	7.05m	Alluvial deposit. Stiff, light greeny brown sterile clay.
122	2	2.19m	7.10m	Alluvial deposit. Very wet, soft, dark grey silty clay. Organic rich with charcoal.
123	1	1.71m	7.58m	Boulder clay. Very stiff, light brown mottled blue grey clay.
124	1	1.53m	7.76m	Natural sand. Very soft, fine, orange brown sand.
WS02				
200	5	9.33m	0.00m	Modern ground surface. Concrete.
201	5	9.19m	0.14m	Made ground. Brick rubble.
202	5	9.09m	0.24m	Made ground. Loose dark grey to black coke, ash and clinker with glass slag.
203	5	8.79m	0.54m	Made ground. Loose mid grey clay with charcoal, brick and mortar fragment inclusions.
204	5	8.69m	0.64m	Made ground. Soft, light grey redeposited clay and light brown sand. Sterile.
205	5	8.33m	1.00m	Loose gravelly clinker, smells strongly of hydro carbons. Industrial waste.
206	5	N/A	N/A	Void.
207	5	7.86m	1.47m	Made ground. Stiff, orange brown mottled mid grey clay with mortar inclusions.
208	4	7.58m	1.75m	Made ground. Soft, dark grey clay mottled with mid brown clay. CBM fragments. Smells of hydro carbons.
209	4	7.09m	2.24m	Made ground. Soft, dark grey, silty clay with charcoal inclusions.
210	4	6.88m	2.45m	Made ground. Mid brown stiff clay mottled with grey clay, turning sandier further down context. Smell of hydro carbons.
211	4	6.42m	2.91m	Made ground. Soft, wet, grey sand.
212	4	6.08m	3.25m	Made ground. Soft grey clay mottled with stiff mid brown clay. pot retrieved.
213	4	5.60m	3.73m	Made ground. Soft dark grey silty clay with occasional charcoal flecks and animal bone.
214	4	5.21m	4.12m	Made ground. Very wet dark grey silty sand.
215	4	4.82m	4.51m	Made ground. Soft, dark grey sandy silty clay with CBM, bone and mortar fragments present.
216	4	4.33m	5.00m	Made ground. Very wet, moderately compact dark grey clayey sand.

Context Number	Phase	Depth of deposit (AOD)	Depth of deposit (BGL)	Description
217	3	4.02m	5.31m	Fish pool deposit. Very soft dark grey sandy silty clay with mid brown clay lenses.
218	3	3.72m	5.61m	Fish pool deposit. Dark brown soft clay with occasional charcoal flecks.
219	3	3.62m	5.71m	Fish pool deposit. Stiff mid grey brown clay with frequent charcoal flecks and organic material.
220	3	3.37m	5.96m	Ground build-up. Soft, almost black organic silty clay.
221	3	2.58m	6.75m	Ground build-up. Soft mid grey brown clay with organics and mussel shell fragments.
222	2	2.36m	6.97m	Alluvial deposit. Soft dark grey clay with charcoal inclusions, laminations of mid to dark grey clay.
223	2	2.03m	7.30m	Alluvial deposit. Moderate to stiff mid grey clay laminated with light grey clay.
WS03				
300	5	9.32m	0.00m	Grey concrete ground surface.
301	5	9.16m	0.16m	Made ground. Loose mid orange sand with black clinker and ash.
302	5	9.07m	0.25m	Made ground. Dark grey gritty clay with frequent fragments of medium to small sized brick.
303	5	8.89m	0.43m	Made ground. Soft, creamy white crushed mortar.
304	5	8.75m	0.57m	Made ground. Compact mid orange brown clayey sand.
305	5	8.57m	0.75m	Made ground. Stiff mid grey silty clay.
306	5	8.52m	0.80m	Made ground. Loose black clinker and silt. Smells strongly of hydro carbons. Industrial waste.
307	5	8.02m	1.30m	Made ground. Stiff dark grey clay mottled with orange brown sand. CBM and mortar fragments present. Redeposited alluvial deposit.
308	5	7.75m	1.57m	Moderately compact mid grey brown clayey silt with rounded cobbles, yellow brick dust and charcoal flecks.
309	4	7.52m	1.80m	Made ground. Moderate dark grey sandy silty clay with charcoal flecks and occasional cessy lenses.
310	4	6.83m	2.49m	Made ground. Soft, dark grey mottled light brown sandy clay with CBM.
311	4	6.36m	2.62m	Made ground. Soft, dark grey mottled mid brown silty clay with sand lenses, frequent charcoal flecks and roots present. Redeposited earlier material.
312	4	6.12m	2.98m	Made ground. Soft dark grey, silty clay with frequent charcoal flecks and roots.
313	4	6.02m	3.30m	Made ground. Stiff, light brown clay with very occasional rounded pebbles.

Context Number	Phase	Depth of deposit (AOD)	Depth of deposit (BGL)	Description
314	4	5.76m	3.56m	Made ground. Soft, dark grey silty clay with mortar flecks, CBM (tile and bricks), and angular limestone fragments.
315	4	5.19m	4.13m	Made ground. Soft, dark grey, sandy silty clay mottled with mid brown stiff clay with occasional charcoal, mortar CBM and stone (limestone and green sandstone) present. V occasional rounded pebbles.
316	4	4.82m	4.50m	Made ground. Laminations of soft dark grey silty clay and mid brown stiff clay with crumbly mortar fragments, degraded roots and v occasional rounded pebbles.
317	3	4.46m	4.86m	Fish pool silt. Dry, soft, organic rich mid to dark brown silty clay. Much root material.
318	3	3.15m	6.17m	Fish pool silt. Very soft and wet mid grey brown sandy silty clay with root material.
319	3	2.96m	6.36m	Build-up. Moderate, dark grey, almost black mottled mid grey brown organic rich, clay silt.
320	2	2.61m	6.71m	Alluvial deposit. Laminations of dark grey and mottled mid brown clay. Less soft and drier than 319.
321	2	1.92m	7.40m	Alluvial deposit. Soft dark grey silty clay. CBM.
322	2	1.76m	7.56m	Alluvial deposit. Soft dark grey silty clay, darker in colour than 321.
323	2	1.39m	7.93m	Alluvial deposit. Friable, mid grey brown sandy silt with animal bone and sub-angular sandstone fragments.
324	2	0.64m	8.68m	Alluvial deposit. Moderate, dark grey silty clay, organic rich.
325	2	-0.32m	9.64m	Alluvial deposit. Dark grey organic rich silty clay with CBM and leather fragment. Darker grey than C324.
326	2	-0.58m	9.90m	Alluvial soil. Soft mid to light grey brown clay with organic lenses and rounded pebbles.
WS04				
400	5	9.32m	0.00m	Concrete ground surface.
401	5	9.14m	0.18m	Made ground. Loose fragments of CBM and concrete.
402	5	9.11m	0.21m	Made ground. Stiff, mid orange brown with frags of coal and mortar.
403	5	8.84m	0.48m	Garden soil. Loose, dark grey brown silt with frequent roots.
404	5	8.58m	0.74m	Made ground. Loose, dark grey brown silt with frequent small fragments of demo material including CBM, mortar and limestone.
405	5	8.32m	1.00m	Made ground. Organic dry mid brown lens of redeposited degraded plant/wood matter.
406	5	8.28m	1.04m	Made ground. Moderately compact orange brown clayey sand.
407	5	8.15m	1.17m	Made ground. Very stiff, light grey brown clay with very occasional rounded sandstone pebbles.

Context Number	Phase	Depth of deposit (AOD)	Depth of deposit (BGL)	Description
408	4	7.90m	1.42m	Made ground. Moderate light grey brown sandy silty clay with iron staining, rounded small to medium pebbles and rare small fragments of burnt bone.
409	4	7.82m	1.50m	Made ground. Soft dark grey clay with occasional mortar frags, lenses of mid brown clay, shells, organics and charcoal.
410	4	7.32m	2.00m	Made ground. Soft, light pinkish grey, very sandy clay. the sand is fine and there was charcoal and pieces of wood present.
411	4	6.92m	2.40m	Made ground. Very soft, light pinkish grey clay with organic lenses.
412	4	6.67m	2.65m	Made ground. Mottled and mixed dark, mid and light grey brown clay and clayey sand with sub-angular limestone frags and mortar
413	4	6.47m	2.85m	Made ground. Soft, almost black highly organic clay with limestone chips. CBM and bone from 3m down.
414	4	6.12m	3.22m	Made ground. Very soft, light grey brown sandy silty clay.
415	4	5.00m	4.32m	Made ground. Very soft, light grey brown sandy silty clay with mussel shell.
416	3	4.66m	4.66m	Degraded wood or wattle. Very degraded wood, possible small stake present, slight curve on outer edge.
417	3	4.56m	4.76m	Fish pool deposit. Very soft, mid grey brown laminated dark grey clay with degraded wood.
418	3	4.32m	5.00m	Wooden stake, tapered end. Evidence of structure? Possible revetment.
419	3	4.32m	5.00m	Build up. Dry, moderate, mid to dark brown organic rich silt. Build up around wooden stake C418.
420	3	3.78m	5.54m	Build-up. Soft dark grey brown clay with frequent degraded wood present. & CBM.
421	3	3.60m	5.72m	Build-up. Very soft and damp, mid grey brown clay.
422	3	3.32m	6.00m	Build-up. Very soft and very wet, mid grey brown clay with degraded wood.
423	3	2.71m	6.61m	Build-up. Moderate, mid to dark brown organic rich clay.
424	2	1.92m	7.40m	Build-up. Wet, moderately compact, mid grey brown silty clay with degraded roots.
425	2	1.85m	7.47m	Alluvial deposit. Stiff, dark grey with laminations of mid grey brown silty clay organic rich.
426	2	1.53m	7.79m	Alluvial deposit. Moderate, mid brown sandy silty clay.
427	4	5.32m	4.00m	Made ground. Soft, light grey brown silty clay with wood fragments.
428	2	2.64m	6.68m	Alluvial deposit. Laminations of mid to dark soft clay.

Context Number	Phase	Depth of deposit (AOD)	Depth of deposit (BGL)	Description
429	2	1.32m	8.00m	Alluvial deposit. Organic rich dark grey clay with occasional fish bone. Rare patches of green/yellow sand.
430	2	0.48m	8.84m	Alluvial deposit. Moderate, light grey brown sterile clay.
431	2	0.32m	9.00m	Alluvial deposit. Moderate, dark grey organic rich silty clay with fish bone present.
432	2	-0.29m	9.61m	Alluvial deposit. Moderate, mid grey brown clay with medium rounded cobbles and degraded wood.
433	1	-0.46m	9.78m	Natural. Stiff mid to light grey brown clay. Boulder clay.

Table 1 Context list

APPENDIX 2 - INDEX TO ARCHIVE

Item	Number of items
Borehole logs	4
Sample register	1
Samples	11
Digital photographs	165
Written Scheme of Investigation	1
Report	1

Table 2 Index to archive

APPENDIX 3 – POTTERY ASSESSMENT

BY A. JENNER

Only two small sherds were retrieved (Table 3). One is an 18th century type which often occurs in 18th and 19th century contexts in York. The other is a small coarsely gritted, oxidised, wheel thrown jar which is probably Roman.

The coarse ware sherd could be sent to Ruth Leary for identification, but otherwise no further work is necessary.

Context	Quantity	Dating	Details
212	1	18TH CENTURY	1 Nottingham type brown glazed stoneware with incised decoration
311	1	ROMAN	1 Roman coarse oxidised ware jar base with external sooting

Table 3 Pottery assessment

APPENDIX 4 – THE CERAMIC BUILDING MATERIAL AND STONE ROOF TILE

BY J. M. MCCOMISH

INTRODUCTION

This assessment relates to 999g of ceramic building material (CBM) and stone roof tile recovered from the archaeological boreholes at Castle Mills (York Archaeological Trust project code 6072). The CBM ranged in date from Roman to post-medieval.

The collection was recorded to a standard YAT methodology (McComish 2015) whereby each sherd is individually recorded on a pro-forma sheet which details the project code, the context number, the weight in grams, the fabric type, the surviving complete dimensions (length, width, thickness, flange height) and any other relevant information (surface marks, glazes, unusual features etc.). A question mark is placed after the form name if the identification is uncertain, for example 'Imbrex?', while the form of non-standardised sherds is listed as 'Other'. The fabric is determined by comparing the sherd to a York fabric reference collection held by York Archaeological Trust (YAT). The data is stored on YATs internal computer system (which is backed up daily to prevent data loss) under the project code 6072)

RESULTS

The various forms present are summarised by historical period on Table 4, while a summary of the forms present in relation to context is given on Table 5.

The Roman CBM accounted for 38% of the total volume of the material examined, but the sherds in question were too abraded to determine the original form. The Roman material included three small fragments of micaceous sandstone which probably originated from stone roof tiles of Roman date. Medieval CBM accounted for 34.1% of the total volume of CBM from the site. The forms present included plain roof tiles of 13-16th century date and fragments of brick of 14-16th century date. Some of the brick was so fragmented that original thicknesses or edges did not survive making identification difficult; the sherds in question could equally be of post-medieval date. A single fragment of post-medieval brick was present accounting for 25% of the total volume of material examined.

All of the material was typical for York as a whole in terms of the dimensions and fabrics seen.

SUMMARY AND RECOMMENDATIONS FOR FURTHER RESEARCH

The collection of CBM was of very poor quality overall being highly fragmented and abraded, with many fragments lacking any surviving original dimensions or surfaces, making identification of the original forms difficult. The collection of CBM has no potential for further research, mainly being of use to provide dating evidence for the various contexts seen. No further work is recommended. None of the material was worthy of museum display.

For excavations within the City of York, YAT routinely adopts a rigorous record and discard policy. In the case of this site all of the material was discarded as it had no potential for further research.

Period	Form	No. of sherds	Weight in grams	% of total weight
Roman	Brick	5	185	18.52
	Stone peg	3	195	19.52
Medieval	Brick	3	325	32.53
	Plain	420	16	1.60
Post medieval	Brick	1	275	27.53

Table 4 CBM by form in relation to period

Context	Dating	Forms present
US	13-16TH	Plain
108	16-18th	Plain, post-medieval brick
111	1-4th	Roman brick
112	13-16TH?	Plain? Too small to be certain of id
210	14-16th	Medieval brick
215	14-16th	Medieval brick, plain, stone peg?
219	13-16TH	Plain
310	1-4th	Roman brick
313	1-4th	Stone peg?
314	13-16th	Plain, Roman brick, stone peg?
315	14-16th	Medieval brick? could be later, plain
316	1-4th	Roman brick
321	13-16th	Plain
325	13-16TH	Plain
413	13-16TH	Plain
415	13-16TH?	Plain? Too small to be certain of id
419	13-16TH	Plain

Table 5 CBM in relation to context

APPENDIX 5 – HYDROLOGICAL REGIME & BASELINE CONDITIONS 22/08 – 20/11/18

INTERIM REPORT FOR PERIOD 22/08 – 20/11/18 BY IAN PANTER

INTRODUCTION

Archaeological evaluation at the site of the former Castle Mills Car Park in York was carried out with the overall aims of characterising the local hydrological regime and baseline conditions of the sediments and archaeological evidence preserved below the surface. A six-month monitoring programme has been implemented and this interim report discusses the results after three months of data collection. A more detailed report will be prepared at the end of the six-month period which will consider the implications for long-term in situ preservation of organic archaeological and biological remains, as well as assessing potential threats to their continued survival.

By necessity a holistic approach has been adopted to help identify and characterise site conditions including measuring ground water levels, ground water quality (as a proxy indicator of the nature of the sediments), a small-scale geotechnical investigation of the deposit, and an assessment of the degree of preservation of the bioarchaeological evidence.

Four boreholes were drilled between 23rd and 25th July 2018 using a lightweight windowless dynamic coring rig (GA Site Investigation) and dipwells installed to monitor ground water levels and water quality. Each dipwell comprised a plastic standpipe, 50mm diameter, and nominally plain pipe to 1.0m below ground surface (BGS) encased in bentonite (to prevent surface water ingress) with the remainder slotted pipe with gravel surround to act as a filter. Boreholes were drilled to a depth of 10m BGS, apart from WS01 where undisturbed natural was encountered at 8.0m BGS and WS02 where an obstruction was hit at 8m and drilling ceased. A strong hydrocarbon odour emanated from boreholes WS02 and WS03 indicating below-ground contamination.

Three sealed undisturbed sediment samples were extracted from boreholes 1, 3 and 4 and submitted for permeability and geochemical assays (Geolabs Ltd)., whilst bulk sediment samples were sent to Palaeoecology Research Services Ltd for bioarchaeological assessment.

Ground water levels are being measured using Rugged Troll 100 transducers (In-Situ Europe Ltd) with atmospheric pressure correction provide by a Rugged Baro Troll.

Water quality data are is provided by an Aqua Probe 2000 sonde, connected to an Aqualogger R 2000 data logger (both Bell Flow Systems Ltd) recording Optical Dissolved Oxygen, pH, conductivity (EC), redox (ORP) and temperature.

