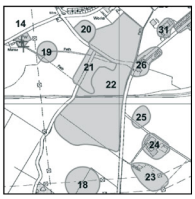
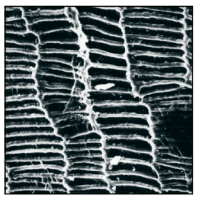
GSSG18










GLOUCESTER SOUTH SEWERAGE GROWTH, HARDWICKE, GLOUCESTERSHIRE

GEOPHYSICAL SURVEY

commissioned by North Midland Construction Plc
on behalf of Severn Trent Water

April 2018

HEADLAND ARCHAEOLOGY

REGISTERED ORGANISATION CIfA

GLOUCESTER SOUTH SEWERAGE GROWTH, HARDWICKE, GLOUCESTERSHIRE

GEOPHYSICAL SURVEY

commissioned by North Midland Construction Plc
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April 2018

This report adheres to the quality standard of ISO 9001:2008

PROJECT INFO:

HA Project Code **GSSG18** / NGR **West: SO 7964 1215, East: SO 8043 1233** /
Parish **Hardwicke** / Local Authority **Gloucestershire** / OASIS Ref. **headland5-314982**

PROJECT TEAM:

Project Manager **Sam Harrison** / Author **David Harrison** / Fieldwork **Krasimir Dyulgerski, Olivier Vansassenbrouck** / Graphics **Caroline Norrman, David Harrison, Rafael Maya Torcelly**

Approved by **Sam Harrison** .....

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HEADLAND ARCHAEOLOGY

PROJECT SUMMARY

Headland Archaeology (UK) Ltd, undertook a geophysical (magnetometer) survey, covering approximately 2 hectares, to inform planning proposals for a proposed sewer pipeline for the Gloucester South Sewerage Growth project at Hardwicke, Gloucestershire. The survey has not identified any anomalies of definite archaeological potential. A cluster of low magnitude anomalies, close to the projected route of a Roman road (Gloucestershire Historic Environment Record 7365) are ascribed moderate archaeological potential, perhaps locating road-side activity, although no clear pattern is discernible within the narrow survey corridor. Elsewhere, anomalies have been identified which are due field drains and to localised variations in the depth and composition of the soils. Therefore, on the basis of the geophysical survey, the archaeological potential of the majority of the proposed pipeline is assessed as low but locally moderate in the vicinity of the projected route of the Roman road.

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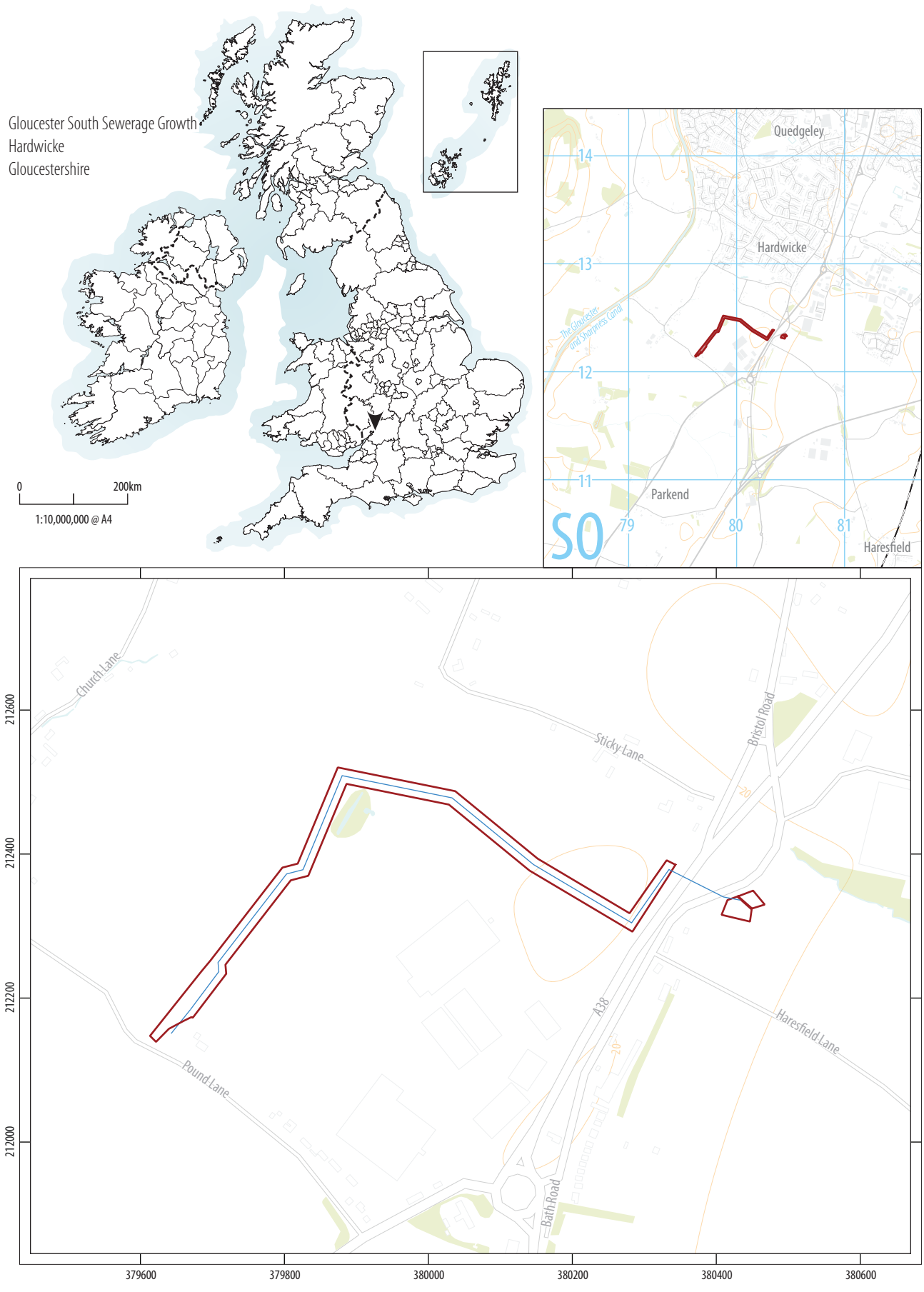
LIST OF ILLUSTRATIONS



