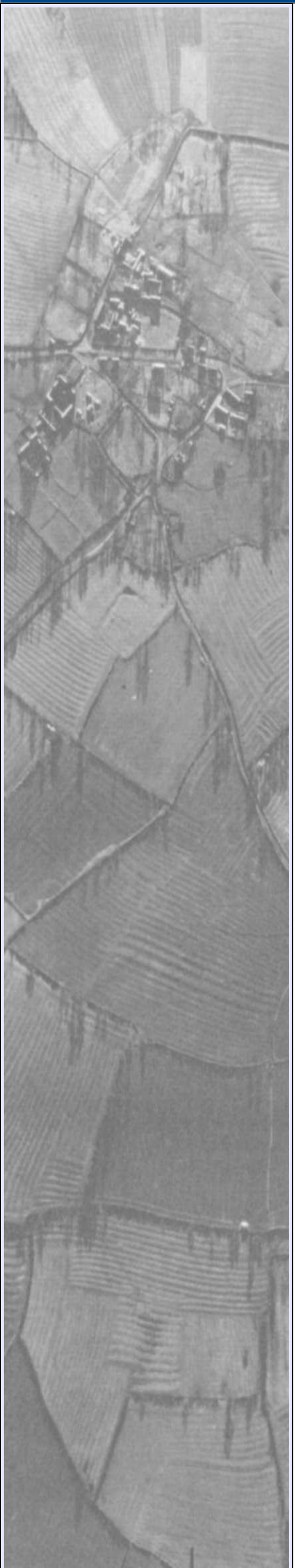
Archaeological Surveys
Specialist Geophysical Surveyors



Land at Provost's Mews
Edgmond
Shropshire

MAGNETOMETER & EARTH RESISTANCE SURVEY REPORT

for

The Ellerdine Partnership

Kerry Donaldson & David Sabin

July 2019

Ref. no. J797

ARCHAEOLOGICAL SURVEYS LTD

Land at Provost's Mews
Edgmond
Shropshire

Magnetometer & Earth Resistance Survey Report

for

The Ellerdine Partnership

Fieldwork by David Sabin BSc (Hons) MCIfA
Report by Kerry Donaldson BSc (Hons)
Report checked by David Sabin
Primary archive location - Archaeological Surveys Ltd, Yatesbury, Wiltshire

Survey date – 22nd July 2019
Ordnance Survey Grid Reference – **SJ 71916 19111**

Archaeological Surveys Ltd
1 West Nolands, Nolands Road, Yatesbury, Calne, Wiltshire, SN11 8YD
Tel: 01249 814231 Fax: 0871 661 8804
Email: info@archaeological-surveys.co.uk
Web: www.archaeological-surveys.co.uk

CONTENTS

LIST OF FIGURES

LIST OF PLATES

LIST OF TABLES

SUMMARY

A geophysical survey, comprising magnetometry and earth resistance survey, was carried out over 0.5ha on land to the rear of Provost's Mews in Edgmond, Shropshire. The magnetometry results indicate the presence of widespread magnetic debris, probably associated with burning and dumping, as well as a number of amorphous anomalies of uncertain origin. Formerly mapped field boundaries and evidence of possible 20th century agricultural activity were also located. The earth resistance anomalies correlate well with those abstracted from the magnetometry, with zones of high and low resistance often associated with zones of magnetic debris. Formerly mapped boundaries and/or paths are also present within the resistance data.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by The Ellerdine Partnership to undertake a magnetometer and earth resistance (resistivity) survey of an area of land to the rear of Provost's House 44 High Street, Provost's Mews 46 High Street, and The Old Stables High Street, Edgmond, Newport, Shropshire, TF10 8JY. The area is referred to as Land at Provost's Mews in this report. Full planning permission has been granted by Telford & Wrekin Council for the erection of 3 detached dwellings with associated garages and access, and the survey is being carried out under a condition of the planning permission (TWC/2018/0744).

1.1.2 The geophysical survey was carried out after consultation with Hugh Hannaford Senior Archaeological Advisor at Shropshire Council and in accordance with a Written Scheme of Investigation (WSI) produced by Archaeological Surveys (2019) and approved by Hugh Hannaford prior to carrying out the fieldwork.

1.1.3 The geophysical survey comprised detailed magnetometry and earth resistance survey over approximately 0.5ha. In order to minimise partial grids the survey was conducted with a straight northern baseline, rather than following the curving development boundary. The red-line development boundary is shown within the figures.

1.2 Survey objectives and techniques

1.2.1 The objective of the survey was to use magnetometry and earth resistance survey (resistivity) to locate geophysical anomalies that may be archaeological in origin so that they may be assessed prior to development of the site. The methodology is considered an efficient and effective approach to archaeological prospection.

1.2.2 Geophysical survey can provide useful information on the archaeological potential of a site; however, the outcome of any survey relies on a number of factors and as a consequence results can vary. The success in meeting the aims and objectives of a survey is, therefore, often impossible to predetermine.

1.3 Standards, guidance and recommendations for the use of this report

1.3.1 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).

1.3.2 Archaeological Surveys Ltd provide a detailed geophysical survey report and it is recommended that where possible the contents should be considered in full. The Summary provides a brief overview of the results with more detail available in the Discussion and/or Conclusion. The *List of anomalies* within the Results provides a detailed assessment of the anomalies within separate categories which can be useful in inferring a level of confidence to the interpretation. Quality and factors influencing the interpretation of anomalies is also set out within the results.

1.3.3 It is recommended that the full report should always be considered when using data and interpretation plots; where this is not possible, in the field for example, the abstraction and interpretation plots should retain their colour coding and be used with a corresponding legend.

1.3.4 Where targeting of anomalies by excavation is to be carried out, care should be taken to place trenches over solid lines or features visible on the abstraction and interpretation plots. Archaeological Surveys abstraction and interpretation avoids the use of dashed or dotted line formats, and broken or fragmented lines used in interpretive plots may well correspond closely with truncation of archaeological features.

1.4 Site location, description and survey conditions

1.4.1 The site is located on the southern edge of the village of Edgmond, 1.7km west of Newport in Shropshire (Telford and Wrekin). It is centred on Ordnance Survey National Grid Reference (OS NGR) SJ 71916 19111, see Figs 01 and

02.

1.4.2 The geophysical survey covers approximately 0.5ha within the southern half of a 1ha triangular land parcel that slopes down to the south. The area contained mown grass at the time of survey. The south eastern part of the site contains a number of young deciduous trees and suckers which prevented survey. This part of the site also contains uneven ground relating to soil and stone dumping associated with landscaping and other works carried out over several decades.

1.4.3 The ground conditions across the site were generally considered to be favourable for the collection of geophysical data with the exception of vegetated areas as noted above. Weather conditions during the survey were very warm and dry.

Plate 1: Survey area looking south west

1.5 Site history and archaeological potential

1.5.1 A Heritage Impact Assessment has been produced for the site development (Morriss, 2018). It outlines that Provost's House was formerly the rectory and is a Grade II* listed building with 14th century origins and later modifications. Early mapping shows that the site was once split into several smaller parcels of agricultural land. Roman pottery was discovered in Edgmond Hall School Garden in 1965, situated c90m south east of the site (HER no 00795). However, subsequent excavation of the platform on which they were located turned out to be a c15th century boathouse and the Roman material was interpreted as being redeposited.

1.5.2 Earthworks were noted in the south eastern part of the site; however, these are likely to be related to a former track and relatively modern dumping of soil and stone.

1.6 Geology and soils

1.6.1 The underlying geology is Triassic interbedded sandstone and conglomerate from the Chester Formation (BGS, 2017).

1.6.2 The overlying soil across the survey area is from the Bridgnorth association and is a typical brown sand. It consists of a well drained, sandy and coarse loamy soil over soft sandstone (Soil Survey of England and Wales, 1983).

1.6.3 Magnetometry survey carried out across similar soils has produced variable results due to a lack of magnetic contrast between the fill of cut features and the material into which they are cut. Earth resistance survey is considered effective on the well drained soils and underlying sandstone.

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 (also known as thermoremanence) are factors associated with the formation of localised fields.

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). Additional details are set out in 2.3 below and within Appendix A.

