Report on Ground-penetrating Radar Surveys:
Possible Cemeteries within Fort Ward Historical Park, Alexandria, Virginia
October 19-20, 2009

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Introduction

The purpose of this project was to use ground-penetrating radar (GPR) to prospect for potential unmarked burials at several known and potential cemetery and grave locations within Fort Ward Historical Park, Alexandria, Virginia. (Figure 1). Fort Ward was recognized as a significant historical site with placement on the National Register of Historic Places in 1982. The nomination for National Register designation highlights the role that the fort played in the Civil War, when it formed one of the strongest links in a chain of 164 forts and batteries protecting Washington D.C., from the Confederate Army. The reconstructed northwest bastion of the Civil War fort, reconstructed officers' quarters and Fort Ward Museum, along with the visible remnants of the original perimeter embankments, bombproofs, outlying gun battery and rifle trench, serve as focal points for historical interpretation in the park. There are, however, other cultural resources that are not obviously visible. The property contains buried evidence of other Union Army activities, traces of Native American occupation, and –of particular relevance to the current GPR project--an African American neighborhood—known as "The Fort"—that thrived on the site from the period of Reconstruction after the Civil War until the park was created in the early1960s (Figure 2).

Figure 1: Fort Ward Park is located on the north side of Braddock Road just east of I-95. A number of potential graves and burial areas have been identified within park boundaries.

Fort Ward Park- African American Structures and Other Resources

11. School/ St. Cyprian's Church/ Sgt. Young House
12. Randall House
13. Clara Adams/ McKnight Family House
14. Ashby House
15. Shorts/ Stuart/ Randall House
16. Belk House
17. Javins House
18. Line of Cedar Trees
19. Lilac Bush
20. Entrance Road to School
21. Braddock Road.
22. Access Road to Harriet Shorts Property, northern part of which may date to Civil War. Straight southern segment dates to Harriet Shorts' 1919 will
23, 24, 25, 26. 27.Unknown Building, Only Visible in 1927 Aerial
28, 29, 30, 31, 32. Unknown Building, Visible in 1927 and 1937 Aerials
33. Unidentified Building Visible only in 1937 Aerial
34. Large rectangular garden plot appearing in 1937 and 1949 Aerials
35. Outbuildings or small structures visible on 1949 Aerial and 1962 Topographic Map
36. Outbuilding or small structure visible on 1962 Topographic Map
37. Unknown Building Visible in 1927-1949 Aerials, Driveway visible in 1962 Topographic Map.
38, 39. Unknown Building Visible in 1937 and 1949 Aerials and 1962 Topographic Map
40, 41, 42. Unknown Building Visible in 1927, 1937 and 1949 Aerials
43. Unknown Building Visible in 1937, 1949 and 1962 Topographic Map
44. High concentration of footpaths radiating from a square, but no apparent building. Only visible in 1927 Aerial
45. Unknown Brick Building identified in 1962 Topographic Map

Note: Resources may be present in other locations but do not have documentation to date

From Fort Ward Cultural Resources Inventory by Doug Appler for OHA/ Alexandria Archaeology

Source: Appler 2009

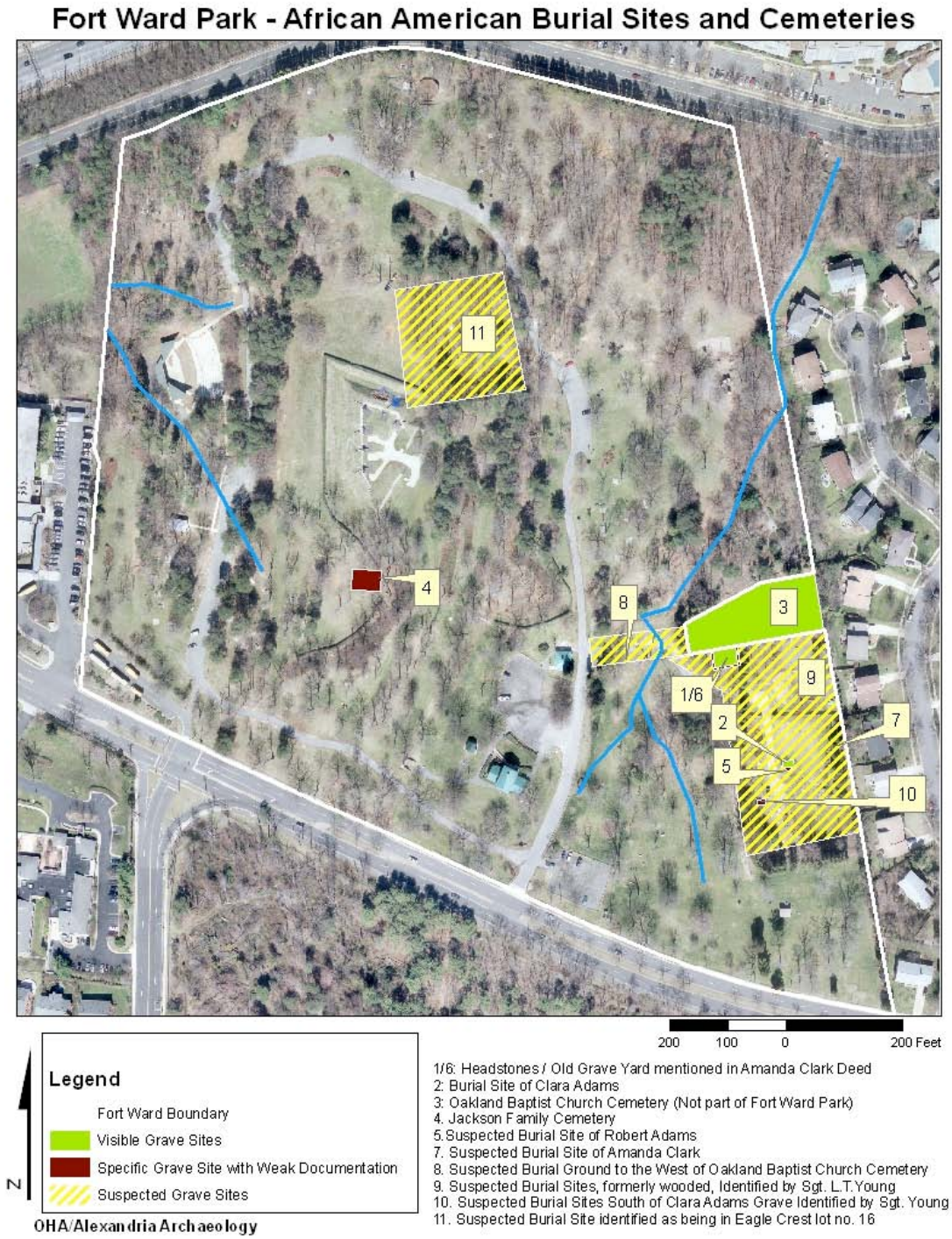
Figure 2: After the Civil War, this area was an African American neighborhood. The draft *Inventory of Historic Resources* identifies the locations of structures that were present during that time.

Potential cemeteries and burials that were associated with this African American community are the focus of the study. The presence of a few gravestones, as well as documentary evidence and accounts from oral history interviews, have indicated that there are a number of known and potential grave locations in the park that were part of "The Fort" neighborhood. However, the exact locations of the burials (some of which are located in a former maintenance yard for the City of Alexandria's Department of Recreation, Parks and Cultural Activities), and the limits of cemeteries on the property have never been determined. This GPR survey serves as a first step in gaining information about the burial and cemetery locations. For management and interpretation purposes, the location of historic resources, including human internments, is an important aspect in planning for future protection.

The areas to be surveyed were located on the basis of documentary research, oral history interviews and physical evidence, as summarized in the draft *Inventory of Historical Resources, Fort Ward Park, Alexandria, Virginia*, prepared by Douglas Appler in 2009 (Figure 3). There are several non-contiguous survey areas within the former maintenance yard; these had to be separated because the GPR data needs to be collected in a rectangular grid, and fence lines and other structures precluded the ability to set up a contiguous rectangle. As shown in Figure 4, the six areas tested for this project are:

- Old Grave Yard Survey Area—with five gravestones still present, identified on a 1960s engineering drawing just south of the Oakland Baptist Cemetery, which is a known grave yard surrounded on three sides by Fort Ward Park (Resource No. 1 on Figure 3 from Appler 2009)
- Jackson Cemetery Survey Area—a possible family cemetery, identified on a 1960s engineering drawing and on a 1913 plat, in a grassy area on the glacis west of the historic fortification (Resource No. 4 on Figure 3 from Appler 2009)
- North Maintenance Yard Survey Area—east of the Old Grave Yard and south of the Oakland Baptist Cemetery, historically part of a grove/wooded area where oral history accounts indicate the possible presence of scattered graves (part of Resource No. 8 on Figure 3 from Appler 2009)
- Maintenance Yard Entrance Survey Area—historically part of a grove/wooded area where oral history accounts indicate the possible presence of scattered graves (part of Resource 8 on Figure 3 from Appler 2009)
- Adams/Clark (South Maintenance Yard) Survey Area—northern section historically part of a grove/wooded area where oral history accounts indicate the possible presence of scattered graves and where deed and probate records suggest the possible location of the grave of Amanda Clark (Resource No. 6 and part of Resource No. 8 on Figure 3 from Appler 2009); southern section historically part of the property of Clara and Robert Adams with a gravestone marking Clara's burial and oral history accounts stating that she is buried next to her husband, Robert (Resource Nos. 2 and 5 on Figure 3 from Appler 2009)
- Sergeant Young's Front Yard (West Maintenance Yard) Survey Area—location that would have historically been the yard in front of a structure that first served as an African American school house, then as St. Cyprian's Church, and later as

the residence of Sgt. Young; Sgt. Young's oral history interview recounts that there were gravestones in his front yard, one of which he moved for his garden (Resource No. 10 on Figure 3 from Appler 2009).



Source: Appler 2009

Figure 3: Locations of visible and suspected grave sites were mapped in the draft *Inventory of Historical Resources*, Fort Ward Park, Alexandria, Virginia, prepared by Douglas Appler in 2009.

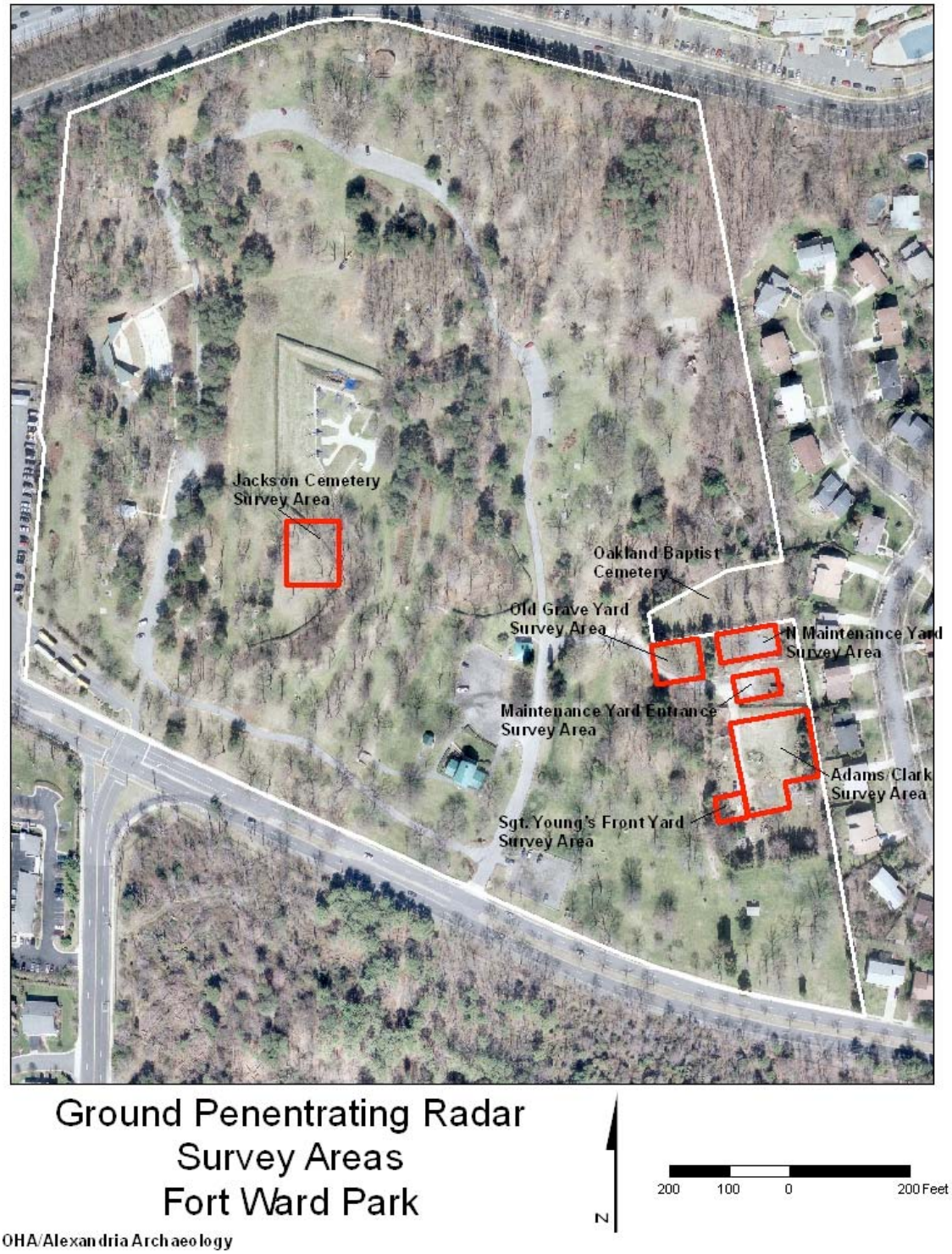


Figure 4: The six areas selected for GPR survey were chosen based on documentary evidence, oral histories, and the locations of gravestones.

