Department of Energy

Portsmouth/Paducah Project Office
1017 Majestic Drive, Suite 200
Lexington, Kentucky 40513
(859) 219-4000

JAN 21 2011

David Snyder, Ph.D.
Archaeology Reviews Manager
Ohio Historic Preservation Office
1982 Velma Avenue
Columbus, Ohio 43211

PPPO-03-1025634-10

Dear Dr. Snyder:

SUBMITTAL OF GEOPHYSICAL SURVEY AT THE HOLT CEMETERY, PIKE COUNTY, OHIO

The enclosed report, *Geophysical Survey at the Holt Cemetery at the Portsmouth Gaseous Diffusion Plant, Pike County, Ohio, (DOE/PPPO/03-0161&D0)* was prepared as part of the Department of Energy (DOE) Portsmouth Site's National Historic Preservation Act (NHPA) Section 110 cultural resource identification efforts. The survey identified grave site locations within the cemetery and better established cemetery boundaries for cultural resource purposes. This evaluation would also provide information for future NHPA Section 106 reviews that may be prepared.

DOE is providing the survey for your information. Should you wish to comment on the survey, please provide your comments by February 23, 2011. DOE will also be forwarding electronic copies of the report to our consulting parties. A copy of this survey will be available to the general public at the U. S. Department of Energy Environmental Information Center, 1862 Shyville Road Piketon, Ohio 45661. DOE will be placing a public notice in newspapers of local circulation to notify the public of the availability of the survey. If you have any questions in reference to this submittal please contact Kristi Wiehle of my staff at (740) 897-5020.

Sincerely,

Vincent Adams
Portsmouth Site Director
Portsmouth/Paducah Project Office

cc:
William.Murphie@lex.doe.gov, PPPO/PORTS
Joel.Bradburne@lex.doe.gov, PPPO/PORTS
Kristi.Wiehle@lex.doe.gov, PPPO/PORTS
Mike.Logan@lex.doe.gov, RSI/PORTS
tmcculloch@achp.gov, ACHP
PPPO Records/LEX
Blaine Beekman
Ervin Craft
Andrew Feight
John Finley
John Hancock
Mark Johnson
Karen Kaniatobe
Sharon Manson
Jane Murray
Hawk Pope
Geoffrey Sea
Steven Shepherd
Charles Whitt

DOE/PPPO/03-0161&D0

Geophysical Survey at the Holt Cemetery at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio

Geophysical Survey at the Holt Cemetery
at the
Portsmouth Gaseous Diffusion Plant,
Piketon, Ohio

Date Issued—January 2011

Prepared for
U.S. Department of Energy
Portsmouth/Paducah Project Office

Prepared by Ohio Valley Archaeology, Inc. for
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Waverly, Ohio
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EXECUTIVE SUMMARY

On May 11, 2009, Ohio Valley Archaeology, Inc. conducted a geophysical survey at the Holt Cemetery in the northeast corner of the U.S. Department of Energy's Portsmouth Gaseous Diffusion Plant property. This survey was performed using a magnetometer and a ground-penetrating radar in an attempt to locate unmarked graves and other cemetery-related features within the mowed area of the cemetery.

As a result of these surveys, four probable and six possible unmarked graves were located that, when combined with an accurate map (made with a laser transit) of the depressions and marker stones in the cemetery, indicate there could have been as many as 24 bodies buried at Holt Cemetery. Besides mapping the known and possible locations of graves, the geophysical surveys also confirmed the presence of a perimeter fence that once encircled the cemetery and enclosed an area of about 10,000 ft^2.

This report is divided into four main sections: 1) the physical and historical setting of the Holt Cemetery, 2) historic-era graves and what about them is detectable when using a magnetometer and ground-penetrating radar, 3) background for understanding the survey results that follow in the final section, and 4) concluding remarks that analyze the survey results with regard to the historical information.

1. BACKGROUND

The Holt Cemetery is located in a forest clearing in the northeast corner of the Department of Energy's (DOE) Portsmouth Gaseous Diffusion Plant (PORTS), as shown in Fig. 1. This land was first granted to William Holt (as part of Tract 157) in April of 1821 for his service in the U. S. Army, during which he achieved the rank of lieutenant. Sometime during the 1800s, perhaps as early as October of 1821, the cemetery was platted on a hill within Tract 157.

The early historical information available for Tract 157, which includes the Holt Cemetery, is meager. Mr. Holt transferred ownership of the land to Newton Holt - presumably his son - in 1836, but there is a gap in the land ownership records until 1900-1915 when a property ownership map lists George Hunt as the owner. On this same map, a nearby parcel is listed as being owned by Hugh Farmer, who according to the genealogical information is buried in Holt Cemetery, along with many members of his family. In 1919, Daniel Farmer took possession of Tract 157 and the cemetery. The Farmers maintained ownership of the cemetery until 1952 when they sold it on November 13 to the Atomic Energy Corporation (AEC), DOE's predecessor.

According to information from the Pike County Genealogical Society, as many as 15 bodies are known to have been buried in the Holt Cemetery, but very few headstones are present today (Fig. 2 [map] and Fig. 3 [photographs]). Table 1 contains a list of names and other information related to those buried in the cemetery, which curiously does not include any Holts. Headstones or plot markers are present for Charles and Sabina Hunter (Fig. 4), who died in the late 1800s; Pvt. Henry Pry, who served in the 33rd Ohio Infantry Company E during the Civil War; and Nancy Farmer (Fig. 4), who died in 1908. A few other marker stones, likely footstones, are also present and the locations of these are shown in Fig. 2, along with numerous grave-sized depressions and trees. Two old roads are also evident near the cemetery (Fig. 2). One is the two-track currently used to access the cemetery from the north. It runs by the west side of the cemetery and continues on to the south. The second old road, which is no longer used, starts at the south edge of the cemetery and heads to the south and west. No perimeter fence was evident, but during the geophysical survey, the remains of a wire fence were discovered in the weeds and vegetation at the edge of the forest surrounding the cemetery.

