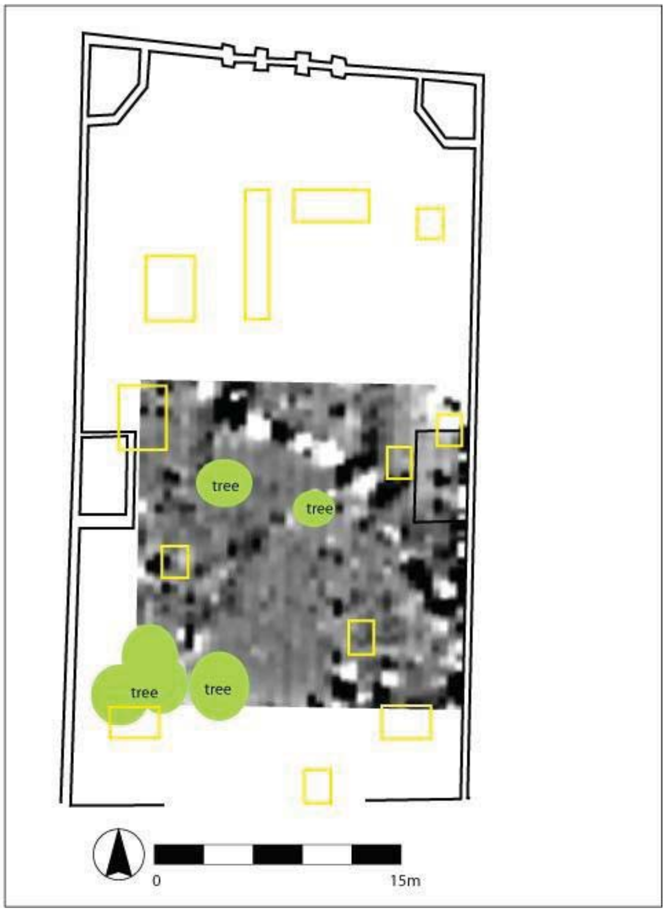
A Geophysical Survey of Portions of Wragg Mall, Wragg Square, and the Aiken-Rhett House



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Submitted to: Carl Borick (Charleston Museum) and
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INTRODUCTION

This report summarizes the results of a geophysical survey conducted between March 12 and March 14, 2012. The survey, which was performed by Dr. Jon Bernard Marcoux of Auburn University Montgomery and Inna Burns Moore and Dave Baluha of Brockington and Associates, Inc., covered portions of three study areas in downtown Charleston, SC – Wragg Mall, Wragg Square, and the back lot of the Aiken-Rhett house (Figure 1). Investigators employed both ground penetrating radar (GPR) and magnetic gradiometry in the survey of Wragg Mall and the back lot of the Aiken-Rhett house. This report does not discuss the results of the GPR survey of the Aiken-Rhett house back lot, the data from which are still being analyzed by Inna Burns Moore. The survey of Wragg Square was conducted solely using a magnetic gradiometer. There were two main goals for the survey: 1) to determine whether the three study areas contain any remaining archaeological traces of British trenches (Second and Third Parallels) associated with the 1780 Siege of Charleston (Borick 2003); and 2) to identify any anomalies in the Aiken-Rhett house back lot that might aid in cultural and historic interpretation. The results of both GPR and magnetic gradiometer survey determined that, despite the hope that it was relatively undisturbed, Wragg Mall had indeed been significantly affected by the installation of two large metal pipes that run the entire length of the mall. No anomalies matching the size and/or orientation of the British Third Parallel were identified by the magnetic gradiometer. However, an anomaly matching the size and orientation of a military trench was detected by the GPR survey in the northeast corner of the survey area. At Wragg Square, the surveyed portion again did not detect any linear anomalies as would be expected for siege trenches; however, a number of point anomalies were identified. Given the location of a cemetery to the east of the study area, I recommend that these anomalies be investigated prior to any ground disturbing activities. We identified a number of anomalies in the back lot of Aiken-Rhett house. These include metal pipes, buried metal fragments, small ditch features, a fence line, and numerous features that may be the remnants of garden plantings. None of these anomalies can be associated with the British trenches.

SURVEY METHODS

This survey employed techniques and methods falling under the subfield of archaeological geophysics (AG). Archaeological geophysics is a field of study that utilizes precise measurements of certain physical properties of soil in order to identify and define buried archaeological features (e.g., storage pits, trash-filled pits, burials, house posts). The most obvious benefit of AG is that it provides the archaeologist with a "picture" of sorts of what lies beneath the surface of the ground. This image can be used as map to direct excavations to specific features within an archaeological site - greatly reducing the amount of time spent searching for these features using traditional field methods. Archaeological geophysics has been in existence since the 1940s; however, only within the last decade have major advances in computing power and increases in the sensitivity of measuring instruments made AG a practical and cost-effective research tool (Ernenwein and Hargrave 2009; Gaffney and Gater 2003; Johnson 2006). While still at a nascent stage, AG is growing in popularity among archaeologists in the southeastern U.S.. Recently, AG techniques were used to define the size and structure of manmade "shell rings" along the coast of Georgia (Thompson et al. 2004) and to identify buried trash-filled pits and house structures at the Crystal River Mound site in western Florida (Pluckhahn et al. 2009). Despite this recent growth,

