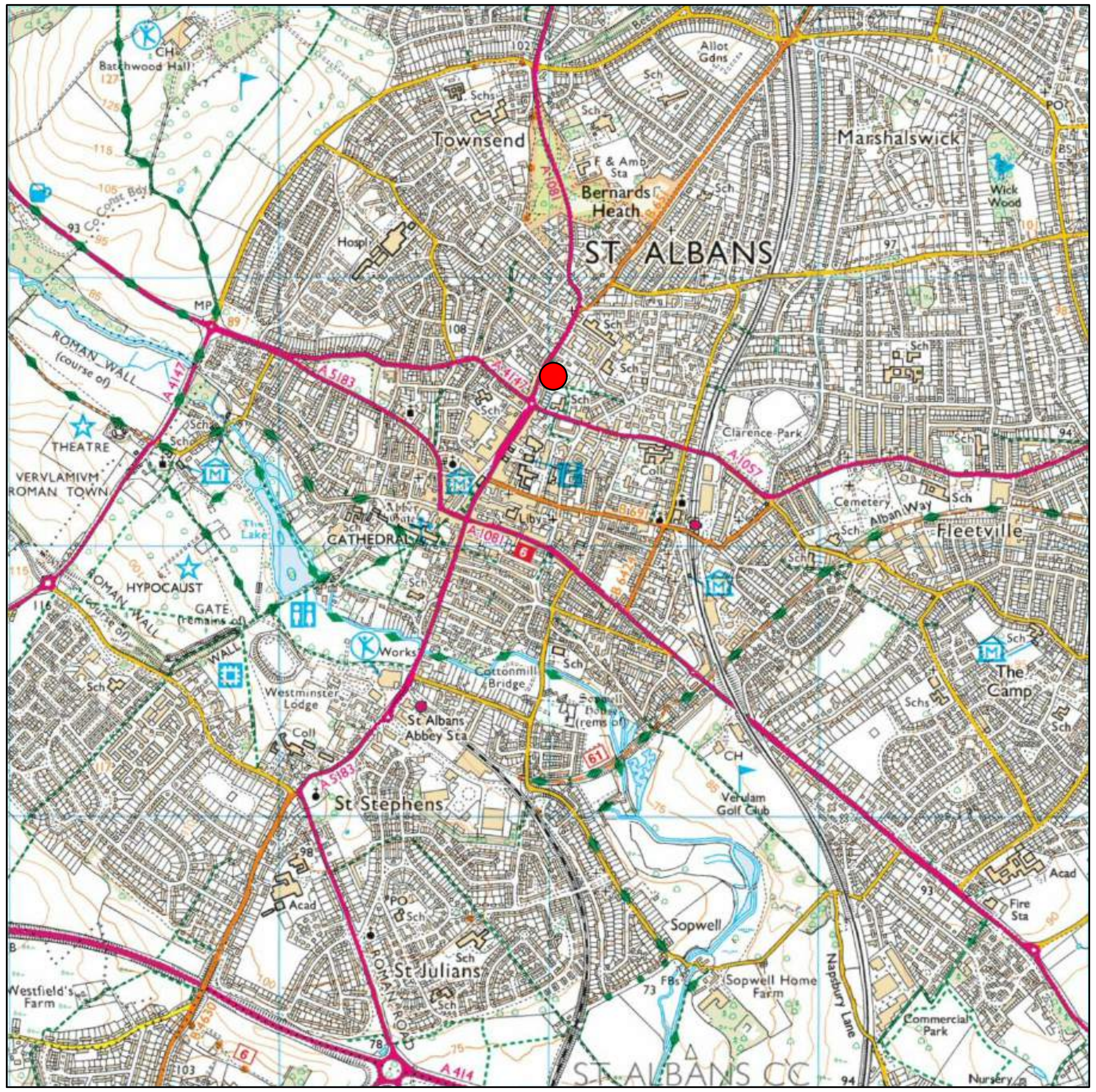


N

Site Location

Reproduced from Ordnance Survey's 1:25 000 map of 1998 with the permission of the controller of Her Majesty's Stationery Office.

