GEOPHYSICAL SURVEY OF THE METUCHEN COLONIAL CEMETERY IN METUCHEN, NEW JERSEY

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Abstract

The Archaeological Services Center (ARCSERV) of the Indiana University of Pennsylvania (IUP) conducted a geophysical survey of the landscapes associated with the Metuchen Colonial Cemetery, Metuchen, New Jersey from December 21 to 21, 2022 to determine the probable presence or absence of potential archaeological features and burials within a defined survey area. The possibility of archaeological features and burials within the geophysical survey areas is based on documentation and personal communication with the Metuchen-Edison Historical Society. The geophysical survey encompassed nearly a 0.23-acre (approximately 925 sqm) contiguous area of the cemetery. The geophysical survey areas were surveyed using ground penetrating radar (GPR). Three (3) GPR geophysical grids, ranging in size from 15 meters by 20 meters to 15 meters by 24 meters were placed along the western edge of the cemetery.

Based on the results of the geophysical survey, numerous geophysical anomalies were identified. Most of the anomalies (425) are likely burials while the remainder being other potential archaeological features. The geophysical anomalies that are likely related to archaeological features are interpreted as two (2) potential structures, one (1) potential shaft feature, and one (1) area of disturbance. Only ground truthing the geophysical anomalies will provide resolution on if they are archaeological features and what these interpreted archaeological features represent temporally and culturally.

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1.0 INTRODUCTION

The Archaeological Services Center of the Indiana University of Pennsylvania (ARCSERV) was tasked by the Metuchen-Edison Historical Society with conducting a geophysical survey of the landscapes associated with the Metuchen Colonial Cemetery in Metuchen, New Jersey from December 21 to 22, 2022 to determine the probable presence or absence of potential archaeological features and burials within a 15-meter by 64-meter Survey Area (Figure 1, Plate 1 and Plate 2). The likely presence of burials and archaeological features is based on presence or absence of anomalies within the geophysical data. The use of geophysics has become a common method to narrow down areas that are likely to contain potential archaeological features from those areas that do not.

Geophysics is used to determine where within a landscape the soils have been disturbed to identify potential burials and archaeological features. The excavation, placement, and filling related to building a structure or excavating a privy or a burial is a case where the soils have been disturbed. However, this is not the only way in which soils and landscapes have been disturbed. Soils can also be disturbed by other human actions and by nature. Human activity greatly alters the natural landscape through time. The building of structures and digging holes are landscape altering activities that create deviation from the natural landscape. These deviations are what geophysical systems can identify. Thus, the identification of disturbances related to structures, burials, or other features that are no longer apparent on the landscape is based on the identification of these disturbances that are similar in morphology. However, the identification of these potential features is based on deviations (anomalies) from the natural landscape and natural processes and animals can disturb natural deposits. Thus, the true interpretation of these potential features can only be accomplished through the archaeological excavation, interpretation, and recordation of these features.

Figure 1. Metuchen Colonial Cemetery located on Perth Amboy, NJ-NY 1956 (photorevised 1981) 7.5-minute USGS Quadrangle.

Plate 1. General view facing North of the landscape within the geophysical Survey Area.

Plate 2. General view looking South of the landscape within the Survey Area.

2.0 BACKGROUND

The Survey Area lay within the Piedmont Physiographic Province New Jersey (Figure 2). The Piedmont in New Jersey tends to be a region of low relief with gently rolling landscapes containing dendritic drainage patterns with elevations ranging between 0 feet and 180 feet. The geologic bedrock associated with the Survey Area is the Passaic Formation (JTrp). The Passaic Formation is Lower Jurassic and Upper Triassic in age (Figure 3). The formation consists of reddish-brown to brownish-purple and grayish-red siltstone and shale (Olsen, 1980). The surface geology associated with the Survey Area is a Pleistocene aged, weathered shale, mudstone and sandstone (Qws) deposit (Figure 4).

The Soils within the Survey Area are mapped as Boonton-Urban land complex, 0 to 8 percent slopes (BouB) (Web Soil Survey, 2021; Figure 5). Boonton-Urban land complex are well drained soils derived from coarse-loamy till. Because they are associated with urban settings, it typically includes deposits that have frequently been graded, disturbed, or filled based on the historic development of the urban landscape. Because of the nature of the soils, traditional archaeological methods are typically difficult and necessitate the use of mechanical removal of the materials related to the changing urban landscape to find intact archaeological features. Based on the age of the cemetery, the urban impacts are unlikely to affect any geophysical survey or potential archaeological testing.

