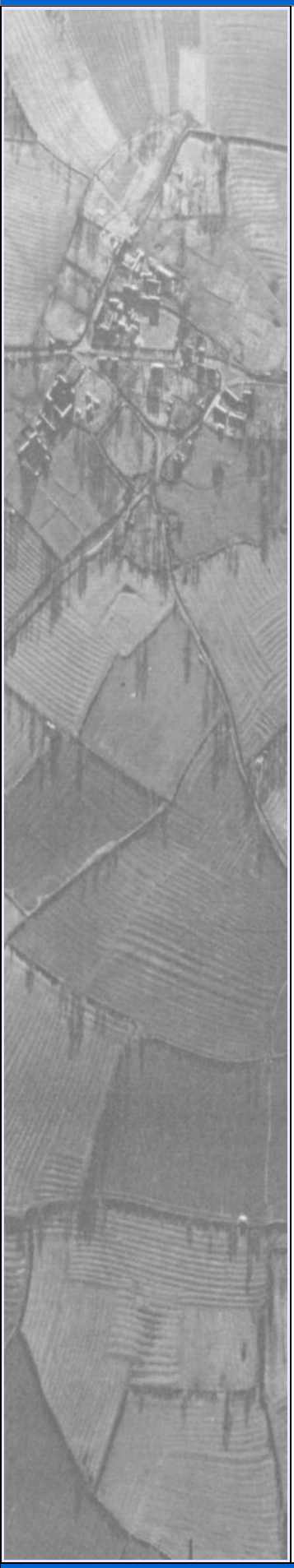

Redcliffe Wharf
Redcliffe Way
Bristol

MAGNETOMETER SURVEY &
GROUND PENETRATING RADAR TRIAL SURVEY
REPORT

for

Cotswold Archaeology

Kerry Donaldson and David Sabin

December 2018

Ref. no. J771

ARCHAEOLOGICAL SURVEYS LTD

Redcliffe Wharf
Redcliffe Way
Bristol

Magnetometer Survey and
Ground Penetrating Radar Trial Survey Report

for

Cotswold Archaeology

Fieldwork and report by David Sabin BSc (Hons) and Kerry Donaldson BSc (Hons)

Survey date - 20th November 2018
Ordnance Survey Grid Reference - **ST 58985 72375**

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SUMMARY

A geophysical survey was carried out by Archaeological Surveys Ltd on behalf of Cotswold Archaeology at Redcliffe Wharf in Bristol. The site has been subject to previous evaluation by Cotswold Archaeology and is known to contain evidence for a glass works dating to the 18th century as well as pottery manufacturing and warehousing and other structures from the 19th century.

Magnetometry was undertaken with the aim of locating potential strongly magnetic responses that could relate to glass cone or pottery kiln furnaces. An area of magnetic enhancement was located towards the centre of the site, but its origin is uncertain. Several strong, discrete, dipolar responses were evident in the vicinity of the projected glass cone area, but these indicate a response to ferrous material and could relate to modern objects.

A ground penetrating radar trial survey was also undertaken over the area of the previously evaluated glass cone as well as a wider area in order to determine if there was a response to features associated with an extension to the wharf and other 18th and 19th century structures. The results have revealed a well defined zone of complex and planar responses along the western edge that relate to infill and former surfaces that are bounded by a possible former wharf wall. The area of the glass cone does contain several strong reflectors that correspond to a previously evaluated brick surface. The anomalies may indicate further bricks or an area of intense burning inside the glass cone, which could relate to the internal furnace. The glass cone wall was not evident within the results. To the south are a number of further radar responses that could relate to structural remains, but they lack a clear and coherent morphology which prevents confident interpretation. Due to this lack of correlation between the excavation and radar results, and a high level of complexity associated with the radar reflections, the GPR survey was not extended beyond the trial area.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Cotswold Archaeology (CA) to undertake a geophysical survey comprising detailed magnetometry and a trial ground penetrating radar survey. The site is located at Redcliffe Wharf in Bristol and has been outlined for redevelopment. The survey forms part of an archaeological assessment of the site. The site has been subject to several archaeological evaluations by Cotswold Archaeology and others which have revealed building remains, demolition layers and industrial activity, including the partial excavation of a possible 18th century glass cone.

1.2 Survey aims, objectives and techniques

1.2.1 The aim of the survey was to use geophysical survey techniques to locate

archaeological features within the site. Primarily detailed magnetometry was used in order to locate highly magnetic features. Although modern debris and services can obscure weaker features, any anomalies that may relate to glass or pottery manufacturing furnaces should result in a strongly magnetic response. A trial of ground penetrating radar (GPR) was also undertaken over the area of the possible glass cone located by evaluation excavation. A wider zone to cover the location of former buildings and former possible harbour walls was also undertaken.

1.2.2 The objectives of the survey were outlined by the client and are summarised below:

- To ascertain a better understanding of the plan form of all buried structural remains within the site, in particular the location and extent of the brick glass cone of the 18th century glassworks partly revealed in Trench 2 of the 2005 CA evaluation, but also the location of any kilns or furnaces relating to the glassworks or potteries.
- To use the abstraction of results on historic maps to try to differentiate the 19th century buildings from the 18th century glassworks structures.
- To try to locate the position of earlier harbour walls or river bank as the wharf has been extended out to its current position by some distance since the 17th century.
- Attempt to locate the remains of an earlier (17th century) glassworks first shown on Millerd's 1710 map and as an L-shaped building on Rocque's 1742 map.

1.2.3 The survey and report generally follow the recommendations set out by: European Archaeological Council (2015) *Guidelines for the Use of Geophysics in Archaeology;* Institute for Archaeologists (2002) *The use of Geophysical Techniques in Archaeological Evaluations*. The work has been carried out to the Chartered Institute for Archaeologists (2014) *Standard and Guidance for Archaeological Geophysical Survey.* Note: currently Historic England (2018) no longer support the guidelines set out in English Heritage (2008) *Geophysical survey in archaeological field evaluation* and there are currently no plans to update the document. As a consequence other sources of written guidance referring to this document may be out of date and/or contain unsupported information (e.g. Chartered Institute for Archaeologists, 2014).

1.3 Site location, description and survey conditions

1.3.1 The site is located at Redcliffe Wharf, off Redcliffe Way in Bristol. It is centred on Ordnance Survey National Grid Reference (OS NGR) ST 58985 72375, see Figs 01 and 02.

1.3.2 The magnetometry survey covers approximately 0.3ha and the GPR trial area approximately 0.1ha. The ground surface is made up of various elements,

including cobbles, concrete, tarmac and loose ground make-up.

Plate 1: Magnetometry survey area looking south west

Plate 2: GPR survey area looking west (with magnetometry survey in progress)

1.3.3 The ground conditions across the site were generally considered to be favourable for the collection of ground penetrating radar data. Weather conditions during the survey were mainly fine.

1.4 Site history and archaeological potential

1.4.1 The site has been subject to several archaeological investigations through desk-based assessment (Leech 2001, CA 2005a & Leech 2006) as well as several phases of evaluation (Ponsford et al 1989, CA 2005b, CA 2007, CA 2017 & CA 2018).

