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Geophysical Survey of St. Botolph's Churchyard

Report: MSTL01B

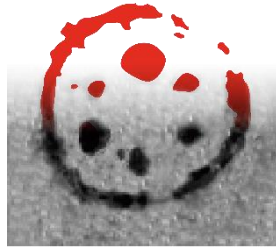


**For
The Hadstock Society**



Magnitude Surveys Ref: MSTL01

November 2015



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Issued:

20/11/15

Abstract:

Magnitude Surveys was commissioned by the Hadstock Society to undertake a Heritage Lottery Funded geophysical survey of the Parish Church of St Botolph's churchyard in Hadstock, Essex. Magnetic and earth resistance data were simultaneously collected using the Geoscan Research MSP25 cart system. The results resolve several paths, as well as a number of anomalies in the immediate vicinity of the church.

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1. Introduction

- 1.1. Magnitude Surveys Ltd (MS) was commissioned by the Hadstock Society to undertake geophysical survey over the churchyard of the Parish Church of St. Botolph's in Hadstock.
- 1.2. The archaeological geophysical survey consisted of:
 - 1.2.1. Simultaneous, hand pulled, cart mounted, fluxgate gradiometer and earth resistance survey.
- 1.3. The survey was conducted following the current best practice guidelines produced by the Chartered Institute of Field Archaeologists (CIfA 2014) and Historic England (David *et al.* 2008).
- 1.4. Fieldwork collection occurred from Monday, 19 October to Friday, 23 October 2015.

2. Quality Assurance

- 2.1. Project management, data collection, data processing and report production have been carried out by qualified and professional geophysicists to standards exceeding the current best practice (CIfA 2014, David *et al.* 2008).
- 2.2. Magnitude Surveys is a corporate member of ISAP (International Society of Archaeological Prospection).
- 2.3. Finnegan Pope-Carter is a Fellow of the London Geological Society, the Chartered UK body for geophysicists and geologists.

3. Objectives

- 3.1. Survey over St. Botolph's churchyard sought to expand on previous earth resistance survey undertaken by the Maldon Archaeology and Historical Society, who concluded there was a possible path leading from a former door in St. Botolph's nave.
- 3.2. An overall survey objective was to identify and record any previously unknown archaeological assets.

4. Geographic Background

- 4.1. St. Botolph's churchyard is under short grass. Many of the grave markers have been cleared to the edge of the cemetery.
- 4.2. Bedrock geology consists of Lewes Nodular Chalk formation and Seaford Chalk formation (undifferentiated) – Chalk with superficial deposits comprising the Lowestoft formation - Diamicton (British Geological Survey).
 - 4.2.1.1. According to Historic England Guidance the magnetometry response over chalk is generally "good" (David *et al.* 2008).
- 4.3. Soils consist are lime-rich loamy and clayey soils with impeded drainage (Soilscapes).

5. Archaeological Background

- 5.1. The nearby Red Field, NE of Hadstock, is a potential location of the Battle of Assandun in 1016. While the exact location of the battle is disputed, the construction of the Saffron Walden to Barlow branch line through the Red Field in the 1860s discovered a large number of skeletal remains in the cutting (Officers of Uttlesford District Council 2014). The bed was later refilled with refuse and the skeletal remains have not been recovered (Croxtton-Smith 2002).
- 5.2. Further evidence supporting the Red Field as the site of the Battle of Assandun is the Parish Church of St. Botolph's in Hadstock village. The present church was constructed in the 11th century around the time King Cnut dedicated a minster in commemoration of the battle. The church is dedicated to St. Botolph; a saint Cnut is believed to have taken a special interest in (Croxtton-Smith 2002). Previous geophysical survey around the churchyard reveals anomalies possibly relating to archaeological features. Of interest for this work are the potential paths running from the NE corner of the churchyard to a former door in the church's nave (Officers of Uttlesford District Council).

6. Methodology

6.1. Data Collection

6.1.1. Geophysical prospection of St. Botolph's churchyard comprised magnetic and earth resistance methods as described in the following table (6.1.2).

6.1.2. Table of survey strategies for St. Botolph's churchyard:

Method	Instrument	Traverse Interval	Sample Interval
Magnetic	Geoscan Research FM256 mounted on Geoscan MSP25	0.5m	0.125m
Earth Resistance	Geoscan Research RM85 with MSP25 square array (alpha, beta and gamma)	0.5m	0.125m

6.1.3. Magnetic and earth resistance data were collected using a Geoscan Research MSP25 hand pulled cart.

6.1.3.1. The Geoscan Research MSP25 base is formed by an $a = 0.75\text{m}$ square electrode array. Current is injected and potential difference is measured continuously through the wheels. Measurements are logged in the Geoscan Research RM85 at regular distance intervals, triggered by the optical encoder wheel. The odometer wheel is calibrated for the traverse length at the beginning of survey. Square alpha, beta and gamma configurations were collected simultaneously with a sampling interval of 0.125m along lines spaced 0.5m apart.

6.1.3.2. The cart base also supports a Geoscan Research FM256 fluxgate gradiometer operating in trigger mode. Measurements are logged in the Geoscan Research FM256 at regular distance intervals, triggered by the optical encoder wheel. Data were collected at a sampling frequency of 0.125m along lines spaced 0.5m apart.

- 6.1.4. A series of temporary sight markers were established in each survey area to guide the surveyor and ensure full coverage with the cart. Grid nodes were set out using a Hemisphere S320 RTK GPS to sub 5cm accuracy.

6.2. Data Processing

- 6.2.1. Data were processed using bespoke software developed by MS and a commercial software package, Geoplot 4.0 (Beta Version).

- 6.2.2. Magnetic processing steps were limited to:

Zero Median Traverse – The median of each sensor traverse is calculated within a specified range and subtracted from the collected data. This removes striping effects caused by small variations in sensor electronics. Care is taken to ensure this filter does not remove linear trends running parallel to the survey direction.

Interpolation to Square Pixels – Data are interpolated using a bicubic algorithm to increase the pixel density between sensor traverses. This produces images with square pixels for ease of visualisation.

