



Witley Court, Great Witley, Worcestershire Report on Geophysical Surveys, November 2016

Neil Linford and Andrew Payne

Discovery, Innovation and Science in the Historic Environment



WITLEY COURT,
GREAT WITLEY,
WORCESTERSHIRE

REPORT ON GEOPHYSICAL SURVEY,
November 2016

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SUMMARY

A Ground Penetrating Radar (GPR) survey was conducted at Witley Court, Great Witley, Worcestershire, at the request of the English Heritage Trust who manage the site. The aim of the high sample density GPR survey (2.7ha) was to provide evidence for any surviving structural remains, drains or cellarage in the stable yards area, to assist with the provision of new staff welfare facilities on site, and to complement the previous geophysical coverage in the reconstructed gardens surrounding the ruined house. Despite the presence of modern planting in the garden and limited access within the stable yards, the GPR survey revealed surviving structural remains related to the original house and service wings, together with limited additional elements of the previous garden designs.

CONTRIBUTORS

The geophysical fieldwork was conducted by Neil Linford and Andrew Payne.

ACKNOWLEDGEMENTS

The authors are grateful to Jasmine Grove, Head Gardener, and her colleagues for assistance with access to allow the survey to take place and providing us with invaluable information on the site.

ARCHIVE LOCATION

Fort Cumberland, Portsmouth.

DATE OF SURVEY

The fieldwork was conducted between 14th to 18th November 2016 and the report completed on 29th March 2017. The cover image shows the survey in progress with the south portico of the house and restored parterre gardens in the background.

CONTACT DETAILS

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INTRODUCTION

A Ground Penetrating Radar (GPR) survey was conducted at Witley Court, Great Witley, Worcestershire, (Scheduled Monument List Entry 1005292) to complement a condition survey of the site and support the development of staff welfare facilities in the stable yards. The house is of medieval origin, rebuilt in the C17th century with numerous periods of remodelling and landscaping of the gardens, particularly the design by W A Nesfield completed in 1861 encompassing the two impressive ornamental fountains. Following a fire in 1937 the building was sold and many of the architectural features were stripped and sold for salvage. Contemporary photographs show the house and gardens in their prime, although much of this was lost once the site was neglected before more recent restoration of the fountains and gardens through the care of English Heritage.

A previous geophysical survey had been conducted over two areas to the N and S of the house, before the restoration of the gardens, using area magnetic and earth resistance survey, together with trial Ground Penetrating Radar (GPR) profiles collected with a 300MHz centre frequency antenna (Bartlett *et al.* 1997). Based on this earlier successful work it was hoped that an area GPR survey could complement the existing results and, potentially, clarify some of the responses found in the original GPR profiles.

Site conditions were mixed between hard surfaces in the stable yards, the gardens surrounding the house, that are mainly laid to lawn with areas of formal planting, and the fountain bowls, all joined by connecting gravel paths. Well drained reddish coarse loamy soils of the Bromsgrove (541b) association have developed over soft sandstones inter-bedded with red and brown siltstones and mudstones, of the Bromsgrove sandstone formation (Geological Survey of Great Britain 1976; Soil Survey of England and Wales 1983). The previous geophysical survey also noted the presence of clay deposits, perhaps up to 1m thick, to the W of the site. Weather conditions were generally good with one heavy down pour of rain during the survey.

METHOD

Ground Penetrating Radar survey

A 3d-Radar MkIV GeoScope Continuous Wave Stepped-Frequency (CWSF) Ground Penetrating Radar (GPR) system was used to conduct the survey collecting data with a multi-element DXG1820 vehicle towed, ground coupled antenna array (Linford *et al.* 2010). A roving Trimble R8 Global Navigation Satellite System (GNSS) receiver, together with a second R8 base station receiver established using the Ordnance Survey VRS Now correction service, 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 in the stable yards and 4MHz increments in the gardens, 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 in the field (Linford 2013).

Post-acquisition processing involved conversion of the raw data to time-domain profiles (through a time window of 0 to 75ns), 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 topographically corrected 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 2.5ns (two-way travel time) windows (e.g. Linford 2004). An average sub-surface velocity of 0.106m/ns was assumed following constant velocity tests on the data, and used as the velocity field for the migration and time to estimated depth conversion. Each of the resulting time slices, shown as individual greyscale images, therefore represents the variation of reflection strength through successive ~0.13m intervals from the ground surface in Figures 2, 4, 5 and 6. Further details of both the frequency and time domain algorithms developed for processing this data can be found in Sala and Linford (2012).

RESULTS

A graphical summary of the significant GPR anomalies, [**gpr1-84**], discussed in the following text, are shown superimposed on the base OS map data on Figures 7 and 8.

Stable yards

Access within this area was restricted by the presence of standing buildings and a considerable degree of masonry and other material stored in the working yard. The ground surface was metalled throughout, producing good ground coupling, either with cobbles or decorative tiles the pattern of which has been replicated in the near-surface data [**gpr1**] on Figure 7 along with the bollard bases [**gpr2**] in the passage by the stable block. Other near surface linear anomalies appear to relate to visible drain runs and surface gratings in the yard, including a central drain [**gpr3**] (marked by parallel kerb stones on the surface of the yard) branching to the W at [**gpr4**], and with a spur [**gpr5**] running S towards the current welfare Portacabin, found between approximately 5 and 30ns (0.27 to 1.61m). It is difficult to fully interpret the nature of these anomalies from the

GPR data alone, although [gpr3] and [gpr5] both appear to be formed of a single pipe or conduit, with a more complex response from [gpr4], perhaps suggesting a more substantive subsurface feature. The fall of [gpr3] and [gpr4] runs from E to W.

The area of collapse visible against the W wall appears to be associated with a complex group of linear anomalies [gpr6] between approximately 2.5 and 35ns (0.13 to 1.87m), beyond which it becomes a larger, more amorphous response associated with airwave reflections suggestive of a more substantial area of subsurface voiding. Again, other service type responses [gpr7] and [gpr8] appear to cut [gpr6], but may not necessarily be directly associated with the more substantial anomaly as they are found between 12.5 and 20ns (0.67 to 1.07m), perhaps more suggestive of electricity supply cables, or other similar services.

Anomaly [gpr9] runs S from [gpr6] at depth between approximately 12.5 and 20ns (0.67 to 1.07m) towards the current Portacabin. It is unclear whether [gpr9] represents a service supplying the welfare facility, perhaps associated with the brick cabinet against the N wall of the yard close to the fenced area of surface collapse. A more substantial response [gpr10] is partially described in the area available for survey in the immediate vicinity of the current Portacabin site, with a fall of approximately 12.5ns (0.57m) to 20ns (1.07m) W to E beneath the welfare facilities. Anomaly [gpr10] appears to represent a subsurface feature, such as a service pipe or drainage conduit, rather than wall footings, other structural elements of a previous building, or a lean to structure against the S wall, such as the shallow rectilinear response [gpr11] immediately to the N.

Two linear anomalies [gpr12] and [gpr13] cross the yard, but it is unclear whether either of these is associated with the other services identified by the survey. To the E of the yard fragmented responses at [gpr14] and [gpr15] appear more structural, perhaps representing wall footings removed from between the surviving standing buildings.

Access to the other areas of the stable yards towards the main house was more restricted, although a response in the vicinity of the open cellars at [gpr16] appears from approximately 10ns (0.54m) onwards, and may also extend S of the colonnade to [gpr17]. Both [gpr16] and [gpr17] represent more complex anomalies with a linear, service type component in the near surface data developing into more amorphous areas of response in the deeper time slices. An area of surface deformation was noted during the survey in the vicinity of [gpr17] which may suggest some subsurface instability. The response at [gpr18] relates to wall footings and structural elements of the curved wall addition to the main house, which remains partially standing in this area. Some further areas of possible structural remains are found at [gpr19-21] together

with a number of linear responses [**gpr22-26**], possibly related to drainage or services, although the area available for survey limits further interpretation of these anomalies.

North Forecourt and the East Parterre

The North Courtyard contains a central drain [**gpr27**] on Figure 8 which falls towards the house from 10ns (0.54m), where it meets a spur at [**gpr28**] and turns abruptly to the W, and is met along its length by a herring bone pattern of feeders [**gpr29**], falling from the edges of the metalled drive way in to [**gpr27**]. A linear low amplitude anomaly [**gpr30**] extends from the junction of [**gpr27**] and [**gpr28**] between the wings of the house, but is apparently of different construction to the main drain and is partially obscured by a network of shallow linear services [**gpr31**]. Most of the drainage system here would appear to be constructed from stone-lined conduits, rather than ferrous or ceramic pipes, as there is little correlation between the GPR responses and the previous magnetic survey (cf Bartlett *et al.* 1997, Plan 2, anomaly c).