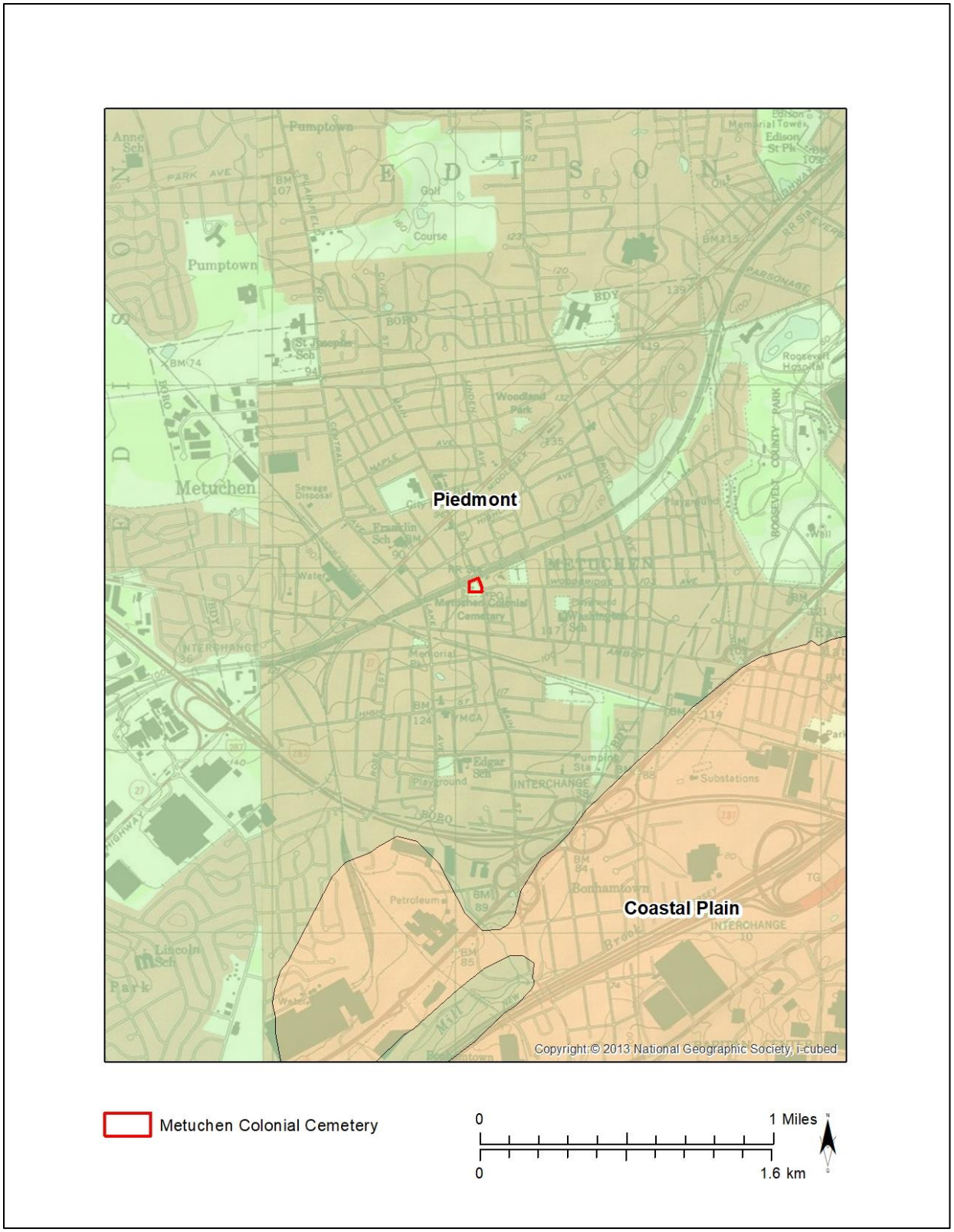

Figure 2. The Metuchen Colonial Cemetery in relation to New Jersey Physiographic Provinces.

Figure 3. The bedrock geology related to the Metuchen Colonial Cemetery.

