FHAS19

LAND AT FORMBY HALL, LIVERPOOL

GEOPHYSICAL SURVEY

PLANNING REF. DC/2018/00586 & DC/201800587

commissioned by X1 Developments Limited

October 2019

HEADLAND ARCHAEOLOGY

REGISTERED ClfA ORGANISATION

LAND AT FORMBY HALL, LIVERPOOL

GEOPHYSICAL SURVEY

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This report adheres to the quality standard of ISO 9001:2015

PROJECT INFO:
HA Project Code **FHAS19** / NGR **SD 3113 0996** / Parish **Formby** / Local Authority **Sefton Council** / OASIS Ref. **headland-371023**

PROJECT TEAM:
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Approved by **Sam Harrison** ....

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HEADLAND ARCHAEOLOGY

part of the RSK Group

REGISTERED CIfA ORGANISATION

PROJECT SUMMARY

Headland Archaeology (UK) Ltd undertook a geophysical (earth resistance and ground-penetrating radar) survey of a 0.5 hectare proposed development at Formby Hall, Liverpool. No anomalies of definite archaeological potential have been recorded in either survey indicative of formal gardens, only a series of drains/services have been identified in the surveys. An extremely tentative, square shaped anomaly, similar in response to the background readings has been identified, although this is considered to be natural in origin a possible archaeological interpretation cannot be dismissed. A single linear anomaly aligned slightly oblique to the drains has been recorded in the data, the origin of which is unknown. A possible former ground surface has been recorded in the ground penetrating radar survey from 0.79m below the current surface, which may indicate the land surrounding the hall was levelled before being landscaped. Overall the archaeological potential of this part of the site is considered low.

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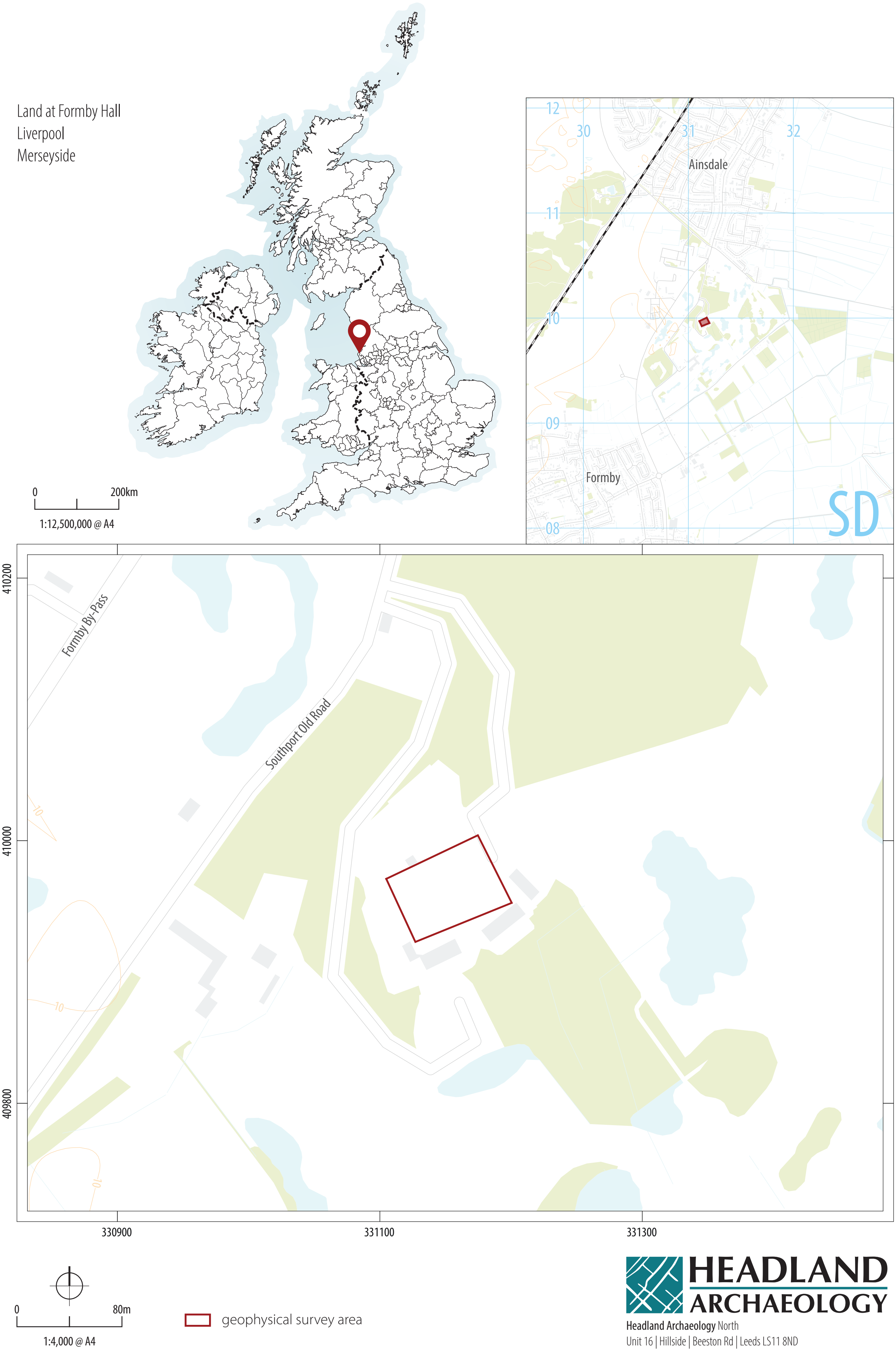

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ILLUS 1 Site location

LAND AT FORMBY HALL, LIVERPOOL

GEOPHYSICAL SURVEY

1 INTRODUCTION

Headland Archaeology (UK) Ltd was commissioned by RSK (the consultant) on behalf of X1 Developments Ltd (the client), to undertake geophysical (earth resistance and ground-penetrating radar) surveys at the site of a proposed development at Formby Hall, Liverpool. The surveys were carried out in order to determine the archaeological potential of the site prior to determination of planning applications DC/2018/00586 and DC/2018/00587.

The work was undertaken in accordance with a Written Scheme of Investigation (Harrison 2019) which was submitted to, and approved by the Client, and with guidance contained in the National Planning Policy Framework (DCLG 2019). All work was undertaken in line with current best practice (Chartered Institute for Archaeologists 2014, EAC 2016).

The survey was carried out on July 3rd and 4th 2019.

1.1 SITE LOCATION, LAND-USE AND TOPOGRAPHY

The Geophysical Survey Area (GSA) comprises a rectangular area within former landscaped gardens, located immediately north of Formby Hall, centred on SD 3113 0996 (see Illus 1). It is encompassed by woodland screening of Formby Hall Golf Course and Spa, to the south, Formby Wood to the north and east, and Southport Old Road to the north-west.

At the time of the survey the site was under short, recently mown grass (see Illus 2–4), however isolated areas were overgrown, notably immediately south of the dovecot at the north of the survey area, and to the south-east of the survey area. A recently felled line of trees running north/south, left several tree stumps limiting access. These obstructions mostly affected the ground-penetrating radar survey, while the earth resistance survey was less affected.

Site topography was uniformly flat at 7m Above Ordnance Datum (AOD).

1.2 GEOLOGY AND SOILS

The underlying bedrock geology comprises Singleton Mudstone Member (mudstone), overlain by superficial deposits of Blown Sand (NERC 2019).

The soils are classified in the Soilscape 15 Association, characterised as naturally very acid sands and loams (Cranfield University 2019).