1.4.2 Cartographic evidence indicates that the area contained a glasshouse in c1710 with Millerd's plan showing one in the south west corner of the site. The 1772 Rocque's plan indicates a circular glass cone towards the centre of the site. The site is also recorded as containing a pottery in the late 18th century. During the 19th century the site was used for warehousing associated with the wharf.

1.4.3 The 2005 (Trench 2) evaluation located evidence for a circular structure in the centre of the site, with associated flagstones and an internal burnt brick surface. The north eastern corner was re-exposed in 2016. The feature had been interpreted as the remains of a glass cone with a diameter of 8-9m, smaller than the majority of most glass cones, although the full extent of the structure was not exposed. The 1989 evaluation revealed a very small section of a similar feature approximately 16-18m to the south. This section was re-opened in 2005 (Trench 17) and could relate to the southern part of the same glass cone, although it is also possible that there were several phases of glass cones and they are not necessarily contemporary. The evaluation also revealed a WW2 air raid shelter cut into the northern section of the outer glass cone wall in Trench 2.

1.4.4 The 2007 evaluation identified evidence for land reclamation from the 18th century onwards with several phases of wharf walls pre-dating the existing waterfront. Walls and flooring associated with a 19th warehouse and Counting House as well as a residential dwelling were also recorded (Trench 15).

1.4.5 The site contains evidence for complex archaeology dating to the 18th, 19th and 20th centuries. Dumped material, ground make-up and services have also been encountered. There is, therefore, a high potential for the survey to locate similar features; however, the complexity may mean that the origin of the anomalies cannot be confidently interpreted.

1.5 Geology and soils

1.5.1 The underlying geology is Triassic sandstone from the Redcliffe Sandstone Member with overlying tidal flat deposits of clay and silt (BGS, 2017).

1.5.2 The overlying soils across the site is from the Fladbury 1 association and is a pelo-alluvial gley. It consists of stoneless, clayey soils, variably affected by groundwater (Soil Survey of England and Wales, 1983). However, site has been subject to occupation and industrial activity since at least the 18th century and archaeological evaluation has revealed deep layers of demolition material and ground make-up with alluvial deposits at depth.

1.5.3 Tidal flat deposits containing high levels of salt can limit the penetration of the GPR wave; however, this may also be limited by the nature of material used within buried surfaces and subsurfaces of anthropogenic origin.

2 METHODOLOGY

2.1 Technical synopsis - Magnetometry

2.1.1 Magnetometry survey records localised magnetic fields that can be associated with features formed by human activity. Magnetic susceptibility and magnetic thermoremnance are factors associated with the formation of localised fields. Additional details are set out below and within Appendix A.

2.1.2 Iron minerals within the soil may become altered by burning and the break down of biological material; effectively the magnetic susceptibility of the soil is increased, and the iron minerals become magnetic in the presence of the Earth's magnetic field. Accumulations of magnetically enhanced soils within features, such as pits and ditches, may produce magnetic anomalies that can be mapped by magnetic prospection.

2.1.3 Magnetic thermoremnance can occur when ferrous minerals have been heated to high temperatures such as in a kiln, hearth, oven etc. On cooling, a permanent magnetisation may be acquired due to the presence of the Earth's magnetic field. Certain natural processes associated with the formation of some igneous and metamorphic rock may also result in magnetic thermoremnance.

2.1.4 The localised variations in magnetism are measured as sub-units of the Tesla, which is a SI unit of magnetic flux density. These sub-units are nano Teslas (nT), which are equivalent to 10^{-9} Tesla (T).

2.2 Technical synopsis - Ground Penetrating Radar

2.2.1 Ground penetrating radar systems transmit an electromagnetic wave into the ground and record the time delay and amplitude of reflections from buried features. Reflections occur from changes in conductivity or dielectric permittivity.

2.2.2 Electromagnetic waves are increasingly attenuated as frequency increases and, therefore, lower frequencies provide greater penetration into the subsurface. However, the longer wavelengths associated with lower frequencies reduce the resolution of buried features. Typical frequencies chosen for archaeological prospection are around 500 and 200 MHz.

2.3 Equipment configuration and data collection - Magnetometry

2.3.1 The detailed magnetic survey was carried out using a SENSYS MAGNETO®MXPDA 5 channel cart-based system. The instrument has 5

fluxgate gradiometers spaced 0.5m apart with readings recorded at 20Hz. The gradiometers have a range of recording data between 0.1nT and 3,000nT. The sensors are not zeroed in the field, as the vertical axis alignment is fixed using a tension band system. The system is linked to a Leica GS10 RTK GPS with data recorded by SENSYS MAGNETO®MXPDA software on a rugged computer.

2.3.2 Data are collected along a series of parallel survey tracks wherever possible. The length of each track is variable and relates to the size of the survey area and other factors including ground conditions. A visual display aids accurate placing of tracks and their separation.

2.3.3 Data are not collected within fixed grids and data points are considered to be random even though the data are collected in a systematic manner covering all accessible areas (Aspinall, Gaffney and Schmidt, 2009).

2.4 Equipment configuration and data collection - Ground Penetrating Radar

2.4.1 Ground penetrating radar data were acquired using an Utsi Electronics Groundvue 3A system running with a 400MHz shielded antenna. The system utilises a wheeled encoder system on a small cart. A dielectric constant of 10 was used in the field to set up the instrument and view data. The value is for display purposes only and does not affect the recorded data. A value of 80ns (nanoseconds) was chosen for the time sweep (two way GPR signal travel time) in order to balance potential depth of penetration and resolution.

2.4.2 Data were collected from scans recorded at 0.0295m along traverses separated by 0.5m. The data captured along each traverse were logged to an internal disk drive to allow further processing and analysis.

2.5 Survey grid and base mapping - Ground Penetrating Radar

2.5.1 The trial area for the GPR survey was targeted on the known glass cone found during the 2005 and 2016 evaluations towards the northern part of the site. In order to tie in any potential further survey a common baseline was established parallel with the bounding western fenceline, 25m long, but with the first traverse being carried out at 0.5m along the baseline (see Fig 06). Heras fencing surrounding the eastern buildings was pushed back as far as possible in order to cover as wide an area as possible in the area of the glass cone. Another checkline was set out 35m east of the main baseline. The area was set out using the Leica GS10 RTK GPS for a high level of positional accuracy.

2.6 Data processing - Magnetometry

2.6.1 Magnetic data collected by the MAGNETO®MXPDA cart-based system are initially prepared using SENSYS MAGNETO®DLMGPS software. Survey tracks are analysed and georeferenced data (UTM Z30N) are then exported in

ASCII format for further analysis and display using TerraSurveyor. The data are collected between limits of ±3000nT and clipped for display at ±250nT (Fig 03) ±1000nT with values over 700nT highlighted in red and under -700nT highlighted in blue to indicate highly magnetic responses (Fig 04). Data are interpolated to a resolution of effectively 0.5m between tracks and 0.15m along each survey track.