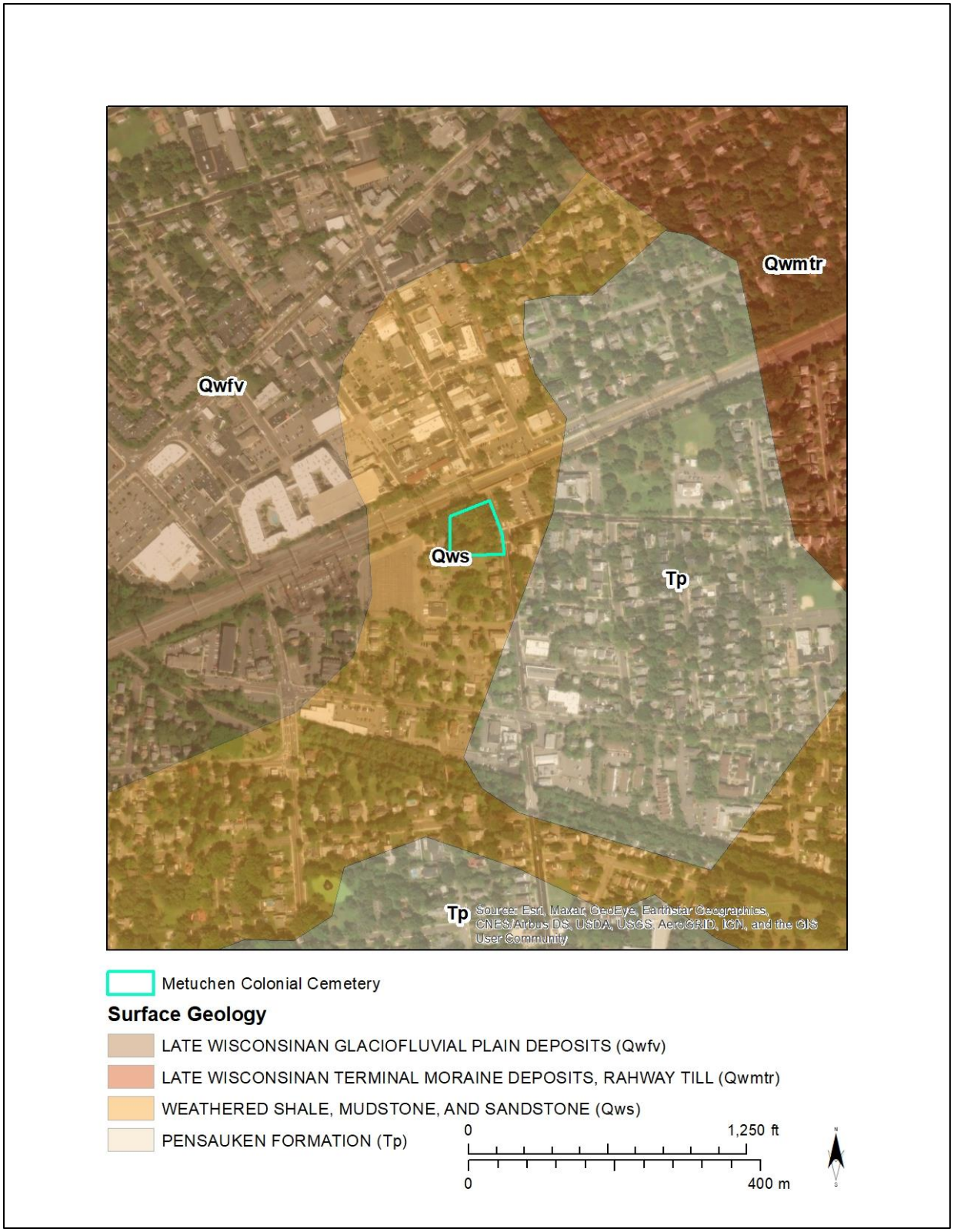

Figure 4. The surface geology related to the Metuchen Colonial Cemetery.

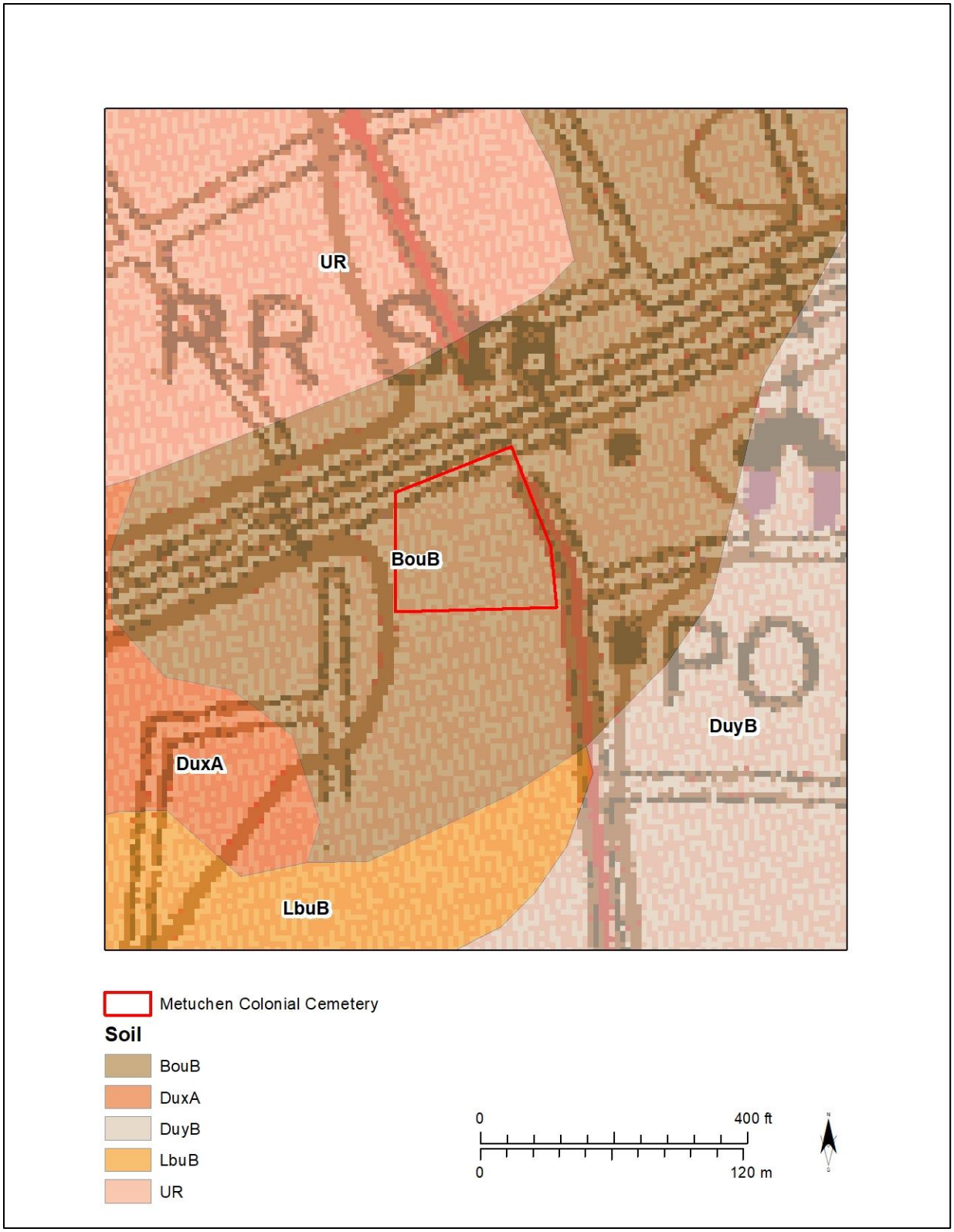

Figure 5. The soils related to the Metuchen Colonial Cemetery.

3.0 GEOPHYSICAL METHODS

3.1 Ground Penetrating Radar

Ground penetrating radar (GPR) is an active, non-invasive geophysical method that records contrasts in the dielectric properties of subsurface materials. A pulse of transmitted electromagnetic energy is reflected or absorbed by dielectric contrasts and the intensity and two-way travel-time of the response is recorded to produce a vertical profile. Reflections are generated from deviations in propagation velocity at interfaces between materials of differing relative dielectric permittivity. A two-dimensional GPR profile consists of individual traces, resulting from a single pulse of energy and the resulting reflections at a given location, that are stitched together horizontally to produce an image of dielectric contrasts. In this sense GPR is not providing a stratigraphic profile, rather it is generating a vertical representation (radargram) of local dielectric contrasts which provides a proxy for subsurface stratigraphic changes.

