ABSTRACT

Title of Thesis:	EXAMINING THE INFRASTRUCTURE OF THE WINDSOR RUINS SITE (22CB602) VIA GROUND-PENETRATING RADAR FOR THE METHODS OF COMFORT IN A BURNED ANTEBELLUM PLANTATION MANOR IN MISSISSIPPI.
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The Windsor Ruins site (22Cb602) located in Claiborne County Mississippi, was built between 1859 to 1861 by the enslaved population of Smith Coffee Daniell II, supplemented by imported craftsmen. It was built a little over 10 miles from the closest town at the time, Port Gibson, Mississippi. The 17,000 ft^2 manor burned down on February 17, 1890, leaving 23 Corinthian columns standing. The fire destroyed most of the records, photographs, and architectural plans of the structure, with the only surviving image being a drawing from a United States soldier discovered in 1990. This thesis examines if ground-penetrating radar (GPR) data collected at the Windsor Ruins site (22Cb602) will establish new understandings of the house by revealing infrastructure that offered methods of modern comfort of the time. From excavations conducted on the site in 1976, it is known that the house contained an elaborate plumbing and cistern system. Eye-witness accounts also indicate that it had full plumbing and a dumbwaiter. A

geophysical survey of the site using a 350MHz GSSI UtilityScan ground-penetrating radar unit was conducted in October 2024 using 0.5 m (1.64 ft) spaced unilateral transects. Through the use of the oral historical accounts, combined with past archaeological excavations, the geophysical survey data collected does reveal new aspects of the house and gives prospects of new areas to investigate to broaden our understanding of the manor. This research is expanding and examining the interpretation of the burned manor and hopefully will serve as a launching point into further research of the site, most notably of the enslaved people there, while being repeatable at numerous other burned plantation manor sites in the state.

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by

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I also would like to give a special thank you to both Jared Brown and Dakota Street. I would not have made it here without the support from both of you, and for that, I am eternally grateful. The number of times you listened to me vent, helped me talk things out (while I know your eyes glazed over), and proofread my work really means the world to me. I would not have made it this far without the two of you, and I will forever be indebted to you both. Thank you.

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Chapter 1: Introduction

During Mississippi's time as a territory (1798 to 1817), and its Antebellum period (1817 to 1861), the state was populated by numerous rural slave plantations that served as miniature, near self-sufficient towns, centered around what was known as "the big house", usually a home that displayed luxury and conveniences as opposed to the utilitarianism of the buildings surrounding them. Does ground-penetrating radar (GPR) data collected at the Windsor Ruins site (22Cb602) reveal infrastructure that offered methods of modern comfort of the time that assists with determining, or establishing, new understandings of the house? Another smaller question this thesis asks is what can be learned via the use of GPR surveys on burned plantation manors, so that this methodology could be applied to other manors in the state? The Windsor Ruins site, located in Claiborne County Mississippi, is the remains of the Windsor manor, historically the largest Greek Revival plantation manor in the state. The manor stood from 1861, when construction via the work of the enslaved population was completed, to February 17, 1890, when it burned down in a massive fire. The exact causes of this fire were never discovered, although several stories exist (Frasier 2019).

Windsor Ruins

The Windsor manor was an example of contrast with the lives of those who built it. It is located in Claiborne County, about a 16-minute drive from Port Gibson, and is easily accessible from the Natchez Trace Parkway. The manor cost approximately 175,000 dollars to be built and furnished in the 1860s, which when accounting for inflation, is almost 6.8 million dollars in 2025 (Frasier 2019; Alioth Finance 2025). It stood at two and a half stories, with a ground floor

basement, totaling approximately 17,000 ft^2 (1579 m^2), with at least 23 rooms that included bathrooms with running water, parlors, library, kitchen, and a doctor's office (Fraiser 2019). The main structure was surrounded by 29 brick and stucco Corinthian columns, each one standing approximately 12m (45 ft) tall with cast iron capitals, of which 23 survived the fire and stand today. The site is currently owned by the Mississippi Department of Archives and History (MDAH) and is most well-known for its extravagant columns. It is open to the public and is a popular tourist destination in the state, with individuals from all over the world coming to view the remains of the manor (Figure 1).

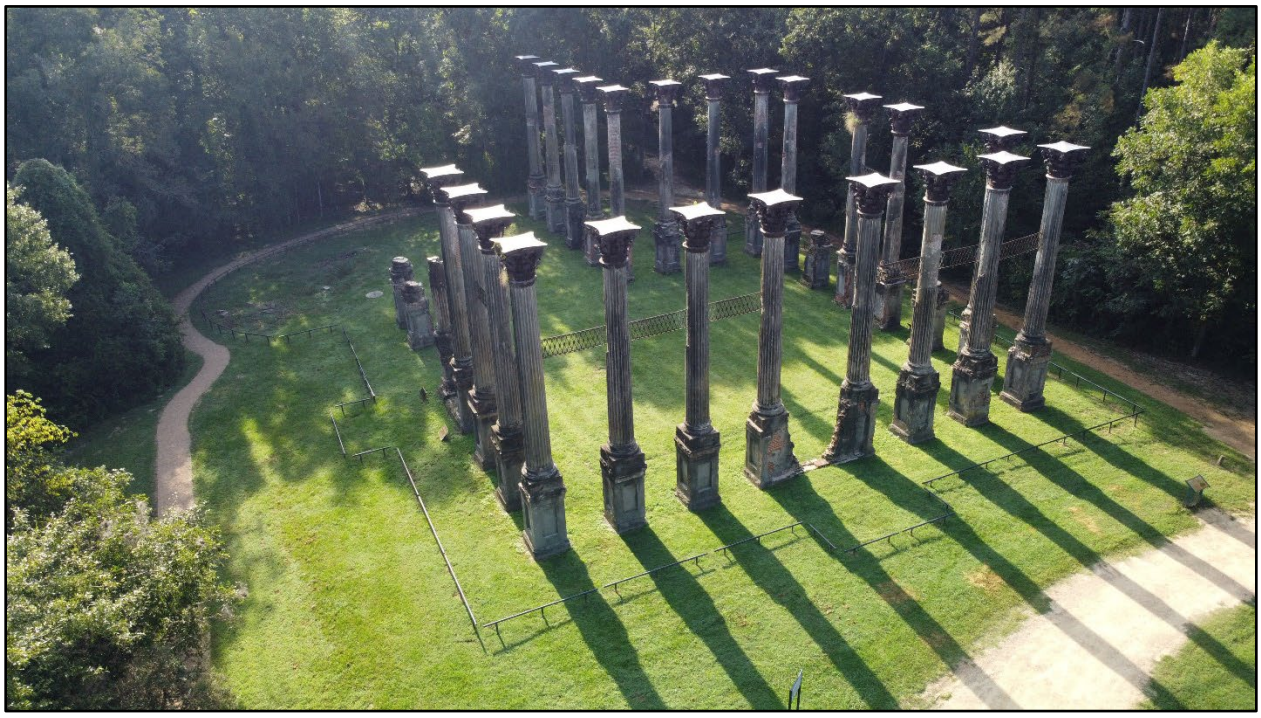


Figure 1: The Windsor Ruins site today. Image original work of author.

