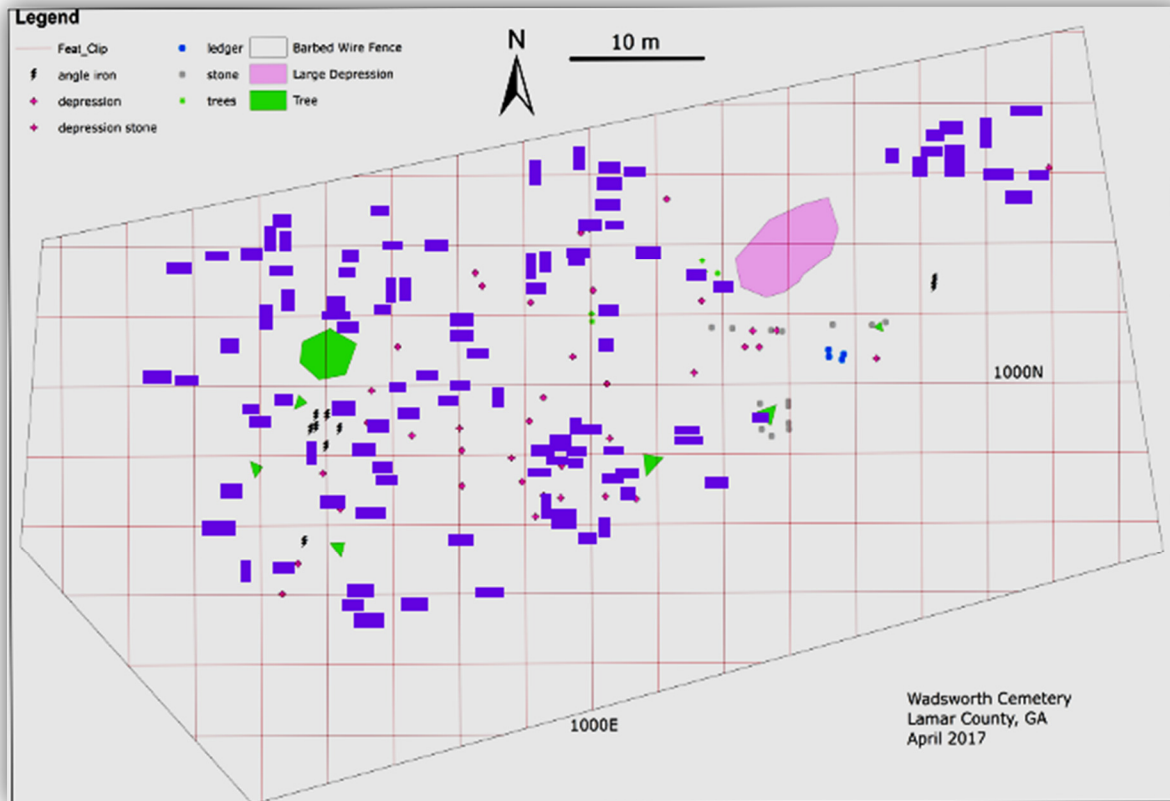


Ground Penetrating Radar Survey of the Wadsworth Cemetery, Lamar County, Georgia



LAMAR Institute Publication Series, Report Number 218

By Daniel T. Elliott

The LAMAR Institute, Inc.
Savannah, Georgia
2017

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I. Introduction

This report presents the findings of a Ground Penetrating Radar (GPR) survey by the LAMAR Institute for the Wadsworth Cemetery in Lamar County, Georgia. This work was performed for Southern Research Historic Preservation Consultants, Inc. and the City of Barnesville, Georgia (Wood and Wood 2017). The GPR survey provides a better understanding of the historic resources in the Wadsworth Cemetery. The present report addresses the methods, findings, and interpretations of the GPR portion of the project. The GPR survey resulted in the identification of at least 103 potential graves.

Historical Background

The Wadsworth Cemetery is located in Lamar County, Georgia (Figure 1). It contains the interments of the Wadsworth family from the nineteenth century and possibly many others. Several families of Wadsworths are recorded in the 1850 census for Pike County, Georgia. The patriarch was Archibald Wadsworth, who was listed in the 1830 census for Pike County and in the 1850 as an 85 year old farmer (Ancestry.com 2017). He died in 1856 and was buried in the family cemetery. Other family members thought to be buried in this cemetery include Clarissa Wadsworth (1800-Unknown) and John Wadsworth (1802-1864) (Whitehead 2003).

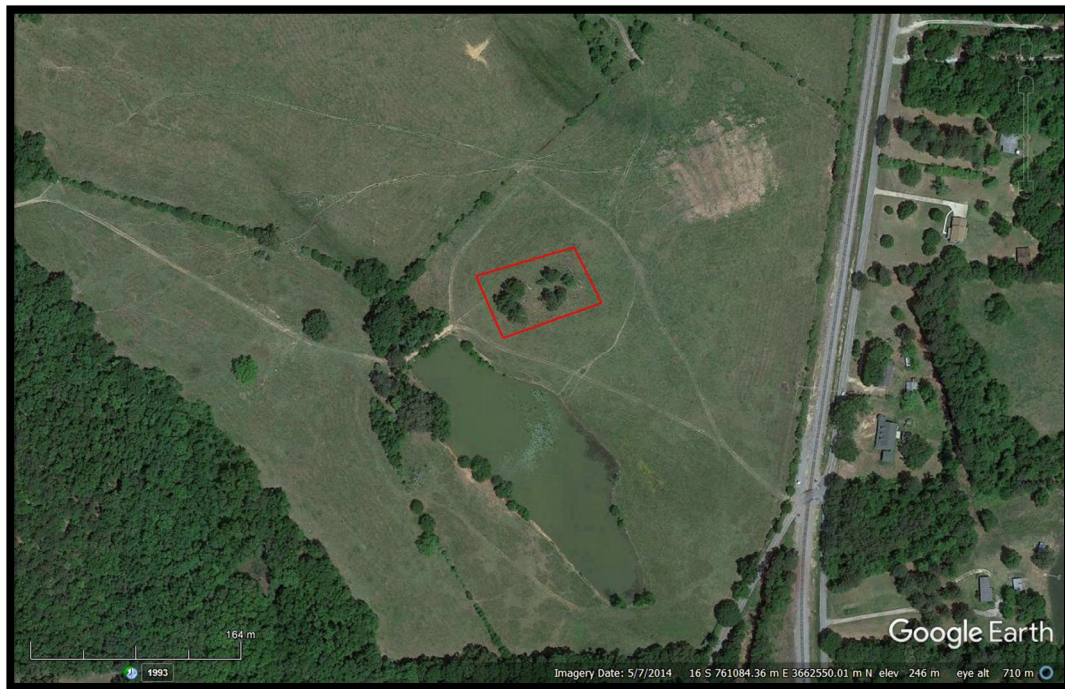


Figure 1. Wadsworth Cemetery Location Map (General Location Outlined in Red).

