Ground Penetrating Radar (GPR) Survey of the 19th Century St. Mary's in the Pines Graveyard – Block 706/Lot 14, Pleasant Mills, Atlantic County, New Jersey

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Abstract

The ground penetrating radar (GPR) survey described in this report was conducted with the aid of a National Park Service grant. The grant was awarded to the Pinelands Commission for the purposes of promoting, facilitating, and improving people's understanding of natural, cultural, recreational, and other aspects of the Pinelands Area and Pinelands National Reserve. The GPR survey was conducted at the Saint Mary's of the Assumption Cemetery on Pleasant Mills Road in Mullica Township, Atlantic County, New Jersey. The survey included documentary research and fieldwork. The results of the survey revealed numerous subsurface anomalies that may represent unmarked burials, and an area of disturbance associated with the remains of the original church building.

The Pinelands Commission would like to thank the National Park Service (NPS) for its support of this and many other projects which contribute to a greater understanding of the history and heritage of the Pinelands. The Commission would also like to thank archaeologist Budd Wilson, whose contributions to our understanding of Pinelands history can barely be calculated. Also, a hearty nod to the NJ Pine Barrens Forums whose members possess an unparalleled knowledge of (and genuine love for) the Pinelands. And finally, thanks to Father Neil Dante, the guardian of St. Mary's of the Pines cemetery who immediately saw the usefulness of this project, then supported it with the great energy that is a hallmark of his character.

Copies of this report and data can be found at the New Jersey Pinelands Commission office and are available upon request.

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1. Introduction and Project Background

A ground penetrating radar (GPR) survey was conducted with the aid of a National Park Service grant. The grant was awarded to the Pinelands Commission for the purposes of promoting, facilitating, and improving people's understanding of natural, cultural, recreational, and other aspects of the Pinelands Area and Pinelands National Reserve. The GPR survey was conducted at the Saint Mary's of the Assumption Cemetery on Block 706, Lot 14 in Mullica Township, Atlantic County, New Jersey (Figure 1-1). The survey included documentary research and fieldwork performed by former Pinelands archaeologist, Tony McNichol. The writing of this report was started by Mr. McNichol and finished by Marc Paalvast using the field notes and data generated during the survey as well as additional environmental and historical research.

The project was initiated when Father Neil Dante asked if the Pinelands Commission could conduct a GPR survey of the St. Mary's cemetery to identify possible unmarked burials. Given the age of the site and its importance to Pinelands history this project was deemed an appropriate use of the National Park Service Grant funds. Fieldwork for this project took place during September and October in 2020.

Section 2 provides a basic environment context for the project and Section 3 gives a brief historic overview of the parcel. Section 4 contains background information on ground penetrating radar and its uses for archaeology and historic cemeteries. The results of the survey are found in Section 5 and Section 6 provides concluding remarks. The references cited throughout the report are included in Section 7.

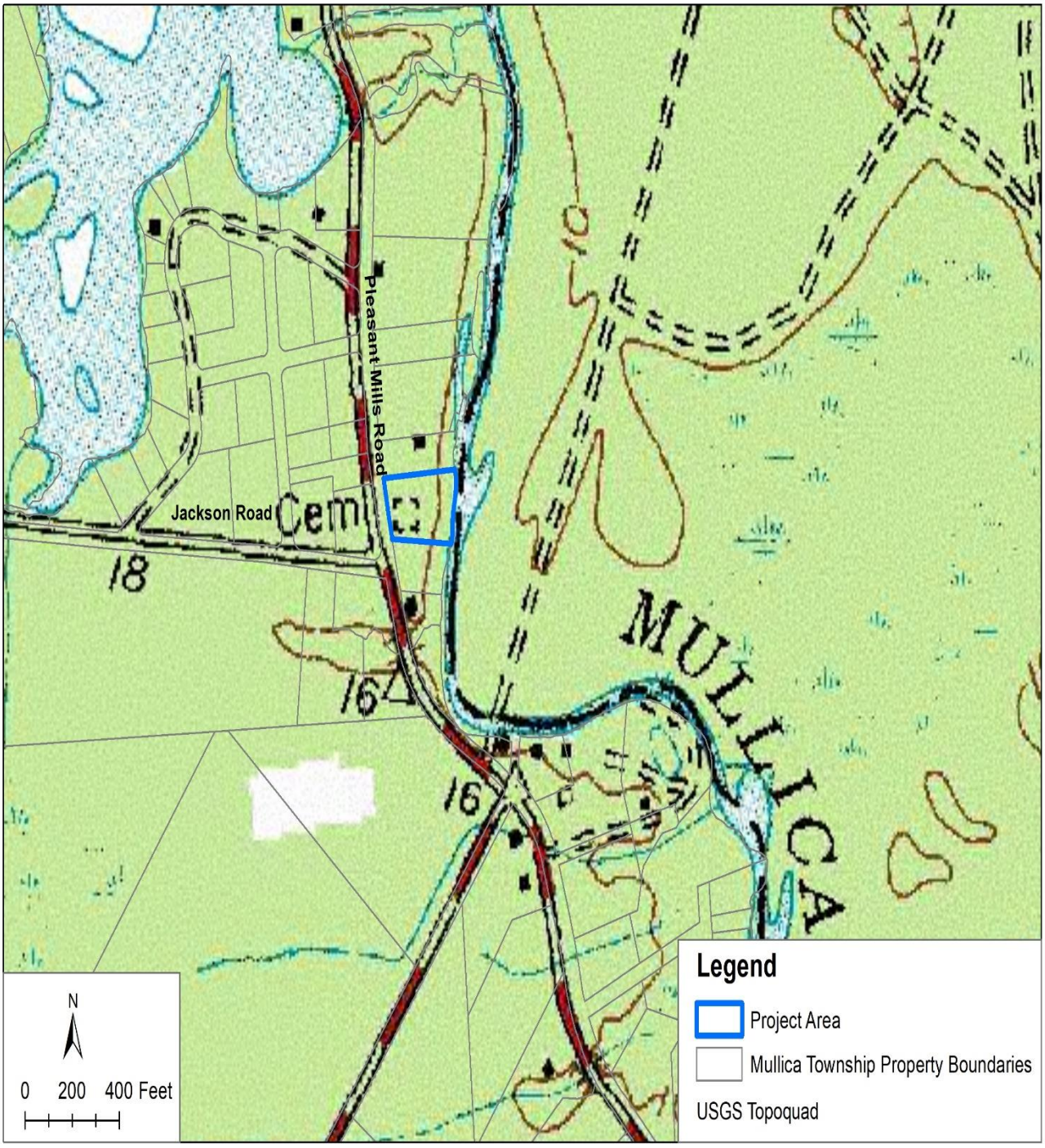


Figure 1-1 U.S.G.S. Map-(New Jersey Office of GIS/1973 U.S.G.S 7.5' Quadrangle: Atsion, NJ)

2. Environmental Context

This section briefly describes the environmental setting of the project area including soils, topography, vegetation, and hydrology.

The St. Mary's Cemetery is located within the Cohansey Formation of the New Jersey Coastal Plain physiographic province, which is characterized primarily by unconsolidated medium- to coarse-grained quartz, sandy soils. According to the New Jersey Geological Survey, the entire surficial geology of the study area is made up of Swamp and Marsh Deposits generally deposited in modern freshwater wetlands. Two distinct soil types are mapped within the parcel, Lakehurst sand and Atsion sand (Figure 2-1). Atsion sand makes up approximately 50 percent of the parcel and is described as a poorly drained soil composed of sandy eolian deposits and/or fluviomarine deposits (Web Soil Survey). Lakehurst sand also makes up approximately 50 percent of the parcel and is described as a moderately well drained soil composed of sandy fluviomarine deposits (Web Soil Survey). Sandy soils are optimal for GPR surveys as they provide an ideal medium for radar to travel through, allowing for deep and more predictable readings.

The parcel is bounded to the west by Pleasant Mills Road, to the east by the Mullica River, and to the north and south by private properties. The property is marked with a sign along Pleasant Mills Road and contains a horseshoe shaped driveway. Vegetation includes mowed grass and sparsely spaced trees surrounded by woodlands on its sides.

The property is situated on the west bank of the Mullica River and slopes down toward the river on its eastern boundary.

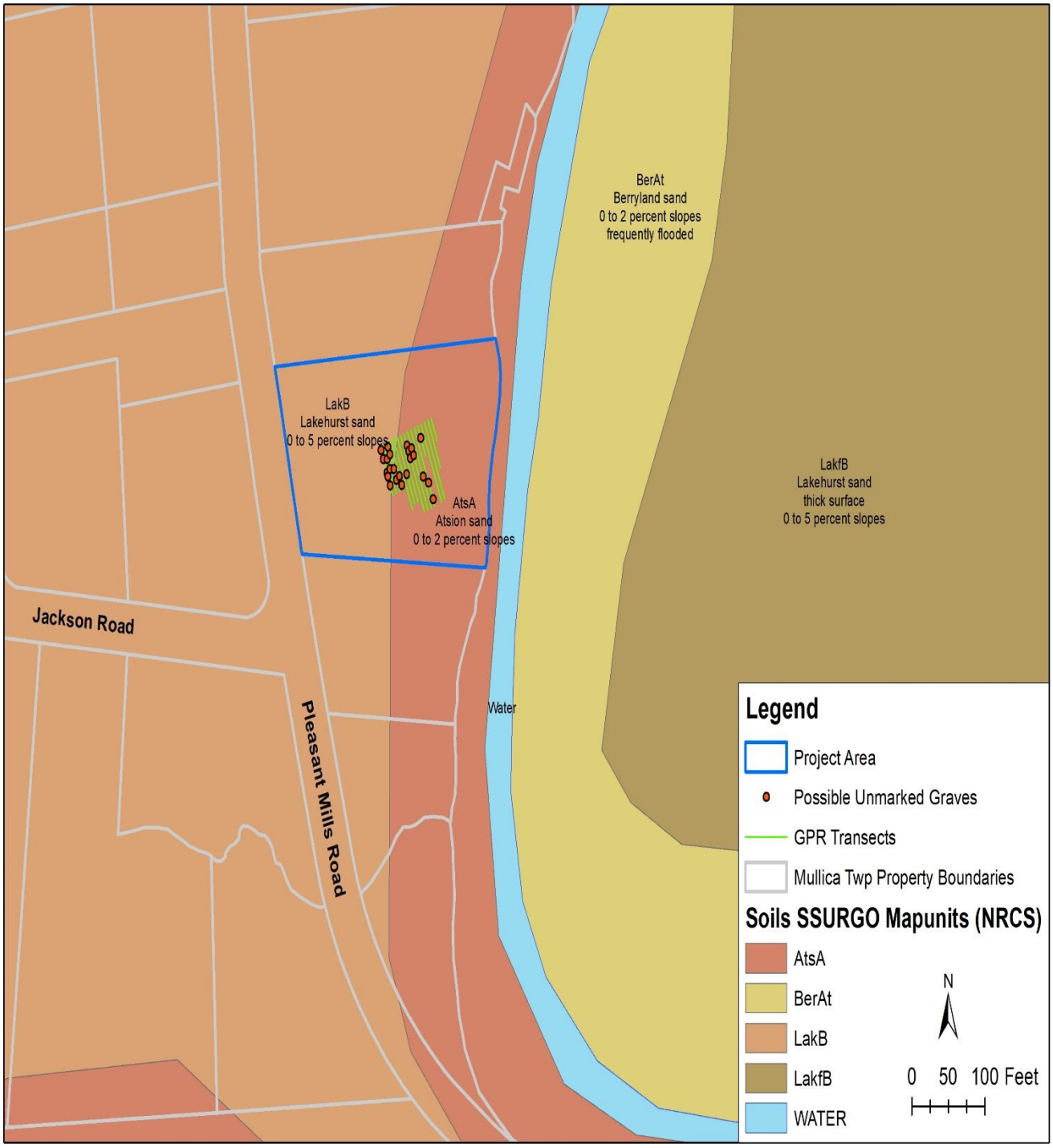


Figure 2-1 Soils Map with GPR Transects.

3. Historical Background

A general history of the cemetery at St. Mary's of the Pines is well known. Perhaps more accurately, the story of the place is well known precisely because so little has actually been documented beyond the benevolent inclinations of the parcel's original owner (Jesse Richards of Batsto), and a date list of attending priests whose tenures rarely last more than a year. No significant Church records were kept pursuant to the establishment and maintenance of the remote little Mission, and no descriptions of the church's interior exist other than oblique references to pews and a painting removed from the structure in the late 19th century. These items are reported to have been moved to a church in Hammonton, then never seen again. Perhaps, like a scene from Indiana Jones, these items may be found someday languishing in a dark warehouse patiently awaiting their opportunity to contribute to the story of St. Mary's yet untold.

Before reiterating what is known about St. Mary's cemetery, it may be useful to think about what is no longer here. A quick survey of the parcel today reveals a near bucolic setting; a remote, relatively undeveloped corner of the Pine Barrens. There is the soft rush of the Mullica River to the immediate east of the cemetery, the incessant chirping of songbirds, the rare hiss of a car passing by on Pleasant Mills Road oblivious to the presence of the tiny site, and the rows of stone markers amidst the now well mowed and tended burial ground with headstones and footstones oriented east in the traditional fashion awaiting the arrival of Judgement Day.

Maps from the 19th century show development in the area (Figures 3-1 through 3-3). Figure 3-4 is an aerial image of the cemetery taken in 1930 overlayed with the GPR survey transects and subsurface anomalies detected during the survey. The church building was erected in 1827. In 1826, Jesse Richards, then master of the Batsto Iron Works, donated land so that the Catholic workers could build a place of worship (Plates 3-1 and 3-2). It took the workers a year to put together the funds and materials to construct the building. The building was formally dedicated in 1830 (Leahy 1906). The congregation thrived there for approximately 30 years before membership began to fall off due to the decline in the iron ore industry at Batsto, and the final church service was held in 1860 (Leahy 1906). Although there were no more services at the church after 1860, the burial grounds were still used until shortly after the building was destroyed by a wildfire in 1900. This may have been because the wooden grave markers were also destroyed in the fire and uncertainty of where existing burials were located drove people to bury their loved ones elsewhere.

Plates 3-3 through 3-14 show historic drawings of the site, modern and historic photographs, news media regarding the church and cemetery, and examples of wooden grave markings from other sites in the area.