SUMO Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Site Location Diagram

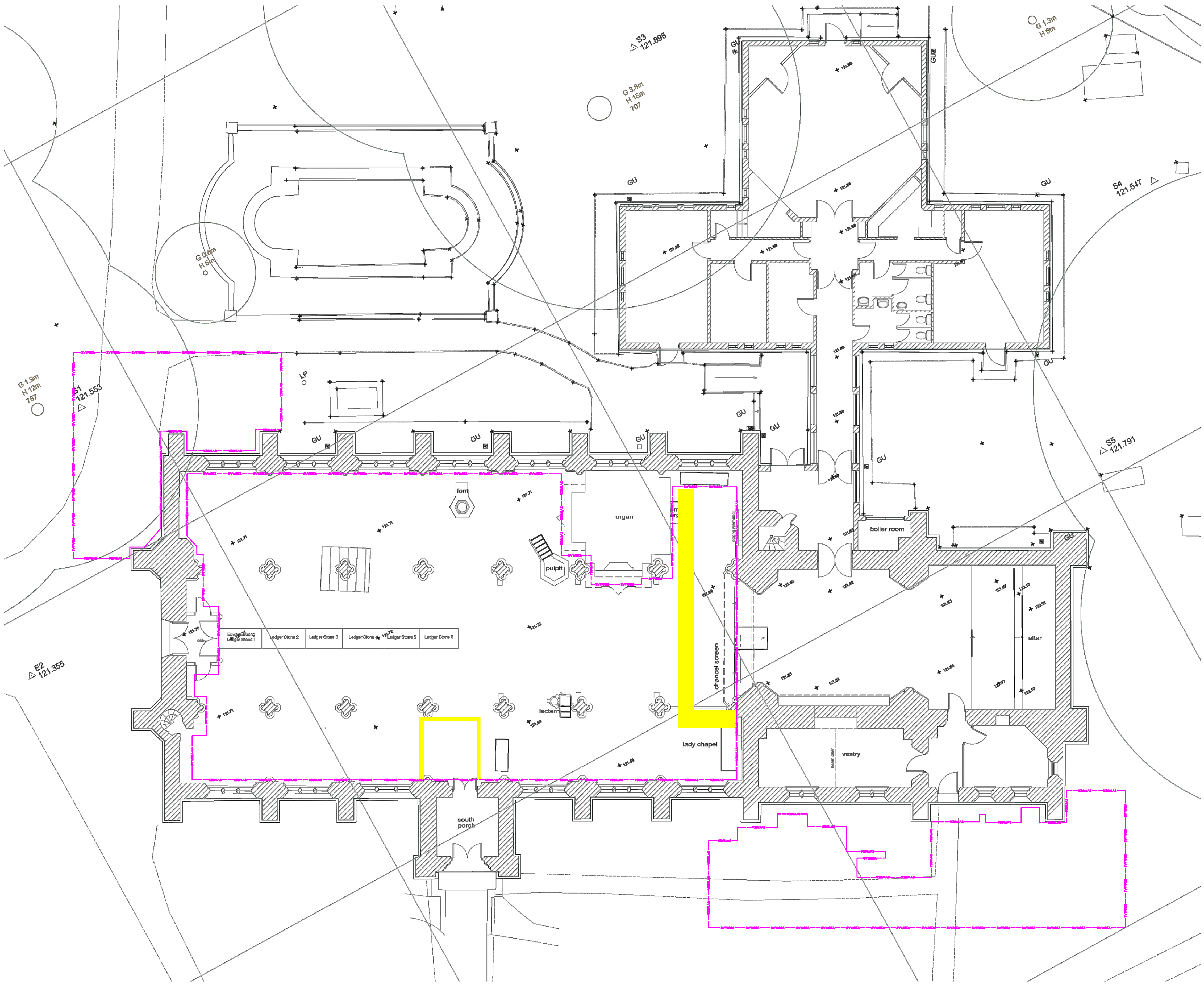
Client:
Michael Dales Partnership Ltd.

Project:
SOR15675 - St Peter's Church, St Albans

Scale:
0 metres 1000
1:25000 @ A3

Fig No:
01

Survey date	Drawn by	Checked by
July 2019	MUK	SDH



N

KEY

	Survey area
	Radar traverse

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Location of Survey Area

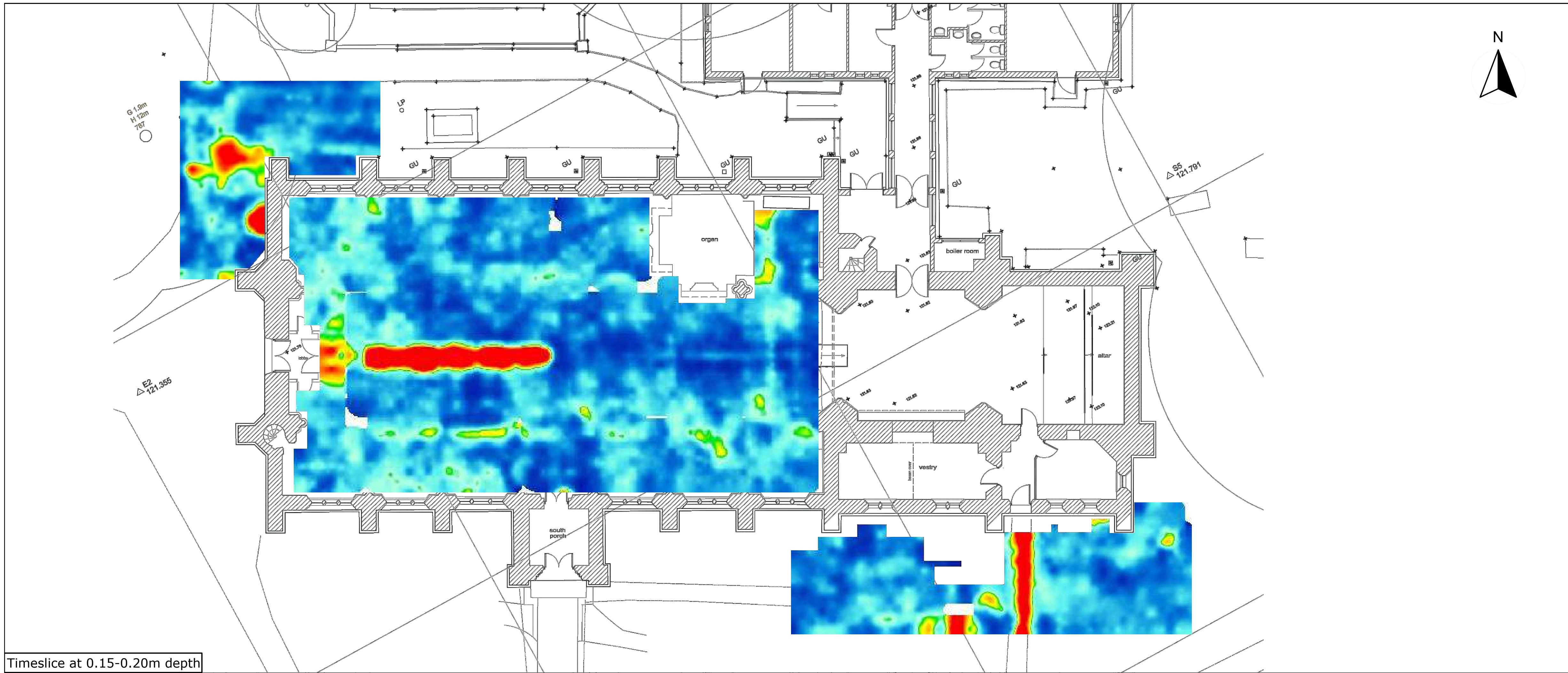
Client:
Michael Dales Partnership Ltd.