2.2 Technical synopsis - resistivity

2.2.1 The electrical resistance or resistivity of the soil depends upon moisture content and distribution. Buried features such as walls can affect the moisture distribution and are usually more moisture resistant than other features such as the infill of a ditch. A stone wall will generally give a high resistance response, and the moisture retentive content of a ditch can give a low resistance response although in certain conditions it may also produce a high resistance anomaly.

2.2.2 Localised variations in resistance are measured in ohms (Ω) which is the SI unit for electrical impedance or resistance. Additional details are set out in 2.2 below and within Appendix B.

2.3 Equipment configuration, data collection and survey detail - 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 (FGM650) spaced 0.5m apart with readings recorded at 20Hz. The cart is pushed at walking speed and not towed. Each sensor is not zeroed in the field as the vertical axis alignment is precisely fixed leaving sensor offsets that are removed during data processing. The fixing of the vertical alignment ensures the sensors are not unduly influenced by localised magnetic fields and that the vertical component of a magnetic anomaly is measured. The gradiometers have a range of recording data between ±0.1nT and ±8000nT. They are linked to a Leica GS10 RTK GNSS with data recorded by SENSYS MAGNETO®MXPDA software on a rugged PDA computer system.

2.3.2 Due to the fixed offsets within the fluxgate sensors, as a result of the manufacturing and tensioning process, the survey data do not provide a visually useful dataset until a zero median traverse algorithm is applied. It is recognised that this has the potential to affect some anomalies detrimentally by removing linear features orientated parallel to survey transects. However, this has not been noted as a particular problem with the system due to the high resolution data collection, generally long length of traverses and variability within the magnetic characteristics of a linear anomaly.

2.3.3 Data are collected along a series of parallel survey transects to achieve 100% coverage of the surveyable land. The length of each transect is variable and relates to the size of the survey area and other factors including ground conditions. A visual display allows accurate placing of transects and helps maintain the correct separation between adjacent traverses. 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).

2.3.4 Fluxgate sensors are highly sensitive to temperature change and this manifests as drift during the course of a survey. This can be particularly noticeable during the morning as temperatures rise and the equipment warms or cools. Sensor drift within the course of a traverse will appear as a line trending from negative to positive after processing with a zero median traverse algorithm. To remove the potential for temperature drift, data were collected after a 20 minute stabilisation period and traverses were limited to a time of generally <60s.

2.4 Equipment configuration, data collection and survey detail - resistivity

2.4.1 The earth resistance survey was carried out using a Geoscan Research Ltd RM85 resistance meter using a mobile twin probe array with a 0.5m electrode separation. Data were recorded at 1m intervals along traverses separated by 1m using a multiplexer where two traverses are recorded almost simultaneously using a wide mobile base containing four probes. The configuration requires two remote probes linked to the instrument by cable. The instrument was set to filter stray earth currents which can cause errors within the resistance measurements. The survey was carried out in a zig-zag fashion over grids 30m x 30m in size.

2.4.2 The survey grids were set out to the Ordnance Survey OSGB36 datum using a Leica GS10 RTK GNSS. The GNSS is used in conjunction with Leica's SmartNet service, where positional corrections are sent via a mobile telephone link. Positional accuracy of around 10 – 20mm is possible using the system.

2.5 Data processing and presentation

2.5.1 Magnetic data collected by the MAGNETO®MXPDA cart-based system are initially prepared using SENSYS MAGNETO®DLMGPS software. The software effectively allocates a geographic position for each data point and can compensate for fixed offsets present within the FGM650 sensors. The offsets are positive or negative values present on all fluxgate gradiometer sensors. Some systems use manual or electronic balancing to effectively zero the sensors; however, this is a short term measure that is prone to drift through temperature changes and vibration and can easily be incorrectly set due to localised magnetic fields. The FGM650 sensors are very accurately aligned to the vertical magnetic gradient and are highly stable showing negligible drift on long traverses. The offset values are removed using TerraSurveyor software.

2.5.2 Survey tracks are analysed and georeferenced raw data (UTM Z30N) are then exported in ASCII format for further analysis and display within TerraSurveyor. The removal of the offset values (compensation) of the sensors is also carried out in TerraSurveyor using a zero median traverse function. Data are then considered to be minimally processed. Note: without the zero median traverse function it is not possible to create a meaningful data plot as all sensors have a different offset value. Although a zero median traverse algorithm can remove anomalies aligned with the survey tracks, in practice this rarely occurs due to the use of long traverses, high resolution measurement and variability within the magnetic susceptibility of long linear features.

2.5.3 The minimally processed magnetic data are collected between limits of ±8000nT and clipped for display at ±5nT. Data are interpolated to a resolution of effectively 0.5m between tracks and 0.15m along each survey track.

2.5.4 Appendix D contains metadata concerning the magnetometer survey and data attributes and is derived directly from TerraSurveyor. Reference should be made to Appendix C for further information on processing.

2.5.5 For magnetometry data a TIF file is produced by TerraSurveyor software along with an associated world file (.TFW) that allows automatic georeferencing (OSGB36 datum) when using GIS or CAD software. The main form of data display used in the report is the minimally processed greyscale plot. With regard to the Sensys MXPDA, minimally processed data is considered by the manufacturer to be data that is compensated by SENSYS MAGNETO DLMGPS software, see 2.3.3 and 2.3.4. Note: traceplots are not considered to be appropriate as they do not provide an accurate or useful assessment of the magnetic anomalies due to very high density of data collection.

2.5.6 Data logged by the RM85 resistance meter are downloaded using Geoplot 4 and processed within TerraSurveyor software. Appendix D metadata sets out the data range and the processing sequence, with further details regarding the processing functions set out within Appendix C.

2.5.7 TIF files are prepared in TerraSurveyor for the earth resistance data. The main form of resistivity data display used in the report is the minimally processed greyscale raster graphic image.

2.5.8 The raster images are combined with base mapping using ProgeCAD Professional 2016 creating DWG (2010) file formats. All images are externally referenced to the CAD drawing in order to maintain good graphical quality. The CAD plots are effectively georeferenced facilitating relocation of features using GPS, resection method, etc.

2.5.9 An abstraction and interpretation is also drawn and plotted for all geophysical anomalies located by the survey. Anomalies are abstracted using colour coded points, lines and polygons. All plots are scaled to landscape A3 for paper printing.

2.5.10 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. Where further interpretation is possible, or where a number of possible origins should be considered, more subjective discussion is set out in Section 4.

2.5.11 A digital archive is produced with this report, see Appendix E below. The main archive is held at the offices of Archaeological Surveys Ltd.

3 RESULTS

3.1 Data interpretation

3.1.1 The list of sub-headings below attempts to define a number of separate categories that reflect the range and type of features located during the survey. A basic explanation of the characteristics of the geophysical anomalies is set out for each category in order to justify interpretation, see Table 1.

Interpretation category	Description and origin of anomalies
Anomalies with an uncertain origin	The category applies to a range of anomalies where there is not enough evidence to confidently suggest an origin. Anomalies in this category may well be related to archaeologically significant features, but equally relatively modern features, geological/pedological features and agricultural features should be considered. Morphology may be unclear or uncharacteristic and there may be a lack of additional supporting information.
Anomalies relating to land management	Anomalies are mainly linear and may be associated with the fill of cut features (i.e. ditches). The anomalies may be long and/or form rectilinear elements and they may relate to topographic features or be visible on early mapping. Associated agricultural anomalies (e.g. headlands, plough marks and former ridge and furrow) may support the interpretation. Land drains can appear in a classic herringbone pattern or as parallel linear anomalies.
Anomalies with an agricultural origin	The anomalies are often linear and form a series of parallel responses or are parallel to extant land boundaries. Where the response is broad, former ridge and furrow is likely; narrow response is often related to modern ploughing. This category does not include agricultural features of early date or considered to be of archaeological potential (e.g. animal stockades, enclosures, farmsteads, etc).
Anomalies associated with magnetic debris	Magnetic debris often appears as areas containing many small dipolar anomalies that may range from weak to very strong in magnitude. They often occur where there has been dumping or ground make-up and are related to magnetically thermoremnant materials such as brick or tile or other small fragments of ferrous material. This type of response is occasionally associated with kilns, furnace structures, hearths and nail spreads from former wooden structures or rooves and may, therefore, be archaeologically significant. It is also possible that the response may be caused by natural material such as certain gravels and fragments of igneous or metamorphic rock. Strong discrete dipolar anomalies are responses to ferrous objects within the topsoil.

