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**KING'S QUARTER /
WHITEFRIARS (PLOT 4)
GLOUCESTER:
GEOARCHAEOLOGICAL
ASSESSMENT OF
BOREHOLE STRATIGRAPHY**

Prepared for Cotswold
Archaeology Ltd

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King's Quarter/Whitefriars (Plot 4)
Gloucester: Geoarchaeological Assessment Of Borehole Stratigraphy

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SUMMARY

This document reports on the geoarchaeological significance of strata sampled from two boreholes drilled at the King's Quarter / Whitefriars (Plot 4) site in July 2020 at the request of Cotswold Archaeology Ltd. The boreholes were drilled through the backfill of Trenches 2 and 5 in order to record strata too deep for archaeological excavation. Five records of BGS geotechnical boreholes and three records of Oxford Archaeology Ltd boreholes are also discussed.

The sedimentary sequence found in the boreholes is divided into five stratigraphic units. These units are from youngest to oldest:

- 1. Made Ground: gravel backfill (modern).*
- 2. Archaeological diamict (Holocene).*
- 3. Fine grained alluvium (Holocene).*
- 4. Cheltenham Sand and Gravel (Pleistocene).*
- 5. Blue Lias and Charmouth Mudstone Formation (Triassic: Lias Group bedrock).*

The River Twyver occupies a valley c. 300m wide and 4m deep, and is at present in a culvert that bisects the site from southeast to northwest. The Lias Group bedrock is found between 12.07m OD and 11.51m OD. More deeply incised mudstone lies on the south side of the valley c. 40m from the site where a sharp rise in the bedrock is also evident. Thin, weathered and reworked deposits of Pleistocene date overlie the bedrock.

In the Holocene, thin fine grained alluvial deposits containing granules of ceramic building material (cbm) fill a channel of the River Twyver at 12.97m OD. The succeeding very thin flood plain silt/ clays are at first sterile of archaeological material but higher in the stratigraphy more humic clays are found, and contain charcoal, cbm, bone fragments and limestone clasts. These humic clay deposits were also encountered at the base of Trenches 2 and 5. Thick alluvial deposits with intercalated organics are found in one Oxford Archaeology Ltd borehole to the south of the site.

Modern gravel backfill capped the core sequence.

1. INTRODUCTION

1.1 Project outline

1.1.1 This report discusses the results of a geoarchaeological investigation of two geoarchaeological boreholes drilled by Geotechnical Engineering Ltd at the King's Quarter /Whitefriars (Plot 4) site in the city of Gloucester, Gloucestershire (henceforth 'the site'). The investigation was carried out by ARCA on behalf of Cotswold Archaeology Ltd on 31st July 2020. An additional eight boreholes that lie close to the site are also reported on: five recorded by the British Geological Survey (BGS) and three recorded by Oxford Archaeology Ltd in 2019.

1.2 Structure of the report

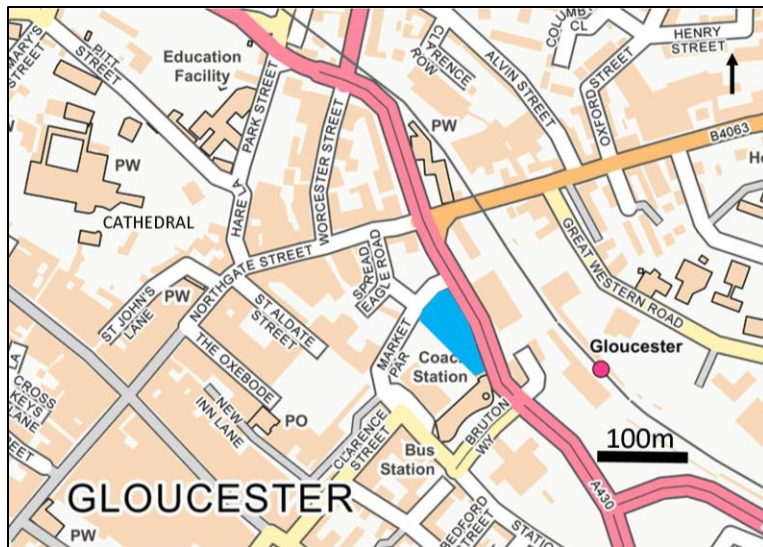
1.2.1 The report is arranged as follows: Section 1 provides essential background to the project, i.e. the geographic and geological situation of the site, and the aims of the present work. Section 2 outlines the methodology employed to carry out the fieldwork, subsequent data processing and laboratory examination. The results of the logging of the stratigraphy and laboratory assessments are presented in Section 3, while Section 4 assesses the significance of the results in relation to the aims that have been set. A bibliography and appendices providing details of borehole locations and lithology complete the document.

