

Appendix F

The following report was prepared by Dr. Jon Bernard Marcoux. It provides more detailed results of the Ground Penetrating Radar surveys conducted for this project.

Ground Penetrating Radar Survey at Three Sites
Associated with the Battle of Rhode Island
Middletown and Portsmouth, RI

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Introduction

This report summarizes the results of a ground penetrating radar (GPR) survey conducted between July 16, 2014 and November 19, 2015 for Dr. Kenneth Walsh of the Middletown Historical Society. The survey was performed by Dr. Jon Bernard Marcoux of Salve Regina University, primarily assisted by Dr. Kenneth Walsh and Mersina Christopher. Areas included in the survey were distributed across three sites – the Redoubt de St. Onge, the Aaron Lopez Farm, and the suspected site of Fort Fanning (Figure 1). All of these sites are associated with the Revolutionary War landscape on Aquidneck Island during the Battle of Rhode Island. The goal of the survey was to determine whether the study sites contained any intact archaeological deposits that might be associated with the Revolutionary War period. The results of the survey demonstrate the following: 1) the Redoubt de St. Onge is quite intact, with construction layers still visible in the GPR profiles; 2) one of the areas investigated at the Aaron Lopez farm (Grid 1) contains an anomaly that may related to a structure or stone wall foundation; 3) the surveyed area at the suspected site of Fort Fanning did not show evidence of a military feature; instead the primary anomaly was a mid-20th century baseball diamond.

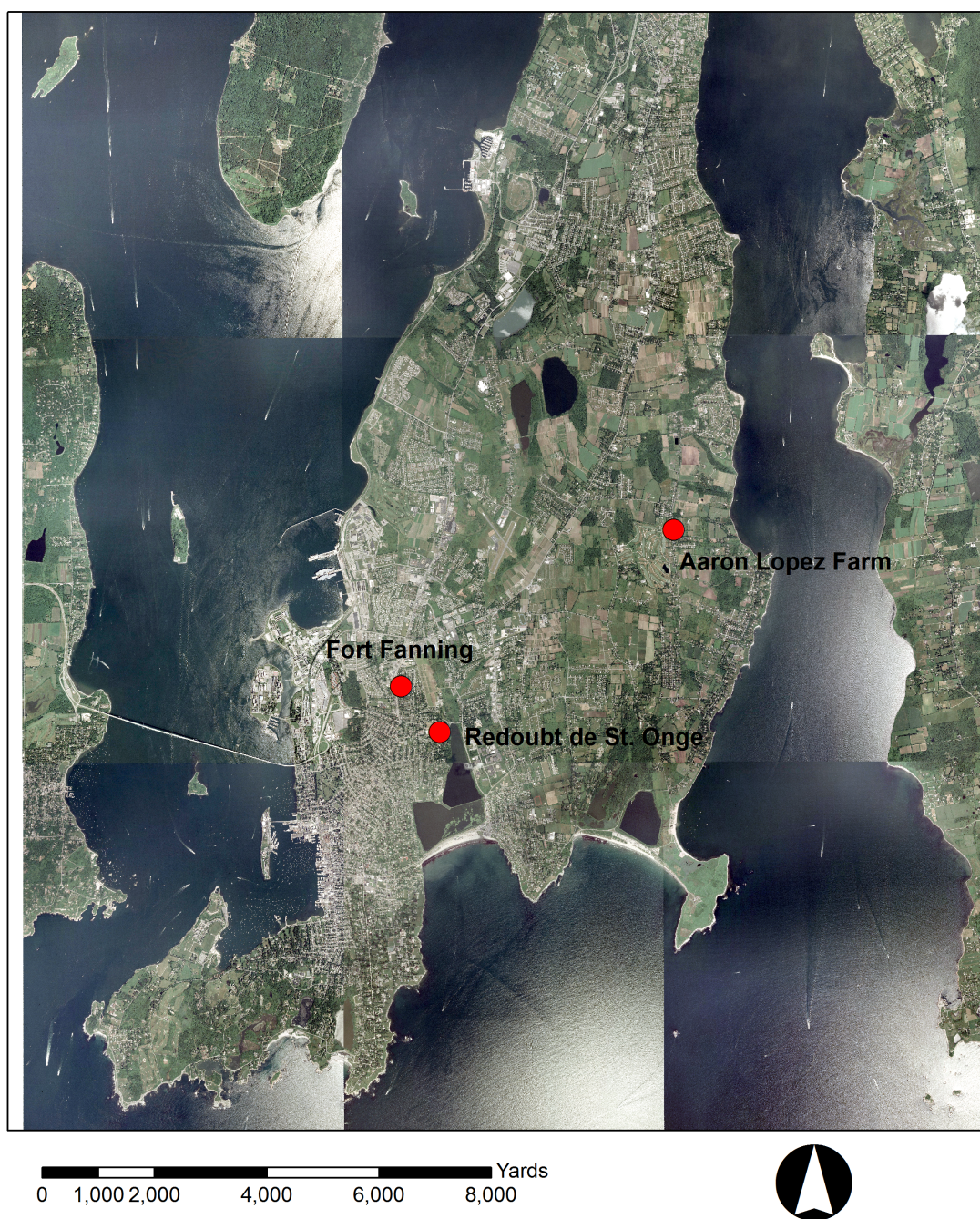


Figure 1 Map depicting three survey areas in current study.