- 6.2.3. Earth resistance processing steps were limited to:

Despike—Erroneous measurements (“spikes”) due to high contact resistance or poor electrode-to-ground contact are corrected by analysing the mean of measurements in a specified window size and replacing measurements outside a defined threshold with the average measurement of neighbouring positions.

High Pass Filter—Low frequency background responses are removed to emphasise near-surface archaeological responses by subtracting the weighted average from the central reading in a specified window.

Interpolation to Square Pixels – Data are interpolated using a bicubic algorithm to increase the pixel density between sensor traverses. This produces images with square pixels for ease of visualisation.

6.3. Data Visualisation

- 6.3.1. Unprocessed and processed data are presented as greyscales within a layered environment. Refer to the digital appendices for the unprocessed greyscales and XY traces.

- 6.3.2. The combined earth resistance greyscale is an average of the alpha and beta configurations (Figure 5), reducing the directional biases of the individual configurations. The gamma configuration is presented separately (Figure 6), due to its uniqueness from the alpha and beta configurations.

7. Results

7.1. Qualification

7.1.1. *The results of survey using geophysical techniques are not a map of the ground and are instead a direct measurement of subsurface properties. Detecting and mapping features requires that said features have properties that can be measured by the chosen technique(s) and that these properties have sufficient contrast with the background to be identifiable. The interpretation of any identified anomalies is always subjective. While the scrutiny of the results is undertaken by qualified, experienced individuals and rigorously checked for quality and consistency it is often not possible to classify all anomaly sources; while there will be degrees of certainty for others. Where possible an anomaly source will be identified along with the certainty of the interpretation. The only way to improve the interpretation of results is through a process of comparing excavated results with the geophysical reports. MS actively seek feedback on their reports as well as reports of further work in order to constantly improve our knowledge and service.*

7.2. Discussion

7.2.1. General Statements

- 7.2.1.1. The geophysical results were interpreted in consideration with satellite imagery c. 2003 (Digital Globe from Google Earth) and c. 2007 (Get Mapping from Google Earth) and historic mapping, the 1904 Cambridgeshire six inch (NLS 2015).
- 7.2.1.2. Specific anomalies discussed within the text have been assigned reference numbers. These are emboldened within square parenthesis [**1**]. Numbers relate to magnetic anomalies, while capitalised Roman numerals are used for earth resistance anomalies.

7.2.2. Magnetic Method Summary

- 7.2.2.1. The following summary refers to Figure 3.
- 7.2.2.2. The fluxgate gradiometer data within St. Botolph's churchyard is fairly uniform except for the strong responses from the grave markers and the church and its associated features. The current gravel path running NE across the survey area is weakly resolved.
- 7.2.2.3. Ferrous anomalies are visible within the survey area. These ferrous anomalies tend towards two forms: small, discrete spikes usually associated with modern ferrous or fired debris in the topsoil. The church and its associated features produce strong magnetic responses around the building's perimeter.

7.2.3. Earth Resistance Method Summary

- 7.2.3.1. The following summary refers to Figures 5 and 6.
- 7.2.3.2. The combined earth resistance interpretation represents the alpha, beta and gamma configuration responses.
- 7.2.3.3. The current gravel paths running NE-SW and E-W across the survey area are clearly resolved in the earth resistance data. Additional paths are resolved, which correlate with historic mapping.

- 7.2.3.4. The earth resistance data with the churchyard is fairly uniform except for the high-contrast zones with strong responses likely associated with burial activity and landscaping.

7.3. Magnetic Interpretation

- 7.3.1. The following summaries refer to Figure 4.

7.3.2. Path

- 7.3.3. The current gravel path is weakly resolved in the magnetic data. The now disused path that runs from the porch past the well, denoted in the historic mapping, has not been resolved. The strong, magnetic 'halos' from the grave markers are likely saturating the instruments and overshadowing the magnetic signal of the path.

7.3.4. Undetermined

- 7.3.5. A linear anomaly resolved near the church is likely an associated building feature such as a drain or service and of presumed modern origin.

7.4. Earth Resistance Interpretation

- 7.4.1. The following summaries refer to Figures 7 and 8.

7.4.2. Path

- 7.4.3. The current gravel paths are strongly resolved in the earth resistance data. The data from the Maldon Society survey have been georeferenced over the historic mapping (Figure 8); however, as no location information has been provided, the positional accuracy of the data is to be viewed with caution. The Maldon Society results correlate well with the modern paths. However, no evidence can be seen of the pre-14th century path that was interpreted by the Maldon Society. Analysis of the Maldon Society results against Magnitude Survey's results suggests the Maldon Society's coarser sampling density may give the impression of a single feature, when in fact the anomaly is comprised of separate, distinct features.

7.4.4. Archaeology Probable

- 7.4.5. Two parallel linear anomalies run N-S perpendicular to the church. These anomalies correlate with path features on the historic mapping [I]. The strong anomalies are resolved in the alpha, beta and gamma datasets, but the weak path anomalies are only resolved in the gamma dataset. Compared to the alpha and beta configurations, the gamma configuration is particularly effective at detecting abrupt edges.

7.4.6. Undetermined

- 7.4.7. A weak linear anomaly oriented N-S is resolved adjacent to the church [II]. Due to the displacement of the anomaly E-W to the probable path anomalies and its proximity to the church, this anomaly has been categorised as Undetermined.

- 7.4.8. Further Undetermined anomalies are all found around the perimeter of the church. The anomalies to the north of the church are likely caused by the building and its associated features, drainage and foundations; although their exact origin is unknown. A high-resistance anomaly to the east [III], similar to one detected in the Maldon Society's results, has been identified. Due to the increased sampling strategy of the current data, the shape of the anomaly is better resolved. The Maldon Society has previously

interpreted this as the original chancel end; it is difficult to be certain of this interpretation due to the proximity of the anomaly to the current wall. The anomaly may be resultant of rubble from the Victorian rebuilding work, foundation, or drainage. The current survey's identification of a high resistance spur heading east from the anomaly makes the interpretation more uncertain.