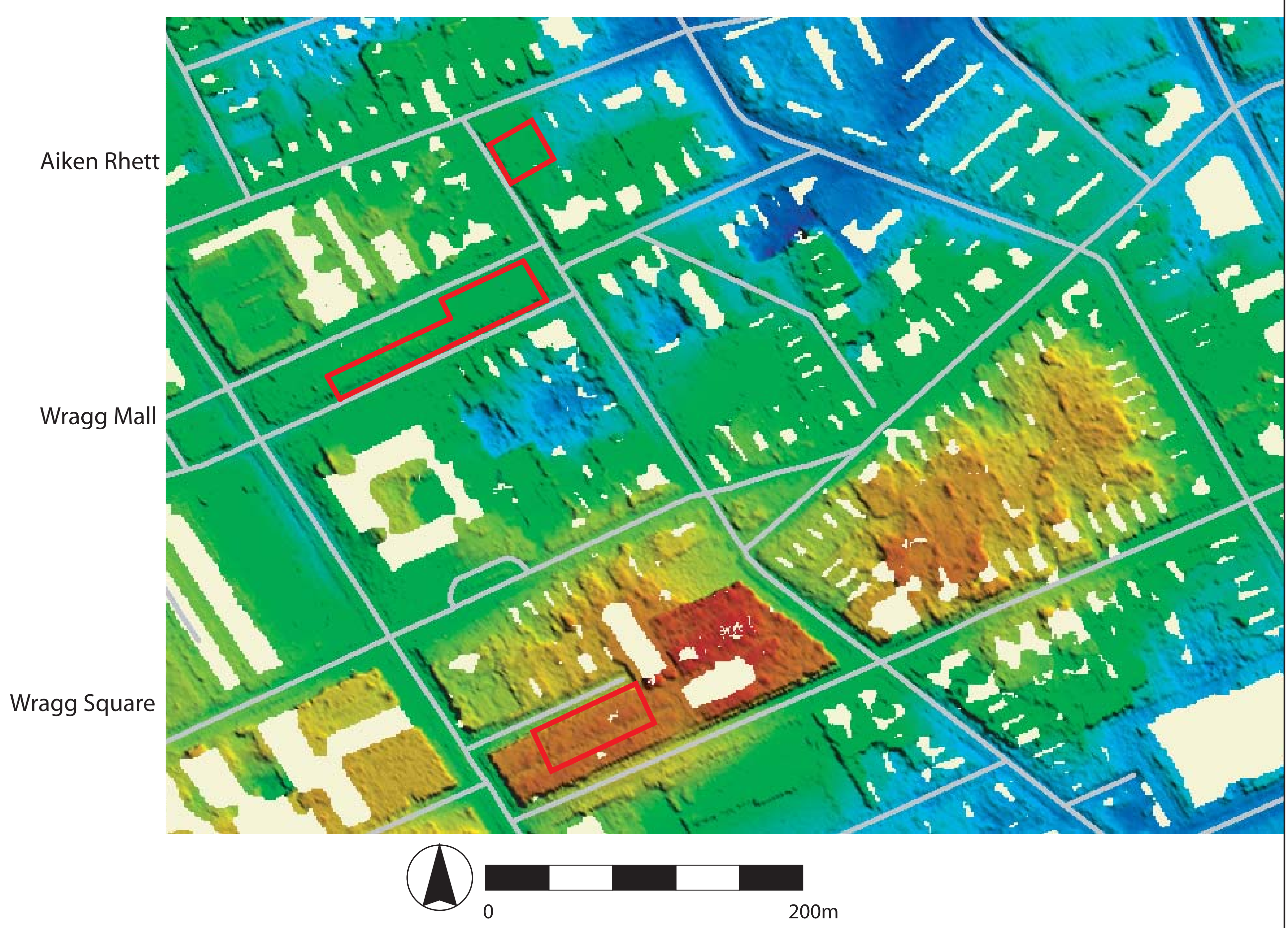

Figure 1. Map depicting the three survey areas (outlined in red) on a LIDAR-based elevation map.

however, AG remains largely limited to projects conducted by researchers at large universities (Johnson 2006).

Archaeological geophysics includes a number of different techniques, each of which focuses on a different physical property of soil. Ground penetrating radar (GPR) and magnetometry are the two most popular techniques because they are cost effective and time efficient (Conyers 2006; Aspinall et al. 2008; Kvamme 2006) Each technique requires a different piece of equipment and has different costs and time requirements. GPR accurately maps objects (like metal pipes) and archaeological features by sending radar wave pulses through the soil and measuring the time it takes for each wave to be reflected back to an antenna at the surface. Differences in soil, such as would be expected between the subsoil and a filled-in military trench, or the presence of subsurface objects are detected as changes in the velocity of the radar wave. The benefit of GPR is that it results in a three-dimensional picture of subsurface features, where the analyst can record the horizontal positions of features as well as their depths.

As the name implies, magnetometry identifies buried archaeological features by measuring magnetic fields below the surface of an archaeological site. These measurements are taken using a piece of equipment called a magnetic gradiometer. The gradiometer records changes in magnetic fields up to 1.5 meters deep. The goal is to identify localized anomalies that represent changes in the strength (called the gradient) of the earth's magnetic field. These anomalies are usually caused by stark differences in the composition of the soil, which would occur in a trash-filled pit or a burial, or by thermal alteration, such as in a hearth or the remains of a burned house (Ernenwein and Hargrave 2009).

For the magnetic gradiometer survey, we established a grid of 18 10-x-10m blocks for Wragg Mall, three 20-x-20m blocks for Wragg Square and a single 20-x-20m block for the Aiken-Rhett house back lot. Permission to survey Wragg Mall and Wragg Square was granted by the City of Charleston and by the Historic Charleston Foundation for the Aiken-Rhett house back lot. The sampling density for all areas was established at 12.5cm (eight readings per meter) on transects spaced 50 cm apart. This provides 1600 data points for a 10-x-10m block and 6400 data points for a 20-x-20m, block. Ropes spaced one meter apart were used as transect guides for Dr. Marcoux, who covered each grid by pacing in a zigzag pattern (Figure 2). The results of the magnetic gradiometer survey were processed by Dr. Marcoux using *Archaeofusion* software generously provided by the University of Arkansas Center for Advanced Spatial Technologies.

For the GPR survey of Wragg Mall, we used the same grids as that established for the magnetic gradiometer survey (Figure 3). The wave pulses provide essentially continuous readings along transects. The transects were spaced two feet apart. The data recovered from the survey were processed by Inna Burns Moore using *GPR Slice* software.