Survey Methods

The survey employed techniques and methods that fall 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, 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) is the most popular technique because it is cost effective and time efficient (Conyers 2006; Aspinall et al. 2008; Kvamme 2006) 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 pit 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.

For the GPR survey, we established a 45m-x-19m grid at the Redoubt de St. Onge site, a 25m-x-12m grid and a 23m-x-27m grid at the Aaron Lopez Farm site, and an 80m-x-20m grid at the Fort Fanning site. The geophysical survey instrument parameters were set to collect the maximum amount of data within reasonable time and data storage limits. The GPR instrument is capable of relatively dense data point collection. The GPR instrument was set to record 50 scans per meter with 512 individual radar pulses per scan on transects spaced 50 cm apart. This resulted in 25,600 radar pulses per meter, which for example would equate to 20,992,000 individual pulses for a 20 m-x-20m area. Pin flags were used to mark transects for Dr. Marcoux, who covered each grid by pacing in a zigzag pattern. The data recovered from the GPR survey were processed by Dr. Marcoux using RADAN software by GSSI, Inc.

Survey Results

Redoubt de St. Onge

Figure 2 shows the location of the survey area at the site of Redoubt de St. Onge in Middletown, RI. This site is owned by the Newport Historical Society, who graciously gave us permission to perform the survey. The upper-right portion of Figure 3 depicts the survey results at a depth of 50 centimeters below surface (cmbs). This plan view map, and those associated with the other two sites in the survey are oriented with North facing the top of the page. The

plan view map depicts the amplitude of radar reflections recorded by the GPR instrument. The amplitude, or strength, of the reflection is color-coded from dark low (gray) to high (white). As stated above, one of the benefits of GPR is the ability to explore subsurface features in three dimensions. Each transect in the survey captures a vertical profile of the soil to a depth of approximately two meters. The bottom of Figure 3 shows a single representative profile from the survey. The location of this profile is shown as a dashed line in the plan view. The features shown as high amplitude reflections (light colored) represent significant differences in the soil encountered by the radar waves. Hyperbolas - the upside-down, U-shaped reflections- suggest a round object like rocks, which there are plenty of, roots, and perhaps even ordinance. Flat or undulating planar reflections represent flat objects or surfaces, such as what would be expected in rammed earth fortifications. The profiles of features with multiple high amplitude point-source reflection hyperbolas and planar reflections typically indicate a fill. The profiles from each survey block are combined to create a three-dimensional subsurface model. All of the plan-view map figures in this report represent horizontal “slices” taken at a particular depth below surface.

The plan view map in the upper right portion of Figure 3 shows two North-South oriented linear anomalies at approximately 50 cmbs. One anomaly is located in the center of the survey area and the other along the eastern margin. When the GPR profiles are consulted, it is clear that these are high-amplitude planar reflections that increase in depth as they move east. Such reflections represent sloped surfaces that descend from West to East across survey area. In the lower portion of Figure 3, the GPR profile shows three such planar surfaces. The first surface (on the left) likely represents the original ground surface of the slope from which the redoubt was constructed. The second surface (in the center of the profile) represents tamped or rammed earth that was used to level and extend the redoubt away from the natural slope. The last surface (on

the right) is associated with a final extension and construction of the embankment that protected the soldiers within the redoubt. The upper left portion of Figure 3 shows a photograph of the redoubt taken in the late 19th century.

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Figure 2 Map depicting GPR survey grid at Redoubt de St. Onge.