2.7 Data processing - Ground Penetrating Radar

2.7.1 Ground penetrating radar data were analysed using REFLEX v8 software. Each traverse was analysed as an individual profile to allow a manual assessment of anomalies. A velocity of 0.1m/ns was used to analyse the depths of features, the value was derived from hyperbola matching and is consistent with the type of material used within the ground make-up. In addition, profiles across each survey area were combined and processed in order to create time slices showing the variation in reflector amplitude at various depths. The following processing has been carried out on GPR data captured during this survey:

- background removal - improves the appearance of the data by removal of strong horizontal bands,
- gain - increased with time in order to amplify weaker reflections from deeper features,
- bandpass filtering - lowers noise by the removal of energy below 200MHz and above 800MHz.

2.7.2 Time slices were analysed using both absolute and envelope reflectivity strengths. The latter use a square root function of the energy at an instant in time and is generally the preferred option; however, occasionally the absolute values provide more detailed anomalies.

2.8 Data presentation

2.8.1 An abstraction and interpretation is offered for all geophysical anomalies located by the survey. A brief summary of each anomaly, with an appropriate reference number, is set out in list form within the results (Section 3) to allow a rapid and objective assessment of features within each survey area. Approximate depths to anomalies is added to the abstraction and interpretation plot.

2.8.2 The main form of data display prepared for this report is the colourscale plot derived from Reflex as a TIF for the GPR and greyscale from TerraSurveyor for the magnetometry. Anomalies are abstracted using colour coded points, lines and polygons. All plots are scaled to landscape A3 for paper printing.

2.8.3 The raster images are combined with base mapping using ProgeCAD Professional 2016 creating DWG file formats. All images are externally referenced to the CAD drawing in order to maintain good graphical quality. A

digital archive, including raster images, is produced with this report, see Appendix D below.

3 RESULTS

3.1 General overview - Magnetometry

3.1.1 The detailed magnetic survey was carried out over approximately 0.6ha. Magnetic anomalies located can be generally classified as anomalies relating to surface features, anomalies of uncertain origin, anomalies relating to ferrous objects and services. Anomalies have been numbered and are described in 3.5 below.

3.2 Statement of data quality - Magnetometry

3.2.1 The magnetic data are considered representative of the high magnitude anomalies present within the site. Low magnitude anomalies would be obscured by the high magnitude responses across the site but are not relevant to the objectives of the magnetometry. High magnitude anomalies relate to ferrous material and potentially areas of intense burning.

3.3 General overview - Ground Penetrating Radar

3.3.1 The GPR survey located linear, discrete and complex anomalies within the survey areas. The majority of the anomalies cannot be confidently interpreted and have been classified as of uncertain origin. Interpretation is limited by the weak and fragmented nature of anomalies and a lack of characteristic morphology. Several anomalies are associated with features of modern origin such as services and paved surfaces. Anomalies have been numbered and are described in 3.7 below.

3.4 Statement of data quality - Ground Penetrating Radar

3.4.1 The GPR data were collected with due consideration given to surface conditions, obstructions and area constraints. GPR signals appear to have achieved moderate penetration within the trial survey area and maximum depth is likely to be approximately 2m. Uneven surfaces were frequently encountered and as a consequence antenna coupling is occasionally poor resulting in very small patches of increased noise. It is unlikely that these have obscured more significant features.

3.5 List of magnetometry anomalies

Area centred on OS NGR 358985 172375, see Figs 03 - 05.

Anomalies with an uncertain origin

(1) - A positive possible curvilinear anomaly is located in the centre of the survey area. The position corresponds to a zone of planar reflectors and a low amplitude response (16). It has a response of 100nT, which may indicate an association with burning. Another positive linear anomaly is located 9m to the west, within the area of made ground seen in the GPR results (10).

Anomalies associated with surface features

(2) - Two L-shaped strongly magnetic responses appear to be associated with surface material; however, the strong response indicates they relate to ferrous material (probably steel) which is likely to be just below the surface.

(3) - Magnetic debris corresponds to a change in surface material and relates to the backfill of a 2016 evaluation trench (Trench 18).

(4) - Strong, discrete, dipolar responses in linear formations along the western edge of the survey area relate to former posts or bollards.

(5) - A rectangular zone of very highly magnetic material corresponds to a cobbled area. It is likely that the magnetic response is to a sub-surface or bedding layer, rather than to the cobbles.

Anomalies relating to strongly magnetic material

(6) - The survey area contains numerous strong, discrete, dipolar responses; however, the majority of them are concentrated within the area of the glass cone. They are generally over 2000nT, indicating that they relate to ferrous objects. It is not possible to determine if they are directly associated with any of the archaeological deposits, or if they are associated with services and other modern magnetic debris within the overlying deposits.

(7) - Strong, multiple, dipolar linear anomalies appear to relate to buried cables or pipes, but they are not clearly defined.

3.6 List of ground penetrating radar anomalies

Area centred on OS NGR 358990 172388, see Figs 07 - 09.

Anomalies associated with known archaeological features

(8) - An area of very strong planar reflectors can be seen at a depth of c0.3-0.5m and appears to correlate with the position of the evaluated possible glass cone interior brick surface and ashy deposits. It may extend to the south of the evaluated area. The curving outer glass cone wall does not appear clearly in the data.

(9) - An area of planar reflectors seen at c0.3 - 0.5m relates to the evaluated WW2 air raid shelter seen in Trench 2 in 2005.

(10) - A broad zone of planar and complex reflectors is located along the western edge of the survey. They appear to relate to made ground and previous surfaces and can be seen from near the current surface to a depth of around 2m. The eastern edge appears to be delimited by a wall, not clearly defined all the way along, but visible from around 0.4m to 1.6m. This appears likely to relate to a former retaining or possible harbour wall with infilling on the western side.

Anomalies with an uncertain origin

(11) - Situated immediately to the south of anomaly (8) is a circular zone of high amplitude GPR reflections which appears to be surrounded by a ring of very low amplitude reflections. This may suggest a surface or feature surrounded by material that absorbs GPR waves (e.g. stoneless clayey soil) or where the waves are reflected away from the antenna (e.g. near vertical face,edge). Its position could indicate an association with the brick surface and ashy deposits immediately to the north (8) and, therefore, relate to the interior of the glass cone. The responses are visible at around 0.7m below the present ground surface.

(12) - The eastern part of the surveyed zone contains a number of small areas of planar and complex reflectors. They do not correspond with mapped 19th century buildings, and could indicate fragmented buried surfaces at depths of around 0.3m to 0.5m, possibly the glass cone, but they cannot be clearly resolved.

(13) - Similar complex and planar responses to (12) can also be seen in the central part of the survey area. Several buildings were mapped in this location during the 19th century and there is high potential for these anomalies to be associated with these structural remains. They are at a similar c0.3-0.5m depth as anomalies (12).

(14) - Narrow, linear, high amplitude planar reflectors could relate to walling. Some appear curvilinear and they range in depth although some can be seen at 0.7m deep. An association with the glass cone or any other structure cannot be confidently established.

