RESEARCH REPORT SERIES no. 1-2015

WREST PARK, SILSOE, BEDFORDSHIRE REPORT ON GEOPHYSICAL SURVEY, NOVEMBER 2014

Neil Linford and Andrew Payne

REMOTE
SENSING

ENGLISH HERITAGE

This report has been prepared for use on the internet and the images within it have been down-sampled to optimise downloading and printing speeds.

Please note that as a result of this down-sampling the images are not of the highest quality and some of the fine detail may be lost. Any person wishing to obtain a high resolution copy of this report should refer to the ordering information on the following page.

Research Report Series 1-2015

WREST PARK, SILSOE, BEDFORDSHIRE

REPORT ON GEOPHYSICAL SURVEY, NOVEMBER 2014

Neil Linford and Andrew Payne

NGR: TL 091 353

ISSN 2046-9799 (Print)
ISSN 2046-9802 (Online)

SUMMARY

A Ground Penetrating Radar (GPR) survey was conducted over two separate areas of approximately 1.3ha at Wrest Park, Silsoe, Bedfordshire. The survey was undertaken to determine evidence for the presence of any significant buried remains in these areas, prompted by a request to erect ground tethered event marquees. Possible building remains were detected in the area immediately north of the Evergreen Garden, and appear to survive beneath the modern gravel Broadwalk path, although few significant anomalies were found over the lawn to the south. Interpretation of the results collected in the vicinity of Le Petit Trianon were complicated by the presence of modern planting and the recent removal of modern buildings from this area.

CONTRIBUTORS

The field work was conducted by Neil Linford and Andy Payne.

ACKNOWLEDGEMENTS

The author wishes to express his thanks to our colleagues Chris Slatcher and his team at the site for both practical assistance with the survey and, together with Magnus Alexander (Archaeological Investigation and Survey Team, Cambridge), for very useful discussions regarding the results.

ARCHIVE LOCATION

Fort Cumberland.

DATE OF FIELDWORK AND REPORT

The fieldwork was conducted on the 19th November 2014 and the report was completed on 22nd December 2014. The cover shows a view looking S towards the Bowling Green House, with the Evergreen Garden to the E.

CONTACT DETAILS

Geophysics Team, English Heritage, Fort Cumberland, Fort Cumberland Road, Eastney, Portsmouth, PO4 9LD.
Dr Neil Linford; tel. 02392 856761; email neil.linford@english-heritage.org.uk

CONTENTS

INTRODUCTION

The current rectangular mansion at Wrest Park was designed and built by its owner, Thomas Philip 2nd Earl de Grey, between 1834-39 following the demolition of the original house. Surrounding the mansion lies an extensive 40ha pleasure ground of formal gardens, parkland, woodland carriage drives and canalised water features (Scheduled Ancient Monument BD48). Whilst a considerable degree of remodelling to this designed landscape has occurred, including the addition of buildings for the Silsoe Research Institute for Agricultural Engineering Research that occupied the site until 2006, an ambitious restoration project been proposed to present four centuries of garden history to the public (Cocroft 2010).

The aim of the current geophysical survey, prompted by a request to erect ground tethered event marquees, was to determine whether evidence for the presence of any significant buried remains could be found in two separate areas of the site in the vicinity of the Evergreen Garden and Le Petit Trianon. Ground Penetrating Radar (GPR) was chosen for the survey following the successful application of this technique as part of a previous multi-disciplinary research project and the ability to estimate the depth to any significant buried remains (Linford 2011; Alexander *et al* 2013).

The site is centred on TL 09 35 and both areas covered by the current survey were laid down to well-kept lawns, interrupted by gravel pathways, planting and statues. In addition, buildings associated with the Research Institute have been recently removed from the area in the vicinity of the Le Petit Trianon, but still appear on the digital Ordnance Survey (OS) mapping. Soils of the Evesham 3 association have developed over Gault Clay (Soil Survey of England and Wales 1983; Geological Survey of Great Britain (England and Wales) 1992). In contrast to the GPR survey conducted in 2010 weather conditions, whilst dry and sunny on the day of the field work, had been preceded by heavy rain with standing water pooling in some low lying areas adjacent to the survey grid.

METHOD

Ground Penetrating Radar survey

A 3d-Radar Mk1V GeoScope Continuous Wave Stepped-Frequency (CWSF) radar system was used to conduct the survey collecting data with a multi-element DXG1922 vehicle towed, ground coupled antenna array (Linford *et al* 2010). A roving Trimble R8 Global Positioning System (GPS) receiver was mounted on the GPR antenna array to provide continuous positional control for the survey collected along the instrument swaths shown on Figure 1. Data were acquired at a 0.075m x 0.075m sample interval across a continuous wave stepped frequency range from 60MHz to 2.99GHz in 2MHz increments using a dwell time of 2ms. A single antenna element was monitored continuously to ensure data quality during acquisition together with automated processing

software to produce real time amplitude time slice representations of the data as each successive instrument swath was recorded (Linford 2014).

Post acquisition processing involved conversion of the raw data to time-domain profiles (through a time window of 0 to 50ns), adjustment of time-zero to coincide with the true ground surface, background and noise removal, and the application of a suitable gain function to enhance late arrivals. Representative profiles from the GPR survey are shown on Figure 3. To aid visualisation amplitude time slices were created from the entire data set by averaging data within successive 1.2ns (two-way travel time) windows (e.g. Linford 2004). An average sub-surface velocity of 0.102m/ns was assumed following constant velocity tests on the data, and was used as the velocity field for the time to estimated depth conversion. Each of the resulting time slices, shown as individual greyscale images in Figures 2, 4, 5, 6 and 7 therefore represents the variation of reflection strength through successive ~0.06m intervals from the ground surface. Further details of both the frequency and time domain algorithms developed for processing this data can be found in Sala and Linford (2010).

RESULTS

A graphical summary of the significant GPR anomalies, [gpr66-94], continuing the previous numbering scheme (Linford 2011, Figure 8), discussed in the following text, superimposed on the base OS map data, is provided in Figure 8.