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ILLUS 1 Site location

GLOUCESTER SOUTH SEWERAGE GROWTH, HARDWICKE, GLOUCESTERSHIRE

GEOPHYSICAL SURVEY

1 INTRODUCTION

Headland Archaeology (UK) Ltd was commissioned by North Midland Construction Plc (the Client), on behalf of Severn Trent Water, to undertake a geophysical (magnetometer) survey along the route of a proposed pipeline (part of the Gloucester South Sewerage Growth project) at Hardwicke, Gloucestershire. The results of the survey will inform planning proposals and future archaeological strategy.

All work was undertaken in line with current best practice (Chartered Institute for Archaeologists 2014, English Heritage 2008).

The survey was carried out on 5th April 2018.

1.1 SITE LOCATION, LAND-USE AND TOPOGRAPHY

The proposed pipeline is located north and west of Quedgeley Trading Estate West, Hardwicke (see Illus 1) and extends from the pumping station on Pound Lane (SO 7964 1215) north-eastwards for 450m before turning south-eastwards and terminating at the site of a proposed flushing chamber on the east side of the A38 (SO 8043 1233). The geophysical survey area (GSA) covers a 20m wide corridor, crossing seven fields (F1-F7) which were under mixed arable use at the time of the survey (see Illus 2 and Illus 3). A pond precluded any survey within the south of F2, whilst spoil from recent groundworks prevented survey within the north of F7.

The GSA is low-lying at between 15m above Ordnance Datum (AOD) in the west and 22m AOD in the east.

1.2 GEOLOGY AND SOILS

The bedrock geology comprises mudstone of the Blue Lias and Charmouth Formation (undifferentiated). No superficial deposits are recorded (NERC 2018).

The soils are classified in the Soilscape 9 association, characterised as lime rich loamy and clayey soils with impeded drainage (Cranfield University 2018).

2 ARCHAEOLOGICAL BACKGROUND

The Gloucestershire Historic Environment Record (GSHER) details the projected course of a Roman road as passing north north-east/south south-west to the west of the GSA (Ref. 7365; see Illus 4). The road formerly connected the Roman fort and settlement at Gloucester with the port at Sea Mills. No further archaeological records are known within the GSA.

3 AIMS, METHODOLOGY AND PRESENTATION

The general aim of the geophysical survey was to provide sufficient information to establish the presence/absence, character and extent of any archaeological remains within the survey area. This will therefore enable an assessment to be made of the impact of the proposed development on any sub-surface archaeological remains, if present.

ILLUS 2 F3 (north), looking east

The specific archaeological objectives of the geophysical survey were:

- to provide information about the nature and possible interpretation of any magnetic anomalies identified;
- to therefore model the presence/absence and extent of any buried archaeological features; and
- to prepare a report summarising the results of the survey.

3.1 MAGNETOMETER SURVEY

Magnetic survey methods rely on the ability of a variety of instruments to measure very small magnetic fields associated with buried archaeological remains. A feature such as a ditch, pit or kiln can act like a small magnet, or series of magnets, that produce distortions (anomalies) in the earth's magnetic field. In mapping these slight variations, detailed plans of sites can be obtained as buried features often produce reasonably characteristic anomaly shapes and strengths (Gaffney & Gater 2003). Further information on soil magnetism and the interpretation of magnetic anomalies is provided in Appendix 1.

The survey was undertaken using four Bartington Grad601 sensors mounted at 1m intervals (1m traverse interval) onto a rigid carrying frame. The system was programmed to take readings at a frequency of 10Hz (allowing for a 10-15cm sample interval) on roaming traverses (swaths) 4m apart. These readings were stored on an external weatherproof laptop and later downloaded for processing and interpretation. The system was linked to a Trimble R8s Real Time Kinetic (RTK) differential Global Positioning System (dGPS) outputting in NMEA mode to ensure a high positional accuracy for each data point.

