11-2010

Loring-Greenough House, North Yard Archaeogeophysics, Jamaica Plain, Massachusetts

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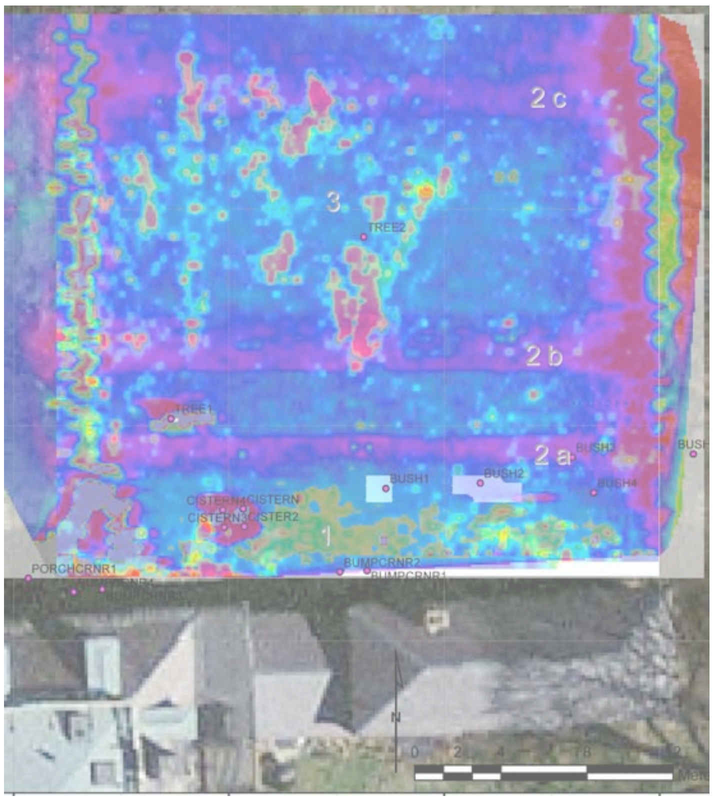

Prepared for:
Jamaica Plain Tuesday Club
Loring-Greenough House
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Cultural Resources Management Study No. 40

November 2010

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Fiske Center for Archaeological Research

The Andrew Fiske Memorial Center for Archaeological Research at the University of Massachusetts Boston was established in 1999 through the generosity of the late Alice Fiske and her family as a living memorial to her late husband Andrew. The Fiske Center was formally known as the Center for Cultural and Environmental History.

As an international leader in interdisciplinary research, the Fiske Center promotes a vision of archaeology as a multi-faceted, theoretically rigorous field that integrates a variety of analytical perspectives into its studies of the cultural and biological dimensions of colonization, urbanization, and industrialization over the past thousand years in the Americas and Atlantic World. Intellectually the Center Staff is committed to building a highly integrated archaeology that embraces the multiplicity of methodological and theoretical approaches the field offers. As part of a public university, the Center maintains a program of local archaeology with a special emphasis on research that meets the needs of cities, towns, and Tribal Nations in New England and the greater Northeast. The Fiske Center also seeks to understand the local as part of a larger Atlantic World.

Acknowledgements

Barry Hannegan on behalf of the Jamaica Plain Tuesday Club Inc. commissioned this work. John Steinberg obtained the GPS (Global Positioning System) points. John Steinberg and Christa Beranek along with Barry Hannegan specified the location and position of the survey grid. John Schoenfielder mapped the features and set out the corners of the survey grid. Kathryn Catlin, Christa Beranek, and John Steinberg carried out the geophysical survey. John Steinberg is responsible for the quality control of the survey.

None of the suggestions or recommendations in this report should be construed as geological interpretations (none of the authors are licensed geophysicists). Rather, these are archaeological interpretations of shallow geophysical data, in reference to previous excavations whenever possible. All of the suggestions herein need to be ground truthed with archaeological investigations. The interpretations and assessments are the responsibility of John Steinberg.

Abstract

An archaeogeophysical survey was carried out in May 2010 using and Geonics EM-38 RT and a Malå Ground Penetrating Radar (GPR) system with a 500 MHz antenna over an 28x26 m grid immediately northeast of the Loring-Greenough house in Jamaica Plain, MA. Three major anomalies were identified. These anomalies have not been ground truthed, but they appear to be archaeological features. First, we suggest that there is builders trench just north of the house. Second, we suggest that there could be three east-west garden paths or other landscape features about 30 cm below the surface crossing the entire length of the survey grid. Third, we suggest that there could be a buried foundation or cellar hole 110 cm below the ground surface and 20 m north of the house. We recommend additional archaegeophysics be performed at the Loring-Greenough house, as well as a program of exploratory archaeological investigations with the goal of better understanding the past landscape around the house.

Introduction

Are there significant geophysical anomalies in the north yard of the Loring-Greenough house that might warrant archaeological investigations or further archaeogeophysical testing (Figure 1)? Specifically could there be wells, privies, garbage middens, garden features, or structure foundations still preserved in the north yard? These were the questions that the Jamaica Plain Tuesday Club Inc. (12 South Street, Jamaica Plain, MA 02130) asked.

In an attempt to non-invasively answer these questions, in early May of 2010, we (the Fiske Center) applied Ground Penetrating Radar (GPR) and electromagnetic (EM) geophysical survey techniques to the north yard, as these two techniques were mostly likely to identify these features (Holley, et al. 1993; Rodrigues, et al. 2009). A letter was sent to the Massachusetts Historical Commission (MHC) informing them that such a survey was going to take place.

The HABS map (Detwiller 1998) suggests that that in 1935 there were no buildings in the north yard and that there were two main pathways, the north-south pathway to the north entrance to the house and an east-west path running 3-4 m north of the house (Figure 2). The HABS map also suggests ornamental gardens in the very northeast section of the surveyed area.

There are several previous excavations in the north yard (Mohler, et al. 2000; Smith and Howlett 2004): three test pits close to the house (STP 12, 13, & 14), a pit across the north-south path (EU 1-4), and a test pit just north of the east-west running path (EU 6 & 7). These excavations are outlined in Figure 3 and will be used to interpret the archaegeophysics.

Archaeogeophysics

Archaeogeophysics, in general, is the application of non-destructive geophysical methods and principles to archaeological settings. More specifically, archaeogeophysics is the interpretation of buried archaeological sites and features based on the results of shallow geophysical investigations. Archaeological features, important subsurface geology, and sometimes artifacts and ecofacts can be located and partially analyzed using geophysical signatures. These surveys have been identified as particularly useful in understanding landscape features such as gardens that cover a large area and cannot be completely excavated (Yentsch and Kratzer 1994). Broad coverage geophysical survies can also be immensely helpful for investigating broad settlement patterns.

Archaeogeophysics is not an exact science. We have found that small differences in the environment (e.g., soil moisture, surface cover, changes in ambient temperature) can change the geophysical properties of the near surface, and therefore change the nature and shape of geophysical anomalies. A geophysical anomaly is a general term for any structure that exhibits significantly different geophysical properties from its surrounding environment. Anomalies can be natural (such as a glacial erratic) or artificial (such as a wall). Determining which anomalies are natural and which reflect buried archaeological features can be difficult.

In archaeogeophysics, the choice of equipment, technique, transect direction, transect spacing, and area covered can have as much or more effect on the reliability of the identification of archaeological features as the contrasts between the features and the surrounding matrix. Because the work is non-destructive, surveys can, and usually are, preformed multiple times with slightly different parameters in order to obtain the best results.

In general, interpretations based on archaeogeophysical data are dramatically more accurate when made in the context of archaeological excavations. Even small excavations of targeted anomalies greatly enhance the archaeological interpretation of geophysical anomalies. Along the same lines, using archaeogeophysical evidence as a guide for excavations makes these excavations considerably more efficient. The reflexive use of archaeology and geophysics can establish a geophysical signature of an archaeological feature. That is, when archaeological investigations are in a feedback loop with geophysical surveys we can turn a geophysical anomaly into archaeological signature.

There are many important archaeological features that do not exhibit geophysical contrasts that are strong enough to be identified with the methods and post-processing applied herein. It is common for important archaeological deposits to be identified in areas without significant anomalies. We generally use multiple geophysical methods that identify different types of anomalies to try to mitigate this problem. In some cases anomalies that show up with one technique may not show up in another. Sometimes more accurate archaeogeophysical interpretations can be made when an anomaly only manifests itself with one geophysical technique. However, anomalies that manifest themselves in multiple methods are usually substantial.

Archaeological interpretations based only on geophysical tests can be inaccurate. While some anomalies are much more suggestive than others, there are no guarantees of the accuracy for any of them. Nonetheless, even when incorrectly interpreted, the data itself can still provide valuable information especially when reevaluated. Therefore, we make the best interpretations we can based on the archaeological context, the geophysical context, any previous excavations, and comparisons with similar anomalies where those anomalies have been excavated at other sites. Given these parameters, we make the most accurate and specific archaeogeophysical assessments we can.

GPS & Total Station

Accurate geophysical readings must be associated with a very specific location for them to be useful. Slight differences between the actual location of a geophysical reading and the coordinate assigned during survey can weaken or eliminate archaeogeophysical signatures. Inaccurate surveying can also create anomalies where there are none. The effects of inaccurate surveying are magnified when the data is post-processed and filtered. Therefore, quality control (QC) lines along the northern most transect were used at the beginning and end of each survey. During EM-38 survey, intermediate base readings were also taken to check for instrument drift. All of these QC data indicate that the survey was accurate and reproducible under similar conditions. The most important QC parameter is the accuracy of the geophysical survey grid.

Therefore, in anticipation of the geophysical survey, we established two GPS points using a Trimble GeoXH with a Zepher antenna. In both locations, the points established with over 900 position collection instances in three 300 reading groups, where a GPS position collection point was taken every 5 seconds. These 900 readings were then averaged. Both points were then used as resectioning points for the Topcon GPT9005A robotic total station, which was set up midway between the two GPS points. The two GPS points were then remeasured and now serve as a semi-permanent benchmarks on the Massachusetts State Plane system. These points are described in Appendix 1 and shown in Figure 4.

With benchmarks established, significant points in the north yard and along the north facing house wall were measured (e.g., trees, cisterns, steps, basement window kick outs). A lager scale topographic grid was established over the entire yard with topographic points measured in at least every 5 meters. In areas of significant relief, such as close to the house, the topographic points were measured closer together. Again, these points are listed in Appendix 1.

We also established a Massachusetts State Plane grid along East 231742 to East 231770 and North 8955333 to North 895559. Along the east and west sides of this grid, a tape line was established and each meter flagged with flags of alternating colors. The geophysical survey transects were all taken east-west within this grid. In general, we refer to coordinates within the Loring-Greenough property with the last three digits of the Massachusetts State Plane system.

EM-38

The EM-38 ground conductivity meter emits an alternating current and measures the strength of resulting magnetic field, which is a measure of bulk conductivity.

The unit does not need to be in direct contact with the ground, and therefore, can be used on rough and undulating terrain (Dalan 1991). The 1-m separation on the EM-38 provides for a relatively shallow depth of investigation (10-100 cm) and therefore good resolution of changes in conductivity close to the ground surface. The EM-38 produces readings of the bulk conductivity component of the soil (C for Conductivity or Q – for Quadrature) in milliSiemens per meter (mS/m). MilliSiemens per meter is the inverse of ohm-meters which is a measure of the resistivity of the soil (McNeill 1980). (Resistivity is a complementary method employed on archaeological sites that can produce pseudo profiles of the soil across the site, as opposed to conductivity maps presented here).

We used am EM-38 RT manufactured in 2001 which was temperature compensated by Geonics Ltd. in December of 2009. This modification reduces the sensitivity of the unit to changes in temperature caused by changes in sun, shade, or ground heat. However, some conductivity changes may be a response to taking readings with different ambient temperatures.

The EM-38 RT can also yield the In-phase component (I) in parts per million. The In-phase readings are similar to those of a metal detector. Unfortunately, the particular model of EM-38 we employ (RT), only one component can be recorded at a time. At Loring-Greenough, we chose to record the Q phase in hopes of identifying changes in conductivity associated with garden features and to identify any middens.

In general, clays and salty soils, especially those associated with middens, tend to be conductive. Sandy soils, rocks, dried turf, and especially stonewalls, tend to be low conductivity (i.e., resistive) anomalies. By mapping these contrasts through a series of closely spaced transects, buried and subsurface features can be identified on the map. This identification depends on structures and features that exhibit sufficiently different conductivity from the background that we will be able to identify them in plan.

At Loring-Greenough EM-38 readings were taken every 10 cm east-west, along transects that were spaced 33 cm apart north-south in the south half of the grid and 50 cm apart in the north half of the grid. Conductivity ranged from 362 mS/m to -776 mS/m. The average is about 30 mS/m. Most of this variation is due to north-south running metal pipes at each end of the survey area (Figure 5). Large metal objects cause huge swings in conductivity (see the N547 conductivity reading profile in Figure 6). The range of conductivity relevant for the identification of non-metallic archaeological features is from 10-40 mS/m (Figure 7). The metal utility pipes are substantially out of this very typical range of soil bulk conductivity.

Ground Penetrating Radar

Ground Penetrating Radar (GPR) has become The Fiske Center's principal archaeogeophysical method for high-resolution mapping of buried architecture and cultural deposits (Goodman, et al. 2008; Goodman, et al. 2007). A GPR antenna/receiver unit sends microwaves into the ground. Interfaces that exhibit significant contrasts can reflect some of the microwave energy back to the receiver. The longer it takes for the microwaves to return, the deeper the reflector. The more energy a feature sends back, the stronger the reflector. Buried flat rocks, laying parallel to the ground, are some of the strongest microwave reflectors. Salt water absorbs microwave energy and does not reflect any energy back. Therefore, assuming a body does not absorb all the microwave energy, or an interface does not reflect all of the energy back to the receiver, a GPR microwave pulse has information about reflectors over a variety of depths (Conyers 2005).

As the antenna/receiver unit is dragged across a transect, it sends a microwave pulse every cm or so. The strength and time lag of the reflected energy can be plotted to create a pusedo-profile of the intensity of reflectors over the depth. A series of these pusedo-profiles can then be "sliced" across the site at a given depth to create a GPR map of the subsurface.

At Loring-Greenough we used the Malå X3M integrated radar control unit with a XV10 Monitor attached to a 500 MHz antenna. The radargrams are some of the strongest and cleanest we have ever collected in an urban environment. We were able to get good reflections from interfaces over 3 m below the ground surface. GPR transects were 33 cm apart across the survey grid. The radargrams were sliced using GPR-Slice and after some experimentation, we settled on using 14 cm slices (25 samples within 5 ns) every 10 cm. This provides significant overlap and continuity between slices, yet gives good resolution. The raw data is contained in enclosed CD and can be re-sliced at other depths and thicknesses. Thirty-one slices (Figure 8 through Figure 37) are shown, each with some overlap.

Modern Features & Utilities

There are two metal pipes running north-south at each edge of the survey area. These are the strongest anomalies in the EM-38 conductivity map. The western pipe can also be seen most strongly in 40 cm below ground surface (bgs) slice (Figure 11) and is also visible in the 30-40 cm bgs slice (Figure 11). In general, this pipe is parallel to the E742 line. As indicated in the EM-38 Q map (Figure 6) this pipe may be either two pipes or splits into two pipes at about E743, N573.5. The two pipes can be seen in the 50-60 cm slice (Figure 13) and the 60-70 cm slice (Figure 14). The western pipe, also probably metal, which enters the grid at E769 N559 and leaves the grid at approximately E770, N539, does not appear to intercept the Loring-Greenough house proper.

There may be a third pipe indicated on the GPR 70-80 cm bgs slice (Figure 15). This depth is below the sensitivity range of the EM-38. However, there is some suggestion that this also might be metal. On a few profiles (e.g., at N547 in Figure 6) a slight uptick in conductivity can be seen. This suggests that this is also a metal pipe but it could be PVC. This pipe can be seen entering the grid at E747, N559 on the 120-130 cm bgs slice (Figure 20) and entering the house at approximately E749, N534. The depth and placement is consistent with a metal water line that can be identified in the basement wall at approximately that location.

The cistern, in particular its metal lid, is the third major utility that is obvious in the EM-38 data as well as many of the upper slices of the GRP data. There do not appear to be any consistent hard reflectors surrounding the cistern lid.

Archaeological Interpretations

There is no obvious anomaly consistent with the buried well signature we obtained from previous work in Newport RI (Figure 38). However, there are two possible candidates for a well, although both anomalies are slightly larger than would be expected from a well. The slightly more likely well candidate is centered on E744 N542 and can be first seen in the 130-140 cm bgs slice (Figure 21) and continues though the 160-170 cm bgs slice (Figure 24). An anomaly at that location cannot be seen again until the 250-260 cm bgs slice (Figure 33) where it appears strongly and continues through the rest of the slices down to the 300 cm bgs slice (Figure 37). The anomaly at this depth is circular and about 2.4 m in diameter.

The second candidate for a well (based on size, strength of reflection, and shape) is centered on E745 N534 and can be first seen in the 230 cm bgs slice (Figure 31) and downwards. The anomaly is about 3.5 m across, which is larger than the typical range of a well at that depth. Furthermore, this anomaly, if it is a well, is so close to the current house that it seems unlikely to be associated with the current house. Wells tend to show a consistent anomaly though multiple slices (ie their signature) and because this disappears, it may not be a well.

There is little evidence of the square garden in the north east of the grid depicted in the 1937 HABS map. While one could imagine that some of the smaller anomalies in the northeast of the 20-30 cm bgs slice (Figure 39) could be associated with that garden, it is difficult to make any reasonable direct associations. Apparently, the main tree depicted in the 1937 HABS map is probably still standing and has been labeled “TREE2.” Those roots seem to stretch over 10 m in the 20-30 cm bgs slice (Figure 40).

There are no obvious privy signatures in either the EM-38 data or the GPR data. The cistern (Figure 4) is a known below ground feature, but its geophysical signature is neither particularly broad nor deep, possibly because the metal cover interferes with data collection. Furthermore, we can find no evidence of any surviving substantial (deep/pit shaped) midden deposits. Rather, there are dense sheet middens in some areas below the artificially laid down yard loam (at about 35 cm bgs) as encountered by Smith and Howlett in earlier excavations (Smith and Howlett 2004). The dramatic difference seen between the 60-70 cm bgs slice and the 70-80 cm bgs slice (Figure 14 and Figure 15) would seem to correspond to the bottom artifact rich layer and the sterile subsoil which contains larger rocks and other hard reflectors.

There are several good signatures that probably correspond to substantial buried archaeological features. These include the area immediately north of the house (Anomaly 1), three paths (Anomaly 2a, 2b & 2c), and a possible buried foundation (Anomaly 3). These anomalies are labeled in Figure 43.

<u>Anomaly 1: Builders trench</u>. Near the house (N534 to N536) close to the surface (e.g., the 30-40 cm bgs slice, Figure 11 and Figure 40), there are a whole series of strong reflectors that are 10-20 mS/m more resistive (eg 19-25 mS/m) than the general conductivity of about 30 mS/m. Shovel test pits 11, 12 & 13 were put into this area and indicated little cultural material (Mohler, et al. 2000). This soil matrix probably contains stony upcast from the excavation of the cellar and possibly from the cistern (at E750 N535). The 30-40 and 40-50 cm bgs slices (Figure 11 and Figure 12) show this high reflective area continues all the way across the southern edge of the survey grid. Because of the magnitude of the metal pipes at either end of the survey area the reduced conductivy from the stony upcast is probably swamped at the west and east ends of the survey grid. The most obvious candidate for a builders trench can be seen in the 110-120 cm bgs slice (Figure 19). The builders trench seems to be partially disturbed by the cistern. The trench seems to extend about 1.5 m north of the house and is evidenced by the series of strong reflectors running along the N533 line from the west edge or the grid to E750.

<u>Anomaly 2: Possible garden paths</u>. The East-West path 4.5 m north of the house shown in the HABS map seems to correspond with a hard reflector on the GPR slices at 10-20 cm bgs (Figure 39), 20-30 cm bgs (Figure 40), and a little bit at 30-40 cm bgs (Figure 41). This path follows the N538 line and can be seen in various locations at all three depths. We term this anomaly 2a. Anomaly 2a can also be seen as a linear conductive anomaly (i.e., 32-35 mS/m against the 30 mS/m background) in the EM-38 data (Figure 42).

In the EM-38 data there are three linear anomalies, the strongest along N539 (Anomaly 2a), a larger and more defuse one at N 543.5 (Anomaly 2b), and the weakest one at N 555.5 (Anomaly 2c). These linear anomalies are clearly visible in the overall plan and anomaly 2a corresponds well to the path depicted in the HABS map (Figure 42). We can find no GPR anomaly that corresponds with the elevated linear conductive anomaly at 2b. However, on the 10-20 and 20-30 cm bgs slices (Figures 9 and 10) a faint reflective anomaly that corresponds to Anomaly 2c can be seen. A profile of the EM-38 Q readings across the site (from north to south) show that Anomaly 2a and 2b are more distinct than Anomaly 2c (Figure 44).

Smith and Howlett's (2004:24-28) excavations into the Herb Bed (Units 6 & 7, Figure 3) probably intercepted this garden path at 2a. They interpreted the coarse sandy loam with gravel at about 30 cm bgs to be part of this path. This corresponds well to the GPR readings in Figure 39 and Figure 40. However, sand and gravel, are generally resistive anomalies (and hard reflectors). That these paths are conductive anomaly suggests that if it is a path, it contains higher concentrations of clay or salts. Furthermore, the inherent inaccuracies of the HABS map (and its georeferencing) make it difficult to tell if the East-West running path close to the house shown on the map is in exactly the same location the linear anomaly at 2a in the EM-38 data.

Another caution in making the interpretation of garden paths comes from the location of the trees in the yard. The EM-38 RT, while temperature compensated, may still be sensitive to subtle changes in unit temperature due to shade. Because this survey was performed on a sunny day, and the higher areas of conductivity are between trees, what appear as paths may just be sunnier ground. It is possible that the areas of lower conductivity are a response to readings taken in the shade of the house, and trees (TREE1, TREE2, & TREE3, Figure 5). While we think this is unlikely, it should be considered.

Based on the HABS map and the excavation at EU 6 & 7, we interpret all three linear anomalies as buried garden paths. However, while these anomalies look like paths they could easily be some other feature, and should be investigated by further geophysics and excavation. Whatever they are, they in all likelihood, predate the 1937 HABS map. Anomaly 2a is most likely a path since it presents both GPR and Q signatures. Anomaly 2c presents both slightly elevated conductivity and a GPR hard reflectors at 20-30 cm bgs. Therefore, we feel fairly confident that the 2c is the signature of a garden path, albeit less robust. The anomaly at 2b is more difficult. Anomaly 2b exhibits the same elevated conductivity, with sharper edges that 2c, but does not have any hard reflectors associated with it.

One interpretation of the paths detected in the remote sensing is that they relate to an early yard layout, possibly one related to Loring's initial construction of the house c. 1758 or even to the pre-Loring use of the landscape. Because they are parallel with the back edge of the house, they more likely related to the standing structure (or an earlier structure along the same orientation) than to the proposed cellar hole (Anomaly 3 on Figure 43) in the north yard, which seems to lie at a different orientation. The features run across the whole survey grid until their signatures are washed out by the stronger signatures from the buried utilities at either end of the grid. Therefore, we do not know the length of these features. They may have run the whole width of the yard.

The uneven spacing of the paths led us to consider whether they were laid out according to 18th-century principles of garden and landscape design which have been observed at plantation houses and large estates in Maryland, Virginia, Pennsylvania, and New Jersey, but not, as far as we know, in New England. Julie Ernstein's (2004) work summarizes much of this earlier research into garden geometries (e.g., Leone 1984) and applies it to the analysis of the gardens at five Maryland properties. The landscaping and garden design for some of these large estates included terraces of varying but related depths falling away from the house (Yentsch and Kratzer 1994). While the topography at the Loring-Greenough property does not allow for descending terraces (and terrace-building does not seem to have been carried out in Massachusetts), the yard space may still have been laid out according to geometric principles. One hypothesis is that the paths, if that is what they are, may have formally divided the landscaped space beyond the house, and that their spacing may be more regular than random.

The EM-38 data overlaid on the air photograph (Figure 43) was used as the basis for these measurements. If the back of the house is taken as zero, path 2a is 25 ft away, path 2b at 38 ft, and path 2c at 78 ft. The current north edge of the property (the border between the lawn and the sidewalk) is at 146 ft, though the street with may have changed since the 1750s, so this measurement is not necessarily meaningful. These measurements are to the apparent center of the geophysical anomaly, so have room for error.

Table 1. Path distances and increments from house.

Feature	Distance from house (ft)	Idealized distance from house (ft)	Increment
House	0	--	--
Path 2a	25	26	2 x 13
Path 2b	38	39	3 x 13
Path 2c	78	78	6 x 13
Edge of yard	146	--	--

If two of these distances are adjusted by a foot (Table 1), the features are spaced at multiples of 13 feet. Feature 2a is two increments from the house; feature 2b is three increments from the house; and feature 2c is six increments from the house.

The distance between the house and feature 2b is equal to the distance between features 2b and 2c. (Twelve increments from the house, doubling the spacing once more, would be at 156 feet from the back of the house, into the space occupied by the current street.) Ernstein (2004: 111) found a similar spacing for terraces at the Belle Aire Mansion in Maryland. At that property, terrace 2 was twice the depth of terrace 1, and the depth of terrace 3 was equal to the depths of terraces 1 and 2. The interpretation of these as formally spaced paths based on geometric principles is hypothetical at this point and should be considered in light of future excavation and remote sensing (to date and more accurately define the features) and research into Loring's landscape design influences and contemporary Massachusetts garden layouts.

In sum, while the nature of these anomalies is still unknown and should be confirmed by excavation, they may be remnants of landscape features that predate the HABS map. We think that the most likely interpretation, given the data on hand, is that they are paths that formally divided the yard space. Whether they are associated with the Loring-Greenough House or an earlier building on the same orientation in not knowable from remote sensing data alone. Barry Hannegin has pointed out that little is known about the pre-Loring layout of the property, so we cannot rule out the possibility that these features are associated with the earlier farm. They seem, however, not to be on the same orientation of a possible buried cellar hole, discussed below as Anomaly 3.

