Ground Penetrating Radar (GPR) and Electromagnetic Induction (EMI) Surveys Mason Family Cemetery Area

Gunston Hall Plantation

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INTRODUCTION

Purpose

Geophysical surveys were conducted in June and July 2006 in an area surrounding the brick-walled Mason Family Cemetery at Gunston Hall Plantation, Fairfax County, Virginia. The purpose of these surveys was to estimate using non-invasive techniques the areal extent of unmarked burials that may reside outside of the cemetery walls. These geophysical surveys included ground-penetrating radar (GPR) and electromagnetic induction (EMI), supplemented by a few measurements of vertical magnetic gradiometry and magnetic susceptibility.

Earlier work

Earlier geophysical surveys inside of the cemetery walls--about 300 yards southwest of the mansion (also known as "The Hall")-- indicated the probable presence of as many as 22 adult burials, most not spatially associated with the 8 inscribed markers within the walls.

Known cemetery burials

A bronze plaque attached to the cemetery wall states

This wall was built in 1922 through
the concern and generosity of
Lillian Seeligson Winterbotham
and other Mason descendants.

Interred here are

George Mason of Gunston Hall, Patriot	**1725 - 1792**
Ann Eilbeck Mason	**1735 - 1773**
James and Richard Mason	**1772**
George Mason V of Lexington	**1753-1796**
Elizabeth Mary Ann Barnes Hooe Mason Graham	**1768 - 1814**
John Graham	**1806 - 1811**
Richard Graham	**1814**
George Mason VI of Gunston Hall	**1786 - 1834**
Elizabeth Thomson Mason Mason	**1789 - 1821**
Eleanor Ann Clifton Patton Mason	**1807 - 1867**
John McCarty Mason	**1817 - 1837**
George Mason Ellzey	**1837 - 1838**
Richard Barnes Patton Mason	**1824 - 1847**
William Stuart Mason	**1795 - 1857**
George Mason of Hollin Hall	**1797 - 1870**

and others in unmarked graves.

Inscribed stones

The cemetery currently contains a total of 8 inscribed markers for 10 persons, all in east-west alignment:

(1) George Mason IV of Gunston Hall [box tomb]
(2) Ann Mason, wife of George Mason IV [box tomb]
(3) George Mason V of Lexington
(4) Elizabeth Mary Ann Barnes [Hooe] [Mason] Graham, wife of George Mason V of Lexington; the stone indicates that beside her lie her sons, John Graham and Richard Graham
(5) William [Stuart] Mason, son of William Mason and grandson of George Mason IV
(6) George [William] Mason [of Hollin Hall], son of Thomson Mason and grandson of George Mason IV
(7) Eleanor Ann Clifton [Patton], wife of George Mason VI
(8) "L. G.", presumably unidentified. [W.F. Hanna note: This repaired, footstone-size marker is very similar in shape and composition to the gravestones of Elizabeth Mary Ann Barnes Graham (#4 above) who was the daughter of Gerard and Sarah Hooe of Barnesfield. This "L. G." might correspond to a Graham not known in genealogical records–perhaps an infant. Alternatively, it is of passing interest, because of several coincidences of names, that a descendant of George Mason IV, Lucy Grymes, who died in Barnesfield, married a Hooe, and provided each of her three Hooe children the middle name Barnes. Although Lucy was interred in St. Paul's Episcopal Cemetery, it might be that this gravestone somehow commemorates her name–perhaps having been "saved" and placed within the family cemetery. These are mere speculations.]

In corroboration with some of the information on the bronze plaque, written accounts indicate that others buried in the Mason Family Cemetery, include:

Richard and James Mason (both d.1772, one day old), twin sons of George Mason IV and Ann Eilbeck

John (d. 1811, 6 years old) and Richard (d. 1814, an infant) Graham, sons of George Graham and Elizabeth Mary Ann Barnes (widow of George Mason V)–both claimed on an inscribed slab to "lie beside her".

John McCarty Mason (d. 1837, 20 years old), son of George Mason VI and first wife Elizabeth Thomson Mason

Richard Barnes Patten Mason (d. 1847, 23 years old), son of George Mason VI and second wife Eleanor Ann Clifton

Our earlier GPR work indicates that gravestones within the walled cemetery do not accurately reflect the exact locations of interments, including the marble box tombs commemorating George Mason IV and his first wife Ann.

We see from J. Harry Shannon's 1905 glass-negative image "Jefferson Walnut Tree at Gunston Hall" that, as noted by authors Connie Pendleton Stuntz and Mayo Sturdevant Stuntz, "not far from the black walnut tree is a grave marked by a simple granite headstone inscribed 'George

Mason, Author of the Bill of Rights and the First Constitution of Virginia 1725-1792'." We also learn from Bertha Louisa Robinson's 1910 article "Pilgrimages to American Landmarks–Gunston Hall" (Journal of American History) that the grave of George Mason IV "is *unmarked*, but tradition tells us that his body was interred beside that of his wife." In more recent times, the cemetery has gone through the cyclic process of becoming overgrown and then cleared, like many–if not most--others of its age in this part of the country. We have discovered through our work in very old cemeteries elsewhere in northern Virginia that, over time, gravestones have been inadvertently (or sometimes intentionally) moved, broken, repaired, replaced, removed, or naturally buried for any number of reasons, including planned re-interments, accidents during caretaking, vandalism, passive neglect, plowing, and the natural forces of frost-heaving followed by settling. Just as some burials exist in an unmarked state, some gravestones remain in place where no burials exist–notably where re-interments have occurred .and where inscribed stones have been purposely "saved" from anticipated destruction and re-emplaced at another burying ground.

The cemetery has long been known as the "Gunston Hall Graveyard" in some records. It is coded as Fairfax County Cemetery #FX144 in the compilation of Brian Conley (1994) and titled by him the "Mason Family Cemetery". The brick wall enclosing it is 50 ft north-south by 40 ft east-west; the bronze plaque indicates that it was constructed in 1922. This wall orientation is congruent with the grave-marker orientation within it–that is, the traditional Judeo-Christian burial pattern of the decedent resting in a supine position oriented west to east with the head to the west.

Geophysical survey dates, 2006

Following a preliminary meeting of Hanna and Petrone with Dave Shonyo, Staff Archaeologist, at Gunston Hall on June 6, Hanna, Petrone, and Imlay conducted GPR surveys south of the walled cemetery on June 9; west of the cemetery on June 16; east of the cemetery on June 20; and north of the cemetery on June 29. EMI surveys were conducted by Hanna on June 30 and July 6, 7, and 8. A limited amount of probing, soil coring, and troweling was conducted by Imlay and Shonyo on July 7. Hanna and Shonyo observed some vertical magnetic gradiometry and magnetic susceptibility measurements on July 8.

Gunston Hall occupancy

Gunston Hall's original owner, George Mason IV (1725-1792), has been described as one of the least known and most influential of America's Founding Founders. Among his many Colonial and Revolutionary accomplishments, he wrote Virginia's Declaration of Rights and its Constitution, both of which influenced Thomas Jefferson's composition of the Declaration of Independence. Gunston Hall was occupied almost continuously by many owners throughout a period of nearly 250 years; one owner in 1875 constructed a cupola atop the mansion to house his telescope. Today, Gunston Hall is a 550-acre National Historic Landmark owned by the

Commonwealth of Virginia and administered by a Board of Regents appointed from The National Society of The Colonial Dames of America.

The "numbered George Mason" line of ascent is as follows:

George Mason VI was the son of George Mason V and wife Elizabeth Mary Ann Barnes Hooe
George Mason V was the son of George Mason IV and his first of two wives, Ann Eilbeck
George Mason IV was the son of George Mason III and his wife Ann Thomson
George Mason III was the son of George Mason II and his first of three wives, Mary Fowke
George Mason II was the son of George Mason I and his first of two wives, Mary French

Children of George Mason IV and Ann Eilbeck were George Mason V; Ann Eilbeck Mason; William Mason, died at one year of age; a second William Mason, born one year later; Thomson Mason; Sarah Eilbeck Mason; Mary Thomson Mason; John Mason; Elizabeth Mason; Thomas Mason; and twins Richard Mason and James Mason, who were born prematurely and died one day old. Ann Eilbeck died 3 months after the birth and death of these twins.

Geographic Setting

Gunston Hall Plantation is located in Fairfax County, Virginia **(figure 1)**, about 14 miles south of Alexandria, on a cove of the Potomac River at geographic coordinates 38.6641^{O} N, 77.1603^{O} W, and elevation 123 ft (GPS and Fort Belvoir 7.5-minute USGS topographic quadrangle). Gunston Hall was constructed mainly during the period 1755-1759 with a probable permanent occupation no later than 1760. Contemporary plantations on or near the Potomac River included Mount Vernon and Marshall Hall to the northeast and Rippon Lodge to the southwest. Gunston Hall has a mailing address of 10709 Gunston Road, Mason Neck, VA 22079 and a worldwide web site of "gunstonhall.org". It is accessed from the Richmond Highway (U.S. Route #1) by traveling about 3.6 miles southeast along Gunston Road (Route 242) and turning left onto the well-marked entrance road. The cemetery survey area is about 300 yards from Gunston Hall, the mansion **(figure 2)**.

Geologic Setting

Gunston Hall Plantation is situated on the Atlantic Coastal Plain physiographic province. It is underlain by unconsolidated sediments of the Potomac Formation, Cenozoic upland gravels, and Quaternary alluvium. The Potomac Formation consists of medium to coarse sands, silty sands, silty clays, and gravelly sands. The soil surrounding the mansion, including our southwest side-yard survey area, has been labeled "manmade" on a soils map; this term indicates that the soil here is largely introduced fill. The coarse, brown soil at the family cemetery, which has a fragipan at about 2 ft depth, is labeled "Beltsville loam, undulating phase" and has developed from Coastal Plain sand, silt, and clay. Soils topographically higher than the mansion typically consist of a mantle of silty and sandy materials over older river terrace deposits that overlie sedimentary beds of the Potomac Formation. Soils topographically lower than the mansion typically consist of alternating strata of sands, silts, and clays with some river-deposited cobbles and boulders. The presence of clay is relevant to our GPR surveys in that significant quantities tend to attenuate the signal and thus impede the passage of radar energy into the subsurface.

Acknowledgments

Staff archaeologist Dave Shonyo and archaeology volunteers–most notably Gretchen Wendelin and Art Eaton--observed the GPR surveys and helped with measurement tapes. Shonyo also participated in the limited amount of probing, coring, and troweling. Staff librarian Kevin Shupe also visited our field site.

Among our GPR team, Pete Petrone, owner and operator of the GPR system, monitored signals received during the surveys, used his custom-made pole-cam digital camera to supply overhead photographs. John Imlay announced the GPR line numbers and distances for audio/video recording, managed antenna cables, and tested soil conditions at a few locations using a steel probe and coring tool. Bill Hanna pulled and timed the antenna passage and analyzed and interpreted the GPR data. Hanna also conducted the EMI surveys, analyzed and interpreted the data, and composed this multi-disciplinary report.

EXACTLY WHAT PHYSICAL PROPERTIES WERE REMOTELY SENSED?

Subsurface objects, structural features, or disturbed soil of possible archaeological interest can be remotely sensed by several geophysical techniques. Those most frequently used are GPR, EMI (or, alternatively, galvanic resistivity), and magnetic methods. Each technique senses a different property or combination of properties of a material *if and only if the property appears as a sufficiently strong contrast to that of surrounding material.* The properties sensed in our surveys include induced and remanent magnetization, electrical conductivity, dielectric permittivity, and magnetic viscosity. We have used two primary instruments and two secondary instruments. The primary tools were the GPR system and an EMI instrument used in the in-phase mode. The secondary tools were a fluxgate magnetic locator and a handheld magnetic susceptibility meter. The GPR system mainly sensed dielectric permittivity or electrical conductivity. The EMI instrument sensed magnetic susceptibility of soil or anti-phased high electrical conductivity of metal, or both, in its in-phase mode. The secondary instruments measured induced and remanent magnetization of soil, brick and other materials.

GROUND-PENETRATING RADAR SURVEY

Instrumentation

GPR measurements were made by using a Subsurface Interface Radar system SIR-8, manufactured by Geophysical Survey Systems (GSSI), Inc. (**figure 3**). The antenna used with this system acts both as the transmitter and receiver of radar energy--this is called operating in "monostatic mode". The principle of operation is that pulses of multi-frequency energy are transmitted into the subsurface by the antenna which is pulled continuously along the ground surface. Where the transmitted energy encounters an interface of contrasting electromagnetic properties--an object or other feature--, some of the energy reflected (or back-scattered) from the interface will be received by the antenna. By noting the positions of signals on the radar record (or radargram), one can draw inferences about both the horizontal and vertical locations of an object or feature in the subsurface.

By carefully measuring the two-way time between the transmitted and received energy, one can infer the distance between the antenna and reflecting interface *if the average velocity of energy travel in the soil can be reasonably estimated.* It should be emphasized that one of the virtues of the GPR technique over other lower-frequency electromagnetic techniques (such as EMI) is that it is capable of sensing *non-metallic* targets as well as *metallic* targets.

On the basis of previous work, we elected to use an antenna having a central frequency of 500 MHz. This antenna is shielded in order to effectively eliminate any upward generation of signal that might reflect from overhead tree limbs or wires. The antenna is "broadband", meaning that it generates energy in a bandwidth of about 250 MHz to 1 GHz downward in the approximate shape of an elliptical cone. As a result of this conical shape, the antenna "sees" not only downward, but also a certain distance forward and backward as well as to either side. The transmitter generated pulses at a repetition rate of 50,000 times per second; reflections were recorded at a rate of 12.8 scans per second.

In these surveys, the antenna was continuously moved on the ground surface along parallel lines spaced 18 inches apart. The antenna was moved at a time-regulated rate of 50 ft/min. Time marks were inscribed on each GPR record at an interval of 5 ft. Two closely spaced time marks on the resulting record delineate the beginning and end of each line. The scan range (duration of recording of each scan line) was set at 36 nanoseconds (abbreviated "ns"; one ns is one-billionth of a second) on the basis of field tests. Filter settings were retained at low values to maximize the amount of returned signal. All of the data were displayed real-time on a GV-8 color monitor via a Model 38 Video Display Unit manufactured by GSSI, Inc. The color linescans were recorded on the GV-8 in 8-mm video tape format for further analysis.

Each recorded scan represents a wiggly reflected signal (not seen, except through use of post-surveying computer software) that has a variable amplitude greater or less than operator-set color thresholds. Thus, on the video screen, each scan takes the form of a skinny vertical line composed of many colored segments, each color corresponding to signal amplitude or "strength". The top of any scan line represents the start of the scan at the antenna; the bottom of the scan line represents the two-way travel time of the reflected radar energy (time required to travel from "antenna acting as transmitter" - to - "subsurface reflector" - to - "antenna acting as receiver"). The complete color linescan record seen on the video screen is the side-by-side ensemble of all of these skinny multi-color lines. In our records, bright whites, reds, yellows and greens usually represent large-amplitude positive signals and dark blues usually represent large-amplitude negative signals. Most moderately sized signals are various shades of gray.

The zero time mark and the duration of the near-field zone (where the transmitted signal is coupled to the uppermost part of the subsurface) was subjectively determined by comparison with other records previously acquired by this system under identical parameter settings. Each color linescan record shows (1) from left-to-right, distances at 5-foot intervals in the direction indicated on the radargram and (2) from top-to-bottom, the 2-way travel time (from transmitter-to-reflector-to-receiver) of the reflected signal in nanoseconds (ns), a total of 36 ns (vertical scale).

Our experience suggests that a reasonable estimate of the average velocity of radar energy in this soil is about 1/3 ft per nanosecond. Thus, we expect a reflection observed *halfway down* on the color timescan record (about 18 ns of 2-way travel time) to correspond to a reflector depth of about 3.0 ft; a reflection observed at the bottom of the record (about 36 ns of 2-way travel time) would correspond to a depth of about 6.0 ft. Where the soil velocity varies significantly in a lateral direction, the estimate of depth likewise varies.

GPR record analysis

After completion of field work, the data were analyzed by viewing and reviewing the video tape records on a Sony Trinitron 25-inch high-resolution NTSC television monitor. A transparent template with 36 major tick increments along its vertical axis was used to pick best estimates of first arrivals of primary reflections.

Ordinarily, the most conspicuous GPR reflections in a given area have the shape of a hyperbola or upward arch. This shape usually results from the reflection of radar energy from a single underground object--ideally a "point source". These signals resemble those of sonic echo-finders used by fishermen. Ideally, a well-formed hyperbolic echo in GPR work results when energy reflects from an object with a circular or curvilinear top, such as a horizontal cylinder (pipe or conduit), sphere, top of a tunnel--or in a graveyard, top of coffin. In practice, hyperbolic echoes are often broken, distorted, asymmetrical, or obscured by interfering signals from nearby objects or by other noise. A given reflector may be a rock, brick, tree root, animal burrow, conduit, utility line, tunnel, ditch, wall foundation, air- or water-filled void, or any metallic, ceramic, glass, or plastic object. Within a graveyard, a reflector may be any feature of a burial container or its contents--such as a knotty portion of a pine box, coffin hardware, a viewing pane, more massive bones, or a ceremonial object buried with the decedent.

A hyperbolic echo on rare occasions can underlie strong secondary reflections from a V-shaped trench ("bowtie" signature); can be produced from the "velocity pullup effect" associated with a large subsurface void--also applicable to some graves; and can be generated from constructive wave interference patterns. Other conspicuous GPR reflections can take the form of horizontal to sub-horizontal bands, corresponding to flat subsurface features (such as a buried root cellar) or soil facies, or conspicuous columns of reverberations caused by multiple reflections from metallic objects.

GPR presentation of results

The color linescans are examined and notes are taken on the location, two-way travel time, and relative strength of hyperbolic echoes. For plotting purposes, the hyperbolic echoes are separated into 4 categories: "shallow & weak", "deep & weak", "shallow & strong", and "deep & strong". The break between "shallow" and "deep" is made at the 18 ns two-way travel time mark. Thus, if the average soil velocity is 1/3 ft per ns, "shallow" reflectors are those less than 3 ft deep. Those taken to be "weak" are those of amplitudes 1 and 2; those taken to be "strong" are those of amplitudes 3, 4, and 5. In a cemetery setting, we also commonly note, in a subjective manner based upon our experience, those signals that seemed likely to represent graves. The notes also include some abbreviated descriptive comments.

IN-PHASE EMI SURVEYS

The EM measurements were made with a Model EM-38 Conductivity Meter manufactured by Geonics Limited (**figure 4**). The principle of operation is that, after a small transmitter coil at one end of the elongate instrument generates a magnetic field downward into the soil, this field induces a magnetization in the soil or induces eddy currents within electrically conductive material, or both, that can be detected by a small receiver coil at the opposite end of the instrument. This signal will contain both in-phase and quadrature-phase components, that are respectively "in step" and 90 degrees "out of step" with respect to the transmitting signal. This device operates at a frequency of 14.6 kHz (much lower than frequencies used in GPR) and was designed to detect magnetic susceptibility to a depth of about 2 ft or metallic conductivity to a depth of about 4 ft. Measurements were made in walking mode at a 12-inch station interval along lines spaced 18 inches apart. At each field location, measurements were made on the ground surface with the long axis of the instrument parallel to the traverse line. All of the data were recorded real-time on a data logger--the Omnidata 720 Polycorder. The Polycorder data were later downloaded to a computer for processing, analysis, and display.

It is conventional to express in-phase results when using the Polycorder in units of "ppt"--that is, parts-per-thousand of the ratio of in-phase secondary field to in-phase primary field. However, for archaeological purposes, the in-phase and quadrature-phase units can be simply and conveniently expressed as "IP units".

COORDINATE SYSTEM

We used the same coordinate system that we established for our 2005 work (Hanna and Petrone, 2005). In each region surrounding the cemetery, our measurement tapes were aligned north-south, parallel to the long dimension of the brick wall. The coordinate origin was retained near the southwest corner, inside of the cemetery wall–approximately 3 ft east of the outside edge of the west wall and 6 ft north of the outside edge of the south wall.

We set up measurement tapes 3 ft apart and pulled the GPR antenna (which is 1-ft wide) along 2 lines within each lane formed by 2 adjacent tapes. Thus, the edge of the antenna along each of these 2 lines was 3 inches from the closest tape. This procedure ensures that the tapes are not disrupted by dragging while the antenna is moved. For EMI work, it was convenient to carry the instrument directly (and slightly) above each tape and then along a line halfway between adjacent tapes. Thus, both the GPR and EMI data were acquired at an 18-inch spacing but the two data sets are offset slightly from each other. This offset is shown in **figure 5** which indicates the map locations of GPR lines and EMI measurement points. The brown lines south of the cemetery represent GPR lines 1 - 74, run north to south; red, blue, and green lines west, east, and north of the cemetery represent GPR lines 75 - 103, 104 - 137, and 138 - 165, all run south to north. As noted above, these sets of GPR lines were run on 4 separate field days; the EMI subsets of data were acquired on other days.

Measurement tapes laid out west and east of the cemetery are shown in photographs of **figure 6.** Tapes laid out north of the cemetery are shown in the top photograph of **figure** 7.

RESULTS

Preliminary analysis of GPR echoes

For a very preliminary analysis, all GPR echoes (regardless of signal strength and depth-to-reflector) were plotted in relation to the cemetery wall **(figure 8)**. Also plotted were highly subjective inferences about characteristics of some of these echoes–whether "grave-like", "tree root-like", or "classic" in some significant sense (e.g., exceptionally well formed and thus a textbook example). This map was merely a working tool to be used also in conjunction with EMI data. South of the cemetery, 89 echoes were in some sense "grave-like", 17 were "root-like", and 12 were "classic" or especially significant. West of the cemetery, 51 echoes were in some sense "grave-like", 103 were "root-like", and 8 were "classic" or especially significant. East of the cemetery, 19 echoes were in some sense "grave-like", 213 were "root-like", and 24 were "classic" or especially significant. North of the cemetery, 38 echoes were in some sense "grave-like", 83 were "root-like", and 8 were "classic" or especially significant.

In the more highly developed maps that follow, "deep" refers to a depth-to-reflector of 2 ft or greater, assuming a radar velocity in soil of 1/3 ft per nanosecond.

Area south of cemetery

GPR echoes and lateral discontinuities along the 74 lines south of the cemetery are shown in **figure 9**. Also shown are regions of significant in-phase EMI anomalies, as displayed in more detail in **figure 10**, representing 1,804 measurement points.

Among the 451 echoes noted (**Appendix A**), 93 (~ 20 %) are "shallow & weak", 233 (~ 52 %) are "deep & weak", 113 (~ 25 %) are "shallow & strong", and 12 (~ 3 %) are "deep & strong". Echo alignments, together with other observations, suggest the likelihood of 15 graves and evidence suggestive of 13 others. Many, if not most of these echoes, also may be associated with invading tree roots. Examples of GPR echoes are shown in **figure 11.**

The EMI map shows a distinctive east-west string of bubble anomalies at northing coordinate -18 ft (that is, 18 ft south of the coordinate base line or about 12 ft south of the outside south wall of the cemetery). This string may mark a former fence line. The large isolated bubble anomaly at coordinate (-13.5', -2') has not been investigated but it appears near where an east-west alignment of GPR echoes was detected.

Area west of cemetery

GPR echoes and lateral discontinuities along the 28 lines west of the cemetery are shown in **figure 12**. Also shown are regions of significant in-phase EMI anomalies, as displayed in more detail in **figure 13**, representing 434 measurement points (an additional 1,085 in-phase EMI measurements were made in this area in 2005).

Among the 405 echoes noted (**Appendix A**), 122 (~ 30 %) are "shallow & weak", 165 (~ 41 %) are "deep & weak", 107 (~ 26 %) are "shallow & strong", and 11 (~ 3 %) are "deep & strong". Echo alignments, together with other observations, suggest the likelihood of 3 graves and evidence suggestive of 21 others. Many, if not most of these echoes, also may be associated with invading tree roots. Examples of GPR echoes are shown in **figure 14.**

The EMI map shows an east-west string of bubble anomalies at northing coordinate +38 ft extending across the small area surveyed from easting -47 ft to easting -28 ft. This string may mark part of a fence line. The single isolated anomaly at coordinate (-36', +60') has not been investigated.

Area east of cemetery

GPR echoes and lateral discontinuities along the 33 lines east of the cemetery are shown in **figure 15**. Also shown are regions of significant in-phase EMI anomalies, as displayed in more detail in **figure 16**, representing 1,234, 647, 160 measurement points, respectively, in the main eastern region (upper left), east wall region (upper right), and far east region (lower right).