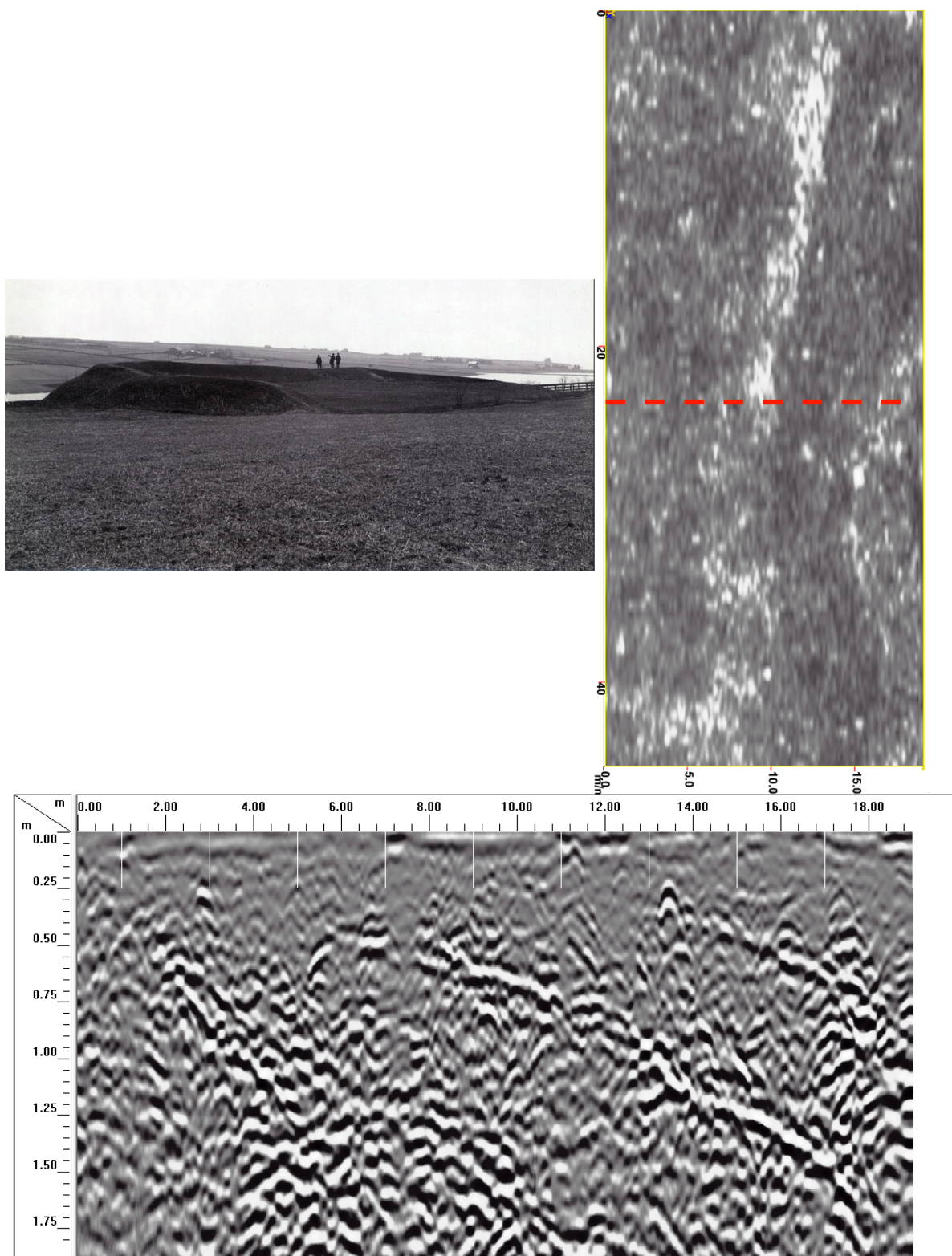


Figure 3 Top Left: 1896 Photograph of Redoubt de St. Onge. Top Right: Plan view of GPR survey at 50 cm below surface (cmbs). Bottom: GPR profile taken at position marked by dotted line.

Aaron Lopez Farm

The Aaron Lopez Farm site is located in Portsmouth, RI. We surveyed two areas searching for possible intact remains of outbuildings associated with this merchant's 18th century farm (Figure 4). The results of the GPR survey in Grid 1 are presented in Figure 5. The upper portion of the figure depicts a horizontal "slice" of the survey area at 100 cmbs. There are a number of small bright "spots" in the survey area. These are high amplitude point anomalies that likely represent large rocks, as the soil at this site contained many large pieces of glacial till. In addition to these, there appear to be a number of lower amplitude linear anomalies trending Southeast to Northwest. In the eastern portion of the survey area, two of these linear anomalies intersect with two other perpendicular linear anomalies to form a square-shaped feature (outlined in Figure 5). A GPR profile cutting through this feature (Figure 5: bottom) shows two areas of multiple high amplitude reflections at a depth of 100 cm (approximately at 18m and 26m along the transect measured along the top of the profile). In between these two areas are multiple moderate amplitude reflections. Taken together, this data suggests the possible remnants of a stone foundation that has been filled in.

The results of the survey in Grid 2 are presented in Figures 6 and 7. Figure 6 includes a plan view "slice" of the survey area at a depth of 40 cmbs (top), as well as a representative profile (bottom) whose position in the survey area is marked by the dotted line. The profile contains a high amount of reflectivity. This "noisy" appearance is doubtless caused by the dense glacial till observed in the soil. The eastern margin of the survey area contains a high amplitude linear anomaly that appears as a distinct hyperbola in the profile. It is the anomaly at the very eastern edge of the profile highlighted at the bottom of Figure 6. This feature, which runs Northeast to South-Southwest, is a metal or ceramic pipe. Two other anomalies identified at this

depth may be associated with the Aaron Lopez occupation. In the plan view (Figure 6: top), these anomalies appear as two rectangular areas of high reflectivity along the northern margin of the survey grid. In profile, they are two distinct areas of high amplitude point (hyperbolic) and planar (flat) reflections (Figure 6: bottom). These types of reflections are often associated with filled-in features like pits. The western feature extends to a depth of approximately 100 cmbs and the eastern feature to a depth of 50 cmbs. These features may be associated with the stone wall that forms the northern boundary of the survey grid. However, given that that the features extend approximately two meters south of the wall and that they are 50 cm and 100 cm deep, it seems more likely that another interpretation is warranted.