GPR is an excellent technique for non-invasive prospection for historic archeological features, including wells, privies, graves, and other shaft features, as well as buried building foundations, trenches, and stratigraphic features. GPR excels at identifying these features due to the dielectric contrasts that often exist between feature fill and surrounding sediment, visible truncation of internal stratigraphic layers, or high reflection amplitude from intense signal reflection from bricks or stones.

The depth of penetration for GPR depends on numerous factors, including but not limited to the antenna frequency, sediment type, moisture content, compaction, and salt content. Higher frequency antennas can resolve smaller targets and interfaces, though depth penetration is sacrificed. Moisture content increases sediment density through filling of interstitial pore spaces, while compaction causes a similar effect through compressing spaces between particles. The presence of water, salts, and clay particles results in an increase in conductivity and thus a reduction in the quality of GPR data. Clays, shale, and other high conductivity materials may attenuate or absorb GPR signals.

For the survey, ARCSERV utilized a GSSI SIR-4000 GPR system with a 400 MHz central-frequency antenna (Plate 3). The system is mounted on a Utility Cart and utilizes odometer-triggered collection of 50 traces per meter (1 reading every 2 centimeters). GPR data were collected within several geophysical survey grids. Post-processing routines for the GPR data were conducted

in GSSI's RADAN 7 Software included position correction (time zero), background removal, and high and low pass filtering. The data were interpreted in both cross-section view (2D), map view (2D) and 3D view. The cross-section and map views allow an analysis of the vertical and horizontal patterning between subsurface anomalies. The 3D view allows visualization of the relationship between cross-section and map views.

Plate 3. IUP GSSI SIR-4000 GPR system at Metuchen Colonial Cemetery.

3.2 Survey Grids

The IUP ARCSERV conducted a survey within the Metuchen Colonial Cemetery that encompasses approximately 0.23-acre (approximately 925 sqm) contiguous area. The cemetery includes open areas, areas with headstones and footstones, plot marking stones, and trees. Three (3) GPR geophysical grids ranging in size from 15-meters by 20-meters to 15-meters by 24-meters were placed along the western boundary of the cemetery. These were placed in consultation with a representative from the Metuchen-Edison Historical Society (Figure 6). The individual grids where surveyed in directions based on the orientation of the area being surveyed. The direction of travel was either south to north or north to south to traverse individual graves perpendicular to their trend. The geophysical grids were surveyed as individual units with a 0.25-meter (approximately 0.8ft) step intervals from west to east. All geophysical data was collected in one direction except where barriers where encountered (headstones and footstones, trees, etc.). This methodology facilitated the post-processing of results and the production of geophysical maps. The creation of mosaic geophysical site map depicts the geophysical anomalies identified within the entire area surveyed.

Figure 6. GPR survey grids within Metuchen Colonial Cemetery on 2016 aerial photograph.

4.0 GEOPHYSICAL RESULTS

Radargrams and the composite 3D ground penetrating radar (GPR) data from the Survey Area were examined to identify any anomalies that may represent potential burials and potential archeological features based on the presence, absence, and structure of anomalies. Based on this analysis, a series of anomalies, interpreted as potential archaeological features were identified within the individual geophysical grids. The identification of the potential burials and archaeological features is based on the examination of both the radargrams and timeslices related to the GPR data within the survey area. (Figure 7).

The identification of 425 potential burials, three (3) potential archaeological features, and one (1) disturbed area is based on the examination of both radargrams and timeslices within the survey area. Figure 8 depicts the relationship between individual vertical radargrams and horizontal time slices related to potential burials. The potential burials are identified by breaks in the natural stratigraphy resulting from the excavation of the burial shafts. The identified potential burials rand in depth from as shallow as 40 centimeters below ground surface (cmbgs) to approximately 140 cmbgs. They average approximately 2 meters in length and 0.54 meters in width.

Figure 9 depicts the relationship between individual vertical radargrams and horizontal time slices related to the potential archaeological features. Some of these potential archeological features are rather large and cut across other features that may not have been individually interpreted due to overprinting or cross-cutting. Potential archaeological features Feature Number 1 and Feature Number 2 are interpreted as potential structures (Table 1). These features are interpreted as potential structures based on the horizontal and vertical dimensions and that the data deviated from the interpreted natural stratigraphy and the anomalies interpreted as potential burials, landscapes, and disturbances. Feature Number 1 is approximately 4.5 meters (15ft) wide and at least 8 meters (26 feet) long. This feature extends to a depth of approximately 0.30 meters bgs. This feature is truncated by the slope along the eastern edge of the cemetery. Feature Number 2 is approximately 2.5 meters wide along its western side and extends at least 2 meters east to the break in slope along the eastern edge of the cemetery (Figure 8). It is suggested that the feature originally extend beyond the position where it now ends. This feature extends to a depth of approximately 0.30 meters bgs.

Figure 7. Survey Area with potential burials and archaeological features identified on aerial photograph.