Other potentially structural anomalies are found in between the two wings of the house, but are difficult to interpret due to their fragmentary nature and the extensive drainage system. An apparently semi-circular, low amplitude anomaly [**gpr32**] is evident from between 5.0 and 32.5ns (0.27 to 1.74m) and seems likely to represent the centre of the former gravel carriage turning circle, the outer elements of which appear to survive in aerial photographs of the derelict house taken in 1969. An alternative interpretation for [**gpr32**] may be sub-surface structural remains or a cistern associated with either surface drainage or rain water collection.

The East Parterre is mainly laid to lawn interrupted by planting and paths surrounding the Flora fountain, and some mature specimen trees whose root systems are visible [**gpr33**] in the near surface data between 2.5 and 10ns (0.13 to 0.54m). As expected from the previous geophysical survey the wall footings [**gpr34**] of the service wings demolished in 1804 have been detected between 7.5 and 37.5ns (0.4 to 2.01m) with the radar data, perhaps, suggesting a little more detail than the original earth resistance and magnetic results. This includes two parallel low amplitude anomalies [**gpr35**], apparently an extension of the building or related structures further to the E, perhaps the stable block added by the 1st Lord and Lady Foley in 1733. There are a number of elements within the building footprint that are more difficult to interpret, including three discrete reflectors at [**gpr36**] that do not extend as deep as the surrounding walls, and possible services at [**gpr37-39**].

Other services detected by the radar survey include the pipe [**gpr40**] recorded by the previous magnetic survey (cf Bartlett *et al.* 1997, Plan 2, anomaly a), and what appear to be two more substantial services [**gpr41**] and [**gpr42**] heading

E from the house. The previous GPR results show a pipe following the approximate course of [gpr41], assuming this is linear between the recorded GPR profiles and across the new parterre where the current survey could not gain access. However, the precise course of [gpr41] is less distinct as it continues E suggesting it either terminates at the foot of the slight scarp onto the level garden, continues as a pipe rather than a more substantial brick feature, or is buried at more considerable depth here. Between 2.5 and 7.5ns (0.13 to 0.4m) [gpr41] passes beneath a circular anomaly [gpr43] of diameter 4m which seems most likely to represent a former planting feature. There is also some evidence at a similar depth for a service, possibly [gpr42], cutting through the buried metalled surfacing of the path heading N from the steps onto the lawn at [gpr44]. Other, more fragmented responses are found in the vicinity of the demolished service range, but are difficult to interpret.

Further services are found in the accessible areas surrounding the East Parterre and Flora fountain, possibly related to water supplies and drainage [gpr45-53], and could well correspond with pipe type responses identified to the S of Lines 2 and 3 in the original GPR survey (cf Bartlett *et al.* 1997, Plan 2). Anomaly [gpr53] follows a course SW from the Flora fountain and appears to correlate with the two large pipes identified in the previous magnetic survey conducted to the S of the house.

South Parterre garden

This area is partially interrupted by modern metalled paths, the replanted south parterres and other planting together with the Perseus and Andromeda fountain. The water supply [gpr53] continues across the parterres but is only partially visible due to the interrupted area available for the survey, and does not correlate directly with the ferrous pipes interpreted from the magnetic data. A further short drain [gpr54] appears to run from a replanted parterre into a broader, low amplitude rectilinear anomaly [gpr55], possibly a soak-away or former area of planting. The near surface data between 5.0 and 12.5ns (0.27 to 0.67m) shows a high amplitude anomaly [gpr56] adjacent to [gpr55], which may represent a gravel or paved platform adjacent to the E balustrade wall of the garden. Other more fragmented responses in this area [gpr57-59] are difficult to interpret and may relate to partially surviving elements of the garden design, mature tree roots and some low amplitude anomalies likely to represent former planting beds [gpr60].

Evidence for drainage or other services beneath the modern paths is found at [gpr61-64], with further anomalies found towards the Perseus and Andromeda fountain including a surface inspection cover [gpr65], possible drains or pipes [gpr66] and three parallel linear responses [gpr67] associated with the water feature. An area of low amplitude response in the vicinity of [gpr53] and [gpr66] may be due to water leaking from these pipes and presents a possible

explanation for the local deformation of the path that has occurred here. Two other pipe runs are evident at [gpr68] and [gpr69] that are also partially represented in the previous magnetic survey (cf Bartlett *et al.* 1997, Plan 2, anomaly n). The outrun from the N of the fountain [gpr67] is intriguing as it would appear to comprise three large diameter (~0.5m) drain pipes, a parallel pair at a depth of ~0.7m from the surface matching the two openings currently visible inside the drained bowl, and central, slightly deeper response at ~1.0m. Further comparison with the promotional film made by the rock band Procul Harum in 1967 also depicts the drained fountain bowl but with four parallel drainage apertures visible (Fly Records 2012, visible at 0:33/4:00).

The fragmented anomalies at [gpr70] are similar to the magnetic and earth resistance responses and seem likely to represent elements of a previous formal garden design, although this would appear to be highly degraded. To the S of the restored central parterres some evidence for elements of Nesfield's original garden design appears to survive, including terrace walls [gpr71] which are partially visible on the surface, but may have been recut and more extensive than the current topography of the site might immediately suggest. Elements of the E-W path [gpr72] centred on the Perseus and Andromeda fountain also appear to extend beyond the modern settings, perhaps suggesting a connection with the perimeter of the garden taking in more circular walks and vistas. The location of four, ornate planters positioned around the fountain have been revealed by the current survey, at [gpr73-76], together with the central plinths supporting raised pedestals. It would appear that only part of the original design for eight such planters shown in a watercolour by Nesfield were actually realised, confirmed by historic photographs of the site c1870 (Gray 1997, p31 and p32). The area in the vicinity of [gpr76] seems quite disturbed and it is unclear whether this may be due, in part, to the course of the large vaulted conduits running from the service entrance immediately beyond the garden boundary to the fountain.

Further elements of the original garden design, only partially represented in the surviving topography, are found to the S of the Perseus and Andromeda fountain. These appear to represent former planting beds [gpr77] and [gpr78] together with other linear terracing or garden walls [gpr79-81] which partially reflect the design immediately N of the fountain (cf [gpr71]). A central linear anomaly [gpr82] could represent a former water supply to the fountain, believed to have been removed during the second world war, running down the hill from an area of possible hard standing [gpr83] associated with the location of the Golden Gates that once terminated the south parterre. Other responses within the south parterre are too fragmented to suggest a definitive interpretation, although a short linear anomaly [gpr84] seems likely to represent a drain run.

CONCLUSIONS

In general, the GPR survey has proved successful although the response has varied throughout the site, dependent largely on the ground surface conditions that have been presented. The survey conducted within the stable yards to assist with the location of new site welfare facilities has produced a complex response associated with a series of linear anomalies, representing drain runs, services or cellars. From the GPR data alone it is difficult to determine the precise nature of these anomalies, or identify whether these are likely to be load bearing without danger of future collapse or subsidence. Correlation with existing service plans, if these exist, is recommended together with further invasive investigation of GPR anomalies falling within the footprint of any new structures.

The wider survey of the North Forecourt, East and South Parterre gardens has, despite the slightly interrupted nature of the areas available, complemented the previous magnetic, earth resistance and limited GPR coverage conducted in advance of reinstating the formal gardens. Some known deeper lying structures have not been detected due, perhaps, to the soil conditions at the site which appear to have limited the maximum depth of penetration to approximately 1.5m in parts, although the majority of GPR anomalies identified by the original survey have been confirmed. In addition, the current survey has provided new information regarding the location and survival of Nesfield's garden design, particularly in the south parterre. Whilst elements of this garden are known from historic photographs and Nesfield's own design drawings and water colours, it is evident from the geophysical survey that not all of the original plans were actually realised.

LIST OF ENCLOSED FIGURES

- Figure 1* Location of the GPR instrument swaths superimposed over the base OS mapping data (1:2000).
- Figure 2* Greyscale image of the GPR amplitude time slice from between 12.5 - 15.0ns (0.67 - 0.8m) superimposed over the base OS mapping data. The location of the GPR profiles shown on Figure 3 are also indicated (1:2000).
- Figure 3* Topographically corrected profiles from the GPR survey shown as greyscale images with annotation denoting significant anomalies. The location of the selected profiles can be found on Figures 1, 2, 7 and 8.
- Figure 4* GPR amplitude time slices between 0.0 and 25.6ns (0.0 to 1.34m) (1:4000).
- Figure 5* GPR amplitude time slices between 25.0 and 50.0ns (1.34 to 2.68m) (1:4000).
- Figure 6* GPR amplitude time slices between 50.0 and 75.0ns (2.68 to 4.01m) (1:4000).
- Figure 7* Graphical summary of significant GPR anomalies from the Stables Courtyard superimposed over the base OS mapping (1:500).
- Figure 8* Graphical summary of significant GPR anomalies from the gardens superimposed over the base OS mapping (1:2000).