Table 1: List and description of interpretation categories

3.2 General assessment of survey results - magnetometry

3.2.1 The detailed magnetic survey was carried out over approximately 0.5ha.

3.2.2 Magnetic anomalies located can be generally classified as positive anomalies of an uncertain origin, anomalies associated with land management, linear anomalies of an agricultural origin, areas of magnetic debris and disturbance and strong discrete dipolar anomalies relating to ferrous objects. Anomalies located within the survey area have been numbered and are described in 3.4 below.

3.3 Magnetometry data quality and factors influencing the interpretation of anomalies

3.3.1 Data are considered representative of the magnetic anomalies present within the site. There are no significant defects within the datasets.

3.3.2 The magnetic data demonstrate the presence of widespread magnetic debris that in the eastern part of the site is dense enough to potentially obscure other weak anomalies if they are present. The material probably relates to dumping and burning and is considered unlikely to be archaeologically significant. Coal clinker was occasionally observed within the survey area where grass cover was thin.

3.4 List of anomalies – magnetometry

Area centred on OS NGR 371916 319111 see Figs 03, 04 & 08.

Anomalies with an uncertain origin

(1 & 2) - A number of amorphous positive anomalies have been located, primarily within the northern part of the survey area, with several just to the north of the development boundary. The response indicates magnetically enhanced material, but it is not clear what has caused the response. Anomaly (1) corresponds to a zone of low resistance (10), which could relate to a natural feature and anomalies (2) are generally within zones of magnetic debris and could be associated with burning.

(3) - A small number of weakly positive, narrow linear anomalies have been located towards the south western corner of the site. It is not clear if they relate to cut features, or if they have an association with former agricultural activity.

Anomalies associated with land management

(4) - Two positive linear anomalies relate to former field boundaries removed between 1926 and 1951.

Anomalies with an agricultural origin

(5) - A series of parallel linear anomalies can be seen in the south western part of the survey area. They extend across the southern former field boundary (4) and end at the northern one. This suggests that the anomalies date to the first half of the 20th century.

Anomalies associated with magnetic debris

(6) - The survey area contains widespread zones of magnetic debris. This is a response to dumped magnetically thermoremnant material and/or in-situ burning probably of a relatively modern date.

(7) - Strong, discrete, dipolar anomalies relate to ferrous and other magnetically thermoremnant objects, such as brick and tile, within the topsoil.

3.5 General assessment of survey results - resistivity

3.5.1 The earth resistance survey was carried out over approximately 0.5ha.

3.5.2 Resistance anomalies located can be generally classified as high and low resistance anomalies of uncertain origin and anomalies associated with land management. Anomalies located within each survey area have been numbered and will be outlined in 3.7 below.

3.6 Resistivity data quality and factors influencing the interpretation of anomalies

3.6.1 Data are considered representative of the earth resistance anomalies present within the site. There are no significant defects within the datasets.

3.6.2 The dry soil and underlying sandstone have produced a high baseline level of resistance across the site, although no problems with high contact resistance were encountered and very few high resistance spikes relating to poor contact are present in the dataset.

3.6.3 Anomalies generally demonstrate useful contrast and several may relate to relatively modern dumping and moisture uptake by vegetation.

3.7 List of anomalies – resistivity

Area centred on OS NGR 371916 319111, see Figs 05 - 08.

Anomalies of uncertain origin

(8) - A high resistance linear or curvilinear anomaly can be seen in the south eastern part of the site. It lies within a very restricted part of the survey area adjacent to trees, and it is not clear what has caused the anomaly.

(9) - The survey area contains a number of zones of high resistance. Some correspond to zones of magnetic debris and it is likely that they relate to dumped material.

(10) - A linear zone of low resistance appears to be flanked by higher resistance,

but lies just north of the development area. The low resistance corresponds to a positive anomaly (1), but it is not clear if it relates to a natural feature, such as within the underlying geology, or if it is of anthropogenic origin.

(11) - A zone of low resistance lies between former field boundaries (12) and also partially corresponds to a zone of magnetic debris.

Anomalies associated with land management

(12) - High resistance linear anomalies in the south western part of the survey area relate to former land boundaries and correspond to anomalies (4) abstracted from the magnetometry data.

(13) - Low resistance linear anomalies in the north eastern part of the survey area correspond to formerly mapped paths and/or boundaries.

4 CONCLUSION

4.1.1 The geophysical survey comprised magnetometry and resistivity within the site. The results of the magnetometry indicate widespread magnetic debris from modern dumping and burning as well as a number of formerly mapped field boundaries. Several amorphous positive responses have also been located, although several lie beyond the development boundary. These generally lack a coherent morphology for them to be interpreted as cut features. The resistivity results show a number of high and low resistance areas, several of which correspond to the zones of magnetic debris or amorphous positive responses. There is a good correlation between several of the anomalies seen within the magnetometry and resistivity results.

5 REFERENCES

Archaeological Surveys, 2019. *Land at Provost's Mews, Edgmond, Shropshire, Geophysical Survey Written Scheme of Investigation.* Unpublished typescript document.

British Geological Survey, 2017. *Geology of Britain viewer, [online]* available from http://mapapps.bgs.ac.uk/geologyofbritain3d/index.html [accessed 15/7/2019].

Chartered Institute for Archaeologists, 2014. *Standard and Guidance for archaeological geophysical survey*. IfA, University of Reading.

European Archaeological Council, 2015. *EAC Guidelines for the Use of Geophysics in Archaeology: Questions to Ask and Points to Consider.* Europae Archaeologia Consilium and Association Internationale sans But Lucratif, Belgium.

Historic England, 2018. Geophysical Survey Advice [online] available from https://historicengland.org.uk/advice/technical-advice/archaeological-science/geophysics/ [accessed July 2018].

Institute for Archaeologists, 2002. *The use of Geophysical Techniques in Archaeological Evaluations*. IfA Paper No. 6. IfA, University of Reading.

Morriss, R. K., 2018. *Land off High Street, Edgmond, Nr, Newport, Shropshire, A Heritage Impact Assessment on Proposed Development.* Richard K Morriss & Assocaites.

Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 3 Midland and Western England.*

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 magnetic field. The difference between the two sensors will relate to the strength of 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 – basic principles of earth resistance survey (resistivity)

Earth resistance survey, commonly known as resistivity, relies on the variability of conduction of current through soil and the subsurface matrix. The variability relates to the distribution of moisture within different materials so that non-porous features, such as foundations, produce a relatively high resistance response and more moisture retentive soil, such as found within the fill of a former ditch, produces a low resistance measurement. The technique is, therefore, influenced by climatic factors although the success of a survey can be difficult to predict based on these alone. Soil type, ground use, vegetative cover and the nature of buried features and subsoil are all factors that will influence the outcome of a survey.

The technique involves inputting a small electrical current into the ground and measuring subtle variations to the current at regular intervals across an area. The current input and measurement requires a series of probes to be inserted into the ground and the configuration of these can influence the resolution of resistive anomalies and the depth of response. Research has demonstrated that the twin electrode configuration is one of the most useful for archaeological prospection. It requires a mobile frame with two electrodes separated usually by 0.5m and a pair of remote probes linked to the logging instrument using a long cable.

Cart-based systems are also regularly used in archaeological prospection, and generally these require four spiked wheels to inject current into the ground and take measurements. The four wheels act as a square array which can be electronically switched to change the orientation of measurement and current input. Two or three readings are rapidly logged at each recording station and these are referred to as alpha, beta and gamma. The gamma is often not recorded as this represents the difference between the alpha and beta configurations and can be derived during data processing. The alpha and beta datasets often demonstrate subtle differences that relate to the orientation of subsurface features and both are analysed as part of the abstraction and interpretation process. Advantages of cart systems are speed and resolution and they do not require a trailing cable; however, ground conditions are more critical and problems can be encountered with ground cover and in areas that are excessively damp or dry.

