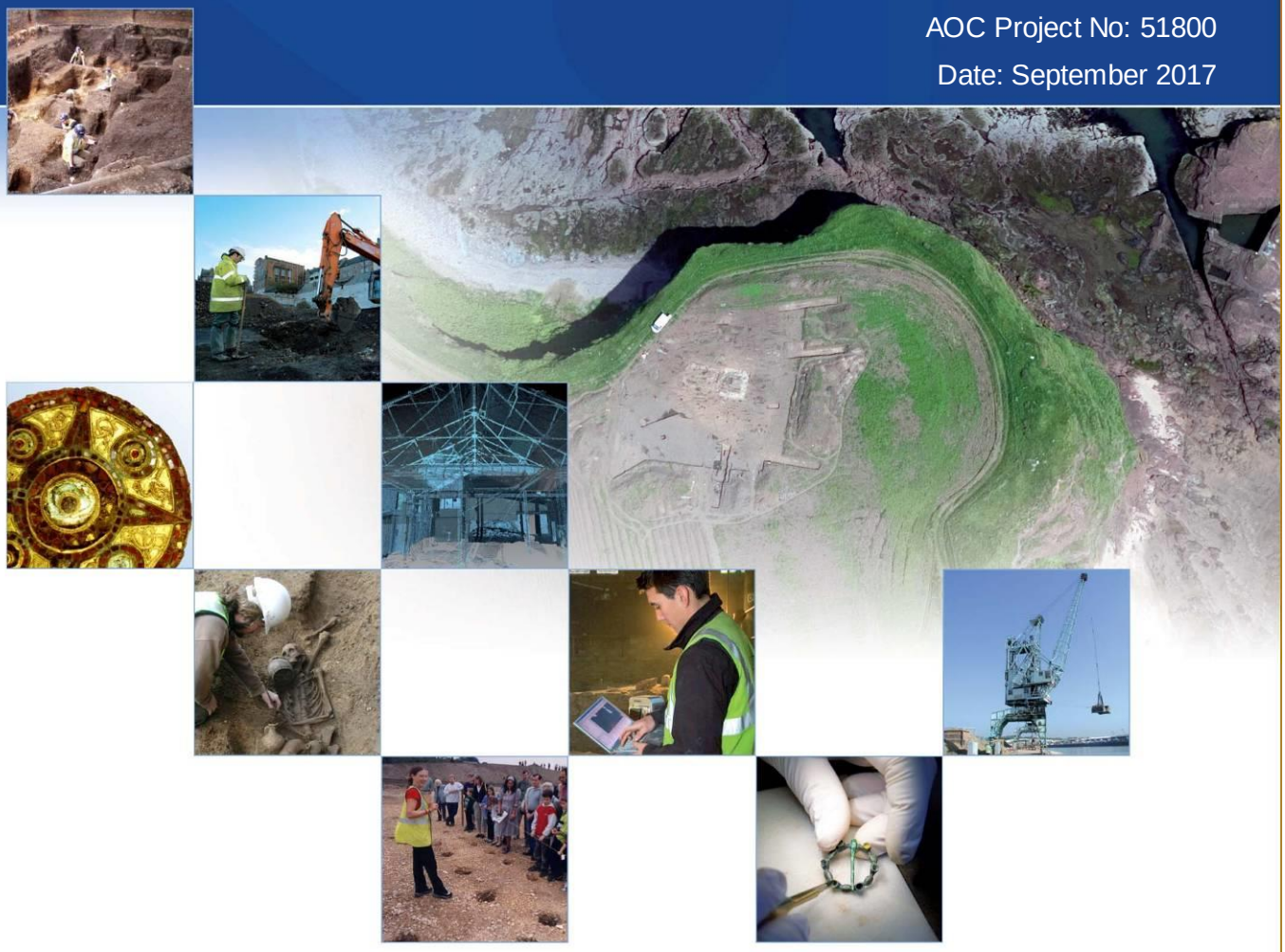
A9 Dualling Programme
Kindallachan Cairn and Kindallachan Standing Stone
Pass of Birnam to Glen Garry – Stage 3
Scotland

Archaeological Geophysical Survey

National Grid Reference: NN 9948 4973 & NN 9938 4994

AOC Project No: 51800

Date: September 2017



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A9 Dualling Programme

Kindallachan Cairn and Kindallachan Standing Stone

Pass of Birnam to Glen Garry – Stage 3

Scotland

Archaeological Geophysical Survey

On Behalf of:	**Jacobs UK Limited** **95 Bothwell Street** **Glasgow** **Scotland** **G2 7HX**
National Grid Reference (NGR):	**NN 9948 4973 & NN 9938 4994**
AOC Project No:	**51800**
Prepared by:	**Kimberley Teale**
Illustrations by:	**Kimberley Teale**
Date of survey:	**27th – 28th September 2017**

This document has been prepared in accordance with AOC standard operating procedures.

Author: Kimberley Teale	**Date: 11th October 2017**
Approved by: James Lawton	**Date: 18th October 2017**
Report Stage: Final Draft	**Date: 24th October 2017**

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Non-Technical Summary

AOC Archaeology Group was commissioned by Jacobs UK Limited (hereafter Jacobs), on behalf of Transport Scotland with Historic Environment Scotland as the Curator, to undertake an archaeological geophysical survey (Magnetometer and Earth Resistance) to investigate the potential for buried archaeological remains along the proposed A9 Dualling Southern Section, Scotland.

Two parcels of land were outlined for geophysical survey, covering an area of approximately 0.43ha. A magnetometer and earth resistivity survey were undertaken over land at Kindallachan cairn (centred at NN 9948 4973) and a magnetometer survey was undertaken on land at Kindallachan standing stone (centred at NN 9938 4994).

The results of the gradiometer survey located a linear anomaly, possibly of archaeological origin, in the location of the Kindallachan cairn. Further linear trends were identified across the data for both parcels that are more discrete and tentative and have an unclear origin.

Magnetic disturbance and ferrous anomalies were also identified.

The results of the earth resistance survey positively identified the western extents of the Kindallachan cairn, displaying a sub-circular area of high resistance. Further areas of low resistance were identified which could relate to archaeology but could also relate to vegetation or geological changes in the ground surrounding the cairn.

1 Introduction

1.1 AOC Archaeology Group was commissioned by Jacobs on behalf of Transport Scotland with Historic Environment Scotland as the Curator, to undertake an archaeological geophysical survey to investigate the potential for buried archaeological remains at specified parcels in Kindallachan, as part of the A9 Dualling Southern Section from the Pass of Birnam to Glen Garry.

1.2 The survey was carried out to provide information on the extent and significance of potential buried archaeological remains within the proposed development site.

2 Site Location and Description

2.1 Two parcels of land were outlined for geophysical survey; one at Kindallachan cairn (SM1554, HER MPK1568, centred at NN 9948 4973) and one at Kindallachan standing stone (SM9618, HER MPK1569, centred at NN 9938 4994) Scotland, (see Figure 1).

2.2 Parcel 1, located at Kindallachan standing stone, consisted of pasture located on relatively level land at approximately 60m-80m aOD (above Ordnance Datum). Parcel 2, located at Kindallachan cairn, consisted of rough overgrown vegetation located on relatively level land of a similar height. A tree on top of the cairn also inhibited the survey somewhat, resulting in gaps in both the earth resistance and gradiometer data.

2.3 Collectively the survey parcels covered an area of approximately 0.43 hectares (ha).

2.4 The bedrock recorded geology within the survey area consists of metamorphic bedrock of Dalradian age, belonging to the Southern Highland Group (BGS 2017). These are overlain by alluvium of clays, silts, sands and gravels, with glaciofluvial deposits of gravels, silts and sands. These are overlain by humus-iron podzols with mineral alluvial soils and peaty alluvial soils (Scotland's Soils, 2017).

3 Archaeological Background

3.1 The archaeological background below is drawn from the P3 Specification for Archaeological Geophysical Survey (Jacobs, 2017).