Radargram **Timeslice**

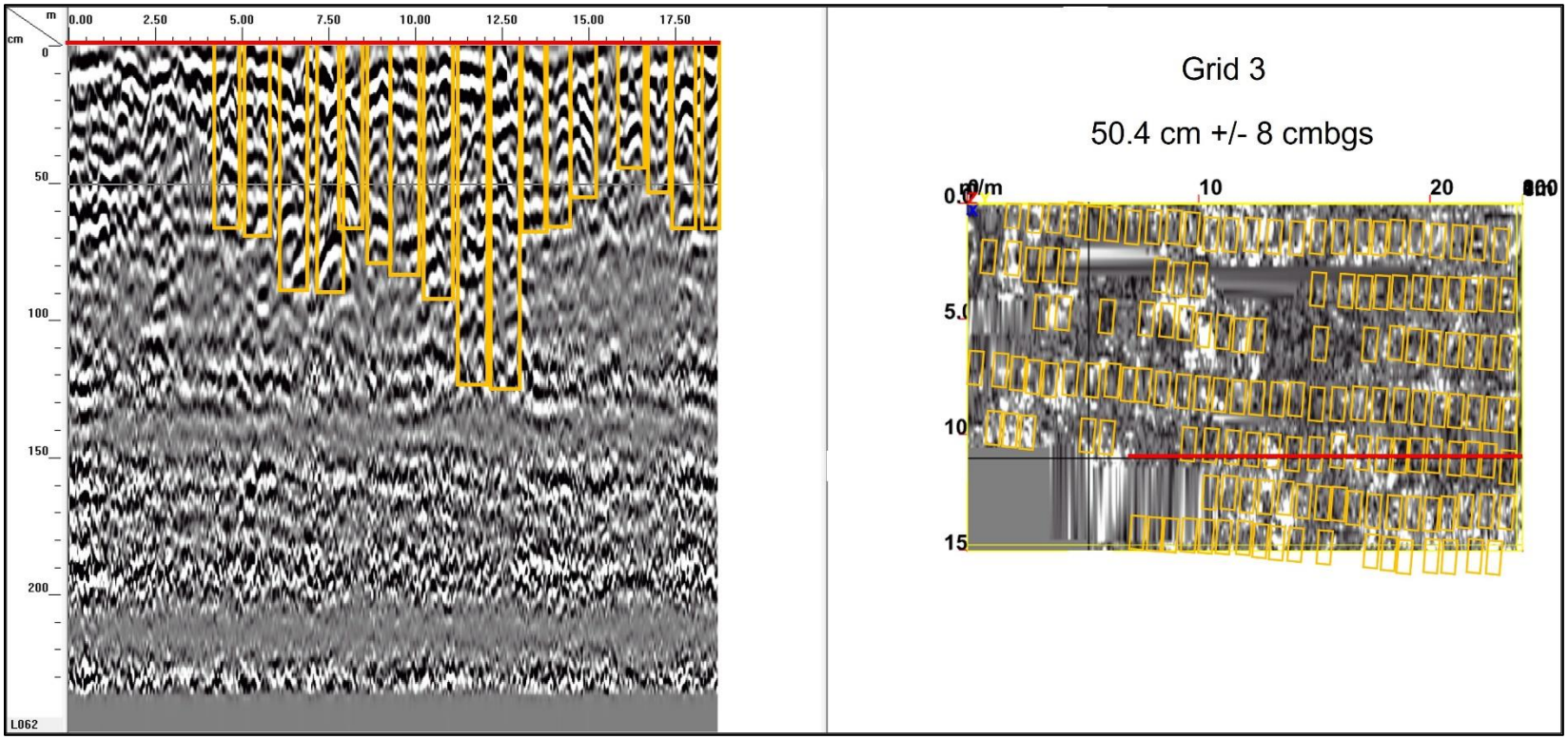

Figure 8. Radargram on the left depicting potential burial shafts related to the timeslice map on the right. The red line depicts the location of the radargram on the map.