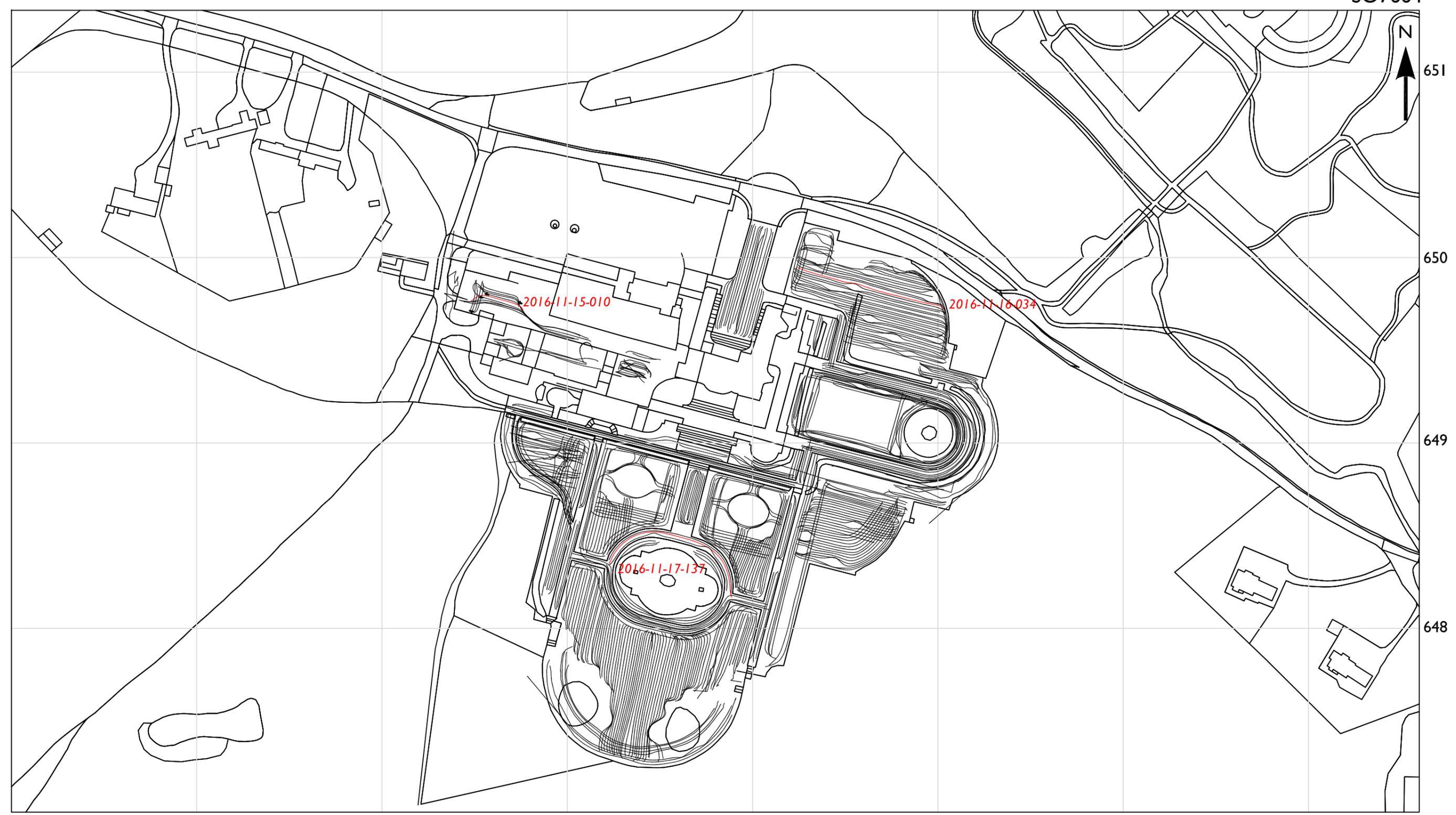
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WITLEY COURT, GREAT WITLEY, WORCESTERSHIRE

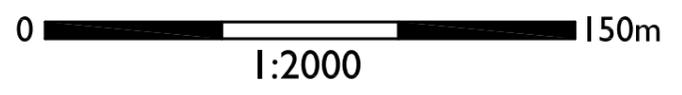
Location of GPR survey swaths, November 2016

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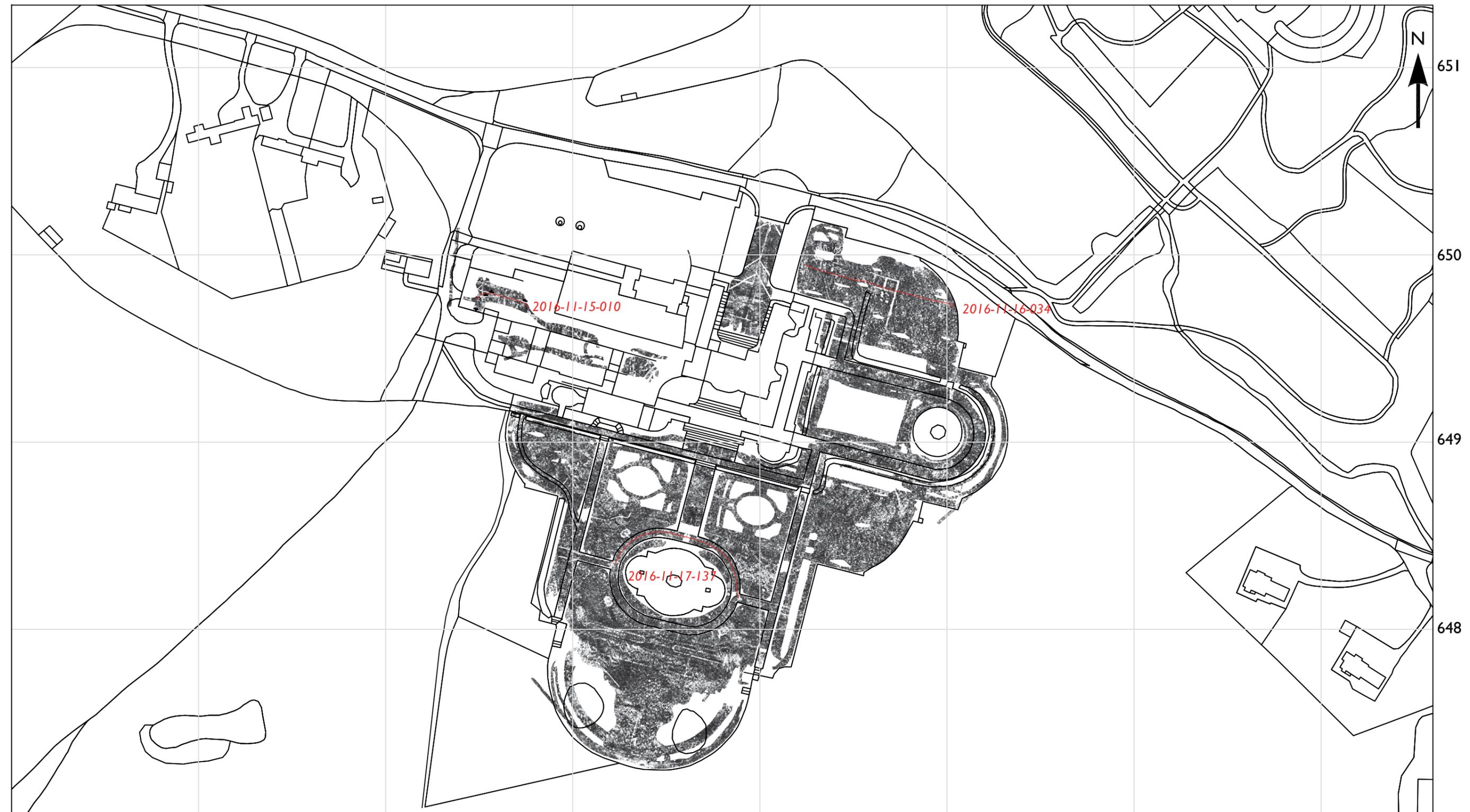
— Location of selected GPR profiles shown on Figure 8
 2016-11-15-010