1.3 Location, topography and geology

1.3.1 The site was formerly the Bruton Way multi-storey car park and occupies c. 0.32ha of level open ground in the city of Gloucester, c. 400m southeast of the Cathedral. It is centred at NGR SO 83500 18642, c. 15m OD and is bound by Market Parade to the west, Bruton Way to the southeast and the A430 trunk road to the east (Cotswold Archaeology 2020, 5) (Figure 1 and Figure 2).

1.3.2 The archaeology of the site is summarised in the Cotswold Archaeology evaluation report (2020, 6-7) and discussed in depth in the Cotswold Archaeology desk-based assessment report (2019). In brief, Roman remains are known from Market Parade and represent extra-mural activity fronting Northgate Street – the route of a Roman road. Southwest of the site waterlogged Roman deposits exist and are possibly coincident with BGS borehole SO81NW231 (see Section 4.1.2).

- 1.3.3 The 2020 excavations opened five trenches and found Roman soil horizons and demolition rubble lying at 13.28m – 12.98m OD in Trenches 1, 3 and 5. In Trench 5 waterlogged deposits were found and ‘probable alluvial clay’ (context 520) at 12.87m OD with a *terminus ante quem* of 2nd to 3rd century AD. Overlying the alluvial clay were thin deposits of silt/clay (contexts 518 and 519) believed to represent seasonally flooded soil/cultivation horizons. A second and final alluvial clay (context 521) was laid down over context 518 (Cotswold Archaeology 2020, 16). Possible soil horizons are recorded higher in the stratigraphy, for example, in Trench 4 at c. 13.9m OD (see Section 4.1.2).
- 1.3.4 The alluvial clay deposits are described as ‘mid brown yellow silt clay’ (context 520) and ‘light green grey silt clay’ (context 521) and were <0.1m thick (*ibid.*, 31).
- 1.3.5 In around 1268 a Carmelite Friary was established in the Market Parade area and the River Twyver was diverted along the line of Station Road and Market Parade. The modern river is now culverted and bisects the site southeast to northwest. Evidence unearthed in excavations in 2020 on the site that may represent the friary were: surfaces, walls and a stone-lined drain. These features were found at 13.61m – 13.1m OD in Trenches 1–4 (*ibid.*, 3).
- 1.3.6 The British Geological Survey (BGS 1975, sheet 234; 2016) map the site as lying on the western edge of an extensive outcrop of Cheltenham Sand and Gravel that covers 2.5km² from Robinswood in the south, to Kingsholm in the north. The lithology of this unit is fine to medium sands with ooidal limestone stringers and it is believed to have been deposited in the middle of the Devensian cold stage (76,000 – 26,000 ka) by aeolian and solifluction processes. It was derived from the Middle Jurassic Great Oolite and Inferior Oolite Groups on the Cotswold Escarpment. Underlying the superficial deposits is the bedrock limestone and mudstone of the undifferentiated Blue Lias and Charmouth Mudstone Formations, strata that formed between 210 – 183 Ma in the late Triassic to Early Jurassic Epochs. The bedrock lithology is described as dark grey laminated shales with occasional sideritic nodules (BGS 2020a; 2020b).



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Figure 1. Map showing the location of the King's Quarter/Whitefriars site (in blue).