Figure 7 shows a plan view “slice” of the survey Grid 2 at a depth of 100 cmbs (top) and a representative profile (bottom) whose position in the survey area is marked by the dotted line. The prominent feature at this depth is a high amplitude linear anomaly along the eastern margin of the survey area. In profile, this anomaly presents as a high amplitude hyperbola similar to that identified as a pipe in Figure 6. Indeed, it is clear in the profile that this anomaly is another ceramic or metal pipe laid at a greater depth than that described in Figure 6. At a depth of 100 cm, the soil in the western half of the survey area is more highly reflective. The profile in the western portion of Grid 2 shows a series of high amplitude reflective surfaces at this depth (Figure 7: bottom). The likely cause of these reflections is a stratigraphic change in soil composition, as soils in this portion of Aquidneck Island are characterized by a change from silty loam to sandy loam at this depth.

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Figure 4 Map depicting GPR survey grids at the Aaron Lopez Farm site.

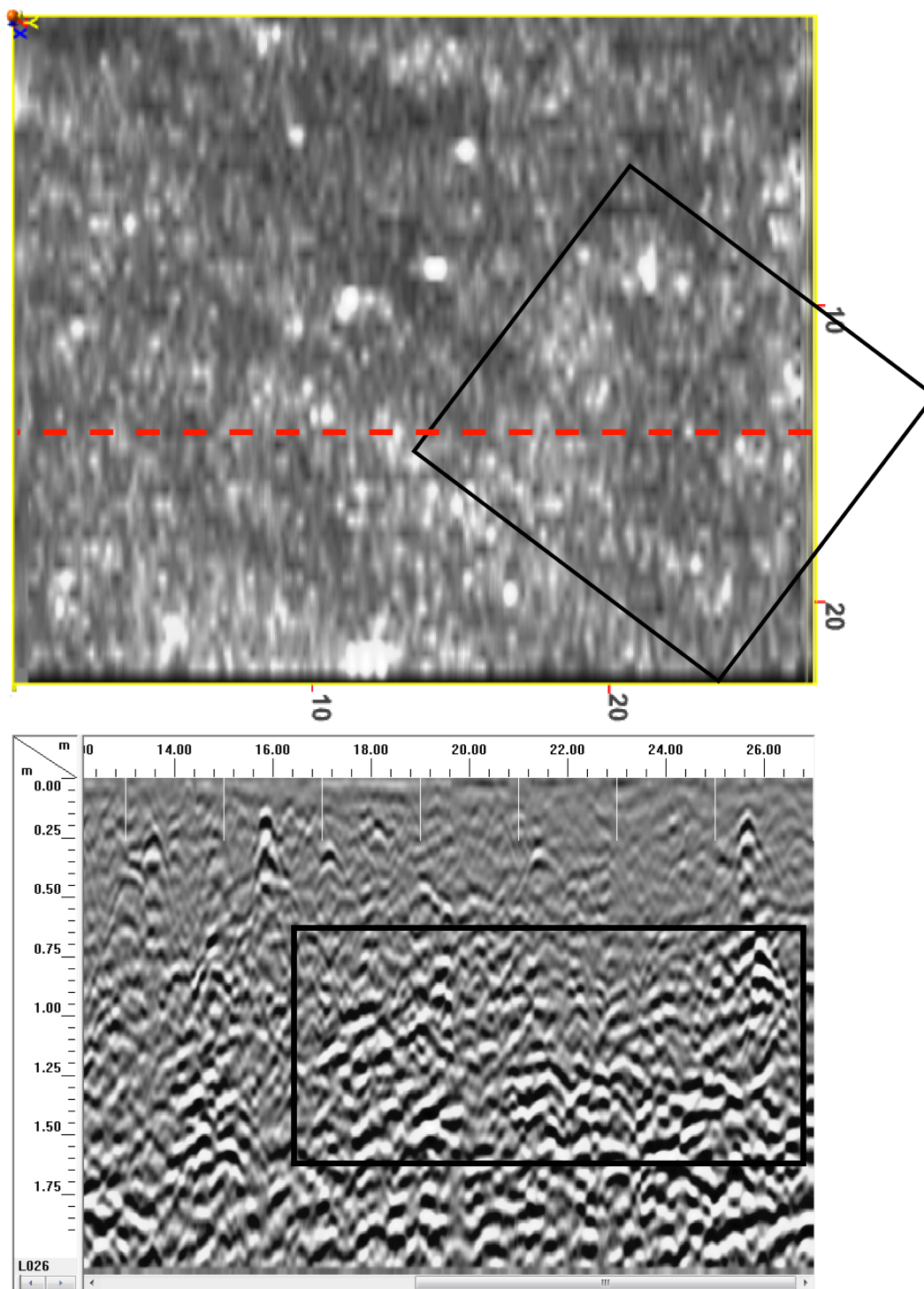


Figure 5 Top: Plan view of GPR survey Grid 1 at 100 cm below surface (cmbs). Bottom: GPR profile taken at position marked by dotted line.