8. Conclusions

- 8.1. The survey of St. Botolph's churchyard could not confirm the previous geophysical interpretation of an additional path running NE from a former door in the church's nave. The georeferenced plot (figure 8) shows clear correlation between the two surveys with regards to the current path. Nonetheless, the earth resistance and magnetic methods resolve other paths, which are denoted in the historic mapping.
- 8.2. The anomaly interpreted by the Maldon Society as the original chancel wall has been resolved; however, the additional spur makes the identification uncertain. A small test pit could demonstrate the origin of the anomaly and could potentially provide dating evidence for the construction of any archaeological feature identified.
- 8.3. The magnetic and earth resistance methods are well correlated with the high contrast responses associated with the burials and the church and its associated features.

9. Archiving

- 9.1. Magnitude Surveys Ltd maintains an in-house digital archive, which is based on (Schmidt and Ernenwein 2013).
- 9.2. Magnitude Surveys Ltd contributes all reports to the ADS Grey Literature Library subject to any timed embargoes dictated by the client.
- 9.3. Whenever possible Magnitude Surveys has a policy of making data available to view in easy to use forms on its website. This can benefit the client by making all of their reports available in a single repository, while also being a useful resource for research. Should a client wish to impose a time embargo on the availability of data this can be achieved in discussion with MS.

10. Copyright

- 10.1. Copyright and the intellectual property pertaining to all reports, figures, and datasets produced by Magnitude Services Ltd. is retained by MS. The client is given full licence to use such material for their own purposes. Permission must be sought by any third party wishing to use or reproduce any IP owned by MS.

11. References

British Geological Survey. *Geology of Britain Viewer*. [Online]. [Accessed November 2015]. Available from: <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>

Chartered Institute for Archaeologists, 2014. *Standards and Guidance for archaeological geophysical survey*. CIfA.

Croxtton-Smith, P., 2002. The Site of the Battle of Assandun, 1016. *Saffron Walden Historical Journal* **3**.

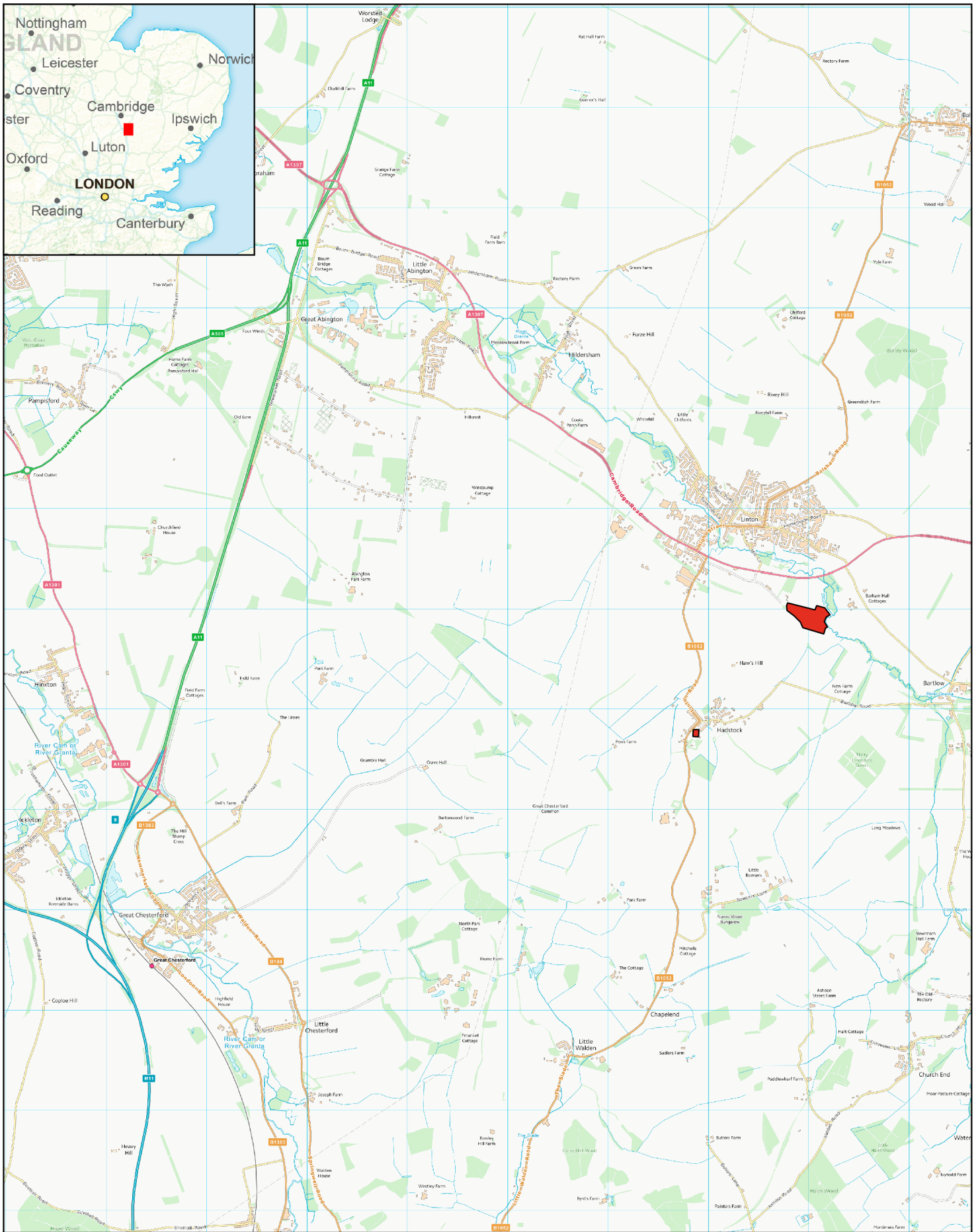
David, A., Linford, N., Linford, P. and Martin, L., 2008. *Geophysical Survey in Archaeological Field Evaluation: Research and Professional Services Guidelines*. 2nd ed. English Heritage.

Etté, J. and Hinds, S., 1993. *Excavations at Linton Roman Villa*. Cambridgeshire Archaeology Report no. 88.

Officers of Uttlesford District Council, 2014. *Hadstock Conservation Area Appraisal and Management Proposals*.