GROUND WATER LEVELS

Transducers were installed on the 7th August 2018, after allowing a week or so for ground water levels to rebound and stabilise following dipwell insertion. One Rugged Troll100 and Rugged Baro Troll were installed into WS04, but a second transducer could not be installed into WS01 as access was impossible due to damage caused by plant running over the well head. Neither WS02 nor WS03 were suitable due to the overpowering hydrocarbon odour emanating from each when the dipwell plugs were removed.

The Rugged Troll 100 was installed to a depth c. 4m BGS and set to log data at 6 hourly intervals (i.e.4 reading per 24-hour period). The Baro Troll was installed to a depth of approximately 0.5m BGS to ensure it remained above the water table.

Both transducers were then transferred to WS01 on 22/8/2018 (following repairs to the well head) and the water quality meter installed in WS04.

The data from the three-months period are plotted below (Figures 1 and 2) together with rainfall data from the Weather Underground website (www.wunderground.com) which provides free access to several weather stations operating around the York area. The data is used by City of York council following the demise of the University of York weather station.

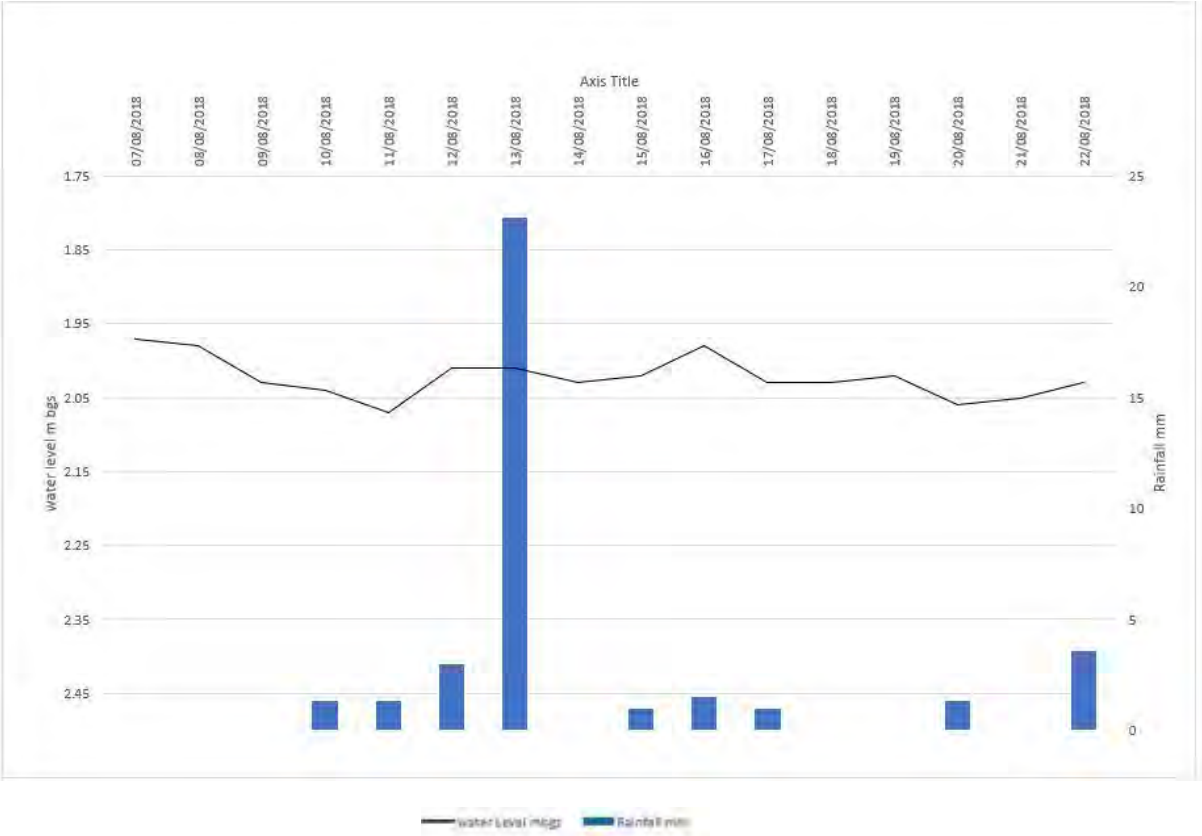


Figure 1 Groundwater levels and rainfall data for WS04, between 7th and 22nd August 2018

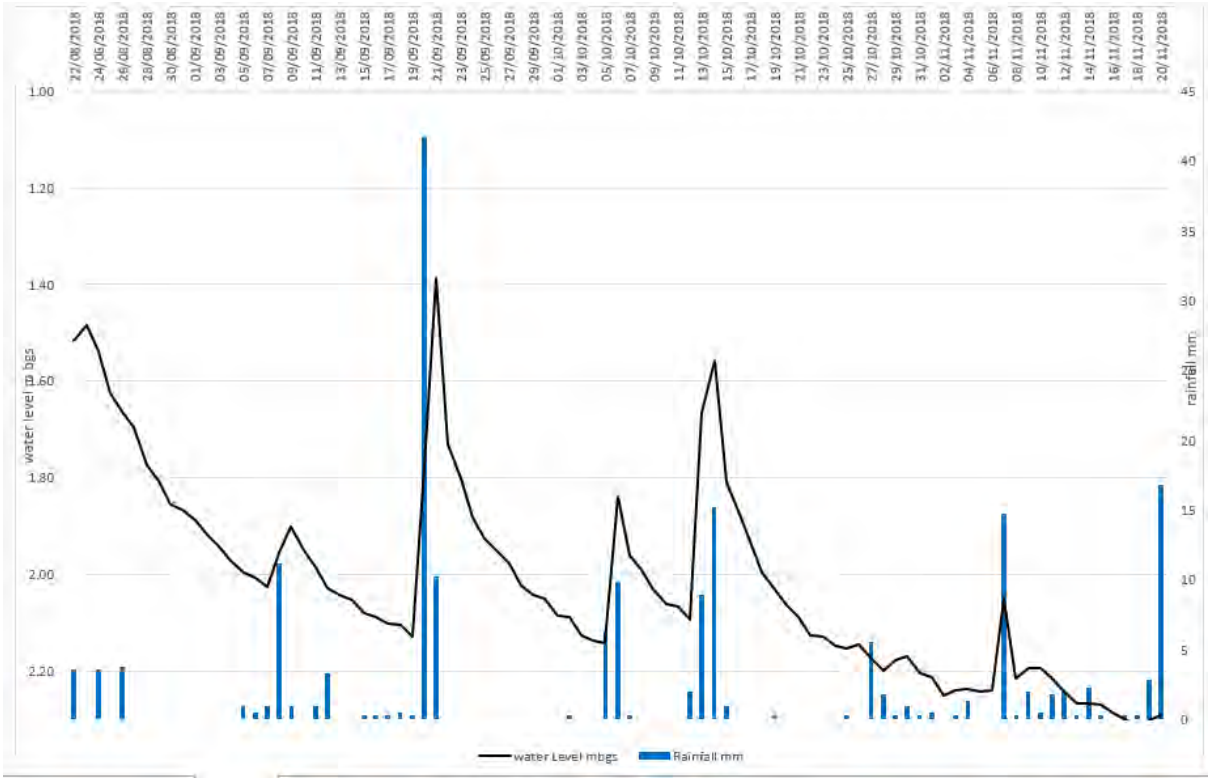


Figure 2 Groundwater and rainfall data at WS01, between 22nd August and 20th November 2018

Monitoring point WS01 is located close to the boundary of the site with Piccadilly and hence furthest away from the river Foss. Throughout the period the trend has been an overall drop in water levels with periodic recharge resulting directly from rainfall events. Ground water is currently at 2.29 m BGS, and the highest the water level has risen was 1.39m BGS on the 21st September following 41.7mm of rainfall on the preceding day.

The limited period of monitoring conducted at WS04 (7th-20th August) indicates the water table here is prone to fewer fluctuations, with a maximum height of 1.96m BGS but more typically, around 2.05m BGS. The overall higher level for the water table at this location is likely due to the canalization of the Foss acting as a barrier to groundwater flow.

The results from the monitoring indicate that deposits below 2.3 m BGS have remained saturated throughout this 3-month period.

WATER QUALITY MEASUREMENT

The water quality sonde, the Aqua Probe AP2000, was installed in WS04 to a depth of circa 4.5m BGS on 22nd August 2018, and data downloaded on the 20th November 2018. For the purposes of this interim report, the maximum and minimum values for each parameter are reported on Table 1 below.

Parameter	Maximum	Minimum	Comments
pH	7.62	7.15	
Dissolved Oxygen	89.9%	0%	Highest value observed soon after sensor installed, then dropping to 0% almost immediately
Redox (ORP)	113mV	-542.7mV	Highest value recorded at installation then trending towards highly reducing conditions (increasingly negative values)
Conductivity (EC)	2312 uS/cm	1965uS/cm	
Temperature	16.3°C	12°C	Highest value recorded at installation, then temperature broadly stable around 12°C

Table 1 water quality parameters from WS04 22nd August to 20th November 2018

The results indicate the conditions are anoxic (no oxygen), pH neutral and stable in relation to temperature. The redox (ORP) values are highly negative, again indicative of environments where oxygen is absent. A positive ORP value was recorded at the start of the monitoring program. These conditions are conducive to the continued preservation of organic archaeological remains. High conductivity values indicate that the below ground deposits are recharged primarily by groundwater flow and rainfall (recharge through rainfall only produces much lower conductivity values).

SEDIMENT CHARACTERISTICS

Sediment characterization was performed on three undisturbed sediment samples from WS01, WS03 and WS04. Geotechnical tests include permeability, porosity and organic content to assess how fast water can flow through, or be bound, to the sediment, and a couple of chemical tests to identify the pH and the total sulphate concentration, the latter providing a coarse indicator of the reducing (or oxidizing) nature of the sediments. All tests were performed by Geolabs Ltd (UKAS accredited).

Borehole	Depth BGS	Description	pH	Organic Content	Total Sulphate content	Porosity	Coefficient of Permeability $X10^{-10}$ m/s
WS01	6.5-7.0m	Firm dark brown sandy clayey amorphous peat with rare fine to medium brick fragments	7.7	8.5%	0.74%	41%	9.3×10^{-10} m/s
WS03	5.5-6.0m	Firm dark brown and black clayey sandy amorphous peat with rare gravel sized ceramic pipe fragments	7.8	6.2%	0.56%	57%	7.1×10^{-10} m/s
WS04	3.5-4.0m	Firm dark brown sandy organic clay with rare gravel	8.4	1.9%	0.27%	59%	1.8×10^{-9} m/s

Table 2 results of the geotechnical investigation of samples from Castle Mills, York

Low coefficient of permeability values, together with moderate organic content and porosity values indicate sediments that have the capability to retain water during fluctuations in the water table. The nature of the sediments is such that as the water level drops, a capillary zone will be established as a result of the water gradually rising due to capillary action, even if the water table drops.

All sediments are neutral or slightly alkaline (WS04), and the presence of low concentrations of sulphate suggest that reducing conditions prevail throughout the deep deposits within the water table.

APPENDIX 6 - SUMMARY OF MICROFOSSIL AND MACROFOSSIL EVIDENCE

BY IAN PANTER

The biological characterization of the deposits at Castle Mills was carried out by Palaeoecology Research Services (please refer to report PRS 2018/29 for further information Appendix 8), assessing three samples from WS01, one from WS03 and four samples from WS04. Nothing was submitted from WS02 due to the hydrocarbon contamination.

This assessment demonstrated that whilst biological remains are preserved across the site either by waterlogging or by charring, the overall level of preservation is poor, presumably resulting from fluctuating groundwater levels leading to oxygen ingress into the deposits. Comparison with the results from a previous campaign of coring conducted by YAT in 1991 suggests that the preservation levels have declined over the intervening 27 years. However it is noted that this is a personal and subjective assessment made by the author of the report who states that "..the two exercises are not directly comparable, as no attempt was made to record scale for abundance, diversity and preservation of remains in 1991".

CONCLUSIONS

The data collected to date suggests that deposits below circa 2.4m BGS reside below the water table and have remained saturated and anoxic throughout the period of monitoring.

Investigations carried out on the biological markers indicates an overall poor level of preservation, especially when compared with samples retrieved in 1991, although it is noted that this is a subjective observation from the specialist who worked on both sets of material.

Full results of the study into the site hydrology are detailed in Appendix 7.

APPENDIX 7 – GROUNDWATER AND DEPOSIT MONITORING: FINAL REPORT

BY IAN PANTER

INTRODUCTION

This report discusses the results of a six-month groundwater monitoring programme at the site of the former public car park in Castle Mills, Piccadilly, York, and should be read in conjunction with the interim report issued in November 2018. Due to operational reasons the monitoring period covers just over seven months of recorded data.

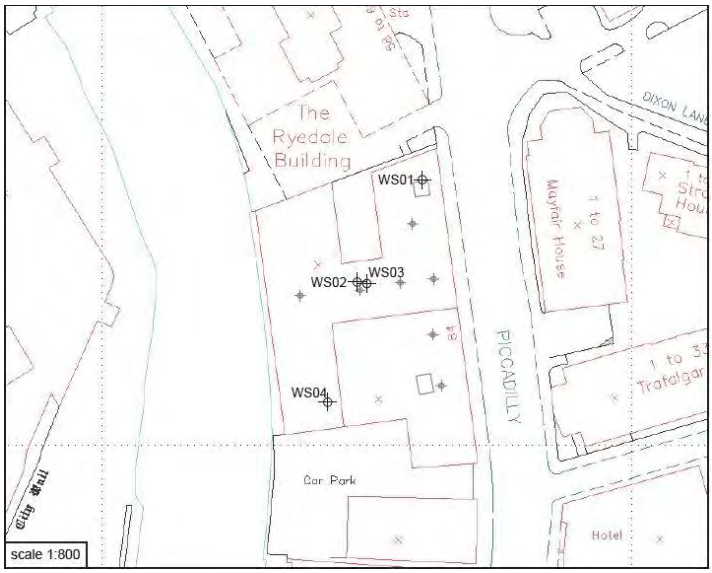


Figure 1. Borehole locations

To recap, four boreholes (figure 1) were drilled between 23rd and 25th July 2018 using a lightweight windowless dynamic coring rig (GA Site Investigation) and dipwells installed to monitor ground water levels and water quality. Each dipwell comprised a plastic standpipe, 50mm diameter, and nominally plain pipe to 1.0m below ground surface (BGS) encased in bentonite (to prevent surface water ingress) with the remainder slotted pipe with gravel surround to act as a filter. Boreholes were drilled to a depth of 10m BGS, apart from WS01 where undisturbed natural was encountered at 8.0m BGS and WS02 where an obstruction was hit at 8m and drilling ceased. A strong hydrocarbon odour emanated from boreholes WS02 and WS03 indicating below-ground contamination.

Water levels are logged using the Rugged TROLL™ 100 pressure transducer (from In-Situ Europe) suspended below the groundwater table. As these transducers are of the non-vented type, a BaroTROLL™ (recording barometric pressure) was deployed to enable compensation for localised changes in atmospheric pressures.

Prior to installation the transducer was calibrated to the initial depth to the groundwater table, measured with an audible dipmeter and set to collect readings every six hours starting 30 minutes following installation.

Water quality data has been collected by the Aqua Probe™ 2000 sonde, connected to an Aqualogger™ R2000 data logger (both Bell Flow Systems Ltd) recording optical dissolved oxygen, pH, conductivity (EC), redox (ORP) and temperature.

Three sealed undisturbed sediment samples were extracted from WS01, 03 and 04 and submitted for permeability and geochemical assays (Geolabs Ltd), whilst bulk sediment samples were sent to Palaeoecology Research Services Ltd for assessment of the preservation of the bioarchaeological remains.

GROUND WATER LEVELS

Transducers were installed on the 7th August 2018, after allowing a minimum of at least one week for groundwater levels to rebound and stabilise following intervention. One Rugged TROLL™ 100 and Rugged BaroTROLL™ were installed into WS04, but a second transducer could not be installed into WS01 as access was impossible due to damage caused by plant running over the well head. Neither WS02 nor WS03 were suitable due to the overpowering hydrocarbon odour emanating from each when the dipwell plugs were removed.

The transducer was installed to a depth c. 4m BGS with the BaroTROLL™ installed to a depth of approximately 0.5m BGS to ensure that it remained above the groundwater level throughout.

Both transducers were transferred to WS01 on 22/8/2018 (following repairs to the well head) and the water quality meter installed in WS04.

The data has been corrected for variations in barometric pressure using the Win-Situ Baro Merge™ software and the pressure data collected by the BaroTroll installed in WS01. Figure 2 shows the groundwater level in WS04 from the 7th August – 22nd August 2018, whilst Figure 3 shows the level at WS01 covering the period 22nd August 2018 – 23rd April 2019. Rainfall amounts have been downloaded from the Weather Underground website, using data from the York 40 station (https://www.wunderground.com/weather/gb/york/IYORK40).

Figure 2: depth to groundwater for period 07/08/18 – 21/08/18 in WS04

The limited period of monitoring conducted at WS04 (7th-21st August 2018) indicates the water table here is relatively stable and prone to less fluctuations, reaching a maximum height of 1.96m BGS but more typically, around 2.05m BGS. The overall higher level for the water table at this location is likely due to the canalization of the Foss which is acting as a barrier to groundwater flow. Evidence suggests that rainwater has little or no effect on the groundwater levels at this location.