The six grids of GPR data were collected, totaling approximately 37,500 square feet (Table 1). The goals of this project were to identify burials within each grid and to map the number and extent of burials. Each site grid was placed by the Alexandria City survey crew in an area determined by Alexandria Archaeology staff; however, dense vegetation and buildings constrained the survey area to a limited extent. Before beginning the GPR survey, several test transects were collected in the Oakland Baptist Cemetery in order to identify the geometry of graves from a similar time period (Figure 5). This helped to determine what types of reflections might be seen in the GPR grids.

Figure 5: Ground-penetrating radar data were collected on top of marked burials in Oakland Baptist Cemetery to determine what unmarked burials might look like in GPR profiles.

Site Name	Collection Name	Grid Dimensions (at largest extent)
Old Graveyard	Area 2	65 ft by 76.5 ft
North Maintenance Yard	Area 3	47 ft by 99 ft
Maintenance Yard Entrance	Area 4	75 ft by 40 ft
Adams/Clark Area (South Maintenance Yard)	Area 5	145 ft by 96 ft
Colonel Young's Front Yard (West Maintenance Area)	Area 6	48 ft by 40 ft
Jackson Cemetery	Area 7	105 ft by 88.5 ft

Table 1: There were six cemeteries and possible grave locations surveyed for this project. Alexandria Archaeology staff and vegetation restrictions determined each surveys dimensions.

The GPR data were collected October 19th and 20th, 2009 using a GSSI SIR-3000 control system with 400 MHz dipole antennas. Radar reflection data were processed to yield amplitude slice-maps and reflection profiles, both of which were used to delineate burials. Amplitude slice-maps allowed for spatial analysis in plan view, while

profile analysis aids were used to delineate stratigraphy and the vertical structure of buried features in two-dimensional vertical slices. Often it is not possible to see older or less well-preserved burials in horizontal amplitude slice maps, in that case, profile analysis was used to determine locations.

GPR Use and Background

Ground-penetrating radar data are acquired by transmitting pulses of radar energy into the ground from a surface antenna, reflecting the energy off buried objects, features, or bedding contacts and then detecting the reflected waves back at the ground surface with a receiving antenna. When collecting radar reflection data, surface radar antennas are moved along the ground in transects, typically within a surveyed grid, and a large number of subsurface reflections are collected along each line (Figure 6). As radar energy moves through various materials, the velocity of the waves will change depending on the physical and chemical properties of the material through which they are traveling (Conyers 2004). The greater the contrast in electrical and magnetic properties between two materials at an interface, the stronger the reflected signal, and therefore the greater the amplitude of reflected waves (Conyers 2004). When travel times of energy pulses are measured, and their velocity through the ground is known, distance (or depth in the ground) can be accurately measured (Conyers and Lucius 1996). Each time a radar pulse traverses a material with a different composition or water saturation, the velocity will change and a portion of the radar energy will reflect back to the surface and be recorded. The remaining energy will continue to pass into the ground to be further reflected, until it finally dissipates with depth.

Figure 6: To collect GPR data an antenna is pulled along a transect within a grid.

The depths to which radar energy can penetrate, and the level of resolution that can be expected in the subsurface, are partially determined by the frequency (and therefore the wavelength) of the radar energy transmitted (Conyers 2004). Standard GPR antennas generate radar energy that varies in frequency from about 10 megahertz (MHz) to 1000

MHz. Low frequency antennas (10-120 MHz) generate long wavelength radar energy that can penetrate up to 50 m in certain conditions, but are capable of resolving only very large buried features. In contrast, the maximum depth of penetration of a 900 MHz antenna is about one meter or less in typical materials, but its generated reflections can resolve features with a maximum dimension of a few centimeters. A trade-off therefore exists between depth of penetration and subsurface resolution. In this survey, a 400 MHz antenna was used, which generally produced data of good resolution at depths of about four and a half feet. Below this depth, extraneous noise sources overwhelmed the very weak radar energy that had been attenuated at about 4 and a half feet depth. Any features located below this depth could not be imaged.

The success of GPR surveys in cemetery studies and archaeology is largely dependent on soil and sediment mineralogy, clay content, ground moisture, depth of burial, and surface topography and vegetation. Electrically conductive or highly magnetic materials will quickly attenuate radar energy and prevent its transmission to depth. The best conditions for energy propagation are therefore dry sediments and soil, especially those without an abundance of clay. In this survey, the ground surface was relatively flat at all of the sites, and the only surface obstructions included some bushes/shrubbery, tree trunks, and an abandoned greenhouse. The antenna was therefore able to maintain good contact with the ground. In these areas I was able to find numerous burials to about four and a half feet below the ground surface.

The "time window" within which data were gathered was 45 nanoseconds (ns) at all of the survey grids. These are the times during which the system is "listening" for returning reflections from within the ground. The greater the time window, the deeper the system can potentially record reflections. To convert time in nanoseconds to depth, it is necessary to determine the length of time it takes the radar energy to be transmitted, reflected, and recorded back at the surface by doing a velocity test. For this project, this was done using the program *GPR Slice*, in which hyperbolas found on reflection profiles are measured to yield a relative dielectric permittivity (RDP), which is a way to calculate velocity. The shape of hyperbolas generated in programs is a function of the speed at which energy moves in the ground, and can therefore be used to calculate velocity (Conyers 2004). At all of the sites included in this project, the RDP is approximately 25, which, when converted to one-way travel time, (the time it takes the energy to reach a reflection source), is approximately 3 cm/nanosecond. All profiles and processed maps were converted from time in nanoseconds (ns) to depth in feet and inches using these average velocities.

Data Processing Procedures

The initial data processing involved the generation of amplitude slice-maps (Conyers 2004). Amplitude slice-maps are a three-dimensional tool for viewing differences in reflected amplitudes across a given surface at various depths. Reflected radar amplitudes are of interest because they measure the degree of physical and chemical differences in the buried materials. Strong or high amplitude reflections often indicate denser (or different) buried materials, such as historic features or burials. In

burials they can be generated by pockets of air, such as within caskets. Amplitude slice-maps are generated through comparison of reflected amplitudes between the reflections recorded in vertical profiles. In this method, amplitude variations, recorded as digital values, are analyzed at each location in a grid of many profiles where there is a reflection recorded. The amplitudes of all reflection traces are compared to the amplitudes of all nearby traces along each profile. This database can then be "sliced" horizontally and displayed to show the variation in reflection amplitudes at a sequence of depths in the ground. The result is a map that shows amplitudes in map view, but also with depth. Often when this is done changes in the soil related to disturbances such as burials can become visible, making many features visible to the human eye that may not be visible in individual profiles.

Slicing of the data generally begins with the reversal of even numbered profiles, to compensate for the data collection technique. This is necessary because the data are collected while moving up and back along transects. Since every other line is collected in the opposite direction, reversal is necessary prior to mapping the data. Following profile reversal, our protocol requires the creation of .xyz files. This step creates a Cartesian coordinate grid into which the data are eventually incorporated. The final step is the actual generating of amplitude slice-maps, which is done using the mapping program *Surfer 8*. Those slice-maps are a series of x,y,z values, with x and y being the location on the surface within each grid and z being the amplitude of the reflected waves at each depth in the ground. All x,y,z data from each depth in each grid are included in the enclosed DVD, along with all raw reflection data, images files and the grid files used to produce the amplitude maps.

From the original .dzt files (raw reflection data), a series of image files were created for cross-referencing to the amplitude slice maps that were produced. Two-dimensional reflection profiles are also analyzed to determine the nature of the features identified on the amplitude slice-maps. The reflection profiles show the geometry of the reflections, which can lend insight into whether the radar energy is reflecting from a flat layer (seen as a distinct band on profile) or a single object or burial (seen as a hyperbola in profile). Using these profiles to confirm or refute ideas about the nature of buried materials seen in the three-dimensional slice maps, unmarked burials were then delineated.

Data Interpretation

Six grids were collected within the Fort Ward Historical Park. Each grid location was identified by Alexandria Archaeology staff based on historic evidence. The results from each grid are discussed below, including possible grave locations, slice maps with burials marked on them for each grid. In general, the amplitude slice-maps and reflection profiles from these grids show a number of high amplitude reflections. Most of these, however, are likely related to changes in the subsurface moisture content, or coupling changes. To identify burials, it was necessary to look for the features identified in the test transects collected over the known, marked burials within Oakland Baptist Cemetery, including the hyperbolic geometry of reflections from caskets, or the vertical truncation

of buried sediments indicating a burial shaft. In addition, in order to confirm the presence of burials, these types of reflections had to occur consistently in parallel profiles, which would potentially indicate a continuous feature such as a burial, and not a single buried rock, animal burrow, root or other feature that would likely only be found in a single profile.

The Old Grave Yard Survey Area

The Old Grave Yard survey area is directly south of the Oakland Baptist Cemetery and was mentioned as an "old grave yard" in a 1930 deed. This area was also marked on an engineer's drawing at the time the park was created (Bromberg 2009) (Figure 7). Today five gravestones are visible, including the headstones of Virginia Fitzhugh and W.E. Javins, which remain upright and possibly in their original location (Figures 8 and 9). One headstone, marked Cornelia Spence, is broken and is probably near her grave (Figure 10). The remaining gravestones are fragments, one of which is probably the footstone belonging to the Virginia Fitzhugh grave.

Figure 7: The Old Grave Yard has five visible gravestones.

Figure 8: The headstone of Virginia Fitzhugh remains upright and may be in its original location. Another gravestone fragment lies beside it.

Figure 9: The headstone for W.E. Javins is also upright and may be in its original location.

Figure 10: The Cornelia Spence headstone is broken and out of place, but it may be near its original location.

At this site I established a 65 by 76.5 foot grid to the south of the Oakland Baptist cemetery, outside of the former maintenance yard fence. The northwest and northeast corners of this grid are parallel to the fence line of the known cemetery, one foot south of the two points along the fence, placed by the survey crew.

There were 21 possible burials identified in this grid, in large part these burials are unmarked (Figure 11 and Table 2). Most possible burials did not correlate directly to the headstone locations. The exception to this was the direct relationship between the Virginia Fitzhugh headstone and a possible burial at the grid location east 75 feet, north 12 feet. It should be noted that the location of this stone, as depicted in Figure 11, was determined from a field sketch map. Following the GPR survey, the City of Alexandria survey team made a more accurate map of the surface features. In this map (Figure 37), the Fitzhugh headstone is located to the west and the north of the possible burial (rather than the east of the burial as it is located on the sketch map).

Burials were identified by examining each profile and looking for indications of burials (i.e. hyperbolas or shafts) that occur at the same place in multiple profiles, often these types of changes are not visible in slice maps (Figure 12). Burials varied in preservation, probably due to different times that they were interred and the varying quality of coffins used. Often the coffin or burial has degraded and no longer reflects any radar energy, when this occurs burials can still be mapped based on stratigraphic truncations and discontinuities produced by excavating for internment (Figure 13). Higher quality coffins or more recent burials often produce stronger, hyperbolic reflections (Figure 14).

X (East)	Y (North)	Depth (ns)	Depth (ft)	Depth (in)	Description
3	30	30	2.95	35.43	Hyperbolic Reflection
6	41	10	0.98	11.81	Strong Reflection
11	26	8	0.79	9.45	Hyperbolic Reflection
22.5	25	11	1.08	12.99	Hyperbolic Reflection
23	44	14	1.38	16.54	Hyperbolic Reflection
29	22	29	2.85	34.25	Hyperbolic Reflection
29	36	32	3.15	37.80	Discontinuity in Stratigraphy
37	28	42	4.13	49.61	Hyperbolic Reflection
38	34	11	1.08	12.99	Hyperbolic Reflection
40.5	30	36	3.54	42.52	Hyperbolic Reflection
42	54	11	1.08	12.99	Hyperbolic Reflection
46.5	48	28	2.76	33.07	Hyperbolic Reflection
49.5	9	11	1.08	12.99	Hyperbolic Reflection
52	41	38	3.74	44.88	Hyperbolic Reflection
57	29	34	3.35	40.16	Hyperbolic Reflection
60	49	34	3.35	40.16	Hyperbolic Reflection
61.5	1	12	1.18	14.17	Hyperbolic Reflection
61.5	51	34	3.35	40.16	Hyperbolic Reflection
66	42	38	3.74	44.88	Strong Reflection
72	38	14	1.38	16.54	Hyperbolic Reflection
75	12	40	3.94	47.24	Hyperbolic Reflection

Table 2: Each burial was identified based on its characteristics visible in profile and then its X,Y, and Z location were noted. Depth in nanoseconds was converted to feet and inches using the calculated velocity of the radar energy.