Evergreen Garden

Despite the presence of standing water over the lawn to the NW of the survey area the general response is very good with significant reflections recorded to approximately 50ns. The response to both the broadwalk [gpr66] and the path from the Orangery to the Hawking Party statue [gpr67] have produced a high amplitude response in the near-surface data, with [gpr67] more persistent through the data when traversed EW where the antenna has apparently lost coupling over the slight edge kerbing.

To the NE of the survey area a rectilinear anomaly [gpr68] corresponds directly to the location of the laundry building, associated with the former medieval manor house, that was partially described in the 2010 GPR survey (Linford 2011, Figure 8, [gpr2]). Additional rectilinear anomalies [gpr69-71] are suggestive of further buildings in this area that extend beneath the broadwalk path. A low amplitude rectilinear anomaly [gpr72], a more amorphous high amplitude reflector [gpr73] and a linear response [gpr74] are also found in the near surface data beneath the broadwalk between 3.6 and 12ns (0.16 to 0.6m), although it is difficult to determine whether these are related to former buildings or the construction of the path itself, perhaps a drainage feature in the case of [gpr74].

Wider, more diffuse rectilinear anomalies [gpr75-77] are found in this area from between 4.8 and 18ns (0.24 to 0.9m) and whilst these do not persist in the data to the same depth

as the apparent buildings they may, perhaps, represent metalled surfaces, courtyards or building rubble. Anomaly [gpr75] is directly associated with a distinct topographic feature that contains a substantial tree stump, although the wider GPR response may be related to the medieval manor house buildings, similar to [gpr76] immediately to the west that appears to respect a NS interruption to the recorded topographic features (Alexander *et al* 2013, Figure 44). The more distinct rectilinear response at [gpr77] also occurs in an area where a number of topographic features have been recorded and where Roque shows the location of a terraced garden and green house structure, although none of these appears to correlate with either [gpr77] or the more tentative arcuate response [gpr78].

A more complex area of response [gpr79] could, potentially, be associated with the remains of a former mature tree bole with some of the short, broken linear responses are perhaps related to a buried tree roots. The anomalies at [gpr80] are also difficult to fully interpret and may well be associated with former garden features, drainage or water supply pipes. Two linear anomalies [gpr81] and [gpr82] run parallel immediately to the N and S of the broadwalk between 10.8 and 19.2ns (0.54 to 0.96m) and could represent either buried pipes or shallow retaining kerbs associated with the path.

There are relatively few significant anomalies found to the S of the broadwalk, although the linear anomaly at [gpr83] found between 9.6 and 18ns (0.48 to 0.9m), is likely to represent a land drain or service potentially falling to the W. A more discrete response at [gpr84] is found from the first time slice onwards and coincides with an apparent tree bole visible on the surface, and it is unclear whether this is associated with the more tentative, curvilinear responses [gpr85] found between 7.2 and 15.6ns (0.36 to 0.78m) or even, given the position of [gpr84] with the projected course of [gpr83], a collapsed section of the possible service. The right angled linear anomaly, [gpr86], correlates with the approximate location of the original planting shown on the first edition historic mapping activity (OS Historic County Mapping Series: Bedfordshire, Epoch 1, 1843 to 1893).

The near-surface anomalies associated with the building remains do not appear to continue beyond approximately 30ns (1.5m). However, the deeper time slices from between approximately 34.8ns (1.8m) onwards show a series of broad, parallel linear anomalies [gpr87] running on a SW-NE orientation, possibly related to an earlier cultivation pattern that appear to respect a similar response at [gpr88]. It is possible that [gpr88] represents a headland, although it does approximately follow the former boundary between the open lawn and mature planting shown on the current OS mapping.

Le Petit Trianon

The large buildings shown on the current OS mapping in this area have recently been dismantled with the foundations totally removed and compacted soil introduced to allow

replanting (C. Slatcher *pers. comm.*). Some linear anomalies [gpr89] correspond with the previous boundary fence and other, more discrete responses, [gpr90], may be associated with the footprint of the previous buildings. Some additional more diffuse reflectors [gpr91] to the N of the survey area do not appear to be directly related to the previous buildings, but do not immediately suggest any greater degree of significance.

From 3.6ns (0.18m) onwards a series of linear anomalies [gpr92] are partially described within the current survey area, possibly representing paths or walls. These anomalies lie beyond the boundary of the dismantled buildings and also do not appear to represent any previous features recorded on the OS historic mapping. Whilst an extant topographic feature in this area may suggest [gpr92] represents the remains of former garden features, association with later activity such as the war time Nissen huts positioned along Butcher's Row cannot be entirely disregarded (Alexander *et al* 2013, Figure 28). Equally, the more diffuse rectilinear anomaly at [gpr93] is difficult to fully interpret although the more discrete 2m square reflector at [gpr94] could, perhaps, represent a statue plinth.

CONCLUSION

The GPR survey has successfully detected a series of anomalies associated with the former medieval manor house and, potentially, elements of the later garden design in the vicinity of the Orangery. More fragmented anomalies of uncertain origin are found to the S of the broadwalk path towards the Evergreen Garden, although part of the previous garden design shown on the historic mapping does appear to survive. Few significant anomalies were detected in the immediate vicinity of Le Petit Trianon due, no doubt, to the recent removal of modern buildings from this area. Some potentially significant anomalies are partially described in this survey area, although further coverage beyond the scope of the current investigation would be required to suggest a more definitive interpretation. Despite the wet soil conditions the ground coupled antenna array produced comparable results to the original survey results collected in July 2010.

LIST OF ENCLOSED FIGURES

REFERENCES

Alexander, M, Hann, A, Small, F and O'Hara, P 2013 *'Wrest Park, Silsoe, Bedfordshire: Archaeological Landscape Investigations'*. English Heritage, Research Report Series 6/2013.

Cocroft, W 2010 *'Wrest Park, Bedfordshire, historic landscape investigation Research Execution Stage 2 Project Design'*. English Heritage, Research Department Project Design.

Geological Survey of Great Britain (England and Wales) 1992 Leigthon Buzzard, England and Wales Sheet 220, Solid and Drift edition. 1:50000 series., Ordnance Survey, Chessington, Surrey.

Linford, N 2004 'From Hypocaust to Hyperbola: Ground Penetrating Radar surveys over mainly Roman remains in the U.K.'. *Archaeological Prospection*, 11 (4), 237-246.