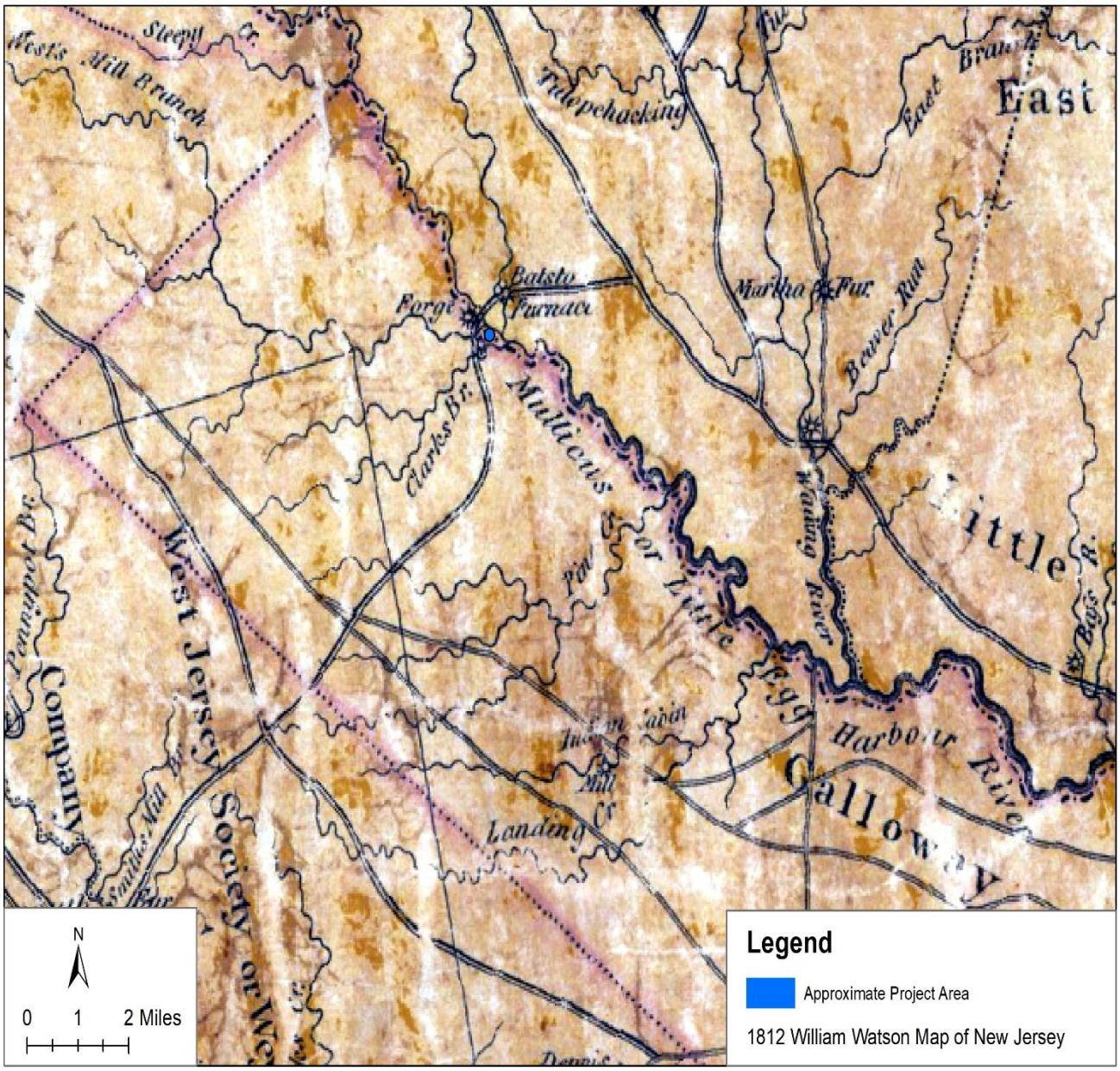


Figure 3-1 Approximate Project Area- Detail: 1812-William Watson, *Map of the State of New Jersey.*

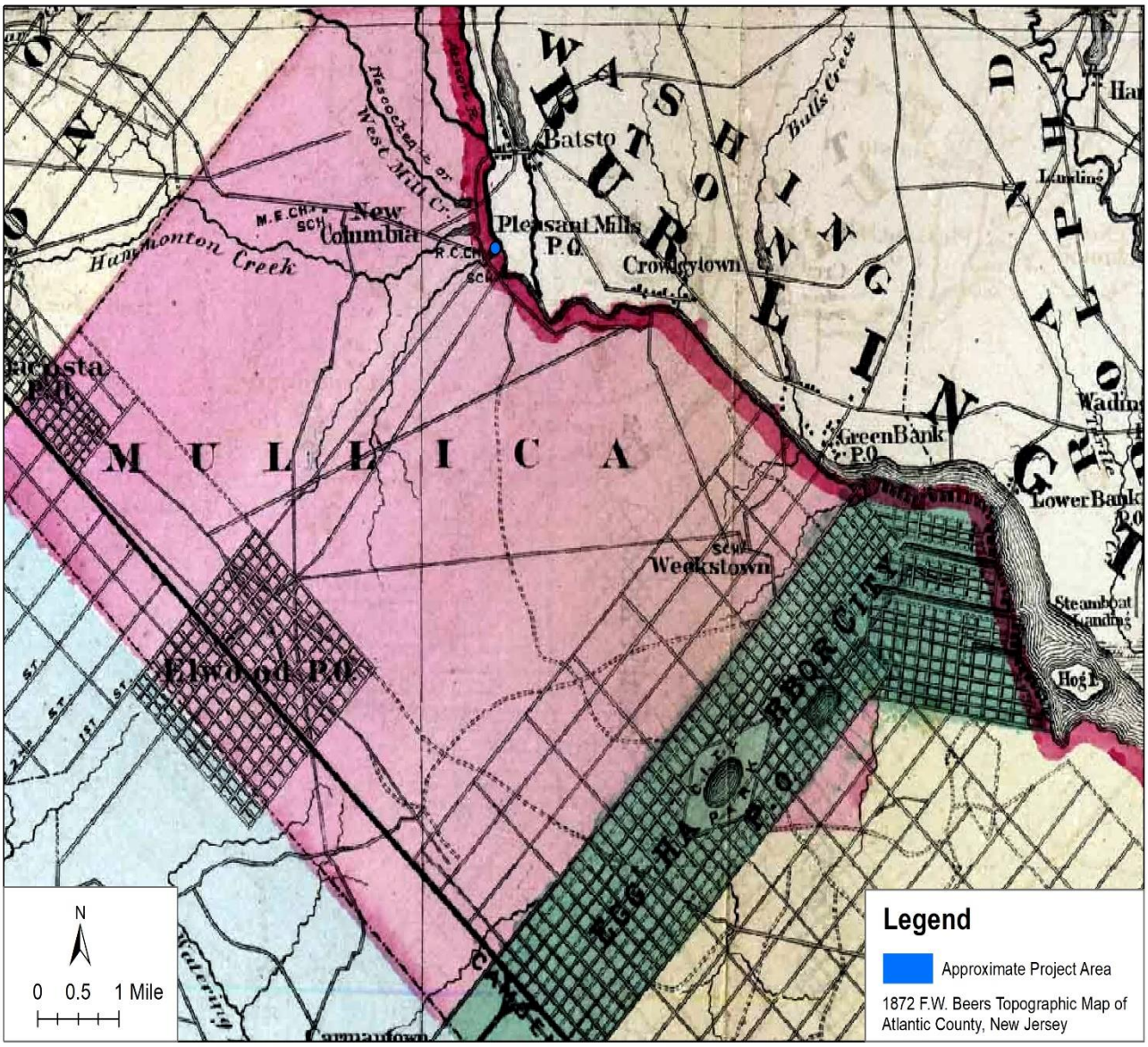


Figure 3-2 Approximate Project Area- Detail: 1872- F.W. Beers, *Topographical Map of Atlantic Co., NJ*. Note "R.C. CH" (Roman Catholic Church) at Project Location

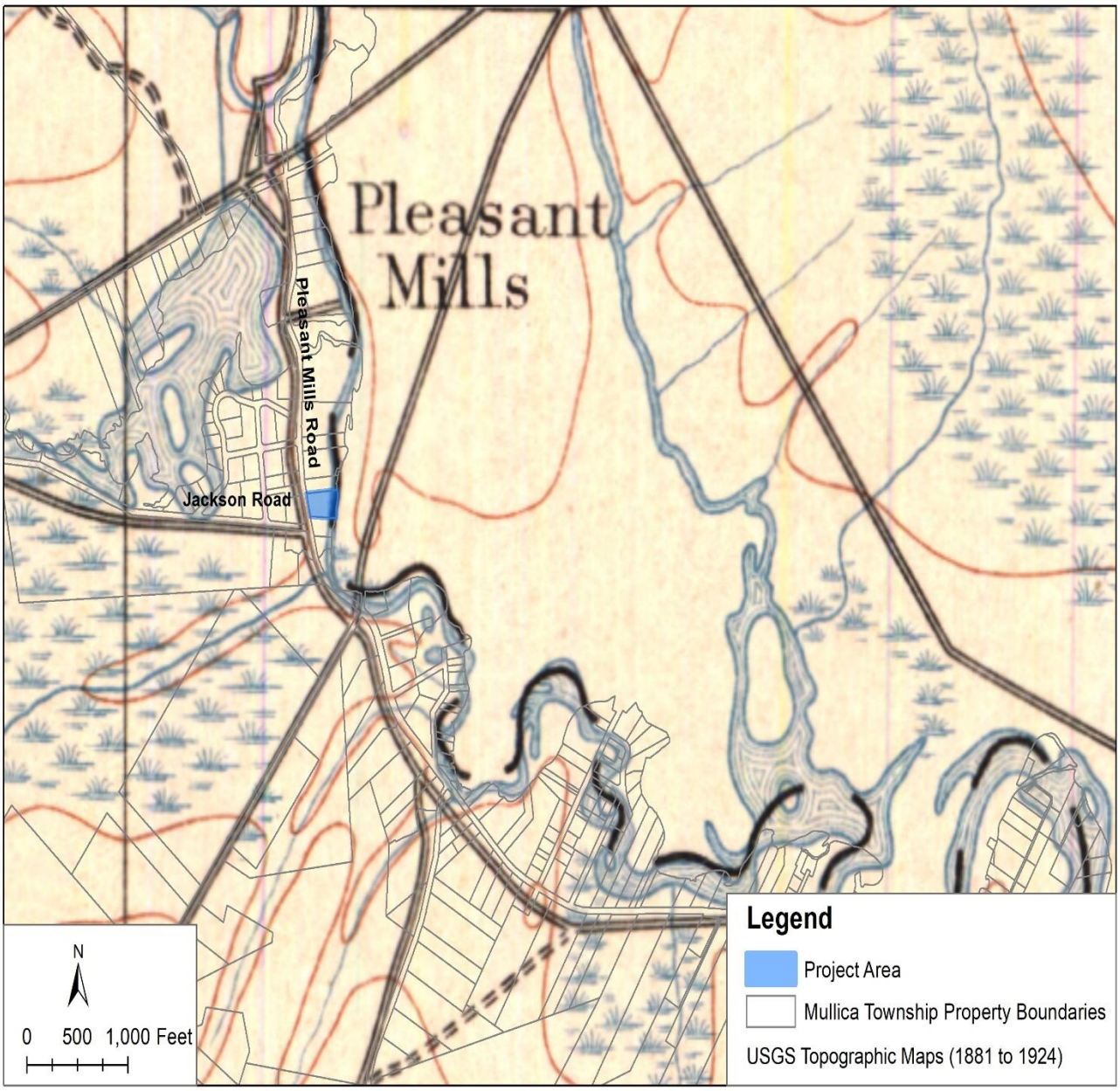


Figure 3-3 1890 U.S.G.S. Map showing Project Area- Quadrangle: Mullica, NJ
USGS Historical Topographic Map Explorer

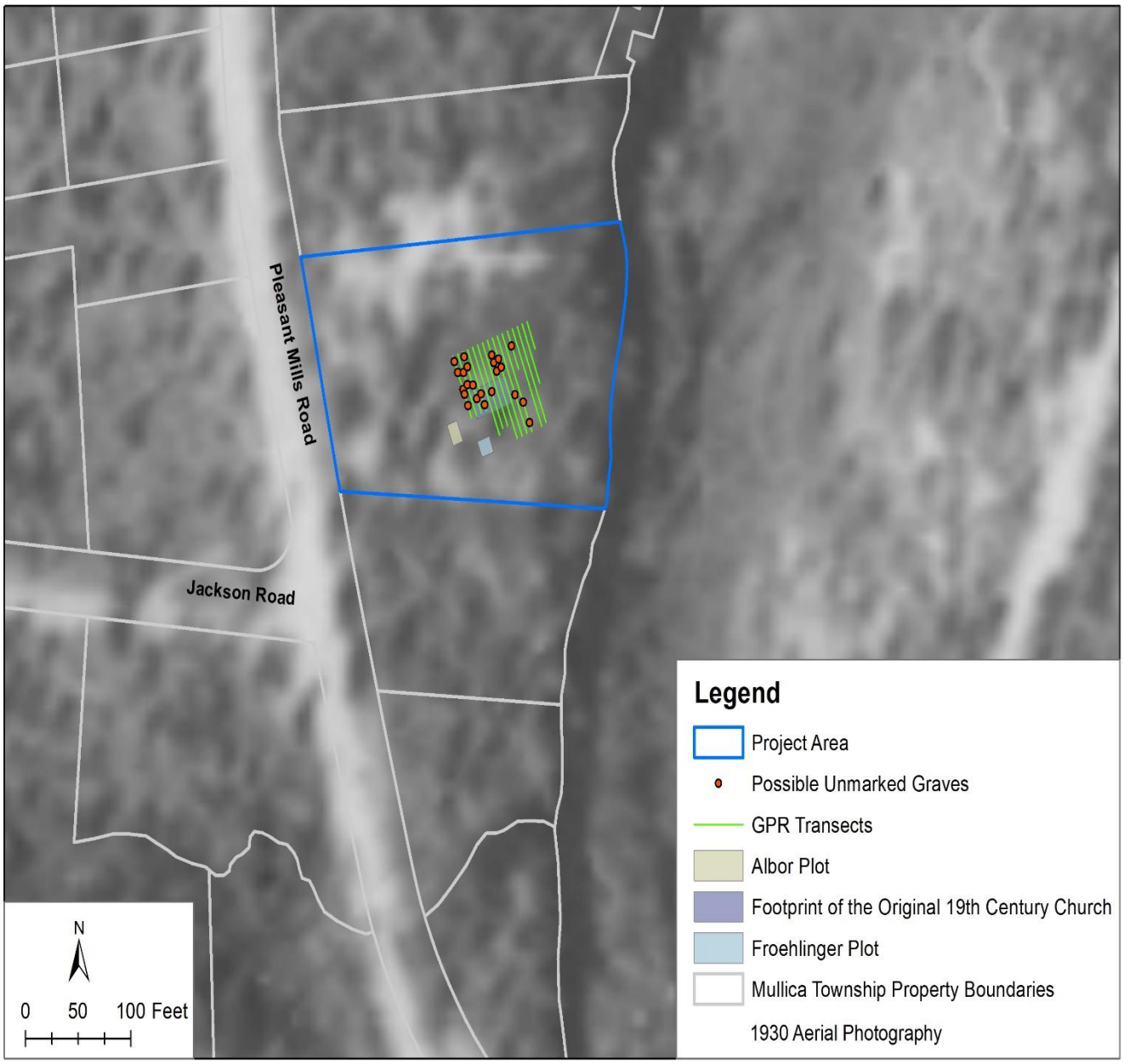


Figure 3-4 Project Area and GPR Transects- 1930 Historic Aerial Photograph.

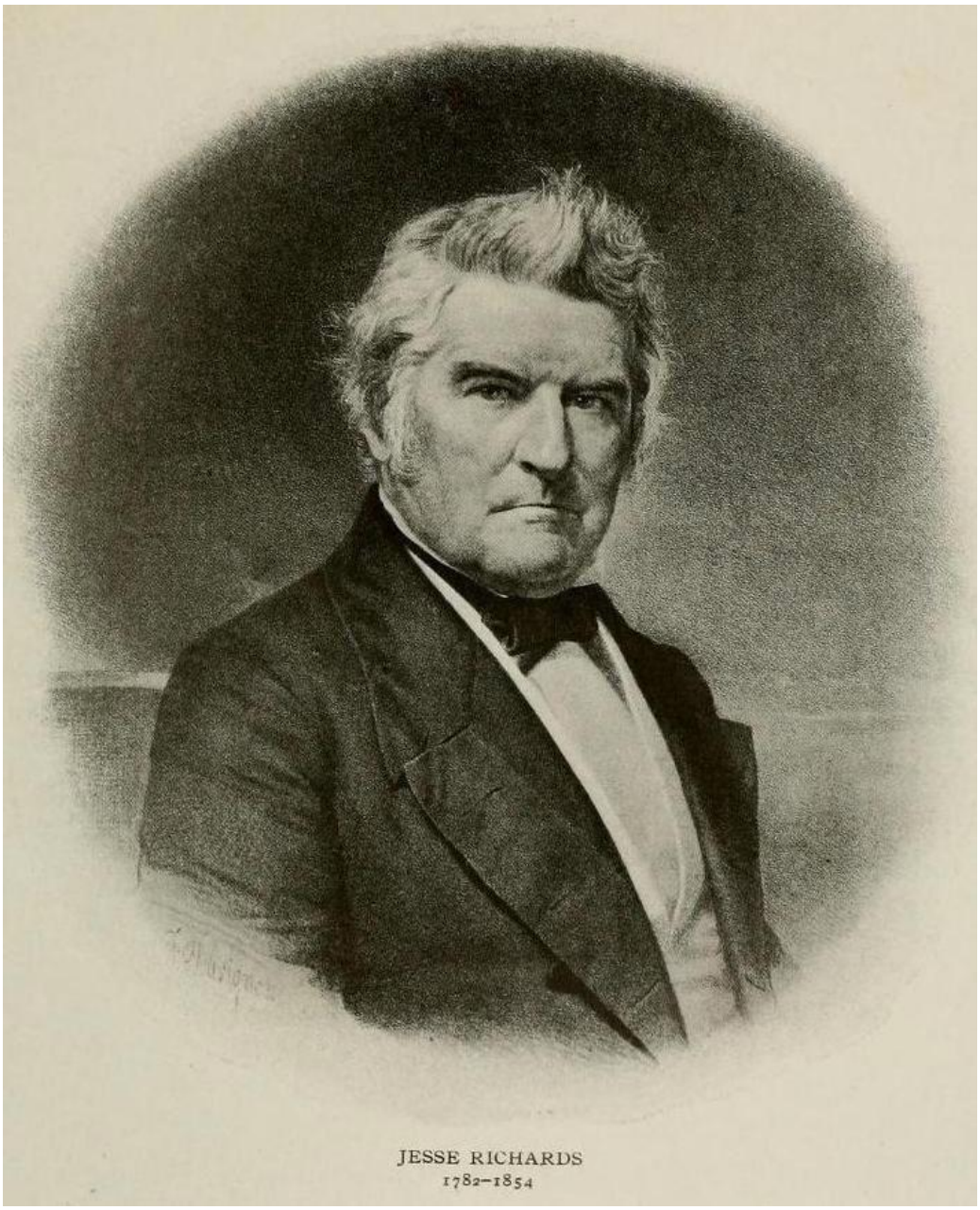


Plate 3-1 Stone lithograph of Jesse Richards-Batsto manager from approximately 1809 until his death in 1854 (Hall 1899).