This cemetery may be the site of a mass grave of Confederate soldiers who were killed in a train wreck on September 1, 1864. One newspaper account of September 4 listed 26 men and one woman (Miss Saffen of Memphis) killed. Among the soldiers killed were Major Saunders of Savannah and Lieutenant Bond of Garrett's battery. The 22nd Georgia

sent Captain Q. Born's Company on the train and Ben Smith and Joe Johnson, of that company, were killed (*Daily Constitutional* 1864a:1). A newspaper story from September 7 noted that 31 dead bodies were taken from the wreck. That account noted, "the collision occurred in a cut and a curve two miles on the other side of that place [Barnesville]" (*Daily Constitutional* 1864b:3). Contemporary newspaper accounts place the location of the wreck between 2 and 2.5 miles north of Barnesville. The Wadsworth cemetery also may have been used by other families in the community.

Report Organization

This report is organized into four chapters. Chapter 2 contains the research methods used in this study. Chapter 3 contains the results and interpretation of the GPR survey. Chapter 4 provides a project summary. This is followed by a bibliography of references cited in the report.

II. Research Methods

GPR is an important remote sensing tool used by archaeologists (Conyers 2002, 2004; Conyers and Goodman 1997). The technology is particularly effective in mapping historic cemeteries. The technology uses high frequency electromagnetic waves (microwaves) to acquire subsurface data. The device uses a transmitter antenna and closely spaced receiver antenna to detect changes in electromagnetic properties beneath them. The antennas are suspended just above the ground surface and the antennas are shielded to eliminate interference from sources other than directly beneath the device. The transmitting antenna emits a series of electromagnetic waves, which are distorted by differences in soil conductivity, dielectric permittivity, and magnetic permeability. The receiving antenna records the reflected waves for a specified length of time (in nanoseconds, or ns). The approximate depth of an object can be estimated with GPR by adjusting for electromagnetic propagation conditions.

The GPR sample block in this study area was composed of a series of parallel transects, or traverses, which yielded a two-dimensional cross-section or profile of the radar data. These samples are termed radargrams. This two-dimensional image is constructed from a sequence of thousands of individual radar traces. A succession of radar traces bouncing off a large buried object will produce a hyperbola, when viewed graphically in profile. Multiple large objects that are in close proximity may produce multiple, overlapping hyperbolas, which are more difficult to interpret. For example, an isolated historic grave may produce a clear signal, represented by a well-defined hyperbola. A cluster of graves, however, may produce a more garbled signal that is less apparent.

The GPR signals that are captured by the receiving antenna are recorded as an array of numerals, which can be converted to gray scale (or color) pixel values. The radargrams are essentially a vertical map of the radar reflection off objects and other soil anomalies. It is not an actual map of the objects. The radargram is produced in real time and is viewable on a computer monitor, mounted on the GPR cart.

GPR has been successfully used in Georgia's coastal plain for archaeological and forensic anthropological applications to locate relatively shallow features, although the technique also can probe deeply into the ground. The machine is adjusted to probe to the depth of interest by the use of different frequency range antennas. Higher frequency antennas are more useful at shallow depths, which is most often the case in archaeology. Also, the longer the receiving antenna is set to receive GPR signals the deeper the search. The effectiveness of GPR in various environments on the North American continent is widely variable and depends on solid conductivity, metallic content, and other pedo-chemical factors. Generally, Georgia's coastal soils have moderately good properties for GPR application.

GPR signals cannot penetrate large metal objects and the signals are also significantly affected by the presence of salt water. Although radar does not penetrate metal objects, it does generate a distinctive signal that is usually recognizable, particularly for larger metal objects, such as a cast iron cannon or man-hole cover. The signal beneath these objects is often canceled out, which results in a pattern of horizontal lines on the radargram. For

smaller objects, such as a scatter of nails, the signal may ricochet from the objects and produce a confusing signal. Rebar-reinforced concrete, as another example, generates an unmistakable radar pattern of rippled lines on the radargram.

Using the same RAMAC X3M GPR system as that used in the present study, Elliott has conducted several GPR studies of eighteenth and nineteenth century cemetery sites in Georgia. The first LAMAR Institute cemetery study to employ GPR was at the New Ebenezer town site in Effingham County, Georgia (Elliott 2003). The results of the GPR work at New Ebenezer were quite exciting and included the delineation of a large portion of a British redoubt palisade ditch and the discovery of several dozen previously unidentified human graves (both within and beyond the known limits of the Jerusalem Lutheran Church Cemetery). GPR survey was conducted by Elliott at Sunbury Cemetery (Liberty County), Woodbine Plantation cemetery (Camden County), the Gould-Bethel Cemetery (Chatham County), Bullhead Bluff Cemetery (Camden County), Behavior Cemetery (McIntosh County) and numerous other coastal cemetery sites with satisfactory results (Elliott 2003, 2004, 2005, 2006a-d, 2009, 2010a-d, 2014). This equipment and survey methodology also has proven successful on cemetery sites in the Georgia piedmont and South Carolina foothills.

The equipment used for this study consisted of a RAMAC/X3M Integrated Radar Control Unit, mounted on a wheeled-cart and linked to a RAMAC XV11 Monitor (Firmware, Version 3.2.36). A 500 megahertz (MHz) shielded antenna was used for the data gathering. MALÅ GeoScience's *Ground Vision* (Version 1.4.5) software was used to acquire and record the radar data (MALÅ GeoScience USA 2006). The radar information was displayed as a series of radargrams. Output from the survey was first viewed using *GroundVision*. This provided immediate feedback about the suitability of GPR survey in the area and the effective operation of the equipment. The time window that was selected allowed data gathering to focus on the upper 1.5 meters of soil, which was the zone most likely to yield archaeological deposits. Additional filters were used to refine the radar information during post-processing. These include adjustments to the gain. These alterations to the data are reversible, however, and do not affect the original data that was collected.