Schmidt, A. and Ernenwein, E., 2013. *Guide to Good Practice: Geophysical Data in Archaeology*. 2nd ed., Oxbow Books, Oxford.

Soilscapes. *Cranfield Soil and Agrifood Institute Soilscapes*. National Soil Resources Institute. [Online]. [Accessed November 2015] Available from: <http://www.landis.org.uk/soilscapes>.



 Survey Area

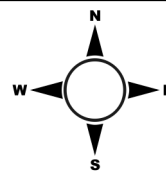
MSTL01B - Geophysical Survey of St. Botolph's Churchyard

Figure 1 - Site Location

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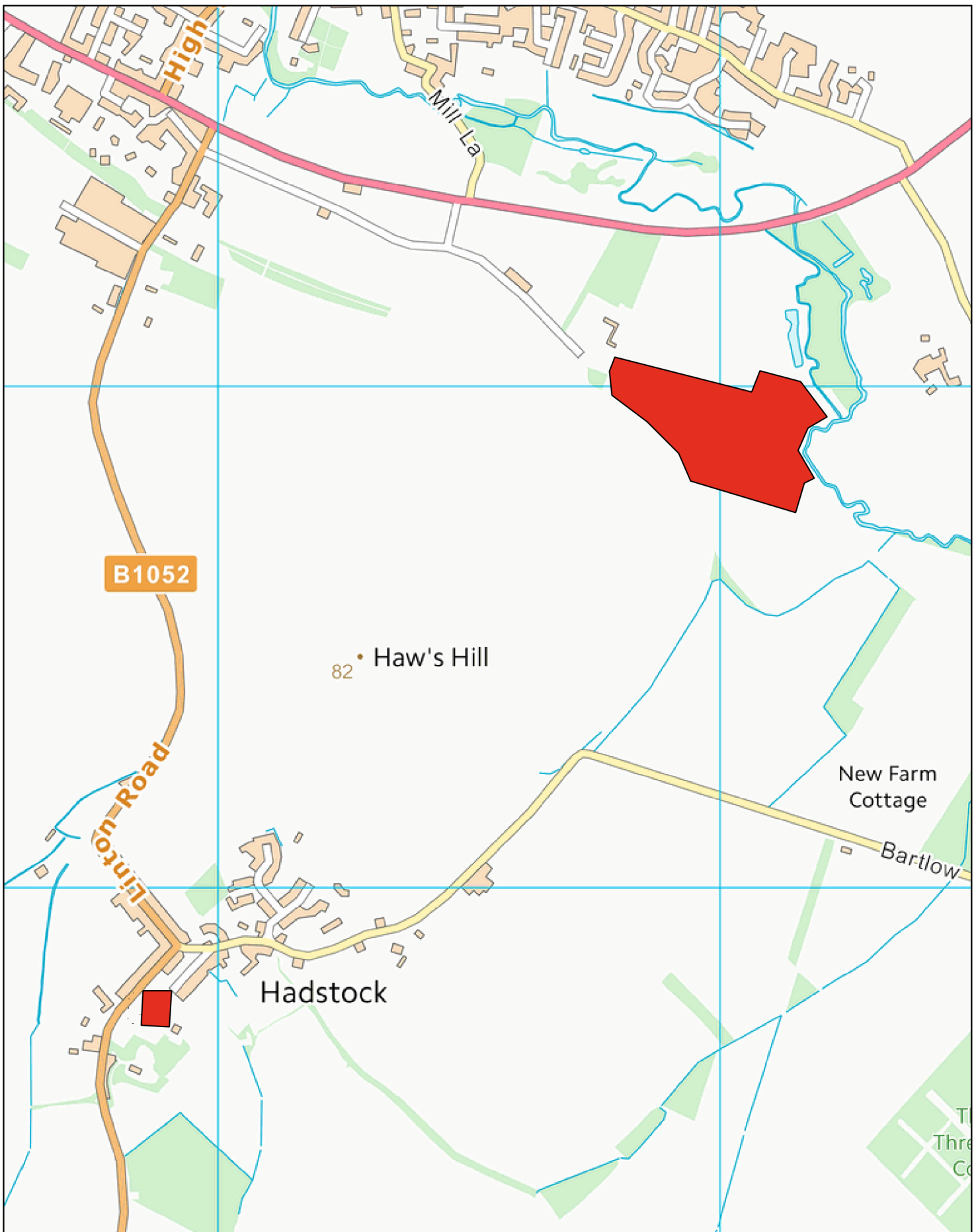
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 Survey Area

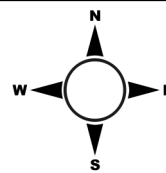
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Figure 2 - Location of Survey Area