Among the 420 echoes noted (**Appendix A**), 97 (~ 23 %) are "shallow & weak", 117 (~ 28 %) are "deep & weak", 196 (~ 47 %) are "shallow & strong", and 10 (~ 2 %) are "deep & strong". Echo alignments, together with other observations, suggest the likelihood of 4 graves and evidence suggestive of 22 others. Many, if not most of these echoes, also may be associated with invading tree roots. Examples of GPR echoes are shown in **figure 17.**

The EMI map shows 3 prominent anomalies and one string segment of bubble anomalies. One prominent anomaly is associated with the iron gate post and gate of the brick-walled cemetery. Another prominent anomaly at coordinate (+79', +9') was investigated with a fluxgate gradiometer and troweled by Dave Shonyo. This anomaly is caused at least in part by shallowly buried barb wire. The third prominent anomaly at the northeast corner of the brick wall was probed and cored by John Imlay, as discussed below. The string of bubble anomalies was detected in the detailed survey and occurs at a northing coordinate of +3 ft. it extends at least from easting 76 ft to easting 87 ft, possibly representing part of a fence line.

Area north of cemetery

GPR echoes and lateral discontinuities along the 27 lines south of the cemetery are shown in **figure 18**. Also shown are regions of significant in-phase EMI anomalies, as displayed in more detail in **figure 19**, representing 1,396 measurement points.

Among the 245 echoes noted (**Appendix A**), 38 (~ 16 %) are "shallow & weak", 82 (~ 34 %) are "deep & weak", 102 (~ 41 %) are "shallow & strong", and 23 (~ 9 %) are "deep & strong". Echo alignments, together with other observations, suggest the likelihood of 7 graves and evidence suggestive of 3 others. Many, if not most of these echoes, also may be associated with invading tree roots. Examples of GPR echoes are shown in **figure 20.**

The EMI map shows one prominent anomaly immediately outside at the northeast corner of the cemetery and one moderate anomaly at coordinate (0', +65'), the latter of which has not been carefully investigated. The prominent anomaly was inspected with a fluxgate gradiometer and troweled by Dave Shonyo. It is caused at least in part by shallowly buried ~~spiral~~ fencing wire.

Results of probing/coring based on EMI data....buried arched vault?

A limited amount of probing and soil coring was conducted by John Imlay and Dave Shonyo at one site inside of the walled cemetery and at another site immediately outside of the cemetery at its northeast corner. This probing and coring was requested by Hanna because of observations he made using in-phase EMI data. While analyzing the EMI anomaly at the northeast corner (which unfortunately seems to extend beneath the brick wall which precludes it from being mapped completely), Hanna observed that the gradient (closeness of contour lines) and plan-view size of the feature may be comparable to that associated with the inferred "iron coffin" feature inside of the cemetery. This inferred "iron coffin" location is unmarked (no grave stone) but was mapped remotely using GPR, in-phase and quadrature-phase EMI, and vertical magnetic gradiometry (Hanna and Petrone, 2005). In the process of re-analyzing the "iron coffin" anomaly for this study, Hanna constructed a computer model that suggested the burial site is wider than that of a single coffin. This model suggested that the "iron coffin" burial may be a vault, possibly wide enough to accommodate 2 side-by-side coffins. The likelihood that at least one of the coffins is iron remains valid. John Imlay cored this subsurface feature and discovered that it appears to be about 4.5 to 5 ft wide with its central top at a depth of 16 inches, laterally changing to a depth of

23 inches, possibly indicating an arched vault. One core hole at the plan-view center recovered a circular disc-shaped fragment that appears to be mortar.

Coring at the northeast corner EMI anomaly yielded depths to the top of subsurface object of 33 inches, 25 inches 23 inches, and 22.5 inches, the latter ones remarkably similar to the outer-depths at the "iron coffin" site. There remains, therefore, the possibility that the northeast corner feature is a burial feature–possibly a vault.

CONCLUSIONS

Tree roots pervasively underlie the ground surface surrounding the brick-walled Mason Family Cemetery, including the open grassy areas. ***Analysis of GPR data suggests the likelihood of 29 adult-sized graves outside of the cemetery wall and many other possible grave sites*** (**figure 21**). Some–if not most-- of these inferred graves appear to be invaded by tree roots. Children's graves are too small to be located without visual inspection of subsoil, which would require the temporary removal of topsoil.

Alignments of GPR echoes and the presence of strings of EMI bubble anomalies suggest the presence of several east-west features that may mark parts of fence lines or wall foundations. We cannot comment on the possible presence of counterpart north-south features because such inferences would have to derive from surveys oriented perpendicular to the ones we conducted. Metal detecting may help pinpoint such features.

Further analysis of the "iron coffin" feature inside of the cemetery wall, based on new computer modeling, suggests that the burial site is wider than that for a single coffin. This 3-D model suggests that the "iron coffin" burial may be a vault, possibly wide enough to accommodate 2 side-by-side coffins. If true, he likelihood that at least one of the coffins is iron remains valid. Soil coring at this site recovered a fragment of the top of this feature that appears to be mortar.

The GPR and EMI data both suggest the presence of a subsurface burial feature beneath the northeast corner of the brick-walled cemetery. The geophysical anomalies of this subsurface feature appear similar to those associated with the "iron coffin" feature but they unfortunately cannot be completely mapped because of the presence of the brick wall.

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Owsley, D. W., Richardson, Malcolm, Hanna, W. F., and Imlay, J. H., 2001, Exhumation of graves associated with the Stisted Plantation–Wagener Family Cemetery: Report for the Colchester Land Development Company, L.L.C., 10406 Gunston Road, Lorton, VA 22079; Edwin W. Lynch, Jr., contact; [field work team of Owsley, Richardson, Hanna, Imlay, Dale Brown, Jackie Cuyler, Rebecca Redmond, and Claude E. Petrone], 33 p.

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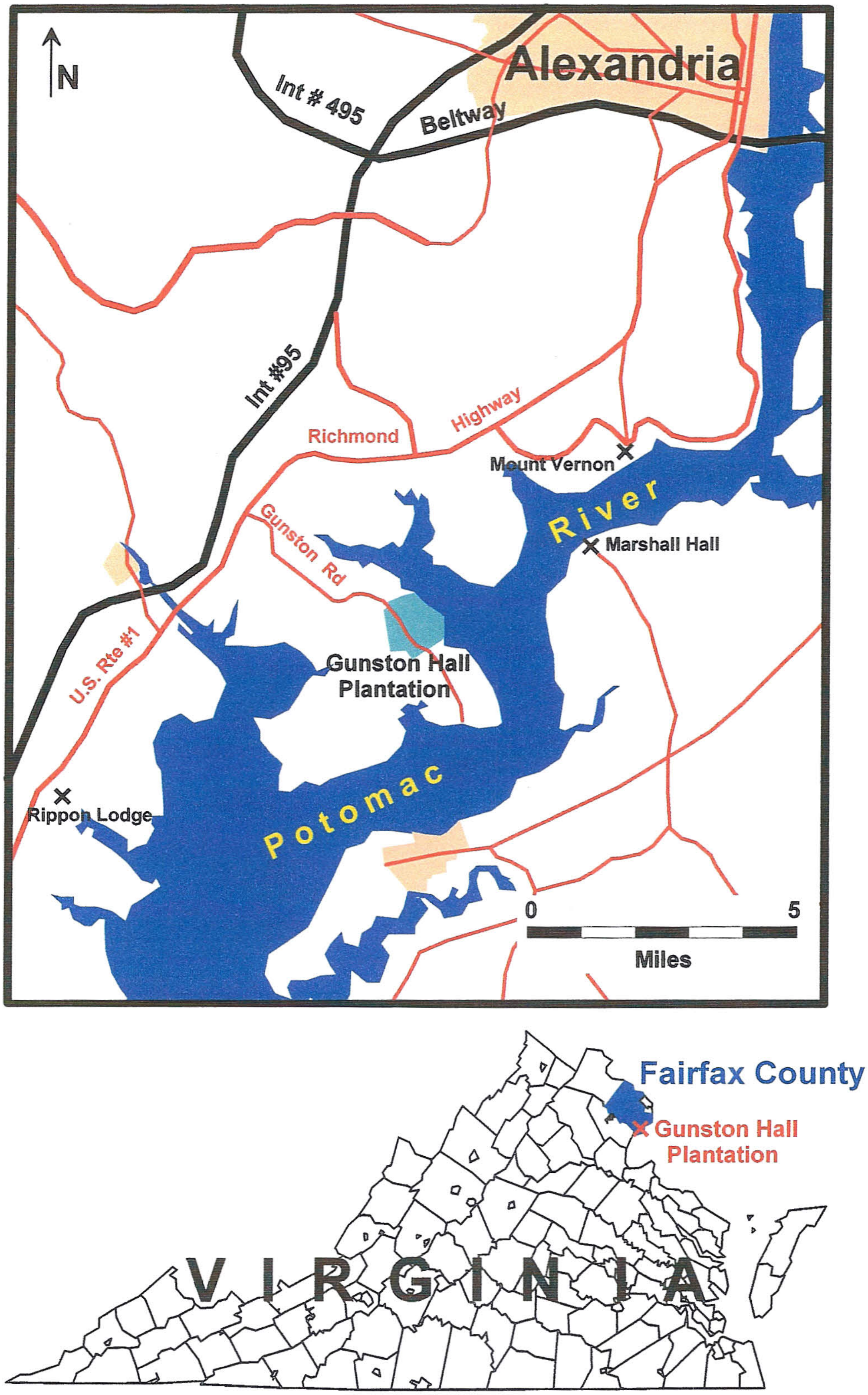


Figure 1. Regional map showing Gunston Hall Plantation.

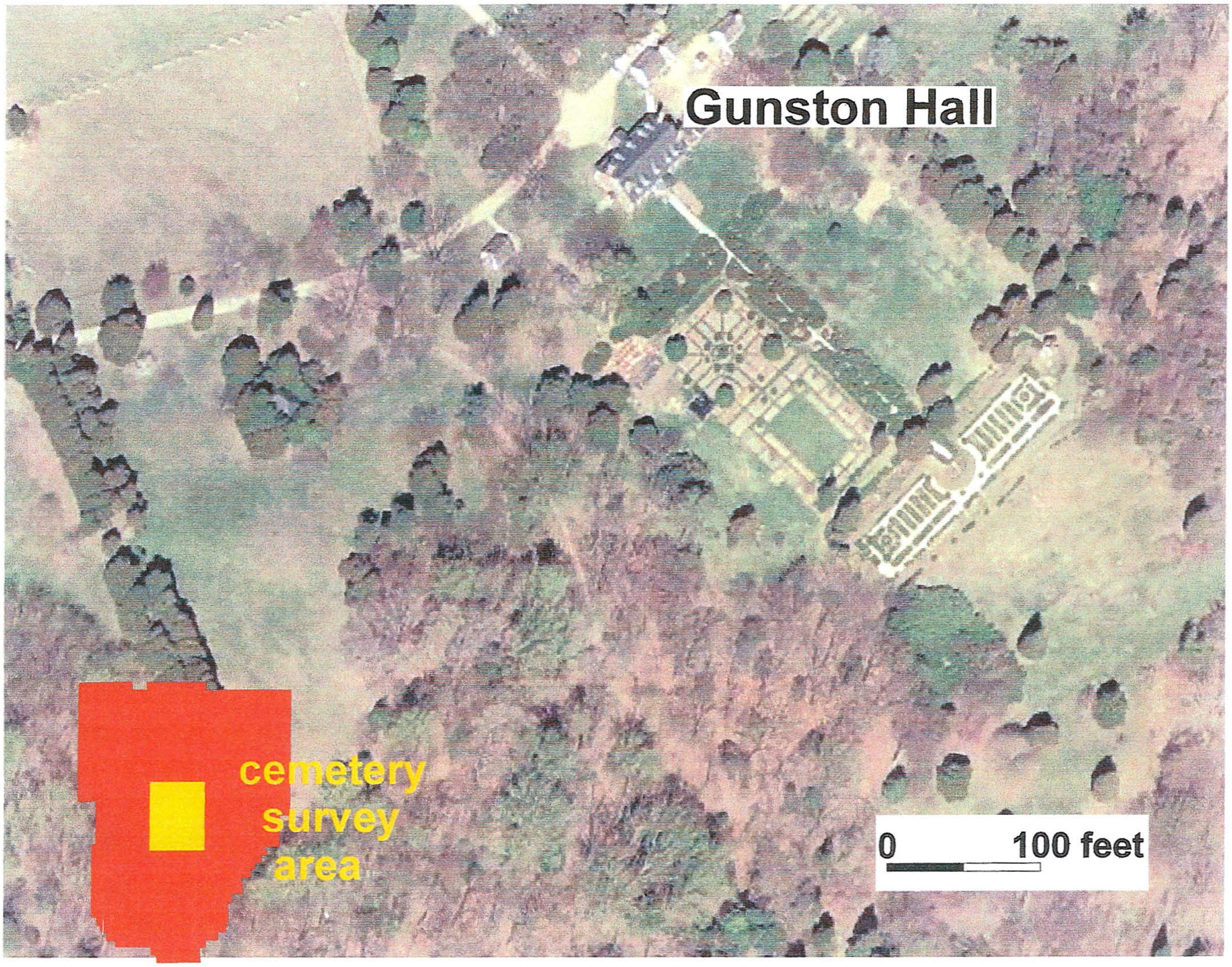


Figure 2. Aerial photograph showing the cemetery (yellow), surveyed in 2005, and surrounding geophysical survey area (red) in relation to Gunston Hall.

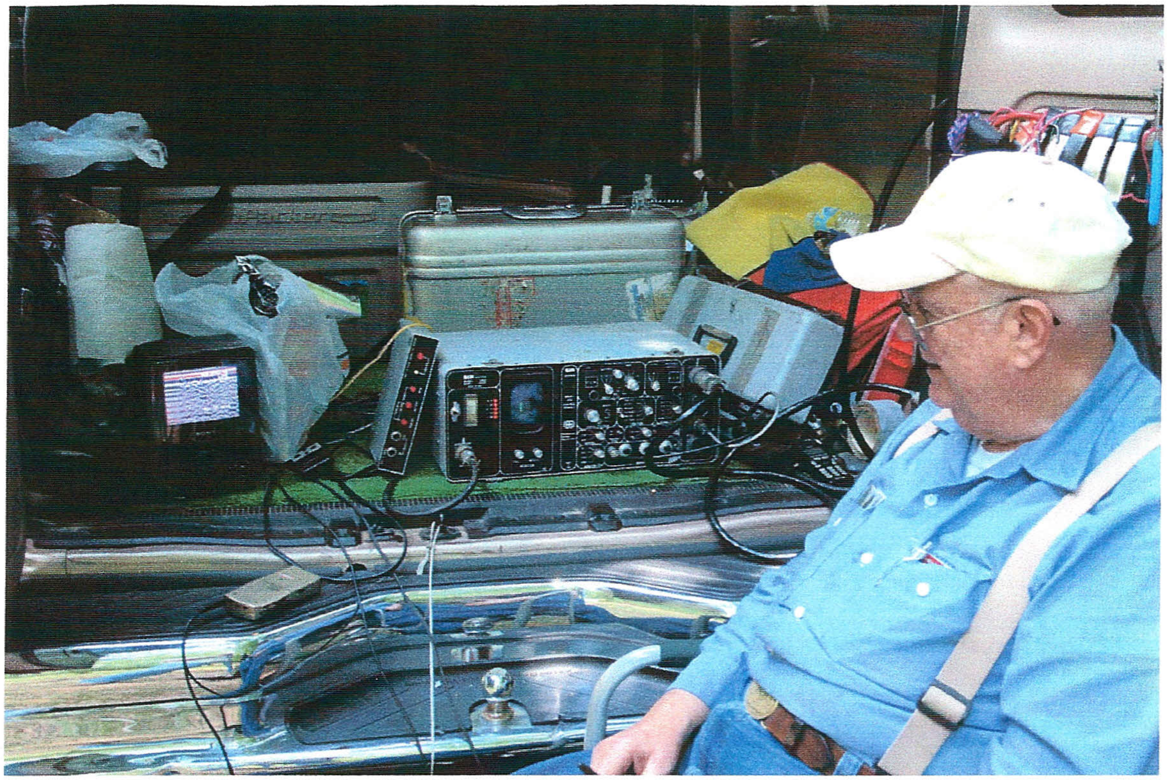
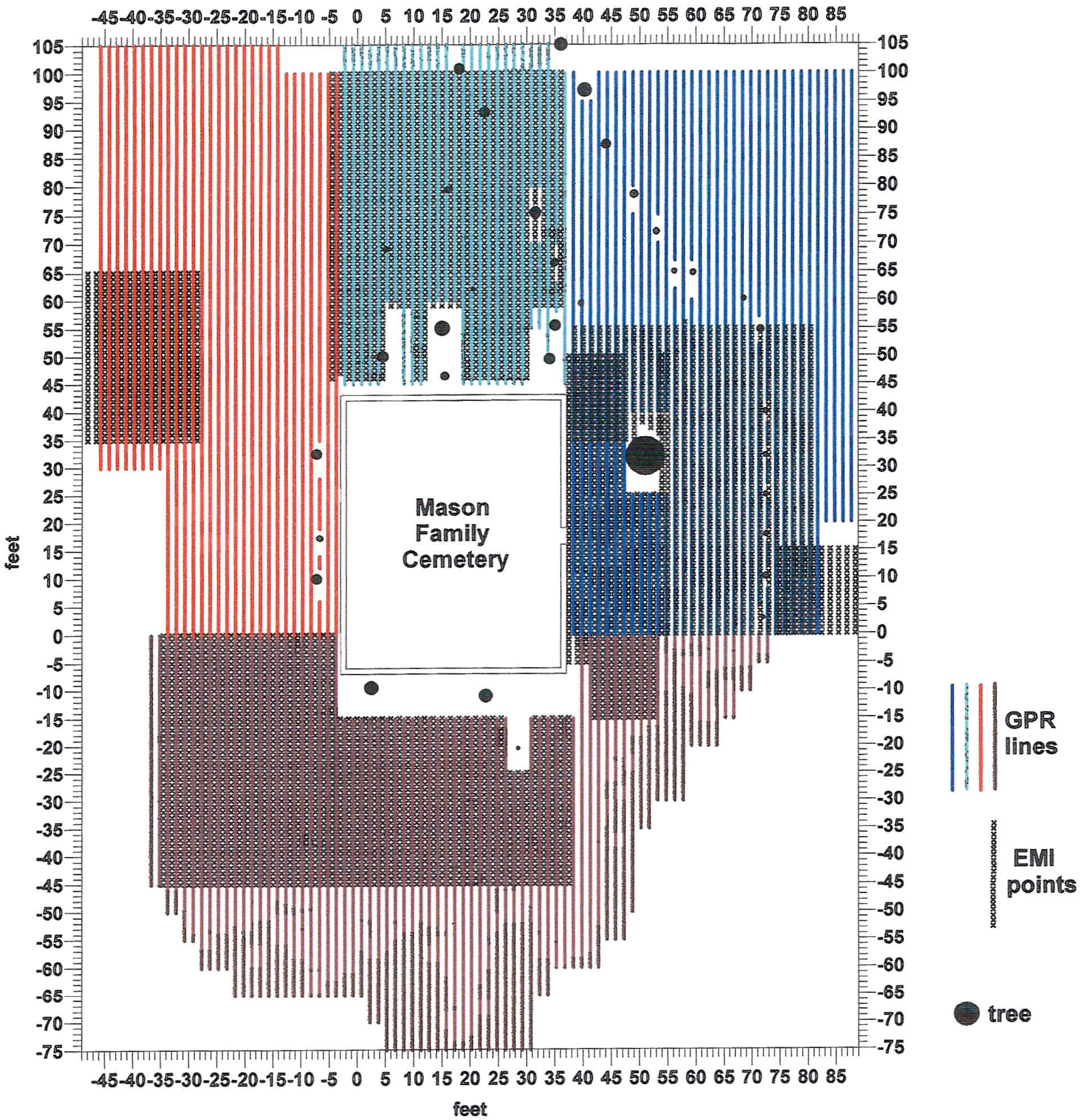


Figure 3. Top: Claude E. "Pete" Petrone operates the electronic equipment associated with the GPR system. Bottom: Bill Hanna (left) and John Imlay operate the 500-MHz antenna south of the walled cemetery.

Figure 4. Top: Geonics EM-38 conductivity meter (orange) with attached microprocessor-based polycorder (red). Bottom: EMI survey in progress north of the cemetery.



Blank areas outside of walled cemetery are heavily wooded and inaccessible.

Figure 5. Locations of GPR lines and EMI measurement points.

Figure 6. Top: Measurement tapes west of cemetery. Bottom: Measurement tapes east of cemetery. The large Spanish Oak [Southern Red Oak] tree in the bottom photograph is now more than 200 years old, as determined by dendrochronology.

Figure 7. Top: Measurement tapes north of the cemetery, looking south. The tapes diagonally cross a pathway bordered by two rows of cedar trees. Archaeology volunteers gathered near Petrone's van will observe the GPR data collection. Bottom: Dave Shonyo (left), Staff Archaeologist, looks on as Hanna and Imlay record probing and coring data.

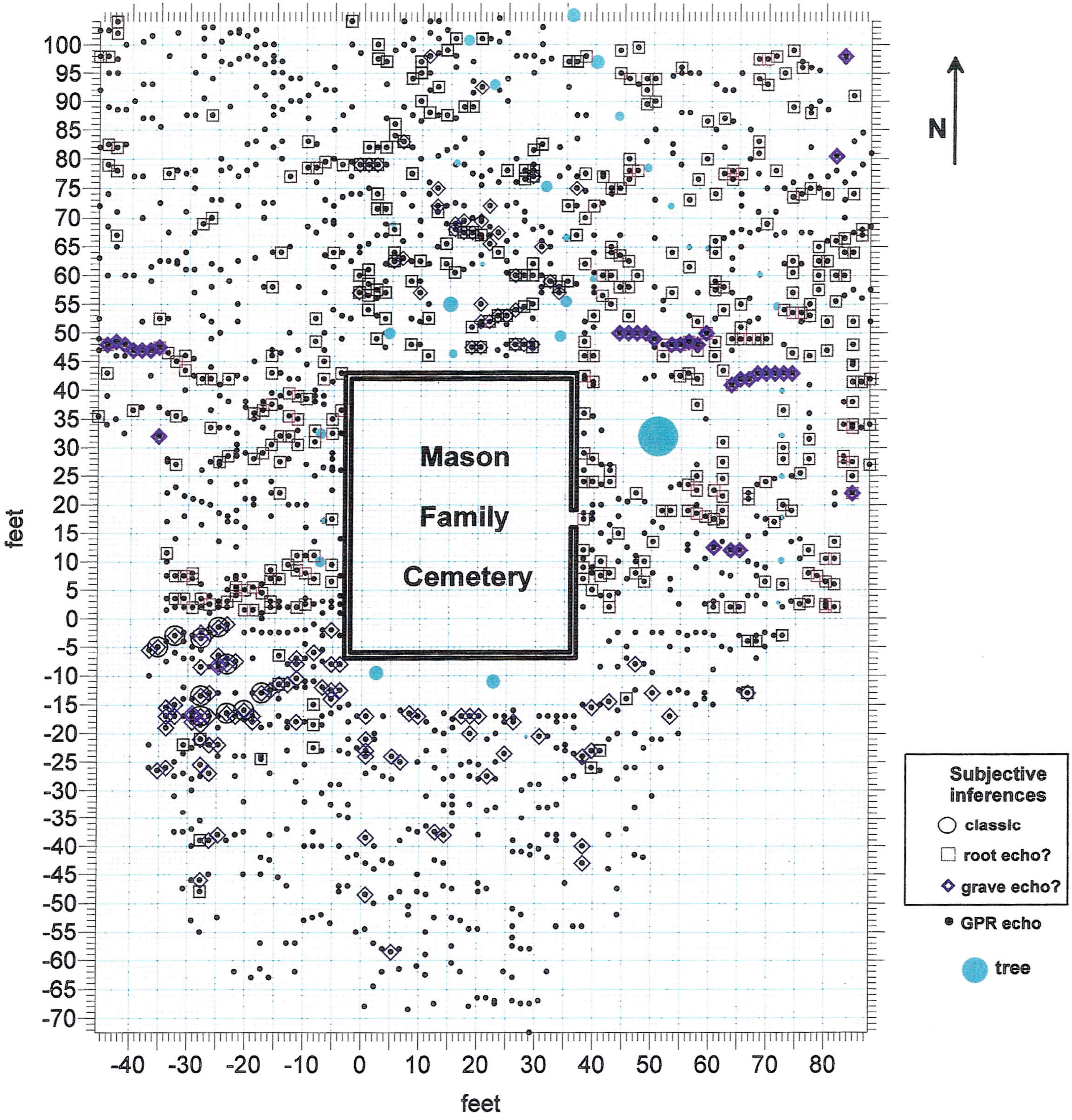


Figure 8. Preliminary map of GPR echoes, unclassified with respect to signal strength and depth-to-reflector, with symbol notations for subjective inferences of tree roots, graves, and video-worthy capture ("classic") for display.