Upon arrival at the site, the RAMAC X3M Radar Unit was set up for the operation and calibrated. Several trial runs were made on parts of the site to test the machine's effectiveness in the site's soils. Machinery settings and other pertinent logistical attributes included the following:

Machine Settings, Block A

Time Window: 64.6 ns
Number of Stacks: 4
Number of Samples: 512
Sampling Frequency: 7,462 MHz
Antenna: 500 MHz shielded
Antenna Separation: 0.18 m
Trigger: 0.04 m
Radargram orientation: South to North (Magnetic North)
Radargram progress: West to East

Radargram Spacing: 50 cm
Total Radargrams: 184
Total Survey Length: 5,020.2 m
Dimensions: 44 m N-S (maximum) by 76 m E-W
UTM Location (WGS 84): Keyed to Figure 3, A- 200891.7E 3663624.1N; B- 200900.2E 3663614.5N; C- 200967.5E 3663631.8N

The GPR survey covered an area approximately 76 m East-West by 44 m North-South. The work required no excavation. The survey was accomplished by Daniel Elliott with the able assistance of archaeologist Matthew Newberry. GPR data collection began on April 3 and was completed on April 4, 2017. Surveyors collected 184 radargrams from the cemetery. Figure 3 shows the radargram plan for Block A. Figure 4 contains a key to the UTM locations for the GPR grid.

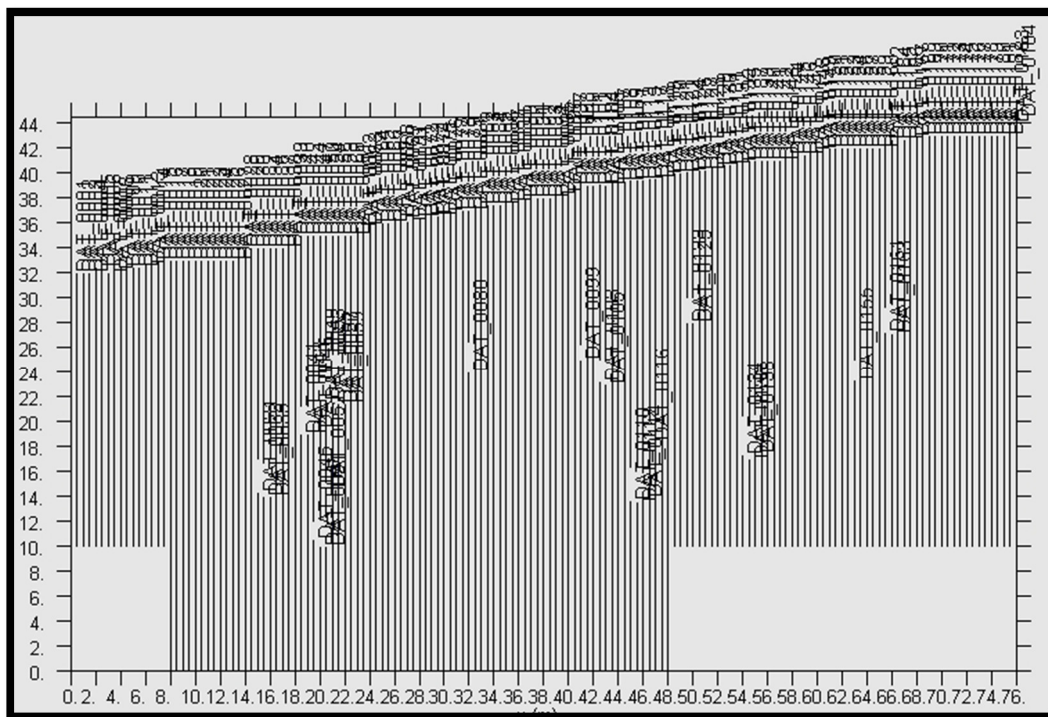


Figure 2. Radargram Plan of GPR Block A, Wadsworth Cemetery.

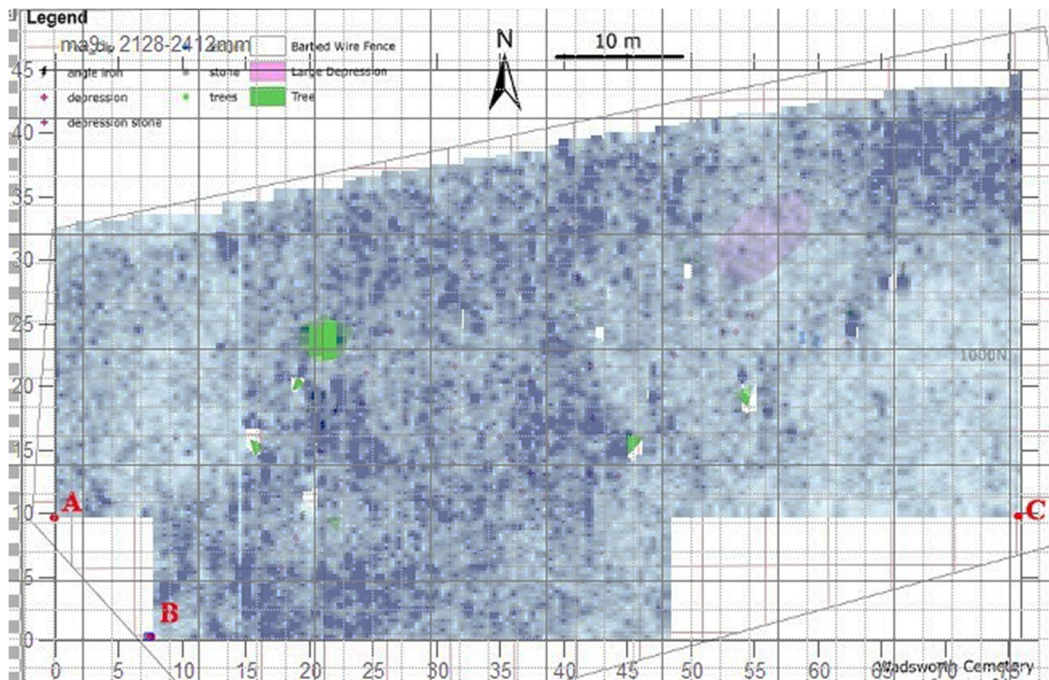


Figure 3. GPS Locations A, B and C, Wadsworth Cemetery.