MLGrad601 and MultiGrad601 (Geomar Software Inc.) software was used to collect and export the data. Terrasurveyor V3.0.32.4 (DWConsulting) software was used to process and present the data.

3.2 REPORTING

A general site location plan is shown in Illus 1 at a scale of 1:7,500. Illus 2–3 are site condition photographs. Illus 4 is a 1:3,000 scale survey location plan showing the GPS swaths and the projected course of the Roman road. Large-scale fully processed (greyscale) data, minimally processed data (XY traceplot) and accompanying interpretative plots are presented at a scale of 1:2,500 in Illus 5–7.

Technical information on the equipment used, data processing and magnetic survey methodology is given in Appendix 1. Appendix 2 details the survey location information and Appendix 3 describes the composition and location of the site archive. Data processing details are presented in Appendix 4. A copy of the OASIS entry (Online Access to the Index of Archaeological Investigations) is reproduced in Appendix 5.

The survey methodology, report and any recommendations comply with the Written Scheme of Investigation (Bishop 2018), guidelines

ILLUS 3 F5, looking south-east

outlined by Historic England (English Heritage 2008) and by the Chartered Institute for Archaeologists (CIfA 2014). All illustrations from Ordnance Survey mapping are reproduced with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

The illustrations in this report have been produced following analysis of the data in 'raw' and processed formats and over a range of different display levels. All illustrations are presented to most suitably display and interpret the data from this site based on the experience and knowledge of management and reporting staff.

4 RESULTS AND DISCUSSION

The ground conditions were generally good allowing for a balanced and stable operating system. Consequently the data quality is good throughout. It should be noted at the outset when examining the data from a corridor that is only 20m wide it is often difficult to accurately interpret linear single responses which cross the corridor or zones of variable magnetic response. It is particularly difficult to gauge whether the latter are simply a result of localised variations in the soils and geology or to unenclosed areas of archaeological activity.

A moderate level of background magnetic variation has been detected throughout the GSA resulting in an even grey tone to the dataset. This is due to the homogenous properties of the soils and the mudstone bedrock from which they derive. Against this background, anomalies have been identified. All are discussed below and cross-referenced to specific anomalies on the interpretative drawings, where appropriate.

4.1 FERROUS AND MODERN ANOMALIES

Ferrous anomalies, characterised as individual 'spikes', are typically caused by ferrous (magnetic) material, either on the ground surface or in the plough-soil. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation, as modern ferrous debris is common on most sites, often being present as a consequence of manuring or tipping/infilling. There is no obvious clustering to these ferrous anomalies which might indicate an archaeological origin. Far more probable is that the 'spike' responses are likely caused by the random distribution of ferrous debris in the upper soil horizons.

A high magnitude dipolar linear anomaly (SP1, see Illus 7) at the eastern edge of F6 locates a buried water main.

Magnetic disturbance around the field edges is due to ferrous material within the adjacent boundaries and is of no archaeological interest.

4.2 AGRICULTURAL ANOMALIES

Analysis of historic Ordnance Survey (OS) maps indicates that a single field boundary has been removed since the publication of the first edition OS map in 1884. The former boundary has been detected as a north-east/south-west curvilinear anomaly in F1,

caused by a soil-filled ditch (FB1; see Illus 7). Four field drains have been detected across F3 manifesting in the data as a series of regularly-spaced north/south speckled linear trends. North-east/south-west aligned field drains are identified within F1 and F2. More closely-spaced parallel linear trends within F4 and F5 are typical of modern ploughing.

4.3 GEOLOGICAL ANOMALIES

Geological anomalies are present throughout the GSA, occurring in the data as low magnitude discrete areas of magnetic enhancement. These anomalies are probably caused by localised variations in the depth and composition of the soils.

4.4 POSSIBLE ARCHAEOLOGICAL ANOMALIES

A cluster of anomalies has been identified to the immediate west of a pond in F3, close to the projected route of a Roman road (GSHER 7365). Whilst no clear archaeological pattern is discernible within the narrow pipeline corridor, and no anomalies suggestive of a Roman road have been identified, an archaeological origin should be considered given the recorded proximity of the road. The anomalies are identified within an otherwise quiet magnetic background and may locate road-side activity such as pits and ditches.

5 CONCLUSION

The survey has successfully evaluated the proposed pipeline corridor and has not identified any anomalies of definite archaeological potential. A cluster of low magnitude anomalies, close to the projected route of a Roman road (Gloucestershire Historic Environment Record 7365) are ascribed moderate archaeological potential, although no clear pattern is discernible within the narrow survey corridor. Elsewhere, anomalies have been identified which are due field drains and to localised variations in the depth and composition of the soils. Therefore, on the basis of the geophysical survey, the archaeological potential of the majority of the proposed pipeline is assessed as low and locally moderate in the vicinity of the projected route of the Roman road.