SURVEY RESULTS

Wragg Mall

As with all three study areas, Wragg Mall was chosen by Carl Borick, Director of the Charleston Museum, because it is located in the vicinity of where a British trench is supposed to have been placed during the

Figure 2. Jon Marcoux walking transects with the magnetic gradiometer at Wragg Mall.

Figure 3. Dave Baluha walking transects with the GPR unit at Wragg Mall.

Siege of Charleston in 1780 (Figure 4). Additionally, this area was believed to be relatively undisturbed by construction and utilities since the siege. Figure 4 is a map presenting a roughly geo-referenced sketch map, known as the Sir Henry Clinton Map 310, obtained by Carl Borick from the William L. Clements Library at the University of Michigan. The sketch map was tied to modern-day points along Judith Street, where the angle of a British tidal creek crossing on the map matches the modern orientation of Judith Street. The other anchor point is the southwestern corner of the northeastern projection of American Horn Work, which can be found as a monument today in Marion Square. The sketch map is laid over a Light Detection and Ranging (LIDAR) elevation raster graphic of Charleston obtained from the National Oceanic and Atmospheric Administration Coastal Services Center. While only a schematic, the figure shows a significant correlation between the topography and tidal creeks, on the LIDAR map, and the earthworks and creek crossings on the Sir Henry Clinton Map 310.

Because of time constraints, we concentrated our survey on the eastern portion of the mall, where Borick's cartographic research suggested the trench would cross. Additionally, the northern section of the mall was obstructed by construction fences. The results of the magnetic gradiometer survey are depicted in Figure 5. The colors on the map represent the divergence of magnetic gradients (measured in nanoteslas) from a baseline value established for an undisturbed piece of ground. The darker areas have values of greater magnetism while lighter areas have values of lesser magnetism. The map is dominated by linear anomalies running parallel to the mall. The southern anomaly alternates between black and white - extreme values whose pattern represents a *dipolar* anomaly. In magnetometry, a dipolar anomaly is a tell-tale sign of a highly magnetic material like iron or an iron alloy, a material that has its own magnetic field. Fired bricks made with iron-rich clays can also be detected as dipolar anomalies. The patterning in both northern and southern areas represents large metal pipes. Other dipolar anomalies are located along the borders of the survey area, where cars are parked. The total effect of these large metal objects can be seen in the "shadow" they cast across the survey area, essentially drowning out any weaker anomalies that may be present. In sum, the magnetic gradiometer, an extremely sensitive measuring device, was simply overwhelmed by the presence of large, highly magnetic objects.

The results of the GPR survey are depicted in Figure 6 and Figure 7. A smaller area was covered in this survey because Ms. Moore and Mr. Baluha had less time to volunteer than Dr. Marcoux. The colors in the GPR results correspond to reflectivity, with blue-green-yellow-red representing increasing amounts of reflectivity. Figure 6 shows the presence of a highly reflective linear object running parallel to the mall between 60 and 75 cm beneath the surface. The position of these anomalies in both the northern and southern portions of the mall matches the anomalies detected in the magnetic gradiometer survey. This confirms the presence of pipes running the length of the mall. Figure 7 depicts an anomaly of high reflectivity that is located deeper than the pipe disturbance (80 – 175 cm). In the northern portion of the mall, the anomaly is oriented from northeast to southwest, which roughly matches the orientation of the British Third Parallel in the Sir Henry Clinton Map 310. The anomaly is present at the same depth in the southern portion of the mall, although here it is much more amorphous.

Wragg Square

In Figure 4, one can see the correspondence between the modern-day location of Wragg Square and the

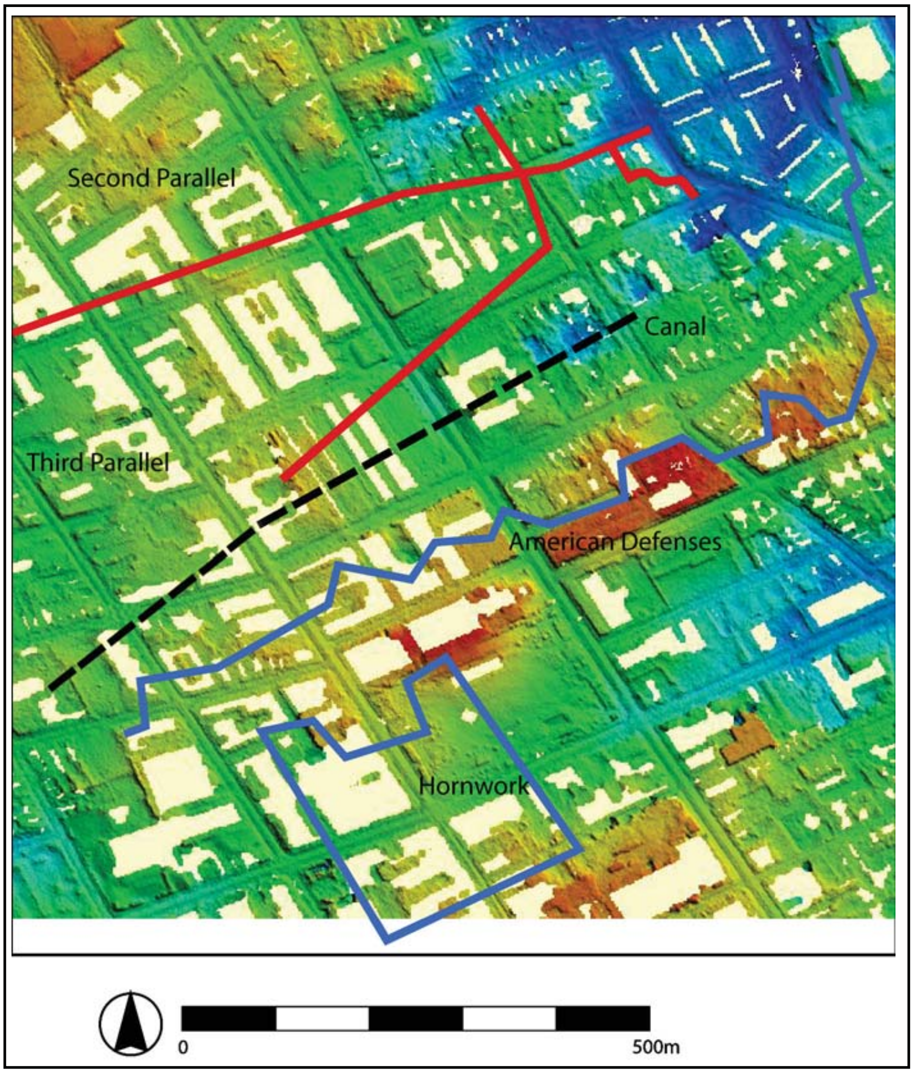

Figure 4. A schematic depicting a portion of the 1780 Henry Clinton Map superimposed over a LIDAR elevation map of the study areas.