The GPR data from the present study was processed with *GPR-Slice* (Version 7.0). Dean Goodman's *GPR-Slice* program is recognized as the world leader in GPR imaging and it has proven quite effective in mapping historic cemeteries (Goodman 2010). Mapping in 3D entailed merging the data from the series of radargrams for each block. Once this was accomplished, horizontal slices of the data were examined for important anomalies and patterns of anomalies, which were likely of cultural relevance. These data were displayed as aerial plan maps of the sample areas at varying depths below ground surface. These horizontal views, or time-slices, display the radar information at a set time depth in nanoseconds (ns). Time-depth can be roughly equated to depth below ground. This equivalency relationship can be calculated using a mathematical formula.

This GPR survey report was prepared under subcontract for Southern Research Historic Preservation Consultants, Inc. for the City of Barnesville, Georgia. It was included as an appendix in a broader survey report on the Wadsworth Cemetery by Wood and Wood (2017).

III. GPR Survey-Results and Interpretation

As expected, the GPR survey identified many marked graves and unmarked potential graves in the Wadsworth Cemetery. GPR mapping also generated images of known graves except in areas where the tombstones or other obstacles prevented data collection. Quantifying the potential graves in the cemetery from the GPR data is challenging. For many of the graves, their recognition on plan maps is straightforward. In other instances, clusters of graves that are closely spaced generated more amorphous “large blobs” and it is not readily apparent how many individual graves these radar reflections represent. Large trees also confuse the interpretation of the cemetery data by creating large radar reflections that often masked historic graves. In some cases the large reflections generated by tree stumps and tree roots are very difficult to distinguish from clusters of burials or shallow, infant burials. The GPR survey also was hampered by several fieldstone grave markers in the cemetery, which served as minor obstacles for the collection of data.

GPR Radargrams

Radargrams provide a profile view of the radar reflections. This class of information is useful when studying cemeteries because graves often create characteristic radar profiles. Depending on the spacing of the graves, a grave may be recognized by the hyperbola that is a reflection from the top of coffin, by the steep slope created by the grave shaft excavation, by the disturbed soil conditions within the grave pit relative to the less disturbed matrix soils, and sometimes by a reverse hyperbola created by the radar pulses reflecting off of the base of the grave excavation pit. Burials with high metal content, typically more massive coffin hardware and not simply coffin nails, may generate distinctive signatures. A grave with a metal vault cover or a metal coffin creates its own distinctive profile. When graves are clustered and closely spaced, however, it becomes more difficult to distinguish individual graves. In these cases, large areas of soil disturbance may be recognized.

Figures 4 through 6 are three examples of radargrams collected by the survey. Figure 4 shows Radargram 30 from the survey. This transect is located along the suspected western margin of the cemetery. Many of the hyperbolas that appear in this diagram likely represent large tree roots. Figure 5 shows Radargram 101, which is located near the suspected center of the cemetery. As compared with Figure 4, this radargram contains many strong radar anomalies, including several that likely represent human burials. This transect also passed over several large metal objects, which may represent grave furniture. Figure 6 shows Radargram 168, which is located near the suspected eastern end of the cemetery. At the eastern end of this transect (right-hand side) a large, deep radar anomaly is represented. It remains to be determined if the strong, massive radar anomalies that appear in the eastern end of the study area represent human burials or not. These may represent some other type of deep cultural feature, such as a buried agricultural terrace. For now, however, our interpretation is that these anomalies may represent human burials.

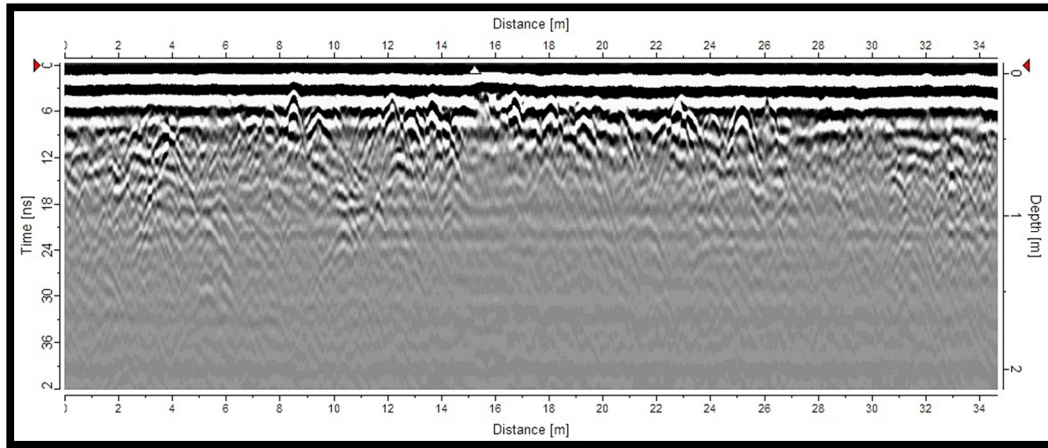


Figure 4. Radargram 30, West End, Wadsworth Cemetery.

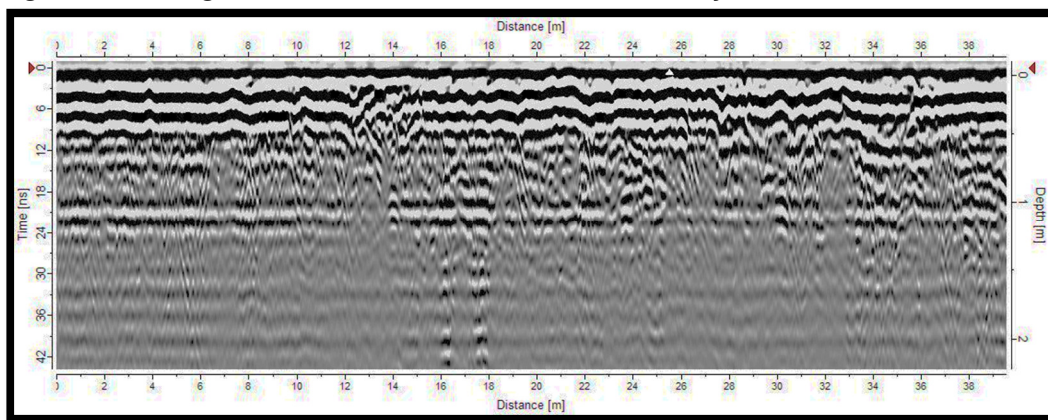


Figure 5. Radargram 101, Cemetery Center, Wadsworth Cemetery.

