Report On The Ground Penetrating Radar Study of Slaves Burying Ground for The Oysterponds Historical Society

Introduction

On Saturday September 9th, 2020 Christine Saturno and I arrived at Orient, NY to conduct a Ground Penetrating Radar (GPR) survey of the Slaves Burying Ground. We timed the survey to coincide with a dry day following a primarily dry week, and began the survey at 11:30 AM, just before low tide in an effort to ensure that the groundwater table was as low as possible so as to maximize the depth of the radar penetration. The Surficial Geologic Map of New York for the Lower Hudson Region (Cadwell et al., 1986) shows the study location contains "glacial outwash" in front of the Harbor Hill moraine. This environment would have been rivers of water melting out of the front of the glacier bringing with them and depositing large quantities of sediment. This is consistent with all other geological reports on the area and indicates that we should expect sorted and layered sand and gravel below the surface. This material would be ideal for GPR surveying provided that it is not saturated with water. The study location is up on a small promontory surrounded by coastal wetland on three sides which would suggest that it is a residual natural landform like the other promontories along the shoreline of Long Beach Bay cut by stream processes when sea level was lower and eroded by subsequent sea level rise.

The orientation of the cemetery is NW-SE (Figure 1), so for simplicity throughout this report we will refer to our *grid* orientation as if the gate to the cemetery is in the *western* wall, and that the two prominent monuments (Maria Tuthill – 1840 & Seth Tuthill – 1850) face east. Our initial measurements of the enclosure show that the west, north, and east walls are 14.8 m long and the south wall is 15.2 m long along the inside. The low rock wall itself is composed of quarried arkose blocks (a type of sandstone) that appear to be the same variety from the Newark basin that were used to build "brownstone" buildings in New York City.

We set up our survey grid as a 12 X 12 m grid with the origin 1.8 m from the west wall and 1.8 m from the south wall, so that we had enough room between the edge of the grid and the walls to maneuver the GPR. In our grid the "Y" axis goes from west to east and the "X" axis goes from south to north (Figure 2). The individual lines for this grid are numbered in sequence, so for example the first line we surveyed in the grid was "y0" which ran south to north on the east side of the Tuthill's monuments, and the second line was "y1" which was parallel to y0, but 0.5 m east and ran just to the west of the Tuthill's footstones. Our third line "y2" was again parallel to the others, but 0.5 m from y1 and ran just to the east of the Tuthill's footstones. The eastern most line in the grid is therefore y24 (12 m east of the first line). These numbers are shown on all GPR *grid* cross-sections so that they can be correctly oriented.

The GPR we used is a Sensors & Software Noggin with external Global Position System (GPS) and propelled on a cart. Our first survey action was to cover the grid at 0.5 m line spacing using our 250 MHz antenna set to read to a depth of 3.0 m (9.84 feet). This allowed us to generate a 3D depth model through which we could take 10 cm depth slices in map view. During this survey we also recorded a digital flag on our line whenever the transect passed just to the east of a monument or marker stone in the field, so that we could later determine if there were any specific anomalies associated with the monuments or marker stones. Once we had completed the grid we also ran the GPR across single lines between the outside of the grid and the inside of the wall for all for sides. GPR cross-sections done

outside the grid are simply labeled “Line 1” – “Line 4” (Figure 1). On the west side this line (Line 1) passed behind the monuments for the Tuthills, and the location of the monuments were again digitally flagged. Once this was completed we ran one long line from the inside of the east wall (Line 5, which begins grid line x3 in reverse), through the gate and down the path to the edge of Narrow River Road (Figures 1 & 3). Finally we switched our antenna to the 500 MHz unit which would give us higher resolution results, but cannot penetrate as deep into the ground. We set it to record down to 2 m depth (6.56 ft) and re-surveyed several of the south-north (y) grid lines to give us more contrast at burial depths. Lines from the 500 MHz survey are labelled as Lines 6-16, but will be referenced to using their corresponding survey grid line designations in “y-axis” coordinates (Figure 4).

Results

Overview

The first critical result is that ground between the surface and 3 m depth contains two distinctive units (Figure 3). The upper until from the surface to about 1 m depth (~3 feet) does not appear to be the glacial outwash we were expecting, but rather what I would call a more “massive” (meaning not layered) sediment – probably sand. Within this top layer the GPR picked up many “reflectors” which are buried objects somewhat larger than the background sediment grain size. These can be seen in the radar readouts as downward opening parabola with the depth of the object being measured at the very top of the parabola (Figure 5). The widths of the parabola ***do not*** indicate the size of the object, but rather the velocity that the radio wave is traveling trough the ground. (You will notice that the geometry of the parabola are all the same meaning that the density of the soil is consistent throughout this top layer.) Most of these reflectors are consistent with stones and are generally between the surface to about 0.5 m (~1.5 feet) deep. There is one reflector however, that is more consistent with being metal objects on line x23 (x=11.5 m) at y=7.9 m and is probably just below the surface (Figure 6). I saw this in the GPR survey on the day of the survey but did not see anything immediately obvious at that location.

A second critical result is that the thickness of this upper sedimentary unit changes just outside the burial ground encloser. An examination of Line 5 (Figures 1&3) shows that it is a little more than a meter (~3+ feet) within the enclosure but west of the gate the land surface drops down and just a few meters past the gate towards the road the lower unit is only about 0.5 meters below the surface. It gets a little thicker again near the road and at about 3 meters from the road (~10 feet) everything becomes obscured likely by road engineering. The fact that the Burying Ground enclosure is the high point and that the upper unit is thickest there strengthens that hypothesis that it is built up artificially, not just covered in wind-blown sand.

A third observation, and this one comes from the 3D grid, is that the groundwater table is apparent at a depth of about 2.2 m (7.2 ft) at the very northeastern corner and slopes downward to the southwest to below the 3m detection level where the grid is red in Figure 7. You can see the effect of the ground water on the returning deep radar signal when comparing the bottoms of lines x0 (mostly above the groundwater on the right side) with x24 (groundwater higher on the right side washing out the signal). This adds strength to the hypothesis that the field was perhaps built up to make it drier. The

oldest map I could locate quickly was surveyed in 1903 (Figure 8) and does show this promontory sticking out into the wetland.

Fourth, (from the 3D grid) there are several shallow (less ~0.5 meters or less) clusters of buried gravel or stone, mostly running east-west in ~2 m long linear trends about 0.25 - 0.5 m wide. (Figure 2). They show up in the radar cross-sections as strong clusters of reflectors and partly obscure the sediments below them. I don't believe they cover burial sites, however I'm not entirely sure why they should be so strongly oriented with walls of the cemetery if they are indeed natural clusters.

Potential for Burials

There is no direct evidence of any sort of casket or remains in the radar results, however that is expected in burials of this age. Any non-metallic material that was buried has since mostly decomposed and would appear to the radar to be no different than the surrounding sediments. What we would expect to see is a disturbance in the natural stratigraphy (sediment layers) where a hole has been dug and backfilled. The massive upper unit now presents a problem in that it does not have any observable layering in it, so it is nearly impossible to tell if a hole has been dug, therefore we must carefully examine the lower unit in the hopes that any burial would be deep enough to cut into it. In most places at this site that requires a depth of greater than 1.2 – 1.4 m (4.0 – 4.6 ft). Modern burials are 1.5 – 1.8 m (5.0 – 6.0 ft). Anther indication of burial would be a layered mounding of back-fill within the grave that may be visible withing the massive upper unit or a monument (stone) buried above the body (which is not common but has been observed in some historical burials).

Let's first examine the area between the monuments for the Tuthills and their footstones, as these all appear to be period correct marble and so we would expect an undisturbed traditional period burial. This would include transects y0, and y1. Figure 9 is line y0 and y1 from 250 MHz antenna. The digital flags in y0 mark where the monuments for the Tuthills are just to the west of the GPR transect (1= Maria & 2=Seth). Line y0 does not really show an indication of ground disturbance associated with Maria as I can see what appears to be an undisturbed layer at 1.2 m depth, however I can see what appears to be disturbance down to 2 m associated with Seth. In line y1 the opposite is true as there appears to be a disturbance for Maria down to about 1.7 m and no disturbance for Seth down to 1.2 m. Figure 10 is a repeat of line y1 but with the 250 MHz result on top and the 500 MHz result on the bottom. This image shows that result more clearly but also indicates the possibility of an unmarked burial on the other side of Seth at the 7.5 m mark along line y1. There are other disturbances in the lower unit along line y1 at 3.5 m, 9.0 m, and 11.5 m. The 7.5 and 11.5 m disturbances are fairly prominent, but the 9.0 m disturbance isn't very large. The 3.5 m disturbance barley cuts into the lower unit at 1.2 m depth and is likely too shallow to be a burial.

The result from line y1 is repeated in line y2 (Figure 11) but again shows up better in the 500 MHz signal. Using a color filter on the 500 MHz readings from lines y1 and y2 (Figure 12) show these disturbances a little better even though y2 is beyond the footstones. Given that we really only need to focus between the depths between 1 and 2 m, let's investigate the rest of the detailed analysis using the 500 MHz results, for which we took two adjacent 0.5 meter transects between every row of stones (Figure 4). Lines y5 and y6 (Figure 13) show potential disturbances at about the 5 and 7 m marks. The cluster of shallow reflectors from 7.5-9.5 m are part of the largest reflector cluster at the site (Figure 2). Lines y10 and y11 (Figure 14) show a very weak potential for a shallow burial site at 5-5.5 m (I don't believe it is) and again a shielded signal under the reflector cluster at 8-8.5 m. Lines y14 and y15 are on

Figure 15. Line y15 shows a weak signal return at about 1.5-2.0 m and 11.5-12 m. At this point along the northern wall (at the 12 m mark there is a bush sticking out into our path that made surveying here a bit more difficult, plus we are starting to get into the area where groundwater is shallower at depth weakening our signal. I don't believe I see anything in these lines or line y19, y20, and y24 (Figures 16 & 17) that I would consider potential burial sites.