Plate 3-2 Jesse Richards' marble burial marker located in the Batsto-Pleasant Mills cemetery.

Plate 3-3 Artist's conception of the St. Mary's in the Pines Church. Watercolor by Carol Freas; Courtesy of The Mullica in the Pines Historical Society.

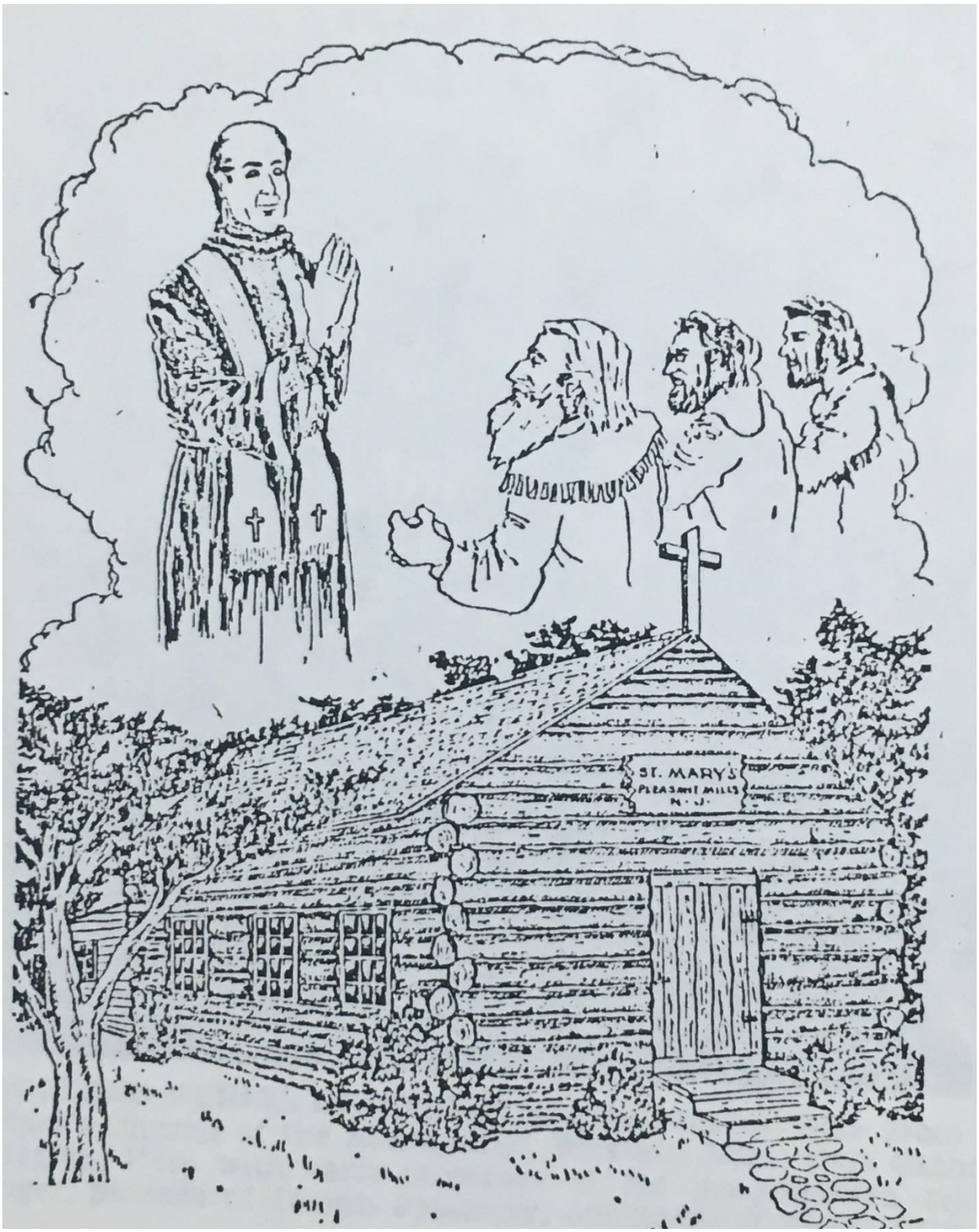


Plate 3-4 Artist's conception of mission priest at St. Mary's preaching to Irish and German settlers in the early 19th century Mullica wilderness. Image courtesy of the Batsto Archives.

ST. MARY'S IN THE PINES CHURCH AND CEMETERY

Pleasant Mills (or "Sweet Water"), Atlantic County. The second Catholic Church opened in New Jersey. Dedicated August 15, 1830; destroyed by forest fire in April, 1899.

Plate 3-5 Crude sketch of the St. Mary's in the Pines log church. Note the rear addition that is also visible in the previous plate. Image courtesy of the Batsto Archives.

Plate 3-6 Approximate location of original church foundation marked by commemorative bricks. The long axis of the church is oriented east-west. Photograph view is to the east toward the Mullica River.

Plate 3-7 Remaining portions of the original ironstone foundation for the St. Mary's in the Pines church.

Plate 3-8 Overgrown marker of Daniel Dellett in the 1970's. Courtesy of Batsto Archives.

Plate 3-9 Photograph of the Froehlinger marker in the mid-1950's. Courtesy of Batsto Archives.

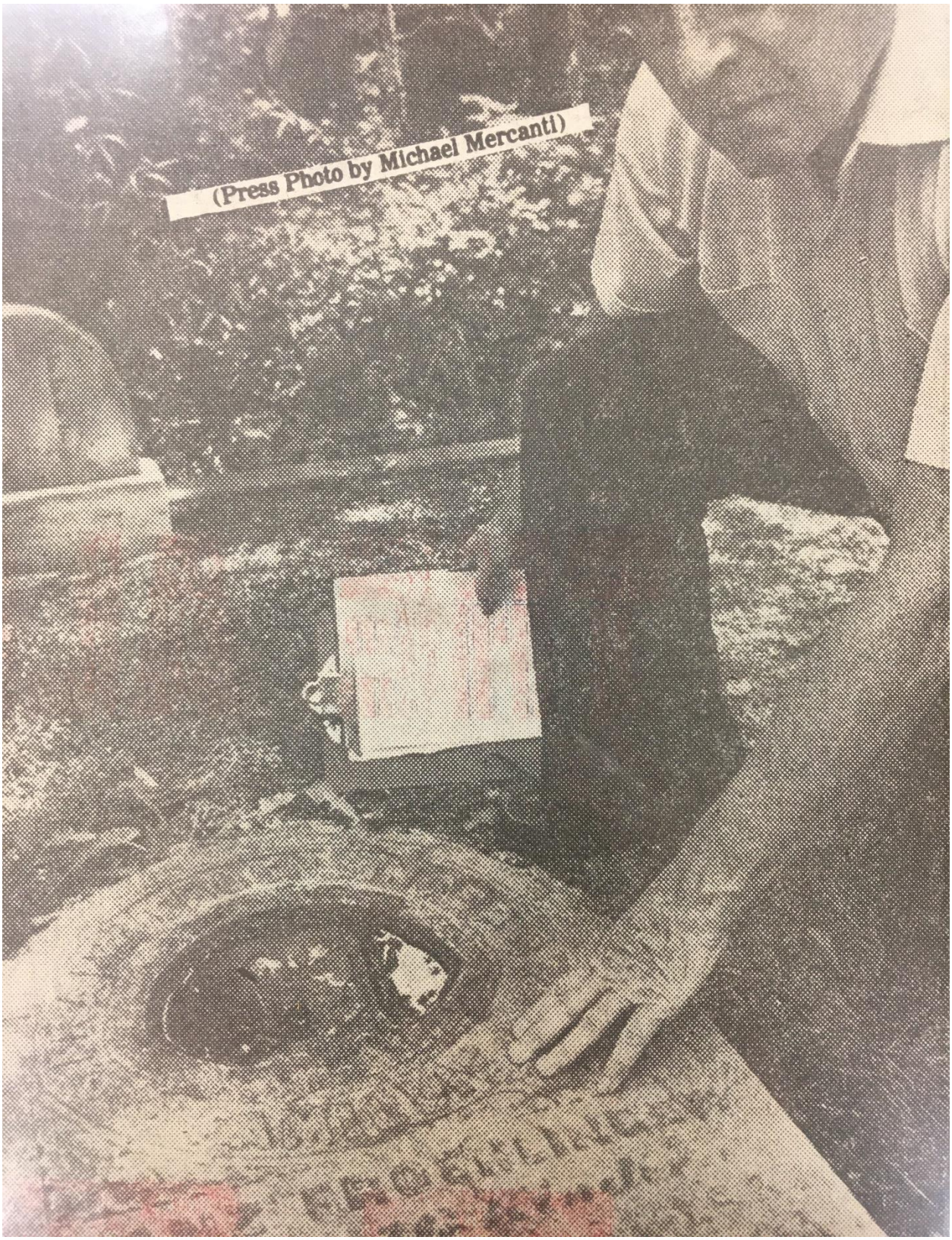
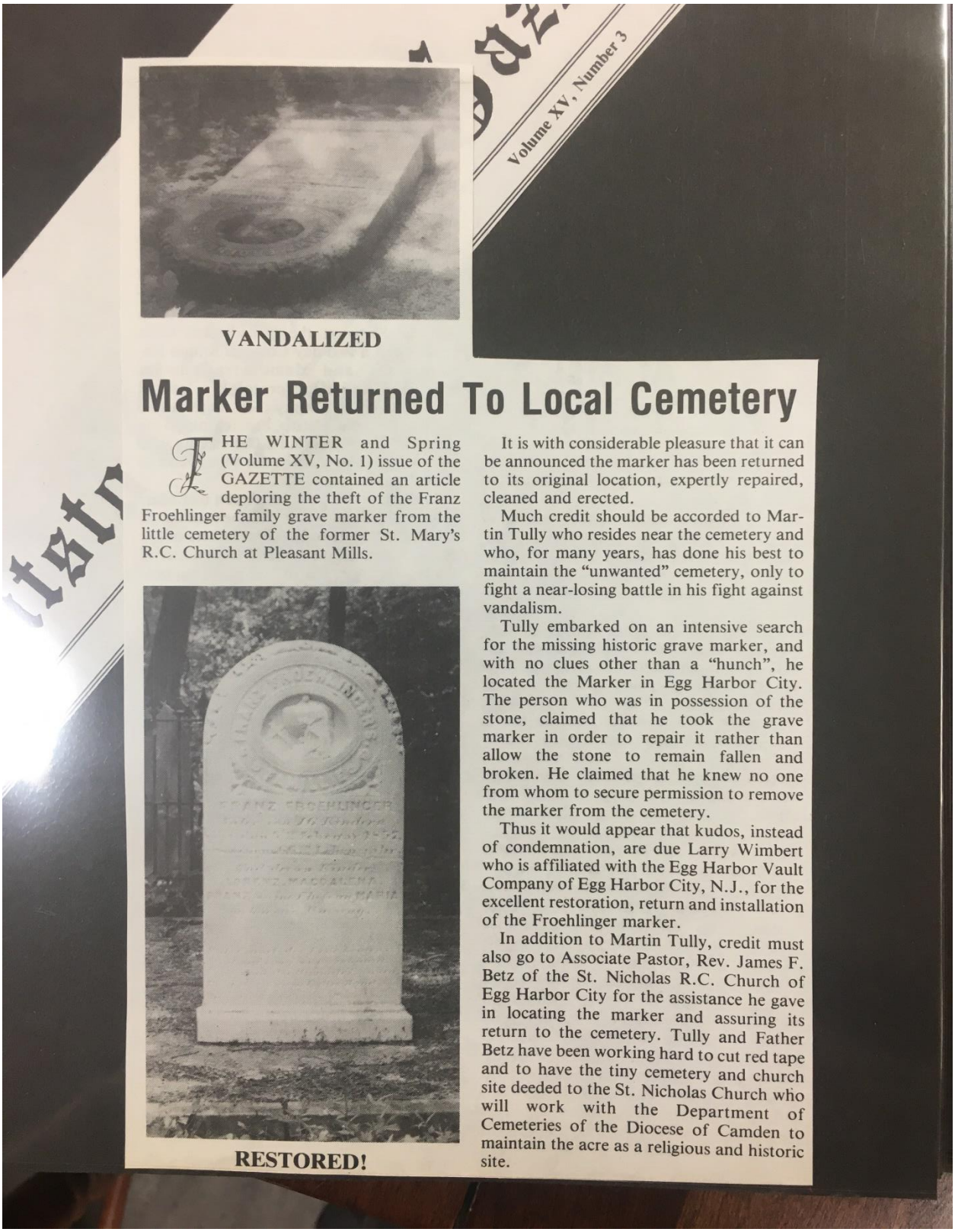


Plate 3-10 Local historian Martin Tully kneeling by the vandalized Froehlinger marker. The Press, Atlantic City. Friday, August 18th, 1978.



Volume XV, Number 3

VANDALIZED

Marker Returned To Local Cemetery

THE WINTER and Spring (Volume XV, No. 1) issue of the GAZETTE contained an article deploring the theft of the Franz Froehlinger family grave marker from the little cemetery of the former St. Mary's R.C. Church at Pleasant Mills.

RESTORED!

It is with considerable pleasure that it can be announced the marker has been returned to its original location, expertly repaired, cleaned and erected.

Much credit should be accorded to Martin Tully who resides near the cemetery and who, for many years, has done his best to maintain the "unwanted" cemetery, only to fight a near-losing battle in his fight against vandalism.

Tully embarked on an intensive search for the missing historic grave marker, and with no clues other than a "hunch", he located the Marker in Egg Harbor City. The person who was in possession of the stone, claimed that he took the grave marker in order to repair it rather than allow the stone to remain fallen and broken. He claimed that he knew no one from whom to secure permission to remove the marker from the cemetery.

Thus it would appear that kudos, instead of condemnation, are due Larry Wimbert who is affiliated with the Egg Harbor Vault Company of Egg Harbor City, N.J., for the excellent restoration, return and installation of the Froehlinger marker.

In addition to Martin Tully, credit must also go to Associate Pastor, Rev. James F. Betz of the St. Nicholas R.C. Church of Egg Harbor City for the assistance he gave in locating the marker and assuring its return to the cemetery. Tully and Father Betz have been working hard to cut red tape and to have the tiny cemetery and church site deeded to the St. Nicholas Church who will work with the Department of Cemeteries of the Diocese of Camden to maintain the acre as a religious and historic site.

Plate 3-11 Stolen Froehlinger marker returned to St. Mary's in better shape than before. Batsto Citizen's Gazette. Vol XV, No. 3.

Plate 3-12 Wooden grave marker (Unidentified) located at the Batsto-Pleasant Mills cemetery.

Plate 3-13 Lichen covered, ironstone grave marker (Unidentified) located at the Batsto-Pleasant Mills cemetery.

Plate 3-14 Wooden cross marker (John Gant) at the Batsto-Pleasant Mills cemetery.

4. Ground Penetrating Radar (GPR)

GPR is a near-surface geophysical imaging method which creates data by emitting radar wave pulses of varying frequencies from a surface antenna into the ground. Those waves propagate out and downward into the ground from the unit in a 'cone-shape', then are subsequently reflected back to the surface from buried materials. The reflected waves are then recorded by a receiving antenna located within the unit. As radar waves encounter buried materials, changes in their velocities are reflected back to the surface and recorded by the unit in nanoseconds. This ability to calculate the velocity of radar travel times through buried objects and their return to the surface enables the unit to measure the vertical depth of an object relative to the ground surface (Conyers 2012).

GPR generates (initially) a two-dimensional data set of buried 'reflection' profiles. These profiles identify the presence or absence of a range of materials located at the interfaces between subsurface units (Conyers 2012). Frequently, distinct objects in the ground will create what is referred to as a 'point source hyperbolic reflection' in the data profile. These typically present as an inverted 'U' or 'V' shape that indicate where propagating waves have come into contact with an object and reflected that contact back toward the surface antenna. Alternatively, planar reflections may indicate a change in stratigraphic composition or even a buried floor or living surface.

After careful interpretation of the initial two-dimensional profiles (sometimes akin to reading omens from steaming entrails!), the data can then be processed through various software programs to create considerably more complex amplitude slice and isosurface maps of a survey area if necessary. The success of a GPR survey is dependent on multiple factors:

1. soil types and chemistry
2. knowledge of local geomorphology
3. how the energy from the GPR unit will behave as a result of local conditions
4. type, size and possible distribution of buried cultural features
5. local hydrology
6. possible presence of 'noise-making' materials within the survey area such as tree roots and/or animal burrows as well as surface interference such as cell phones and radio transmissions and,
7. the choice of the correct GPR frequency to ensure the ideal resolution for the target depth required (Conyers 2012:17-18).