(15) - A reversed L-shaped low amplitude anomaly can be seen in the eastern part of the survey area. This feature is visible at 0.7-1.4m deep, indicating that it is a deeper feature than most of those surrounding it. Its function is not clear, as although it could relate to cut, trench-like features, which could relate to flues associated with a glass cone or kiln structure, this type of response could also relate to a feature such as a culvert or drain.

(16) - An area of low amplitude responses at a depth of 0.8-1.4m could relate to a

cut feature with a damp clayey fill. There is some correspondence to the position of magnetic anomaly (1), but it cannot be determined if they are responses to the same feature.

Anomalies with a modern origin

(17-19) - Three zones of high amplitude responses can be seen at a depth of 0.2-0.4m. These correspond to previous evaluation trench 14 (anomaly 17), trench 15 (anomaly 18) and trench 17 (anomaly 19).

(20) - A rectilinear zone of planar responses relates to a modern surface layer.

4 DISCUSSION

4.1.1 The magnetometer survey located a number of strongly magnetic responses within the survey area. Several relate to relatively modern features, such as former posts or bollards, and others in a linear formation appear to relate to buried services. Several are clustered within the area of the evaluated glass cone, but it is not possible to determine if there is any association. One weaker anomaly (100nT) could relate to an area of burning, but its origin is uncertain (1).

4.1.2 The ground penetrating radar trial was conducted over the area of the possible glass cone as interpreted from evaluation excavation. A high amplitude response (8) corresponds to a brick surface within the interior of the glass cone but this is generally bounded within evaluation trench 2 and does not appear to extend further south. The GPR trial survey has not provided reliable data with which to infer the size of the cone as the northern wall revealed by the evaluation cannot be clearly resolved, neither can the majority of excavated and mapped structures within the area. However, high amplitude complex and planar responses could relate to former structural remains, with some in the area of mapped 19th century buildings, and others towards the area of the projected 16-18m glass cone diameter. While it is possible that some of these responses could be related to a glass cone, it is not possible to confidently interpret them as such.

4.1.3 A well defined zone (10) in the western part of the survey area appears to relate to an area of ground make up and former surfaces, bounded by a wall. This may represent a former harbour wall and infill to the west. Weak reflections were obtained from approximately 2m deep in this area and this may relate to salty ground water at this level.

5 CONCLUSION

5.1.1 The GPR trial survey has provided only limited evidence to support further interpretation of the complex archaeology revealed in fragments by evaluation excavation. The GPR data have revealed planar and complex reflections across all parts of the trial area; however, it has not been possible to provide a confident interpretation of these reflections, probably due to fragmentation and ground disturbance associated with numerous phases of redevelopment. It was considered unlikely that extending the survey to cover the whole site would be beneficial to understanding the nature and extent of the archaeological resource and in particular the location of industrial structures associated with the glass industry.

5.1.2 Magnetometry was carried out over all accessible areas but was of limited use to understanding the archaeological potential of the site. The majority of the anomalies located are high magnitude responses associated with steel objects, such as bollards, given some indication of former recent features on the site. A small zone possibly indicative of burnt material was located along with evidence for several services.

5.1.3 With regard to the objectives of the survey, the GPR trial has not improved the plan of structural remains within the site. No clear structure relating to a glass cone or cones could be resolved, although an associated brick surface, formerly revealed by evaluation excavation, produced strong planar reflections. A possible furnace area immediately to the south of this may indicate the central part of a cone or other industrial structure. The northern wall of the possible cone, as revealed by evaluation, could not be clearly resolved from the GPR data.

5.1.4 A rectangular zone within the western part of the trial area may define an extension to the edge of the wharf. The zone appears to be bounded by a wall with planar and complex reflections suggesting former surfaces over deep ground make-up.

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Appendix A – basic principles of magnetic survey

Iron minerals are always present to some degree within the topsoil and enhancement associated with human activity is related to increases in the level of magnetic susceptibility and thermoremnant material.

Magnetic susceptibility is an induced magnetism within a material when it is in the presence of a magnetic field. This can be thought of as effectively permanent due to the presence of the Earth's magnetic field.

Thermoremnant magnetism occurs when ferrous material is heated beyond a specific temperature known as the Curie Point. Demagnetisation occurs at this temperature with re-magnetisation by the Earth's magnetic field upon cooling.

Enhancement of magnetic susceptibility can occur in areas subject to burning and complex fermentation processes on biological material; these are frequently associated with human settlement. Thermoremnant features include ovens, hearths, and kilns. In addition thermoremnant material such as tile and brick may also be associated with human activity and settlement.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil can create an area of enhancement compared with surrounding soils and subsoils into which the feature is cut. Mapping enhanced areas will produce linear and discrete anomalies allowing an assessment and characterisation of hidden subsurface features.

It should be noted that areas of negative enhancement can be produced from material having lower magnetic properties compared to the topsoil. This is common for many sedimentary bedrocks and subsoils which were often used in the construction of banks and walls etc. Mapping these 'negative' anomalies may also reveal archaeological features.

Magnetic survey or magnetometry can be carried out using a fluxgate gradiometer and may be referred to as gradiometry. The SENSYS gradiometer is a passive instrument consisting of two fluxgate sensors mounted vertically 65cm apart. The instrument is carried about 10-20cm above the ground surface and the upper sensor measures the Earth's magnetic field as does the lower sensor but this is influenced to a greater degree by any localised buried field. The difference between the two sensors will relate to the strength the magnetic field created by the buried feature.

There are a number of factors that may affect the magnetic survey and these include soil type, local geology and previous human activity. Situations arise where magnetic disturbance associated with modern services, metal fencing, dumped waste material etc., obscures low magnitude fields associated with archaeological features.

Appendix B – data processing notes magnetometry

Clipping

Minimum and maximum values are set and replace data outside of the range with those values. Extreme values are removed improving colour or greyscale contrast associated with data values that may be archaeologically significant. It has been found that clipping data to ranges between ±5nT and ±3nT often improves the appearance of features associated with archaeology. Different ranges are applied to data in order to determine the most suitable for anomaly abstraction and display.

Zero (destripe) Median/Mean Traverse

The median (or mean) of each traverse is calculated ignoring data outside a threshold value, the

median (or mean) is then subtracted from the traverse. The process is used to equalise differences between the baseline value of gradiometer sensors.

High Pass Filtering

A mathematical process used to remove low frequency anomalies relating to survey tracks and modern agricultural features.