When using the twin probe configuration a useful reading interval for archaeological prospection across an area is 1m. Data are logged at 1m centres along traverses separated by 1m. Where areas contain known archaeological features 0.5m x 0.5m or 1m x 0.5 readings are considered more informative. Data collected by cart-based systems are typically at 0.25m centres along traverses separated by 1m.

Appendix C – data processing notes

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. Different ranges are applied to data in order to determine the most suitable for anomaly abstraction and display.

Despike

Removal of data points that exceed the mean/median/threshold by selecting a window size of data points and replace by mean/median/threshold. Magnetic spikes can be caused iron objects on the surface or within the topsoil. Spikes in resistivity data are often related to poor electrical contact often associated with ground conditions. Despike can improve the appearance of data and remove extreme readings that may affect further processing.

Edge Match

Calculates the mean of the 2 lines (rows or columns) of data either side of the edge to match. It then subtracts the difference between the means from all datapoints in the selected area. The process is used to suppress or remove discontinuities between survey grids that are often a consequence of changes in soil moisture content during the course of a survey.

High Pass Filter

Removes low frequency anomalies within the data that are not considered to be archaeologically significant and may be natural in origin. A window passes over the data, the mean of all the data within the window is subtracted from the centre value. The size of the window is adjusted as is the weighting which may be uniform or Gaussian. The process is used to improve the visibility of anomalies of interest.

Low Pass Filter

Removes high frequency anomalies or 'noise' within datasets and provides a smoother output. A window passes over the data, the mean of all the data within the window is used to replace the centre value. The size of the window is adjusted as is the weighting. The process is used to improve the visibility of anomalies of interest.

Zero Median/Mean Traverse

The median (or mean) of data from 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 offset values of the gradiometer sensors. The process can remove archaeological features that run along a traverse but with the high resolution datasets created by the Sensys FGM650 sensors and the method of data collection this has not been a notable problem. In fact, the removal of offsets using software avoids carrying out a balancing procedure on site, which inevitably can never be done in magnetically clean conditions and results in improperly aligned fluxgate sensors and/or electronic adjustment values.

Appendix D – survey and data information

Magnetometer data

Filename: J797-mag.xcp
Description: Imported as Composite from: J797-mag.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 371839.85, 319154.34 m
Southeast corner: 371990.45, 319080.24 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702
Source GPS Points: 188500
Dimensions
Composite Size (readings): 1004 x 494
Survey Size (meters): 151 m x 74.1 m
Grid Size: 151 m x 74.1 m
X Interval: 0.15 m
Y Interval: 0.15 m
Stats
Max: 5.53
Min: -5.50
Std Dev: 2.30
Mean: 0.01
Median: 0.04
Composite Area: 1.1159 ha
Surveyed Area: 0.45886 ha
PROGRAM
Name: TerraSurveyor
Version: 3.0.23.0
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -5.00 to 5.00 nT

Resistivity data

Filename: J797-res.xcp
Description: Imported as Composite from GeoPlot : J797-res
Instrument Type: Resist. (RM85)
Units: ohm
Direction of 1st Traverse: 67.5 deg
Collection Method: Zig zag
Dummy Value: 2047.5
Dimensions
Composite Size (readings): 180 x 60
Survey Size (meters): 180 m x 60 m
Grid Size: 30 m x 30 m
X Interval: 1 m
Y Interval: 1 m
Stats
Max: 346.58
Min: 67.91
Std Dev: 60.71
Mean: 205.66
Median: 204.50
Composite Area: 1.08 ha
Surveyed Area: 0.4657 ha
Processes: 3
1 Base Layer
2 Clip at 2.00 SD
3 Despike Threshold: 3 Window size: 1x1

Appendix E – 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 ShropshireHistoric Environment Record with printed copies on request. The report will also be uploaded to the Online AccesS to the Index of archaeological investigationS (OASIS).

File type	Naming scheme	Description
Data	J797-mag.asc J797-mag.xcp J797-mag-proc.xcp J797-res-raw.xcp J797-res-proc.xcp	Raw data as ASCII CSV TerraSurveyor raw data TerraSurveyor minimally processed data TerraSurveyor raw data TerraSurveyor minimally processed data
Graphics	J797-mag-proc.tif J797-res-raw.tif J797-res-proc.tif	Image in TIF format
Drawing	J797-version 2.dwg	CAD file in 2010 dwg format
Report	J797 report.odt	Report text in Open Office odt format

Appendix F – CAD layers for abstraction and interpretation plots

The table below sets out Archaeological Surveys Ltd CAD layer names with associated colours and graphical content. Where CAD files are available layers may be extracted for further CAD/GIS use. Note: hatched polygon boundaries are contained within layers with the RGB colour code 254, 255, 255 (near white) in order to prevent their visibility.

Report sub-heading and associated CAD layer names	Colour with RGB index		Layer content
Anomalies with an uncertain origin			
AS-ABST MAG POS LINEAR UNCERTAIN		255,127,0	Line, polyline or polygon (solid)
AS-ABST MAG POS UNCERTAIN		255,127,0	Polygon (cross hatched ANSI37)
AS-ABST MAG NEG UNCERTAIN		Blue 0,0,255	Polygon (cross hatched ANSI37)
AS-ABST RES HIGH LINEAR UNCERTAIN		153,133,76	Line, polyline or polygon (solid)
AS-ABST RES HIGH AREA UNCERTAIN		153,133,76	Polygon (net)
AS-ABST RES LOW LINEAR UNCERTAIN		127, 223, 255	Line, polyline or polygon (solid)
Anomalies relating to land management			
AS-ABST MAG BOUNDARY		127,0,0	Line, polyline or polygon (solid or cross hatched ANSI37)
AS-ABST MAG PATH/ROAD/TRACK		0, 153,153	Line, polyline or polygon (solid or partly cross hatched ANSI38)
Anomalies with an agricultural origin			
AS-ABST MAG AGRICULTURAL		Green 0,255,0	Line or polyline
Anomalies associated with magnetic debris			
AS-ABST MAG DEBRIS		132, 132, 132	Polygon (cross hatched ANSI37)
AS-ABST MAG STRONG DIPOLAR		132, 132, 132	Solid donut, point or polygon (solid)