Past and Present Work at the Site

Over the years, the Windsor Ruins site has been subjected to several excavations, with the most expansive excavation conducted in 1976 by John Milner & Associates led by Dr. Alex

Townsend. This excavation reconstructed the floor plan of the manor, discovered the intricate network of pipes used in the manor, and found a smokehouse, which is the only outbuilding of the manor with its location known (Townsend et al. 1978). Other excavations have occurred in 2013, 2022, and 2024, with the 2013 excavation being the only one to add significant new understandings to the site, this time in regard to the chain wall (a type of perimeter foundation) around the columns (Aasand 2022; Hahn 2015; Wendt et al. 2024). Even with great public interest in the site, and these excavations conducted, a GPR survey had not been conducted on the site until October 2024. This survey was conducted both for data collection for this project, and the hopeful start of a new wave of archaeological investigations into not just the manor, but the Windsor Plantation grounds, as no work has been conducted on the plantation's grounds to investigate any facet of the enslaved stories that could be found here. Lastly, it is not a rare occurrence for plantation manors to burn down leaving little understanding of them. It is a common enough occurrence that one of the largest antebellum plantation manors in Louisiana burned down in May 2025 during the writing of this thesis. It is hoped that this research will prompt more investigations into burned planation manors in the state and help with their interpretation. GPR surveys are a great way to assist with this.

GPR surveys are minimally invasive and non-destructive with only electromagnetic energy penetrating beneath the grounds surface. This energy is roughly less than 1% of what a cellular phone emits (Leach 2021: 3). The field portion of these surveys can be conducted quickly. This survey methodology allows for a more holistic view of any subsurface features that have been missed by the previous archaeological investigations into the house. Unfortunately, although highly powerful, GPR is also the most complicated of the archaeological geophysical survey methods (Conyers 2023: 1). The data processing and analysis takes time and expertise,

but the overall benefits are worth the complexity and learning curve of the methodology, as a 3-D representation of the soils and any underlying features around them can be analyzed without excavation.

In regard to the research question and the methodology in general, the current procedure for the analysis is to look for the remains of any still-existing infrastructure that can assist with determining, or establishing, new understandings of the house and the utilities of comfort it offered. It is already known that the house had indoor plumbing, which many houses used for drinking and bathing starting in the mid-19th century, but many questions, including the extent and design of this system, are not answered (McKee 2014: 59; Townsend et al. 1978: 48-50). These elements should appear on the GPR survey data, and any significant unknown reflections of interest would also have to be identified for their research potential.

The Definition of Comfort

Comfort is not an easy word to define, as the Oxford Dictionary has nine different definitions of the word, in addition to eight different sub-definitions. Out of these 17 versions, nine of them are still used today (Oxford Dictionary 2025). Comfort can be defined differently across cultures and throughout different points in space and time, as what was comfortable to one generation quickly becomes uncomfortable to the next (Crowley 1999: 750-751; Ierley 1999: 8-9). It has a definition that everyone knows, as well as they know it when they see it, but is slippery to define. The definition Oxford gives that aligns with the goal of this project is "A state of physical and material well-being, with freedom from pain and trouble, and the satisfaction of bodily needs" (Oxford Dictionary 2025: np). This definition of comfort rose to prominence in the early 1700s, with the association of the term from more of a spiritual, emotional meaning to a

physical one. Then in the Consumer Revolution of the late 17th and 18th centuries, the term comfort became more aligned with the focus on scientific and technological expression on designs and workings in the home. It shifted from just referring to the enjoyment of the home to one being combined with convenience, becoming a crossroads of a luxury and a necessity (Crowley 1999: 751-752; Paris 2019: 93).

A combination of these ideas of the crossroads of luxury and necessity that causes a state of physical and material well-being is the comfort that is being searched for in the ruins of Windsor manor. This definition can encapsulate aspects of other frameworks, such as physical health, or convenience (defined by Oxford as being able to proceed with something with little effort), are both facets to help achieve the state of physical well-being. The addition of luxury, especially in the investigation of a manor as expensive as this, is what elevates an item to comfort, at least for the purposes for this paper.

Although archaeologists will use comfort as a term to describe material culture, it rarely appears that the term is defined in academic works. An artifact or feature is described as one of "material comfort", or comfort may be used to describe a domestic space. The term comfort is never defined though and is expected to be immediately understood by the reader when read. (Horn 1988; Howson 1995; Roller 2019). By looking at the amenities and infrastructure used to support the amenities, a material culture of methods for comfort can be found. With the great changes that household amenities underwent during the 19th century, the modern comforts of the time for a site such as Windsor should be able to be investigated and observed (Ierly 1999:11-12).

Chapter Descriptions

This project will be described in much greater detail in the following chapters. Chapter 2 examines GPR and the theory behind it as a whole, starting with the history of the survey technique from the 1970's onwards. After this review, the physics of GPR will be introduced so that the reader has some understanding of the methodology. From there, there is a quick breakdown on how to read the signals and radargrams generated by a GPR unit. Ending the chapter will be a discussion on the suitability of the survey method under different conditions.

Chapter 3 discusses the historical context of the Windsor Ruins Site. This chapter describes the events leading to the building of the manor, and the culture surrounding it and the owner, Smith Coffee Daniell II. Additionally included in this chapter is the description of the manor, and a small section on other plantation investigations in the area. The chapter finishes with a detailed examination of the previous excavations at the Windsor Ruins site.

Chapter 4 is an overview of methodology and data collection. The chapter starts reviewing the research question and the methodology and planning that will be used to answer it. From there, the chapter delves into the planning of the GPR survey leading into the actual survey itself. It then describes the different data processing methods of GPR data, and the methodology used to process the data collected.

Chapter 5 presents the results of the GPR survey. The reflections of interest (ROI) that will be investigated further are introduced, and the floor plan that was observed when reviewing the data. Each of the five ROI has its physical attributes described. Figures for each ROI are included in both radargram and time-slice formats.

Chapter 6 follows with the analysis of the ROIs introduced in the previous chapter. Although some of the features are easily explained, several are not, and require more processing

and even then, the interpretation is not conclusive. This chapter ends by wrapping the analysis and interpretation of the ROIs into the research question.

The final chapter, Chapter 7, is the conclusion, summarizing the outcomes of the survey, results and the analysis. The research question is addressed again in regard to the research question. Finally, the author gives their recommendations supported by the data on what the next steps for the site should be.

Lastly, three appendices have been added to this thesis for documentation of the data and for repeatability of the analysis. The first, Appendix A, contains scans of the original GPR forms used in the field of data collection. Appendix B contains screenshots of the Radan 7 file headers for the GPR data files. These headings contain a list of all the major data processing techniques conducted on the data. Lastly, Appendix C contains time-slices of the manor taken every 20 cm from the surface until 3 m. All scans were taken at 13 cm thickness.

Chapter 2: Theoretical Background

Ground-penetrating radar (GPR) is a complicated but powerful geophysical remote sensing technique that can be used to assemble 3-D representations of data that do not require the destruction of the archaeological resource. This chapter goes into detail with both the history of this survey methodology, and the physics of it. Then part of the chapter will be spent on the methods for interpretation of data and the variables that need to be considered when planning a survey.

The History of Ground-Penetrating Radar

Since the 1970s, GPR has been used in numerous applications in archaeology. Although some experiments in very basic GPR were conducted in the 1930s, the first modern GPR was created for NASA to determine lunar lander sites in 1967 (Conyers 2023: 18). The first archaeological use of GPR is commonly accredited to Roger Vickers and Lambert Dolphin in 1976 at Chaco Canyon, NM, followed by Bruce Bevan and Jeffery Kenyon in Philadelphia, PA. Both surveys were looking for underground building remains, with Vickers looking for adobe walls at a pre-contact Native American site, and with Bevan and Kenyon attempting to detect cellars and brick barn walls on the grounds of the Stenton Mansion, built in the 1720's (Beven and Kenyon 1975; Conyers 2023:18; Ernenwein and Hargrave 2009:10; Mathien 2005:12). From there, the methodology, although complicated and rough, took off.