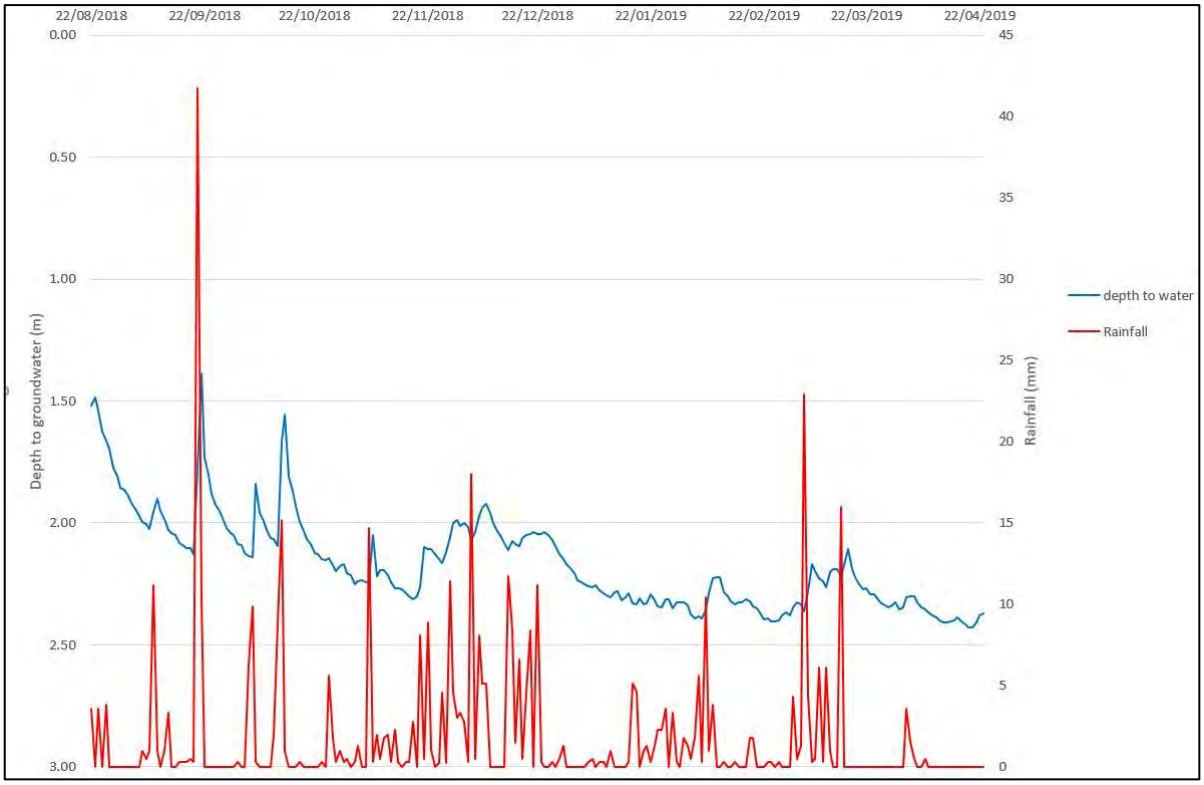


Figure 3: Groundwater levels in WS01 and rainfall data 22/8/18-23/04/19

However, at WS01 (figure 3) which is situated close to the Piccadilly street frontage, the groundwater levels are more dynamic and have fluctuated throughout the period, rising to a maximum height of 1.39m bgs and falling to a low of 2.43m bgs.

There is positive correlation between rainfall and groundwater levels, with water levels responding to rainfall events. For example, an intense storm on the 20th September 2018 where over 41mm of rain fell during the day caused the groundwater to rise to its highest level (1.39m bgs) 24 hours later. A total of almost 440mm of rain was recorded for York during this period which has helped to recharge the deposits.

WATER QUALITY MEASUREMENT

Water quality measurements have been collected in WS04 using the Aqua Probe™ 2000 sonde, connected to an Aqualogger™ R2000 data logger (both Bell Flow Systems Ltd) recording optical dissolved oxygen, pH, conductivity (EC), redox (ORP) and temperature. Prior to installation the pH and conductivity sensors were calibrated using RapidCal™ Solution and the RapidCal™ software, and the ORP (redox) sensor was calibrated using a REDOX standard 250mV solution (at 25°C) for the Silver/Silver Chloride electrode. Recalibration of the ORP sensor was carried out during data download on the 20th November 2018. The dissolved oxygen sensor had been factory calibrated.

The sensor array was installed in WS04 to a depth of circa 4.5m BGS on 22nd August 2018, with the datalogger set to record data every six hours. The averaged results are summarized in Table 1:

Parameter	Maximum	Minimum
pH	7.62	7.15
Dissolved Oxygen	89.9%	0%
Redox (ORP)	113.6mV	-542.7mV
Conductivity (EC)	2312 uS/cm	1734uS/cm
Temperature	16.3°C	12°C

Table 1: water quality parameters from WS04, Castle Mills, York.

The key criteria that define the characteristics of the buried environment are the ORP (redox) potential and the dissolved oxygen concentration. Redox is shorthand for reduction/oxidation – negative readings indicate reducing conditions (good for organic preservation) and positive readings imply oxidizing conditions where decay is ongoing. Likewise for oxygen concentration where low, or no oxygen, is ideal for preservation.

The high oxygen concentration (89.9%) was recorded at the moment of installation into the dipwell, before the sensor was submerged under water. Subsequently, all oxygen values are 0%, indicating that the groundwater is anoxic.

The ORP(redox) values have remained highly negative, typically between -400mV and -500mV (the single positive value of 113.6mV was recorded prior to installation) indicating strongly reducing conditions (Figure 1).

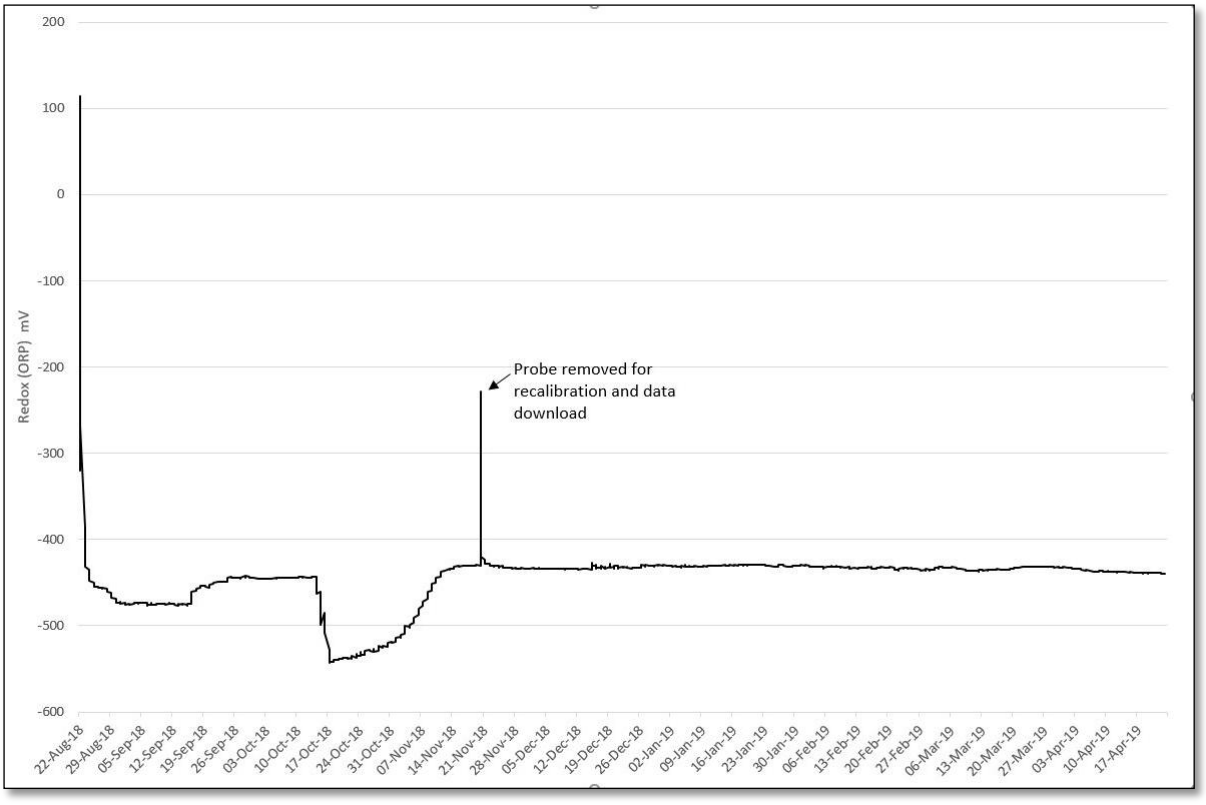


Figure 3: measured redox (ORP) values from WS04, Castle Mills, Piccadilly, York.

The results of the water quality monitoring have confirmed the initial findings that the conditions are anoxic (no oxygen), pH neutral and stable in relation to temperature. The redox (ORP) values are highly negative, again indicative of environments where oxygen is absent. Such conditions are conducive to the continued preservation of organic archaeological remains. High conductivity values indicate that the below ground deposits are recharged primarily by groundwater flow and rainfall (recharge through rainfall only produces much lower conductivity values).

SEDIMENT CHARACTERISTICS

Sediment characterization was performed on three undisturbed sediment samples from WS01, WS03 and WS04. Geotechnical tests include permeability, porosity and organic content to assess how fast water can flow through, or be bound, to the sediment, and a couple of chemical tests to identify the pH and the total sulphate concentration, the latter providing a coarse indicator of the reducing (or oxidizing) nature of the sediments. All tests were performed by Geolabs Ltd (UKAS accredited).

Borehole	**Depth BGS**	**Description**	**pH**	**Organic Content**	**Total Sulphate content**	**Porosity**	**Coefficient of Permeability $X10^{-10}$ m/s**
WS01	6.5-7.0m	Firm dark brown sandy clayey amorphous peat with rare fine to medium brick fragments	7.7	8.5%	0.74%	41%	9.3×10^{-10} m/s
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WS04	3.5-4.0m	Firm dark brown sandy organic clay with rare gravel	8.4	1.9%	0.27%	59%	1.8×10^{-9} m/s

Table 2: results of the geotechnical investigation of samples from Castle Mills, York.

Low coefficient of permeability values, together with moderate organic content and porosity values indicate sediments that have the capability to retain water during fluctuations in the water table. The nature of the sediments is such that as the water level drops, a capillary zone will be established as a result of the water gradually rising due to capillary action, even if the water table drops.

All sediments are neutral or slightly alkaline (WS04), and the presence of low concentrations of sulphate suggest that reducing conditions prevail throughout the deep deposits within the water table.

ASSESSMENT OF MICROFOSSIL AND MACROFOSSIL EVIDENCE

The biological characterization of the deposits at Castle Mills was carried out by Palaeoecology Research Services (please refer to report PRS 2018/29 for further information, Appendix 8), assessing three samples from WS01, one from WS03 and four samples from WS04. Nothing was submitted from WS02 due to the hydrocarbon contamination.

This assessment demonstrated that whilst biological remains are preserved across the site either by waterlogging or by charring, the overall level of preservation is poor, presumably resulting from fluctuating groundwater levels leading to oxygen ingress into the deposits. Comparison with the results from a previous campaign of coring conducted by YAT in 1991 suggests that the preservation levels have declined over the intervening 27 years. However it is noted that this is a personal and subjective assessment made by the author of the report who states that "..the two exercises are not directly comparable, as no attempt was made to record scale for abundance, diversity and preservation of remains in 1991".

CONCLUSIONS

Based on the results from the geochemical sampling exercise and groundwater monitoring program, the sub-surface deposits below 2.4 m bgs) remain waterlogged, anoxic and highly reducing. The primary influences on the water levels are from natural groundwater flow through the site as well as rainwater, with levels closest to the river Foss almost static (due to the canalization of the Foss impeding water movement) whilst greater fluctuations are observed in the deposits furthest away from the river Foss. As almost all of the development area is hard paved or concreted over, effective recharge can only be achieved primarily via continued groundwater movement through the sub-surface deposits. Any activity that physically isolates the site from its surroundings– for example, contiguous sheet piling – should be avoided.

The monitoring equipment has now been retrieved and can be re-instated once all construction work has been completed.

REFERENCES

Carrott, J. Assessment of microfossil and macrofossil remains from samples recovered from borehole investigations at Castle Mills Car Park, Piccadilly, York. (PRS Report 2018/29)

APPENDIX 8 – ASSESSMENT OF MICROFOSSIL AND MACROFOSSIL REMAINS

Palaeoecology Research Services ***PRS*2018/29**

Assessment of microfossil and macrofossil remains from samples recovered from borehole investigations at Castle Mills Car Park, Piccadilly, York

by

John Carrott

Summary

An archaeological evaluation by borehole survey was undertaken at Castle Mills Car Park, Piccadilly, York. The aim of the survey was to characterise the hydrology and soil conditions of the site and to provide a baseline model for comparison with further monitoring points that will be installed and monitored during and after the forthcoming redevelopment of the site; this will create a data set that will aid in understanding the impact of piled developments on waterlogged soil horizons. Four boreholes (WS01-WS04) were sunk to depths of up to 10 metres below the current ground level using a lightweight windowless dynamic coring rig and eight extracted samples (from three of the boreholes) were submitted for an assessment of their bioarchaeological potential. No samples were submitted from Borehole WS02 owing to contamination with fuel.

The assessment demonstrated that biological remains preserved by waterlogging and occasionally by charring were present in the deposits underlying the site. Remains recovered from two deposits in Borehole WS01 suggested aquatic deposition, whereas those from a third, the lowermost assessed, reflected waterlogged rough/waste ground (perhaps an area of scrub vegetation subject to flooding). The assemblages of biological remains from the assessed samples from Boreholes WS03 and WS04, were dominated by decayed wood fragments, with other remains present suggesting marginal wetland at the water's edge rather than a fully aquatic environment.

There was consistent evidence for human activity which appeared to be primarily the casual disposal of artefactual, fuel and food waste – there did not appear to be sufficient material present to represent anything more than this but, given that the current samples have been collected from a borehole survey, and are therefore lacking in archaeological context, this can only be provisionally asserted. Casual disposal of waste materials in such an area at the periphery of occupation, or more systematic disposal in an attempt to consolidate an area of wet marginal land, would be entirely consistent with past human activities, however. From Borehole WS01 there was also evidence of faecal contamination of the deposits in the form of small numbers of intestinal parasite eggs – positively identified from the two upper deposits and more tentatively from the lowermost.

A very small number of artefactual remains recovered from the assessed samples could, perhaps, provide dating evidence for some of the deposits and radiocarbon dating (via AMS) of plant remains could also be employed for all bar two which were contaminated with fuel (although the quantities of dateable material were typically small).

No further study of the current samples is warranted. However, this assessment has shown that deposits at this site continue to exhibit waterlogged preservation of organic remains – albeit (subjectively) there has been some degree of deterioration over time when the results from the current exercise are compared with those from a previous borehole survey of the site undertaken in 1991.

KEYWORDS: CASTLE MILLS CAR PARK; PICCADILLY; YORK; BOREHOLE INVESTIGATION; ASSESSMENT; MEDIEVAL; PLANT REMAINS; WOOD; CHARCOAL (TRACE); CHARRED GRAIN (TRACE); INVERTEBRATE REMAINS; CLADOCERAN EPHIPPIA; INSECTS; BEETLES; MOLLUSCS (TRACE); FRESHWATER MOLLUSCS (TRACE); MICROFOSSILS; POLLEN GRAINS/SPORES; DIATOMS (TRACE); PARASITE EGGS (TRECAE); VERTEBRATE REMAINS; FISH BONE (TRACE); WATERLOGGED PRESERVATION

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26 November 2018

Assessment of microfossil and macrofossil remains from samples recovered from borehole investigations at Castle Mills Car Park, Piccadilly, York

Introduction

An archaeological evaluation by borehole survey was undertaken by York Archaeological Trust (YAT), between the 23rd and the 25th of July 2018, at Castle Mills Car Park, Piccadilly, York (NGR SE 60652 51415).

Four boreholes were extracted and the deposits encountered recorded by YAT. Three instrumented water monitoring points and one instrumented water quality sensor were installed and will be observed over a six month period. The aim of the survey was to characterise the hydrology and soil conditions of the site and to provide a baseline model for comparison with further monitoring points that will be installed and monitored during and after the forthcoming redevelopment of the site; this will create a data set that will aid in understanding the impact of piled developments on waterlogged soil horizons.

Five preliminary phases were assigned to the encountered deposits by YAT based on the recording of the sediments in the field:

Phase 1 – natural deposits
Phase 2 – alluvial clay/organic deposits
Phase 3 – medieval fish pool silts
Phase 4 – 18th-19th century land reclamation
Phase 5 – 20th century industrial waste/ground build-up

Eight small 'bulk' sediment samples ('GBA'/'BS' *sensu* Dobney *et al*. 1992) extracted from the boreholes, were submitted to Palaeoecology Research Services Limited, Kingston upon Hull, for an assessment of their bioarchaeological potential.

Methods

Coring

Four boreholes (designated Boreholes WS01 to WS04) were sunk to depths of up to 10 metres below the current ground level (hereafter BGL) using a lightweight windowless dynamic coring rig.