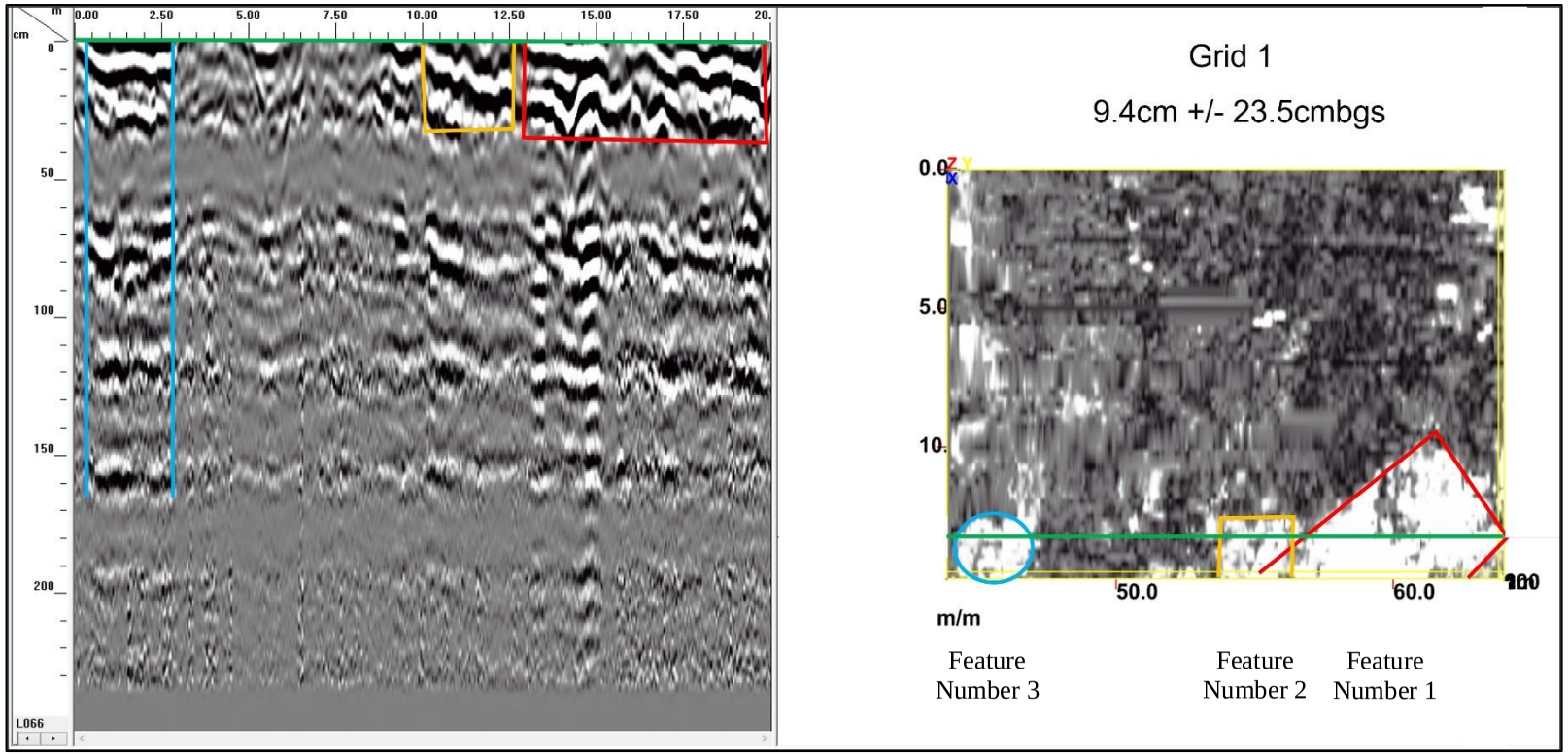

Figure 9. Radargram on the left depicting potential archaeological features related to the timeslice map on the right. The green line depicts the location of the radargram on the map.

Table 1. Potential archaeological features within the survey grids. Centroid coordinates are in NAD 83 UTM 18N.

Feature Number	NAD 83 UTM 18N		Potential Feature Interpretation	Approximate Interpreted Depth Range (m)
	Northing	Easting		
1	4487929.186	554117.841	Structure 1	0.00 – 0.30±
2	4487929.186	554120.247	Structure 2	0.00 – 0.30±
3	4487920.596	554123.035	Shaft Feature	0.00 – 1.70±
4	4487910.390	554119.149	Disturbed Area	0.00 – 0.40±

Feature Number 3 is interpreted as a potential shaft feature. Shaft features can represent historic features such as privies, wells, cisterns, ice houses, etc. This potential shaft feature is approximately 2.5 meters (8ft) in diameter. Based on the geophysical data, it appears that the upper limits of the feature may have collapsed. Theis potential shaft feature extends to at least approximately 1.70 meters bgs. Feature Number 4 is interpreted as a disturbed area. There were no interpreted burials within the disturbed area, even though some may be within the area. This area is somewhat amorphous and is approximately 6.2 meters (21.3 ft) in its north/south dimension and approximately 3.6 meters (18.4 ft) wide in its east/west dimension. This disturbed area extends to approximately 0.40 meters (1.3 ft) bgs.

6.0 CONCLUSIONS

The focus of this survey was to identify the potential for burials and archeological features within the Survey Area of the Metuchen Colonial Cemetery in Metuchen, New Jersey. Based on the examination of the Ground Penetrating Radar (GPR) radargrams, and depth (timeslice) data from the Survey Area, 425 likely burials, three (3) potential archaeological features, and one (1) disturbed area have been identified within the Survey Area (Figure 10). The interpreted archeological features include two (2) potential structures and one (1) potential shaft feature along the eastern edge of the cemetery. The identification of potential structures is based on the size and shape of the features. The potential shaft features are interpreted based on the diameter and the depth to which they extend, which are greater than other interpreted features. The potential disturbed area is defined as a larger area that is amorphous. This disturbance could be related to another archeological feature or may be natural.

Examining historic mapping in relation to the Metuchen Colonial Cemetery, the locations of the identified potential structures lay near the intersection of Woodbridge Avenue and Main Street before being altered in the 19th century (Figure 11 and Figure 12). The location of the map on the 1876 Dripps map of Metuchen place the intersection of the two roads nearly directly across from the potential structures. Based on the 1903 Sanborn map of Metuchen, Woodbridge Avenue was reconfigured to intersect Main Street at nearly a 90-degree angle. This orientation is currently in line with the current monument and wayside sign for the meeting house (Figure 13).

In conclusion, based on the size, orientation, and spatial relationship between the interpreted potential structures and shaft feature within the Survey Area, it is suggested that these may represent the location of razed structures and features associated with early occupation and use of the landscape. Only ground truthing through archaeological survey of the identified geophysical anomalies interpreted as archaeological features will provide resolution on what these interpreted features truly represent temporally and culturally.

Figure 10. Map of Metuchen Colonial Cemetery Survey Area with potential burials and archaeological features identified.