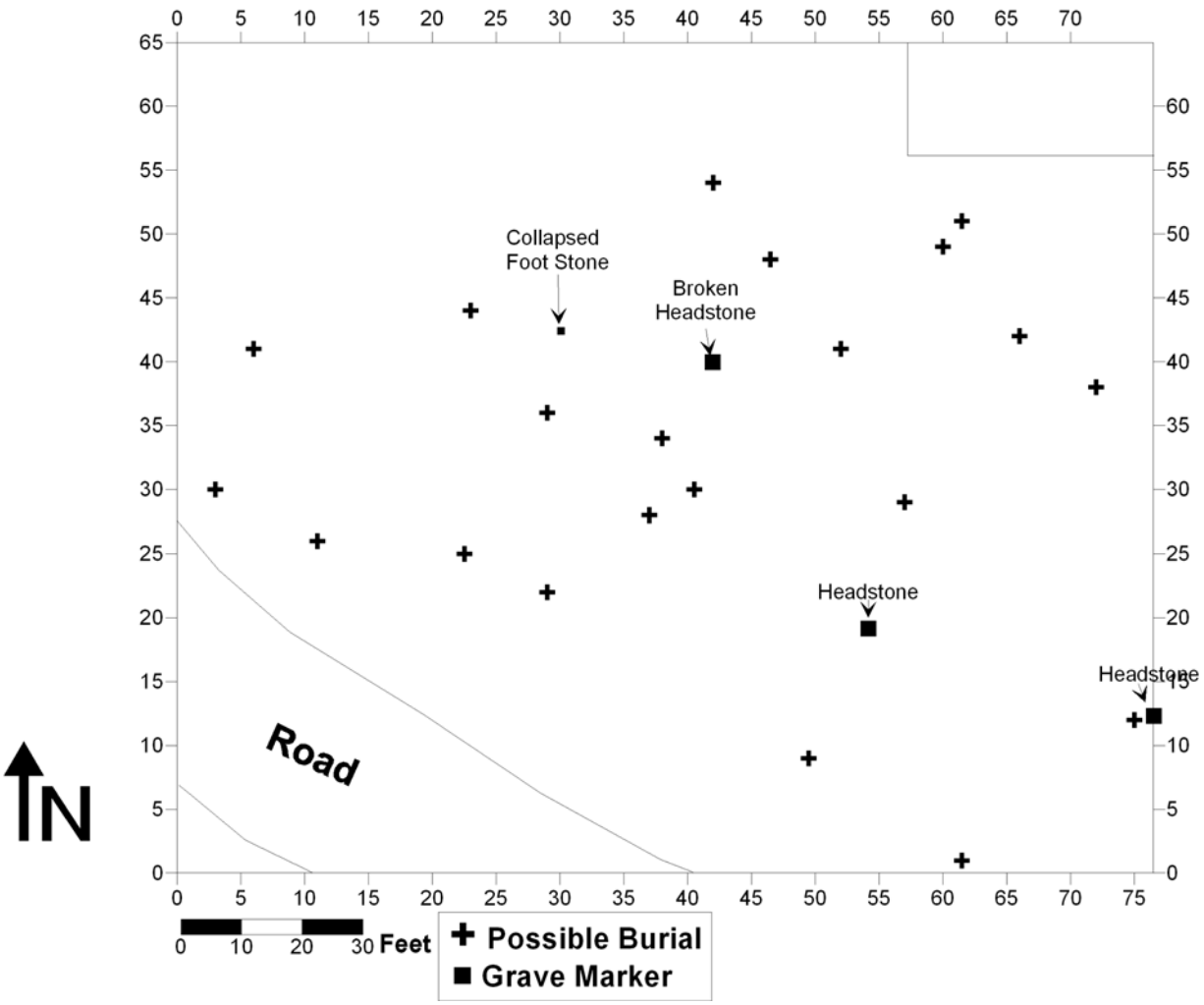


Figure 11: Within the old graveyard, just south of the Oakland Baptist Cemetery, 21 possible burials were identified.

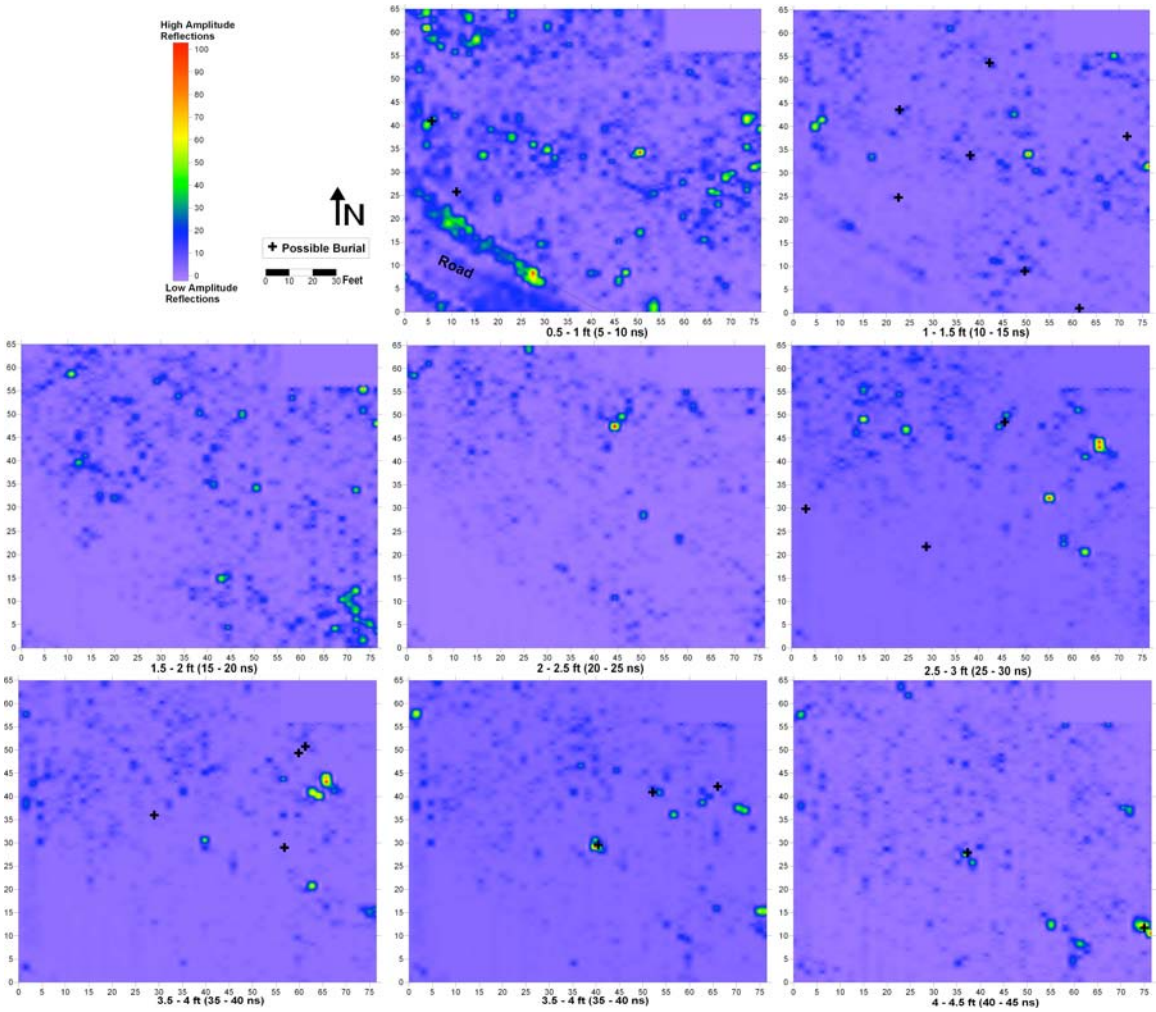


Figure 12: Burials were identified through examining each profile to look for strong hyperbolic reflections or truncations, which are often not visible in slice maps. Very few burials would be identified through simply examining horizontal slices.

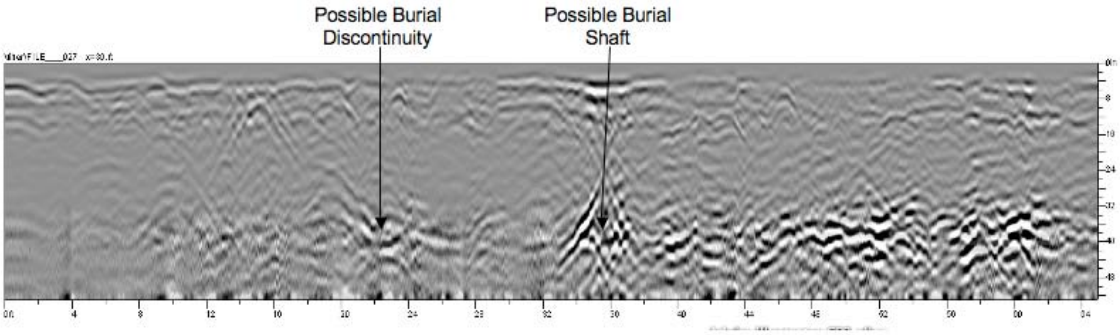


Figure 13: The two possible burials, located in the old graveyard, both produced subtle radar reflections, perhaps suggesting that they are older or not well preserved.

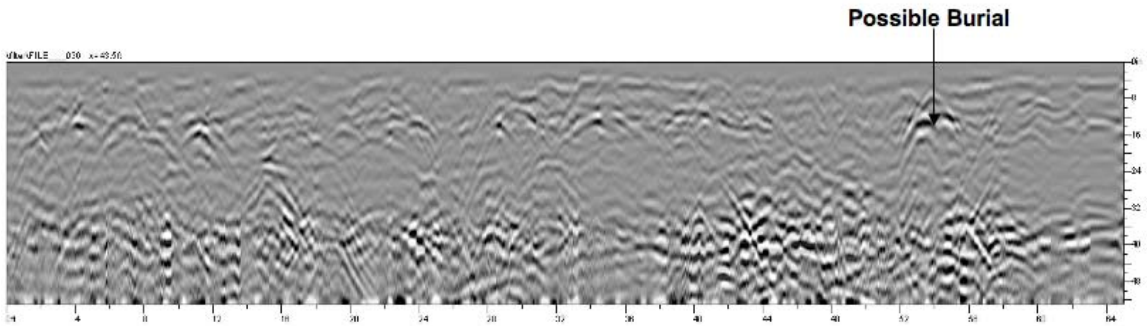


Figure 14: This possible burial, in the eastern side of the old graveyard, is reflected strongly and is probably the result of an intact coffin.

The burials mapped in this cemetery range in depth from between just under one foot (8 ns) to over four feet (42 ns). Most were less than four feet deep (Figure 13). These shallow burials could be the result of erosion, ground settling, or they might be typical at this location. Due to external noise (of other devices producing electromagnetic energy) and energy attenuation at this location, I was unable to collect usable data below 45 ns (about 4.5 ft). Because of this I might have missed burials located deeper. However, when test transects were collected over similar marked burials in the Oakland Baptist Cemetery, these were easily visible in profile, suggesting that the adjacent burials in the Old Grave Yard, would also be visible using GPR. Therefore, I believe this depth penetration was sufficient to map most burials in this area.

The North Maintenance Yard Survey Area

The north maintenance yard survey area is to the east of the Old Grave Yard, within the former maintenance area (Figure 15). This area is also directly adjacent to the Oakland Baptist Cemetery and could also have been used for interment. No headstones or footstones are present in this area. A large grove of trees was historically present in this area, and oral history accounts suggested that burials could be present. Here I established 47 by 99 foot grid, aligned with the grid placed by the City of Alexandria survey crew. This grid was just 3 feet short on the northern edge, due to some vegetation restrictions.

Figure 15: The North Maintenance Yard area is located directly adjacent to the Oakland Baptist Cemetery.

To analyze the GPR results from this grid, I visually examined each individual reflection profile and noted possible burial reflections when they occurred in more than one profile, next to each other. In this grid, I identified 6 possible burials, all located from about one foot to one and a half feet below the ground surface (Table 3 and Figure 16 and 17). These burials all appear to be close to known burials in the Oakland Baptist Cemetery and possible burials in the Old Grave Yard. All of the burials were identified from hyperbolic reflections in profiles, suggesting intact coffins and fairly well preserved burials (Figure 18). These burials do not range much in depth and they are all fairly shallow. It is possible that internments were originally made significantly deeper, but subsequent years of erosion have removed some original topsoil.

X (West)	Y (North)	Depth (ns)	Depth (ft)	Depth (in)	Description
16.5	44	14	1.38	16.54	Hyperbolic Reflection
52.5	42	11	1.08	12.99	Hyperbolic Reflection
58.5	41	14	1.38	16.54	Hyperbolic Reflection
64.5	32	14	1.38	16.54	Hyperbolic Reflection
84	5	14	1.38	16.54	Hyperbolic Reflection
97.5	17	16	1.57	18.90	Hyperbolic Reflection

Table 3: Burials were identified in profile and then its X,Y, and Z location were noted. Depths varied from one foot deep to one and a half feet.

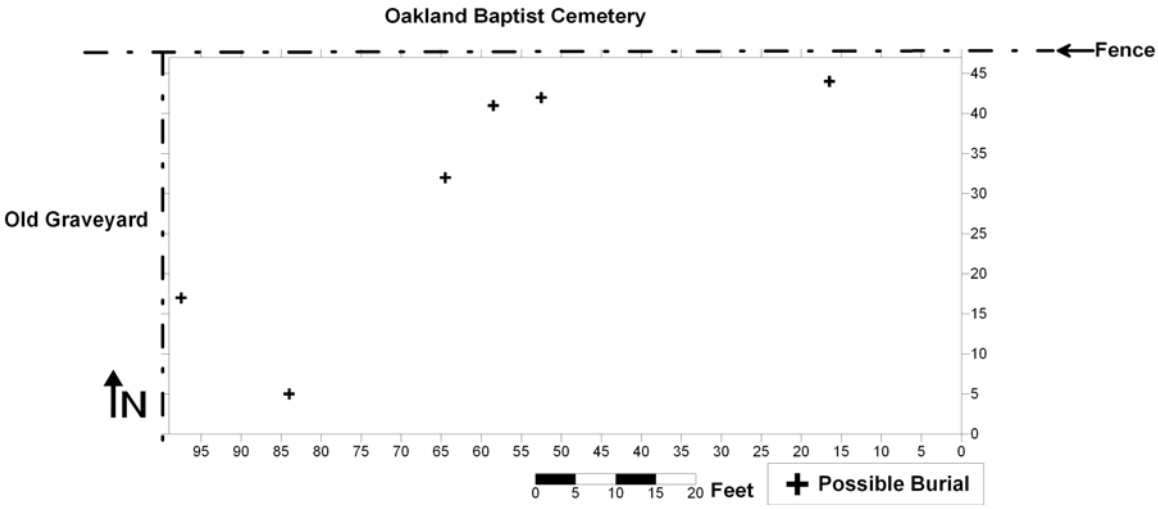


Figure 16: The burials identified in this grid are closer to the burials in the Oakland Baptist Cemetery and the old graveyard.