Sediment descriptions and sampling

The borehole cores were recorded on-site by YAT and sediment subdivisions were assigned context numbers. The eight contexts selected for submission to PRS for assessment were extracted into corresponding samples placed into labelled polythene bags. Descriptions and depth ranges for the represented contexts were recorded by YAT on standard *pro forma* sheets.

The eight bagged samples were delivered to the offices of Palaeoecology Research Services Ltd (PRS) in Kingston upon Hull where the lithologies of the sediments were recorded following a PRS *pro forma*.

Sample selection and processing

Eight samples were submitted to PRS – three from Borehole WS01, one from Borehole WS03 and, four from Borehole WS04. No samples were collected from Borehole WS02 owing to hydrocarbon contamination – also noted to a lesser degree in Boreholes WS01 and WS03.

All eight of the submitted samples were processed for the recovery of plant and invertebrate macrofossils, broadly following the techniques of Kenward *et al*. (1980); weights and approximate volumes of the subsamples were recorded prior to processing. Paraffin flotation, for the separation of insect and other non-molluscan invertebrate remains from waterlogged plant material, was not employed in order to avoid contamination of any potential radiocarbon dating material with fossil hydrocarbons; Two of the samples, from Borehole WS01 (from Contexts 113 and 117) were noted to be already contaminated, however – these sample were processed as they had not been identified as contaminated during the initial inspection.

For each of the processed macrofossil samples, small quantities of sediment (a few grams) were extracted for a parallel investigation of microfossil content and preservation.

Macrofossil and residue recording

Plant and invertebrate remains in the processed subsample fractions (washovers and residues) were recorded by 'scanning' using a low-power, x7 to x45, binocular microscope where necessary, identifiable taxa and other components being listed on paper. All of the washovers were predominantly of waterlogged organic material and were examined wet. A five-point scale was employed to record the proportion of organic material recovered in the washover fraction (see Table 2). Five-point scales were also employed to record the abundance, diversity and preservation of the plant and invertebrate remains recovered (Table 2); the scales for diversity and preservation following those created by Smit *et al*. (2006) for the recording of botanical macrofossils, with some minor modifications to accommodate their extension to additional classes of remains.

The residues were primarily mineral in nature and were dried prior to the recording of their components. The dry weight of each residue was recorded, their general composition was described and they were then sorted (having been separated in to three fractions using 1 and 10 mm sieves to assist this process – the less than 1 mm fractions being scanned but not subject to detailed sorting). Additional data regarding the quantity, size and weight of any inorganic and biological material sorted from the residues was also recorded (see Table 6). The residue fractions, including those less than 1 mm, were also scanned for magnetic material.

Specific identification of macrofossil remains was undertaken where possible to determine values for abundance and diversity and to provide additional information regarding the origin of the material or the nature and depositional environment of the deposits.

Plant macrofossil remains were compared with modern reference material (where possible) and with published works (e.g. Cappers *et al*. 2006; Jacomet 2006) and identified to the lowest taxon possible or necessary to achieve the aims of the project. Nomenclature for plant taxa follows Stace (1997).

Wood and charcoal identifications were attempted for a small number of fragments (all over 4 mm). Pieces were broken to give a clean radial cross-sectional surface and the anatomical structures were examined using a low-power binocular microscope (x7 to x45). Basic identifications were made by comparison with modern reference material, where possible, and with reference to published works (Hather 2000; Schoch *et al*. 2004).

Freshwater mollusc remains were examined and individuals identified as closely as possible, within the time constraints of the assessment (it is, therefore, possible that some identifications could be refined) with reference to published works (chief sources: Ellis 1969 and 1978; Macan 1977). Nomenclature follows Kerney (1999). Non-molluscan invertebrates were also identified with reference to published works (e.g. for beetles, Tottenham 1954; Crowson 1956; Lindroth 1974) and within the constraints of an assessment; in the event some family and provisional genus level identifications could be made but none to species level.

Vertebrate remains were identified to species or species group using the PRS modern comparative reference collection and published works (e.g. Schmid 1972). The bones which could not be identified to species were described as 'unidentified', within which fragments were grouped into size categories (where possible): large mammal (assumed to be cattle, horse or large cervid), medium-sized mammal (assumed to be caprovid (sheep/goat), pig or small cervid), unidentified fish and wholly unidentifiable. Subjective records were made of the state of preservation and other information, such as fragment size, dog gnawing, burning, butchery and fresh breaks, was noted, where applicable. Nomenclature for fish follows Wheeler (1969).

During recording, consideration was given to the suitability of the remains for submission for radiocarbon dating by standard radiometric technique or accelerator mass spectrometry (AMS). Notes regarding the presence of such material are included in Table 4.

Microfossil recording

Microfossil content and preservation was investigated using the 'squash' technique of Dainton (1992). This was originally developed specifically to assess the content of eggs of intestinal parasitic nematodes but routinely reveals other microfossils, such as pollen and diatoms (which were the focus of the investigations here). The assessment slides were scanned at 150x magnification with 600x used where necessary.

The same scale employed for the proportion of organic material within the washover was used to record the percentage of organic material within the raw sediment seen under the microscope (at 150x magnification). Similar five-point scales to those used to record the abundance, diversity and preservation of macrofossils were created for the assessment of the microfossils (Table 3).

Provisional identifications for pollen grains and spores were made by comparison with modern reference material and the use of published works (principally Moore *et al*. 1991). Semi-quantitative abundances were recorded as outlined above for the macroscopic remains.

Determination of the presence/absence of diatoms, their approximate numbers (semi-quantitative scale as above) and an estimation of the minimum number of different forms represented was made with reference to published works (Barber and Haworth 1981; Hartley *et al*. 1996).

Counts were made of any intestinal parasite eggs present. Detailed measurements were not taken but approximate 'spot' measurements were taken for trichurid and ascarid eggs. Nomenclature for these parasites follows Ash and Orihel (1984) for those of humans and Kassai (1998) for non-human hosts.

Results

The results of the investigations are summarised below by borehole. Details of the sediment samples submitted from each borehole are presented in Table 1. Details and summary data for the plant and invertebrate macrofossil remains recovered in the washovers from the processed samples are given in Tables 4 and 5, Table 6 shows the results from the corresponding residues and the microfossil records are presented in Table 7.

It should be noted that any depths given in the following text (and tables) are taken from the on-site records of the sediments made during coring and can only be approximate – allowing for voids in the recovery and the possibility of compression by the coring process.

Borehole WS01

Three samples from Borehole WS01 were processed representing the deposits encountered at below current ground level (BGL) depths of ~3.75-4.40m (Context 112; Sample 1), 4.40-4.70m (Context 113; Sample 2) and 5.60-5.70m (Context 117; Sample 4), and all assigned to Phase 2 (alluvial clay/organic deposits).

All three of the samples yielded waterlogged plant and invertebrate remains but the former was predominantly indeterminate detritus (becoming progressively finer and less 'woody' with decreasing depth BGL) and the latter mostly 'scraps' of indeterminate cuticle. Identifiable plant macrofossils were relatively scarce throughout with those from the lowest deposit, Context 117, being mostly of elder (*Sambucus nigra* L.) fruits and blackberry/raspberry (*Rubus fruticosus* L. agg./*R. idaeus* L.) fruit stones – both 'woody', decay-resistant, structures – perhaps indicating 'scrub' woodland or hedgerow. The uppermost of the three deposits, Context 112, yielded less durable remains of plants indicative of less substantial vegetation on wet and/or rough ground (rush – *Juncus*; stinging nettle – *Urtica dioica* L.; orache/goosefoot – *Atriplex*/*Chenopodium*). Cladoceran (water flea) ephippia ('resting eggs') were recorded from all three deposits and were abundant in Contexts 112 and 113, which suggests aquatic deposition in each case (supported by fragments of ?freshwater mussel (*Margaritifera*/*Unio*) shell from Context 113 and occasional diatoms noted in both of the upper deposits – *Pinnularia* sp.). The ephippia could imply that the water was not permanent and subject to drying-out, however, as they are formed as a response to environmental stress (as a mechanism for rapidly re-establishing populations when suitable conditions return) such as may be induced by the consequent reduction in water quality/over-crowding (Frey 1982). Alternatively, and perhaps more likely here given the presence of food waste (animal bone fragments) and evidence of faecal contamination (intestinal parasite eggs) from all three deposits and artefactual debris (brick/tile, mortar, pot, hammerscale, fuel waste) from Contexts 113 and 117 (the latter in particular), the ephippia may have been formed in response to pollution. Other invertebrate remains were of little interpretative value as, although abundant from Contexts 112 and 113 (and present in Context 117), none were identified more closely than to family for this assessment (rove beetle – Staphylinidae – elytra from Context 112) and very few would be identifiable even to detailed study – if large sediment samples could be collected, of the order of 10-20 litres, then useful assemblage of beetle remains could perhaps be recovered from Contexts 112 and 113, however. Pollen grains/spores were

recorded in the 'squash' subsamples from all three deposits but in small numbers and preservation was uniformly poor – only the tentative identifications of ?birch (cf. *Betula*) pollen and ?trilete moss spores (cf. *Sphagnum*) from Context 113 potentially provided a little more significant information regarding the past vegetation of the area at the time of the deposit's formation.

Borehole WS03

A single sample representing the Phase 2 (alluvial clay/organic deposits) deposit encountered at 9.60-9.75m BGL (Context 325; Sample 10) was processed from this borehole.

The material recovered included artefactual material (brick/tile fragments), food waste (animal bone fragments and a single charred wheat, *Triticum*, grain) and fuel waste (cinder, coal and charcoal), together with some evidence for waterlogged preservation (albeit poor) of plant and invertebrate macrofossils and occasional microfossils. The charcoal was all rectilinear (to no more than 9 mm) and largely indeterminate but the two largest fragments were of oak (*Quercus*). Identifiable waterlogged plant macrofossils were restricted to a few ?stinging nettle achenes as preservation was poor (much of the material was very decayed unidentifiable wood fragments) and the invertebrate remains were mostly 'scraps' of indeterminate insect cuticle (there were a few complete but non-diagnostic beetle abdominal sclerites and a few rove beetle elytra – the latter perhaps identifiable more closely with further study) with a small number of unidentifiable mollusc shell fragments. Interpretatively valuable microfossils comprised occasional poorly preserved pollen grains/spores representing at least three taxa but only one, ?alder (cf. *Alnus*) could be tentatively identified, and two eroded and broken diatom frustules (*Pinnularia* sp. and *Epithemia*/*Eunotia* sp.). Overall, there was little here for interpretation other than to note the poor preservation of the uncharred remains, the hint at aquatic deposition provided by the trace level of diatoms and the inclusion of waste from human activity.

Borehole WS04

Four samples were processed from Borehole WS04 representing the Phase 2 deposit encountered at 8.00-8.80m (Context 429; Sample 8), the Phase 3 (medieval fish pool silts) deposits at 5.60-5.75m (Context 420; Sample 7) and 4.75-4.80m (Context 416; Sample 11) and the Phase 4 (18th-19th century land reclamation) deposit at ~4.10-4.15m (Context 427; Sample 6) BGL.

All four samples again contained plant and invertebrate macrofossils preserved by anoxic waterlogging but in rather poor condition, together with a little, fuel and other waste from human activity and, if all bar the uppermost deposit (Context 427), a few microfossils.

The lowermost (Phase 2) deposit, Context 429, included waterlogged wood fragments some of which were roundwood 'twigs' retaining bark – two were partially identified as a diffuse-porous species and representing five or less years of wood growth – and biconvex sedge (*Carex*) nutlets which most likely indicate wet/waterlogged ground. Invertebrate remains were predominantly indeterminate fragments of beetle sclerites – with occasional non-diagnostic abdominal elements and a few rove beetle elytra (perhaps identifiable to species by further study) – and there was a single piece of ?freshwater mussel shell. Traces of fuel waste were present in the form of a little coal, cinder and fine indeterminate rectilinear charcoal, and there was a little mortar. There were also two tiny bone fragments, one of which was possibly fish, but these could not be identified any more closely

and do not necessarily reflect food waste. Occasional pollen grains/spores were noted in the 'squash' subsample. These exhibited variable preservation as most were crumpled and eroded but there were a few somewhat better preserved grains which were provisionally identified as ?plantain (cf. *Plantago*). Also noted was a single diatom frustule which was complete but somewhat eroded (*Cyclotella* sp).

The organic remains from the two Phase 3 deposits, Contexts 416 and 420, were mostly indeterminate waterlogged wood fragments which were decayed and largely indeterminate; a small number of larger pieces were all of oak or ?oak but there was no roundwood where number of years of wood growth represented could be determined. Both deposits contained small numbers of biconvex and trigonous sedge nutlets probably representing waterlogged ground/waterside, with Context 416 also yielding stinging nettles achenes suggesting waste ground. Invertebrate remains were more numerous in Context 420 but extremely poorly preserved, whereas the lesser numbers from Context 416 included a water scavenger beetle (cf. *Cercyon* sp.) elytron (again suggesting a waterside location) and also some ant (Formicidae) heads which would suggest a terrestrial habitat (so perhaps an area subject to periodic inundation); both deposits also gave a little ?freshwater mussel shell. Only a single pollen grains/spore was noted from Context 416 (not identified but perhaps identifiable to further study) but Context 420 contained rather more which exhibited variable preservation with better preserved remains including ?plantain, grass-type and ?chickweed/stitchwort (cf. *Stellaria*). Both deposits contained a little fuel waste in the from of indeterminate rectilinear charcoal and cinder, from Context 420 there was also a little brick/tile and mortar, and Context 416 gave a single fish vertebra provisionally identified as herring (*Clupea harengus* L.) and (if confirmed) most likely to represent food waste. A few spheres of hammerscale were present in Context 420 and there were two small rusted iron fragments from Context 416 which *may* also be artefactual.

Organic material from the Phase 4 deposit, Context 427, was also predominantly of indeterminate decayed waterlogged wood fragments with the three largest fragments positively identified as oak; all of the wood was rectilinear and of an indeterminate number of years of wood growth. Other plant macrofossil remains were scarce and poorly preserved but included seeds of orache/goosefoot and chickweed/stitchwort and some moss (Bryophyta) 'stems and leaves'. Invertebrate remains were restricted to some indeterminate 'scraps' of insect cuticle and three fragments of ?freshwater mussel shell, and vertebrate remains to three fragments of indeterminate medium-sized or large mammal bone (the last presumably food waste). Other material derived from human activity consisted of a few spheres of hammerscale and traces of indeterminate rectilinear charcoal and cinder (the two last presumably fuel waste). No interpretatively valuable microfossils were recorded from the 'squash' subsample which was largely inorganic.

Discussion and statement of potential

This assessment has demonstrated that biological remains preserved by anoxic waterlogging and charring are present in deposits underlying the site at Castle Mills Car Park, Piccadilly, York. Preservation of the waterlogged remains was consistently poor, however, and it seems likely that this is a reflection of fluctuations in the level of the water table resulting in repeated wetting and drying and an influx of oxygenated water – i.e. that the permanently waterlogged and ultimately anoxic conditions which lead to excellent preservation of uncharred organic remains have not occurred, or at least not persisted.

The biological remains from the two upper deposits assessed from Borehole WS01, Contexts 112 and 113 (Phase 2), suggested aquatic deposition, whereas this was much less strongly implied by those

from the lower deposit, Context 117 (also Phase 2) where the assemblages appear to reflect waterlogged rough/waste ground (perhaps an area of scrub vegetation subject to flooding). It should be noted, however, that the identifiable plant remains from Context 117 were predominantly of robust, decay-resistant, structures (blackberry/raspberry fruit stones, elder fruits,) and that there is, therefore, a strong suggestion of taphonomic bias in the interpretation of the assemblages – particularly given the small size of the available sediment samples inherent in recovery by coring.

The assemblages of biological remains from the assessed samples from Boreholes WS03 and WS04, were dominated by decayed wood fragments, with other remains present suggesting marginal wetland at the water's edge rather than a fully aquatic environment.

There was consistent evidence for human activity which appeared to be primarily the casual disposal of artefactual, fuel and food waste – there did not appear to be sufficient material present to represent anything more than this but, given that the current samples have been collected from a borehole survey, and are therefore lacking in archaeological context, this can only be provisionally asserted. Casual disposal of waste materials in such an area at the periphery of occupation, or more systematic disposal in an attempt to consolidate an area of wet marginal land, would be entirely consistent with past human activities, however. From Borehole WS01 there was also evidence of faecal contamination of the deposits in the form of small numbers of intestinal parasite eggs – positively identified from the two upper deposits and more tentatively from the lowermost.

A small number of artefactual remains recovered from the assessed samples could, perhaps, provide dating evidence for some of the deposits and radiocarbon dating (via AMS) of plant remains could also be employed (although the quantities of material were typically small). Potentially dateable artefacts comprised two pot sherds from Borehole WS01 (Context 117) and there were brick/tile fragments from Borehole WS01 (Contexts 112, 113 and 117), Borehole WS03 (Context 325) and Borehole WS04 (Context 420); the latter were all small pieces and most likely non-diagnostic, however. There were also trace levels of hammerscale noted from Borehole WS01 (Contexts 113 and 117) and Borehole WS04 (Contexts 420 and 427), with, also from Borehole WS04, two small rusted iron fragments which were perhaps artefactual (Context 416) and a single leather offcut (Context 420). All of the processed samples gave at least some remains which could be considered for submission for AMS dating – though Contexts 113 and 117 should perhaps be excluded owing to hydrocarbon contamination.