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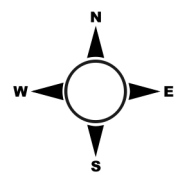
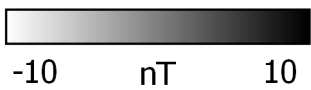
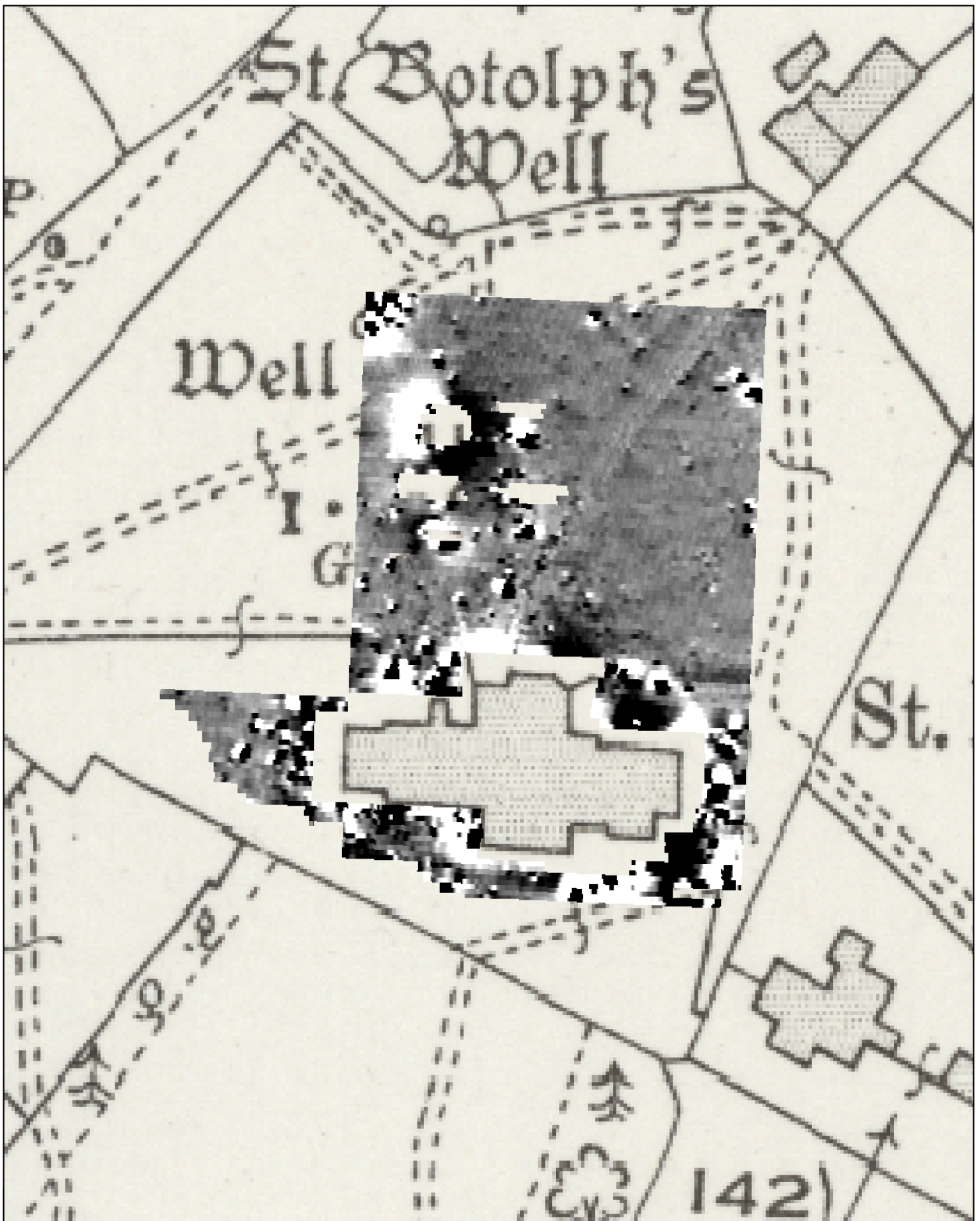
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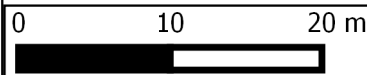
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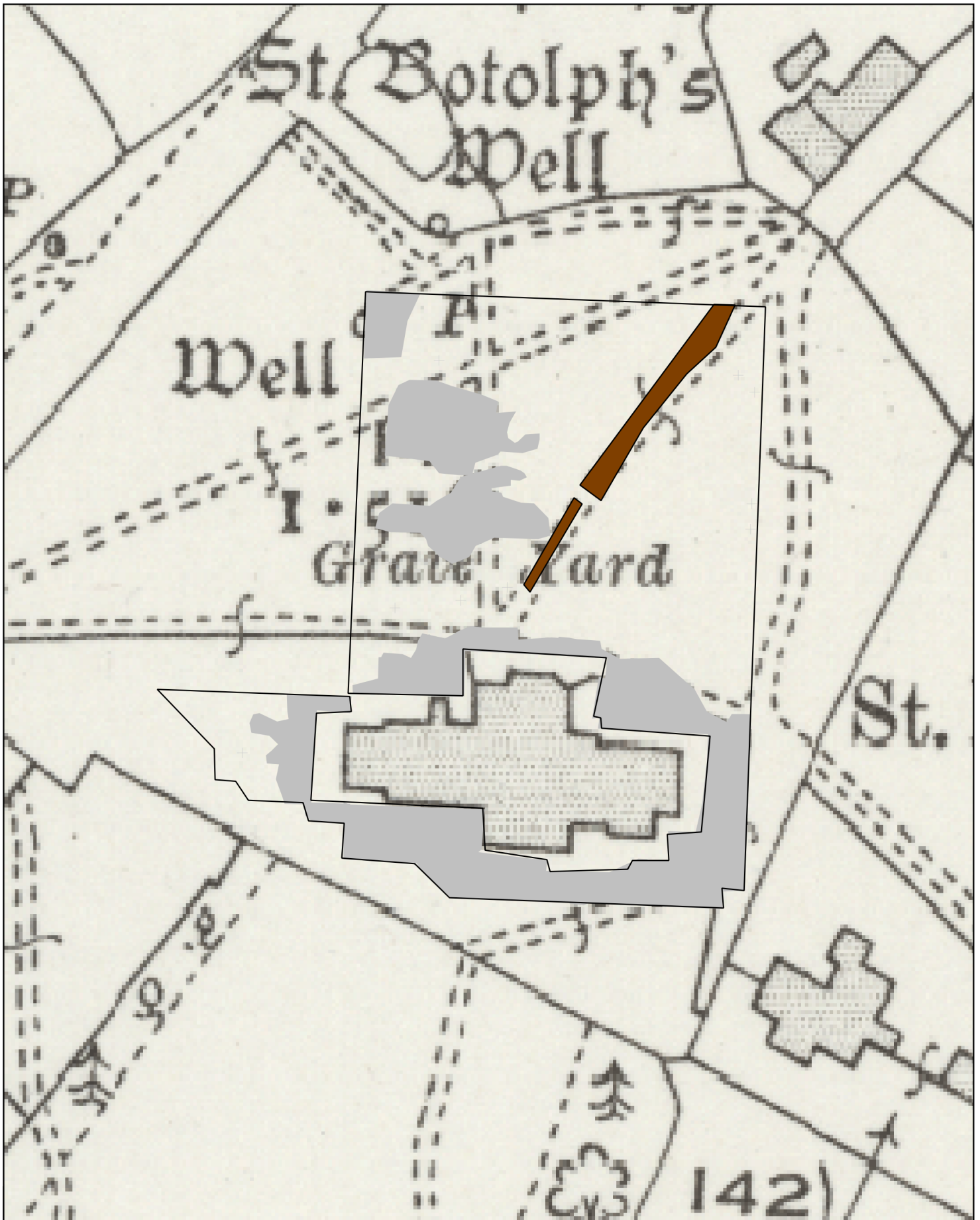
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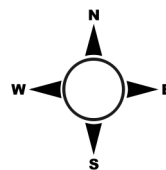