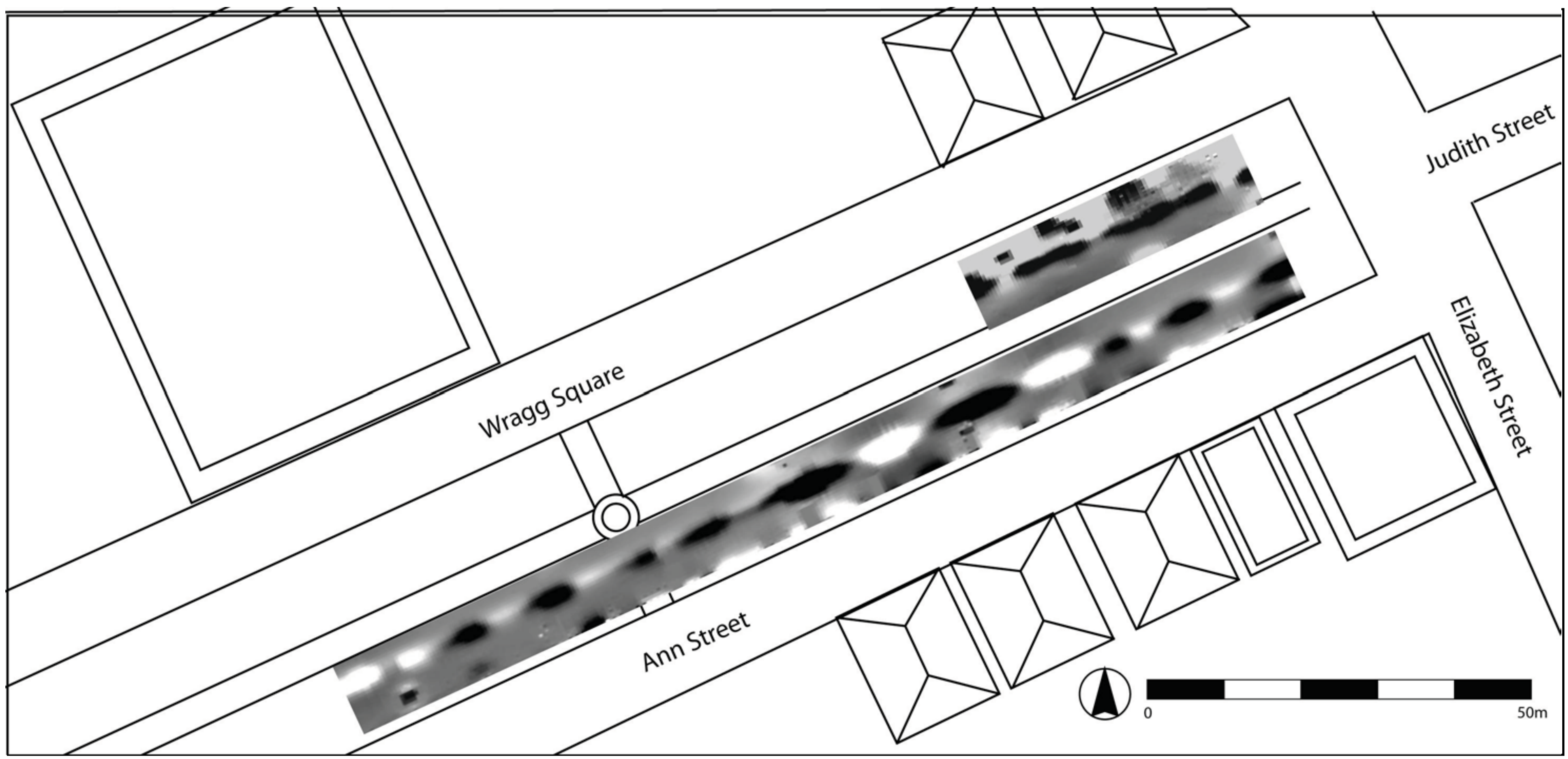

Figure 5. Results of the magnetic gradiometer survey of Wragg Mall.