Table 1. List of those buried at the Holt Cemetery.*

Last Name	First Name	Birth Date	Death Date	Other Info
Farmer	Nancy A.	1840	1908	
Hunter	Charles		31 Aug 1881	77y8m25d
Hunter	Sabina C.		1877	54y3m1d; w/o Charles
Pry	Henry			Co. E 33 R.D. Ohio Inf
Farmer	Clara			
Farmer	Eleanor Phillips			
Farmer	Florence Rebecca			
Farmer	Henry			
Farmer	Hugh			
Farmer	Newton			
Farmer	Robert Jr.		27 Oct 1821	11 months old
Farmer	William			
Gibson	Catherine Farmer			
Gibson	Frederick			
Lucas	Sumner	22 Aug 1831		s/o Robert & Friendly

**Source: Pike County Genealogical Society (contributed by Grace Carson).*

The ground surface inside the cemetery is undulating with numerous depressions and was covered in mowed weeds at the time of the survey. Most of the depressions are about the size expected for graves and many occur in rows (Fig. 2). Below ground, the grave shafts are excavated into Coolville Series soils, which are well developed forest soils with A, BE, and Bt horizons and soft shale bedrock that typically occurs between 49 and 60 inches (124-152 cm) below surface (U.S. Department of Agriculture 2001).

Fig. 1. Location of the Holt Cemetery on portions of the USGS Piketon (1961[rev. 1979]) and Waverly South (1992) 7.5 minute topographic quadrangle maps.

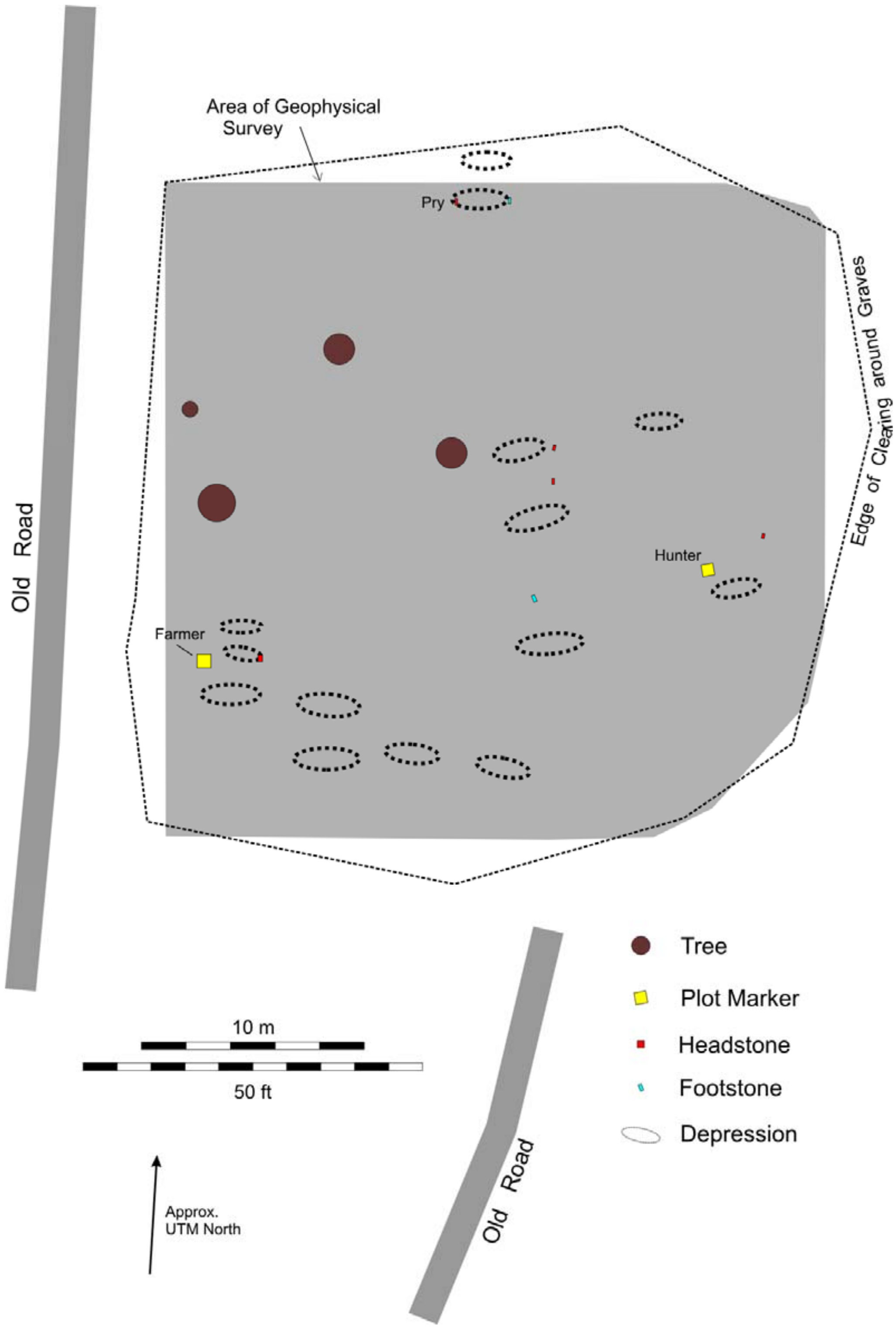

Fig. 2. Map of Holt Cemetery area showing locations of marker stones and depressions.

Fig. 3. Images of the Holt Cemetery: A) The cemetery sign in the northwest corner; B) Southwest corner looking toward northeast. The Farmer headstone is at the left and the Hunter plot marker is at right.

Fig. 4. Images of two extant stones with writing: A) The plot marker for Charles Hunter and his wife Sabina; B) The headstone of Nancy Farmer.

2. GEOPHYSICAL SURVEY OBJECTIVES AND HISTORIC GRAVES

Historic graves are notoriously difficult to detect with geophysical survey instruments because of varying soil conditions (Bevan 1991; Scott and Hunter 2004), and detection probability can be inconsistent across different instrument types (e.g., King, *et al*. 1993). All survey instruments, from magnetometers to ground-penetrating radar units, work by identifying contrasting geophysical properties in the ground, such as different moisture levels, different kinds of soil and sediment layers, or the presence of disturbed soil. If a desired target (e.g., a grave or prehistoric cooking pit) contrasts enough with its surrounding soil, then its geophysical signature will stand out against the background geophysical signature of the area surveyed. A variety of properties of historic-era graves can make them stand out from the background soil in a geophysical survey, including - most importantly - the grave shaft and its fill (Bevan 1991), the presence of a burial vault, and the type of coffin used and its condition at the time of survey (Conyers 2006).