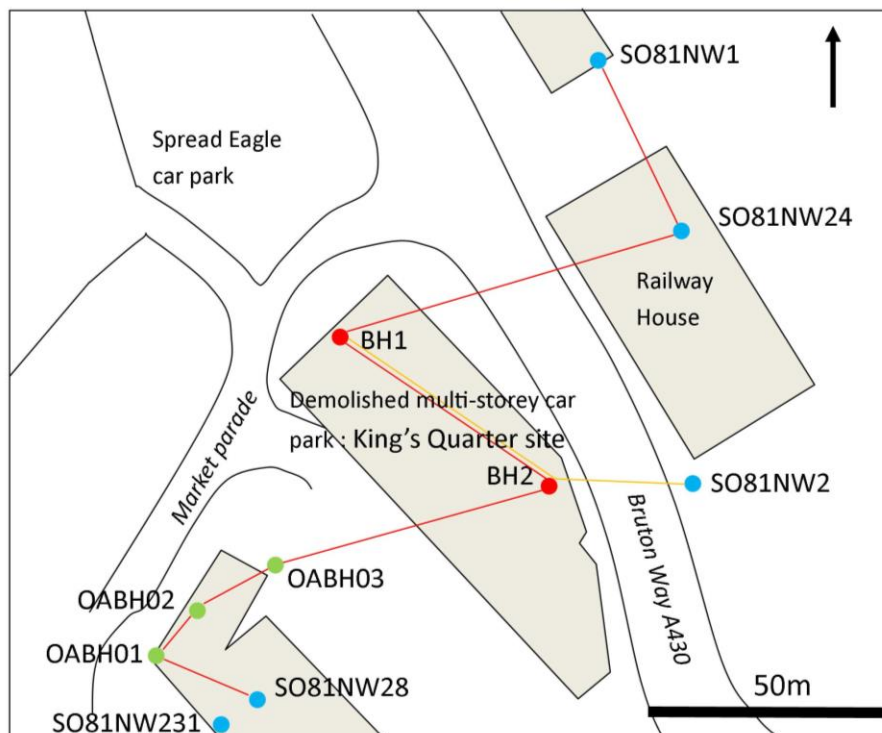


Figure 2. Map showing the borehole locations (red ARCA, blue BGS, and green Oxford Archaeology Ltd) and the two lithostratigraphic cross sections.

1.4 Aims

The aims of the work at the site were to:

1.4.1 Sample the Quaternary deposits preserved below the level of the base of the archaeological trenches;

1.4.2 Determine the date, state of preservation, and survival of any archaeological or biological remains;

1.4.3 Determine the nature and depositional environments for any Quaternary deposits preserved;

1.4.4 Assess the archaeological and palaeoenvironmental potential of the deposits.

2. METHODOLOGY

2.1 Field methodology and core logging

2.1.1 Drilling took place after the 2020 archaeological campaign was complete and the trenches backfilled with gravel. BH1 was positioned on the backfill of Trench 5 and BH2 on the backfill of Trench 2 (Figure 2). The two borehole locations were surveyed by Cotswold Archaeology Ltd to the National Grid and Ordnance Datum.

2.1.2 Drilling commenced from the ground surface and continued until bedrock was reached. A Pioneer 2 drilling rig capable of both rotary and percussion drilling was used to retrieve continuous cores of 100mm diameter contained in Perspex liners (Geotechnical Engineering Ltd 2019). Boreholes were cased to ensure the minimum of contamination and the integrity of the borehole. The cores were sealed and labelled on site and transported to Geotechnical Engineering's warehouse at Quedgeley for geoarchaeological logging.

2.1.3 The sediment retained in the core tubes was carefully hand-cleaned using a sharp scalpel to expose a fresh surface for photography and description. Cores were photographed and the lithology was described using standard geological criteria (Jones *et al.* 1999; Munsell Color 2000; Tucker 2011).

2.2 Desk top methodology

2.2.1 Lithological and positional data from BH1, BH2; four of the five BGS boreholes (labelled as SO81NW1 etc.), and the three Oxford Archaeology Ltd boreholes (OABH01 – OABH0 03) have been transcribed into a database of the RockWorks 15 geological utilities program (RockWare 2012). The software was then used to plot the lithostratigraphic cross-sections (Figure 3 and Figure 4). The location and elevation of the boreholes are recorded in Appendix 1 and lithological data in Appendix 2.

2.3 Palaeoenvironmental assessment

No suitable organic material (peat or organic refuse, for example) was recovered from the borehole cores and as a consequence no palaeoenvironmental sampling was undertaken.

2.4 Archive

No cores were selected for storage and no archaeological material was recovered. The digital archive consists of photographs of the cores in JPG format and this report in PDF format. These digital archives are stored both on the University of Winchester server and on an external hard drive stored outside the University of Winchester. Copies of these data can be supplied on request.

3. RESULTS: BOREHOLE LITHOLOGY

3.0.1 The sedimentary sequence found in the boreholes is divided into five stratigraphic units. These units are from youngest to oldest:

1. Made Ground: gravel backfill (modern).
2. Archaeological diamict (Holocene).
3. Fine grained alluvium (Holocene).
4. Cheltenham Sand and Gravel (Pleistocene).
5. Blue Lias and Charmouth Mudstone Formation Undifferentiated (Triassic: Lias Group bedrock).

Each unit is discussed in stratigraphic order in the following Sections.