Linford, N 2011 *'Wrest Park, Silsoe, Bedfordshire: Report on Geophysical Survey, July 2010'*. English Heritage, Research Department Reports 28/2011.

Linford, N 2014 '*Rapid processing of GPR time slices for data visualisation during field acquisition'*. In Lambot, S, Giannopoulos, A, Pajewski, L, André, F, Slob, E and Craeye, C (Editors), Proceedings of the 15th International Conference on Ground Penetrating Radar (Square Brussels Meeting Centre, Brussels, Belgium: Université catholique de Louvain). 731-5.

Linford, N, Linford, P, Martin, L and Payne, A 2010 'Stepped-frequency GPR survey with a multi-element array antenna: Results from field application on archaeological sites'. *Archaeological Prospection*, 17 (3), 187-198.

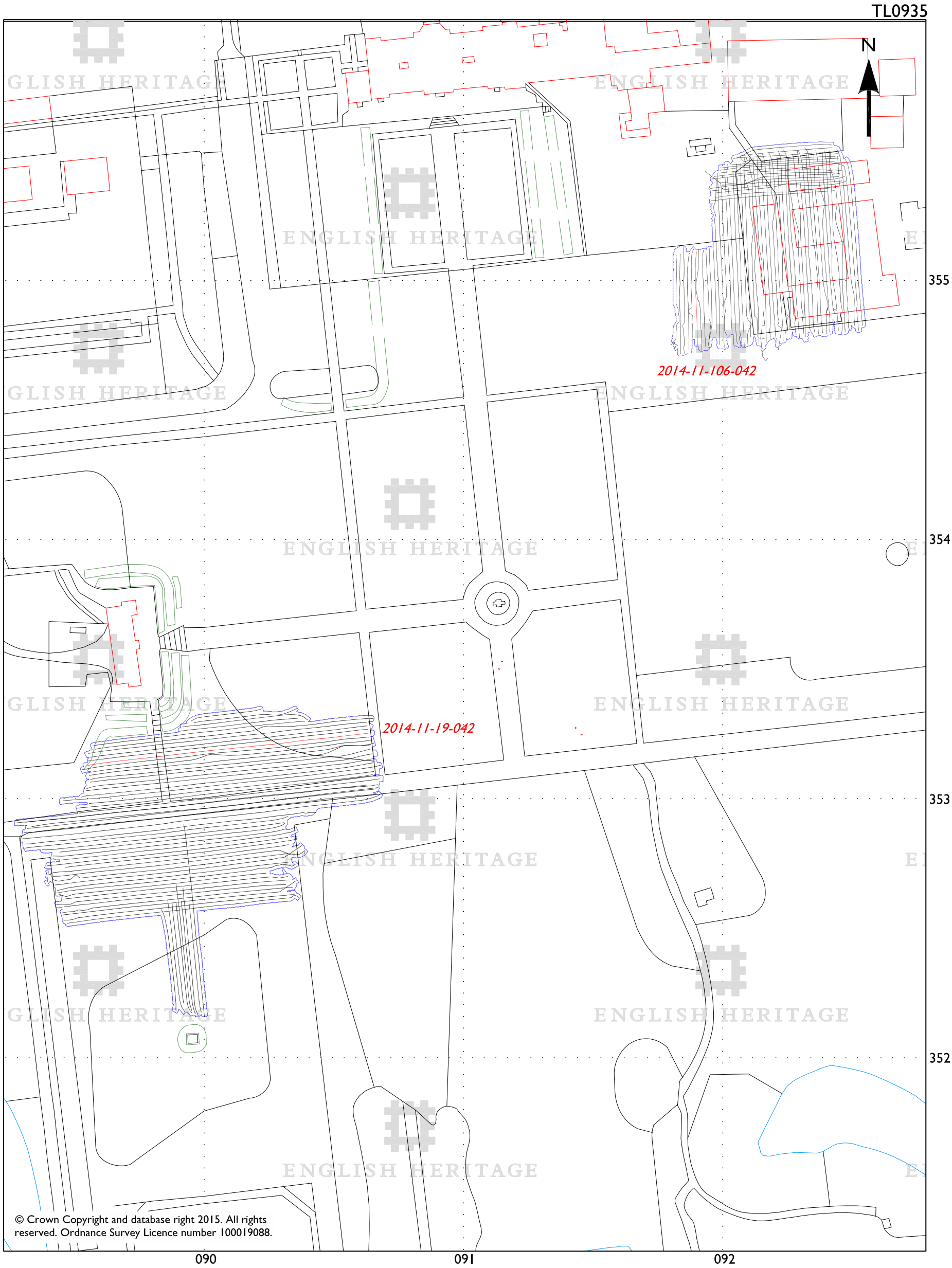
Sala, J and Linford, N 2010 '*Processing stepped frequency continuous wave GPR systems to obtain maximum value from archaeological data sets'*. In Crocco, L, Orlando, L, Persico, R and Pieraccini, M (Editors), Proceedings of the XIII International Conference on Ground Penetrating Radar Lecce (Italy), 21-25 June 2010 (Lecce: IEEE).

Soil Survey of England and Wales 1983 Soils of England and Wales: Sheet 4 - Eastern England, 1:250,000 soil map. Harpenden, Lawes Agricultural Trust.

Figure 1

WREST PARK, SILSOE, BEDFORDSHIRE

Location of GPR instrument swaths, November 2014.

