Geophysical Survey of A Portion of Prince George's Chapel

Dagsboro, Sussex County, Delaware

prepared for

Delaware Division of Historical and Cultural Affairs
Dover, Delaware

by

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West Chester, Pennsylvania

MAY 2013

DRAFT

GEOPHYSICAL SURVEY OF A PORTION OF

PRINCE GEORGE'S CHAPEL

DAGSBORO, SUSSEX COUNTY, DELAWARE

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by

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ABSTRACT

On April 11, 2013, JMA conducted a ground-penetrating radar investigation at Prince George's Chapel in Dagsboro, Delaware. Based on the map provided by the Division of Historical and Cultural Affairs, JMA conducted the survey to delineate the extent of the presence or absence of graves within the footprint of the proposed geophysical survey area. The geophysical survey entailed a field survey designed to provide information regarding the presence or absence of potential graves, and an understanding of the distribution of any interpreted graves, within the proposed geophysical survey area.

A total of 2.2 miles (3,638 meters) of GPR data were examined for the presence or absence of anomalies likely related to unmarked burials. A total of six graves associated with grave markers were identified in the geophysical survey area. In addition to the six marked graves, two potential structure footprints were identified along the north and northeastern edges of the geophysical survey area. During the course of the survey, several burial plot markers were identified and then mapped with a sub-meter accurate GPS unit within the survey area However, there were no burial-like anomalies identified within the geophysical survey area that were not already associated with an existing gravestone.

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1.0 INTRODUCTION

The purpose of this survey is to determine the presence or absence of potential grave shafts within the footprint of the proposed geophysical survey area (Figure 1). The geophysical survey employed a field survey designed to provide information regarding the presence or absence of potential graves, and an understanding of the distribution of any interpreted graves, within the proposed geophysical survey area. This information is expected to be used to manage any discovered resources within the footprint of the geophysical survey area.

The GPR survey area consists primarily of open ground between areas of grave markers currently used as a parking area and a vehicle access area to the property (Figure 2 and Plate 1). At the southwestern end of the area is a gate within a post and rail fence (Plates 2 and 3). The northeastern corner of the survey area is approximately eight (8) meters southwest of the southwestern corner of Prince George's Chapel. Historical records suggest that the current Prince George's Chapel has existed on the property since 1757, although there is mention of a chapel in the area as early as 1717 (Gerken 1986). The longitudinal center of this survey area lay much lower than the longitudinal edges. A series of grave markers mark the southern boundary of the survey area (Plate 3). The oldest gravestone within the existing property dates to 1816 and the cemetery is still active as evident by the modern gravestones along the southern edge of the survey area.

2.0 ENVIRONMENTAL CONTEXT

The geophysical survey area consists of a manicured and slightly sloping lawn with a few mature trees and several gravestones and plot markers. It is bounded at the western end by a post and rail fence and gate. The geophysical survey area is located within the Coastal Plain Geomorphic Province of Delaware. The geophysical survey area is underlain by the late Pleistocene age Ironshire Formation (Qi). The Ironshire Formation is described as consisting of a lower loose, pale-yellow to white, well-sorted, medium sand characterized by long, low-angle inclined beds with thin layers of black minerals. The upper portion of the formation is described as consisting of light-colored, trough cross-stratified, well-sorted sand with pebbles (Owens and Denny 1979). Thus, the primary constituent of the Ironshire formation is sand-sized grains into which the current soils have developed.

Hydrologically, the geophysical survey area is located within the Pepper Creek water shed that encompasses approximately thirteen (13) square miles. The Pepper Creek watershed falls within the larger Indian River Bay watershed that drains approximately 69 square miles. The water table within the project are lay between eight (8) and ten (10) feet below ground surface (Martin and Andres 2005).

3.0 GROUND-PENETRATING RADAR METHODS

JMA used a GSSI UtilityScanTM survey cart GPR system with a distance encoder wheel using a GSSI SIR-3000 Data Acquisition System with a 400MHz antenna for the survey. This system is registered with the FCC under CFR 47, Part 15. The GPR operates by transmitting a pulse, at specific times or distances, of ultra high frequency radio waves (microwave electromagnetic energy) into the ground through an antenna. When the transmitted signal enters the ground, it encounters subsurface materials with different electrical conductivities and dielectric constants (e.g. brick versus sand). Another antenna then receives the reflected waves and stores them in digital format. Only part of the signal reflects off any interfaces between differing materials; while the rest of the waves pass through to the next interface. Then part of that signal is reflected when it hits another interface and is returned to the antenna, and so on. These reflected signals received through the receiving antennae are then stored by the systems specific digital control unit. The control unit registers the reflections against two-way travel time in nanoseconds and then amplifies the signals. The output signal voltage peaks plot on the GPR profile as different color/shade bands by the digital control unit. This data is later downloaded and processed using GPR processing software for analysis and display.