3.1 Lias Group bedrock

- 3.1.1 The Lias Group bedrock is found in both boreholes on the site. It lies between 12.07m OD and 11.51m OD in BH1 and BH2 respectively (Figure 3).
- 3.1.2 The lithology of the bedrock is Gley 2 5/5B Bluish grey grading into Gley 2 3/5B Very dark bluish grey, moist and stiff to indurate mudstone. It is homogenous with rare granular-sized greyish white irregularly rounded nodules (diagenetic siderite) and exhibits a sub-parallel, shale-like lamination with a lustrous appearance. The top is reworked as 5Y 4/3 Olive, firm silt/clay and incorporated into overlying Quaternary deposits.
- 3.1.3 The bedrock is unconformably overlain by superficial Quaternary deposits.

3.2 Cheltenham Sand and Gravel

- 3.2.1 Cheltenham Sand and Gravel *sensu stricto* was not recovered in the two boreholes. However in BH2 a lens of well-sorted sand found lying over the mudstone is indicative of the presence of this Pleistocene formation on or near the site. The sand is incorporated into a firm to stiff silt/clay that subcrops at 11.84m OD and is 0.3m thick, and probably represents an ancient, fluvial reworking of the top of the mudstone.
- 3.2.2 Fine grained deposits succeed Pleistocene strata in both boreholes.

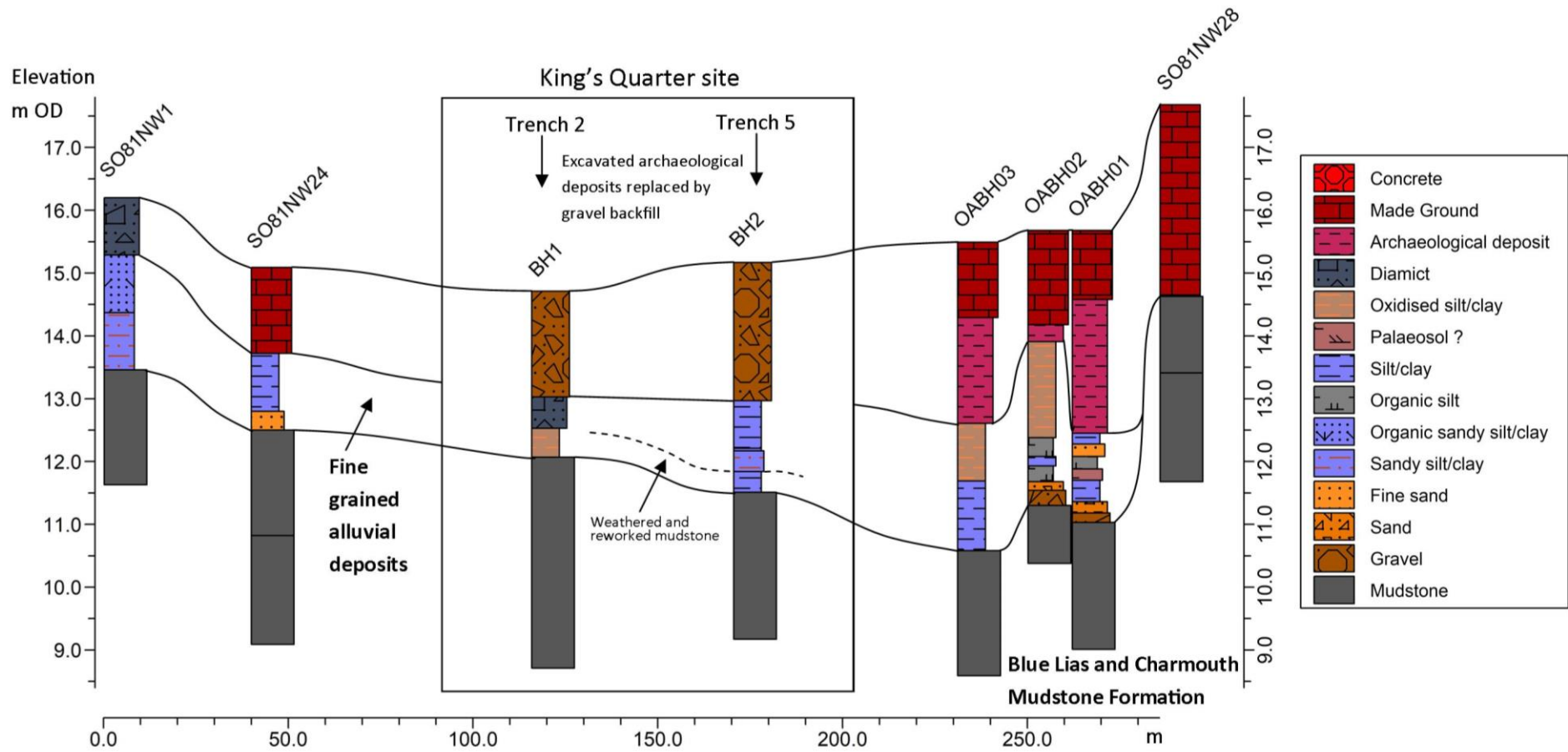


Figure 3. North to south lithostratigraphic cross section. Vertical exaggeration x17.