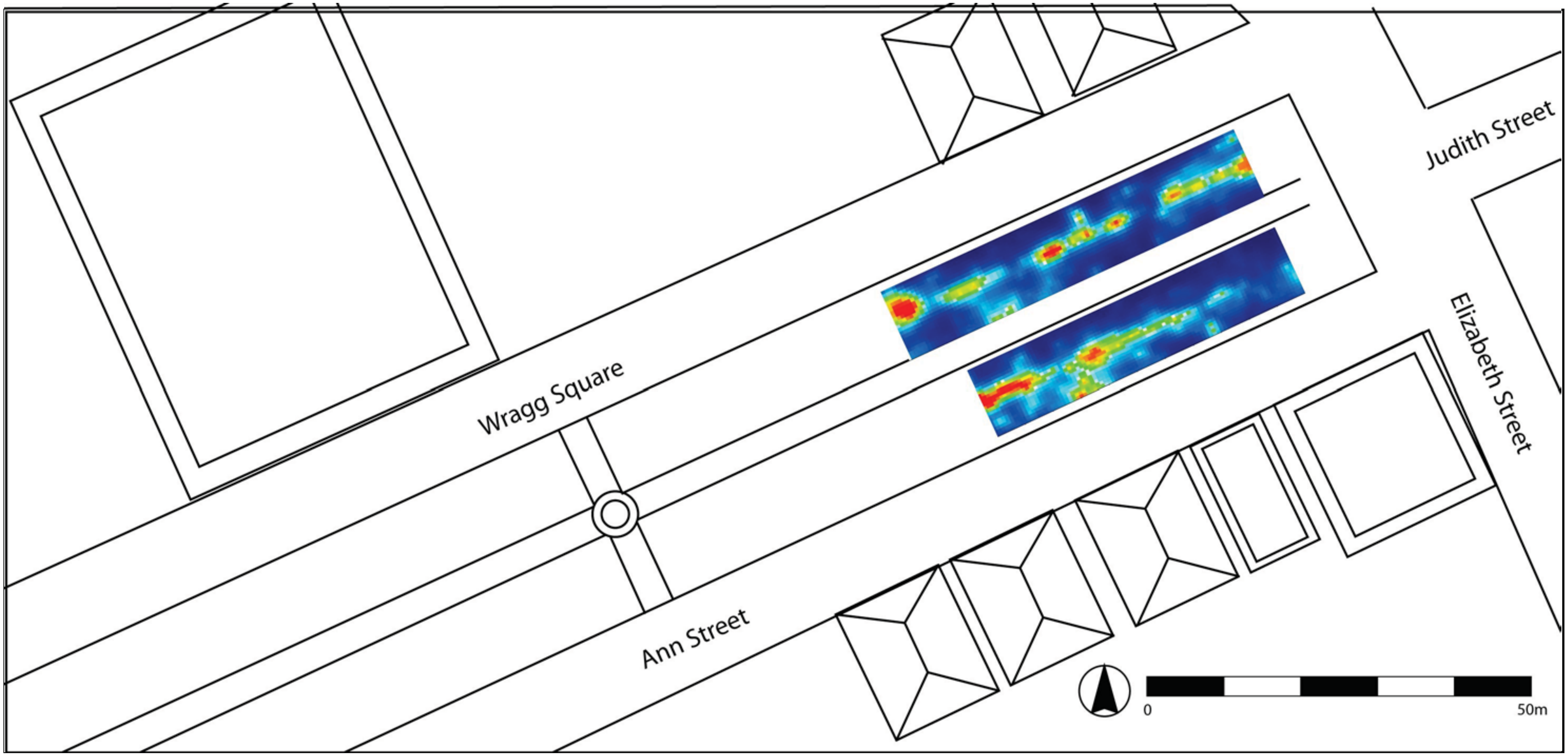

Figure 6. Results of the GPR survey of Wragg Mall at 60-75 cm below surface.

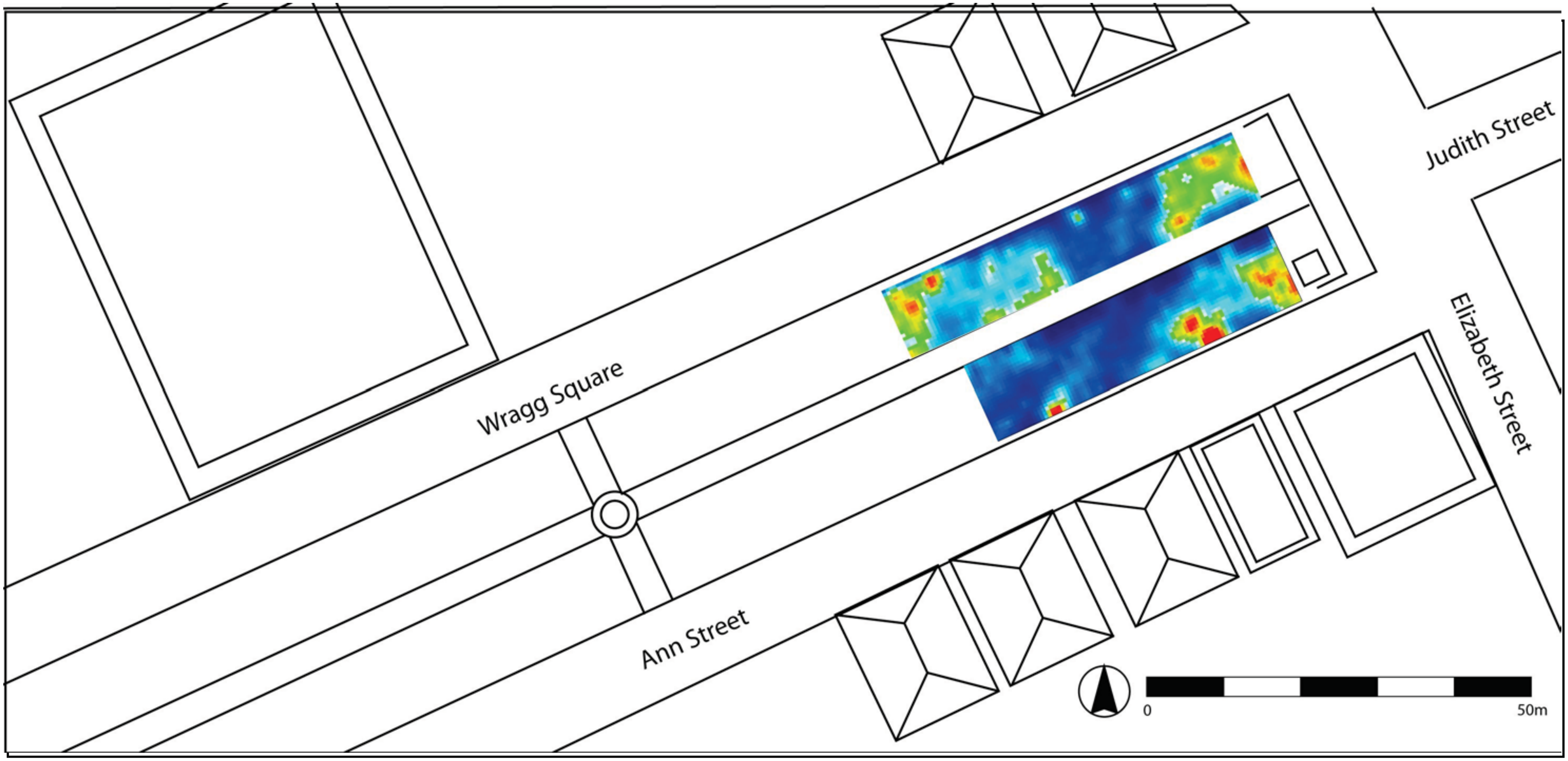

Figure 7. Results of the GPR survey of Wragg Mall at 80-175 cm below surface.