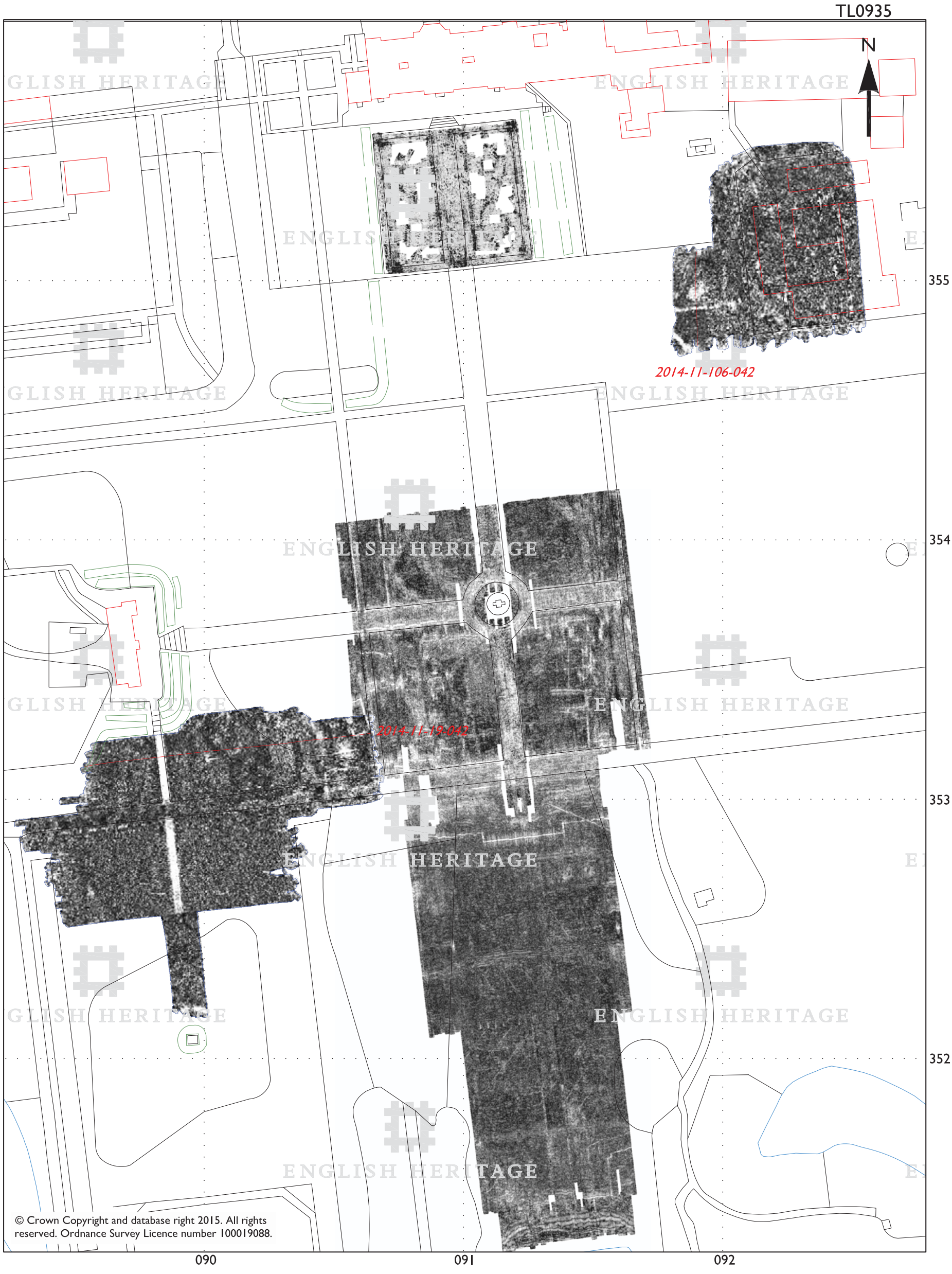


Geophysics Team 2015

ENGLISH HERITAGE

Figure 2

WREST PARK, SILSOE, BEDFORDSHIRE
GPR amplitude time slice 10.8 - 12.0ns (0.54 - 0.6m), July 2010, November 2011 and November 2014.



Geophysics Team 2015

ENGLISH HERITAGE

Figure 3

WREST PARK, SILSOE, BEDFORDSHIRE
Selected GPR profiles, November 2014

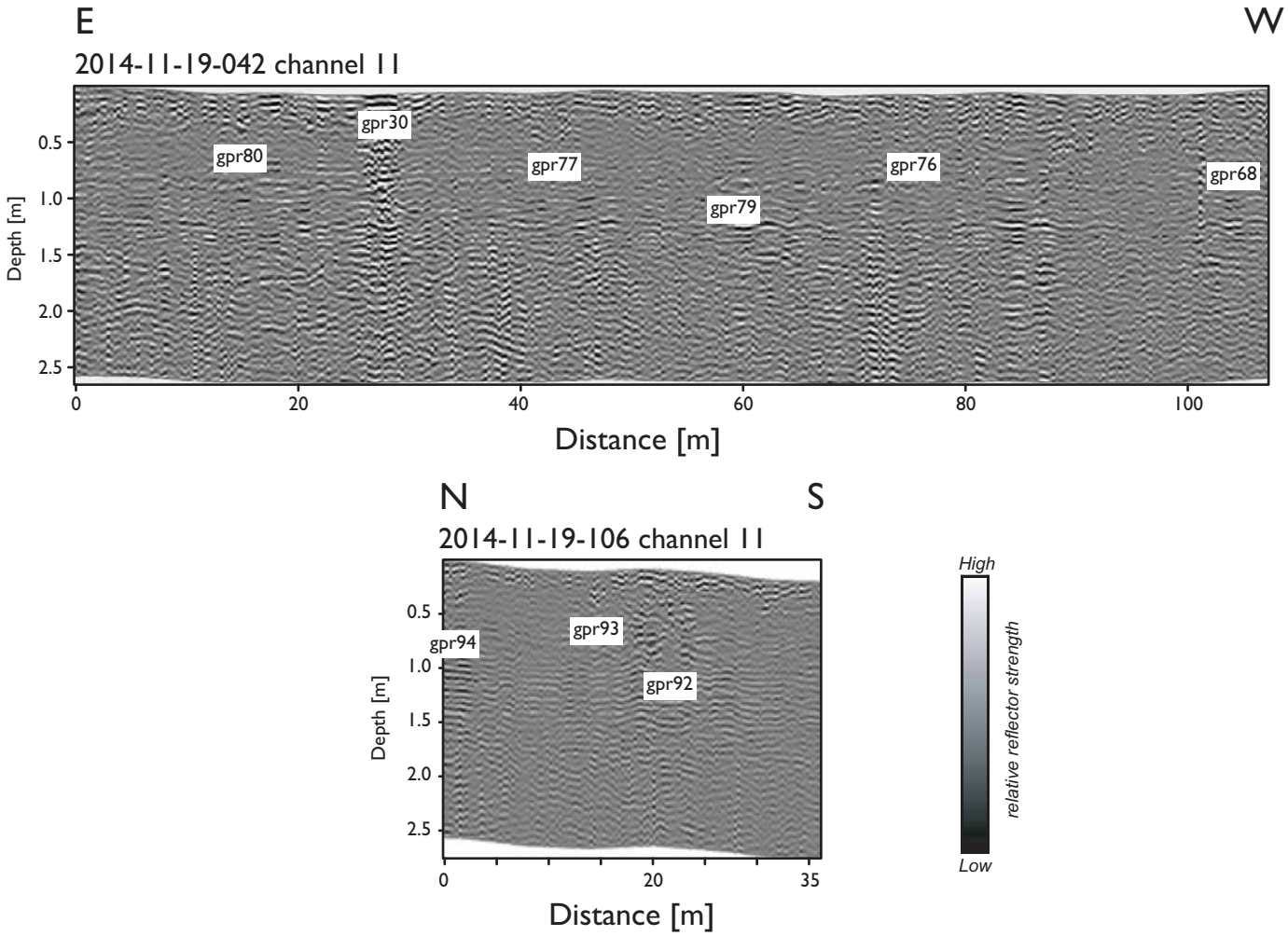
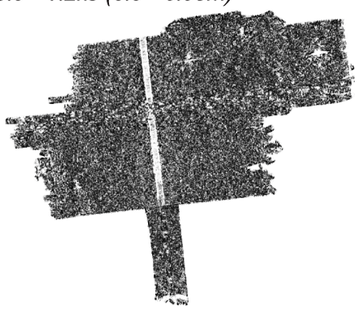