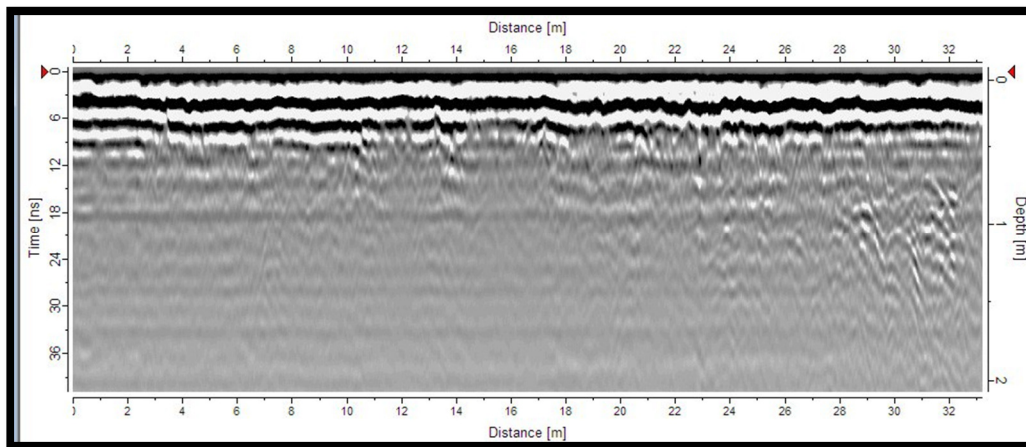


Figure 6. Radargram 168, East End, Wadsworth Cemetery.

GPR Time Slice Maps

The GPR survey of the Wadsworth Cemetery adds another dimension of information about the content and characteristics of the graveyard. We used the combined overlay map for the upper and lower zones to plot potential grave locations from the GPR data. Figures 7 through 12 show a series of time slice plan view maps at increasing depths.

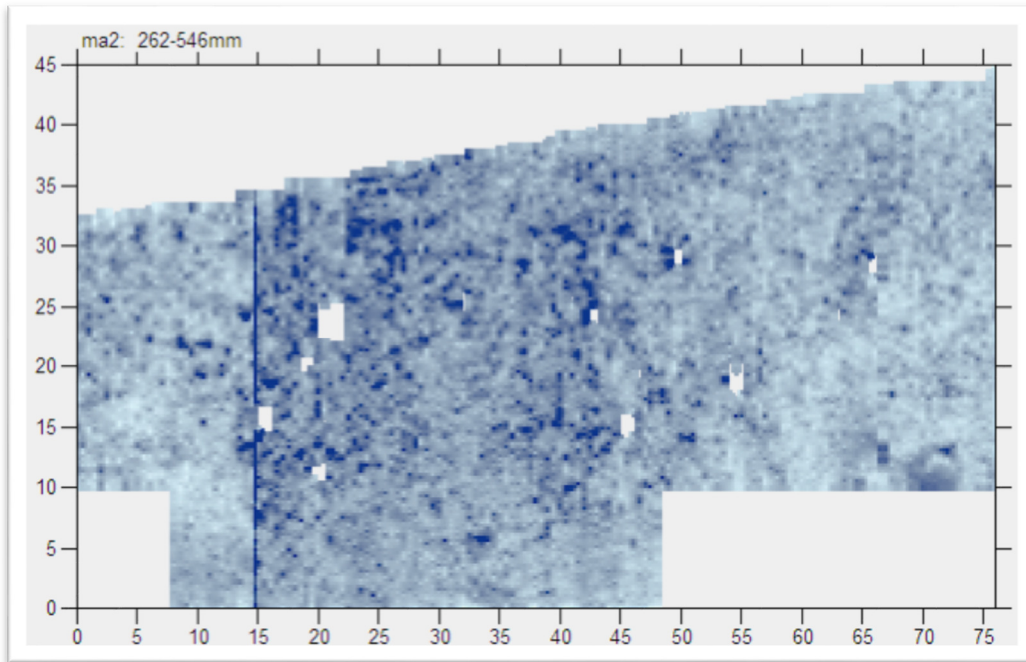


Figure 7. Composite GPR Plan Map, 262-546 mm Depth, Wadsworth Cemetery.

Many graves appear as rectangular dark blue shapes. Other isolated strong radar reflections indicate possible graves that are unmarked. Other strong radar reflections in these maps probably represent trails or vehicle ruts and large trees. Many smaller radar reflections are problematic, as it is possible that some represent children's graves, but these cannot be readily distinguished from other small cultural features or natural features.

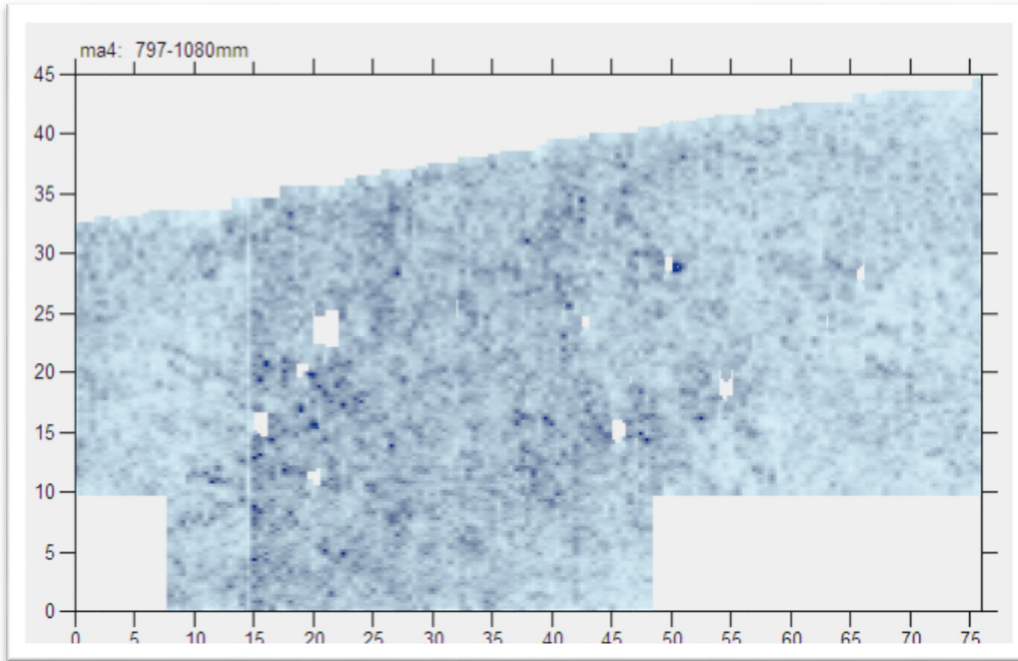


Figure 8. Composite GPR Plan Map, 797-1080 mm Depth, Wadsworth Cemetery.