<u>Anomaly 3: Buried structure</u>. There is a possible buried structure or cellar hole centered on E754.5 N550.5, the outline of which can be best seen in the 110-120 cm bgs slice (Figure 19) as well as the 120-130 cm bgs slice (Figure 20). This anomaly is an area of almost no hard reflectors surrounded by a square of very hard reflectors. Tree 2 is in the southeast corner of this anomaly. If this is some sort of cellar hole, the hard reflectors at E754, N551 in the 130-140, 140-150 & 150-160 cm bgs slices (Figure 21, Figure 22, and Figure 23) might be the base of such a structure. The GPR radargram of 551.67 (Figure 45, along with the others in this area) suggests that this whole anomaly is a connected set of hard reflectors. Distinguishing geological features from archaeological ones at this depth is difficult. However, we think that this is a very likely candidate for a buried cellar hole or the like.

Recommendations

We recommend three more archaeogeophysical surveys, research into 18th-century principles of garden and landscape design, and exploratory archaeological investigations to ground truth some of the anomalies identified be preformed at Loring-Greenough. This information would form the basis of an informed research and preservation plan at the Loring-Greenough House. In general, we recommend that any substantial archaeogeophysics be completed before excavation.

First, the apparent spacing of Anomaly 2 paths should be confirmed by geophysical transects running perpendicular to the paths themselves. Specifically, with GPR using the 800 MHz antenna at 20 cm or 25 cm transect spacing running north-south. This survey should be accomplished before the location of these possible paths are used for broader interpretations, as it is difficult to define features that run exactly parallel to the transects (as these do). Using the 800 MHz GPR antenna with even tighter transect spacing would confirm the existence, spacing, and widths of the linear features very precisely. Unfortunately, it is unlikely that even with the good GPR susceptibility an 800 MHz antenna could get signals back from depths of much more than 1 m. Therefore, the 800 MHz is not likely to yield information about the possible cellar hole at Anomaly 3.

Second, research into Loring's landscape design influences and contemporary Massachusetts garden layouts would be productive to determine if geometrically spaced paths are a plausible feature of Loring's landscape. The existing remote sensing data also do not define the east-west extent of the landscaped area north of the house; the geophysical signature of the possible paths is obscured at both ends by signatures from metal pipes. The paths may continue further east and west beyond the survey area. Identifying the end point would be critical to determining the overall dimensions of the garden and whether the whole layout was governed by geometric principles or by the existing streets and lot size in its east-west dimensions. The house dimensions could also be examined to see if the dimensions of the house relate at all to the dimensions of the garden.

Third, we would recommend another series of EM-38 surveys. We suggest an EM-38 in-phase (I) survey. We believe it possible that larger areas of midden might be evident in the in-phase (I) component map. This component might also yield more information about anomaly 2 (the garden paths). We also suggest another EM-38 conductivity (Q) survey over the area with transects running north-south. Running the transects north-south would eliminate much of the disturbance caused by the pipes at either end of the survey grid. We suggest doing both of these surveys during an overcast day.

Fourth, we recommend a GPR survey with a 200 MHz antenna targeted over anomaly 3 (the possible cellar hole). While not having great resolution, we might be able to isolate larger features and determine if this is archaeological or geological.

Finally, we recommend that after the above surveys are performed and examined, that a series of exploratory archaeological investigations into the major anomalies be carried out. These excavations should be placed so as to crosscut the major anomalies identified.

Figures

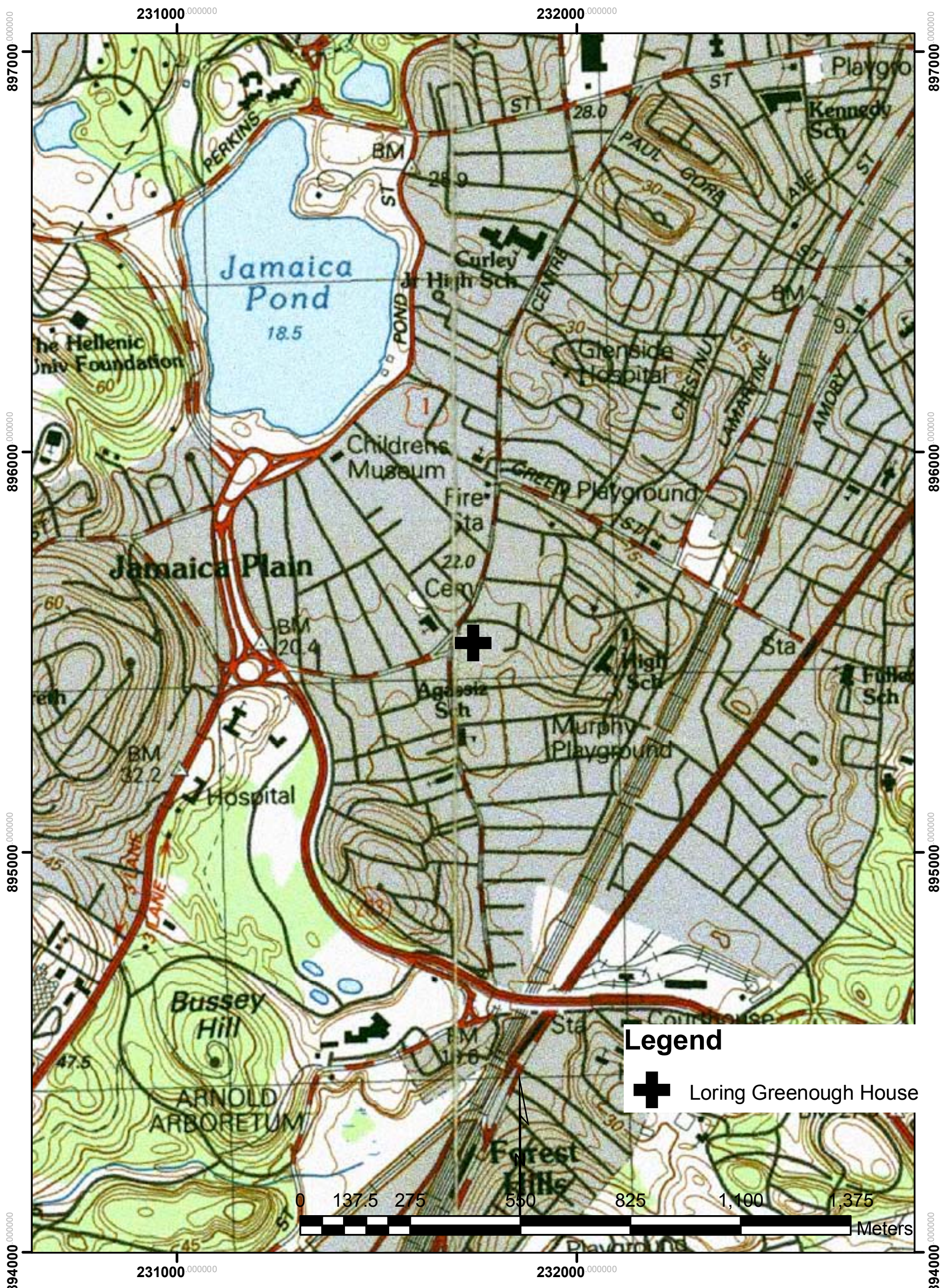

Figure 1. Location of the north yard of the Loring-Greenough house

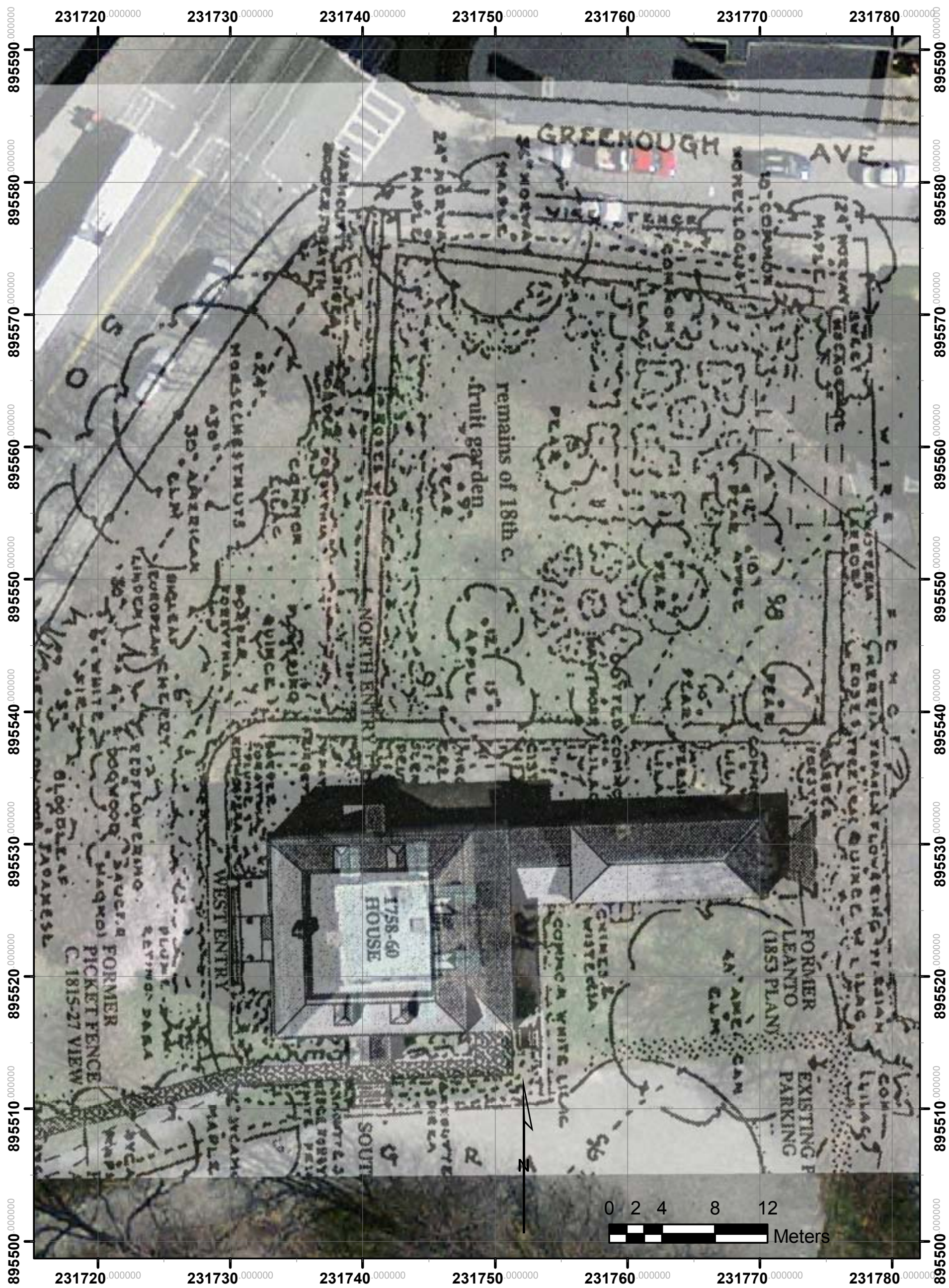

Figure 2. 1937 HABS map of Loring-Greenough house.

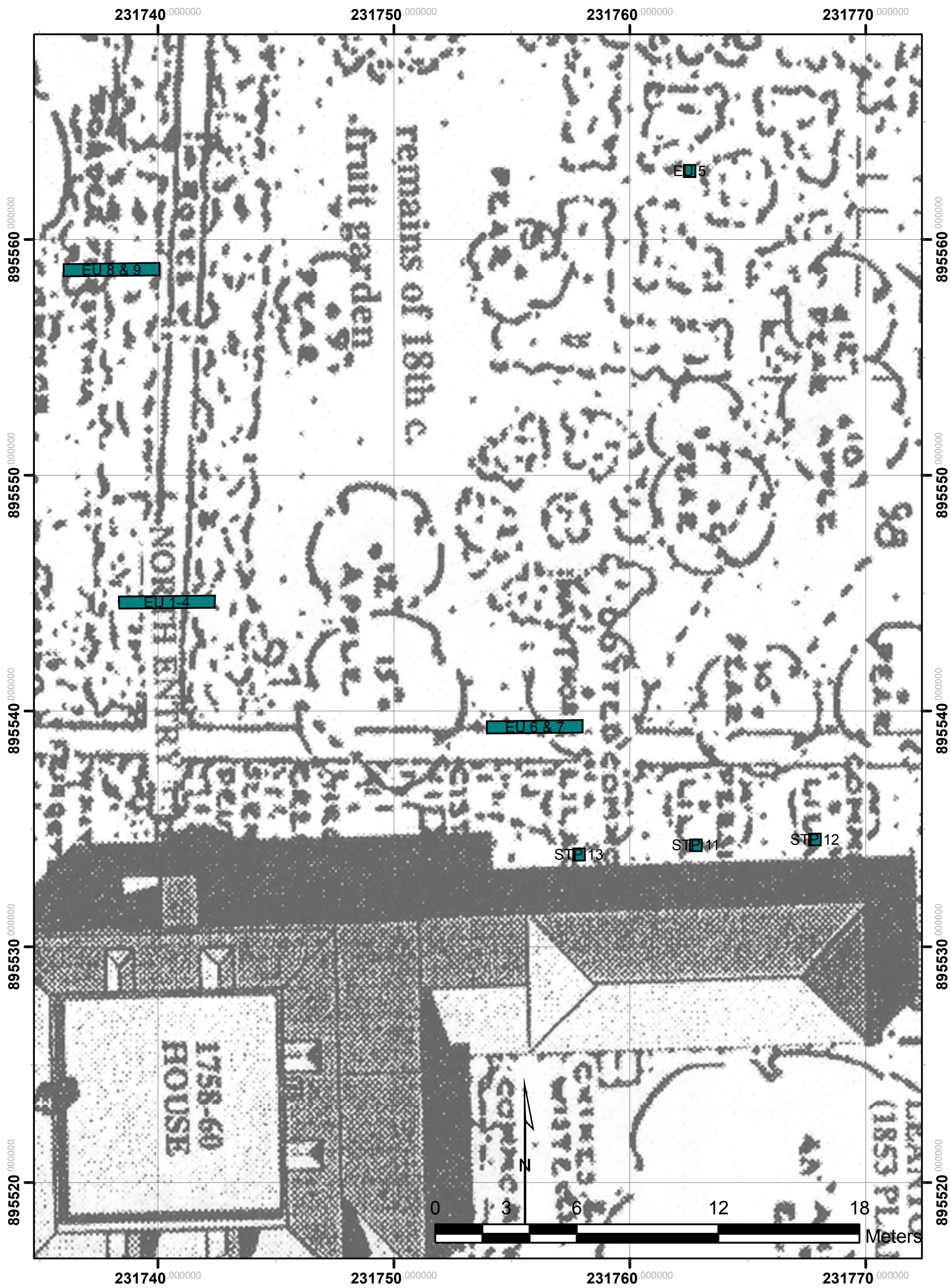

Figure 3. Test excavations from Mohler, et al. (2000) and Smith and Howlett (2004). The 1937 HABS map is also shown.

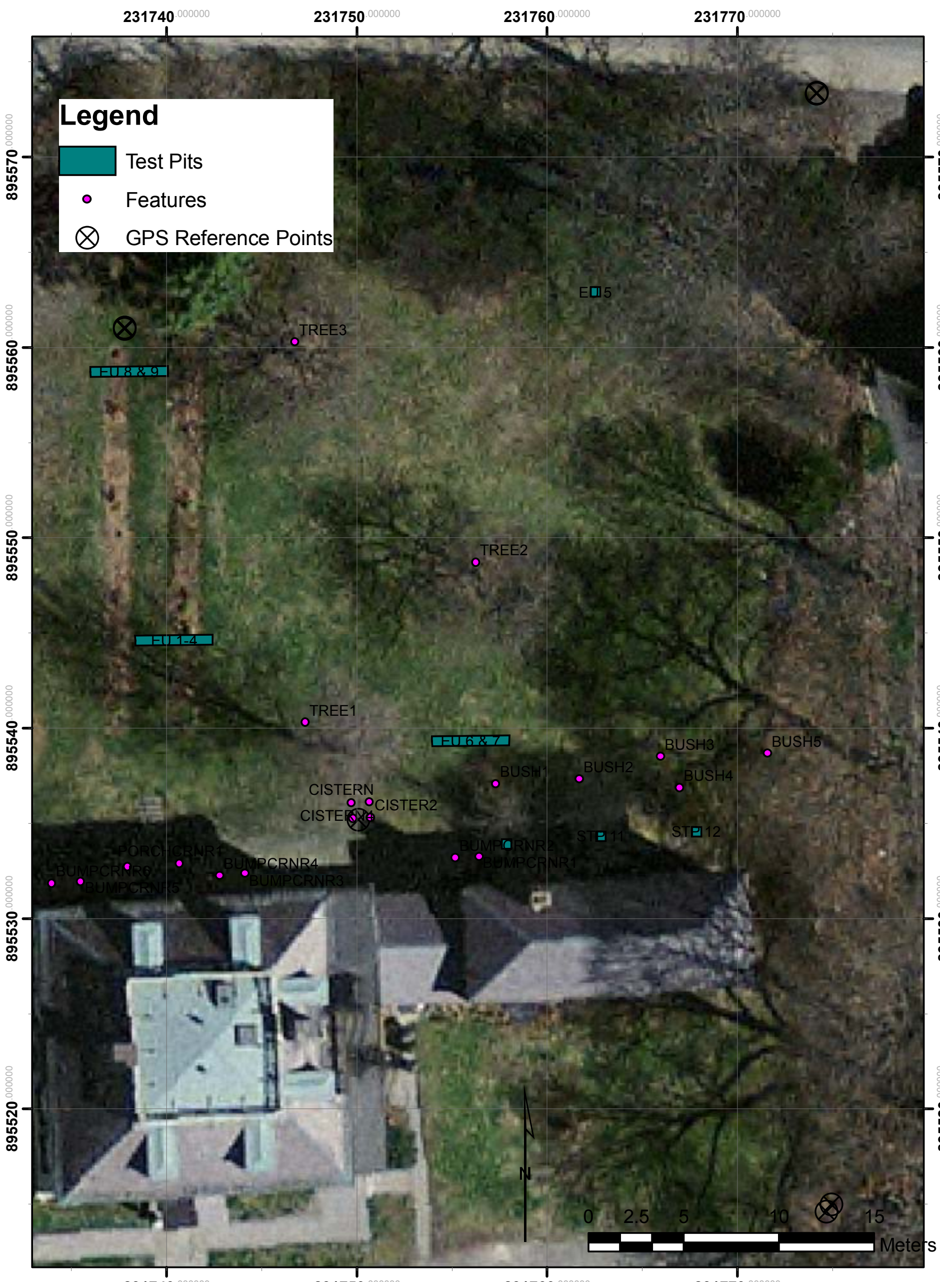

Figure 4. Mapped points and GIS reference points

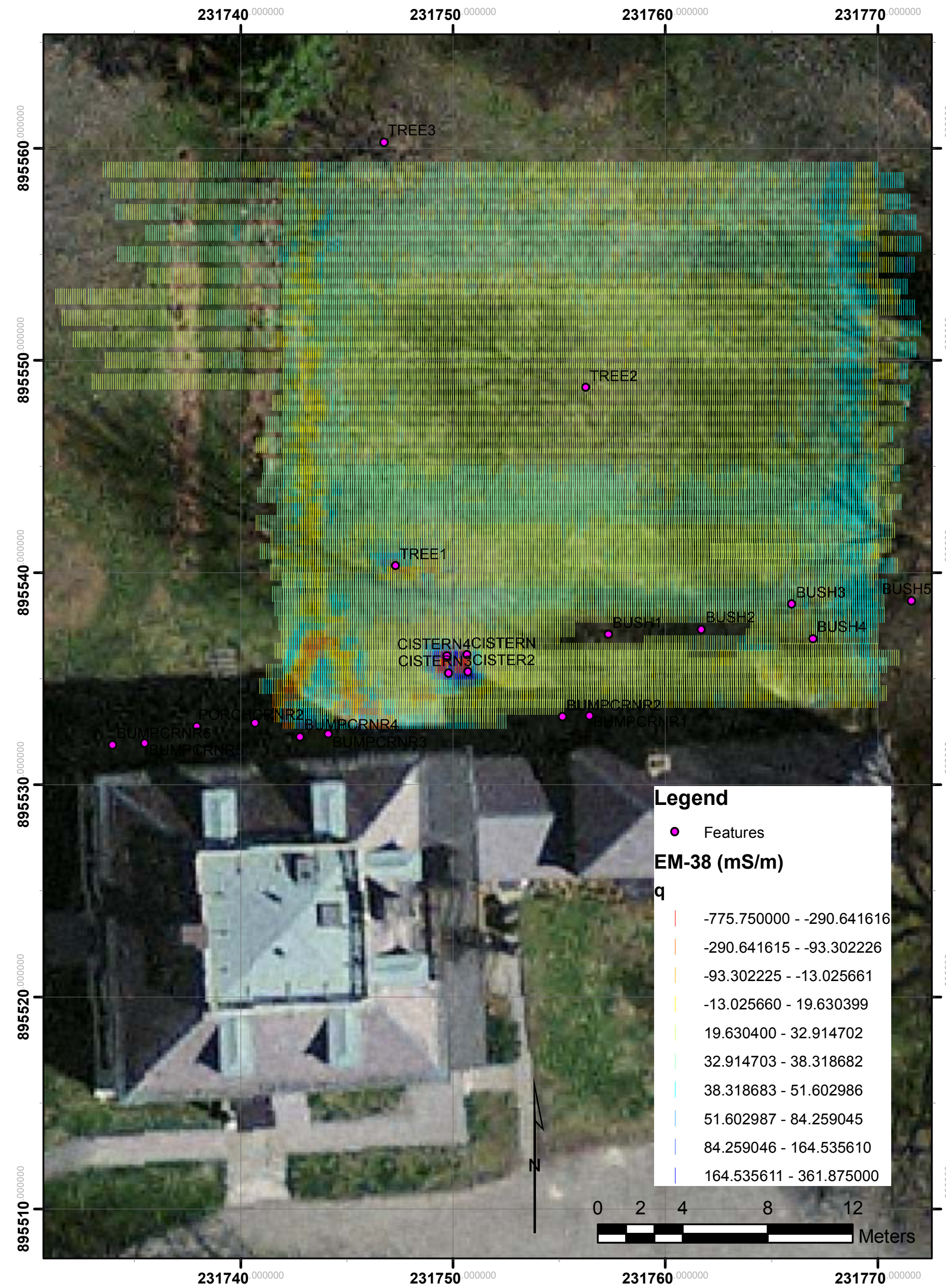

Figure 5. Map of EM-37 data points (colors are proportional to number of readings within a given range of conductivity (mS/m)

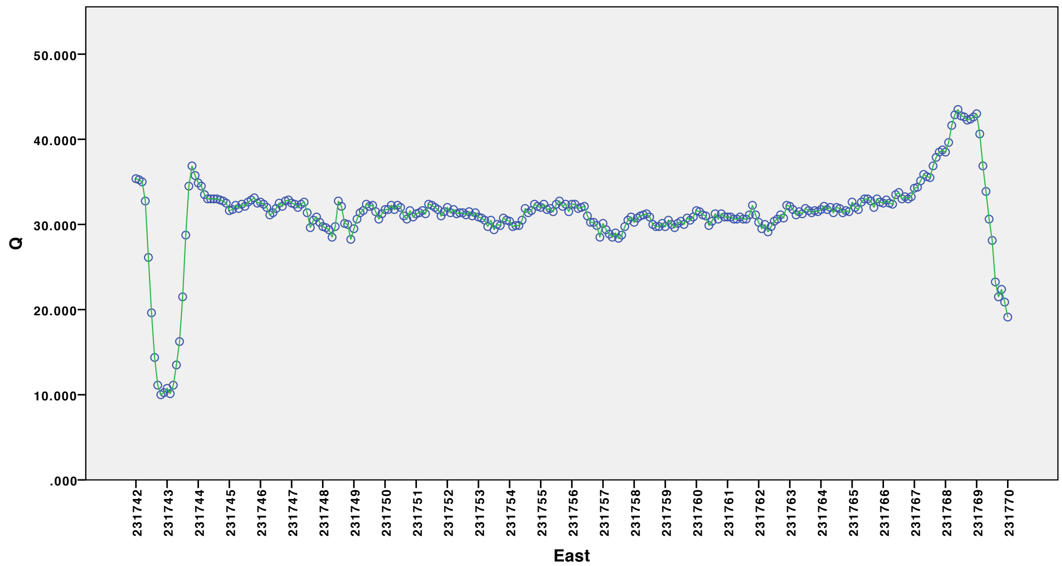

Figure 6. Profile of EM-38 Readings from the N547 line.