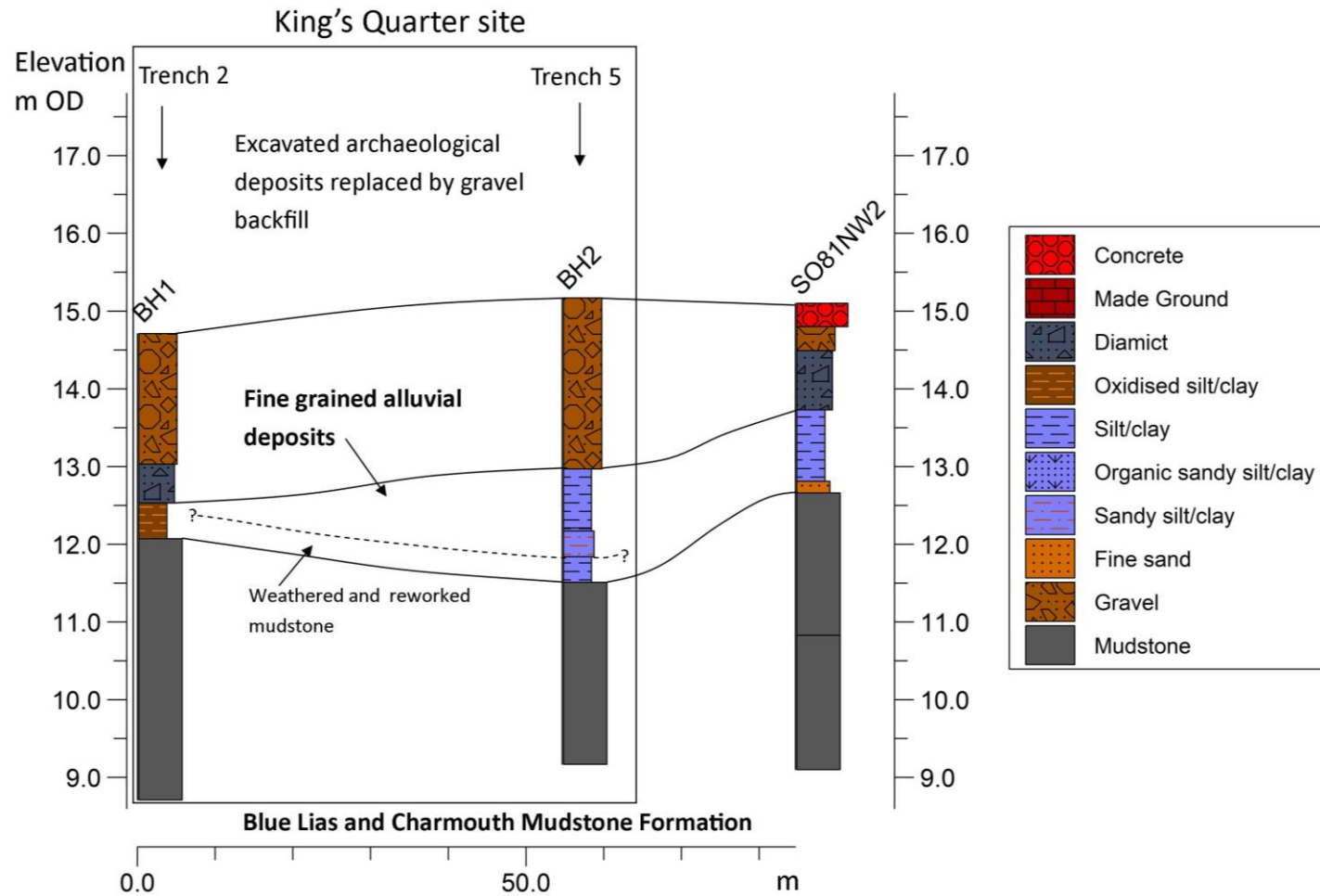


Figure 4. West to east lithostratigraphic cross section. Vertical exaggeration x10.