Radar frequencies typically utilized in archaeology range between 10 to 1,200 MHz, with 4-500 MHz units affording the best subsurface resolution combined with good average depth of radar wave propagation. The general rule of thumb is that the lower the MHz, the deeper the propagating wave but at the expense of resolution. For example, a low frequency antenna (e.g.,10 MHz) can reach depths of approximately 5-15 meters (16-49 feet) but is only really useful for imaging much larger objects. By contrast, a high frequency antenna (e.g., 900 MHz)) is ideal for imaging objects within 1 meter of the surface under ideal conditions. The antenna employed for this survey was a 500 MHz unit. Of course, all of these average depths are subject to additional variables such as the overall electrical resistivity of a soil and how rapidly radar waves may attenuate (or disperse) after transmitting from the ground surface. In addition, archaeologist Lawrence Conyers argues that the most significant variable in radar velocity changes through the ground is the capacity of a buried

material to retain water. If this is true, it certainly bodes well for GPR studies of early historic cemeteries (in the right soil conditions) where the vast majority of coffins will be of wooden construction, though Conyers warns that "reflections produced from burials are not usually simple, and it is a rare and joyous occasion when GPR data show simple point source reflections from each casket or burial, with little variation in depth or burial type" (Conyers 2012:129).

4.1. Historic Cemeteries and GPR

The use of GPR for unmarked grave identification has become widespread in the United States though, as noted above, it can be a challenging task. Ground conditions and disturbance in older cemeteries can be difficult to negotiate, and the natural deterioration of buried materials can easily erase most if not all traces of a centuries-old grave. In areas with humid summers (such as Mullica Township), issues of weathering and decomposition are amplified, and often the only remaining signature of an older internment is a shaft feature containing homogenous soils or sediments distinct from the surrounding matrix. In instances where significant decomposition is assumed, some researchers have even suggested the use of 'cadaver' dogs to either supplement or replace the use of GPR altogether (Conyers 2012:132).

In addition to GPR imaging of distinct shaft fill associated with a historic grave, voids (as in the case of an intact casket), can produce clear reflection signatures as radar waves transition from moving through sediments at a reduced speed to moving through the hollow space of a coffin at the speed of light. In some instances, the presence of 'collapsed' coffins in a cemetery may be visible as sagging or 'flattened' hyperbolas in contrast to those that may still retain a void space (Conyers 2012). Determining the presence or absence of coffin void spaces can also be accomplished in the field by identifying the 'local polarity' of the initially transmitted radar wave (the ground wave), then looking for instances where that wave deflects in the opposite direction upon contact with a buried object or boundary. In a cemetery context, a radar wave moving downward through the ground that reverses polarity from the original ground wave is more than likely encountering an air-filled void (Conyers 2012).

5. St. Mary's in the Pines Cemetery – Survey Conditions and Results

Fieldwork was conducted on October 26th and 27th, 2021 at the St. Mary's of the Assumption (St, Mary's in the Pines) cemetery located on Block 706/Lot 14 in Mullica Township. There had been a steady, heavy rain throughout the evening of the 25th and the early morning of the 26th. Precipitation slowed to a light drizzle by 7:00 AM, ending completely by approximately 7:30. As noted in Section 4 of this report, the presence of moisture in the soil profile may assist in the imaging of buried features. The 27th was a clear and crisp October day with no precipitation. A thin layer of pine needle and deciduous leaf litter covers the surface of the cemetery, but most of the tree growth in the cemetery is limited to the parcel margins. The test area itself was unvegetated and largely clear of obstructions. There are no known buried pipes or utilities present on the parcel as currently delineated although a caretaker's structure was reported to have been built within close proximity to the original 19th century church, features associated with that structure may yet remain beyond the vegetation line further to the north on the adjacent Block/Lot.

Subsurface imaging was accomplished utilizing a USRADAR Q5 Series cart-mounted GPR unit with a built-in survey wheel, 500MHz auto-calibrating antenna, and basic acquisition software. Flat gain was adjusted in the field to maximize visualization of subsurface data shown in the reflection profiles.

A 70-foot (21 meter) baseline was established along the vegetation boundary in the northern, marker-less portion of the cemetery from known plots in the west to the approximate terrace edge in the south where from the head of slope in the southern portion of the parcel, the landform exhibits a significant change in gradient as it dips toward the Mullica River (Plate 5-1). Transects were then established along the baseline at 5ft. (1.5 meter) intervals (Plate 5-2). Several passes were made over known burials to provide baseline data for subsequent testing within portions of the cemetery devoid of markers. While it is certainly not the case in all Catholic cemeteries (Veit and Nonesteid 2008:17-18), all marked graves in St. Mary's cemetery are oriented with the head to the west, the idea being that the occupant may be facing east on Judgement Day to witness the return of Jesus Christ. Consequently, all GPR passes were oriented north to south, perpendicular to the presumed long axes of the grave.

Figure 5-1 Modern aerial photograph of project area showing GPR transects and subsurface anomalies.

Plate 5-1 Pinelands Commission Archaeologist Tony McNichol directing the Ground Penetrating Radar (GPR) unit toward the southern portion of the cemetery. Photograph view is to the northeast. Note slope toward the Mullica River immediately to the photo-right of operator.

Plate 5-2 Establishing a transect base line at 5ft. (1.5 meter) intervals along the northern margin of the cemetery. Photograph view to the east. Adjacent property to the north begins at the vegetation line.

5.1. Test Passes Over Marked-Burial Plots

5.1.1. Albor Plot Reflection Profile

The Albor plot is a kerbed, rectangular feature containing four burials in an east/west orientation. The plot is located in the far western/central portion of the cemetery. The reflection profile derived from a pass of the GPR unit across the plot clearly reveals:

1. The long axis dimensions of the plot located at approximately 2.25 and 17.50 feet evidenced by two high amplitude point source reflection hyperbolae
2. The disturbed soils in the grave shaft distinct from the surrounding matrix, and
3. A burial situated at approximately 6.0 feet down in the soil profile (Figure 5-2 Circled).

5.1.2. Froehlinger Plot Reflection Profile

The reflection profile for the Froehlinger plot exhibits multiple hyperbolic shaped reflections at a lesser depth than that of the Albor burials (Figure 5-3). In addition to the presence of extant burials, multiple high amplitude reflections occur throughout the profile likely attributed to either reflections from other point sources, bioturbation, or both. The radar energy begins to attenuate past the 7-foot mark. Plate 5-3 shows the Froehlinger marker.

5.1.3. Slope Edge at Eastern Margin of the Cemetery

A test pass was completed along the head of slope located at the eastern margin of the parcel where the terrace then dives toward the Mullica River (Plate 5-4). The reflection profile for this pass shows multiple high amplitude point-source hyperbolae with apices at or near the surface (Figure 5-4). These hyperbolae likely reflect the presence of rodent burrows and/or roots within the bank. In addition, the profile appears to show a differentiation between soil units between 4.20 and 5.5 feet where the radar energy then appears to attenuate as it moves deeper through the profile. The contacts between pedological units across the parcel becomes consistently evident in the formal transect reflection profile data, which may have resulted in part from the retention of water in the soil column from heavy rains the previous evening. An anomalous reflection is present at approximately 31.50 horizontal/ 5.25ft vertical, but its nature is unclear.

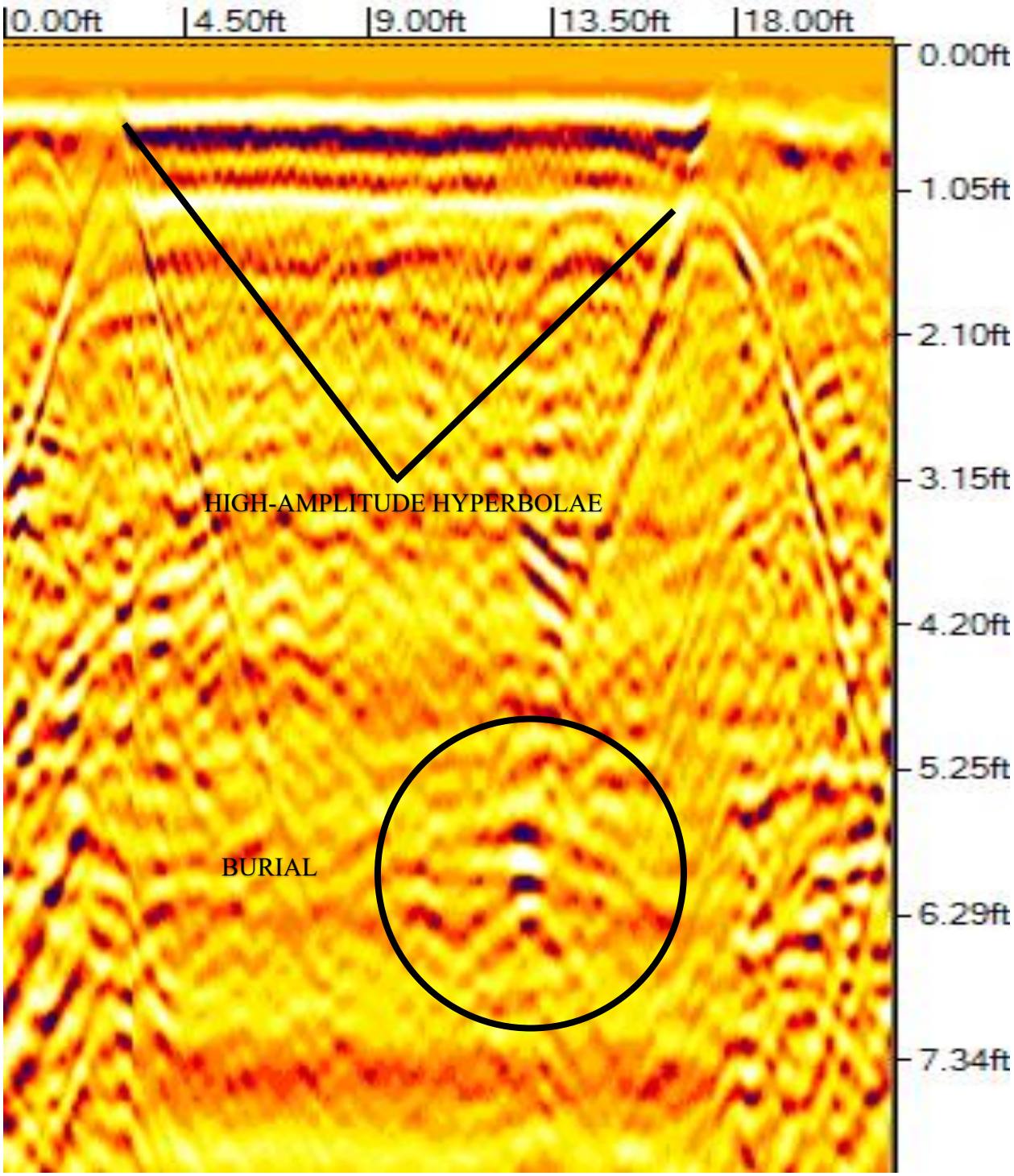


Figure 5-2 Albor plot reflection profile. Test Transect 1

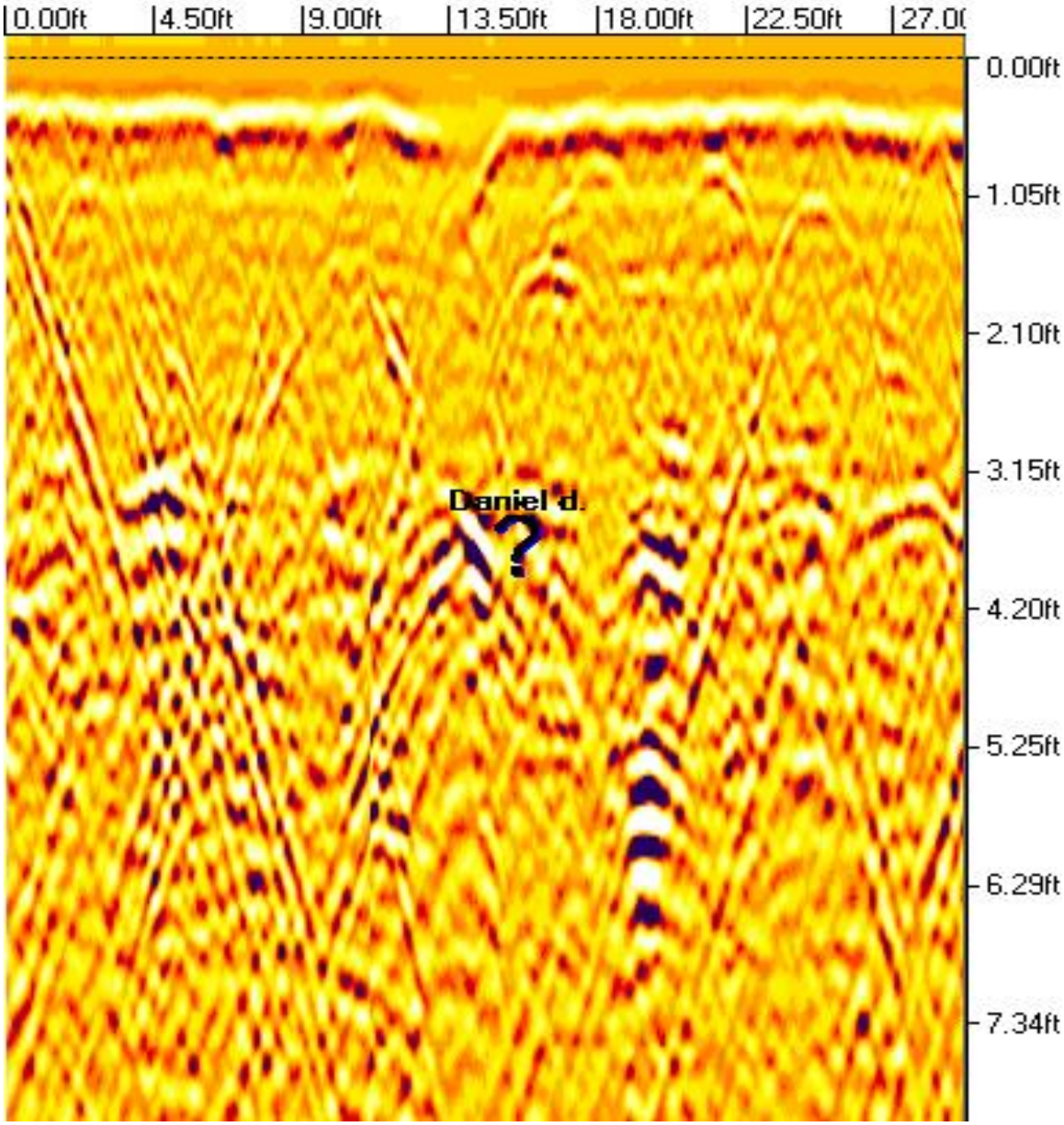


Figure 5-3 Franz Froehlinger Plot Reflection Profile. Test Transect 2.

Plate 5-3 Gravestone of Franz Froehlinger. Froelinger was the father of Joseph Fralinger, creator of Atlantic City's famous Fralinger Salt Water Taffy.

Plate 5-4 Slope edge leading to the Mullica River. Note headstones in upper right corner of the photograph. View to the south from baseline.