Figure 4

WREST PARK, EVERGREEN GARDEN, SILSOE, BEDFORDSHIRE
GPR amplitude time slices from 0.0 to 24.0ns (0.0 to 1.2m), November 2014.

0.0 - 1.2ns (0.0 - 0.06m)



1.2 - 2.4ns (0.06 - 0.12m)

2.4 - 3.6ns (0.12 - 0.18m)

3.6 - 4.8ns (0.18 - 0.24m)

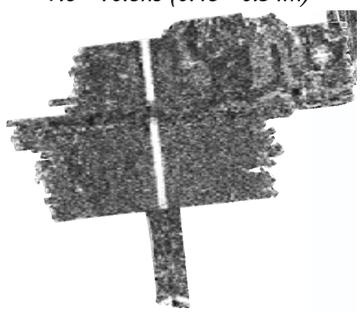
4.8 - 6.0ns (0.24 - 0.3m)

6.0 - 7.2ns (0.3 - 0.36m)

7.2 - 8.4ns (0.36 - 0.42m)

8.4 - 9.6ns (0.42 - 0.48m)

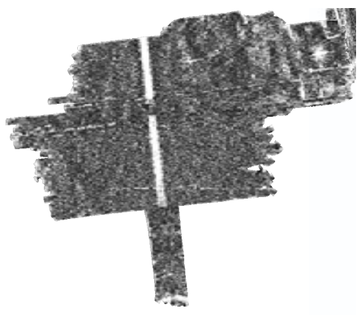
9.6 - 10.8ns (0.48 - 0.54m)



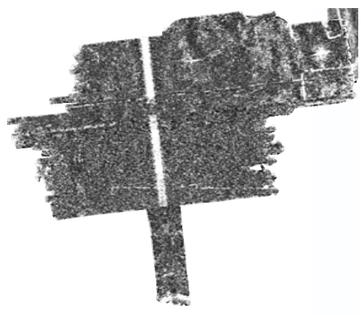
10.8 - 12.0ns (0.54 - 0.6m)

12.0 - 13.2ns (0.6 - 0.66m)

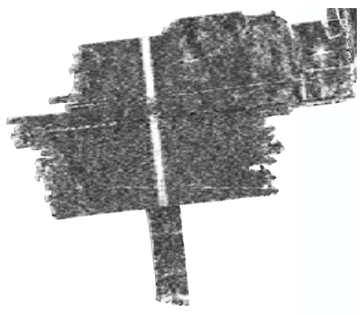
13.2 - 14.4ns (0.66 - 0.72m)



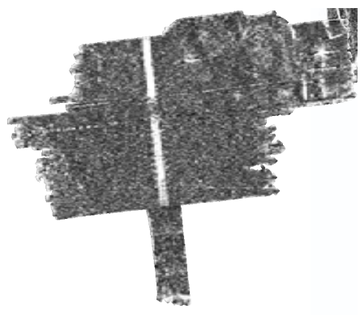
14.4 - 15.6ns (0.72 - 0.78m)



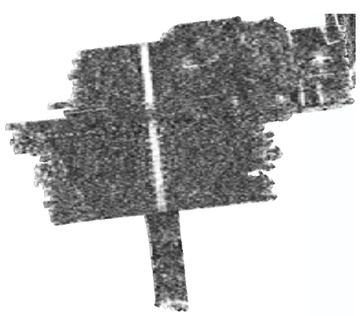
15.6 - 16.8ns (0.78 - 0.84m)



16.8 - 18.0ns (0.84 - 0.9m)



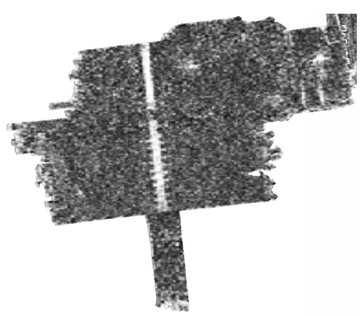
18.0 - 19.2ns (0.9 - 0.96m)



19.2 - 20.4ns (0.96 - 1.02m)

20.4 - 21.6ns (1.02 - 1.08m)

21.6 - 22.8ns (1.08 - 1.14m)



22.8 - 24.0ns (1.14 - 1.2m)

N

0 90m

1:2500

Low *High*
relative reflector strength

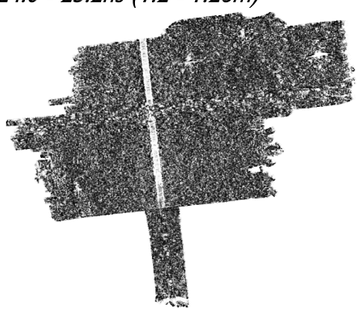
Geophysics Team 2015

ENGLISH HERITAGE

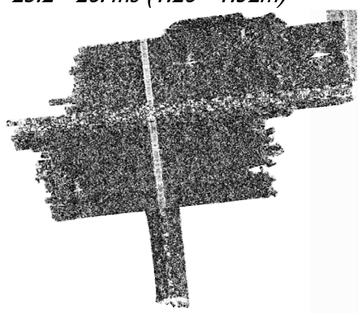
Figure 5

WREST PARK, EVERGREEN GARDEN, SILSOE, BEDFORDSHIRE
GPR amplitude time slices from 24.0 to 48.0ns (1.2 to 2.4m), November 2014.