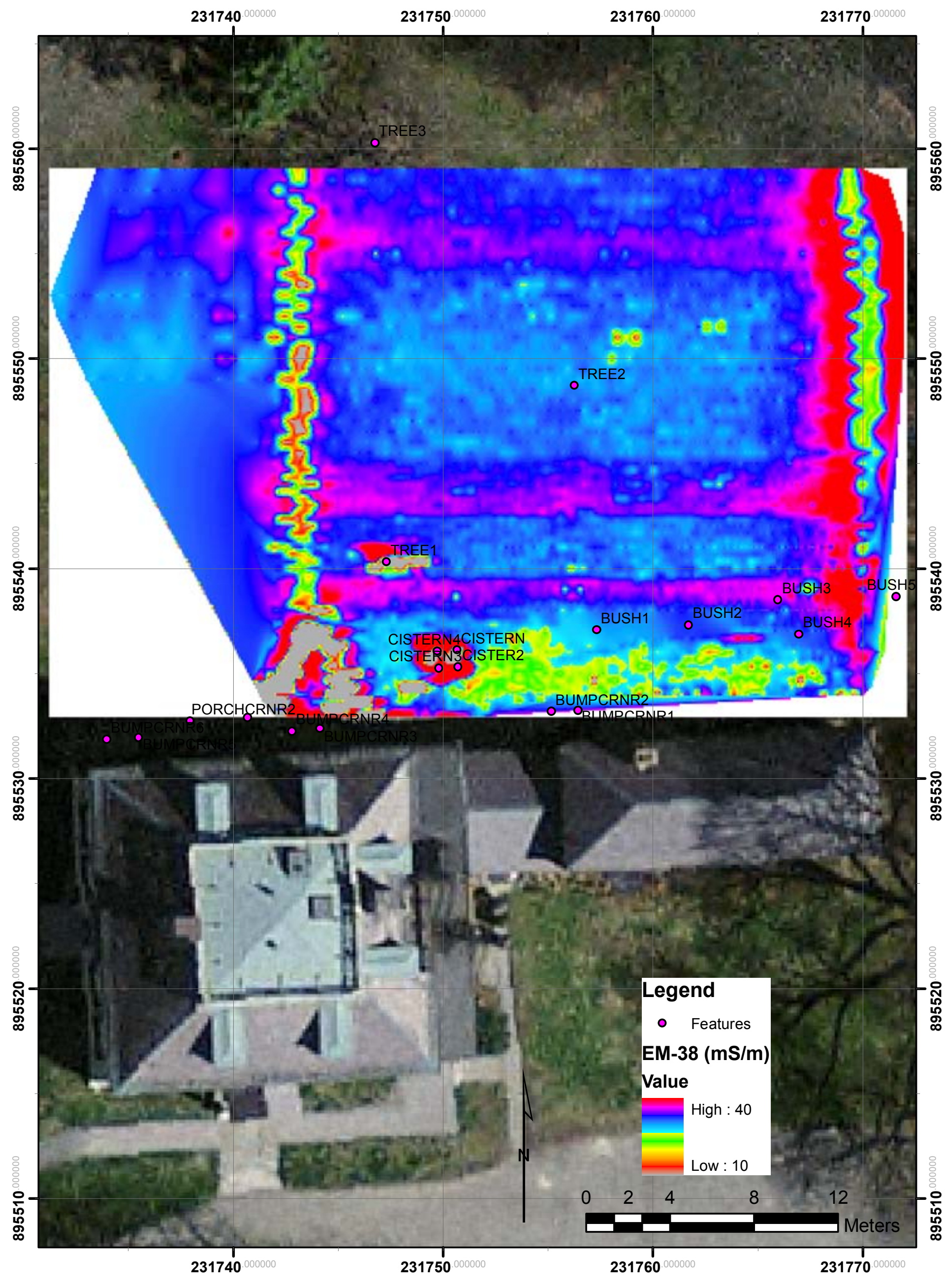

Figure 7. Map of EM-38 data points between 10-40 mS/m. The EM-38 image is interpolated between readings, making the image clearer, but possibly misleading.

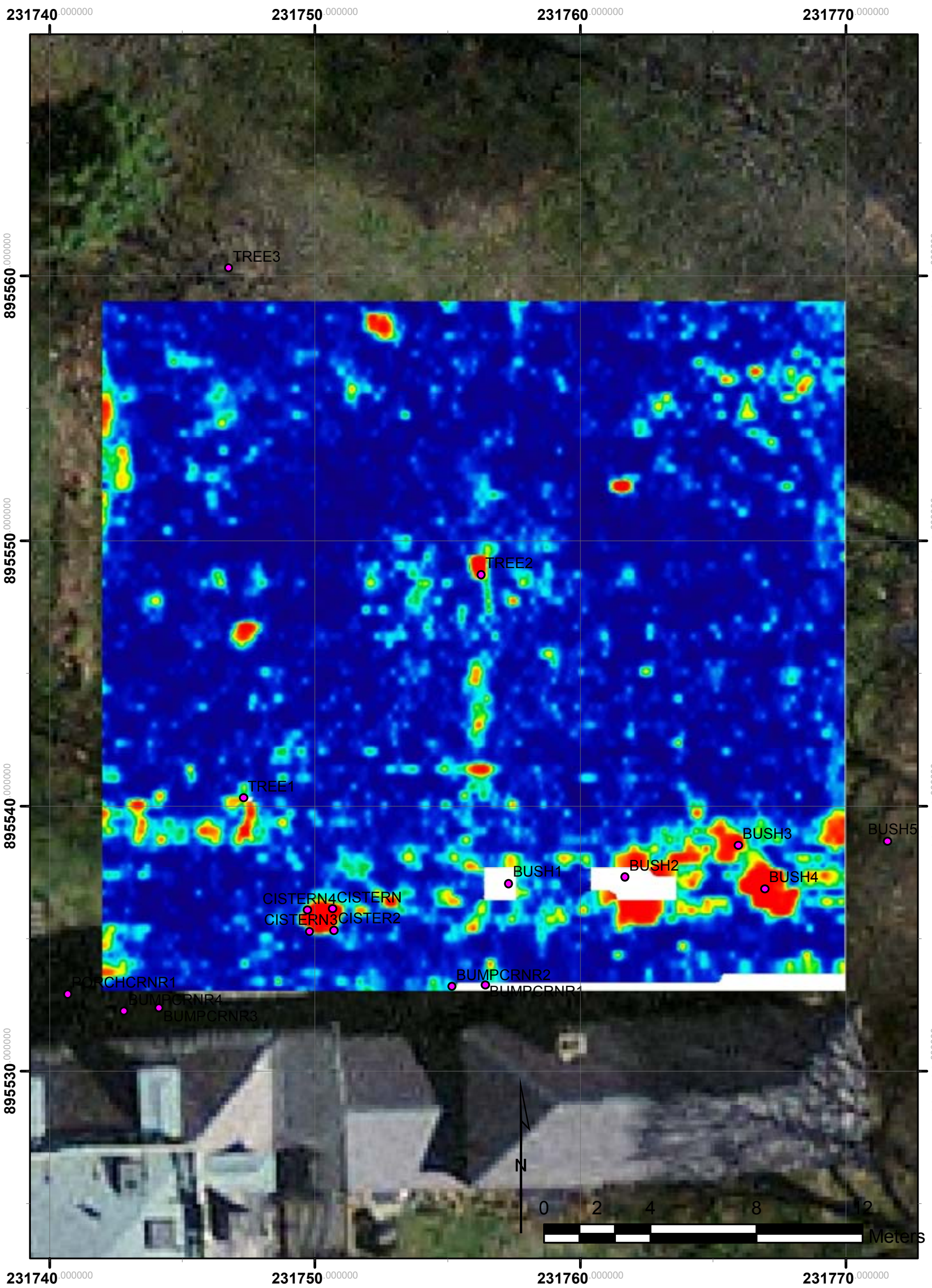

Figure 8. GPR slice of 0-10 cm bgs. Hard reflectors are in red.

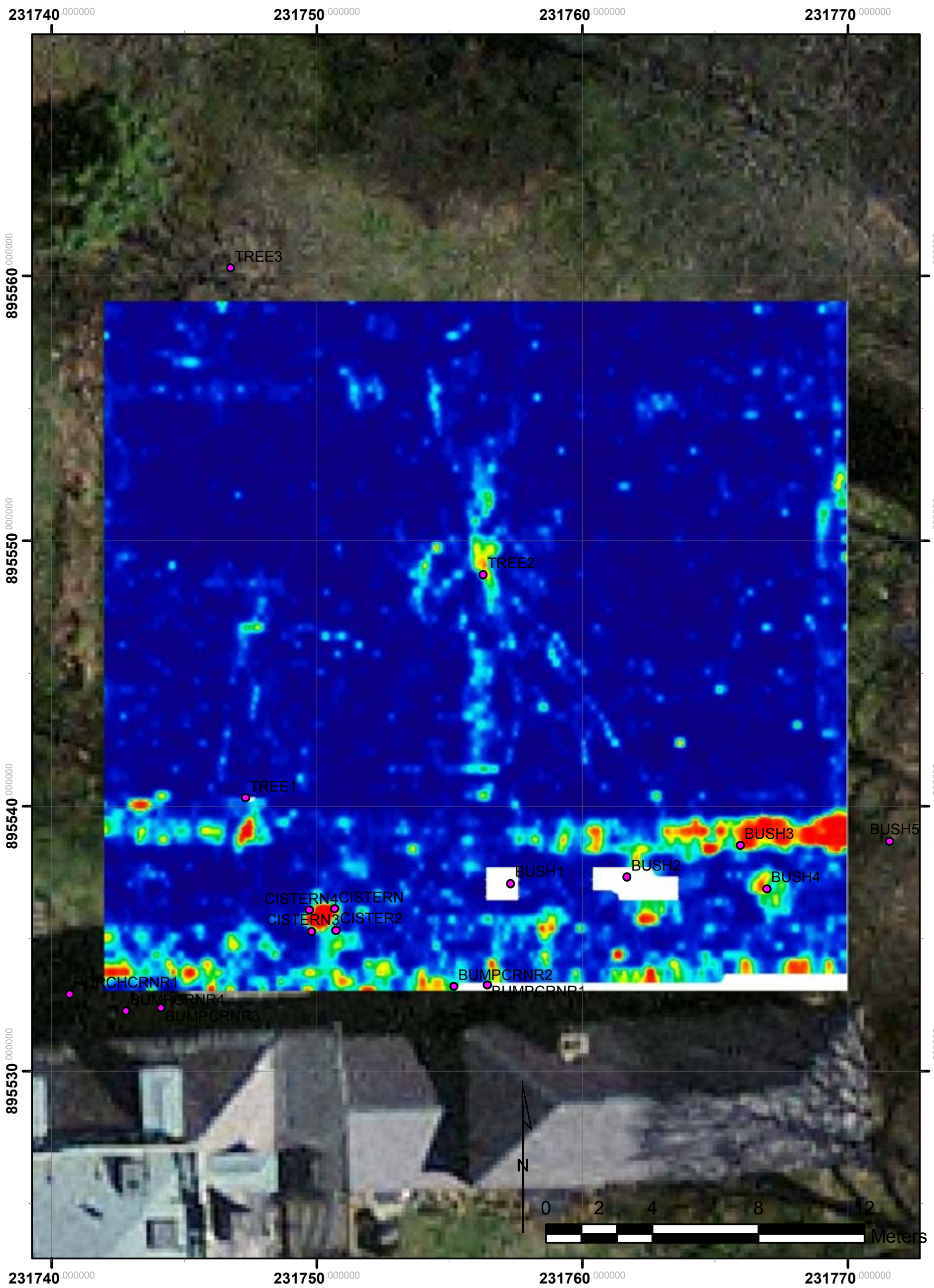

Figure 9. GPR slice of 10-20 cm bgs. Hard reflectors are in red.

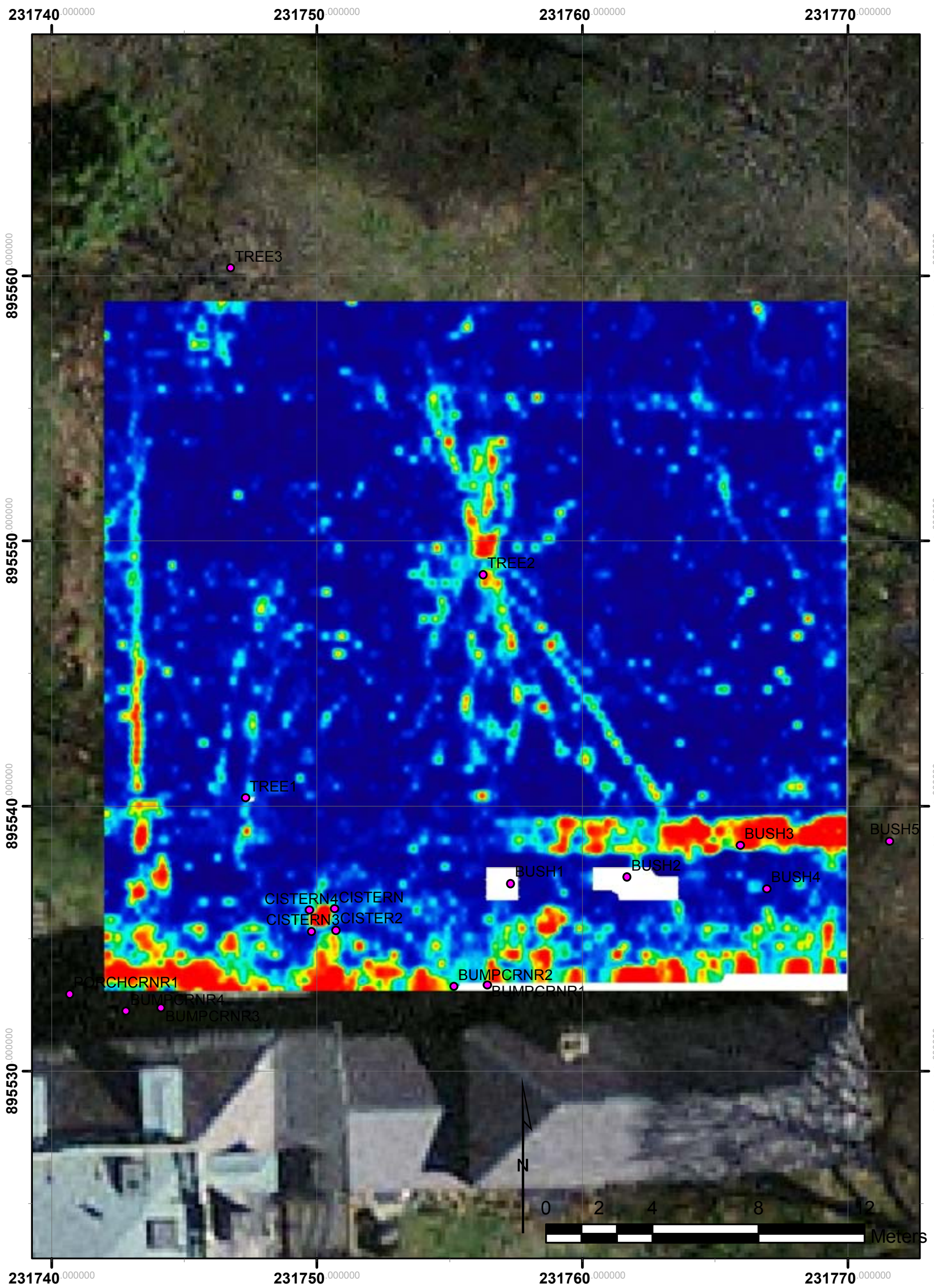

Figure 10. GPR slice of 20-30 cm bgs. Hard reflectors are in red.

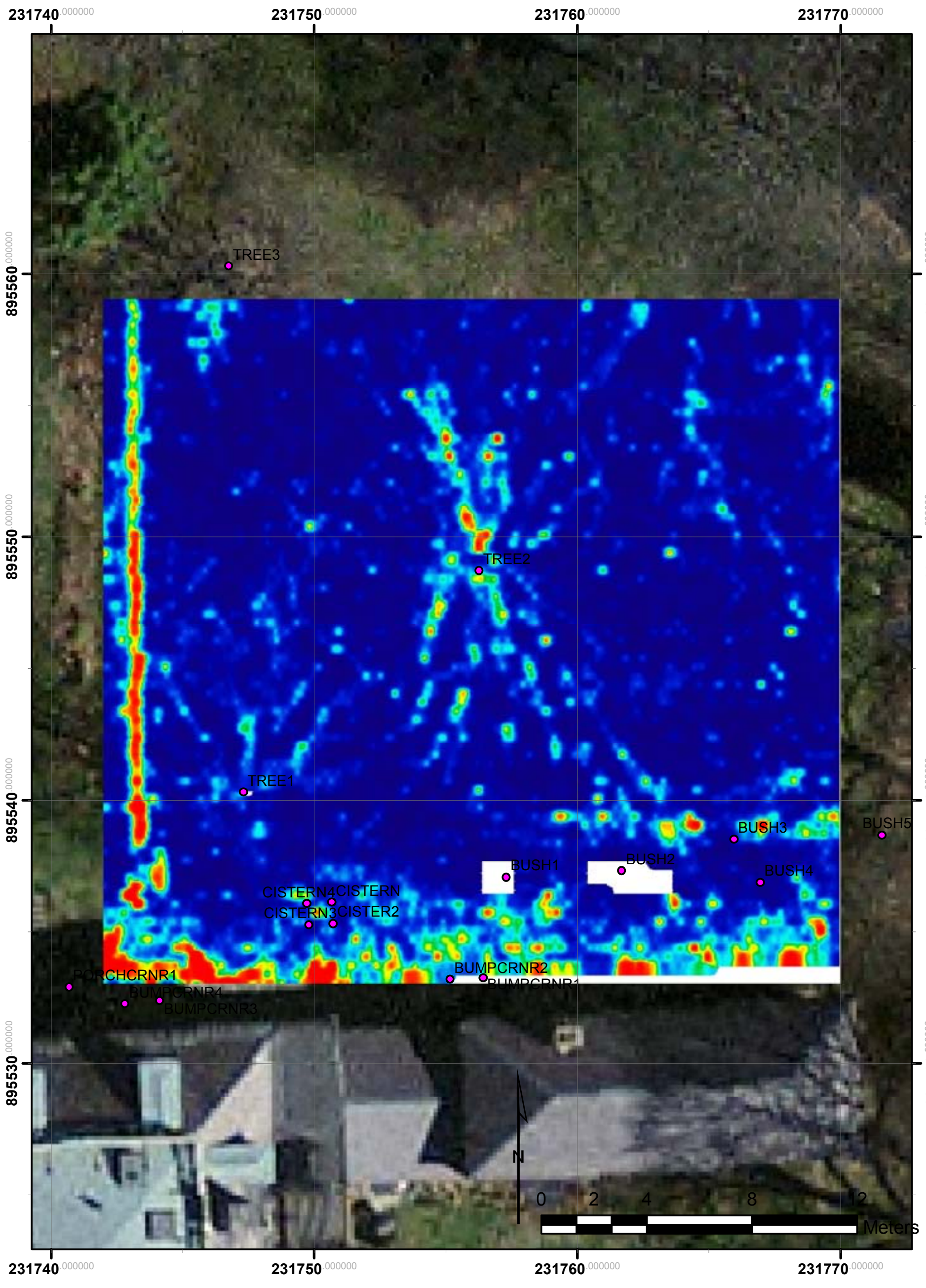

Figure 11. GPR slice of 30-40 cm bgs. Hard reflectors are in red.

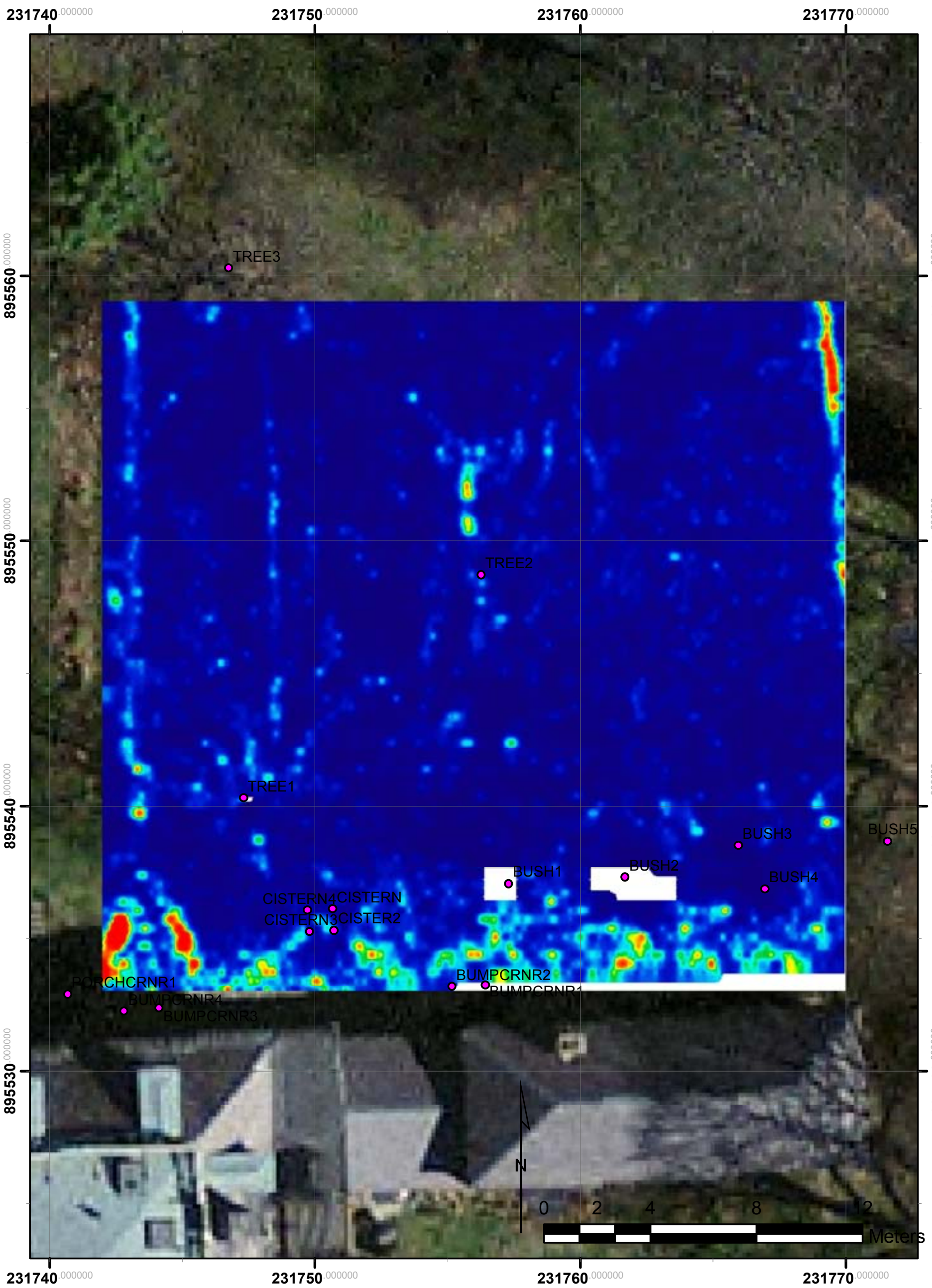

Figure 12. GPR slice of 40-50 cm bgs. Hard reflectors are in red.

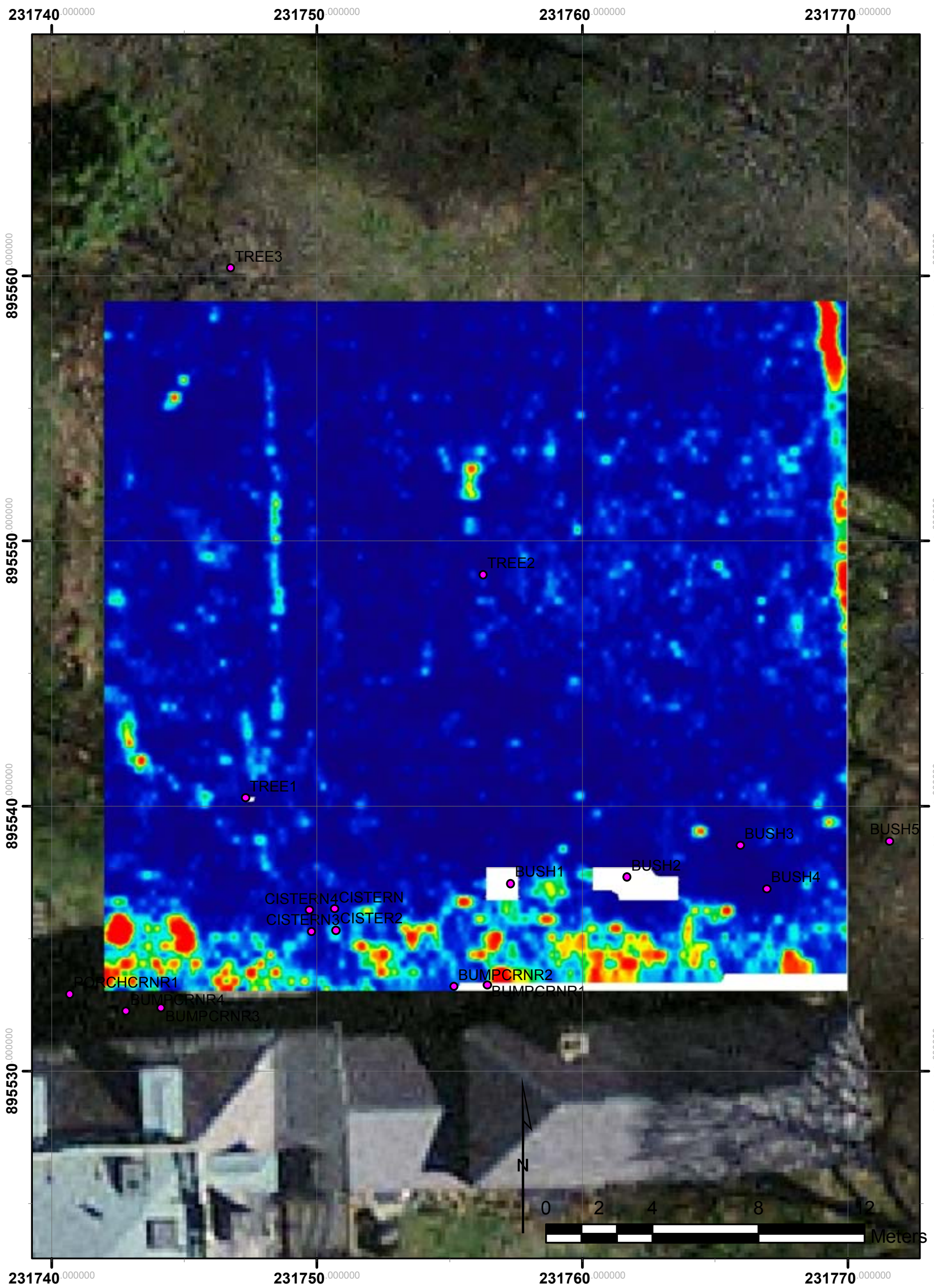

Figure 13. GPR slice of 50-60 cm bgs. Hard reflectors are in red.