2.1 GRAVE SHAFT AND FILL

Perhaps the most important aspect of a grave for successful detection during geophysical surveys is the grave shaft and its fill (Bevan 1991). Historic grave shafts are oval to rectangular holes two to six ft into the ground. Their horizontal extent varies widely and is dependent on the size of the individual buried and the use of a coffin and/or a burial vault. Larger grave shafts, such as those for adult burials, are more likely to be detected by geophysical instruments than those of smaller, adolescent burials. In general, adult graves should be about 6-8 ft long and 1.5-2.5 ft wide.

Along with grave size, the type of soil within the grave shaft is also important for detection with geophysical survey devices. The sediments in grave shafts are detectable because their properties are significantly different (i.e., they are disturbed) than the surrounding, intact soils. However, a grave shaft dug into weakly-developed soil (no or few distinctive soil layers) will on average be less detectable than one dug into well-developed soil (one with numerous, distinctive layers). In the extreme, a hole dug into sand and then backfilled with the same sand will be much more difficult to detect (if not impossible) than a hole dug into a soil with multiple horizons (for example, topsoil over clay subsoil) and then backfilled with the combined soil.

Grave shafts also tend to hold and drain moisture differently than their surroundings because the soil properties (porosity, compactness, etc.) of grave shaft fill differ from their surroundings. Interruptions or disturbances of soil layers, which are common to all graves, can sometimes be detected by geophysical instruments, especially ground-penetrating radar (Conyers 2006). If the grave shaft is holding more moisture or is better drained than the surrounding soils, this too can create conditions detectable with ground-penetrating radar. If the grave shaft is backfilled with soil that differs from what was originally removed from it, or more (different) soil is brought in to fill the top of a subsided grave, then a magnetometer will probably detect the grave.

2.2 PRESENCE OF A BURIAL VAULT

Nearly all modern graves in the midwestern United States involve placing a coffin in a subsurface burial vault. Today, these vaults are often made from reinforced concrete or fiberglass. Older graves sometimes contain vaults made from brick. Whatever the material, vaults will certainly impact the soil moisture levels present in the grave, making them detectable with most instrument types.

Reinforced concrete vaults and brick vaults are easily detected during magnetic surveys. Ground-penetrating radar units can probably detect just about any kind of vault, especially if it has not filled up with soil.

2.3 TYPE OF COFFIN USED

Coffin type may also affect a grave's detectability during a geophysical survey. Most wood coffins cannot be detected, and in older cemeteries most wood coffins have collapsed and rotted away. However, it is possible that intact wood coffins, if they still contain an air pocket, can be detected by ground-penetrating radar. With only one exception, coffins and coffin hardware are generally not detectable during magnetic surveys because of the small size of the magnetic components of the coffin (mostly the coffin hardware) and the depth of burial beyond the range of detection for magnetometers. One type of coffin, on the other hand, is easily detected by magnetometers — cast iron coffins/caskets. The first patent for a cast iron coffin was issued in 1848 and not long thereafter (1850s) iron coffins were used in cemeteries across the United States, though in small numbers (Crane, Breed, and Co. 1858). Large cast iron objects, be they coffins, stoves, or pipes, are highly magnetic and should be detectable with magnetometers even when buried at 5-6 ft below the surface. Their magnetic signatures will likely be larger than the actual size of the coffin or grave shaft because iron coffins are so magnetic. The ground-penetrating radar can detect metallic coffins of any type and may even be able to detect coffin hardware if it is large enough (nails are not likely large enough to detect with radar), assuming the radar signal can penetrate deep enough to reach the coffin, which is not always the case.

In summary, three main aspects of historic-era graves determine their detectability in geophysical surveys 1) the grave shaft and the soils within and around it, 2) the presence of burial vaults, and 3) the type of coffin used and whether or not it is still intact. The presence of trees within the survey area can complicate the results of geophysical surveys, in particular radar surveys, because the roots are readily detected and they are usually located close to the surface, thus obscuring the geophysical signatures of the graves.

3. MAGNETIC AND RADAR SURVEYS

Geophysical survey instruments are increasingly being used by archaeologists to find things below ground. Most things of archaeological interest are no more than a few feet below the surface. At these depths, geophysical instruments detect archaeological features by measuring subtle changes in a range of soil properties, including electrical conductivity, electrical resistance, and magnetism (Bevan 1998; Clark 2000; Conyers 2004; Gaffney and Gater 2003; Heimmer and DeVore 1995; Lowrie 1997; Weymouth 1986). Each instrument is designed to measure a different property of the ground, and some of these properties, like magnetism and electrical resistance, are almost totally independent of one another. As such, when looking for buried items that are subtle and difficult to detect, like graves, it is worth using multiple instruments.

Geophysical surveys are typically conducted by using the instruments to take numerous readings along parallel lines (i.e., transects) in a rectilinear block (i.e., block). Data points are recorded at timed intervals, or based on distance, as the instrument is moved along the transects in each block. Once the instrument's memory is full or the survey is completed, the data are transferred to a computer where they are processed and used to make a map of the survey results. In these maps, the data values are assigned colors, with higher values getting one range of colors and lower values getting another range of colors.

Two geophysical instruments were used to survey the ground at the Holt Cemetery: a magnetometer and ground-penetrating radar. Magnetometers can detect the presence of magnetic objects (like iron objects) and subtle changes in the soil, especially if these soil changes involve the local accumulation or removal of topsoil. Although objects in the ground like smaller, square nails are quite magnetic, they are usually too far from the instrument to be detected. However, most iron objects located in the first couple inches of soil that are larger than the average square nail are detected. In general, this instrument can detect down into the ground about 3 ft, unless there is something exceptionally magnetic in the area, which could be detected even deeper. Buried features like wells, cisterns, privies, burned areas or buildings, and some kinds of foundations can be detected with magnetometers. Graves can also be detected, and usually it is the soil within the grave shaft that the magnetometer detects. If the area surveyed has lots of other magnetic items on or near the surface, like iron or steel fences, this can make it difficult or impossible to detect subtle graves. Fig. 5 shows an example of some magnetic data from a cemetery in Washington Court House, Ohio, in which the magnetometer detected graves.