2 ARCHAEOLOGICAL BACKGROUND

A desk-based assessment (RSK 2018) of the proposed development identified there to be a *'low potential for any previously unknown archaeological remains relating to the prehistoric and Romano-British periods, there is a moderate potential for medieval archaeology relating to the earlier phases of the hall and possible associated moat. There is a high potential for the presence of post-medieval archaeological remains relating to the formal gardens, Formby Hall School House and earlier phases of the hall.'*

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 GSA. This will therefore enable an assessment to be made of the impact of the proposed development on any sub-surface archaeological remains, if present.

The specific archaeological objectives of the geophysical surveys were:

› to assess non-intrusive methods to research the layout of the gardens an whether it was desirable to reinstate them;

› to provide information about the nature and possible interpretation of any anomalies identified;

ILLUS 2 Survey Area, looking south-east

- 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 EARTH RESISTANCE SURVEY

Earth resistance survey methodology involves the insertion of four electrodes into the ground surface, which an electrical current is induced into. Two electrodes known as the current electrodes introduce the electrical current and two potential electrodes record the voltage at a given point, indicating the local resistivity.

The earth resistance survey was undertaken using a Geoscan RM85 resistance meter and an MPX15 multiplexing unit, utilising the twin probe parallel setup. The instrument logs each reading automatically at 0.5m intervals on traverses placed 1.0m apart. The mobile probe spacing was 0.5m with the remote probes located a minimum of 20m away from the survey area. Probe spacing of 0.5m gives an approximate maximum depth penetration of 1m. The survey area was subdivided into grids measuring 30m by 30m, established using a Trimble R8s dGPS system for accuracy (see Illus 8 & 9).

The readings were stored on the memory of the instrument and later downloaded for processing and interpretation. Geoplot 4 (Geoscan Research) software was used to process and present the data.

3.2 GROUND-PENETRATING RADAR SURVEY

Ground-penetrating radar (GPR) works by discharging a short pulse of energy into the ground with reflections being returned from the interfaces between different materials in the ground. The amplitude of these returns depends on the change in velocity of the radar wave as it crosses these interfaces. A measure of these velocities is given by the dielectric constant of that material. The travel times are recorded for each return on the radargram and an approximate conversion made to depth by calculating or assuming an average dielectric constant. An advantage of a GPR survey is its capability to be used on a variety of ground conditions and supply the user with an estimation of depth. This technique even works in cluttered environments which would usually prevent other geophysical techniques being used.

Drier materials such as sand, gravel and rocks, i.e. materials which are less conductive (or more resistant), will permit the survey of deeper sections than wetter materials such as clays which are more conductive (or less resistant). Penetration can be increased by using longer wavelengths (lower frequencies) but at the expense of resolution. As the antenna emits a "cone" shaped pulse of energy, an offset target showing a perpendicular face to the radar wave will be "seen" before the antenna passes over it. A resultant characteristic diffraction pattern is thus built up in the shape of a hyperbola. A classic target generating such a diffraction is a pipe when the antenna is travelling across the line of the pipe. However, it should be pointed out that if the interface between the target and its surroundings does not result in a marked change in velocity, then only a weak hyperbola will be seen, if at all.

A MALÅ Ground Explorer (GX) was used to conduct the survey. A 450MHz frequency antenna was selected to best evaluate the survey area and give better target definition. This antenna has an approximate maximum depth penetration of 5m.

Data was recorded at 0.05m intervals on transects at 0.5m separation; a Trimble R8s dGPS system was used to accurately locate the instrument during data collection. Data was collected on the systems on-board field controller and later transferred to a secure server for processing in the office.

ILLUS 3 Survey Area, looking south-east

ReflexW (Sandmeier geophysical research) software was used to process and display the data.

3.3 REPORTING

A general site location plan is shown in Illus 1 at a scale of 1:4,000. Illus 2–4 inclusive are site condition photographs. Illus 5 is a 1:500 scale survey location plan showing the GPS swath data from the GPR survey. The processed greyscale data and an overall interpretation plot of the GPR survey are presented at 1:500 on Illus 6 and Illus 7. Unprocessed, processed and an interpretative plot of the earth resistance survey data are presented on Illus 8 to Illus 10 inclusive, also at a scale of 1:500. Illus 11 presents selected GPR profiles, and Illus 12 to Illus 15 inclusive present GPR time-slices from 0.78 ns to 39.84 ns.

Technical information on the equipment used, data processing and survey methodologies are given in Appendices 1 and 2. Appendix 3 details the survey location information and Appendix 4 describes the composition and location of the site archive. 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 (Harrison 2019) and guidelines outlined by the Europae Archaeologia Consilium (EAC 2016) 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 within 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

Despite the presence of some overgrown vegetation and tree stumps in the survey area, generally, the ground conditions across the GSA were good for both survey methods, and the overall quality of the data collected was good throughout.

The mottled appearance of the earth resistance data (see Illus 9-11) is caused by variations in the composition of the superficial deposits and the topsoil, with the areas of increased soil compaction displayed as higher resistance (darker shades). An extremely tentative, square-shaped anomaly, E1, measuring approximately 15m by 15m can be seen in the data, consisting of amorphous anomalies, being similar in appearance to the natural background. A possible feature being close to the surface cannot be dismissed given the anomaly's shape, and as such as possible archaeological interpretation has been attributed.

The survey has identified two parallel linear anomalies (FD1 and FD2), orientated north-west/south-east, and separated by c 7.5m, These manifest as two, well-defined high resistance anomalies in the ground resistance data (see Illus 10), and two shallow, low amplitude responses in the GPR data (see Illus 7 & Illus 11 DAT-1191). These anomalies have been interpreted as drains. A third drain (FD3), which FD1 and FD2 appear to terminate at is located at the southern end of the survey area.

A further linear anomaly (FD4) lies between and runs parallel with FD1 and FD2, albeit at a deeper position in the GPR data. This response is clearly visible in the GPR data (see Illus 7 & Illus 11 DAT-1191) but not in the earth resistance data possibly signifying a deeper location. FD4 also appears to terminate at anomaly FD3. These anomalies have been identified field drains due to the distinct hyperbola observed in the GPR data.

A band of high resistance (FB1) is visible running north-south in the earth resistance data, (see Illus 10), this corresponds to the area of

ILLUS 4 Survey Area, looking south-west

recently felled trees and is caused by the presence of tree roots and compacted soils. This area was not accessible for GPR survey. This anomaly corresponds with the boundaries on historical mapping (RSK 2018).

Immediately east of the felled tree line and west of FD2, running on a slightly different alignment is a further linear anomaly (L1), this is present in both the earth resistance data as a high resistance linear, and in the GPR data as an area exhibiting a high amplitude response (see Illus 7 & Illus 10). This anomaly is of unknown origin and may be archaeological or historical origins.

Finally, anomalies indictive of the former ground surface (FGS1) can be observed beneath the lawn immediately north of Formby Hall, this can be seen in the GPR time-slices from 17.38ns (0.79m) onwards (see Illus 13–15) and in the GPR profiles (see Illus 11). The surface appears to have originally been formed of a low domed shaped hillock in the centre of this area. It is thought that the ground surface may been built up and levelled to the height of that surrounding the Hall.

5 CONCLUSION

The survey has successfully evaluated the geophysical survey area, identifying anomalies within the datasets, that appear to be a field boundary and a series of drains/services. No anomalies of definite archaeological potential that may have been associated with formal gardens, if any, have been recorded in either survey. A possible square anomaly of weak resistance has been recorded in the survey, this response from this anomaly is consistent with the background composition, although given its shape a possible archaeological origin cannot be dismissed. A single linear anomaly, aligned slightly oblique to the drains has been recorded in the data, the origin of which is unknown. A possible former ground surface has been recorded in the ground penetrating radar survey from 0.79m below the current ground surface, which may indicate the land surrounding the hall was levelled before landscaping. Overall the archaeological potential of this part of the site is considered low.