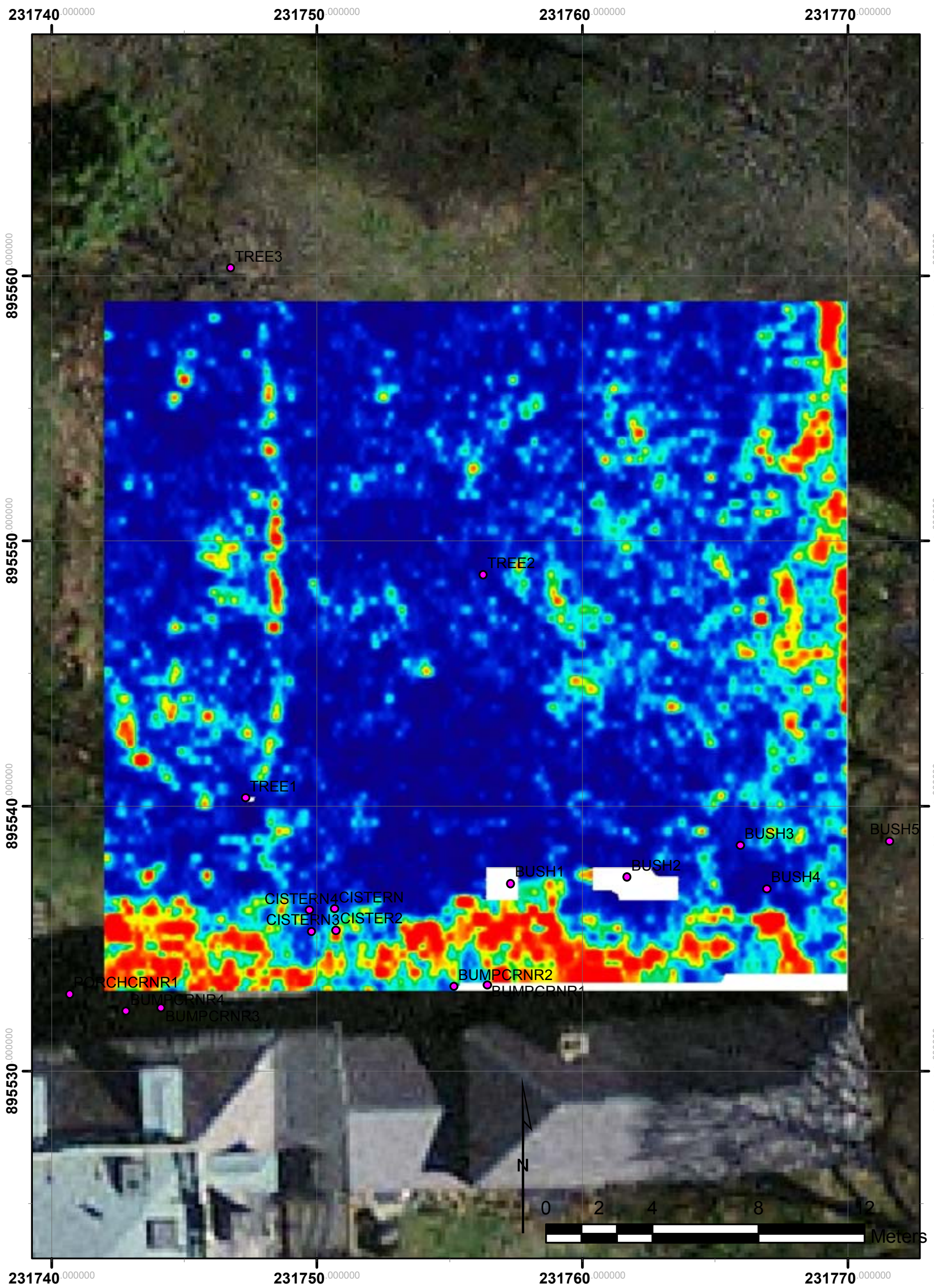

Figure 14. GPR slice of 60-70 cm bgs. Hard reflectors are in red.

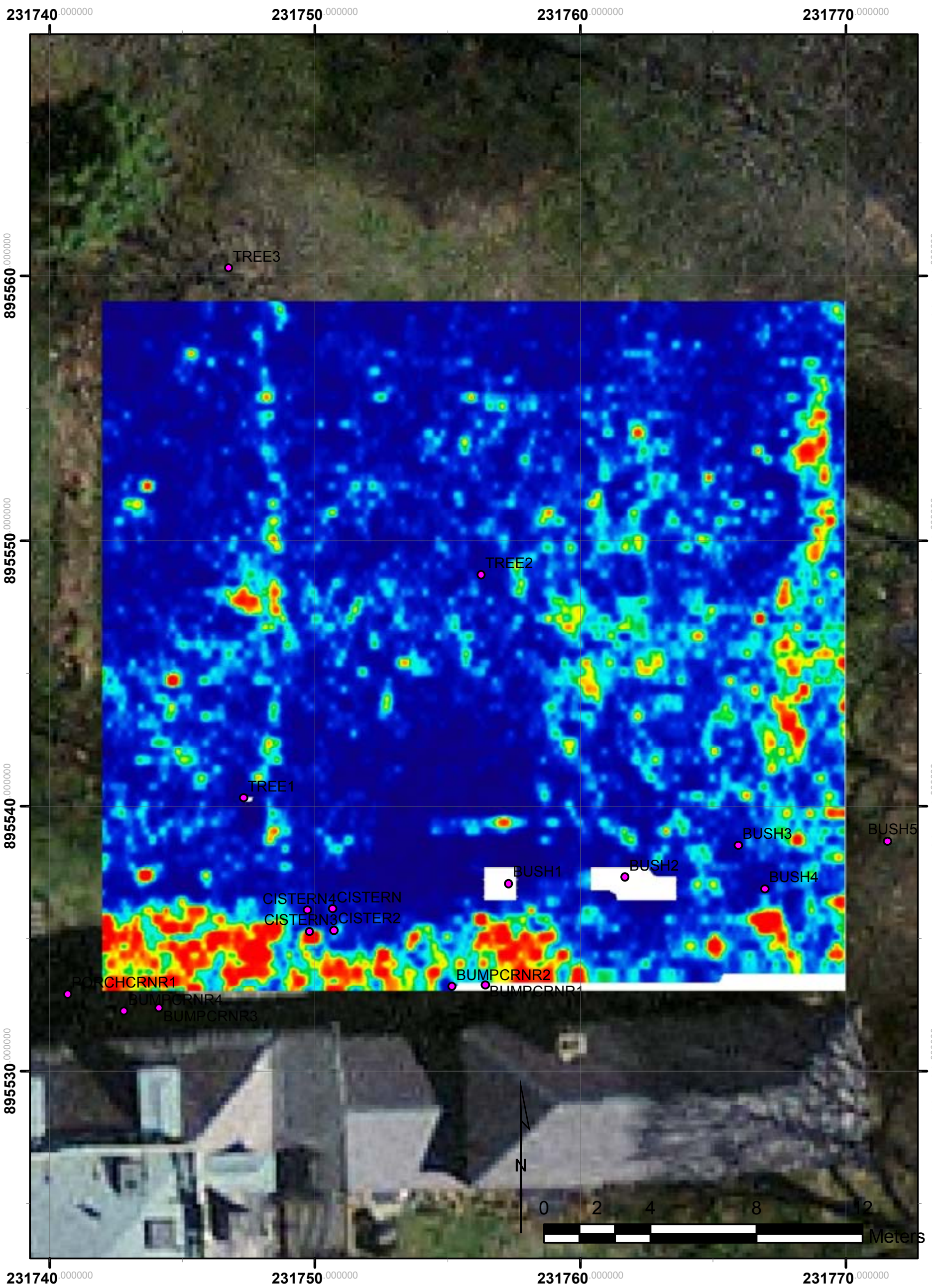

Figure 15. GPR slice of 70-80 cm bgs. Hard reflectors are in red.

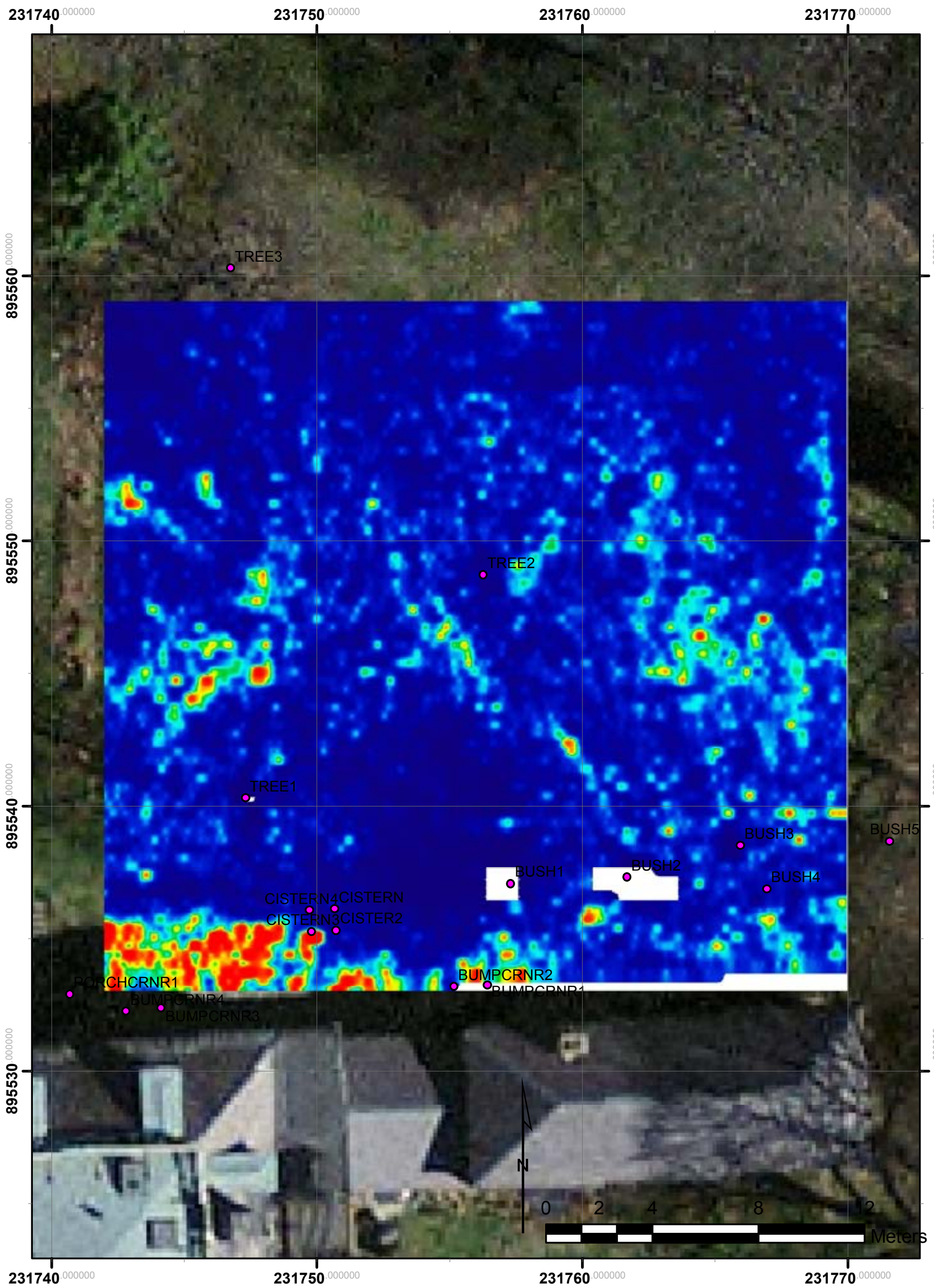

Figure 16. GPR slice of 80-90 cm bgs. Hard reflectors are in red.

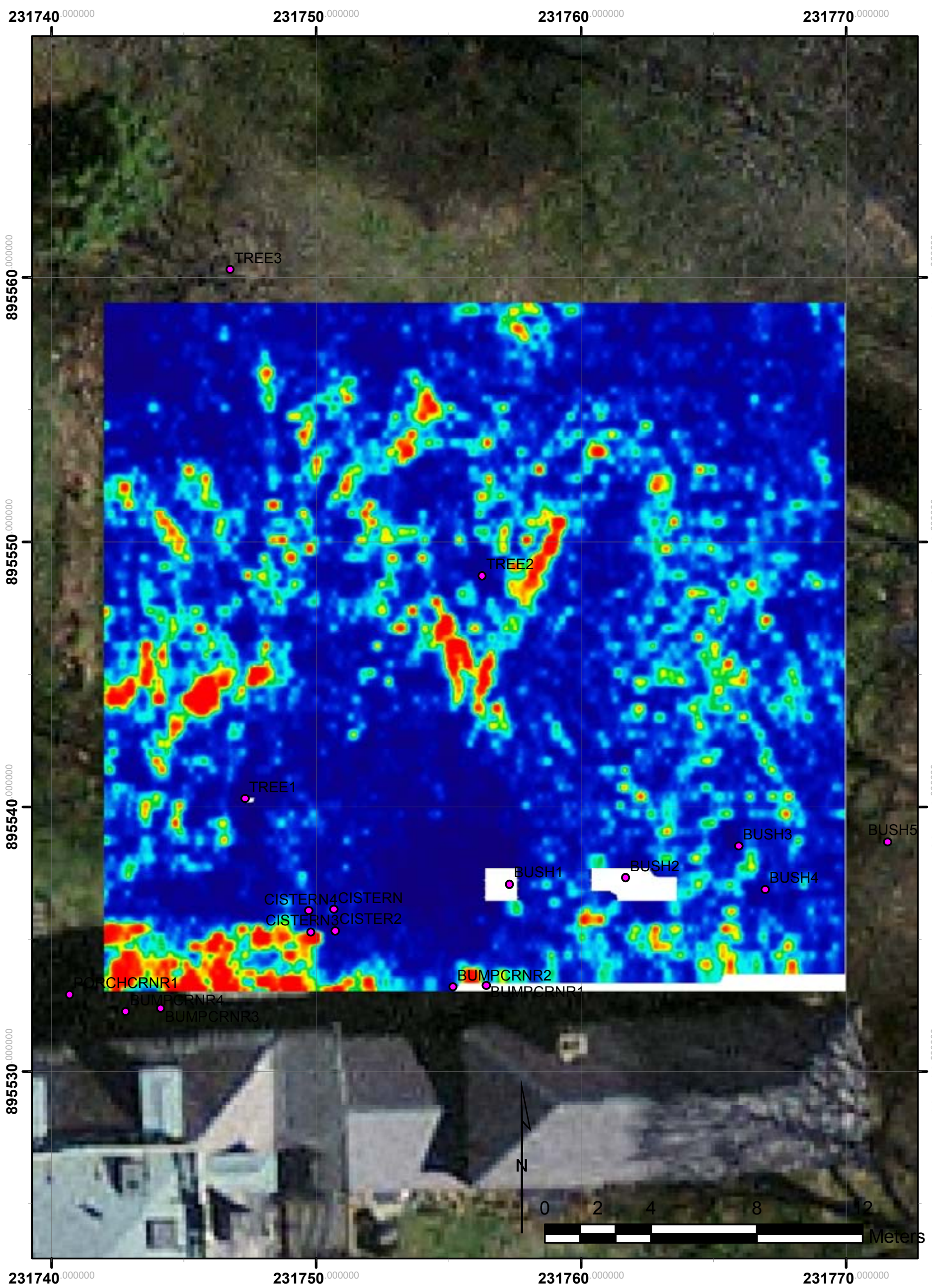

Figure 17. GPR slice of 90-100 cm bgs. Hard reflectors are in red.

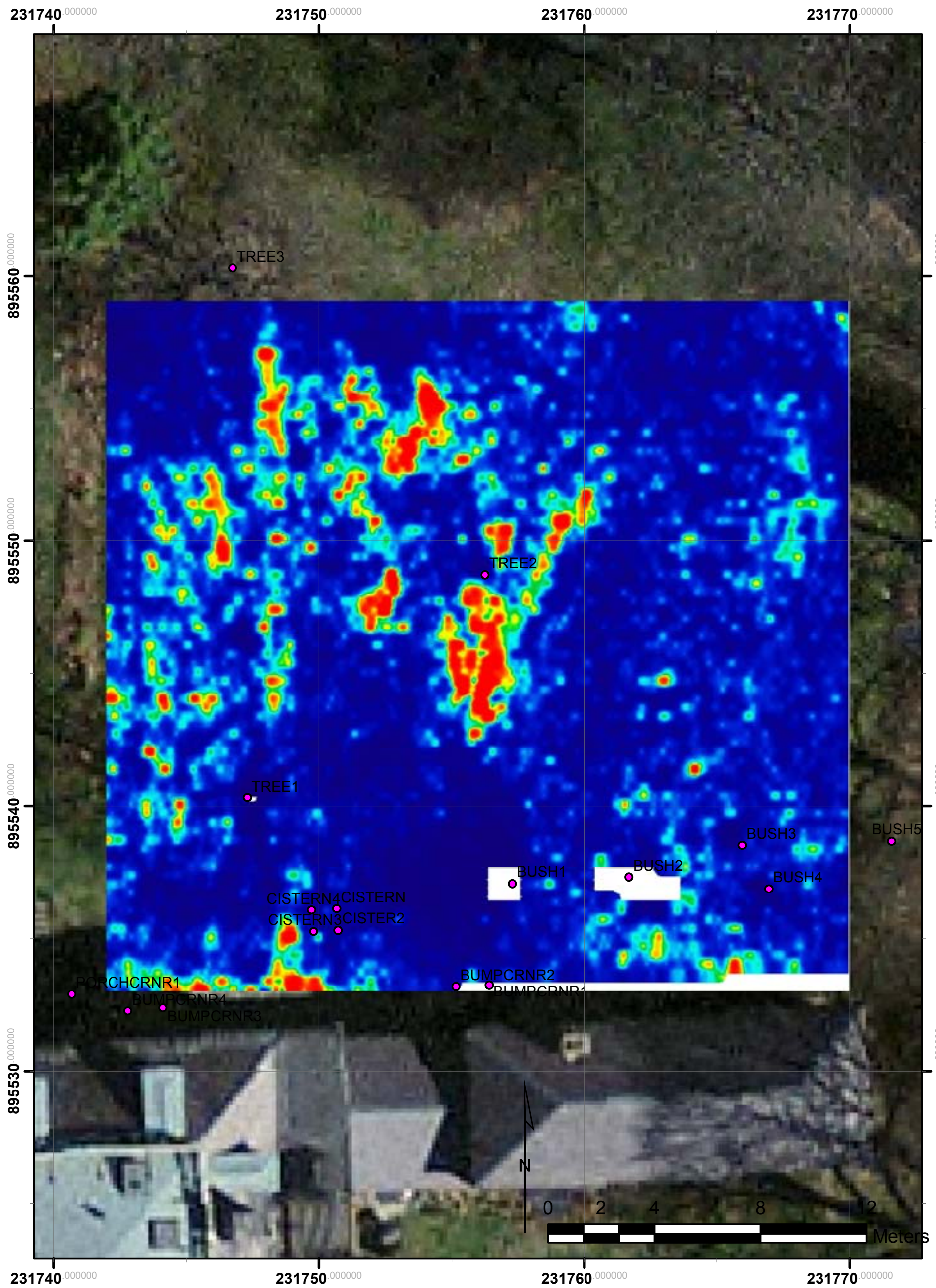

Figure 18. GPR slice of 100-110 cm bgs. Hard reflectors are in red.

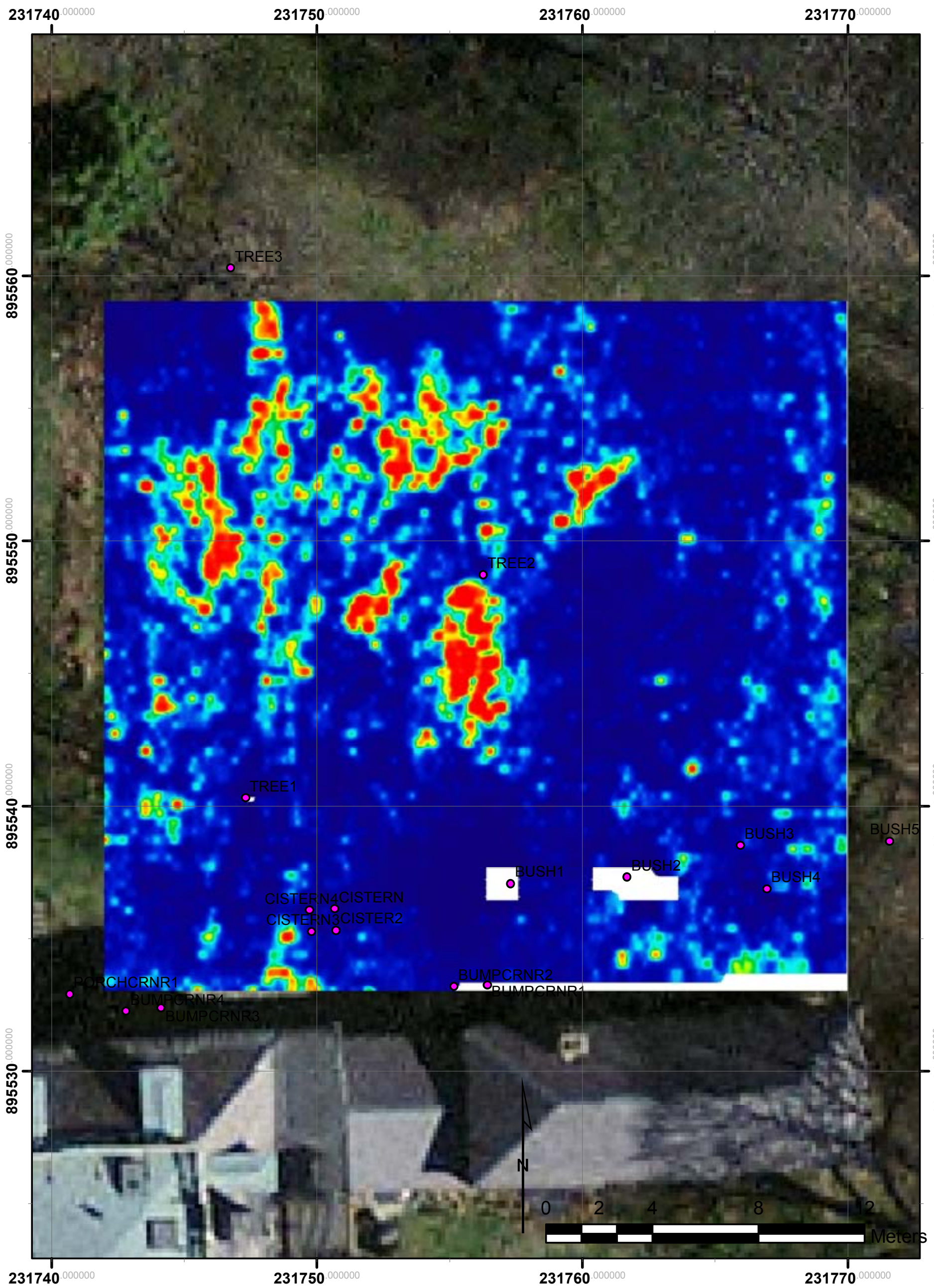

Figure 19. GPR slice of 110-120 cm bgs.

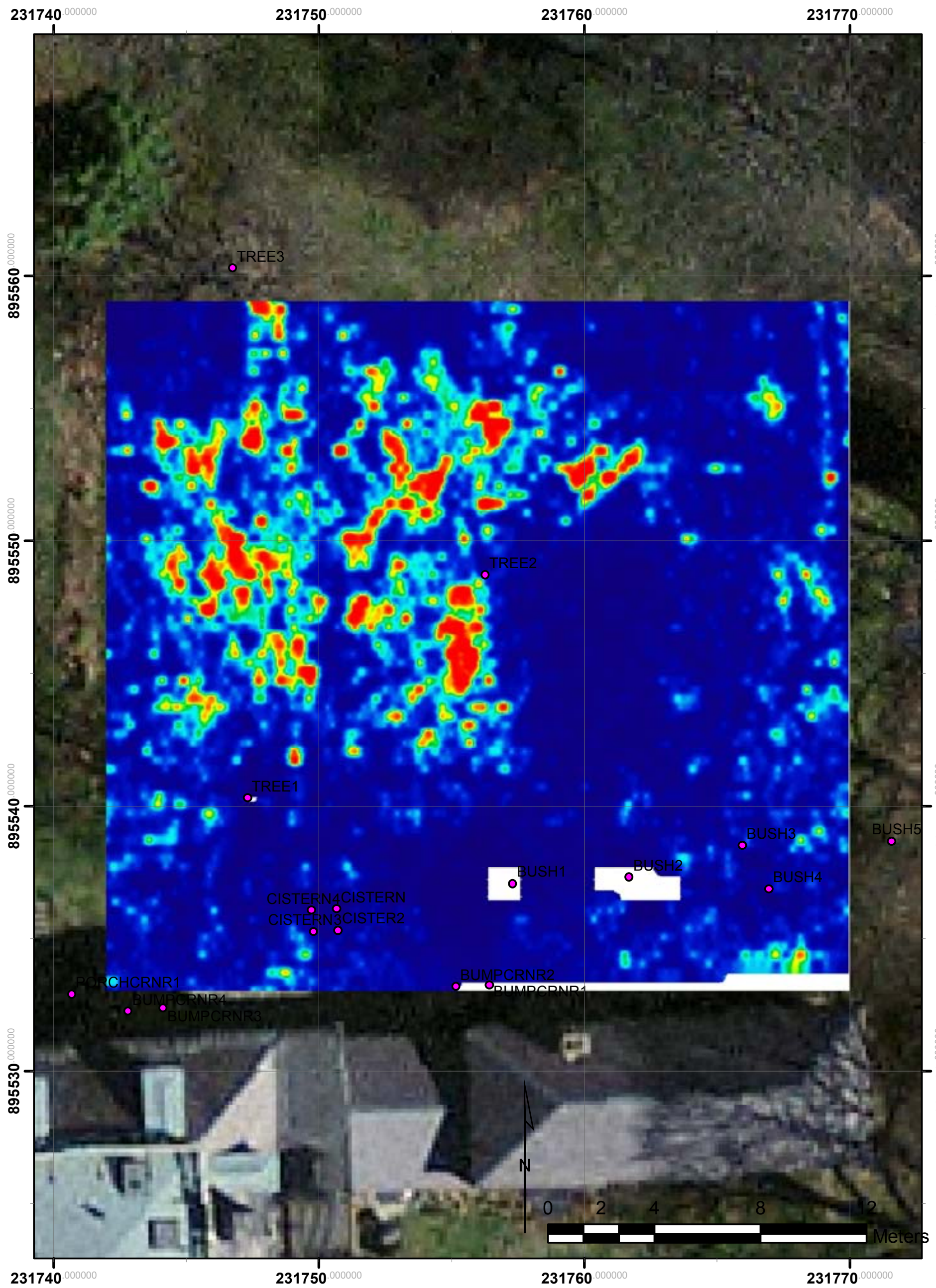

Figure 20. GPR slice of 120-130 cm bgs.