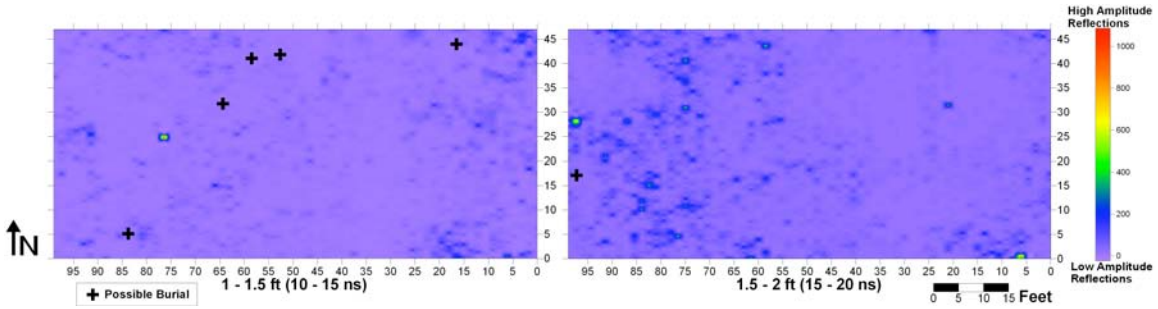


Figure 17: The possible burials identified in the north maintenance yard range from about 1 foot to a little deeper than one and a half feet.

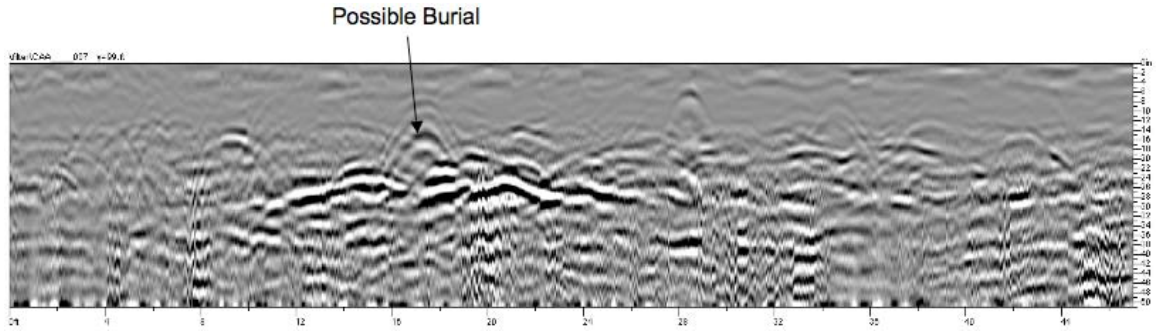


Figure 18: Possible burials are visible in profiles as hyperbolic reflections like this one.

The Maintenance Yard Entrance Survey Area

The maintenance yard entrance survey area is just to the south of the north maintenance yard, in the former maintenance yard. The area examined is largely graveled and currently has no surface obstructions (Figure 19). A large grove of trees was historically present in this area, and oral history interviews suggested that burials could be present.

Figure 19: Oral histories suggested that maintenance yard entrance may have burials.

A 75 by 40 foot grid was established using stakes set up by the Alexandria survey crew as corners (Figure 20). After careful analysis of all of the profiles collected in this grid, no burials were identified. Some interesting, possibly historic, architectural features were mapped in slice maps and confirmed through profile analysis (Figures 21 and 22). Another compacted surface below the ground surface was also identified. These features might be the remains of structures related to the neighborhood located in this area or they could be debris related to the former maintenance yard.

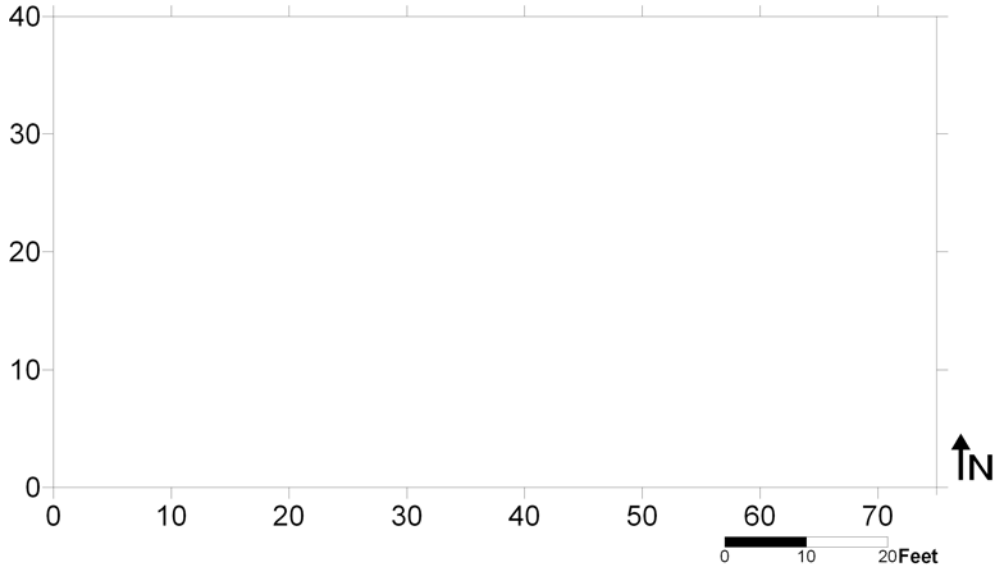


Figure 20: The maintenance yard entrance area grid measured 75 by 40 feet and was set up using stakes placed by the survey crew.

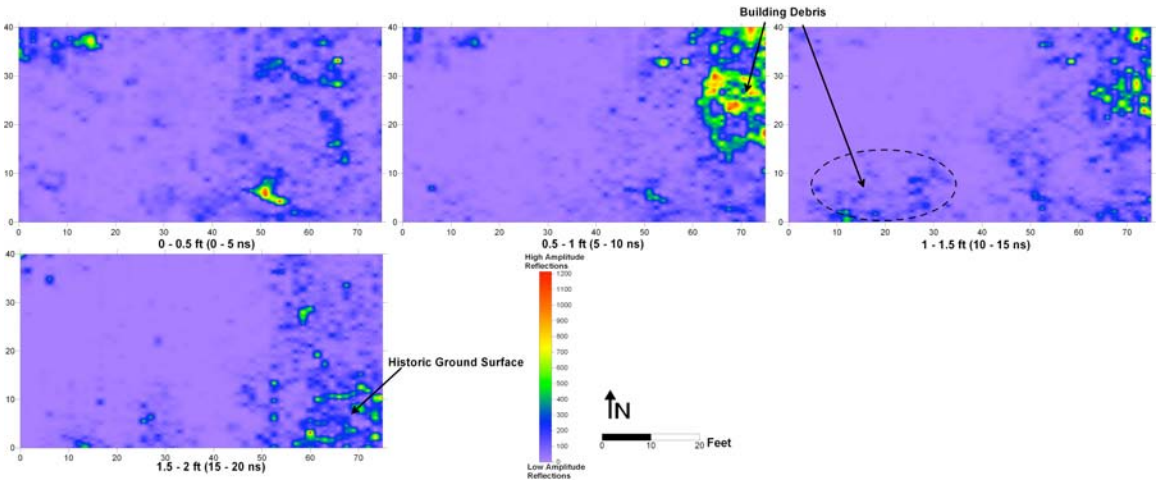


Figure 21: In the slice maps several large collections of building debris and a compacted surface were identified.

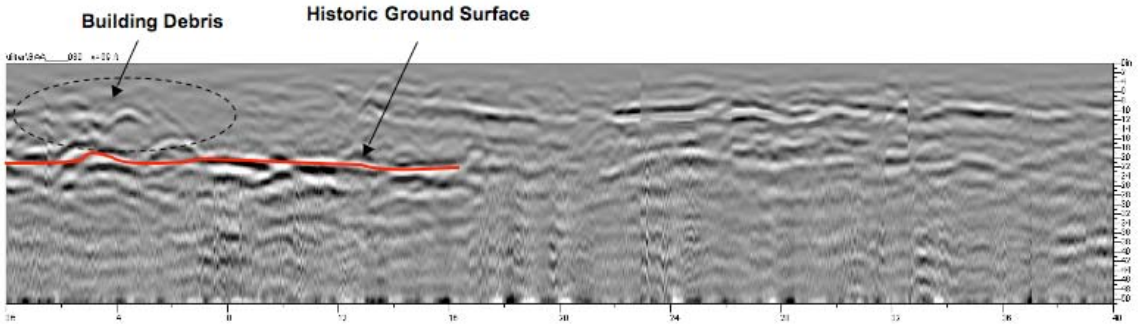


Figure 22: Profile analysis suggests that there are large numbers of small point reflection in this area, perhaps building debris, on top of at least one relatively flat surface.

The Adams/Clark Survey Area

The Adams/Clark survey area is located just to the south of the maintenance yard entrance area in the largest section of the former maintenance yard (Figure 23). Clara Adams and Amanda Clark were the descendants of Burr and Harriet Shorts, who were probably the first African Americans to purchase property at Fort Ward after the Civil War. There is one standing headstone in this area, marked Clara Adams, and Clara's husband Robert is thought to be buried next to her (Figure 24). Amanda Clarke's 1923 will states she wished to be buried next to the property line with Clara Adams, in a little grove in the corner of her property, a location which would also be within this survey area, along the eastern fence line about 50 to 60 feet south of the northeast corner. In addition, in the northern part of this survey area, a large grove of trees was historically present, and oral history accounts have indicated that there were additional grave sites in the woods. The western section of this survey area extended onto the property of an African American schoolhouse, that later became St. Cyprian's Episcopal Church, and still later served as a residence.

Figure 23: The Adams/Clarke survey area was located in the largest section of the former maintenance yard.

Figure 24: The Clara Adams grave is located in the middle of the maintenance yard and her husband Robert is thought to be buried next to her.

Today this area is mostly covered with grass and a gravel road running north and south. There is a greenhouse and a well associated with the former maintenance yard. In the eastern portion of the yard there are a number of large trees and low vegetation.

In order to locate these possible burials, a 145 by 96 foot grid was established over the large open area using the survey stakes placed by the survey crew. The vegetation at its eastern edge limited the extent of this grid. In order to extend the coverage, and look for the Amanda Clark grave, several transects were collected around the vegetation. Because this was not complete coverage it could not be interpolated and sliced with larger more complete section, but profile analysis allowed for burial identification and then the location of any burials could be associated with the larger grid.

Using profile analysis two possible burials were identified in a north/south row in the grassy section of the Adams/Clark area. The southernmost of these potential burials is roughly adjacent to Clara Adams' marker and the other possible burial may be her husband Robert (Figure 25). These were identified at about one and a half feet below the surface. They are relatively shallow burials, but they were mapped using discontinuities in the reflection profiles, which may be much shallower than the actual burial. Again, it should be noted that the field sketch of the marker location (Figure 27) is inaccurate and the marker was mapped to the west of the possible burials by the City of Alexandria Surveyors (Figure 37).

In the eastern section of this grid another possible burial was identified within the heavy vegetation (Figure 26). In total three burials were identified in this large grid (Figure 27 and Table 4). There was no indication of a burial in the expected location for Amanda Clark's grave, about 50 to 60 feet south of the southeast corner of the grid.

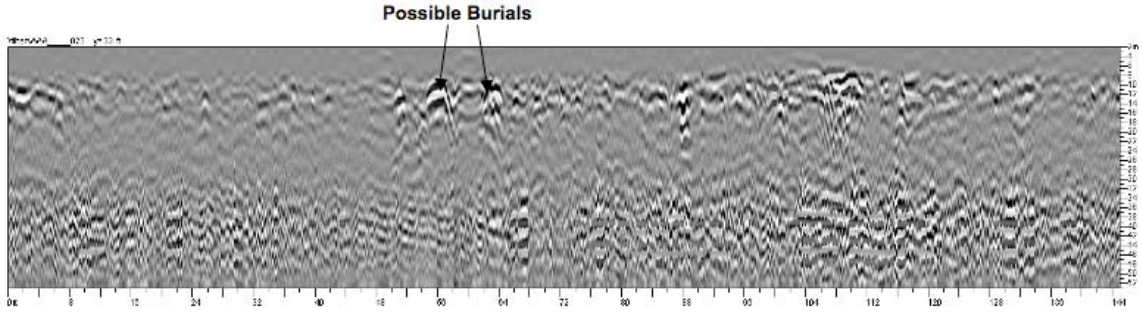


Figure 25: The two possible burials identified in the middle of the Adams/Clark area are thought to be Clara and Robert Adams. The soil changes for these burials produced discontinuities in the GPR reflection profiles.