Conclusions

I think it's possible that the top 1-1.2 m of soil at this location is not natural and has been used to raise the site higher above the local groundwater table to provide a drier surface. If this is true, I can't speculate whether or not this was done specifically to provide a dry burial site or for some other origin like a building foundation or garden, however the 1904 map shows no structure directly associated with this property. I suspect the top layer is quite sandy and the lower layer below 1.2 m is the glacial outwash that is mapped as covering most of the area of Orient south of the Harbor Hill moraine that runs along the north shore. It is possible that the upper unit is natural and if it is sandy with a lack of structure then I suspect a shallow water depositional environment like a lake formed here sometime after the glacier but before sea-level rose.

I do believe that the graves of Maria and Seth Tuthill contain remains although I am more certain of Maria's grave than I am about Seth's. I don't see any pattern in the shallow reflectors that might indicate shallowly buried grave markers (Figure 18), however I think it's possible that there are other unmarked burials in the western area of the grid and specifically in the northwestern corner (Figure 19). I don't believe that there are any other potential burials at this site, but an investigation near the location of the metallic reflector might be worth doing even though I doubt that is marks a burial location (Figures 6 & 19). The unique soil stratigraphy makes it very difficult to spot soil disturbances, given the "massive" nature of the upper unit and the clusters of what I believe are stones in it.

I do not believe that the rocks currently used to signify unmarked graves across the property signify any known burials and were placed there as symbolic.

Dr. John A. Rayburn
Professor of Geology
SUNY New Paltz

September 21, 2020

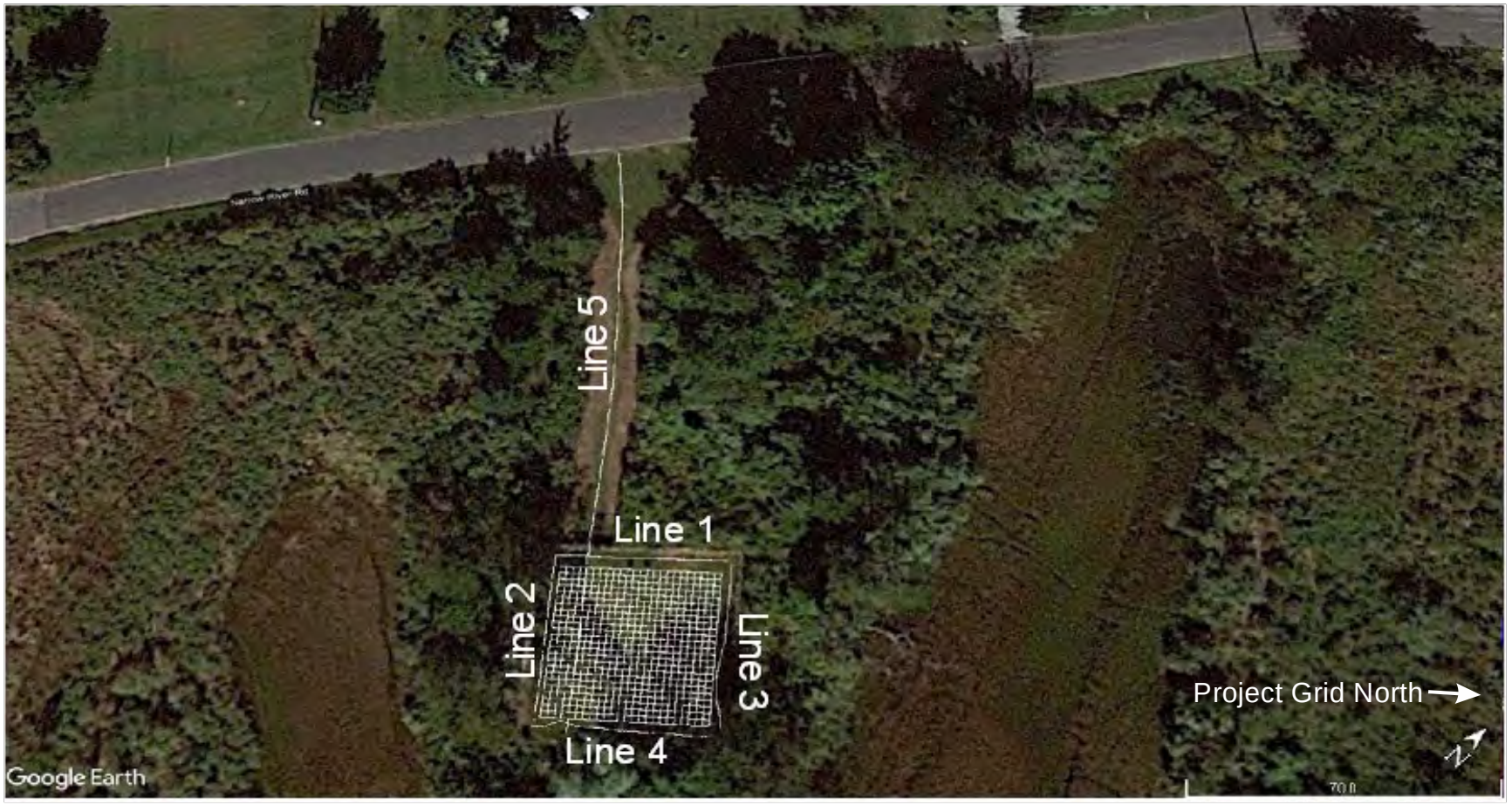

Figure 1. Orientation of the study site with 12 x 12 m grid and all other survey lines. For simplification I refer to *grid north* as towards the right of this photo and west towards the top. The 0,0 point of the grid would therefore be in the study defined "southwest" corner near the gate. Lines 1-4 were surveyed between the grid and the wall and line 5 was surveyed through the grid and along the path to the road.

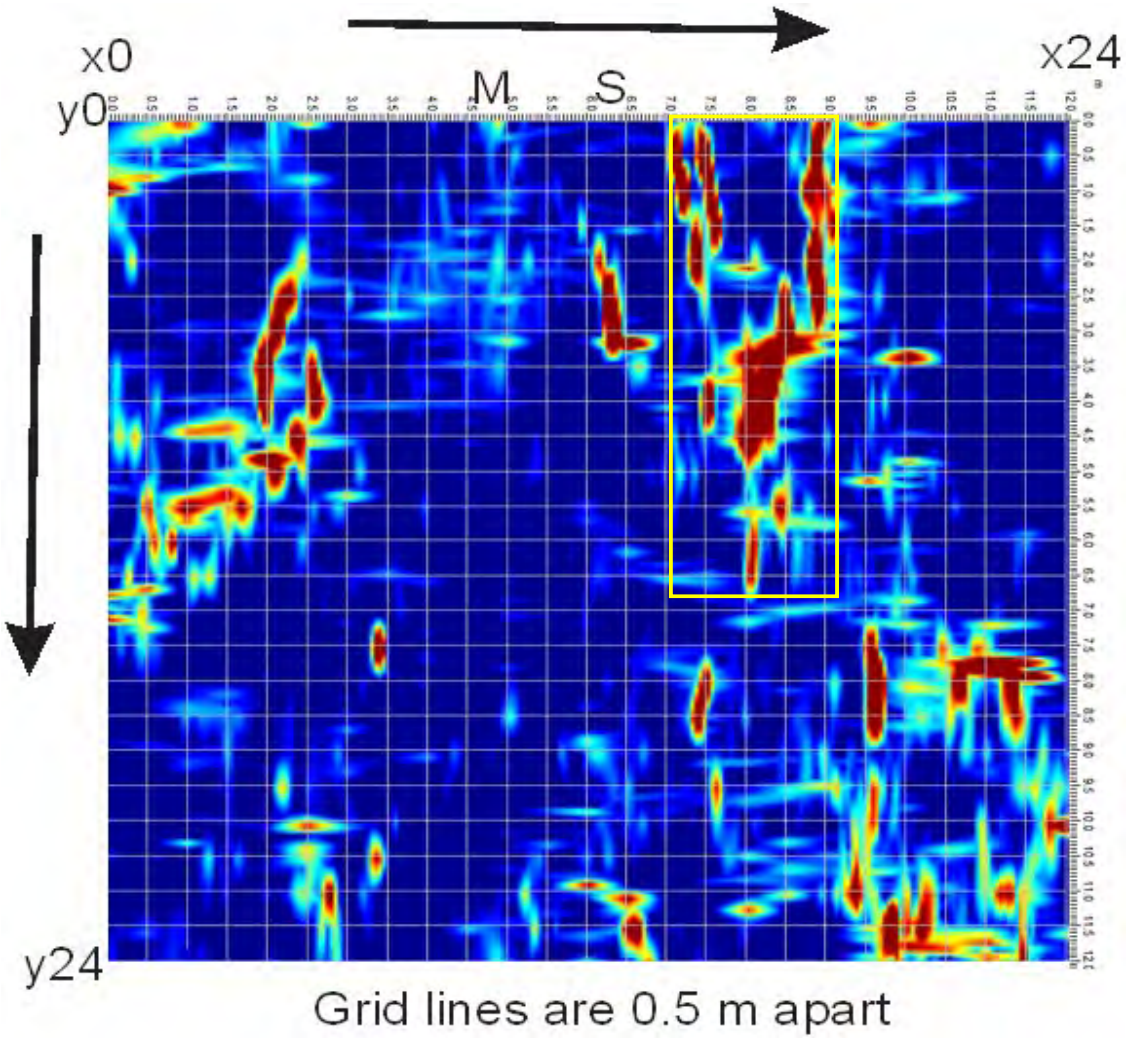

Figure 2. Layout of the 12x12 m grid with x increasing to the north and y increasing to the east. The origin 1.8 m from the west wall and 1.8 m from the south wall, so that we had enough room between the edge of the grid and the walls to maneuver the GPR. The location of Maria (M) and Seth (S) Tuthill's headstones are just off the grid on the west side. This is a 3D GPR depth slice showing the strength of "reflectors" (likely clusters of rocks) at 0.5 to 0.6 m (1.6 – 2.0 ft.) depth. The yellow box represents a cluster line discussed in Figure 13.