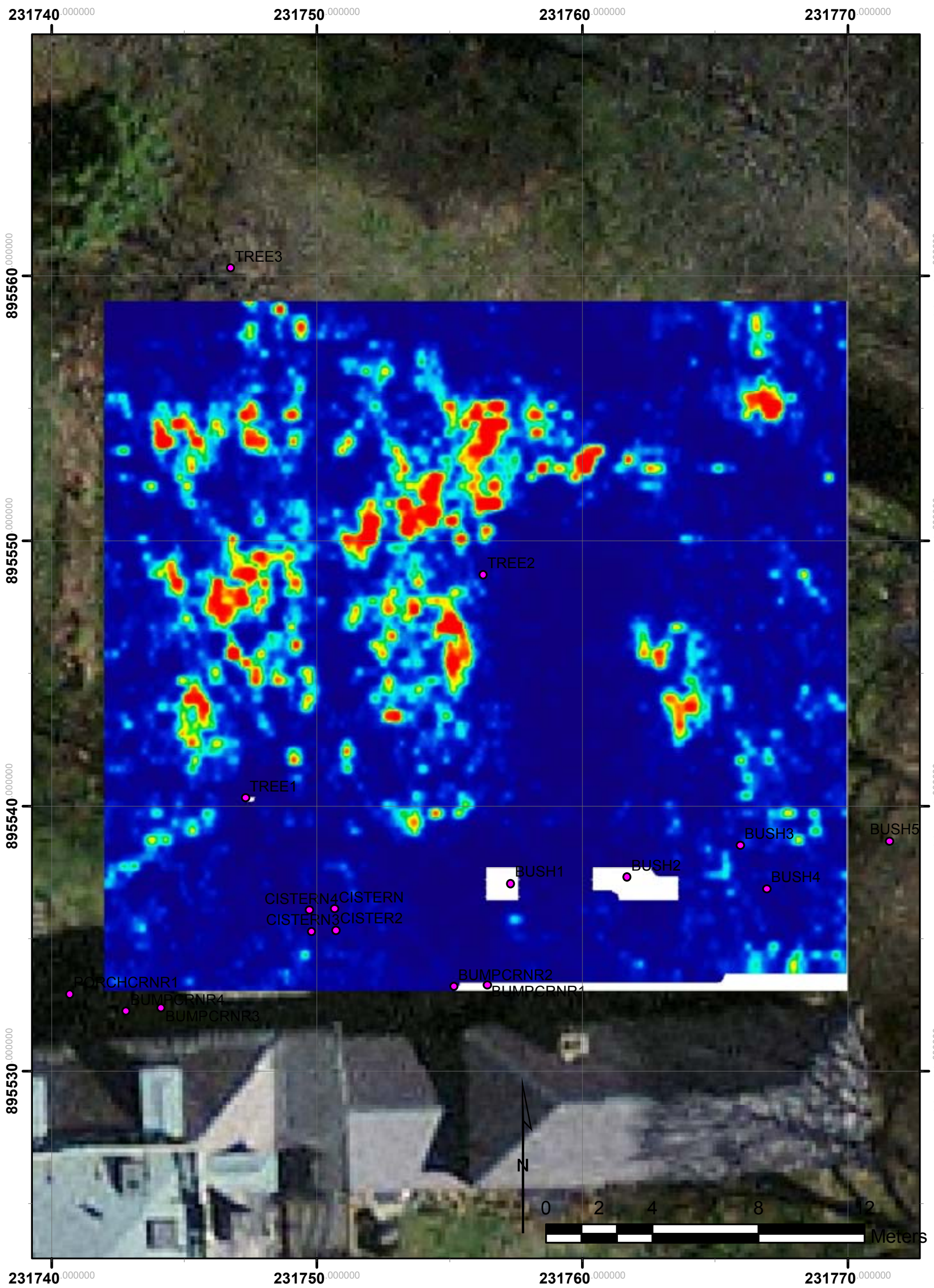

Figure 21. GPR slice of 130-140 cm bgs

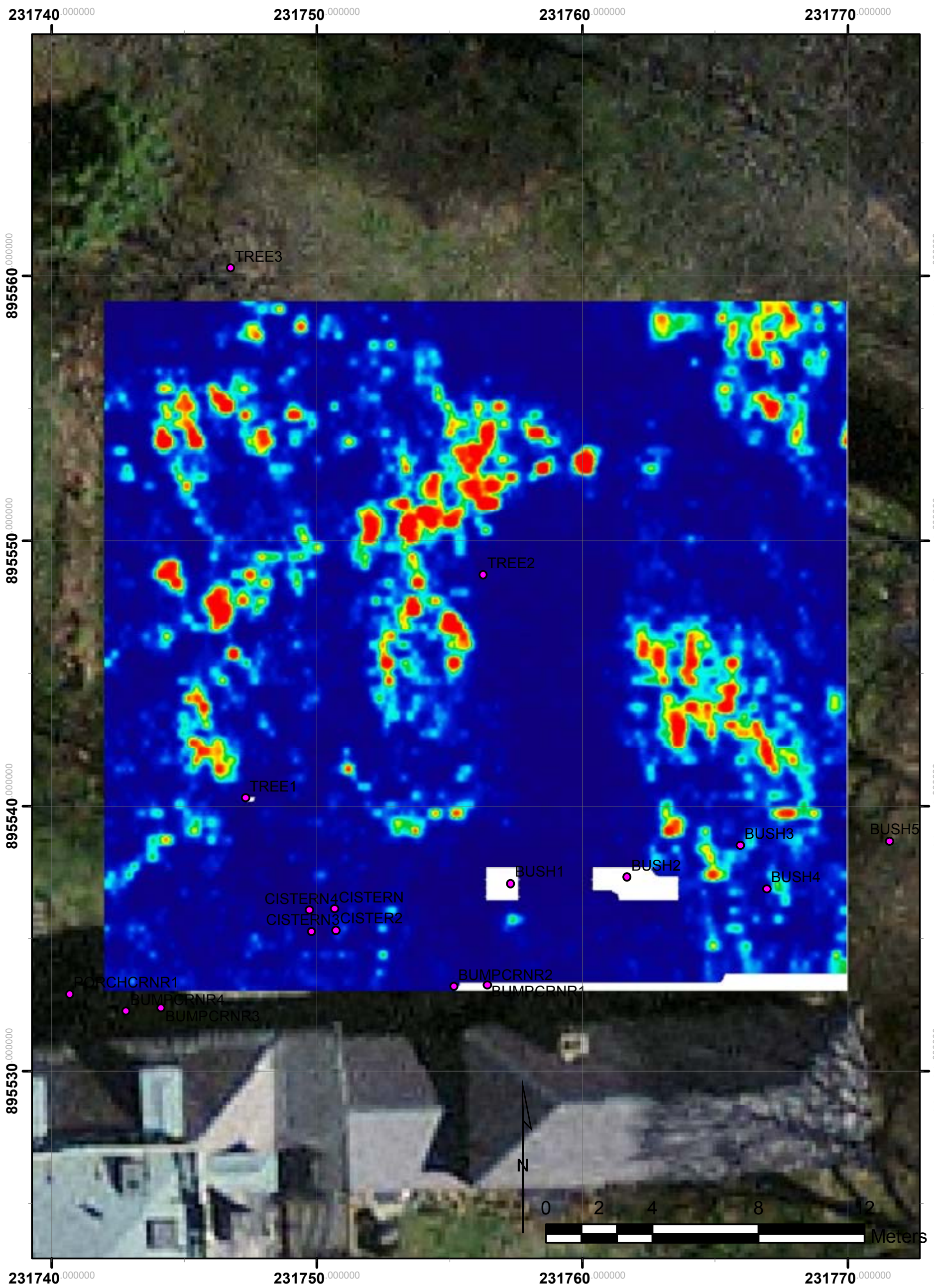

Figure 22. GPR slice of 140-150 cm bgs.

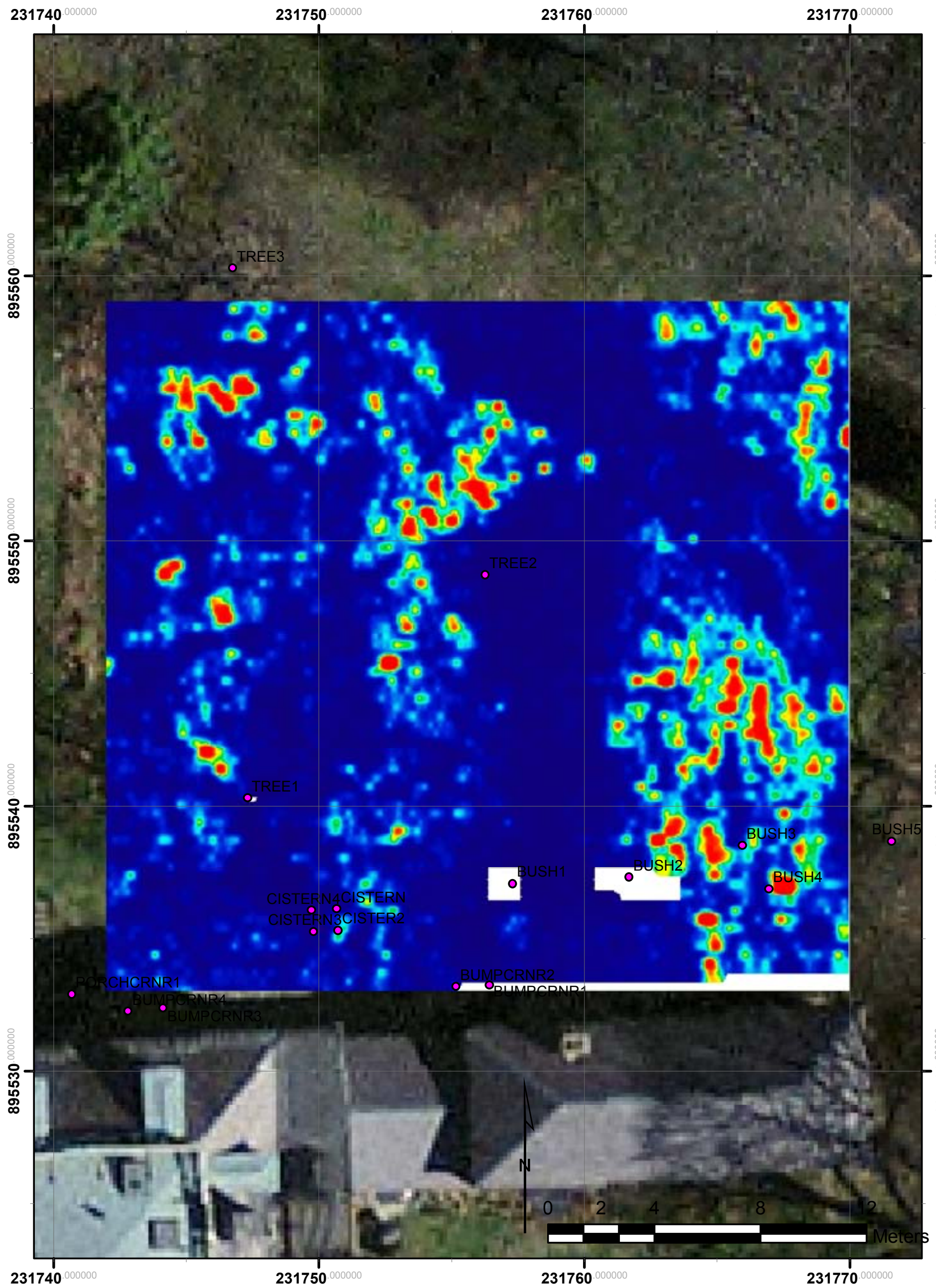

Figure 23. GPR slice of 150-160 cm bgs.

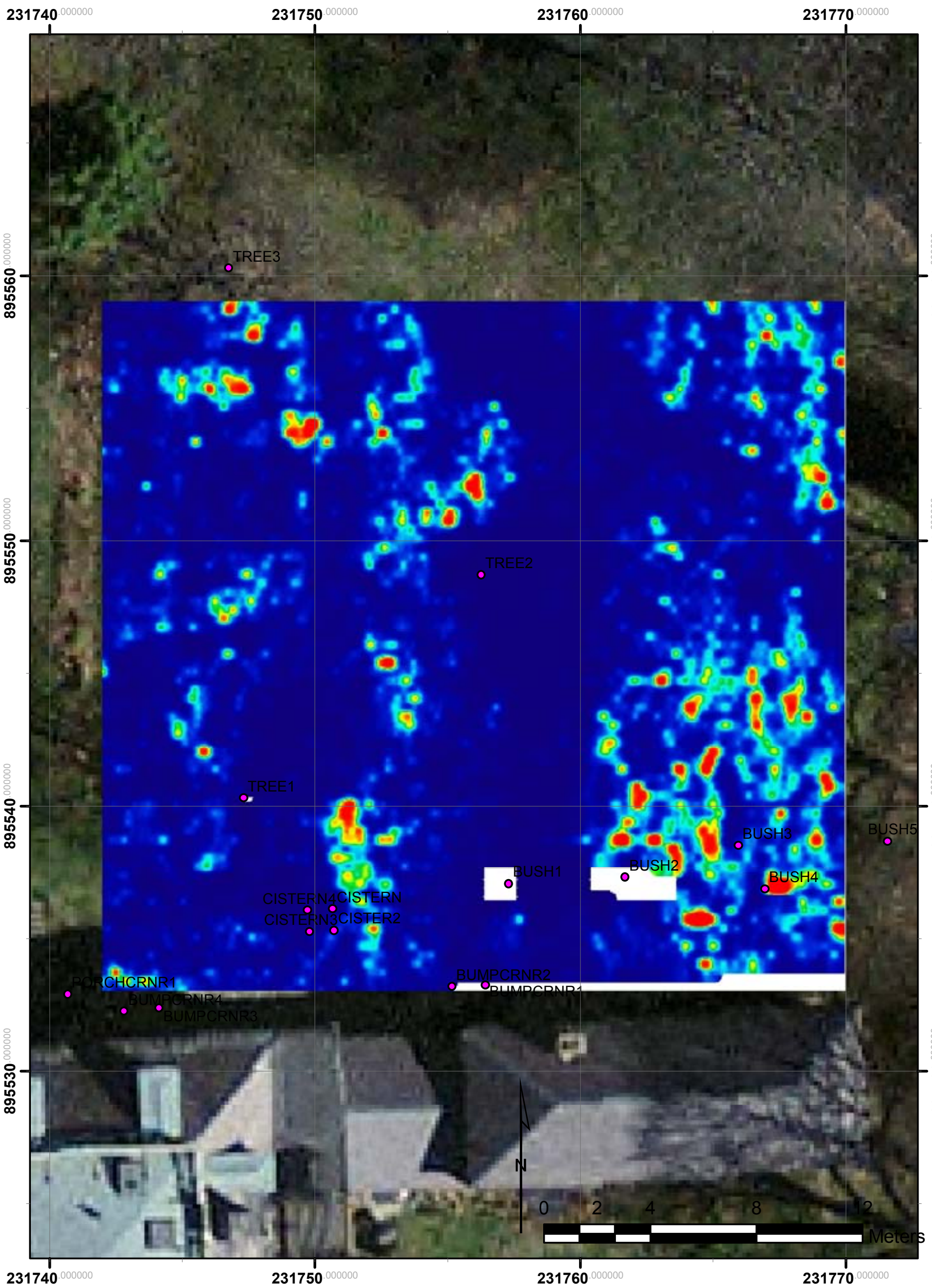

Figure 24. GPR slice of 160-170 cm bgs.

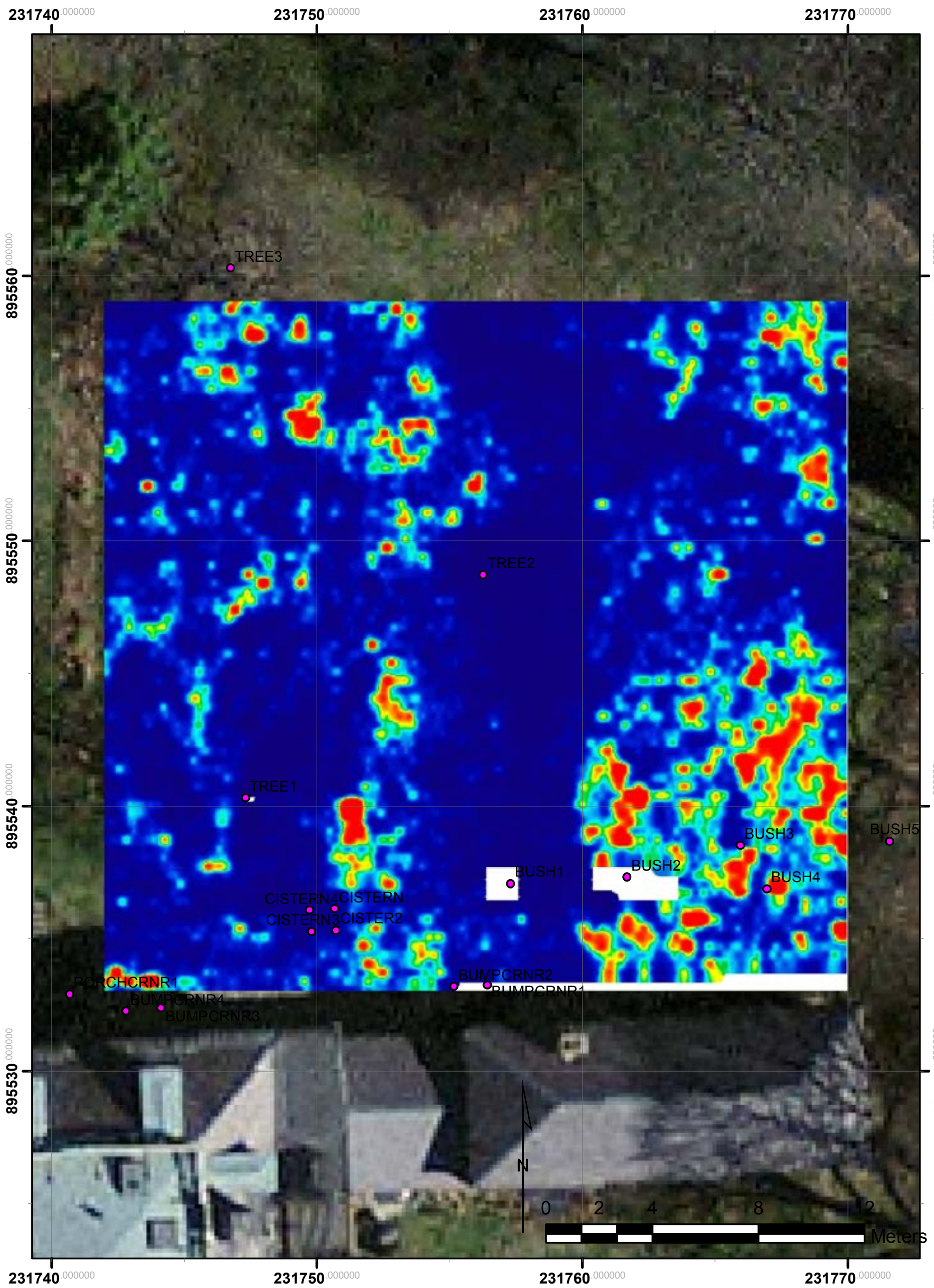

Figure 25. GPR slice of 170-180 cm bgs.

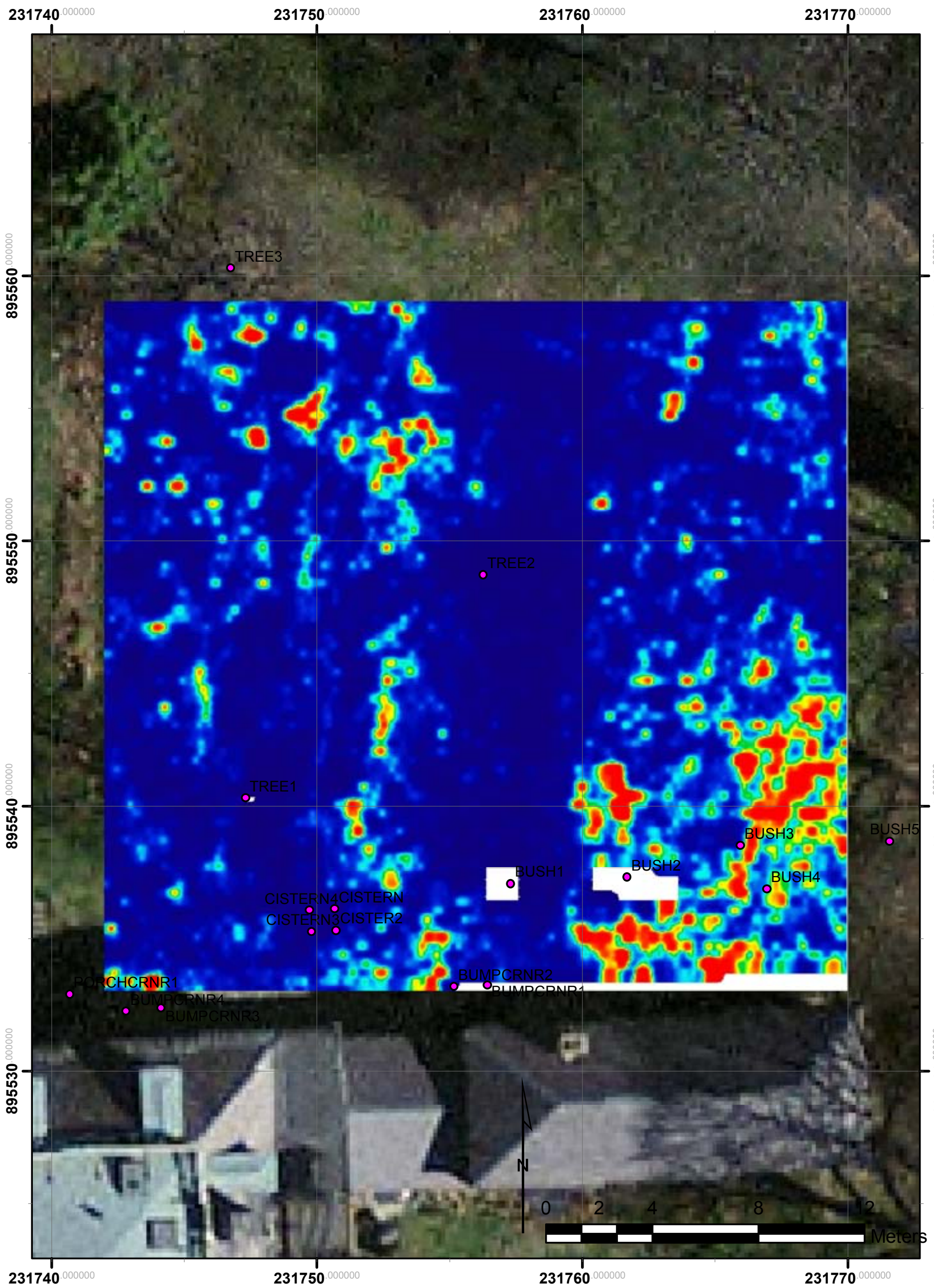

Figure 26. GPR slice of 180-190 cm bgs.