Ground-penetrating radar works by moving a radar antenna along the ground as it transmits many pulses of radar energy every second. As these waves of energy travel into the ground and locate items, especially those with distinctly different electrical properties, some of the energy is reflected back to the surface and received by the antenna (Conyers 2004; Witten 2006). The instrument records how strong the reflections are, their radio frequency, and how long it took the energy to travel away from and back to the antenna. The latter can be used to calculate the depth of a detected object or feature.

Many items below ground can cause strong and weak radar reflections, including tree roots, pipes, larger rocks/bedrock, distinct layers, foundations, shaft-type features (e.g., graves, wells, cisterns, and privies), and disturbances to the natural soil layers. Fortunately, radar energy can easily penetrate asphalt, concrete, and gravel. In fact, concrete and asphalt are excellent materials on which to survey because they are very good at allowing the radar energy to pass into the ground. Other materials, especially clayey, moist soils, tend to absorb radar energy and allow it to pass. At the extreme, radar energy cannot penetrate metals, so metal pipes and other large metal objects are easily detected, but they can obscure items below them. Ultimately, the depth of the radar signal penetration, and the depth to which objects can be detected, depends on the frequency of the antenna being used and the conductivity of the ground. Higher frequency antennas (e.g., 1,000 MHz) can detect very small items, but only at shallow depths, while lower frequency antennas (e.g., 100 MHz) can penetrate into the ground much deeper, but can only detect larger items. The size of the antenna, however, can be a moot point if the ground is so conductive that all of the radar energy is absorbed before it can make its way back to the surface.

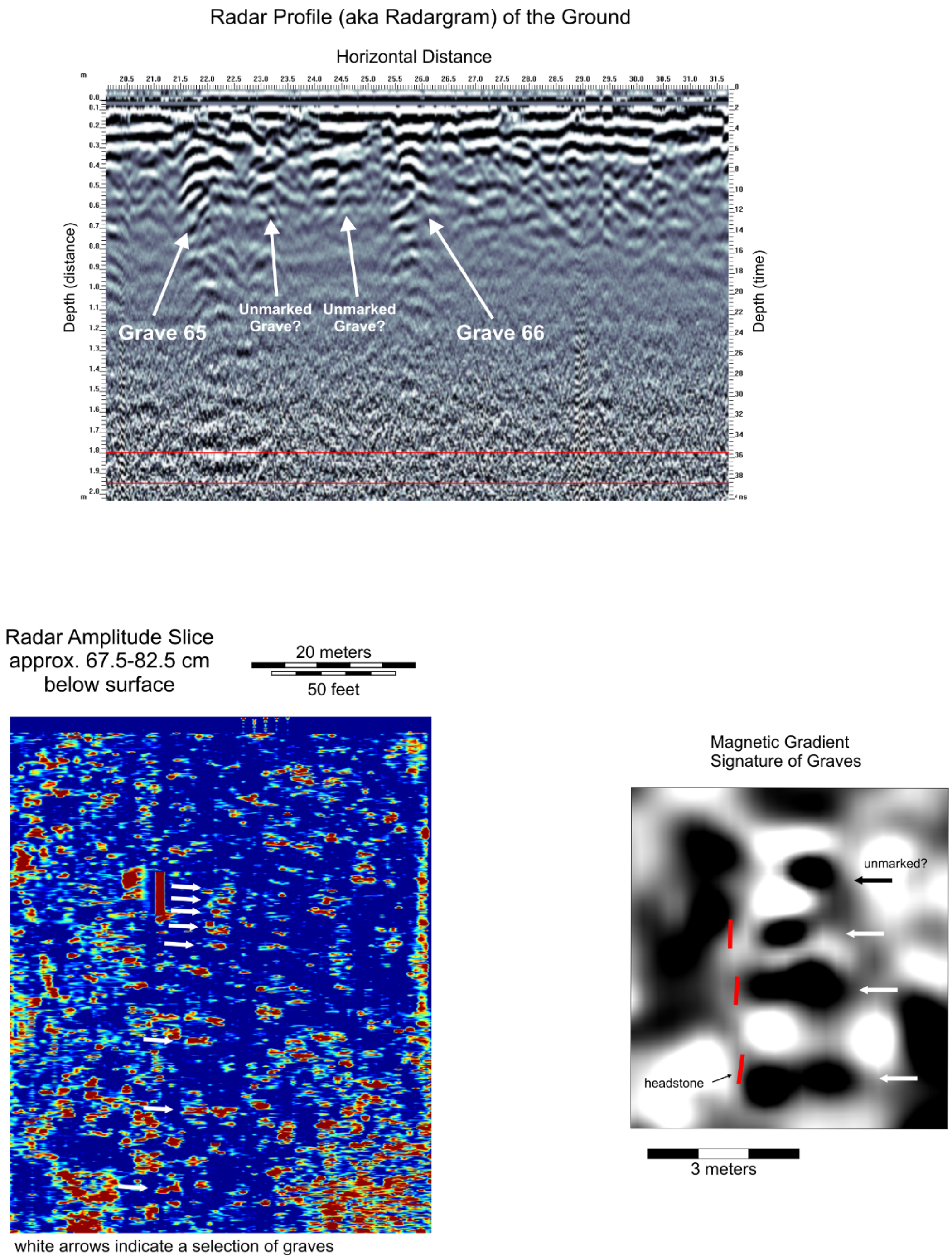

Fig. 5. Examples of Radar and Magnetic Gradient Data Over Graves in Washington Court House, Ohio.

Radar systems are often used to collect 20 traces per meter (essentially, a "reading" [i.e., trace] taken every 5 cm) along transects spaced 50 cm apart. Each radar trace is like a tiny profile of the ground. When all of these tiny profiles, or traces, are put together side by side along their collection transect they form a radargram (Fig. 5). These radargrams are the essential elements of a radar survey, showing the locations and shapes of the radar reflections. However, it can be difficult to interpret what has been found based on the radargrams alone. One useful aspect of radar data is that the radargrams can be stacked up side-by-side and then the whole group can be "sliced" horizontally and looked at from the top rather than the side, giving the effect of being able to excavate down through the data, and the site, one layer at a time. These horizontal data slices are called “time slices” or “amplitude slices” and they show a horizontal map of the radar reflection amplitude (or reflection strength) at a desired depth.