From the 1970s into the 1990s, GPR was used almost exclusively as an exploratory technique, with anything detected being excavated to demonstrate the potential. This methodology gave more and more credence to the technique, as it showed that the technology

was useful at detection of archaeological features. During this time, the methodology, applications, and limits of this technology were refined. Although complicated and high tech for this period, it was still relatively crude, being described as a “hit or miss” technique, since there was little understanding and interpretation of what was being observed. As such, when a detected feature was ground-truthed, it was either an archaeological feature or it was not, there was very little in between (Conyers 2023: 18).

According to Lawrence Conyers, who over the years has become one of the most cited and influential archaeological GPR experts, the next large advent for GPR came with the introduction of digital recording devices. Before the 1990’s, the data could not be recorded and could easily be lost. Early tests with magnetic tapes proved successful and allowed for the saving of the data. This capability was combined with computer programs that allowed for the digitization and the processing of many different slices of data at once. These sets of data could then be easily processed to create 3-D imagery that made analysis far easier and accurate (Conyers 2023: 20-21). These programs, which have been used since this time, were also a necessity, and still are today. The amount of data collected by today’s machines is at volumes unmanageable without the help of computer processing and graphical interfaces. GPR is not alone in this, as it applies to all of the geophysical archaeological survey techniques (Kvamme 2003: 437).

Today ground-penetrating radar is one of the most common forms of geophysical nondestructive testing but can still be one of the most complicated. As with all of the remote sensing geophysical techniques, it requires an understanding of soils, physics, and digital imagery to be effective to an archaeologist (Johnson 2006). In the last decade, the ability to use multiple geophysical and GIS datasets overlaid with one another, creating a fusion of sorts for

data, has bolstered the power of GPR yet again (Conyers 2023: 22-23; Goodman and Piro 2013: 3-4).

The Physics of Ground-Penetrating Radar

To understand the basics of how GPR works, one must delve into the physics of electromagnetic waves, as well as into electric conductivity[1]. GPR units use electromagnetic wave pulses in the microwave band of radiation. In archaeology it is usually between the 100 MHz and 900 MHz frequency range used, where 1 Hertz (Hz) is 1 cycle per second, and 1 Megahertz (MHz) is one million cycles per second. Waves are measured from crest to crest (wavelengths), and the stronger the wave (i.e. more cycles per second, or higher the frequency), the sooner the wave will disperse. In terms of GPR, this creates an interesting effect, the higher the MHz, the less depth is achieved, but the resolution of that area is much higher (Conyer 2023:27-29). The energy of the waves cast off of and received by the machine are measured in decibels (dB), although many factors of the wave can reveal information. No matter the frequency, when emitted from the radar wave antenna unit, the waves will pass through the air and soil, until they either reflect off of a surface to be collected by the unit, or they lose energy and will attenuate (lose all energy) as they travel (Conyers 2023: 25; Goodman and Piros 2013: 20-21). To calculate the speed of these waves, dielectric constants have to be considered.

Dielectrics, sometimes known as dielectric constant or Relative Dielectric Permittivity (RDP), is the numerical value placed on a material that is a representation of its ability to store

[1] Although there are numerous equations that can be used in this information, for the sake of any readers, only the most important ones in their easiest forms will be included. If one is interested to see the full range of equations that are involved or the entire equations before being broken down, Goodman and Piros 2013 text *GPR Remote Sensing in Archaeology* contains many of these equations and is much more involved in the physics of GPR.

and transmit an electromagnetic field and then transmit that charge. The higher the dielectric constant, the slower the wave takes to travel through the layer (Conyers 2023: 30-33; 202; Leach). More or less, these numbers are a representation of how fast or slow the waves will travel through a material. These numbers range from 0 (air), to 80 (fresh water). Metal has an infinite dielectric due to its conductivity, acting like an antenna for the GPR unit, reflecting all the GPR energy back at the unit. With water, at 80, the signal is travelling almost one-ninth the speed that it would in the air, although it can act as a great medium for GPR. To determine the dielectric of a material, several equations can be used, but the simplest breaks down to:

$$K = (c / v)^2 \text{ which can be rearranged to } v = c / (\sqrt{K})$$

Where K is the dielectric constant, c is the speed of light (think $e=mc^2$), which is about 30 centimeters per nanosecond (cm/ns), v is the velocity of the wave, usually recorded in GPR as cm/ns or m/ns. For example, if the dielectric constant of ice, which is given as 4, is known, then the velocity of the electric signal being emitted would be 15 cm/ns through the ice. Since the unit is aware of the time between when the signal is transmitted and received, this is the basis for how the depth of the signal is calculated. A standard 400 MHz GPR unit in glacier ice can go down hundreds of meters vs the few meters one would get in sandy or clay soil, thanks to conductivity (Conyer 2023: 30-33; Goodman and Piros 2013: 13-15).

Conductivity conditions can greatly affect the depth the signal reaches, as the more conductive a material is, the larger the amount of energy from the wave is retained by the substance. The more energy the wave loses, the sooner the wave will attenuate. This gives the GPR shallower depths in materials that are conductive, and greater depths in materials that are less so. When wet, certain minerals in the ground can react to the water, creating a more conductive environment. This phenomenon is where the idea of water being a negative item for

GPR comes from, even though modern experiments are starting to show otherwise. (Conyers 2023: 31; 55; 60-61; 199).

Dielectric Constants are not a constant value for a material but are values that are constantly changing along with the variables in the soil. A large factor of this is water, as water tends to slow waves down, but gives higher detail. The amount of moisture in the soil affects the dielectric constant, with more moisture, the higher the dielectric constant. This can potentially make one stratum of the soil vastly different than another of the same soil if the moisture is different. This can also affect the quality of results on certain days, needing to include weather, as well as why GPR units should be calibrated for the dielectric constant before starting any new grid (Conyers 2023: 33-34; 55-57; 60-61).

As the energy travels from one stratum to another in the ground, it will reflect energy back to the device. The amount of energy reflected is dependent on the conductivity of the two materials in question, usually represented by the dielectric constant. If they are close in conductivity, most of the energy will pass through, and a weak distinction will be recorded by the device. If it is vastly different, let's say as in between dry sandy soil (K= ~2.5) and wet sandy soil (K= ~25), then a large very noticeable distinction will take place on the user's end. This could show up a thick "surface" or "floor" line on the radargram (Leach 2021: 20). The ratio of the reflection wave's amplitude, or reflection coefficient, represented by R, can be calculated via the following equation:

$$R = (\sqrt{K_1} - \sqrt{K_2}) / (\sqrt{K_1} + \sqrt{K_2})$$

In this equation, K_1 is the dielectric constant of the first strata, while K_2 is the dielectric constant of the second. Although the equation itself will most likely never be used in the field, it is useful as it mathematically shows that the amount of energy reflected is based directly off of the

difference of the dielectric constants of the two substrates. If both substrates have the same dielectric constant, such as 3, the R will equal 0, allowing for no signal to be reflected back and no distinction between the readings of the unit (Goodman and Piros 2013: 15-16).

With the last bit of science and geometry to discuss before field methodology, one needs to look at the way the wave spreads through the ground. Unlike what one may think, the signal is actually projected as a cone that is expanding as it descends into the ground, with the strongest signal always being directly under the unit (Leach 2021: 11). The signal, as it travels through the different strata, will refract between strata at different rates and angles. This is usually due to the difference in velocity of signal in the two strata, with the main cause behind it being the dielectric constant. When the shallower stratum is less dielectric, the velocity increases, creating a spreading pattern of the waves. When it is more dielectric, the beam will be at a much steeper angle, creating a tighter cone. As the beam descends, its velocity will always increase, so it will never be a perfect 90° angle, meaning that the cone is always expanding outwards, never contracting inwards. The rate this occurs can be calculated by Snell's Law:

$$\sin\theta_1 / \sin\theta_2 = v_1/v_2$$

Mathematically, Snell's Law describes the relationship between refraction angles and velocities as the signal travels through the different stratum (Goodman and Piros 2013: 17-18). This mathematically describes the situation we are all familiar with where an object partially in water will look out of place and not continuous because of displacement and refractions when viewed from outside the water. This occurs with GPR and must be accommodated for, although for most users, this is handled by the machine.

