Appendix 3D: Geophysical Survey Report

Geophysical Survey Report

Kingston Solar Farm, Nottinghamshire

Client
Neo Environmental Ltd.

On behalf of
RES
(Renewable Energy Systems Ltd.)

TAG Project
2021UK24

Date
November 2021

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TARGET REPORT 2021UK24
KINGSTON SOLAR FARM, NOTTINGHAMSHIRE

PROJECT BACKGROUND

Geophysical survey was undertaken in connection with the proposed Kingston Solar Farm development located at 453196 328362 (OSGB 1936 central coordinates), c.0.8 miles S of the village of Gotham, to the S of Nottingham. Situated S-SE of Kegworth Road and S of Leake Road, the site of the proposed solar farm encompasses a total 85ha of agricultural land comprising of 2 areas sub-divided in to 16 fields bound to the E-NE by Wood Lane and a public bridleway, and to the SE by Stocking Lane. A total 78ha of high-resolution magnetometer survey was undertaken at the site, investigating all available lands situated within the proposed development boundary.

This work was commissioned by Neo Environmental Ltd. on behalf of RES (Renewable Energy Systems Ltd.) and was conducted with the following aims:

- to identify any geophysical anomalies of possible archaeological origin within the proposed development boundary
- accurately locate these anomalies and present the findings in graphical format
- describe the anomalies and discuss their likely provenance in a written report

Coordinates: 453196 328362 (OSGB 1936 central coordinates)

County: Nottinghamshire

Landuse: Grazed pasture land and tillage

Landscape, soils, geology

The site of the proposed solar farm extends over a ridge of high ground situated c.85m above sea level, and occupies lime-rich slightly acid loamy soils and clays with impeded drainage (Soilscapes, Cranfield Soil & Agrifood Institute). Bedrock geology comprises of Barnstone Member interbedded grey mudstone and limestones (Geology of Britain Viewer, British Geological Survey).

Archaeology

No designated heritage assets are located within the boundary of the proposed development. Two non-designated heritage sites, L27 (MNT27), a find spot for prehistoric flint flakes, and MNT48, the site of a former well, are located within the site boundary. The Historic Environment record (HER) details a total 78 monuments within a 1000m radius of the proposed development, 54 of which are categorised as modern in origin and relate to industrial activity, including limestone and brick kilns, brick works, clay pits, air and mine shafts, quarrying and mining. In addition to L27 (MNT27) and MNT48, the HER refers to a total 2 Bronze Age sites, 1 Roman, 5 medieval, 2 post medieval, 3 post medieval to modern, and 13 sites of unknown origin within a 1000m radius of the proposed development:

Mon UID	Name	Monument type	Easting	Northing
MNT12	Rushcliffe Moat, Gotham	Moat	454460	328050
MNT12431	Moated Manor, Rushcliffe Moat, Gotham	Moat?; Manor House?; Moat?	454460	328050
MNT12473	Waterhouse, Gotham	Water House	454350	328090
MNT66	Waterhouse, Gotham	Map Depiction	454350	328090
MNT12479	Limestone Quarry and Lime Kiln, West Leake	Lime Kiln; Limestone Quarry	454740	327660
MNT12546	Martloegis Works, East Leake	Works	455400	328000
MNT12547	Gypsum Mine, East Leake	Gypsum Mine	455030	327980
MNT144	Martloegis Works, East Leake	Map Depiction	455400	328000
MNT145	Gypsum Mine, East Leake	Map Depiction	455030	327980
MNT17215	Brick Kiln, East Leake	Brick Kiln	455030	327980

MNT25	Roman Coin Hoard from Rushcliffe Halt, East Leake	Coin Hoard	455180	327670
MNT27	Flint Flakes from Crow Wood Hill, Gotham	Artefact Scatter	454400	327800
MNT72	Mine Shaft in East Leake	Mine Shaft	454980	327900
MNT73	Limestone Quarry, West Leake	Map Depiction	454740	327660
MNT8906	Brick Kiln, East Leake	Map Depiction	455030	327980
MNT12480	Lime Kilns, East Leake	Lime Kiln	454660	327210
MNT74	Lime Kilns, East Leake	Map Depiction	454660	327210
MNT12458	Glebe Mine, Gotham	Gypsum Mine	453670	329160
MNT12459	Gotham Plaster Works	Plaster Works; Gypsum Works	453800	329150
MNT12460	Gypsum Mines, Gotham	Gypsum Mine	453370	329280
MNT12461	Gypsum Mine, Gotham	Gypsum Mine	453090	329400
MNT12462	Gypsum Mine, Gotham	Gypsum Mine	452840	329390
MNT12463	Winser's Mines, Gypsum Mines, Gotham	Gypsum Mine	452950	329550
MNT12464	Gypsum Slab Works, Gotham	Gypsum Works	453470	329370
MNT17208	Tramway Near Plaster Works, Gotham	Tramway	453800	329150
MNT49	Mine Shaft, East Leake	Mine Shaft	453210	329130
MNT50	Glebe Mine, Gotham	Map Depiction	453670	329160
MNT51	Gypsum Works, Gotham	Map Depiction	453800	329150
MNT52	Gypsum Mines, Gotham	Map Depiction	453370	329280
MNT53	Gypsum Mine, Gotham	Map Depiction	453090	329400
MNT54	Gypsum Mine, Gotham	Map Depiction	452840	329390
MNT55	Winser's Mines, Gotham	Map Depiction	452950	329550
MNT56	Slab Works, Gotham	Map Depiction	453470	329370
MNT8896	Tramway, Gotham	Map Depiction	453600	329150
MNT9977	Ridge and Furrow and Bank at Gotham	Ridge And Furrow; Boundary; Bank	453370	329880
MNT10	Circular Features on Fox Hill, West Leake	Mound; Ring Ditch	453600	326800
MNT12468	Windpump, Kingston on Soar	Wind Pump	451830	328340
MNT12472	Kingston Mine, West Leake	Gypsum Mine	452450	328740
MNT12477	Clay Pit and Brickworks in Kingston on	Brickworks; Clay Pit	451790	328600
MNT17209	Gypsum Mine, Kingston on Soar	Gypsum Mine?	451790	328600
MNT60	Windpump, Kingston on Soar	Map Depiction	451830	328340
MNT64	Kingston Mine, West Leake	Map Depiction	452450	328740
MNT70	Clay Pits and Brickworks, Kingston on Soar	Map Depiction	451790	328600
MNT12439	Cuckoo Bush Mound, Gotham	Round Barrow?	453430	328780
MNT12474	Rushcliffe Moot, Court Hill, Gotham	Moot	453700	328800
MNT12476	Lime Kiln and Quarries, West Leake	Lime Kiln; Limestone Quarry	453490	328070
MNT12478	Monument To Frederick Strutt, West Leake	Commemorative Monument	453140	328140
MNT12484	Sheepwash, West Leake	Sheep Wash	453280	327800
MNT22	Cuckoo Bush Mound, Gotham	Ditch; Mound	453430	328780
MNT65	Air Shafts at Glebe Mine, Gotham	Ventilation Shaft	453750	328880
MNT67	Documentary Reference to Rushcliffe	Documentary Reference	453700	328800
MNT69	Lime Kiln and Quarries, West Leake	Map Depiction	453490	328070
MNT71	Map Depiction of Monument, West Leake	Map Depiction	453140	328140
MNT78	Sheepwash, West Leake	Map Depiction	453280	327800
MNT12475	Wind Pump, Gotham	Wind Pump	454170	328340
MNT68	Map Depiction of Wind Pump, Gotham	Map Depiction	454170	328340
MNT12482	Sand Pit, West Leake	Sand Pit	453750	326990
MNT273	Cropmark, West Leake	Circular Enclosure	454200	327100