It can be difficult to show all of the important radar features from a survey area in one map because there are numerous ways to slice and display radar data. Often, radar data are shown in just one way, as a series of side-by-side amplitude slices at varying depths. Each slice generally is chosen to display the variability in the radar data with depth.

Details on the soils and setting of the area surveyed, the instruments used, and the kind of data processing employed for the Holt Cemetery project are summarized in Appendix A.

4. RESULTS

4.1 MAGNETIC SURVEY RESULTS

Both the magnetometer and the ground-penetrating radar were used to collect data covering about 10,000 ft^2 at the Holt Cemetery. Fig. 6 shows the results of the magnetic survey. Darker areas are more magnetic and lighter areas are less magnetic. The challenge with any map of geophysical data, especially magnetic data, is determining the archaeological significance of the many anomalies present in the data.

An anomaly is any area in the data that deviates significantly from the background signature (medium gray areas in Fig. 6) of the site. There are many anomalies in the Holt Cemetery magnetic data. For reference, a typical piece of iron, like a piece of fence wire or an old screwdriver, will produce a magnetic anomaly with a strong positive area (darker) and a strong negative area (lighter) that are side by side. These anomalies are labeled as dipolar simple anomalies (some geophysics professionals use different terms). These dipolar simple anomalies are almost always associated with an iron object or a magnetic rock. When a large number of dipolar simple anomalies cluster together, they form a larger dipolar complex anomaly with many highs and lows in complex patterns. Frequently, dipolar complex anomalies are associated with building foundations and trash dumps, both of which tend to contain many iron objects.

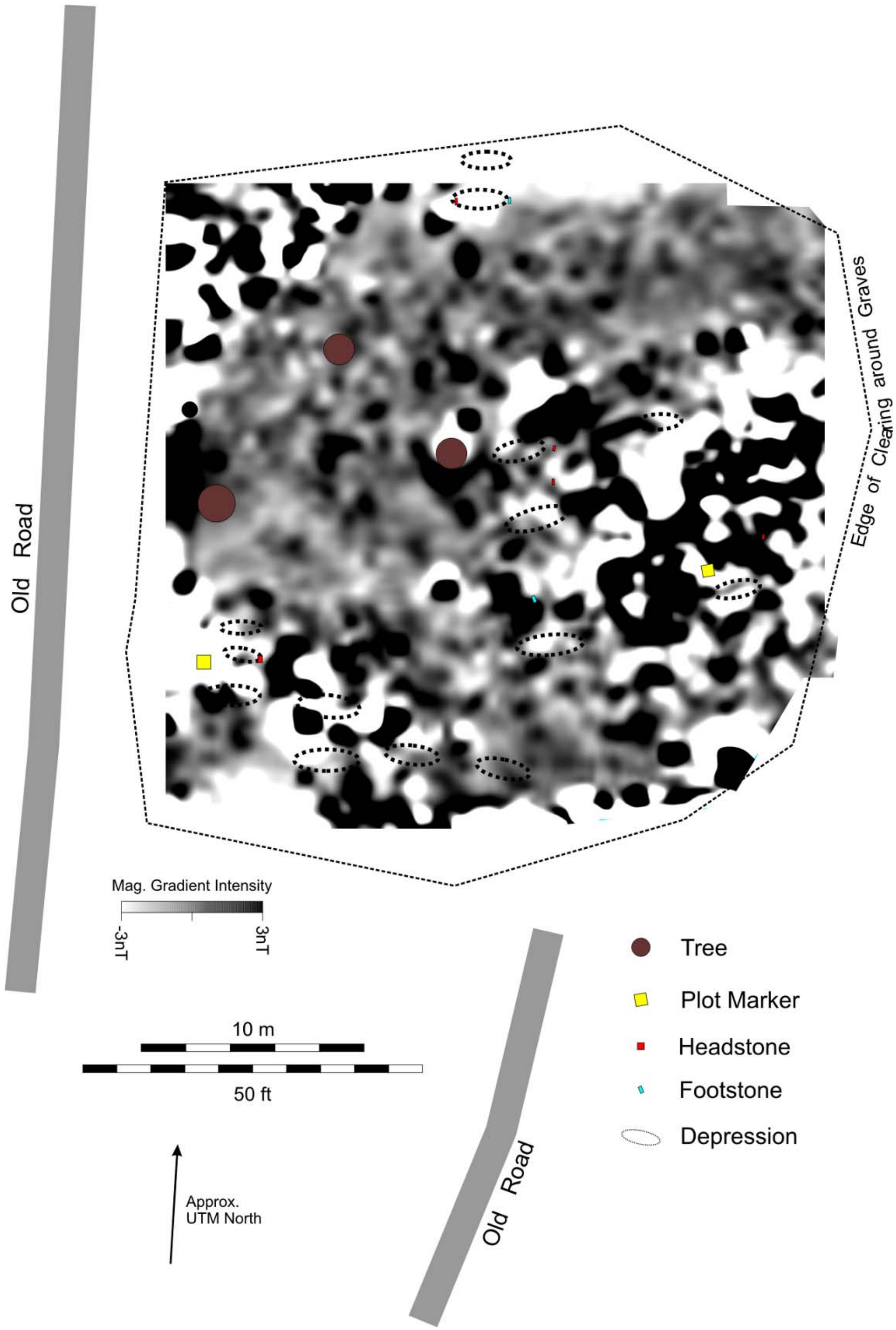

Fig. 6. Magnetic gradient survey results.

The Holt Cemetery magnetic data are full of dipolar simple and dipolar complex anomalies. The strong readings evident along the west and south edges of the survey area were created by the remains of the perimeter fence wire that is lying on the ground and under brush at the edge of the clearing. Moving away from the edges of the data, there appears to be three clusters of dipolar simple anomalies: in the northwest corner, the southwest corner, and a large area in the east half of the cemetery. The anomalies in the southwest corner and in the east half there are spatially associated with known graves and surface depressions. Surface depressions are very common in cemeteries and occur when the soil in the grave shaft subsides, from either general compaction and settling or after the coffin collapses and the dirt above it moves down and into the coffin.