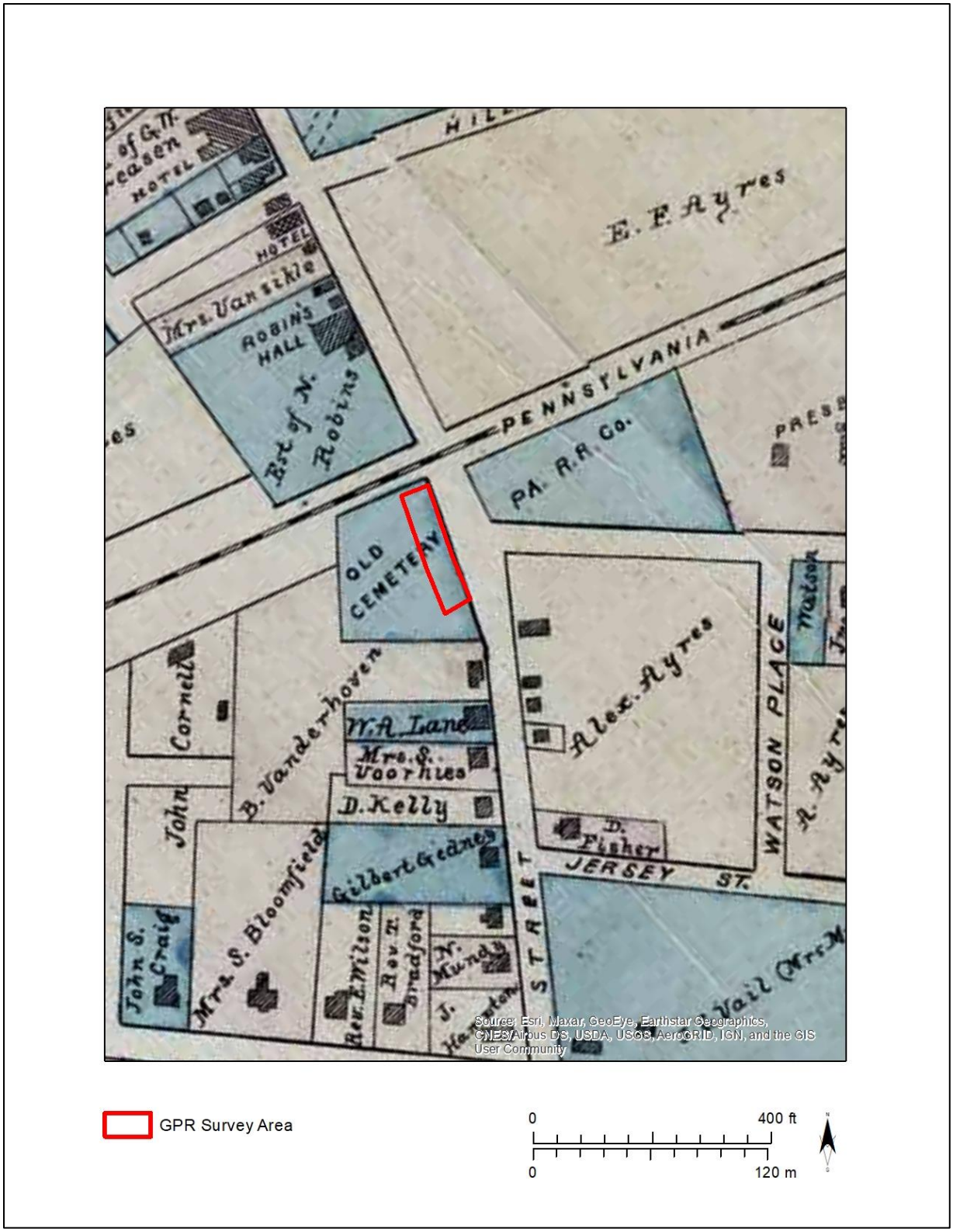

Figure 11. Dripps 1867 Map of Metuchen with the Metuchen Colonial Cemetery Survey Area identified.