▨ Ground Penetrating Radar survey swaths

WITLEY COURT, GREAT WITLEY, WORCESTERSHIRE

GPR amplitude time slice between 12.5 - 15.0ns (0.67 - 0.8m), November 2016

SO7664



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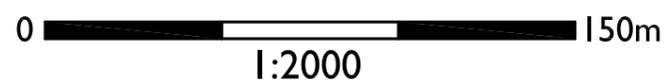
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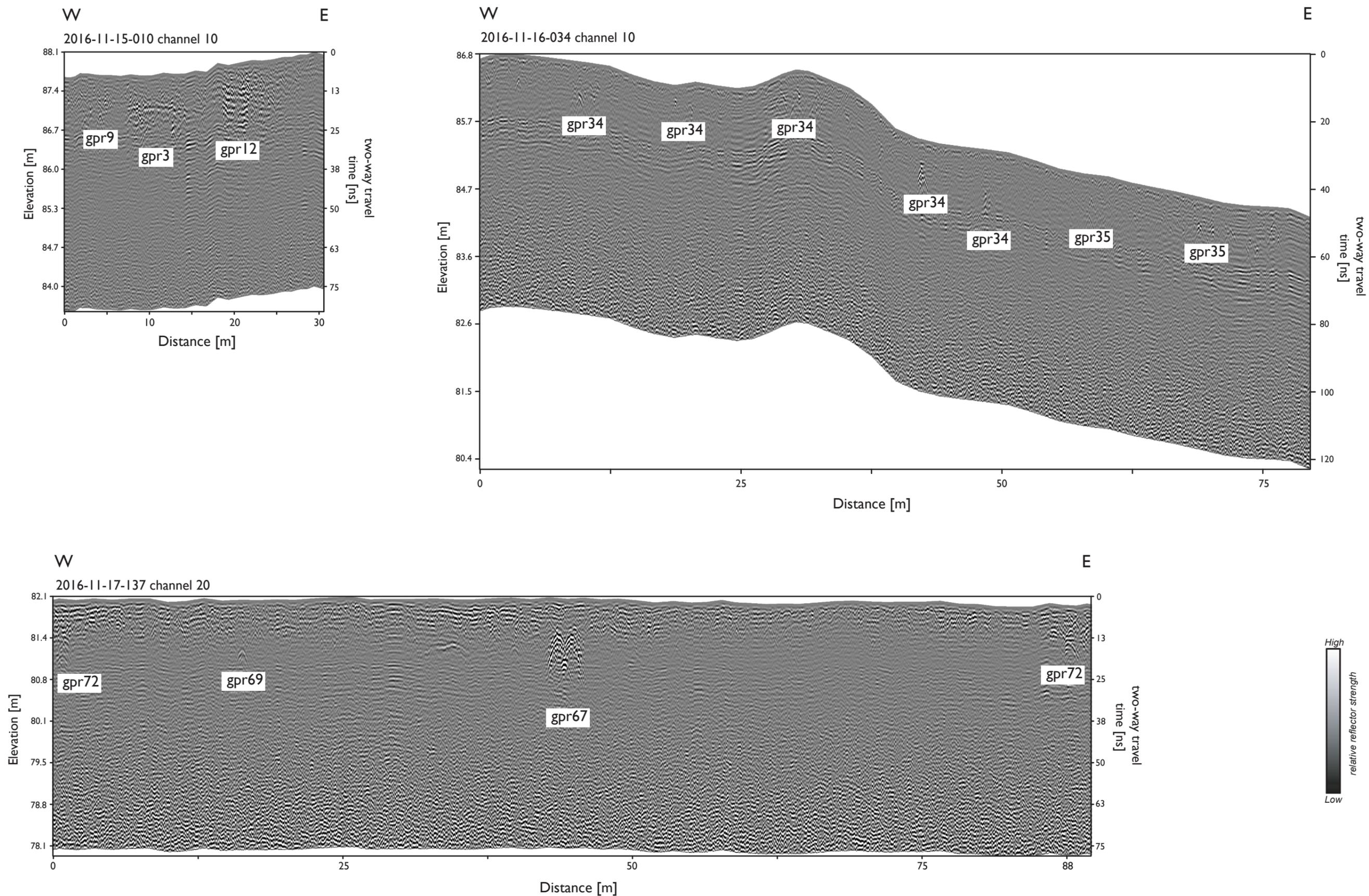
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— Location of selected GPR profiles shown on Figure 3
2016-11-15-010



WITLEY COURT, GREAT WITLEY, WORCESTERSHIRE
GPR amplitude time slice between 0.0 - 25.0ns (0.0 - 1.34m), November 2016

Figure 4

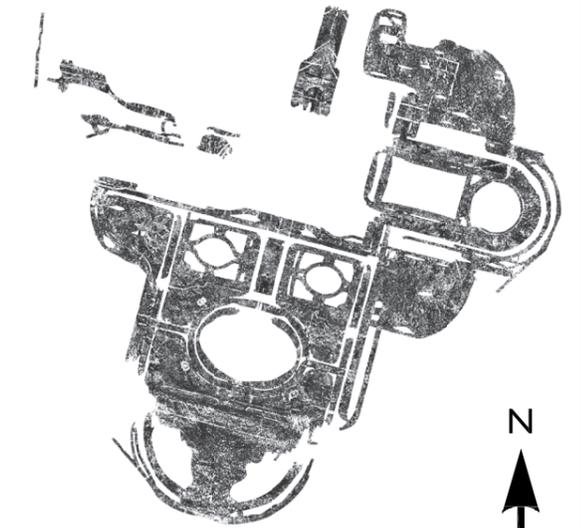
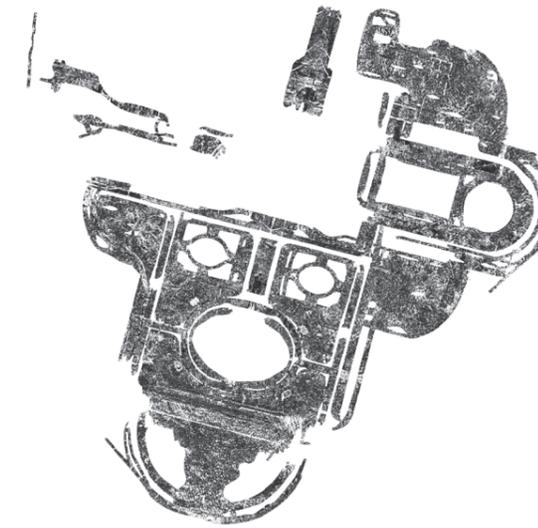
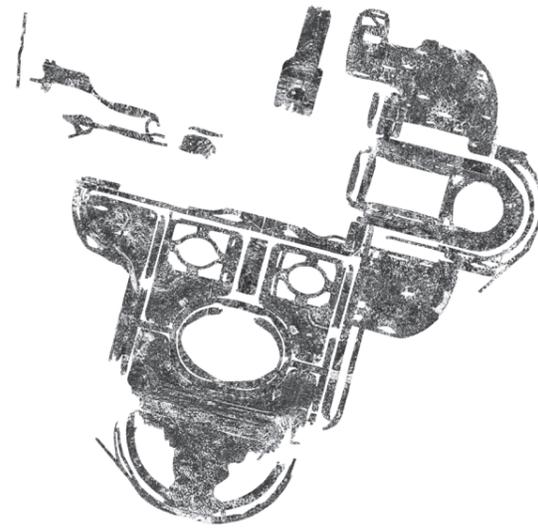
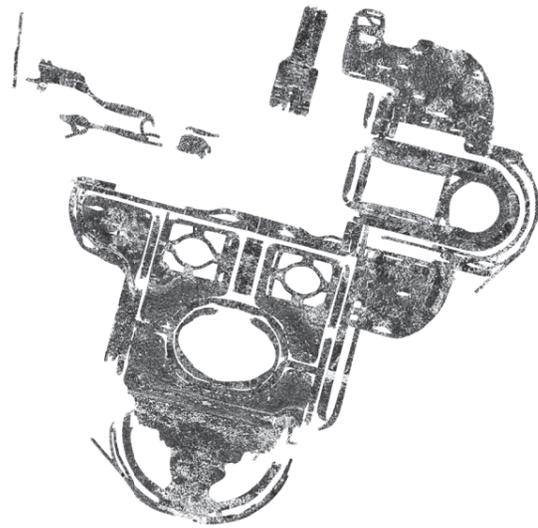
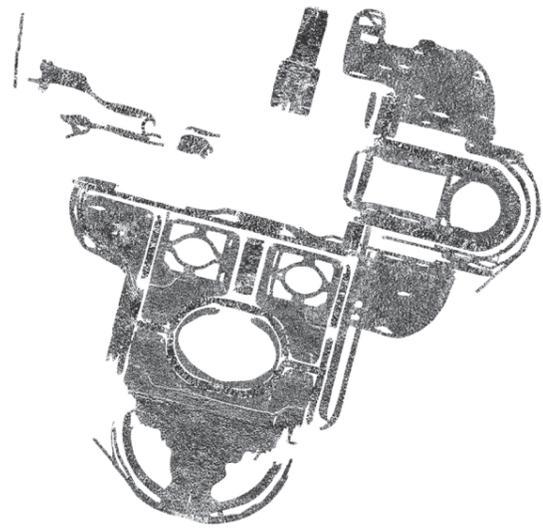
0 - 2.5ns (0.0 - 0.13m)

2.5 - 5.0ns (0.13 - 0.27m)

5.0 - 7.5ns (0.27 - 0.4m)