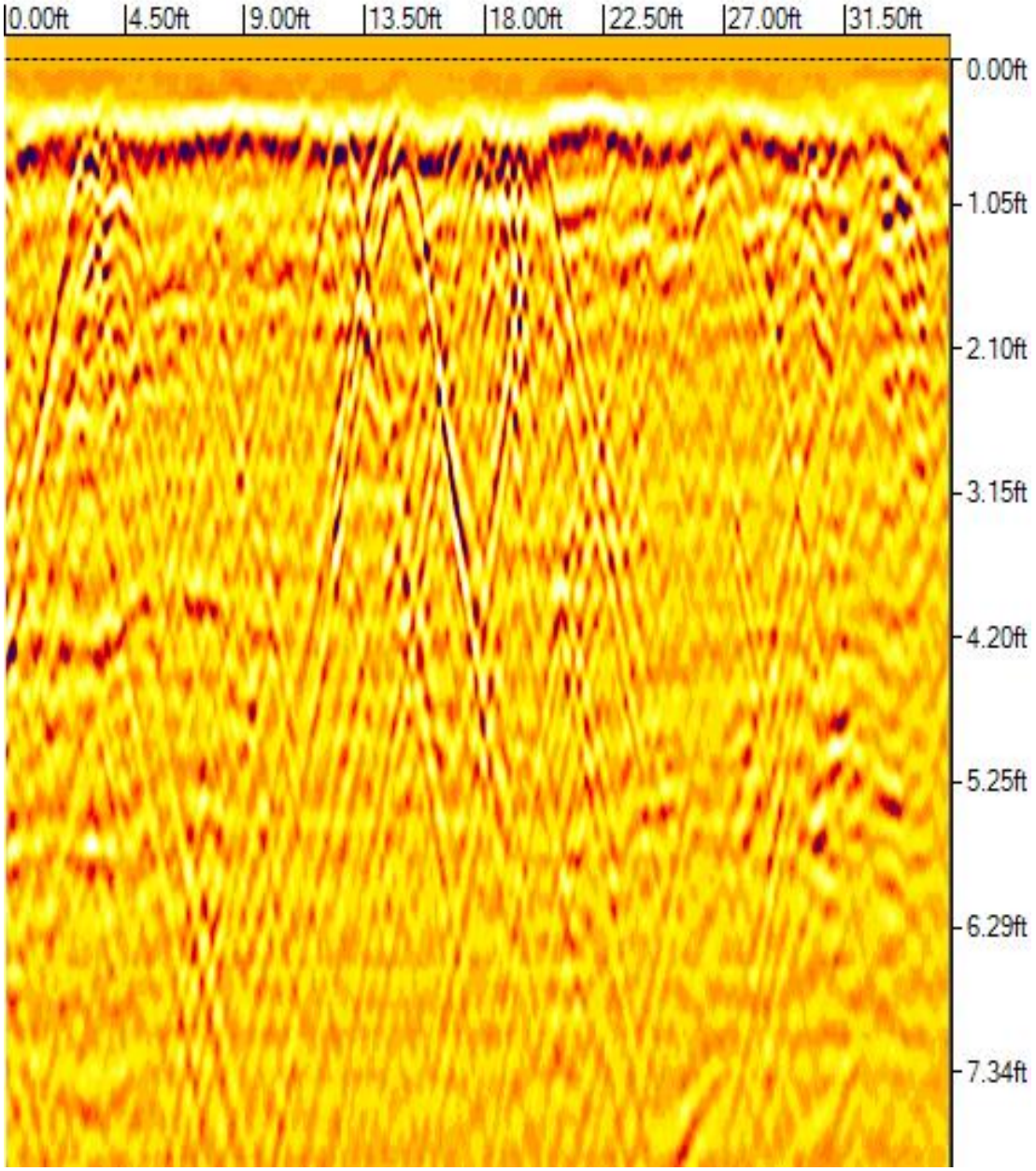


Figure 5-4 Transect 16- Slope edge to the Mullica reflection profile- East of last row of graves. Note acute hyperbolae near the ground surface.

5.2. Transect Reflection Profiles

5.2.1. Transect 1

The reflection profile for this transect may indicate the presence of five unmarked graves. These are apparent at or near the shift in soil composition which occurs at approximately 4.20 ft in depth in the left portion of the profile, and then gradually dips to approximately 5.25 feet to the right (south). It also appears that water is retained to some degree at this boundary, causing the distinction between the two soil units to stand out in relief. There may be a correlation between depth of burial at St. Mary's and the presence of a high-water table combined with changes in soil composition at depth. The series of stacked, planar reflections to the right of the profile corresponds with what would have been the original entrance to the church structure located in the western façade of the building. It is quite possible that these reflections indicate the presence of a path that may have led up to the church door. Radar attenuates at approximately 7.4 ft below ground surface (Figure 5-5).

5.2.2. Transect 2

The reflection profile for this transect may indicate the presence of two unmarked graves. The image also clearly shows the original church foundation beginning at approximately 31.50 ft along the transect line and continuing to the right of the profile (south). The soil transition is also evident and continues underneath the church floor. There appear to be multiple hyperbolic reflections under the church floor, but the identity of their point sources is unknown. The possible grave that abuts the wall of the church would be quite shallow, but oftentimes, the burials of infants did not occur as deeply as those of adults. In addition, depending on the time of year, the will of the grave digger may have been less inclined toward digging a deep hole into frozen ground (Figure 5-6).

5.2.3. Transect 3

The reflection profile for this transect may indicate the presence of four unmarked graves. Note that the anomaly located to the far right lies beneath the original church floor. Multiple hyperbolae likely reflect the presence of stones, roots, or bioturbation (Figure 5-7).

5.2.4. Transect 4

The reflection profile for this transect may indicate the presence of unmarked burials underneath the original church floor. There is significant 'noise' in the left (north) portion of the profile which may be a result of natural disturbance. There is an anomaly at ground surface between approximately 20 and 29 feet which may reflect the original extent of a builder's trench associated with the construction of St. Mary's church (Figure 5-8).

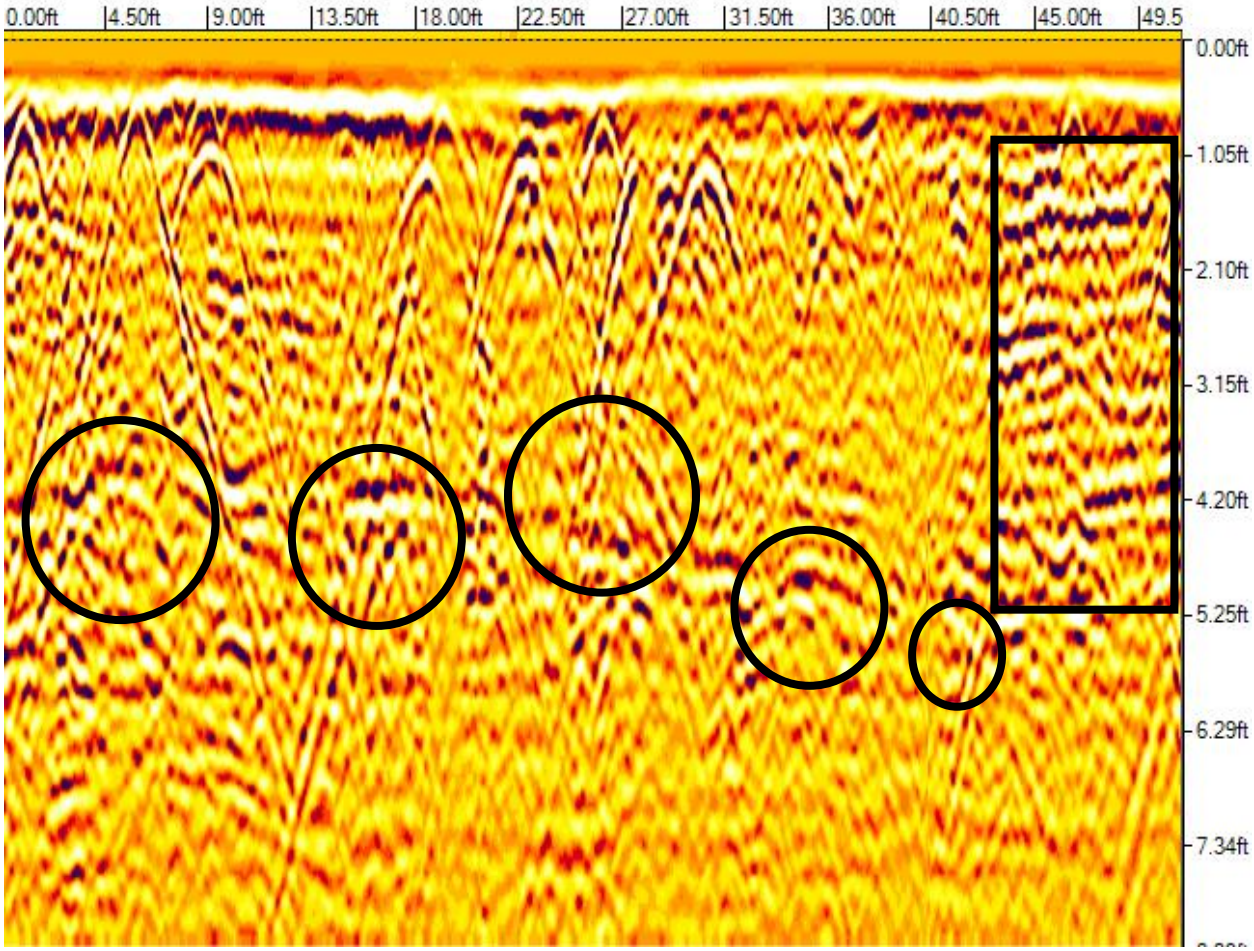


Figure 5-5 Transect 1 reflection profile- Five possible unmarked burials and possible signature of original church path. Note multiple high amplitude hyperbolae near ground surface.

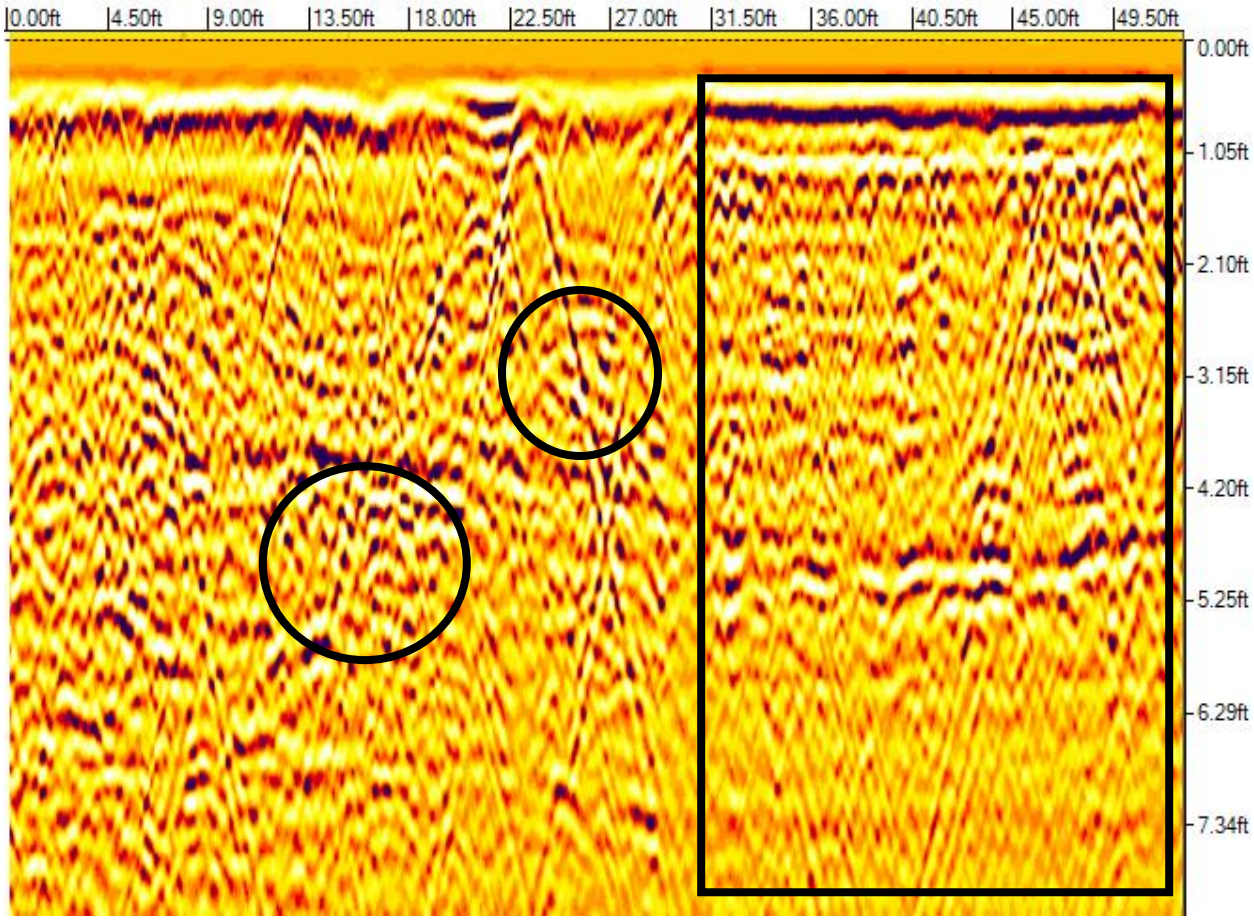


Figure 5-6 Transect 2 reflection profile- Two possible unmarked graves and the foundation of the church. Note the relative homogeneity of soils underneath the church floor as compared to soils in the left portion of the profile. Also note the surface disturbance adjacent to the church foundation and directly above a suspected burial. Radar begins to attenuate at approximately 7 ft.

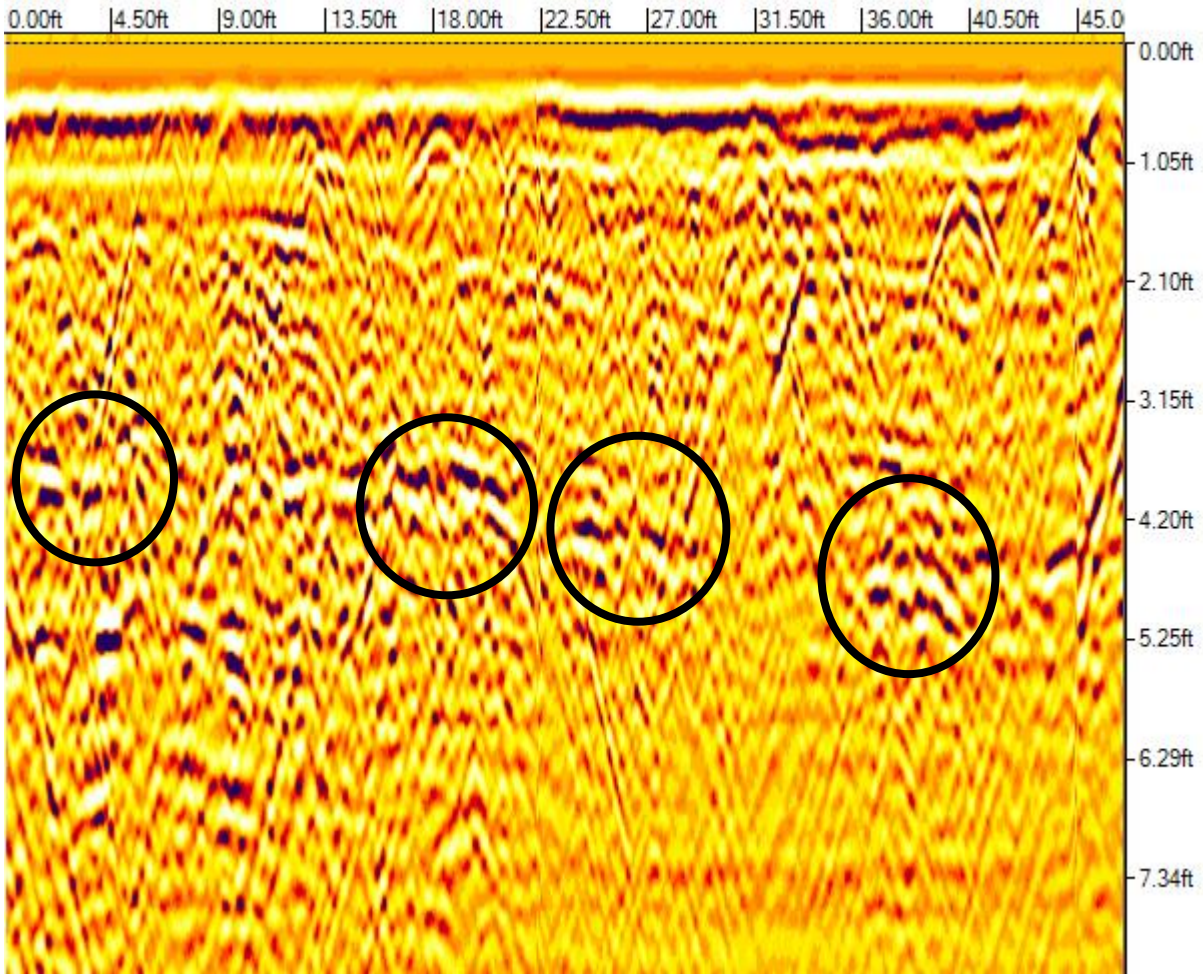


Figure 5-7 Transect 3 reflection profile - Four possible unmarked graves. Note the homogeneity of the subsoil beneath and in close proximity to the church foundation beneath the soil change in comparison to the left portion of the profile.