Although GPR units are usually referred to by a specific frequency, such as the 350MHz UtilityScan used for data collection with this project, although they produce more frequencies

than just the one listed. The frequency listed with a GPR unit is referred to as the central frequency. The bandwidth of signals emitted and received are usually in the range from ¼ of the central frequency, up to double the frequency. For a 350MHz unit, the range of frequencies for the signal would be from 87.5 MHz to 700 MHz (Conyers 2023: 50; Leach 2021: 15). Features may reveal new information when observed mostly in the higher or lower frequency ranges (Leach 2019: 4). The central frequency and dielectric constant can also reveal other important items to know.

Using the dielectric constant and the central frequency, one can calculate the smallest size of the object seen by the radar at different depths. First, obtain the wavelength from a chart such as the one on page 68 of Conyers 2023 text *Ground-Penetrating Radar for Archaeology*, using the dielectric constant and the center frequency of the unit. This value will be the wavelength at the surface. The smallest objects that can be seen in the GPR data are usually 25% to 40% of the wavelength, with 40% being the safer and often cited number to use (Conyers 2023: 66-68; Leach 2021: 16). To estimate depth, at least for a 350 or 400 MHz unit, you add 2.5 cm for every 30 cm of depth (Leach 2021: 16). For example, for a dielectric constant of 5, and a 400MHz unit, the wavelength chart gives a value of 0.335 m, or 33.5 cm (Conyers 2023: 68). From there, 40% of 33.5 (or 33.5 * 0.4), would be 13.4 cm. Any object smaller than 13.4 cm and a higher frequency unit is needed. If one knew the depth the reflection was to occur at, they could then use the information above to calculate the increase in size observed, and if a higher frequency unit is again needed. Although it must be restated that by going with higher frequency units, the depth the radar can obtain is reduced.

Reading the Signals

As the pulse from the GPR wave transmitter is constantly expanding away from the point of emittance, any different substances it hits will reflect back at different angles. In the readings displayed to the user, it creates a hyperbola, as the signal will be moving towards, on top of, then away from the feature. These "point source" hyperbolas are what are used on the display data to indicate changes (Figure 2). The angle of the hyperbolas will display the velocity change between the soil and the feature. The tails on the hyperbola can also be used for calculating the velocity of the signal, with some newer GPR systems able to automatically detect the hyperbola and then calculate the velocity of the wave (Conyers 2023: 63-65). If these signals encounter a feature such as a floor, or a very distinguished thick layer, it may appear as a series of black or white lines on the display, depending on how the wave hit the object (Figure 3) (Leach 2021: 9). These are usually referred to as flat planar reflections (Conyers 2023: 63), although they can be relayed as different items in different regions.

A multitude of features can create a result that is harder to make any sense of, although knowing the archaeology and the history of the site would assist with this, such as with brick foundations or middens. Lastly, false readings can be acquired by anything that is very conductive or very reflective, such as metal and water. These can either be seen as super reflective and distinct signals, or as a "barber pole" strip. These readings will usually be fairly easy to spot, as they are fairly "blown out" compared to the normal reading and can create a stripe on the vertical data (Figure 4). Additionally, any outside electromagnetic fields signals, such as cell phones, radio towers, or underground cables can cause interference, appearing as static in the radargram, making actual results harder to detect. (Conyers 2023: 77-78).

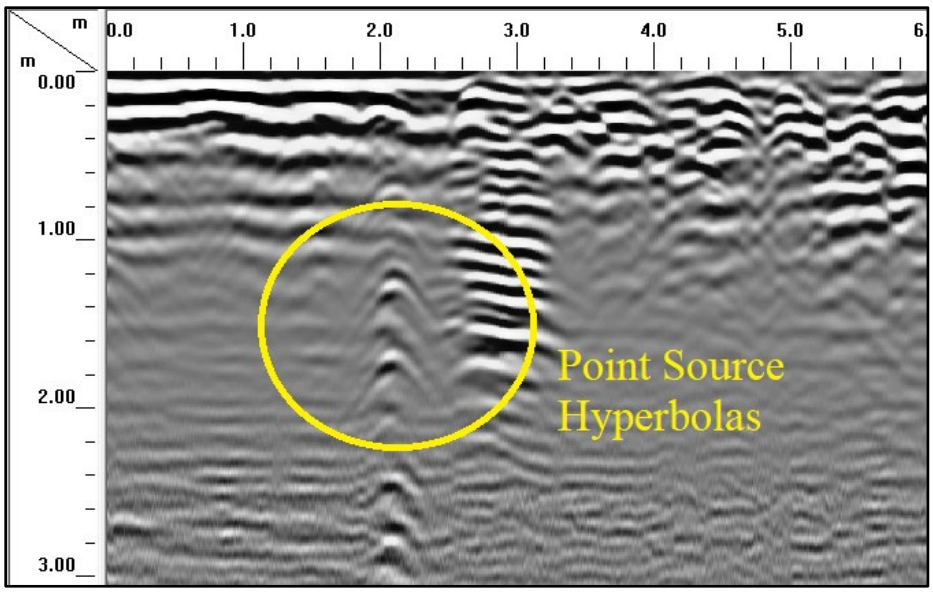


Figure 2: Hyperbolas in GPR data. Image original work of author.

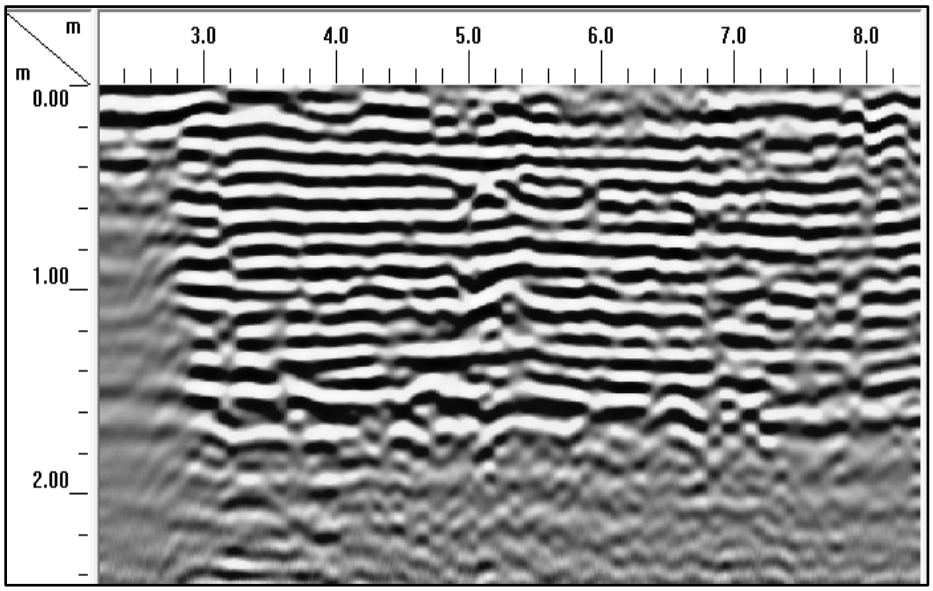


Figure 3: Example of flat planar reflections in a GPR profile. In this case, a brick foundation. Image original work of author.