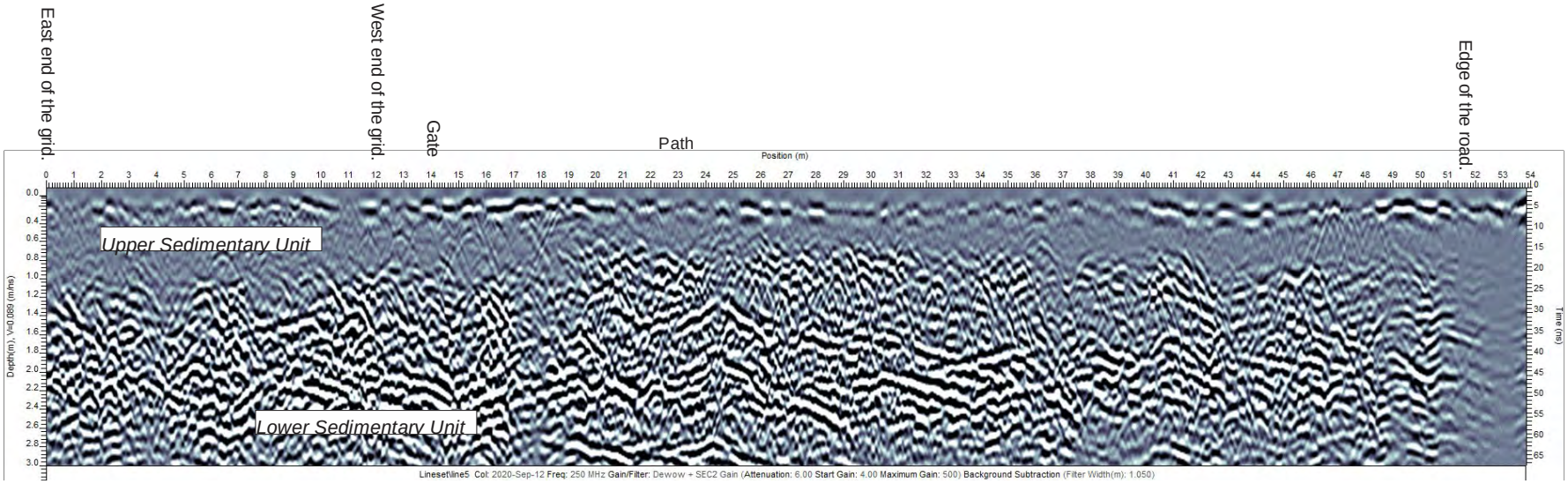

Figure 3. GPR line 5 surveyed with 250 MHz antana from the eastern end of the grid, through the gate, down the path and to the edge of the road. You can clearly see two distinctive sedimentary units. An upper "massive" (no sedimentary structures) unit that is more than a meter thick through the property, and where the path drops down in elevation thins to less than half a meter. The lower unit is likely "glacial outwash" with is mostly sand and gravel melted out of the front of the glacier and deposited by streams or rivers.

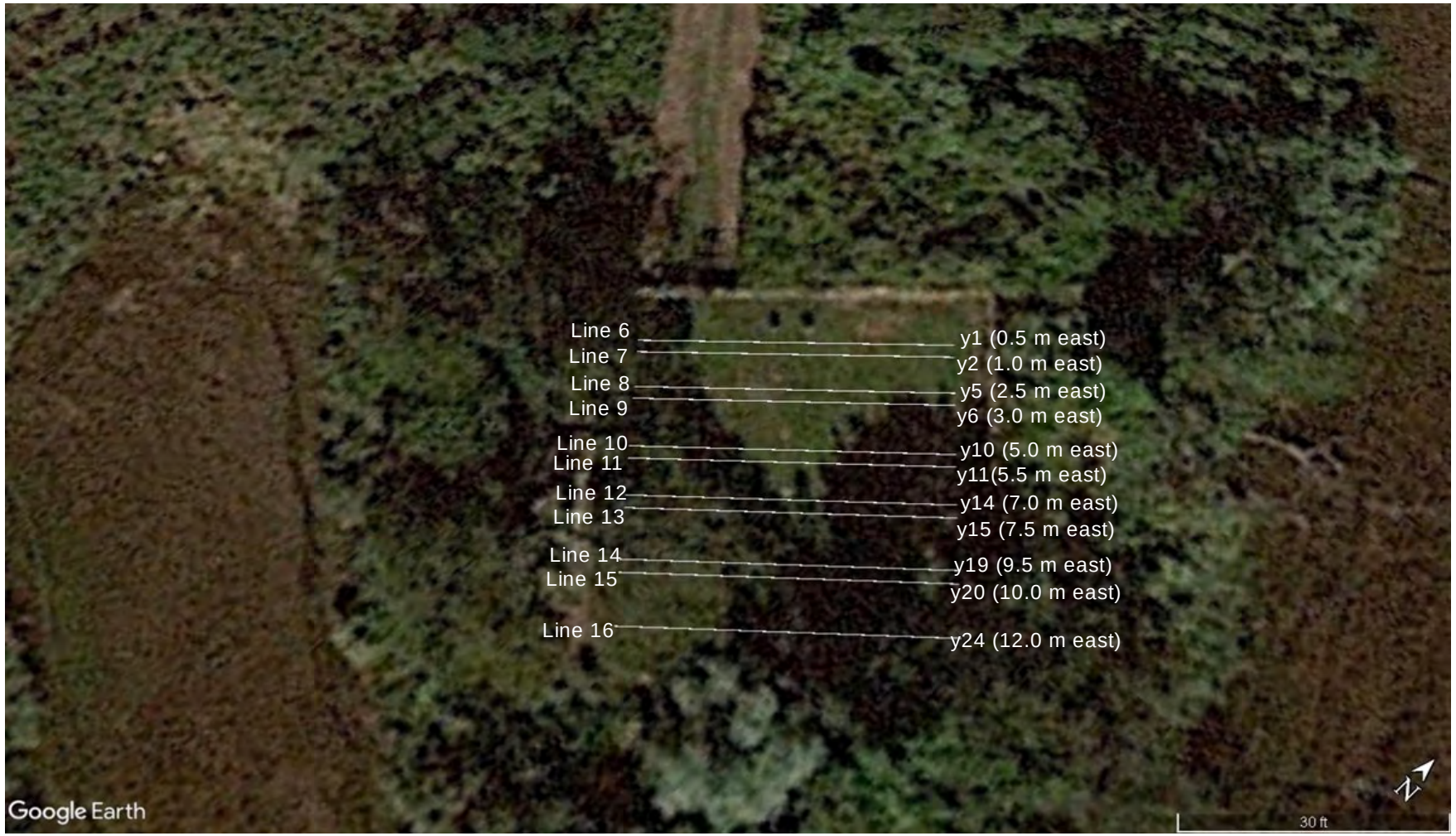

Figure 4. Location of GPR transect lines using 500 MHz antena, and where they overlay the 12 x 12 m grid.

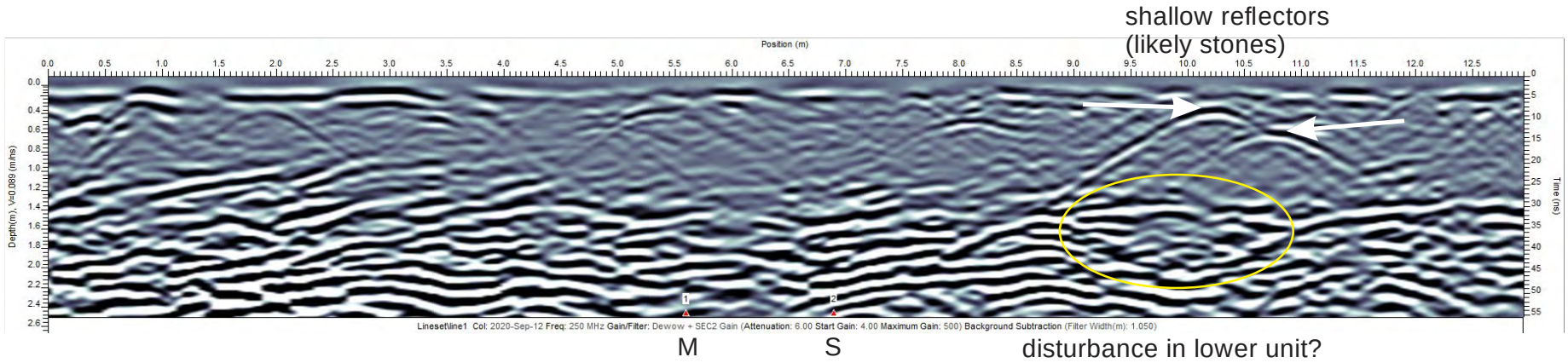

Figure 5. Line 1 taken with the 250 MHz antena between the west end of the grid and the western wall (see Figure 1.). This is behind the Tuthill's monuments (M&S). You can see the two distinctive sedimentary units as well as some shallow reflectors in the upper unit which are likely small stones. The depth of the stones is measured at the top of the parabola. Below the two prominent reflectors marked above there appears to be the sort of variation in the lower unit that reaches a depth of 2 m (~6 ft) that might indicate a back-filled hole at about 10 m along Line 1, however given that the top of the disturbance is in line with the contact between the two units at about 1.5 m depth, I think this is more likely to be a natural scour and fill created in the ancient stream that deposited these sediments.