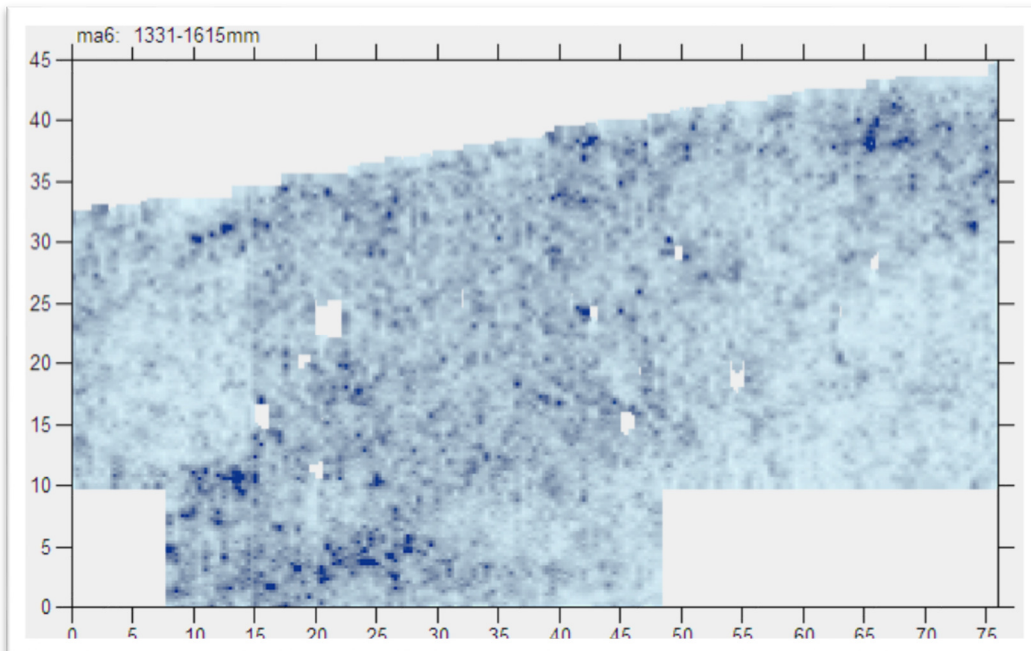


Figure 9. Composite GPR Plan Map, 1331-1615 mm Depth, Wadsworth Cemetery.

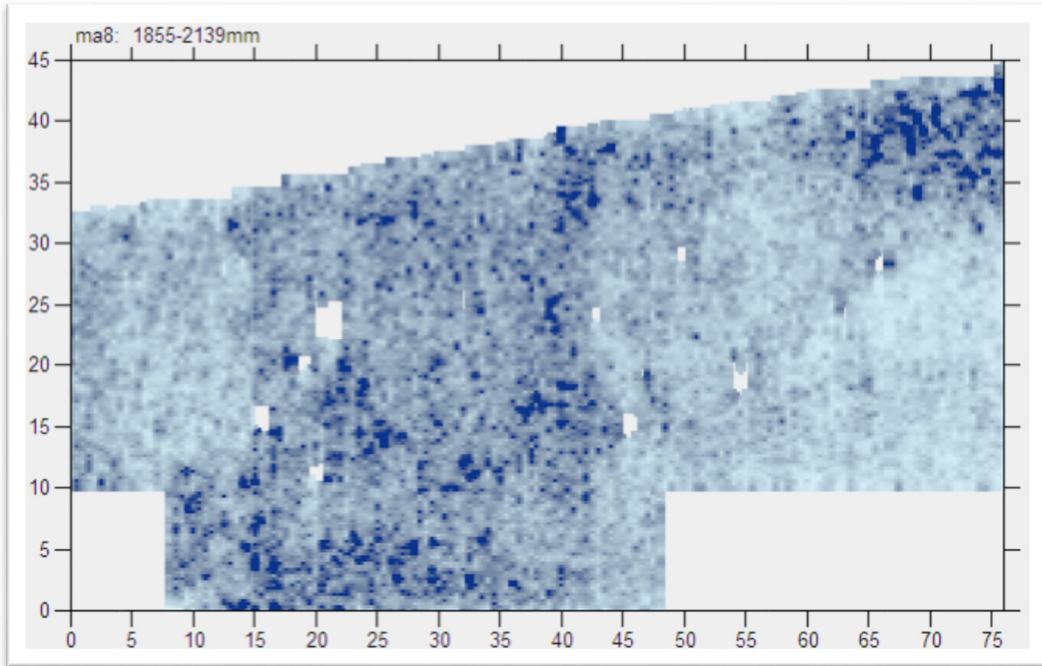


Figure 10. Composite GPR Plan Map, 1855-2139 mm Depth, Wadsworth Cemetery.