3.2 **Kindallachan, cairn (SM1554)**

No information is provided by HES in the Schedule Entry which is available on PASTMAP. However, a manuscript held by HES at the former Royal Commission on the Ancient and Historical Monuments of Scotland records the investigation of the remains of a cist on a prominent isolated mound prior to the re-alignment of the A9 trunk road in 1956. At this time only the side slabs remained and the excavators noted that the contents of the cist had been disturbed some considerable time previously. Excavations recovered a few scraps of burnt bone and a rounded quartz pebble. Following the investigation part of the eastern side of the mound was removed as a result of the re-alignment and it was noted that the section thus exposed 'could be seen to consist of sand and gravel of natural origin.' (HES, MS 453/2).

3.3 Subsequent works in advance of junction improvements in 2007 comprised a monitored topsoil strip and excavation of that part of the scheduled area impacted by the improvements. Excavations revealed a possible grave cut measuring 1.9m x 1.1m and 0.2m in depth. The cut contained two fills and although the basal fill was subject to soil phosphate analysis this proved to be inconclusive. Nevertheless the feature was tentatively identified as a grave cut based on its morphology (CFA, 2008).

3.4 Kindallachan, standing stone (SM9618)

Kindallachan standing stone is described in the Schedule Entry, which is available on PASTMAP, as a single standing stone of prehistoric date, known locally as the 'Druid's Stone'. The monument is considered to be of national importance because of its potential to contribute to our understanding of prehistoric ritual practices and this importance is increased due to its proximity to the potentially contemporary Kindallachan, cairn (SM1554).

4 Aims

4.1 The main aim of the geophysical survey was to inform and support the cultural heritage chapter of the Environmental Statement for Project 03 – Tay Crossing to Ballinluig. It will provide information that will be used in the assessment of the value of known heritage assets and the potential for unknown archaeological remains within the survey parcels, and the potential magnitude of the impact of the scheme on them (Jacobs, 2017).

4.2 Other aims of the archaeological geophysical survey were:

- to determine (so far as possible) the presence or absence of buried archaeological remains in the survey parcels;
- to clarify the extent and layout of known sites of archaeological interest within the survey parcels;
- to clarify the extent and layout of previously unknown buried remains within the survey parcels;
- to interpret any geophysical anomalies identified by the survey;
- to disseminate the results of the archaeological geophysical survey through the deposition of an ordered archive and detailed report at the National Record of the Historic Environment (NRHE).

5 Methodology

5.1 All geophysical survey work was carried out in accordance with recommended good practice specified in guideline documents published by English Heritage – now Historic England (David *et al.* 2008) and the Chartered Institute for Archaeologists *Standard and Guidance for archaeological geophysical survey* (2014).

5.2 Parameters were selected that were suitable for the prospective aims of the survey and in accordance with recommended professional good practice (David *et al.* 2008, 8).

5.3 A gradiometer survey was conducted at both sites and was carried out using Bartington Grad601-2 fluxgate gradiometers (see Appendices 2 and 3). Data was collected on an east-west alignment using zig-zag traverses, with a sample interval of 0.25m and a traverse interval of 1m. A total of 16 full or partial 30m by 30m grids were surveyed within both specified areas, totalling approximately 0.43ha.

5.4 Attention was taken to avoid metal obstacles present within the survey area during data collection using gradiometers. Gradiometer survey is affected by 'above-ground noise' such as metal objects, and avoiding these improves the overall data quality and results obtained.

5.5 An Earth Resistance survey was conducted at Kindallachan cairn (Parcel 2) only and was carried out using a Geoscan Research RM15 resistance meter, utilising a MPX15 multiplexor attachment (see

Appendices 2 and 3). Data was collected on an east-west alignment using zig-zag traverses, with a sample interval of 0.5m and a traverse interval of 0.5m. A total of 4 full or partial 30m by 15m grids were surveyed, totalling an area of approximately 0.28ha.

5.6 The gradiometer data were downloaded using Bartington Grad601 PC Software v313 and processed using Geoscan Geoplot v3.0 / v4.0. The details of these processes can be found in Appendices 4 and 5. Data processing, storage and documentation were carried out in accordance with the good practice specifications detailed in the guidelines issued by the Archaeology Data Service (Schmidt and Ernenwein, 2009).

5.7 The Earth Resistance data were downloaded and processed using Geoscan Geoplot v3.0 / v4.0, and the details of these processes can be found in Appendices 4 and 5.

5.8 Interpretations of the data were created as layers in AutoCAD LT 2009 / GIS and the technical terminology used to describe the identified features can be found in Appendix 6.

6 Results and Interpretation

6.1 The gradiometer survey results have been visualised as greyscale plots, with the minimally processed data plotted at -1nT to 2nT in Figure 3 and Figure 6. The processed data is plotted at -2nT to 5nT to help minimalize the effects of the local geology and can be seen in Figure 4 and Figure 7.

6.2 The earth resistance survey results have also been visualised as greyscale plots, with the minimally processed data plotted at -127.06 Ohms to 900.74 Ohms in Figure 6. The processed data is plotted at -103.42 Ohms to 207.52 Ohms and can be seen in Figure 8.

6.3 An interpretation of the data can be seen in Figures 5, 7 and 8 and an individual characterisation of the identified anomalies follows this in Appendix 1.

Gradiometer survey results

Kindallachan standing stone - Parcel 1

Archaeology

6.4 No responses indicating definitive archaeological remains have been located in the survey area.

Linear trends – Unclear origins

6.5 Several discrete linear trends have been identified in the dataset for Parcel 1 which have an unclear origin. These are described as anomalies of a linear / curvilinear form which are composed of a weak or different change in magnetic values. Coupled with poor patterning, the anomaly is difficult to interpret and it is unclear whether it has an archaeological origin, or if they relate to agricultural practises or geology.

6.6 In the north of the dataset a tentative positive linear trend runs east-west (**G1**).

6.7 A tentative positive linear trend runs north-south along the western boundary and may relate to an agricultural headland (**G2**).

6.8 A longer, very faint, intermittent linear trend runs north-west to south-east across the centre of the dataset and may relate to a former field boundary; however this has not been confirmed through any available historic mapping (**G3**).

6.9 A negative linear trend runs roughly north-south in the south west of the dataset (**G4**) through the centre of a small area of magnetic disturbance which also has unclear origins (**G5**). It is not clear if the two anomalies are related.

Discrete pits

6.10 Three anomalies with the appearance of pits have been identified in the dataset for Parcel 1. These are described as an anomaly composed of an increase in magnetic values with a patterning that is suggestive of buried remains, such as the infill of a pit, but is isolated in its location and association with other features.

6.11 In the south of the dataset two pit-like features are observed which have a magnetic signal typical of pits (**G6**); however, as they are isolated from other features their interpretation is tentative.

6.12 Similarly in the north east of the dataset, a larger pit like anomaly has been identified (**G7**) but it is unclear if the feature if archaeological or more natural in origin.

Non-Archaeology

6.13 Areas of magnetic disturbance are observed around the survey area boundaries of Parcel 1 which are most likely modern in origin (e.g. **G8**). They are likely to result from modern activity such as metallic fencing or road materials, or larger pieces of magnetic debris such as bits of plough. Areas of modern disturbance are characterised by significant increases or decreases in values compared with background readings.

6.14 Across the data set there is a large quantity of isolated dipolar anomalies (iron spikes). These are commonly caused by ferrous or high magnetically susceptible material on the surface or within the topsoil of the site, and it is likely that modern agricultural activity has changed the magnetic properties of the top soil and created a high level of background 'noise' within the data set.

Kindallachan cairn - Parcel 2

Archaeology

6.15 A negative linear trend is visible running north-west south-east in the south of the dataset (**G9**). This is located in the vicinity of the cairn and is likely to be archaeological in origin.

Linear trends / Magnetic disturbance – Unclear origins

6.16 Magnetic disturbance is visible in the dataset along the eastern boundary (**G10**). This mostly negative anomaly is situated to the north-east of the cairn and it is unclear if the two are related. It is also unclear if the anomaly has modern origins, due to its location next to a road. The anomaly is mirrored in the earth resistance results as a band of low resistance (**R2**).