3.3 Fine grained deposits

- 3.3.1 Fine grained alluvial strata deposited in the Holocene by the River Twyver are found at 12.53m OD in BH1 and at 12.97m OD in BH2. In BH1 the deposit is 2.5Y 5/3 Light olive brown grading into 10YR 5/6 Yellowish brown silt/clay and contains frequent grains of red iron oxide. It appears to be ultimately derived from the weathered top of the mudstone and has undergone post-depositional oxidation as a result of the rise and fall of the water table. In BH2 (Trench 5) a more complex sequence is present: overlying the Pleistocene alluvium (see Section 3.2.1 above), with a sharp boundary, is 2.5Y 5/2 Greyish brown, soft sandy silt/clay, 0.33m thick, which contains occasional granules of angular ooidal limestone. Rare red cbm grains are also present and coarser particles tend to be found towards the base. This channel deposit is overlain by 40mm of mottled 5Y 4/3 Olive silt/clay. Succeeding deposition (0.76m) on the flood plain is humic, dark coloured and of heterogeneous lithology. Human action is evinced by the presence of charcoal, bone, cbm and rare pebbles of quartz and limestone found within the predominantly silt/clay lithology. This stratum probably corresponds to context 518 at the base of Trench 5. It is described as 'Dark brown grey silt clay with occasional gravel inclusions' and is interpreted as a 'Buried soil horizon/cultivation soil' (Cotswold Archaeology 2020, 31).
- 3.3.2 An archaeological diamict succeeds the fine grained deposits in BH1 and gravel backfill in BH2.

3.4 Archaeological diamict

- 3.4.1 In BH1 a 2.5Y 4/2 Dark greyish brown diamict 0.5m thick was recorded at 13.03m OD. It is humic with a coarse gritty texture and an archaeological clastic content that includes flint, ooidal limestone and rare, angular, red brick granules.
- 3.4.2 Gravel backfill succeeds the archaeological diamict in BH1.

3.5 Made Ground

- 3.5.1 Trenches 2 and Trench 5 were backfilled with gravel to depths below ground level of 1.68m recorded in BH1 (Trench 5) and 2.20m recorded in BH2. This material constitutes modern Made Ground.

4. ASSESSMENT

4.0.1 The sub-sections below review the lithostratigraphic evidence against the relevant aims of Section 1.4.

4.1 Lithostratigraphic sequence

4.1.1 On the site and its immediate environs the Lias Group bedrock forms a heavily weathered basement to the Quaternary sediments of the ancient River Twyver. The borehole records from the site, the BGS and Oxford Archaeology Ltd indicate the presence a shallow valley c. 300m wide with a depth of c. 4m incised in the bedrock (Figure 3). The lowest elevation is found at OABH03 at 10.58m OD, c. 40m to the southwest. Between OABH01 and SO81NW28 over a distance of c. 20m, there is a notable rise of c. 3.5m in the elevation of the bedrock. An outcrop of more indurate limestone could account for this feature and may have been exposed at the top of the river bank/valley side in historic times.

4.1.2 Unconformably overlying the bedrock are alluvial deposits derived from the weathered mudstone laid down in the Pleistocene. A minor sand body in BH2 points to the presence of the Cheltenham Sand and Gravel Formation present in the locality. Fine sand is recorded over the bedrock in SO81NW24 70m north east of the site and both sand and gravel are also preserved in OABH01 and OABH02. These alluvial deposits, which are <0.5m thick, probably represent Cheltenham Sand and Gravel reworked by the ancient River Twyver.

4.1.3 At the end of the Pleistocene, climatic amelioration brought about a stabilisation of the land surface and an end to channel gravel aggradation. Colonisation by plants reduced the supply of sediment and stream flow energy fell as a result of milder winters and the shift from surface to ground water drainage succeeding the melting of the permafrost. These processes result in the River Twyver becoming established in low elevation channel(s) on its floodplain. In the Holocene in general, a high water table and propensity to flood promoted the eventual formation of fresh water marshes and peat accumulation in river valleys. Evidence for local peat formation in the Twyver valley is found in borehole SO81NW231, c. 90m south southwest of the site (Figure 1). This borehole, which lacks an elevation, records soft blue grey peaty clay at c. 0.9 – 2.1m bgl. The three BGS boreholes (SO81NW1, SO81NW2 and SO81NW24) to the northeast and east also record fine grained

alluvial deposits that in SO81NW1 include organic material – although this deposit is described as ‘fill’ in the lithological description (BGS 2020a). A more secure elevation for the alluvial deposits is seen in SO81NW2 and SO81NW24 where brown mottled clay with small stones are recorded at c. 13.7m OD. OABH02 records alluvium at a slightly higher elevation (13.91m OD) where it is described as ‘*Firm greyish brown clayey SILT, few olive brown mottles, shell fragments, few inclusions of sandstone (angular) <40mm and charcoal 2%.*’: an oxidised alluvial deposit with a minor anthropogenic input. The corresponding deposits on the site would therefore appear to have been truncated by archaeological deposits, although dark brown and green brown clays are recorded as possible agricultural soils in Trench 4 at a similar elevation c. 13.9m OD (contexts 404 and 405) (Cotswold Archaeology 2020, 30).