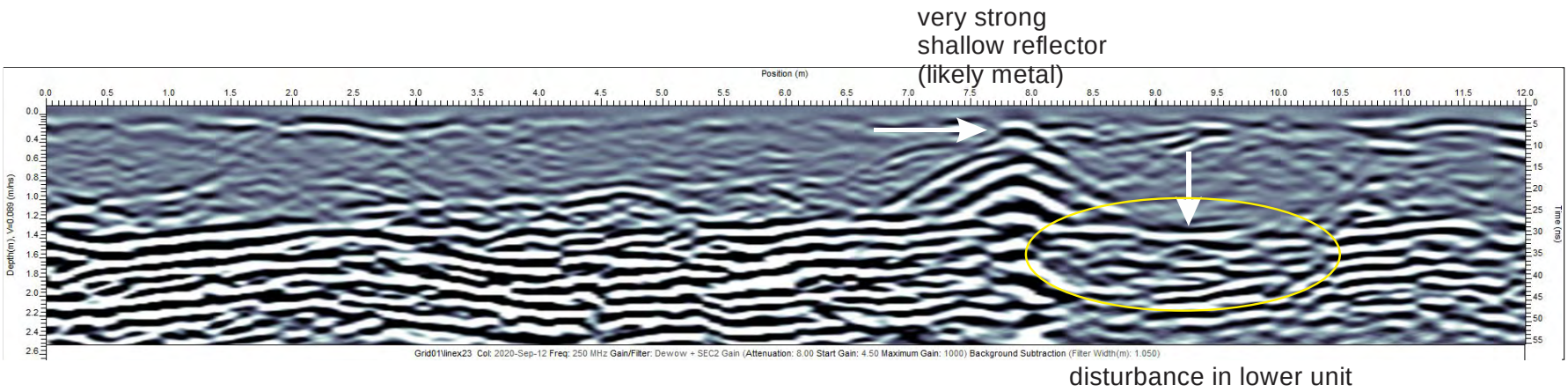

Figure 6. Line x23 (west to east). The two units are clearly differentiated and there is one very strong reflector that likely represents a piece of metal just below the surface at y=7.9 m. I saw this reflector on the GPR on the day of the survey but did not see anything obvious in the ground at that location. Just to the east of it (y = 9 m) the signal for the lower unit again shows a disturbance down to a depth of about 2 m. This again may be either a back filled hole or a nature scour fill. The "washed out" appearance of the lower unit signal east of the metal object is perhaps due to shallower groundwater at the northeast corner of the site. The effect is even stronger in lines x24 & 3 closer to the wall (see Figure 7).

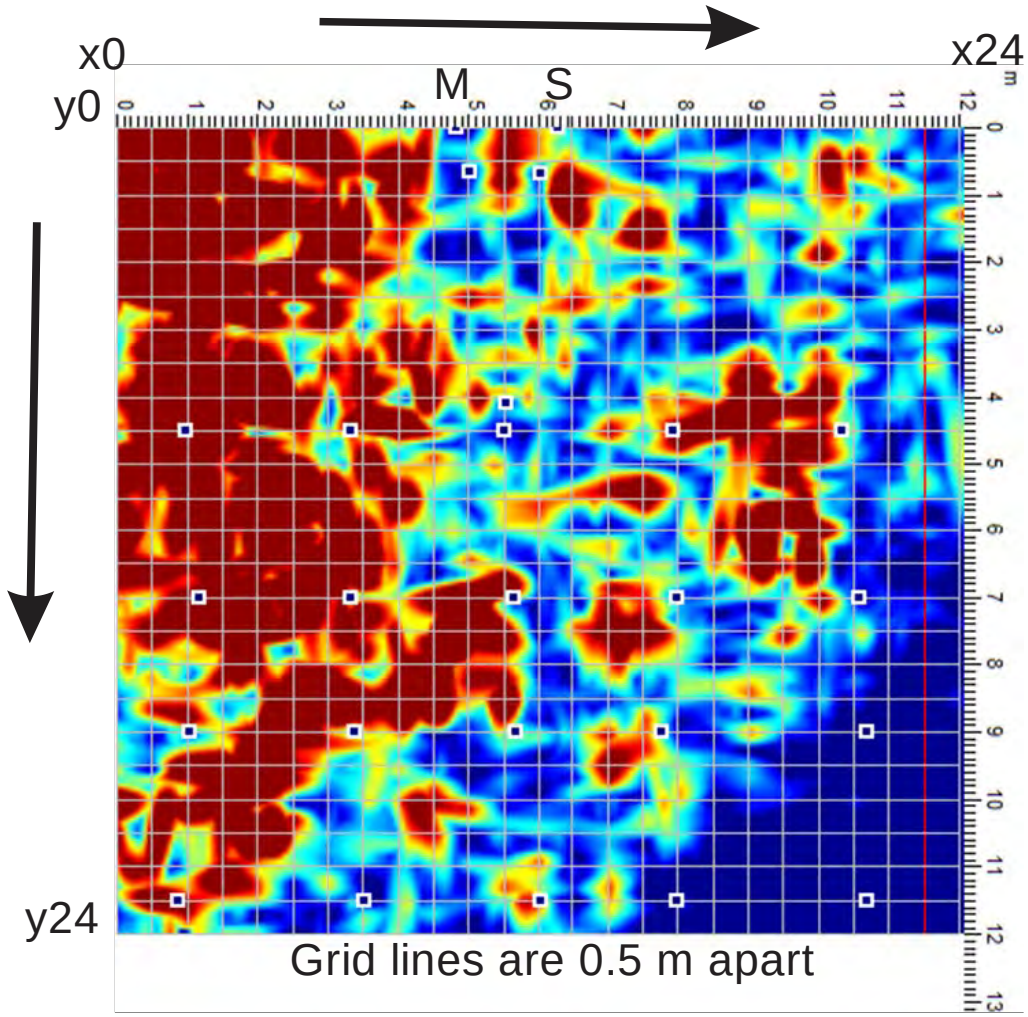

Figure 7. 3D GPR depth slice set for 3.0 m (9.8 ft) showing in dark blue the areas that are saturated with groundwater at that depth. The groundwater table is dipping from the northeast to the southwest across the study area. The locations where the GPR passed by monuments and marker rocks are flagged with dots.

Figure 8. 1904 (Surveyed in 1903) USGS topographic map of the study area showing the site as a promontory into the coastal wetland. The Harbor Hill moraine (southern end of the glacier) is prominent on the north shore as "Browns Hills" and "Terry Point". The nearest properties to the study site at the time were two houses at the end of a dead-end road that is now King Street.

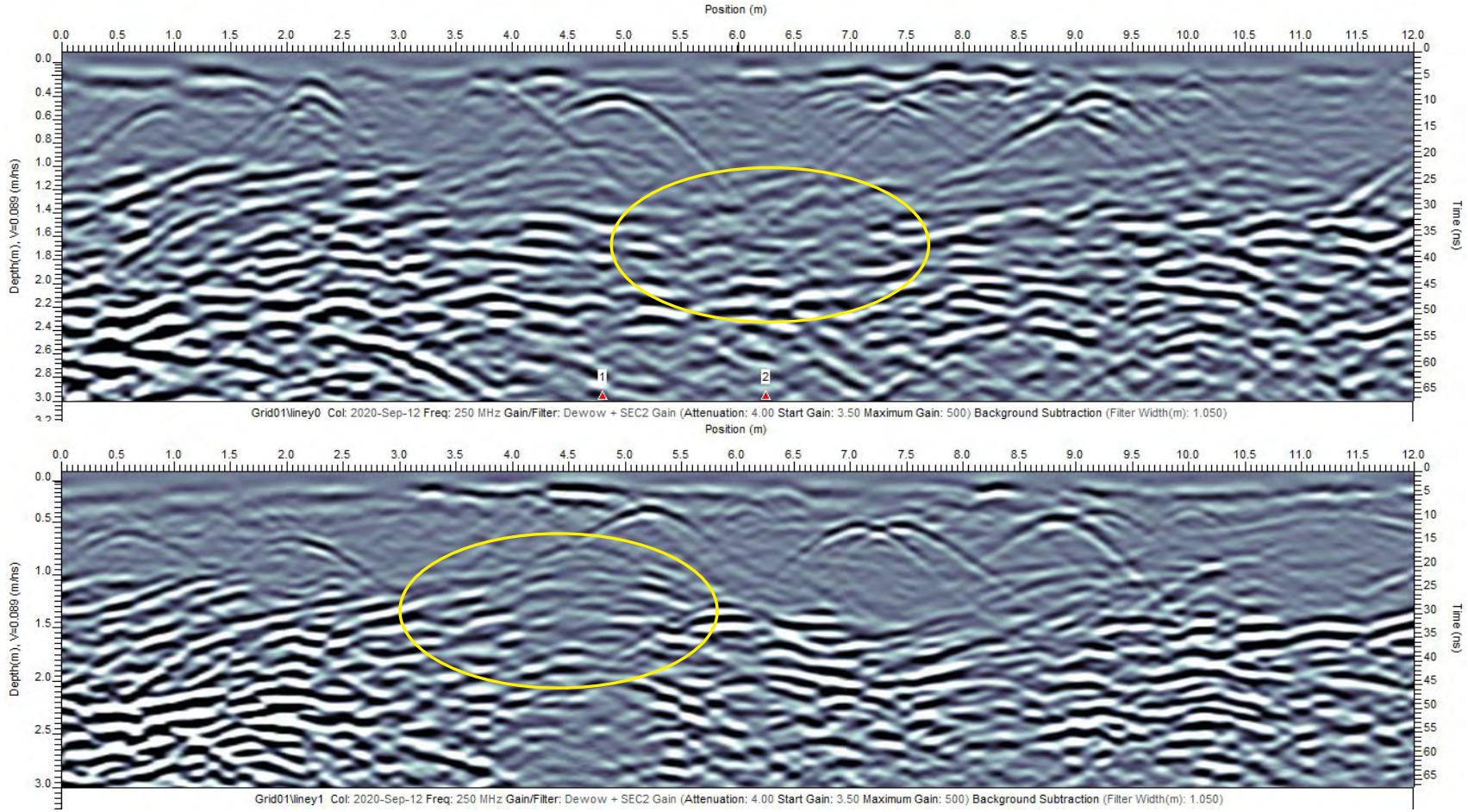

Figure 9. Lines y0 (top) & y1 (bottom) from the 250 MHz antena. The digital flags on the bottom of y0 indicate the center of the monuments from Maria (1) and Seth (2) where the radar passed right in front of them. I see a good indication of disturbance in the lower unit down to 2 m for Seth in line y0, but Maria's burial is better indicated in line y1. The zone for Maria's burial appears "washed out" possible because there is something in the soil interfering with the radar signal.