Appendix C – survey and data information

Raw magnetometer data clipped at ±250nT

COMPOSITE
Filename: J771-mag-raw-250nT.xcp
Description: Imported as Composite from: J771-mag.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 358936.67, 172423.55 m
Southeast corner: 359025.77, 172344.05 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702
Source GPS Points: 104500
Dimensions
Composite Size (readings): 594 x 530
Survey Size (meters): 89.1 m x 79.5 m
Grid Size: 89.1 m x 79.5 m
X Interval: 0.15 m
Y Interval: 0.15 m
Stats
Max: 276.25
Min: -275.00
Std Dev: 146.86
Mean: -53.84
Median: -65.19
Composite Area: 0.70835 ha
Surveyed Area: 0.30471 ha
PROGRAM
Name: TerraSurveyor
Version: 3.0.23.0
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 Clip from -1000.00 to 1000.00 nT
4 Clip from -250.00 to 250.00 nT

Raw magnetometer data clipped at ±1000nT

Stats
Max: 1105.00
Min: -1100.00
Std Dev: 354.28
Mean: -60.99
Median: -64.94
Composite Area: 0.70835 ha
Surveyed Area: 0.30471 ha
GPS based Proce3
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 Clip from -1000.00 to 1000.00 nT

Appendix D – digital archive

Archaeological Surveys Ltd hold the primary digital archive at their offices in Wiltshire. Data are backed-up onto an on-site data storage drive and at the earliest opportunity data are copied to CD ROM for storage on-site and off-site.

A PDF copy will be supplied to the Bristol Historic Environment Record. The report will also be uploaded to the Online AccesS to the Index of archaeological investigationS (OASIS).

Archive contents:

File type	Naming scheme	Description
Data	J771-mag.asc J771-mag.xcp	Raw data as ASCII CSV TerraSurveyor raw data
Graphics	J771-mag-raw-250nT.tif J771-mag-raw-1000nT-rbtif	Image in TIF format
Drawing	J771 version 5.dwg	CAD file in 2010 dwg format
Report	J771 report.odt	Report text in Open Office odt format

This report has been prepared using the following software on a Windows XP platform:

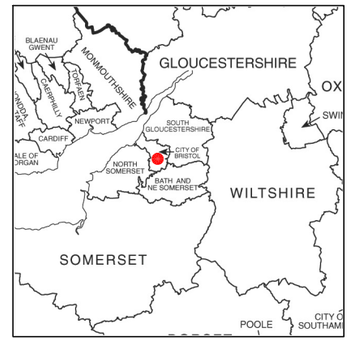
- Reflex v8 (GPR data analysis)
- ProgeCAD Professional 2016 (report plots),
- OpenOffice.org 4.1.1 Writer (document text),
- PDF Creator version 0.9 (PDF archive).

Appendix E – copyright and intellectual property

Archaeological Surveys Ltd

Geophysical Survey
Redcliffe Wharf
Redcliffe Way
Bristol

Map of survey area



Survey location

Site centred on OS NGR
ST 58985 72375

SCALE 1:25 000

0m 500m 1000m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 01

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Geophysical Survey
Redcliffe Wharf
Redcliffe Way
Bristol

Magnetometry survey referencing information

Referencing grid to OSGB36 datum at 10m intervals

Data collected at 20Hz and georeferenced to ETRS89 zone 30 with conversion to OSGB36 using OSTN02

Area of GPR trial survey

Area of formerly observed glass cone

Evalutation trench

T1 2005 evaluation trench number

T11 2007 evaluation trench number

T19 2016 evaluation trench number

SCALE 1:500

0m 10 20m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 02

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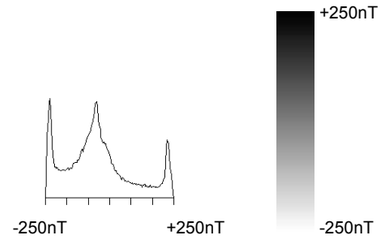
Redcliffe Wharf
Redcliffe Way
Bristol

Greyscale plot of raw magnetometer data clipped at ±250nT



SCALE 1:500

0m 10 20m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 03

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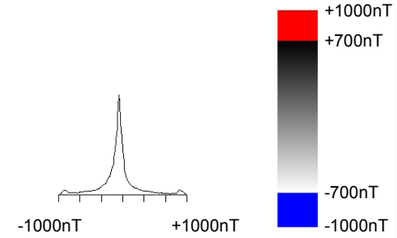
Geophysical Survey
Redcliffe Wharf
Redcliffe Way
Bristol

Greyscale plot of raw magnetometer data clipped at ±1000nT



SCALE 1:500

0m 10 20m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 04

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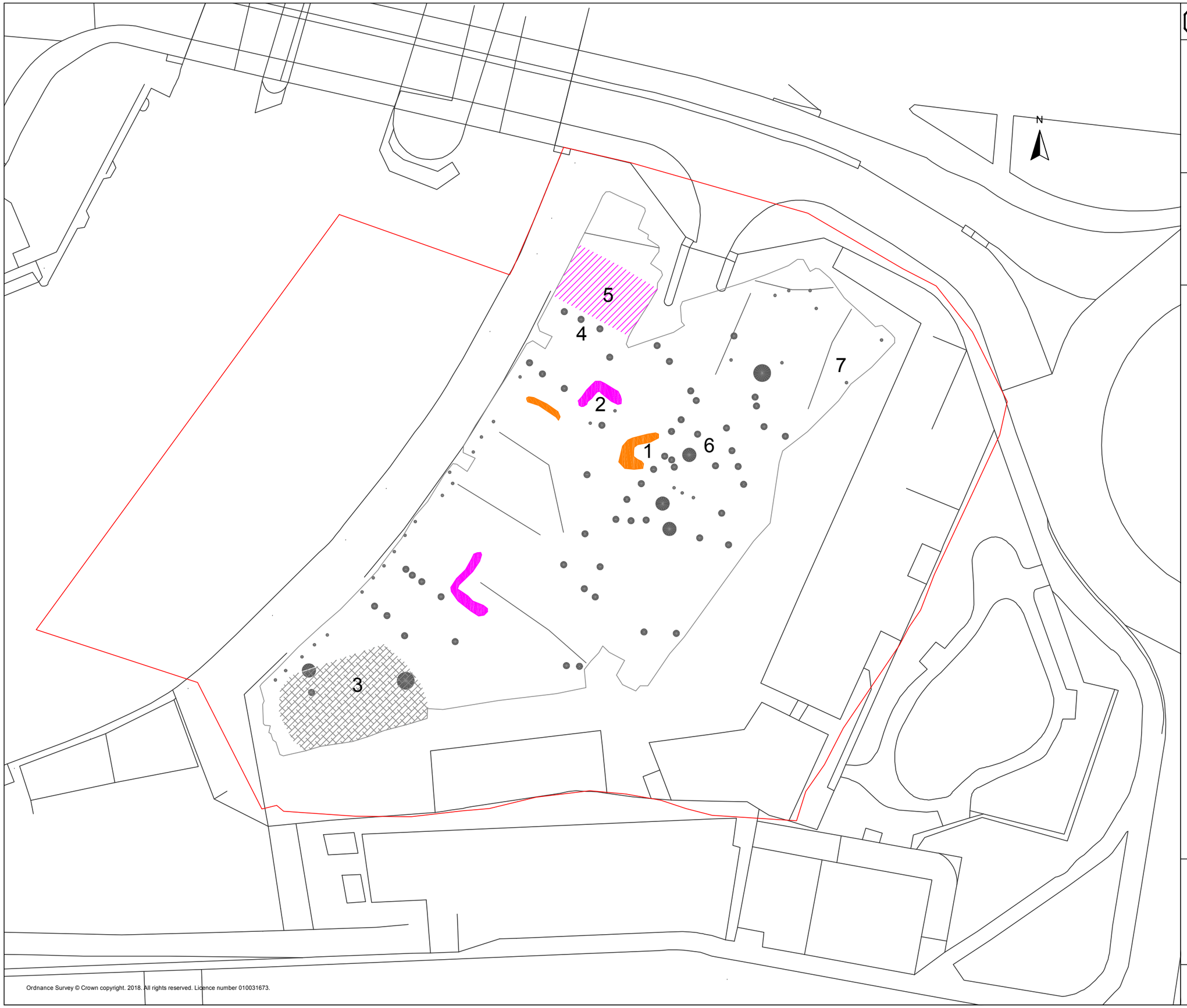
Bristol