6.17 Four tentative linear trends can be seen in the dataset (**G11**) though as the survey area is so small, it is difficult to tell whether these are part of larger trends of an archaeological origin or if they are related to the local geology. In the north the trends run north-east south-west and north-west south-east and in the south they are curvilinear.

Earth Resistance survey results

Kindallachan cairn – Parcel 2

6.18 A sub-circular area of high resistance can be seen in the centre of the dataset which relates to the location of the Kindallachan cairn (**R1**). The mixture of high to very high resistance readings relate to the material making up the mound, such as stones, gravels and compacted soils. The gap in the centre of the data is due to a large tree obstructing the ground.

6.19 To the north of the high resistance readings, a long swathe of low resistance readings can be seen running north-south along the eastern boundary (**R2**). It is unclear if this anomaly relates to the cairn, though there is a possibility. This low resistance anomaly corresponds with an area of magnetic

disturbance observed in the gradiometer data (**G9**) and it is possible this anomaly has likely been caused by modern activity.

6.20 A second area of low resistance can be seen in the south of the dataset (**R3**) which possibly continues from **R2** in the north.

6.21 A small area of low resistance is visible to the south of the cairn (**R4**) which could be related to vegetation or moisture being held in the ground.

6.22 A further area of low resistance can be seen to the west of the cairn (**R5**) which may be a result of moisture build up from surface run off/drainage from the road draining into this significantly lower area to the side of the road.

7 Conclusion

7.1 The gradiometer survey has identified an archaeological linear trend in Parcel 2 which relates to the Kindallachan cairn present in the survey area.

7.2 Discrete trends and areas of disturbance of an unknown origin can be seen across both datasets and though they could be archaeological in nature, given their proximity to known archaeological features, their interpretation is tentative.

7.3 Three possible pit-like features have been observed in Parcel 1 which could be of an archaeological origin.

7.4 Modern magnetic disturbance and ferrous anomalies can be seen across Parcel 1.

7.5 The earth resistance survey has identified the extents of the Kindallachan cairn mound in Parcel 2 with a sub-circular area of high resistance.

7.6 Areas of low resistance can also be seen which could be related to the cairn mound but could also relate to vegetation or water content in the ground due to the lower topography and run off/drainage from the road above.

8 Statement of Indemnity

8.1 Although the results and interpretation detailed in this report have been produced as accurately as possible, it should be noted that the conclusions offered are a subjective assessment of collected data sets.

8.2 The success of a geophysical survey in identifying archaeological remains can be heavily influenced by several factors, including geology, seasonality, field conditions and the properties of the features being detected. Therefore the geophysical interpretation may only reveal certain archaeological features and not produce a complete plan of all of the archaeological remains within a survey area.

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Plate 1. Parcel 1 looking north-west

Plate 2. Parcel 1 looking south showing Kindallachan Standing Stone

Plate 3. Parcel 2 looking west

Plate 4. Parcel 2 looking north-west with Kindallachan Cairn on the right

A9 DUALLING - KINDALLACHAN CAIRN & STANDING STONE
ARCHAEOLOGICAL GEOPHYSICAL SURVEY
(AOC PROJECT NO. 51800)

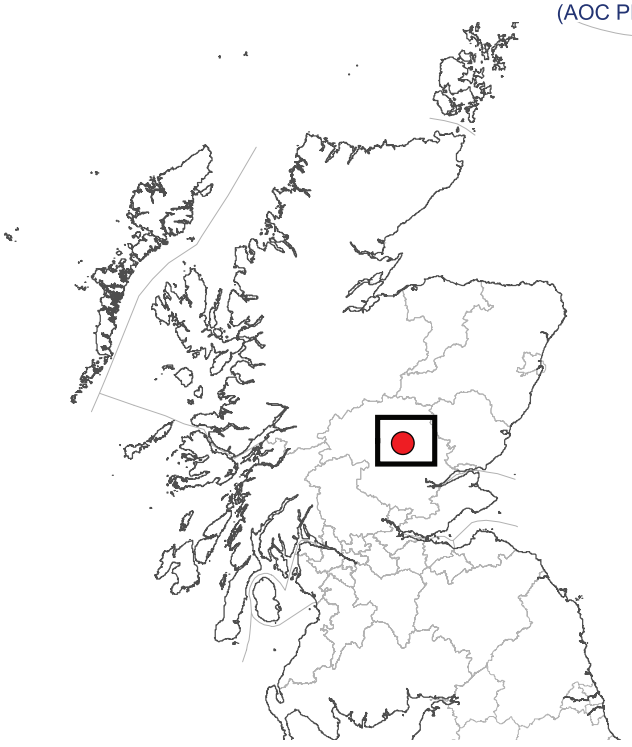

Figure
1

N

Site location

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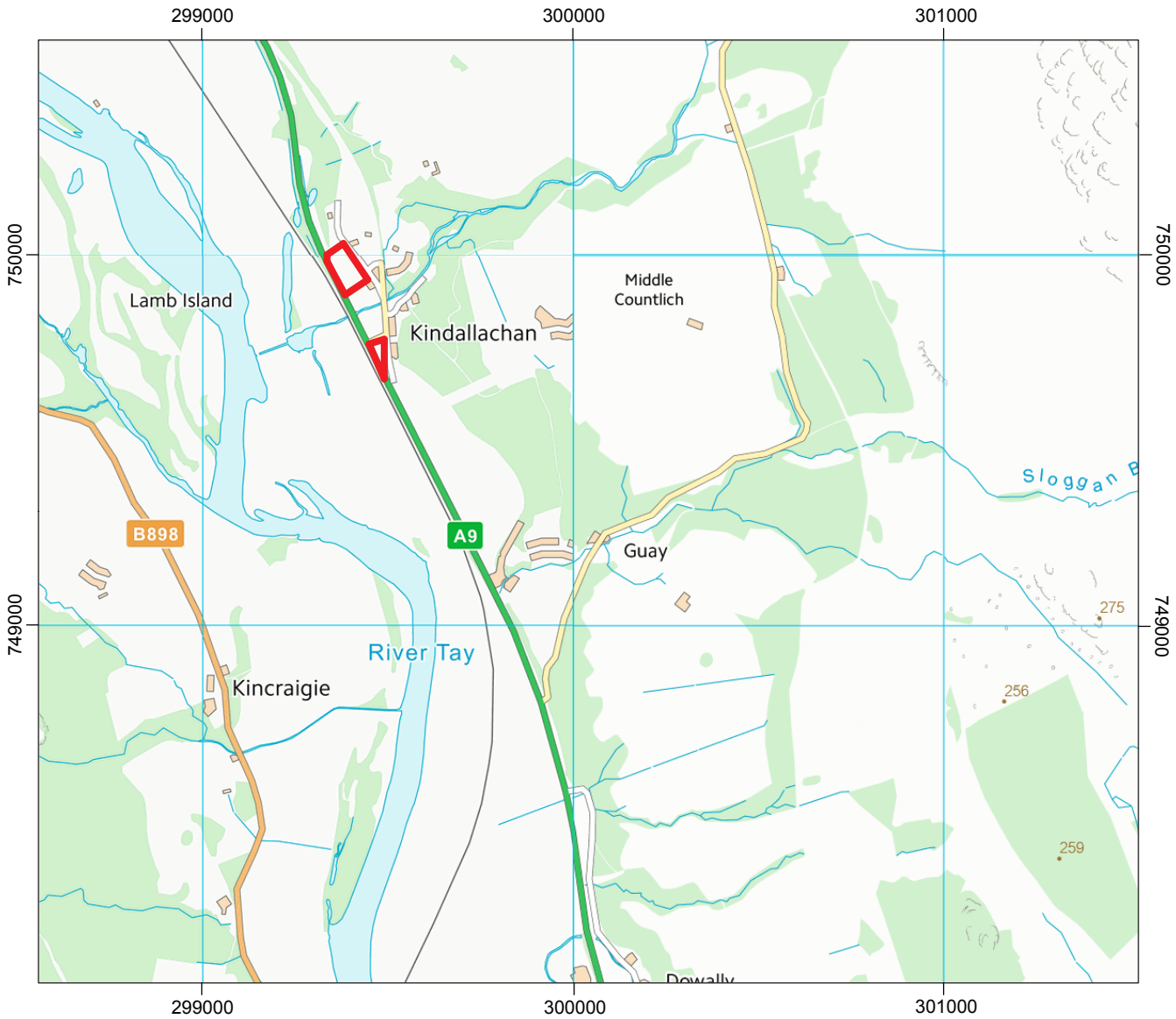