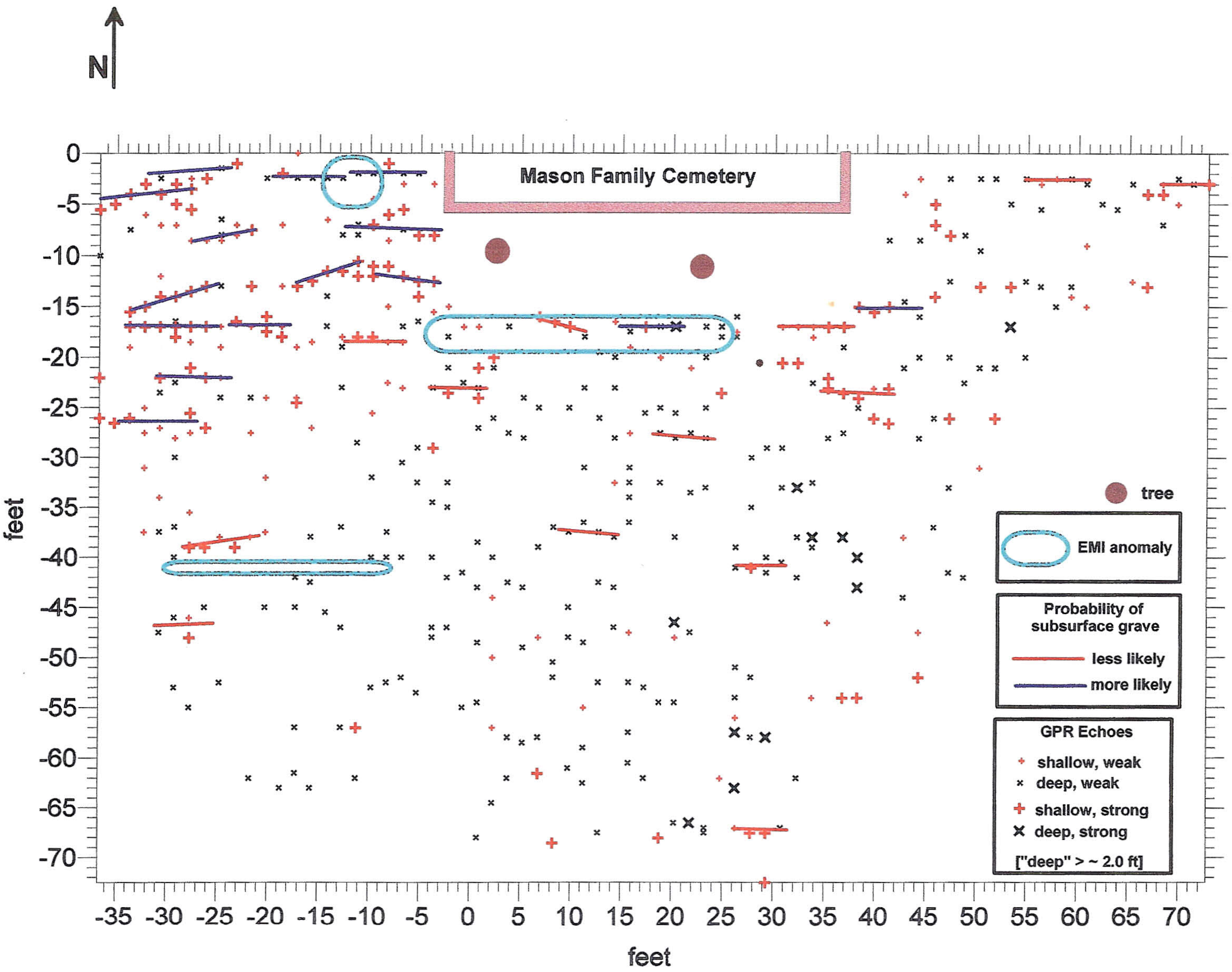


Figure 9. GPR echoes (classified by signal strength and depth) and regions of major EMI anomalies south of the brick-walled cemetery. Echo alignments, which were determined in part by subjective inferences of root-like and grave-like radar signatures, refer to the probability of a grave occurrence. The southernmost linear region of EMI anomalies is based on 2005 data.

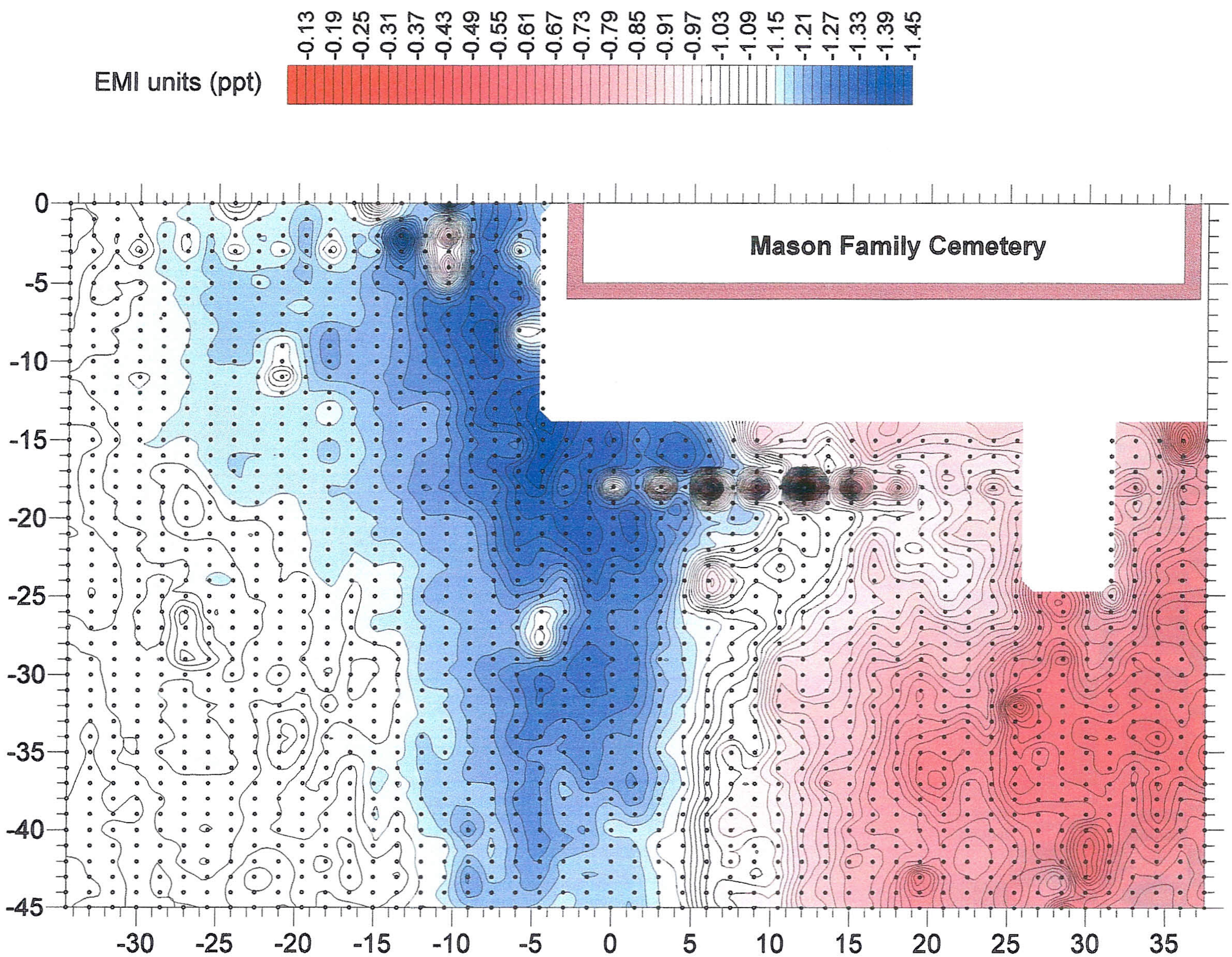
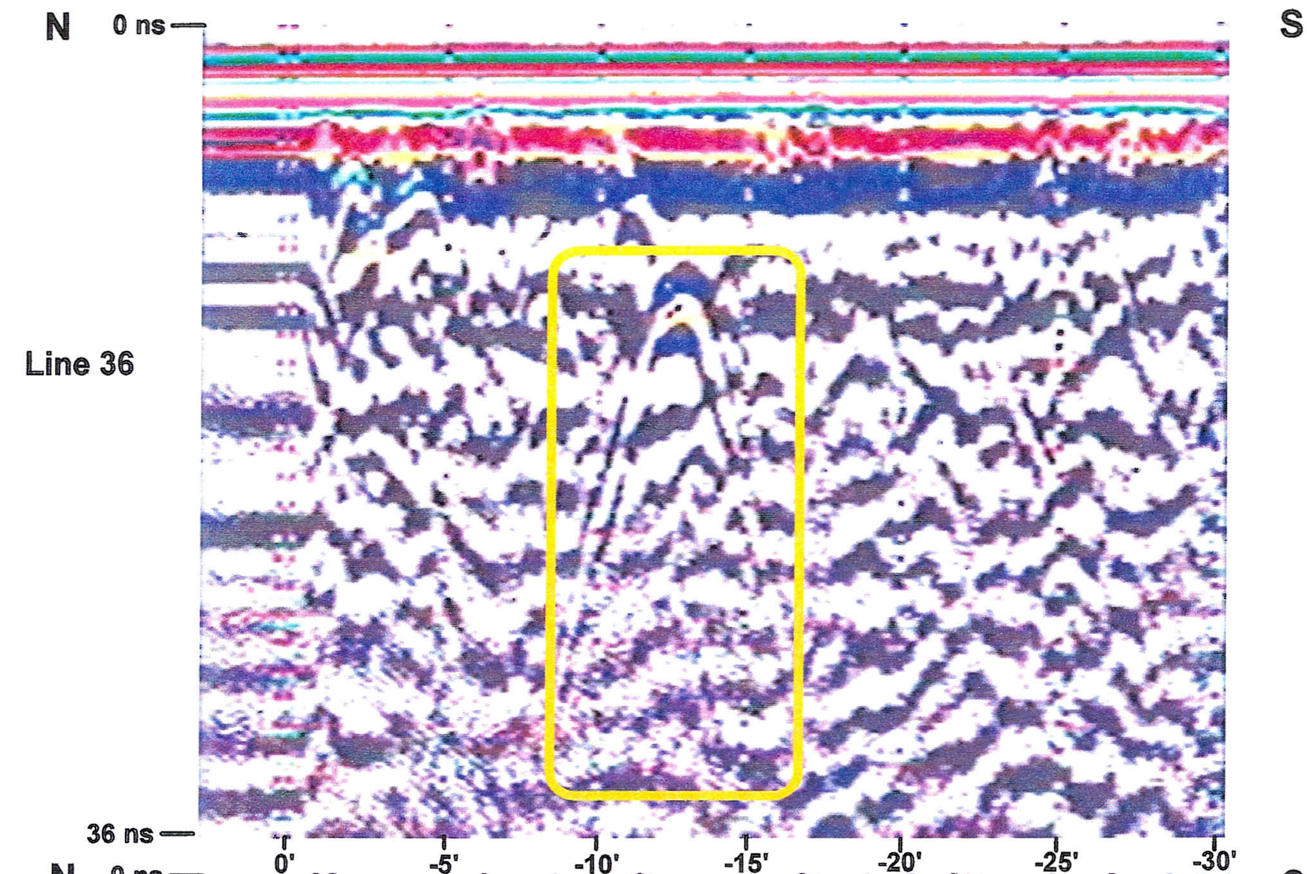


Figure 10. In-phase EMI anomalies over part of the GPR-surveyed area south of the cemetery.



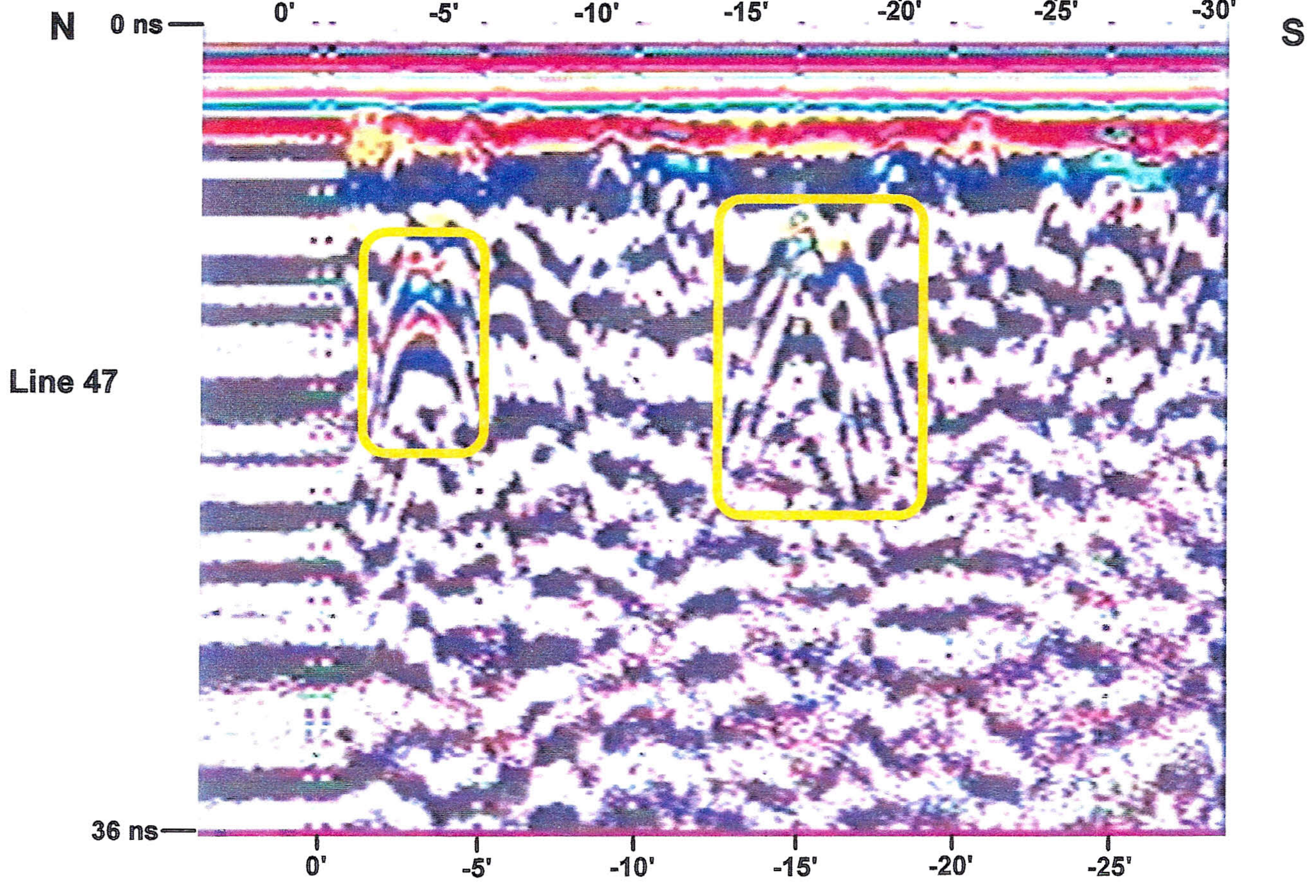


Figure 11. GPR record segments for Line 36 (upper) and Line 47 (lower) south of the walled cemetery, showing major echoes suggesting graves, possibly invaded by tree roots.

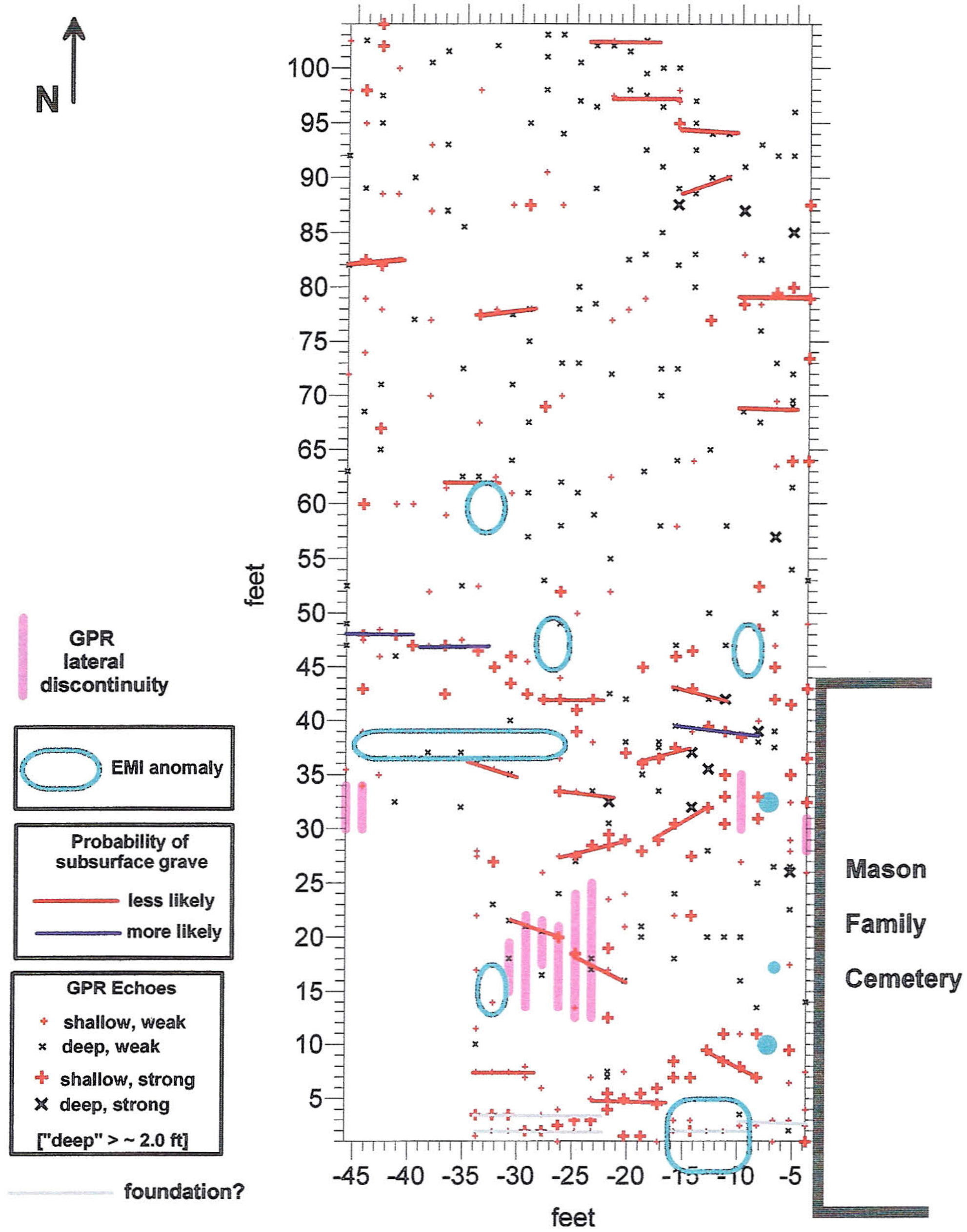


Figure 12. GPR echoes (classified by signal strength and depth), GPR lateral discontinuities, and regions of major EMI anomalies west and northwest of the brick-walled cemetery. Echo alignments, which were determined in part by subjective inferences of root-like and grave-like radar signatures, refer to the probability of a grave occurrence.

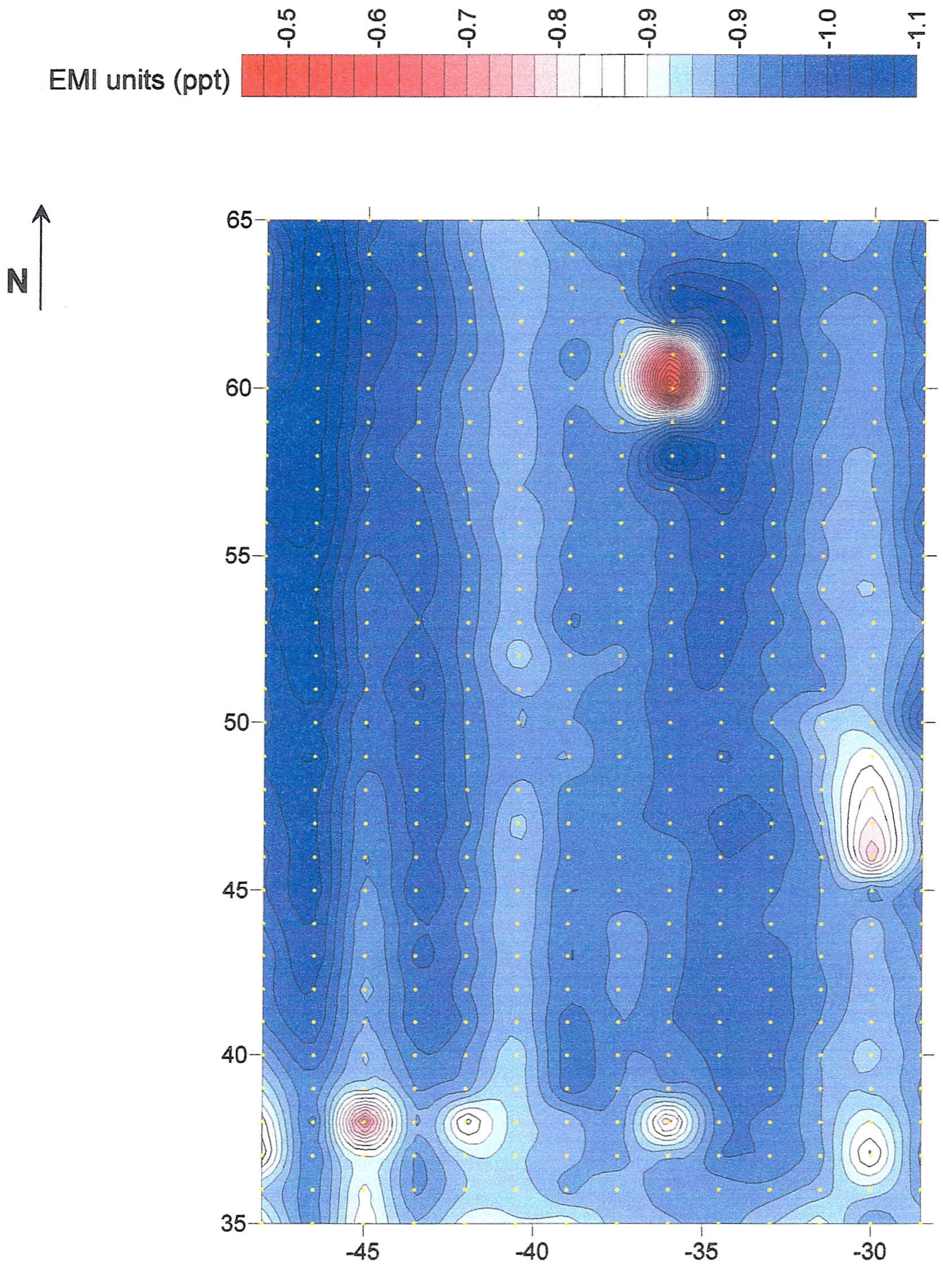


Figure 13. In-phase EMI anomalies over part of the GPR-surveyed area west of the cemetery.