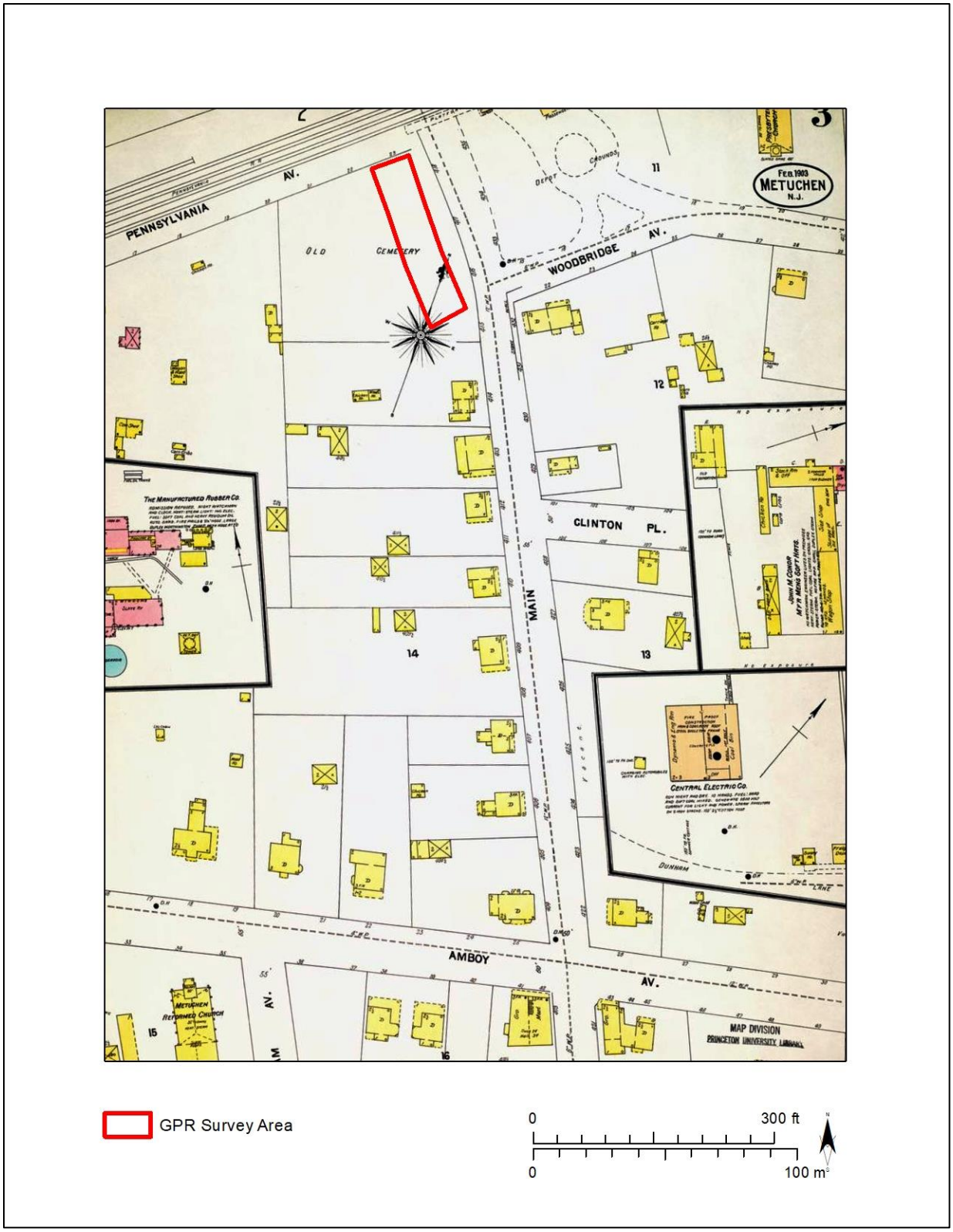

Figure 12. 1903 Sanborn Map of Metuchen with the Metuchen Colonial Cemetery Survey Area identified.

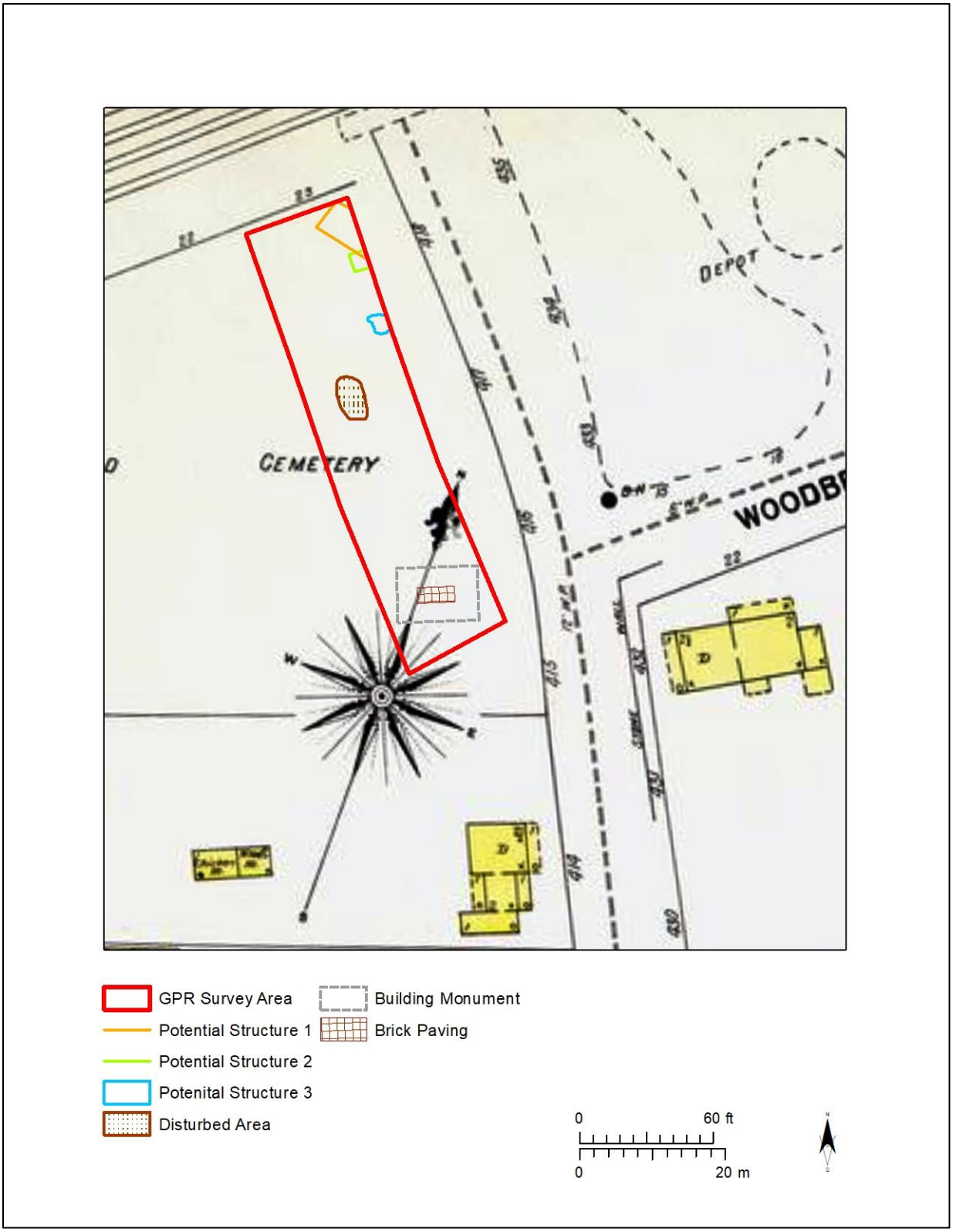

Figure 13. Sanborn 1903 map of Metuchen depicting the Metuchen Colonial Cemetery Survey Area with structural features identified.

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