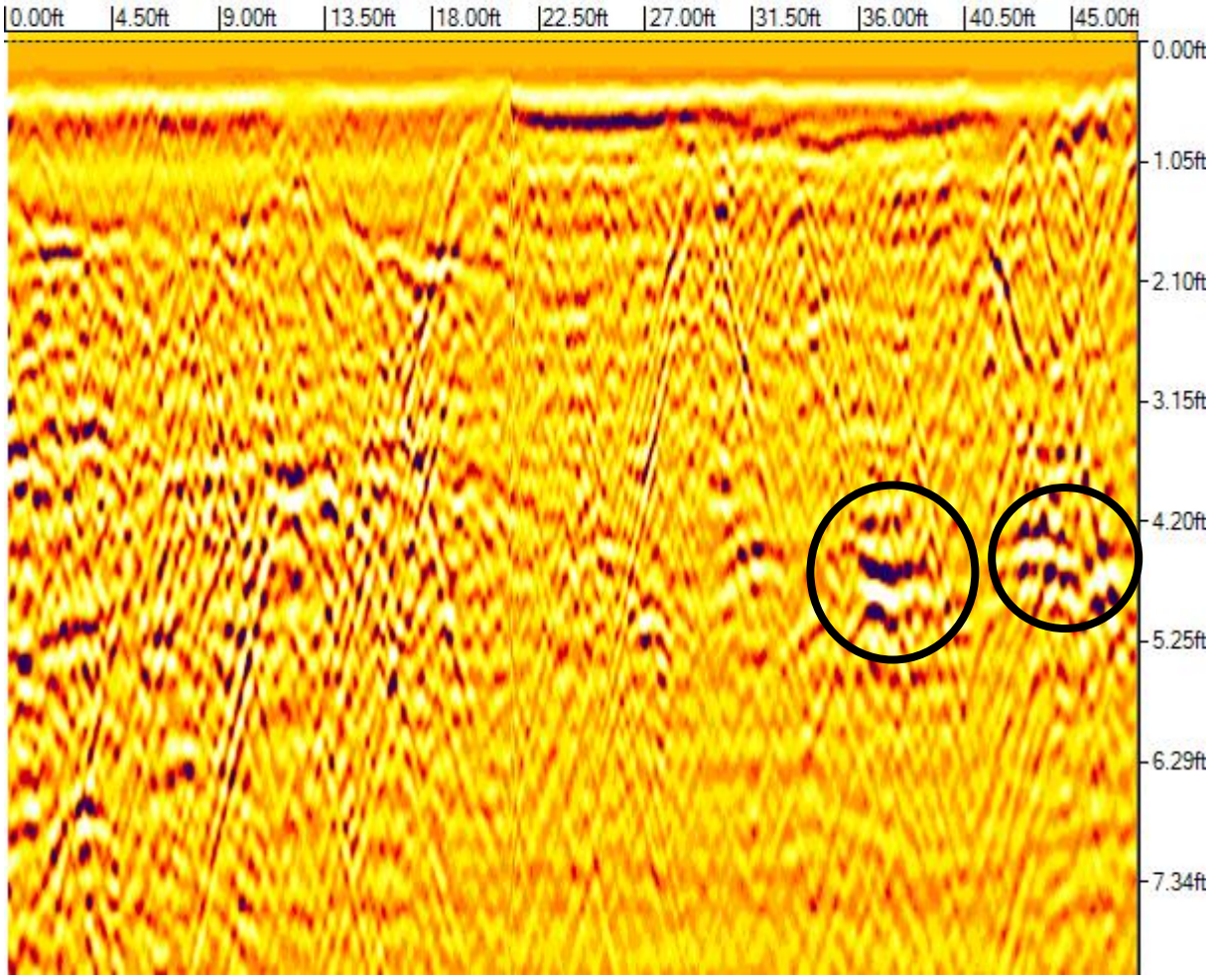


Figure 5-8 Transect 4 reflection profile- Two possible unmarked graves. Both anomalies are situated underneath of the church floor. 'Noise' in the left portion of the profile may be caused by buried rubble and/or reflections from the vegetation line along the northern margin of the parcel. The transition between distinct soils is visible between approximately 4 and 5 feet in depth.

5.2.5. Transect 5

The reflection profile for this transect does not clearly indicate the presence of unmarked burials. Surface disturbance and multiple reflections evident in this profile and others would seem to indicate the remains of a possible builder's trench along the northern margin of the church foundation (A). In the right portion of the profile (south), known graves are evidenced not only by their subsurface signatures, but by the subsidence occurring at ground level (B) (Figure 5-9).

5.2.6. Transect 6

The reflection profile for this transect does not clearly indicate the presence of unmarked burials in the left portion of the profile (north) but does show 'noise' from a cluster of known burials/markers south of the church foundation. However, there are multiple hyperbolae visible underneath the church floor with a particularly interesting cluster at approximately 38 feet along the transect line at a depth of approximately 4.50 feet. There is almost certainly something deliberately buried here; whether or not this is a grave or something altogether different is unknown (Figure 5-10).

5.2.7. Transect 7

The reflection profile for this transect does not clearly indicate the presence of unmarked burials however, there is still a residual reflection visible underneath the church floor at the same depth as the anomaly identified in Transect 6. The Price family plot is situated at '0' on the transect line, and additional known burials are present immediately south of the church floor beginning at approximately 54 feet along the transect line. Note that these burials tend to occur between 4-6.0 feet below ground surface,. There are multiple high amplitude point source reflection hyperbolae at or near ground surface which may be indicative of ironstone fragments exfoliating off of the original church foundation (Figure 5-11).

5.2.8. Transect 8

The reflection profile for this transect may indicate the presence of three unmarked burials at approximately 12.0, 18.0, and 25.0 feet respectively along the transect line at a depth of 3.30 feet. In addition, multiple known graves occur in the right portion of the profile or the south end of the transect (Figure 5-12).

5.2.9. Transect 9

The reflection profile for this transect may indicate the presence of two unmarked burials at approximately 17 and 24 feet along the transect line at a depth of approximately 5.0 feet. There is also the possibility that these represent 'ghost' reflections perpendicular to features seen in Transect 8 at similar depth. The soils above the potential burial exhibit characteristics of prior disturbance/subsidence. There is 'noise' from known burials south of the church foundation. There are multiple point source hyperbolae throughout the upper portion of the profile (Figure 5-13).

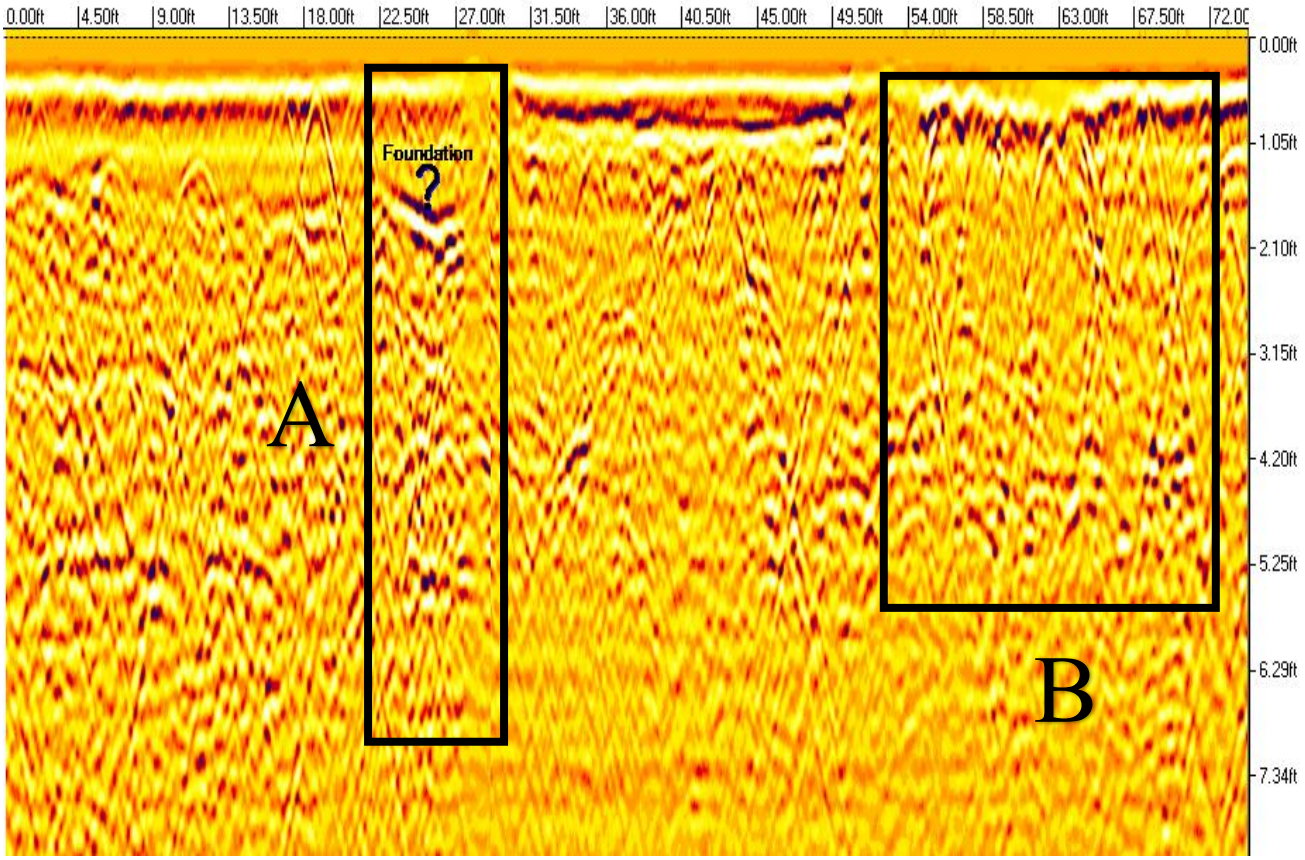


Figure 5-9 Transect 5 reflection profile- Evidence of a possible builder's trench (A) and known graves along Transect 5 (B). Radar wave attenuation begins at approximately 7 feet below ground surface.

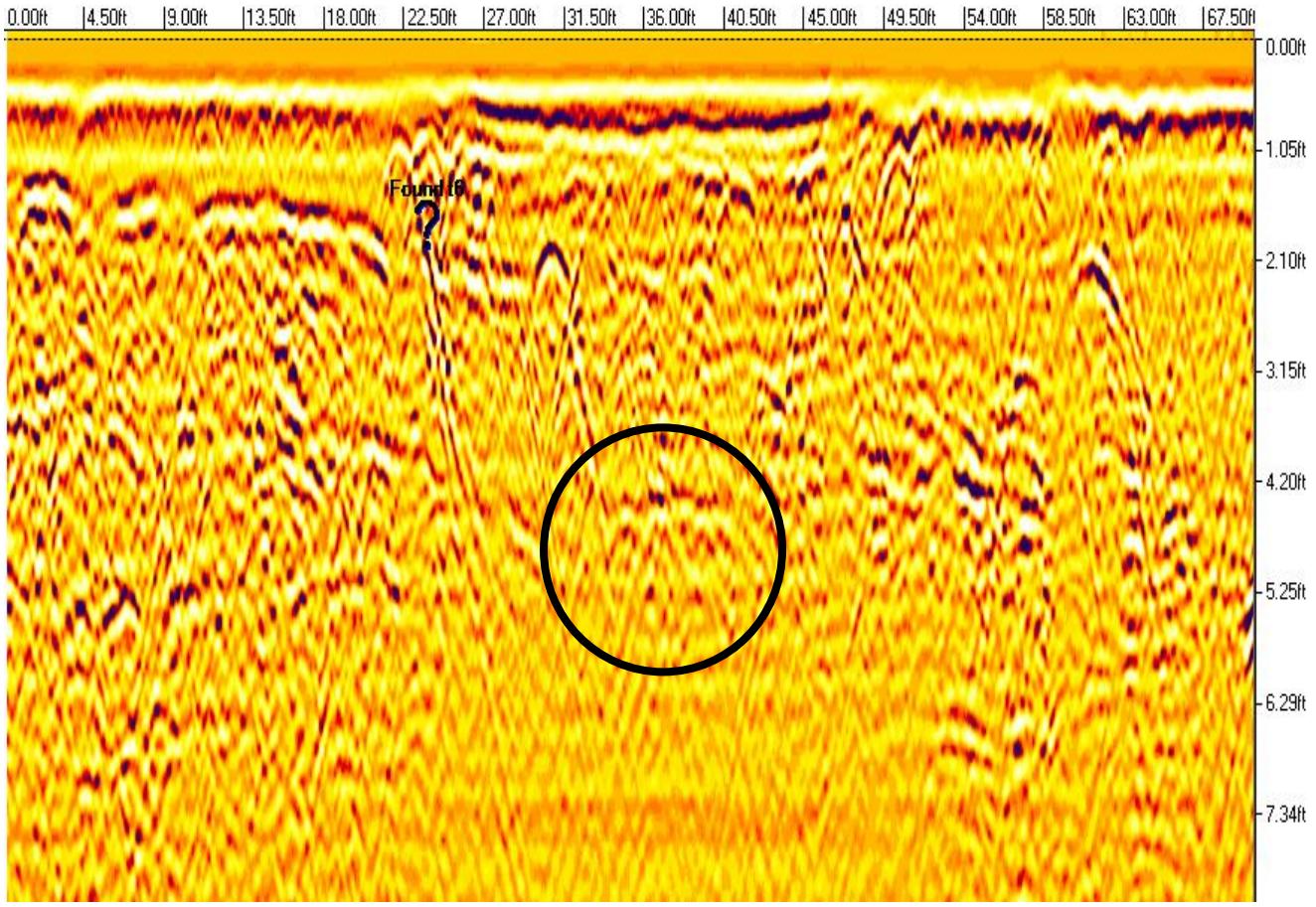


Figure 5-10 Transect 6 reflection profile- Multiple point source hyperbolae clustered beneath the original church floor footprint. Note additional hyperbola at 30 feet horizontal, 2.1 feet vertical.

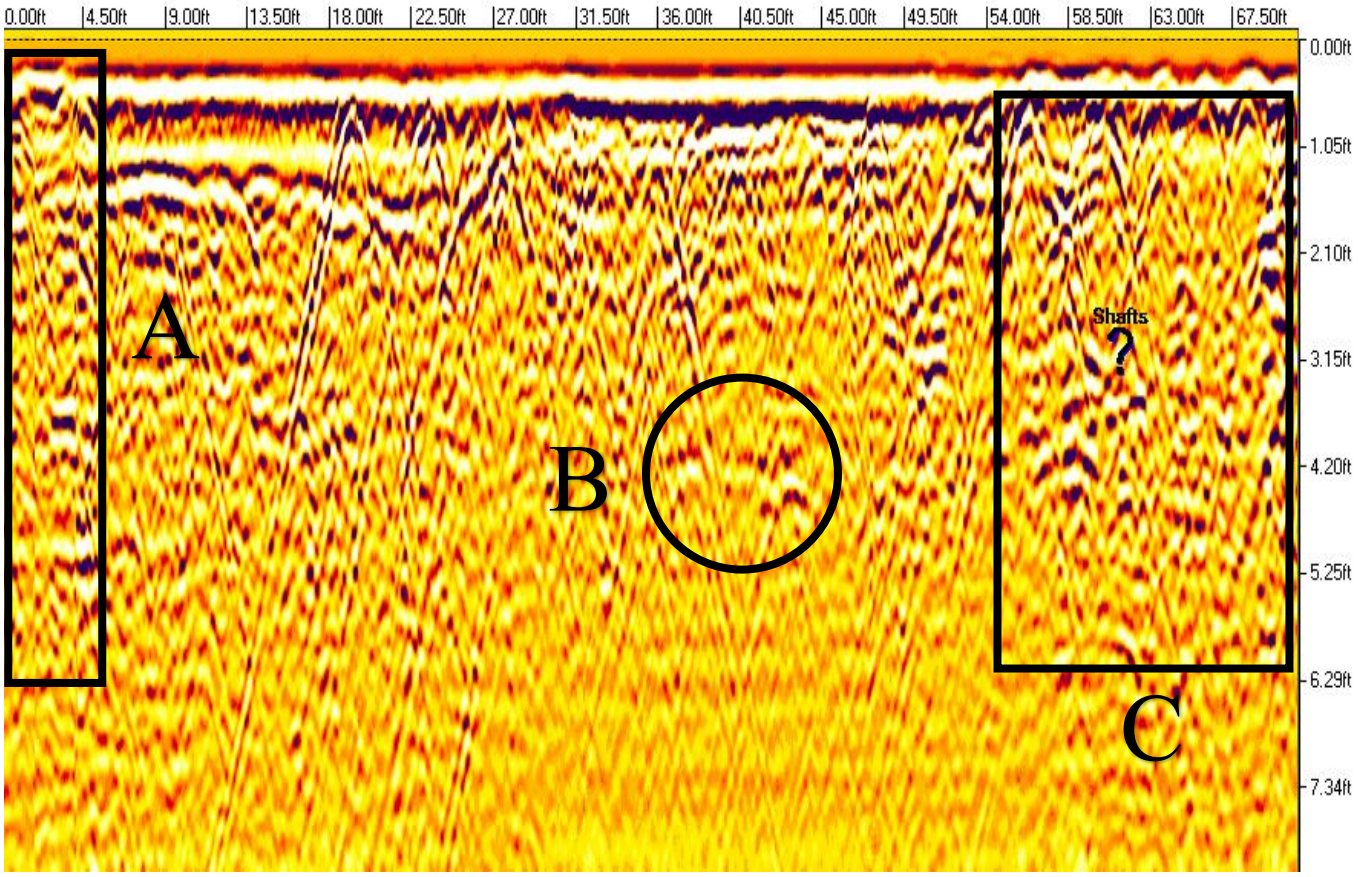


Figure 5-11 Transect 7 reflection profile- 'Price' burial at the start of transect line (A) in addition to reflection underneath the church floor (B) and known burials south of the foundation (C).