Biological remains from samples collected during a previous borehole survey of the site undertaken by YAT in 1991 (YAT site code 1991.16) gave rather similar results to those reported here (Carrott *et al*. 1991). Although the two exercises are not directly comparable, as no attempt was made to record a scale for abundance, diversity and preservation of remains in 1991, a subjective comparison of the results would suggest that the state of preservation of waterlogged plant and invertebrate remains has deteriorated in the intervening 27 years.

Recommendations

No further study of the current samples is warranted. However, this assessment has shown that deposits at this site continue to exhibit waterlogged preservation of organic remains – albeit (subjectively) with some degree of deterioration over time.

Any future excavations at the site should, therefore, incorporate a systematic sampling strategy and subsequent programme of assessment and, where applicable, analysis for organic remains.

In the absence of further archaeological excavation, any development of the site should aim to minimise impact on the archaeological deposits. In particular, every effort should be made to avoid works which would disturb and potentially cause de-watering of the deposits which exhibit preservation of waterlogged organic remains.

Retention and disposal

All of the current material should be retained, for the present at least, pending a decision regarding any further work to be undertaken – in particular, the possibility of obtaining dating for the deposits; artefactual remains recovered will be returned to the excavator to be considered by appropriate specialists.

Archive

All material is currently stored by Palaeoecology Research Services (Unit 4, National Industrial Estate, Bontoft Avenue, Kingston upon Hull). Palaeoecology Research Services also retains the paper and electronic records pertaining to the work described herein.

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Table 1. Borehole investigations at Castle Mills Car Park, Piccadilly, York: Description of submitted samples – Boreholes WS01, WS03 and WS04 – no samples submitted from Borehole WS02. Key: 'B' = borehole number; 'Wt /g' = weight in grams; 'Vol /ml' = approximate volume in millilitres. Approximate depths 'From' and 'To' (extrapolated from draft figures supplied by YAT) are given in metres below current ground level (BGL). Key: Phase 1 – natural deposits; Phase 2 – alluvial clay/organic deposits; Phase 3 – medieval fish pool silts; Phase 4 – 18th-19th century land reclamation; Phase 5 – 20th century industrial waste/ground build-up.

B	From	To	Phase	Context	Sample	Wt /g	Vol /ml	Sediment description	Hydrocarbon contamination	Notes
WS01	5.60	5.70	2	117	4	1000	750	Moist, mostly dark grey (mottled with mid/dark grey and grey-brown and mid brown at a cm-scale), firm to crumbly (working soft), slightly sandy silt. Stones (20 to 60 mm) and decayed waterlogged wood fragments were present	Yes – slight 'diesel' odour and oily sheen on water surface during processing	-
WS01	~4.40	4.70	2	113	2	700	500	Moist, mid to dark grey-brown to dark grey-brown and streaked with black, stiff to brittle and crumbly (working soft), silt. Stones (6 to 20 mm) and shell of a large freshwater bivalve (probably freshwater mussel; cf. *Margaritifera*/*Unio*) were present – the latter probably representing a substantial part of a single individual but crushed (perhaps *in situ* or perhaps by compression from the coring) and will be in small fragments post-processing.	Yes – strong 'diesel' odour and oily sheen on water surface during processing	-
WS01	3.75	~4.40	2	112	1	450	300	Moist, mid to dark grey-brown, stiff to brittle and crumbly (working soft), silt. Waterlogged 'seeds' (i.e. actual seeds and other similar plant structures) and bone fragments were present.	No	Very slight sulphide odour
WS03	9.60	9.75	2	325	10	600	400	Moist, mostly mid grey-brown but internally mid/dark grey, brittle and slightly stiff to crumbly and very slightly sticky (working soft), silt. Bone fragments were present.	No	-
WS04	8.00	8.80	2	429	8	700	500	Moist, mostly mid/dark grey-brown but internally dark grey, brittle to crumbly (working soft and slightly sticky), silt. No obvious inclusions.	No	Very slight sulphide odour
WS04	5.60	5.75	3	420	7	1250	1000	Moist, varicoloured (jumbled shades of brown, gery and grey-brown from light/mid to dark amd occasionally more or less black), firm to slightly crumbly (working soft and slightly sticky), ?slightly sandy silt. Stones (2 to 60 mm), decayed	No	Slight sulphide odour

B	From	To	Phase	Context	Sample	Wt /g	Vol /ml	Sediment description	Hydrocarbon contamination	Notes
								waterlogged wood fragments and fragments of ?freshwater mollusc shell were present.		
WS04	4.75	4.80	3	416	11	700	500	Moist, mid brown to mid grey-brown (mottled at a cm-scale) and occasionally mid/dark grey, firm to crumbly (working soft and slightly plastic), slightly sandy silt. Stones (2 to 20 mm) and decayed waterlogged wood fragments were present.	No	-
WS04	~4.10	~4.15	4	427	6	850	500	Moist, mid grey-brown (mottled with mid/dark grey-brown at a cm-scale) and occasionally dark grey, stiff to brittle and somewhat crumbly (working soft and more or less plastic), slightly sand slightly silty clay (much more silty in places and approximately one-third composed of lumps of more or less 'pure' clay). Stones (2 to 20 mm) and waterlogged wood fragments were present.	No	-

Table 2. Borehole investigations at Castle Mills Car Park, Piccadilly, York: Scales employed for the recording of the general composition of the washover fractions from the processed subsamples and the plant and invertebrate (other than unidentified mollusc shell fragments) macrofossil remains recovered.

1) Description of composition of the washover fractions: proportion of organic component

1 – 0%
2 – <25%
3 – <50%
4 – <75%
5 – >75%

2) Abundance: number of recorded items (identifiable waterlogged plant or invertebrate remains – seeds or fruits/minimum number of individuals represented)

1 – sample contained no identifiable items
2 – sample contained 1-20 items
3 – sample contained 21-100 items
4 – sample contained 101-500 items
5 – sample contained more than 500 items

3) Diversity: range of recorded items (minimum numbers of identifiable waterlogged plant or invertebrate taxa present)

1 – sample contained no non-carbonised, determinable botanical macro-remains, or only largely sub-recent intrusive/contaminant remains, carbonised macro-remains may be present
2 – sample contained non-carbonised remains of 1-5 taxa, typically largely corrosion-resistant species (e.g. goosefoot, chickweed, stinging nettle, knotweed)
3 – sample contained non-carbonised macro-remains of 6-10 taxa
4 – sample contained non-carbonised macro-remains of 11-40 taxa
5 – sample contained non-carbonised macro-remains of more than 40 taxa

4) Preservation: condition of recorded items (waterlogged plant or invertebrate remains)

1 – no taxon/species determination was possible to the level that should theoretically be possible for the taxon concerned, the material was too severely fragmented and/or corroded
2 – some species determination was possible, though the remains were highly fragmented and/or the seed coat (for example) was highly corroded
3 – most remains could be determined to the maximum taxonomic level feasible, though there was some damage or corrosion to the seed coat (for example – other than splitting, which can be caused by germination prior to deposition)
4 – remains complete and undamaged, though no fine elements such as hairs or fragile husk remains were present
5 – remains complete and undamaged, and fine, fragile elements such as hairs and some husk remains were present. NB: A large number of species do not include these elements, and the husk of most types of grain is in fact more resistant than the seed coat, so this cannot be used for classification in category 5

The categories for Diversity and Preservation follow Smit *et al*. (2006) with minor modifications.

Table 3. Borehole investigations at Castle Mills Car Park, Piccadilly, York: Scales employed for the recording of the general composition of the 'squash' subsamples and the microfossils present.

1) Description of composition of the 'squash': proportion of organic component

1 – 0%
2 – <25%
3 – <50%
4 – <75%
5 – >75%

2) Abundance: number of recorded items (identifiable microfossil remains)

1 – sample contained no identifiable items
2 – sample contained 1-20 items
3 – sample contained 21-100 items
4 – sample contained 101-500 items
5 – sample contained more than 500 items

3) Diversity: range of recorded items (minimum numbers of microfossil taxa present)

1 – sample contained no non-carbonised, determinable microfossil remains, or only largely sub-recent intrusive/contaminant remains, carbonised remains may be present
2 – sample contained non-carbonised remains of 1-5 taxa
3 – sample contained non-carbonised remains of 6-10 taxa
4 – sample contained non-carbonised remains of 11-40 taxa
5 – sample contained non-carbonised remains of more than 40 taxa

4) Preservation: condition of recorded items (microfossils)

1 – no taxon/species determination was possible to the level that should theoretically be possible for the taxon concerned, the material was too severely fragmented and/or corroded
2 – some species determination was possible, though the remains were highly fragmented and/or corroded
3 – most remains could be determined to the maximum taxonomic level feasible, though there was some damage or corrosion
4 – remains more or less complete and undamaged, there may be some very slight chemical erosion (e.g. parasite eggs may be intact but rather pale)
5 – remains complete and undamaged

Table 4. Borehole investigations at Castle Mills Car Park, Piccadilly, York: General description of the washovers and records for plant and other remains present. Key: 'B' = borehole; 'Wt (g)' = weight of processed subsample in grams; 'V (ml)' = approximate volume of processed subsample in ml; 'w/o (ml)' = approximate volume of washover in ml; 'res (g)' = weight of residue in grams; 'C14' = possible/sufficient suitable material for radiocarbon dating present; 'Des' = description; 'Ab' = abundance; 'Div' = diversity; 'Pr' = preservation; 'Vert.' = vertebrate remains; 'det' = indeterminate waterlogged plant detritus; 'se' = seeds or similar structures; 'ch' = charcoal and/or other charred plant remains; 'chg' = charred grain.; 'moss = fragments of moss 'leaves and stems''; 'ec' = earthworm egg capsules; 'i' = indeterminate non-molluscan invertebrate cuticle (mostly probably insect); 'b' = beetle sclerite fragments; 'moll' = mollusc shell; 'de' = cladoceran (including Daphnia*) ephippia; 'leath = leather; 'sph' = spere hammerscale; 'sand/ss' = sand and small stones; 'cin' = cinder.*
Semi-quantitative abundance scale: 1 – few/rare, up to 3 individuals/items or a trace level component of the whole; 2 – some/present, 4 to 20 items or a minor component; 3 – many/common, 21 to 50 or a significant component; 4 – very many/abundant, 51 to 200 or a major component; and 5 – super-abundant, over 200 items/individuals or a dominant component of the whole.

									Macrofossils			Botanical remains						Invertebrates					Mineral/artefactual				
B	**Phase**	**CN**	**Wt (g)**	**V (ml)**	**w/o (ml)**	**res (g)**	**C14**	**Des**	**Ab**	**Div**	**Pr**	**det**	**se**	**ch**	**wood**	**chg**	**moss**	**ec**	**i**	**b**	**moll**	**de**	**leath**	**coal**	**sph**	**sand/ ss**	**cin**
WS01	2	117	1000	750	20	112.1	Y*	5	2	2	2	4	2	4	3	-	-	-	2	-	-	2	-	2	-	-	-
WS01	2	113	700	500	25	41.7	Y*	5	3	2	2	5	3	-	3	-	-	-	5	5	-	4	-	-	-	-	-
WS01	2	112	450	300	30	14.4	Y*	5	3	3	2	5	3	1	2	-	-	-	5	5	-	5	-	-	-	-	-
WS03	2	325	600	400	10	33.5	Y	3	3	3	2	4	2	3	3	1	-	-	2	2	2	-	-	2	1	2	2
WS04	2	429	700	500	5	15.7	Y	5	2	3	2	5	2	-	2	-	-	-	2	2	-	-	-	2	-	-	1
WS04	3	420	1250	1000	150	190.6	Y*	5	2	3	2	5	2	-	4	-	-	-	3	1	-	-	1	-	-	-	-
WS04	3	416	700	500	45	109.9	Y*	5	2	3	2	5	2	-	5	-	-	-	2	1	-	-	-	-	-	-	-
WS04	4	427	850	500	80	136.8	Y*	5	2	2	2	5	2	1	4	-	1	-	2	-	-	-	-	1	-	-	-

* – indicates that 'suitable' material for radiocarbon dating is present but that the quantity available may be insufficient to obtain a date and/or that some remains *may* be contaminants

Table 5. Borehole investigations at Castle Mills Car Park, Piccadilly, York: Written descriptions of washovers from samples from boreholes, with notes on identified (or partially so) macrofossil remains. Key: 'B' = borehole; 'CN' = context number; 'Wt (g)' = weight of processed subsample in grams; 'V (ml)' = approximate volume of processed subsample in ml; 'w/o (ml)' = approximate volume of washover in ml; 'res (g)' = weight of residue in grams.
Semi-quantitative abundance scale: 1 – few/rare, up to 3 individuals/items or a trace level component of the whole; 2 – some/present, 4 to 20 items or a minor component; 3 – many/common, 21 to 50 or a significant component; 4 – very many/abundant, 51 to 200 or a major component; and 5 – super-abundant, over 200 items/individuals or a dominant component of the whole.

B	Phase	CN	Wt (g)	V (ml)	w/o (ml)	res (g)	General description	Plant macrofossils	Invertebrate macrofossils	Vertebrate remains
WS01	2	117	1000	750	45	112.1	Approximately equal parts (both score 4) waterlogged 'woody' plant detritus (with perhaps one-quarter comprised of finer 'filmy' material) and indeterminate rectilinear charcoal (to 6 mm but almost all less than 4 mm). A little coal (to 6 mm; score 2) and some decayed waterlogged wood fragments (to 16 mm; score 2) were also present.	'Seeds': some (score 2) waterlogged fragments, some indeterminate but including elder (*Sambucus nigra* L.) fruits (score 2) and blackberry/raspberry (*Rubus fruticosus* L. agg./*R. idaeus* L.) fruit stones (score 1), together with indeterminate remains of at least one other taxon (score 1)	Insect: some 'scraps' of indeterminate insect cuticle only (score 2). Crustaceans: some cladoceran (water flea) ephippia ('resting eggs') (score 2).	None
WS01	2	113	700	500	150	41.7	Mostly waterlogged plant detritus (score 5) – approximately equal parts 'woody' fragments and more 'filmy' material (score 2).	'Seeds': frequent (score 3) waterlogged fragments, mostly eroded and indeterminate but including some unidentified (but probably identifiable to further study) large glossy 'seeds' (score 2) – probably the same as seen from Context 112 (immediately overlying).	Insect: abundant (score 5) 'scraps' of heavily fragmented insect cuticle. Few remains identifiable at assessment beyond noting that many of the fragments were of beetle (Coleoptera) sclerites (score 5) – including non-diagnostic leg and abdominal elements (both score 2) and some wing cases (score 2) which could perhaps be identified more closely by further study Crustaceans: abundant cladoceran (including *Daphnia*) ephippia (score 5).	None
WS01	2	112	450	300	5	14.4	Mostly waterlogged plant detritus (abundance score 5 – predominantly 'filmy' but with some more 'woody' fragments, score 2), with a trace of indeterminate rectilinear charcoal (to 2 mm; score 1).	'Seeds': frequent (abundance score 3) waterlogged fragments, mostly eroded and indeterminate but including stinging nettle (*Urtica dioica* L.) achenes (score 2), orache/goosefoot (*Atriplex*/*Chenopodium*) seeds (score 2) and ?rush (cf. *Juncus*) capsules (score 1), together with a few unidentified (but probably identifiable to further study) large glossy 'seeds' (score 1) – probably the same as seen from Context 113 (immediately underlying).	Insect: abundant (abundance score 5) 'scraps' of heavily fragmented insect cuticle. Few remains identifiable at assessment beyond noting that many of the fragments were of beetle sclerites (score 5) – including non-diagnostic leg elements (score 2) and a few wing cases (elytra) of rove beetles (Staphylinidae) (score 1) which could perhaps be identified more closely by further study. Crustaceans: abundant cladoceran (including *Daphnia*) ephippia ('resting eggs') (score 5).	None
WS03	2	325	600	400	80	33.5	Approximately half waterlogged	'Seeds': some waterlogged fragments	Insect: some (score 2) 'scraps' of heavily fragmented	None