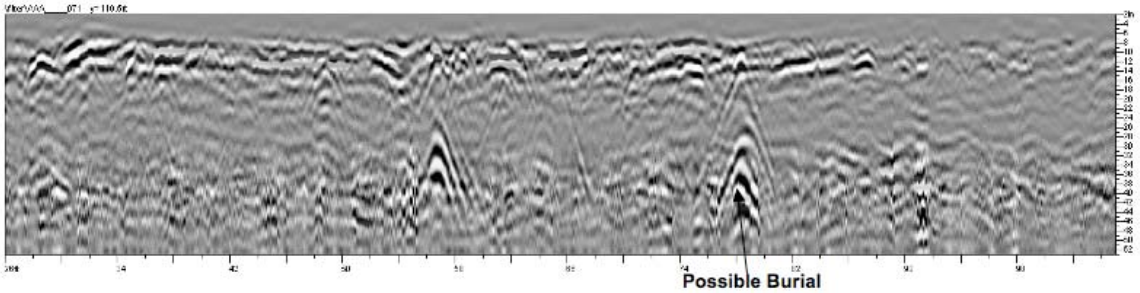


Figure 26: The possible burial identified within the trees was identified because the strong hyperbolic reflection is visible in several concurrent profiles collected in this area.

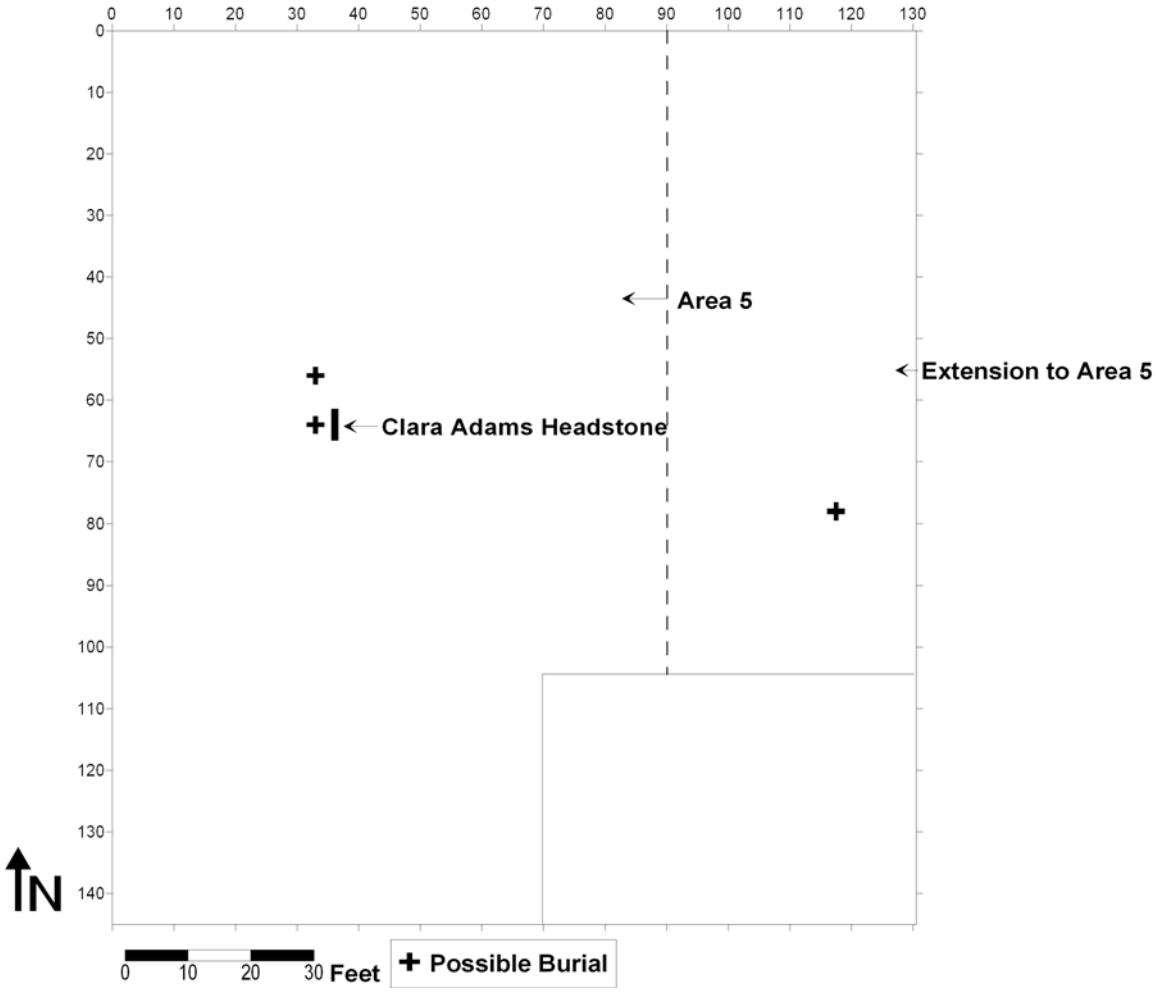


Figure 27: Three burials were identified in the Adams/Clark area, two are located in the western part of the grid and the other in the extended area within relatively dense vegetation.

X (East)	Y (South)	Depth (ns)	Depth (ft)	Depth (in)	Description
33	64	14	1.38	16.54	Hyperbolic Reflection
33	56	14	1.38	16.54	Hyperbolic Reflection
117.5	78	38	3.74	44.88	Hyperbolic Reflection

Table 4: Three burials were identified through the analysis of reflection profiles.

The horizontal slice maps made for this area have the possible remains of architecture visible between one half and one foot below the subsurface (Figure 28). There is a square feature in the northern section of the grid and several linear high amplitude reflections. These features may be related to the former maintenance yard or the African American neighborhood.

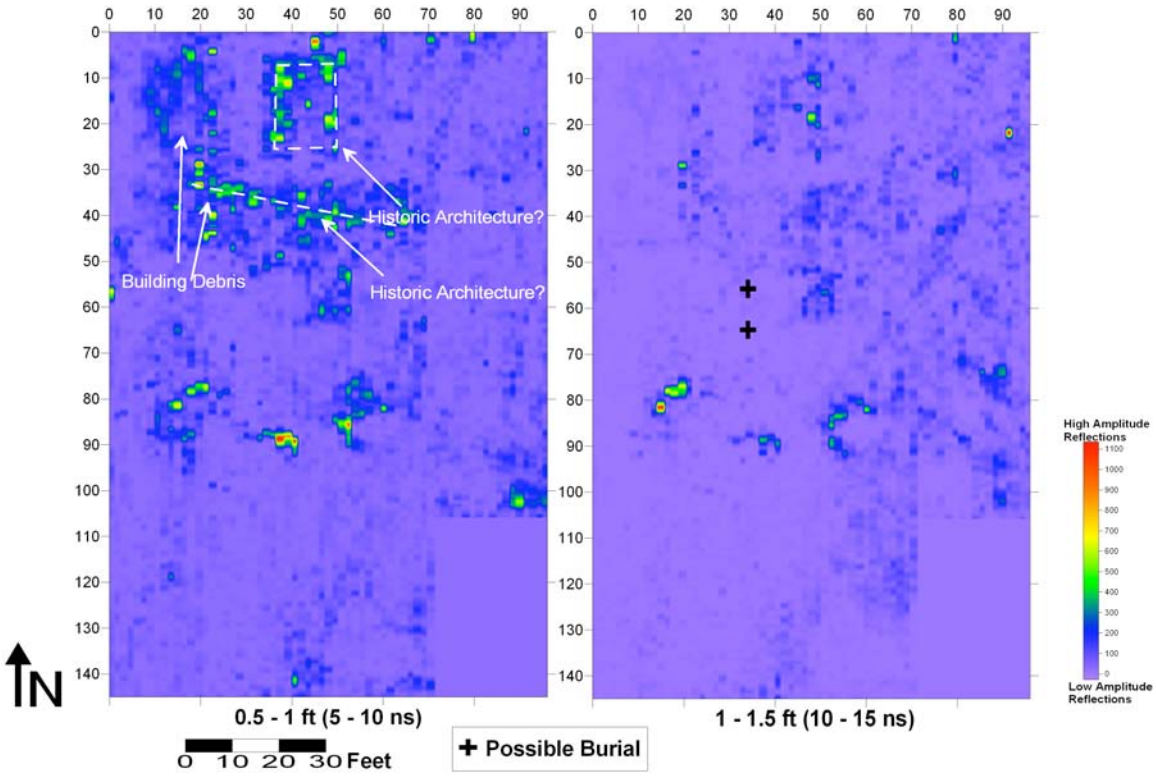


Figure 28: In the slice maps some architectural features are visible in the northern part of the grid. The burials in this section are not visible in the slice maps and were identified with profile analysis.

The Sergeant Young's Front Yard Area

The Sergeant Young's front yard survey area is just to the west and adjacent to the Adams/Clark area, still within the largest section of the former maintenance yard. This area was identified for GPR survey based on Sergeant Young's oral history interview. In the mid-20th century, Sergeant's Young's family lived in the old schoolhouse/church. He recalled that there were broken gravestones in his front yard, one of which he moved for his flower garden. Currently the area is partially graveled with a low mound of dirt in the center. There were no obstructions to the GPR survey.

A 48 by 40 foot grid was established using the stakes placed by the survey crew. One possible burial and a large number of point reflections (hypothesized to be building debris) were identified in this area (Figure 29 and Table 5). The burial was identified through analyzing each profile to look for contiguous reflections; it is located on the eastern site of this grid at almost two feet below the surface (Figure 30). In profile this possible burial is as a hyperbolic point reflection, perhaps reflecting off an intact coffin, at the same point across at least five feet (Figure 31). The building debris was identified because they are random (non-continuous) point reflections within the profiles and slice maps (Figure 32). These materials may be the remains of buildings or landscaping from the African American neighborhood and it may, at least partially, be debris from the former maintenance yard.

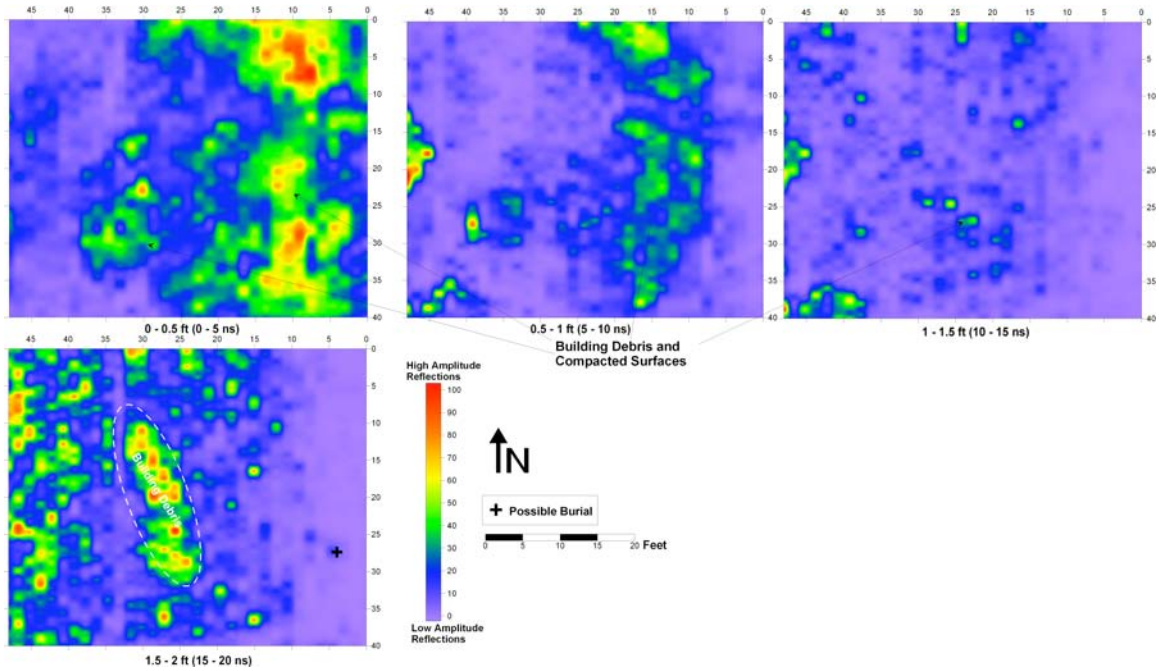


Figure 29: One possible burial and large quantities of possible building materials were identified in the Colonel Young's front yard area using reflection analysis.

X (West)	Y (South)	Depth (ns)	Depth (ft)	Depth (in)	Description
3	27	18	1.77	21.26	Hyperbolic Reflection

Table 5: The possible burial identified through reflection profile analysis is located in the eastern section of the grid, underneath the modern gravel road.