MNT76	Elongated Pit, West Leake	Pit	453750	326990
MNT12430	Searchlight Battery, West Leake	Searchlight Battery?	453600	326800
MNT12498	Quarry, West Leake	Quarry	453330	326700
MNT12499	Sheepfold, West Leake	Sheep Fold	453510	326680
MNT12657	Osier Bed, East Leake	Dam; Osier Bed	454240	326530
MNT12658	Osier Beds, West Leake	Osier Bed?	454230	326590
MNT271	Dams and Shallow Ditch, Rempstone	Ditch; Bank (Earthwork)	454240	326530
MNT272	Rectangular Ditched Enclosure, West Leake	Moat; Ditch; Enclosure	454230	326590
MNT8883	Linear Feature on Fox Hill, West Leake	Linear Feature	453600	326800
MNT8895	Earthworks At Town End Farm, West Leake	Lynchet; Terraced Ground	453190	326640
MNT92	Quarry, West Leake	Map Depiction	453330	326700
MNT93	Sheepfold, West Leake	Map Depiction	453510	326680
MNT12457	Well, Gotham	Well	452820	329130
MNT12648	Stonepit Farm, Gotham - stone quarry	Stone Quarry?	452150	329650
MNT258	Place name, Stonepit Farm, Gotham	Place Name	452150	329650
MNT48	Well, Gotham	Map Depiction	452820	329130
MNT10404	Pillbox at Gotham	Structure	452369	330101
MNT12849	Stonepit Wood, Gotham - possible quarry	Stone Quarry?	452100	330100
MNT596	Stonepit Hill/Stonepit Wood, Gotham	Place Name	452100	330100
MNT8898	Old gypsum mine, Kingston on Soar	Map Depiction	451790	328600

Fieldwork	22nd September – 30st September 2021
Report issue	7th November 2021
Author	John Nicholls MSc.
Client	Neo Environmental on behalf of RES (Renewable Energy Systems Ltd.)
Geophysical technique	High-resolution magnetometry (fluxgate gradiometry)

1 SURVEY METHODOLOGY

1.1 Methodology

1.1.1 A total 78ha of high-resolution magnetometer survey was undertaken at the site, investigating 16 fields, examining all lands available within the site boundary.

1.1.2 The survey employed an advanced multichannel fluxgate gradiometer system combined with cm precision GPS, recording magnetometer and GPS data simultaneously at rates of 50Hz and 1Hz respectively, conducting parallel instrument traverses 3.6m in width throughout fields 1-16, with the instrumentation installed in 'tow configuration' for use with an ATV.

1.2 Instrumentation

1.2.1 The following instrumentation was employed for this geophysical survey:

Technique	Sensor spacing	Sample rate	Instrumentation	Sensitivity/precision	No. of data recorded
Magnetometry (fluxgate gradiometry)	0.3m	50Hz	12-channel fluxgate gradiometer array	<75pT/√Hz @ 1Hz (650mm baseline)	4,419,669
GPS	3.6m	1Hz	Trimble R10 GPS (operating in VRS mode)	<0.1m	85,822

1.2.2 The instrumentation and software employed for this geophysical survey were configured to apply a spatial resolution of c.80-100 magnetometer measurements per $m.^2$ This spatial resolution meets with ease the 'Level 3 – Characterisation' EAC Guidelines recommendation for geophysical survey in archaeology (Schmidt et al, 2016).

1.3 Data processing

1.3.1 Post fieldwork geophysical data processing was performed as follows:

Process	Description
i	Positioning of magnetometer data based on real-time GPS measurements
ii	Zero median transect processing for multi-sensor magnetometer data collected along parallel transects
iii	Gridding (nearest neighbor interpolation)
iv	Export of georeferenced greyscale images at optimum range to project CRS (OSGB 1936)

1.3.2 To ensure the integrity of the processed geophysical data, and maintain close correlation with the original raw on-site measurements, no further processing, filtering or 'smoothing' of the data was undertaken proceeding steps i-iv.

1.4 Data display

1.4.1 Figure 1 presents a site location diagram (scale 1:16,000), highlighting the extent of the proposed development and relevant HER data within a 1000m radius.

1.4.2 Figures 2 details the locations of geophysical survey in fields 1-16 (scale 1:8000), with figures 3-4 presenting separate greyscale plots of the data for fields 1-11 and 12-16 at a scale of 1:4000.

1.4.3 Figures 5-13 present greyscale plots of the results from the geophysical survey in Fields 1-16 at a scale of 1:1500. XY-trace plots of the survey results, generated to aid interpretation of the processed data, may be made available upon request, and delivered as shapefiles combined in a single AutoCAD DWG file.