6 REFERENCES

Chartered Institute for Archaeologists (CIfA) 2014 ***Standard and guidance for archaeological geophysical survey*** (Reading) http://www.archaeologists.net/sites/default/files/CIfAS%26GGeophysics_2.pdf accessed 16 July 2019

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Europae Archaeologia Consillium (EAC) 2016 ***EAC Guidelines for the Use of Geophysics in Archaeology: Question to Ask and Points to Consider*** (Namur, Belgium) http://www.old.european-archaeological-council.org/files/eac_guidelines_2_final.pdf accessed 19 July 2019

Harrison, S 2019 ***Land at Formby Hall, Liverpool, Merseyside: Written Scheme of Investigation for Geophysical Survey*** [unpublished client document] Headland Archaeology, Ref. FHAS19

Ministry of Housing, Communities and Local Government MHCLG) 2019 ***National Planning Policy Framework*** https://assers.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/81017/NPPF_Feb_2019_revised.pdf accessed 16 July 2019

Natural Environment Research Council (NERC) 2019 ***British Geological Survey*** http://www.bgs.ac.uk/ accessed 12 July 2019

RSK 2018 ***Formby Hall, Liverpool: Desk-Based Assessment*** [unpublished client document] RSK Ref. 662061

location & direction of ILLUS 2–4

GPR swath

0 10m

1:500 @ A3

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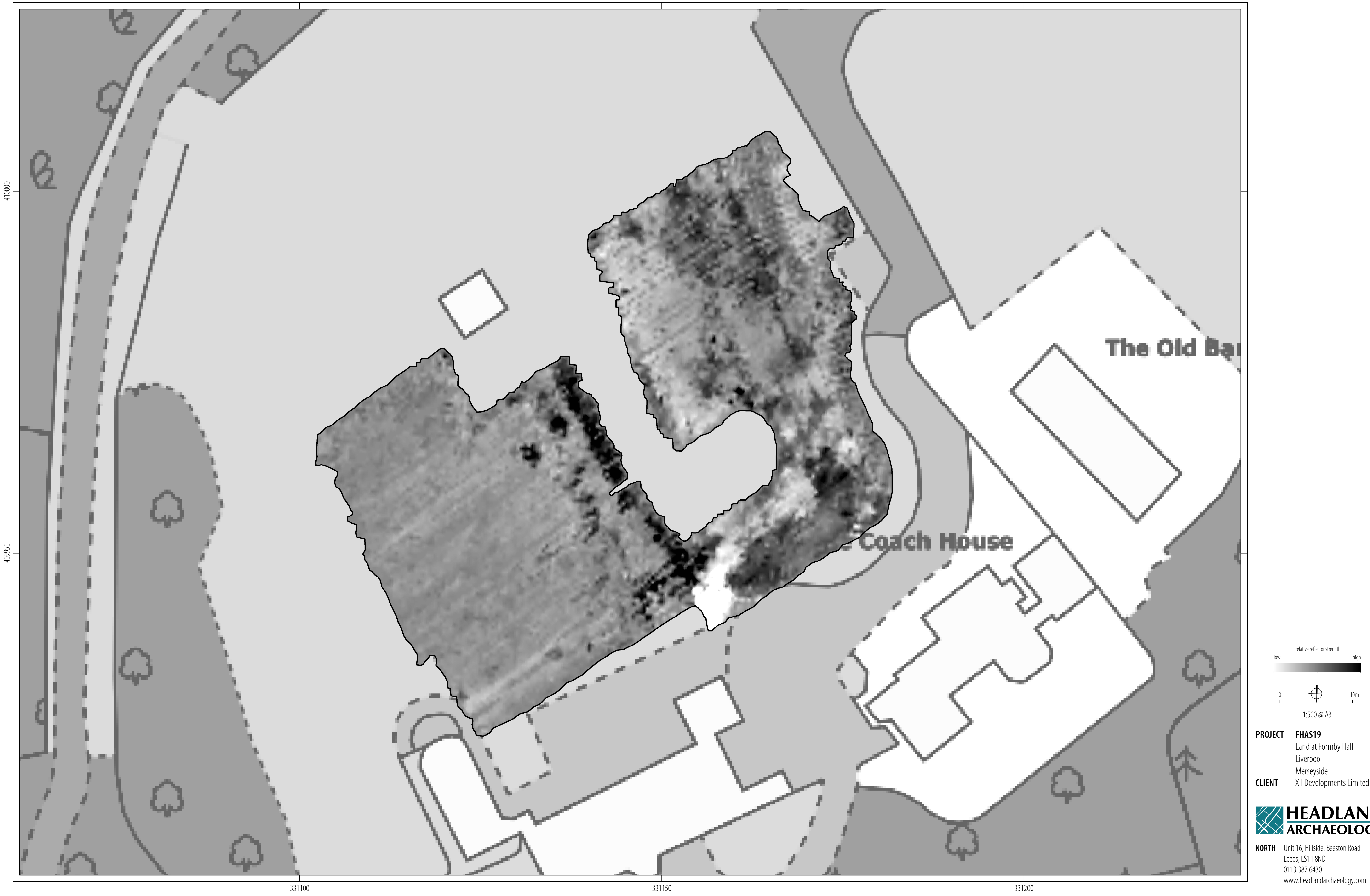
ILLUS 5 Location of GPR swaths



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ILLUS 6 Processed greyscale GPR data (shown at 1.75ns = 0.08m)