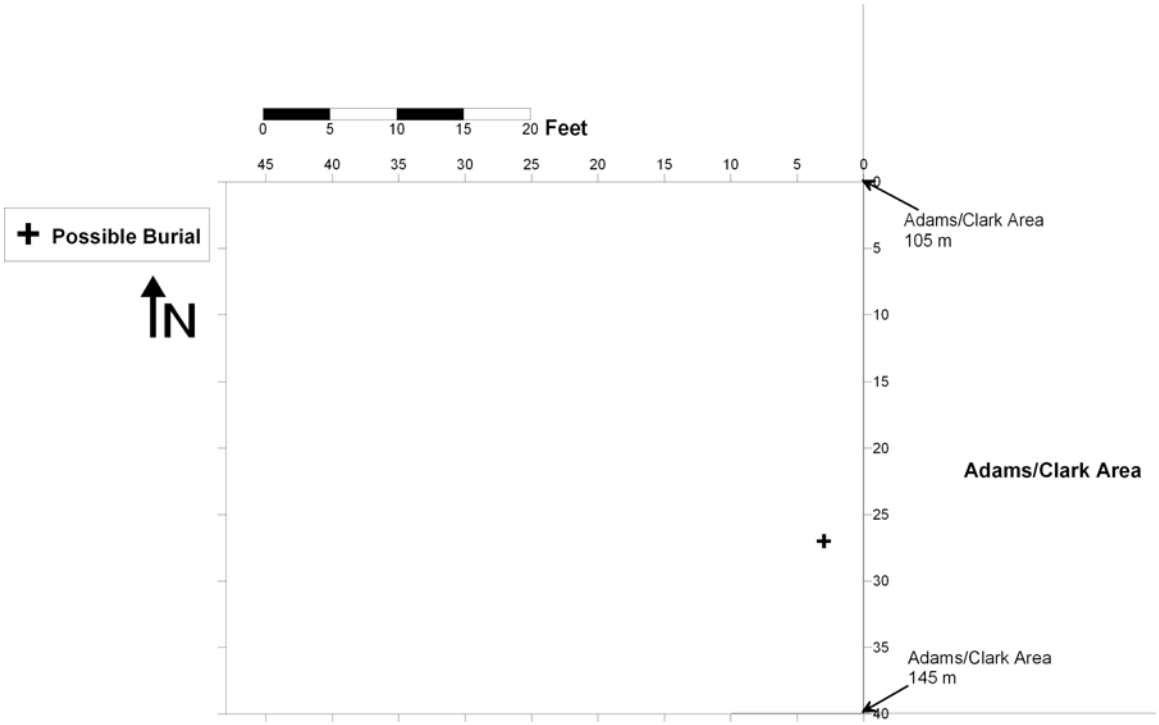


Figure 30: The possible burial identified in the Colonel Young's front yard area is located in the southeastern section of the grid.

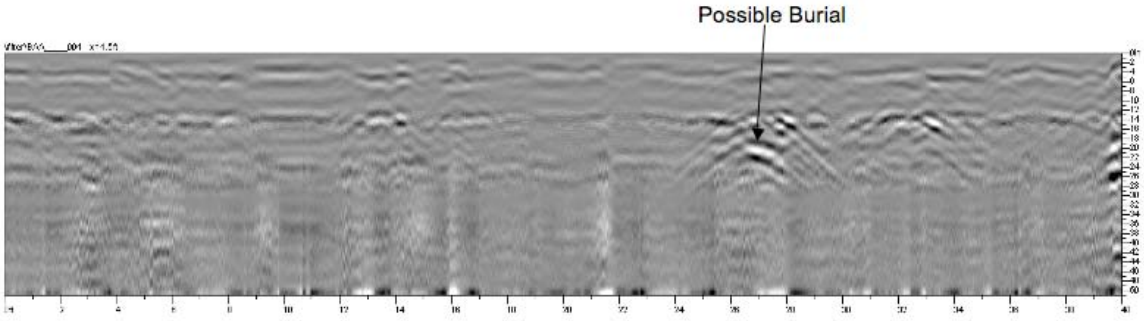


Figure 31: The possible burial in this grid is a hyperbolic point reflection within the grid, visible in several profiles at the same point.

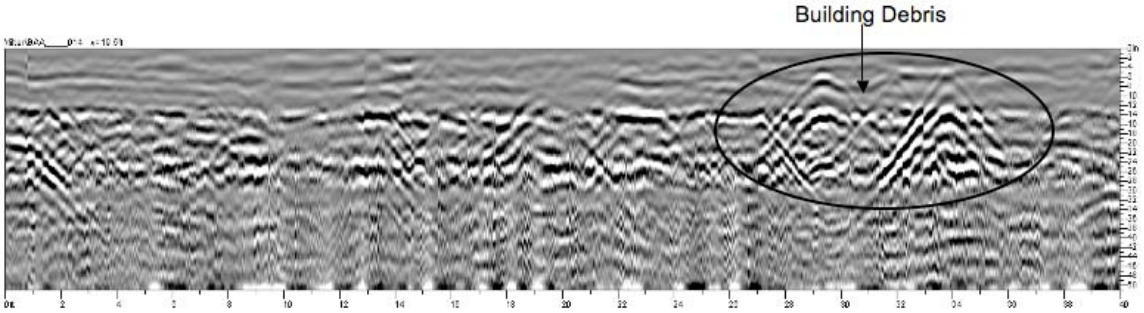


Figure 32: The building debris is also hyperbolic, point reflections that are random and isolated.

The Jackson Cemetery

The Jackson Cemetery is located west of the Fort Ward fortification, on the glacis of the fortification (Figure 33). This was part of the Jackson property, purchased by James F. Jackson in 1894. The cemetery is also marked on a 1960s engineering map. Presently, it is a grassy area, with a few scattered trees and a line of impassible thorny vegetation. There are a few surface depressions, which may be the result of settling burials or tree fall.

Figure 33: The Jackson Cemetery is away from the maintenance area, on the glacis of the Fort Ward fortification.

The survey crew staked a 50 by 70 foot grid to enclose the area shown as the cemetery on the 1960s engineering drawing, but as that grid did not cover many of the depressions and was partially covered by thorny vegetation, we decided to extend that grid to the west and the north, creating a grid measuring 87.5 by 105 feet at its largest extent. In this area, seven possible burials were identified mostly within in the eastern part of the grid, which also was the crest of a slight slope within the grid (Figure 34). Six of the possible burials fell within the area marked as the cemetery on the 1960s drawing.

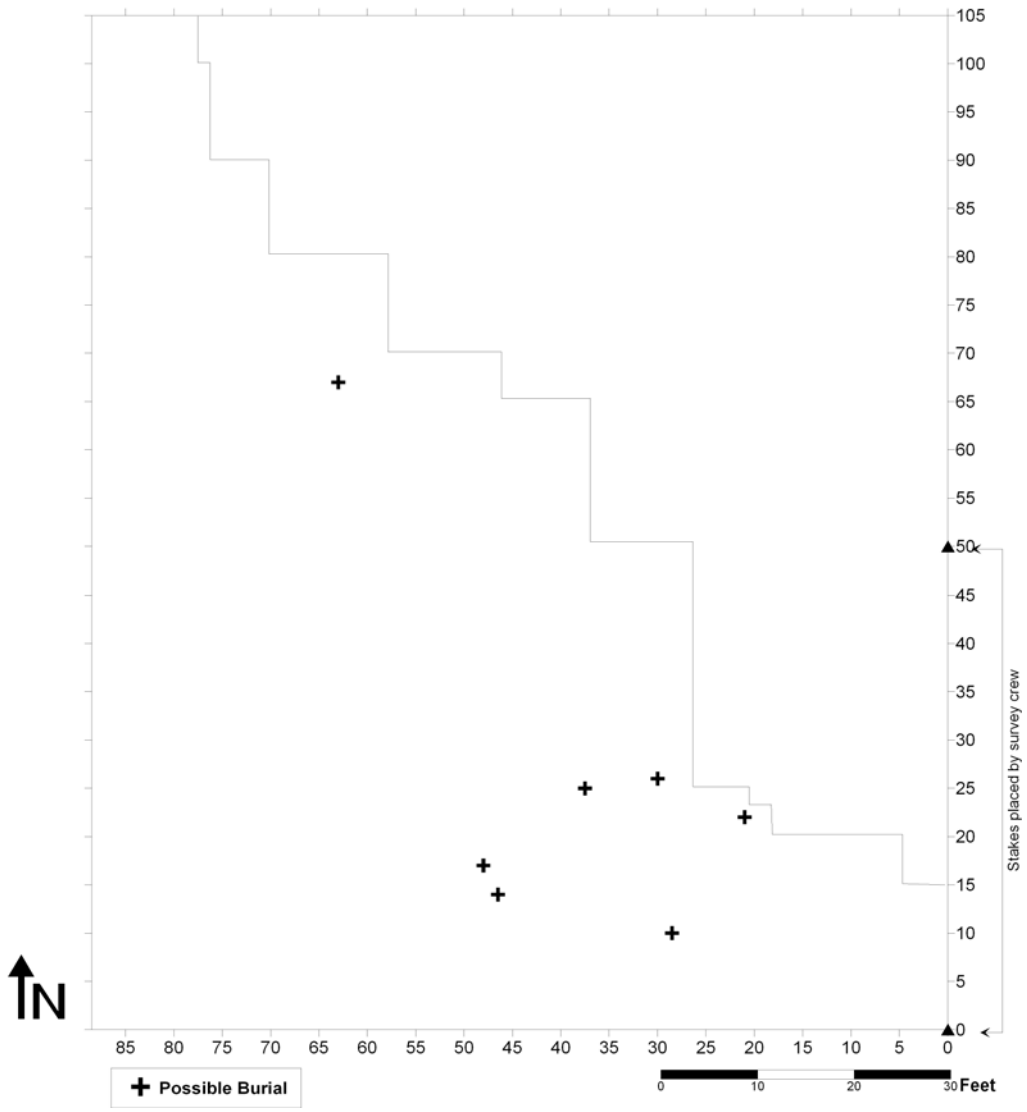


Figure 34: The possible burials are largely clustered in the southeastern section of the grid on the crest of the slope.

The burials identified in this cemetery were all visible as strong hyperbolic reflections, suggesting excellent preservation and intact coffins (Figure 35). They range in depth from nearly one and a half feet to nearly three feet (Figure 36 and Table 6). These burials are still fairly shallow, but as they are positioned on a slight slope there may have been some topsoil loss. Settling may have also occurred, some of which is apparent on the surface, as a few of the surface depressions in the area do contain burials (other depressions could be due to tree fall).

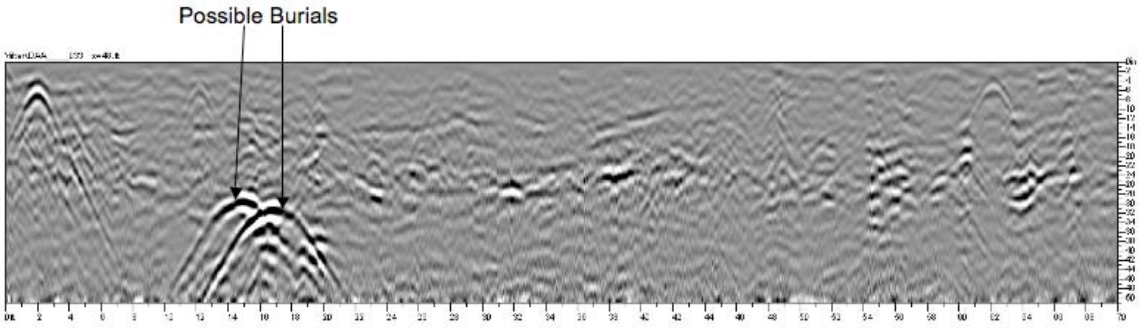


Figure 35: Possible burials in the Jackson Cemetery seem to be well preserved, producing high amplitude reflection like these two burials.

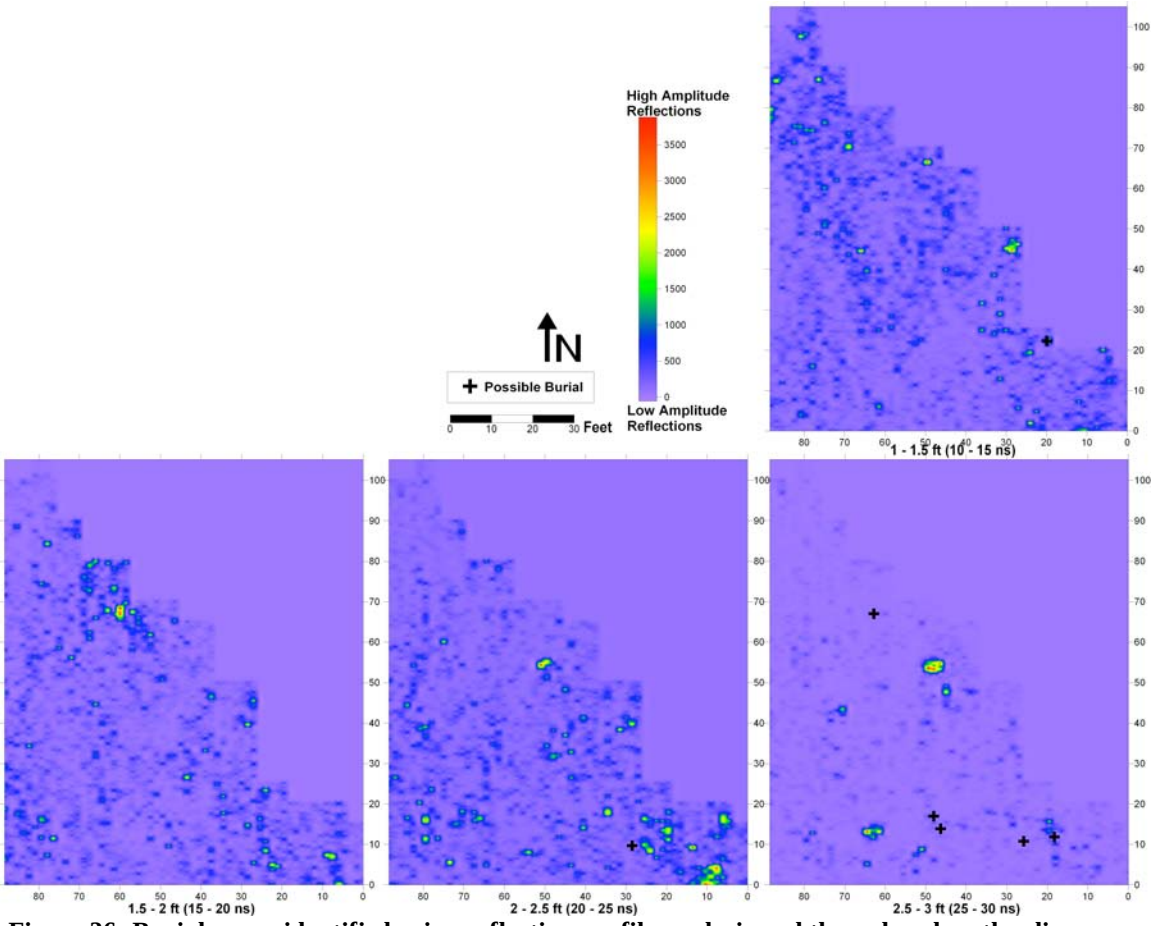


Figure 36: Burials were identified using reflection profile analysis and then placed on the slice maps according to their depth. Most of them are between two and a half and three feet below the surface.