American defensive earthworks depicted in the Sir Henry Clinton Map 310. Due to time constraints, we concentrated our efforts on a 60-by-20m area along the northern portion of the square, where we had the highest likelihood of intersecting the earthwork. Figure 8 depicts the results of the magnetic gradiometer survey of this area. The figure shows that much of the area Is magnetically "quiet." This is a good indication that despite its suspicious prominence, the area is indeed natural high ground and not artificially raised. The major disturbance is a metal pipe running just under the cinder footpath of the square along the southern edge of the survey area. This pipe doubtless carries electricity to light posts along the walk. Three large regularly spaced anomalies are likely former positions of light posts that are still electrified. Three additional areas of significantly lesser magnetism (colored white in the figure) occur at the eastern end of the area, running perpendicular to the walk. These are also likely associate with electricity, as this force significantly alters magnetic fields and thus creates large anomalies in gradient surveys.

No linear anomalies, as would be expected for a defensive earthwork, were identified. A number of point anomalies were detected (circled in red in Figure 8). These are all areas of higher magnetism that may be the result of human activity. Typically, anomalies such as these represent subterranean refuse-filled pit features, such as wells, privies, pits for building piers, or the results of thermoremnant magnetism from bricks or hearths. The regular spacing of the anomalies within the large circle is provocative – perhaps suggesting the pattern of structural piers and a chimney. Alternatively, while highly speculative, these anomalies may be burials associated with the cemetery on the east side of the Second Presbyterian Church. These anomalies should be tested archaeologically with limited and targeted excavation in order to confirm their existence and determine their function.

Aiken-Rhett House Back Lot

This study area is the open lot behind the Aiken Rhett house. As shown in Figure 4, the lot was chosen because it might contain remnants of the British Second Parallel. In addition to testing for the presence of this military feature, the magnetic gradiometer survey was conducted to identify near surface archaeological features that might be used to aid in the interpretation of the historical use of the back lot. This area was previously the focus of excavations by Martha Zierden (2003) of the Charleston Museum. Given time constraints, we chose a single 20-x20m block to survey. We placed the block in an area that appeared to have the least metal disturbance during a preliminary magnetometer scan of the area (in scan mode, the magnetometer functions like a metal detector). As stated in the introduction of this report, a GPR survey was conducted in the courtyard between the stable and kitchen buildings in an area where Martha Zierden (2003) uncovered very complex deposition events; however, these results are still being analyzed by Ms. Moore of Brockington and Associates, Inc.

Figure 9 depicts the results of the survey. The yellow rectangles mark the approximate locations of Zierden's 2001-2002 excavation units. Compared to the other study areas, these results identify a number of anomalies. Figure 10 highlights and classifies the various anomalies in order to make interpretation easier. Generally, the magnetic gradient values are quite variable across the surveyed area (outlined in purple in Figure 10). This is most likely caused by a combination of three factors. First, it is probable that the back lot was leveled by adding fill soil, and this heterogeneous fill is detected by the magnetometer. As shown in Figure 4, there is an abrupt increase in elevation at the edge of the