4.1.4 Two organic deposits are recorded in OABH02 as ‘organic rich silts’. They are intercalated towards the base of a c. 2.5m thick alluvial deposit. Each silt unit is c. 0.3m thick and the earliest at 11.66m OD contained twigs and cbm.

4.1.5 On the site 0.33m of fine grained alluvial deposits fill a channel of the River Twyver (BH2, Trench 5). Rare cbm grains and granules are present and the deposit exhibits a poorly developed upward fining – typical of fluvial transport and deposition. The fine-grained size of the thin sedimentary fill of the channel implies sluggish stream power and minor stream proportions. Archaeological evidence from the base of Trench 5 suggests the channel was active prior to the 2nd – 3rd century AD (see Section 1.3.3). No channel is seen in BH1 as a result of the higher elevation of the bedrock. Thin, oxidised flood plain silt/clays over lie the channel and are recorded in BH1 too. Succeeding deposits are more humic and contain undateable cbm. They represent human occupation of the flood plain whereby archaeological material is incorporated into the flood alluvium as a result of cultivation and building activities, for example.

4.1.6 Modern gravel backfill, which was placed in the archaeological Trenches prior to drilling, completes the sampled sedimentary sequence.

4.2 Archaeological and palaeoenvironmental potential

4.2.1 Dateable ceramic was not recovered from BH1 or BH2. Where charcoal was recorded, the deposits that contained it were

redeposited, and as a result are not suitable for radiometric dating. The archaeological potential is therefore low.

- 4.2.2 The deposits recorded in BH1 and BH2 are mineral in nature and have no potential for the preservation of organic remains. Furthermore, there is evidence of oxidation in the form of mottling that militates against good preservation of pollen, for example. The palaeoenvironmental potential is deemed low.

5. CONCLUSIONS

- 5.1 The borehole cores from the site and its environs provide evidence of an incised mudstone basement which is occupied by the modern day River Twyver. The southern side of the valley is marked by a sharp rise in the bedrock. The top of the mudstone is weathered and reworked in the Pleistocene with the incorporation of nearby superficial deposits of the Cheltenham Sand and Gravel. Shallow channel deposits of the River Twyver are recorded in BH2 and contain evidence of human action in the Holocene. No channel is seen in BH1 where the bedrock lies at a higher elevation. A thin, fine grained and sterile alluvial clay overlies the channel in BH2. BH1 also records an alluvial clay stratum. Human occupation of the floodplain is seen again in the overlying heterogeneous lithology of dark silt/clays in BH2 and the diamict in BH1. To the southwest, Borehole OABH02 records a thick alluvial sequence with deep seated organic units.

- 5.2 No further work is recommended on the core strata.

6. ACKNOWLEDGEMENTS

- 6.1 ARCA would like to thank the following for their help during the project: Andrew Armstrong of Gloucester City Council; Garry Baddeley and Steve Sheldon of Cotswold Archaeology Ltd; Matthew Hollow of Geotechnical Engineering Ltd and his drilling team; and Dr Eleanor Standley of the University of Oxford.

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APPENDIX 1: BOREHOLE LOCATIONS

Borehole	Easting	Northing	Elevation m
BH1	383540	218619	14.71
BH2	383495	218650	15.17
SO81NW2	383570	218620	15.1
SO81NW1	383550	218710	16.2
SO81NW24	383567	218674	15.09
SO81NW28	383479	218574	17.68
OABH01	383457.4	218583.9	15.68
OABH02	383465.2	218592.9	15.68
OABH03	383481.6	218602.6	15.49

APPENDIX 2: BOREHOLE LITHOLOGY

Borehole	Top m	Base m	Lithology	Description
BH1	0.00	1.68	Gravel	Backfill.
BH1	1.68	2.18	Diamict	2.5Y 4/2 Dark greyish brown grading into 4/3 Olive brown moist and firm archaeological diamict. Granular to medium pebble-sized clasts of sub-angular flint and ooidal limestone; rare angular red brick granule. Occasional charcoal granules. Very sandy silt/clay matrix with frequent fine, medium and coarse sand-sized grains. Coarse gritty texture, humic, heterogeneous unit. Poorly defined greenish mottling. Gradual boundary to:

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BH1	2.18	2.64	Oxidised silt/clay	2.5Y 5/3 Light olive brown grading into 10YR 5/6 Yellowish brown silt/clay with frequent grains of red iron oxide. (Oxidation of weathered top of mudstone from water table). Sharp boundary to:
BH1	2.64	6.00	Mudstone	Gley 2 5/5B Bluish grey grading into Gley 2 3/5B Very dark bluish grey, moist and stiff mudstone. Homogenous with rare granular-sized greyish white irregular rounded nodules (diagenetic siderite). Sub-parallel, shale-like laminae and lustrous appearance. (Blue Lias Formation and Charmouth Mudstone Formation (Undifferentiated)). End of BH.
BH2	0.00	2.20	Gravel	Backfill.
BH2	2.20	2.96	Silt/clay	2.5Y 3/2 Very dark greyish brown grading into 5Y 4/3 Olive, moist firm silt/clay. Frequent cobble-sized diffuse mottles. Humic unit especially towards top with rare sand-sized mineral grains. Occasional grains and granules of charcoal, cbm and sub-angular ooidal limestone. Rare, black limb bone fragment (30x5mm). Rare coarse pebble-sized angular red brick, rare medium pebble-sized cinder-like black clast; rare angular ooidal limestone and well-rounded white quartz fine pebble. Fragmented, soft, red mudstone clast. Gradual boundary to:
BH2	2.96	3.00	Silt/clay	5Y 4/3 Olive moist and firm silt/clay mottled greenish grey. (Fine grained alluvium).
BH2	3.00	3.33	Sandy silt/clay	2.5Y 5/2 Greyish brown, wet and soft sandy silt/clay. Occasional granules of angular ooidal limestone. Coarser particles in the basal 40mm with less silt/clay. Rare red cbm grains and granules. Poorly preserved fining upward sequence. (Alluvium). Sharp boundary to:
BH2	3.33	3.66	Silt/clay	5Y 4/3 Olive moist and firm to stiff silt/clay with cobble-sized lens of yellowish sandy silt/clay at base. (Reworked mudstone plus Cheltenham Sand and Gravel). Diffuse boundary to:
BH2	3.66	6.00	Mudstone	5Y 4/1 Dark grey silt/clay grading into Gley 2 3/5B Very dark bluish grey, moist and stiff mudstone. Homogenous with rare granular-sized greyish white irregular rounded nodules (diagenetic siderite). Sub-parallel, shale-like laminae and lustrous appearance. (Blue Lias Formation and Charmouth Mudstone Formation (Undifferentiated)). End of BH.

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BGS borehole lithology				
SO81NW2	0.00	0.30	Concrete	Concrete.
SO81NW2	0.30	0.61	Gravel	Limestone fill (compacted).
SO81NW2	0.61	1.37	Diamict	Dark brown clayey organic soil and stones (fill).
SO81NW2	1.37	2.29	Silt/clay	Firm light brown mottled clay with tiny stones.
SO81NW2	2.29	2.44	Fine sand	Fine sand.
SO81NW2	2.44	4.27	Mudstone	Firm to stiff dark grey, light brown mottled clay
SO81NW2	4.27	6.00	Mudstone	Stiff dark grey fissured shaley clay (containing white specs).
SO81NW1	0.00	0.91	Diamict	Dark brown sandy clayey rubble and brick (fill).
SO81NW1	0.91	1.83	Organic sandy silt/clay	Soft yellow brown sandy clay with organic soil and bricks (fill).
SO81NW1	1.83	2.74	Sandy silt/clay	Soft light brown mottled sandy clay.
SO81NW1	2.74	4.57	Mudstone	Soft to firm grey brown mottled clay.
SO81NW24	0.00	1.37	Made Ground	Fill
SO81NW24	1.37	2.29	Silt/clay	Mottled clay with small stones.
SO81NW24	2.29	2.59	Fine sand	Fine sand.
SO81NW24	2.59	4.27	Mudstone	Firm dark grey clay.
SO81NW24	4.27	10.67	Mudstone	Blue clay
SO81NW28	0.00	3.05	Made Ground	Made ground
SO81NW28	3.05	4.27	Mudstone	Firm hard grey clay.
SO81NW28	4.27	7.62	Mudstone	Firm hard dark grey shaley clay.
Oxford Archaeology boreholes (OABH01, OABH02 and OABH03): for lithology descriptions see <i>Kings Quarter, Whitefriars, Gloucester. Archaeological Evaluation Report</i> (Oxford Archaeology 2019, 103-106)				