MSTL01B - Geophysical Survey of St. Botolph's Churchyard
 Figure 3 - Magnetic Greyscale 1 : 500 @ A4
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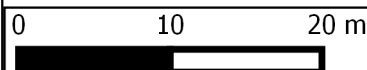
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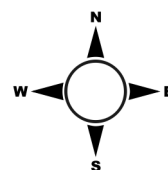
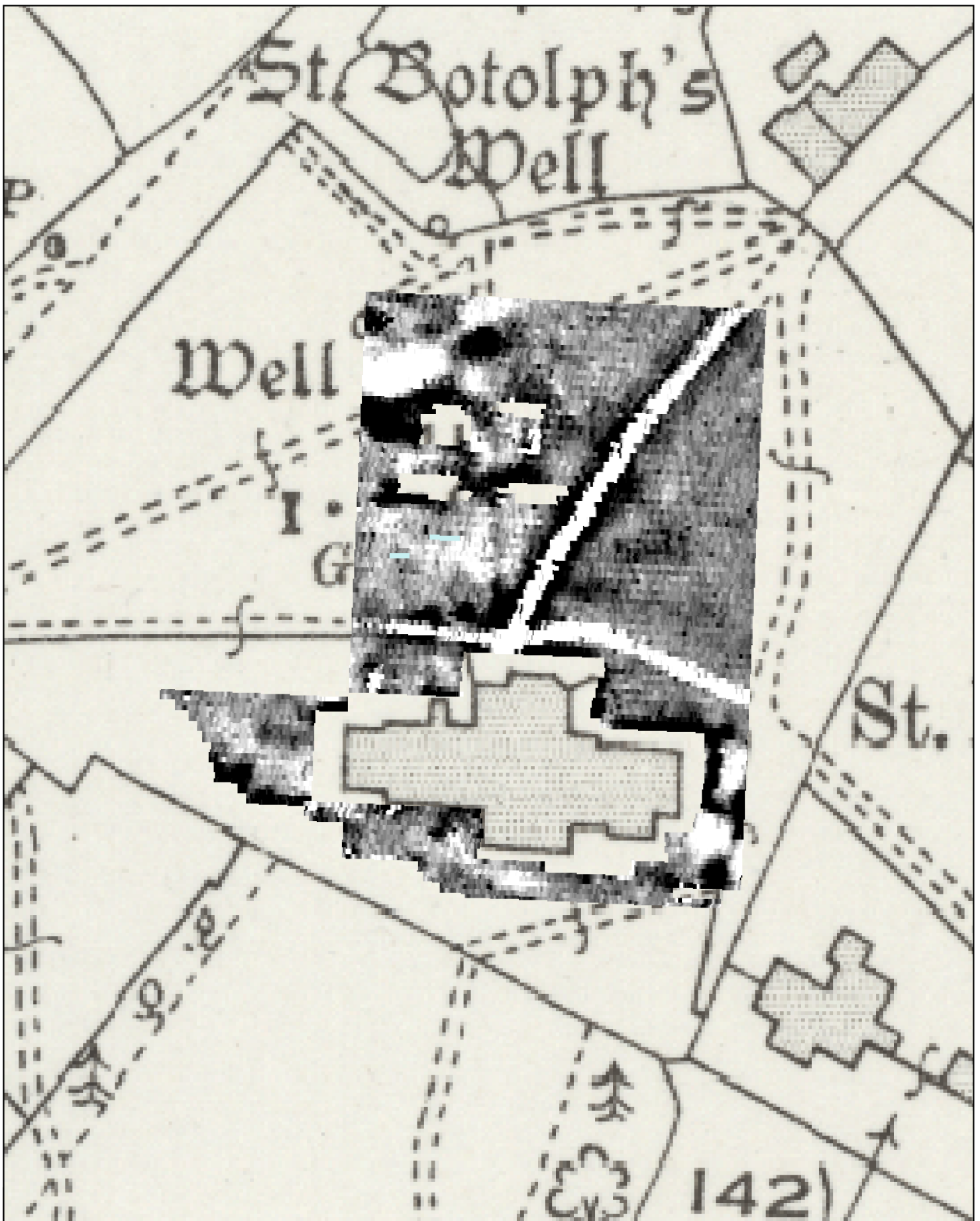
Magnetic Disturbance
 Modern Path
 Ferrous Point