Location of survey areas

Figure 2

Areas Surveyed
Areas Not Surveyed
Heritage Asset

N
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1:2000 at A3

Project Title: A9 Dualling Programme: Pass of Birnam to Glen Garry Project No: 51800		
Drawing Title: Figure 2 Location of survey areas		
V1/51800/GEO/F2/16.10.17 		
Drawn by: KT	Checked by: JL	Approved by: JL
16/10/2017	16/10/2017	16/10/2017

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Minimally processed Gradiometer survey results - Greyscale plot - Parcel 1

Figure 3

Scale
2nT
-1nT

N

0 40m

1:1000 at A3

Project Title: A9 Dualling Programme: Pass of Birnam to Glen Garry Project No: 51800		
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V1/51800/GEO/F3/16.10.17 		
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16/10/2017	16/10/2017	16/10/2017

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Processed Gradiometer survey results - Greyscale plot - Parcel 1

Figure 4

Scale
5nT
-2nT

N

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V1/51800/GEO/F4/16.10.17 		
Drawn by: KT	Checked by: JL	Approved by: JL
16/10/2017	16/10/2017	16/10/2017

AOC Archaeology Group

Interpretation of Gradiometer survey results - Parcel 1

Figure 5

- Discrete Pit (Archaeology?)
- Trend (Unclear Origin)
- Area of Disturbance (Unclear Origin)
- Area of Disturbance (Modern)
- Ferrous / Iron Spikes

N

0 40m

1:1000 at A3

Project Title: A9 Dualling Programme: Pass of Birnam to Glen Garry Project No: 51800		
Drawing Title: Figure 5 - Interpretation of Gradiometer survey results - Area 1		
V1/51800/GEO/F5/16.10.17 		
Drawn by: KT	Checked by: JL	Approved by: JL
16/10/2017	16/10/2017	16/10/2017

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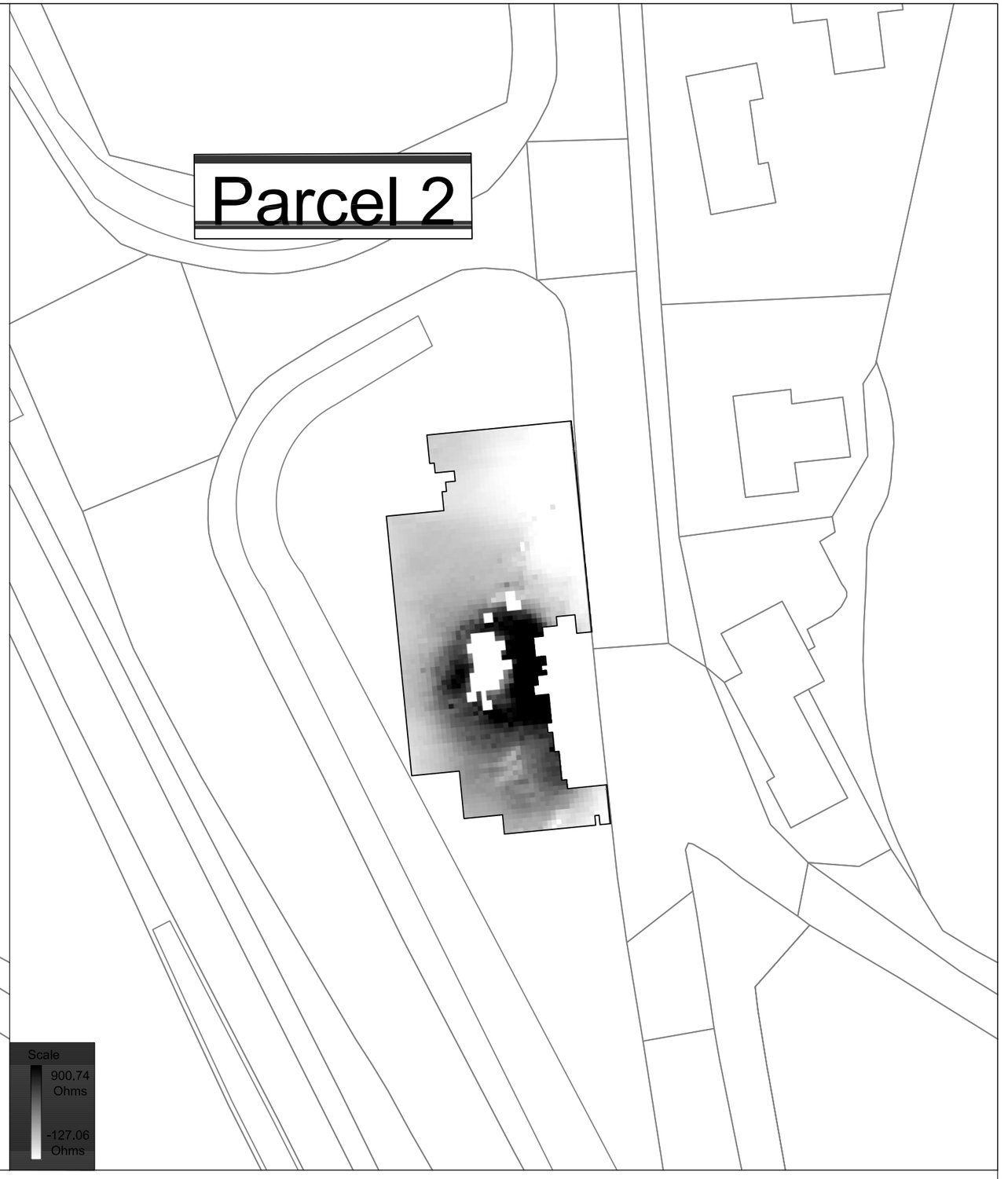
Minimally processed Gradiometer survey results - Greyscale plot - Parcel 2