JMA began the survey by collecting geophysical data related to other marked graves within the property and outside the geophysical survey area as a comparative data set for this project. This geophysical survey provided information useful to identify locations of probable disturbances and features within the geophysical survey area based on the identification of anomalies or their absence. Because geophysics is a non-invasive method, it will not provide conclusive evidence that any anomalies encountered during the survey can be associated absolutely with human activity related to the cemetery. In addition, because GPR utilizes electromagnetic waves, any unanticipated electromagnetic or magnetic interference within the geophysical survey area may render this survey erroneous in those areas experiencing such interference.

The geophysical survey area was then divided into two geophysical blocks encompassing 0.23 acres (916 sq m) of the property (Figure 2). The orientation of the survey was northeast to southwest based on the orientation of the existing grave markers. The two geophysical blocks were surveyed as individual units with a 0.25 m (approximately 0.8 ft) interval between geophysical transects. The antenna and SIR-3000 data collector were mounted on a Utility Cart and utilized odometer-triggered collection of one (1) reading every 0.8 inches (every 2 cm). The GPR data were collected within geophysical survey grids in a unidirectional collection pattern along the X axis of lines. This methodology facilitated the post-processing of results and the production of geophysical maps.

GPR grids were combined into one file using the Super3D function of RADAN and processed simultaneously. The data were interpreted in cross-section view (2D) as well as in 3D mode. In 3D mode individual cross-section profiles are combined using grid coordinates to produce a three-dimensional cube of the entire dataset. The cube can be sliced through at different depth intervals to reveal horizontal patterning between subsurface anomalies that may otherwise be missed though analysis solely of cross-section profiles. Individual time slices were exported from RADAN and then imported and georeferenced to sub-meter accurate GPS survey data in a GIS workspace.

4.0 RESULTS

JMA processed the GPR data using GSSI's RADAN 6.6 software. A total of 2.2 miles (3,638 meters) of GPR data were examined related to the survey area to determine the presence or absence of potential unmarked graves. JMA achieved near-complete coverage of proposed survey areas. Trees, gravestones, and other obstacles precluded GPR data collection in some areas.

Time slices of the three-dimensional GPR data were exported from RADAN, and imported into ArcGIS for spatial comparisons with other datasets. Figure 3 depicts four (4) of these time slices. As one moves from a shallow time slice (A) to the deepest time slice (D) depicted, anomalies appear and disappear. Based on an examination of these and other time slices, anomalies are identified and interpreted.

Taking the time slice located 2.5 feet below the ground surface with a depth window of 2 feet ±; an aggregate view of the identified anomalies is presented (Figure 4). Within the survey area, six graves were identified associated with existing grave markers in the southeastern corner of the survey area (Figure 4). Two anomalies likely related to structural footprints are identified along the northern boundary of the survey area. The interpreted structural footprint in the northeastern corner of the survey area is well-defined. Based on the geophysical data, this likely structural footprint is at least 16 feet long and 8 feet wide and appears within the record at approximately 1.5 feet below ground surface and disappears from the geophysical record at approximately 4 feet below ground surface. The interpreted structural footprint along the northern edge of the survey area is less well defined. Based on the geophysical data, this potential structural footprint is 17 feet long and 10 feet wide and appears within the geophysical record at approximately 2.5 feet below ground surface and disappears from the geophysical record at approximately 3 feet below ground surface. In the southeastern corner of the survey area, the root system of an existing tree within the survey area can be clearly seen in the record. Another root system is also seen in the northwestern corner of the survey area but the tree itself is outside the survey area. No other anomalies were identified that are likely related to human activity within the survey area.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The GPR data collected at the Prince George's Chapel were of high quality and maximized the amount of coverage possible in light of few obstructions. A total of six graves associated with markers were identified with the geophysical survey area (Figures 5 and 6). Two potential structural footprints were identified along the northern and northeastern edges of the survey area. During the course of the survey, several burial plot markers were identified and then mapped with a sub-meter accurate GPS unit within the survey area (Figures 5 and 6). Upon review of the data collected, there were no additional anomalies exhibiting the characteristics of graves identified within the geophysical survey area that were not associated with an existing gravestone.