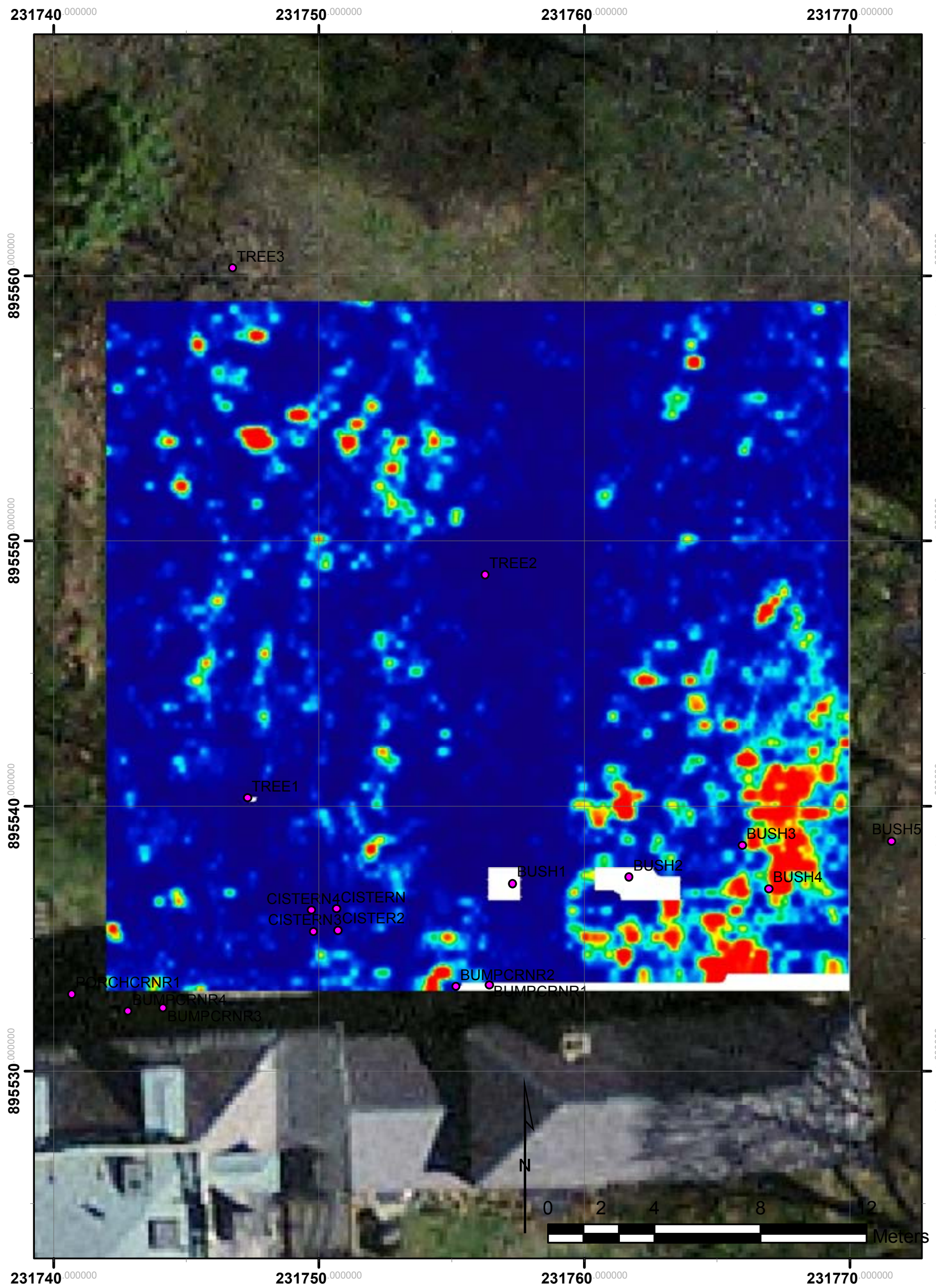

Figure 27. GPR slice of 190-200 cm bgs

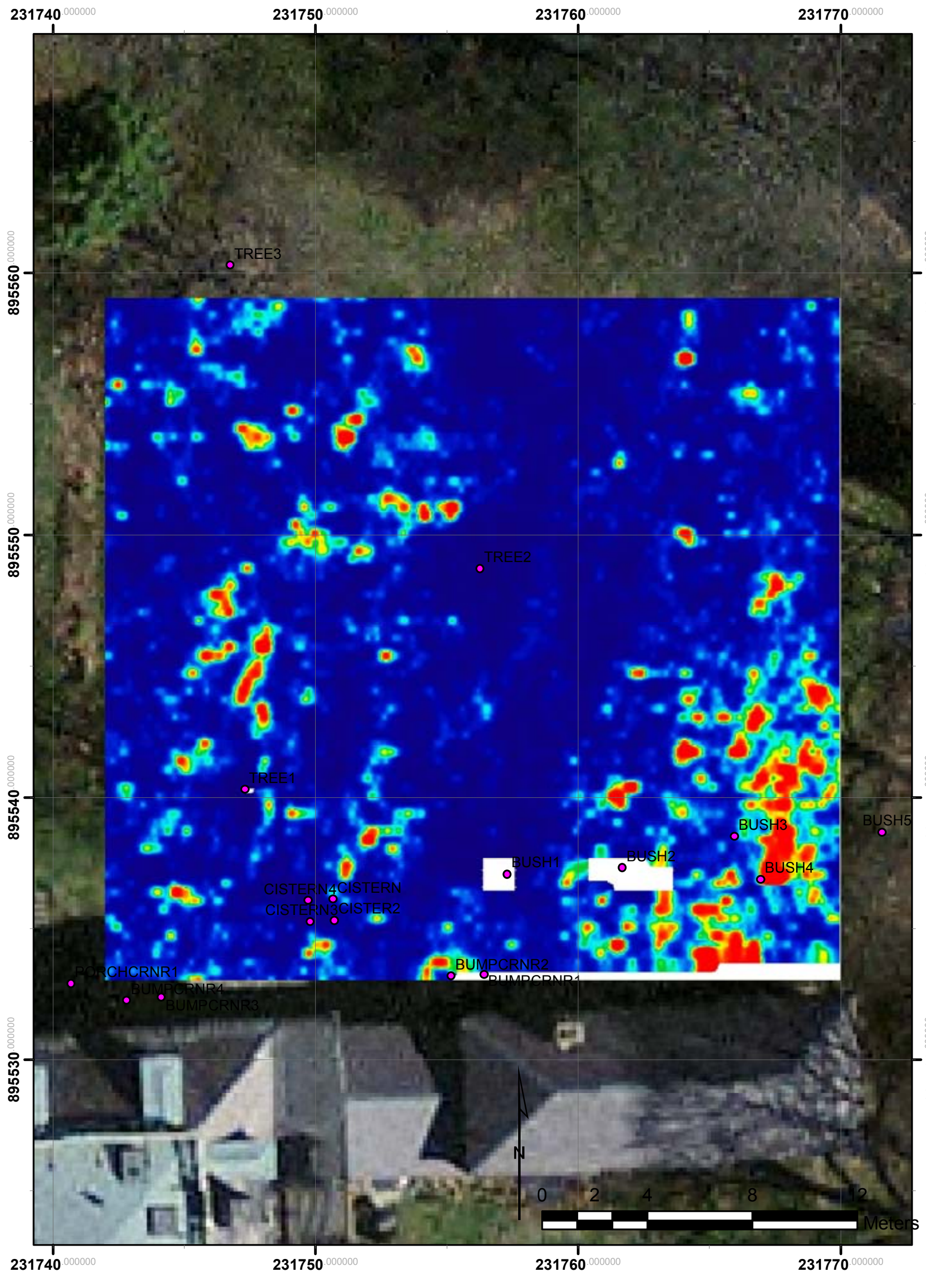

Figure 28. GPR slice of 200-210 cm bgs

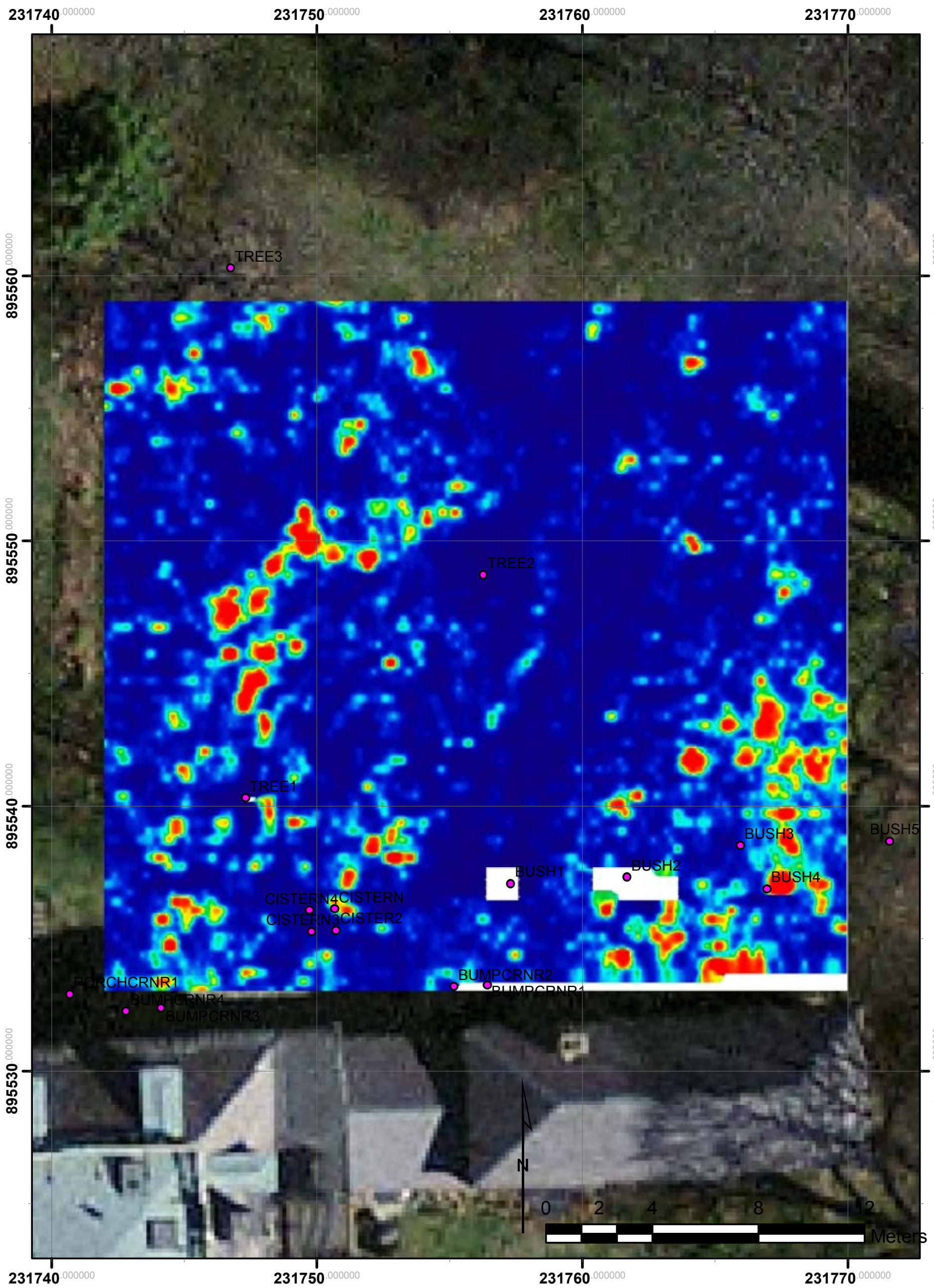

Figure 29. GPR slice of 210-220 cm bgs

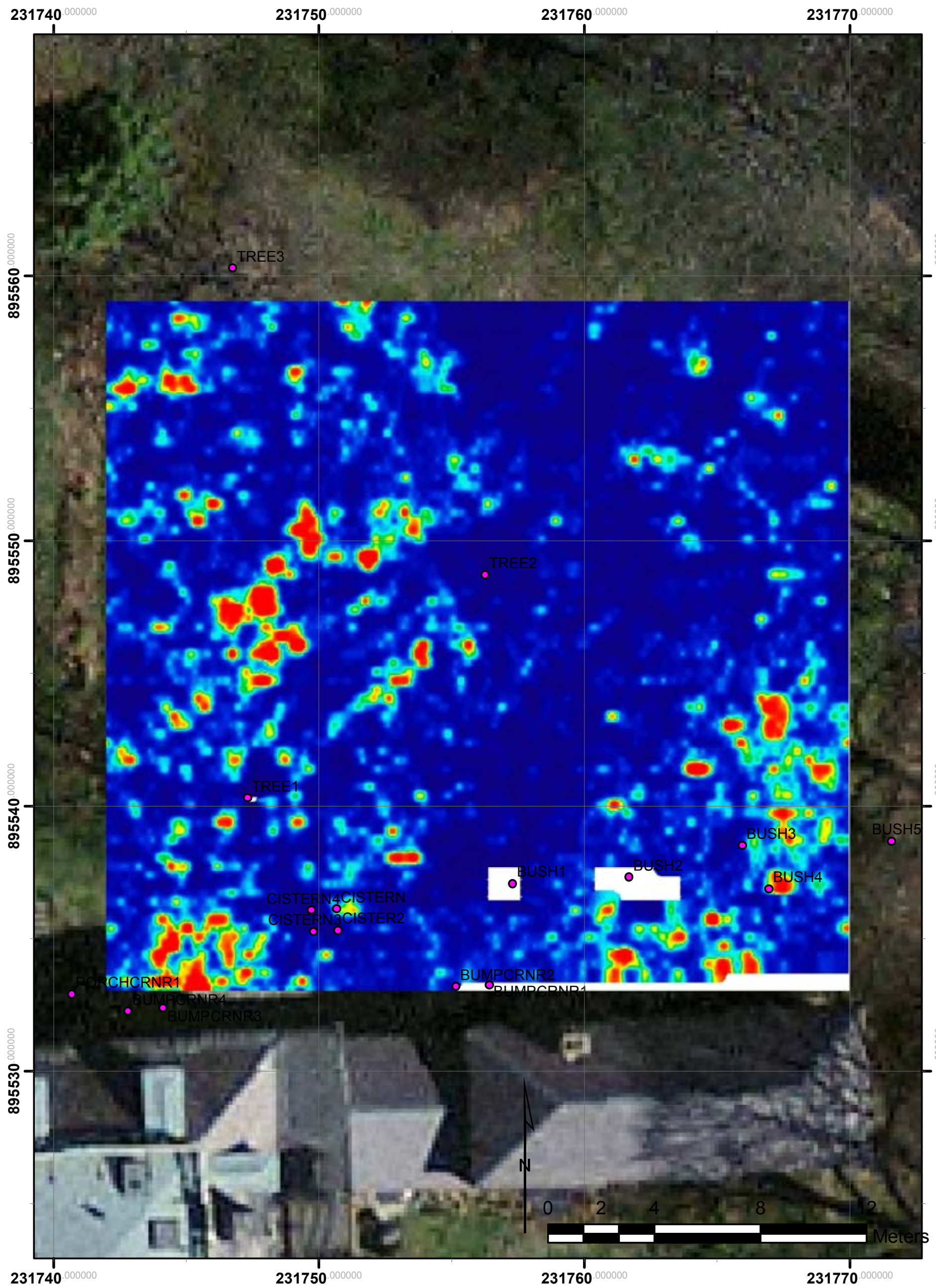

Figure 30. GPR slice of 220-230 cm bgs

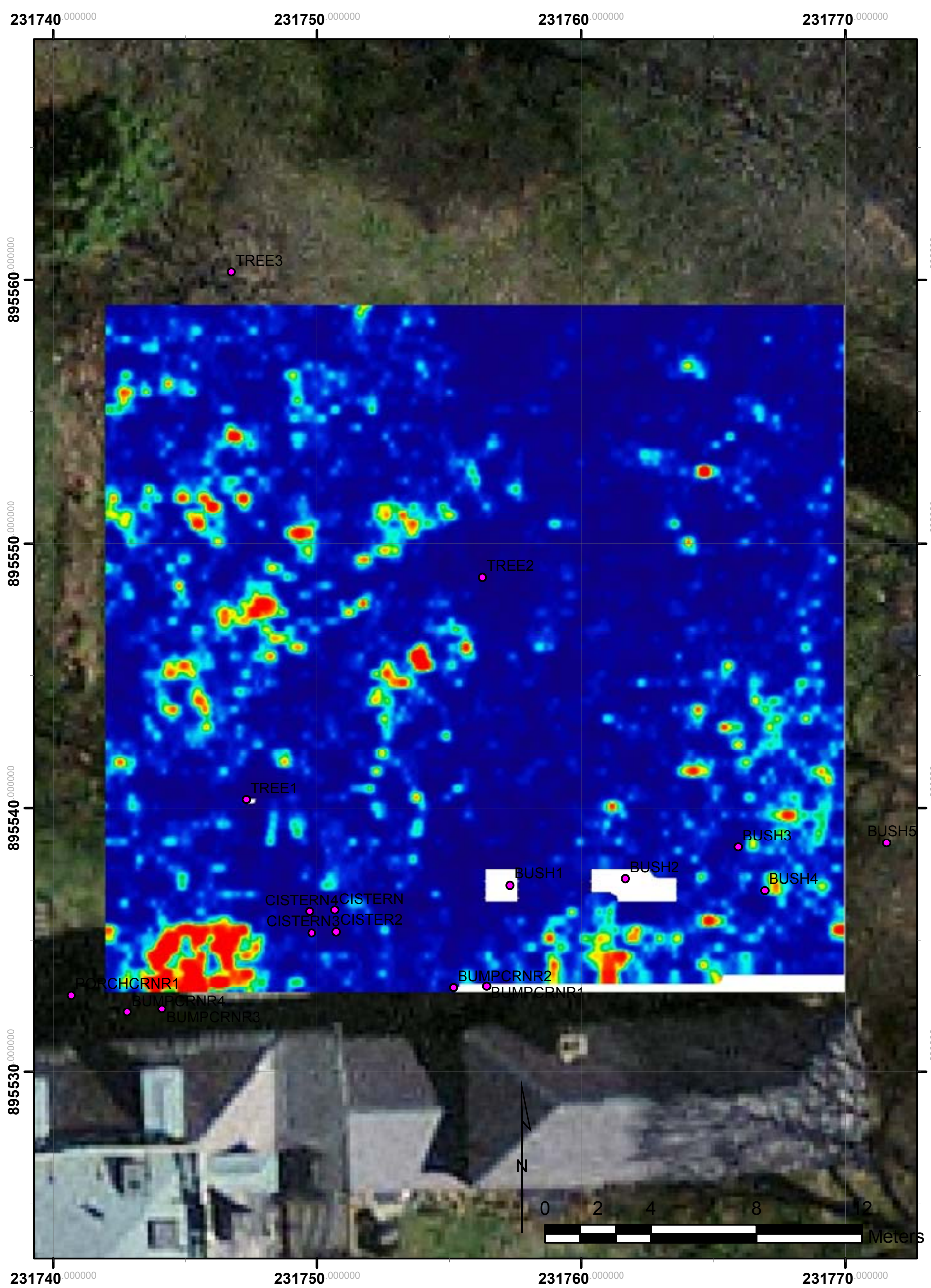

Figure 31. GPR slice of 230-240 cm bgs

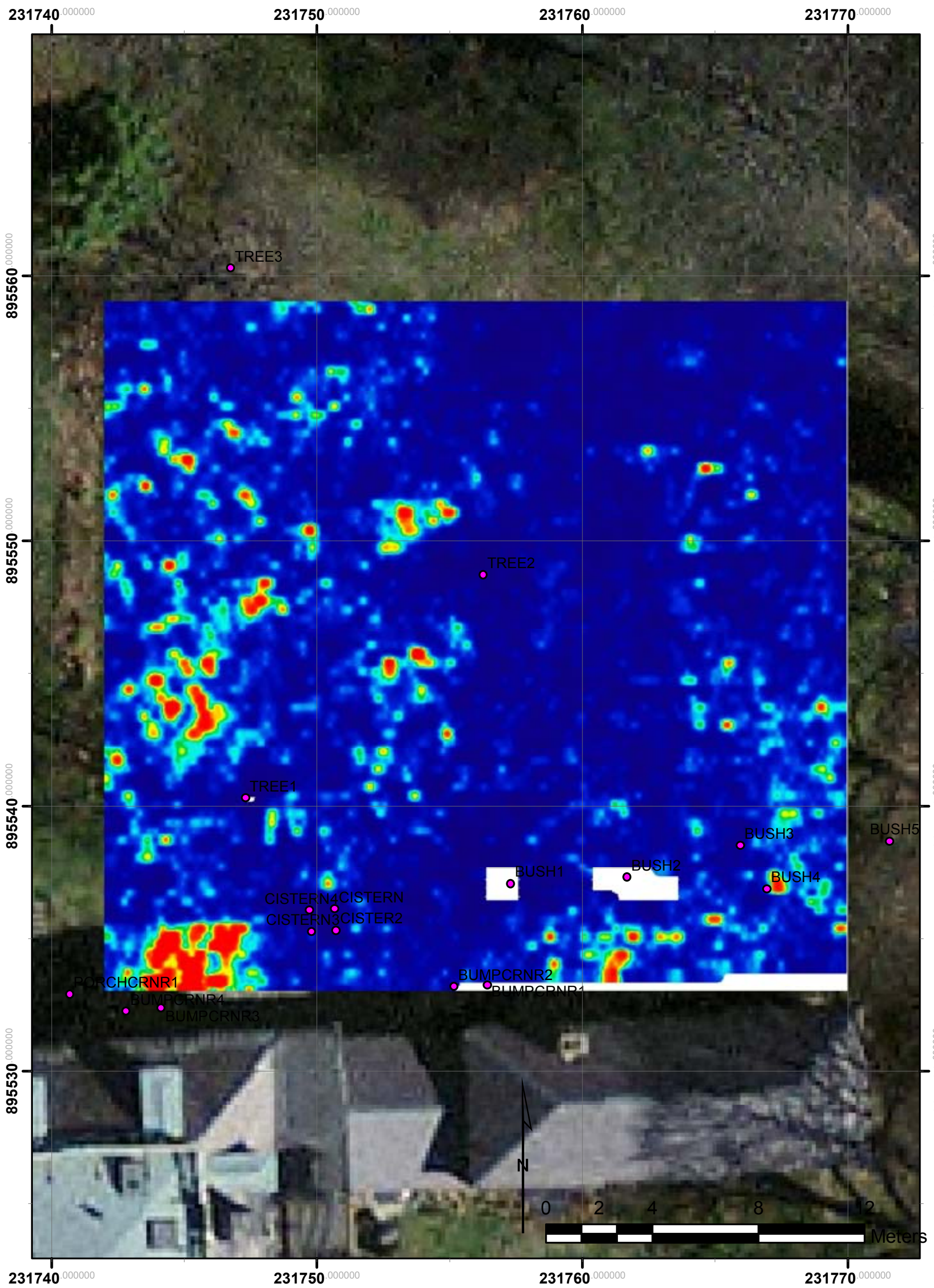

Figure 32. GPR slice of 240-250 cm bgs

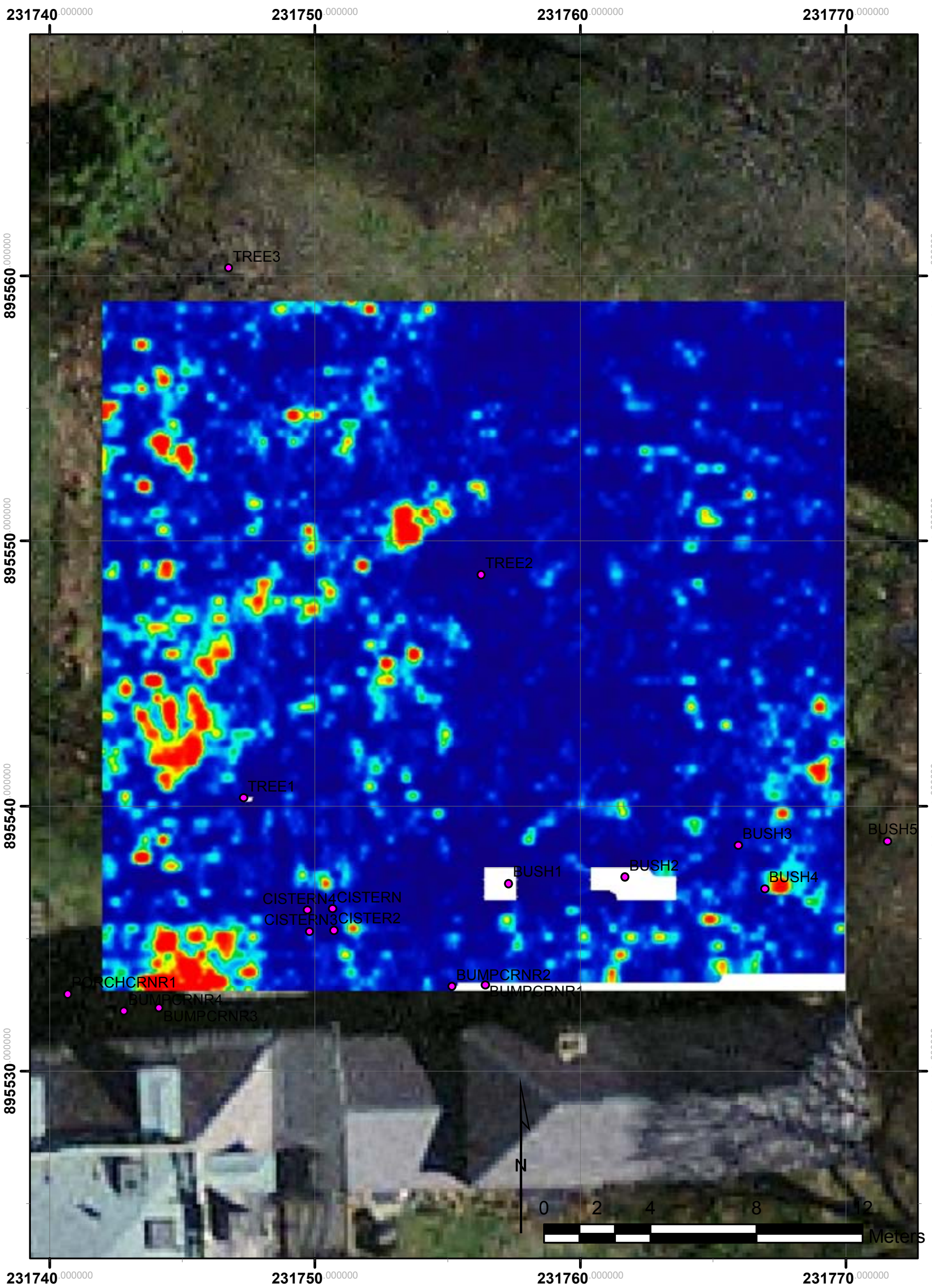

Figure 33. GPR slice of 250-260 cm bgs

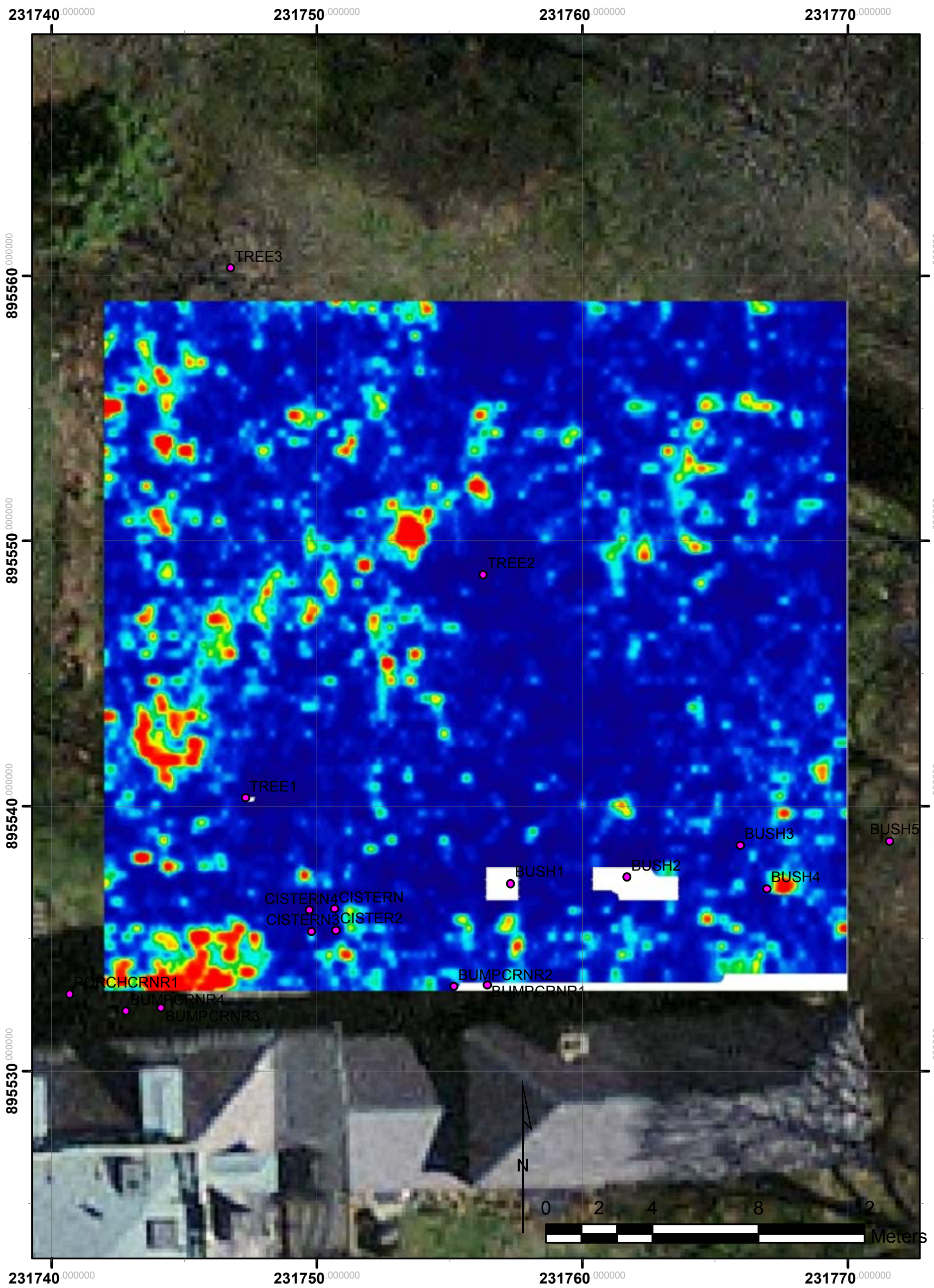

Figure 34. GPR slice of 260-270 cm bgs

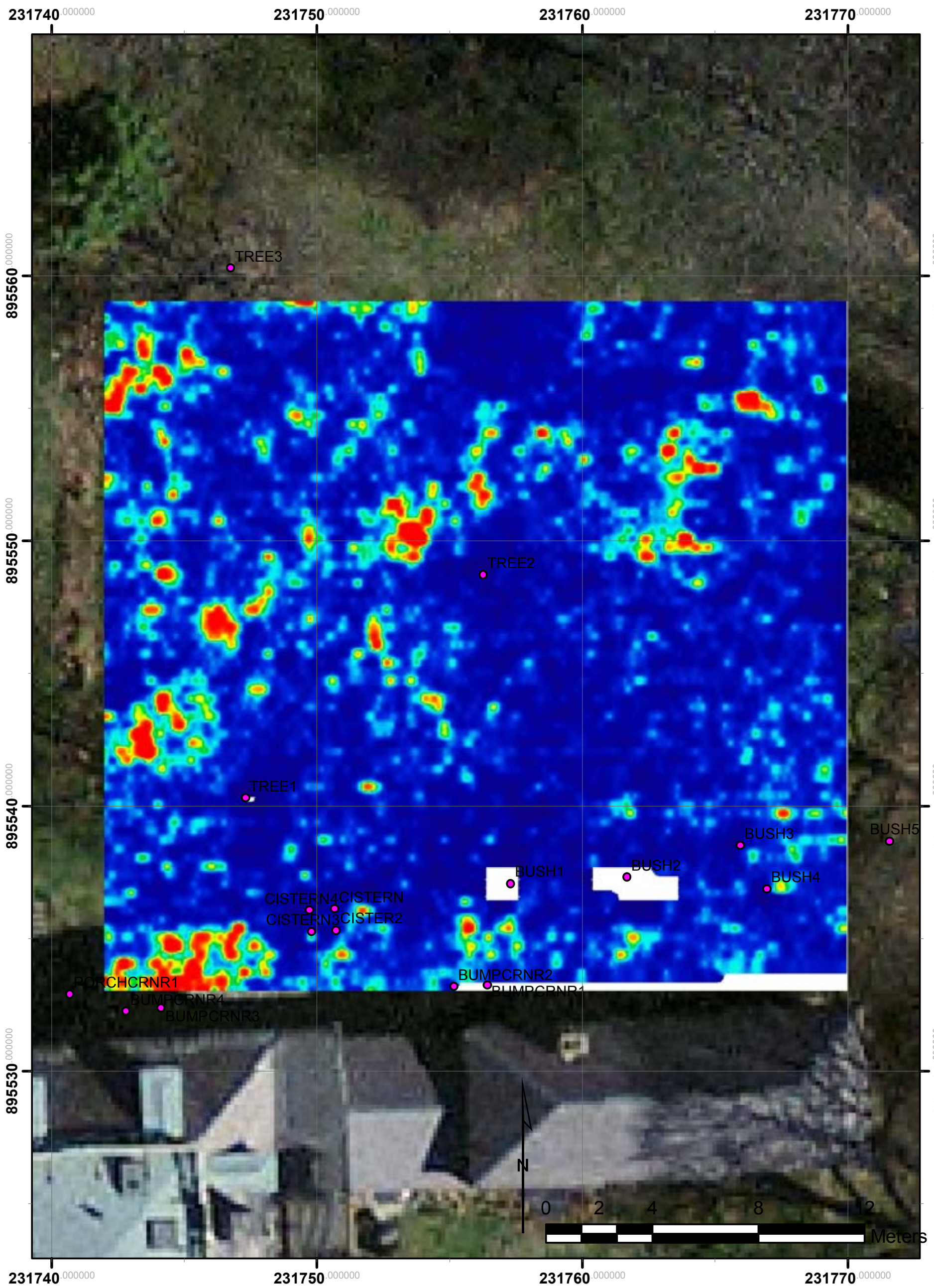

Figure 35. GPR slice of 270-280 cm bgs

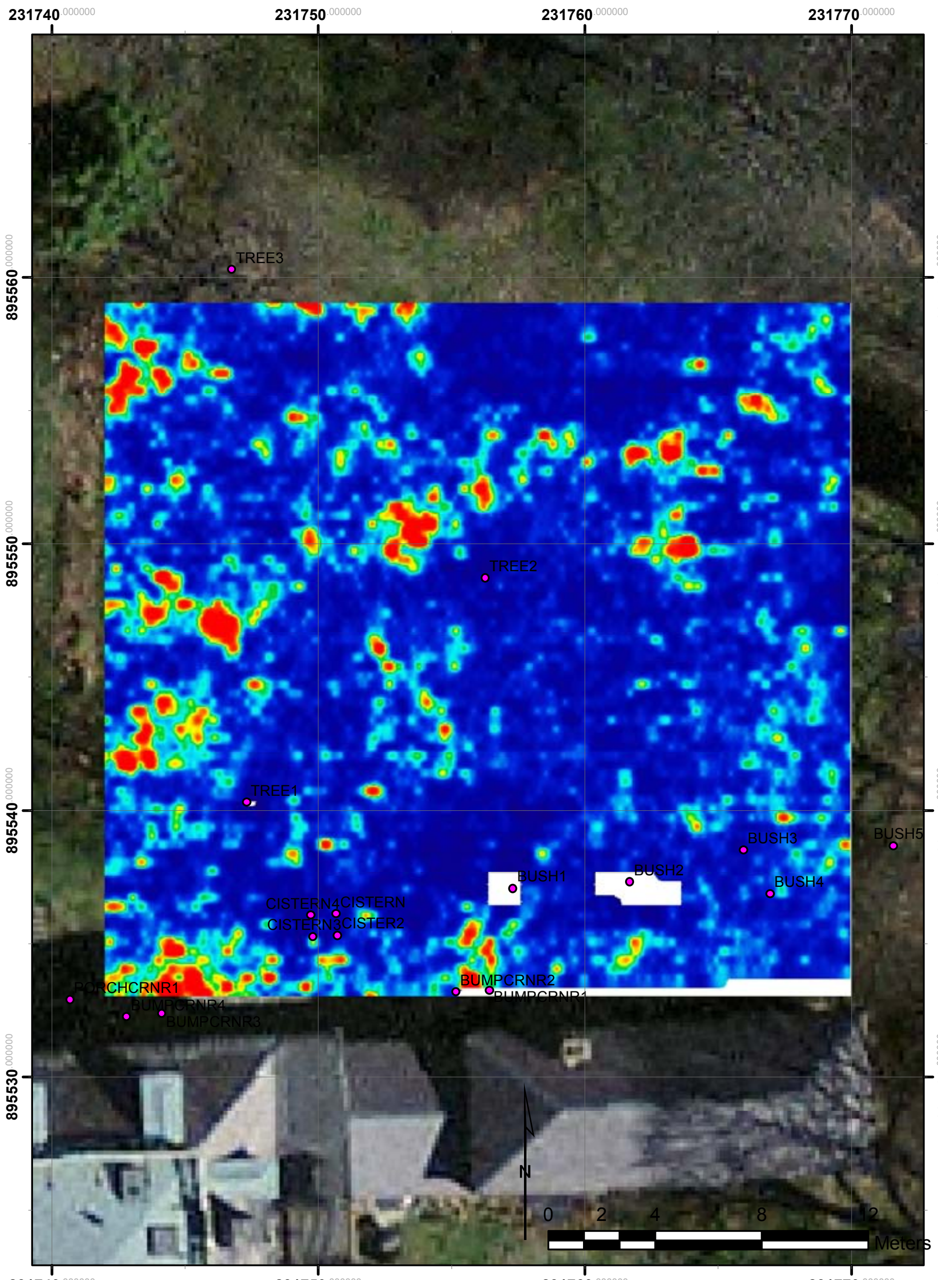

Figure 36. GPR slice of 280-290 cm bgs

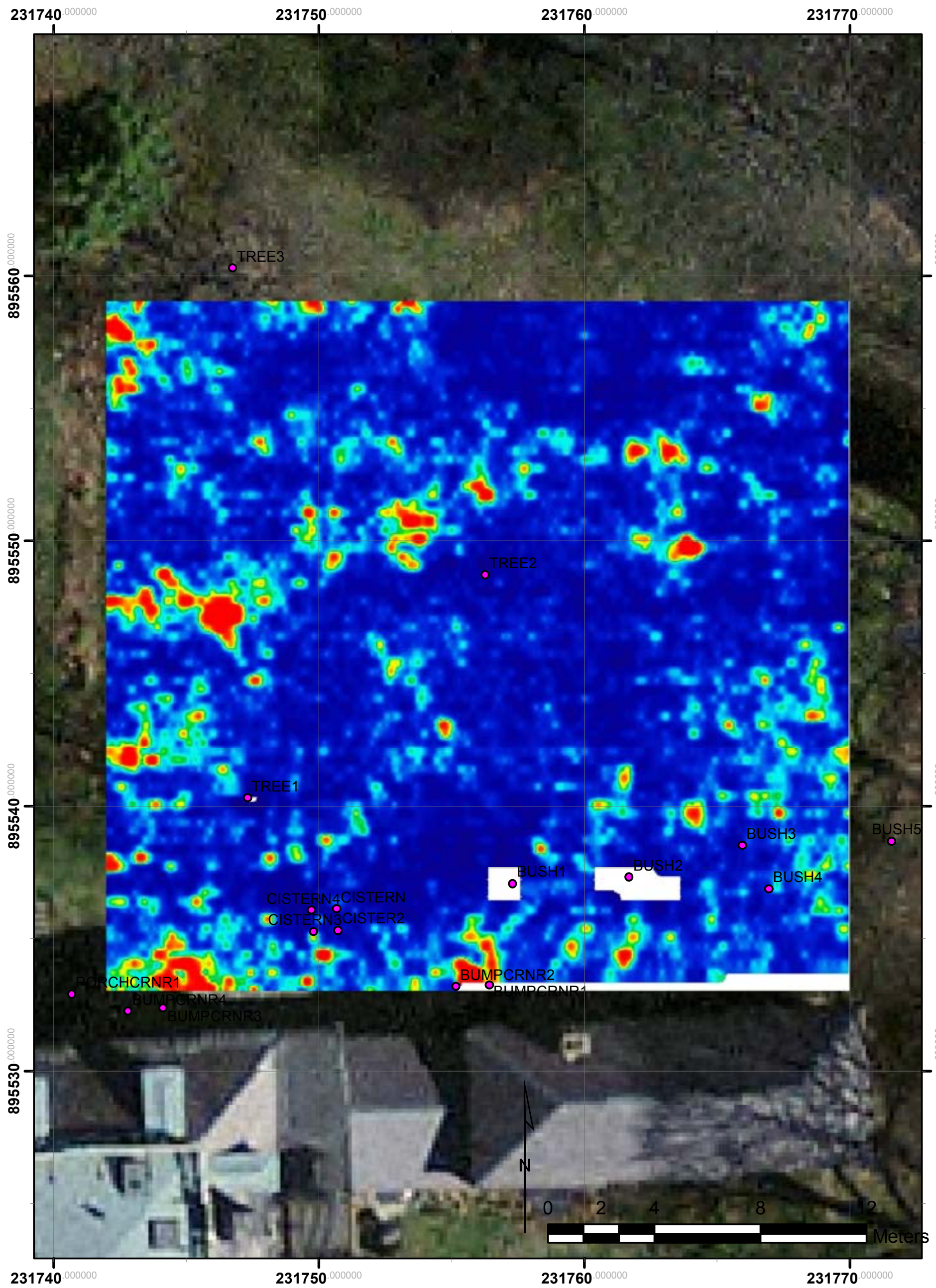

Figure 37. GPR slice of 290-300 cm bgs. Note the east-west line noise in the areas without strong reflectors.