Minimally processed Earth Resistance survey results - Greyscale plot - Parcel 2

Figure
6

N

0 20m

1:500 at A3

Project Title: A9 Dualling Programme: Pass of Birnam to Glen Garry Project No: 51800		
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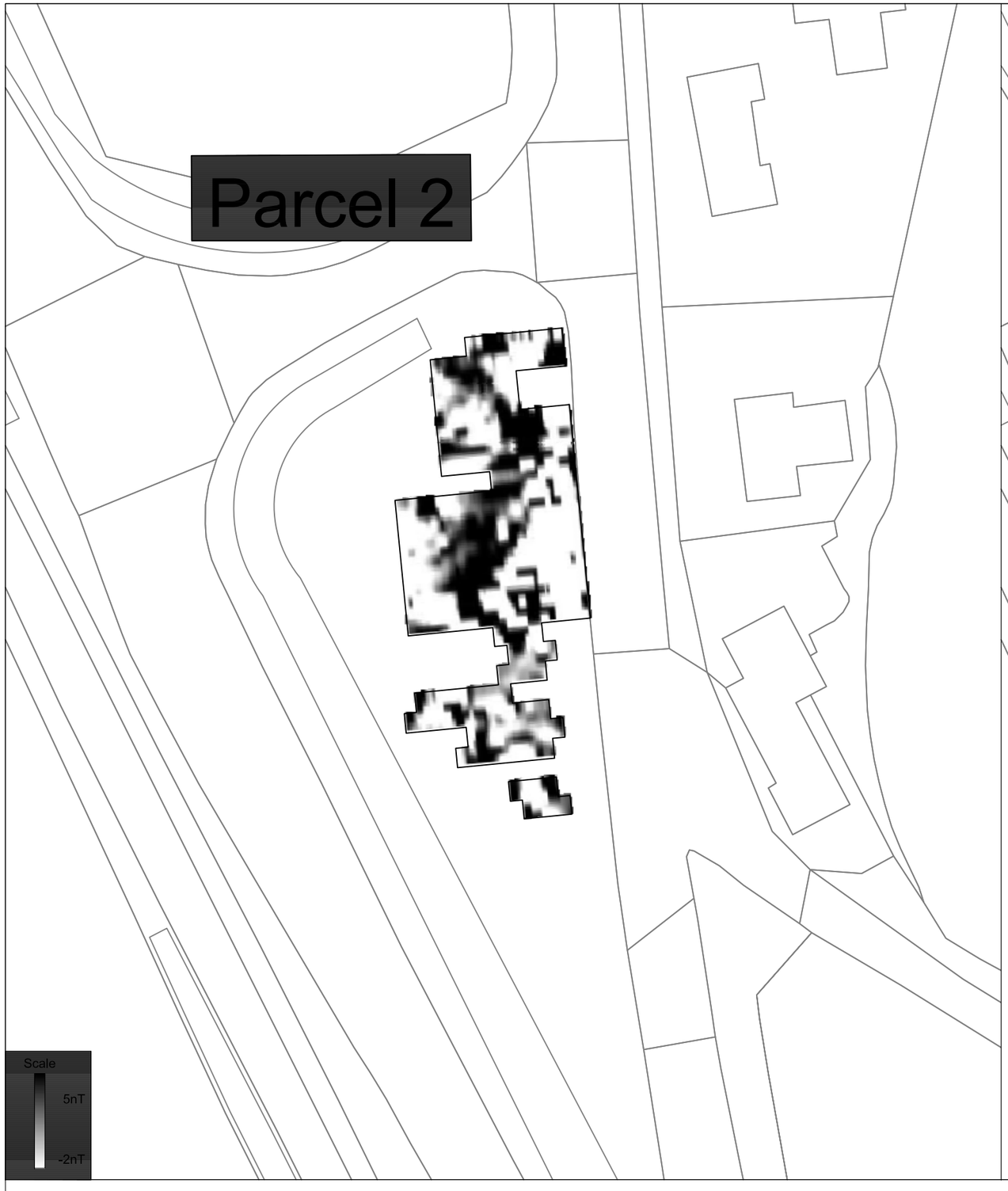
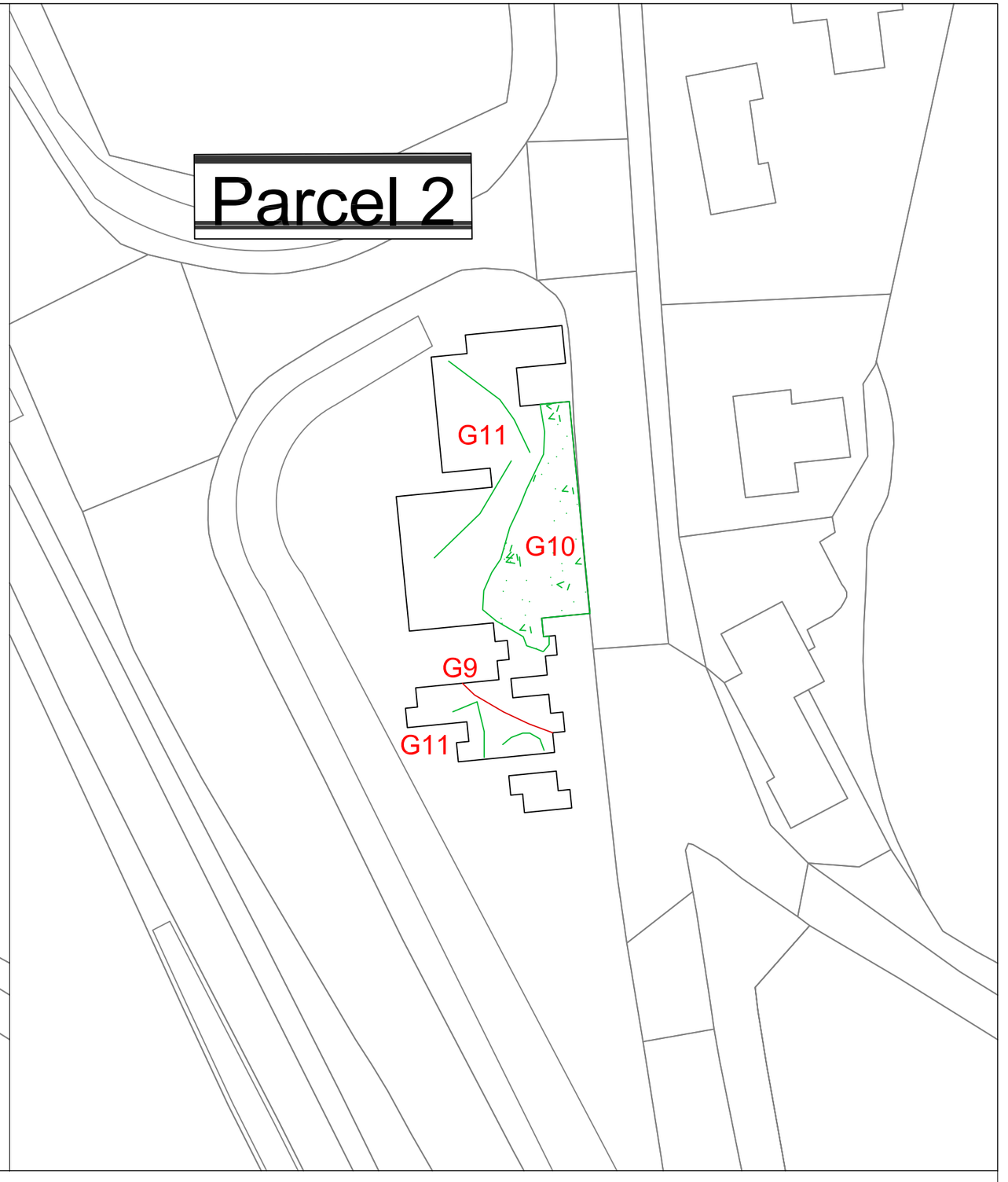


Processed Gradiometer survey results - Greyscale plot - Parcel 2



Interpretation of Gradiometer survey results - Parcel 2

Figure 7

Trend (Archaeology)

Trend (Unclear Origin)

Area of Disturbance (Unclear Origin)