6 REFERENCES

Chartered Institute for Archaeologists (CIfA) 2014 ***Standard and guidance for archaeological geophysical survey*** (Reading) http://www.archaeologists.net/sites/default/files/CIfAS&Geophysics_1.pdf accessed 11 April 2018

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Gaffney, C & Gater, J (2003) ***Revealing the Buried Past: Geophysics for Archaeologists*** Stroud

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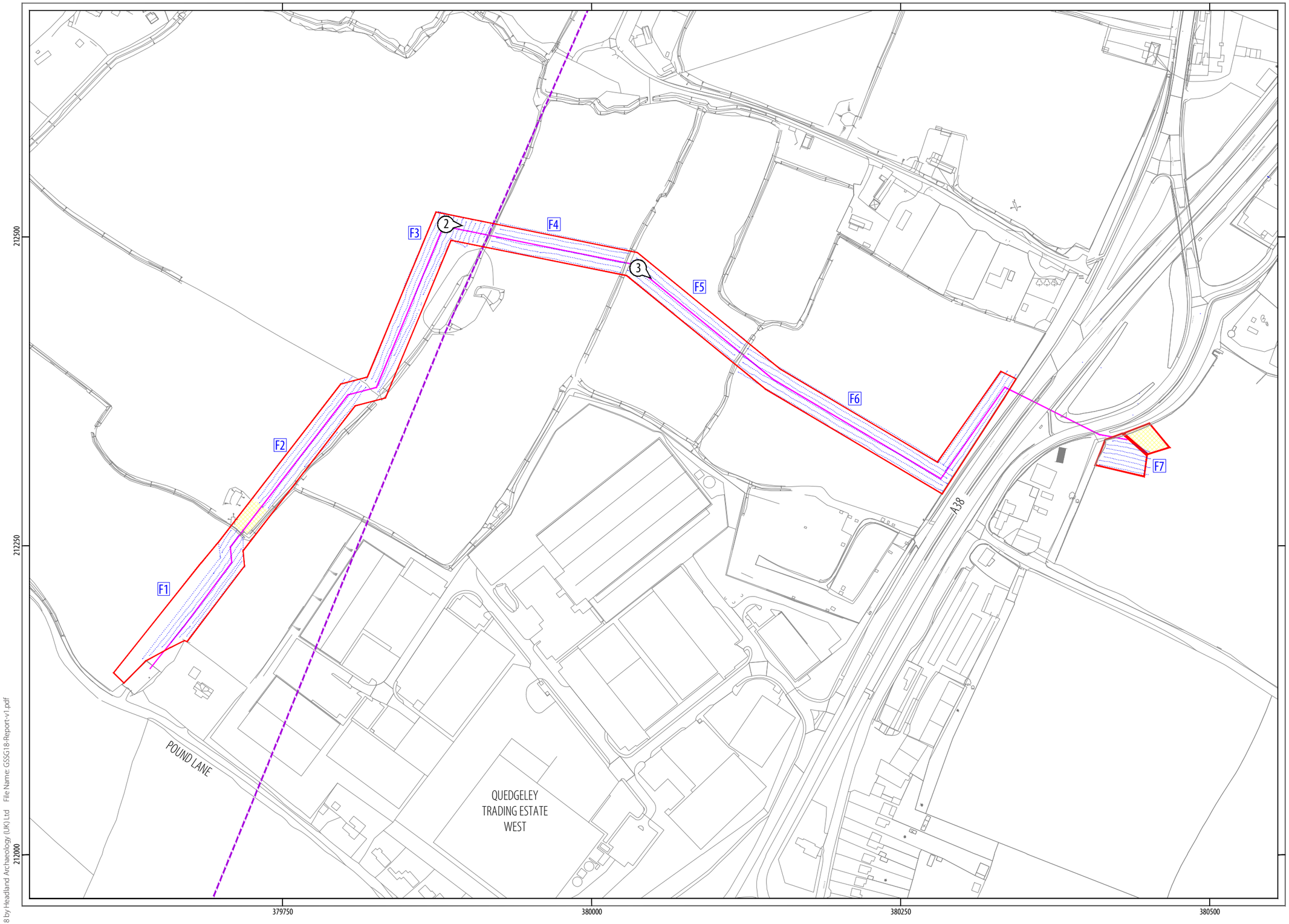

geophysical survey area
proposed pipeline
GPS swaths
Roman Road GSHER 7365
area unsuitable for survey
location and direction of ILLUS 2-3