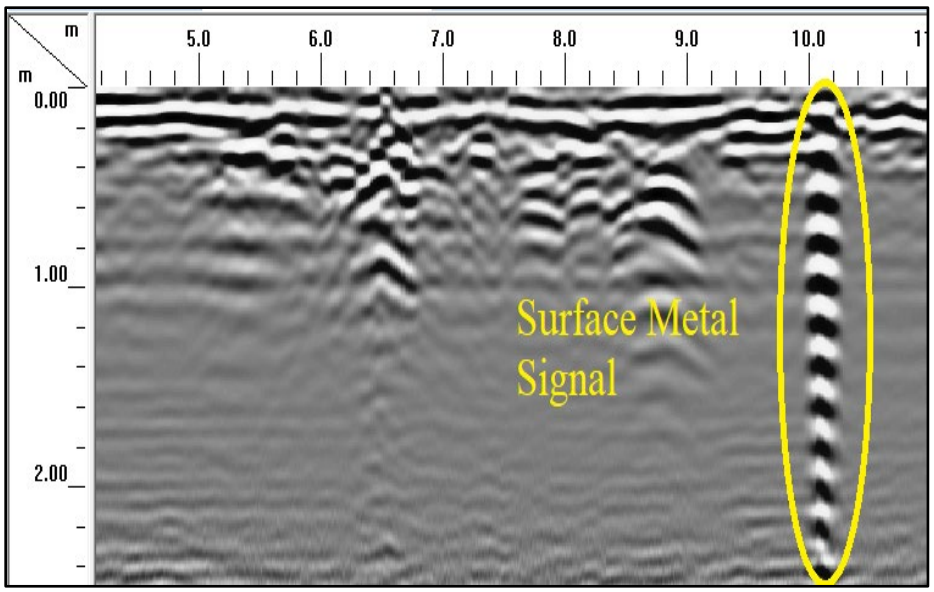


Figure 4: Example of an unknown metal "barber-pole" in a GPR Profile. Image original work of author.

Considerations of a Field Survey

With the science behind GPR reviewed, it's time to take things to the field. In choosing a field site or wondering if a field site is right for GPR, several variables must be considered. Since some soils are not receptive to GPR surveys, maps have been created by the Natural Resources Conservation Service (NRCS) that show the general condition of the soil to be surveyed. Although these, like any soil guide, are to be used as guidelines rather than absolutes (Doolittle et al 2010). The best way to understand if a site is a good contender for GPR is to record a test transect and see if the data received are usable for the project at hand. Unfortunately, it takes time for any user to become proficient in the field with any of these devices, so there will be some frustration at first.

To start with some of the difficulties and frustrations with GPR, the device needs to be "coupled" to the ground, or touching/right above the ground, the best places for GPR are flat,

wide-open spaces. Hills will have to be calculated for, and roots will show up in the tests. If the unit becomes uncoupled, the data will have errors in it that will look like breaks in the data, causing issues and potentially false readings (Conyers 2023: 45-46). Other factors to consider are whether any features, if present, would stand out perceptibly from unknown clutter or their surrounding soil (Ernenwien and Hargrave 2009: 48). Sometimes military installations can become challenging, because of unknown signals (radar, radio, etc.) being picked up through the machine and skewing the data, although some of these can be fixed with processing (Conyers 2023: 78; Goodman and Piros 2013: 46-48). It is usually a good idea to try to do a Google Earth or Google Map Streetview inspection of the surrounding area to see if any major sources of interference can be detected prior to a field survey.

The best method for conducting a GPR survey is via rectangular grids. These grids are composed of transects, or the line along ground that the antenna moves, usually aligned with the grid. Using a grid provides many advantages, especially when obstacles that cannot be removed are encountered (such as headstones) (Conyers 2023: 41-43; Leach 2021: 50-51). Transects are usually spaced either 0.25 or 0.5 m apart. Usually, 0.25 is recommended for cemeteries or pre-contact sites, while 0.5 is good for historical sites (Leach 2021: 48). Each transect provides vertical data for the radargrams discussed before. A completed grid of transects can be entered a program such as Radan 7 that assembles transect data together to create an amplitude, or "time-slice" map of the grid. These are usually top-down planar images that can be adjusted to show different depths of the data provided (Conyers 2023: 121-123).

Any good use of GPR survey and processing requires that background research of the archaeological site should always be conducted so that the GPR operator knows what to be prepared for. This can shape the way that the profiles of the survey are viewed and interpreted.

So, to assist with this, a discussion of the background history of the Windsor Ruins is presented in the following chapter.

Chapter 3: Historical Background

As no aspect of human culture, and therefore no archaeology, exists in a vacuum, the historical context of the Windsor Ruins site (22Cb602) and the manor that once stood there must be considered. The site is located in Claiborne County in the southwestern part of Mississippi, just 16 miles southwest of the county seat of Port Gibson and is about 3.75 miles east of the Mississippi River today (Figure 5, Figure 6). When the plantation was built in 1861, the river was much closer than it currently is located. It was originally less than two miles away until a major river shift in the early 1900's pushed the Mississippi more westward (Figure 7). Additionally, the plantation was between two of the wealthiest towns in Mississippi at the time, Natchez and Vicksburg, in what is today distinguished as the Natchez Plantation District (Kaye 2007: 2; Townsend et al. 1978: 5; Singleton 1991: 20-22). While the house stood from 1861 to 1890, massive changes in the culture and economy swept Mississippi as a whole during that period. The method of construction for the manor would not have even been possible if not for the forced labor of enslaved individuals that were owned by Smith Coffee Daniell II. He was the plantation owner who ordered the construction of the manor, and the original owner of the house. In this chapter, we will look at the history of the area the site resides in, and that of the manor itself.

Adams and Claiborne County

The area that would be known as Claiborne County today was first granted to Samuel Gibson in 1788 by the Spanish government, although he had been living in the area since 1772. Although Europeans lived in the area since the 1720s, this was the creation of the first permanent

major settlement in the area. This allotment of 850 arpents (719.338 acres) around Bayou Pierre would become known as Gibson's Port or Gibson's Landing, depending on the source, which would later be renamed as Port Gibson in 1803 (Works Progress Administration [WPA] 1939: 9). This settlement would become the county seat of the future Claiborne County. Although the Choctaw did not cede the land to the United States Government until 1801 with the Treaty of Fort Adams, the Spanish officially gave the land to the United States in 1795 via the Treaty of San Lorenzo (DeRosier 2018). In 1798, the Mississippi Territory was officially formed, and in 1817, the state of Mississippi was established.