7.5 - 10.0ns (0.4 - 0.54m)

10.0 - 12.5ns (0.54 - 0.67m)



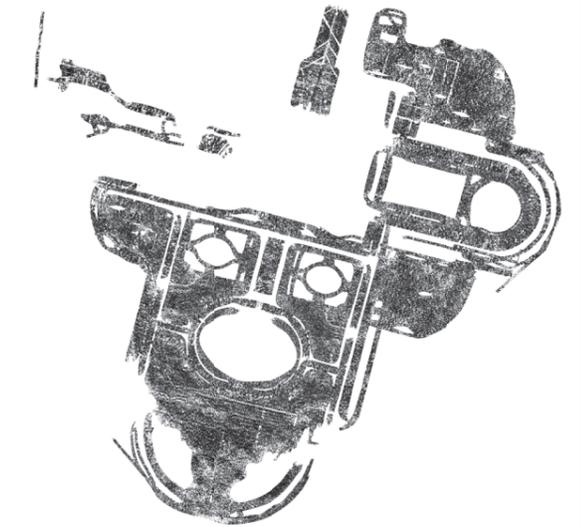
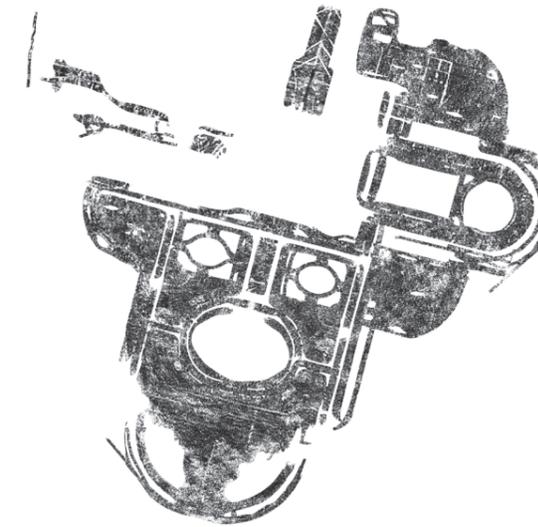
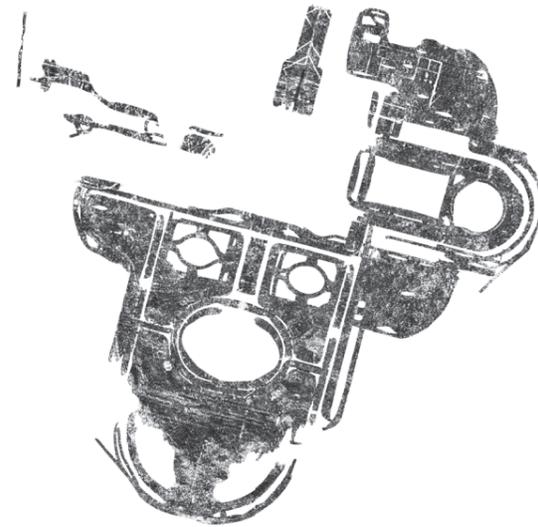
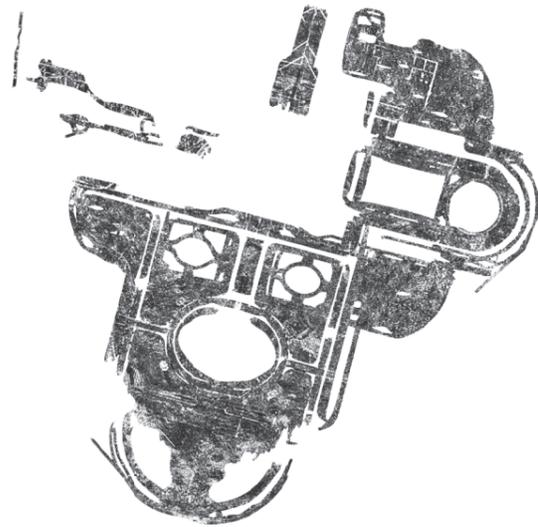
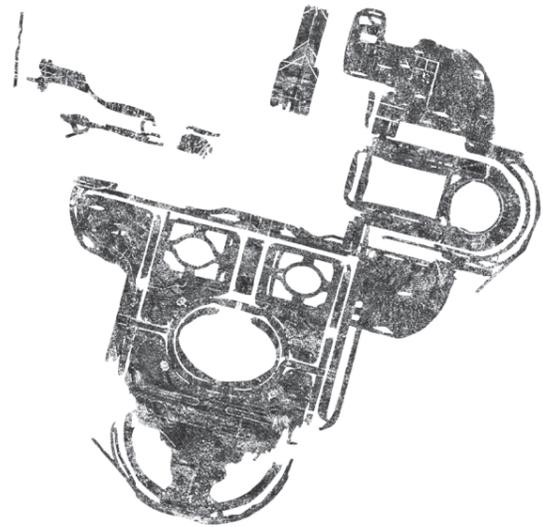
12.5 - 15.0ns (0.67 - 0.8m)

15.0 - 17.5ns (0.8 - 0.94m)

17.5 - 20.0ns (0.94 - 1.07m)

20.0 - 22.5ns (1.07 - 1.2m)

22.5 - 25.0ns (1.2 - 1.34m)



0 150m
1:4000

Low High
relative reflector strength

WITLEY COURT, GREAT WITLEY, WORCESTERSHIRE
GPR amplitude time slice between 25.0 - 50.0ns (1.34 - 2.68m), November 2016

Figure 5

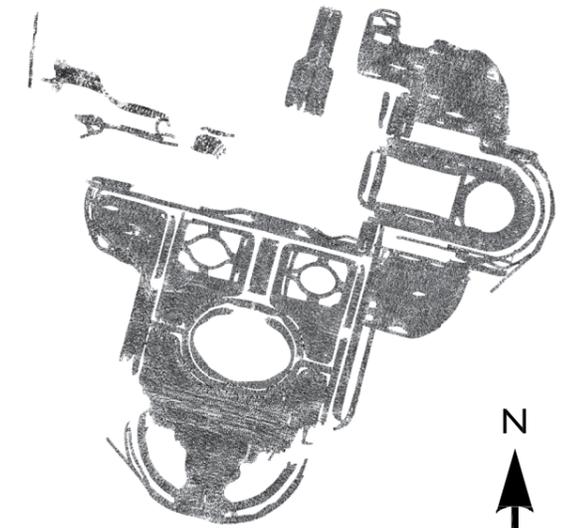
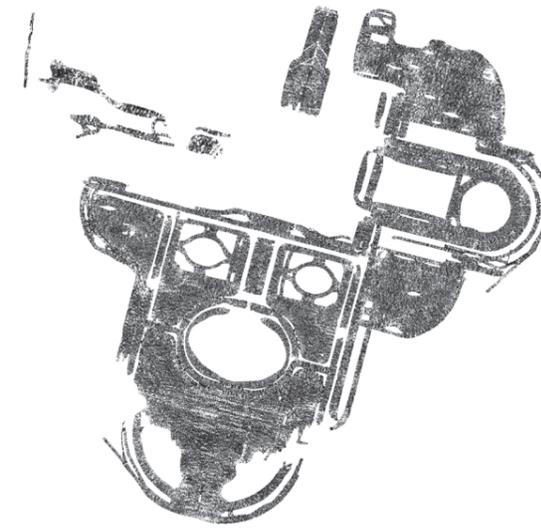
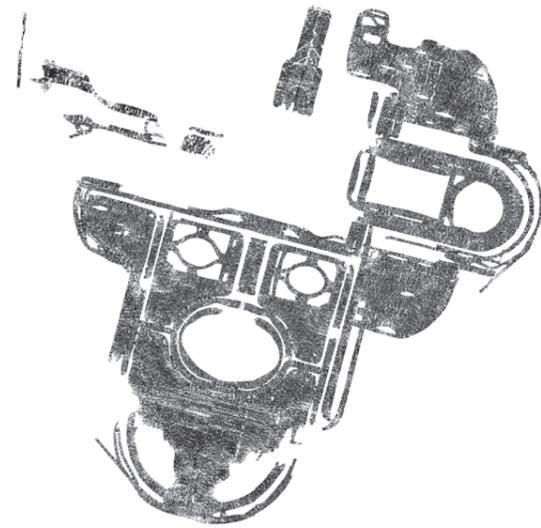
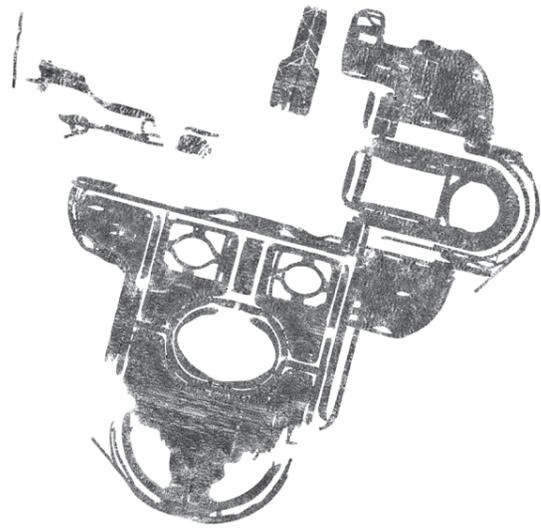
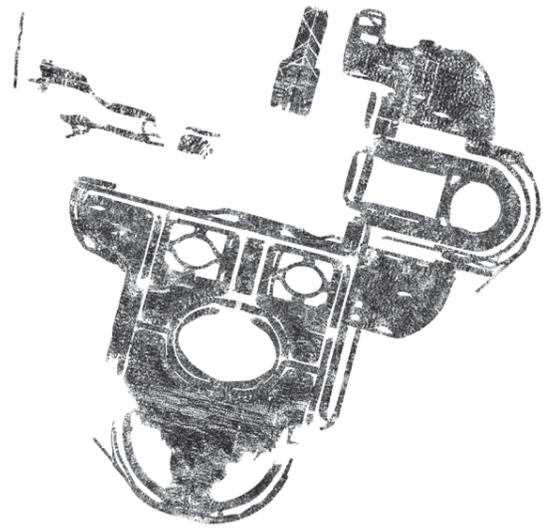
25.0 - 27.5ns (1.34 - 1.47m)