Project:
SOR15675 - St Peter's Church, St Albans

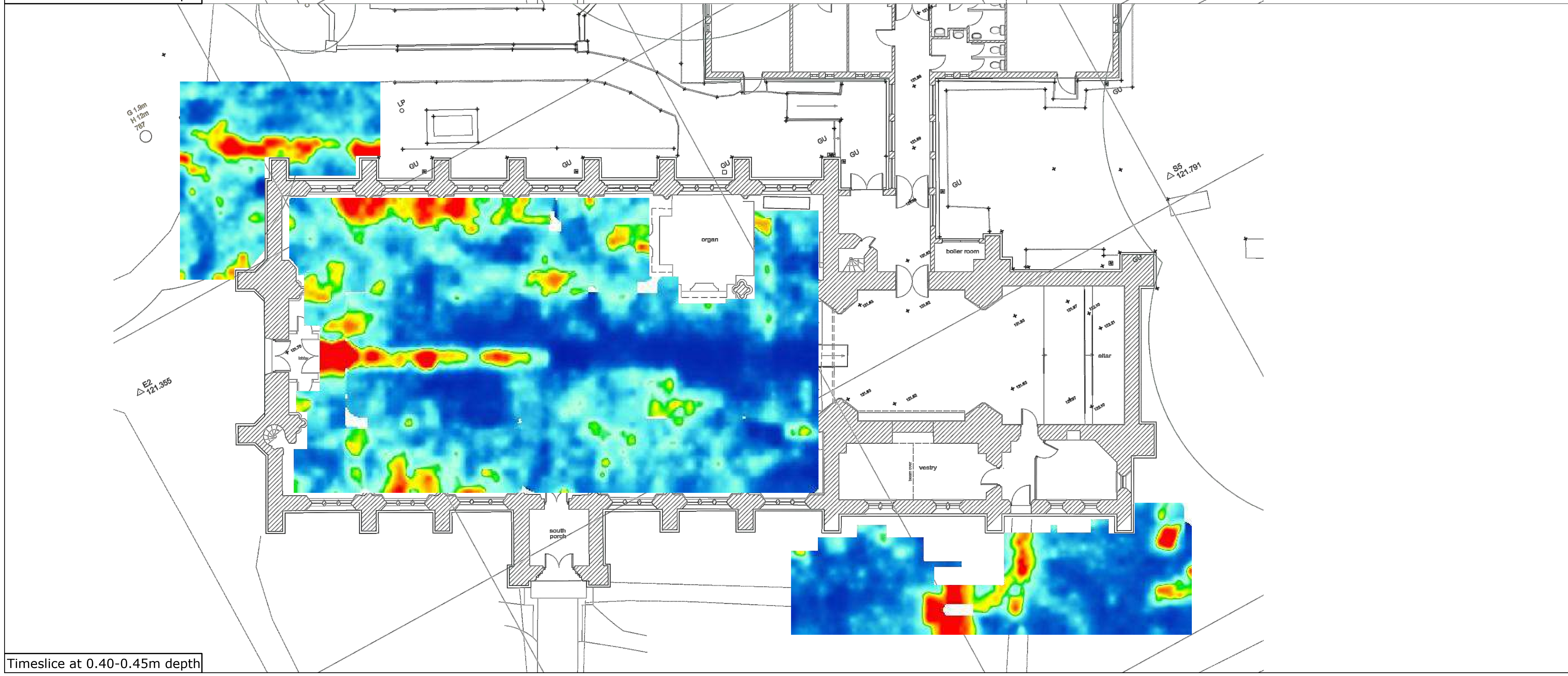
Scale: 0 metres 10
1:200 @ A3

Fig No: 02

Survey date	Drawn by	Checked by
July 2019	MUK	SDH



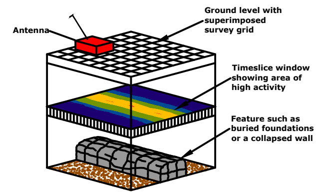
Timeslice at 0.15-0.20m depth



Timeslice at 0.40-0.45m depth

TIMESLICE PLOTS

In addition to a manual abstraction from the radargrams, a computer analysis was carried out. The radar data is interrogated for areas of high activity and the results presented in a plan format known as timeslice plots. In this way it is easy to see if the high activity areas form recognisable patterns.

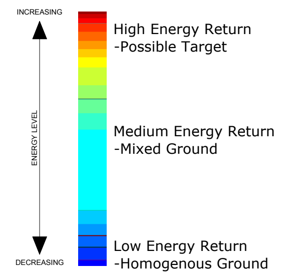


The GPR data is compiled to create a 3D file. This 3D file can be manipulated to view the data from any angle and at any depth within range. The data was then modelled to produce activity plots at various depths. As the radar is actually measuring the time for each of the reflections found, these are called "time slice windows". Plots for various time slices have been included in the report. Calculations, based on an average velocity, have been made to show the equivalent depth into the ground. The data was sampled between different time intervals effectively producing plans at different depths into the ground.

The weaker reflections in the time slice windows are shown as dark colours namely blues. The stronger reflections are represented by brighter colours such as light green, yellow, orange and red.