Appendix G – copyright and intellectual property

Archaeological Surveys
Specialist Geophysical Surveyors

Geophysical Survey
Land at Provost's Mews
Edgmond
Shropshire

Map of survey area

N

Survey location

● Survey location

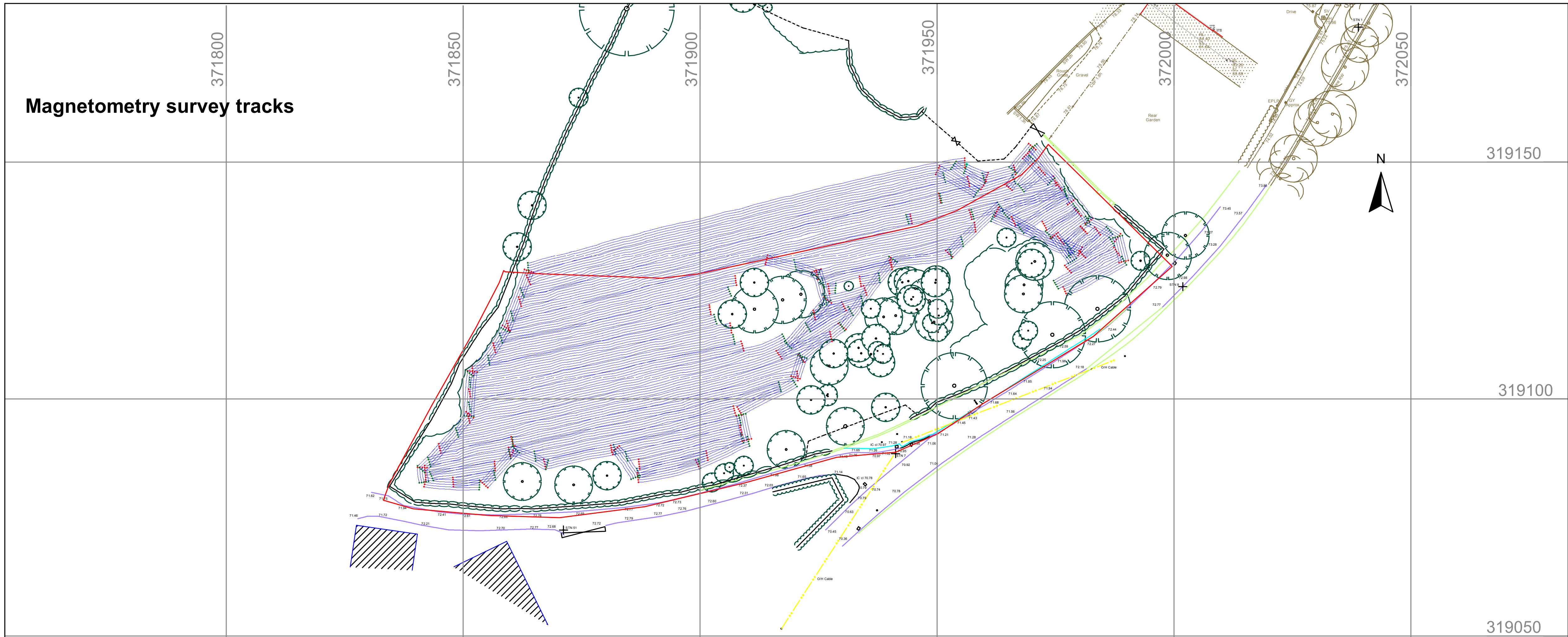
Site centred on OS NGR
SJ 71916 19111

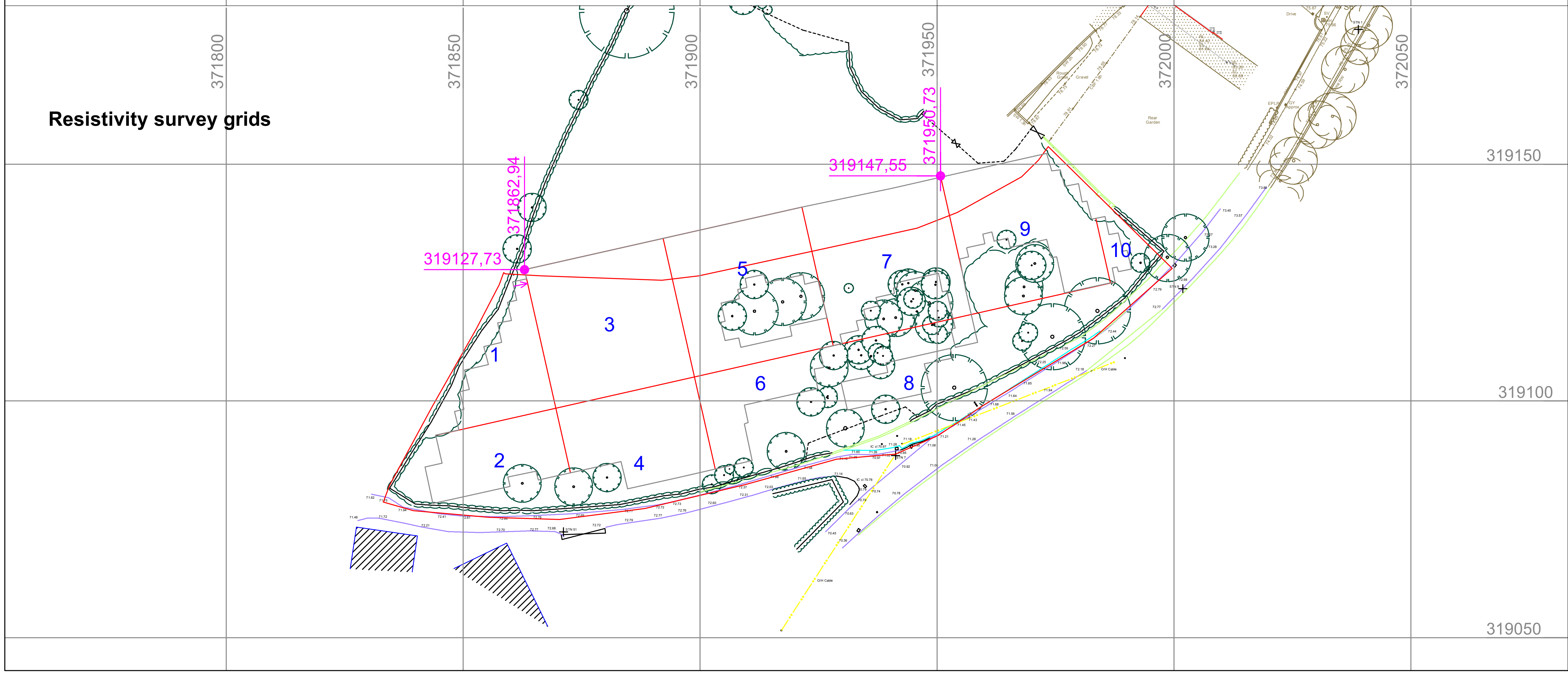
SCALE 1:25 000

0m 500m 1000m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 01





Archaeological Surveys
Specialist Geophysical Surveyors

Geophysical Survey
Land at Provost's Mews
Edgmond
Shropshire

Referencing information

Magnetometry referencing grid to OSGB36 datum at 50m intervals

Survey tracks

Survey track start

Survey track stop

Development boundary

Resistivity grid coordinates based on Ordnance Survey OSGB36 datum

Grids set out using RTK GNSS with Leica SmartNet correction data RTCMv2 format OSTN02 transformation