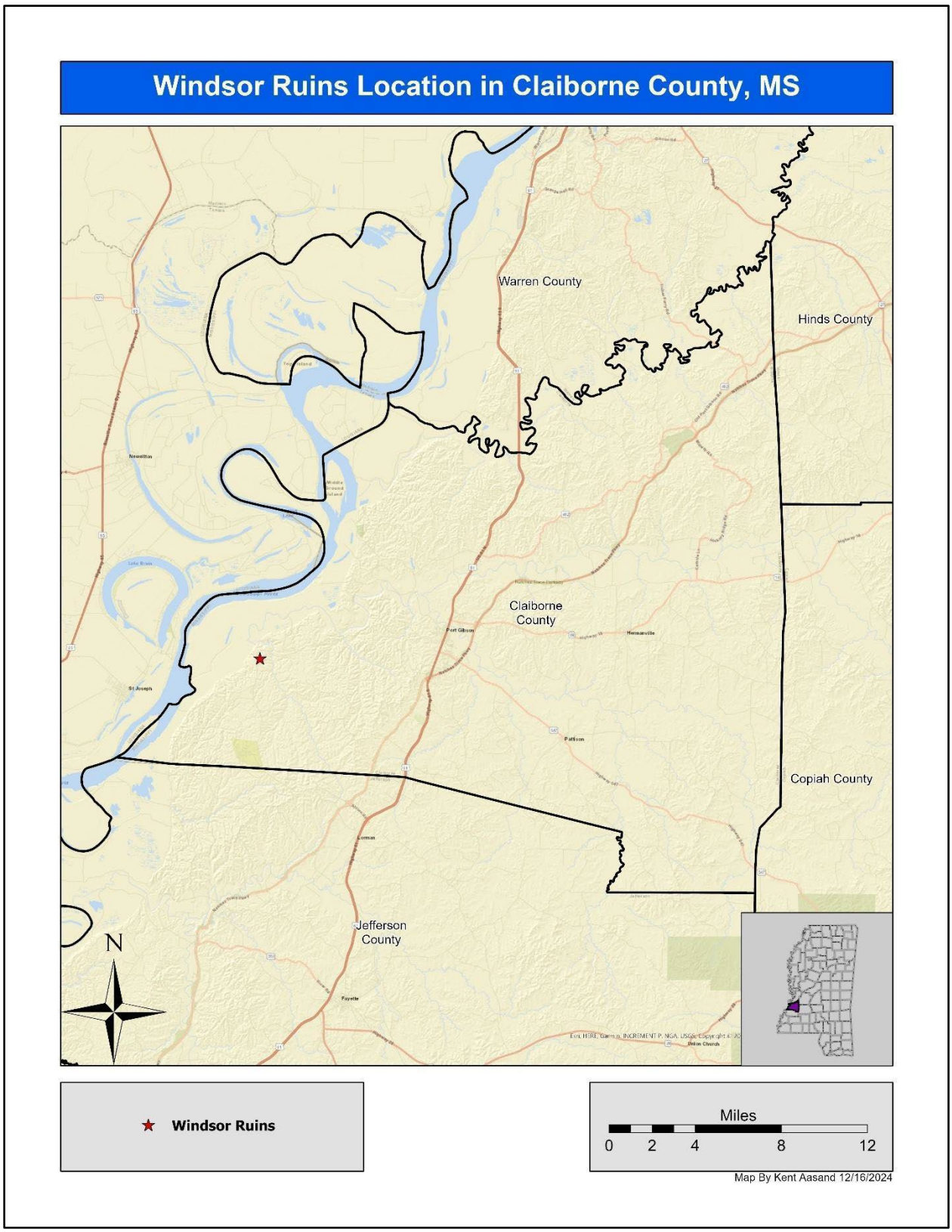


Figure 5: Windsor Ruins location in Claiborne County and Mississippi.

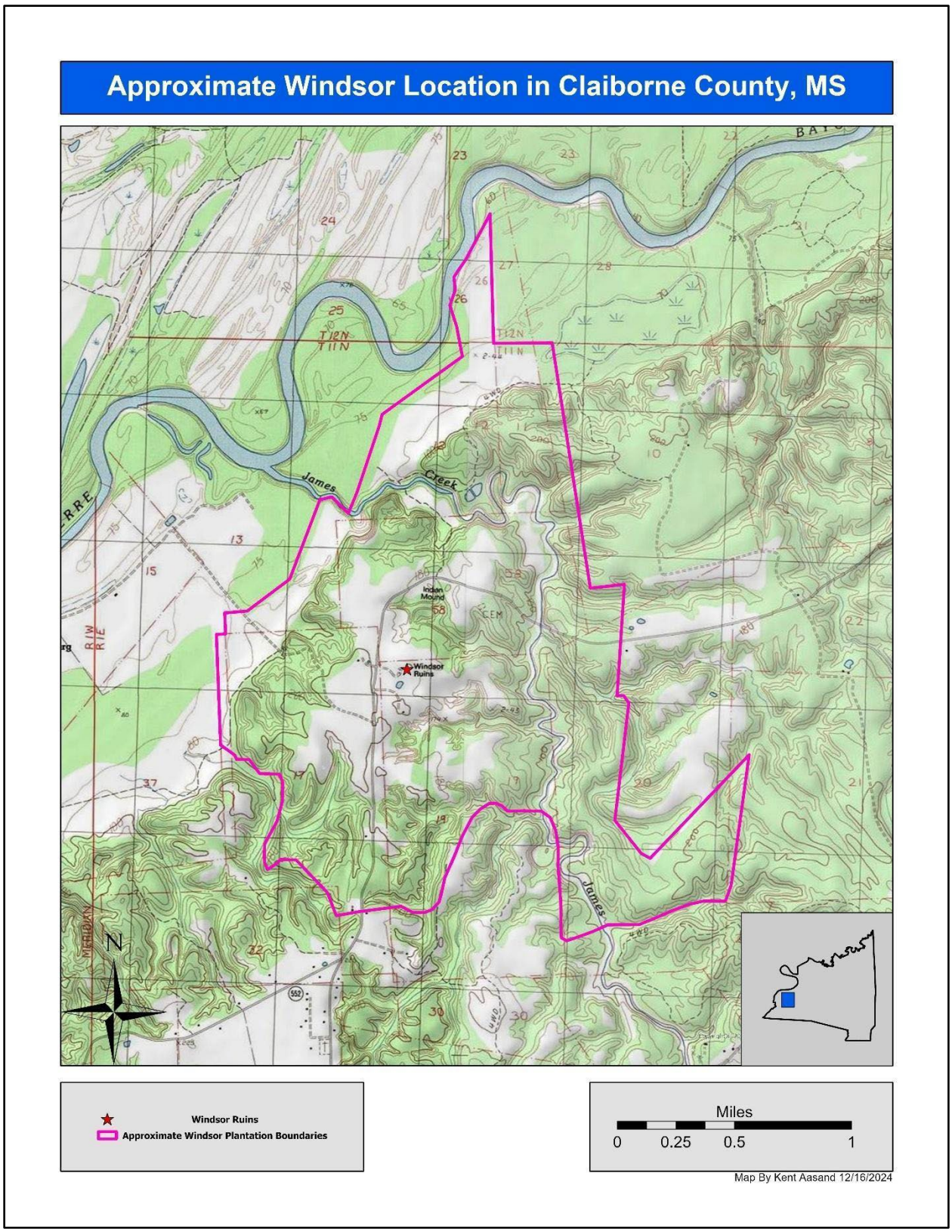


Figure 6: The Windsor Plantation boundaries in modern day Claiborne County.

Figure 7: Unmanned Aerial Vehicle (UAV) photo from center of Windsor Ruins, yellow circle shows Bruinsburg, where the Mississippi River was in the 1860s. The purple circle shows a structure in Louisiana, on the western bank of the river. The black circle shows St. Joesph, LA, 7 miles away. Image is original work of the author.

In 1802, Claiborne County was established as the fourth county of the Mississippi Territory, and was named for the second territorial governor, William C. Claiborne. The county grew to be a large agricultural plantation center. By 1860, the county contained at least 305 plantations containing over 400 acres of land and was one of the largest cotton producers in the state, ranking 14th in the production of cotton in the state, which was the largest cotton-producing state in the nation (Mississippi Encyclopedia Staff [MES] 2019). In the antebellum south, the cotton plantations cannot be mentioned without acknowledging the evils of human slavery, and Claiborne County is no different. By 1810, the county had an enslaved population of over 3,000 individuals, which rose sharply to 12,200 by 1860, and comprised 78.6% of the population of the county (Hergesheimer 1861, MES 2019).

As mentioned above, the area of the state that Windsor belongs to is known as The Natchez District, at least in terms of plantation regions. This area consists of Adams, Amite, Claiborne, Franklin, Jefferson, Warren and Wilkinson counties in Southwest Mississippi (Kaye 2007: 2; Singleton 1991: 20-24; Young 2004: 67). The area comprising the Natchez District, centering around the Natchez in Adams County, is one of the oldest regions of the state, which was settled by the French in the 1700's. Slavery was used as a way to support farming even then, with the predecessor of Natchez, Fort Rosalie, participating in the practice. In 1784, under Spanish rule, almost a third of the approximately 1,500 colonists in the area were enslaved (Singleton 1991: 21). Natchez served as the capital of the Mississippi Territory (comprising then of Alabama and Mississippi) from 1798 to 1803 and was the capital of Mississippi from its creation in 1817 until 1822 (MES 2025).