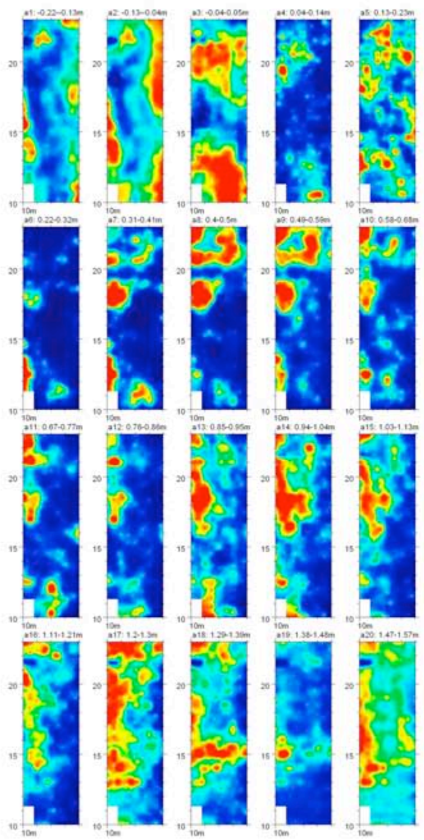

Figure 38. GPR slices from 500 MHz antenna of strip of backyard at 428 Thames, Newport RI. The well is centered on E11, N18. The well signature starts to appear in the 4-14 cm bgs slice (a4) and continues strongly through 120-130 cm bgs (a17).

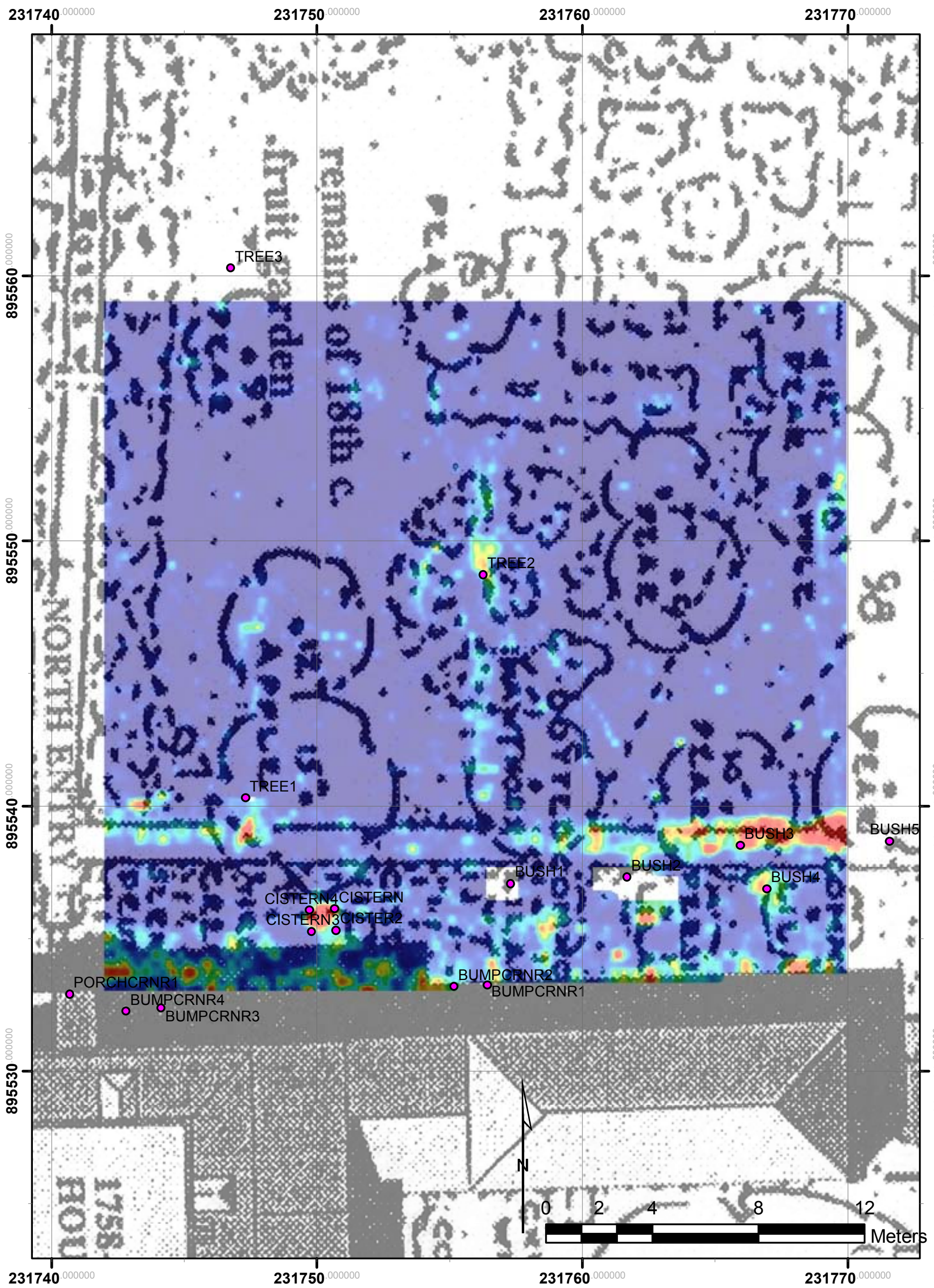

Figure 39. GPR 10-20 cm bgs slice with 1937 HABS map. The HABS map is in black and white, the GPR slice is blue to red, with strong reflectors in red.

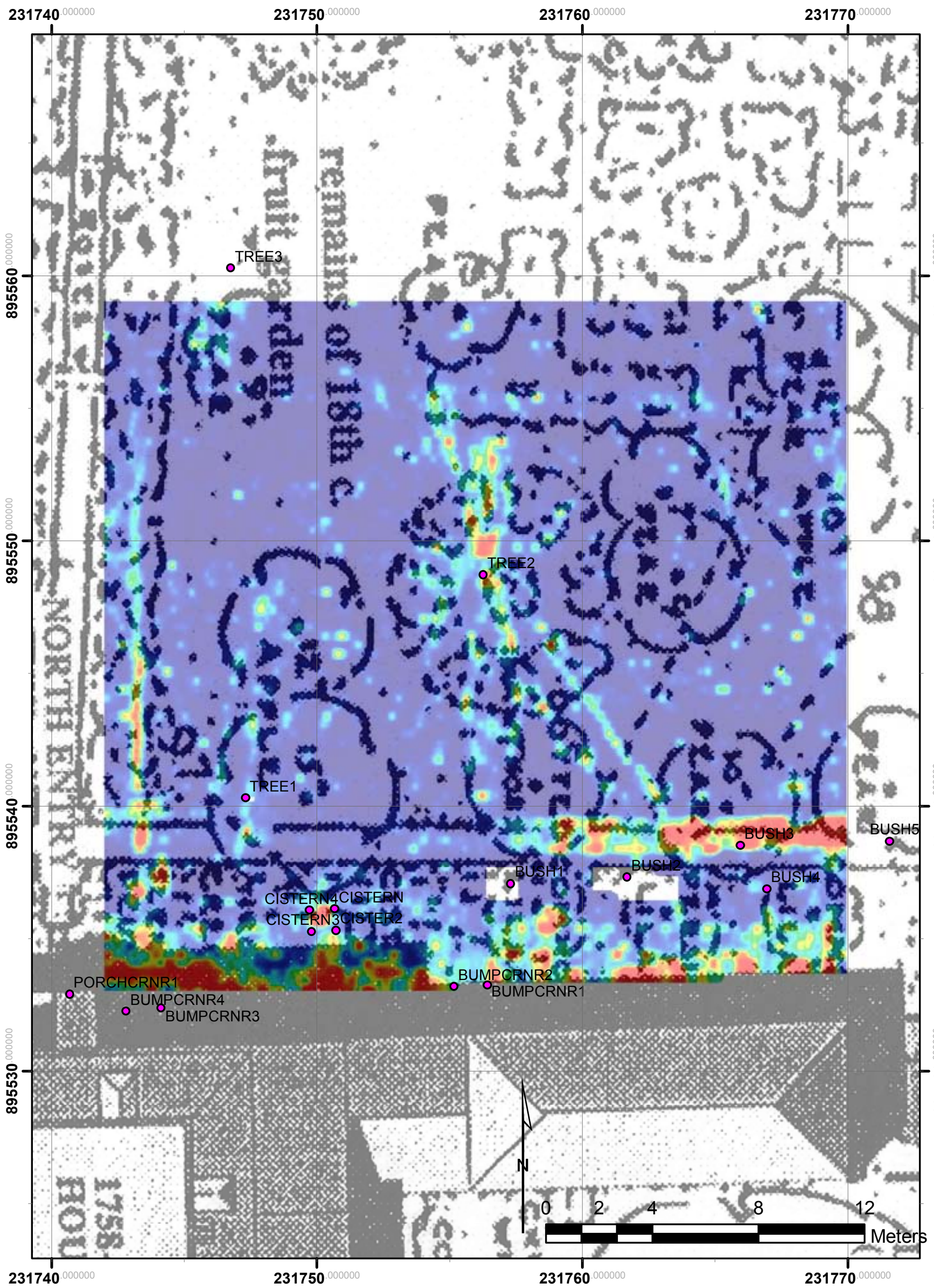

Figure 40. GPR 20-30 cm bgs slice with 1937 HABS map. The HABS map is in black and white, the GPR slice is blue to red, with strong reflectors in red.

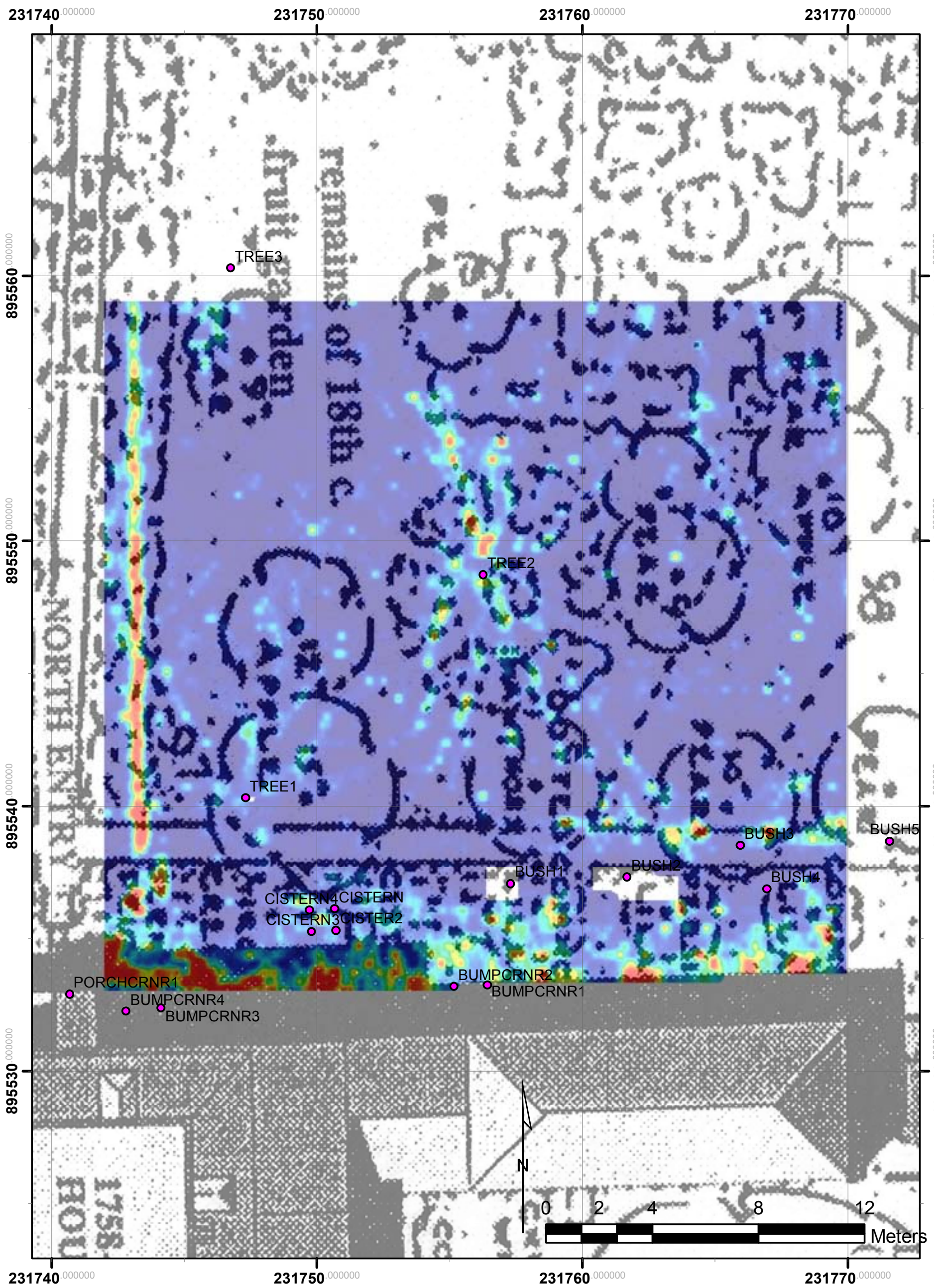

Figure 41. GPR 30-40 cm bgs slice with 1937 HABS map. The HABS map is in black and white, the GPR slice is blue to red, with strong reflectors in red.