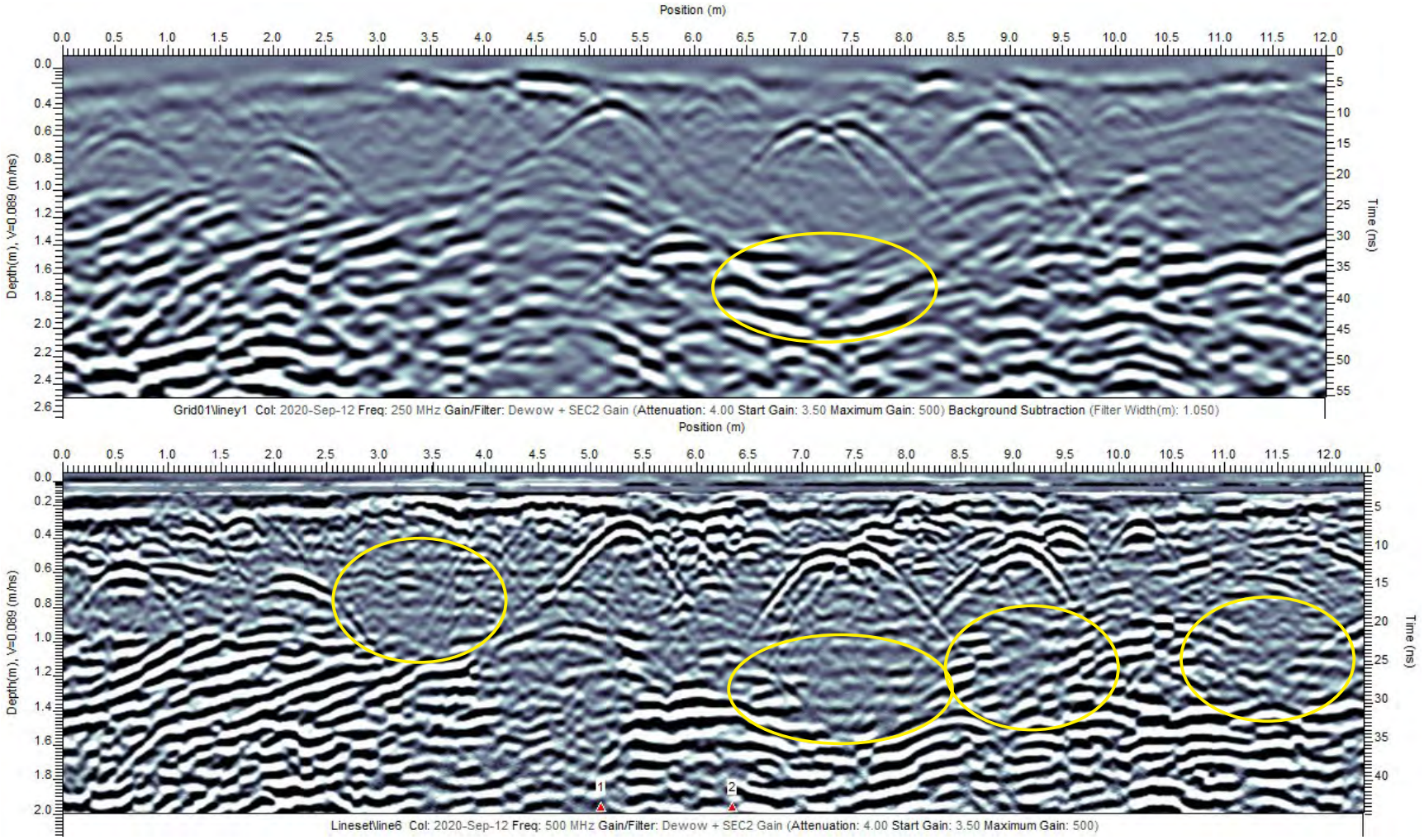

Figure 10. The top line is the same as y1 from Figure 9, but the bottom line is the same transect imaged with the 500 MHz antena. The disturbance associated with Maria's grace is even more apparent, however there is now a clearer indication of a potential burial at 7.5 m, although it is a shallower anomaly going down to a depth of only about 1.6 m (5.25 ft.). If this a burial, then either Seth is actually buried a little to the north of his monument or this is a separate burial. There are also the indication of a shallower and smaller anomaly at 3.5 m, 9.0 m, and 11.5 m along the line.

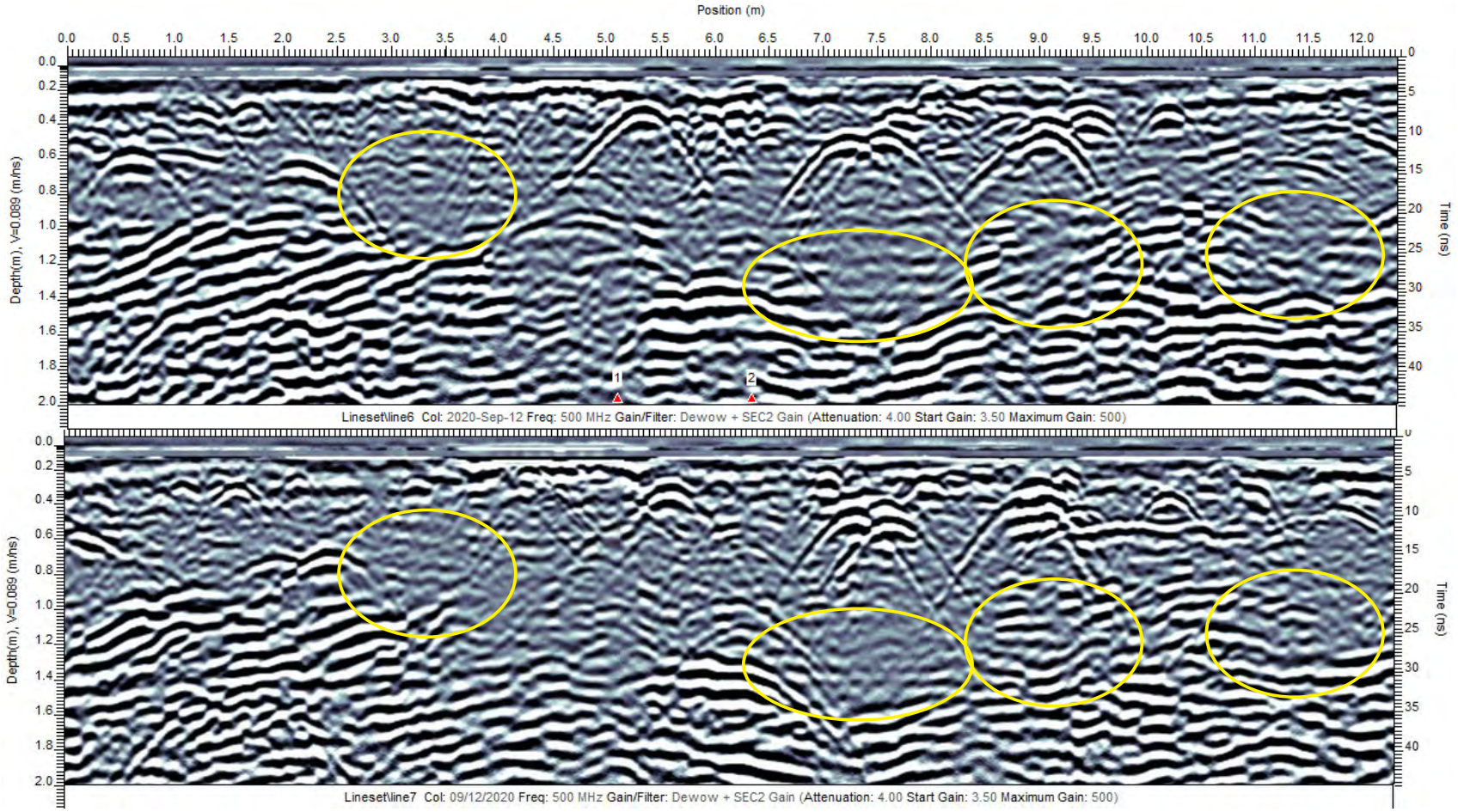

Figure 11. The top line is the same as y1 from Figure 10, but the bottom line y2 which is parallel and half a meter to the east (just beyond the footstones for Maria and Seth). All of the anomalies appear to be continuous as is the one at Maria's location, although with the exception off the 7.5 m anomaly, a little less evident. There is still no clear evidence of a burial corresponding to Seth's monument.