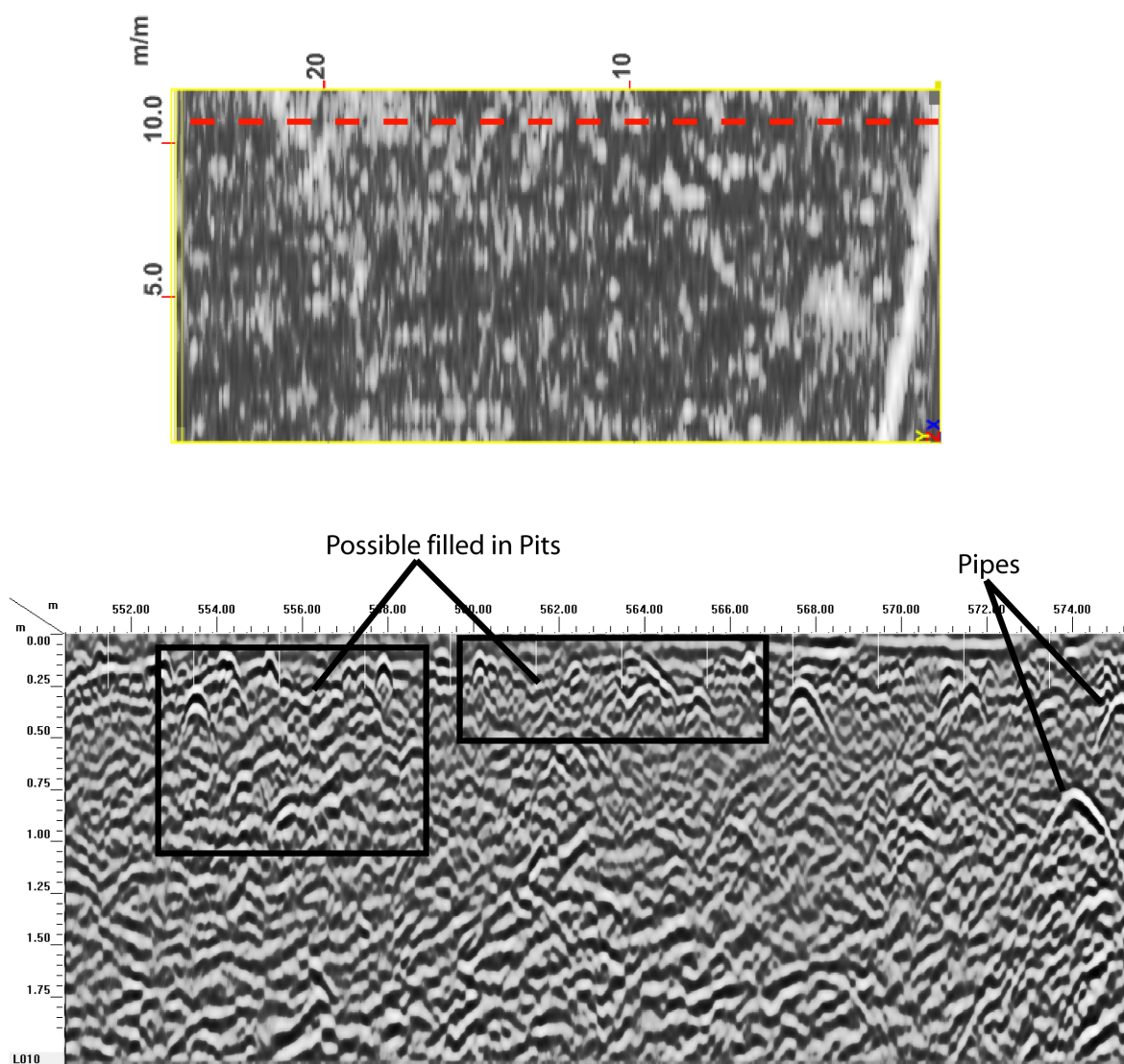


Figure 6 Plan view of GPR survey Grid 2 at 40 cm below surface (cmbs). Bottom: GPR profile taken at position marked by dotted line.