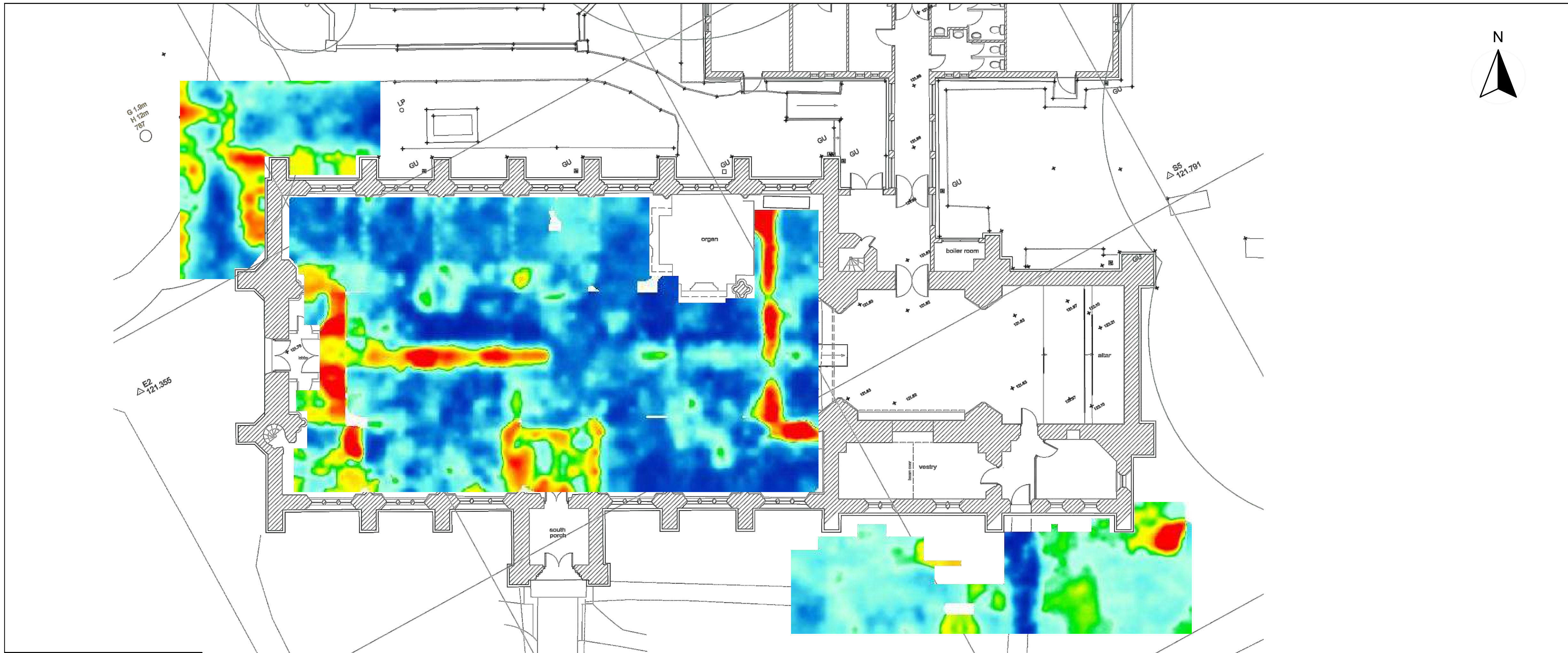
Reflections within the radar image are generated by a change in velocity of the radar from one medium to another. It is not unreasonable to assume that the higher activity anomalies are related to marked changes in materials within the ground such as buried foundations or surfaces within the soil matrix.

Colour Scale for Timeslice 'Activity' Plots and Simplified Key

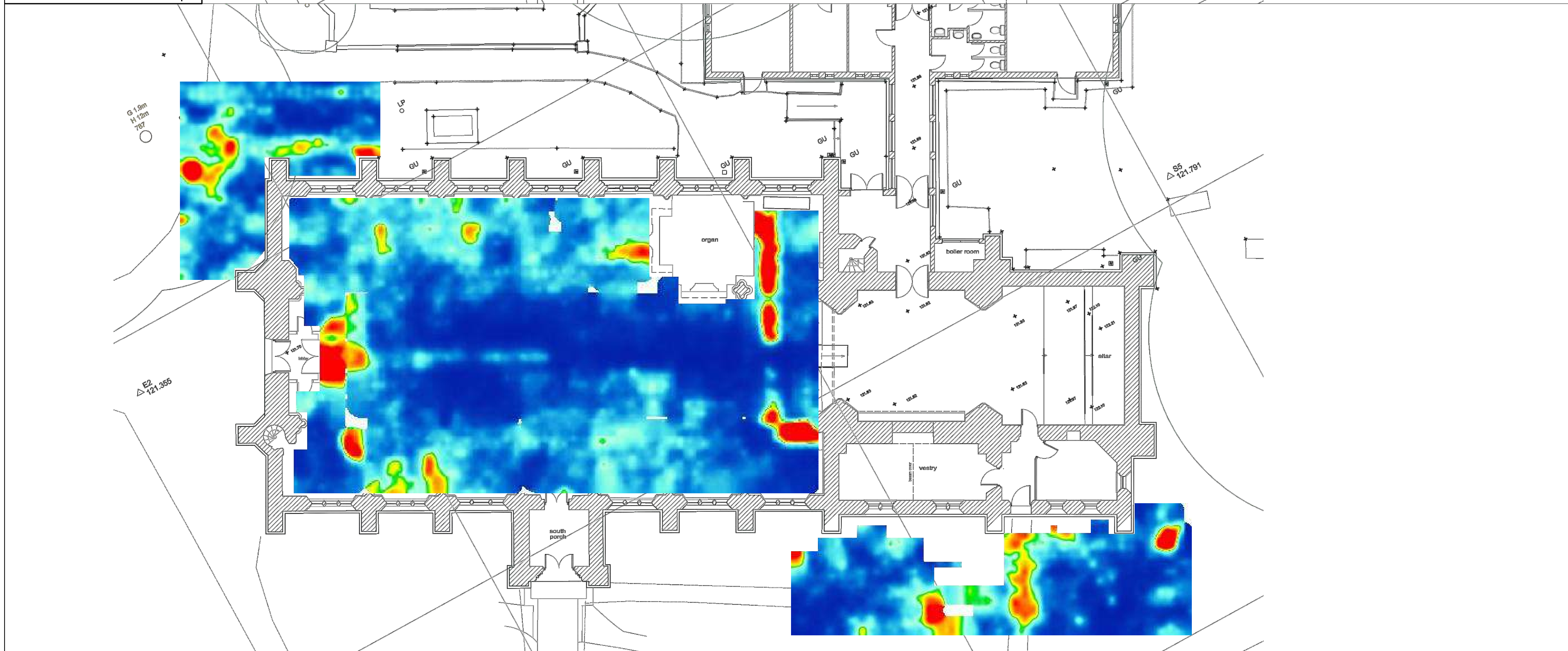


Sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title: GPR Survey - Timeslices at 0.15-0.20m and 0.40-0.45m depth		
Client: Michael Dales Partnership Ltd.		
Project: SOR15675 - St Peter's Church, St Albans		
Scale: 0 metres 12.5 — 1:250 @ A3		Fig No: 03
Survey date July 2019	Drawn by MUK	Checked by SDH



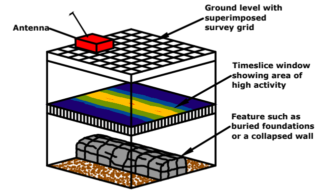
Timeslice at 0.55-0.60m depth



Timeslice at 0.75-0.80m depth

TIMESLICE PLOTS

In addition to a manual abstraction from the radargrams, a computer analysis was carried out. The radar data is interrogated for areas of high activity and the results presented in a plan format known as timeslice plots. In this way it is easy to see if the high activity areas form recognisable patterns.