1.4.4 Figures 14-24 present interpretation diagrams for the results from survey in fields 1-16. Figures 14-15 are provided at a scale of 1:4000 as separate interpretation diagrams for fields 1-11 and 12-16. Figures 16-24

presented at a scale of 1:1500 include numbers on the interpretation diagrams referring to notable anomalies recorded from survey, which are discussed in tabular format in the results section of this report.

2 GENERAL CONSIDERATIONS

2.1 Access & ground conditions

2.1.1 The geophysical survey of the site extended through 16 arable and pasture fields. Ground conditions were generally good throughout, with no major obstructions to impede the progress of fieldwork.

2.2 Modern interference, recent landuse and cultivation

2.2.1 The results from survey in fields 1-11 demonstrate widespread modern disturbance throughout. This likely derives from removal of past field boundaries (fields 5-6), installation of multiple land drains/suspected land drains and intensive cultivation (areas 2-8, 10-11); areas of modern landscaping/ground disturbance indicated by magnetic disturbance in areas 2, 3, 6 & 10-11, and the site of a former pumping station at the northern perimeter of fields 8-9. Cultivation in fields 1-11 has caused the wider dispersal of modern ferrous material originating from the above sources across this north-western portion of the proposed development. The geophysical data from fields 1-11 therefore, therefore have a very 'noisey' magnetic appearance.

2.2.2 The data from fields 12-16 exhibit a lesser degree of modern disturbance. Numerous small-scale modern ferrous responses are visible throughout, particularly in fields 13-14, and these, as in most cases, represent modern metallic debris contained within the topsoil. Broader concentrations of ferrous response are also present in the data, notably to the NW in area 15, and relate mostly to large concentrations of modern debris at the edges of survey, modern debris at existing field boundaries and adjacent modern surfaces.

2.2.3 Three buried services are visible in the results extending through fields 5-6 NW-SE, 9-11 NE-SW, and 16 roughly E-W. These strongly magnetic responses may potentially have masked subtle contrasts of archaeological interest, if present, within the site boundary.

2.3 Natural soil/geological variation

2.3.1 Responses indicative of natural soil/geological variation are also apparent in the results from fields 1, 4, 12-13 and 15-16, and visible mostly as groups of weakly negative/positive linear response.

3 GEOPHYSICAL SURVEY RESULTS

N.B. Read this section of the report with the greyscale/interpretation diagrams provided.

3.1 General overview

3.1.1 The results from magnetometer survey in fields 1-16 display the effects from modern landuse across the site. The disturbance caused by this is particularly evident in the fields 1-11 where large quantities of small-scale ferrous, broad zones of magnetic disturbance, remnants of former boundaries, cultivation trends and land drains/suspected land drains are in abundance. Natural variations in soil morphology/underlying geology are also evident in the results from fields 1, 4, 12-13 and 15-16, though these are generally weakly magnetic. Taking the above variations into account, the magnetic background of the soils and geology on site is within a range of approximately +/-3nT.

3.1.2 No sites of definitive archaeological character have been identified from geophysical survey in fields 1-16. Concentrations of potentially significant response and discrete anomalies of possible interest have, however, been recorded. The potential that these relate to remnants of relatively recent industrial activity typical of the region, for example limestone/brick kilns, clay pits, air/mine shafts, quarrying and mining, should not be ignored. The possibility that these anomalies may also relate to remains of former boundaries, modern ferrous, recent cultivation and/or natural soil/geological should not be ignored.

3.1.3 The most notable responses recorded from survey in fields 1-16 include:

Fields 2 & 4: Possible burnt/fired responses to SE in field 1 and S of centre in Field 4

Field 6: Discrete positives NW-SE.

Field 10: Well-defined positives and trends SE-SW of survey centre.

Field 11: Strongly magnetic positives and linear response at survey centre, to the W and SW.

Field 12: Concentration of potential burnt/fired material, well defined positives, increased response and trends W of survey centre.

Field 15: Sub-circular pattern of weakly magnetic trends SE of survey centre.

3.1.4 Numerous small-scale positives, poorly defined linear anomalies and trends are also evident in the results from survey in fields 1-16. The exact origin of these remains uncertain. Where no clear archaeological context or patterning is evident in the results these likely derive from recent/past landuse, natural soil/geological variation and/or modern ferrous.

3.1.5 Significant/potentially significant responses recorded in fields 1-16 are presented below in tabular format in Sections 3.2-3.17.

3.2 Field 1

Geophysical survey area		Figure(s)	Hectares	Terrain & landuse
Field 1		5, 16	2.65	Irregular shaped pasture field facing S.
Response(s)	**Location from survey centre**	**Interpretation**	**Description**	
NA	NA	NA	No responses of archaeological character or clear archaeological potential have been recorded in field 1. The results highlight an abundance of small-scale modern ferrous throughout, natural soil/geological variation to the S, with weak trends of uncertain origin to the SE and SW.	

3.3 Field 2

Geophysical survey area		Figure(s)	Hectares	Terrain & landuse
Field 2		5, 16	3.23	Rectangular pasture field descending gently to the SE.
Response(s)	**Location from survey centre**	**Interpretation**	**Description**	
1	SE	? Archaeology - possible burnt/fired material	Strongly magnetic positive c.6m x 3m, potentially remnants of recent industrial activity. This response is likely too discrete/small to represent remains of a brick or limekiln. A modern ferrous explanation for response 1 should not be ignored.	

3.4 Field 3

Geophysical survey area		Figure(s)	Hectares	Terrain & landuse
Field 3		5, 16	3.23	Sub-rectangular pasture field descending gently S-SW.
Response(s)	**Location from survey centre**	**Interpretation**	**Description**	
NA	NA	NA	No responses of archaeological character or clear archaeological potential have been recorded in field 3. The results highlight effects from recent landuse in the form of multiple responses from former cultivation, land drains/suspected former land drains, modern strong magnetic disturbance, linear trends of uncertain origin and abundant small-scale ferrous.	

3.5 Field 4

Geophysical survey area		Figure(s)	Hectares	Terrain & landuse
Field 4		5-6, 16-17	2.47	Sub-rectangular pasture field descending steeply S-SE.
Response(s)	**Location from survey centre**	**Interpretation**	**Description**	
2	S of survey centre	? Archaeology - possible burnt/fired material	Strongly magnetic positive c.7m x 4m, potentially remnants of recent industrial activity. Response 2 lies over a small section of relatively flat disturbed ground. A modern ferrous explanation for response 2 should not be ignored.	