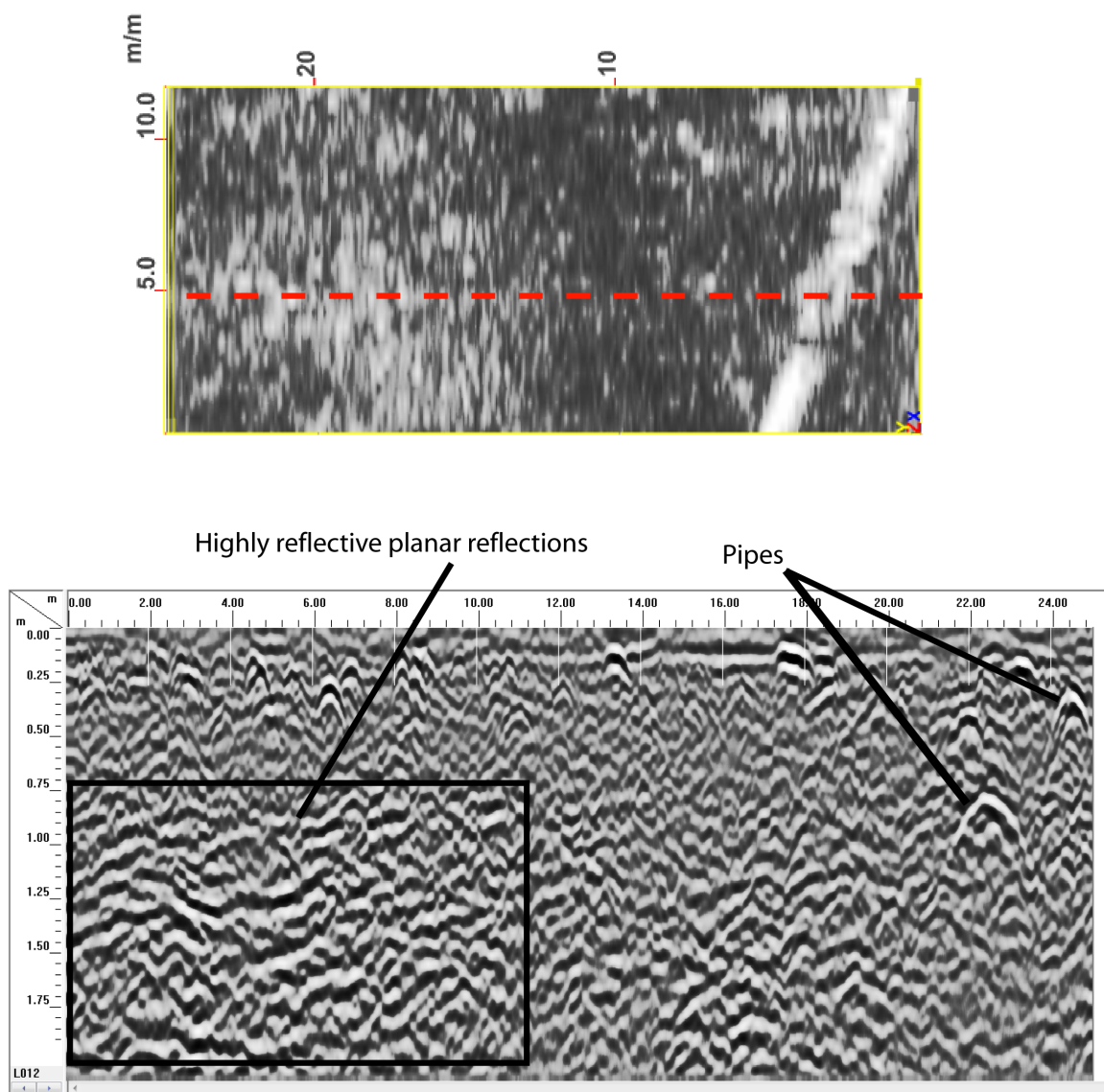


Figure 7 Plan view of GPR survey Grid 2 at 100 cm below surface (cmbs). Bottom: GPR profile taken at position marked by dotted line.

Fort Fanning

The suspected site of Fort Fanning includes a portion of a public park (Linden Park) in Middletown, RI (Figure 8). This wooden fort was one a complex of British military features commanding the heights of Aquidneck Island. The site was used for a school for a number of decades in the 20th century and is currently a public park featuring athletic fields and a playground. The survey grid at this site was established in an area where we believed a remnant of the fort might still exist based on comparisons to Revolutionary War-era maps.

The results of the survey are shown in Figure 9. The top of the figure is a plan view “slice” of the survey area at a depth of 40 cmbs, and the bottom of the figure is a representative profile whose position in the survey area is marked by the dotted line. The high-amplitude linear anomaly located in the eastern portion of the survey area is a cement sidewalk that is visible on the surface. Three other anomalies are visible in the central and western portions of the survey area. In the center of the survey area, there is a roughly diamond-shaped area containing patches of highly reflective soil. Indeed, a profile cutting through the center of the anomaly shows a single, somewhat dissected, high amplitude planar reflection at a depth of 40cmbs (Figure 9: bottom). This suggests that the diamond-shaped feature forms a single surface. The same type of high-amplitude planar reflection defines the profiles of the ovoid area along the south-central portion of the survey area and the “bent” linear anomaly to the west and north of the ovoid anomaly.