- high amplitude
- low amplitude
- former ground surface
- GPR profile location

ABBREVIATIONS
FD - field drain

0 10m
1:504 @ A3

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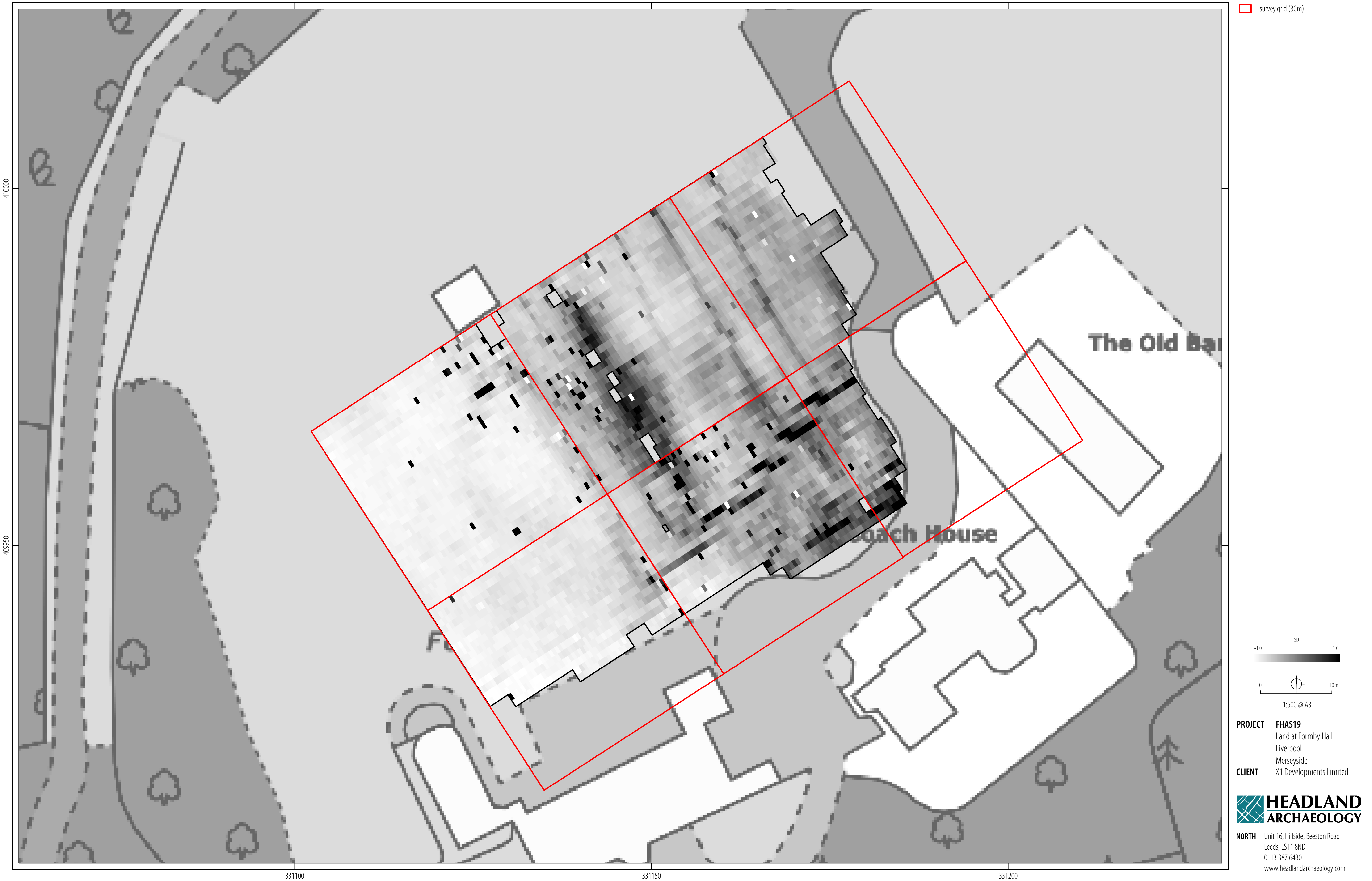
ILLUS 7 Interpretation of GPR data



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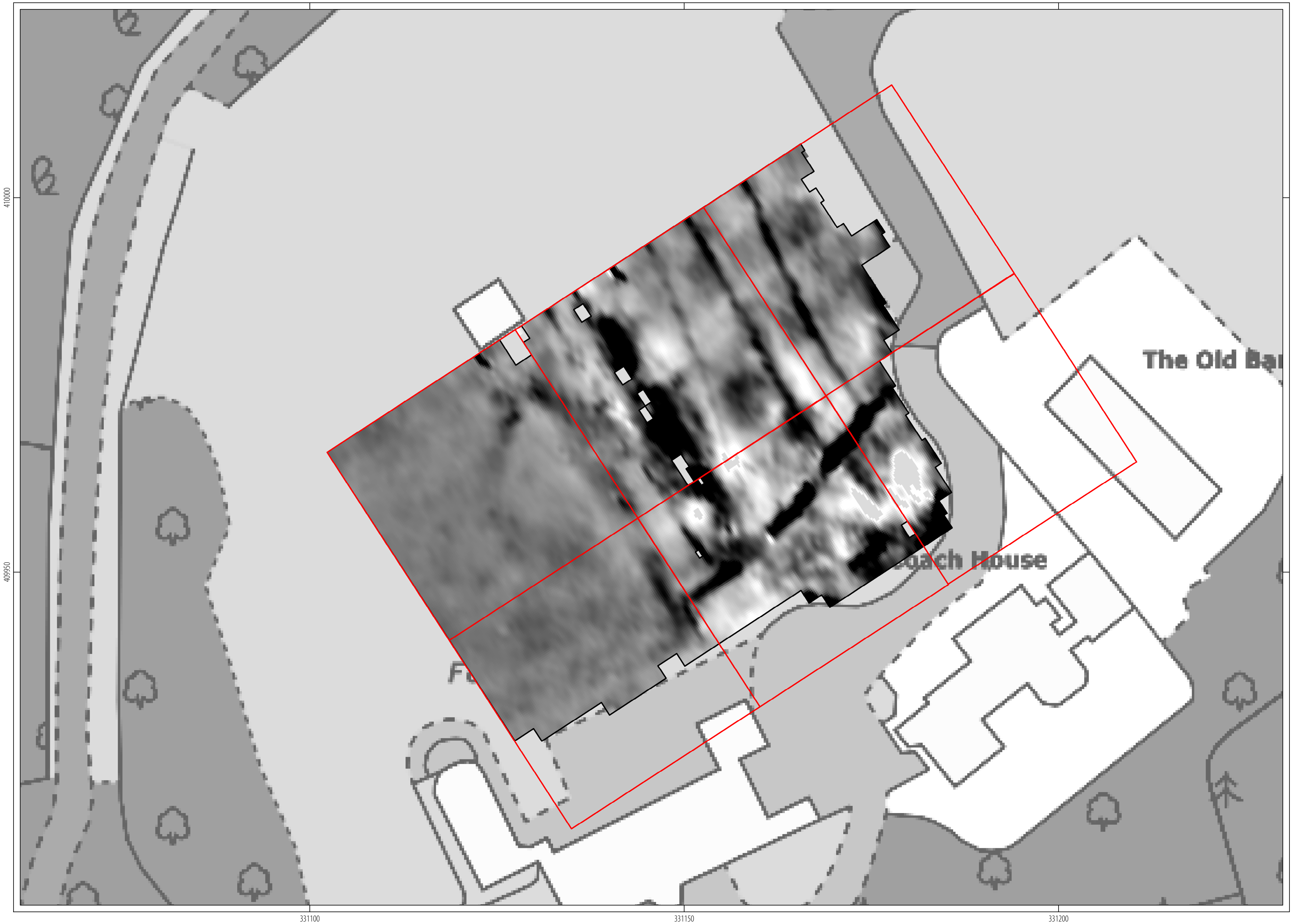
ILLUS 8 Unprocessed greyscaleearth resistance data



survey grid (30m)

SD
-1.0
1.0

0
10m
1:500 @ A3

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ILLUS 9 Processed greyscale earth resistance data