3.6 Field 5

Geophysical survey area		Figure(s)	Hectares	Terrain & landuse
Field 5		6, 17	5.91	Large sub-rectangular pasture field bound to the NE by Wood Lane, descending gently to the E-NE.
Response(s)	**Location from survey centre**	**Interpretation**	**Description**	
NA	NA	NA	No responses of archaeological character or clear archaeological potential have been recorded in field 5. No indication of the site of former well MNT48 is indicated by the results from survey in this location. The results highlight effects from recent landuse in the form of remnants of a disused boundary, past cultivation, land drains/suspected former land drains, a buried service, linear trends of uncertain origin and abundant small-scale ferrous.	

3.7 Field 6

Geophysical survey area		Figure(s)	Hectares	Terrain & landuse
Field 6		6, 17	6.23	Large irregular shaped pasture field bound to the NE by Wood Lane, descending gently to the E and W-SW.
Response(s)	**Location from survey centre**	**Interpretation**	**Description**	
3-6	NW-SE	?? Archaeology	Discrete positives of potential interest, possibly pit remains. Interpretation is tentative considering historic mapping indicates poorly drained land and multiple trees across Field 6.	

3.8 Field 7

Geophysical survey area		Figure(s)	Hectares	Terrain & landuse
Field 7		7, 18	3.65	Level rectangular pasture field bound to the NE by a public bridleway.
Response(s)	**Location from survey centre**	**Interpretation**	**Description**	
NA	NA	NA	No responses of archaeological character or clear archaeological potential have been recorded in field 7. The results highlight effects from recent landuse in the form of past cultivation, land drains/suspected former land drains, abundant small-scale ferrous, and large-scale ferrous from a telecommunications mast at the southern limit of survey.	

3.9 Field 8

Geophysical survey area		Figure(s)	Hectares	Terrain & landuse
Field 8		7, 18	3.38	Level rectangular pasture field bound to the N by a public bridleway.
Response(s)	**Location from survey centre**	**Interpretation**	**Description**	
NA	NA	NA	No responses of archaeological character or clear archaeological potential have been recorded in field 8. The results highlight effects from recent landuse in the form of strong magnetic disturbance associated with the site of a former pumping station, land drains/suspected former land drains3, and abundant small-scale ferrous.	

3.10 Field 9

Geophysical survey area		Figure(s)	Hectares	Terrain & landuse
Field 9		7-8, 18-19	4.13	Level sub-rectangular pasture field bound to the N by a public bridleway.
Response(s)	**Location from survey centre**	**Interpretation**	**Description**	
NA	NA	NA	No responses of archaeological character or clear archaeological potential have been recorded in field 9. The results highlight effects from recent landuse in the form of strong magnetic disturbance associated with the site of a former pumping station, a buried service, and abundant small-scale ferrous.	

3.11 Field 10

Geophysical survey area		Figure(s)	Hectares	Terrain & landuse
Field 10		8, 19	2.99	Level sub-rectangular pasture field bound to the N by a public bridleway.
Response(s)	**Location from survey centre**	**Interpretation**	**Description**	
7-10	SE-SW	?? Archaeology	Groups of well-defined positives and trends of potential note, potentially remnants of recent industrial activity. Historic mapping highlights a number of trees formerly in this location and the potential that 7-10 derive from these should not be ignored.	

3.12 Field 11

Geophysical survey area		Figure(s)	Hectares	Terrain & landuse
Field 11		8, 19	2.84	Level triangular pasture field bound to S-SE by extensive woodland.
Response(s)	**Location from survey centre**	**Interpretation**	**Description**	
11-15	W-SW	?? Archaeology	Strongly magnetic positives and linear response at survey centre, to the W and SW. Historic mapping highlights a number of trees in this location. The strong magnetic signature of responses 12-15, and c.2m-5m diameter suggests, 12-15 may represent remans of industrial activity, potentially clay pits or possibly kilns. Interpretation remains tentative.	

3.13 Field 12

Geophysical survey area		Figure(s)	Hectares	Terrain & landuse
Field 12		9, 20	5.76	Large sub-rectangular arable field gently facing S-SW.
Response(s)	**Location from survey centre**	**Interpretation**	**Description**	
16-19	W-SW	? Archaeology - possible burnt/fired material ?? Archaeology Increased response Trend	Strongly magnetic positives (16-18) c.8m x 3m, and c.3m x 3m in diameter indicative of burnt/fired remains, with linear responses, small-scale positives and trends in proximity, These responses are bound NE-S by a weak linear trend (19). Combined 16-19 extend over an area c. 80m x 80m in size and are expected to represent remains of potential mining activity or quarrying. Interpretation of 16-19 remains tentative.	

3.14 Field 13

Geophysical survey area		Figure(s)	Hectares	Terrain & landuse
Field 13		10, 21	5.8	Sub-rectangular arable field descending steeply to the W-SW.
Response(s)	**Location from survey centre**	**Interpretation**	**Description**	
NA	NA	NA	No responses of archaeological character or clear archaeological potential have been recorded in field 13. The results highlight responses from recent landuse in the form of suspected former cultivation/suspected land drains and small-scale ferrous, with natural soil/geological variation visible from survey centre to the S-SW.	

3.15 Field 14

Geophysical survey area		Figure(s)	Hectares	Terrain & landuse
Field 14		11, 22	6.51	Sub-rectangular arable field descending gently E-SE.
Response(s)	**Location from survey centre**	**Interpretation**	**Description**	
NA	NA	NA	No responses of archaeological character or clear archaeological potential have been recorded in field 14. The results highlight responses from recent landuse in the form of former cultivation/suspected land drains and small-scale ferrous. Two weakly magnetic trends traversing the survey area NE-SW likely derive from performing the 'null zero' command during data acquisition to correct for instrument drift.	

3.16 Field 15

Geophysical survey area		Figure(s)	Hectares	Terrain & landuse
Field 15		9, 12, 20, 23	11.92	Large irregular shaped level arable field bound to the SE by Stocking Lane.
Response(s)	**Location from survey centre**	**Interpretation**	**Description**	
20	SE	Trend	Sub-circular group of linear trends of potential note. An archaeological interpretation for responses 20 is tentative and a natural soil/geological explanation variation for these responses is expected. Responses 20 lie c.65m SE of prehistoric flint flake find spot L27 (MNT27).	