The diamond shape and orientation of the first anomaly is reminiscent of what would be expected for Fort Fanning based on its depiction on 18th century maps; however, the anomaly is much too small and its profile is much too uniform to suggest a match. Furthermore, the other two anomalies do not match any expectations generated by the maps. The probable interpretation

for all three anomalies is depicted in Figure 10. An aerial photograph of the area taken in 1962 (when the school was in use) clearly shows a baseball diamond in the same area as the anomalies detected in our survey. The use of clay to build the diamond and the pitcher's mound explains the high amplitude planar reflections recorded in the profiles.

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Figure 8 Map depicting GPR survey grid at the Fort Fanning site.

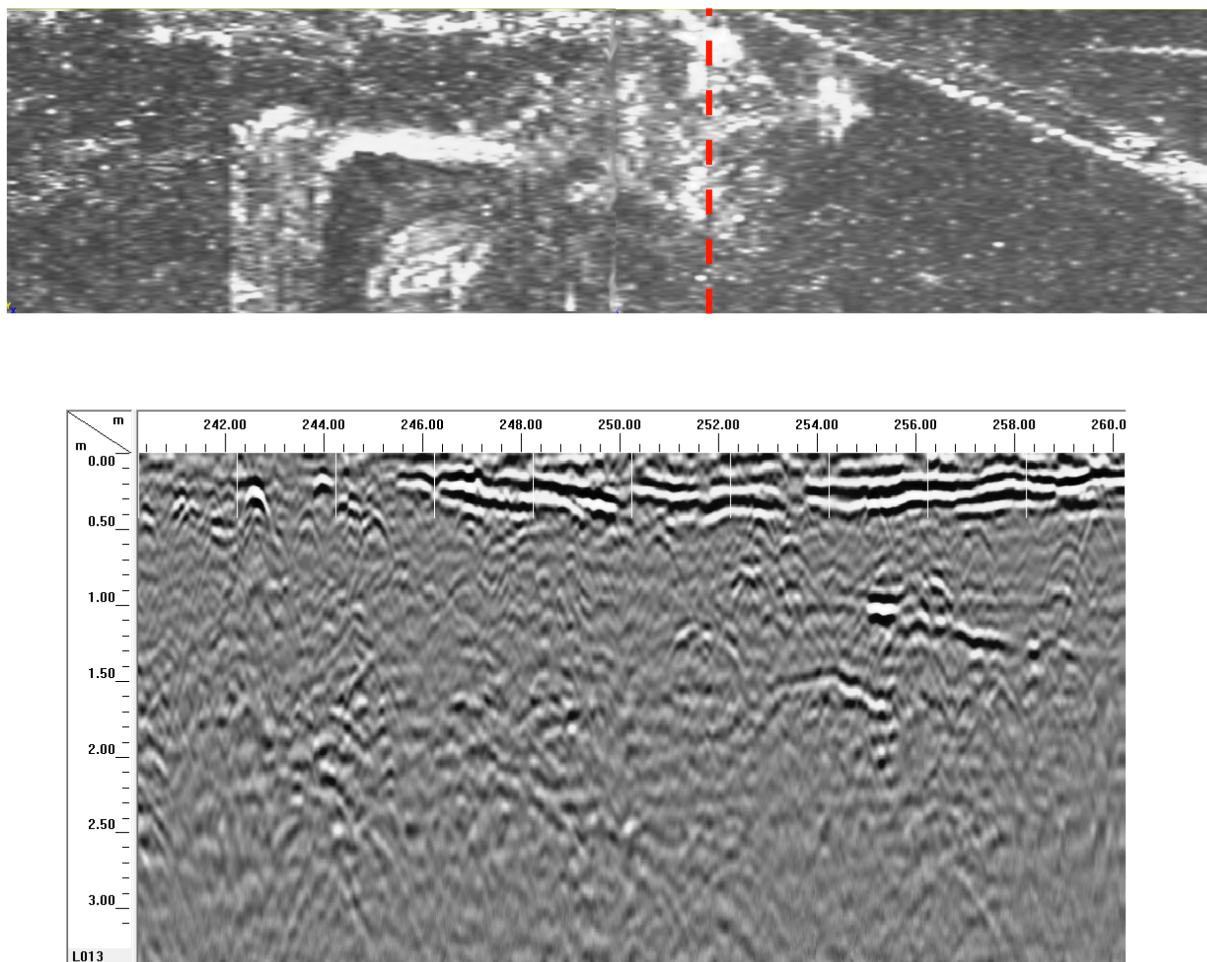


Figure 9 Top: Plan view of GPR survey at 40 cm below surface (cmbs). Bottom: GPR profile taken at position marked by dotted line.