27.5 - 30.0ns (1.47 - 1.61m)

30.0 - 32.5ns (1.61 - 1.74m)

32.5 - 35.0ns (1.74 - 1.87m)

35.0 - 37.5ns (1.87 - 2.01m)



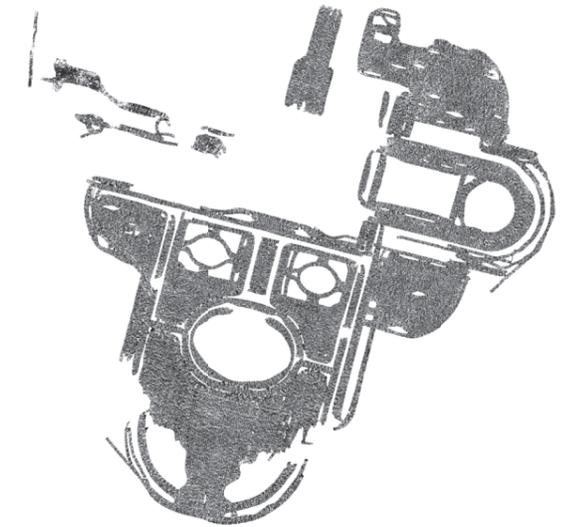
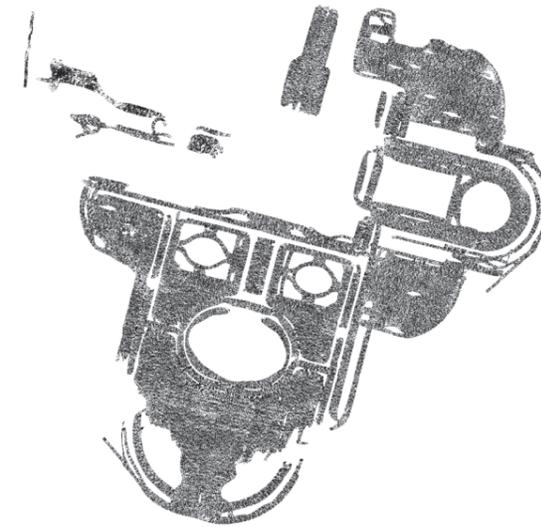
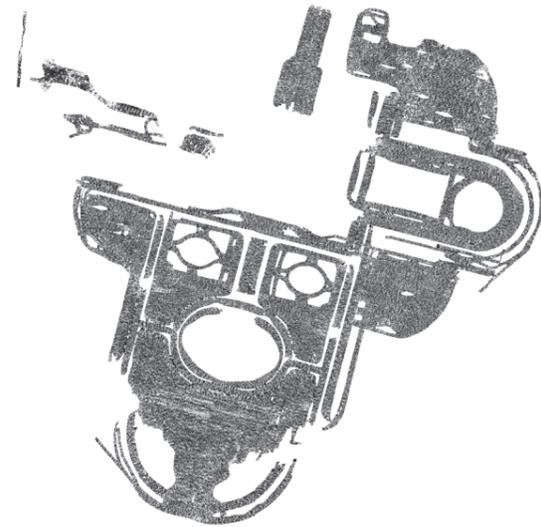
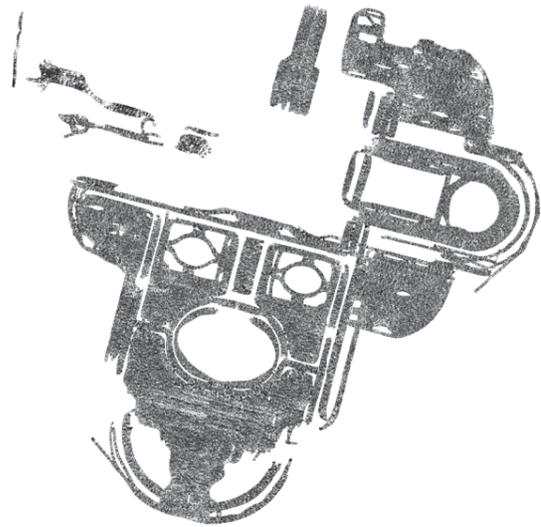
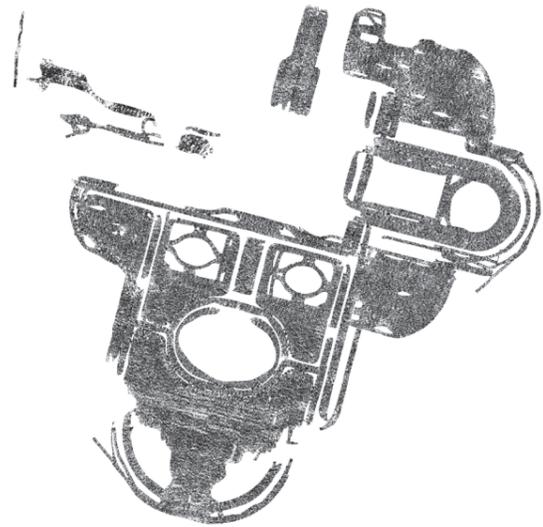
37.5 - 40.0ns (2.01 - 2.14m)

40.0 - 42.5ns (2.14 - 2.27m)

42.5 - 45.0ns (2.27 - 2.41m)

45.0 - 47.5ns (2.41 - 2.54m)

47.5 - 50.0ns (2.54 - 2.68m)



0 150m
1:4000

Low High
relative reflector strength

WITLEY COURT, GREAT WITLEY, WORCESTERSHIRE
GPR amplitude time slice between 50.0 - 75.0ns (2.68 - 4.01m), November 2016