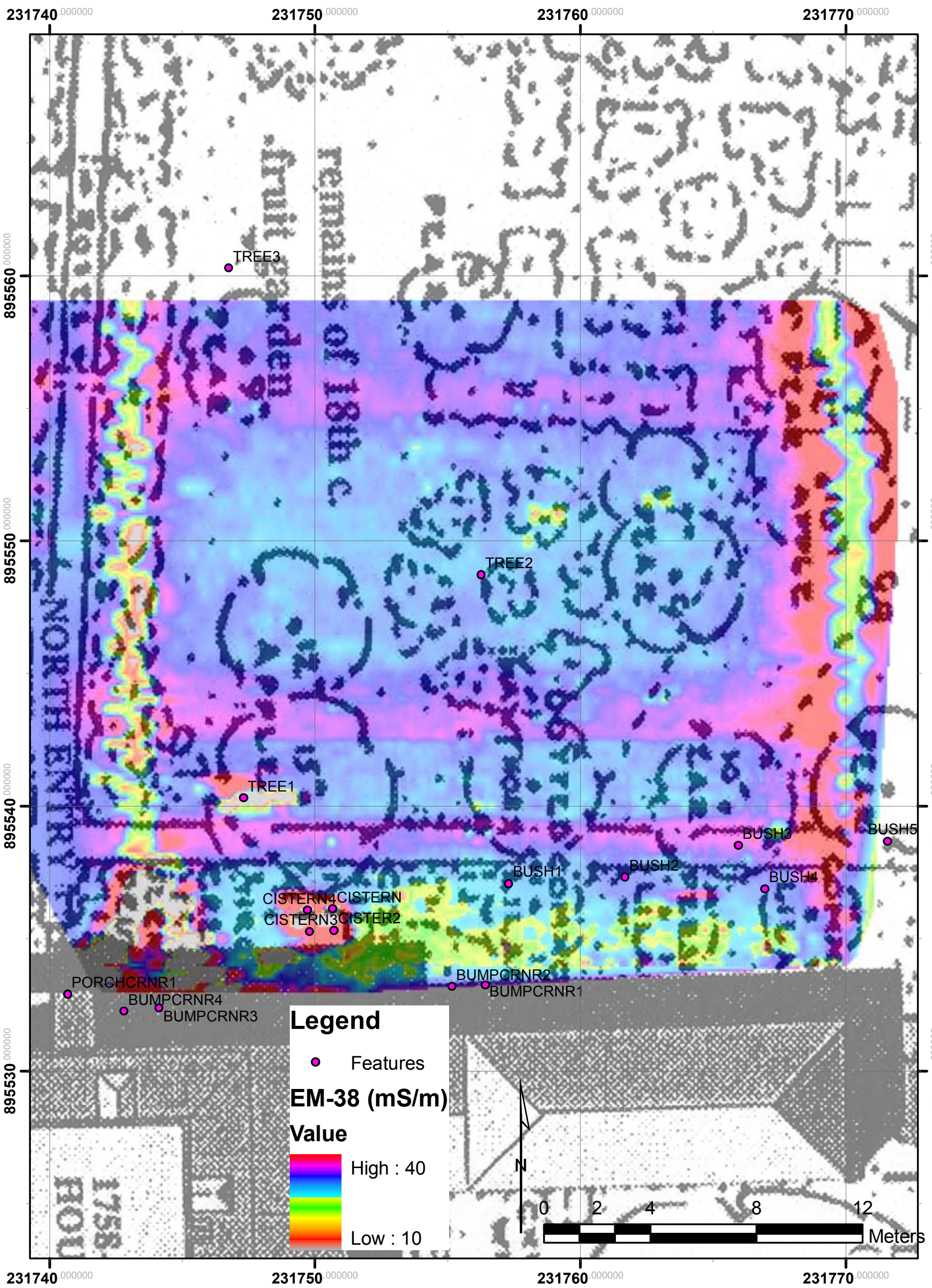

Figure 42. EM-38 interpolated image superimposed under 1937 HABS map. The HABS map is in black and white. More conductive is depicted in red and yellow.

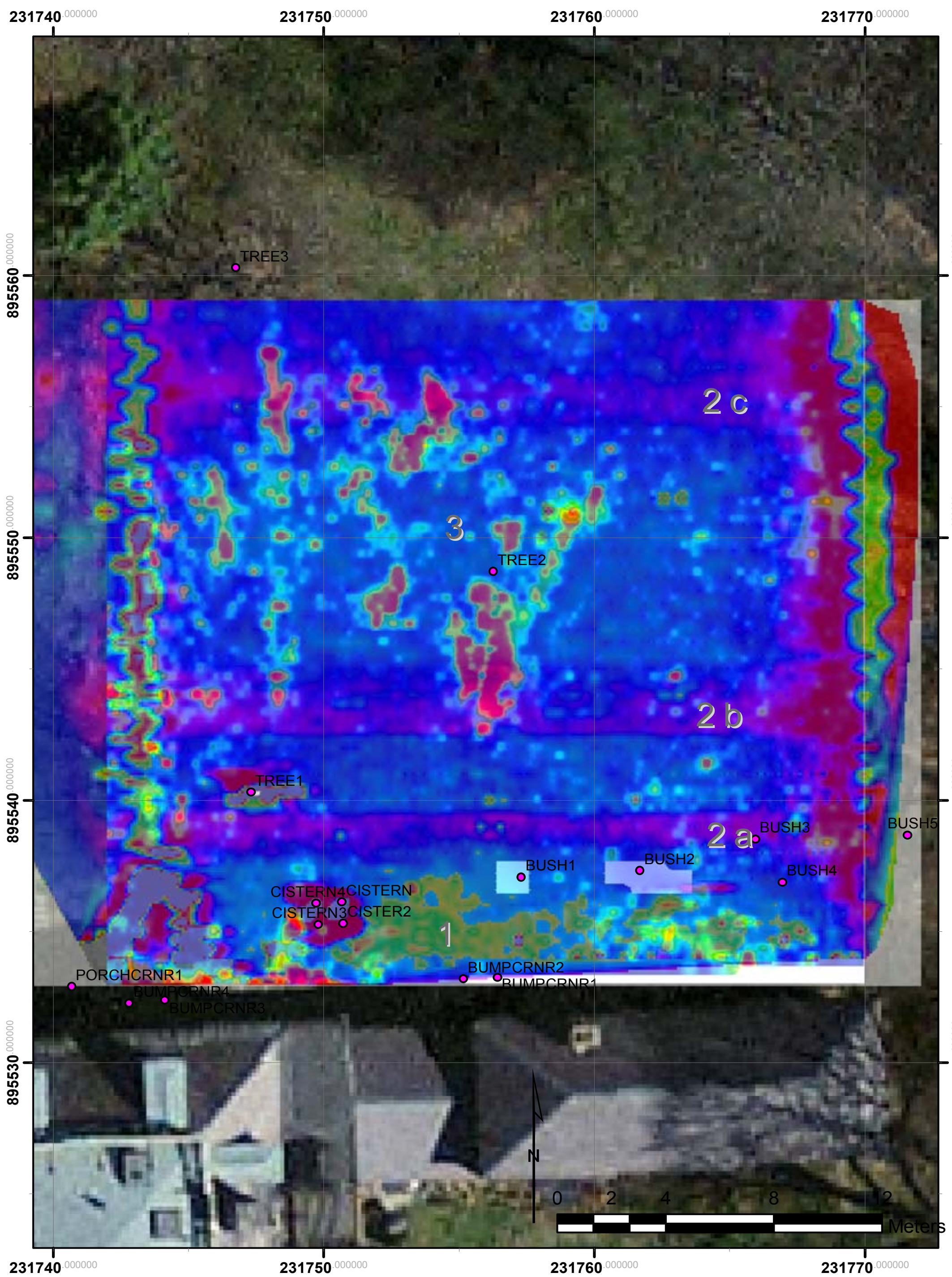

Figure 43. Anomaly 1 (builders trench), Anomaly 2 (garden paths), and Anomaly 3 (possible house foundation) are labeled on the air photo. Underneath the labels is the EM-38 map as well as the 110-120 cm bgs GPR slice.

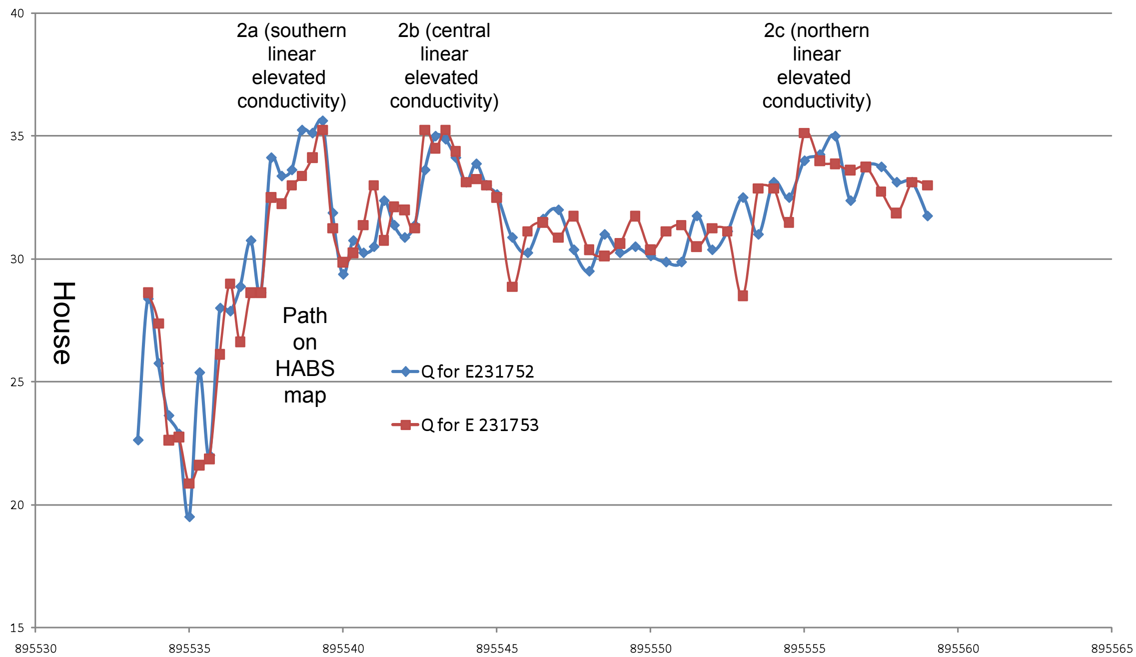

Figure 44. Profile of EM-38 readings along E752 & E753 running perpendicular to transects as collected.

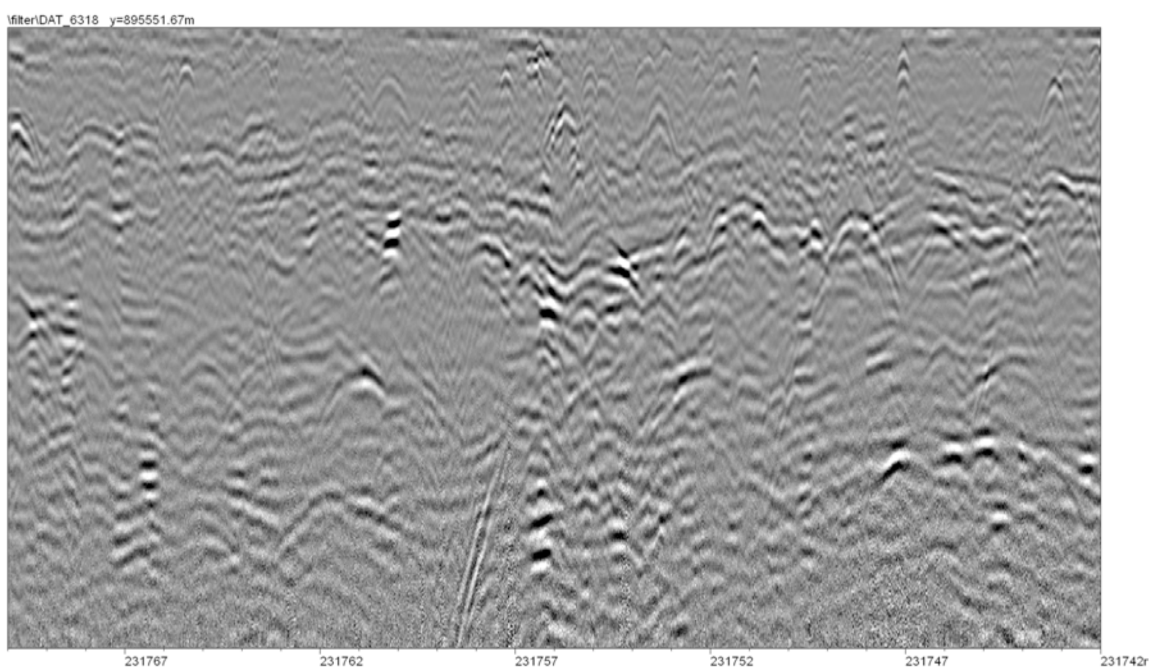

Figure 45. GPR radargram of transect N551.67

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Appendix 1: Survey points

Shot Order	Name	Grid Northing (m)	Grid Easting (m)	Elevation (m)	Code	Note	Usable for topo
1	ARBOR-GPS	895561.056	231737.8	19.016	GPS	POINTY TIP 3.5CM ADJUSTED	No
2	BACKSTUMP-GPS	895573.36	231774.152	19.83	GPS		No
3	050310 BASE1	895549.121	231749.558	20.165	OCCUPIED	ARBOR-GPS + BACKSTUMP-GPS	No
4	ARBOR	895561.052	231737.784	19.011	2NDY_BENCH		No
5	BACKSTUMP	895573.365	231774.162	19.837	2NDY_BENCH		No
6	050310 BASE2	895549.125	231749.544	20.165	OCCUPIED	ARBOR + BACKSTUMP	No
7	CISTERN_SW	895535.469	231750.016	19.6	2NDY_BENCH		No
8	050310 SWGRIDCORNR	895533	231742	0	IDEAL		No
9	050310 Grid1	895533	231742	0	IDEAL		No
10	050310 Grid1_stk	895533.004	231741.99	20.079	GRID	Not for topo	No
11	050310 Grid2	895533	231752	0	IDEAL		No
12	050310 Grid2_stk	895532.995	231751.995	19.633	GRID	Not for topo	No
13	050310 Grid4	895534	231752	0	IDEAL		No
14	050310 Grid4_stk	895534.007	231751.997	19.571	GRID	Not for topo	No
15	050310 Grid7	895534	231772	0	IDEAL		No
16	050310 Grid7_stk	895534.004	231771.998	19.277	GRID	Not for topo	No
17	050310 Grid8	895559	231742	0	IDEAL		No
18	050310 Grid8_stk	895559.004	231742	18.968	GRID	Not for topo	No
19	050310 Grid9	895559	231752	0	IDEAL		No
20	050310 Grid9_stk	895559.002	231751.998	19.078	GRID	Not for	No

						topo	
21	050310 Grid10	895559	231762	0	IDEAL		No
22	050310 Grid10_stk	895558.995	231762.003	19.241	GRID	Not for topo	No
23	050310 Grid11	895559	231769	0	IDEAL		No
24	050310 Grid11_stk	895558.99	231768.999	19.425	GRID	Not for topo	No
25	050310 Grid12	895559	231772	0	IDEAL		No
26	050310 Grid12_stk	895558.995	231772.009	19.526	GRID	Not for topo	No
27	050310 CHECKTOPO1	895561.066	231737.788	19.045	CHECKPT		Yes
28	050310 HOUSE1	895531.134	231731.993	20.009	ARCHITEC	NW Corner of house	Yes
29	050310 HOUSE2	895531.539	231738.004	20.1	ARCHITEC		Yes
30	050310 HOUSE3	895531.734	231740.787	20.147	ARCHITEC		Yes
31	050310 HOUSE4	895532.148	231748.863	19.905	ARCHITEC		Yes
32	050310 HOUSE5	895532.495	231754.774	19.373	ARCHITEC		Yes
33	050310 HOUSE6	895532.884	231761.209	19.314	ARCHITEC		Yes
34	050310 HOUSE7	895533.322	231769.079	19.308	ARCHITEC	NE Corner of house	Yes
35	050310 TOPO004	895532.134	231740.984	20.121	TOPO		Yes
36	050310 TOPO005	895533.204	231740.878	20.119	TOPO		Yes
37	050310 TOPO006	895534.347	231740.849	20.05	TOPO		Yes
38	050310 TOPO007	895535.61	231740.825	19.897	TOPO		Yes
39	050310 TOPO008	895536.927	231740.737	19.507	TOPO		Yes
40	050310 TOPO009	895538.445	231740.593	19.211	TOPO		Yes
41	050310 TOPO010	895539.718	231740.634	19.144	TOPO		Yes
42	050310 TOPO011	895540.039	231740.634	19.085	TOPO		Yes
43	050310 TOPO012	895540.046	231741.939	19.159	TOPO		Yes
44	050310 TOPO013	895538.338	231741.904	19.228	TOPO		Yes
45	050310 TOPO014	895536.988	231741.957	19.485	TOPO		Yes
46	050310 TOPO015	895535.773	231742.015	19.866	TOPO		Yes
47	050310 TOPO016	895534.455	231742.162	20.017	TOPO		Yes
48	050310 TOPO017	895533.153	231742.108	20.113	TOPO		Yes
49	050310 TOPO018	895532.009	231742.229	20.126	TOPO		Yes
50	050310 TOPO019	895532.404	231743.128	20.103	TOPO		Yes
51	050310 TOPO020	895533.338	231743.161	20.119	TOPO		Yes
52	050310 TOPO021	895534.307	231743.128	20.029	TOPO		Yes

53	050310	TOPO022	895535.282	231743.142	19.975	TOPO	Yes
54	050310	TOPO023	895536.149	231743.103	19.741	TOPO	Yes
55	050310	TOPO024	895536.951	231743.055	19.481	TOPO	Yes
56	050310	TOPO025	895538.062	231743.122	19.284	TOPO	Yes
57	050310	TOPO026	895539.858	231743.403	19.24	TOPO	Yes
58	050310	TOPO027	895539.907	231744.409	19.247	TOPO	Yes
59	050310	TOPO028	895538.721	231744.531	19.222	TOPO	Yes
60	050310	TOPO029	895536.633	231744.362	19.591	TOPO	Yes
61	050310	TOPO030	895537.449	231744.414	19.383	TOPO	Yes
62	050310	TOPO031	895535.83	231744.426	19.841	TOPO	Yes
63	050310	TOPO032	895535.119	231744.521	19.974	TOPO	Yes
64	050310	TOPO033	895533.992	231744.794	20.032	TOPO	Yes
65	050310	TOPO034	895532.668	231744.849	20.114	TOPO	Yes
66	050310	TOPO035	895532.856	231746.726	20.013	TOPO	Yes
67	050310	TOPO036	895534.118	231746.767	19.94	TOPO	Yes
68	050310	TOPO037	895535.35	231746.934	19.897	TOPO	Yes
69	050310	TOPO038	895536.388	231747.11	19.703	TOPO	Yes
70	050310	TOPO039	895537.349	231747.324	19.418	TOPO	Yes
71	050310	TOPO040	895538.271	231747.48	19.252	TOPO	Yes
72	050310	TOPO041	895539.23	231747.797	19.282	TOPO	Yes
73	050310	TOPO042	895540.697	231748.16	19.262	TOPO	Yes
74	050310	TOPO043	895540.834	231746.264	19.205	TOPO	Yes
75	050310	TOPO044	895539.735	231746.12	19.258	TOPO	Yes
76	050310	TOPO045	895538.633	231745.871	19.222	TOPO	Yes
77	050310	TOPO046	895537.541	231745.652	19.378	TOPO	Yes
78	050310	TOPO047	895536.461	231745.781	19.681	TOPO	Yes
79	050310	TOPO048	895535.352	231745.656	19.949	TOPO	Yes
80	050310	TOPO049	895533.886	231745.601	20.009	TOPO	Yes
81	050310	TOPO050	895532.812	231748.804	19.939	TOPO	Yes
82	050310	TOPO051	895533.916	231748.725	19.857	TOPO	Yes
83	050310	TOPO052	895534.893	231748.655	19.799	TOPO	Yes
84	050310	TOPO053	895536.168	231748.76	19.621	TOPO	Yes
85	050310	TOPO054	895537.085	231748.904	19.397	TOPO	Yes
86	050310	TOPO055	895537.081	231748.902	19.396	TOPO	Yes
87	050310	TOPO056	895538.112	231749.033	19.225	TOPO	Yes
88	050310	TOPO057	895539.218	231749.175	19.217	TOPO	Yes
89	050310	TOPO058	895540.503	231749.346	19.241	TOPO	Yes
90	050310	TOPO059	895540.563	231750.56	19.192	TOPO	Yes
91	050310	TOPO060	895539.419	231750.674	19.185	TOPO	Yes
92	050310	TOPO061	895537.447	231750.7	19.349	TOPO	Yes
93	050310	TOPO062	895535.617	231750.864	19.549	TOPO	Yes
94	050310	TOPO063	895533.835	231750.981	19.677	TOPO	Yes
95	050310	TOPO064	895532.572	231751.219	19.742	TOPO	Yes
96	050310	TOPO065	895532.726	231752.958	19.595	TOPO	Yes
97	050310	TOPO066	895534.984	231752.943	19.457	TOPO	Yes
98	050310	TOPO067	895536.812	231753.034	19.338	TOPO	Yes
99	050310	TOPO068	895539.063	231753.365	19.197	TOPO	Yes
100	050310	TOPO069	895540.49	231753.668	19.156	TOPO	Yes
101	050310	TOPO070	895540.026	231755.041	19.218	TOPO	Yes

102	050310 TOPO071	895538.254	231755.083	19.31	TOPO		Yes
103	050310 TOPO072	895536.201	231755.111	19.363	TOPO		Yes
104	050310 TOPO073	895533.989	231755.371	19.376	TOPO		Yes
105	050310 TOPO074	895533.679	231757.112	19.321	TOPO		Yes
106	050310 TOPO075	895536.301	231760.018	19.209	TOPO		Yes
107	050310 TOPO076	895537.864	231765.345	19.334	TOPO		Yes
108	050310 TOPO077	895536.847	231770.296	19.295	TOPO		Yes
109	050310 TOPO078	895535.435	231773.174	19.377	TOPO		Yes
110	050310 TOPO079	895539.842	231769.022	19.364	TOPO		Yes
111	050310 TOPO080	895540.026	231764.684	19.326	TOPO		Yes
112	050310 TOPO081	895539.974	231759.994	19.239	TOPO		Yes
113	050310 TOPO082	895545.061	231760.085	19.201	TOPO		Yes
114	050310 TOPO083	895545.404	231755.794	19.135	TOPO		Yes
115	050310 TOPO084	895545.718	231749.884	19.1	TOPO		Yes
116	050310 TOPO085	895545.976	231742.089	19.01	TOPO		Yes
117	050310 TOPO086	895549.432	231742.122	19.011	TOPO		Yes
118	050310 TOPO087	895549.672	231745.583	18.973	TOPO		Yes
119	050310 TOPO088	895545.384	231746.052	19.052	TOPO		Yes
120	050310 TOPO089	895550.15	231754.319	19.057	TOPO		Yes
121	050310 TOPO090	895550.104	231759.892	19.215	TOPO		Yes
122	050310 TOPO091	895550.077	231765.627	19.343	TOPO		Yes
123	050310 TOPO092	895550.04	231769.745	19.46	TOPO		Yes
124	050310 TOPO093	895555.021	231769.895	19.462	TOPO		Yes
125	050310 TOPO094	895554.879	231765.057	19.362	TOPO		Yes
126	050310 TOPO095	895555.122	231760.049	19.211	TOPO		Yes
127	050310 TOPO096	895555.596	231756.262	19.156	TOPO		Yes
128	050310 TOPO097	895554.72	231749.866	19.026	TOPO		Yes
129	050310 TOPO098	895554.785	231746.428	18.999	TOPO		Yes
130	050310 TOPO099	895554.833	231742.151	18.971	TOPO		Yes
131	050310 TOPO100	895558.984	231742.11	19.008	TOPO		Yes
132	050310 TOPO101	895559.202	231745.554	19.006	TOPO		Yes
133	050310 TOPO102	895559.064	231749.828	19.037	TOPO		Yes
134	050310 TOPO103	895558.973	231755.152	19.136	TOPO		Yes
135	050310 TOPO104	895558.999	231760.111	19.213	TOPO		Yes
136	050310 TOPO105	895559.054	231764.088	19.294	TOPO		Yes
137	050310 TOPO106	895558.993	231769.918	19.452	TOPO		Yes
138	050310 TOPO107	895545.965	231765.292	19.324	TOPO		Yes
139	050310 TOPO108	895545.795	231769.956	19.416	TOPO		Yes
140	0310 CISTERNPADCRNR1	895536.12	231750.675	19.583	ARCH ITEC		Yes
141	0310 CISTERNPADCRNR2	895535.314	231750.729	19.608	ARCH ITEC		Yes
142	0310 CISTERNPADCRNR3	895535.262	231749.806	19.626	ARCH ITEC		Yes
143	0310 CISTERNPADCRNR4	895536.062	231749.73	19.601	ARCH ITEC		Yes
144	050310 BUMPCRNR1	895533.246	231756.422	19.374	MISC	Bump 1 E Corner	Yes
145	050310	895533.189	231755.167	19.371	MISC	Bump	Yes

	BUMPCRNR2					1 W Corner	
146	050310 BUMPCRNR3	895532.378	231744.133	20.198	MISC	Bump 2 E Corner	Yes
147	050310 BUMPCRNR4	895532.252	231742.81	20.239	MISC	Bump 2 W Corner	Yes
148	050310 PORCHCRNR1	895532.897	231740.693	20.085	MISC	NE corner of porch	Yes
149	050310 PORCHCRNR2	895532.732	231737.958	20.111	MISC	NW corner of porch	Yes
150	050310 BUMPCRNR5	895531.942	231735.504	20.111	MISC	Bump 3 E Corner	Yes
151	050310 BUMPCRNR6	895531.858	231733.978	20.116	MISC	Bump 3 W Corner	Yes
152	050310 TREE1	895540.301	231747.312	19.335	MISC		Yes
153	050310 TREE2	895548.71	231756.27	19.224	MISC		Yes
154	050310 TREE3	895560.269	231746.754	19.109	MISC		Yes
155	050310 BUSH1	895537.073	231757.312	19.326	MISC		Yes
156	050310 BUSH2	895537.314	231761.697	19.321	MISC		Yes
157	050310 BUSH3	895538.51	231765.954	19.416	MISC		Yes
158	050310 BUSH4	895536.87	231766.949	19.396	MISC		Yes
159	050310 BUSH5	895538.666	231771.578	19.413	MISC		Yes