0 50m
1:3,000 @ A3

PROJECT GSSG18
Gloucester South Sewerage Growth
Hardwicke
Gloucestershire

CLIENT North Midland Construction Plc
on behalf of Severn Trent Water

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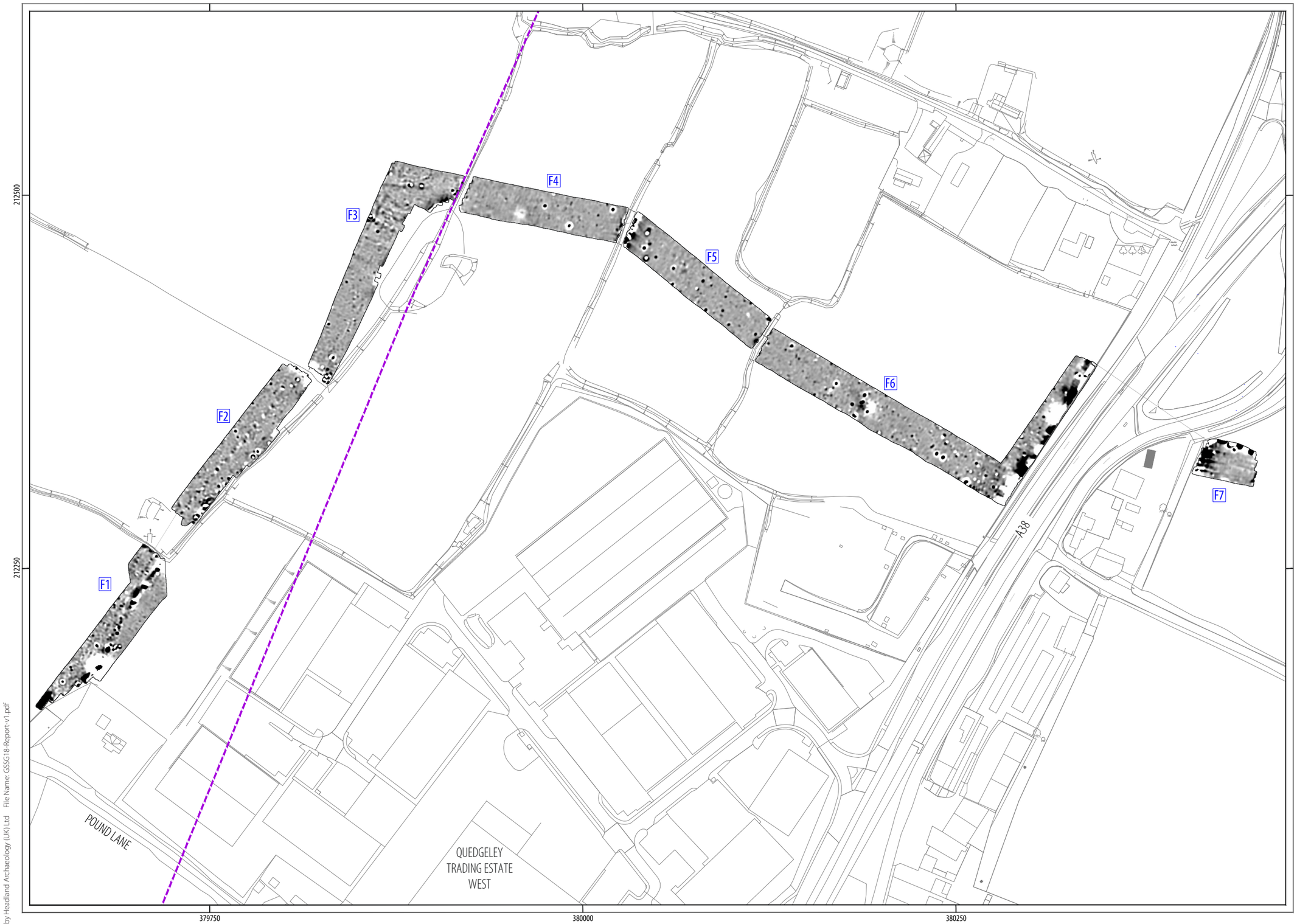
ILLUS 4 Survey location showing GPS swaths (1:3,000)