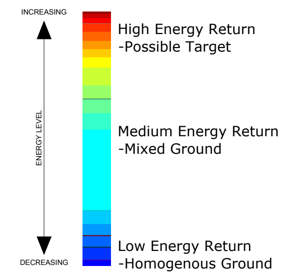


The GPR data is compiled to create a 3D file. This 3D file can be manipulated to view the data from any angle and at any depth within range. The data was then modelled to produce activity plots at various depths. As the radar is actually measuring the time for each of the reflections found, these are called "time slice windows". Plots for various time slices have been included in the report. Calculations, based on an average velocity, have been made to show the equivalent depth into the ground. The data was sampled between different time intervals effectively producing plans at different depths into the ground.

The weaker reflections in the time slice windows are shown as dark colours namely blues. The stronger reflections are represented by brighter colours such as light green, yellow, orange and red.

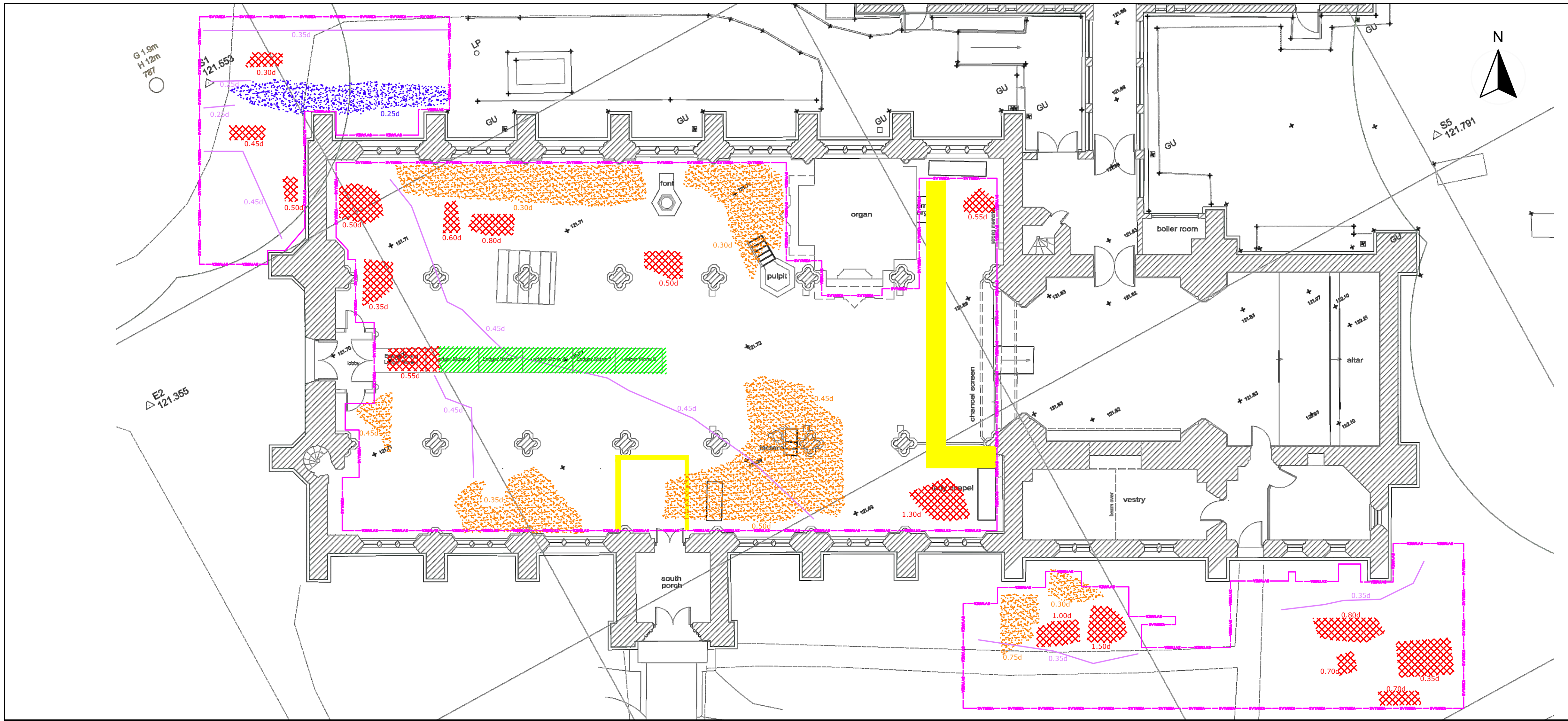
Reflections within the radar image are generated by a change in velocity of the radar from one medium to another. It is not unreasonable to assume that the higher activity anomalies are related to marked changes in materials within the ground such as buried foundations or surfaces within the soil matrix.

Colour Scale for Timeslice 'Activity' Plots and Simplified Key



sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:	GPR Survey - Timeslices at 0.55-0.60m and 0.75-0.80m depth
Client:	Michael Dales Partnership Ltd.
Project:	SOR15675 - St Peter's Church, St Albans
Scale:	0 metres 12.5 — 1:250 @ A3
Fig No:	04
Survey date	July 2019
Drawn by	MUK
Checked by	SDH



The performance of the technologies employed in non-invasive surveys can be adversely affected by factors outside of Sumo's control. Whilst Sumo uses all due diligence and reasonable endeavours it does not warrant that 100% detection can be achieved. Irrespective of the information provided by a geophysical survey, any ground works should be undertaken with extreme caution.