B	Phase	CN	Wt (g)	V (ml)	w/o (ml)	res (g)	General description	Plant macrofossils	Invertebrate macrofossils	Vertebrate remains
							wood fragments ((to 9 mm; score 5 – with ~10% finer 'filmy' plant detritus), one-third charcoal (to 9 mm; score 3) and one-sixth sand (score 2). A little cinder (to 12 mm) and coal (to 3 mm) was present (both score 2) and there was a single sphere of hammerscale (to 1.5 mm).	(score 2), mostly eroded and indeterminate but including ?stinging nettle achenes (score 1). Waterlogged wood: almost all rectilinear with a few small twig fragments (to 3 mm; diameter to 1 mm) with bark (1 or 2 years of wood growth) – all of the wood was very soft and decayed with no identifications possible. Charcoal: all rectilinear fragments with the two largest being identified as oak (*Quercus*). Charred grain: 1x wheat (*Triticum*) grain (no associated chaff).	insect cuticle. Few remains identifiable at assessment beyond noting that most of the fragments were of beetle sclerites (score 2) – including non-diagnostic abdominal elements (score 1) and a few rove beetle wing cases (score 1) which could perhaps be identified more closely by further study. Mollusc: some indeterminate mollusc shell fragments (to 8 mm but almost all to 2 mm) only (score 2).	
WS04	2	429	700	500	5	15.7	Mostly waterlogged plant detritus (score 5 – predominantly 'filmy' with ~15% more 'woody'), with some wood fragments (to 23 mm' score 2), a little coal (to 4 mm; score 2) and a trace of cinder (to 10 mm; score 1).	'Seeds': some waterlogged fragments (score 2), mostly eroded and indeterminate but including biconvex sedge (*Carex*) nutlets (score 1) and remains of at least three other taxa. Waterlogged wood: mostly rectilinear fragments (to 16 mm but all bar one <10 mm), with a few twig fragments (to 23 mm; diameter to 12 mm) which retained bark Two of the latter were partially identified as diffuse-porous with the larger representing 4 or 5 years of growth and the smaller a single year.	Insect: some (score 2) 'scraps' of heavily fragmented insect cuticle. Few remains identifiable at assessment beyond noting that most of the fragments were of beetle sclerites (score 2) – including non-diagnostic abdominal elements (score 1) and a few rove beetle wing cases (score 1) which could perhaps be identified more closely by further study.	None
WS04	3	420	1250	1000	150	190.6	Almost all waterlogged wood fragments (to 38 mm) and 'woody' detritus, with a little finer 'filmy' plant detritus (~5%) and a single 'scrap' of leather offcut (to 35 mm).	'Seeds': some waterlogged fragments (score 2), mostly eroded and indeterminate but including biconvex and trigonous sedge nutlets (both score 1) and remains of at least four other taxa. Waterlogged wood: all rectilinear fragments (to 38 mm but almost all <10 mm) with no bark and of indeterminate age of wood growth – the three largest	Insect: frequent (score 3) 'scraps' of heavily fragmented insect cuticle. No remains identifiable at assessment beyond noting that a few were probably of non-diagnostic beetle leg sclerites (score 1).	None

B	Phase	CN	Wt (g)	V (ml)	w/o (ml)	res (g)	General description	Plant macrofossils	Invertebrate macrofossils	Vertebrate remains
								fragments were all of a ring-porous species and probably oak (cf. *Quercus*).		
WS04	3	416	700	500	45	109.9	Almost all waterlogged wood fragments (to 42 mm) and 'woody' detritus.	'Seeds': some waterlogged fragments (score 2), mostly eroded and indeterminate but including biconvex and trigonous sedge nutlets and stinging nettle achenes (all score 1), together with remains of at least one other taxon. Waterlogged wood: all of the wood fragments (to 42 mm but predominantly <10 mm) were rectilinear apart from the largest which was trunk wood or from a substantial branch (annual ring curvature was very slight) – no bark remained on this fragment and the waney edge was not evident so the number of years of wood growth could not be determined. It was possible to identify the largest wood fragment and two others as being ring-porous and all almost certainly oak, however.	Insect: some (score 2) 'scraps' of heavily fragmented insect cuticle. Few remains identifiable at assessment beyond noting that some of the fragments were of beetle sclerites (score 2) – including a wing case of a water scavenger beetle (cf. *Cercyon* sp.) which was markedly better preserved and which would almost certainly be identifiable to species by further study – and there were also a few ant (Formicidae) heads (score 1).	None
WS04	4	427	850	500	80	136.8	Almost all waterlogged wood fragments (to 67 mm) and 'woody' detritus, with a little finer 'filmy' plant detritus (~10%) which included occasional moss (Bryophyta) 'stems and leaves', and traces of indeterminate rectilinear charcoal (to 2 mm; score 1) and coal (to 5 mm; score 1).	'Seeds': some waterlogged fragments (score 2), mostly eroded and indeterminate but including chickweed/stitchwort (*Stellaria*) and orache/goosefoot seeds (both score 1), together with remains of at least two other taxa. Waterlogged wood: all of the wood fragments (to 67 mm but almost all <10 mm) were rectilinear and of indeterminate age of wood growth (only the largest retained a trace of bark). The three largest fragments were all positively identified as oak (*Quercus*).	Insect: some 'scraps' of indeterminate insect cuticle only (score 2).	None

Table 6. Borehole investigations at Castle Mills Car Park, Piccadilly, York: Residue components from samples from boreholes. Key: 'B' = borehole; 'CN' = context number; 'Wt (g)' = weight of processed subsample in grams; 'V (ml)' = approximate volume of processed subsample in ml; 'w/o (ml)' = approximate volume of washover in ml; 'res (g)' = weight of residue in grams.
Semi-quantitative abundance scale: 1 – few/rare, up to 3 individuals/items or a trace level component of the whole; 2 – some/present, 4 to 20 items or a minor component; 3 – many/common, 21 to 50 or a significant component; 4 – very many/abundant, 51 to 200 or a major component; and 5 – super-abundant, over 200 items/individuals or a dominant component of the whole.

B	Phase	CN	Wt (g)	V (ml)	res (g)	Residue description	Notes/identifications
WS01	2	117	1000	750	112.1	Mostly stones (to 30 mm; score 5) and sand (score 4). Other components were cinder (to 40 mm; 13.0 g; 12x pieces), brick/tile (to 25 mm; 7.7 g; 7x pieces), bone (to 25 mm; 3.1 g), two pot sherds (to 30 mm; 7.1 g), a little mortar (to 10 mm; 1.2 g) and charcoal (to 10 mm; <0.1 g; 8x pieces), and some sand (score 3). There were also black flecks of ?charcoal/cinder (score 2) within the <1 mm fraction which were not sorted. The trace level magnetic component (to 5 mm; 0.3 g) was almost all ?heat-affected sand/small stones and ?cinder, with some spheres (to 1 mm; score 2) and flakes (to 2 mm; score 1) of hammerscale.	Bone: 13x fragments of indeterminate medium-sized or large mammal bone (to 25 mm; 3.1 g) – two of which were burnt (to 20 mm; 0.7 g).
WS01	2	113	700	500	41.7	Mostly stones (to 25 mm; score 5), with a little brick/tile (to 25 mm; 3.4 g; 12x pieces), bone (to 30 mm; 7.1 g; 5x fragments) and shell (to 20 mm; ~0.1 g; 15x fragments), a trace of indeterminate rectilinear charcoal (to 6 mm; 6x pieces) and a little sand (score 2). There were also white and black flecks of shell and ?charcoal (both score 2) within the <1 mm fraction which were not sorted. The trace level magnetic component (to 5 mm; <0.1 g) was almost all ?heat-affected sand/small stones and ?cinder, with a few spheres of hammerscale (to 1 mm; score 1).	Shell: 15x fragments of ?freshwater mussel (cf. *Margaritifera*/*Unio*) shell – minimum number of valves = mnv = 1. Bone: 5x fragments of indeterminate medium-sized or large mammal bone (not burnt).
WS01	2	112	450	300	14.4	Mostly bone (to 40 mm; 14.4 g; 9x larger fragments with occasional unsorted flecks within the <1 mm fraction), with a little sand (abundance score 2). No magnetic material present.	Bone: 9x fragments of indeterminate medium-sized or large mammal bone (not burnt).
WS03	2	325	600	400	33.5	Mostly stones (to 15 mm; score 5) and bone (to 40 mm; 12.4 g; 4x fragments), with single pieces of cinder (to 12 mm; 0,4 g) and brick/tile (to 10 mm; 0.1 g), three fragments of shell (to 5 mm; <0.1 g) and a little sand (score 2). There were also white and black flecks of shell and ?charcoal/cinder (both score 2) within the <1 mm fraction which were not sorted.. The trace level magnetic component (to 3 mm; <0.1 g) was all ?heat-affected sand/small stones and ?cinder.	Shell: 3x indeterminate fragments only. Bone: 4x fragments of indeterminate medium-sized or large mammal bone (not burnt).
WS04	2	429	700	500	15.7	Mostly stones (to 10 mm; score 5) and sand (score 3), with a little mortar (to 15 mm; 7x pieces) and traces of bone (to 10 mm; <0.1 g; 2x tiny fragments), shell (to 10 mm; <0.1 g; 1x fragment) and indeterminate rectilinear charcoal (to 2 mm; <0.1 g; 5x pieces). There were also white and black flecks of shell and ?charcoal (both score 2) within the <1 mm fraction which were not sorted. The trace level magnetic component (to 1 mm; <0.1 g) was all ?heat-affected sand/small stones and ?cinder.	Shell: 1x fragment of ?freshwater mussel valve. Bone: 2x tiny indeterminate fragments (not burnt)– one possibly of unidentified fish
WS04	3	420	1250	1000	190.6	Mostly stones (to 45 mm; score 5) and sand (score 3), with some brick/tile (to 25 mm; 13.4 g; 19x pieces), mortar (to 10 mm; 1.6 g; score 2), shell (to 5 mm; <0.1 g;	Shell: 8x fragments of ?freshwater mussel shell – mnv = 1.

B	Phase	CN	Wt (g)	V (ml)	res (g)	Residue description	Notes/identifications
						8x fragments), a piece of cinder (to 10 mm; <0.1 g) and a little indeterminate rectilinear charcoal (to 7 mm; <0.1 g; 6x pieces). There were also white and black flecks of shell and ?charcoal/cinder (both score 2) within the <1 mm fraction which were not sorted. The trace level magnetic component (to 2 mm; <0.1 g) was almost all ?heat-affected sand/small stones and ?cinder, with a few spheres of hammerscale (to 1 mm; score 1).	
WS04	3	416	700	500	109.9	Mostly stones (to 25 mm; score 5) and sand (score 4), with a little shell (to 5 mm; <0.1 g; 4x fragments), indeterminate rectilinear charcoal (to 5 mm; <0.1 g; 6x pieces), cinder (to 5 mm; <0.1 g; 1x piece), a ?fossil crinoid stem segment (to 2 mm; <0.1 g) and a single fish vertebra (to 2 mm; <0.1 g). There were also white and black flecks of shell and ?charcoal/cinder (both score 2) within the <1 mm fraction which were not sorted. The trace level magnetic component (to 5 mm; 0.2 g) was almost all ?heat-affected sand/small stones and ?cinder, with two small rusted iron fragments (to 4 mm; <0.1 g).	Shell: 1x fragment of ?freshwater mussel valve and 3x indeterminate fragments. Bone: 1x ?herring (cf. *Clupea harengus* L.) vertebra.
WS04	4	427	850	500	136.8	Mostly stones (to 45 mm; score 5) and sand (score 3), with traces of bone (to 20 mm; 0.4 g; 3x fragments), shell (to 10 mm; <0.1 g; 3x fragments), cinder (to 5 mm; <0.1 g; 1x piece) and indeterminate rectilinear charcoal (to 5 mm; <0.1 g; 4x pieces). There were also white and black flecks of shell and ?charcoal/cinder (both score 2) within the <1 mm fraction which were not sorted. The trace level magnetic component (to 5 mm; <0.1 g) was almost all ?heat-affected sand/small stones and ?cinder, with a few spheres of hammerscale (to 1 mm; score 1).	Shell: 3x fragments of ?freshwater mussel shell – mnv = 1. Bone: 3x fragments of indeterminate medium-sized or large mammal bone (not burnt).

Table 7. Borehole investigations at Castle Mills Car Park, Piccadilly, York: General description of microfossil subsamples and notes on remains present. Key: 'B' = borehole; 'CN' = context number; 'Desc' = description; 'Ab' = abundance; 'Div' = diversity; 'Pres' = preservation; 'N' = semi-quantitative numbers; 'types' = minimum number of taxa represented; 'f. hy.' = fungal hyphae; 'plant tissue frags' = fragments of indeterminate plant tissue; '+' = 1-5; '++' = 6-20; '+++' = 21-50; '++++' = 51-200; '+++++' = more than 200.

Note: Approximate measurements taken for whipworm (trichurid) and maw worm (ascarid) intestinal parasite eggs (Contexts 112 and 113) placed these records within the usual size ranges fro the parasites of humans (*Trichuris trichiura* (Linnaeus) and *Ascaris lumbricoides* (Linnaeus)) and/or pigs (*T. suis* (Schrank) and *A. suum* (Goeze)).

				Microfossils			**Pollen/spores**		**Diatoms**		**?Phytoliths**		**Parasite eggs**		**Fungal spores**				
B	**Phase**	**CN**	**Desc**	**Ab**	**Div**	**Pres**	**N**	**types**	**N**	**types**	**N**	**types**	**N**	**types**	**N**	**types**	**Notes/identifications**	**f. hy.**	**plant tissue frags**
WS01	2	117	4	2	2	2	++	4	-	-	+	1	?+	?2	++	3	Pollen/spores: mostly crumpled and eroded; ?chickweed/stitchwort (cf. *Stellaria*) +, at least three other taxa ++ ?Phytoliths: grass-type + Parasite eggs: 1x ?*Capillaria* egg and 2x small eggs possibly of another intestinal parasite (unidentified)	+	++
WS01	2	113	5	2	3	2	++	5	+	1	+	1	+	2	++	3	Pollen/spores: mostly crumpled and eroded; grass-type +, ?trilete spores (cf. *Sphagnum*) +, ?birch (cf. *Betula*) +, at least two other taxa ++ Diatoms: 1x complete but somewhat eroded; *Pinnularia* sp. ?Phytoliths: grass-type + Parasite eggs: 2x ?maw worm (cf. *Ascaris*) eggs and 1x very pale whipworm (*Trichuris*) egg with no polar plugs – all within the size ranges of the parasites of humans and pigs	+	++

				Microfossils			Pollen/spores		Diatoms		?Phytoliths		Parasite eggs		Fungal spores				
B	**Phase**	**CN**	**Desc**	**Ab**	**Div**	**Pres**	**N**	**types**	**N**	**types**	**N**	**types**	**N**	**types**	**N**	**types**	**Notes/identifications**	**f. hy.**	**plant tissue frags**
WS01	2	112	4	2	2	3	+	1	+	1	-	-	2	1	+	1	Pollen/spores: somewhat eroded; 2x grass (Poaceae)-type Diatoms: 1x complete but somewhat eroded; *Pinnularia* sp. Parasite eggs: 2x very pale whipworm eggs – one with no polar plugs and the other with one polar plug – both within the size ranges of the parasites of humans and pigs	+	+
WS03	2	325	4	2	3	2	++	3	+	2	-	-	-	-	++	2	Pollen/spores: crumpled and eroded; ?alder (cf. *Alnus*) +, at least two other taxa ++ Diatoms: 2x frustules both eroded and broken; 1x *Pinnularia* sp. and 1x *Epithemia*/*Eunotia* sp.	+	++
WS04	2	429	4	2	2	2	++	3	+	1	-	-	-	-	++	2	Pollen/spores: variable preservation, remains often crumpled and eroded but occasionally better preserved; ?plantain (cf. *Plantago*) +, at least two other taxa ++ Diatoms: 1x frustule complete but somewhat eroded; *Cyclotella* sp.	+	+
WS04	3	420	3	3	3	2	++	5	-	-	-	-	-	-	++	3	Pollen/spores: variable preservation, remains often crumpled and eroded but occasionally better preserved; grass-type +, ?plantain +, ?chickweed/stitchwort +, at least two other taxa ++	+	+

				Microfossils			Pollen/spores		Diatoms		?Phytoliths		Parasite eggs		Fungal spores				
B	**Phase**	**CN**	**Desc**	**Ab**	**Div**	**Pres**	**N**	**types**	**N**	**types**	**N**	**types**	**N**	**types**	**N**	**types**	**Notes/identifications**	**f. hy.**	**plant tissue frags**
WS04	3	416	2	2	2	3	+	1	-	-	-	-	-	-	+	2	Pollen/spores: a single quite well preserved grain/spore – unidentified at assessment but probably identifiable to further study	++	+
WS04	4	427	2	1	1	1	-	-	-	-	-	-	-	-	-	-	-	++	+

APPENDIX 9 – WRITTEN SCHEME OF INVESTIGATION

YORK ARCHAEOLOGICAL TRUST

WRITTEN SCHEME OF INVESTIGATION FOR
ARCHAEOLOGICAL INVESTGATIONS AT CASTLE MILLS, PICADILLY, YORK

Site Location: **Castle Mills, Piccadilly, York**

NGR: **SE 60652 51415**

Proposal: **Ground investigation works and water monitoring**

Planning ref: **17/01499/FUL**

Prepared for: **City of York Council**

Document Number: **2018/94**

Version	Produced by		Edited by		Approved by	
	Initials	Date	Initials	Date	Initials	Date
1 draft	AJ	4/7/18	IDM	11/07/18	IDM	13/07/18

1 SUMMARY

1.1 City of York Council have appointed York Archaeological Trust to carry out a borehole and water monitoring survey at Castle Mills, Piccadilly, York (SE 60652 51415). The scheme will include a programme of four boreholes and the installation of three instrumented water monitoring points and one instrumented water quality sensor that will be observed over a six month period.

1.2 This Written Scheme of Investigation (WSI) has been prepared in response to a Brief supplied by the client. The work will be carried out in accordance with the Brief and this WSI, and according to the principles of the Institute for Archaeology (CIfA) Code of Conduct and all relevant standards and guidance.