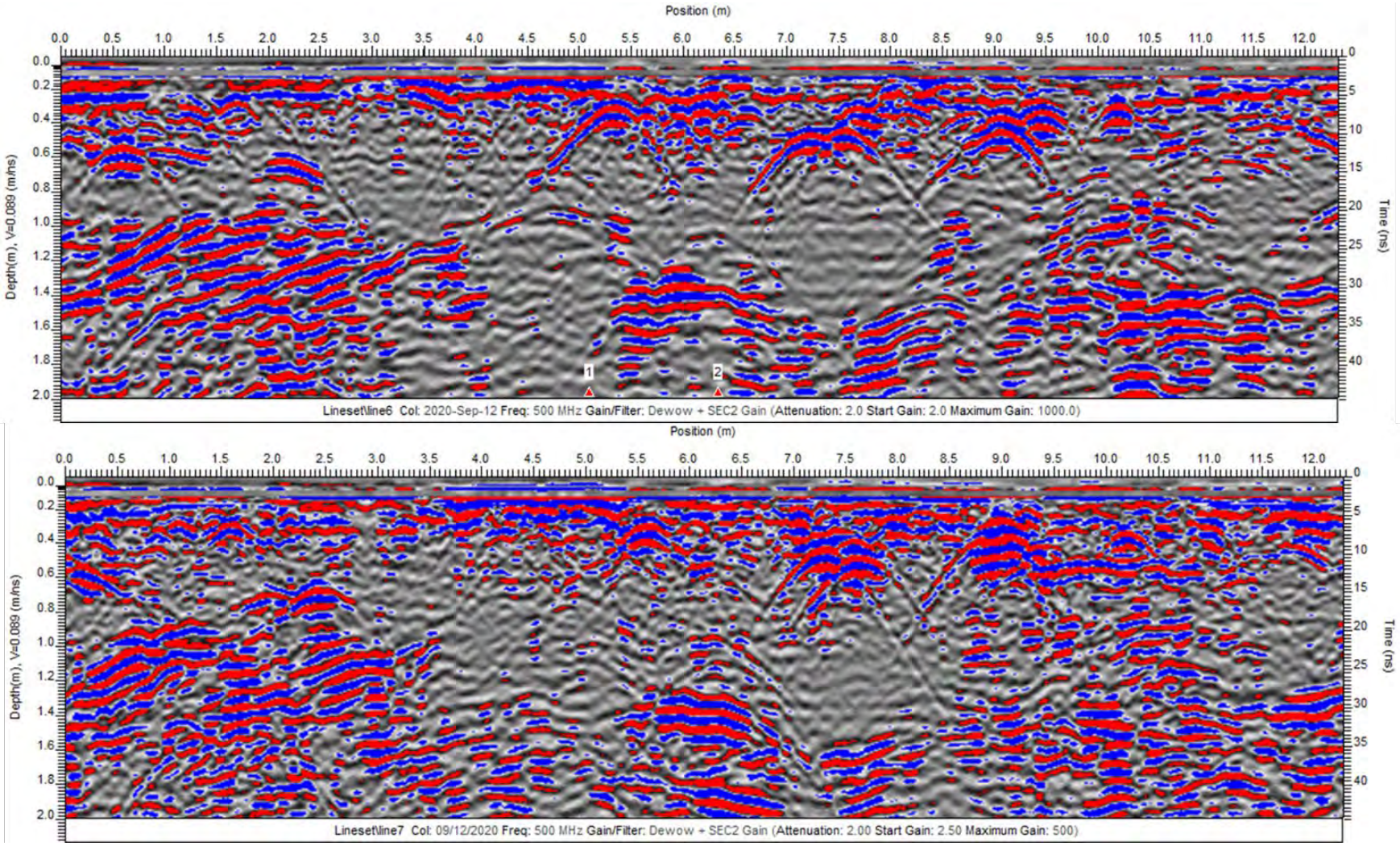

Figure 12. The same radar plots as Figure 11, but with a color filter applied to highlight the disturbances in the lower unit.

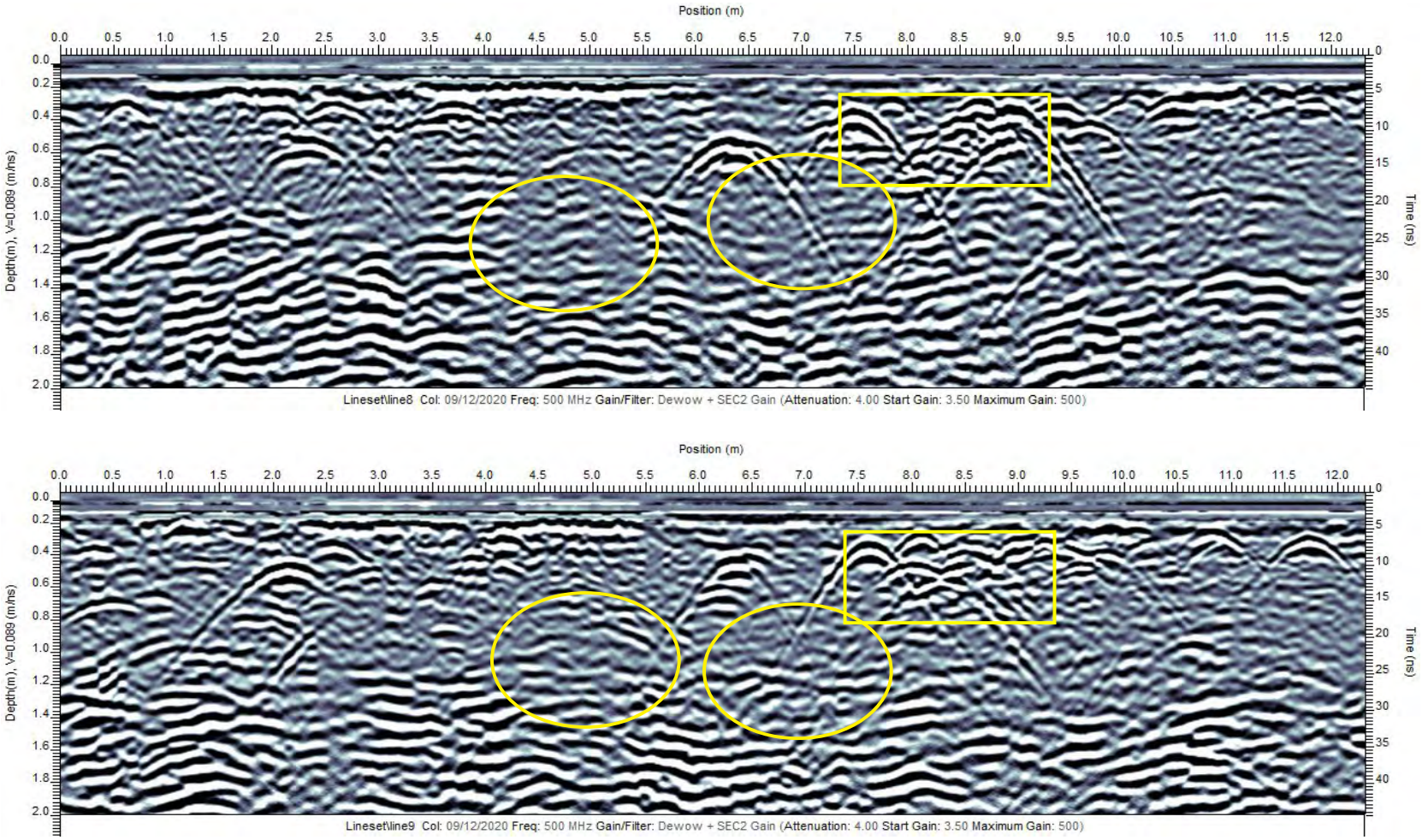

Figure 13. Lines y5 & y6 with the 500 MHz antenna. Shallow anomalies in the bottom unit at 5 m and 7 m, but not strong indications of potential burials. A cluster of shallow reflectors (box) from 7.5 m to 9.5 m are part of a long liner E-W line that start at the west end of grid (y=0 m) and runs almost 7 meters (See figure 2.) The 7.5 and 9.0 m anomalies from lines y1 & y2 lie under this line, and it's possible that the anomaly at 10 m in Line 1 (Figure 5) also does, although it's outside the grid so can't be directly connected.