By the time Windsor was constructed in the early 1860's, the city of Natchez itself was the fourth richest city in America and contained the second largest slave market in the south, Forks of the Road (National Park Service 2024; Scarborough 2018). By 1835, a ship containing 400 enslaved people would leave Virginia for New Orleans every two weeks, before they were sent to Forks of the Road. Not only were fieldhands and servants sold here, but a there was a popular market for light skinned or mixed-race enslaved women dubbed "Fancy Maids". These women were sold here as part of the institutionalization of sexual abuse of enslaved people (Baptist 2001; Buckner 2018; Kaye 2007: 52-53). In Adams County, 70% of farmers owned over 50 enslaved individuals working their land, with only 10% not owning any (Singleton 1991: 22). In 1850, of the 71 plantation owners who owned over 250 enslaved people in the state, 55 of them lived in Natchez and the surrounding area. This contributed to the city recording the highest concentration of millionaires in the United States in the 1850 census (Scarborough 2018). These

practices produced the culture of plantation owners that Smith Coffee Daniell II was born into, and was a participant of, in 1826.

The Community Surrounding Windsor

The community that Smith Coffee Daniell II was a part of followed many trends that were seen in the Mississippi Territory at this time. As the land in the area started to open up from the Treaty of Fort Adams, and with new inventions such as the cotton gin and steamboat, farmers started to be able to easily migrate to the area. With the passing of the Act to Prohibit the Importation of Slaves of 1807, the declining soil quality of the Chesapeake Bay and Virginia areas because of a century of tobacco farming, and a rising slave population, wealthier farmers flocked to Mississippi in droves (Barnett and Burkett 2001, Grivno 2015).

The slave-owning plantation owners that settled near what would be Windsor did not deviate from this. The main families of the Daniells, Freelands, Magruders, and Skinners all came from Maryland between the late 1810s and early 1820s (Barnett 2002: 22, Townsend et al. 1978: 5). Although usually more than a mile from their closest neighbors, these families created a close-knit and interrelated community both culturally and financially. Their homes were usually one and a half to two story homes on brick piers and were deemed "no way comparable to the comfort and good society of Natchez and their extravagant mansions", although this could be questioned with the establishment of the very large Windsor manor. They used religion and social functions, which were also heavily intertwined, as a vehicle of community, establishing the New Bethel Church in 1828. As the community needed education, these families, and others of note in the area (such as Issac Ross and Rush Nutt), established Oakland College, which is

now Alcorn State University (the first land grant black university in the U.S.), just five miles south of the Windsor Ruins Site (Barnett 2002: 22, Townsend et al. 1978: 6-8).

While the families would go to social and religious functions, their plantations were small towns consisting mostly of enslaved individuals. Here, almost all of these enslaved people were hard at work in the fields (Vlach 1993: 18), although some of the enslaved individuals were trained as artisans, cooks or house servants. The vast majority of them were worked dawn to dusk in the fields for most of the year by what is known as the gang method of slavery (Libby 2018). This gang method of labor used groups working together to work at a pace deemed "acceptable" by a white overseer or another enslaved person known as a driver. If some worked too slow, or in a method viewed as unacceptable, they were punished, usually via whipping (Libby 2018, Littlefield 2010). These overseers and drivers allowed the plantation owners to have a degree of separation from the cruelty they profited from. Vlach puts forward the idea that it may have even been more beneficial for a plantation owner to have a cruel overseer. Occasionally, during a public display of cruelty by the overseer, the plantation owner would come in from time to time to stop the punishment and possibly punish the overseer for their acts. This practice allowed the plantation owner to be painted as a kindhearted and benevolent person to not only the slaves but also reinforce this idea in the minds of the slave owners themselves (Vlach 1993: 135). This context for the site needs to be kept in mind observing the history of the Windsor Ruins.

Natchez District Plantation Archaeology

Despite the immense number of plantation manors and grounds in Mississippi that existed in the period leading up to the American Civil War that still exist today, surprisingly little

archaeology has been conducted in Mississippi in regard to plantation archaeology and African American archaeology, which are completely intertwined. This inattention to plantation contexts in Mississippi archaeology persists despite calls for action by both Theresa Singleton in 1991 in the journal Mississippi Archaeology, and Amy Young in 2004. Young states in her 2004 work *The Beginning and Future of African American Archaeology in Mississippi* that there were three issues causing this divide. The first, which the author of this thesis can verify have rectified, is that the Mississippi Department of Archives and History (MDAH) would not issue site numbers to any site that dated after 1840. The second is that contacting some of these descendant communities can be difficult. Lastly, the state is divided into numerous geographic regions, with each slightly different from the others (Young 2004: 67). Although there appears to be somewhat of a rise in this area of study in the state in recent years, it is an area of archaeology that needs to be further investigated, especially considering its significance and the long-lasting effects that the time period had on the region, many of which can unfortunately still be felt today.

In addition to the excavations that were conducted at Windsor discussed in greater detail later in this chapter, only a few academic investigations were carried out in the Natchez District. Very few of these investigations were conducted at the "big house" but more were focused on the surrounding landscapes. The most in-depth investigations published were those by Young who worked on Saragossa Plantation outside of Natchez (Young 1999a; Young, Tuma and Jenkins 2004; Tuma 2006), and at Mount Locust (Young 1999b), located in Jefferson County on the Natchez Trace Parkway. Other investigations include Concord Quarters in Natchez (Bronfman 2022), and Prospect Hill in Jefferson County (Krumcke 2021; Lambert 2024). These last two research sites have been at the forefront of public, community driven archaeology in the state led by Dr. Shawn Lambert (Bronfman 2022; Lambert 2024). Although not in the Natchez

District, LeeAnne Wendt's work at the Strawberry Plains plantation in northern Mississippi is worth mentioning, where she was able to discern landscape layouts of houses for the enslaved population and for the tenant farms that followed (Wendt 2014). Wendt's findings have been used in interpretations of landscape archaeology at plantation sites throughout the state, including Prospect Hill and Billups Gate in Lowndes County (de Gregory et al. 2022; Krumcke 2021).

Although GPR data have been gathered from both Concord Quarters and Prospect Hill by Dr. Shawn Lambert at Mississippi State University, those results have not been published as of the writing of this thesis (Lambert 2024). The only accessible GPR report published on one of these sites was by New South Associates (NSA). This was conducted at Mount Locust in 2024, where NSA were attempting to determine if the knoll the house sat on was a Native American mound, or a natural hill or knoll. In addition to the GPR results, a magnetometry study was also performed (Lowry et al. 2024).

Smith Coffee Daniell II

Smith Coffee Daniell II was born in 1826 to plantation owner Smith Coffee Daniell and his wife, Priscilla Magruder Daniell (née Skinner), the first of four children. Unfortunately, when his father died in 1836, the younger Smith was the only surviving child of the couple. Daniell and his mother then went on to live with his uncle, Thomas Freeland. Freeland had just been widowed, so in a move convenient for all parties, his mother raised Daniell alongside his cousins, including Daniell's future wife, Catherine Skinner Freeland (Townsend et al. 1978: 8-11). Freeland was a wealthy plantation owner and lawyer who owned the 2,200 acres of land that would become the Windsor Plantation. In 1846, Daniell went on to graduate from Oakland

College, and the University of Virginia Law School in 1849. The year 1849 was an important landmark for Daniell, as not only did he move home with his law degree to control his estate, but he married Catherine Skinner Freeland (Barnett 2002: 23, Townsend et al. 1978: 9). At this time, Daniell already owned several plantations in Mississippi, 146 enslaved people, and was elected to the Oakland College board in 1850 (Townsend et al. 1978: 11). He then became the manager of his father-in-law's plantations after Freeland became ill. When Thomas Freeland died in 1856, all of his land went to his three children, and Daniell bought it from them (Townsend et al. 1978: 9-11). By 1860, he owned almost 21,000 acres in MS and LA, and at least 300 enslaved individuals (Barnett 2002: 22; Jeffries et al. 2024; Logan 1980: 253).