Figure 6

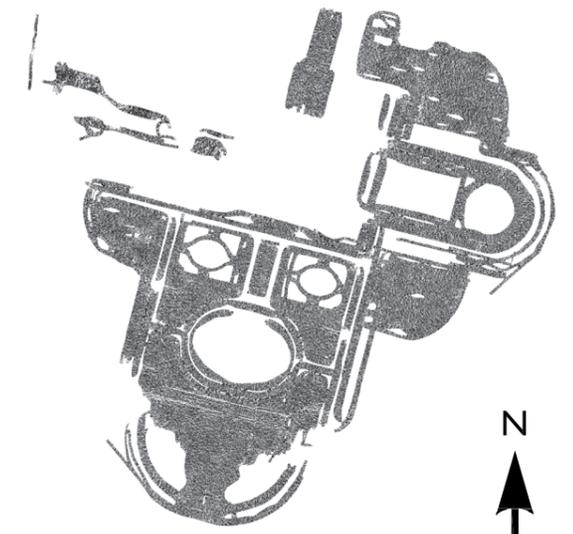
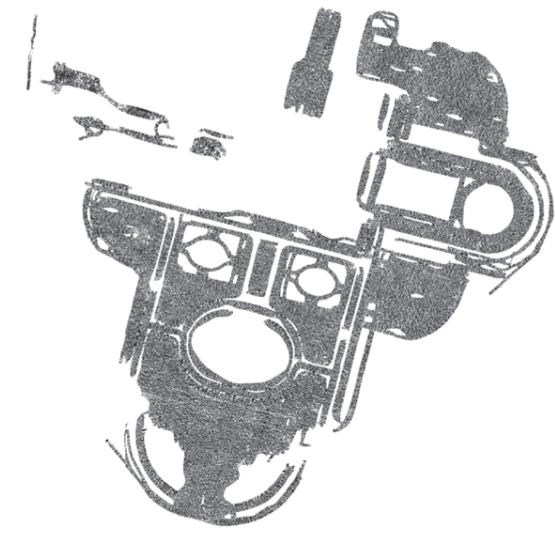
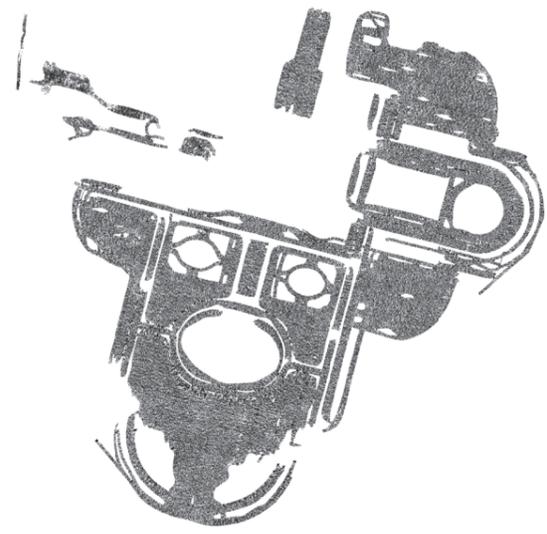
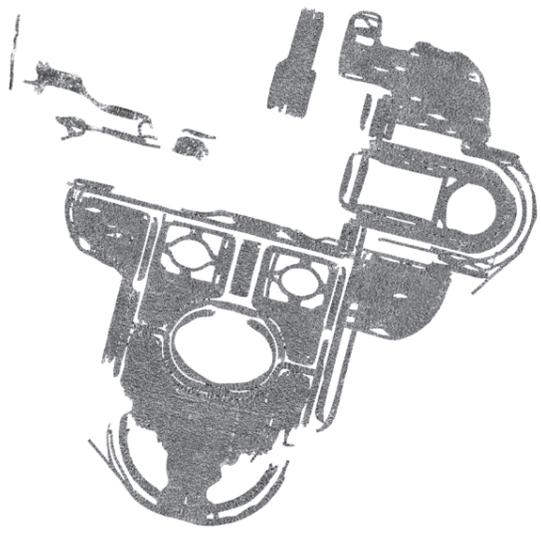
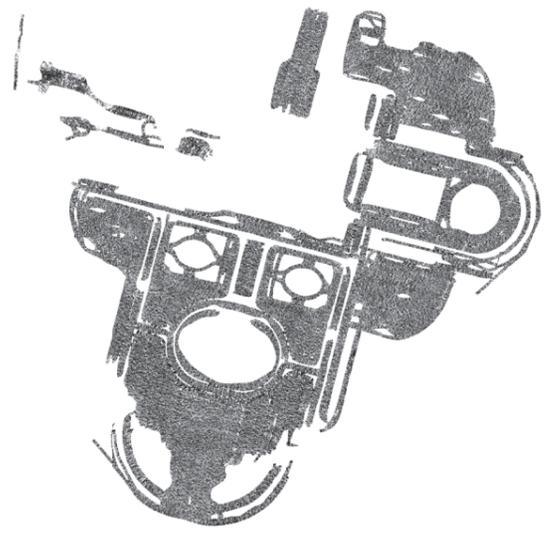
50.0 - 52.5ns (2.68 - 2.8m)

52.5 - 55.0ns (2.8 - 2.94m)

55.0 - 57.5ns (2.94 - 3.08m)

57.5 - 60.0ns (3.08 - 3.21m)

60.0 - 62.5ns (3.21 - 3.34m)



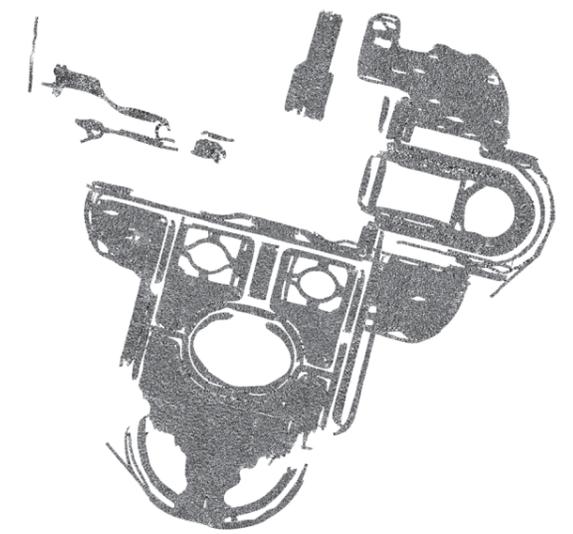
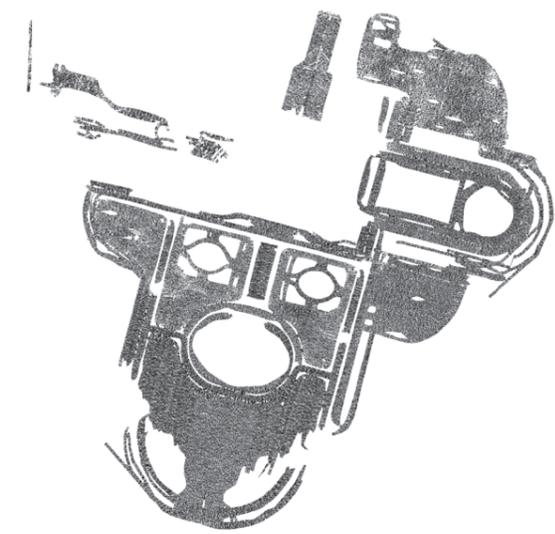
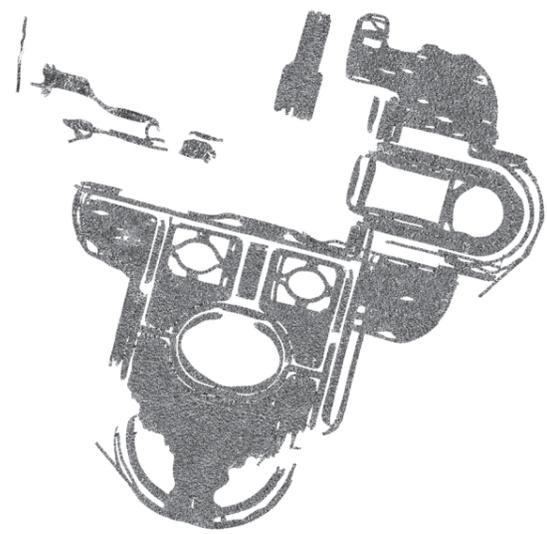
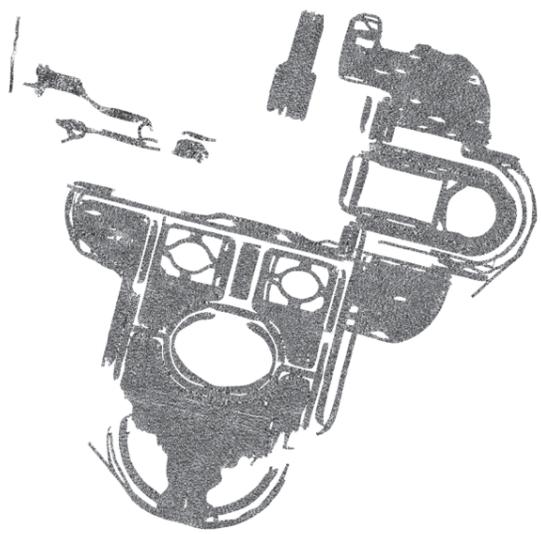
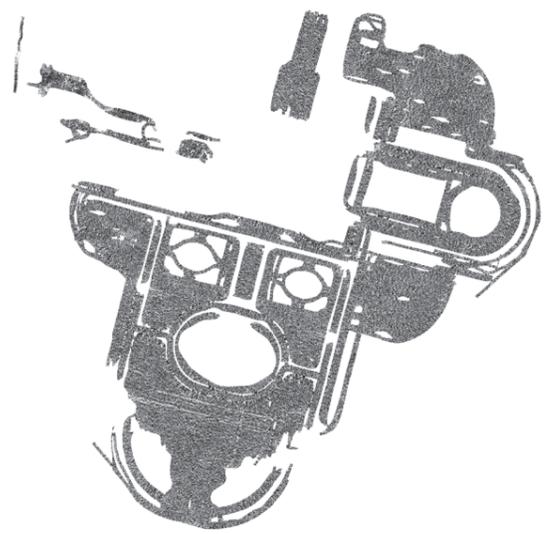
62.5 - 65.0ns (3.34 - 3.48m)

65.0 - 67.5ns (3.48 - 3.61m)

67.5 - 70.0ns (3.61 - 3.75m)

70.0 - 72.5ns (3.75 - 3.88m)

72.5 - 75.0ns (3.88 - 4.01m)