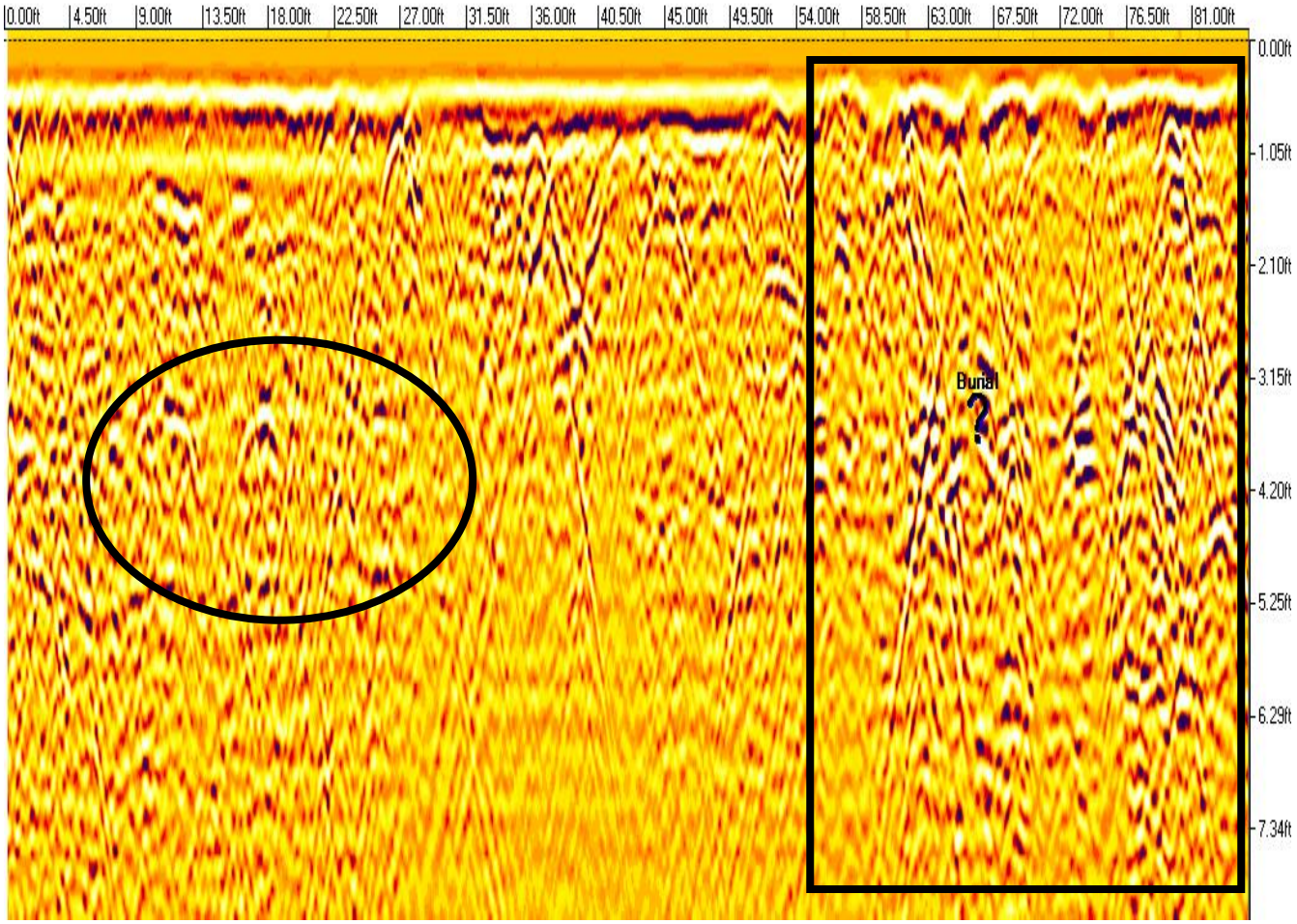


Figure 5-12 Transect 8 reflection profile- Three possible unmarked graves in the left portion of the profile (north), and a series of known burials located south of the church foundation.

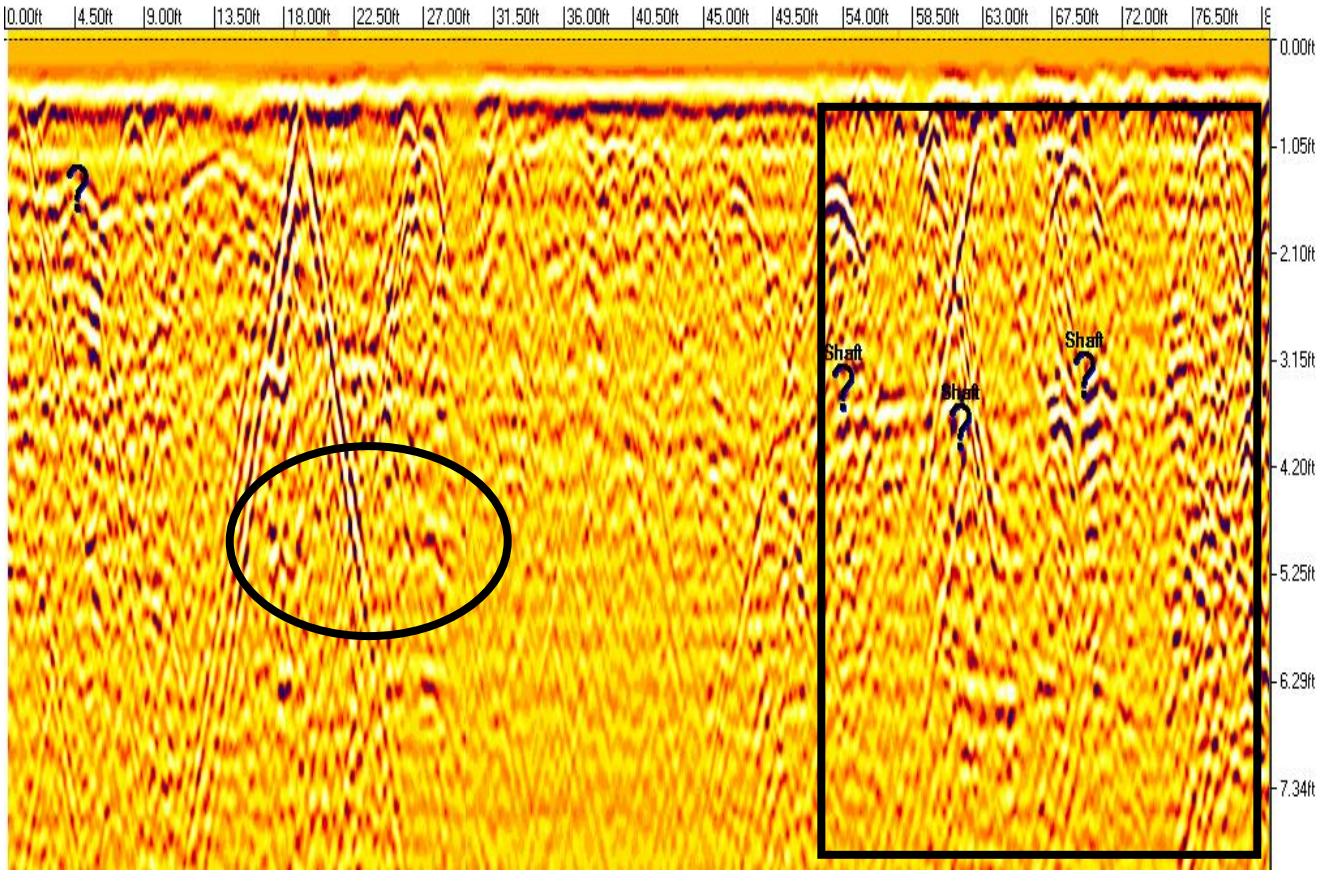


Figure 5-13 Transect 9 reflection profile- Possible unmarked graves to the north of the church foundation, and a cluster of known graves to the south. Note that the soil transition is faintly visible across the profile and that burials tend to cluster at the change. An anomalous reflection occurs high in the profile to the far left (north).

5.2.10. Transect 10

The refection profile for this transect appears to show the presence of an excavated shaft and associated burial(s) located at approximately 5.25 feet below ground surface. In addition, there are multiple anomalies evident toward the south at approximately 3.1 feet in depth. It is unclear whether or not these anomalies represent shallow burials or examples of bioturbation. Multiple point source hyperbolae occur near surface (Figure 5-14).

5.2.11. Transect 11

The refection profile for this transect appear to show three distinct anomalies. PF-1 may represent an unmarked burial with a reflection 'pull-up' created as radar waves speed through a casket void and bounce quickly back to the surface. Two additional reflections occur at approximately 4.20 feet below ground surface. The next reflection in sequence moving to the right of the profile likely represents an unmarked grave. The reflection furthest to the right corresponds to a known/marked grave (Figure 5-15).

5.2.12. Transect 12

The refection profile for this transect indicates a possible unmarked burial at approximately 12 feet south along the line, and approximately 4.20 ft. beneath ground surface. The anomaly is characterized by a point source hyperbola with a possible reflection pull-up immediately above it, as well as a breach in the contacts between soil units.(Figure 5-16).

5.2.13. Transect 13

The reflection profile for this transect exhibits considerable 'noise' from a combination of known/marked graves either immediately adjacent to or along the line, as well as the root systems of multiple pine trees. During post-survey evaluation, the feature identified in the field as a 'crypt' is almost certainly a reflection of the marked grave immediately east of this transect at approximately the same horizontal distance. There is no clear evidence of unmarked graves along this transect (Figure 5-17).

5.2.14. Transect 14

The reflection profile for this transect does not indicate the presence of unmarked graves within this portion of the parcel. The anomalies visible in this profile correspond with the presence of known/marked graves located immediately adjacent to or along the transect line. The frequency of unmarked anomalies decreases in the northern portion of the cemetery within closer proximity to the head of slope leading to the Mullica River. It is unknown how significantly the northeastern portion of the bank has been impacted by erosional process since the late 19th-early 20th century disuse of St. Mary's (Figure 5-18).

5.2.15. Transect 15

The reflection profile for this transect does not indicate the presence of unmarked graves within this portion of the parcel. Anomalies present in this profile represent known/marked graves immediately adjacent to or along the transect line. This transect is situated at the beginning of the terrace slope (Figure 5-19).

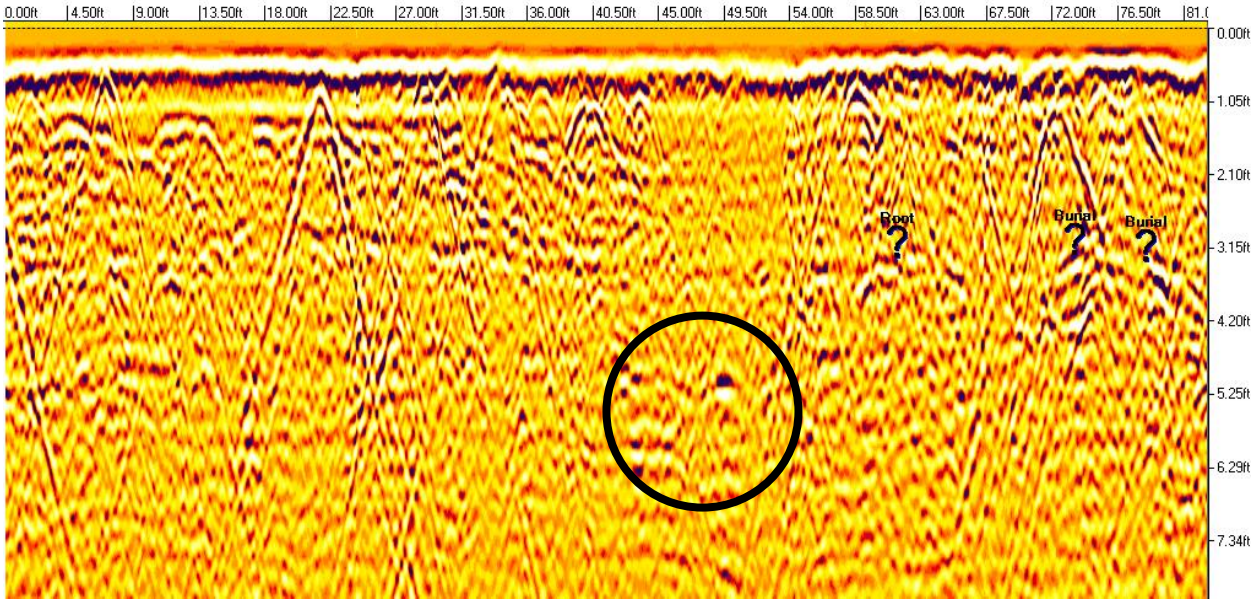


Figure 5-14 Transect 10 reflection profile- Probable unmarked shaft feature with associated grave(s) and multiple anomalies located in the southern portion of the transect. Anomalies may represent reflections from known/marked burials, bioturbation, or both. Note: multiple hyperbolae near ground surface.

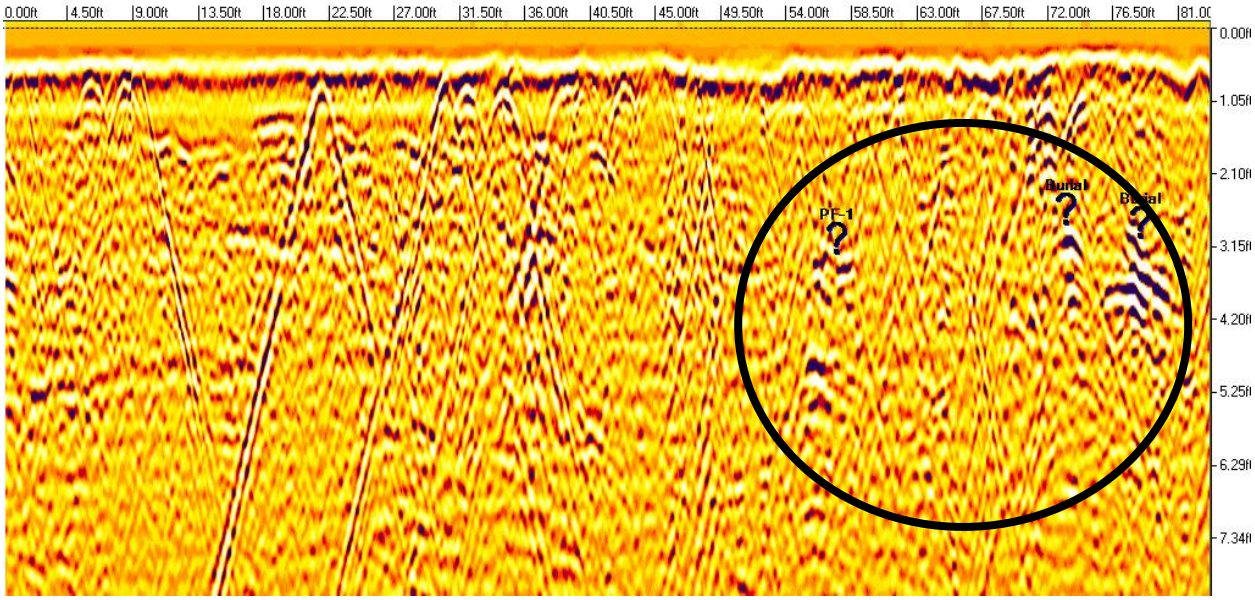


Figure 5-15 Transect 11 reflection profile- Three anomalies, two denoting possible unmarked burials to the rear of the original church. The reflection at approximately 78 feet along the transect is a known/marked grave.