The interpretations of geophysical anomalies described in this technical report are based on the experience of JMA geoarcheologists in many similar archeological settings. However, these interpretations are derived from the use of electromagnetic media to remotely characterize subsurface archeological and stratigraphic features. Thus there is an inherent error margin that cannot be avoided. JMA recommends archeological ground-truthing of anomalies to fully interpret their origins if appropriate. Based on the existence of burial plot corner markers within the survey area that extend beyond the limit of grave markers into the survey area, it is suggested that any project activities avoid the areas of existing grave plots.

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FIGURES

Figure 1. Location of survey on scanned image of United States Geological Survey (USGS) paper topographic maps by National Geographic Society, i-cubed; Copyright:© 2013.

Figure 2. Detail 2012 aerial identifying the location of the geophysical survey in relation the Prince George's Chapel property.

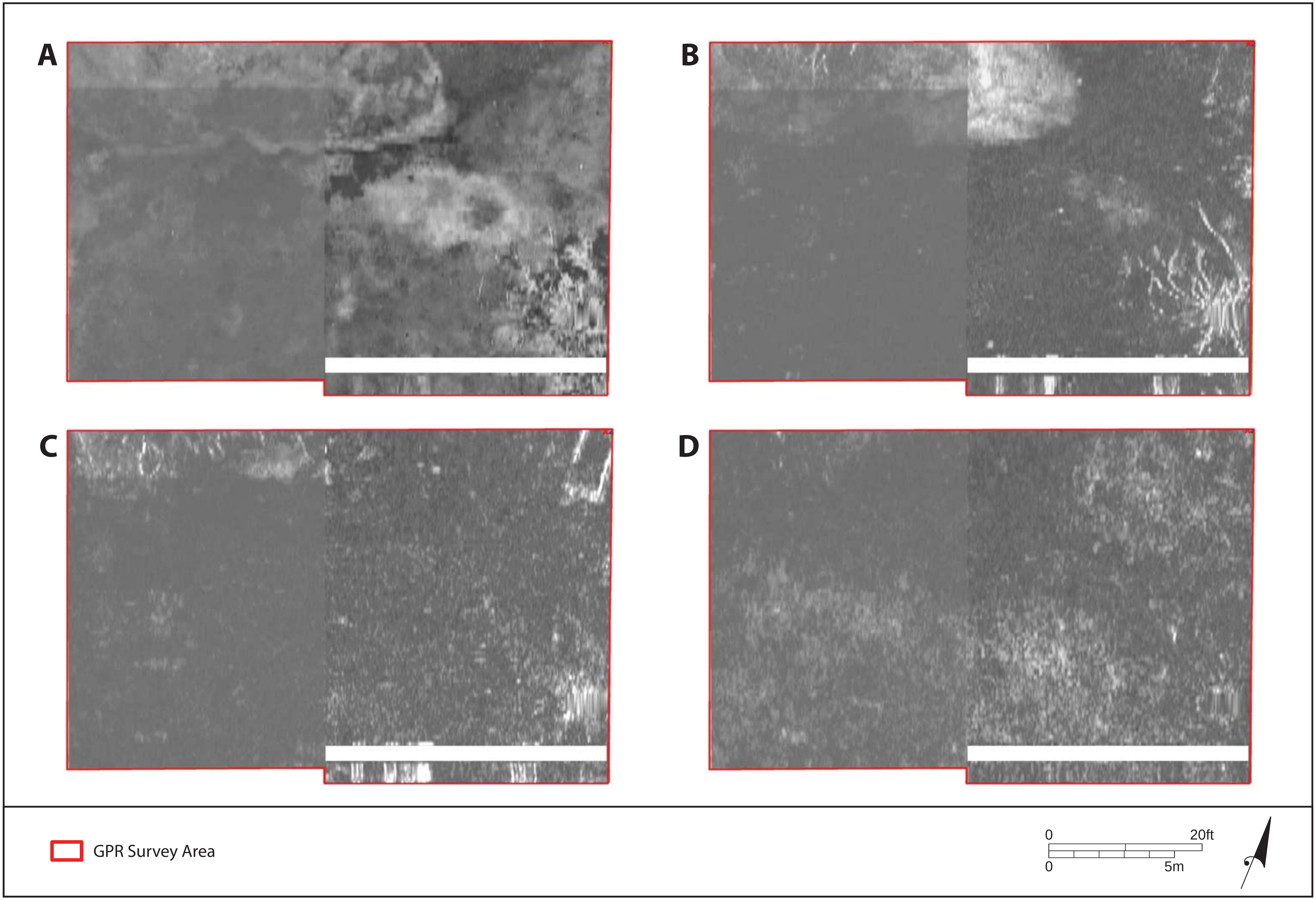

Figure 3. GPR time-slices of geophysical data at 1ft +/- 6 inches (A), 2ft +/- 6 inches (B) 3ft +/- 6 inches (C), and 4ft +/- 6 inches.