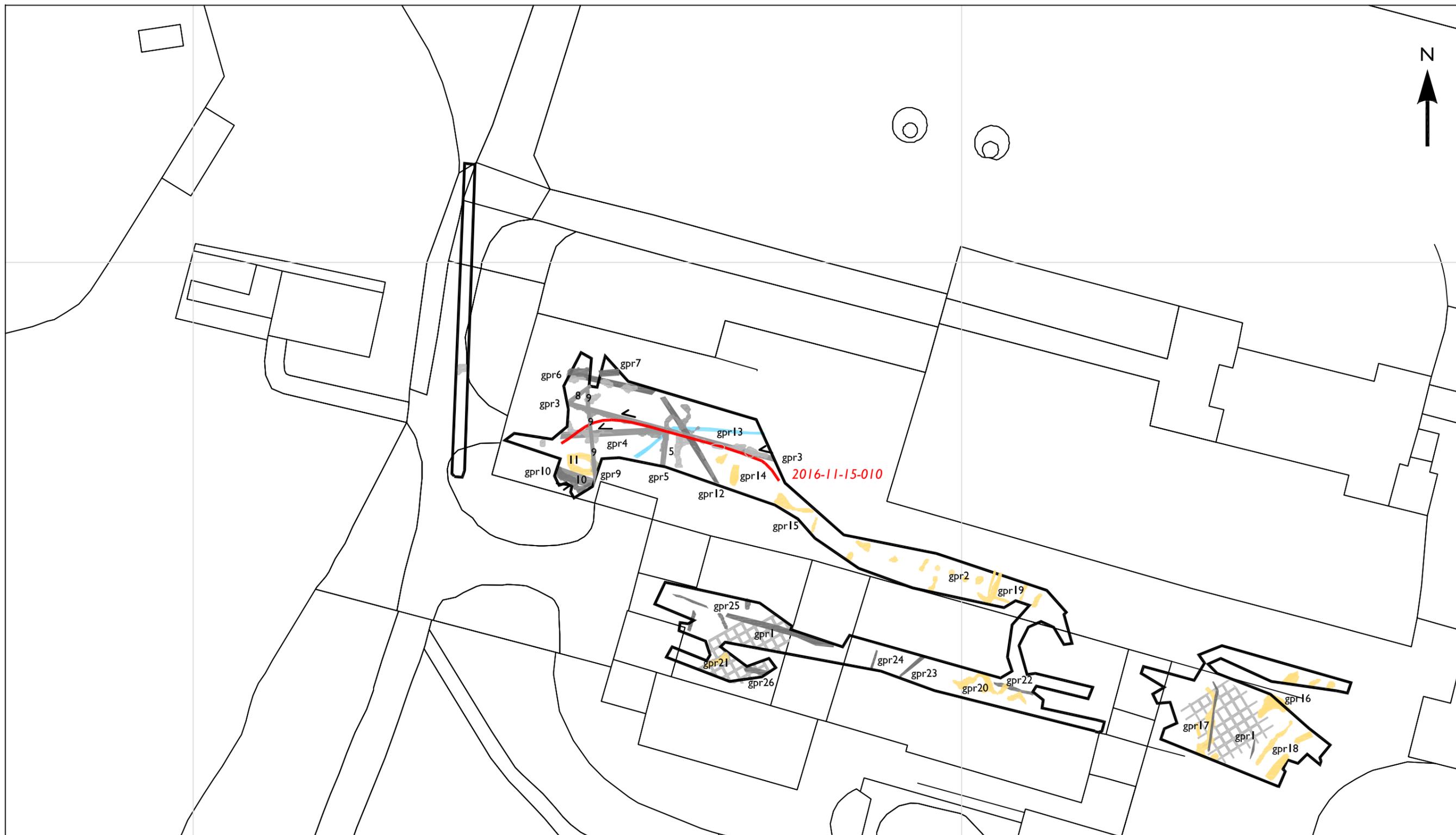
0 150m
1:4000

Low High
relative reflector strength

WITLEY COURT, GREAT WITLEY, WORCESTERSHIRE

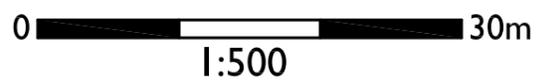
Stable yards, summary of significant GPR anomalies, November 2016

SO7664



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769

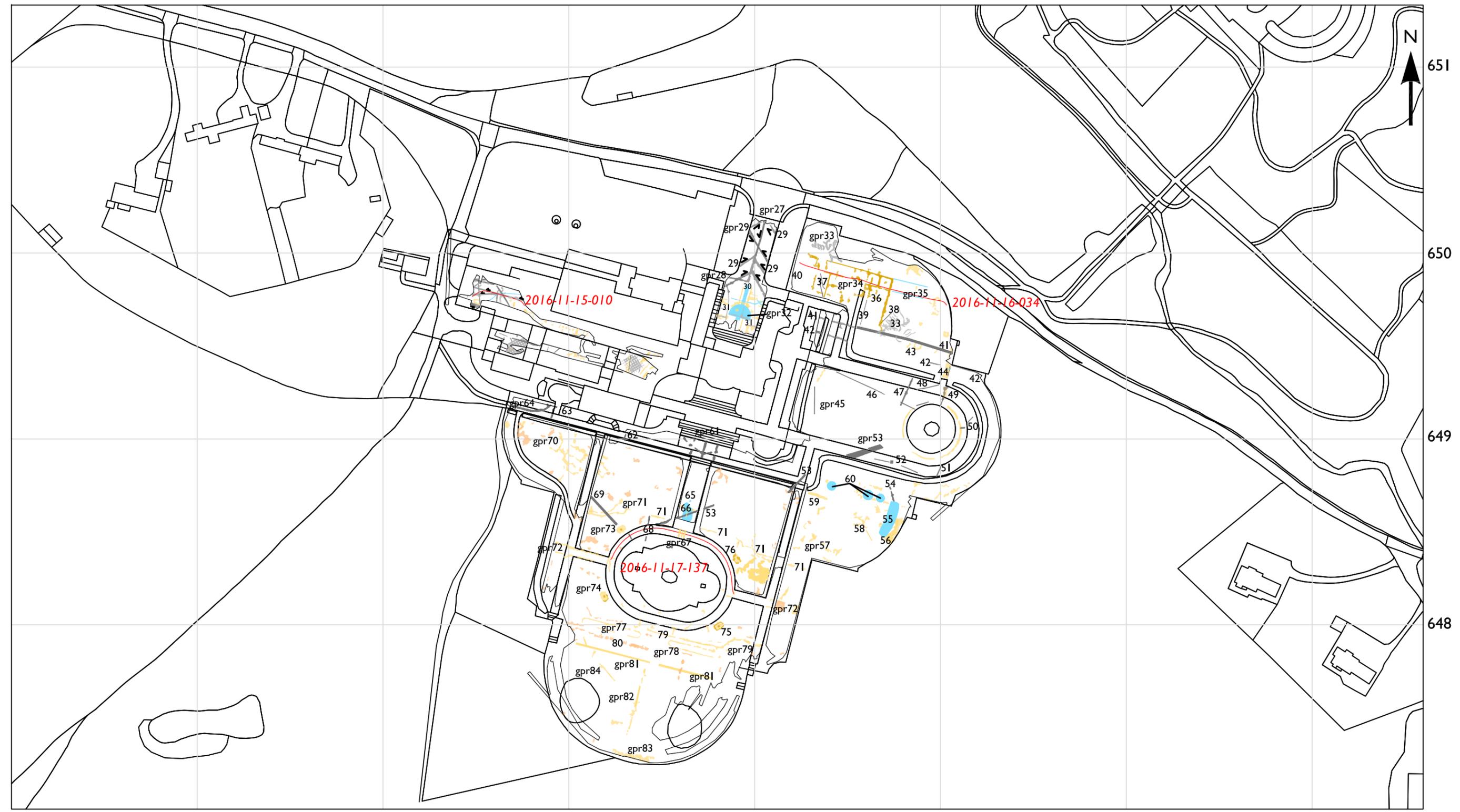


- direction of fall
- low amplitude reflectors
- anomalies of known or recent origin
- high amplitude reflectors
- Location of selected GPR profile shown on Figure 3
2016-11-15-010

WITLEY COURT, GREAT WITLEY, WORCESTERSHIRE

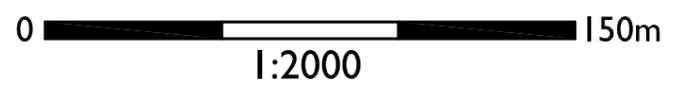
Summary of significant GPR anomalies, November 2016

SO7664



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767 768 769 770 771 772 773



- ← direction of fall
- low amplitude reflectors
- high amplitude reflectors
- anomalies of known or recent origin
- Location of selected GPR profile shown on Figure 3



Historic England Research and the Historic Environment

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