3.17 Field 16

Geophysical survey area		Figure(s)	Hectares	Terrain & landuse
Field 16		12-13, 23-24	6.99	Large irregular shaped level arable field bound to the SE by Stocking Lane and a public bridleway.
Response(s)	**Location from survey centre**	**Interpretation**	**Description**	
21	NE	?? Archaeology	Positive linear response of uncertain origin. An archaeological interpretation response 21 is tentative given the absence of any clear archaeological context in the immediate vicinity.	

4 CONCLUSIONS

4.1 The results from geophysical survey in fields 1-16 of the proposed development display no sites of definite archaeological interest. No clear representation of archaeological settlement or activity in the form of enclosure remains or concentrations of significant response have been recorded. The survey results are dominated by responses from relatively recent landuse, including abundant small-scale ferrous, magnetic disturbance, cultivation trends, former land drains/suspected former land drains, buried services and weakly magnetic trends of uncertain origin.

4.2 Responses worthy of further investigation have been recorded, the majority of which are indicative of relatively recent industrial activity, thought to be associated with past mining activity, quarrying, and possible kilns, for which there is considerable evidence within a 1000m radius of the site boundary. These responses are generally visible in the geophysical data as strongly magnetic burnt-fired anomalies and discrete positives, most notably in the survey results from fields 10-12.

4.3 A sub-circular group of trends to the SE in Field 15 is deemed to be of tentative archaeological significance.

4.4 Interpretation of the results from fields 1-16 has been complicated, and this is due mainly to a 'noisey' and variable magnetic background deriving from widespread modern disturbance across the site. This disturbance likely results from a combination of factors, including removal of past field boundaries, installation of multiple land drains/suspected land drains, intensive cultivation, and landscaping.

4.5 Responses indicative of natural soil/geological origin are also apparent in the results from this survey.

BIBLIOGRAPHY

Schmidt A, (2002), Archaeology Data Service. Geophysical Data in Archaeology. A guide to good practice.

Schmidt A, Linford P, Linford N, David A, Gaffney C, Sarris A, and Fassbinder J, (2016), EAC Guidelines for the Use of Geophysics in Archaeology.

ONLINE RESOURCES

Bing Maps: https://www.bing.com/maps

Geology of Britain Viewer, British Geological Survey: https//mapapps.bgs.ac.uk/geologyofbritain/home.html

Google Maps: https://www.google.com/maps

Ordnance Survey Maps - Six-inch England and Wales, 1888-1913 (https://maps.nls.uk/os/6inch-england-and-wales/)

Soilscapes, Cranfield Soil & Agrifood Institute: https://www.landis.org.uk/soilscapes

LIST OF FIGURES

APPENDIX

TECHNICAL INFORMATION: MAGNETOMETRY

Introduction

Magnetometry represents one of a suite of geophysical techniques employed in archaeological prospection to inform invasive work such as trial trenching and excavation.

Frequently used to determine the often non-visible boundaries of archaeological remains, magnetometer surveys enable archaeologists to identify the location, form and extent of a diverse array of archaeological features no longer visible at the surface.

Buried archaeological remains successfully identified using magnetometry include sites such as enclosure systems and deserted villages, hillforts and military encampments, henges and tumuli, villa/castle foundations, ecclesiastical settlements and formal gardens.

Background to application

The basis for use of magnetometry in archaeological prospection derives from the abundance of natural iron oxides in most soils, and our ability to measure subtle variations in the magnetic properties of these iron oxides caused by human activity. Discrete variations in soil magnetism associated with buried archaeological remains derive typically from in situ burning and organic enrichment of the soil, through activities such as cooking and heating; pottery manufacture and metal working; as well as use of fired building materials such as ceramic tiles and brick. These burnt, fired and organic rich deposits create subtle magnetic contrasts visible as discrete magnetic anomalies superimposed on the earth's geomagnetic field.

1. Example magnetometer survey data in greyscale format highlighting pit remains SE of an enclosure and Roman villa.

2. Example Burnt-fired debris uncovered during excavation of the highlighted area SE of the same enclosure and Roman villa.

Magnetometer surveys conducted in both commercial and research archaeological investigations enable determination of the location, form and extent of buried archaeological remains. Data acquired from these surveys can be quickly generated into georeferenced images and interpretation layers to inform subsequent trial trenching and excavation.

Technology

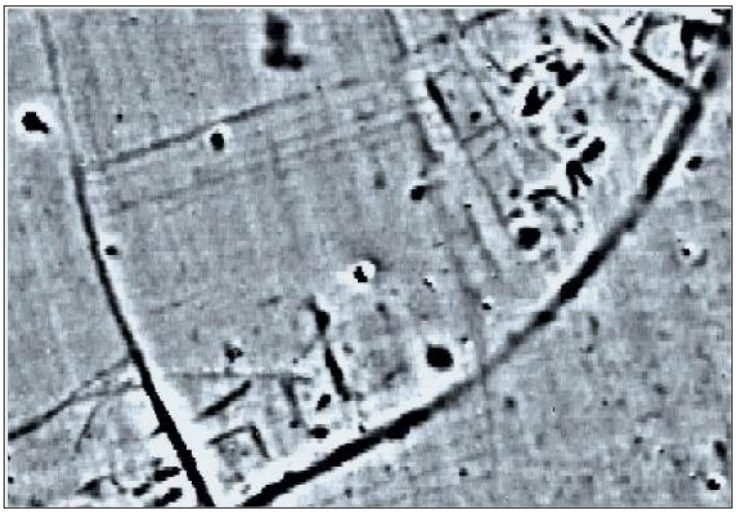
TARGET provides precise mapping and characterization of buried archaeological remains by employing an array of highly stable and sensitive fluxgate gradiometers, combined with an advanced data logging system and cm precision GPS. This state-of-the-art geophysical instrumentation, which is capable of collecting extremely dense data sets, permits detailed high-resolution survey of archaeological sites from as small as 1ha in size, to larger scale investigation of sites up to 150ha or more.