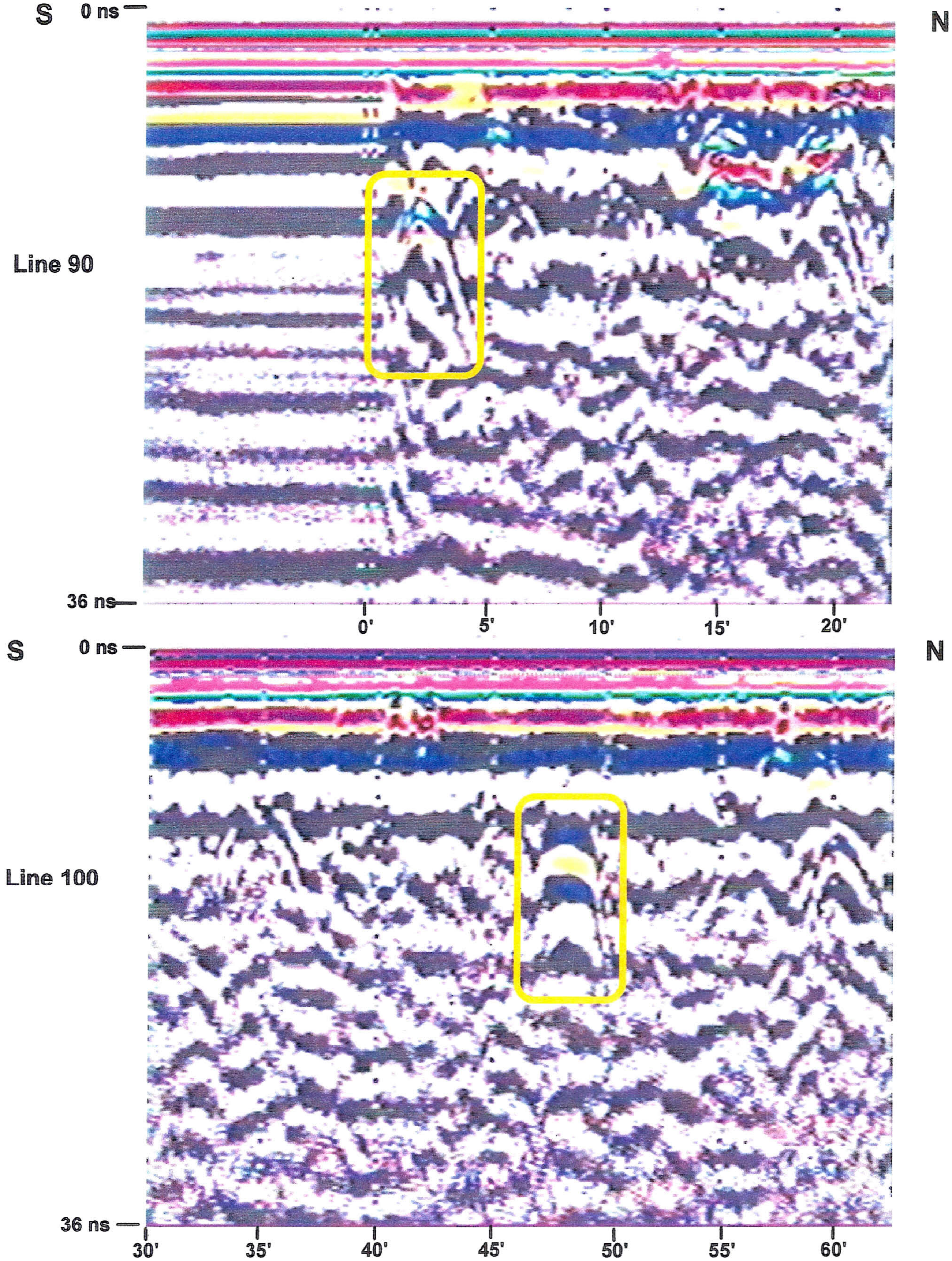


Figure 14. GPR record segments for Line 90 (upper) and Line 100 (lower) west of the walled cemetery, showing major echoes suggesting a foundation (Line 90) and a grave with metallic content (Line 100).

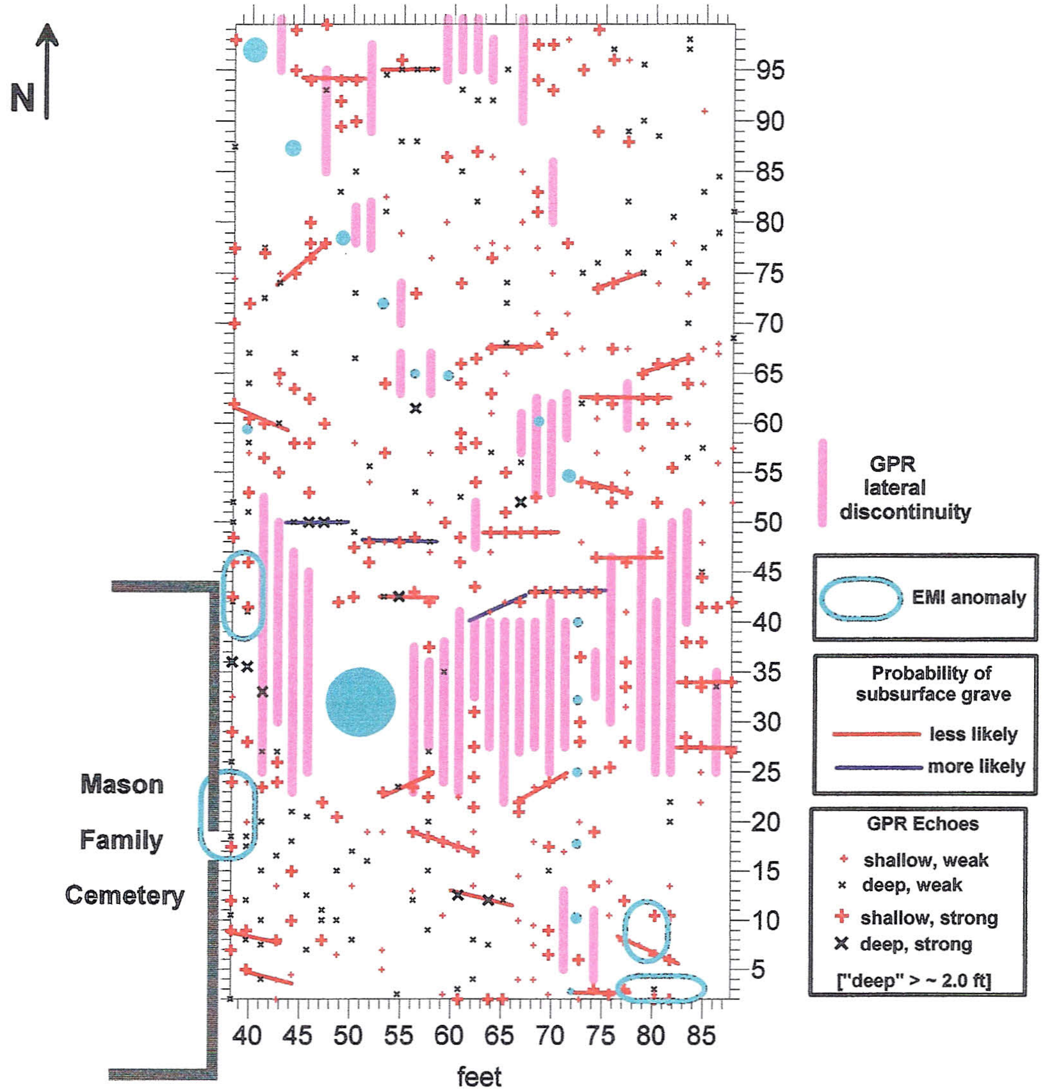
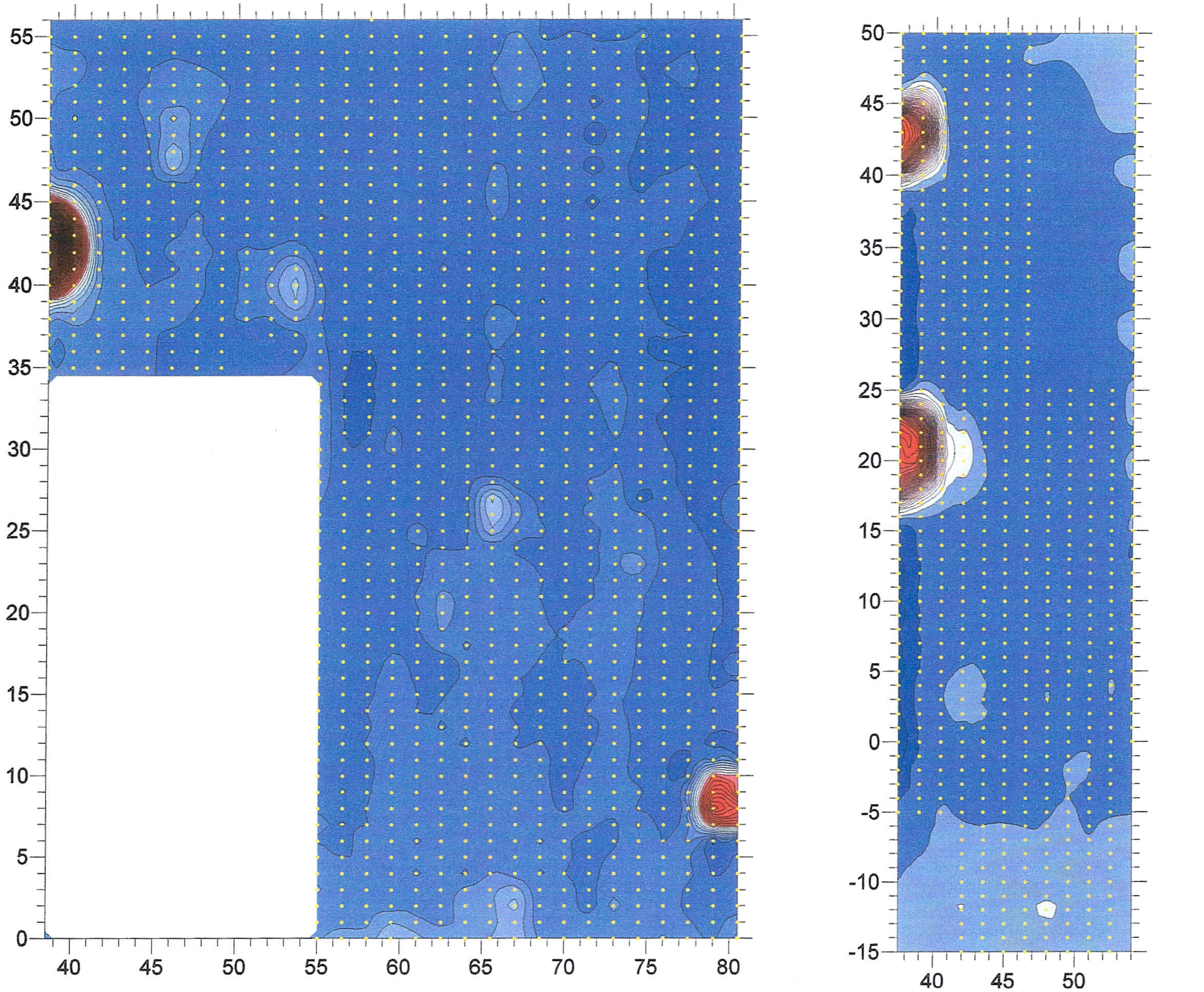


Figure 15. GPR echoes (classified by signal strength and depth), GPR lateral discontinuities, and regions of major EMI anomalies east and northeast of the brick-walled cemetery. Echo alignments, which were determined in part by subjective inferences of root-like and grave-like radar signatures, refer to the probability of a grave occurrence.



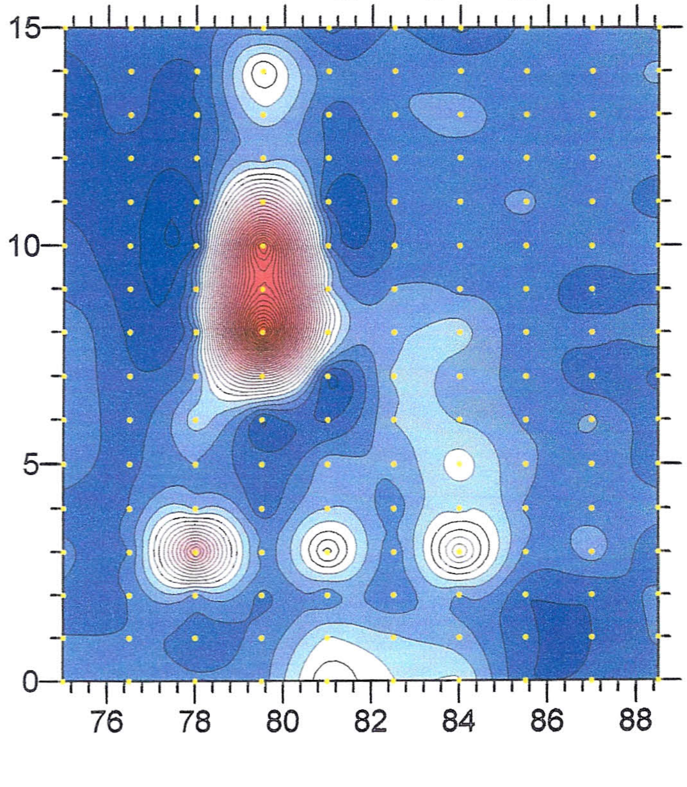


Figure 16. In-phase EMI anomalies over part of the GPR-surveyed area east of the cemetery. The maps in the upper-right and lower-right corners are detailed re-runs of strong anomaly regions of the map in the upper-left corner.

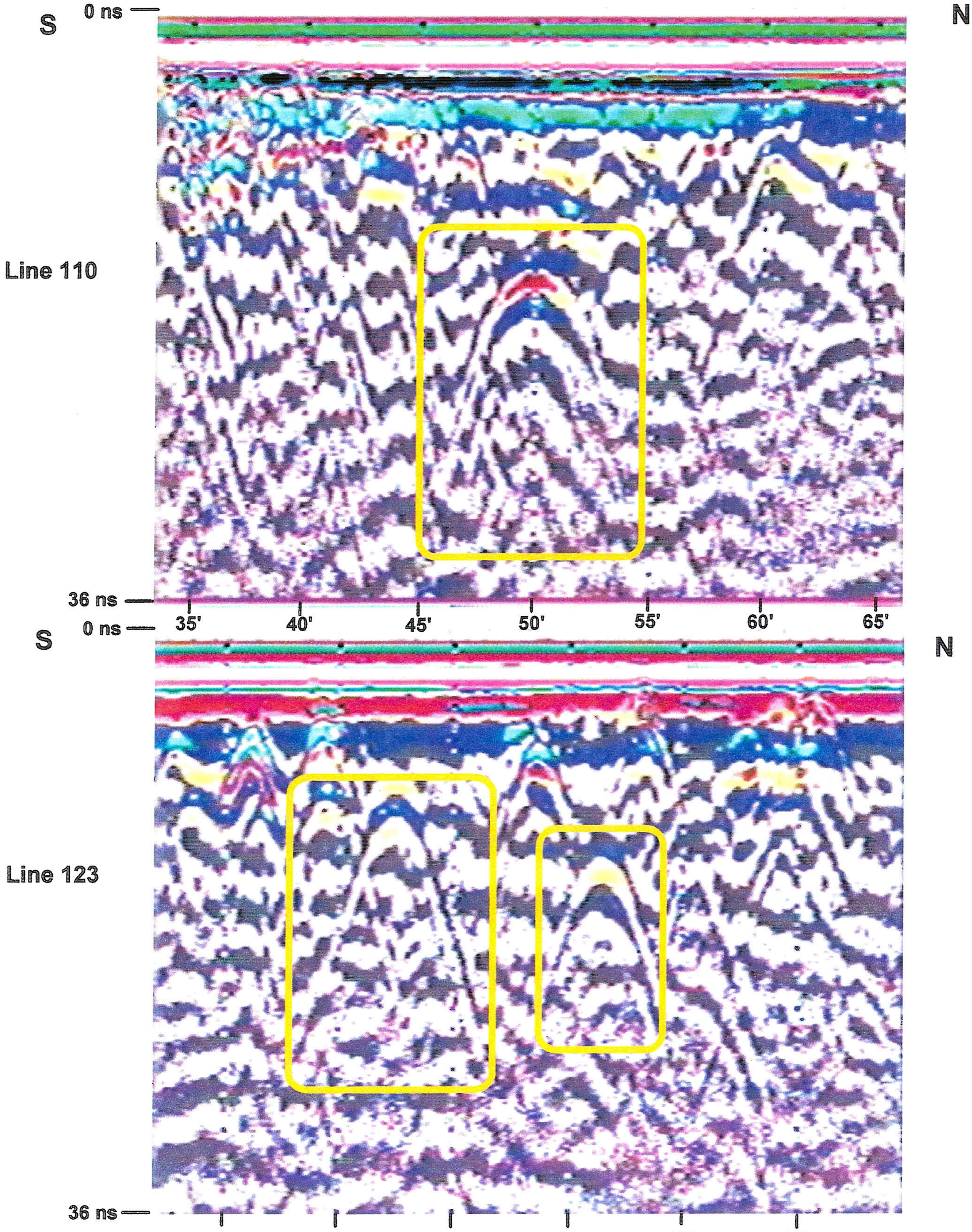


Figure 17. GPR record segments for Line 110 (upper) and Line 123 (lower) east of the walled cemetery, showing major echoes suggesting graves, possibly invaded by tree roots.

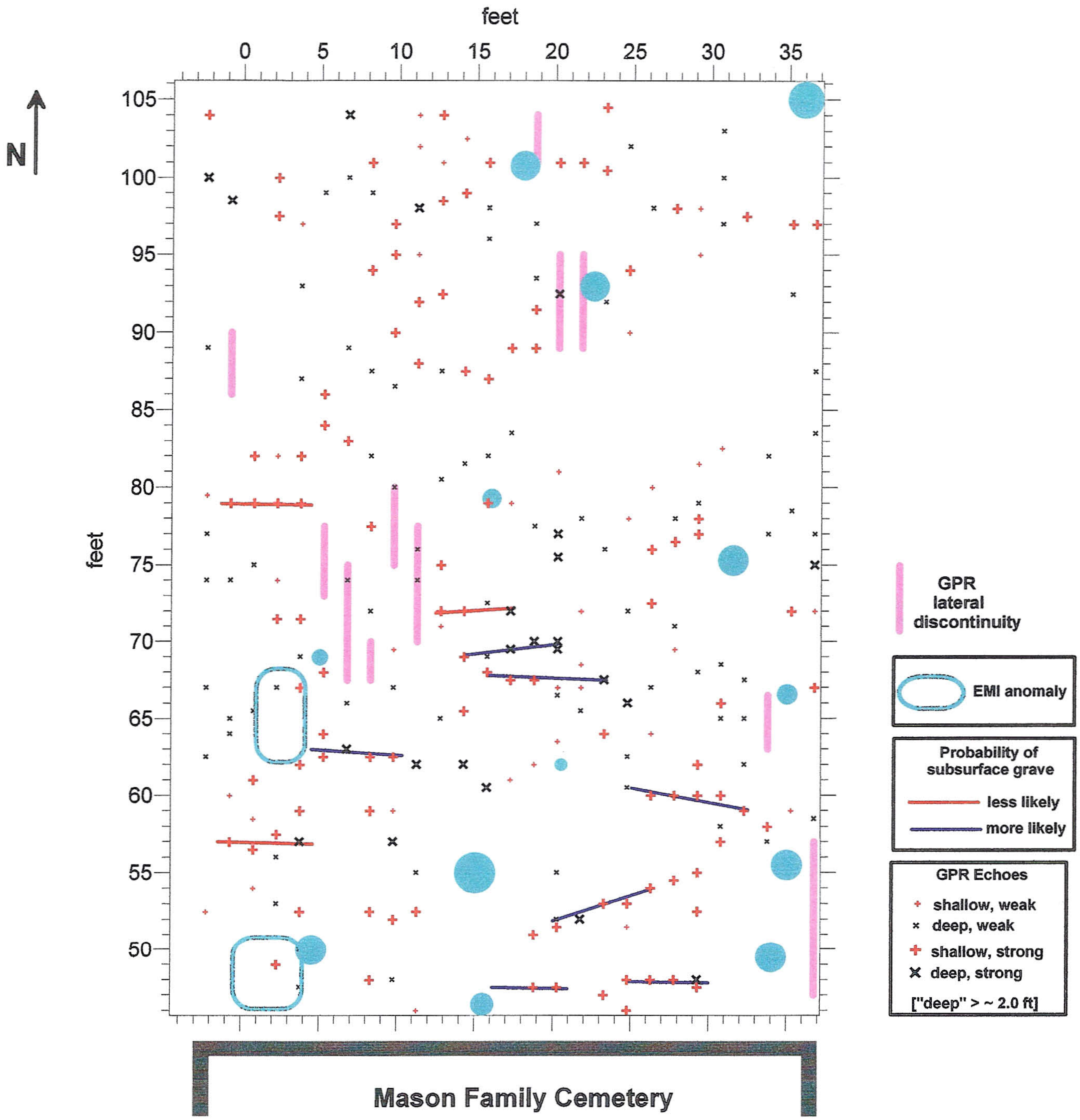


Figure 18. GPR echoes (classified by signal strength and depth), GPR lateral discontinuities, and regions of major EMI anomalies north of the brick-walled cemetery. Echo alignments, which were determined in part by subjective inferences of root-like and grave-like radar signatures, refer to the probability of a grave occurrence.

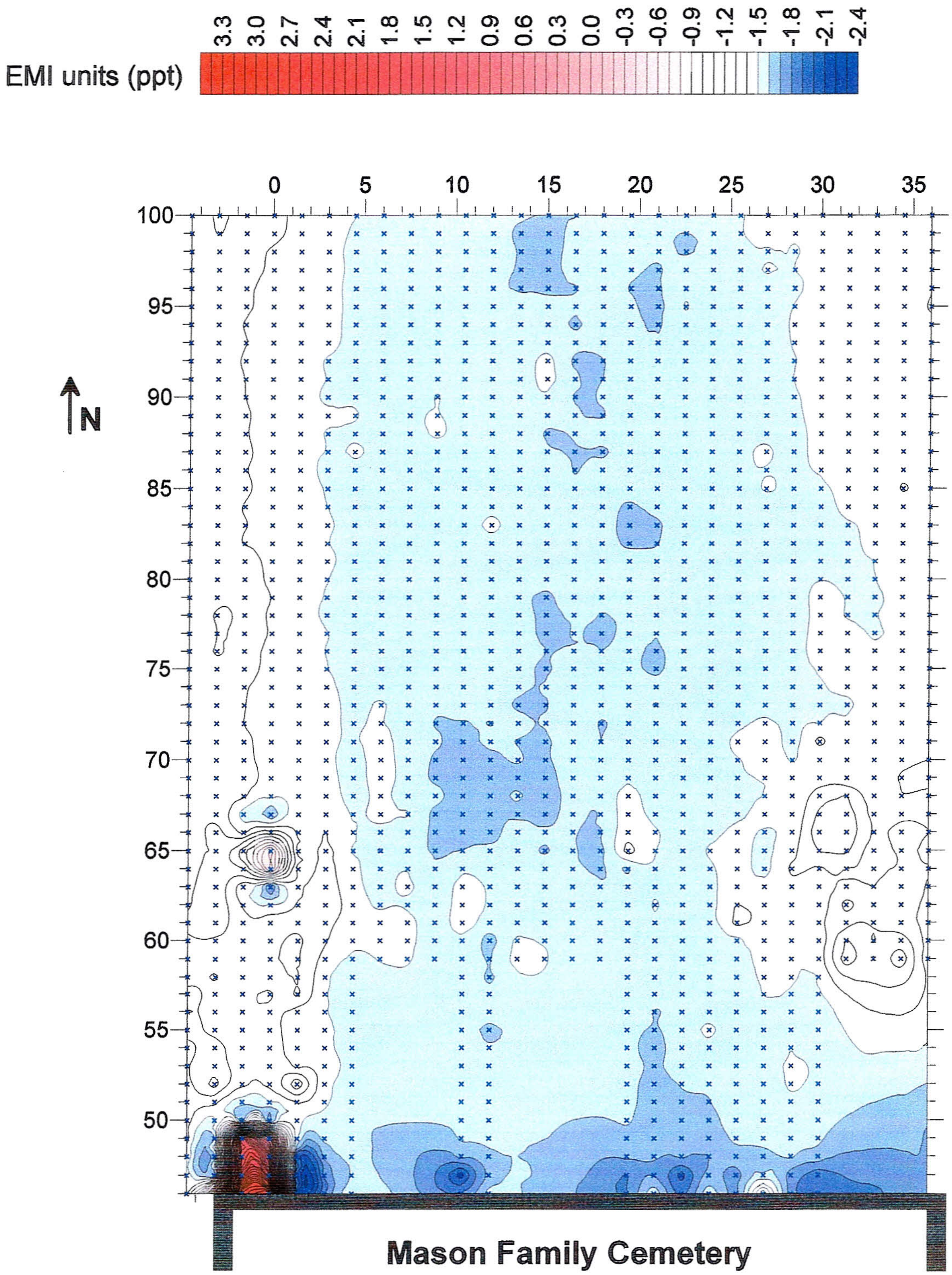


Figure 19. In-phase EMI anomalies over part of the GPR-surveyed area north of the cemetery.