The depressions in the southwest corner of the cemetery, just east of the Nancy Farmer stone, are unusually deep and some could indicate locations where burials were exhumed. If no burials were exhumed, then the graves in this area show an unusual degree of subsidence (at least 50 cm in some cases). The cluster of what are likely iron objects around the depressions in the southwest corner could be the remains of objects placed next to the graves. For example, many of the plastic wreaths and flowers used today in cemeteries have steel wires in them and when the flowers and wreaths are hit by mowers or just slowly break apart the magnetic steel wires make their way into the ground.

The cluster of magnetic anomalies around the Hunter stone seems unusually concentrated and almost rectilinear in shape, suggesting that these anomalies were not simply created by decayed graveside offerings. It is possible that at one point the Hunter family plot had a small fence around it and the magnetic anomalies in this area are the remains of that fence. Conversely, it is also possible that the perimeter fence was pulled into this part of the cemetery and left to decay on the ground.

The cluster of magnetic anomalies in the northwest corner do not seem to be associated with any graves, marked or unmarked, and may be related to parts of the wire perimeter fence that fell into the cemetery. This area is also close to the sign for the cemetery. If the sign came to be located close to the "official" entrance to the cemetery, then perhaps this northwest cluster of anomalies marks the remains of a gate.

The subtle signatures of grave shafts are difficult to pick out of the magnetic data because of all the clutter created by the many strong, dipolar anomalies. However, there are at least four magnetic anomalies that could be unmarked graves. These will be noted on the interpretive map to be presented after a brief discussion of the radar survey results.

4.2 RADAR SURVEY RESULTS

Fig. 7 shows the results of the radar survey as a series of amplitude slices at different estimated depths, the shallowest in the upper left and the deepest in the lower right. Red areas indicate items below ground that created stronger radar reflections and dark blue areas indicate places that lacked strong reflections. The area of strong readings in the northwest quadrant of the shallowest three slices was created by antenna noise as the instrument warmed up during operation. A close inspection of the top three slices shows that many of the depressions (black dotted ovals) are associated with stronger reflections near the surface. These near-surface reflections are likely created by moisture in the depressions and would look as they do in radar data regardless of whether these depressions are graves. Interestingly, in the deeper slices most of the depressions are evident as areas lacking strong reflections. These quiet areas in the data are actually what one might expect for grave shafts. Because the graves are deep holes filled with homogenized soil (i.e., they lack natural soil layers that can create chaotic reflections), they can appear as "holes" in layers that otherwise create stronger reflections in the radargrams. Of course, in a dataset with so many small strong and weak reflections, it is hard to pick out possible unmarked graves from the amplitude slices. For that reason, Ohio Valley Archaeology, Inc. (OVAC) interpretations of the radar data relied on a close inspection of all the radargrams.

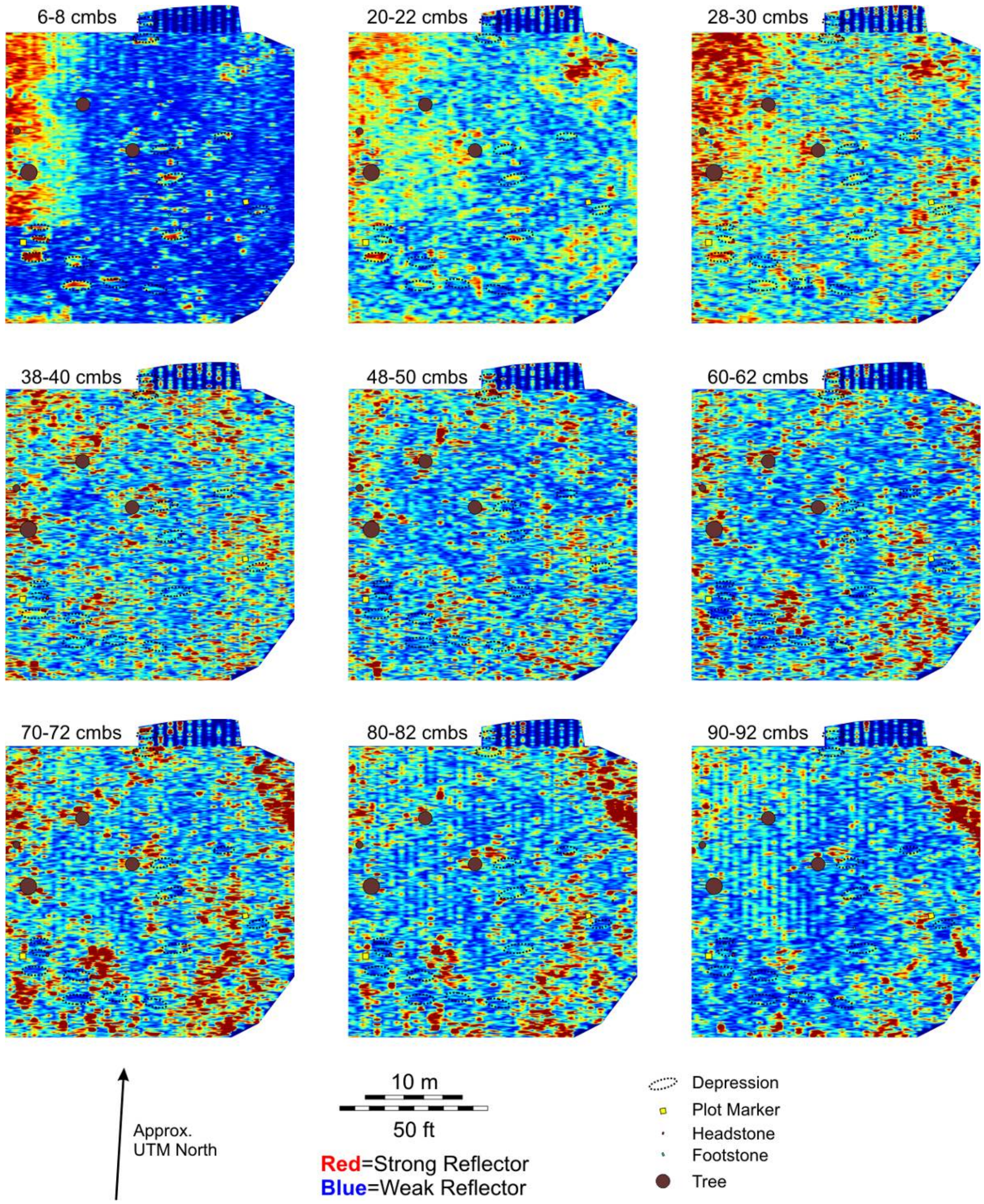

Fig. 7. Ground-penetrating radar amplitude slices showing radar anomalies at different depths with an overlay of depressions and marker stones.