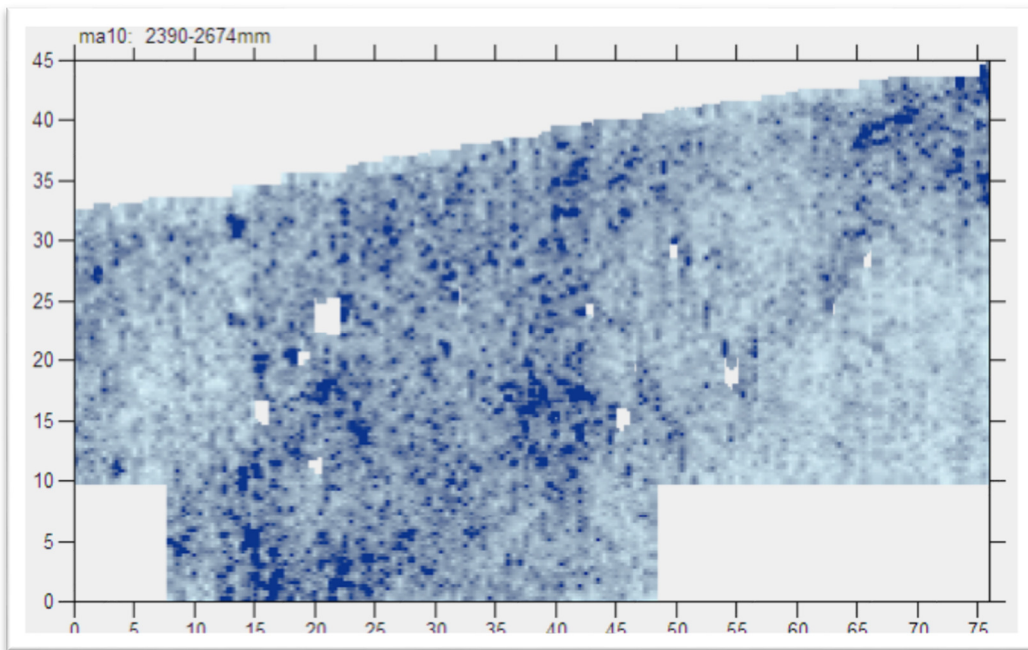


Figure 11. Composite GPR Plan Map, 2390-2674 mm Depth, Wadsworth Cemetery.

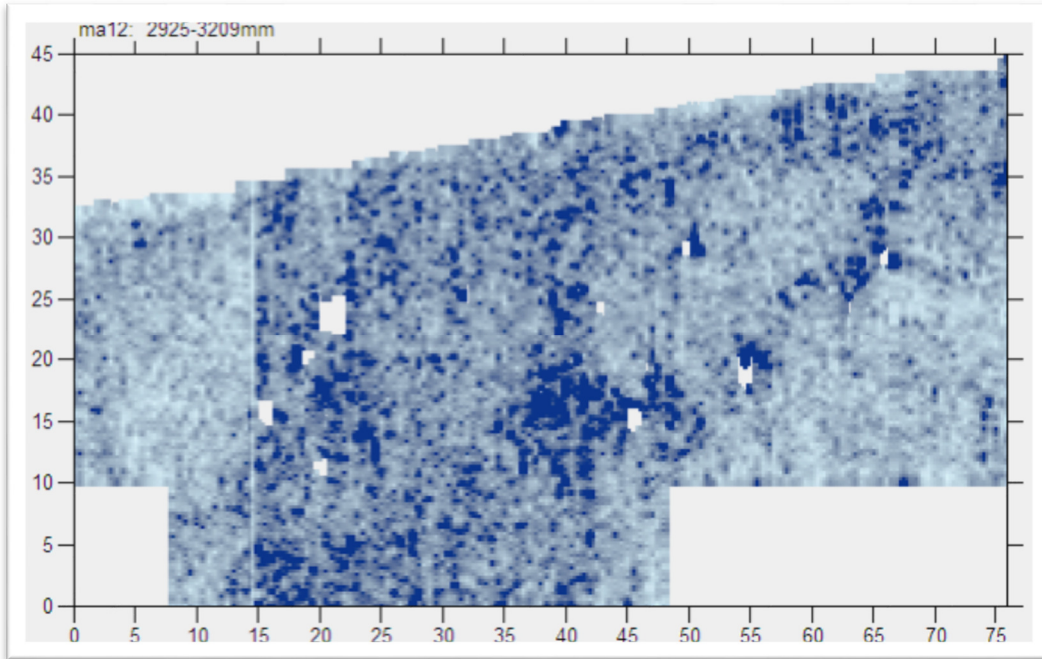
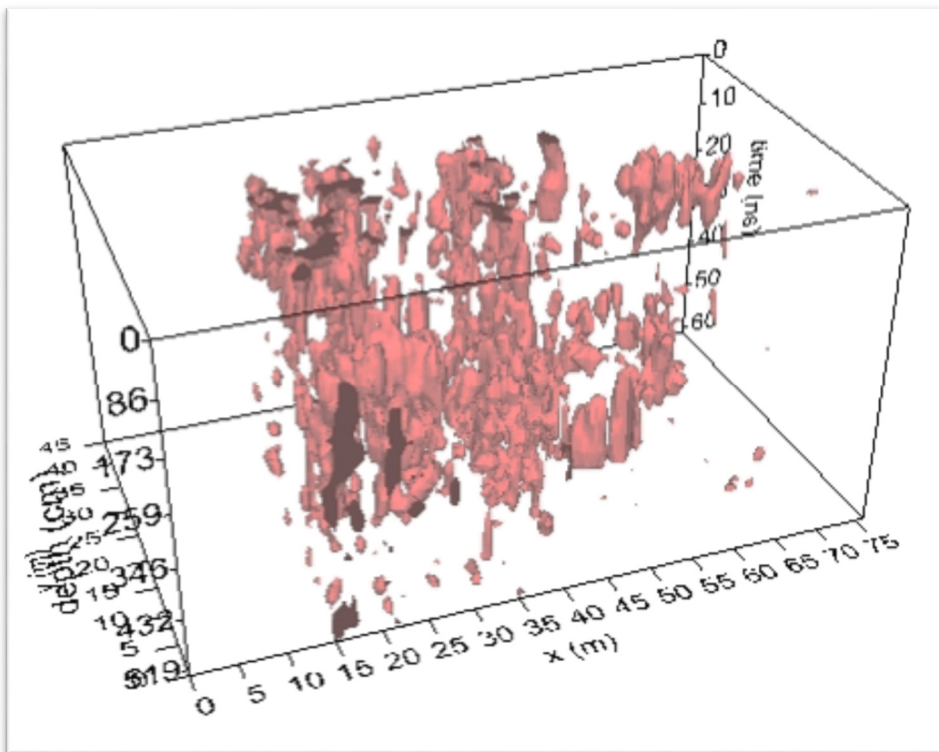


Figure 12. Composite GPR Plan Map, 2925-3209 mm Depth, Wadsworth Cemetery.

Figure 13 is a perspective, isomorphic view of the strongest GPR anomalies from the survey. This is simply another way to view the radar data.



The project geophysicist (Elliott) examined the radargrams, sequential time slices, composite time slices and isomorphic views in interpreting the GPR data. Figures 14 and 15 show the suspected human burials as interpreted. Suspected burials are shown as purple rectangles in these two figures. An estimated 103 potential graves were identified with the GPR information. It is also apparent from Figure 15 that several likely burials, which are indicated by surface depressions or fieldstone head or foot stones, were not detected in the GPR data. So, the actual number of interments may be more than 103 persons.