Roman Road GSHER 7365

nT
-1.0
2.0

0
50m
1:2,500 @ A3

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Hardwicke
Gloucestershire

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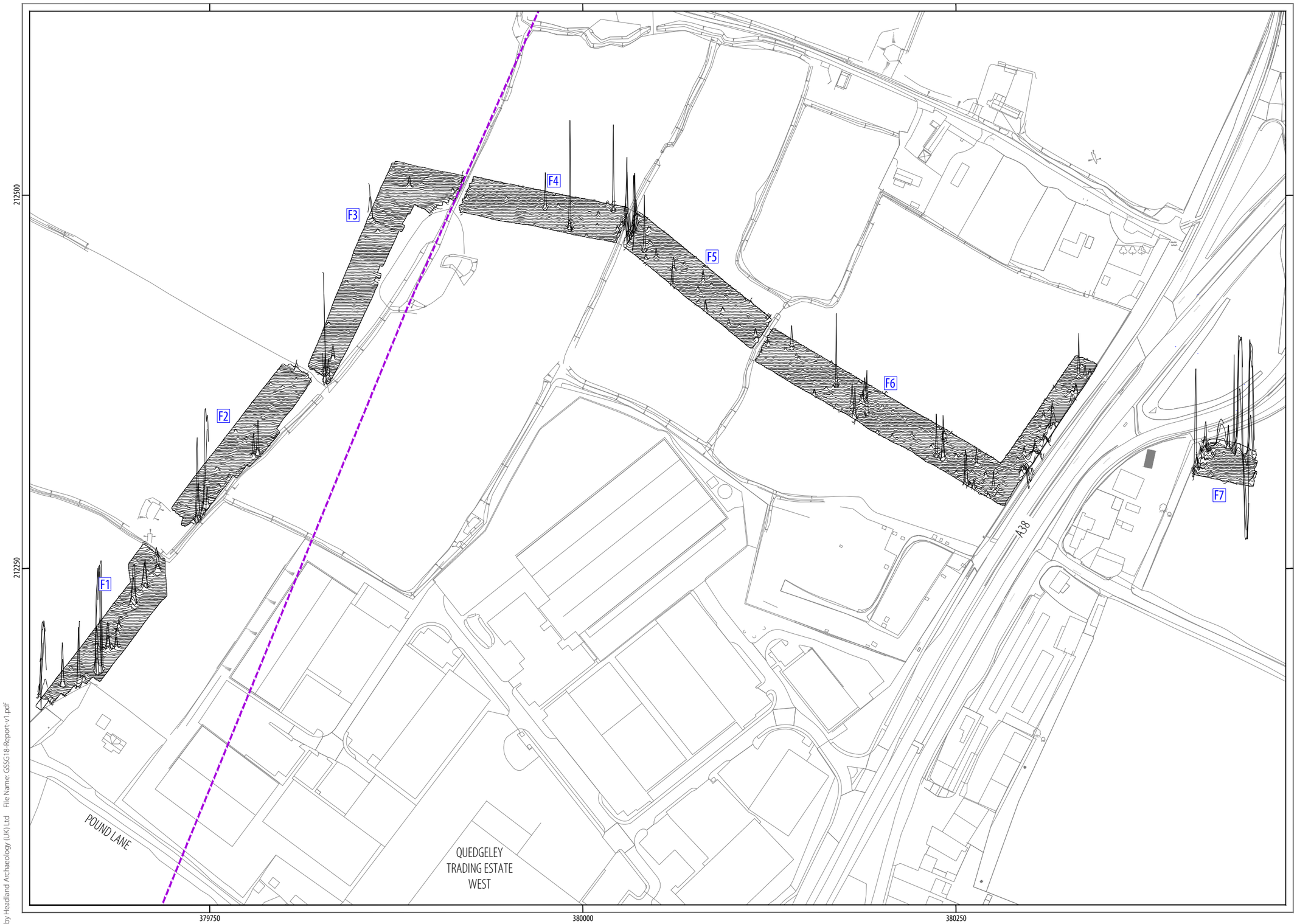
ILLUS 5 Processed greyscale magnetometer data (1:2,500)



50.0nT/cm

0 50m

1:2,500 @ A3

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Gloucester South Sewerage Growth
Hardwicke
Gloucestershire

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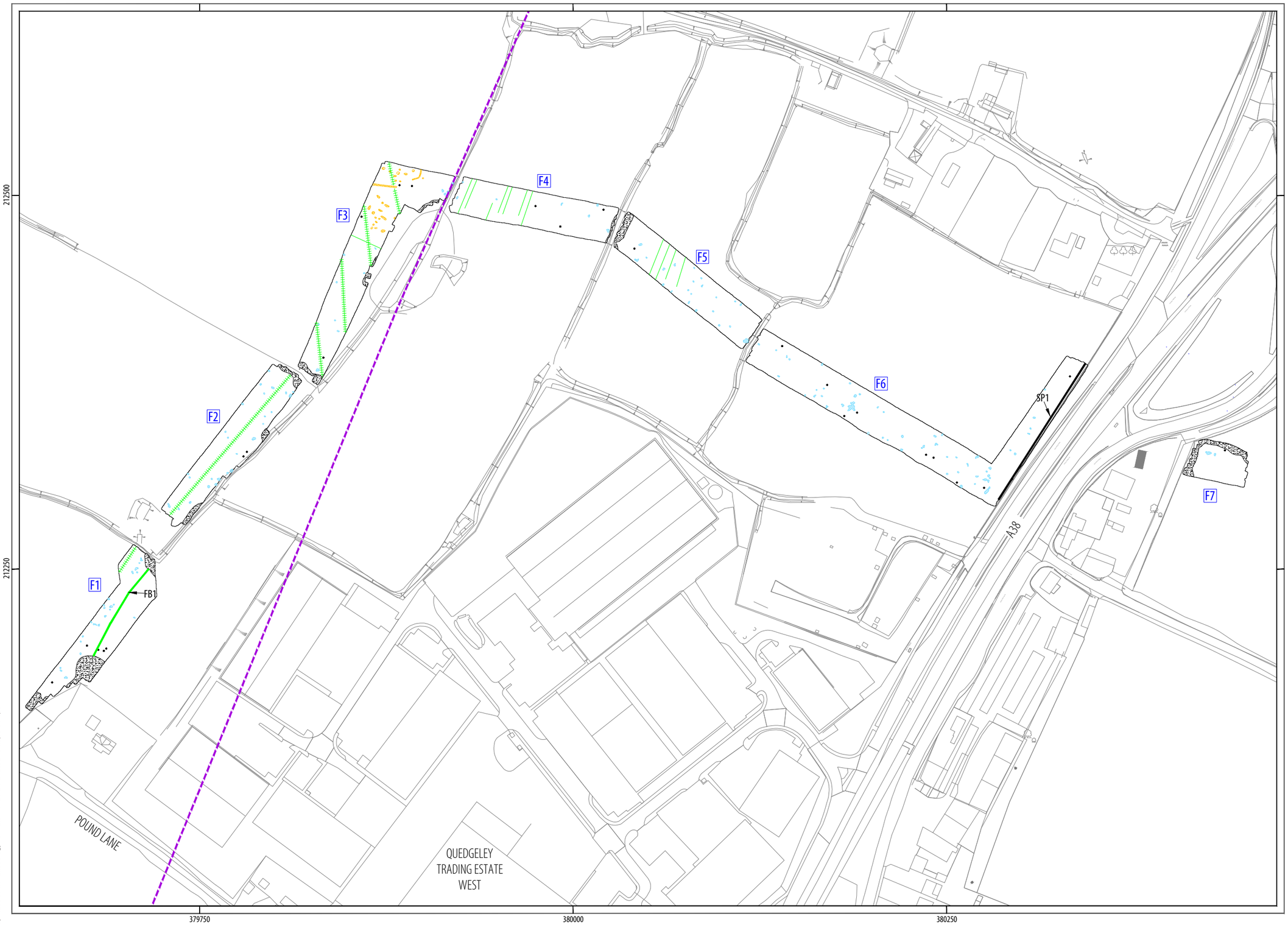
ILLUS 6 XY trace plot of minimally processed magnetometer data (1:2,500)