4.3 INTERPRETATION OF THE GEOPHYSICAL DATA

Fig. 8 is an interpretive map of the geophysical survey results and Table 2 contains information, such as anomaly coordinates, for each of the numbered anomalies/possible graves. The small orange dots mark locations in the radargrams where there was a strong reflection consistent with that expected for a grave. And, not surprisingly, there are many strong reflections all over the cemetery, not all of which are associated with graves.

Each of the radar data-collection transects was spaced 50 cm apart and data was collected in lines that should have been running perpendicular to the long axis of the graves. So, if a grave is visible in the radargrams, it should show up in at least three consecutive transects, unless it is the grave of a child or the grave is not oriented perpendicular to the direction of data collection. Using this interpretive technique, six locales were identified where there are three or more good reflections in a row (See Fig. 8). Four of these areas (Anomalies 1, 8, 15, and 21) produced cohesive and strong enough reflections that OVAC has classified them as probable graves. Anomaly 21, which is located right next to the Hunter plot marker, produced the distinctive radar signature associated with metal, often referred to as multiples or ringing. While there are lots of dipolar anomalies in the magnetic data from this area, there are no exceptionally strong magnetic anomalies above Anomaly 21 that one would expect if this were the location of a cast iron coffin. So, either this anomaly is not a grave, but rather some kind of smaller, deeply buried iron object, or this could be a metal coffin made from something other than cast iron, such as lead. Given its small size, Anomaly 21 may be the grave of a child. The remaining two radar anomalies (10 and 19) were classified as possible graves, rather than probable, because their signatures in the radargrams were diffuse. Interestingly, almost all of the lines of three or more strong reflections line up in a direction that matches the orientations of the known graves and the depressions, and in some cases (e.g., Anomalies 1, 8, 10, and 15) they are in the same rows. This is a good indication that these rows of depressions and linear geophysical anomalies are graves.

There were four anomalies (7, 16, 23, and 24) in the magnetic data that were approximately twice as long as they are wide and not associated with a lot of other dipolar anomalies. These appear as blue ovals in Fig. 8. Anomaly 7 seems to be lined up with the 5-6-8 row. Anomalies 16, 23, and 24 make their own row, but appear to be oriented in the opposite direction (north-south) to the rest of the known and possible graves (east-west). Family cemeteries, like Holt, can go through periods of heavy and light use or transitions from one family to another. During these transitions and changes in use, it is possible for new burials to be interred with their long axes oriented in different directions as compared to previous burials, especially if there are no above-ground markers to indicate where previous burials are located. Perhaps these three anomalies (16, 23, and 24), if they are graves, mark an early period in the use of the cemetery after which the locations of the graves were lost as a new family took over use of the cemetery.

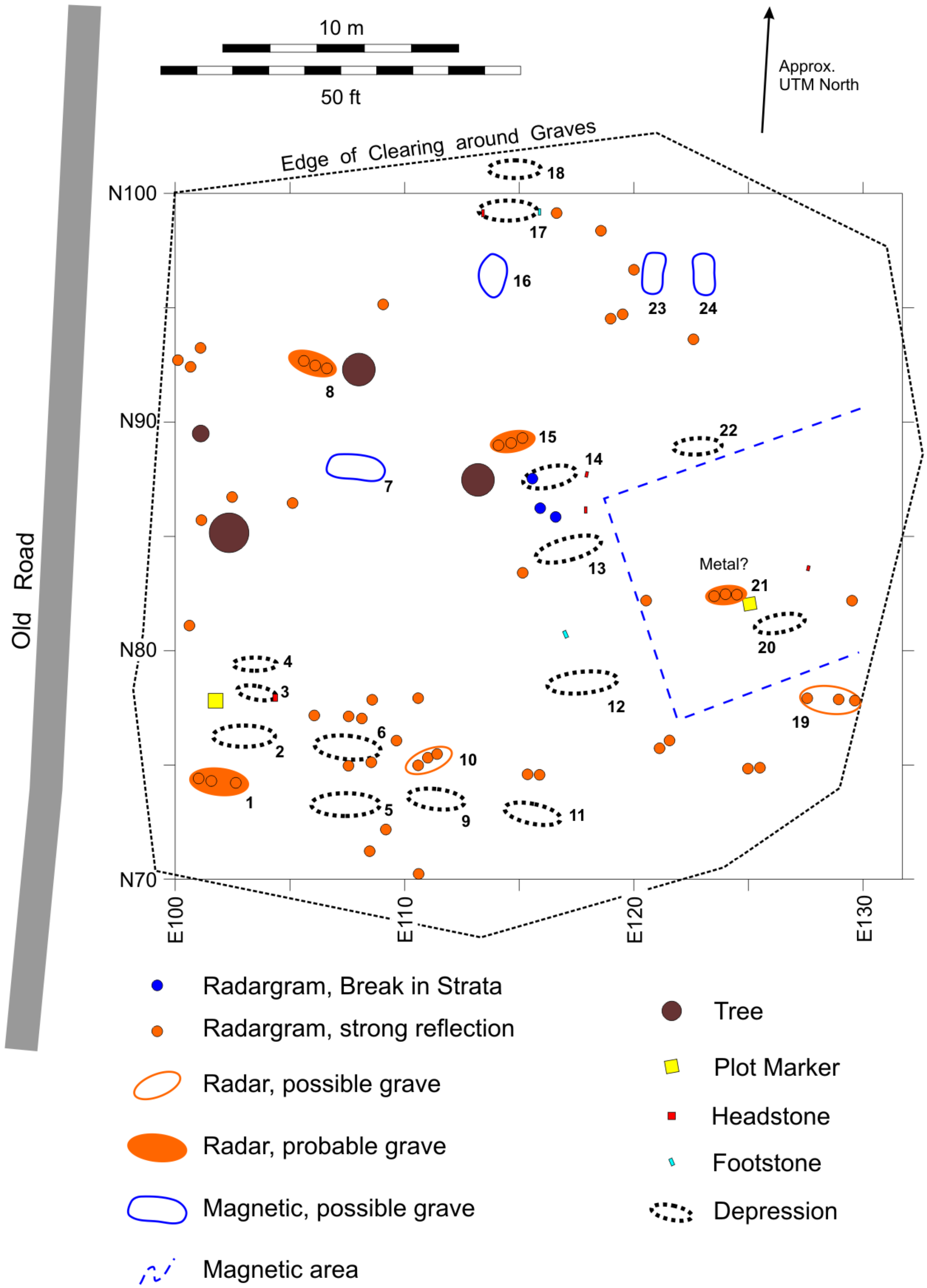

Fig. 8. Interpretive map showing the locations of possible unmarked graves and other anomalies.