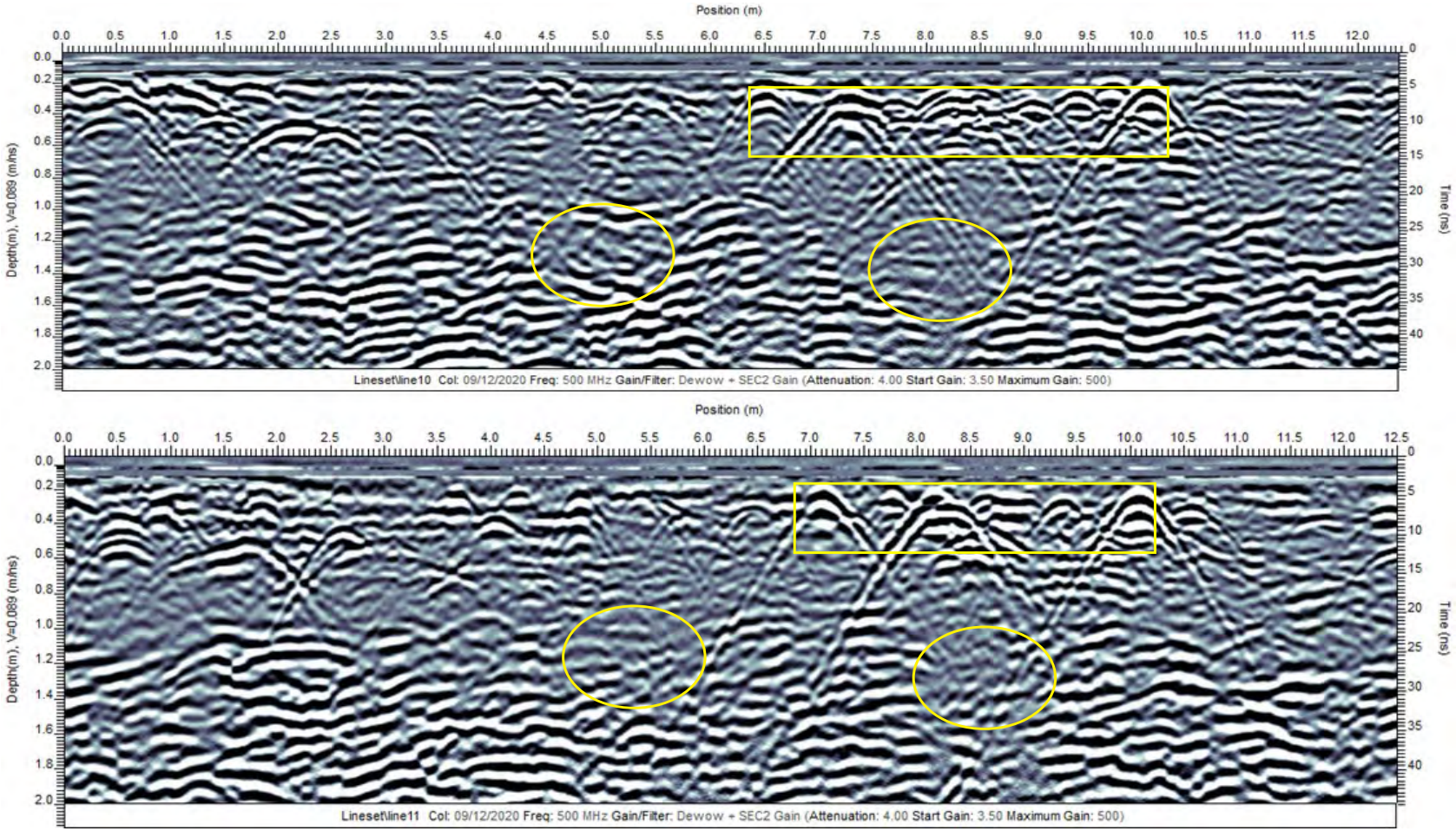

Figure 14. Lines y10 & y11 with the 500 MHz antenna. A shallow anomaly in the lower unit at 5 – 5.5 m and a deeper one at 8 – 8.5 m. The deeper anomaly is directly under the shallow linear rock cluster (Figures 2 & 13). The "washed out" appearance may be due to radar shielding by the rocks.

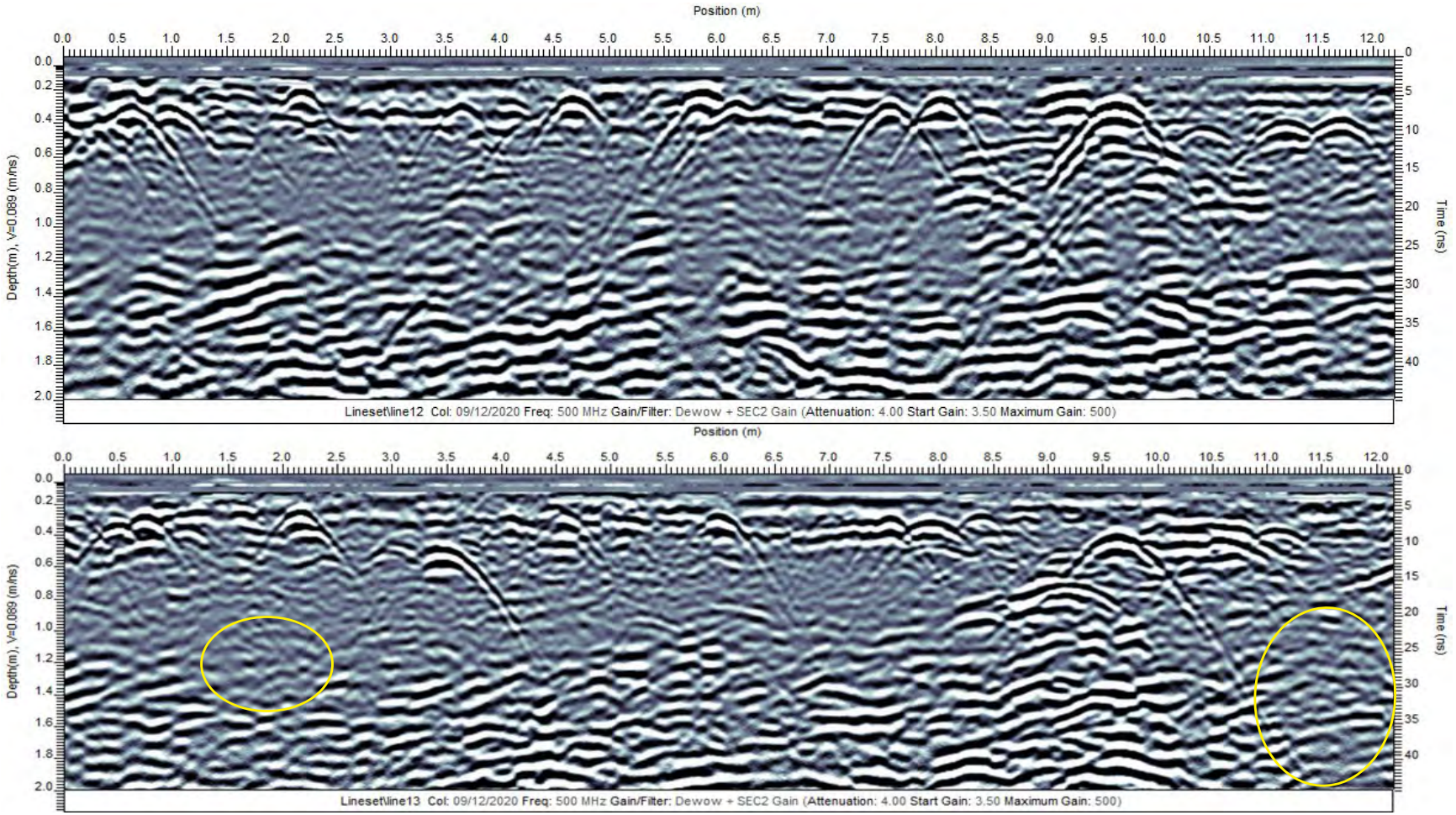

Figure 15. Lines y14 & y15 with the 500 MHz antenna. Line y14 does not indicate anything that could be interpreted as a potential burial. The linear rock cluster sill appears between 7.5 – 10 m, but is a little deeper in the ground. There is a weak disturbance in the lower unit in y15 at 1.5 – 2.0 meters, but again it's shallow. At the north end of y15 the radar signal is very washed out. This may be due to the shallower groundwater table or the roots of the bush that sticks out across the wall at this end of the grounds. From here to the eastern end of the grid the lower unit is more difficult to see near the northern wall.

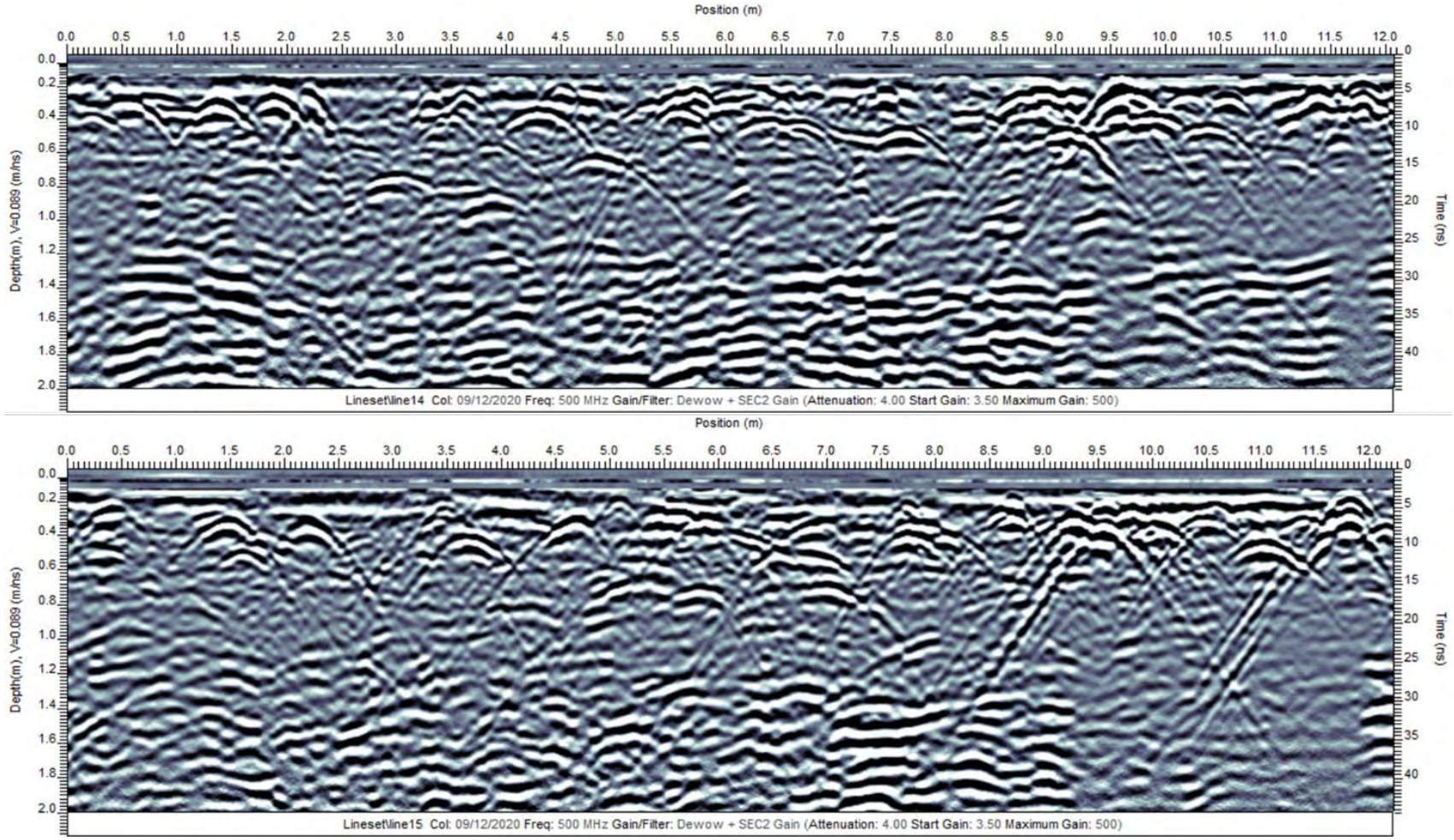

Figure 16. Lines y19 & y20 with the 500 MHz antenna. No obvious anomalies, and more lower unit "washout" near the northern wall likely due to groundwater. Also there appears to be far more shallow reflectors at this end of the field, indicating that the upper unit is stonier.