High resolution magnetometer surveys are undertaken as standard, recording data at c.5cm intervals with probe separations of 0.3m for precise measurement and characterization of buried archaeological remains. This spatial resolution meets with ease the 'Level 3 – Characterisation' EAC Guidelines recommendation for geophysical survey in archaeology (Schmidt et al, 2016).

Instrumentation is used in combination with cm precision GPS and data collected along parallel traverses with the system installed in 'tow configuration' for use with an ATV or in push mode.

Data Display

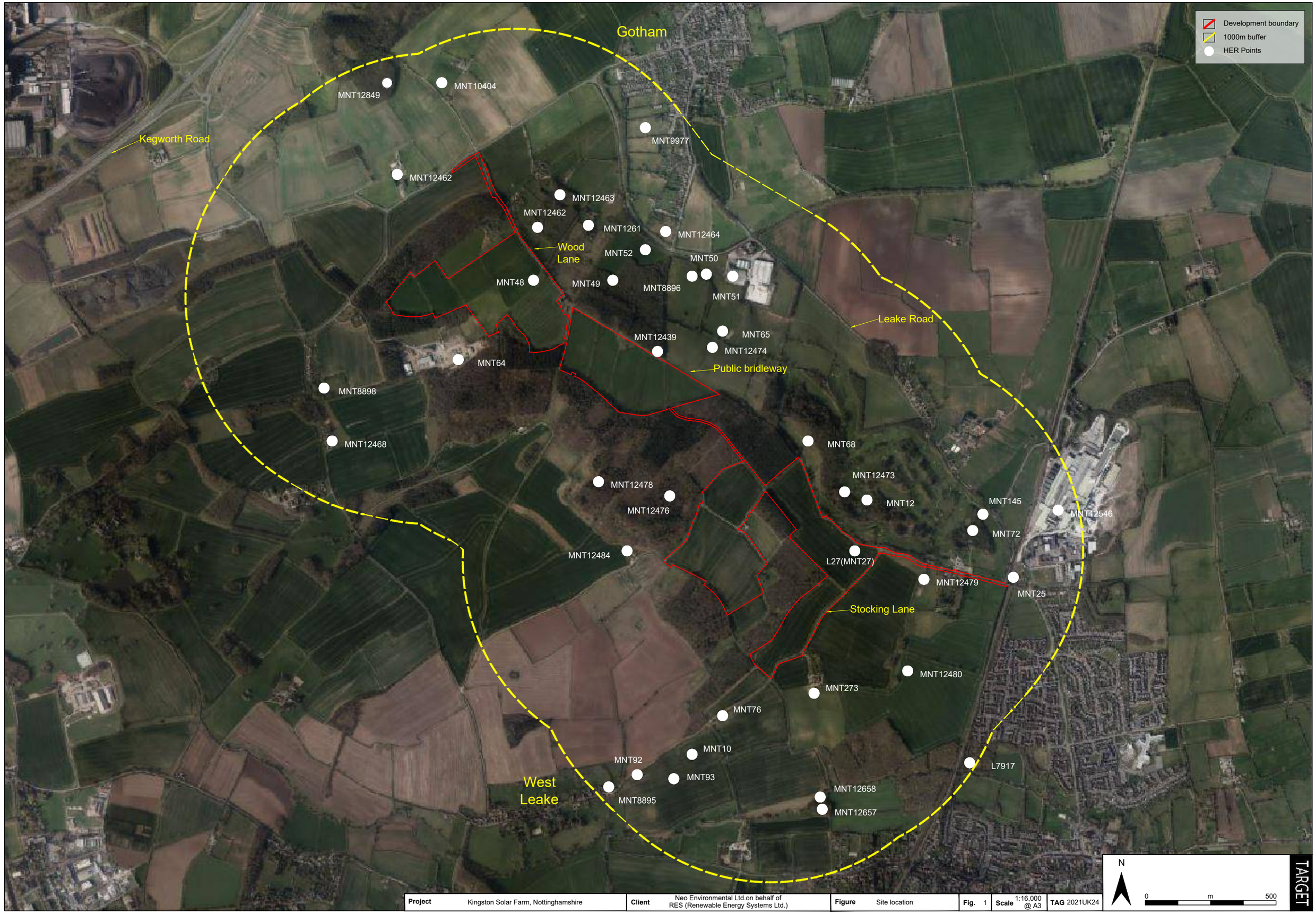
Greyscale plots are the most common format for displaying magnetometer data. This display format assigns a cell to each datum according to its location on the grid. The display of each data point is conducted at very fine increments, allowing the full range of values to be displayed within a given data set. This display method also enables the identification of discrete responses barely visible above natural 'background' magnetic variation on site.