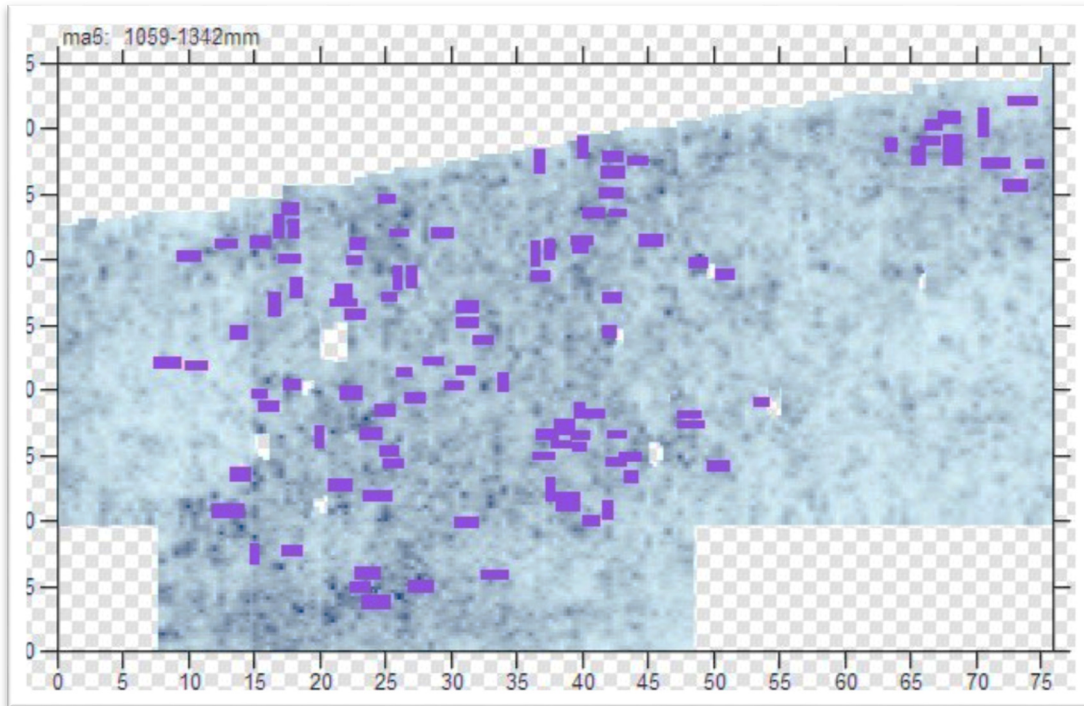


Figure 14. Potential Burials (Indicated by purple rectangles), Wadsworth Cemetery.

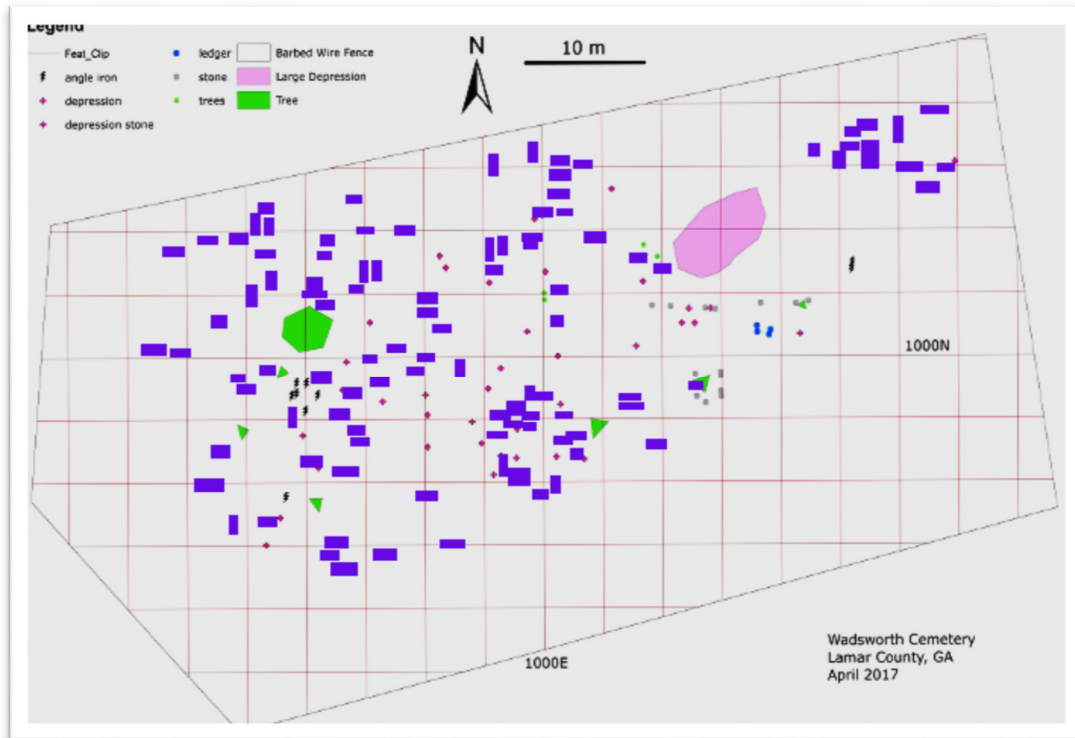


Figure 15. Wadsworth Cemetery Plan Map (Potential Graves from GPR Survey Shown as Purple Rectangles).

IV. Summary

The LAMAR Institute was pleased to be involved in the Wadsworth Cemetery project. The site is an extremely important part of the history of both Lamar County, Georgia and the region in general. The institute sees the value of this important site and research associates were delighted to meet many descendants of families associated with the cemetery. The GPR survey project of the Wadsworth Cemetery undertaken by The LAMAR Institute for the City of Barnesville, Georgia created a body of information that will enable wise stewardship of this important historical, cultural, natural, and spiritual site and help with its long-term preservation. Superimposed maps of this data with modern maps to determine where unmarked, likely burials may be located across the cemetery. As with all GPR data, anomalies cannot be verified as being graves without their scientific, archaeological investigation. This is traditionally not an option chosen when the cemetery is not facing relocation. There is always the possibility that some anomalies marked as potential graves are not, and some not marked may be graves – particularly with infant burials. The GPR data and its analysis by a professionally trained, highly-experienced archaeologist, however, provides for the most comprehensive and educated determinations on where unmarked burials are without archaeological excavation. If the City of Barnesville opts to exhume these remains, then the GPR data will serve as an invaluable aid in that process.

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