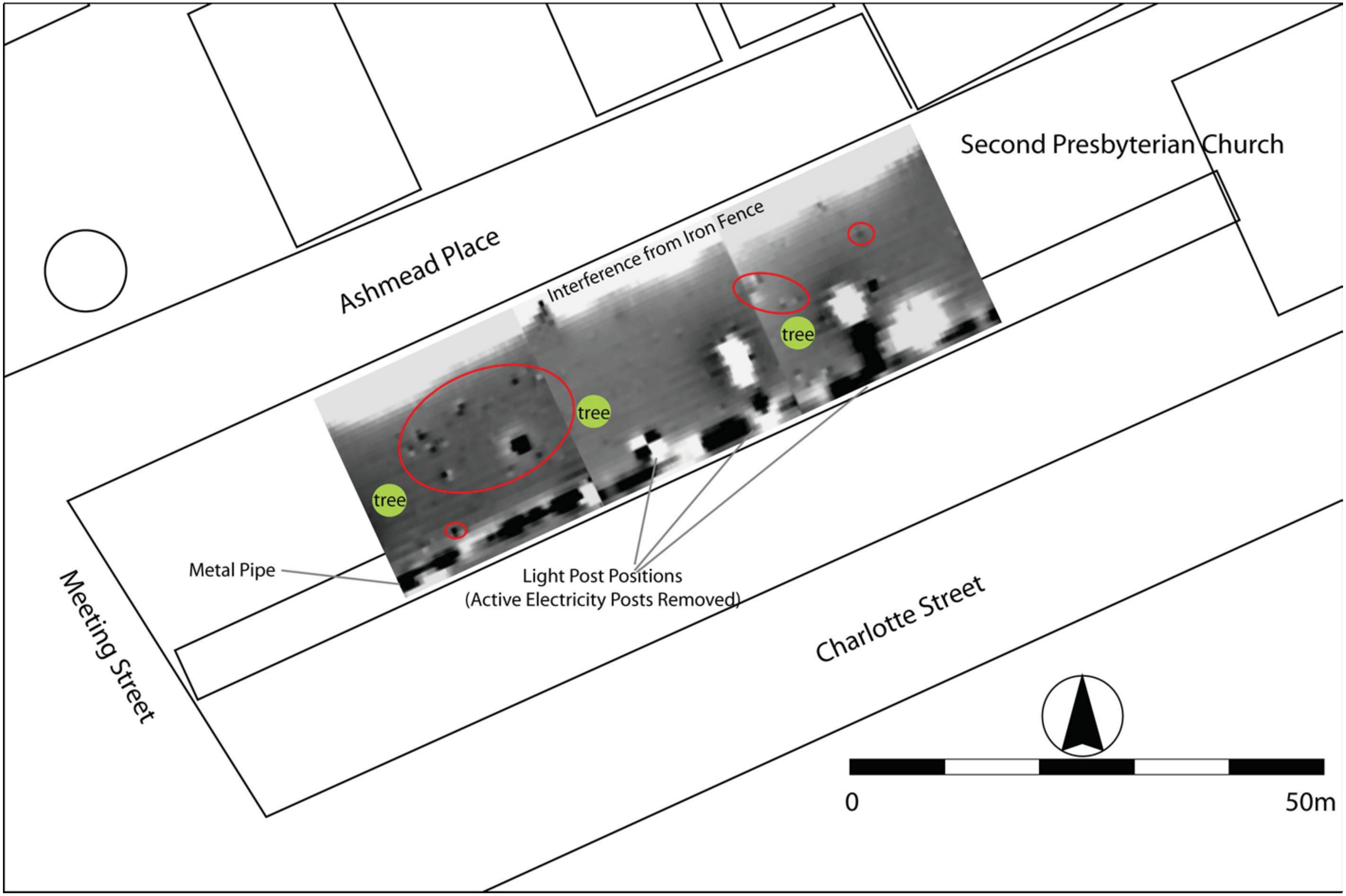

Figure 8. Results of magnetic gradiometer survey of Wragg Square.

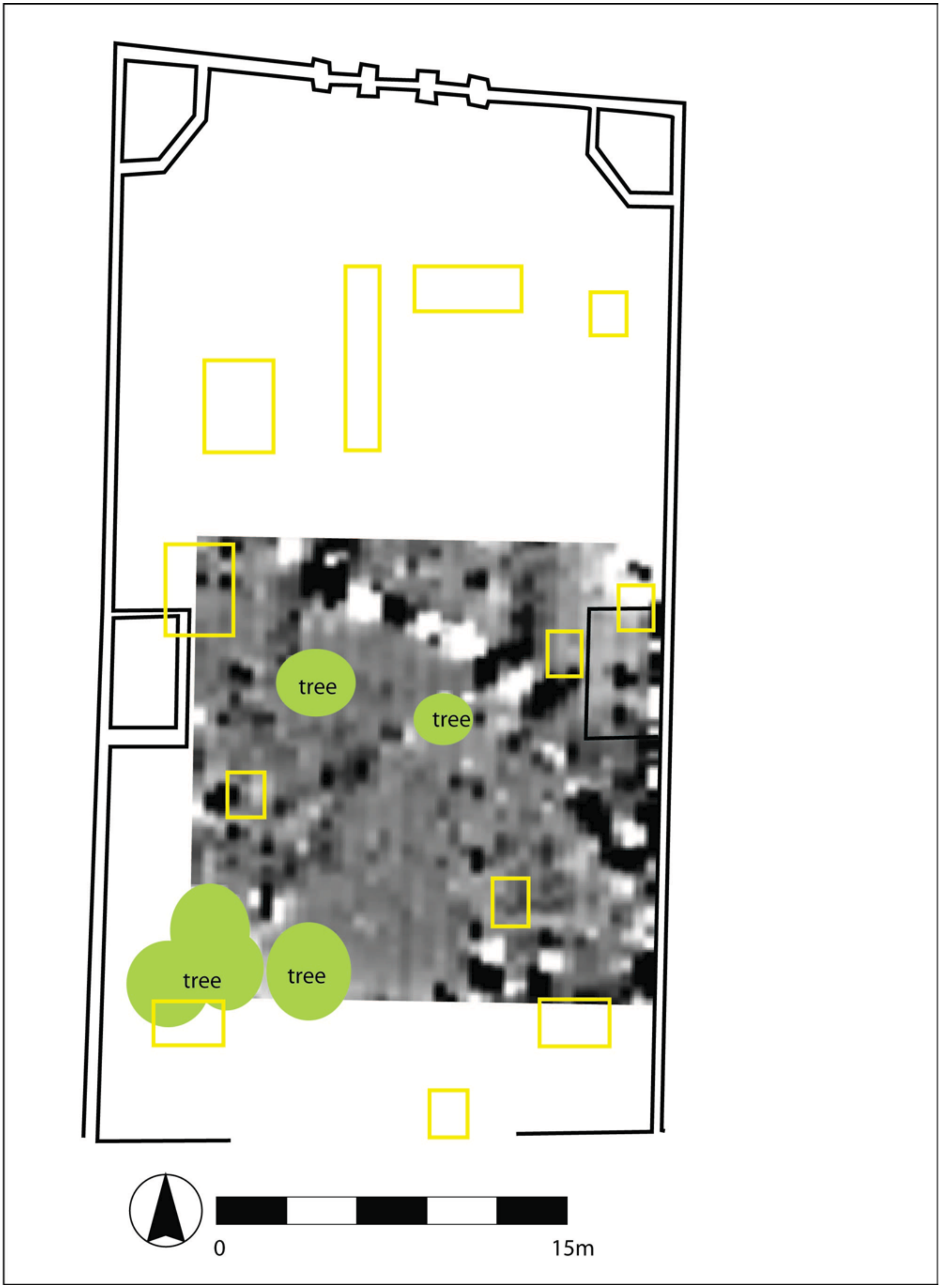

Figure 9. Results of the magnetic gradiometer survey of the Aiken-Rhett house back lot.

Figure 10. Interpretation of results of the magnetic gradiometer survey of the Aiken-Rhett house back lot.