X (West)	Y (North)	Depth (ns)	Depth (ft)	Depth (in)	Description
21	22	14	1.38	16.54	Hyperbolic Reflection
28.5	10	22	2.17	25.98	Hyperbolic Reflection
30	26	18	1.77	21.26	Hyperbolic Reflection
37.5	25	16	1.57	18.90	Hyperbolic Reflection
46.5	14	29	2.85	34.25	Hyperbolic Reflection
48	17	28	2.76	33.07	Hyperbolic Reflection
63	67	29	2.85	34.25	Hyperbolic Reflection

Table 6: The seven possible burials identified in this area range in depth from about one and a half feet to three feet, but they seem to be primarily clustered in the southeast corner of the grid.

Conclusions and Recommendations

The GPR surveys performed at Fort Ward Park were successful in locating 38 possible burials: 21 in the Old Grave Yard, 10 in the former maintenance yard, and 7 in the Jackson Cemetery. No burials were identified in the maintenance yard entrance area. Figure 37 shows the locations of the burials within the survey areas and Figure 38 is a close-up of the Old Graveyard and former maintenance yard. These figures were created as CAD maps by the City of Alexandria surveyors from a variety of sources. Recent field surveys by the City team mapped existing surface features including: topography, fence lines, contours, gravestones, and the GPR grids. Historical property lines were reconstructed from deed descriptions. The names of some of the associated property owners are shown on the map. Possible burial locations were placed on the map from the data (x,y coordinates within each survey grid block) collected from the GPR investigations. This CAD map will be used and updated in all future investigations, as all features on it are tied to State of Virginia survey coordinates. All discoveries, therefore, will be accurately relocated in the field for future preservation and interpretation.

It should be noted that there is some error in the possible burial locations. Radar energy does not necessarily travel in a straight line underneath the ground. There may be some discrepancy between where reflections appear in the radar reflections and where features are actually positioned below the ground. It is estimated, in this case, that there is an approximately 1.5 foot possible error within the possible grave locations. In addition, the radar data are collected in transects, using long tape measures running over irregular and sometimes sloping ground surfaces. This means that a slight error in distances is possible. The possible burial locations on the CAD map are probably accurate within about 1.5 to 2 feet.

Figure 37: The possible burials identified in this GPR survey (and placed on the CAD drawing by the City Surveyors) indicate areas to be preserved and investigated in the future.

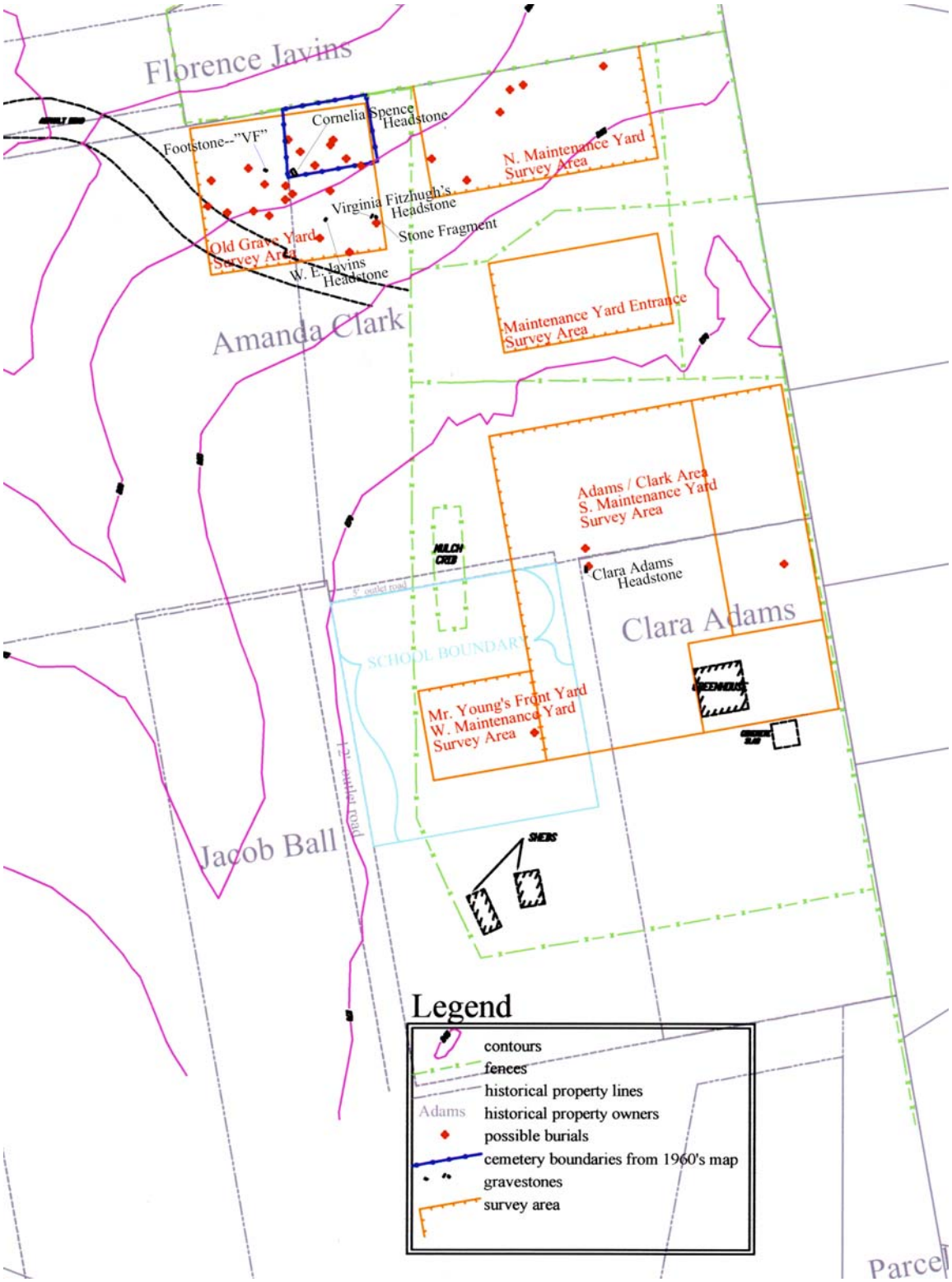


Figure 38: In a close up of gravestones and possible grave locations in the Old Grave Yard and former maintenance area it is possible to see the actual survey locations of the five stones in the Old Grave Yard and the headstone of Clara Adams in the former maintenance yard.

The 21 possible burials identified in the Old Grave Yard were expected, as this area includes the cemetery plot identified on the 1960's engineer's drawing, is adjacent to the Oakland Baptist Cemetery, and has possible *in situ* and moved grave markers. Interestingly, only six of the possible burials identified are located within the area demarcated as the Old Grave Yard on the 1960's drawing. It is possible that the burial area was more extensive than it was depicted at the time.

One of the possible burials identified was located in the vicinity of what may be the *in situ* headstone of Virginia Fitzhugh. There was no indication of burials near the other possible *in situ* gravestone (marked with the name W.E. Javins) or in the immediate vicinity of the stones that were clearly out of place. It is noteworthy that neither of the two possible *in situ* gravestones lies within the area designated as the Old Grave Yard on the 1960s drawing. It seems incongruous that the Old Grave Yard boundary would have been drawn to exclude *in situ* stones, therefore, it is possible that these stones were moved after the 1960s. Of course, if the gravestones were moved, it is coincidental that the Virginia Fitzhugh stone roughly lines up with one of the potential burials. Archaeological investigations will be able to test this alignment.

In the north maintenance yard, directly east of the Old Grave Yard and directly south of the Oakland Baptist Church Cemetery, an additional six possible graves were mapped. This is also unsurprising considering the close location of these grave sites to both known cemeteries. It is possible that one or both of these cemeteries extended into this area.

The Adams/Clark area has a total of three identified possible burials. Two of these are in line with one another. One is undoubtedly Clara Adams' marked grave (to the south), while a second may be that of her husband, Robert (the possible burial to the north). The possible Robert Adams burial is currently characterized by a depression in the ground surface. This possible northern burial, may be on the property of Amanda Clark, rather than on the land that had belonged to Clara and Robert Adams (Figure 38). Miss Clara, however, was buried on what was the Adams' lot. A number of questions arise related to the fact that these burials appear to be on different properties: Are the property line and burial features accurately mapped in relation to one another? Were the owners aware of the exact location of the property line? Is the possible northern grave really the burial of Robert Adams, and are there additional burials in this north/south row, with Robert buried to the south of his wife, as suggested by some of the oral history accounts? Although some of these questions may be difficult or impossible to answer, archaeological work may help to establish the number of graves in the row. Thus, it could provide insight into whether the possible northern burial is Robert Adams' grave.

As inferred from deed and probate records, the grave of Amanda Clark was also expected in this survey area along the eastern fence line about 50 or 60 feet south of the northeast corner, just north of the property line between Clara and Amanda's lots (See Figures 37 and 38). A burial was not found in this location, but one additional possible burial was found in the eastern section of the survey area, about 50 feet northeast of the greenhouse.

One possible burial was identified in the eastern part of Sergeant Young's front yard area. In an oral history interview, Sergeant Young indicated that there were gravestones in this general area, one of which he moved to create a garden. The possible burial identified by the GPR survey may be confirmation of graves in this area.

In the Jackson Cemetery, seven possible burials were mapped. Their locations coincide with documentary evidence that this area was used as a family graveyard. Six of the seven possible burials were identified within the area that was marked out as the Jackson Cemetery on a 1960s engineering drawing.

All interpretations were made using analyses of both the reflection profiles and the generated three-dimensional amplitude slice maps, and both methods were important for identifying potential burials. The amplitude slice-maps helped in identifying the extent and spatial layout of possible burials, while the reflection profiles were key in confirming the geometry and vertical structure of possible burials; this was particularly important at this site where building debris and vegetation had to be differentiated from burials. It is noteworthy for future archaeological investigations that the GPR survey also identified the buried remains of one or two possible structures in the northeastern part of the Adams/Clark survey grid, as well as areas of building debris and a possible buried surface in the maintenance yard entrance grid. Additional research and archaeological investigation may allow for a determination of whether these features relate to other activities in the African American community or to activities within the maintenance yard.

Even with the successful identification of numerous possible unmarked burials in these areas, however, it is important to remember that the number of possible burials we identified may not be exhaustive; this is especially true for the eastern section of the Adams/Clark area where bushes and trees did not permit a comprehensive survey. It should be kept in mind that it is possible that there are unmarked burials here that lack caskets, soil changes, or associated grave goods necessary to be discernable in the GPR reflection data (Conyers 2006). It is thus recommended that any future construction or use of the surveyed areas proceed with caution, as there could be burials that are so subtle (or have disintegrated so much) as to be invisible with GPR mapping procedures. To comprehensively map unmarked burials and to ensure that possible burials noted in this report are burials, I recommend targeted archaeological excavations as the next step in this project. No ground disturbance should occur until such testing is done and grave locations are confirmed and identified.