Table 2. Geophysical anomaly information.

Anom. #	North	East	Anomaly Source[a]	Magnetic Strength[b]	Radar depth[c]	Comments
1	74.5	102	R		40-80	
2	76.5	103	D			2.25 m long
3	78.25	103.5	D			1.75 m long, associated with stone
4	79.5	103.5	D			1.75 m long
5	73.25	107.5	D			3 m long
6	75.5	107.5	D/R			2.75 m long
7	88	108	M	8.02		2.25 m long
8	92.5	106	R		20-80	
9	73.5	111.5	D			
10	75.25	111	R		25-65	
11	72.75	115.5	D		30-95	2.25 m long
12	78.5	117.75	D			3 m long
13	84.5	117	D			2.75 m long
14	87.5	116.25	D/R			2.25 m long, associated with stone
15	89	114.5	R			
16	96.5	113.75	M	16.92		
17	99.25	114.5	D			2.5 m long, associated with head- and footstones
18	101	114.75	D			2.13 m long
19	77.75	128.5	R		30-95	
20	81.25	126.25	D			2.25 m long
21	82.5	124	R/M	+20s/ -20s	60-?	multiples extend all the way down profile starting at 60
22	89	122.75	D			2 m long
23	96.5	121	M	3.65		
24	96.5	123	M	3.27		

a – R=radar, M=magnetic gradient, D=surface depression.
b – measured nanotesla (nT).
c – depth measured in cm below surface using radargrams in Ekko Mapper software.

5. CONCLUSION

The magnetic and ground-penetrating radar surveys in the Holt Cemetery conducted on May 11, 2009, located four probable and six possible unmarked graves, as well as 14 grave-sized depressions. Many of these depressions and geophysical anomalies have long axes that are parallel to one another and they occur in row, as expected in a cemetery. A burial inventory from the cemetery (Table 1) lists 15 names. Clearly there is some discrepancy in the number of graves based on the number of stones, the burial list, and the results of the geophysical survey.

Unfortunately, the results of non-invasive techniques like geophysics and laser transit mapping do not allow us to directly link up unmarked graves with names on burial lists. Sometimes, however, there are suggestive patterns that allows speculation about what name belongs to which unmarked grave. For example, the burial list in Table 1 contains nine members of the Farmer family (not including Catherine Gibson) and a quick count of the depressions and geophysical anomalies clustered next to the Farmer plot marker (the Nancy Farmer stone) also yields a count of nine.

Although it could be mere coincidence, this continuity in numbers suggests that if these depressions and geophysical anomalies are the locations of graves then we can at least say with some confidence that they likely are the graves of Farmer family members.

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ATTACHMENT A: GEOPHYSICAL SURVEY SUMMARY

Site Name: Holt Cemetery
Location: Portsmouth Gaseous Diffusion Plant, DOE Facility, Pike County, Ohio
Drainage: Big Beaver Creek-Scioto River
Landform: Hilltop
Surface Conditions: Mowed grass in cemetery, area surrounded by forest
Soils: Coolville Silt Loam (Aqua Ultic Hapludalfs)

Survey Objective: Locate historic-era graves

Survey Type: Vertical Magnetic Gradient; ground-penetrating radar
Instrument: Mag. Gradient=Geoscan Research FM 256 Fluxgate Gradiometer, 1 nT resolution; Ground-Penetrating Radar=Sensors and Software Noggin 500
Surveyor: Jarrod Burks
Assisted by: Albert Pecora
Date of Survey: May 11, 2009
Area Surveyed: About 10,000 ft^2
Readings per meter along transect: Mag gradient= 8, parallel data collection mode, 50 cm transect spacing; ground-penetrating radar=one trace every 5 cm, 50 cm transect spacing.

Data Processing: Mag. gradient=Geoplot 3.0s: Zero Mean Traverse, Interpolate, Low Pass Filter; ground-penetrating radar=Ekko Mapper v. 3: background subtraction, migration, enveloping, dewow

Target Anomalies: Historic-era graves

Results: The magnetic gradient survey found large areas of iron objects in the ground near surface, especially around the Hunter graves. These iron objects could be part of an old fence that surrounded this portion of the cemetery. The magnetometer also detected the remains of a wire fence that used to enclose the cemetery. At least four magnetic anomalies could be the locations of unmarked graves. The radar survey detected an additional four probable and two possible unmarked graves.

ATTACHMENT B: NOTES

NOTES

NOTE 1: The Holt Cemetery is not properly located on the USGS 7.5 minute topographical quad map shown in Fig. 1. The actual center point (approximately) for the cemetery in UTM coordinates (in meters) N4322852.77, E328663.85 (Zone 17 north, Datum=NAD 1927(conus). These data are an average of 13 WAAS-corrected GPS positions collected with a Trimble GeoXT global positioning system.

NOTE 2: The coordinates (in meters) provided in Table 2 for each of the depressions and numbered geophysical anomalies are based on the grid set up to collect the geophysical data. The northwest corner of this grid, where the transit was set up, was arbitrarily assigned the coordinate of N100, E100. The wooden grid stakes set in the ground at N100, E100; N80, E100; N70, E100; N100, E120; and N80, E120 were pounded down flush with the ground surface. While the wood will eventually decay, one should be able to relocate these stakes at least for the next 5-10 years. The N100, E100 stake is located about a meter south of the Holt Cemetery sign (see Fig. 3).