N

0 20m

1:500 at A3

Project Title: A9 Dualling Programme: Pass of Birnam to Glen Garry Project No: 51800		
Drawing Title: Figure 7 - Processed Gradiometer survey results & Interpretation of survey results - Area 2		
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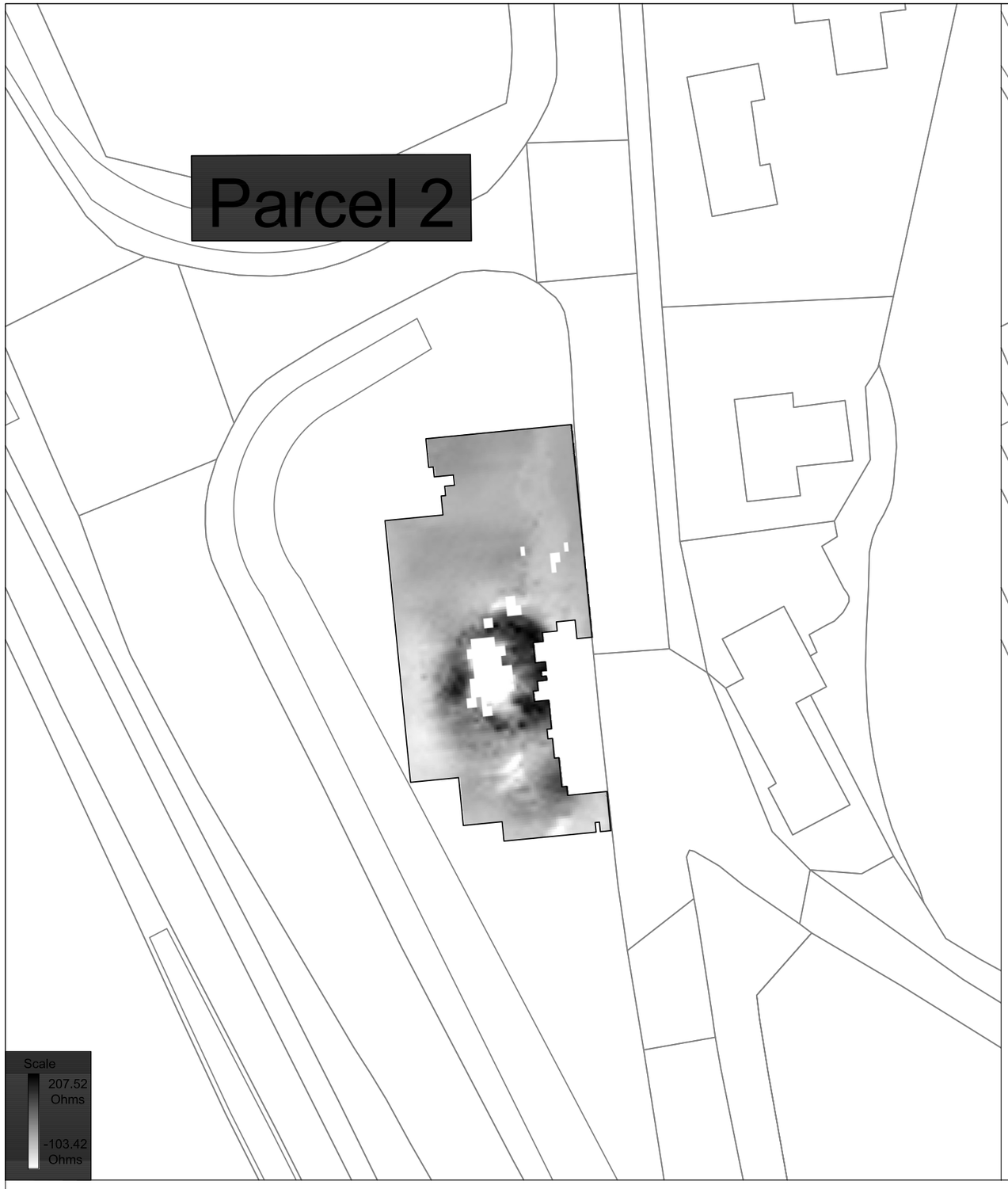
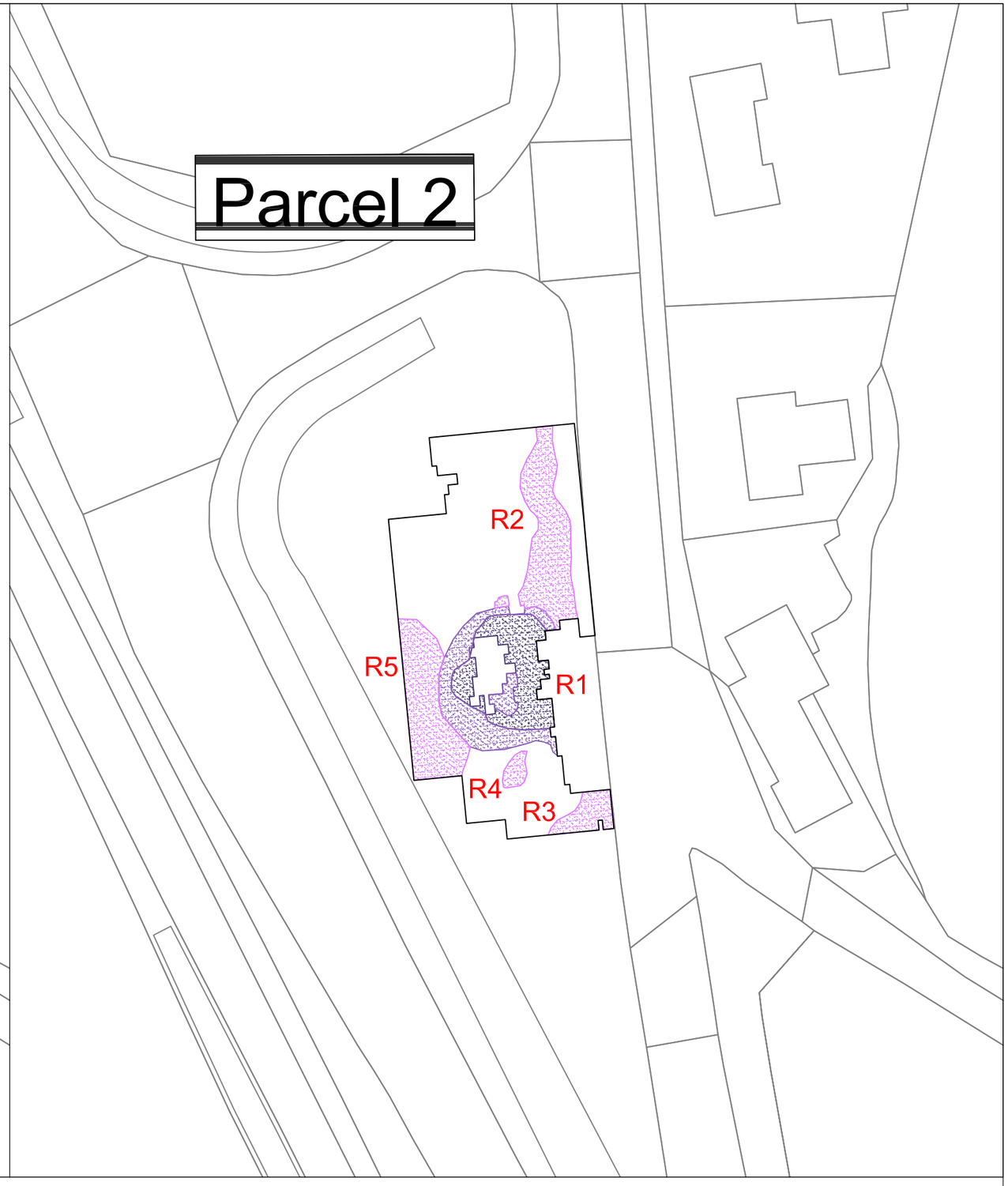


Processed Earth Resistance survey results - Greyscale plot - Parcel 2



Interpretation of Earth Resistance survey results - Parcel 2

Figure 8

- Area of very high resistance
- Area of high resistance
- Area of low resistance

N

0 20m

1:500 at A3

Project Title: A9 Dualling Programme: Pass of Birnam to Glen Garry
Project No: 51800

Drawing Title: Figure 8 - Processed Earth Resistance survey results & Interpretation of survey results - Area 2

V1/51800/GEO/F8/16.10.17

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Appendix 1: Characterisation of Identified Anomalies

Gradiometer survey

Site Specific Anomaly Code: **G**

Anomaly	Type of Archaeology
G1	Linear trend – unclear origin
G2	Linear trend – unclear origin
G3	Linear trend – unclear origin
G4	Linear trend – unclear origin
G5	Magnetic disturbance – unclear origin
G6	Discrete pit – archaeology?
G7	Discrete pit – archaeology?
G8	Magnetic disturbance
G9	Archaeology – linear trend
G10	Magnetic disturbance – unclear origin
G11	Linear trends – unclear origins

Earth Resistance survey

Site Specific Anomaly Code: **R**

Anomaly	Type of Archaeology
R1	Area of high resistance
R2	Area of low resistance
R3	Area of low resistance
R4	Area of low resistance
R5	Area of low resistance