A Ground Penetrating Radar (GPR) survey was conducted at St Peter's Church, in Saint Albans, Hertfordshire. The survey encompassed the nave and two external areas around the north-west and south-east corners of the church. The survey objective inside the nave was to search for evidence of burials. In the two external areas, the objectives were to look for evidence of voids, a water main and drainage channels. The survey used a GSSI Dual Frequency Radar system in conjunction with 300MHz and 800MHz antennae. An orthogonal of profiles was carried out in the survey areas at a spacing of 1.0 X 0.5 metres, subject to available access.

Most ground conditions contain electrically contrasting layers, which produce reflection events on the Ground Probing Radar (GPR) profiles. Features such as soil or fill boundaries provide the background signals around unusual features such as voids or pipes. Processing and interpretation procedures are designed to separate the reflections into various target categories, and then map the different reflection types on to a plan diagram. This process involves the interpretation of each individual radar profile, followed by an areal interpretation of all the radar profiles. Features identified across several profiles are interpolated in areas where the data is well constrained.

The confidence levels placed on a plan interpretation depend on the spacing of the survey grid. A target such as a void or pipe must be intersected by at least one radar profile to be detected. Ideally, the profile spacing should allow any target to be intersected by several profiles. It is not usually possible to obtain total survey coverage of a site. Consequently the survey line spacing is selected to provide a good indication of site conditions and allow for available access.

In a typical church, unmarked burial features could be either individual graves or larger vaults. Radar reflections produced by such features will dependant whether the coffin or vault is intact and has an internal void, or if it has collapsed internally. The method used to detect voids depends on identifying the strong electrical changes associated with void targets. The large electrical contrast between solid material and air generates a high amplitude response, which should stand out clearly against the background reflections. Void reflections may also be associated with ringing, caused by reverberation of the radar pulse within the void. In some cases strong diffractions are produced by the corners of the grave, which produce a characteristic crossover effect.

Many older graves and vaults are likely to have collapsed internally, causing the reflection amplitude to diminish significantly and the reflection characteristics to change laterally. The presence or absence of a grave slab is also likely to effect the resultant reflections. Closely spaced burial areas are likely to produce zones of composite, heterogeneous reflections.

The data interpretation identified six significant categories of reflection targets:

i) Possible burial
ii) Conductive surface associated with grave slabs
iii) Possible high void ratio ground
iv) Disturbed ground
v) Possible service
vi) Conductive surface

i) Possible burial
Areas identified as possible burials inside the church generally appear as discrete zones of moderate amplitude, irregular, reflections with broken layering. In some cases a slightly chaotic internal structure may be evident, resulting from the limited interaction between a number of small, high amplitude reflections. The plan dimensions of most these anomalies is approximately 1 x 2m, with an east-west orientation. Both characteristics are suggestive of burials inside a church. Most of the possible burials were not associated with clear open voids or crossover diffractions. Some examples of possible burials are shown in Example Radargrams 3, 4 and 5.

ii) Conductive surface associated with grave slabs
The reflections from a linked series of grave slabs running down the centre of the nave display discrete planar top surfaces and crossover diffractions, but with no evidence of an internal void or disturbed ground. This can be seen in Example Radargram 3. The evidence suggests these features could be empty graves, although the conductive surface could be masking features beneath it.

iii) Possible High Void Ratio Ground
Possible high void ratio ground appear on the external profiles as dense zones of high amplitude reflections, in some cases displaying evidence of pulse ringing. A characteristic chaotic structure is evident caused by complex interference between numerous small, high amplitude reflections. These reflection characteristics are generally indicative of loose, high void ratio ground and may be associated with demolished structures or poorly backfilled excavations. Radargram 1 presents an example of high void ratio ground. The area of high void ratio ground appears as a linear, east-west orientated strip along the northern edge of the outside wall of the church. This feature may be associated with a linear feature such as a service trench.

iv) Disturbed ground
Areas identified as disturbed ground generally appear as zones of moderate amplitude, irregular, reflections with broken layering. In some cases there is evidence of a slightly chaotic internal structure, resulting from interaction between individual reflections. Radargram 6 presents an example of the disturbed ground reflection category. Disturbed ground can be caused by localised disturbance of the ground or by discrete changes in ground composition.

v) Possible service
A GPR profile either orthogonal or at a high angle to a length of service typically produces a steeply curved or hyperbolic reflection of moderate amplitude, which should be discernible against background reflections. The service position is located at the apex of the hyperbola. Pipe tracks are identified by the recognition of alignments of similar reflections between adjacent parallel profiles. At low angles of intersection between survey lines and service tracks, the resultant planar reflection response is more ambiguous and can be difficult to identify. Examples of the possible service reflection are given in Radargrams 1,2, 4 and 5. Though the possible services in the south east of the site are not characteristic of drainage channels it is possible that they may relate to them.

vi) Conductive surface
Two conductive surfaces were identified by the survey. The small area around the main entrance appears to be related to metal carpet grips and is unlikely to have an archaeological origin. The conductive surface reflection to the east appears as very high amplitude, near surface reflections associated with pronounced ringing caused by signal reverberations. No signal penetration was possible through this conductive layering. The cause of the conductive surface is uncertain, but appears to correlate to a change in the floor surfacing that is intersected by an inspection cover. This suggests this feature may be related to a drainage channel.

Conclusions
The GPR survey identified features that may be associated with burials, voids and drainage channels. Not all of this evidence is clear due to large areas of disturbed ground throughout the survey area. Possible burials and possible services were present throughout all survey areas. In the north west area a linear area of high void ratio ground was identified but no obvious voids were present in the data. Whilst there was evidence of possible services to the south east of the church there was no clear evidence of a typical drainage channel; the conductive surface found in the eastern interior of the church may mask a drainage channel but there is no evidence of a void here.