Abstraction and interpretation of magnetic anomalies



- Positive linear anomaly - area of weaker (100nT) magnetic enhancement
- Strongly magnetic response associated with surface features
- Magnetic debris - associated with evaluation trench backfill
- Magnetic disturbance associated with subsurface material beneath cobbles
- Strong multiple dipolar linear anomaly - possible cable / service
- Strong dipolar anomaly - ferrous object / material

SCALE 1:500

0m 10 20m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 05

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Geophysical Survey
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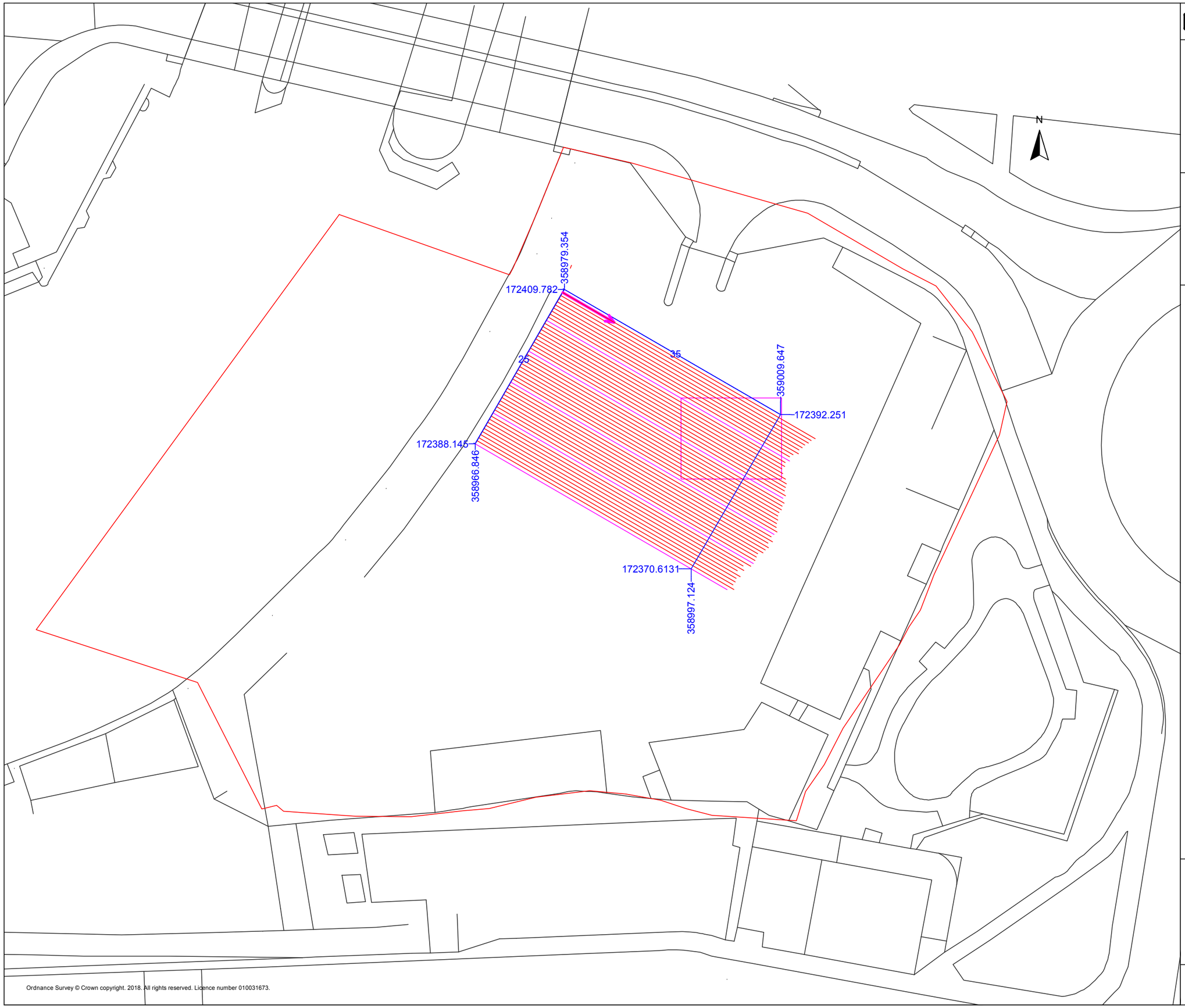
Bristol

GPR survey referencing information



Baseline coordinates based on Ordnance Survey OSGB36 datum

Baselines set out using RTK GPS with Leica SmartNet correction data RTCMv2 format OSTN02 transformation

Survey starts at 0.5m along baseline. Traverses are 0.5m apart and data is collected in 50 parallal traverses heading south east

Survey start and traverse direction

Area of formerly observed glass cone

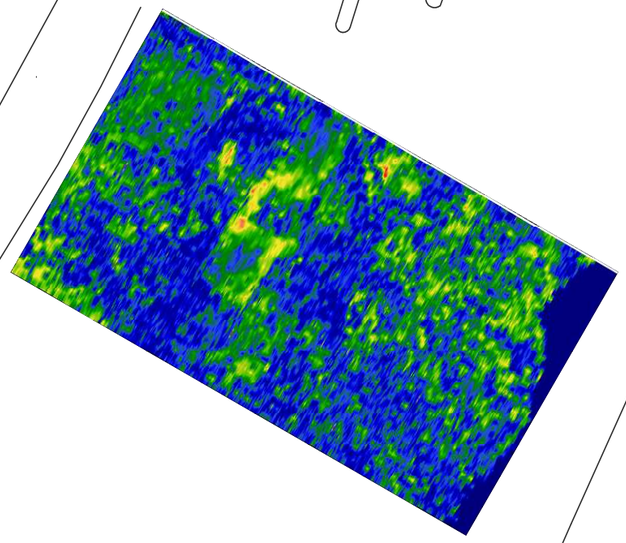
SCALE 1:500

0m 10 20m

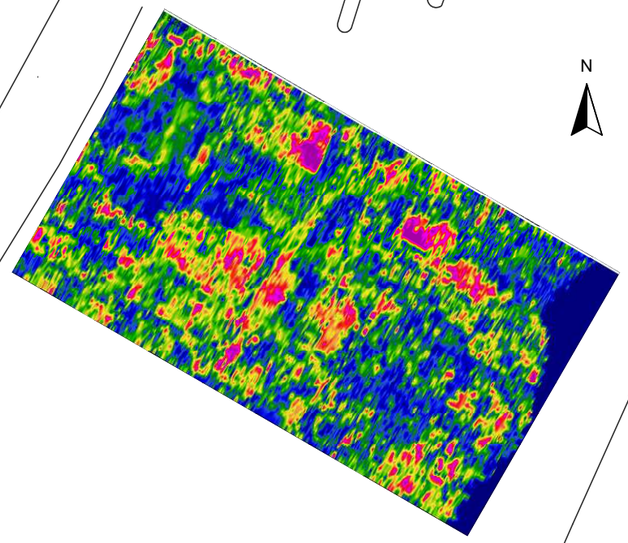
SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 06