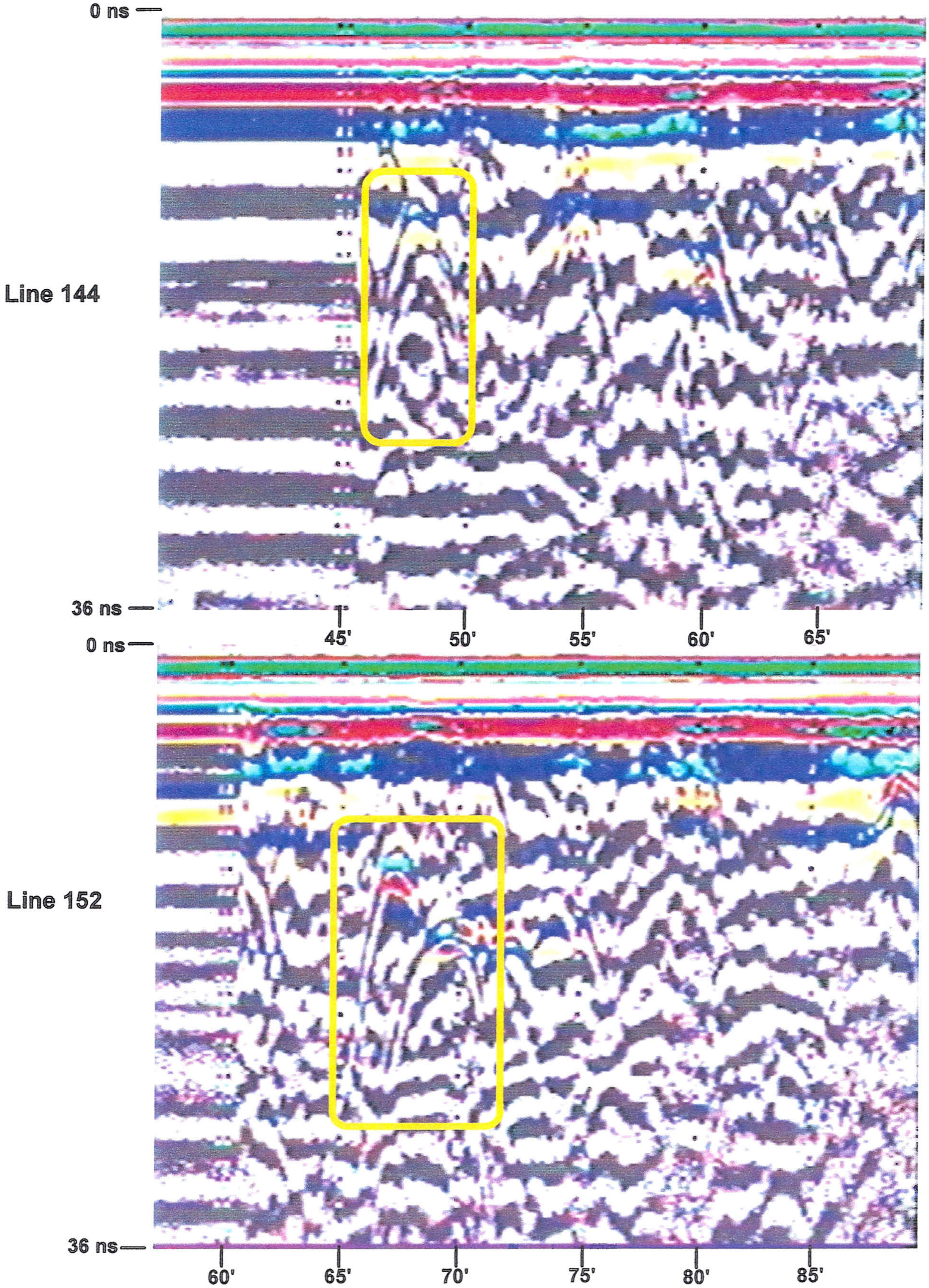


Figure 20. GPR record segments for Line 144 (upper) and Line 152 (lower) north of the walled cemetery, showing major echoes suggesting graves, possibly invaded by tree roots. The echo outlined in yellow on the upper segment (Line 144) shows a circular dark spot, possibly reflecting a void.

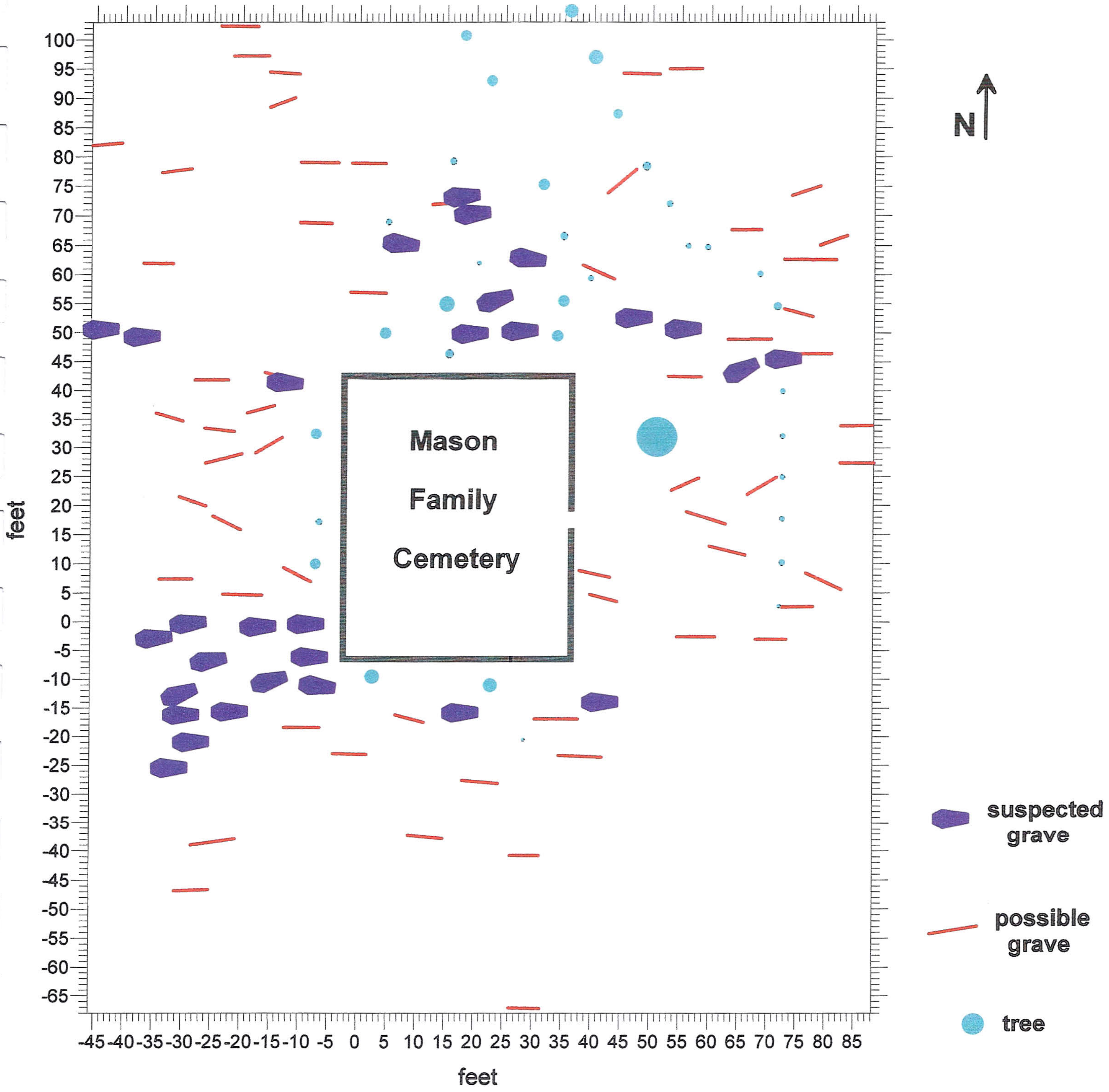


Figure 21. Locations of twenty-nine "suspected graves" and many other "possible graves", commonly also associated with inferred tree roots, outside of the cemetery wall.

APPENDIX A

Data entries for GPR echoes

"Easting" [column 1], and "northing" [column 2] refer, respectively, to distances in feet, increasing eastward and northward relative to the origin of the local coordinate system. Negative values of easting indicate locations west of the coordinate origin. Negative values of northing indicate locations south of the coordinate origin. "2W_TT" [column 3] refers to the two-way travel time, in nanoseconds, that reflected energy travels from the antenna (as transmitter) to the reflector and back to the antenna (as receiver). This two-way travel time can be converted to depth in feet by assuming a specific value for the velocity of the traveling waves. A velocity of 1/3 ft per nanosecond is a reasonable estimate, in the absence of physical measurements. The heading "signal strength" [column 4] refers to the subjectively estimated amplitude or strength of the returned signal, based on values of 1 (weakest) to 3 (strongest). Comments [column 5] are discretionary. Line numbers [column 6] in increasing sequence correspond to the chronological order in which GPR data were acquired. There is no "Line 151"; this label was inadvertently skipped despite the fact that all lines were run in sequence.

The comments, where added, contain informal abbreviations for characteristics of the signal. Examples are "brd" for broad; "nrrw" for narrow; "brkn" for broken; "Lhf" for left-hand flank of hyperbola; "Rhf" for right-hand flank of hyperbola; "asymm" for asymmetrical; "reverb" for reverberation or ringing of signal; "spot" for localized bright region; and "distort" for distorted.

Example

For example, the first entry of Appendix A shows that, along GPR Line Number 1, where the center line of the antenna is 36.75 ft east of the coordinate origin, an echo was noted at a distance of 17.0 ft south of the origin. The top of the echo was recorded at a two-way travel-time of 11.0 ns, or one-way travel time of 5.5 ns. If we assume a soil velocity of 1/3 foot per nanosecond, we multiply this velocity by 5.5 ns to obtain an estimated depth to reflector of approximately 1.8 ft. The relative amplitude of this echo was subjectively assigned a value of "3", meaning that it is very strong. There is no comment for this particular entry.

APPENDIX B

At the suggestion of Dave Shonyo, we ran GPR and EMI surveys along a 300-ft line extending from coordinate point (-33', 100') in a direction N27^{o}W northwest of the cemetery. The purpose of this reconnaissance line was to test remote-sensing soil conditions in an accessible open area. Historical records imply that slave quarters and "Logtown" existed in this general region but whether it resided in what is now cleared areas or heavily wooded areas remains unknown. The GPR data indicated that radar penetration downward is at least as good as at the cemetery area. Both the GPR and EMI data indicate the subsurface presence of iron pipe conduits (see the 2 associated figures).

Appendix A: GPR Echoes, Mason Family Cemetery area

Easting (ft)	Northing (ft)	2W_TT (ns)	Signal Strength	Comment	Line Number
36.75	-17.0	11.0	3		1
36.75	-19.0	14.0	1	vague	1
36.75	-23.5	6.5	3	nrrw	1
36.75	-27.5	15.0	1	X-intersect	1
36.75	-38.0	12.5	3	brd_RHf	1
36.75	-54.0	11.0	3		1
35.25	-17.0	9.0	3		2
35.25	-22.0	6.0	3		2
35.25	-23.0	6.0	3		2
35.25	-28.0	13.0	1	vague	2
35.25	-46.5	11.0	1	nrrw	2
33.75	-17.0	11.0	1		3
33.75	-18.0	10.0	1		3
33.75	-22.5	13.0	1	nrrw	3
33.75	-32.5	15.5	1	brd_rvrb	3
33.75	-38.0	12.5	2	brd_rvrb	3
33.75	-39.0	30.0	1	rvrb	3
33.75	-54.0	9.0	1	brd	3
32.25	-17.0	7.5	1		4
32.25	-20.5	8.5	3		4
32.25	-33.0	19.5	2	symm	4
32.25	-38.0	16.0	1	brd	4
32.25	-42.0	16.0	1	distort	4
32.25	-62.0	15.5	1		4
30.75	-17.0	7.5	1	RHf	5
30.75	-20.5	7.5	3		5
30.75	-29.0	13.0	1	rvrb	5
30.75	-33.0	26.5	1	brd_vague	5
30.75	-40.5	19.5	1	vague	5
30.75	-67.0	13.0	1	brd	5
29.25	-29.0	15.0	1	rvrb	6
29.25	-40.0	19.0	1	brd_rvrb	6
29.25	-41.5	20.0	1		6
29.25	-58.0	22.0	2		6
29.25	-67.5	5.0	3		6
29.25	-72.5	6.0	2		6
27.75	-30.0	17.0	1	brd_LHfs	7
27.75	-35.0	16.5	1	brkn	7
27.75	-41.0	7.5	2	rvrb	7
27.75	-52.0	20.0	1	nrrw	7
27.75	-58.0	12.0	1	rvrb	7
27.75	-67.5	4.5	3		7
26.25	-16.0	14.0	1	nrrw_rvrb	8
26.25	-17.5	8.0	1	rvrb	8
26.25	-18.0	22.0	1		8
26.25	-39.0	13.5	1	rvrb	8
26.25	-41.0	13.0	1	rvrb	8
26.25	-51.0	27.0	1	brd_asymm	8
26.25	-54.0	15.5	1		8
26.25	-56.0	10.5	1	rvrb	8
26.25	-57.5	13.0	2	brd	8
26.25	-63.0	12.0	3		8
26.25	-67.0	10.5	1	brd	8
24.75	-17.0	15.5	1		9
24.75	-18.0	13.5	1	brd	9
24.75	-23.5	6.5	3	brd	9
24.75	-62.0	10.0	1	distort	9
23.25	-17.0	20.5	1		10
23.25	-20.0	12.0	1	brd	10
23.25	-25.0	22.5	1	brd	10
23.25	-28.0	28.0	1	rvrb	10
23.25	-33.0	22.0	1	spot	10
23.25	-67.0	16.0	1	chevron	10
23.25	-67.5	20.5	1	chevron	10
21.75	-21.0	10.5	1	RHf	11
21.75	-27.5	30.0	1	brd_spot	11
21.75	-33.5	16.5	1		11
21.75	-47.5	18.5	1	brd_vague	11
21.75	-66.5	15.0	2	symm	11
20.25	-17.0	12.0	2		12
20.25	-25.5	14.5	1		12
20.25	-28.0	13.5	1		12
20.25	-38.0	14.0	1	nrrw	12
20.25	-46.5	17.0	2		12
20.25	-48.0	11.5	1	brd	12
20.25	-54.5	26.5	1	brd	12
20.25	-66.5	20.0	1	rvrb	12
18.75	-17.0	13.0	1		13
18.75	-20.0	10.5	1		13
18.75	-25.0	14.0	1	brd	13
18.75	-27.5	25.5	1	brd_vague	13
18.75	-32.5	22.5	1		13
18.75	-54.5	14.0	1	distort	13
18.75	-68.0	7.0	3		13

Easting (ft)	Northing (ft)	2W_TT (ns)	Signal Strength	Comment	Line Number
17.25	-17.0	7.0	3		14
17.25	-25.5	13.0	1	brd	14
17.25	-53.0	13.0	1	brkn_rvrb	14
17.25	-62.0	12.0	1		14
15.75	-17.5	32.0	1	brd_chevron	15
15.75	-19.0	11.5	1	rvrb	15
15.75	-27.5	11.5	1	rvrb	15
15.75	-31.0	23.5	1		15
15.75	-32.5	21.0	1		15
15.75	-34.0	21.0	1		15
15.75	-36.5	17.0	1	chevron	15
15.75	-47.5	11.0	1	spot	15
15.75	-52.5	17.0	1	brd_brkn	15
15.75	-57.5	12.0	1	brd_rvrb	15
15.75	-60.5	12.0	1	rvrb	15
14.25	-16.5	8.5	1	nrrw_rvrb	16
14.25	-20.0	18.0	1		16
14.25	-23.0	32.5	1	brd	16
14.25	-28.0	15.5	1	rvrb_spots	16
14.25	-32.5	9.5	1	asymm	16
14.25	-38.0	29.0	1	brd_rvrb	16
14.25	-43.0	17.0	1	brd	16
14.25	-47.0	16.0	1	brd	16
12.75	-19.5	31.0	1	chevron	17
12.75	-26.0	28.0	1	brd	17
12.75	-37.5	27.0	1	spot	17
12.75	-42.5	26.0	1	brd	17
12.75	-52.5	25.5	1	brd_brkn	17
12.75	-67.5	12.5	1		17
11.25	-18.0	24.0	1	brd	18
11.25	-23.0	29.0	1	rvrb	18
11.25	-31.0	26.0	1	vague	18
11.25	-36.5	30.5	1	rvrb	18
11.25	-48.5	25.5	1	rvrb	18
11.25	-55.0	7.5	1	brd	18
11.25	-59.0	12.5	1		18
11.25	-62.5	17.5	1	rvrb	18
9.75	-17.0	7.5	3		19
9.75	-25.0	28.0	1	brd_rvrb	19
9.75	-37.5	21.0	1		19
9.75	-45.0	29.0	1		19
9.75	-48.0	22.5	1		19
9.75	-61.0	32.5	1		19
8.25	-16.5	9.0	2		20
8.25	-37.0	32.0	1		20
8.25	-50.5	22.5	1		20
8.25	-52.0	26.0	1	brd_rvrb	20
8.25	-68.5	6.5	3	brd	20
6.75	-16.0	8.0	2	rvrb	21
6.75	-25.0	31.5	1	brd	21
6.75	-39.0	18.0	1		21
6.75	-48.0	9.0	1	brd_rvrb	21
6.75	-58.0	12.5	1		21
6.75	-61.5	5.5	3	rvrb	21
5.25	-24.0	29.5	1	brd	22
5.25	-28.0	28.5	1	rvrb	22
5.25	-43.0	31.0	1	rvrb	22
5.25	-49.0	22.0	1	nrrw_vague	22
5.25	-58.5	30.0	1	brd	22
3.75	-17.0	22.5	1	vague	23
3.75	-27.5	30.0	1	rvrb	23
3.75	-42.5	24.0	1	brd	23
3.75	-58.0	31.5	1	brd_vague	23
3.75	-62.0	30.5	1	brd	23
2.25	-20.0	6.5	2	brd	24
2.25	-21.0	21.5	1	brd_rvrb	24
2.25	-26.0	23.0	1	rvrb	24
2.25	-40.0	24.5	1	brd_spot	24
2.25	-44.0	6.5	1		24
2.25	-50.0	11.5	1	brd	24
2.25	-57.0	8.5	1	brkn_spot	24
2.25	-64.5	12.0	1		24
0.75	-17.0	8.5	1	rvrb_symm	25
0.75	-21.0	5.0	3	rvrb	25
0.75	-23.0	12.5	1	spot	25
0.75	-24.0	6.5	2	brd_rvrb	25
0.75	-27.0	27.5	1		25
0.75	-38.5	31.0	1	brd_rvrb	25
0.75	-43.0	25.5	1	brd_rvrb	25
0.75	-48.5	25.5	1	brd_rvrb	25
0.75	-54.5	19.0	1	brd_LHf	25
0.75	-68.0	12.0	1	brd_brkn	25
-0.75	-17.0	11.0	1		26
-0.75	-22.5	16.0	1	brd_vague	26

Appendix A: GPR Echoes, Mason Family Cemetery area

Easting (ft)	Northing (ft)	2W_TT (ns)	Signal Strength	Comment	Line Number
-0.75	-41.5	26.0	1	brd	26
-0.75	-55.0	28.5	1	RHf	26
-2.25	-15.0	8.0	1		27
-2.25	-18.0	12.0	1		27
-2.25	-21.0	16.5	1		27
-2.25	-23.5	5.0	3	nrrw_rvrb	27
-2.25	-32.5	31.5	1	brd	27
-2.25	-35.0	14.0	1	rvrb	27
-2.25	-42.0	20.5	1	brd_rvrb	27
-2.25	-47.0	14.0	1	brd	27
-3.75	-3.0	11.5	1	brd	28
-3.75	-8.0	7.0	3	rvrb	28
-3.75	-12.5	6.0	2	rvrb_spot	28
-3.75	-15.5	8.0	1	vague	28
-3.75	-23.0	20.5	1	LHf	28
-3.75	-29.0	5.0	2	spot	28
-3.75	-34.5	30.5	1		28
-3.75	-40.0	26.5	1	brd_rvrb	28
-3.75	-47.0	28.0	1	brd	28
-3.75	-48.0	31.5	1	brd	28
-5.25	-2.0	13.0	1	rvrb_symm	29
-5.25	-8.0	8.0	3		29
-5.25	-12.5	6.5	2		29
-5.25	-14.0	6.0	2		29
-5.25	-16.5	13.0	1		29
-5.25	-29.0	27.5	1	nrrw_rvrb	29
-5.25	-32.5	23.5	1	brd	29
-5.25	-53.5	16.5	1		29
-6.75	-2.0	15.0	1	nrrw_rvrb	30
-6.75	-3.0	11.5	1	rvrb_RHfs	30
-6.75	-5.5	5.0	2	brd_RHf	30
-6.75	-7.5	14.0	1	brd	30
-6.75	-12.0	6.5	3	rvrb	30
-6.75	-17.0	12.5	1	symm	30
-6.75	-18.5	5.0	1		30
-6.75	-23.0	5.0	1		30
-6.75	-30.5	24.0	1	brd_rvrb	30
-6.75	-40.0	26.0	1	brd_rvrb	30
-6.75	-52.0	15.0	1	brd	30
-8.25	-1.0	6.5	2	RHfs	31
-8.25	-6.0	5.5	2		31
-8.25	-8.5	7.5	1	rvrb_distort	31
-8.25	-11.0	6.5	2		31
-8.25	-15.0	4.0	1		31
-8.25	-18.5	5.0	1		31
-8.25	-22.5	5.0	1		31
-8.25	-37.5	26.5	1	brd	31
-8.25	-40.0	29.0	1	brd	31
-8.25	-52.5	30.0	1	brd_brkn	31
-9.75	-2.0	14.0	1	spot	32
-9.75	-4.5	7.0	1	brkn	32
-9.75	-7.0	5.5	3		32
-9.75	-11.0	5.0	3		32
-9.75	-12.0	6.5	2		32
-9.75	-18.0	9.5	2		32
-9.75	-25.5	10.0	1		32
-9.75	-32.0	32.0	1		32
-9.75	-40.0	31.0	1		32
-9.75	-53.0	21.5	1	brd_rvrb	32
-11.25	-2.0	20.0	1	spot	33
-11.25	-7.0	13.0	1	nrrw_rvrb	33
-11.25	-8.0	13.0	1	brd	33
-11.25	-10.5	5.5	3	metall	33
-11.25	-12.0	6.0	2		33
-11.25	-18.0	11.5	2		33
-11.25	-28.5	26.5	1	brd_vague	33
-11.25	-57.0	6.5	2		33
-11.25	-62.0	22.0	1	brd_rvrb	33
-12.75	-2.5	14.0	1	brd_rvrb	34
-12.75	-8.0	30.5	1		34
-12.75	-11.5	5.5	3		34
-12.75	-18.0	7.0	1		34
-12.75	-19.0	12.5	1		34
-12.75	-23.0	32.5	1	chevron	34
-12.75	-37.0	29.0	1	brd	34
-12.75	-47.0	32.0	1	chevron	34
-12.75	-57.0	35.0	1	brd_rvrb	34
-14.25	-2.5	21.0	1	brd	35
-14.25	-6.5	4.0	1	chevron	35
-14.25	-11.5	4.5	2		35
-14.25	-14.0	15.0	1	chevrons	35
-14.25	-17.0	24.0	1	brd	35
-14.25	-45.5	29.0	1	brd_RHf	35
-15.75	-2.5	16.5	1	spot	36

Easting (ft)	Northing (ft)	2W_TT (ns)	Signal Strength	Comment	Line Number
-15.75	-12.5	10.0	3		36
-15.75	-18.5	11.5	1		36
-15.75	-27.0	11.0	1	rvrb	36
-15.75	-38.0	13.0	1	spot	36
-15.75	-42.5	23.0	1	brd	36
-15.75	-63.0	25.0	1	spot	36
-17.25	0.0	5.5	1	RHfs	37
-17.25	-2.5	12.0	1	brkn_spot	37
-17.25	-13.0	7.0	3	flanks	37
-17.25	-19.0	6.5	1		37
-17.25	-24.0	8.5	1		37
-17.25	-24.5	5.5	2		37
-17.25	-42.0	14.0	1	brd_rvrb	37
-17.25	-45.0	31.0	1	brd	37
-17.25	-57.0	19.0	1	RHf	37
-17.25	-61.5	21.0	1	brd	37
-18.75	-2.0	5.0	3	rvrb_metall	38
-18.75	-7.0	7.0	1		38
-18.75	-13.0	7.0	1		38
-18.75	-17.0	11.5	1	rvrb	38
-18.75	-18.0	6.0	2	rvrb	38
-18.75	-63.0	17.0	1	brd_spot	38
-20.25	-2.5	17.0	1	spot	39
-20.25	-16.0	10.0	2	flanks	39
-20.25	-17.5	6.5	2		39
-20.25	-24.0	5.0	1		39
-20.25	-32.0	11.0	1		39
-20.25	-37.5	10.0	1		39
-20.25	-45.0	18.0	1		39
-21.75	-7.5	6.5	2	rvrb	40
-21.75	-13.0	6.0	2	nrrw_rvrb	40
-21.75	-17.0	7.5	1	rvrb	40
-21.75	-24.0	12.5	1		40
-21.75	-27.5	6.5	1	spot_vague	40
-21.75	-38.0	5.0	1	nrrw_brkn	40
-21.75	-62.0	26.0	1	brd	40
-23.25	-1.0	9.5	2	nrrw_spot	41
-23.25	-7.0	6.5	1		41
-23.25	-8.0	11.5	1	brd_LHf	41
-23.25	-16.5	6.0	3	rvrb	41
-23.25	-39.0	5.0	2	nrrw_rvrb	41
-24.75	-1.5	13.0	1	RHfs	42
-24.75	-6.5	15.0	1	spot	42
-24.75	-8.0	16.0	1	spot	42
-24.75	-8.5	6.5	1		42
-24.75	-13.0	12.5	1	brd_brkn	42
-24.75	-17.0	6.0	1		42
-24.75	-19.0	6.5	1	nrrw_brkn	42
-24.75	-22.0	6.5	1	RHfs	42
-24.75	-24.0	12.5	1	spot	42
-24.75	-38.0	6.5	1		42
-24.75	-52.5	25.5	1	brd_rvrb	42
-26.25	-2.5	10.0	2	brd	43
-26.25	-8.5	9.0	1	spot	43
-26.25	-13.0	7.0	2	rvrb	43
-26.25	-17.0	6.5	2		43
-26.25	-22.0	6.0	2		43
-26.25	-27.0	7.5	2	rvrb	43
-26.25	-39.0	6.0	2	brd	43
-26.25	-45.0	13.0	1	brd	43
-27.75	-2.5	7.5	1	rvrb	44
-27.75	-3.5	11.0	2	brd	44
-27.75	-5.5	9.5	2	g?	44
-27.75	-8.5	9.0	1	spot	44
-27.75	-13.5	5.5	3	brd_spot	44
-27.75	-17.0	7.0	3	brd_RHfs	44
-27.75	-18.5	8.0	1		44
-27.75	-21.0	4.5	2		44
-27.75	-25.5	4.0	2	rvrb	44
-27.75	-27.5	11.0	1	brkn	44
-27.75	-35.5	8.0	1	rvrb	44
-27.75	-39.0	6.0	2		44
-27.75	-46.0	8.5	1		44
-27.75	-48.0	6.0	2		44
-27.75	-55.0	17.5	1	brd_rvrb	44
-29.25	-3.0	6.5	3	rvrb_asymm	45
-29.25	-5.0	6.5	2	brkn	45
-29.25	-7.0	7.0	1	rvrb	45
-29.25	-14.0	5.5	3		45
-29.25	-16.5	17.5	1	rvrb	45
-29.25	-17.0	8.5	2	rvrb	45
-29.25	-18.0	8.5	2		45
-29.25	-22.5	31.5	1	brd	45
-29.25	-28.0	7.0	1	vague	45