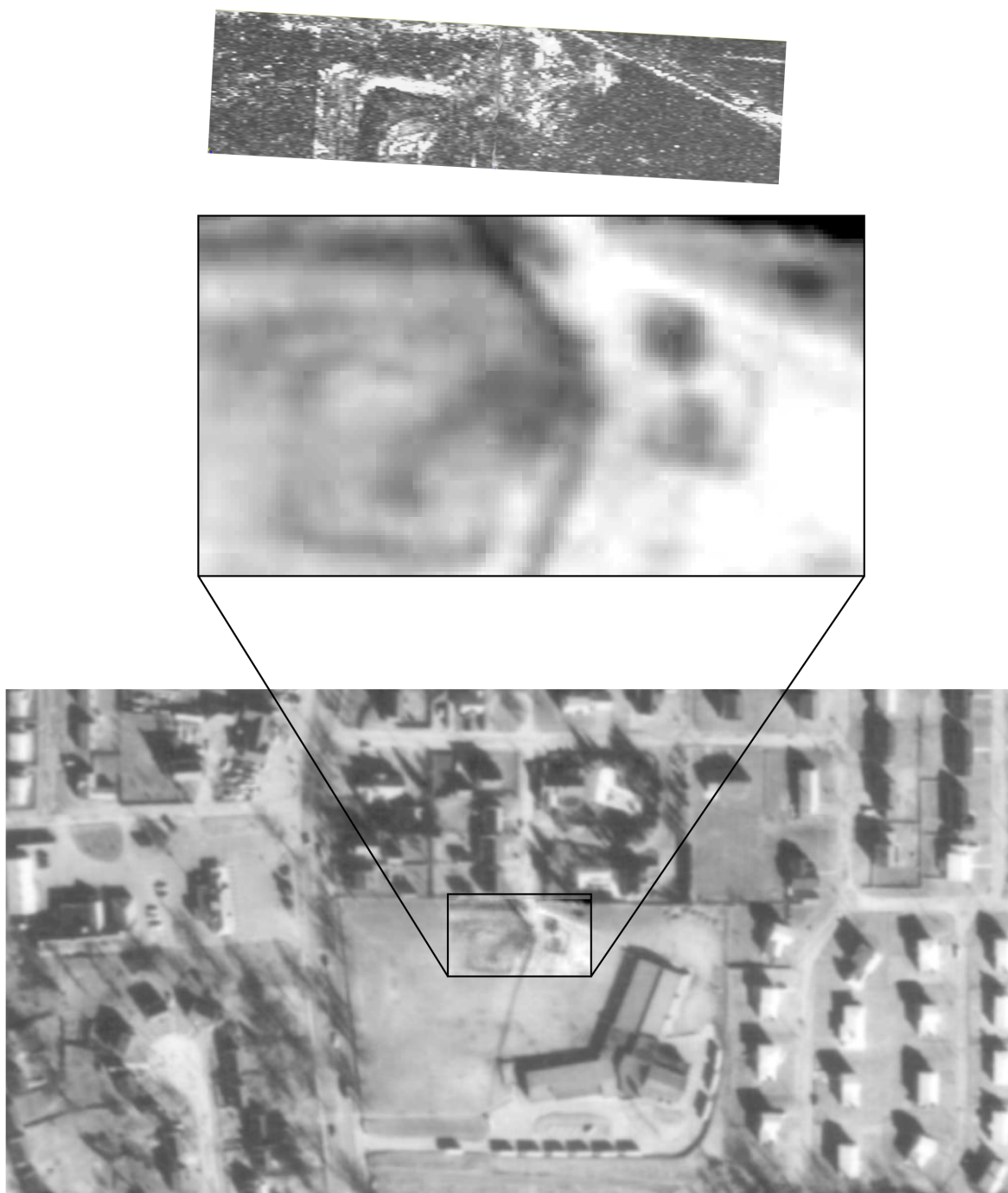


Figure 10 Comparison of GPR survey results with a 1962 aerial photograph of the Fort Fanning site.

Conclusions

The results of the survey suggest that GPR can contribute useful information to the search for remnants of the Revolutionary War landscape on Aquidneck Island. The survey provided new information addressing the construction history of the Redoubt de St. Onge. At the Aaron Lopez Farm site, the GPR survey identified a potential buried structure foundation and two filled pits. Based on comparisons to 18th century maps, the structure foundation likely served as the base for an outbuilding. Finally, the survey did not find any evidence for remains of Fort Fanning. Given that the survey area at this site only included a small portion of the park, these results should not be seen as definitive evidence of the fort's absence. Indeed, more GPR survey should be conducted to the east and west of the current survey grid. While the anomalies identified in this survey must also be "ground truthed" through archaeological testing, in all, the results of this survey are encouraging that portions of Aquidneck Island's Revolutionary War landscape are still intact.

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