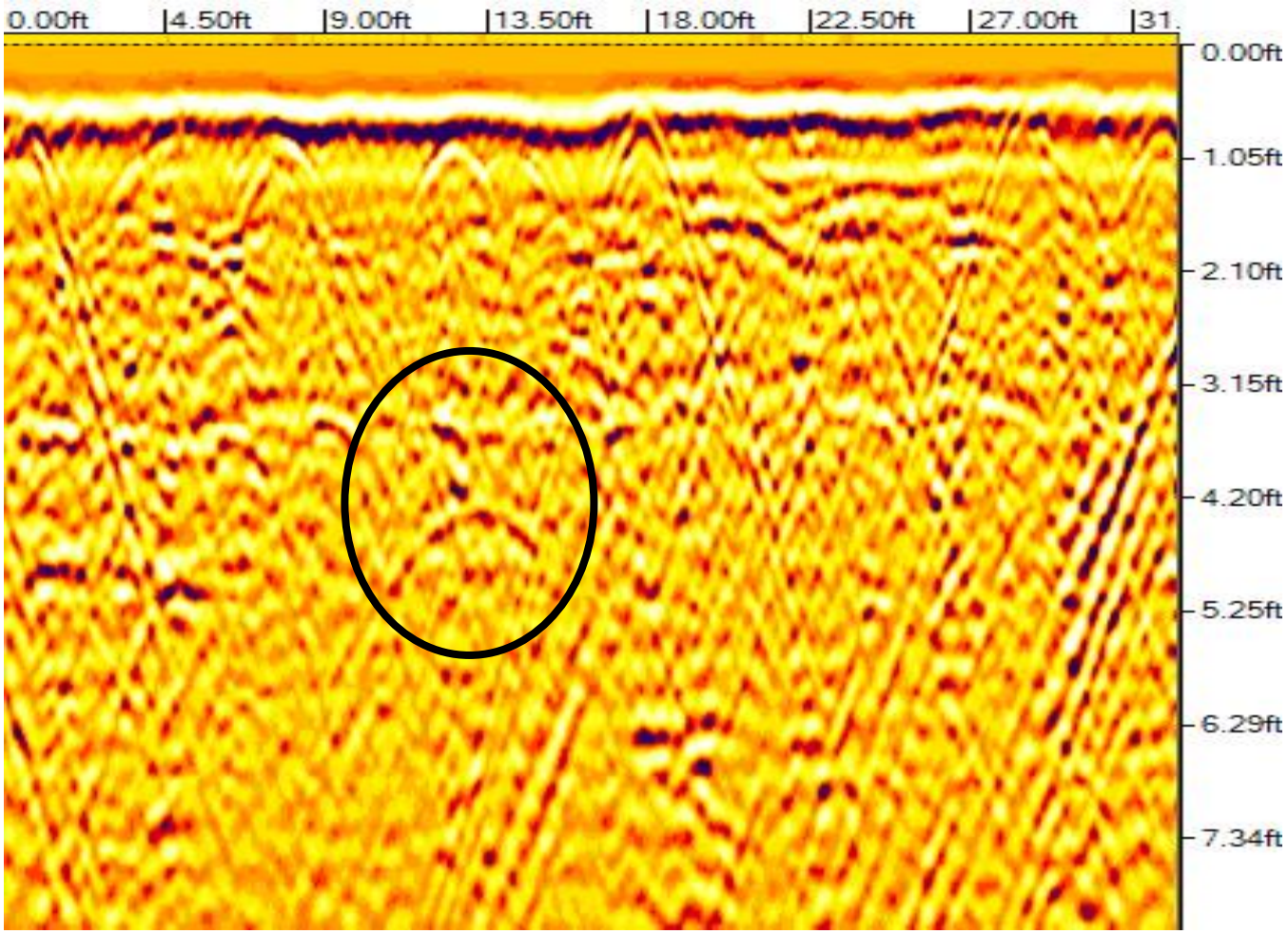


Figure 5-16 Transect 12 reflection profile- Probable unmarked burial with point source hyperbola.

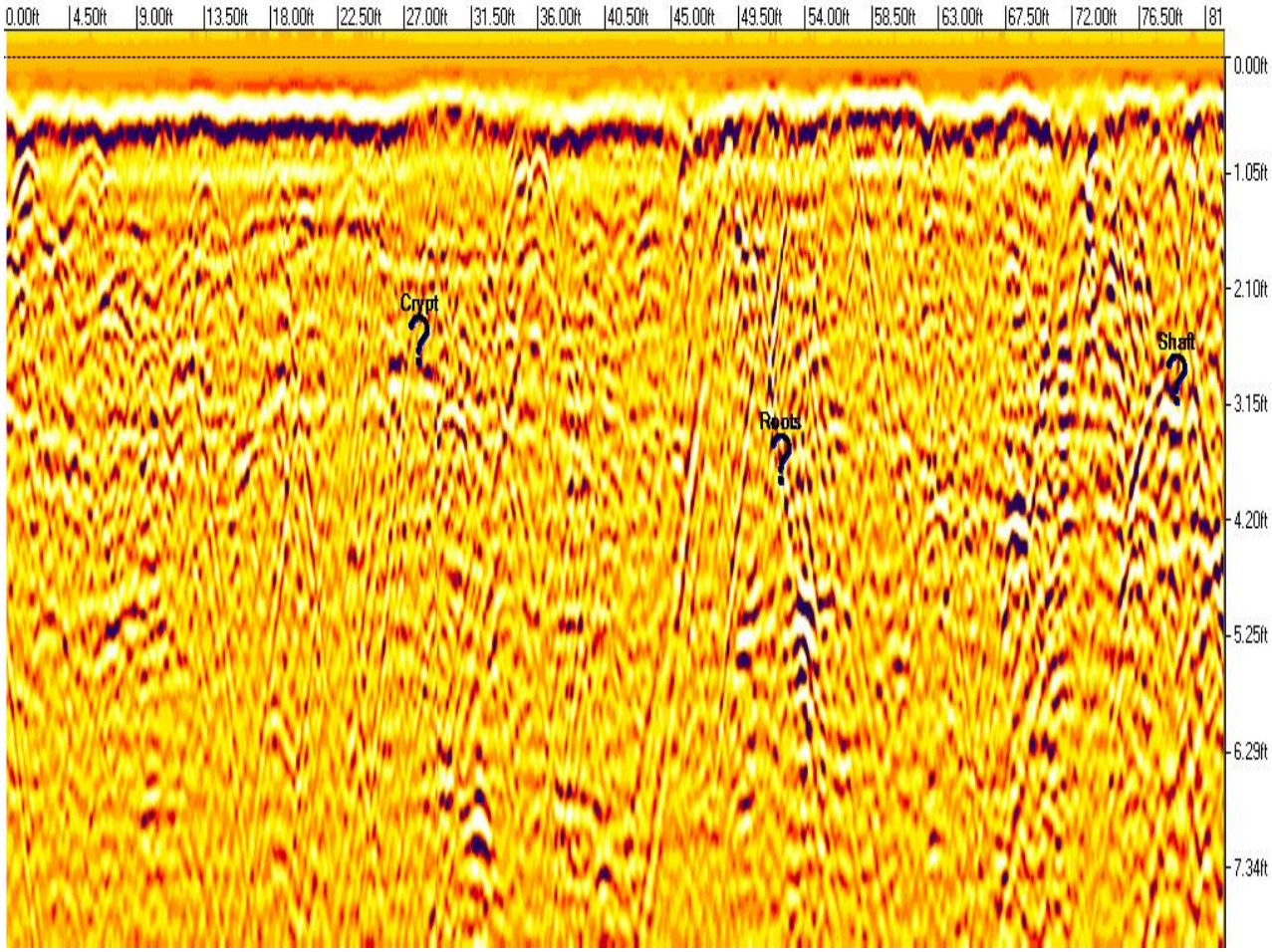


Figure 5-17 Transect 13 reflection profile- Known/marked graves and tree root 'noise'.

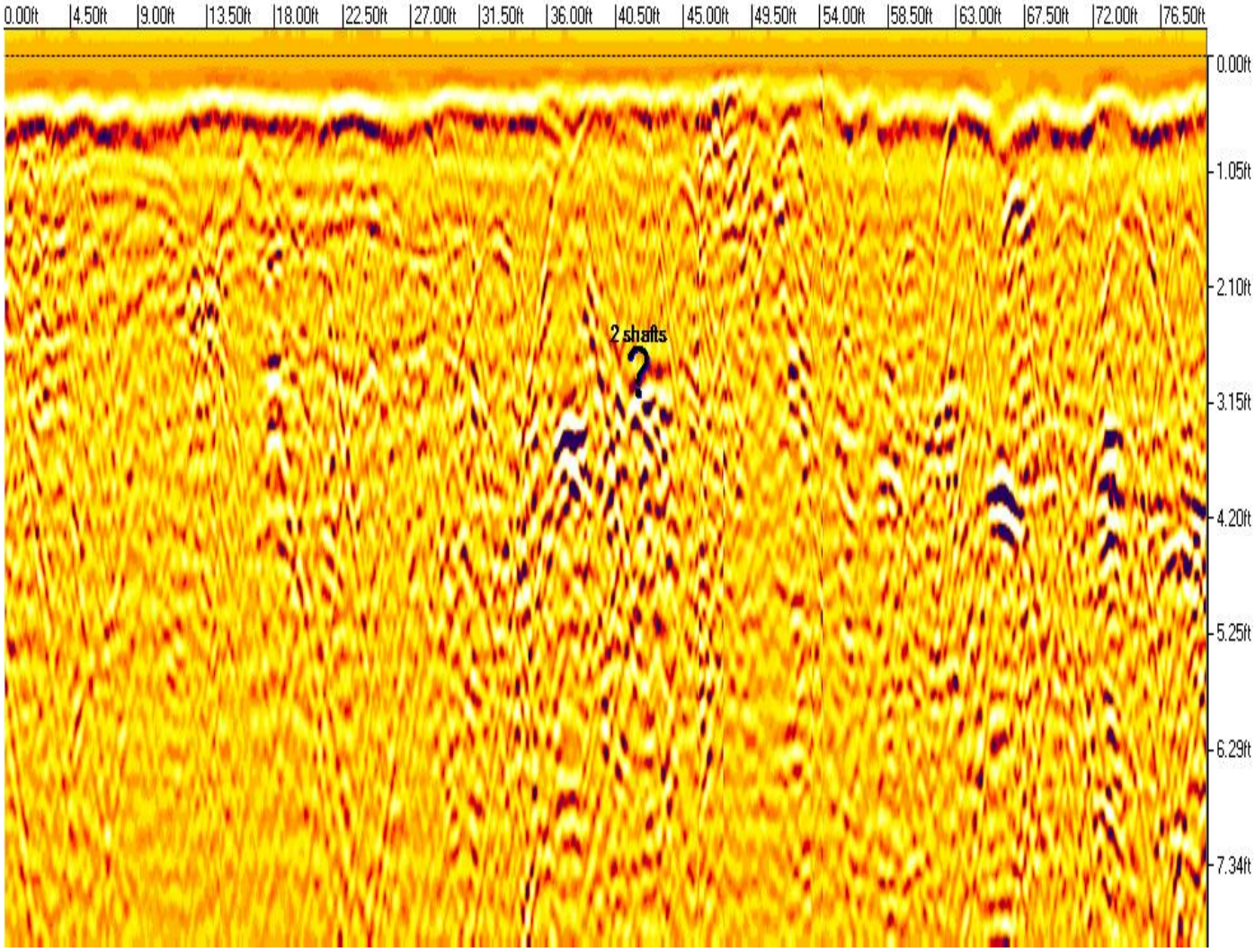


Figure 5-18 Transect 14 reflection profile- Known/marked graves adjacent to or along the transect line. There are no discernible unmarked burials evident in this profile.

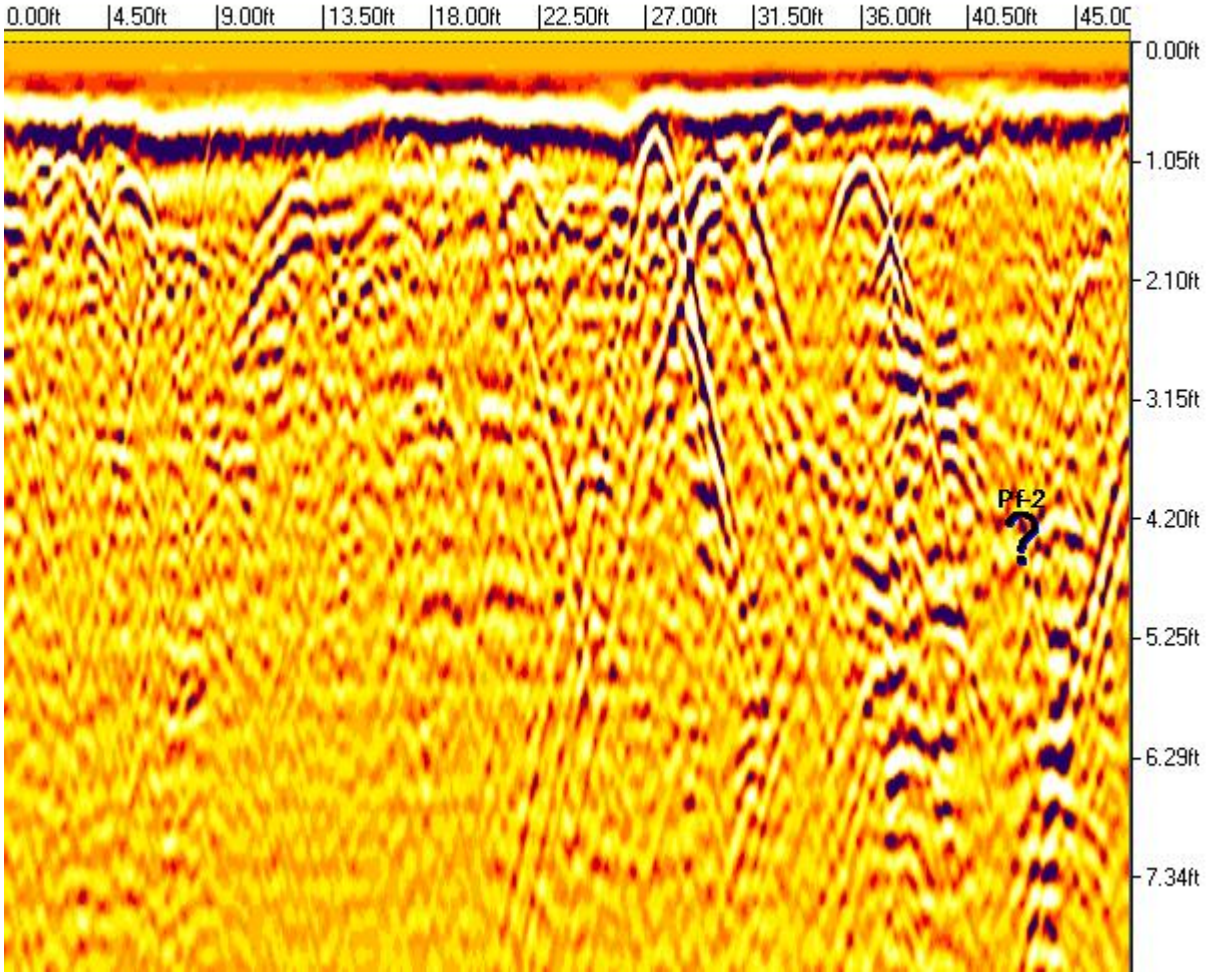


Figure 5-19 Transect 15 reflection profile- Known/marked graves adjacent to or along the transect line. There are no discernible unmarked burials evident in this profile.

6. Conclusions

Based on the findings of this ground penetrating radar survey, the St. Mary's cemetery is very likely to contain multiple unmarked graves. There are several historical reasons why the St. Mary's cemetery is likely to contain unmarked graves. Firstly, a devastating wildfire ran through the area in 1900, destroying the church building as well as many other historic buildings in the area, and is very likely to have destroyed or irreparably damaged any wooden grave markers. Heavy erosion preceding wildfires is also possible due to the loss of ground stabilizing vegetation and, therefore, it is also possibly that grave markers would have fallen, been washed away, or also potentially buried in the aftermath of the wildfire. Finally, given the cemetery's state of abandonment for many years during the 20th century it is likely that some of the markers have also been stolen by vandals.

Evidence supporting the presence of unmarked graves was provided by multiple subsurface anomalies detected during the GPR survey. These anomalies are shown in Figures 5-5 through 5-14. It is very important to note that there are other potential causes for the anomalies, such as tree roots, animal burrows, rubble from the church foundations, and other sources of ground disturbance or intrusions. Despite this, when comparing the hyperbolas (sub-surface anomalies) seen in the known grave plots with some of those found in areas with no markers there are undeniable similarities in shape and depth.

The survey also confirmed the foundation of the church and identified the likely location of the church entrance path. Some sub-surface anomalies were identified below the church floor and could represent offerings or even burials from the date of construction. A wide shallow hyperbola was noted in Transect 2 near the building foundation that could represent a shallow burial or burials.

Further research could involve tracing the land deeds beyond when Jesse Richards donated it to the church to determine prior use of land. It is also recommended that a commemorative marker be placed on the site identifying the presence of unmarked burials.

It was an honor to be a part of this project and to have the opportunity to conduct field work and research at the St. Mary's cemetery, a place of great historical significance and beauty.

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