Appendix A: GPR Echoes, Mason Family Cemetery area

Easting (ft)	Northing (ft)	2W_TT (ns)	Signal Strength	Comment	Line Number
-29.25	-30.0	21.0	1	brd_rvrb	45
-29.25	-37.0	28.0	1	rvrb	45
-29.25	-40.0	25.0	1	brd_vague	45
-29.25	-46.0	27.0	1	brd	45
-29.25	-53.0	18.0	1	brd_rvrb	45
-30.75	-2.5	14.0	1	nrrw_rvrb	46
-30.75	-4.0	10.0	2	nrrw_rvrb	46
-30.75	-7.0	7.5	1		46
-30.75	-12.0	8.0	1	spot	46
-30.75	-14.0	7.0	2		46
-30.75	-17.0	10.0	2		46
-30.75	-22.0	5.0	2		46
-30.75	-23.5	22.0	1	rvrb	46
-30.75	-27.0	9.0	1	brd_asymm	46
-30.75	-34.0	7.0	1	chevrons	46
-30.75	-37.5	28.0	1	brd_rvrb	46
-30.75	-47.5	26.0	1	brd_rvrb	46
-32.25	-3.0	8.5	3	rvrb	47
-32.25	-6.0	10.5	1		47
-32.25	-15.0	9.0	2	brd_flanks	47
-32.25	-17.0	8.0	2	flanks	47
-32.25	-25.0	9.5	1		47
-32.25	-27.5	10.0	1	brkn	47
-32.25	-31.0	6.5	1	rt?	47
-32.25	-37.5	7.0	1	RHf	47
-33.75	-4.0	7.5	3	brkn	48
-33.75	-7.5	21.0	1	brd_rvrb	49
-33.75	-15.5	6.5	2	rvrb_LHfs	49
-33.75	-17.0	6.5	2	rvrb	49
-33.75	-19.0	7.5	1	RHf	49
-33.75	-26.0	6.0	2		49
-35.25	-5.0	11.5	2	brd_rvrb	49
-35.25	-26.5	6.5	2	brd	49
-36.75	-5.5	8.0	2	brd_rvrb	50
-36.75	-10.0	18.0	1	brd_rvrb	50
-36.75	-22.0	4.5	2	rt?	50
-36.75	-26.0	5.0	2	g?/rt?	50
38.25	-15.0	5.5	2	RHfs	51
38.25	-24.0	6.0	2		51
38.25	-25.0	18.0	1	brd_rvrb	51
38.25	-40.0	17.5	2	brd	51
38.25	-43.0	14.0	2	RHfs	51
38.25	-54.0	11.0	2	asymm	51
39.75	-15.5	6.5	3		52
39.75	-23.0	8.5	1		52
39.75	-26.0	4.5	3		52
41.25	-8.5	21.0	1	brd	53
41.25	-15.0	6.0	2		53
41.25	-23.0	6.5	2		53
41.25	-26.5	6.5	2		53
42.75	-4.0	7.5	1	LHf	54
42.75	-14.5	14.0	1	brd_rvrb	54
42.75	-21.0	24.5	1	brd_rvrb	54
42.75	-38.0	11.5	1		54
42.75	-44.0	14.0	1	brkn	54
44.25	-2.5	6.5	1	vague	55
44.25	-8.5	25.0	1	brd_rvrb	55
44.25	-16.0	12.0	1	rvrb	55
44.25	-20.0	29.5	1	rvrb	55
44.25	-28.0	24.0	1		55
44.25	-47.5	11.0	1	spot	55
44.25	-52.0	10.0	2		55
45.75	-5.0	5.0	2		56
45.75	-7.0	5.5	2	RHf	56
45.75	-14.0	5.5	3		56
45.75	-26.0	18.0	1	rvrb_distort	56
45.75	-37.0	16.5	1	brd	56
47.25	-2.5	14.0	1	brd_rvrb	57
47.25	-8.0	11.5	2		57
47.25	-12.5	13.5	1	rvrb	57
47.25	-20.0	28.0	1		57
47.25	-26.0	10.0	2	brd	57
47.25	-33.0	18.5	1	rvrb	57
47.25	-41.5	18.0	1	nrrw_rvrb	57
48.75	-8.0	18.5	1		58
48.75	-22.5	17.5	1	brd	58
48.75	-42.0	16.0	1	asymm	58
50.25	-2.5	17.5	1	rvrb_vagie	59
50.25	-9.5	18.0	1	brd_rvrb	59
50.25	-13.0	7.0	2		59
50.25	-21.0	21.5	1	brd_rvrb	59
50.25	-31.0	8.0	1	rvrb	59
51.75	-2.5	12.0	1	brd_rvrb	60
51.75	-21.0	30.0	1		60
51.75	-26.0	4.0	2	nrww_rvrb	60
53.25	-5.0	26.0	1	brd_rvrb	61
53.25	-13.0	5.0	3	brkn	61
53.25	-17.0	16.0	2		61
54.75	-2.5	14.0	1	brd	62
54.75	-12.5	19.0	1	brd_rvrb	62
54.75	-20.0	25.5	1	brd_rvrb	62
56.25	-3.0	6.0	1	brd_brkn	63
56.25	-5.5	23.0	1	rvrb	64
56.25	-13.0	13.5	1		64
57.75	-2.5	10.5	1		64
57.75	-15.0	24.0	1	brd_rvrb	64
59.25	-2.5	23.0	1		65
59.25	-13.0	14.0	1	rvrb	65
59.25	-14.0	11.0	1		65
60.75	-3.0	23.0	1	brd_rvrb	66
60.75	-9.0	6.0	1	nrrw_asymm	66
60.75	-15.0	9.0	1	RHfs	66
62.25	-5.0	25.0	1	brd_vague	67
63.75	-5.5	21.0	1	brd_vague	68
65.25	-3.0	21.0	1	brd_rvrb	69
65.25	-12.5	8.0	1		69
66.75	-4.0	4.0	3		70
66.75	-13.0	6.0	3	brd_rvrb	70
68.25	-3.0	5.0	1	chevrons	71
68.25	-4.0	3.5	2		71
68.25	-7.0	23.0	1	brd_rvrb	71
69.75	-2.5	18.0	1	RHfs	72
69.75	-5.0	10.0	1		72
71.25	-3.0	12.0	1	brd_brkn	73
72.75	-3.0	5.0	3		74
-3.75	1.0	5.0	3	nrrw_rvrb	75
-3.75	2.5	7.5	1	nrrw_rvrb	75
-3.75	4.0	7.5	1	rvrb	75
-3.75	7.5	11.5	1		75
-3.75	14.0	15.5	1	brd_vague	75
-3.75	26.0	6.5	1	brd_chevron	75
-3.75	32.5	11.0	2		75
-3.75	36.5	10.0	2		75
-3.75	43.0	4.5	3	rvrb	75
-3.75	49.0	11.5	1	RHf_vague	75
-3.75	53.0	15.5	1	brd	75
-3.75	64.0	4.5	3	nrrw_rvrb	75
-3.75	73.5	11.5	2	brd	75
-3.75	79.0	7.5	2		75
-3.75	87.5	11.5	2	brd	75
-5.25	2.0	16.5	1	brd_RHf	76
-5.25	3.0	9.0	1	rvrb	76
-5.25	6.5	5.5	1	brd_rvrb	76
-5.25	9.5	5.5	2		76
-5.25	17.5	8.0	1	brd_chevron	76
-5.25	22.5	12.0	1	brd_vague	76
-5.25	26.0	13.0	2		76
-5.25	26.5	12.5	1	brd_RHf	76
-5.25	28.0	11.0	1		76
-5.25	29.0	8.0	1	nrrw_rvrb	76
-5.25	32.5	11.0	1	rvrb	76
-5.25	35.0	7.0	2	nrrw_rvrb	76
-5.25	41.5	8.0	2	brd_rvrb	76
-5.25	54.0	24.0	1	brd_rvrb	76
-5.25	61.5	25.0	1	nrrw_rvrb	76
-5.25	64.0	6.5	2	rvrb	76
-5.25	69.0	23.5	1	nrrw_rvrb	76
-5.25	69.5	32.5	1		76
-5.25	72.0	30.0	1		76
-5.25	80.0	7.0	2	r?	76
-5.25	85.0	12.0	2	brd_rvrb	76
-5.25	92.0	28.0	1	brd_rvrb	76
-5.25	96.0	18.5	1	brd_rvrb	76
-6.75	1.0	8.0	1	chevrpns	77
-6.75	3.0	10.0	1	chevron_RHf	77
-6.75	26.5	14.0	1	RHf	77
-6.75	37.5	32.0	1	brd_vague	77
-6.75	39.0	17.0	1		77
-6.75	42.0	7.0	2	brd_rvrb	77
-6.75	45.0	5.5	2	brd_rvrb	77
-6.75	47.0	10.5	1		77
-6.75	50.0	26.0	1	brd_rvrb	77
-6.75	57.0	13.0	2	brd_brkn	77
-6.75	63.5	10.0	1	nrrw	77
-6.75	69.5	10.5	1	rvrb	77
-6.75	73.0	18.0	1	brd	77
-6.75	79.5	5.5	3		77
-6.75	92.0	25.5	1	brd_chevron	77

Appendix A: GPR Echoes, Mason Family Cemetery area

Easting (ft)	Northing (ft)	2W_TT (ns)	Signal Strength	Comment	Line Number
-8.25	2.5	11.0	1	RHf	78
-8.25	7.0	11.5	2	brd	78
-8.25	11.0	8.0	2	brd	78
-8.25	13.5	12.0	1	brd_RHf	78
-8.25	25.0	12.5	1	brd_rvrb	78
-8.25	31.0	6.0	3	nrrw_rvrb	78
-8.25	33.0	5.5	3	nrrw_rvrb	78
-8.25	38.0	19.5	1	rvrb	78
-8.25	39.0	13.0	2	brd	78
-8.25	40.0	7.0	1		78
-8.25	48.5	5.5	2	nrrw_rvrb	78
-8.25	52.5	5.0	3	nrrw_rvrb	78
-8.25	67.5	18.0	1	brd_rvrb	78
-8.25	76.0	24.0	1	brd_rvrb	78
-8.25	78.5	8.0	1		78
-8.25	82.5	30.0	1	brd_rvrb	78
-8.25	93.0	24.0	1	brd_chevrons	78
-9.75	2.5	6.0	1	rvrb	79
-9.75	3.5	16.5	1		79
-9.75	8.0	10.0	2	brd	79
-9.75	11.0	6.5	1	brd_RHf	79
-9.75	16.0	12.5	1	brd_rvrb	79
-9.75	20.0	13.0	1	brd	79
-9.75	27.0	11.5	1	brd_rvrb	79
-9.75	38.5	3.5	3		79
-9.75	44.5	9.5	1	brd_RHf	79
-9.75	68.5	32.5	1	brd_symm	79
-9.75	78.5	8.0	2	brd	79
-9.75	83.0	8.0	1	brd	79
-9.75	87.0	13.0	2	brd_distort	79
-9.75	91.0	22.0	1	brd	79
-11.25	2.0	9.0	1	nrrw	80
-11.25	8.5	10.0	2	brd	80
-11.25	11.0	6.5	2	brd_rvrb	80
-11.25	20.0	17.0	1	brd_vague	80
-11.25	30.5	5.0	3	rvrb	80
-11.25	33.0	10.0	2	r?	80
-11.25	35.0	9.5	2	brd_RHf	80
-11.25	39.0	5.0	3	rvrb	80
-11.25	42.0	14.0	2	brd_RHf	80
-11.25	47.0	19.0	1	brd_chevron	80
-11.25	58.0	14.0	1	brd_chevrons	80
-11.25	90.0	23.0	1	brd_rvrb	80
-11.25	94.0	18.0	1		80
-12.75	2.0	9.0	1		81
-12.75	9.5	11.0	3		81
-12.75	20.0	18.5	1	rvrb	81
-12.75	28.0	13.0	1		81
-12.75	32.0	8.0	3	rvrb	81
-12.75	35.5	12.0	3	brd	81
-12.75	39.5	6.0	3	rvrb	81
-12.75	42.0	26.5	1	brd	81
-12.75	50.0	31.5	1	brd_vague	81
-12.75	65.0	32.0	1	brd	81
-12.75	77.0	9.0	2	brd_symm	81
-12.75	90.0	23.0	1	brd_LHfs	81
-12.75	94.0	22.5	1	brd_spot	81
-14.25	2.0	8.5	2	rvrb	82
-14.25	3.0	10.5	1		82
-14.25	7.0	11.0	2	brd_rvrb	82
-14.25	22.0	5.0	2		82
-14.25	27.5	5.0	3	rvrb	82
-14.25	32.0	12.5	3	brd	82
-14.25	37.0	12.5	2	RHf	82
-14.25	39.0	6.5	1		82
-14.25	43.0	10.0	2	brkn	82
-14.25	46.5	11.5	2		82
-14.25	64.0	6.0	1	brd	82
-14.25	80.0	13.0	1	brd_LHf	82
-14.25	83.0	28.5	1	brd_brkn	82
-14.25	88.5	29.0	1	brkn	82
-14.25	92.5	26.5	1	vague	82
-14.25	95.0	27.0	1		82
-14.25	97.0	16.0	1	LHfs	82
-15.75	2.0	8.0	1	nrrw_rvrb	83
-15.75	3.0	11.5	1		83
-15.75	7.0	7.5	3	rvrb	83
-15.75	8.5	11.5	2		83
-15.75	18.0	12.5	1	asymm_spot	83
-15.75	22.0	10.5	1	brd_brkn	83
-15.75	24.0	12.5	1	rvrb_vague	83
-15.75	30.5	9.0	3	brd_RHf	83
-15.75	37.5	7.5	2	rvrb	83
-15.75	39.5	14.0	1	flanks	83
-15.75	43.0	15.0	1	brd_spot	83
-15.75	46.0	7.5	2	brd	83
-15.75	47.0	30.5	1	rvrb	83
-15.75	58.0	6.0	1	chevron	83
-15.75	64.0	22.0	1	rvrb	83
-15.75	72.5	28.5	1	brd_rvrb	83
-15.75	82.0	13.5	1		83
-15.75	87.5	12.5	2	rvrb	83
-15.75	89.0	14.0	1	LHf_vague	83
-15.75	95.0	2.5	3	nrrw_rvrb	83
-15.75	97.0	11.0	1	spot	83
-15.75	98.0	11.0	1		83
-15.75	100.0	21.0	1	brd_LHf	83
-17.25	1.0	6.5	1	nrrw	84
-17.25	4.5	9.0	3	brd_flanks	84
-17.25	6.0	10.0	2	brd_RHf	84
-17.25	29.0	9.5	3	brd_rvrb	84
-17.25	33.5	12.5	1	brd_vague	84
-17.25	36.5	10.0	2	rvrb	84
-17.25	37.5	13.5	1	rvrb	84
-17.25	38.0	31.0	1	brd	84
-17.25	58.0	17.0	1	brkn_spot	84
-17.25	70.0	31.5	1	brd_spot	84
-17.25	72.5	31.0	1	spot	84
-17.25	85.0	31.0	1	brd_chevron	84
-17.25	91.0	31.0	1	spot_vague	84
-17.25	96.5	31.5	1		84
-17.25	100.0	17.0	1	brd_LHfs	84
-18.75	1.5	7.0	2	nrrw	85
-18.75	5.5	7.0	2	brd_rvrb	85
-18.75	20.0	16.5	1		85
-18.75	21.0	15.0	1		85
-18.75	28.0	7.0	3	brd_rvrb	85
-18.75	35.0	14.0	1	RHf	85
-18.75	36.0	6.5	2		85
-18.75	45.0	6.0	3	nrrw_rvrb	85
-18.75	63.0	24.0	1	rvrb	85
-18.75	79.0	11.0	1		85
-18.75	83.0	31.0	1	brd	85
-18.75	92.5	32.5	1	chevron	85
-18.75	97.5	30.0	1	brd	85
-18.75	99.5	20.5	1	brd_LHf	85
-18.75	102.5	20.0	1	brd_rvrb	85
-20.25	1.5	6.5	2	nrrw	86
-20.25	5.0	8.0	3	RHf	86
-20.25	7.5	10.0	1	RHf	86
-20.25	16.0	18.0	1	brd	86
-20.25	21.0	11.0	1	brd_rvrb	86
-20.25	24.0	11.0	1	brkn_vague	86
-20.25	29.0	6.5	3	r	86
-20.25	37.0	5.0	2	r	86
-20.25	38.0	12.0	1	brd_brkn	86
-20.25	42.0	21.0	1	brd	86
-20.25	78.0	10.0	1	brkn	86
-20.25	82.5	31.0	1	brd	86
-20.25	98.0	22.5	1	brd	86
-20.25	101.5	18.0	1	brd	86
-21.75	4.0	7.0	2	nrrw	87
-21.75	5.0	10.0	1	nrrw_rvrb	87
-21.75	5.5	6.0	3	nrrw_rvrb	87
-21.75	7.0	12.0	1		87
-21.75	7.5	21.0	1	spot	87
-21.75	12.5	8.0	2	LHfs	87
-21.75	17.0	10.0	1	chevron	87
-21.75	19.0	6.5	2	r	87
-21.75	23.5	11.0	1	brd	87
-21.75	28.5	10.0	2	rt	87
-21.75	29.5	7.0	2	r	87
-21.75	30.5	14.5	1		87
-21.75	32.5	14.0	2	rvrb	87
-21.75	42.5	24.0	1		87
-21.75	52.0	10.0	1	vague	87
-21.75	55.0	30.0	1	brd	87
-21.75	62.5	11.0	1	brd	87
-21.75	72.0	13.0	1		87
-21.75	77.0	10.5	1	brkn	87
-21.75	97.5	11.5	1	brd	87
-21.75	102.0	18.0	1		87
-21.75	102.5	10.0	1		87
-23.25	2.0	9.5	1	nrrw	88
-23.25	3.0	4.5	3	nrrw_rvrb	88
-23.25	5.0	10.0	1		88
-23.25	7.0	9.0	1	chevron	88
-23.25	17.0	27.0	1	RHf	88

Appendix A: GPR Echoes, Mason Family Cemetery area

Easting (ft)	Northing (ft)	2W_TT (ns)	Signal Strength	Comment	Line Number
-23.25	18.0	18.5	1	brd_rvrb	88
-23.25	28.5	6.0	3	LHf	88
-23.25	33.5	12.0	1	LHf	88
-23.25	38.0	10.0	1		88
-23.25	42.0	7.5	2		88
-23.25	59.0	18.0	1	chevron_spot	88
-23.25	78.5	28.0	1	chevron_spot	88
-23.25	89.0	28.0	1	brd_rvrb	88
-23.25	96.5	15.5	1	brd_RHf	88
-23.25	102.0	16.0	1	brd	88
-24.75	2.0	10.0	1	nrrw_revrb	89
-24.75	3.0	8.5	2	brd_rvrb	89
-24.75	13.5	11.5	1	brd	89
-24.75	18.5	10.5	3		89
-24.75	27.0	18.0	1	brd_spot	89
-24.75	27.5	8.0	2		89
-24.75	33.5	10.0	1	rvrb_spot	89
-24.75	39.0	9.0	2	rvrb	89
-24.75	41.0	9.0	3	rvrb	89
-24.75	50.0	10.0	1	chevron_LHf	89
-24.75	61.0	14.5	1	chevrons	89
-24.75	73.0	23.0	1	brd_rvrb	89
-24.75	78.0	25.0	1		89
-24.75	80.0	14.0	1	brd	89
-24.75	97.0	23.5	1	brd	89
-24.75	100.5	22.0	1	RHf	89
-26.25	1.0	8.0	1	nrrw	90
-26.25	2.5	10.5	3	RHf	90
-26.25	4.0	8.0	1		90
-26.25	20.0	9.5	3		90
-26.25	24.0	12.0	1		90
-26.25	27.5	11.5	1		90
-26.25	33.5	7.0	2		90
-26.25	36.5	10.0	1		90
-26.25	42.0	7.5	2		90
-26.25	44.0	8.0	1	rvrb	90
-26.25	49.0	31.0	1	brd	90
-26.25	52.0	5.0	2	nrrw_rvrb	90
-26.25	58.0	18.0	1	rvrb	90
-26.25	62.0	16.0	1	spot	90
-26.25	70.0	8.0	1	nrrw	90
-26.25	73.0	13.0	1	spot_vague	90
-26.25	87.5	8.0	1	nrrw	90
-26.25	94.0	24.5	1	brd	90
-26.25	103.0	21.0	1	brd	90
-27.75	2.0	10.0	2		91
-27.75	3.5	7.5	1	r?	91
-27.75	6.0	8.0	1		91
-27.75	16.5	12.0	1	brd	91
-27.75	20.5	13.0	1	nrrw_rvrb	
-27.75	26.0	9.0	1		91
-27.75	42.0	8.5	2	brd_rvrb	91
-27.75	53.0	31.5	1	brd	91
-27.75	69.0	7.0	2	nrrw_rvrb	91
-27.75	90.5	10.0	1	brd	91
-27.75	98.0	13.0	1	chevron	91
-27.75	101.0	23.5	1	brd	91
-27.75	103.0	27.0	1	brd_chevrons	91
-29.25	2.0	10.0	2	brd	92
-29.25	7.0	8.0	1	rvrb	92
-29.25	8.0	8.0	1		92
-29.25	21.0	20.5	1	brd	92
-29.25	42.5	10.0	2	brd	92
-29.25	45.5	8.0	1	spot	92
-29.25	57.0	32.0	1	nrrw	92
-29.25	61.0	13.0	1		92
-29.25	67.5	30.0	1	brd	92
-29.25	75.0	16.5	1		92
-29.25	78.0	13.0	1		92
-29.25	87.5	7.5	2	r?	92
-29.25	95.0	26.0	1	rvrb	92
-30.75	2.0	6.5	1	LHf	93
-30.75	3.5	8.0	2		93
-30.75	7.5	7.0	1		93
-30.75	18.0	18.5	1		93
-30.75	21.5	14.5	1		93
-30.75	35.0	18.0	1	vague	93
-30.75	40.0	14.0	1		93
-30.75	43.5	10.0	2		93
-30.75	46.0	10.0	2		93
-30.75	61.0	11.5	1	rvrb	93
-30.75	64.0	13.5	1	RHf	93
-30.75	71.0	23.0	1	brd_rvrb	93
-30.75	77.5	31.5	1		93
-30.75	87.5	10.0	1	rvrb	93
-32.25	2.0	9.0	1	nrrw	94
-32.25	3.5	10.0	2		94
-32.25	7.5	7.0	1		94
-32.25	14.0	11.0	1	rvrb	94
-32.25	23.0	17.5	1		94
-32.25	27.0	9.0	2		94
-32.25	35.5	10.0	1	brd	94
-32.25	45.0	8.0	2	rvrb	94
-32.25	62.0	11.5	1	rvrb	94
-32.25	62.5	11.0	1	RHf	94
-32.25	78.0	7.5	1		94
-32.25	102.0	20.0	1	brd	94
-33.75	1.5	11.0	1	nrrw	95
-33.75	3.5	9.5	2	f?_r?	95
-33.75	7.5	7.0	1		95
-33.75	10.0	16.0	1	brd	95
-33.75	11.5	7.5	1	rvrb	95
-33.75	17.0	8.0	1	rvrb	95
-33.75	22.0	9.0	1	rvrb	95
-33.75	27.5	9.0	1		95
-33.75	28.0	11.0	1	spot	95
-33.75	36.0	16.5	1		95
-33.75	46.5	11.0	2	brd_rvrb	95
-33.75	52.5	11.0	1	rvrb	95
-33.75	62.5	12.5	1	RHfs	95
-33.75	67.5	10.5	1	RHfs	95
-33.75	77.5	8.0	2		95
-33.75	98.0	7.5	1	rvrb	95
-35.25	32.0	27.5	1		96
-35.25	37.0	21.5	1	brd_RHf	96
-35.25	47.5	11.0	1		96
-35.25	52.5	12.0	1		96
-35.25	62.5	12.0	1	spot	96
-35.25	72.5	12.0	1	RHf	96
-35.25	85.5	22.0	1	LHf	96
-36.75	42.5	11.5	2	rvrb	97
-36.75	47.0	11.0	2	rvrb	98
-36.75	59.0	9.0	1	nrrw	98
-36.75	61.5	11.0	1		98
-36.75	87.0	30.0	1	brd	98
-36.75	93.0	12.0	1	brd	98
-36.75	101.5	27.0	1	brd	98
-38.25	37.0	24.0	1	brd_rvrb	98
-38.25	47.0	9.5	1	chevrons	98
-38.25	52.0	10.0	1	nrrw_rvrb	98
-38.25	70.0	11.5	1	RHfs	98
-38.25	77.0	11.0	1	RHf	98
-38.25	87.0	6.0	1		98
-38.25	93.0	10.0	1		98
-38.25	100.5	29.5	1	brd	98
-39.75	36.5	8.0	1		99
-39.75	47.0	7.5	2	flanks	99
-39.75	60.0	10.5	1	chevron	99
-39.75	77.0	29.5	1	brd_rvrb	99
-39.75	90.0	29.0	1	brkn_vague	99
-41.25	32.5	20.0	1	nrrw_rvrb	100
-41.25	46.0	22.0	1	rvrb	100
-41.25	48.0	9.0	3	brd_rvrb	100
-41.25	60.0	11.0	1	rvrb	100
-41.25	82.5	5.5	1		100
-41.25	88.5	9.5	1	brd_brkn	100
-41.25	100.0	10.5	1	brkn_chevron	100
-42.75	35.0	10.5	1		101
-42.75	46.0	10.5	1		101
-42.75	48.5	8.5	1	LHf	101
-42.75	65.0	21.5	1	spot	101
-42.75	67.0	4.0	2		101
-42.75	71.0	20.5	1	rvrb	101
-42.75	78.0	7.0	1		101
-42.75	82.0	6.5	2		101
-42.75	88.5	10.5	1	rvrb_LHfs	101
-42.75	95.0	28.0	1	brd	101
-42.75	97.5	31.0	1		101
-42.75	102.0	5.0	2	rvrb	101
-42.75	104.0	4.5	2	rvrb	101
-44.25	34.0	11.0	1	nrrw_vague	102
-44.25	39.0	11.0	1	vague	102
-44.25	43.0	10.0	2	rvrb	102
-44.25	47.5	6.0	1	r?	102
-44.25	48.0	10.0	3	RHf	102
-44.25	60.0	4.5	2	r	102
-44.25	68.5	13.5	1	chevron	102
-44.25	74.0	9.0	1	r	102