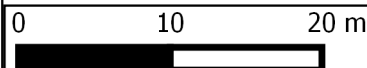
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 Figure 4 - Magnetic -- Interpretation 1 : 500 @ A4
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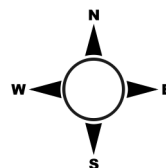
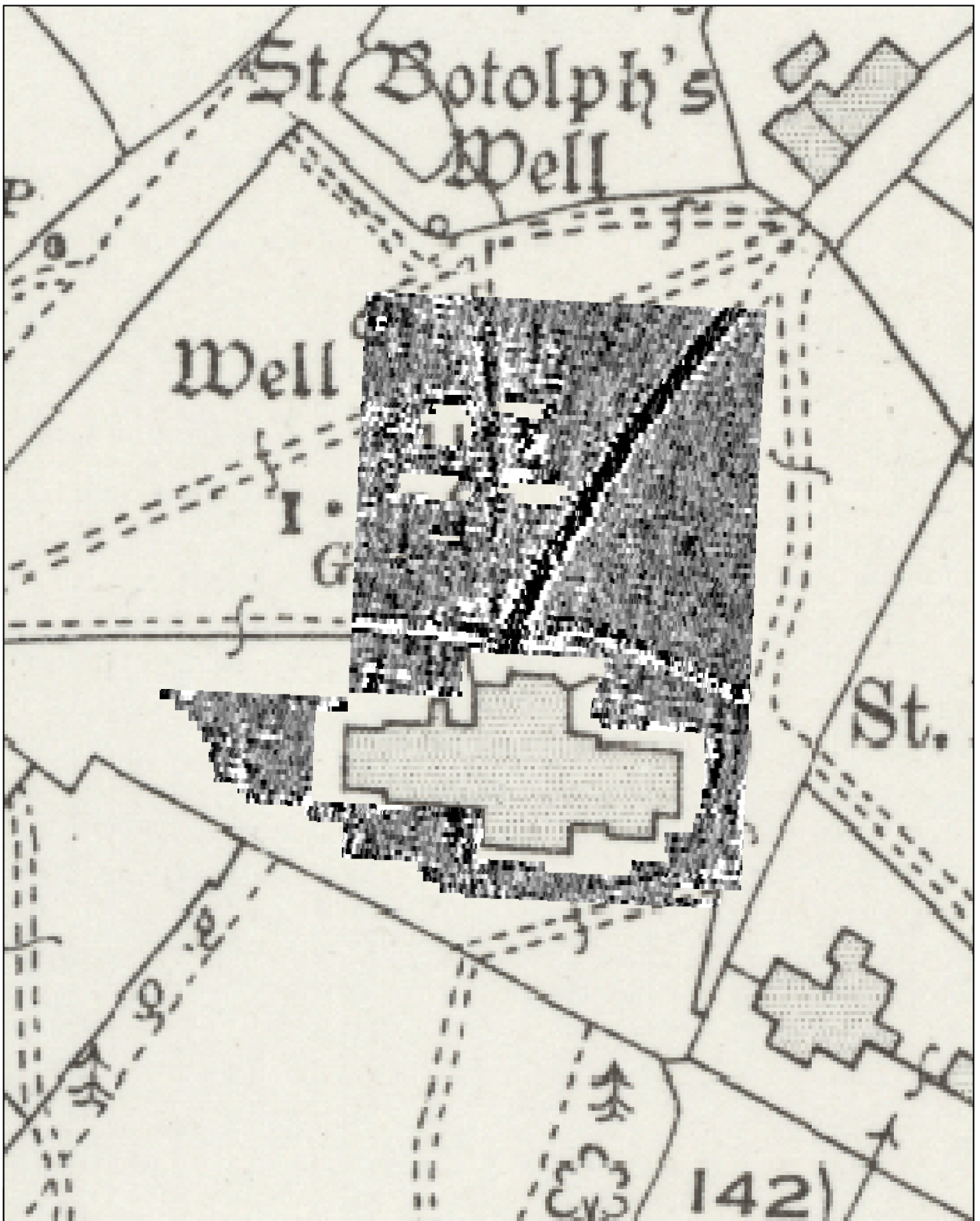
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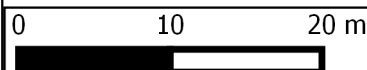
MSTL01B - Geophysical Survey of St. Botolph's Churchyard 1 : 500 @ A4
 Figure 5 - Combined Alpha & Beta Earth Resistance Greyscale
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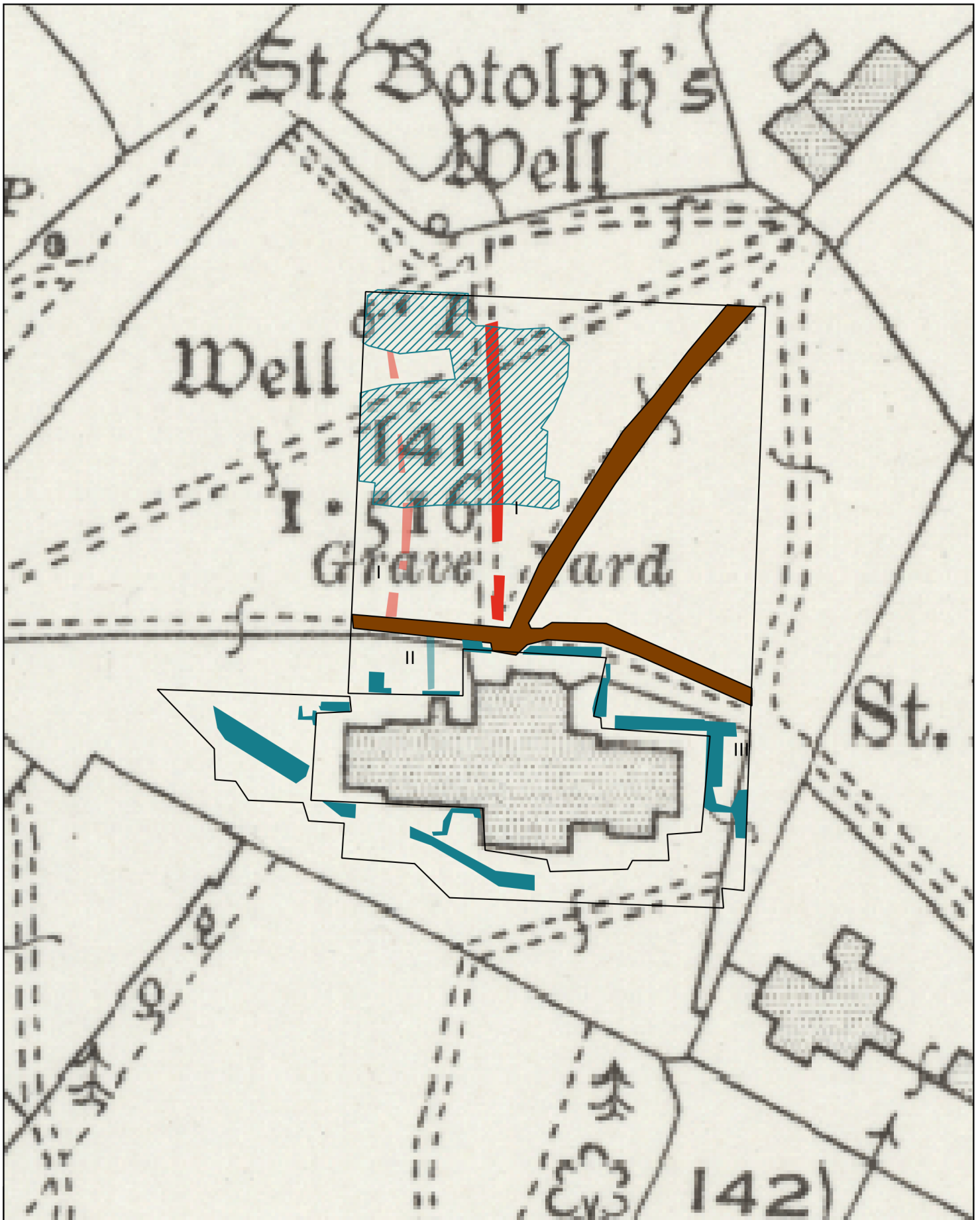
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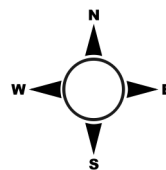
MSTL01B - Geophysical Survey of St. Botolph's Churchyard 1 : 500 @ A4
 Figure 6 - Gamma Earth Resistance Greyscale