high resistance anomaly

low resistance anomaly

ABBREVIATIONS
E - enclosure
FB - field boundary
FD - field drain
L - Linear

0 10m
1:504 @ A3

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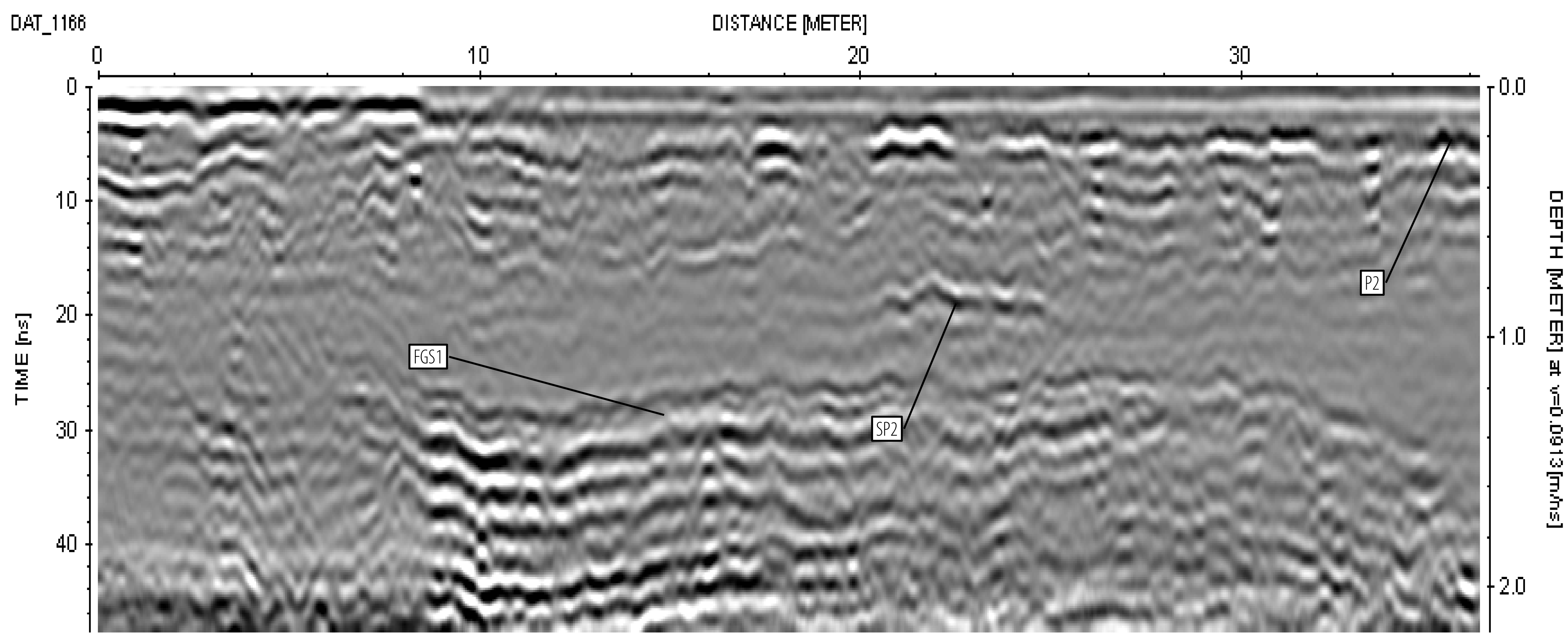
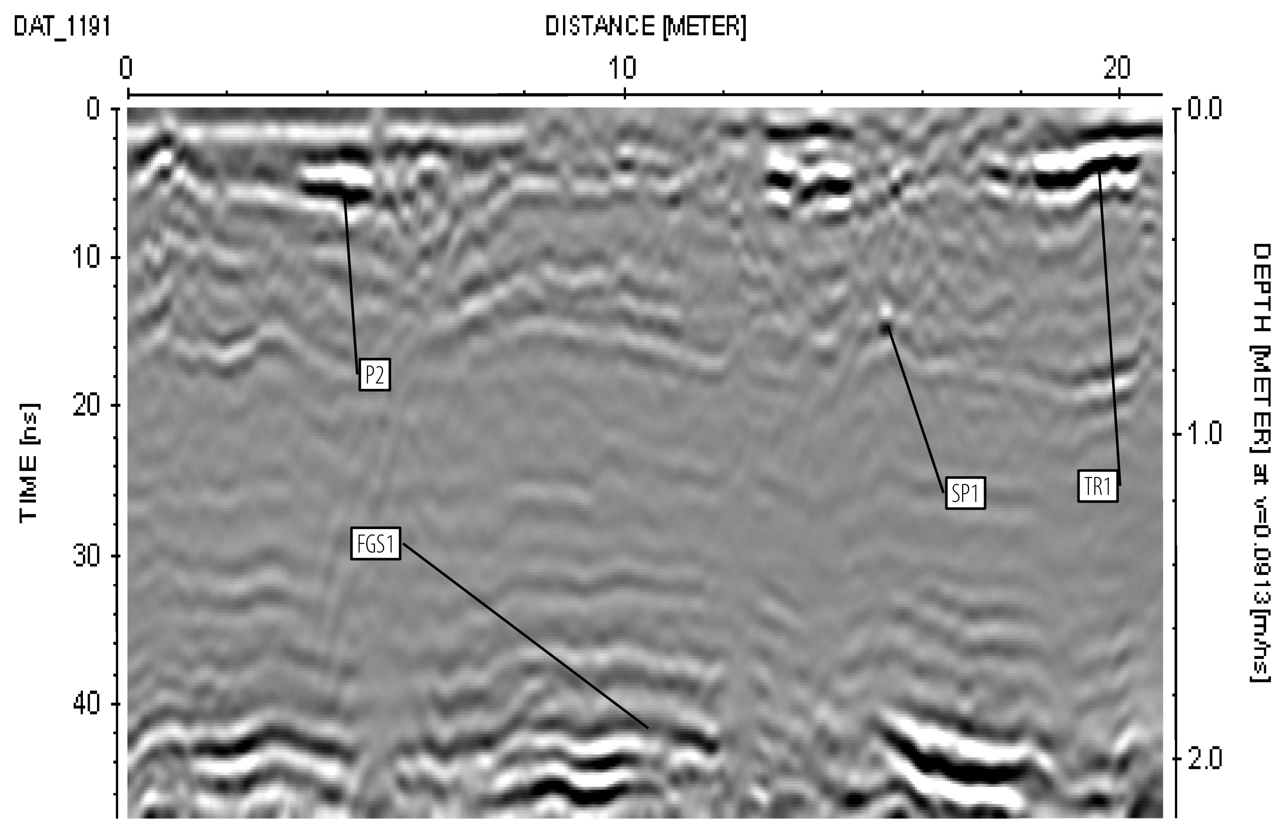
ILLUS 10 Interpretation of earth resistance data





ABBREVIATIONS
FGS - former ground surface
P - pathway
SP - service pipe
TR - trackway