24.0 - 25.2ns (1.2 - 1.26m)

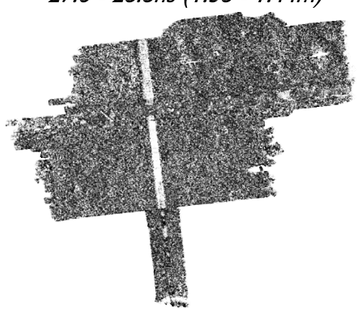


25.2 - 26.4ns (1.26 - 1.32m)



26.4 - 27.6ns (1.32 - 1.38m)

27.6 - 28.8ns (1.38 - 1.44m)

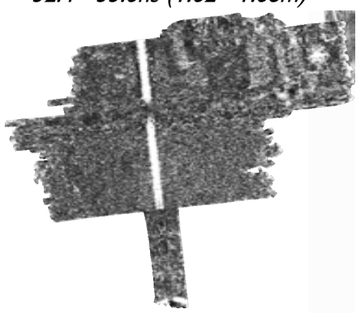


28.8 - 30.0ns (1.44 - 1.5m)

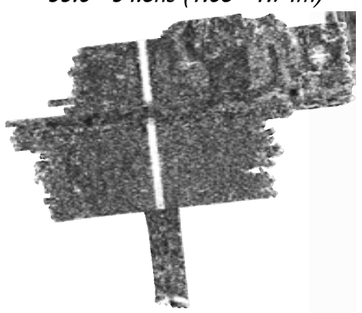
30.0 - 31.2ns (1.5 - 1.56m)

31.2 - 32.4ns (1.56 - 1.62m)

32.4 - 33.6ns (1.62 - 1.68m)

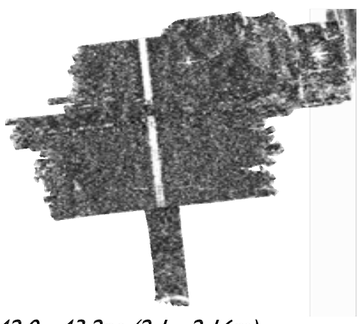


33.6 - 34.8ns (1.68 - 1.74m)



34.8 - 36.0ns (1.74 - 1.8m)

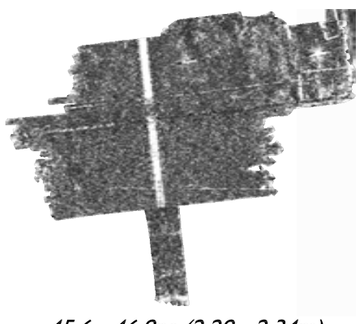
36.0 - 37.2ns (1.8 - 1.86m)



37.2 - 38.4ns (1.86 - 1.92m)

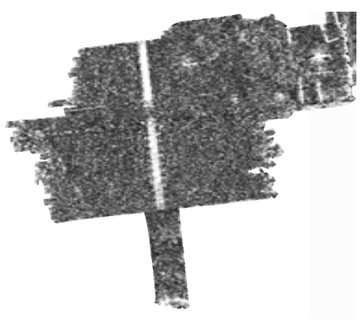
38.4 - 39.6ns (1.92 - 1.98m)

39.6 - 40.8ns (1.98 - 2.04m)

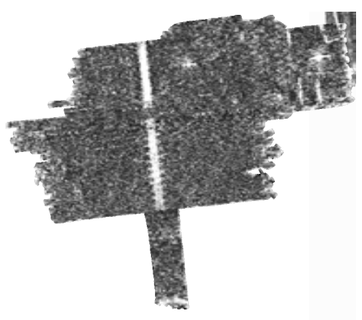


40.8 - 4..02ns (2.04 - 2.1m)

42.0 - 43.2ns (2.1 - 2.16m)

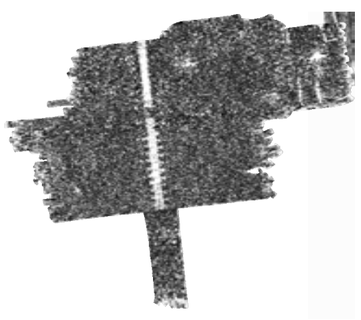


43.2 - 44.4ns (2.16 - 2.22m)

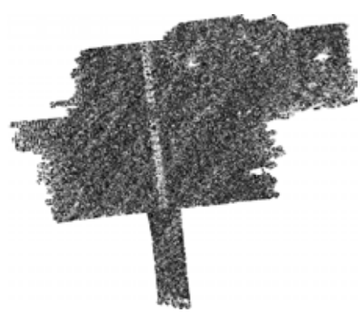


44.4 - 45.6ns (22.2 - 2.28m)

45.6 - 46.8ns (2.28 - 2.34m)



46.8 - 48.0ns (2.34 - 2.4m)



N

0 90m

1:2500

Low *High*
relative reflector strength

Geophysics Team 2015

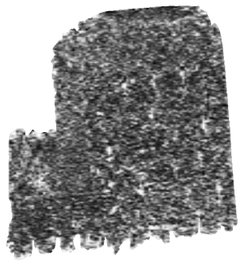
ENGLISH HERITAGE

Figure 6

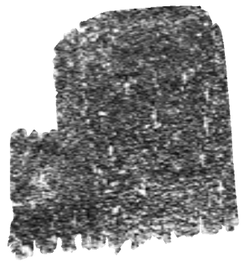
WREST PARK, LE PETIT TRIANON, SILSOE, BEDFORDSHIRE
GPR amplitude time slices from 0.0 to 24.0ns (0.0 to 1.2m), November 2014.