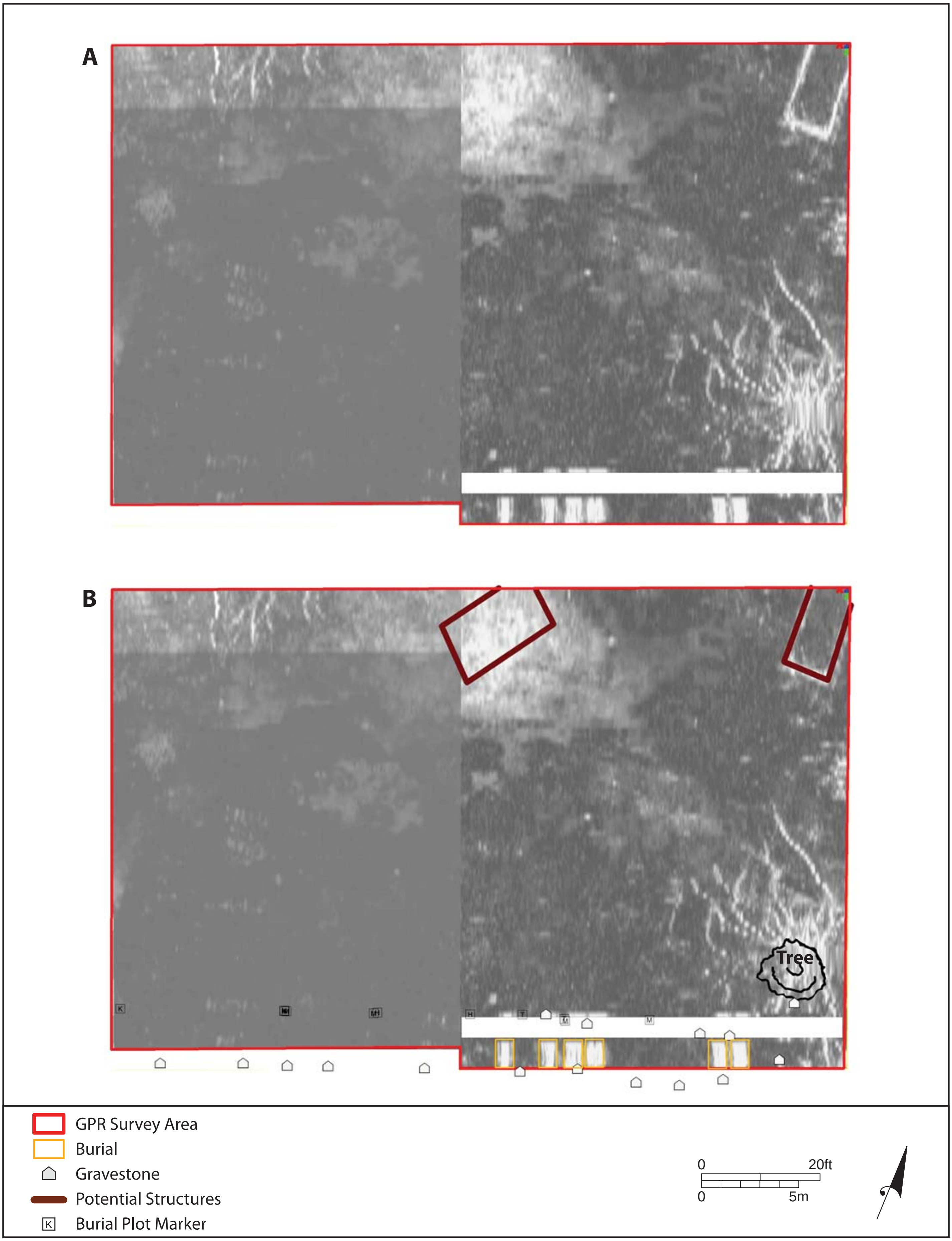

Figure 4. GPR time-slice of geophysical data at 2ft 6 inches +/-2ft. Geophysical anomalies are not interpreted in map A and interpreted in map B.