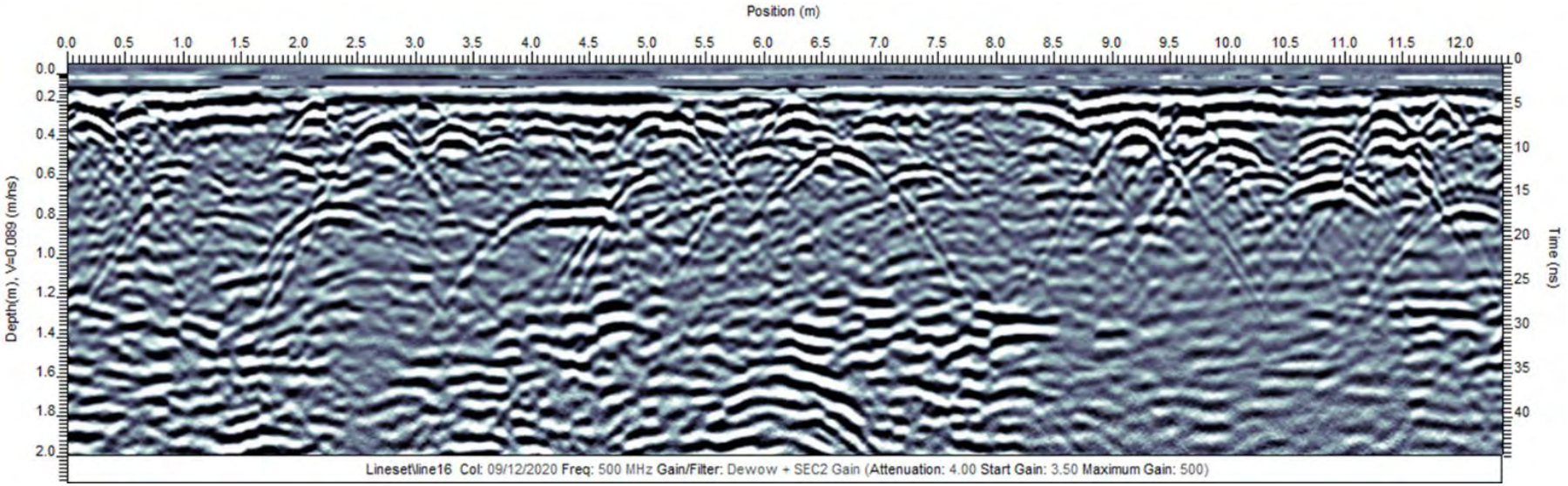

Figure 17. Line y24 along the eastern edge of the grid with the 500 MHz antenna. Very similar to line y20 with no indication of burials at depth.

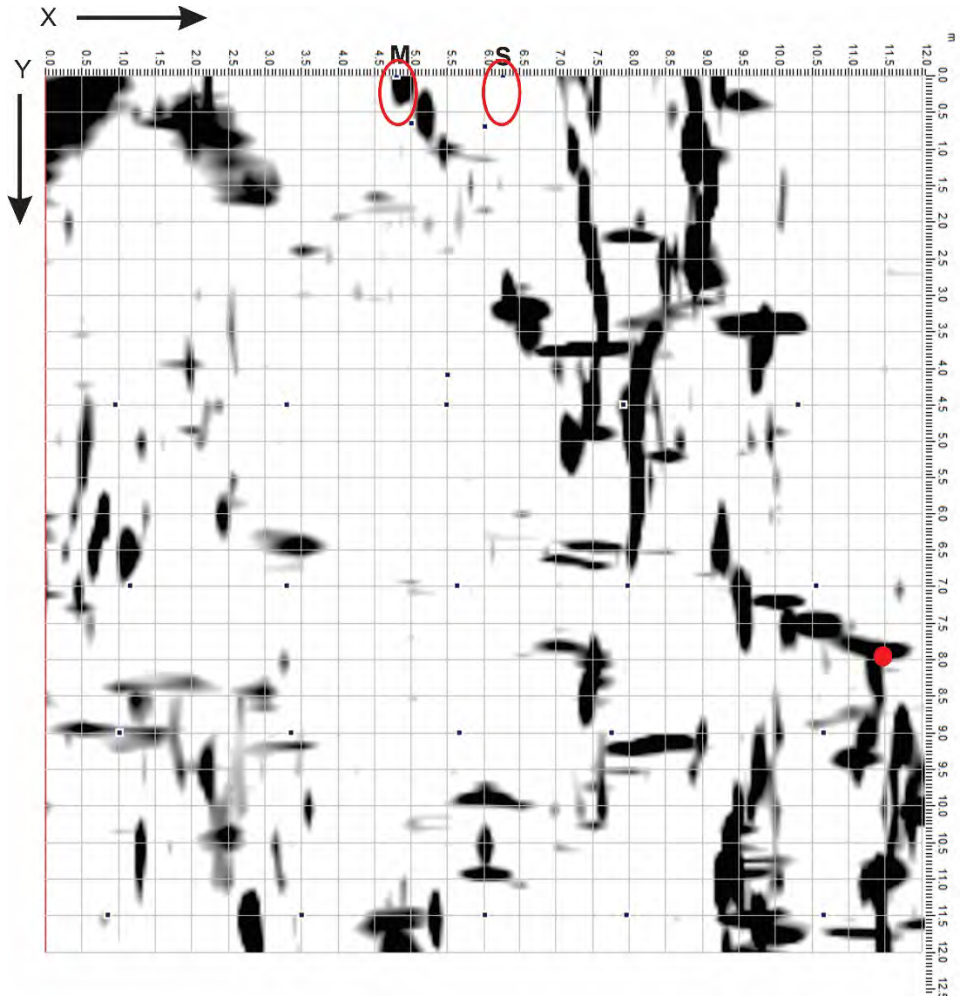

Figure 18. 3D Grid focused at 0.5 m (1.6 ft) depth. West at the top and the locations of the monuments and marker stones are flagged. Maria Tuthill's headstone location is marked with "M" and Seth's is marked with "S" and the red ovals approximate the area of their burial plots. The red dot is the location of the metallic reflector. This shows the locations where shallow reflectors (likely stones) are clustered at 0.5 m depth. If buried stones were used to mark graves in this field I would expect to see evenly spaced rows in a preferred orientation. I did not see that at any depth.

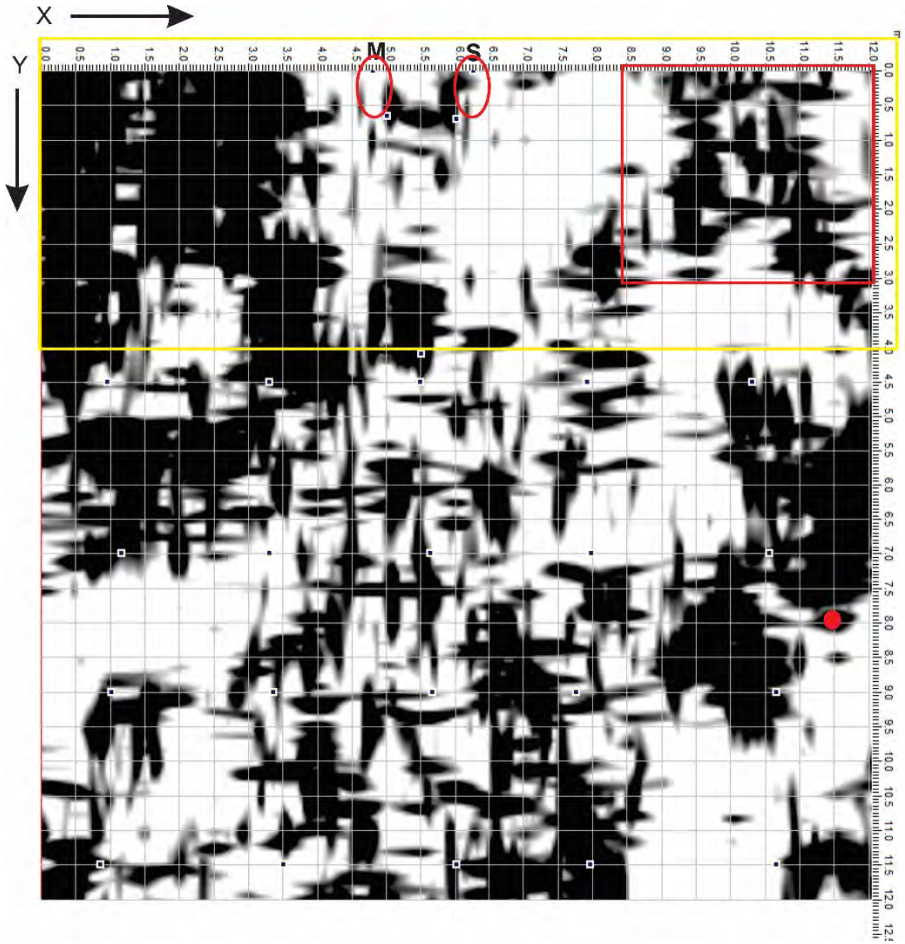

Figure 19. 3D Grid focused at 1.2 m (4 ft) depth. West at the top and the locations of the monuments and marker stones are flagged. Maria Tuthill's headstone location is marked with "M" and Seth's is marked with "S". The red dot marks the location of the metallic reflector. At this depth I was looking for disturbances in the top of the lower sedimentary unit as the possible indication of a burial site. On this figure those disturbances would more likely be ***white colored*** areas like at Maria's plot. Again, I would also be looking for evenly spaced indicators in oriented rows which I mostly do not see with the possible exception of the northwestern corner of the grid (red square). My recommendation is that any further exploration focuses on the western end of the field (yellow box) as beyond this area the GPR evidence for burials at reasonable depths is much less convincing.