6. Greyscale from survey at the site of a deserted medieval village.

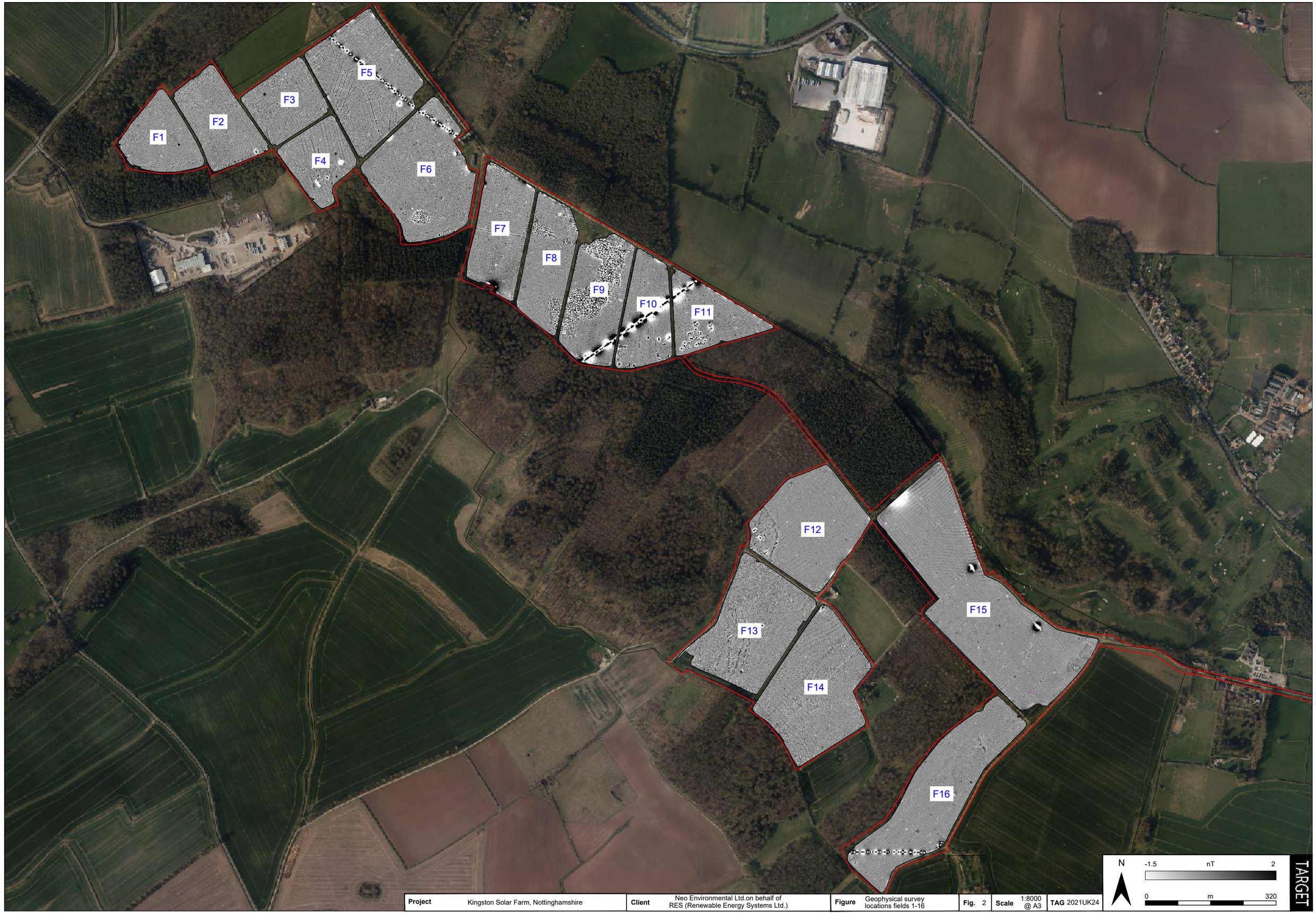
XY trace plots provide a near-perspective representation of measurements along individual lines of data recorded from each magnetometer sensor. The XY trace format is used as a conventional method for identifying responses of modern ferrous debris, and also as an aid in identifying locations of potential industrial features, such kilns and metal working.

7. XY trace from survey at the site of a deserted medieval village.



Project	Kingston Solar Farm, Nottinghamshire	**Client**	Neo Environmental Ltd.on behalf of RES (Renewable Energy Systems Ltd.)	**Figure**	Site location	**Fig.** 1	**Scale** 1:16,000 @ A3	**TAG** 2021UK24

TARGET



Project	Kingston Solar Farm, Nottinghamshire	**Client**	Neo Environmental Ltd.on behalf of RES (Renewable Energy Systems Ltd.)	**Figure**	Geophysical survey locations fields 1-16	**Fig.** 2	**Scale** 1:8000 @ A3	**TAG** 2021UK24

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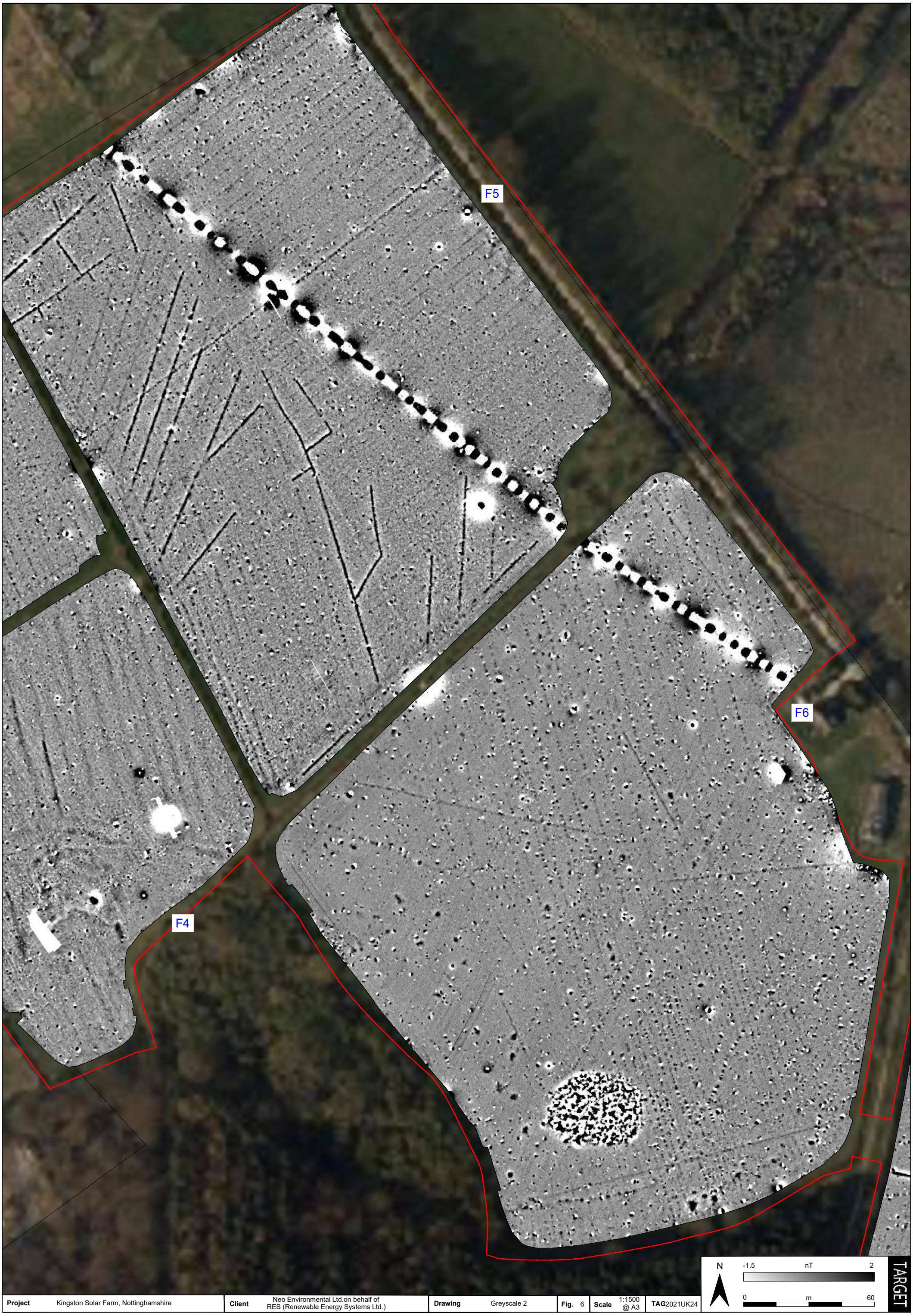
Project	Kingston Solar Farm, Nottinghamshire	**Client**	Neo Environmental Ltd.on behalf of RES (Renewable Energy Systems Ltd.)	**Figure**	Greyscale fields 1-11	**Fig.** 3	**Scale** 1:4000 @ A3	**TAG** 2021UK24