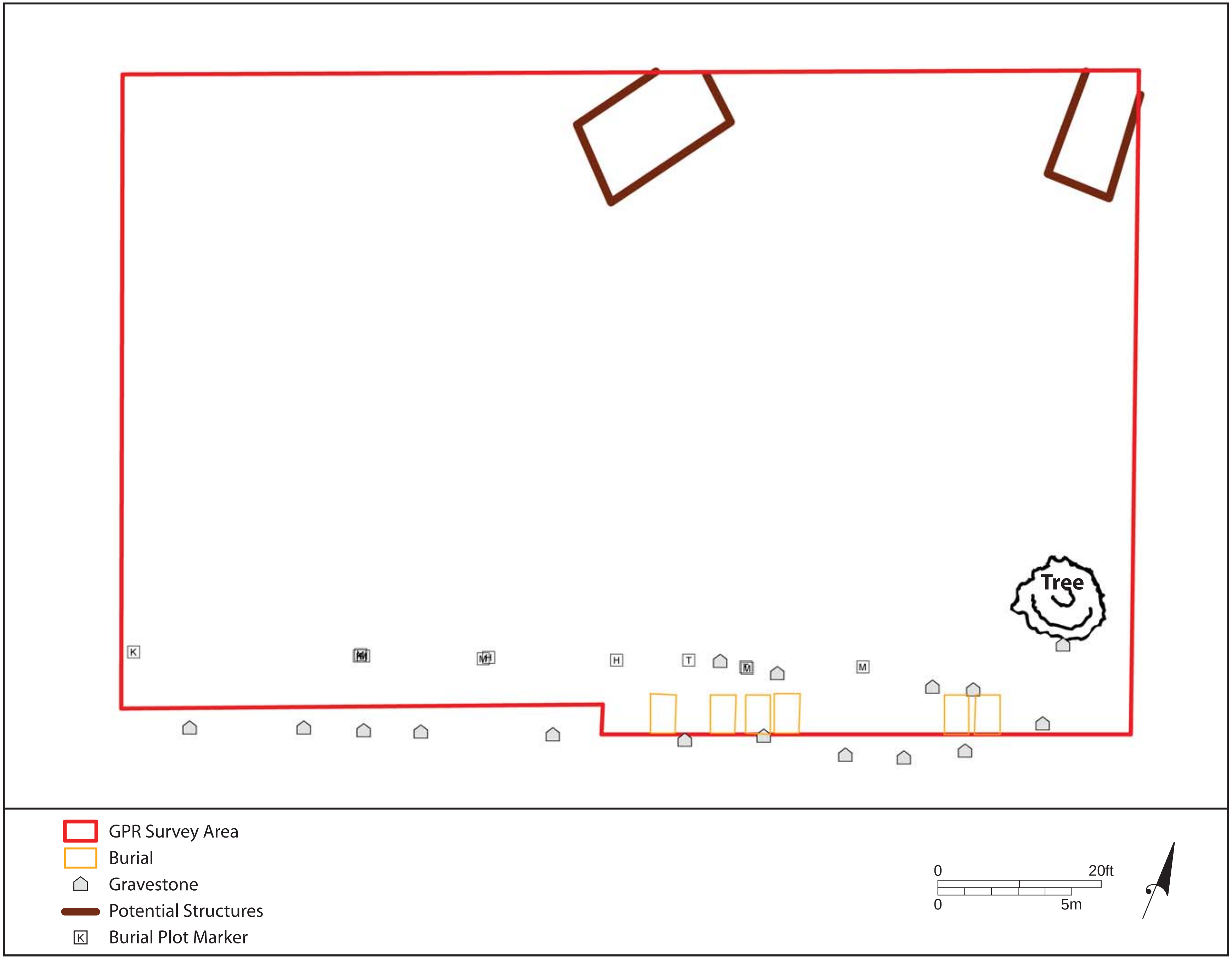

Figure 5. Map of interpreted GPR anomalies, gravestones, and burial plot markers within the geophysical survey area at Prince George's Chapel.

Figure 6. Interpreted GPR anomalies and burial plot markers within the geophysical survey area at Prince George's Chapel on detail 2012 aerial.

PLATES

Plate 1. View of geophysical survey area from entrance gate towards Prince George's Chapel.

Plate 2. View of geophysical survey area from northwest corner of project area towards entrance gate.

Plate 3. View of gravestones along southern edge of the geophysical survey area.