Roman Road GSHER 7365

TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
dipolar linear	service pipe
magnetic disturbance	ferrous material
linear trend	agricultural
linear	former boundary
linear trend	field drain
magnetic enhancement	geology
magnetic enhancement	archaeology?

ABBREVIATIONS

FB former boundary

SP service pipe

0 50m

1:2,500 @ A3

PROJECT GSSG18
Gloucester South Sewerage Growth
Hardwicke
Gloucestershire

CLIENT North Midland Construction Plc
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ILLUS 7 Interpretation of magnetometer data; Sector 1 (1:2,500)

7 APPENDICES

APPENDIX 1 MAGNETOMETER SURVEY

Magnetic susceptibility and soil magnetism

Iron makes up about 6% of the earth's crust and is mostly present in soils and rocks as minerals such as maghaemite and haematite. These minerals have a weak, measurable magnetic property termed magnetic susceptibility. Human activities can redistribute these minerals and change (enhance) others into more magnetic forms so that by measuring the magnetic susceptibility of the topsoil, areas where human occupation or settlement has occurred can be identified by virtue of the attendant increase (enhancement) in magnetic susceptibility. If the enhanced material subsequently comes to fill features, such as ditches or pits, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer).

In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of topsoils, subsoils and rocks into which these features have been cut, which causes the most recognisable responses. This is primarily because there is a tendency for magnetic ferrous compounds to become concentrated in the topsoil, thereby making it more magnetic than the subsoil or the bedrock. Linear features cut into the subsoil or geology, such as ditches, that have been silted up or have been backfilled with topsoil will therefore usually produce a positive magnetic response relative to the background soil levels. Discrete feature, such as pits, can also be detected.

The magnetic susceptibility of a soil can also be enhanced by the application of heat. This effect can lead to the detection of features such as hearths, kilns or areas of burning.

Types of magnetic anomaly

In the majority of instances anomalies are termed 'positive'. This means that they have a positive magnetic value relative to the magnetic background on any given site. However some features can manifest themselves as 'negative' anomalies that, conversely, means that the response is negative relative to the mean magnetic background.

Where it is not possible to give a probable cause of an observed anomaly a '?' is appended.

It should be noted that anomalies interpreted as modern in origin might be caused by features that are present in the topsoil or upper layers of the subsoil. Removal of soil to an archaeological or natural layer can therefore remove the feature causing the anomaly.

The types of response mentioned above can be divided into five main categories that are used in the graphical interpretation of the magnetic data:

Isolated dipolar anomalies (iron spikes) These responses are typically caused by ferrous material either on the surface or in the topsoil. They cause a rapid variation in the magnetic response giving a characteristic 'spiky' trace. Although ferrous archaeological artefacts could produce this type of response, unless there is supporting evidence for an archaeological interpretation, little emphasis is normally given to such anomalies, as modern ferrous objects are common on rural sites, often being present as a consequence of manuring.

Areas of magnetic disturbance These responses can have several causes often being associated with burnt material, such as slag waste or brick rubble or other strongly magnetised/fired material. Ferrous structures such as pylons, mesh or barbed wire fencing and buried pipes can also cause the same disturbed response. A modern origin is usually assumed unless there is other supporting information.

Linear trend This is usually a weak or broad linear anomaly of unknown cause or date. These anomalies are often caused by agricultural activity, either ploughing or land drains being a common cause.

Areas of magnetic enhancement/positive isolated anomalies Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area whilst discrete anomalies are manifest by an increased response (sometimes only visible on an XY trace plot) on two or three successive traverses. In neither instance is there the intense dipolar response characteristic exhibited by an area of magnetic disturbance or of an 'iron spike' anomaly (see above). These anomalies can be caused by infilled discrete archaeological features such as pits or post-holes or by kilns. They can also be caused by pedological variations or by natural infilled features on certain geologies. Ferrous material in the subsoil can also give a similar response. It can often therefore be very difficult to establish an anthropogenic origin without intrusive investigation or other supporting information.