Aiken-Rhett lot- an increase that doubtless is the result of adding fill to a once low marsh area. Second, these areas have been heavily trafficked by livestock. Zierden (2003) argues that the western portion of the lot was used for cows in the early twentieth century. Continual trampling and the addition of manure by livestock would also contribute to the variability seen in magnetic gradient values. Third, small pieces of metal refuse, such as nail fragments, soft drink can tabs, etc. can also affect the instrument's measurements. As can be seen in Figure 9, the central portion of the study area exhibits much less variability in gradient values. This homogeneity is most likely the result of this area being used as an avenue, which was kept clear of metal and refuse, and as argued by Zierden (2003), was at times also separated from the rest of the back lot by fences (See below).

Other anomalies include metal objects, possible ditches, fence posts, and garden plantings. Two metal pipes were identified, one running northwest-southeast across the center of the survey area and one running north-south along the western wall of the back lot. The first pipe is the same water pipe uncovered by Zierden (2003) in her excavations. Five large amorphous dipolar anomalies suggest metal-rich deposits. One such anomaly is located in the southwestern portion of the survey area. There are three additional dipolar anomalies- one located in the northeast corner of the survey area, one along the east edge of the survey area, and one to the southeast of the diagonal metal pipe in the center of the survey area. These anomalies are more than likely pits that contain ferrous metal objects. Zierden (2003) uncovered one such pit, filled with enameled tin pots, in her excavations. A large U-shaped anomaly was also detected in the southeastern portion of the survey area. This dipolar anomaly may be caused by metal objects; however it may also be the result of bricks. The shape and orientation of the anomalies match the slate-capped brick-lined drain Zierden excavated in 2001-2002. Three linear anomalies of increased magnetism were identified in the eastern portion of the survey area. The north-south orientation of these features matches the above-mentioned excavated drain feature, and as such may be additional drainage features.

Twenty four point anomalies of increased magnetism were recorded across the survey area. While some of these anomalies may represent refuse-filled pits, the lack of metal in these features along with Zierden's (2003) previous work, suggest two alternative interpretations. Five of the anomalies are evenly-spaced along a north-south axis in the east-central portion of the survey area. The line created by these features is aligned with the edge of the kitchen structure and gate on the north side of the lot. It is likely that these are post features that represent a fence that lined a central avenue (colored gray in Figure 10). Based on location and alignment, I tentatively identify three features to the west as posts as well. The remainder of the features is interpreted as possible garden plantings (colored green in Figure 10). These small areas of increased magnetism match what would be expected for small pits filled with organically rich topsoil typically used for gardening.

CONCLUSIONS

In addition to the possible identification of a segment of the British Third Parallel in Wragg Mall, we can draw a number of conclusions from the results of this survey. First, magnetometry can be an ill-suited survey method for urban study areas. Magnetometry employs very sensitive equipment that is easily affected by ferrous metal and electricity, which are both quite common in a downtown setting. This weakness can be seen in the results from Wragg Mall and Wragg Square, where iron fences and automobiles significantly influenced the results. GPR is unaffected by magnetic forces, and thus presents a good complement and/or alternative. Second, despite suspicions to the contrary, Wragg Mall has indeed been the site of municipal utilities projects, as evidenced by the pipes identified in both magnetic gradiometer and GPR surveys. Third, Wragg Square appears to be a natural piece of high ground rather than an artificial prominence. Fourth, the magnetic gradiometer survey identified a number of anomalies in the survey area of Wragg Square that will require future work. Fifth, as demonstrated at the Aiken Rhett house, magnetometry is a low cost, non-invasive technique that provides archaeologists with information on feature locations that can be used to focus future excavations and greatly reduce the time and money they spend in the field.

REFRENCES CITED

Aspinall, A., C. Gaffney and A. Schmidt.
2009 *Magnetometry for Archaeologists*. Altamira Press, New York.

Borick, Carl P.
2003 *A Gallant Defense: The Siege of Charleston, 1780* . University of South Carolina Press, Columbia.

Conyers, Lawrence B.
2006 Ground-Penetrating Radar. In *Remote Sensing in Archaeology: An Explicitly North American Perspective*, edited by J. K. Johnson, pp. 131-160. University of Alabama Press, Tuscaloosa.

Ernenwein, Eileen G., and Michael L. Hargrave
2009 *Archaeological Geophysics for DoD Field Use: a Guide for New and Novice Users*. Center for Advanced Spatial Technologies, University of Arkansas, Fayetteville.

Gaffney, C. and J. Gater
2003 *Revealing the Buried Past, Geophysics for Archaeologists*. Tempus Publishing, Ltd., Gloucestershire.

Johnson, Jay K. (editor)
2006 *Remote Sensing in Archeology: An Explicitly North American Perspective*. University of Alabama Press, Tuscaloosa.

Kvamme, K.
2006 Magnetometry: Nature's Gift to Archaeology. In *Remote Sensing in Archaeology: An Explicitly North American Perspective*, edited by J. K. Johnson, pp. 205-233. University of Alabama Press, Tuscaloosa.

Pluckhahn, Thomas J., Victor D. Thompson, Nicolas Laracuente, Sarah Mitchell, Amanda Roberts, and Adrianne Sams
2009 *Archaeological Investigations at the Famous Crystal River Site(8CI1) (2008 Field Season), Citrus County, Florida*. Department of Anthropology, The University of South Florida, Tampa. Submitted to Bureau of Natural & Cultural Resources, Division of Recreation and Parks, Florida Department of Environmental Protection, Tallahassee.

Thompson, V., M. D. Reynolds, B. Haley, R. Jefferies, J. K. Johnson and L. Humphries
2004 The Sapelo Island Shell Rings: Shallow Geophysics on a Georgia Sea Island. *Southeastern Archaeology* 23(2):191-201.

Zierden, Martha
2003 *Aiken Rhett House: Archaeological Research*. Archaeological Contributions 31, The Charleston Museum, Charleston, SC.