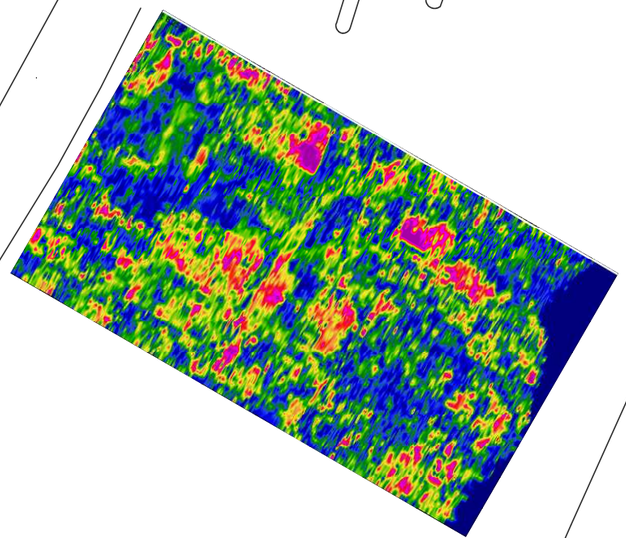
GPR time slice at 2ns approximately 0.1m deep



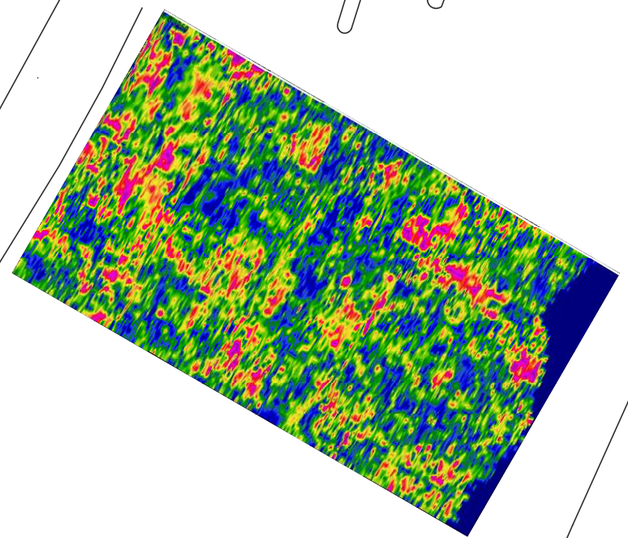
GPR time slice at 4ns approximately 0.2m deep



GPR time slice at 6ns approximately 0.3m deep



GPR time slice at 8ns approximately 0.4m deep



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Ground penetrating radar
time slices c0.1 - 0.4m deep

high amplitude reflection

low amplitude reflection

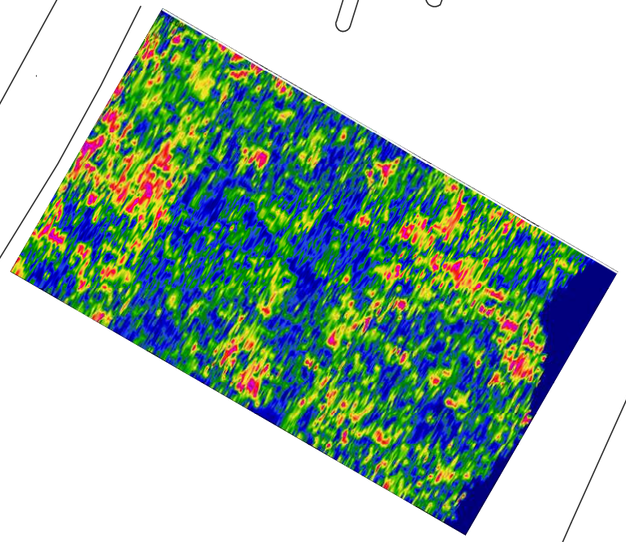
SCALE 1:500

0m 10 20m

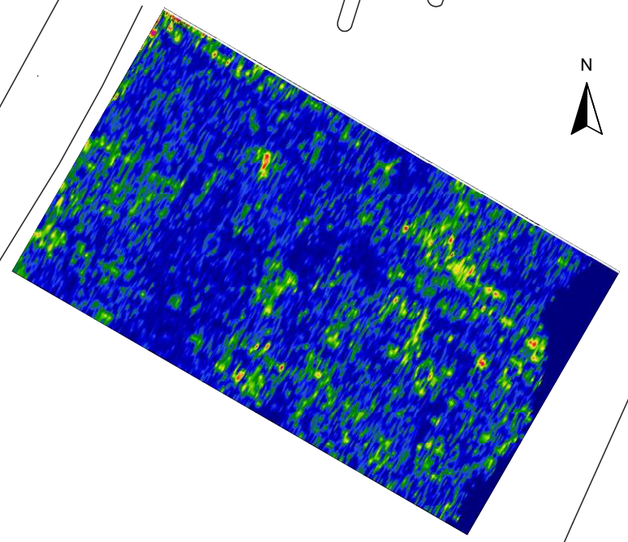
SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 07

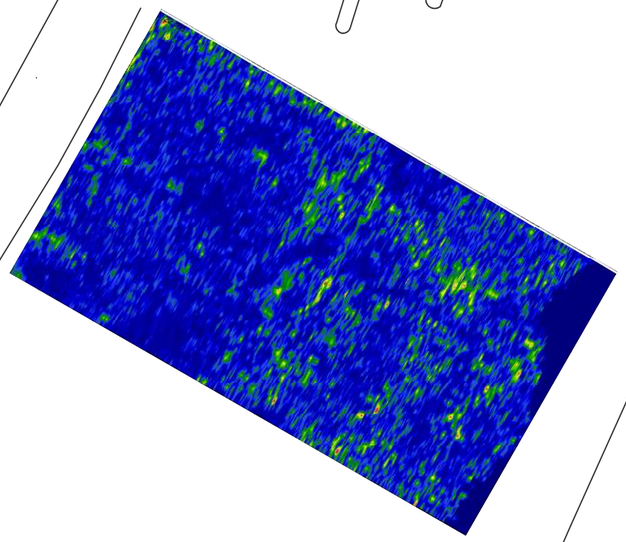
GPR time slice at 10ns approximately 0.5m deep