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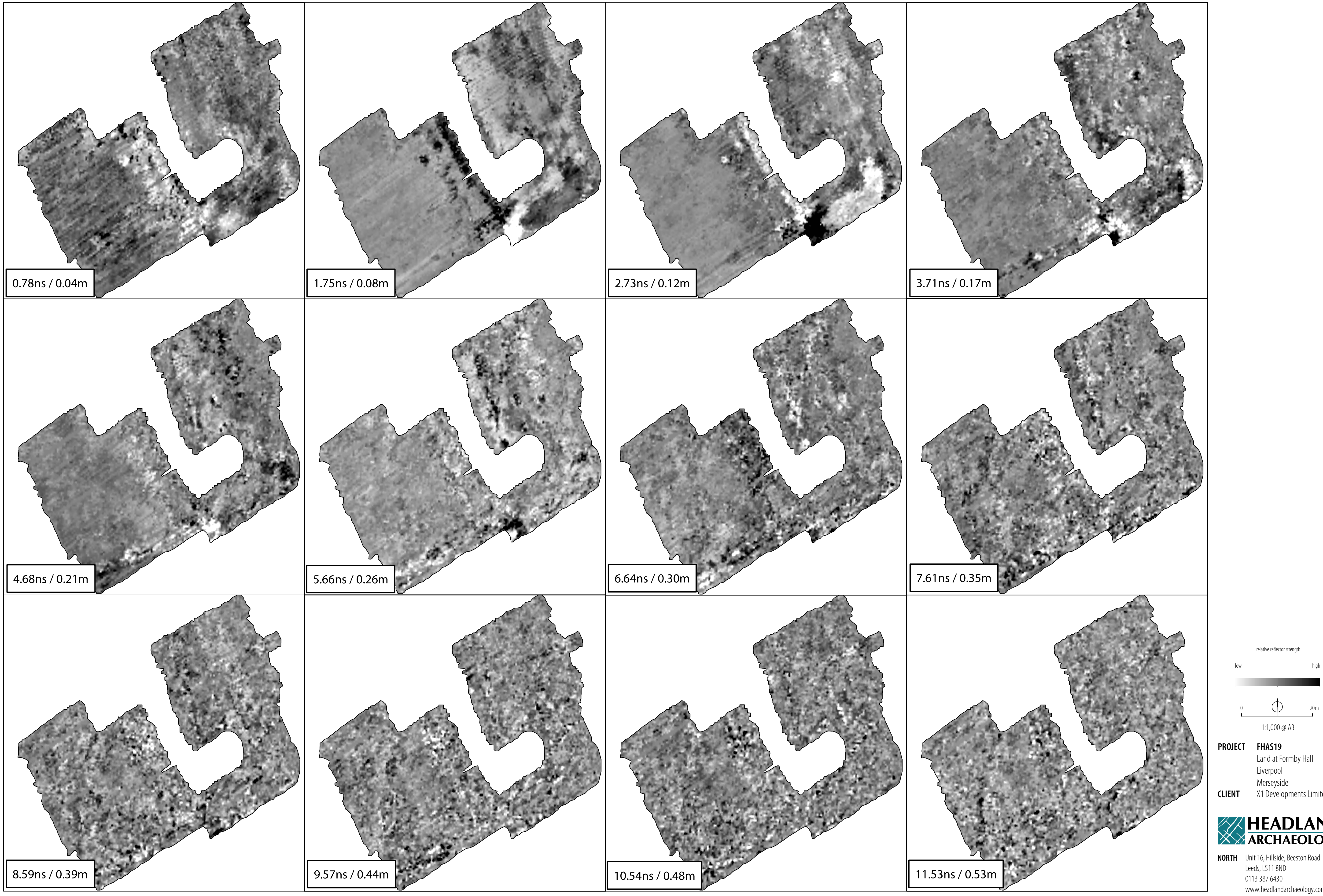
ILLUS 11 GPR profiles



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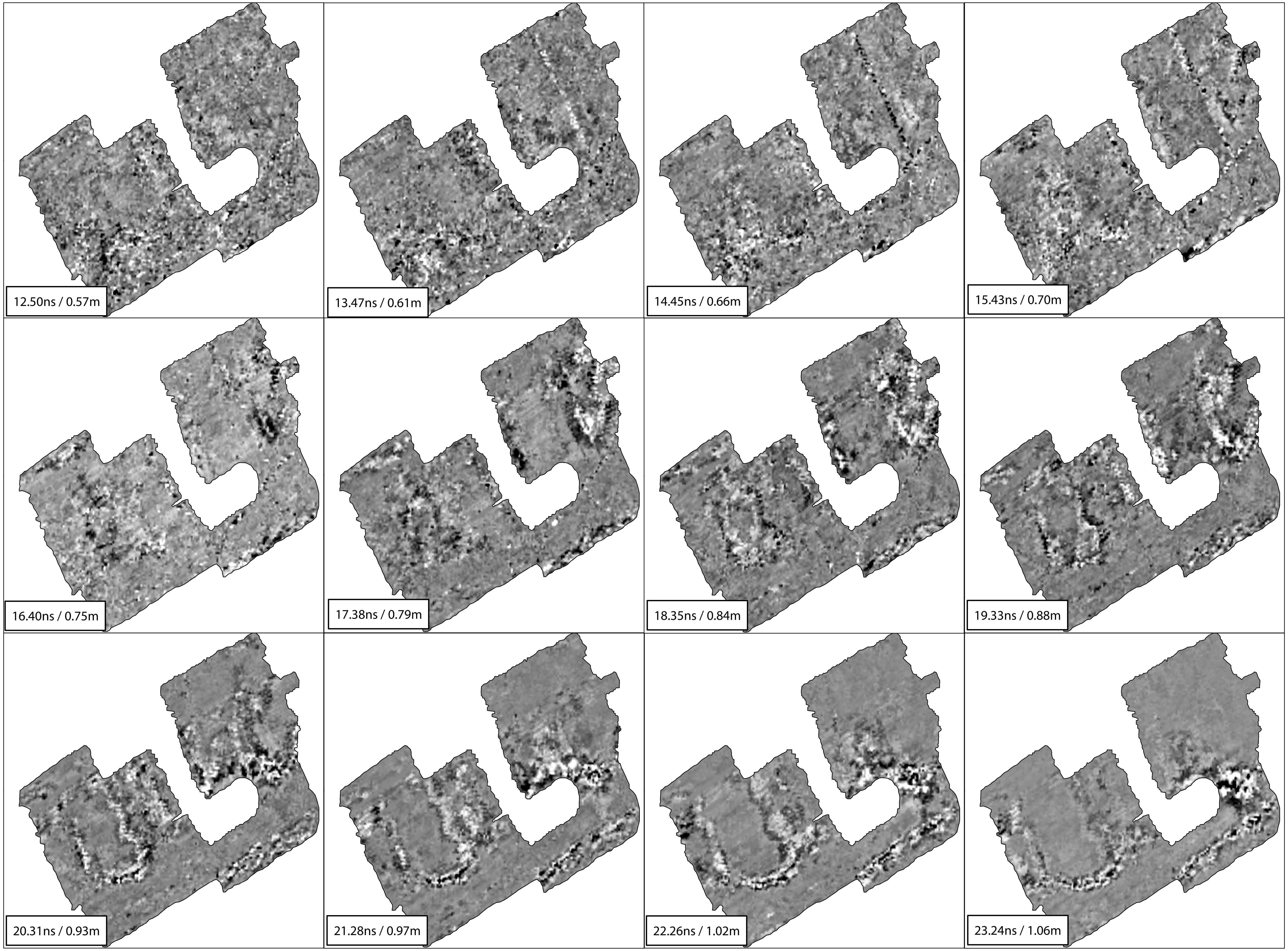
ILLUS 12 GPR time-slices 0.78ns to 11.53ns