KEY

	Possible burial
	Possible high void ratio ground
	Disturbed ground
	Possible service
	Conductive surface associated with grave slabs
	Conductive surface
0.60d	Depth to the top of the feature (in m)

Sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title: GPR Survey - Interpretation

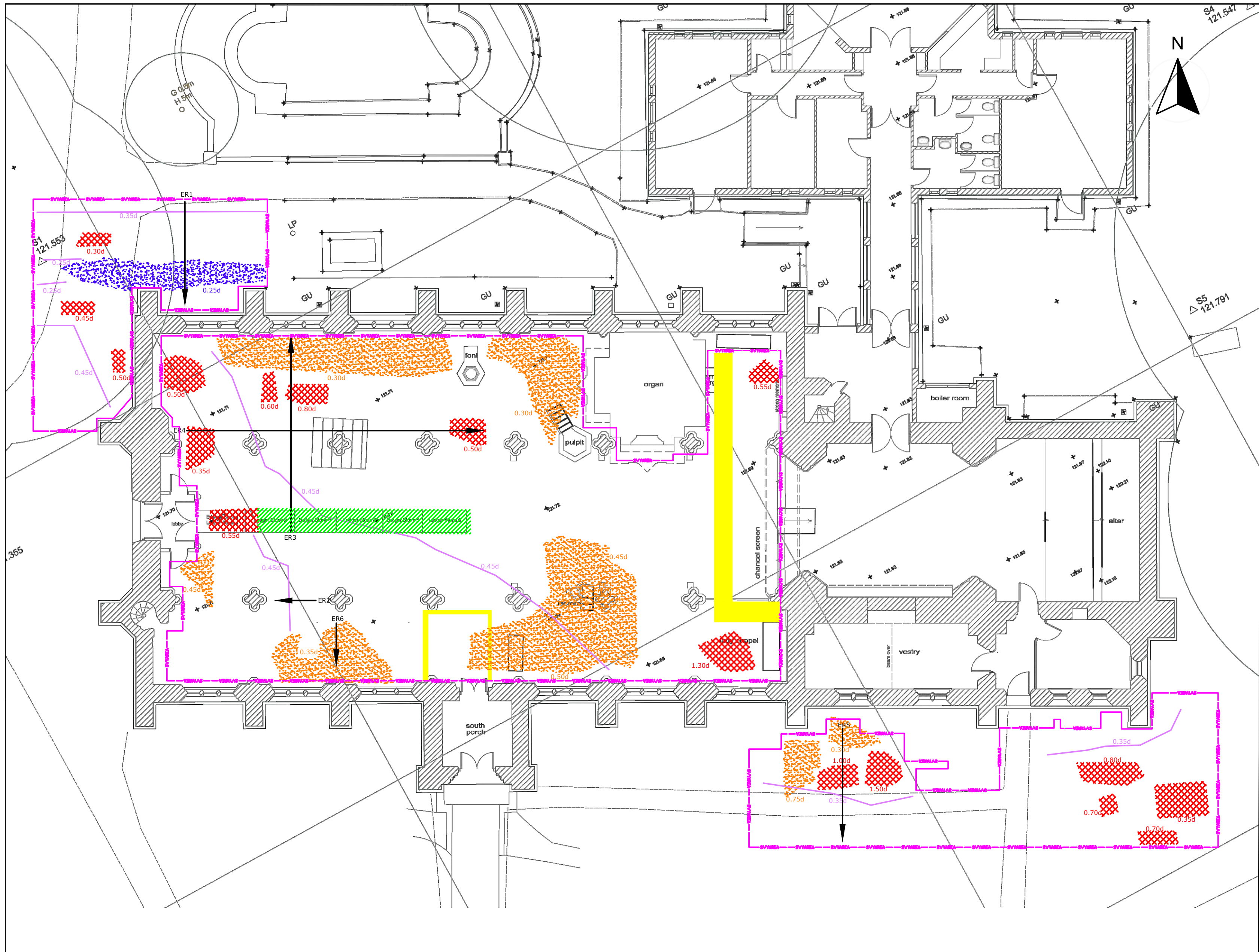
Client: Michael Dales Partnership Ltd.

Project: SOR15675 - St Peter's Church, St Albans

Scale: metres 0 10 1:200 @ A3

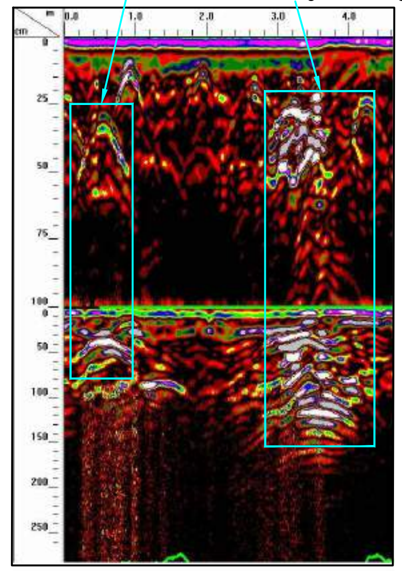
Fig No: 05

Survey date	Drawn by	Checked by
July 2019	ALC	SDH



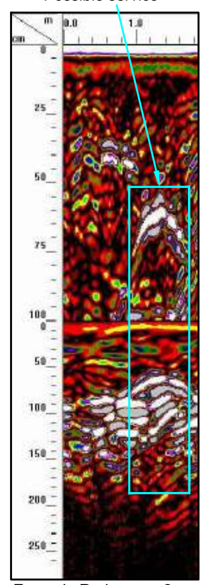
Possible service

Possible high void ratio ground



Example Radargram 1
Possible service and high void ratio ground.