0.0 - 1.2ns (0.0 - 0.06m)

1.2 - 2.4ns (0.06 - 0.12m)

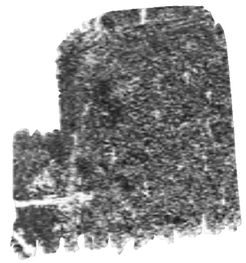


2.4 - 3.6ns (0.12 - 0.18m)

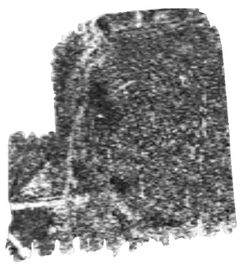


3.6 - 4.8ns (0.18 - 0.24m)

4.8 - 6.0ns (0.24 - 0.3m)



6.0 - 7.2ns (0.3 - 0.36m)



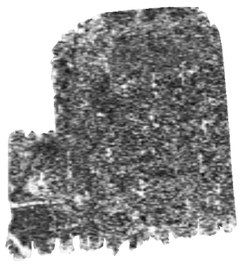
7.2 - 8.4ns (0.36 - 0.42m)

8.4 - 9.6ns (0.42 - 0.48m)

9.6 - 10.8ns (0.48 - 0.54m)

10.8 - 12.0ns (0.54 - 0.6m)

12.0 - 13.2ns (0.6 - 0.66m)



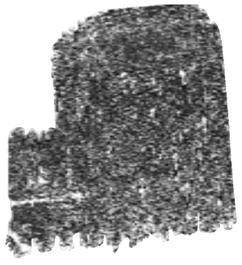
13.2 - 14.4ns (0.66 - 0.72m)

14.4 - 15.6ns (0.72 - 0.78m)

15.6 - 16.8ns (0.78 - 0.84m)

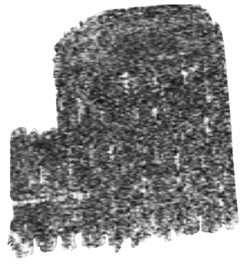
16.8 - 18.0ns (0.84 - 0.9m)

18.0 - 19.2ns (0.9 - 0.96m)

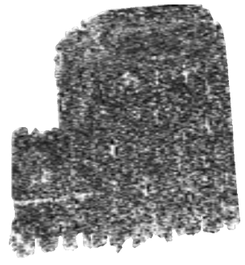


19.2 - 20.4ns (0.96 - 1.02m)

20.4 - 21.6ns (1.02 - 1.08m)



21.6 - 22.8ns (1.08 - 1.14m)



22.8 - 24.0ns (1.14 - 1.2m)

N

0 90m

1:2000

Low *High*
relative reflector strength

Geophysics Team 2015

ENGLISH HERITAGE

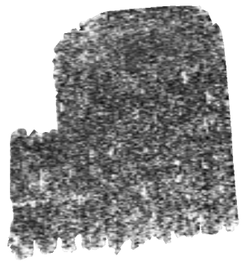
Figure 7

WREST PARK, LE PETIT TRIANON, SILSOE, BEDFORDSHIRE
GPR amplitude time slices from 24.0 to 48.0ns (1.2 to 2.4m), November 2014.

24.0 - 25.2ns (1.2 - 1.26m)

25.2 - 26.4ns (1.26 - 1.32m)

26.4 - 27.6ns (1.32 - 1.38m)

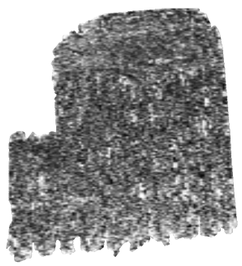


27.6 - 28.8ns (1.38 - 1.44m)

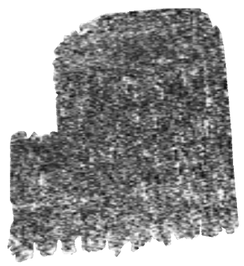
28.8 - 30.0ns (1.44 - 1.5m)

30.0 - 31.2ns (1.5 - 1.56m)

31.2 - 32.4ns (1.56 - 1.62m)



32.4 - 33.6ns (1.62 - 1.68m)



33.6 - 34.8ns (1.68 - 1.74m)

34.8 - 36.0ns (1.74 - 1.8m)

36.0 - 37.2ns (1.8 - 1.86m)

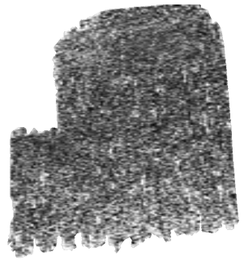
37.2 - 38.4ns (1.86 - 1.92m)

38.4 - 39.6ns (1.92 - 1.98m)

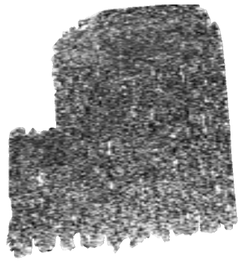
39.6 - 40.8ns (1.98 - 2.04m)

40.8 - 4..02ns (2.04 - 2.1m)

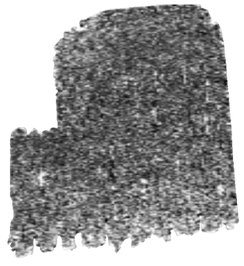
42.0 - 43.2ns (2.1 - 2.16m)



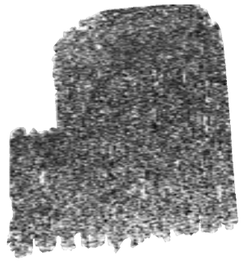
43.2 - 44.4ns (2.16 - 2.22m)



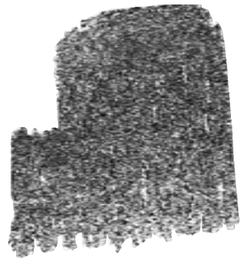
44.4 - 45.6ns (22.2 - 2.28m)



45.6 - 46.8ns (2.28 - 2.34m)



46.8 - 48.0ns (2.34 - 2.4m)