Appendix A: GPR Echoes, Mason Family Cemetery area

Easting (ft)	Northing (ft)	2W_TT (ns)	Signal Strength	Comment	Line Number
-44.25	79.0	10.0	1	LHf_brd	102
-44.25	82.5	5.0	3	brd_rvrb	102
-44.25	89.0	25.0	1	brd_rvrb	102
-44.25	95.0	6.0	1	r	102
-44.25	98.0	5.0	2	rvrb	102
-44.25	102.5	18.0	1	spot	102
-45.75	35.5	7.0	1	flanks	103
-45.75	47.0	21.5	1	rvrb	103
-45.75	49.0	12.0	1	spot	103
-45.75	52.5	13.5	1	brd	103
-45.75	63.0	22.0	1	brd_vague	103
-45.75	72.0	11.0	1	brd_asymm	103
-45.75	82.0	21.5	1		103
-45.75	92.0	25.5	1		103
-45.75	98.0	11.0	1	rvrb	103
-45.75	102.5	6.5	1	brd	103
38.25	2.0	24.0	1	brd_rvrb	104
38.25	7.0	6.5	2	brd	104
38.25	9.0	5.0	3	brd_flanks	104
38.25	10.5	23.5	1	brd_rvrb	104
38.25	12.0	6.0	2		104
38.25	17.5	7.5	3	brd_flanks	104
38.25	18.5	21.0	1	brd_chevrons	104
38.25	24.0	6.0	3	brd_flanks	104
38.25	26.0	32.5	1	doublet	104
38.25	29.0	6.5	3	brd_rvrb	104
38.25	32.5	11.0	1		104
38.25	36.0	14.0	2		104
38.25	42.0	31.0	1	brd	104
38.25	42.5	7.5	2	brd	104
38.25	46.0	10.5	3	nrrw_rvrb	104
38.25	48.5	10.5	3	rvrb_brkn	104
38.25	50.0	29.0	1	brd_asymm	104
38.25	52.0	21.5	1	RHf	104
38.25	62.0	11.0	2	nrrw_rvrb	104
38.25	70.0	3.5	3	rvrb_brkn	104
38.25	74.5	11.5	1		104
38.25	77.5	8.0	2	rvrb	104
38.25	87.5	27.5	1	brd	104
38.25	98.0	3.0	3	brd_rvrb	104
39.75	5.0	3.0	3	brd_brkn	105
39.75	8.0	32.5	1	brd_spot	105
39.75	9.0	4.5	3	r	105
39.75	12.0	32.5	1	brd_spot	105
39.75	17.5	28.0	1	brd_flattop	105
39.75	18.5	18.0	1	chevron	105
39.75	20.0	11.5	1	broken	105
39.75	24.0	11.0	1	brd_LHf	105
39.75	28.0	10.0	2	brd_flanks	105
39.75	35.5	15.0	2	RHfs	105
39.75	41.0	31.5	1	brd	105
39.75	41.5	8.0	3	rvrb	105
39.75	46.0	10.0	3	nrrw_rvrb	105
39.75	51.0	29.0	1	brd_rvrb	105
39.75	53.0	10.0	2	brd	105
39.75	57.0	11.5	1		105
39.75	58.0	19.0	1		105
39.75	60.5	5.0	3	rvrb_brkn	105
39.75	64.0	20.0	1	chevrons	105
39.75	67.0	30.0	1	chevron	105
39.75	72.0	9.5	2	RHf	105
41.25	4.0	33.0	1	vague	106
41.25	7.5	15.0	1	brd_RHf	106
41.25	10.0	12.5	1	brd_RHf	106
41.25	15.0	30.5	1	brd_vague	106
41.25	20.0	33.0	1	brd	106
41.25	23.5	2.0	brd	r	106
41.25	27.0	30.0	1	brd	106
41.25	33.0	14.0	2	r	106
41.25	56.5	11.0	2	brd_LHf	106
41.25	60.0	10.5	2	RHf	106
41.25	72.5	25.5	1	brd_vague	106
41.25	77.0	4.0	3	brd	106
41.25	77.5	23.5	1	brd_vague	106
42.75	2.0	8.0	1		107
42.75	4.0	11.0	1	brd	107
42.75	8.0	5.0	3	brd	107
42.75	13.5	7.0	1	r	107
42.75	16.5	23.5	1	brd_rvrb	107
42.75	24.0	11.0	3		107
42.75	26.0	11.5	3		107
42.75	27.0	25.5	1	brd_chevrons	107
42.75	55.0	9.5	2		107
42.75	60.0	20.0	1	flanks	107
42.75	64.0	10.0	1	chevron_RHf	107
42.75	65.0	8.5	2	RHf	107
42.75	74.0	23.0	1	rvrb	107
42.75	75.0	9.0	1	symm	107
44.25	4.5	10.5	1		108
44.25	10.0	11.5	2	brd_rvrb	108
44.25	15.0	3.5	3		108
44.25	18.0	31.0	1	g?	108
44.25	21.0	30.5	1	distort	108
44.25	50.0	18.0	1	brd_flanks	108
44.25	58.0	6.0	3		108
44.25	63.5	5.5	3	brd	108
44.25	67.0	28.5	1	brd_rvrb	108
44.25	75.0	8.5	2	symm	108
44.25	95.0	5.0	3	nrrw_rvrb	108
44.25	99.0	5.0	3	nrrw_rvrb	108
45.75	7.0	32.5	1		109
45.75	12.5	14.5	1	vague	109
45.75	20.5	29.5	1		109
45.75	50.0	15.0	3	brd	109
45.75	53.0	7.0	3	rvrb	109
45.75	58.0	6.0	3	rvrb	109
45.75	62.5	7.5	2		109
45.75	76.5	7.0	2		109
45.75	78.0	6.5	2		109
45.75	80.0	5.0	2		109
45.75	94.0	4.0	3	rvrb	109
47.25	8.0	5.0	2	brd_rvrb	110
47.25	10.0	21.5	1	rvrb	110
47.25	11.0	15.5	1	rvrb	110
47.25	22.0	4.5	3	brd	110
47.25	50.0	14.0	3	brd_rvrb	110
47.25	60.0	6.0	2	asymm	110
47.25	78.0	8.0	3		110
47.25	93.0	21.5	1	brd_rvrb	110
47.25	99.5	2.5	3	nrrw_rvrb	110
48.75	6.5	8.0	1	chevron	111
48.75	10.0	15.0	1	brd	111
48.75	15.0	16.0	1	vague	111
48.75	20.5	8.0	2	r	111
48.75	42.0	5.5	3	r	111
48.75	50.0	12.0	1	brd_flanks	111
48.75	83.0	27.5	1	brd_vague	111
48.75	89.5	3.5	3	rvrb	111
48.75	92.0	5.5	3	nrrw_rvrb	111
48.75	94.0	3.0	3	rvrb	111
50.25	8.0	28.5	1	brd	112
50.25	13.5	7.0	1	rvrb	112
50.25	17.0	32.0	1	spot	112
50.25	42.5	8.0	3	brd_rvrb	112
50.25	47.5	3.0	3	r	112
50.25	49.0	14.0	1	rvrb	112
50.25	58.0	11.0	1	brd	112
50.25	66.5	12.5	1	brd_RHf	112
50.25	73.0	12.0	1	spot_vague	112
50.25	85.0	15.5	1	rvrb_vague	112
50.25	90.0	4.0	3	nrrw_rvrb	112
50.25	94.0	5.0	3	brd	112
51.75	16.0	21.5	1	brd_rvrb	113
51.75	19.0	10.0	1		113
51.75	46.0	10.5	2		113
51.75	48.0	3.0	3	nrrw_rvrb	113
51.75	54.0	9.0	1	rvrb	113
51.75	55.6	12.0	1	RHf	113
53.25	5.0	9.0	1		114
53.25	7.0	6.0	1	rvrb	114
53.25	19.0	7.5	1		114
53.25	23.0	3.5	3	nrrw_rvrb	114
53.25	42.5	14.0	1	RHf	114
53.25	48.0	11.0	1	RHf	114
53.25	57.0	6.5	3	brd	114
53.25	64.0	3.5	3	nrrw_rvrb	114
53.25	81.0	17.5	1	brd_RHf	114
53.25	82.5	7.5	1	spot	114
53.25	94.5	27.5	1	brd_rvrb	114
54.75	2.5	26.5	1	nrrw_rvrb	115
54.75	23.5	21.0	1	spot_vague	115
54.75	42.5	13.5	2	asynn	115
54.75	48.0	4.0	3		115
54.75	79.0	11.0	1	LHf_vague	115
54.75	88.0	20.5	1	brd_rvrb	115
54.75	95.0	26.0	1	brd	115
54.75	96.0	3.5	5		115
56.25	12.0	26.0	1	brd_RHf	116

Easting (ft)	Northing (ft)	2W_TT (ns)	Signal Strength	Comment	Line Number
56.25	13.0	11.0	1	brd	116
56.25	19.0	4.0	3	nrrw_rvrb	116
56.25	23.5	4.0	3		116
56.25	43.0	4.0	3	brd_rvrb	116
56.25	48.5	4.5	3	brd_rvrb	116
56.25	53.0	18.5	1	rvrb	116
56.25	61.5	12.0	3		116
56.25	73.0	6.5	3	brd_rvrb	116
56.25	88.0	24.0	1	brd_LHfs	116
56.25	95.0	25.0	1	brd_rvrb	116
57.75	9.0	17.0	1	brd_rvrb	117
57.75	15.0	27.0	1	brd_rvrb	117
57.75	18.5	5.0	3	brd	117
57.75	20.0	18.0	1	brd_vague	117
57.75	22.5	5.0	2	brd_rvrb	117
57.75	25.0	6.5	2	nrrw	117
57.75	27.0	21.0	1	brd_rvrb	117
57.75	37.5	5.0	3	brd_rvrb	117
57.75	42.0	8.0	2		117
57.75	47.0	10.5	1		117
57.75	48.0	19.0	1	chevrons	117
57.75	52.0	9.0	1		117
57.75	57.0	10.5	1	rvrb	117
57.75	76.5	8.0	1	brd_flanks	117
57.75	95.0	28.0	1	brd_rvrb	117
59.25	2.5	10.0	1		118
59.25	10.5	6.5	1	brd	118
59.25	18.0	4.0	3	rvrb	118
59.25	35.0	13.0	1	brd_RHfs	118
59.25	50.0	6.0	2	brd_RHf	118
59.25	80.0	10.0	1		118
59.25	86.5	7.5	2		118
60.75	2.0	5.5	2		119
60.75	3.0	20.0	1	brd_rvrb	119
60.75	12.5	32.5	2	dp_clr	119
60.75	17.5	4.0	3		119
60.75	22.5	7.0	1		119
60.75	46.0	5.0	2		119
60.75	48.5	6.0	2		119
60.75	52.5	13.5	1	chevron	119
60.75	57.5	9.5	2		119
60.75	59.0	9.5	2		119
60.75	64.0	6.0	2	rvrb	119
60.75	66.0	10.5	2		119
60.75	74.0	5.5	3	brd	119
60.75	85.0	23.0	1	brd_rvrb	119
60.75	93.0	21.0	1	brd_LHf	119
62.25	4.0	26.5	1	vague	120
62.25	8.0	12.0	1	brd	120
62.25	13.5	10.5	1	rvrb	120
62.25	17.0	6.0	2		120
62.25	19.0	6.5	1	rvrb	120
62.25	21.5	5.5	2		120
62.25	24.5	7.5	2		120
62.25	27.5	5.0	3	RHfs	120
62.25	31.0	7.0	3	rvrb	120
62.25	43.5	9.5	2	brd	120
62.25	54.0	7.5	2		120
62.25	58.0	8.0	2	rvrb	120
62.25	66.5	6.5	2	brd_rvrb	120
62.25	77.5	7.0	1		120
62.25	82.0	27.5	1	brd	120
62.25	87.0	7.0	2		120
62.25	92.0	19.5	1	brd_chevrons	120
63.75	2.0	4.5	2		121
63.75	7.5	14.5	1	rvrb	121
63.75	12.0	29.5	2	dp_clr	121
63.75	41.0	10.0	1	brd_RHf	121
63.75	47.0	10.0	1		121
63.75	49.0	5.5	3		121
63.75	57.0	13.0	1	chevrons	121
63.75	61.0	10.5	1		121
63.75	63.0	6.0	2	brd	121
63.75	67.5	6.0	2	brd	121
63.75	76.5	7.5	2		121
63.75	78.0	8.0	1		121
63.75	86.5	7.0	1		121
63.75	92.0	21.0	1	rvrb_spot	121
65.25	2.0	4.0	2		122
65.25	12.0	27.0	1	brd_rvrb	122
65.25	42.0	10.5	1	brd_RHf	122
65.25	49.0	4.5	3		122
65.25	51.0	4.5	3		122
65.25	55.0	6.0	3		122
65.25	65.0	11.5	1	brd	122
65.25	68.0	16.0	1		122
65.25	72.0	16.0	1		122
65.25	74.0	16.5	1		122
65.25	77.5	7.0	1	LHf	122
65.25	95.0	25.0	1	brd_rvrb	122
66.75	4.0	6.5	1		123
66.75	10.0	11.0	1	brd	123
66.75	14.5	6.5	1		123
66.75	21.0	7.0	2		123
66.75	22.0	3.5	3	nrrw_rvrb	123
66.75	42.0	6.5	3	brd_flanks	123
66.75	49.0	5.0	3		123
66.75	52.0	13.0	2	flanks	123
66.75	56.0	13.0	1	chevron	123
66.75	67.5	7.0	2	brd	123
66.75	80.0	7.0	1	LHf	123
66.75	85.0	7.5	1	RHf	123
68.25	4.0	6.5	1		124
68.25	7.5	6.5	1	brd	124
68.25	9.5	6.0	1		124
68.25	18.0	5.5	1		124
68.25	23.5	5.5	1		124
68.25	43.0	9.0	3	brd_rvrb	124
68.25	49.0	4.0	3		124
68.25	52.5	9.0	2	brd_rvrb	124
68.25	68.0	7.5	1	brd_RHf	124
68.25	71.0	9.5	1	brd_RHfs	124
68.25	77.5	8.0	1	brd_rvrb	124
68.25	81.0	6.0	2		124
68.25	83.0	6.0	2		124
68.25	94.0	4.5	3	rvrb	124
68.25	97.5	4.0	3	rvrb	124
69.75	2.5	5.0	1		125
69.75	6.5	3.5	2		125
69.75	9.0	9.0	3	brd_RHf	125
69.75	15.0	23.5	1	brd_rvrb	125
69.75	17.5	6.0	2	rvrb	125
69.75	24.0	3.0	3		125
69.75	43.0	8.5	2	rvrb	125
69.75	49.0	8.0	1	brd_LHf	125
69.75	69.0	7.0	2		125
69.75	75.0	10.0	1		125
69.75	93.0	6.0	2	rvrb	125
69.75	97.5	2.0	rvrb		125
71.25	17.0	7.5	1	brd_chevron	126
71.25	24.5	7.5	1	brd_RHf	126
71.25	43.0	9.0	3	brd_rvrb	126
71.25	67.0	6.5	1	brd	126
71.25	71.0	7.0	1	chevrons	126
71.25	78.0	5.0	2	rvrb	126
71.25	98.0	6.0	1	chevrons	126
72.75	2.0	11.0	1		127
72.75	6.0	5.0	3		127
72.75	20.0	6.5	1	nrrw_rvrb	127
72.75	28.0	10.0	2		127
72.75	30.0	8.5	2		127
72.75	36.5	6.0	3	rvrb	127
72.75	43.0	5.0	3	brd_rvrb	127
72.75	48.0	9.0	1	brd_RHf	127
72.75	54.0	6.5	2	nrrw_rvrb	127
72.75	62.0	12.5	1	spot	127
72.75	67.5	11.0	1		127
72.75	75.0	17.0	1	rvrb_chevrons	127
72.75	95.0	5.0	2	nrrw_rvrb	127
74.25	3.0	4.0	rvrb	r	128
74.25	13.5	4.5	3	r	128
74.25	19.0	4.0	3	nrrw_rvrb	128
74.25	25.0	6.0	3	brd_rvrb	128
74.25	43.0	9.5	2	brd_rvrb	128
74.25	46.5	5.5	2		128
74.25	53.5	5.0	3		128
74.25	57.0	6.0	1	brd_rvrb	128
74.25	60.5	7.5	1		128
74.25	62.5	6.5	2	flanks	128
74.25	73.5	5.0	2	flanks	128
74.25	76.0	31.0	1		128
74.25	89.0	5.0	2		128
74.25	99.0	5.0	3	nrrw_rvrb	128
75.75	2.5	6.0	2	rvrb	129
75.75	10.5	11.5	1	brd_chevron	129
75.75	14.0	7.0	1	brd	129
75.75	25.5	6.0	3	rvrb	129
75.75	52.0	7.5	2	brd	129

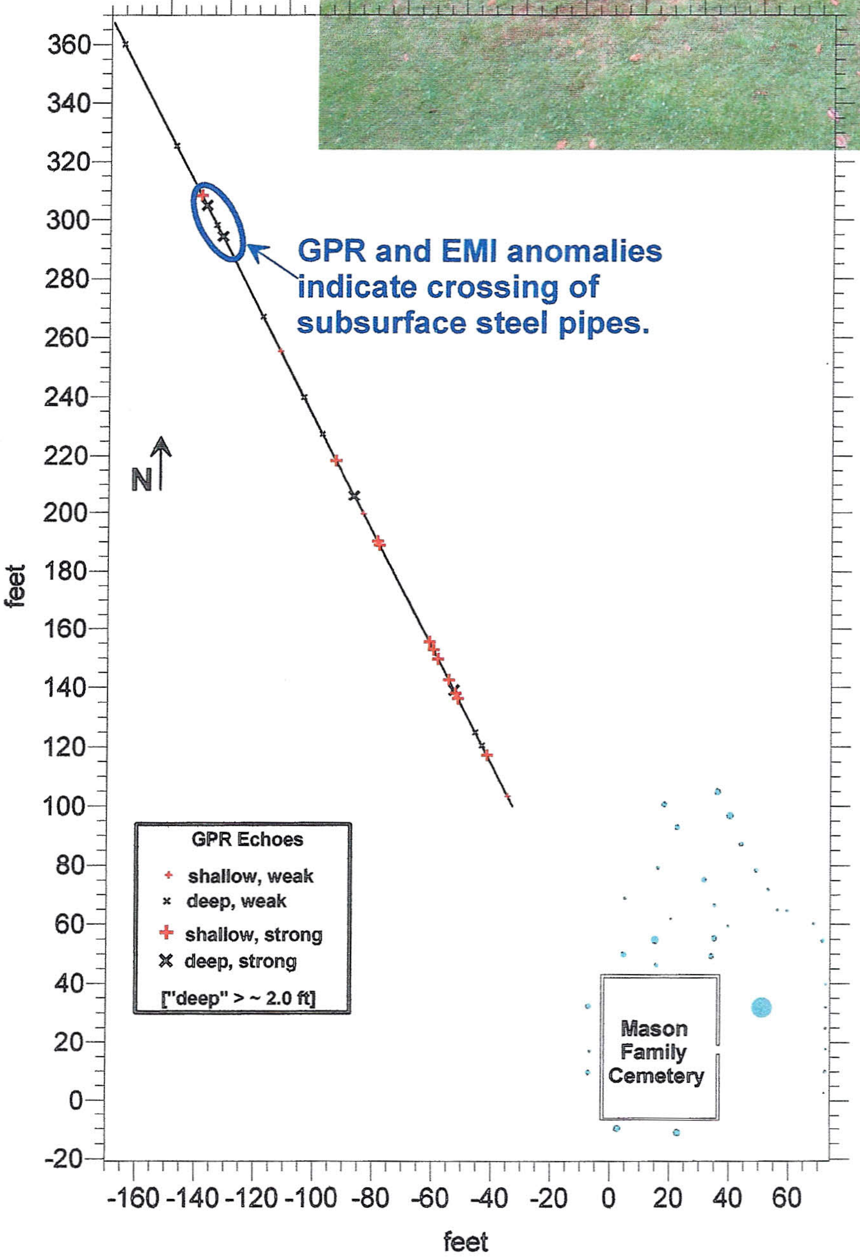
Appendix A: GPR Echoes, Mason Family Cemetery area