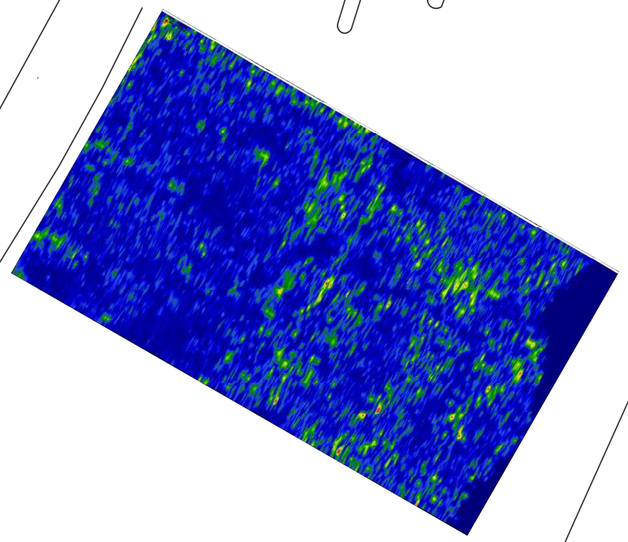
GPR time slice at 14ns approximately 0.7m deep



GPR time slice at 18ns approximately 0.9m deep



GPR time slice at 22ns approximately 1.1m deep



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Geophysical Survey
Redcliffe Wharf
Redcliffe Way
Bristol

Ground penetrating radar
time slices c0.5 - 1.1m deep

high amplitude reflection

low amplitude reflection

SCALE 1:500

0m 10 20m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 08

Archaeological Surveys Ltd

Geophysical Survey
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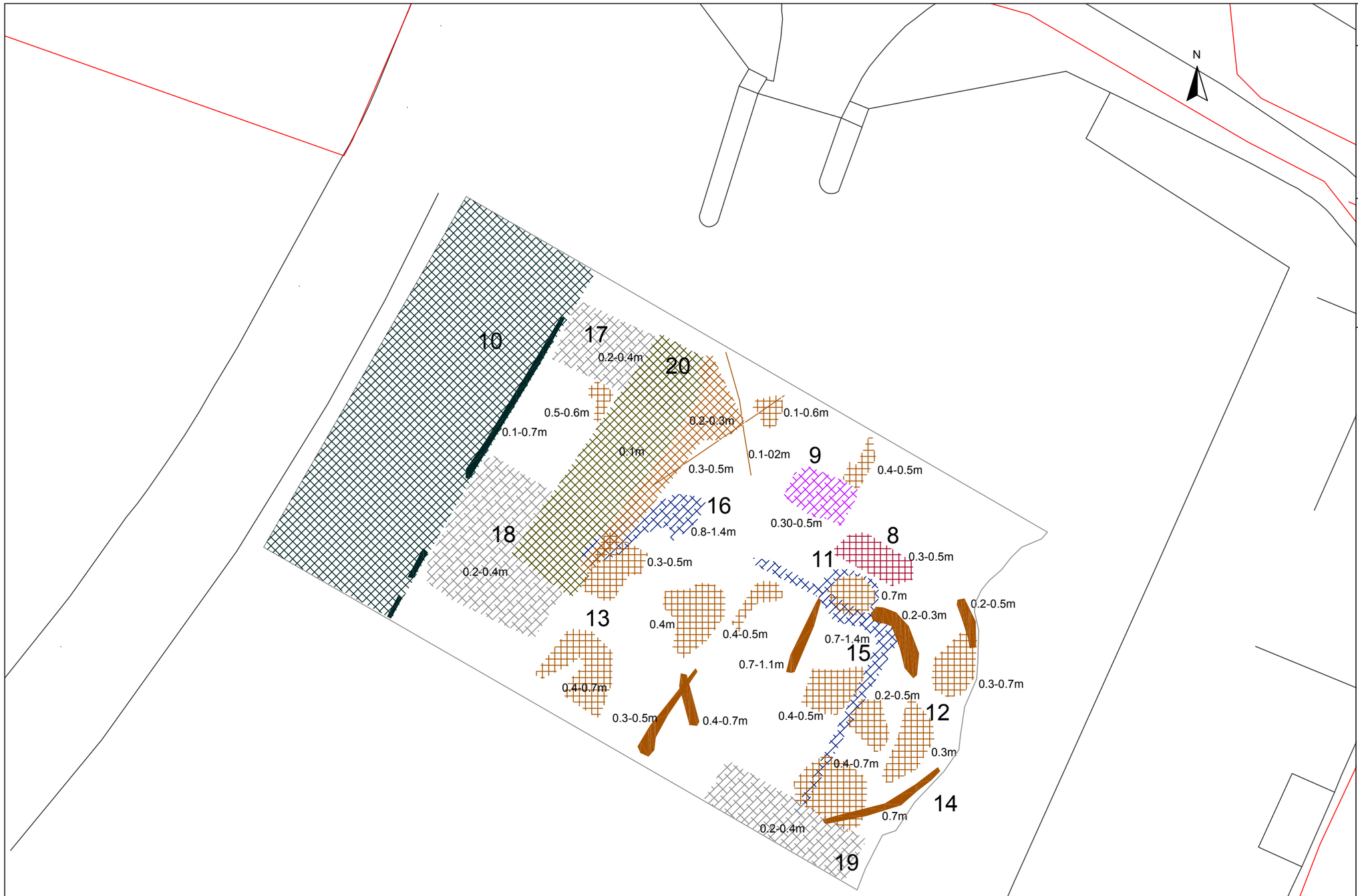
Bristol

Abstraction and interpretation of ground penetrating radar anomalies



- Planar reflectors associated with brick surface and further possible burning within glass cone interior
- Planar reflectors associated with previously excavated air raid shelter
- Planar and complex reflectors associated with subsurface make-up
- Linear wall bounding area of ground make-up
- Planar and complex reflectors of uncertain origin
- Linear feature of uncertain origin
- Low amplitude response - possible cut feature of uncertain origin
- Planar reflectors associated with ground surface material
- Planar and complex reflectors assocaited with backfilled evaluation trenches

SCALE 1:250

0m 5 10m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
DJS	KTD	FIG 09

Archaeological Surveys Ltd

Geophysical Survey
Redcliffe Wharf
Redcliffe Way
Bristol

Abstraction and interpretation of magnetic & GPR anomalies

- Positive linear anomaly - area of weaker (100nT) magnetic enhancement
- Strongly magnetic response associated with surface features
- Magnetic debris - associated with evaluation trench backfill
- Magnetic disturbance associated with subsurface material beneath cobbles
- Strong multiple dipolar linear anomaly - possible cable / service
- Strong dipolar anomaly - ferrous object / material
- Planar reflectors associated with brick surface and further possible burning within glass cone interior
- Planar reflectors associated with previously excavated air raid shelter
- Planar and complex reflectors associated with subsurface make-up
- Linear wall bounding area of ground make-up
- Planar and complex reflectors of uncertain origin
- Linear feature of uncertain origin
- Low amplitude response - possible cut feature of uncertain origin
- Planar reflectors associated with ground surface material
- Planar and complex reflectors assocaited with backfilled evaluation trenches

SCALE 1:500

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 10