Survey grid size = 30m

Survey start and traverse direction

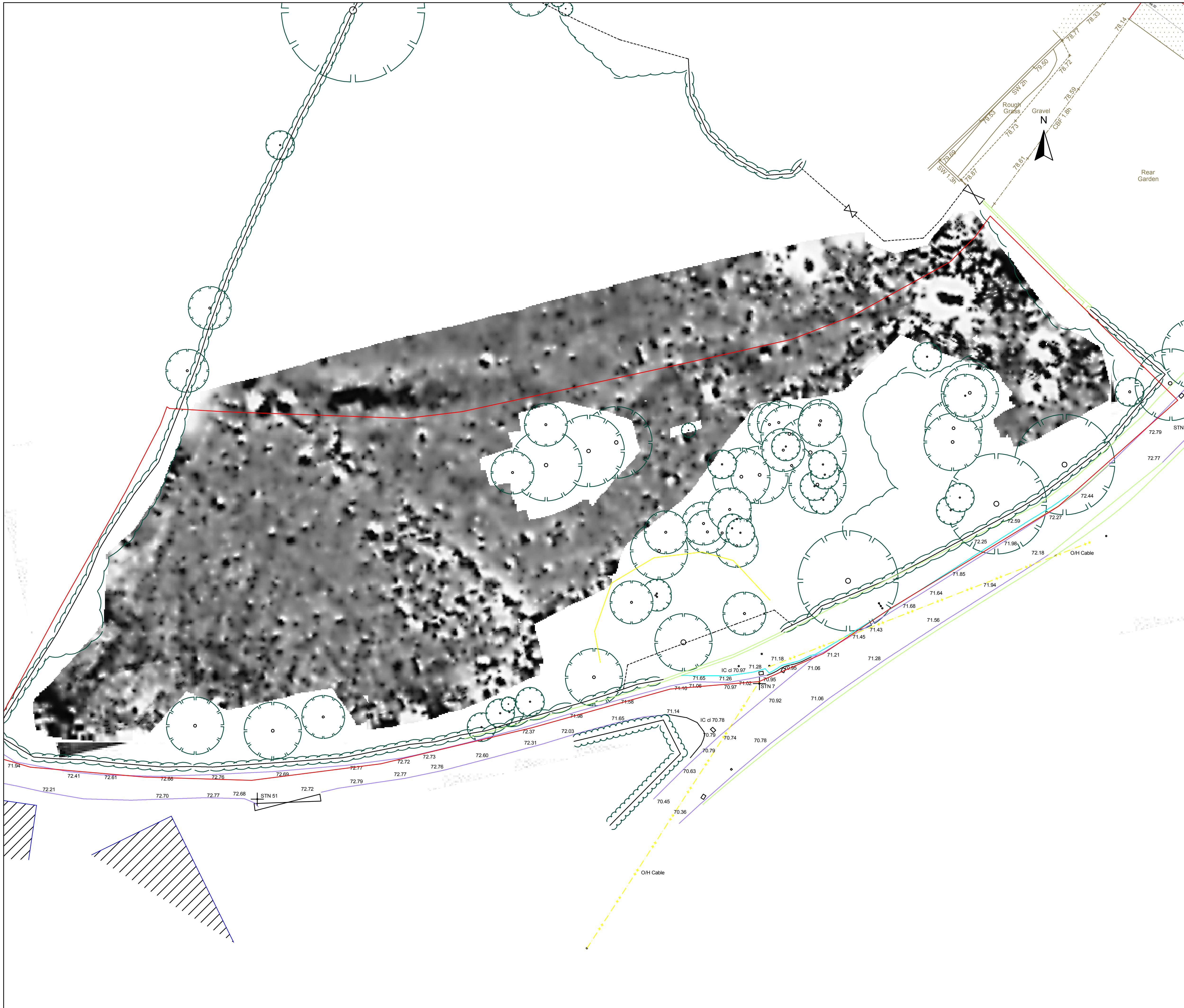
1 Grid reference number and filename

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

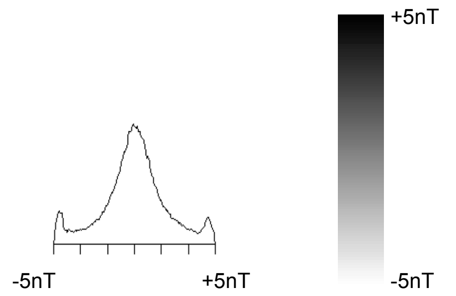
DRAWN BY	CHECKED BY	
KTD	DJS	FIG 02



Archaeological Surveys
Specialist Geophysical Surveyors

Geophysical Survey
Land at Provost's Mews
Edgmond
Shropshire

Greyscale plot of minimally processed magnetometer data

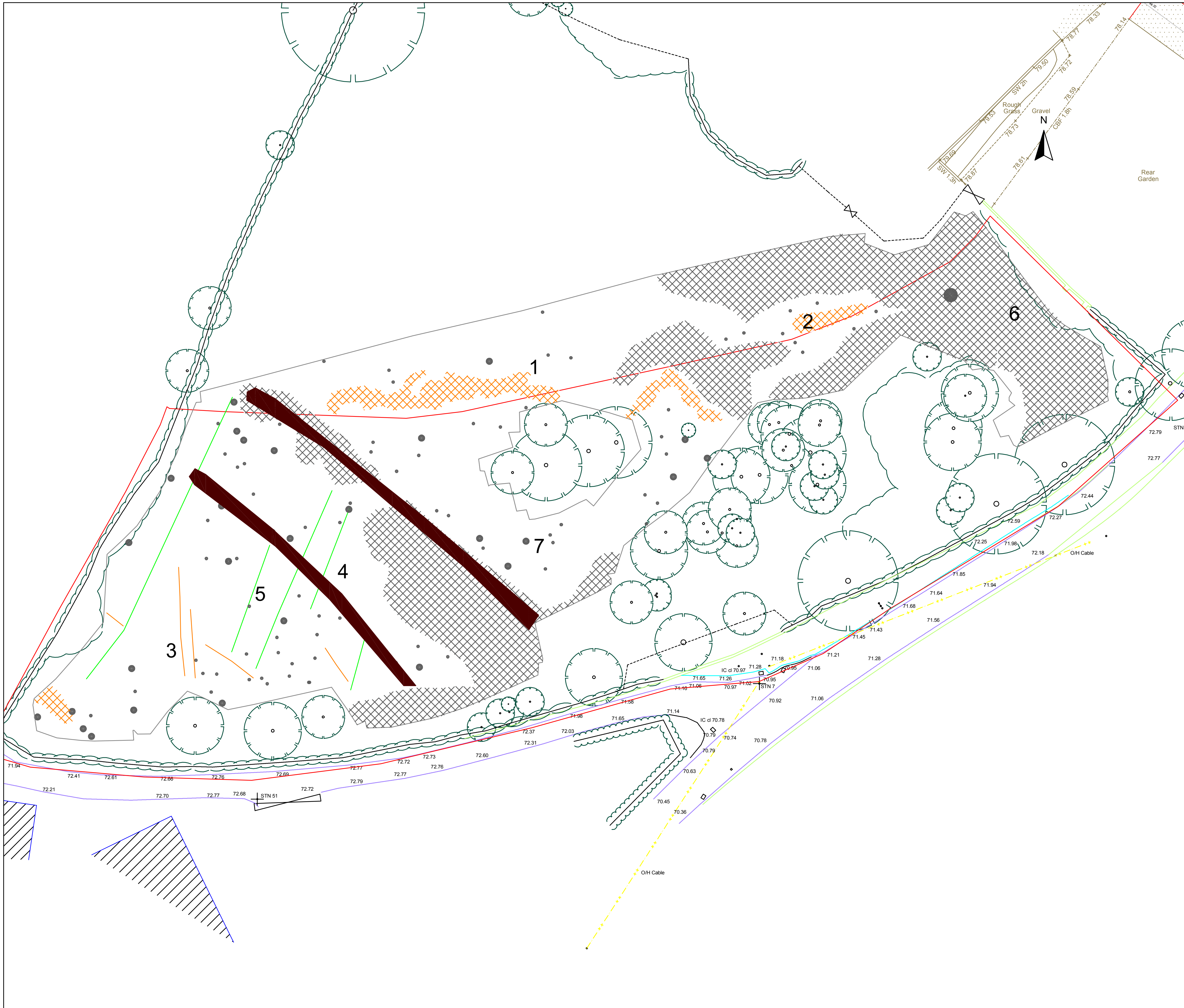


SCALE 1:500

0m 5 10 15 20 25m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 03



Archaeological Surveys
Specialist Geophysical Surveyors

Geophysical Survey
Land at Provost's Mews
Edgmond
Shropshire

Abstraction and interpretation of magnetic anomalies

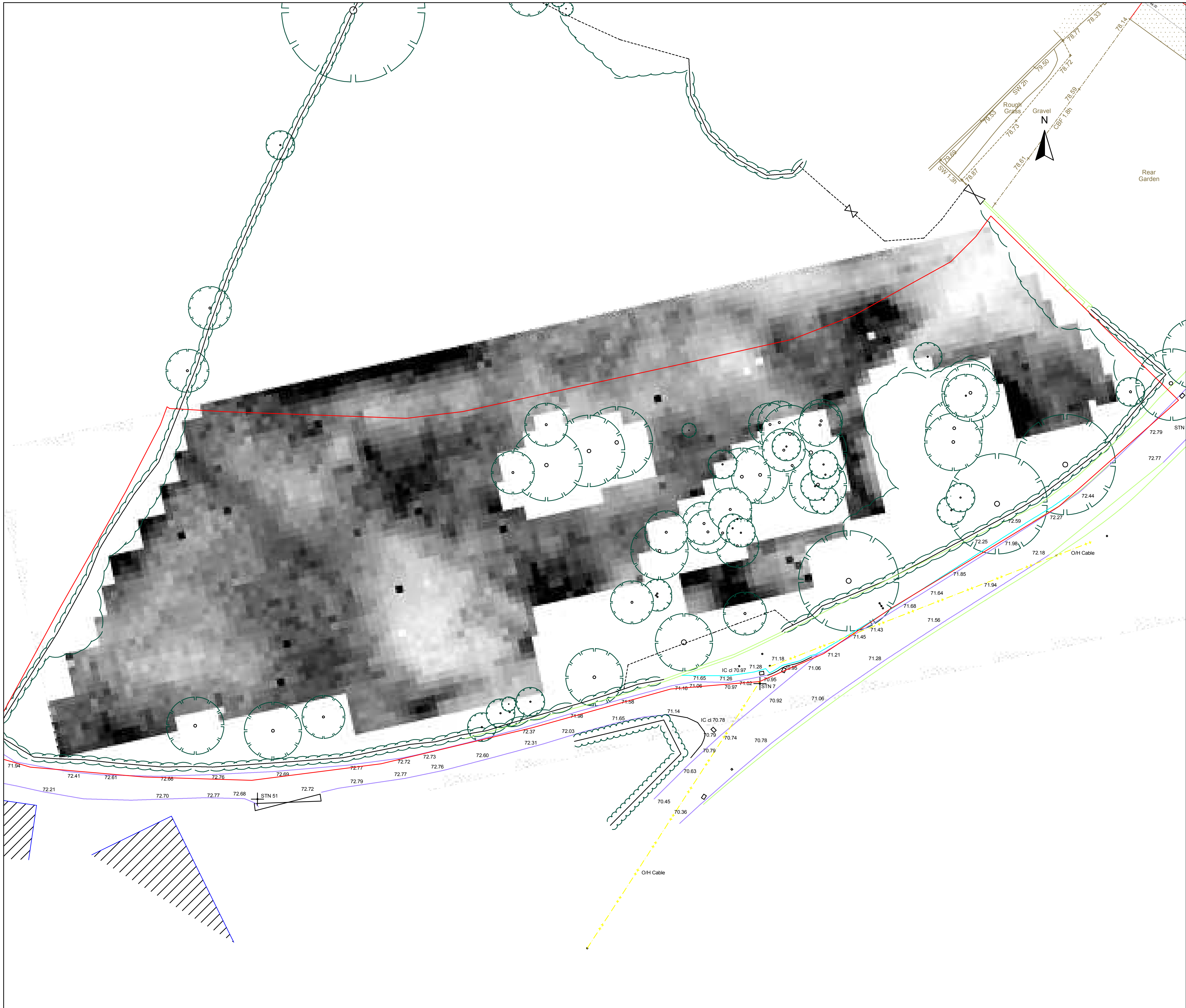
- Positive linear anomaly - of uncertain origin
- Positive linear anomaly - former field boundary
- Linear anomaly - of agricultural origin
- Positive anomaly - magnetically enhanced material
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Strong dipolar anomaly - ferrous object