Appendix 2: Survey Metadata

Field	Description
Surveying Company	AOC Archaeology
Data collection staff	Alistair Galt, Sam Dollman, Gemma Hudson
Client	Jacobs
Site name	A9 Dualling: Kindallachan
County	Perthshire
NGR	NN 9948 4973 & NN 9938 4994
Land use/ field condition	Pasture / scrub
Duration	27th – 28th September 2017
Weather	Overcast/Sunny
Survey type	Gradiometer survey & earth resistance survey
Instrumentation	Trimble GXOR system Bartington Grad 601-2 Earth Resistance – RM15 and MPX15
Area covered	Approx 0.4 ha (16 full and partial)
Download software	Grad601 PC Software v313
Processing software	Geoplot v3.0 or v4.0
Visualisation software	AutoCAD LT 2009
Geology	Metamorphic bedrock of Dalradian age, belonging to the Southern Highland Group (BGS 2017). These are overlain by alluvium of clays, silts, sands and gravels, with glaciofluvial deposits of gravels, silts and sands.
Soils	Humus-iron podzols with mineral alluvial soils and peaty alluvial soils (Scotland's Soils, 2017).
Scheduled Ancient Monument	Yes - Kindallachan cairn (SM1554) & Kindallachan standing stone (SM9618)
Known archaeology on site	See above
Historical documentation/ mapping on site	None
Report title	A9 Dualling – Kindallachan Cairn & Standing Stone
Project number	51800
Report Author	Kimberley Teale
Report approved by	James Lawton

Appendix 3: Archaeological Prospection Techniques, Instrumentation and Software Utilised

Gradiometer survey

Gradiometer surveys measure small changes in the earth's magnetic field. Archaeological materials and activity can be detected by identifying changes to the magnetic values caused by the presence of weakly magnetised iron oxides in the soil (Aspinall *et al.*, 2008, 23; Sharma, 1997, 105). Human inhabitation often causes alterations to the magnetic properties of the ground (Aspinall et al, 2008, 21). There are two physical transformations that produce a significant contrast between the magnetic properties of archaeological features and the surrounding soil: the enhancement of magnetic susceptibility and thermoremnant magnetization (Aspinall *et al.*, 2008, 21; Heron and Gaffney 1987, 72).

Ditches and pits can be easily detected through gradiometer survey as the top soil is generally suggested to have a greater magnetisation than the subsoil caused by human habitation. Also areas of burning or materials which have been subjected to heat commonly have high magnetic signatures, examples include: hearths, kilns, fired clay and mudbricks (Clark 1996, 65; Lowe and Fogel 2010, 24). It should be noted that negative anomalies can also be useful for characterising archaeological features. If the buried remains are composed of a material with a lower magnetisation compared with the surrounding soil, the surrounding soil will consequently have a greater magnetisation resulting in the feature displaying a negative signature. For example stone materials of a structural nature that are composed of sedimentary rocks are considered non-magnetic and so will appear a negative features within the data set.

Ferrous objects- i.e. iron and its alloys- are strongly magnetic and are typically detected as high-value peaks in gradiometer survey data, though it is not usually possible to determine whether these relate to archaeological or modern objects.

Although gradiometer surveys have been successfully carried out in all areas of the United Kingdom, the effectiveness of the technique is lessened in areas with complex geology, particularly where igneous and metamorphic bedrock is present. All magnetic geophysical surveys must therefore take the effects of background geological and geomorphological conditions into account.

Gradiometer survey instrumentation

AOC Archaeology's gradiometer surveys are carried out using Bartington Grad601-2 magnetic gradiometers. The Grad601-2 is a high-stability fluxgate magnetic gradient sensor, which uses a 1m sensor separation. The detection resolution is from 0.03 nT/m to 0.1nT/m, depending on the sensor parameters selected, making the Grad601-2 an ideal instrument for prospective survey of large areas as well as detailed surveys of known archaeology. The instrument stores the data collected on an on-board data-logger, which is then downloaded as a series of survey grids for processing.

Gradiometer survey software

Following the survey, gradiometer data is downloaded from the instrument using Grad601 PC Software v313. Survey grids are then assembled into composites and enhanced using a range of processing techniques using Geoscan Geoplot v3.0 / v4.0 (see Appendix 4 for a summary of the processes used in Geoplot and Appendix 5 for a list of processes used to create final data plots).

Earth Resistance survey instrumentation

AOC Archaeology's Earth Resistance Surveys are conducted using a Geoscan Research RM15 resistance meter, with a set number of probes and remote probes depending on the chosen survey methodology, utilising a MPX15 multiplexor attachment if required (see Appendices 2 and 3).

Data was collected on an east-west alignment using zig-zag traverses, with a sample interval of 0.5m and a traverse interval of 2m. The gain was set appropriate to ground conditions and the local geology.

Earth Resistance survey software

Following completion of the survey, the earth resistance data is downloaded from the instrument using Geoplot v3.0 / v4.0. The survey grids are then assembled into composites and enhanced using a range of processing techniques using Geoscan Geoplot v3.0 / v4.0 (see Appendix 4 for a summary of the processes used in Geoplot and Appendix 5 for a list of processes used to create final data plots).

Appendix 4: Summary of Processes used in Geoplot

Process	Effect
Clip	Limits data values to within a specified range
De-spike	Removes exceptionally high readings in the data that can obscure the visibility of archaeological features. In resistivity survey, these can be caused by poor contact of the mobile probes with the ground. In gradiometer survey, these can be caused by highly magnetic items such as buried ferrous objects.
De-stagger	Corrects a misalignment of data when the survey is conducted in a zig-zag traverse pattern.
Edge Match	Counteracts edge effects in grid composites by subtracting the difference between mean values in the two lines either side of the grid edge.
High pass filter	Removes low-frequency, large scale detail in order to remove background trends in the data, such as variations in geology.
Interpolate	Increases the resolution of a survey by interpolating new values between surveyed data points, creating a smoother overall effect.
Low Pass filter	Uses a Gaussian filter to remove high-frequency, small scale detail, typically for smoothing the data.
Periodic Filter	Used to either remove or reduce the appearance of constant and reoccurring features that distort other anomalies, such as plough lines.
Wallis filter	Applies a locally adaptive contrast enhancement filter.
Zero Mean Grid	Resets the mean value of each grid to zero, in order to counteract grid edge discontinuities in composite assemblies.
Zero Mean Traverse	Resets the mean value of each traverse to zero, in order to address the effect of striping in the data and counteract edge effects.