Easting (ft)	Northing (ft)	2W_TT (ns)	Signal Strength	Comment	Line Number
75.75	53.5	4.0	3	rvrb	129
75.75	62.0	7.0	3	brd	129
75.75	67.5	6.5	2	brd_rvrb	129
75.75	74.0	5.0	2	rvrb	129
75.75	96.0	4.0	3	nrrw_rvrb	129
75.75	97.0	31.5	1	brd_vague	129
77.25	3.0	4.5	3		130
77.25	8.0	4.5	2		130
77.25	12.0	4.5	2		130
77.25	28.0	6.5	2	brd_rvrb	130
77.25	31.5	8.0	1	brd	130
77.25	33.5	6.5	2	brd	130
77.25	36.0	6.0	brd	r	130
77.25	41.0	5.5	1	spot	130
77.25	46.0	7.0	2		130
77.25	53.0	3.0	2	rvrb	130
77.25	55.0	7.0	1		130
77.25	67.5	10.0	1	chevron	130
77.25	75.0	6.0	1		130
77.25	77.0	32.0	1		130
77.25	82.0	31.5	1	spot	130
77.25	88.0	5.5	2		130
77.25	89.0	30.0	1	brd_rvrb	130
77.25	96.0	5.0	1	nrrw	130
78.75	7.5	7.5	1	flanks	131
78.75	57.5	8.5	1	rvrb	131
78.75	60.0	5.0	2		131
78.75	62.5	5.0	2		131
78.75	65.0	4.5	2		131
78.75	75.0	31.0	1	brd	131
78.75	90.0	30.0	1	brd_rvrb	131
78.75	95.5	32.0	1		131
80.25	2.0	4.0	2		132
80.25	2.5	5.5	1	chevrons	132
80.25	3.0	22.0	1	brd_vague	132
80.25	6.5	5.0	2		132
80.25	10.5	5.5	2	RHf	132
80.25	47.0	7.0	3		132
80.25	52.0	5.0	2	rvrb	132
80.25	62.5	5.0	2	rvrb	132
80.25	66.0	4.0	2	r	132
80.25	74.0	7.5	1	rvrb	132
80.25	77.0	30.0	1	brd	132
80.25	88.5	32.0	1	brd_vague	132
81.75	2.0	5.0	2		133
81.75	6.0	5.0	2		133
81.75	10.5	5.0	2		133
81.75	13.5	7.5	1	chevrons	133
81.75	20.0	29.0	1	brd_rvrb	133
81.75	22.0	18.0	1	brd_vague	133
81.75	55.5	5.0	2		133
81.75	60.0	6.5	2		133
81.75	66.0	6.0	2		133
81.75	78.0	10.0	1	distort	133
81.75	80.5	20.0	1	brd_rvrb	133
83.25	27.5	7.0	2		134
83.25	28.5	7.0	2		134
83.25	34.0	5.0	3	flanks	134
83.25	38.0	7.5	2	r	134
83.25	56.5	21.5	1		134
83.25	60.0	8.0	1	RHf	134
83.25	64.0	4.0	2		134
83.25	66.5	4.0	3	RHf	134
83.25	70.0	28.0	1	brd_chevron	134
83.25	73.0	11.0	1	spot	134
83.25	76.0	32.0	1	spot	134
83.25	97.0	32.0	1		134
83.25	98.0	21.0	1	LHf	134
84.75	22.0	8.0	1	rvrb	135
84.75	25.0	5.0	1		135
84.75	27.5	8.0	3	brd	135
84.75	33.5	5.5	2		135
84.75	34.0	5.5	2		135
84.75	38.0	7.0	2		135
84.75	41.5	6.0	3	brd_RHf	135
84.75	44.5	5.0	2		135
84.75	45.0	30.0	1	brd_rvrb	135
84.75	48.0	7.5	1		135
84.75	52.0	6.0	1		135
84.75	57.5	24.0	1	brd	135
84.75	64.0	5.5	1	chevron	135
84.75	67.5	7.0	1	chevron	135
84.75	74.0	4.0	2		135
84.75	77.5	17.0	1		135
84.75	83.0	21.5	1	brd_rvrb	135
84.75	91.0	6.0	1	nrrw_rvrb	135
86.25	33.5	30.0	1	brd	136
86.25	41.5	5.5	3	brd_flanks	136
86.25	56.0	9.0	1	nrrw_rvrb	136
86.25	67.0	6.5	1		136
86.25	68.0	6.5	1		136
86.25	79.0	27.0	1	brd	136
86.25	84.5	24.0	1	brd_spot	136
87.75	27.0	5.0	2		137
87.75	34.0	6.0	3	rvrb	137
87.75	42.0	7.5	3	brd_flanks	137
87.75	52.0	6.0	1	rvrb	137
87.75	57.5	6.0	1		137
87.75	68.5	23.0	1		137
87.75	81.0	20.5	1	doublet	137
36.75	58.5	13.0	1	chevron	138
36.75	67.0	10.5	2	flanks	138
36.75	72.0	8.5	1	chevron_spot	138
36.75	75.0	18.0	2		138
36.75	77.0	27.0	1	rvrb	138
36.75	83.5	17.5	1	chevrons	138
36.75	87.5	30.5	1	brd_vague	138
36.75	97.0	5.0	2	nrrw_rvrb	138
35.25	59.0	8.0	1	nrrw_rvrb	139
35.25	72.0	6.0	2	nrrw_rvrb	139
35.25	78.5	29.0	1	vague	139
35.25	92.5	15.0	1	rvrb_brkn	139
35.25	97.0	7.0	2	nrrw_rvrb	139
33.75	57.0	17.0	1	brd_RHf	140
33.75	58.0	4.0	3	rvrb	140
33.75	77.0	13.5	1	rvrb_brkn	140
33.75	82.0	18.0	1	chevron_LHf	140
32.25	59.0	10.5	3	nrrw	141
32.25	62.0	16.0	1	RHf_brkn	141
32.25	65.0	18.5	1		141
32.25	67.5	16.0	1	brd	141
32.25	97.5	6.0	3	r	141
30.75	57.0	8.0	3		142
30.75	58.0	21.0	1	chevron	142
30.75	60.0	10.0	2		142
30.75	65.0	17.0	1	brd	142
30.75	66.0	5.0	3	r	142
30.75	68.5	24.0	1	nrrw	142
30.75	82.5	8.0	1		142
30.75	97.0	15.5	1	RHfs	142
30.75	100.0	16.5	1	RHfs	142
30.75	103.0	24.0	1	brd	142
29.25	47.5	10.5	3	rvrb	143
29.25	48.0	13.0	2	RHf	143
29.25	52.5	10.0	2	rvrb	143
29.25	55.0	10.0	2		143
29.25	60.0	9.0	3		143
29.25	62.0	7.5	2	rvrb	143
29.25	68.0	12.0	1		143
29.25	77.0	11.0	2	nrrw	143
29.25	78.0	6.5	2	rvrb	143
29.25	79.0	12.0	1	g/r?	143
29.25	81.5	7.5	1	rvrb	143
29.25	95.0	7.0	1	RHfs	143
29.25	98.0	10.0	1	brd_chevrons	143
27.75	48.0	10.5	2	brd_spot	144
27.75	54.5	10.0	2	rvrb	144
27.75	60.0	11.0	2		144
27.75	69.5	10.0	1		144
27.75	71.0	14.0	1		144
27.75	76.5	5.5	3		144
27.75	78.0	12.0	1		144
27.75	98.0	10.0	2	brd	144
26.25	48.0	8.0	3	brd_brkn	145
26.25	54.0	7.5	2	rvrb	145
26.25	60.0	7.5	3	nested	145
26.25	64.0	10.0	1	rvrb	145
26.25	67.0	17.0	1	chevrons	145
26.25	72.5	11.5	2	brd_brkn	145
26.25	76.0	5.0	3	nrrw_rvrb	145
26.25	80.0	11.0	1		145
26.25	98.0	18.0	1	brd	145
24.75	46.0	10.5	2	r?	146
24.75	48.0	10.0	3	r?	146
24.75	51.5	9.5	1	chevron	146
24.75	53.0	10.0	3	rvrb	146
24.75	60.5	16.0	1	brd_RHf	146
24.75	62.5	25.0	1	rvrb	146

Easting (ft)	Northing (ft)	2W_TT (ns)	Signal Strength	Comment	Line Number
24.75	66.0	17.0	2	brd_rvrb	146
24.75	72.0	12.0	1	rvrb	146
24.75	78.0	10.5	1	nrrw	146
24.75	90.0	10.0	1	brd	146
24.75	94.0	6.0	2	nrrw	146
24.75	102.0	28.0	1	brd_rvrb	146
23.25	47.0	8.0	2	nrrw_rvrb	147
23.25	53.0	7.5	3	brd_spot	147
23.25	64.0	7.0	3	nrrw	147
23.25	67.5	13.0	2	brd_rvrb	147
23.25	76.0	12.0	1	RHf	147
23.25	92.0	31.0	1	brd_rvrb	147
23.25	100.5	5.0	3	nrrw_rvrb	147
23.25	104.5	11.0	2	LHfs	147
21.75	52.0	13.5	2	rvrb	148
21.75	65.5	18.5	1	brd	148
21.75	67.0	8.0	1	nrrw	148
21.75	68.5	9.5	1	rvrb	148
21.75	72.0	11.0	1	brd_spot	148
21.75	78.0	13.0	1	rvrb	148
21.75	101.0	6.0	3		148
20.25	47.5	11.0	2	brd	149
20.25	51.5	7.5	2	r?	149
20.25	52.0	13.0	1	brd	149
20.25	55.0	16.5	1	spot	149
20.25	63.5	10.0	1		149
20.25	66.5	18.0	1	spot	149
20.25	67.0	6.5	1	chevron	149
20.25	69.5	14.5	2		149
20.25	70.0	14.5	2	g?	149
20.25	75.5	13.5	2		149
20.25	77.0	12.0	2		149
20.25	81.0	10.0	1		149
20.25	92.5	13.0	2	brd_rvrb	149
20.25	101.0	6.5	3		149
18.75	47.5	10.0	3	brd_rvrb	150
18.75	51.0	9.0	3	rvrb	150
18.75	62.0	9.0	1	brd_rvrb	150
18.75	67.5	9.0	2	rvrb	150
18.75	70.0	15.0	2	g/r	150
18.75	77.5	21.0	1	rvrb	150
18.75	89.0	7.0	2	nrrw_rvrb	150
18.75	91.5	11.0	2	brd	150
18.75	93.5	12.5	1		150
18.75	97.0	24.0	1	vague	150
17.25	61.0	11.5	1	RHf	152
17.25	67.5	11.0	3	rvrb	152
17.25	69.5	15.5	3	rvrb	152
17.25	72.0	15.0	2	rvrb	152
17.25	79.0	10.5	1	brd_rvrb	152
17.25	83.5	24.0	1	brd_rvrb	152
17.25	89.0	6.0	3	nrrw_rvrb	152
15.75	60.5	14.0	2	2	153
15.75	68.0	11.0	3	brd_rvrb	153
15.75	69.0	16.0	1	brd	153
15.75	72.5	17.0	1	chevron	153
15.75	79.0	10.0	2	rvrb	153
15.75	82.0	27.0	1	brd_rvrb	153
15.75	87.0	11.0	2		153
15.75	96.0	22.0	1	rvrb	153
15.75	98.0	16.0	1	RHfs	153
15.75	101.0	7.0	2	chevrons	153
14.25	62.0	12.5	2	brd_rvrb	154
14.25	65.5	6.0	2	nrrw_rvrb	154
14.25	69.0	10.5	3	brd_rvrb	154
14.25	72.0	11.0	3	brd_rvrb	154
14.25	81.5	18.0	1	RHfs	154
14.25	87.5	5.0	3	nrrw_rvrb	154
14.25	99.0	8.5	2	rvrb	154
14.25	102.5	10.0	1	chevrons	154
12.75	65.0	29.0	1	brd_rvrb	155
12.75	71.0	8.0	1		155
12.75	72.0	10.0	3	rvrb	155
12.75	75.0	11.0	3	rvrb	155
12.75	80.5	18.5	1	brd	155
12.75	87.5	25.0	1	brd_rvrb	155
12.75	92.5	10.0	3	rvrb	155
12.75	98.5	8.0	2	rvrb	155
12.75	101.0	11.0	1	LFf	155
12.75	104.0	7.0	2	r?	155
11.25	46.0	9.0	1	nrrw_chevrons	156
11.25	52.5	10.0	3	rvrb	156
11.25	55.0	17.0	1	RHfs	156
11.25	62.0	12.0	2	rvrb	156

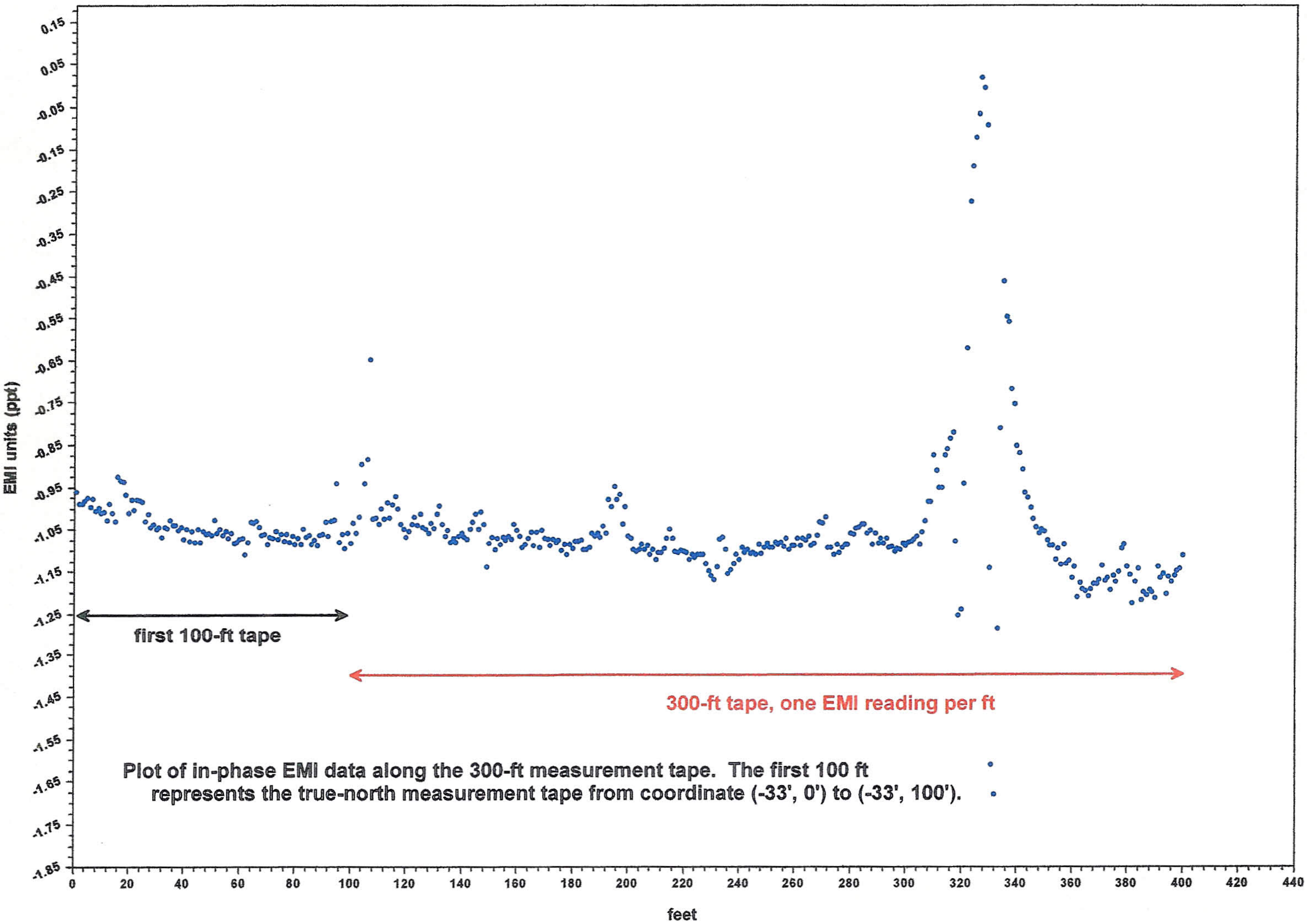
Easting (ft)	Northing (ft)	2W_TT (ns)	Signal Strength	Comment	Line Number
11.25	74.0	17.0	1	flanks	156
11.25	76.0	14.0	1		156
11.25	88.0	6.0	2		156
11.25	92.0	11.0	2		156
11.25	95.0	11.0	1	rvrb	156
11.25	98.0	12.0	2	rvrb	156
11.25	102.0	10.5	1	r	156
11.25	104.0	10.0	1	r	156
9.75	48.0	26.0	1		157
9.75	52.0	10.0	2		157
9.75	57.0	18.0	2	rvrb	157
9.75	59.0	11.0	1		157
9.75	62.5	6.0	2		157
9.75	67.0	16.0	1	chevron_spot	157
9.75	69.5	7.0	1	rvrb	157
9.75	80.0	31.0	1		157
9.75	86.5	31.0	1		157
9.75	90.0	11.0	2	rvrb	157
9.75	95.0	8.5	3		157
9.75	97.0	9.0	2		157
8.25	48.0	6.5	2		158
8.25	52.5	11.0	2	rvrb	158
8.25	59.0	11.0	2		158
8.25	62.5	6.5	2	brd_rvrb	158
8.25	72.0	13.5	1	rvrb_vague	158
8.25	77.5	6.0	3	brd_brkn	158
8.25	82.0	27.0	1	brd_rvrb	158
8.25	87.5	28.0	1	brd_rvrb	158
8.25	94.0	10.0	2		158
8.25	99.0	12.5	1	RHf	158
8.25	101.0	10.0	2		158
6.75	63.0	12.0	2	brd_rvrb	159
6.75	66.0	14.0	1		159
6.75	74.0	26.0	1	RHf	159
6.75	83.0	7.5	3	brd_rvrb	159
6.75	89.0	28.0	1	chevrons	159
6.75	100.0	29.0	1	brd_rvrb	159
6.75	104.0	14.0	2	rvrb	159
5.25	62.5	10.0	3	rvrb	160
5.25	64.0	4.0	2	nrrw_rvrb	160
5.25	68.0	4.0	2		160
5.25	84.0	10.0	2	brkn	160
5.25	86.0	9.0	2		160
5.25	99.0	24.0	1	rvrb	160
3.75	47.5	13.0	1	rvrb	161
3.75	50.0	19.5	1	brd_rvrb	161
3.75	52.5	10.0	2		161
3.75	57.0	12.0	2	rvrb	161
3.75	59.0	11.0	2	nrrw_chevrons	161
3.75	62.0	7.0	2	nrrw_rvrb	161
3.75	67.0	11.0	2	rvrb	161
3.75	69.0	16.0	1	rvrb	161
3.75	71.5	11.5	2	rvrb	161
3.75	79.0	10.0	2	rvrb	161
3.75	82.0	7.0	2		161
3.75	87.0	27.0	1	brd_rvrb	161
3.75	93.0	28.0	1	brd_rvrb	161
3.75	97.0	8.0	1		161
2.25	49.0	8.0	2	rvrb	162
2.25	53.0	15.0	1	vague	162
2.25	56.0	13.0	1	nrrw	162
2.25	57.5	8.0	2	chevrons	162
2.25	67.0	12.5	1		162
2.25	71.5	9.0	3	rvrb	162
2.25	74.0	6.5	1		162
2.25	79.0	10.0	3	rvrb	162
2.25	82.0	10.0	1		162
2.25	97.5	6.0	2		162
2.25	100.0	11.0	2		162
0.75	54.0	11.5	1	nrrw_rvrb	163
0.75	56.5	11.0	3		163
0.75	58.5	8.5	1		163
0.75	61.0	6.5	3	nrrw_rvrb	163
0.75	65.5	28.0	1	brd_rvrb	163
0.75	75.0	13.5	1	LHfs	163
0.75	79.0	11.0	2		163
0.75	82.0	6.0	2		163
-0.75	57.0	11.0	3		164
-0.75	60.0	7.5	1		164
-0.75	64.0	13.0	1	brd	164
-0.75	65.0	28.0	1	brd_rvrb	164
-0.75	74.0	29.0	1	brd_chevrons	164
-0.75	79.0	10.5	2		164
-0.75	98.5	25.0	3	dp_metall	164

Easting (ft)	Northing (ft)	2W_TT (ns)	Signal Strength	Comment	Line Number
-2.25	52.5	11.5	1		165
-2.25	62.5	18.0	1	vague	165
-2.25	67.0	32.0	1	brd	165
-2.25	74.0	18.0	1		165
-2.25	77.0	12.0	1		165
-2.25	79.5	10.0	1		165
-2.25	89.0	31.5	1		165
-2.25	100.0	26.0	3	brd_metall	165
-2.25	104.0	7.5	2	rvrb	165



Appendix B

GPR echoes along the 300-ft line north 27 degrees west from coordinate point (-33', 100'). The photograph above points southeast along this line, toward the brick-walled cemetery.



Plot of in-phase EMI data along the 300-ft measurement tape. The first 100 ft represents the true-north measurement tape from coordinate (-33', 0') to (-33', 100').

APPENDIX C

What our experience has taught us about detecting old graves

In general, a grave site can be geophysically detected *directly* or *indirectly*. It can be detected *directly* by sensing the buried human remains, objects buried with the remains, or the burial container. It can be detected *indirectly* by sensing the soil characteristics of backfill in the grave shaft. Both *direct* and *indirect* detection of grave sites by GPR often involves sensing groups of reflectors that are just as likely to be located at the edges of the grave as at the center of the grave. We have discovered elsewhere that gravestones can be mis-placed by several feet relative to the burial, that gravestones and fieldstones mark only a small percentage of burials in some old cemeteries, and that burials, including burial containers, can be reduced to mere silhouettes or shadows in the subsurface. As expected, graves of children or infants are usually much more difficult to detect than graves of adults because of their smaller size. Also, as expected, of two extremes, it is most difficult to detect a shroud burial and easiest to detect a metallic-coffin burial.

Direct detection of grave sites may involve the sensing of more massive bones, such as the skull, femur, and tibia; coffin hardware (handles, finials, knobs, escutcheons, glass viewing panes); objects attached to the interred (jewelry and favorite possessions), and knotty sections of pine boxes, which are much more resistant to decomposition than other woody parts. The cloth of shroud burials occasionally escapes decomposition, especially if it has been in contact with a brass or copper-based metal object–button, pendant, or buckle--, which protects it from bacterial decay. Environmental factors detrimental to preservation include extremely acidic or extremely alkalic soil and poor drainage resulting in alternating wet-dry subsuface conditions.

Indirect detection of grave sites may involve the sensing of disturbed soil in the grave shaft (a chaotic GPR pattern as compared to a stratified pattern or a sharp GPR lateral discontinuity representing the side of the grave shaft) and objects contained in the backfill, such as rocks or metallic items.

Not unexpectedly, we have discovered that *direct* detection of early and mid-19th-century graves in the Piedmont usually is difficult (compared to late-19th-century graves and those more recent), regardless of methods used, because of dissolution of the buried remains, attached objects, and burial containers, if any. *Indirect* detection also is more difficult because the older the grave, the more compacted the soil surrounding the burial, and the less contrast of disturbed soil relative to undisturbed soil. Preservation conditions are usually much better in the Atlantic Coastal Plain where Gunston Hall Plantation resides.

The most effective ways to delineate these old graves are

(1) by using a steel probe with custom-made bulbous tip, supplemented by using a spoon-tipped coring tool, in the hands of an experienced archaeologist or soil scientist in order to ascertain whether or not the soil is disturbed--as it must be if it is part of a grave shaft. This probing is

sometimes difficult or impossible to accomplish if the soil is frozen, dry-hardened, or exceptionally stony.

(2) by stripping the topsoil in order to visually detect the presence and exact location of a grave shaft on the basis of contrasts in soil color and texture.

It is prudent beforehand or concurrently to use remote-sensing techniques, such as GPR, to help establish where to probe and where to excavate the topsoil. The interred remains themselves often are reduced to "shadows", merely a fraction of an inch thick.

In general, we find that most 19th-century burials are surprisingly shallow--often less than half of the traditionally assumed 6-ft depth. Fortunately, even in adverse soil conditions, it is not necessary for the radar energy to penetrate much below the topsoil in order to detect some characteristics of the grave-shaft soil. It also is our experience that graves sometimes can be detected by reflections from subsurface tree roots and groundhog burrows that invade old grave shafts, following the path of least resistance.

Users of GPR data should recognize that neither this technique nor any other remote-sensing technique can *unambiguously* detect the presence of very old graves in normal circumstances. It is important to remember that GPR signals associated with *a single grave* can be shallow and/or deep; can be weak and/or strong; and can emanate from any part of the grave--from center to edges or top to bottom of the grave shaft.

Dimensions of graves

Today, the average size of a modern casket for adult burial is 84 inches long, 28 inches wide, and 23 inches high. A medium-size grave liner (an unsealed receptacle into which the casket is optionally placed) is 86 inches by 30 inches by 24 inches. A medium size burial vault (a sealed receptacle into which the casket is optionally placed) is 86 inches by 29 inches by 25 inches. Although receptacles may be larger or much smaller (for children), the dimensions of most caskets, liners, and vaults are similar. The rectangular (in plan view) grave shaft, usually dug by use of a backhoe but dug by hand where backhoe access is denied, must be a few inches greater in length and width than the largest container emplaced. These rectangular dimensions also approximately apply to the hexagonal toe-pincher coffins commonly used in the 18th, 19th and early 20th centuries.