relative reflector strength

low high

0 20m

1:1,000 @ A3

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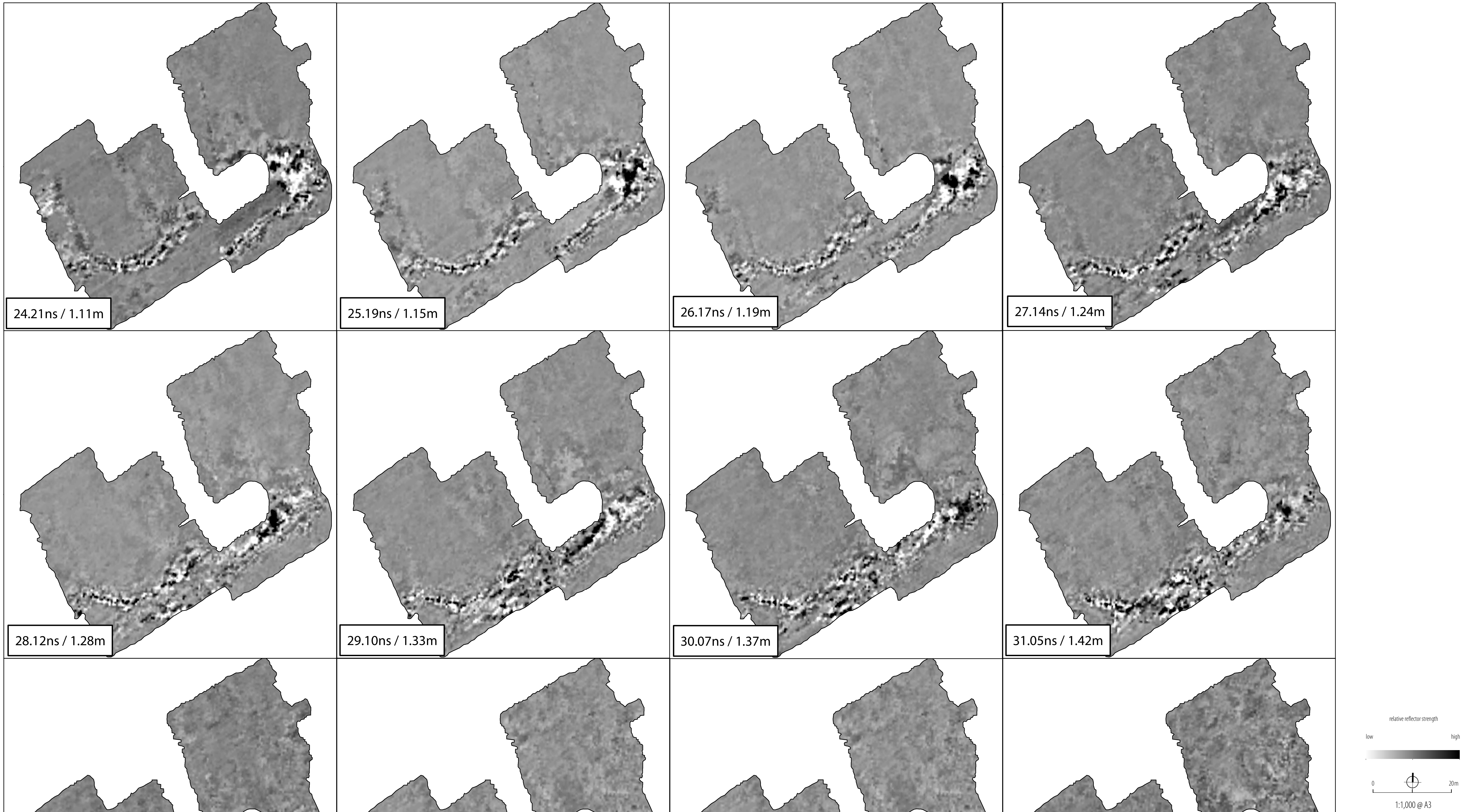
ILLUS 13 GPR time-slices12.50ns to 23.24ns



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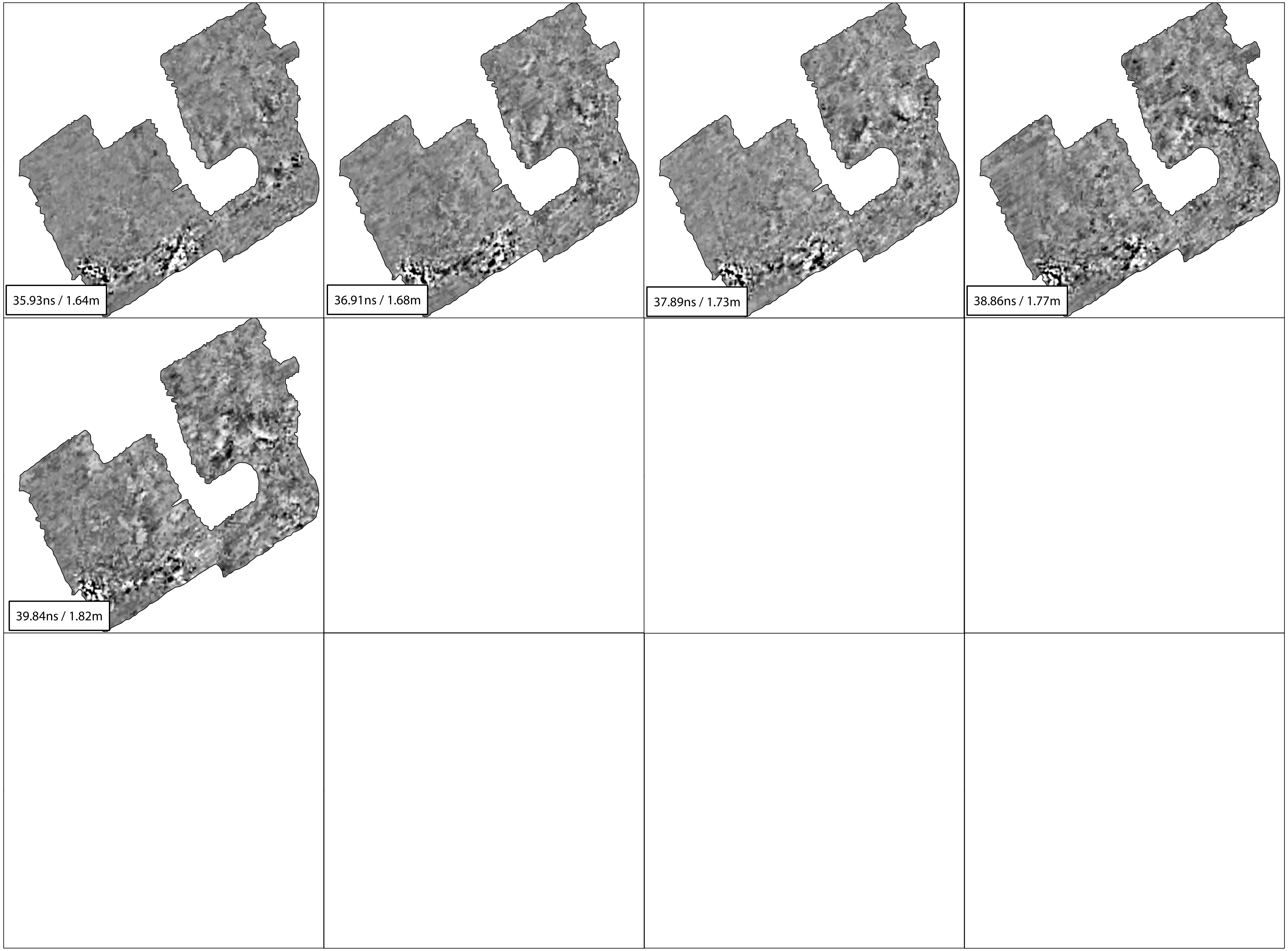
ILLUS 14 GPR time-slices 24.21ns to 34.96ns



relative reflector strength

low high

0 20m

1:1,000 @ A3

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ILLUS 15 GPR time-slices 35.93ns to 39.84ns

7 APPENDICES

APPENDIX 1 APPENDIX 1 EARTH RESISTANCE SURVEY

Soil resistance

The electrical resistance of the upper soil horizons is predominantly dependant on the amount and distribution of water within the soil matrix. Buried archaeological features, such as walls or infilled ditches, by their differing capacity to retain moisture, will impact on the distribution of sub-surface moisture and hence affect electrical resistance. In this way there may be a measurable contrast between the resistance of archaeological features and that of the surrounding deposits. This contrast is needed in order for sub-surface features to be detected by a resistance survey.

The most striking contrast will usually occur between a solid structure, such as a wall, and water-retentive subsoil. This shows as a resistive high. A weak contrast can often be measured between the infill of a ditch feature and the subsoil. If the infill material is soil it is likely to be less compact and hence more water retentive than the subsoil and so the feature will show as a resistive low. If the infill is stone the feature may retain less water than the subsoil and so will show as a resistive high.