Linear and curvilinear anomalies Such anomalies have a variety of origins. They may be caused by agricultural practice (recent ploughing trends, earlier ridge and furrow regimes or land drains), natural geomorphological features such as palaeochannels or by infilled archaeological ditches.

APPENDIX 2 SURVEY LOCATION INFORMATION

An initial survey base station was established using a Trimble VRS differential Global Positioning System (dGPS). The magnetometer data was georeferenced using a Trimble RTK differential Global Positioning System (Trimble R8s model).

Temporary sight markers were laid out using a Trimble VRS differential Global Positioning System (Trimble R8s model) to guide the operator and ensure full coverage. The accuracy of this dGPS equipment is better than 0.01m.

The survey data were then super-imposed onto a base map provided by the client to produce the displayed block locations. However, it should be noted that Ordnance Survey positional accuracy for digital map data has an error of 0.5m for urban and floodplain areas, 1.0m for rural areas and 2.5m for mountain and moorland areas. This potential error must be considered if coordinates are measured off hard copies of the mapping rather than using the digital coordinates.

Headland Archaeology cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party.

APPENDIX 3 GEOPHYSICAL SURVEY ARCHIVE

The geophysical archive comprises an archive disk containing the raw data in XYZ format, a raster image of each greyscale plot with associate world file, and a PDF of the report.

The project will be archived in-house in accordance with recent good practice guidelines (http://guides.archaeologydataservice.ac.uk/g2gp/Geophysics_3). The data will be stored in an indexed archive and migrated to new formats when necessary.

APPENDIX 4 DATA PROCESSING

The gradiometer data has been presented in this report in processed greyscale and minimally processed XY trace plot format.

Data collected using RTK GPS-based methods cannot be produced without minimal processing of the data. The minimally processed data has been interpolated to project the data onto a regular grid and de-striped to correct for slight variations in instrument calibration drift and any other artificial data.

A high pass filter has been applied to the greyscale plots to remove low frequency anomalies (relating to survey tracks and modern agricultural features) in order to maximise the clarity and interpretability of the archaeological anomalies.

The data has also been clipped to remove extreme values and to improve data contrast.

APPENDIX 5 OASIS DATA COLLECTION FORM: ENGLAND

OASIS ID: headland5-314982

Project details	
Project name	Gloucester South Sewerage Growth, Hardwicke
Short description of the project	Headland Archaeology (UK) Ltd, undertook a geophysical (magnetometer) survey, covering approximately 2 hectares, to inform planning proposals for a proposed sewer pipeline for the Gloucester South Sewerage Growth project at Hardwicke, Gloucestershire. The survey has not identified any anomalies of definite archaeological potential. A cluster of low magnitude anomalies, close to the projected route of a Roman road (Gloucestershire Historic Environment Record 7365) are ascribed moderate archaeological potential, perhaps locating road-side activity, although no clear pattern is discernible within the narrow survey corridor. Elsewhere, anomalies have been identified which are due field drains and to localised variations in the depth and composition of the soils. Therefore, on the basis of the geophysical survey, the archaeological potential of the majority of the proposed pipeline is assessed as low but locally moderate in the vicinity of the projected route of the Roman road.
Project dates	Start: 05-04-2018 End: 05-04-2018
Previous/future work	Not known / Not known
Any associated project reference codes	GSSG18 - Sitecode
Type of project	Field evaluation
Site status	None
Current Land use	Cultivated Land 4 - Character Undetermined
Monument type	N/A None
Monument type	N/A None
Significant Finds	N/A None
Significant Finds	N/A None
Methods & techniques	"Geophysical Survey"
Development type	Pipelines/cables (e.g. gas, electric, telephone, TV cable, water, sewage, drainage etc.)
Prompt	National Planning Policy Framework - NPPF
Position in the planning process	Not known / Not recorded
Solid geology (other)	Blue Lias and Charmouth Formation (undifferentiated)
Drift geology (other)	none
Techniques	Magnetometry
Project location	
Country	England
Site location	GLOUCESTERSHIRE STROUD HARDWICKE Gloucester South Sewerage Growth, Hardwicke
Study area	2 Hectares
Site coordinates	SO 7964 1215 51.8071691997 -2.295336003651 51 48 25 N 002 17 43 W Line
Site coordinates	SO 8043 1233 51.808815967214 -2.283886824926 51 48 31 N 002 17 01 W Line
Project creators	
Name of Organisation	Headland Archaeology
Project brief originator	North Midland PLC
Project design originator	Headland Archaeology
Project director/manager	Harrison, S
Project supervisor	Vansassenbrouck, O.
Type of sponsor/funding body	Developer

Project archives	
Physical Archive Exists?	No
Digital Archive recipient	In house
Digital Contents	"other"
Digital Media available	"Geophysics"
Paper Archive Exists?	No
Project bibliography 1	
Publication type	Grey literature (unpublished document/manuscript)
Title	Gloucester South Sewerage Growth, Hardwicke, Gloucestershire: Geophysical Survey
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Other bibliographic details	GSSG18
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Entered on	19 April 2018

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