Possible service

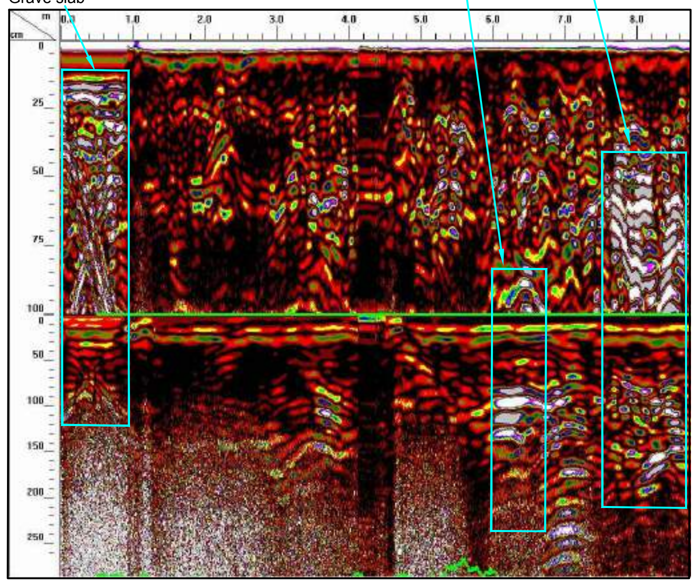


Example Radargram 2
Possible service.

Grave slab

Possible grave

Disturbed ground



Example Radargram 3
Conductive surface associated with grave slab, possible grave and disturbed ground.

The performance of the technologies employed in non-invasive surveys can be adversely affected by factors outside of Sumo's control. Whilst Sumo uses all due diligence and reasonable endeavours it does not warrant that 100% detection can be achieved. Irrespective of the information provided by a geophysical survey, any ground works should be undertaken with extreme caution.

Dual Frequency GSSI radar is collected with 300MHz and 800MHz antennae simultaneously. The example radargrams show data from both frequencies. The top section shows the high frequency (800MHz) data, while the bottom section shows the low frequency (300MHz) data.

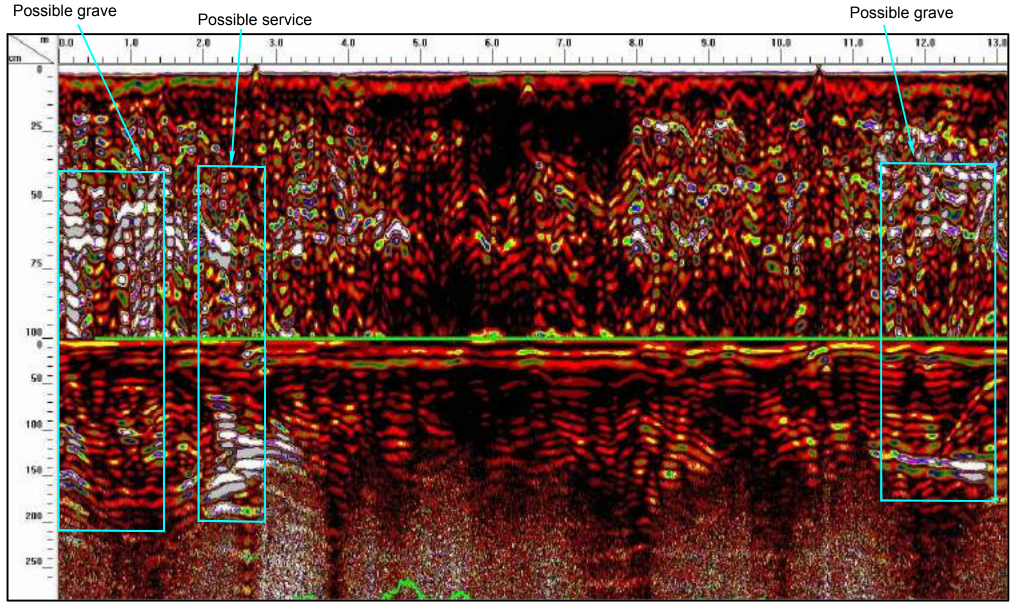
KEY

(red hatch)	Possible burial
(blue hatch)	Possible high void ratio ground
(orange hatch)	Disturbed ground
(magenta line)	Possible service
(green hatch)	Conductive surface associated with grave slabs
(yellow)	Conductive surface
0.60d	Depth to the top of the feature (in m)

Possible grave

Possible service

Possible grave



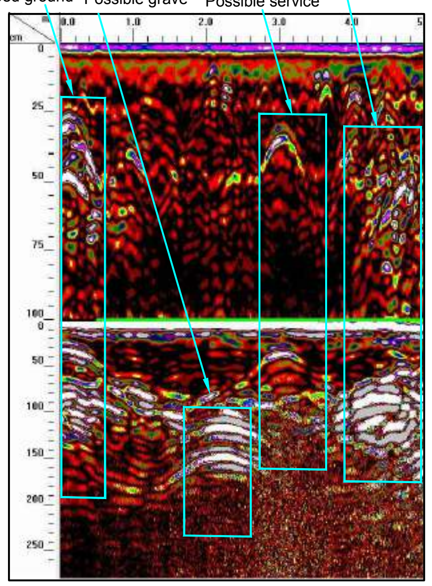
Example Radargram 4
Possible graves and a possible service.

Disturbed ground

Possible grave

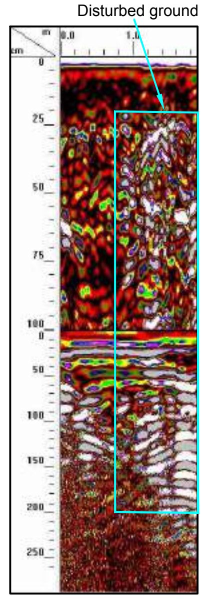
Possible service

Anomaly caused by path



Example Radargram 5
Possible grrave, possible service and anomaly caused by path.

Disturbed ground



Example Radargram 6
Disturbed ground.

Sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title: GPR Survey - Interpretation with Example Radargrams

Client: Michael Dales Partnership Ltd.

Project: SOR15675 - St Peter's Church, St Albans

Scale: 0 metres 12.5
1:250 @ A3

Fig No: 06

Survey date	Drawn by	Checked by
July 2019	ALC	SDH