The method of measuring variations in ground resistance involves passing a small electric current (1mA) into the ground via a pair of electrodes (current electrodes) and then measuring changes in current flow (the potential gradient) using a second pair of electrodes (potential electrodes). In this way, if a structural feature, such as a wall, lies buried in a soil of uniform resistance much of the current will flow around the feature following the path of least resistance. This reduces the current density in the vicinity of the feature, which in turn increases the potential gradient. It is this potential gradient that is measured to determine the resistance. In this case, the gradient would be increased around the wall giving a positive or high resistance anomaly. In contrast a feature such as an infilled ditch may have a moisture retentive fill that is comparatively less resistive to current flow. This will increase the current density and decrease the potential gradient over the feature giving a negative or low resistance anomaly.

Survey methodology

The most widely used archaeological technique for earth resistance surveys uses a twin probe configuration. One current and one potential electrode (the remote or static probes) are fixed firmly in the ground a set distance away from the area being surveyed. The other current and potential electrodes (the mobile probes) are mounted on a frame and are moved from one survey point to the next. Each time the mobile probes make contact with the ground an electrical circuit is formed between the current electrodes and the potential gradient between the mobile and remote probes is measured and stored in the memory of the instrument.

A Geoscan RM85 resistance meter was used during this survey, with the instrument logging each reading automatically at 0.5m intervals on traverses 1m apart. The mobile probe spacing was 0.5m with the remote probes 20m apart and at least 20m away from the grid under survey. Mobile probe spacing of 0.5m gives an approximate depth of penetration of 1m for most archaeological features. Consequently, a soil cover in excess of 1m may mask, or significantly attenuate, a geophysical response.

Data processing and presentation

All of the illustrations incorporating a digital map base were produced in ArcMap 10.6.1.9270 (ESRI). The resistance data is presented in this report in greyscale format with a linear gradation of values and was obtained by exporting a bitmap from the processing software (Geoplot v4.0; Geoscan Research) into ArcMap. The data has been processed and has also been interpolated by a value of 0.5 in both the X and Y axes using a sine wave (x)/x function to give a smoother, better defined plot.

APPENDIX 2 GROUND-PENETRATING RADAR SURVEY

Ground-penetrating radar

Ground-penetrating radar works by discharging a short pulse of electrical energy into the ground, when this energy encounters a buried object or the interface between different materials, a reflection may occur with the pulse being returned to the instrument. The amplitude of these returns is influenced by the change in velocity produced as the radar wave crosses these interfaces or encounters a buried object. A measure of these velocities is given by the dielectric constant of that material. The travel times are recorded for each return on the radargram and an approximate conversion made to depth by calculating or assuming an average dielectric constant. Drier materials such as sand, gravel and rocks, i.e. materials which are less conductive (or more resistant), will permit the survey of deeper sections than wetter materials such as clays which are more conductive (or less resistant).

Depth penetration can be increased by using a longer wavelengths antenna (a lower frequency) but this is at the expense of target resolution. As the antenna emits a "cone" shaped pulse of energy, an offset target showing a perpendicular face to the radar wave will be "seen" before the antenna passes over it. A resultant characteristic diffraction pattern is thus built up in the shape of a hyperbola. A classic target generating such a diffraction is a pipe when the antenna is travelling across the line of the pipe. However, if the interface between the target and its surroundings does not result in a marked change in velocity, then only a weak hyperbola will be seen, if at all.

An advantage of a GPR survey is its capability to be used on a variety of ground conditions and supply the user with an estimation of depth. This technique even works in cluttered environments which would usually prevent other geophysical techniques being used.

Survey methodology

A MALÅ Ground Explorer (GX) was used during this survey, with the instrument logging a reading every 0.05m along 0.5m spaced traverses. The start and end of each traverse was marked to ensure straight and evenly spaced traverses were achieved. The instrument was furnished with a 450MHz antenna as this was deemed to offer the optimum target definition for the ground conditions.

A Trimble R8s dGPS system was employed to accurately locate the instrument during data collection and was synchronised with the GPR. Data was collected on the systems on-board field controller and later transferred to a secure server for post-acquisition processing in the office. All equipment was mounted upon MALÅ's rugged cart chassis.

Data processing and presentation

All of the illustrations incorporating a digital map base were produced in ArcMap 10.6.1.9270 (ESRI). The GPR data is presented in this report in both greyscale format time-slices, with a linear gradation of values, and selected greyscale GPR profiles; theses were obtained by exporting images from the processing software (ReflexW, Sandmeier geophysical research) and importing these into ArcMap. The data has been processed in ReflexW using a number of filtering steps which allow background geological noise to be filtered out of the data for better feature identification and to time correct the data.

APPENDIX 3 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 4 GEOPHYSICAL SURVEY ARCHIVE

The geophysical archive comprises the raw magnetometer and ground penetrating radar data in XYZ and SEGY format, a raster image of each greyscale plot with associate world file where appropriate, 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 5 OASIS DATA COLLECTION FORM: ENGLAND

OASIS ID: headland5-371023

PROJECT DETAILS	
Project name	Land at Formby Hall, Liverpool
Short description of the project	Headland Archaeology (UK) Ltd undertook a geophysical (earth resistance and ground-penetrating radar) survey of a 0.5 hectare proposed development at Formby Hall, Liverpool. No anomalies of definite archaeological potential have been recorded in either survey indicative of formal gardens, only a series of drains/services have been identified in the surveys. An extremely tentative, square shaped anomaly, similar in response to the background readings has been identified, although this is considered to be natural in origin a possible archaeological interpretation cannot be dismissed. A single linear anomaly aligned slightly oblique to the drains has been recorded in the data, the origin of which is unknown. A possible former ground surface has been recorded in the ground penetrating radar survey from 0.79m below the current surface, which may indicate the land surrounding the hall was levelled before being landscaped. Overall the archaeological potential of this part of the site is considered low.
Project dates	Start: 03-07-2019 End: 04-07-2019
Previous/future work	Not known / Not known
Any associated project reference codes	FHAS19 - Sitecode
Type of project	Field evaluation
Site status	None
Current Land use	Grassland Heathland 5 - Character undetermined
Monument type	None
Monument type	None
Significant Finds	None
Significant Finds	None
Methods & techniques	"Geophysical Survey"
Development type	Rural residential
Prompt	National Planning Policy Framework - NPPF
Position in the planning process	Between deposition of an application and determination
Solid geology (other)	Singleton Mudstone Member
Drift geology	Blown sand
Techniques	Ground penetrating radar
Techniques	Resistivity - area

PROJECT LOCATION	
Country	England
Site location	Merseyside Sefton Form by Land at Formby Hall
Study area	0.5 Hectares
Site coordinates	SD 3113 0996 53.581461736617 -3.040366403525 53 34 53 N 003 02 25 W Point

PROJECT CREATORS	
Name of Organisation	Headland Archaeology
Project brief originator	RSK
Project design originator	Headland Archaeology
Project director/manager	Harrison Sam

Project supervisor	Bishop, R
Type of sponsor/funding body	Developer

PROJECT ARCHIVES	
Physical Archive Exists?	No
Digital Archive recipient	In house
Digital Contents	"other"
Digital Media available	"Geophysics","Images raster / digital photography","Images vector"
Paper Archive Exists?	No

PROJECT BIBLIOGRAPHY 1	
Publication type	Grey literature (unpublished document/manuscript)
Title	Land at Formby Hall, Liverpool: Geophysical Survey
Author(s)/Editor(s)	Hannon, N. and Vansassenbrouck, O.
Other bibliographic details	FHAS19
Date	2019
Issuer or publisher	Headland Archaeology
Place of issue or publication	Edinburgh
Description	A4 glue bound report and PDF/A

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Entered on	18 October 2019

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