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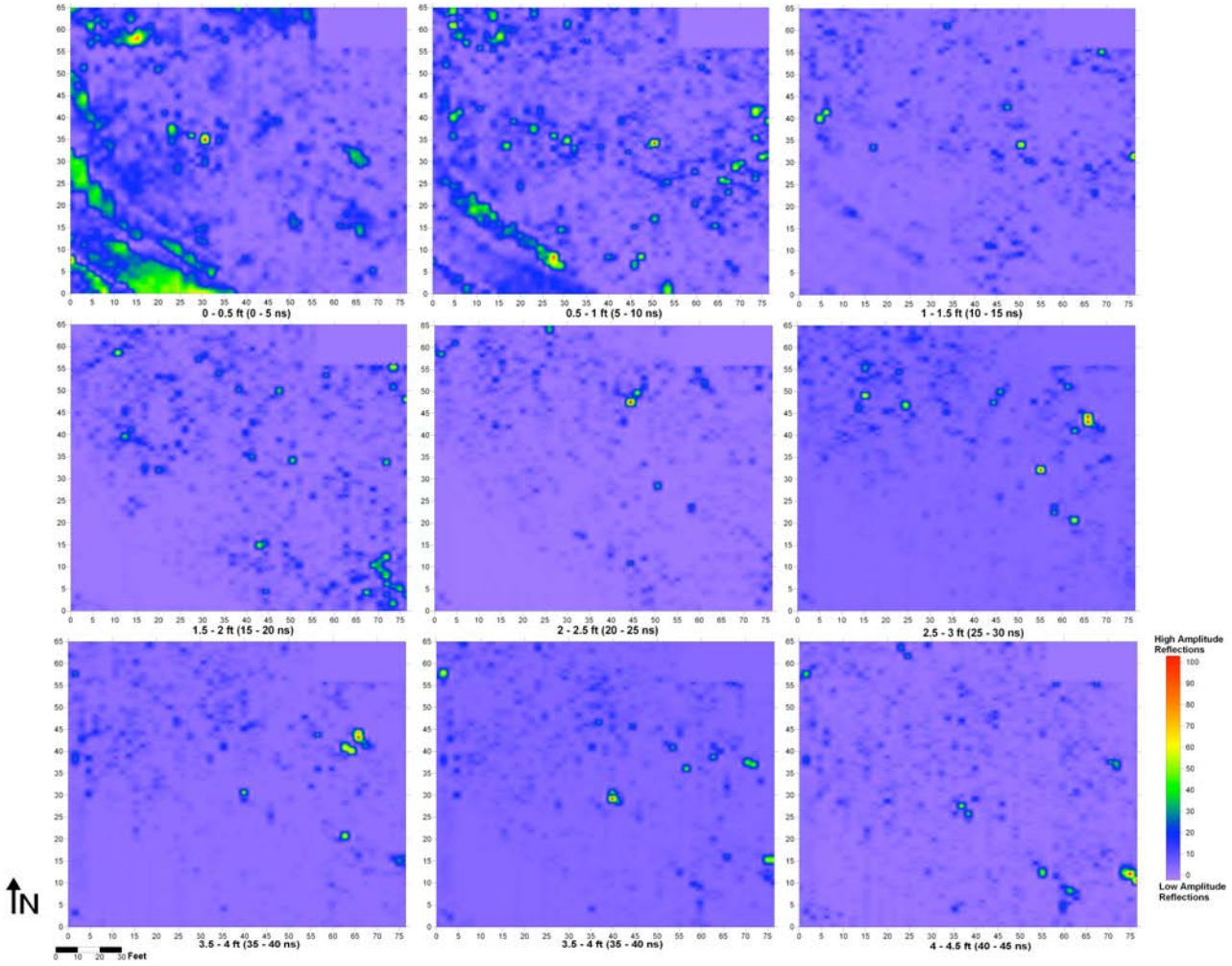
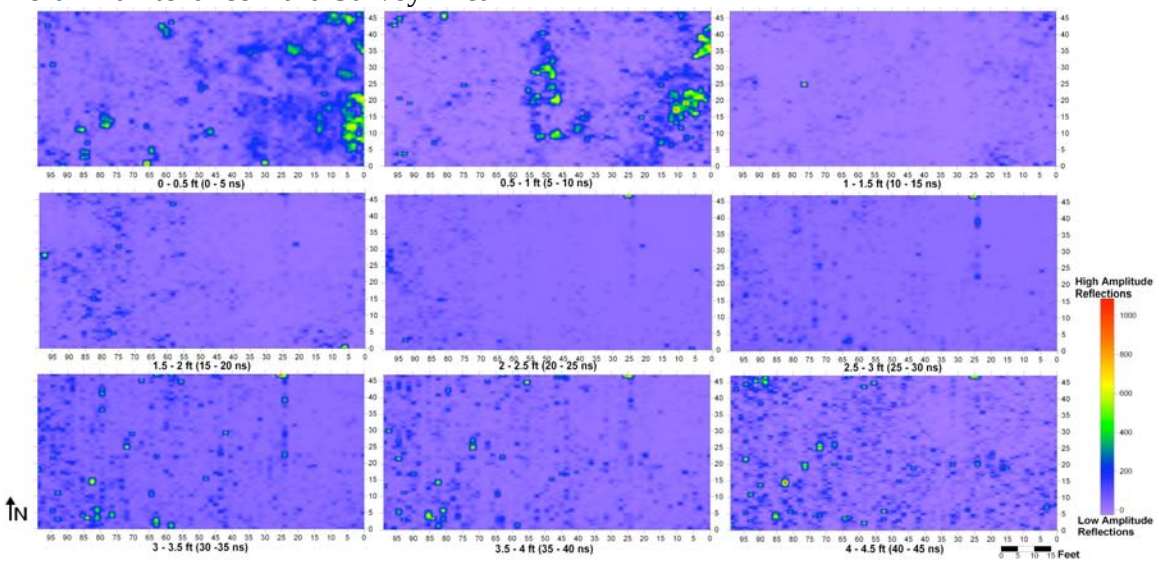
Conyers, Lawrence and Lucius, Jeffrey
1996 Velocity analysis in archaeological ground-penetrating radar studies. *Archaeological Prospection*, v. 3, 25-38.

Slice Maps

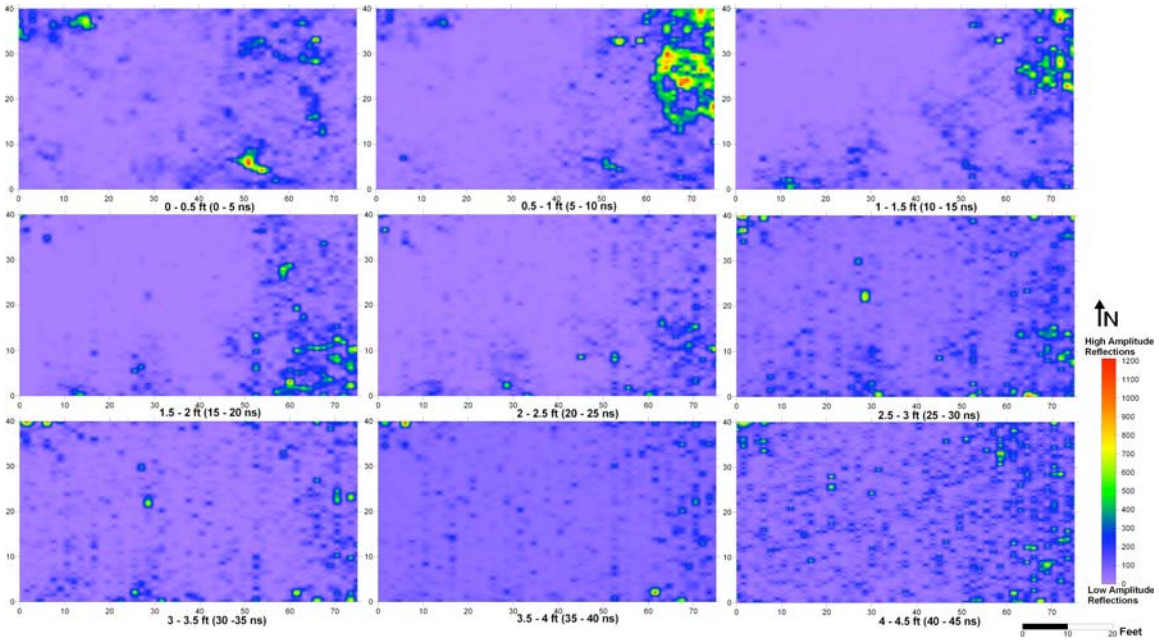
Old Graveyard Survey Area



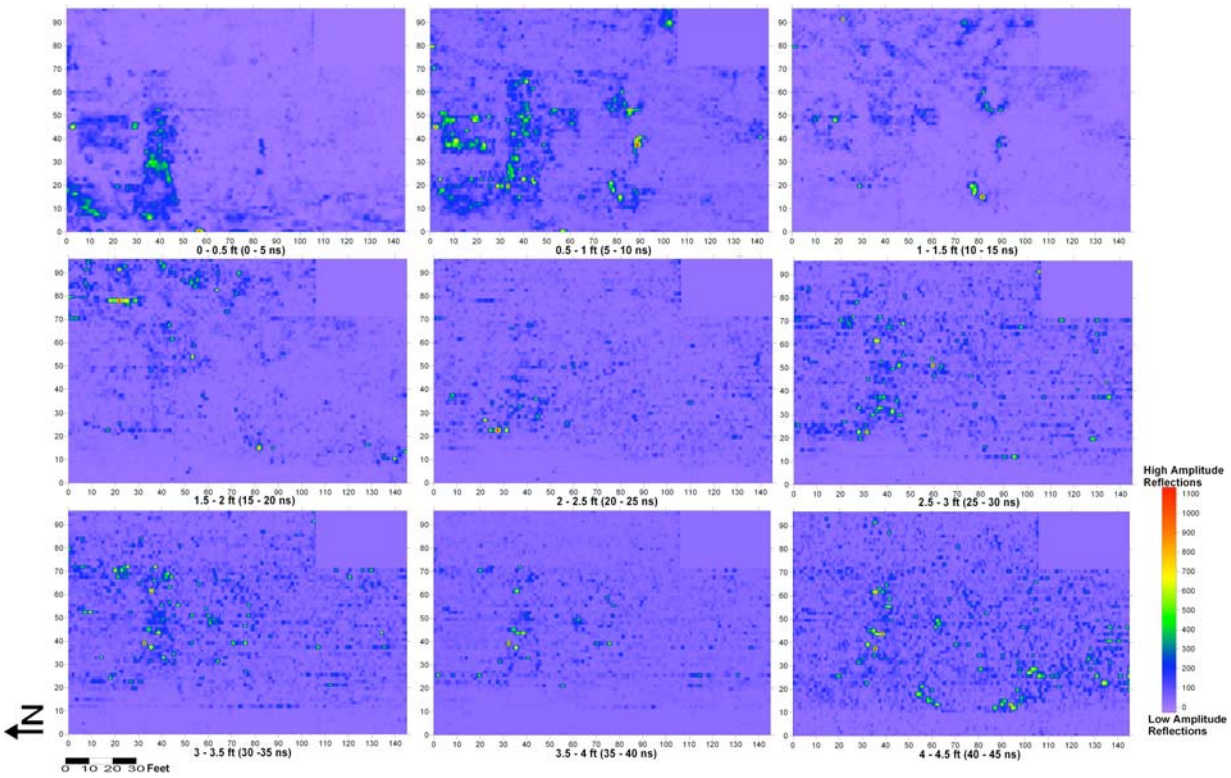
North Maintenance Yard Survey Area



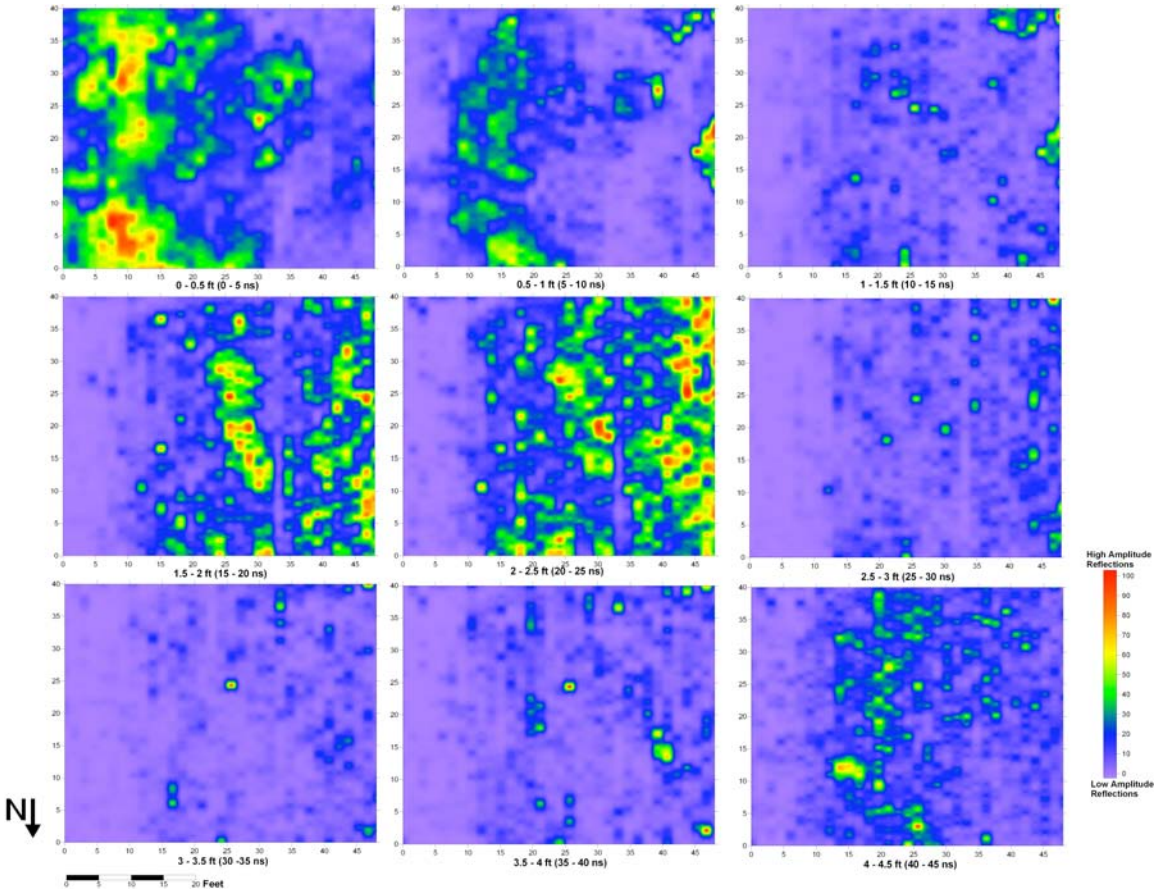
Maintenance Yard Entrance Survey Area



Adams/Clark Survey Area



West Maintenance Yard Survey Area



Jackson Cemetery