2 SITE LOCATION & DESCRIPTION

2.1 The proposal site covers approximately 2,675m² and is located at Castle Mills, Piccadilly, York. The site is presently occupied by the Castle Mills Car Park (Figure 1). The site is bounded to the west by the River Foss, to the east by Piccadilly and to the south and north by the Postern Gate Travelodge and Ryedale House respectively. The buildings that presently occupy the site will be demolished prior to the ground investigations.

2.2 The underlying geology of the site is sandstone of the Sherwood Sandstone Group with superficial deposits of alluvial silt, clay, sand and gravel (http://mapapps.bgs.ac.uk/geologyofbritain/home.html). The present ground level is relatively flat at around 9.10m AOD, however archaeological investigation has shown that natural glacial deposits, buried ground surfaces and archaeological deposits slope down toward the River Foss from a ridge of high ground on Piccadilly (see Section 4.2)

3 DESIGNATIONS & CONSTRAINTS

3.1 The site is located within York's Central Historic Core Conservation Area and the city centre Area of Archaeological Importance (AAI) as defined by the Scheduled Monuments and Archaeological Areas Act 1979. There are no listed buildings within the proposed development area, although the site is within the City Walls and close to Clifford's Tower and numerous other significant sites.

4 ARCHAEOLOGICAL INTEREST

4.1 Period-by-period summary

The Piccadilly area has been subject to numerous archaeological interventions since the 1980s. The following overview of the current archaeological knowledge of the site and surrounding area is taken from YAT Report 2016/85 (Reeves 2016).

4.2 The topography and regime of the River Foss

The importance of York's waterfronts and their potential to provide information about areas of the city once the focus for trade and commerce has long been recognised. The work of York Archaeological Trust since 1972 has shown that excavation of waterfront sites

can reveal evidence for 'the economic basis of the city's life throughout its history' (Addyman et. al. 1988, 1). During the extensive 1981–2 watching brief on the area now occupied by the Coppergate Centre on the west bank of the River Foss the ancient course of the river was found along with revetments, installations, ship fragments, and traces of the water defences of York Castle. Further excavations at the site of the former ABC Cinema, 22 Piccadilly, defined an earlier river channel and associated 11th-century riverside revetments (Addyman et. al. 1988, 8).

The Castle Mills Car Park site is situated on ground at the confluence of the Rivers Ouse and Foss close to the point where these rivers penetrate the York Morraine. The historic fluvial morphology of the lower River Foss is not well understood. What little information there is comes from borehole records and excavations carried out along the south-west side of Piccadilly, Coppergate and more recently the Hungate area; all of which demonstrate a complex landscape morphology which is the product of both natural geological processes and large-scale alterations caused by human agency throughout historic periods.

Evidence from the Walmgate and Piccadilly areas, largely derived from small-scale keyhole excavations carried out by YAT in the early 1990s, has provided valuable evidence about the topographical development of the River Foss and its waterfront areas.

Walmgate occupies a ridge of high ground leading to the crossing point of the Foss at Foss Bridge. The top of natural glacial deposits identified at 31 Walmgate on the street frontage was at depths between 9.92m OD to 9.60m OD (Robinson 2013, 6–7, 15).

To the east of this ridge the archaeological evidence from around the proposal site shows that the ground level on the eastern Foss bank has been increased considerably since the Roman period through land reclamation. At 17–21 Piccadilly, approximately 105m north of the proposal site, the natural slope towards the Foss was identified between 4.5m BGL (approximately 5.50m AOD) at the south end of the site to 7.60m BGL (Approximately 2.40m AOD) at the northern end (Lilley 1991, 2). At 50 Piccadilly, approximately 65m north of the proposal site, natural was identified at 1.20m AOD and a borehole watching brief at 38 Piccadilly identified natural at approximately 9m BGL –a depth of approximately 1.65m AOD. The slope across the same area today is only around 1.60m (YAT Gazetteer 613; Gajos 2013, 7).

4.3 **Prehistoric**

Prehistoric remains from York are scarce, amounting to a small number of casual finds since the 19th century, mainly from the south-west of the River Ouse and a small number of undated but possibly pre-Roman features (Wellbeloved 1862, 61–3; Radley 1974, 10–4; Hall 1996, 25). However, evidence is increasingly being found for Bronze Age and Iron Age activity focused on the York Moraine, particularly to the east of the city. Closest of these discoveries, found at 25 Lawrence Street some 0.6km to the east of Piccadilly, was a Bronze Age cremation urn discovered in 2007 (Reeves forthcoming) and an assemblage of Neolithic flint tools consistent with occupation recovered from recent excavations at Hungate (Kendall 2009, 175) some 0.35km to the north of the site both within the lower Foss area. Considerable evidence for late Neolithic and Bronze Age occupation comes from further east on the moraine such as the recent discoveries in the Heslington area, approximately 3.5km to the east of the city, made during the expansion of the University of York (Antoni, Johnson and McComish 2009).

Prehistoric water levels at the site of Castle Mills Car Park would have fluctuated in tandem with those of the tidal Ouse (Briden 1997, 170; Duckham 1967, 17). The resulting complex marshland ecosystem was likely a place of significance and a valuable subsistence resource to local populations (Whyman and Howard 2005, 14). Although it is unlikely, there may be evidence for prehistoric activity preserved at Castle Mills Car Park, its location and the waterlogged nature of the buried deposits in the area could also hold potential for valuable information about fluvial landscape morphology and environment during this period.

4.4 **Roman**

The site is approximately 485m south-east of the south-east corner of the Roman fortress founded in AD 71. Although the archaeological evidence for Roman activity in the area to the south-east of the River Foss is relatively sparse compared to the fortress area, the area seems to have been utilised throughout the Roman period (McComish 2007).

Roman Road 1a, leading to Eboracum from Throlam near Holme-on-Spalding-Moor is thought to have converged with the Road 1b, a minor road from the south, some 115m to the south east of the Castle Mills site. Roads 1a and 2, from Petuaria (Brough-on-Humber) are thought to have converged approximately 65m north of Castle Mills Car Park (RCHMY I, 2; Ottaway 2004, 12; Ottaway 2015, 9; HTAY 2015, Sheet F). Roman burials were discovered sometime before 2007 by Malton Archaeological Partnership immediately south of Dixon Lane (McComish 2007). A Roman Altar dedicated to the native god Arciaco was found at St Denys Church on Walmgate and two other coffined Roman burials were found nearby (RCHMY 1, 69–70, 118; HTAY 2015, Sheet F).

Evidence for Roman use of the Foss as a navigation comes from 1951–52 excavations for the construction of the Telephone Exchange building in Garden Place, Hungate, where walls and piles interpreted as a Roman wharf and the buried former course of the river were discovered (RCHMY I, 64). In the Piccadilly area, evidence for riverbank activity on the east bank of the Foss comes from excavations at numbers 38, 40 and 50 Piccadilly. A line of stone pillars beneath the Tax Offices on Piccadilly was interpreted as possible evidence for a Roman riverside jetty (Ottaway 1993, 69).

Furthermore, excavations at 38 and 50 Piccadilly suggest there was significant occupation and river front land use during the late 2nd–3rd centuries in the vicinity of the site comprising evidence for management of the riverside, dumped occupation material including domestic pottery and evidence of possible industrial activity.

4.5 **Anglian**

Evidence for Anglian period York is generally elusive and what has been recovered to date is sparsely distributed across the city. Excavated sites and the distribution of find spots suggests that settlement at York was polyfocal with distinct nuclei spread out across the former Roman fortress and colonia, interspersed with cultivated or waste areas (AY 7/2, 298; Palliser 2014, 37). As yet, no evidence has been found for wharves or intensive occupation, however, evidence from sites along the course of the River Foss suggests occupation and other activity along the river bank. A number of Anglian pot sherds have been recovered from Hungate (AY 7/2, 196; YAT forthcoming) and the Haymarket excavations (Reeves forthcoming). At 22 Piccadilly, Anglian pottery, probably of early–mid 9th century date was recovered from two trenches, one of which was associated with a wicker fence running parallel to the river. Silt accumulations above these levels indicate the

area was prone to flooding. Further evidence came from 38 Piccadilly where a sherd of Badorf ware was recovered from some 8m below modern street level beneath a substantial accumulation of probable 11th-century alluvial silt. At 17–21 Piccadilly a 9th century relief-band amphora fragment was recovered from around 5m below the modern street level at around 5.7m AOD (AY 7/2, 196–197; Appendix 2)

The Castle Mills site is close to one of the most important Anglian period sites excavated in York, the former Redfearn National Glass works, 46–54 Fishergate, which is around 0.4km to the south (AY 7/1). The majority of the evidence for Anglian activity elsewhere in the city comes from artefacts which may be the result of casual losses through transient activity and may not necessarily be convincing evidence of occupation. However, evidence from the 1985–6 excavation of 46–54 Fishergate provides evidence of an important production and trading centre, or wic, occupying an area of around 2,500m² sited on the lower east bank of the River Foss, directly opposite the point of confluence with the River Ouse (AY 7/1). This 7th–late 9th century settlement apparently began as a well-organised, probably planned, settlement rather than one that developed organically to exploit the natural communications provided by the rivers and the east–west land route of the York Moraine.

More recent excavations at the former Mecca Bingo and in the Blue Bridge Lane area a little further south from Fishergate have produced further evidence of Anglian period pit groups and occupation (Spall and Toop 2011, 7). Excavation carried out at the junction of Dixon's Lane/George Street in 2006 discovered further evidence for activity possibly associated with the wic approximately 100m to the east of 46–50 Piccadilly (AYW 9, McComish 2007). Based on current archaeological evidence the Castle Mills site lies just to the north-west of the possible Anglian settlement (Figure 4 in Palliser 2014, 24).

4.6 **Anglo-Scandinavian**

The site lies within an extensive area of Anglo-Scandinavian activity to the south-east of the former Roman fortress. It has been suggested that the Anglian period wic at Fishergate was in decline by the 860s–870s and was replaced at around this time by occupation around the Ousegate/Coppergate area (AY 8/4, 299–304). However, evidence found in 2007 for craft and trade activity at Dixon Lane/George Street, located midway between the Fishergate and Coppergate/Ousegate areas, suggests a wider spatial continuity between the Anglian wic and the Anglo-Scandinavian settlement in the late 9th–10th centuries (AYW 8). Evidence for Anglo-Scandinavian activity from YAT excavations at 118–126, 76–82 and 104–112 Walmgate suggests that Walmgate became an important thoroughfare in the burgeoning 9th- and 10th -century town and a substantial suburb developed in the area. The nearby churches of St Stephen, Fishergate and St Denys, Walmgate are thought likely of pre-Conquest origins. A number of sites along Piccadilly have revealed traces of Anglo-Scandinavian activity such as bone working evidence from excavations at 38, 50, and 84 Piccadilly (AY 8/4, 469–472).

4.7 **Medieval**

The landscape of the River Foss was drastically altered by the damming of the southern end of the river at Castle Mills during the Norman period to exploit its waters to feed the moat of the Norman castle at York (VCHY 1961, 509–510). The resulting body of water was called the *Stagnum Regis*, the King's pool. The dam of the Fishpool of the Foss probably provided a causeway across the Foss at the site of the modern Castle Mills Bridge. The first documentary evidence for a bridge at Castle Mills is not until 1585 and the structure was

destroyed during the Siege of 1644 (VCHY 1966, 519–520; Raine 1955, 196). Cartographic evidence, as well as evidence from the excavations at 38 and 84 Piccadilly show that the area which now forms the west side of Piccadilly was largely flooded by the creation of the Fishpool and remained so for much of the late medieval period, during which time the King's Fishpool gradually silted up and some of the land formerly flooded reclaimed. Historic maps show the areas flooded based on archaeological and cartographic sources and the gradual change in area taken up by the King's Pool during the early modern period (Not reproduced here; see YAT Report 2016/85).

The Walmgate sector of the city was enclosed with defences in the late 12th century (RCHMY 2, 11; HTAY 2015, 31). Fishergate Postern, 0.2km to the south was built sometime in the 14th century (Raine 1955, 20).

Cartographic evidence suggests that much of the west side of Piccadilly was at the riverside edge of gardens to the rear of properties fronting onto Walmgate during this period and the archaeological evidence discussed further in Section 6 of this report indicates that waste was dumped along the riverside where there were perhaps jetties or revetments designed to consolidate and reclaim land from the river.

4.8 **Post-medieval**

Canalisation of the River Foss began in the late 18th century, the first stretch from Castle Mills to Monk Bridge being opened in 1794. It was continued to Sheriff Hutton in 1801. Factories and Warehouses at Hungate were still accessible via the Foss Navigation until the 1960s even though its use as a navigation was in decline. In recent decades the remaining light industry has relocated, making way for largely residential development (VCHY 1961, 475; Fife and Walls 1981, 23–25; YAT forthcoming).

The modern street named Piccadilly runs from Pavement across the River Foss and along its east bank to the east end of Castle Mills Bridge. A lane or open space existed at the south end by 1610 and was widened and re-named Piccadilly after the London Street c. 1840. It was extended north to Pavement in 1912 (RCHMY 5, 199).

Much of the street is built over land that was formerly covered by the Kings Pool of the River Foss. The gradual development of the post-medieval landscape can be traced through the historic maps of which there is a sequence available dating from the 17th century. On Speed's map of 1610 the site is depicted as open ground.

Richards' map of 1685, which is largely a copy of an earlier map by Captain James Archer (surveyed 1673 and published 1682; not reproduced), shows open ground, presumably used for commercial horticulture with property boundaries and a path or street leading from Walmgate to the east bank of the River Foss. The distinction between streets built-up with houses and lesser pathways on these early maps is unclear. Their exact location and orientation in relation to the modern landscape is also difficult to determine with complete accuracy but it seems there has, for a considerable time, been some form of access to the east bank of the Foss from Walmgate and the north side of St Denys' church yard.

By 1750, the publication date of Chassereau's map, the area around St Denys' church is largely built-up, the path leading to the east bank of the Foss is no longer shown and a new path or street leading south towards the Castle Mills Bridge area is indicated, forming the predecessor to the modern southern end of Piccadilly.

4.9 **Modern**

Hargrove's map of 1818 appears to differentiate between probable horticultural land to the north-west and west of St Denys' church and what appears to be open ground to the south-west. The line of the path running south towards Fishergate Postern from the west end of the churchyard is in Hargrove's map delineated with a dashed line, possibly indicating it was of lesser status than other lanes shown further to the east. The 1852 Ordnance Survey map shows the path widened and formalised after the creation of Piccadilly.

By 1852 St Denys' Street had been extended along a line to the south-west with a slight dog-leg and is shown as a built-up street of terraced houses. The properties on the north side of the street appear to be small houses with yards and those on the south appear to be back-to-back houses. Walmgate was a notorious area in the 19th century associated with poverty, crime and prostitution. A block of terraced dwellings, immediately south-west of St Denys' Church, were known as Plow's Rectory Buildings. Finnegan describes these as an unwholesome terrace amongst which there were a small number of 'houses of ill fame' such as 'Todds' and 'Mrs Varley's'. Several diseased and destitute prostitutes entered the work house from this address (Finnegan 1979, 54–55).

The present buildings on Piccadilly are predominantly of 20th-century date consisting of a number of former garages, warehouses, offices and retail shops with some residential flats and a large hotel at the south end of the street. A terrace of four small houses (numbers 41, 43, 45) built shortly before 1850 is recorded by the Royal Commission as having been demolished before 1961 and the former White Swan Hotel (now Pavement Vaults and residential flats) at the northernmost end of the street incorporates partial remains of a three-storey mid-18th -century house (RCHMY 5, 199).

4.10 **Previous Investigations**

A 3m x 3m evaluation trench was excavated to natural deposits in 1992 at 50 Piccadilly, a short distance north-west of the Castle Mills site. This trench provides a guideline sequence for the Piccadilly area. Natural geological deposits were observed at a 2.60m AOD and were overlain by a succession of 2nd century dumps, drainage gullies, isolated posts and, ultimately, a 3rd century cobbled surface. During the Anglo-Scandinavian period, this sporadic use of the area appears to have continued, with another succession of drainage features and levelling deposits also being sealed by a cobbled surface at 4.35m AOD (Reeves 2016, 7-8).

Medieval archaeology was characterised by further waterfront activity, including levelling dumps and timber revetments that we're interpreted as land reclamation and consolidation along the edge of the King's Pool. By the 15th century, the ground level had been raised to 6.05m AOD. Dumping was observed to continue across the post-medieval period, while 18th and 19th century deposits were typically horticultural in nature (ibid., 9).

A borehole survey was carried out by YAT in 1998 at Ryedale House, to the immediate south-east of the Castle Mills site. A series of four boreholes were opened revealing a sequence of post-medieval to modern levelling deposits overlying successive layers of silting and levelling interpreted as land reclamation and alluvium associated with the King's Pool (Marwood 1998, 2).

While these investigations have been limited, they suggest that management of the

waterfront, land reclamation and occasional inundations of alluvium seem to have been the focus of activity on and around the Castle Mills site for the majority of its history.