TARGET

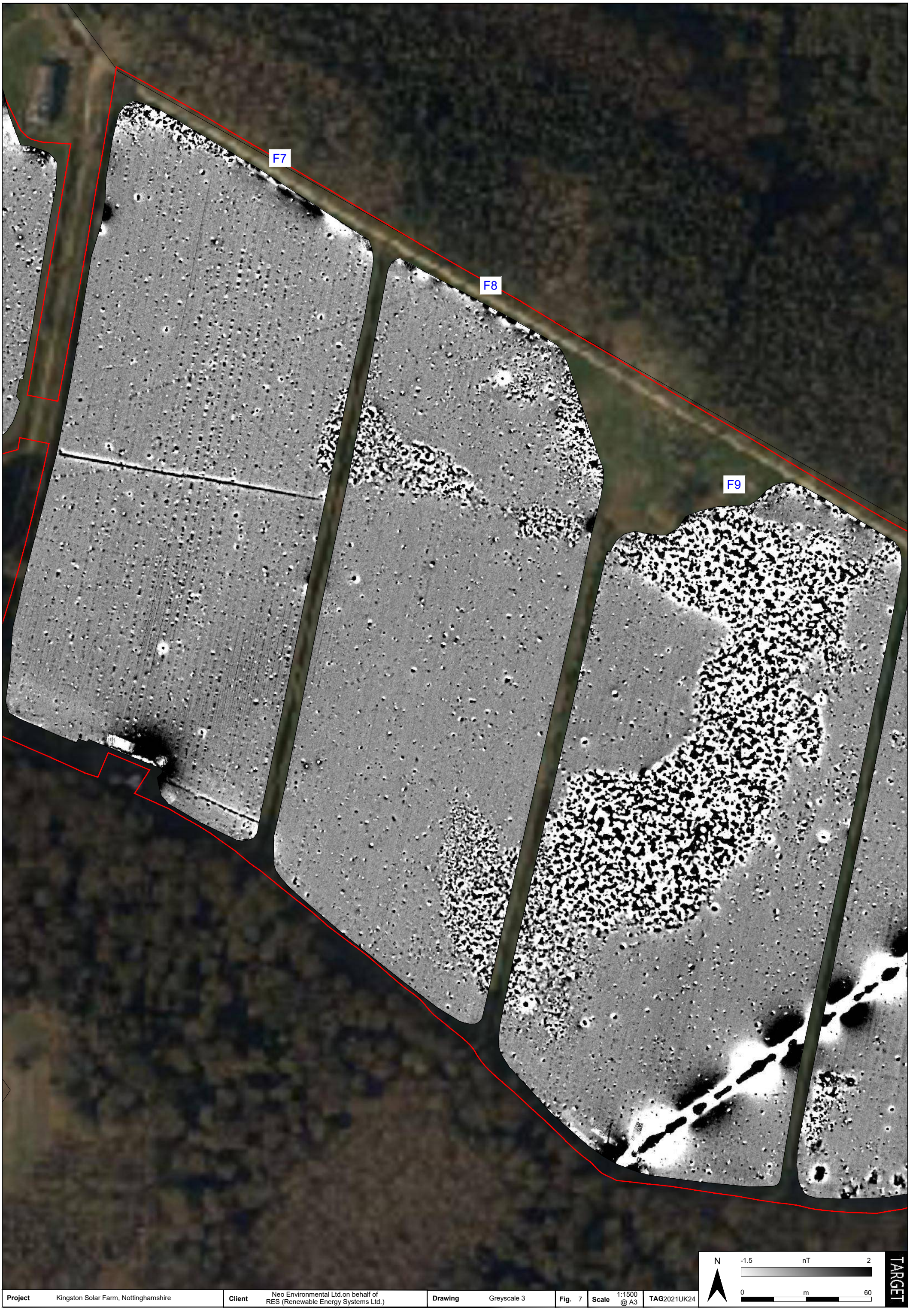
Project	Kingston Solar Farm, Nottinghamshire	**Client**	Neo Environmental Ltd.on behalf of RES (Renewable Energy Systems Ltd.)	**Figure**	Greyscale fields 12-16	**Fig.** 4	**Scale** 1:4000 @ A3	**TAG** 2021UK24

Project	Kingston Solar Farm, Nottinghamshire	**Client**	Neo Environmental Ltd.on behalf of RES (Renewable Energy Systems Ltd.)	**Figure**	Greyscale 1	**Fig.** 5	**Scale** 1:1500 @ A3	**TAG** 2021UK24

TARGET



Project	Kingston Solar Farm, Nottinghamshire	**Client**	Neo Environmental Ltd.on behalf of RES (Renewable Energy Systems Ltd.)	**Drawing**	Greyscale 2	**Fig.** 6	**Scale** 1:1500 @ A3	**TAG**2021UK24



Project	Kingston Solar Farm, Nottinghamshire	**Client**	Neo Environmental Ltd.on behalf of RES (Renewable Energy Systems Ltd.)	**Drawing**	Greyscale 3	**Fig.** 7	**Scale** 1:1500 @ A3	**TAG**2021UK24