Appendix 5: Survey Processing Steps

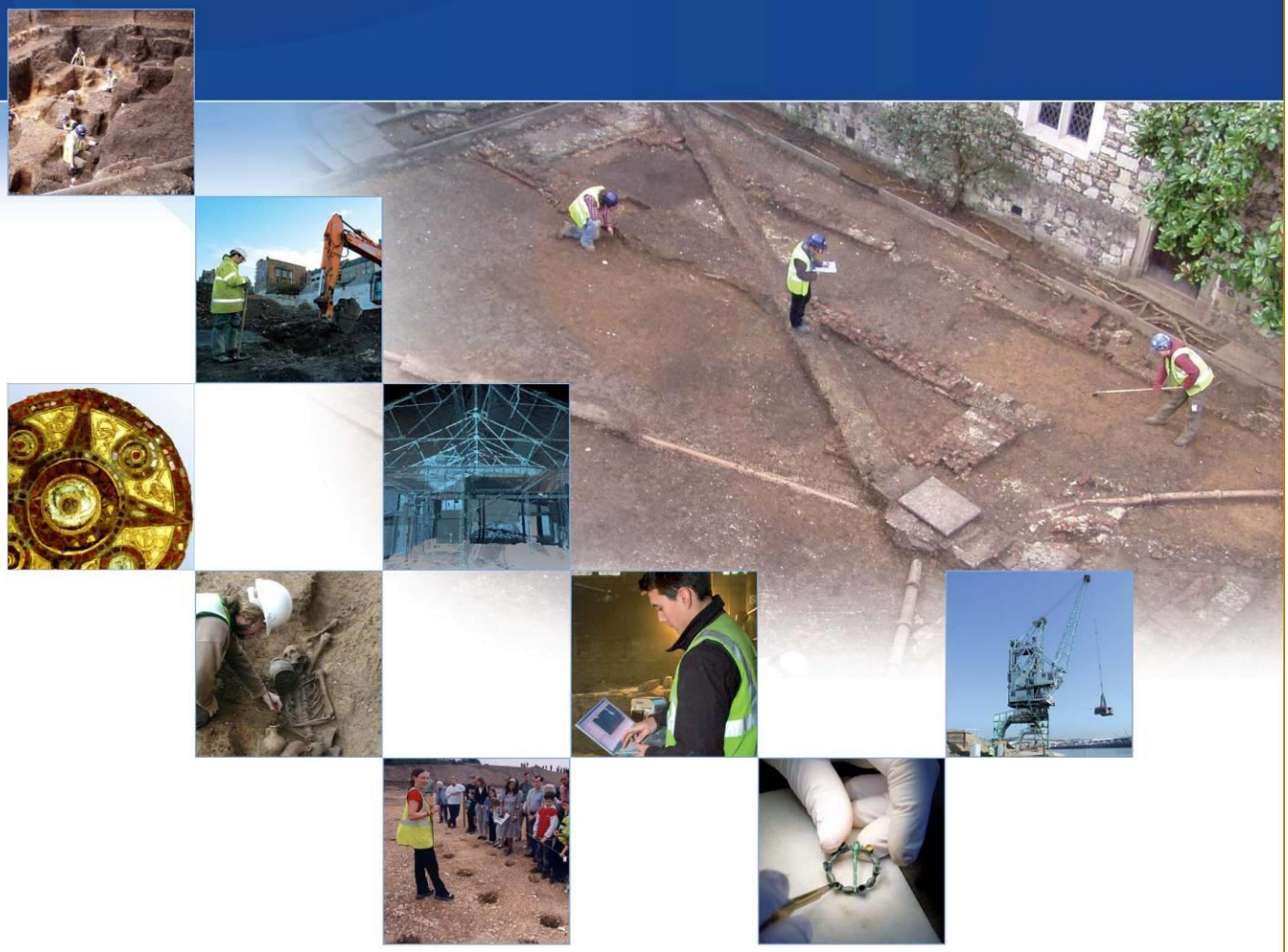
Gradiometer survey	
Process	**Extent**
Zero Mean Traverse	All LMS =on, threshold -5 to 5
Despike	X=1 Y=1 Thr = 3 Repl = Mean
Clip	Min =-5 Max = 5
Destagger	All grids dir Shift = 2 Line Pattern 34-78 Dual-DS
Low Pass filter	X=1 Y=1 Wt=G
Interpolate	Y, Expand – Expand –SinX/X x2
Raw Palette Scale	Grey08 Min= -1nT Max= 2nT
Palette Scale	Grey08 Min= -1nT Max= 2nT

Resistance survey	
Process	**Extent**
Despike	X=1 Y=1 Thr = 3 Repl = Mean
Clip	Min = -5 Max = 5
High Pass filter	HPF x=10 y=10 wt =u
Interpolate	X, Expand – sin x/x Y, Expand – sin x/x
Palette Scale	Grey55 Min= -103.42 ohm Max= 207.52 ohm

Appendix 6: Technical Terminology

Type of Anomaly	Description
Archaeology	
Archaeology - Trend	These are made up of linear / curvilinear / rectilinear anomalies and are either characterised by an increase or decrease in values compared to the magnetic background. This evidence is normally supported by the presence of archaeological remains and is confirmed by other forms of evidence such as HER records and aerial photography.
Archaeology - Area of Disturbance	This is characterised by a general increase and decrease of magnetic responses over a localised area and does not appear as having a linear form. These anomalies do not have the high dipolar response which are manifested in an 'iron spike' anomaly. This anomaly may be supported by the known location of a former building, or other forms of evidence such as HER records and aerial photography.
Archaeology - Pit	An anomaly composed of an increase in magnetic values with a patterning on the XY trace plot that is suggestive of buried remains, such as the infill of a pit. This evidence is normally supported by the presence of archaeological remains and is confirmed by other forms of evidence such as HER records and aerial photography.
Discrete Archaeology	
Archaeology? – Trend	Anomalies of a linear / curvilinear / rectilinear form either composed of an increased or decreased signal compared to magnetic background values. It is possible these anomalies belong to archaeological remains, but poor patterning or weaker response values makes interpretation difficult. Where historical records are present, the anomalies would appear to be weak or inconclusive.
Archaeology? - Area of Disturbance	Anomalies with an increase or decrease in magnetic values compared with the magnetic background over a localised area. Poor patterning or weak signal changes creates difficulty in defining the origin of the anomaly and so interpretation is only tentative. The anomaly lacks definitive records to confirm its origin as being archaeological. Disturbed areas could indicate the presence of buried rubble relating to fallen structures, or instead denote modern material from either quarrying or agricultural activity. On certain geologies these anomalies could be caused by in-filled natural features.
Archaeology? – Pit	An anomaly composed of an increase in magnetic values with a patterning on the XY trace plot that is suggestive of buried remains, such as the infill of a pit, but is isolated in its location and association with other features.
Unclear Origin	
Linear Trend	Anomalies of a linear / curvilinear form which are composed of a weak or different change in magnetic values. Coupled with poor patterning, the anomaly is difficult to interpret and it is unclear whether it has an archaeological origin.
Area of Disturbance	An area of magnetic disturbance which consists of a variety of increased and decreased magnetic values compared with background readings, but lacks sufficient patterning or context for a conclusive interpretation. It is likely that these readings are caused by modern disturbances, but interpretation is tentative.

Agricultural	
Linear Trend (Old Field Boundary)	These isolated long linear anomalies, most often represented as a negative magnetic trend, are likely to relate to former field boundaries. The magnetic signal may appear inconsistent but when the positioning is cross referenced with historic mapping, it is confirmed as a former field boundary.
Linear Trend (Old Field Boundary?)	These isolated long linear anomalies, most often represented as a negative magnetic trend, are likely to relate to former field boundaries. The positioning is not supported by historic mapping, but is often confirmed with adjacent ploughing patterns.
Linear Trend (Ridge and Furrow / Rig and Furrow)	A series of regular linear anomalies either composed of an increased or decreased magnetic response compared to background values. The width between the anomalies is consistent with that of a Ridge and Furrow ploughing regime, which is normally wider than conventional ploughing methods.
Linear Trend (Conventional ploughing)	A series of regular linear anomalies either composed of an increased or decreased magnetic response compared to background values. The regular patterning is likely to denote the presence of ploughing, however isolated trends can occasionally be observed that follow the orientation of ploughing trends seen elsewhere in the area. Anomalies seen adjacent to field edges are representative of headlands caused by ploughing.
Linear Trend (field drainage)	A series of linear anomalies of an indeterminate date, usually with a regular or herringbone patterning and regular spacing. These are likely to represent agricultural activity such as land drainage.
Non- Archaeology	
Geology / Natural	An area of disturbance that is composed of irregular significant increases or decreases in magnetic values compared with background readings and is likely to indicate natural variations in soil composition or geology.
Linear Trend (possible modern service)	Anomalies of a linear form often composed of contrasting high positive and negative values. Such anomalies usually signify a feature with a high level of magnetisation and are likely to belong to modern activity such as pipe lines or modern services.
Disturbed Area (modern disturbance?)	An area of disturbance that is likely to be caused by modern activity and is characterised by significant increases or decreases in magnetic values compared with background readings.
Isolated Dipolar Anomalies / Ferrous (iron spikes)	A response normally caused by ferrous materials on the ground surface or within the top soil, which causes a ‘spike’ representing a rapid variation in the magnetic response. These are generally not assessed to be archaeological when surveying on rural sites, and generally represent modern material often re-deposited during manuring.



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