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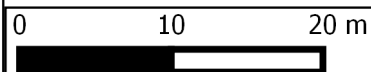
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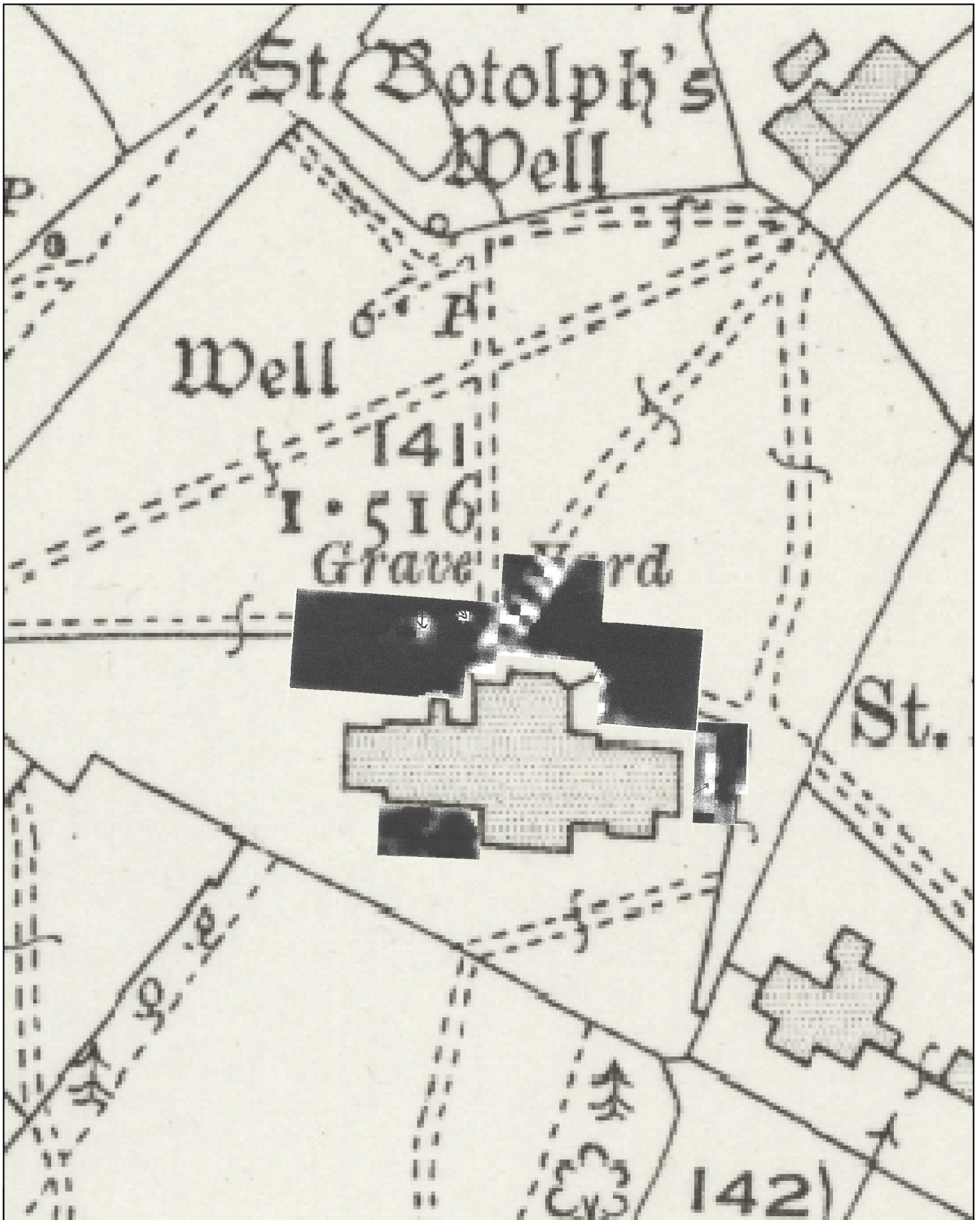
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- Undetermined - Weak
- Archaeology Probable - Weak
- Undetermined Zone
- Undetermined - Strong
- Modern Path



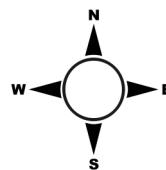
MSTL01B - Geophysical Survey of St. Botolph's Churchyard 1 : 500 @ A4
 Figure 7 - Combined Earth Resistance Interpretation
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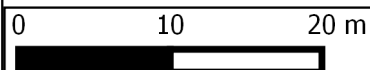
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Unknown Greyscale Scale



MSTL01B - Geophysical Survey of St. Botolph's Churchyard 1 : 500 @ A4
 Figure 8 - Maldon Society Earth Resistance -- Greyscale
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