5 AIMS

5.1 The aim of the borehole survey is to characterise the hydrology and soil conditions of the site and to provide a baseline model for comparison with further monitoring points that will be installed and monitored during and after the forthcoming redevelopment of the site. This will create a data set that will aid in understanding the impact of piled developments on waterlogged soil horizons.

6 BOREHOLE SURVEY METHODOLGY

6.1 A series of four boreholes will be drilled within the proposal area with a compact tracked rig. Two of the boreholes will be located in the centre of the site and the two remaining boreholes will be drilled in the north-west and south-east corners of the proposal area. The proposed locations of the boreholes are shown on Figure 2.

6.2 The borehole locations will be accurately plotted by GPS working at an accuracy of no less than 100mm. All of the boreholes will have dipwells installed with well heads and lockable caps. Three remote sensors (a TROLL/BARO TROLL unit) will be required to monitor the water levels and barometric pressure, giving a diagonal transect across the site.

6.3 The second of the two centrally located boreholes will be installed with a water quality sensor. This will measures four variables: Conductivity, Redox, PH level and Dissolved Oxygen level. These measures provide an accurate assessment of what the current organic conditions are, how they change and why they vary over time. This will allow an impact assessment to be made, in accordance with CYC policy as informed by Historic England guidelines. The sensors can potentially be re-used if monitoring is required elsewhere on the site at a later date.

6.4 A soil sampling programme will be undertaken for the recovery and identification of charred and waterlogged remains where suitable deposits are identified. Up to ten General Biological Analysis (GBA) samples and up to four sealed REDOX samples will be taken. The purpose of these samples is to establish baseline conditions regarding preservation of organic remains, by characterising the potential organic deposits via the recovery of charcoal, burnt seeds, bone, artefacts, macrofossils and microscopic remains such as pollen and insects and by assessing their condition via chemical analysis.

7 HYDROLOGICAL AND WATER QUALITY MONITORING

7.1 Recently published Historic England guidance on Preserving Archaeological Remains (Historic England 2016) has informed the City of York to evaluate potential deeply buried, water-logged and organic deposits by borehole.

7.2 A six month programme of water monitoring work will be undertaken to understand the site hydrology and potential impact of the development. The monitoring and assessment will encompass both hydrology and water quality over the course of the stipulated time frame.

7.3 Water levels will be automatically logged using in situ sensors. The data will be assessed with reference to the levels measured by the Viking Recorder on the River Ouse (the closest Environment Agency monitoring station), along with weekly rainfall levels recorded at the University of York's Heslington Campus and hosted by the Electronics Department.

7.4 The dipwells will be monitored on a monthly basis for 6 months, with an interim report being compiled after the third month. Upon completion of the six month monitoring, the water monitoring equipment will be recovered for re-use.

8 RECORDING METHODOLGY

8.1 All boreholes will be recorded using standardised pro forma record sheets and related to Ordnance Datum. Borehole cores will be examined in the field by an archaeologist suitably experienced in the deep stratigraphic nature of York's archaeological deposits.

8.2 Each context will be described in full on the pro forma borehole record sheet in accordance with the accepted context record conventions. Each context will be given a unique number. These field records will be checked and indexes compiled.

8.3 Photographs of work in progress and recovered cores will be taken. The photographic record will comprise of digital photographs of not less than 10 mega-pixels. All site photography will adhere to accepted photographic record guidelines.

8.4 All finds will be collected and handled following the guidance set out in the CIfA guidance for archaeological materials. Finds of particular interest or fragility will be retrieved as Small Finds. Other finds will be collected as Bulk Finds and bagged by material type.

8.5 All artefacts and ecofacts will be appropriately packaged and stored under optimum conditions, as detailed in the RESCUE/UKIC publication First Aid for Finds, and recording systems must be compatible with the recipient museum. All finds that fall within the purview of the Treasure Act (1996) will be reported to HM Coroner according to the procedures outlined in the Act, after discussion with the client and the local authority.

8.6 The collection and processing of environmental samples will be undertaken in accordance with Historic England guidelines (Campbell, Moffatt and Straker 2011).

8.7 General Biological Analysis (GBA) samples from the potential waterlogged organic deposits will be processed and assessed by specialist staff at Palaeoecology Research Services (PRS).

8.8 Sealed REDOX samples from potential waterlogged organic deposits will be processed and assessed by GEOLABS Ltd.

8.9 If suitable material is identified within the GBA samples then it will be assessed and submitted for AMS dating. This will be conducted by SUERC and will aim to date samples from the top and bottom of the sequence of potential waterlogged organic deposits, with at least one intermediate point, to contribute to the understanding of the archaeology.

9 SPECIALIST ASSESSMENT

9.1 The stratigraphic information, artefacts, soil samples, and residues will be assessed as to

their potential and significance for further analysis and study. The material will be quantified (counted and weighted). Specialists will undertake a rapid scan of all excavated material. Ceramic spot dates will be given. Appropriately detailed specialist reports will be included in the report.

9.2 Materials considered vulnerable should be selected for stabilisation after specialist recording. Where intervention is necessary, consideration must be given to possible investigative procedures (e.g. glass composition studies, residues on or in pottery, and mineral-preserved organic material). Allowance will be made for preliminary conservation and stabilization of all objects and a written assessment of long-term conservation and storage needs will be produced. Once assessed, all material will be packed and stored in optimum conditions, in accordance with Watkinson and Neal (1998), CIfA (2014) and Museums and Galleries (1992).

9.3 All finds will be cleaned, marked and labelled as appropriate, prior to assessment. For ceramic assemblages, any recognised local pottery reference collections and relevant fabric Codes will be used.

9.4 Allowance will be made for the recovery of material suitable for scientific dating and contingency sums will be made available to undertake such dating, if necessary. This will be decided in consultation with CYC Principal Archaeologist, John Oxley.

10 REPORT & ARCHIVE PREPARATION

10.1 An interim assessment report will be compiled after three months of monitoring has been completed.

10.2 Upon completion of the six month monitoring period, a report will be prepared to include the following:

a) A non-technical summary of the results of the work.

b) An introduction which will include the planning reference number, grid reference and dates when the fieldwork took place.

c) An account of the methodology and detailed results of the operation, describing structural data, archaeological features, associated finds and environmental data, and a conclusion and discussion.

d) A selection of photographs and drawings, including a detailed plan of the site accurately identifying the areas monitored, borehole locations and selected artefacts where appropriate.

e) Specialist artefact and environmental reports where undertaken, and a context list/index.

f) Details of archive location and destination (with accession number, where known), together with a context list and catalogue of what is contained in that archive.

g) A copy of the key OASIS form details

h) Copies of the Brief and WSI

i) Additional photographic images may be supplied on a CDROM appended to the report.

10.3 A bound and digital copy of the report will be submitted direct to CYC for planning purposes, and subsequently for inclusion into the HER.

10.4 A field archive will be compiled consisting of all primary written documents, plans, sections and photographs. Catalogues of contexts, finds, soil samples, drawings and photographs will be produced. York Archaeological Trust will liaise with the Yorkshire Museum prior to the commencement of fieldwork to establish the detailed curatorial requirements of the museum and discuss archive transfer and to complete the relevant museum forms. The relevant museum curator would be afforded access to visit the site and discuss the project results.

10.5 The owner of the Intellectual Property Rights (IPR) in the information and documentation arising from the work, would grant a licence to the Local Authority and the museum accepting the archive to use such documentation for their statutory functions and provide copies to third parties as an incidental to such functions. Under the Environmental Information Regulations (EIR), such documentation is required to be made available to enquirers if it meets the test of public interest. Any information disclosure issues would be resolved between the client and the archaeological contractor before completion of the work. EIR requirements do not affect IPR.

10.6 Upon completion of the project an OASIS form will be completed at http://ads.ahds.ac.uk/project/oasis/.

11 HEALTH AND SAFETY

11.1 Health and safety issues will take priority over archaeological matters and all archaeologists will comply with relevant Health and Safety Legislation.

11.2 A Risk Assessment will be prepared prior to the start of site works.

12 PRE-START REQUIREMENTS

12.1 The client will be responsible for ensuring site access has been secured prior to the commencement of site works, and that the perimeter of the site is secure.

12.2 The client will provide York Archaeological Trust with up to date service plans and will be responsible for ensuring services have been disconnected, where appropriate.

12.3 The client will be responsible for ensuring that any existing reports (e.g. ground investigation, borehole logs, contamination reports) are made available to York Archaeological Trust prior to the commencement of work on site.

13 TIMETABLE & STAFFING

13.1 The borehole survey is scheduled to begin on July 23rd 2018 and is expected to take one day.

13.2 Specialist staff available for this work are as follows:

- Human Remains – Malin Holst

- Palaeoenvironmental remains – PRS Ltd.
- Redox sample analysis: GEOLABS Ltd
- Head of Curatorial Services - Christine McDonnell
- Finds Researcher - Nicky Rogers
- Pottery Researcher - Anne Jenner
- Finds Officers – Nienke Van Doorn
- Archaeometallurgy & Industrial Residues – Rachel Cubitt and Dr Rod Mackenzie
- Conservation - Ian Panter

14 MONITORING OF ARCHAEOLOGICAL FIELDWORK

14.1 As a minimum requirement, John Oxley will be given a minimum of one week's notice of work commencing on site, and will be afforded the opportunity to visit the site during and prior to completion of the on-site works so that the general stratigraphy of the site can be assessed and to discuss the requirement any further phases of archaeological work. York Archaeological Trust will notify John Oxley of any discoveries of archaeological significance so that site visits can be made, as necessary. Any changes to this agreed WSI will only be made in consultation with John Oxley.

15 COPYRIGHT

16 KEY REFERENCES

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For the latest Historic England guidance documents see:

https://historicengland.org.uk/advice/latest-guidance/

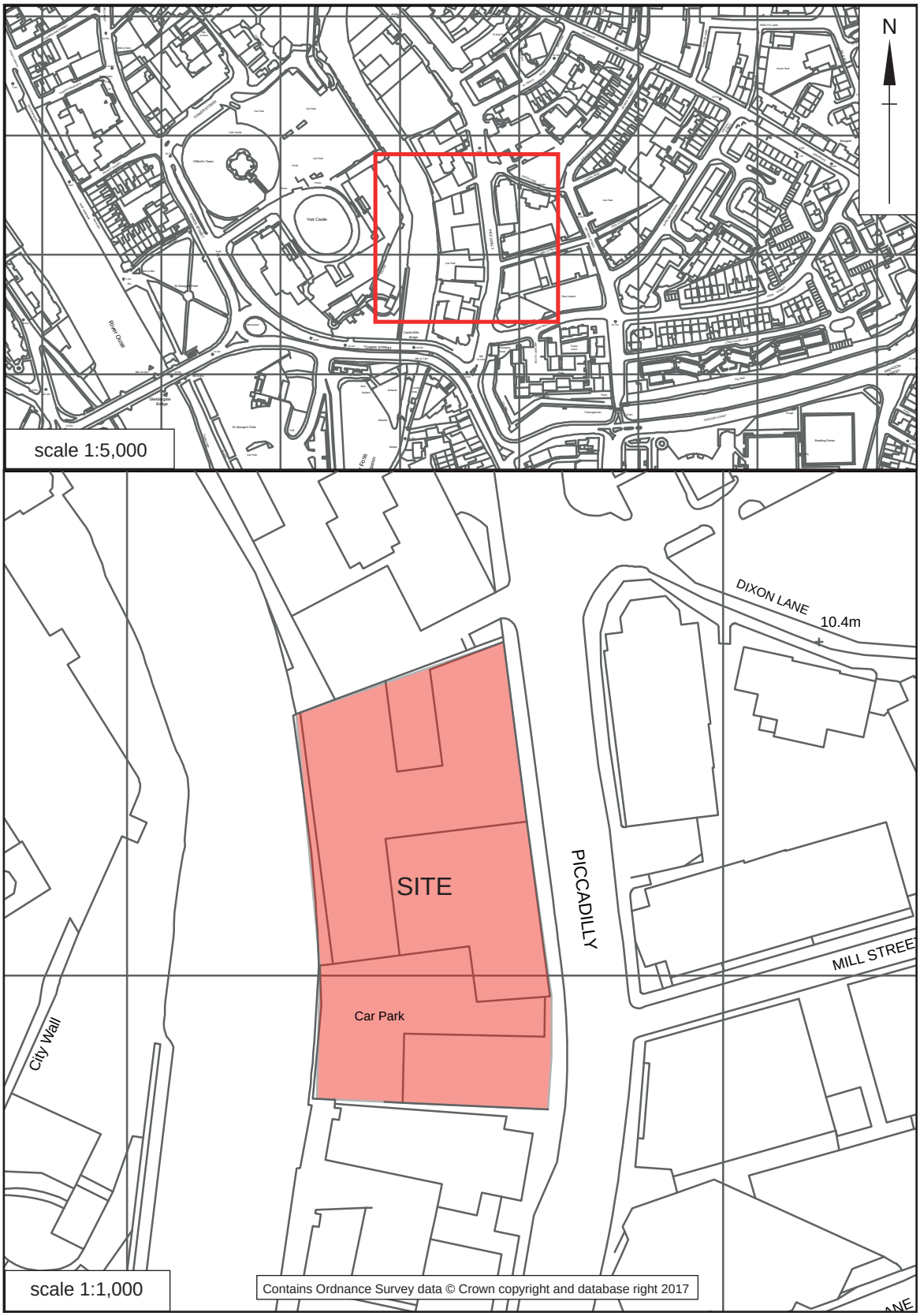

Fig. 01 Location of site

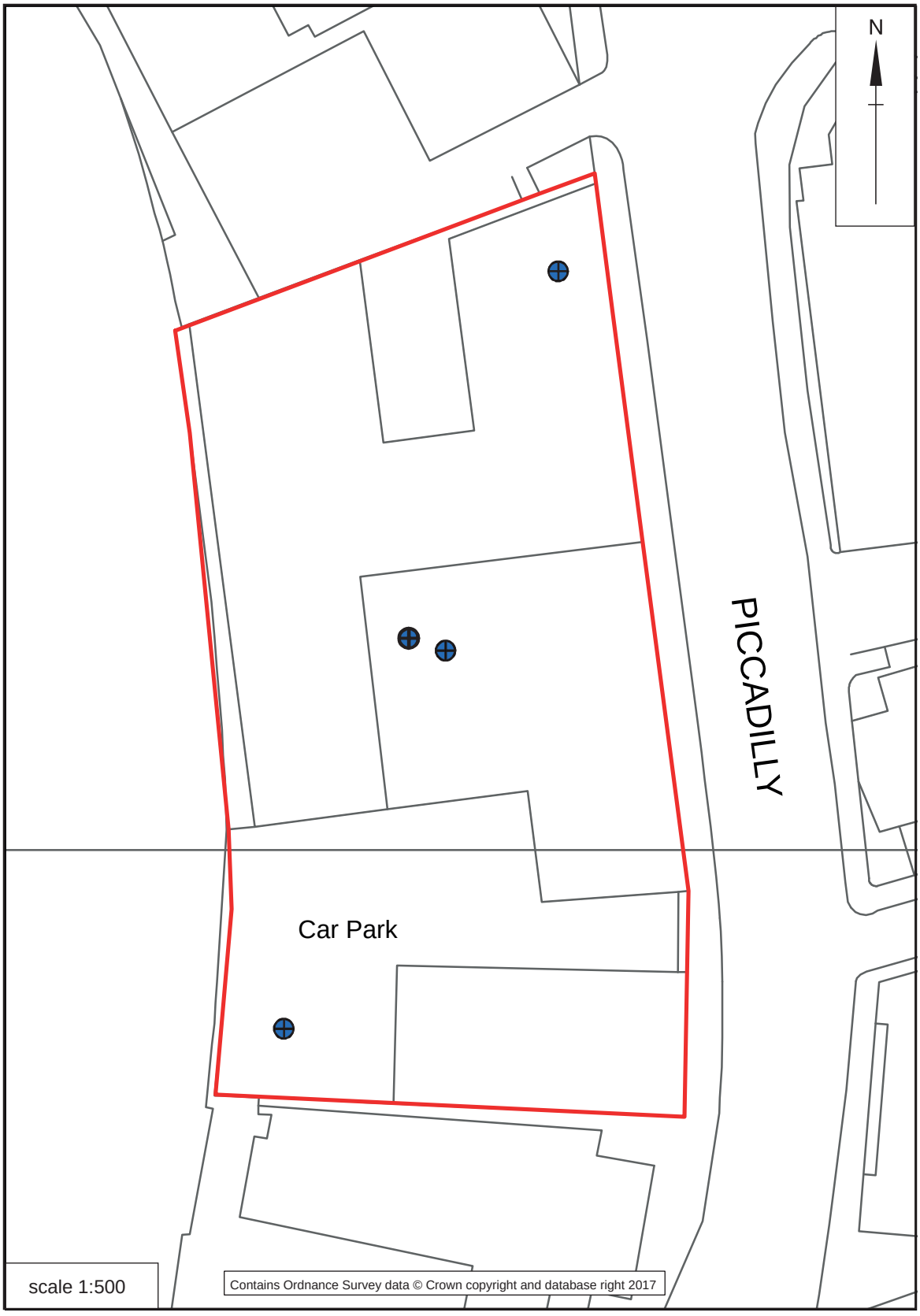

Fig. 02 Location of boreholes 1:500 @ A4

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