SCALE 1:500

0m 5 10 15 20 25m

SCALE TRUE AT A3

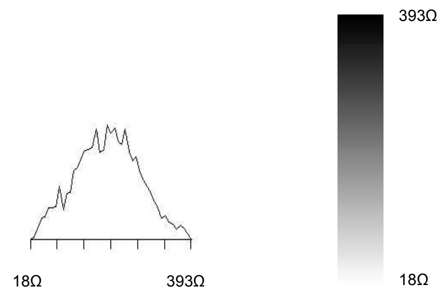
DRAWN BY	CHECKED BY	
KTD	DJS	FIG 04



Archaeological Surveys
Specialist Geophysical Surveyors

Geophysical Survey
Land at Provost's Mews
Edgmond
Shropshire

Greyscale plot of raw earth resistance data



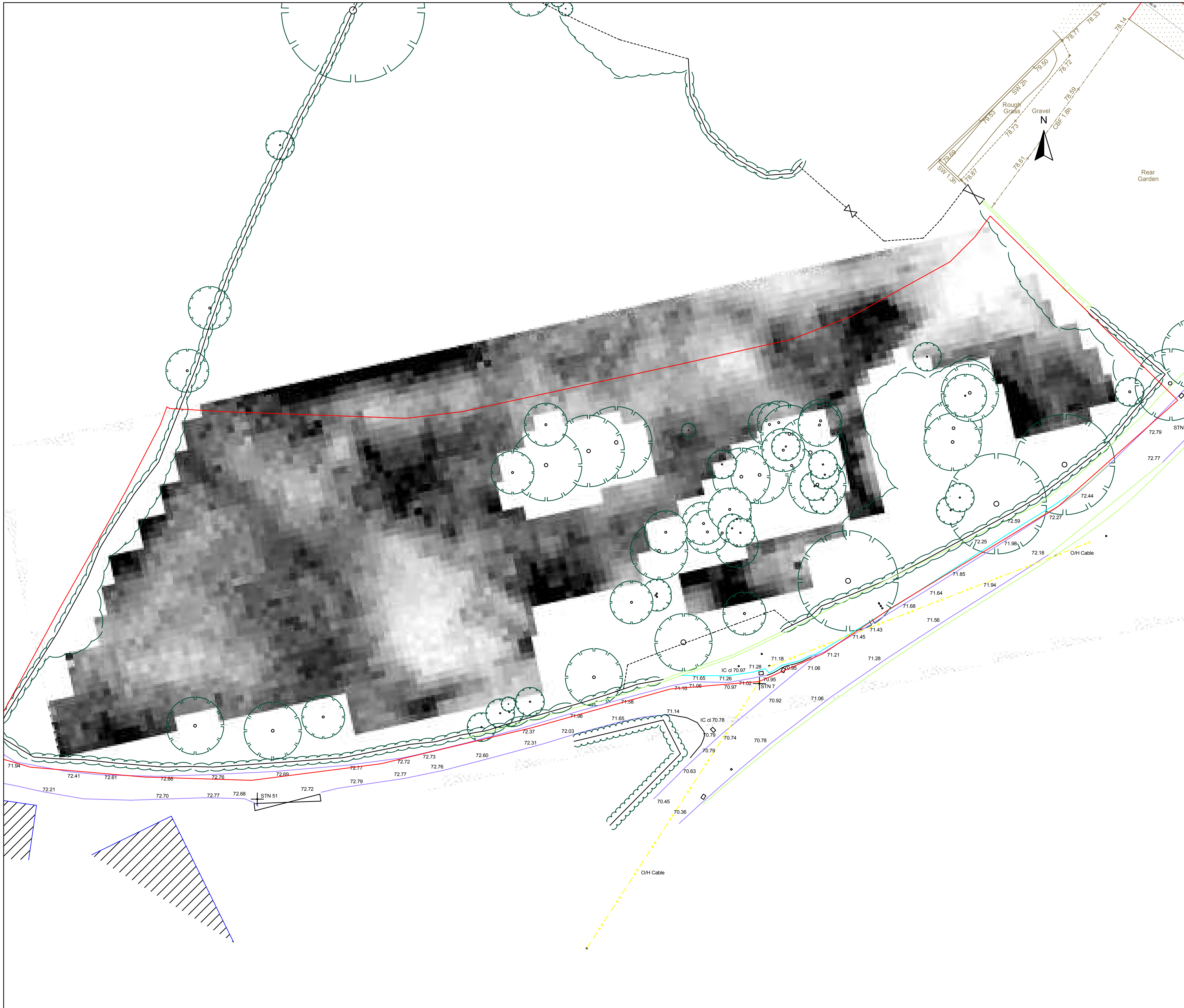
SCALE 1:500

0m 5 10 15 20 25m

SCALE TRUE AT A3

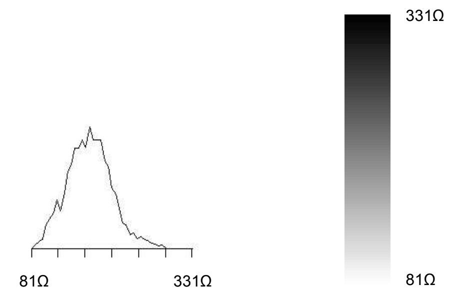
DRAWN BY	CHECKED BY	
KTD	DJS	FIG 05

Archaeological Surveys
Specialist Geophysical Surveyors



Geophysical Survey
Land at Provost's Mews
Edgmond
Shropshire

Greyscale plot of processed earth resistance data

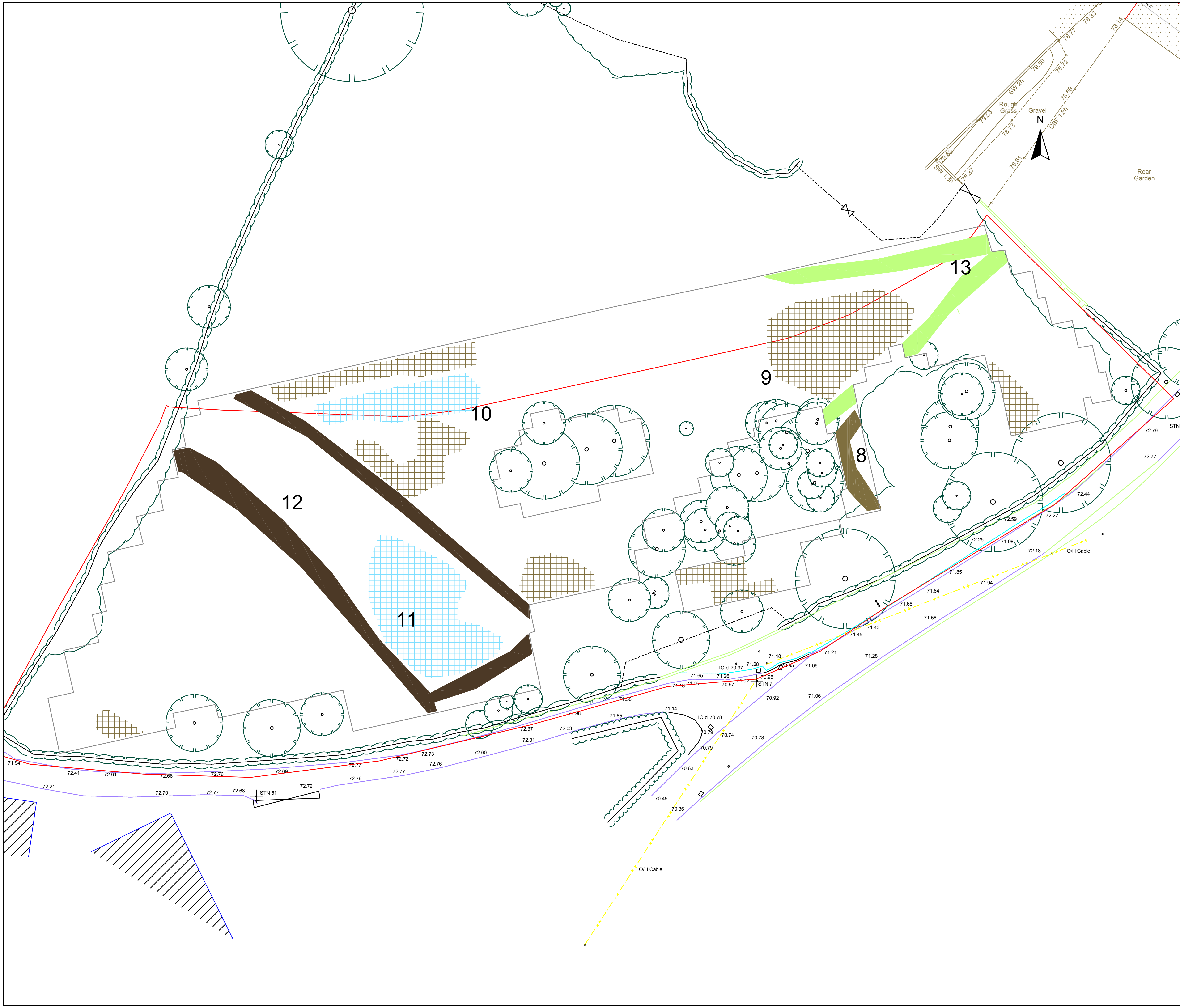


SCALE 1:500

0m 5 10 15 20 25m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 06



Archaeological Surveys
Specialist Geophysical Surveyors

Geophysical Survey
Land at Provost's Mews
Edgmond
Shropshire

Abstraction and interpretation of earth resistance anomalies

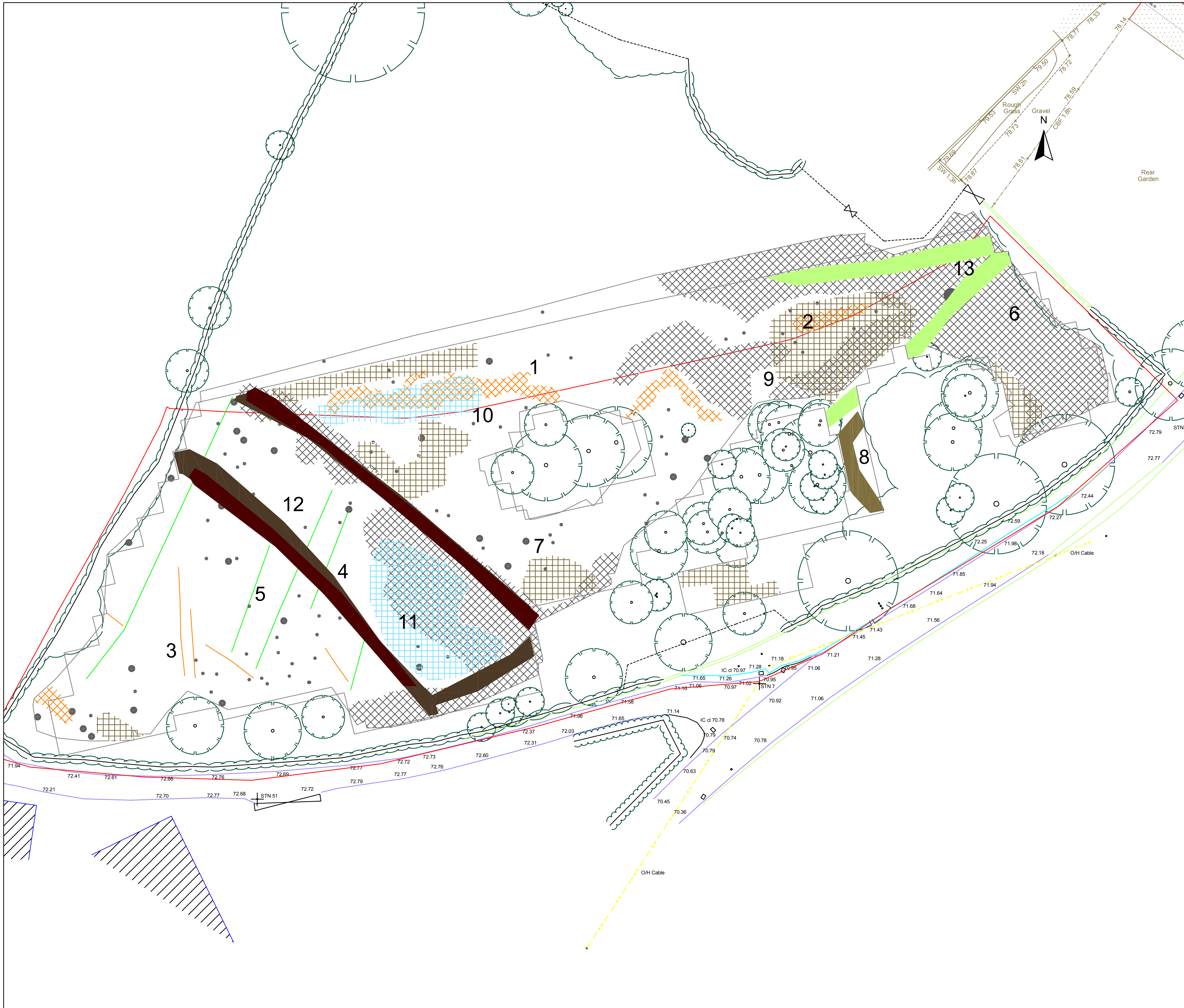
- High resistance linear anomaly - of uncertain origin
- High resistance linear anomaly - former field boundary
- Low resistance linear anomaly - former path/boundary
- Area of high resistance - of uncertain origin
- Area of low resistance - of uncertain origin

SCALE 1:500

0m 5 10 15 20 25m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 07



Archaeological Surveys
Specialist Geophysical Surveyors

Geophysical Survey
Land at Provost's Mews
Edgmond
Shropshire

Abstraction and interpretation of magnetic & resistance anomalies

- Positive linear anomaly - of uncertain origin
- Positive linear anomaly - former field boundary
- Linear anomaly - of agricultural origin
- Positive anomaly - magnetically enhanced material
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Strong dipolar anomaly - ferrous object
- High resistance linear anomaly - of uncertain origin
- High resistance linear anomaly - former field boundary
- Low resistance linear anomaly - former path/boundary
- Area of high resistance - of uncertain origin
- Area of low resistance - of uncertain origin

SCALE 1:500

0m 5 10 15 20 25m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 08