N

0 90m

1:2000

Low *High*
relative reflector strength

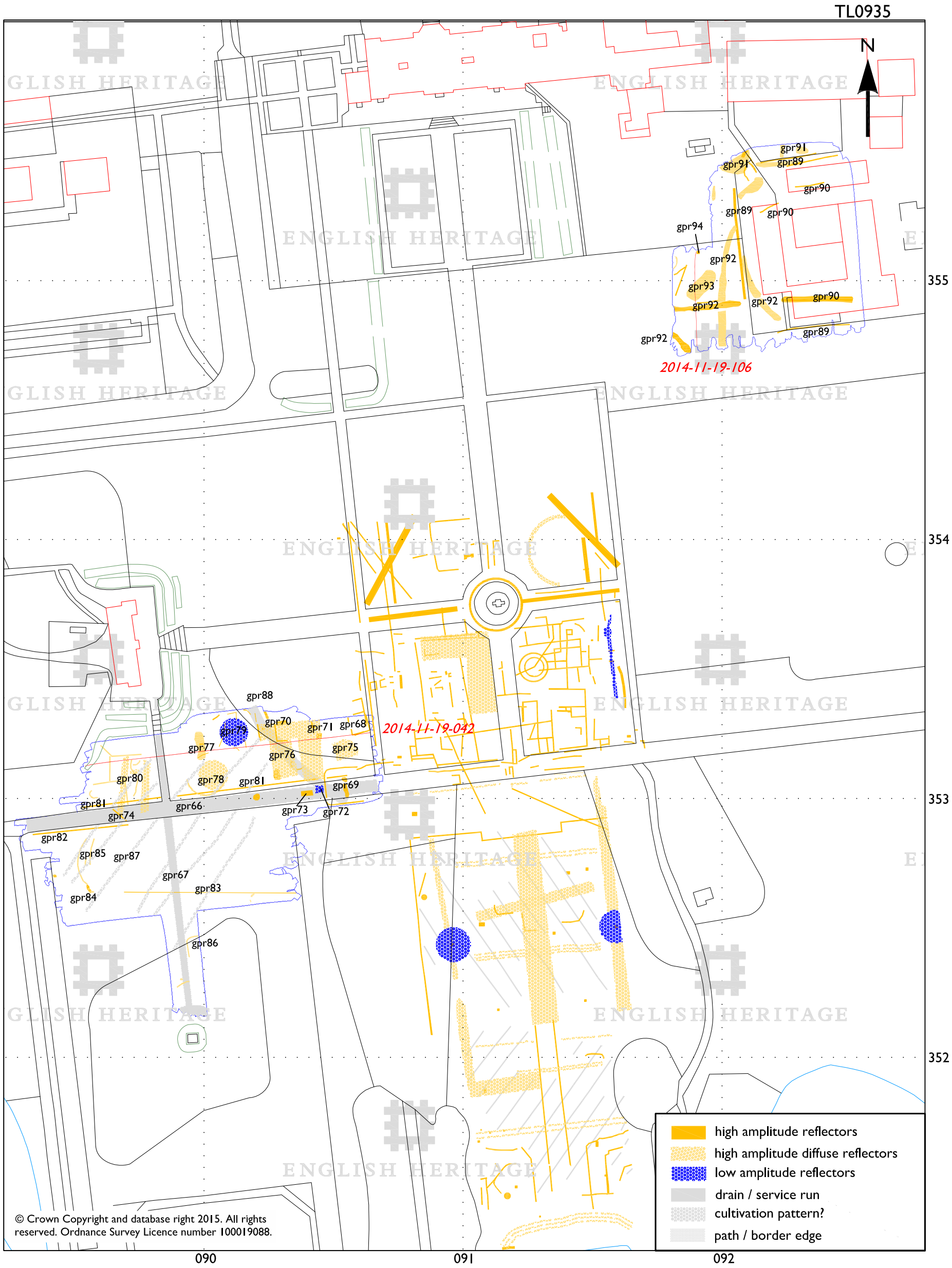
Geophysics Team 2015

ENGLISH HERITAGE

Figure 8

WREST PARK, SILSOE, BEDFORDSHIRE

Graphical summary of significant GPR anomalies, July 2010 and November 2014.



Geophysics Team 2015

ENGLISH HERITAGE

ENGLISH HERITAGE RESEARCH AND THE HISTORIC ENVIRONMENT

English Heritage undertakes and commissions research into the historic environment, and the issues that affect its condition and survival, in order to provide the understanding necessary for informed policy and decision making, for the protection and sustainable management of the resource, and to promote the widest access, appreciation and enjoyment of our heritage. Much of this work is conceived and implemented in the context of the National Heritage Protection Plan. For more information on the NHPP please go to http://www.english-heritage.org.uk/professional/protection/national-heritage-protection-plan/.

The Heritage Protection Department provides English Heritage with this capacity in the fields of building history, archaeology, archaeological science, imaging and visualisation, landscape history, and remote sensing. It brings together four teams with complementary investigative, analytical and technical skills to provide integrated applied research expertise across the range of the historic environment. These are:

* Intervention and Analysis (including Archaeology Projects, Archives, Environmental Studies, Archaeological Conservation and Technology, and Scientific Dating)
* Assessment (including Archaeological and Architectural Investigation, the Blue Plaques Team and the Survey of London)
* Imaging and Visualisation (including Technical Survey, Graphics and Photography)
* Remote Sensing (including Mapping, Photogrammetry and Geophysics)

The Heritage Protection Department undertakes a wide range of investigative and analytical projects, and provides quality assurance and management support for externally-commissioned research. We aim for innovative work of the highest quality which will set agendas and standards for the historic environment sector. In support of this, and to build capacity and promote best practice in the sector, we also publish guidance and provide advice and training. We support community engagement and build this in to our projects and programmes wherever possible.

We make the results of our work available through the Research Report Series, and through journal publications and monographs. Our newsletter *Research News*, which appears twice a year, aims to keep our partners within and outside English Heritage up-to-date with our projects and activities.

A full list of Research Reports, with abstracts and information on how to obtain copies, may be found on www.english-heritage.org.uk/researchreports

For further information visit www.english-heritage.org.uk

ENGLISH HERITAGE

ISSN 2046-9799 (Print)
ISSN 2046-9802 (Online)