In 1858, Smith Coffee Daniell II ordered construction on the house that he would become known for, the Windsor manor. The house was built from 1858 to 1861 using the labor of his enslaved workers, supplemented by artisans from Maryland, Massachusetts, New York, and even Europe. Cast-iron stairs and column capitals were made in St. Louis, then shipped down the Mississippi to Bruinsburg, a few miles to the west of the manor. The bricks were made on site by enslaved labor, and there was an enslaved blacksmith on site. The Windsor manor cost Daniell around $175,000 at the time, and adjusting for inflation, would be around $6,800,000 today according to Alioth Finance. At least $15,000 was spent furnishing it, and at the time of its construction, it was one of, if not, the largest antebellum mansion in the state (Barnett 2002: 22-23; Townsend et al. 1978: 12-14). Although all architectural drawings of the manor have been lost, past archaeological investigations and eyewitness testimony gives us some idea of what the house looked like and what the rooms were used for.

Description of Windsor Manor

Windsor manor was an impressive sight for the 1860s. The manor, set on 2,200 acres of plantation land, was a three and a half story structure[2], that measured approximately 17,000 ft^2. The most noticeable and impressive feature of the manor are the only remains of the house today, the 29 Corinthian columns that surround the house. Each column is 1.1 m in diameter, 12 m tall, made with brick and stucco, and each one has a cast iron capital on top. Out of the 29 columns, 23 remain today, upon 3 m high and approximately 1.5 m wide plinths, with massive chain walls below to help stabilize them (Hahn 2013; Barnett 2002: 28-29; Townsend et al. 1978: 12). The house had four sets of ornate cast-iron stairs, as well as porches and balconies that wrapped around the entire structure. On top of the house was a cupola that viewed the Mississippi River and far into Louisiana. It is family legend that Mark Twain came and marveled at the view, mistaking it for a college. The manor itself was square with a service ell, the main section being 20 m^2, and the service ell being 18 m x 26.5 m. It had approximately 23 rooms split between the three main stories (Barnett 2002: 29-30; Townsend et al. 1978: 12-14). For the outside of the mansion, a single historical image of the manor exists, recovered in the early 1990s, a drawing done by Henry Otis Wright of the 20th Ohio Infantry, believed to have been sketched during his stay on the grounds during the American Civil War (Figure 8) (Barnett 2002: 27-28). The grounds also included a smokehouse, blacksmith shop, a brick kiln, carriage houses, barns, three steam cotton gins, and enslaved people's quarters. Other than the smokehouse, the locations for any of the outbuildings appear to be lost, and to cause insult to injury, there appears

[2]It is sometimes referred to as a two and a half story structure, as the raised basement was considered the ground level at that time. The half story was never finished and is still a question of what it was used for.

to be no record of any investigations into their locations (Barnett 2002; Townsend et al. 1978: 14).

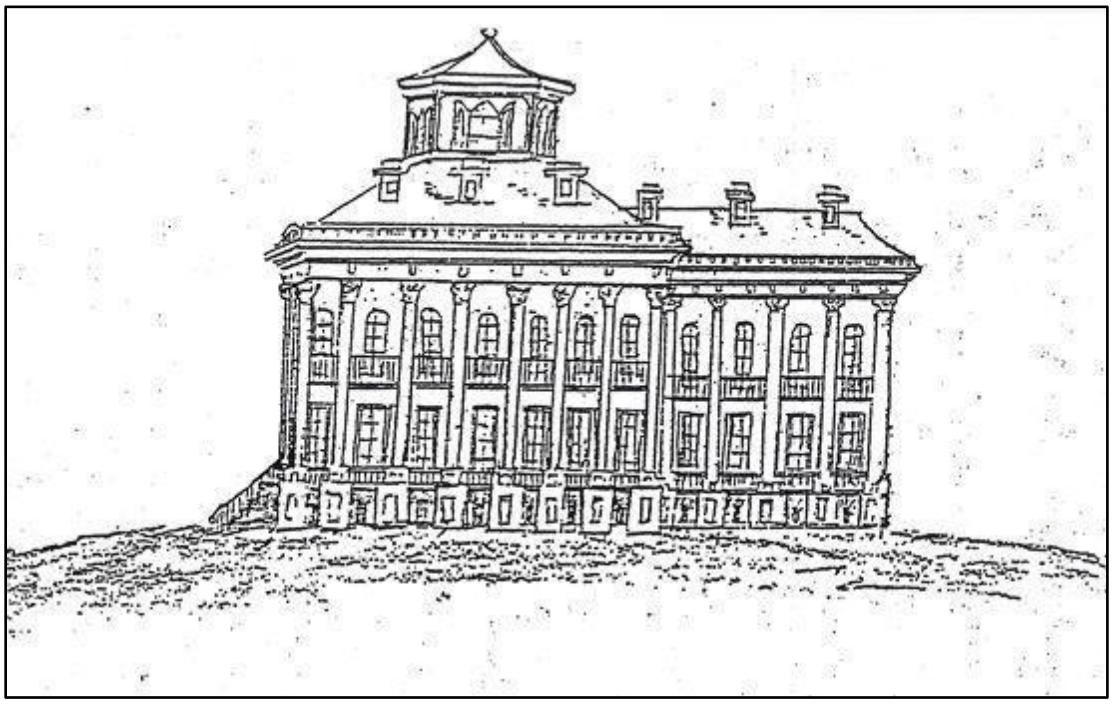


Figure 8: Henry Wright's drawing of Windsor. Image courtesy of MDAH.

The house had several conveniences that would have made life more comfortable for the Daniells. One of the most intricate and most known conveniences was the water storage and drainage system. Water in the area was not the best, having high sulfur and iron content, and due to the Loess soils, wells had to be dug to at least 100 to 200 ft (30.5-61 m). Many houses in the area use rainwater collection systems for their water (Bicker et al 1966: 50-57; Stephenson et al. 1928: 113-116). To hold the rainwater, somewhere in the attic of the mansion was a large wooden cistern. This holding tank would have been made out of wood with a lead lining (McKee 2014: 53; Nicholson 1854: 166). Allegedly, the tank was 8 ft wide, 20ft long, and 5 ft deep (2.4 m x 6.1 m x 1.5 m), although these measurements are questionable with the immense weight of the water that it would have held (Barnett 2002: 3). Nevertheless, the tank would hold the water

until it was needed, and after use, the water would travel down a series of pipes to either a drainage outlet northeast of the manor or perhaps to one of two other cisterns in the immediate grounds (for a total of three cisterns), one of which has been capped and modified but still viewable today, just 4.6 m (15 ft) north of the service ell (Barnett 2002: 30-33). It is unknown if the house had flushing toilets, but other nearby manors, such as Melrose, had them at the time, so it would not have been impossible (NPS 2021). In addition to the plumbing, an indoor kitchen on the ground floor was connected to the 1st floor dining room not only by stairs in the back, but also by a dumbwaiter that was used to transport food up to the first-floor dining room (Barnett 2002: 30, Townsend et al. 1978:80). It is currently unknown whether the kitchen had running water, but the location of a drain on the northwest corner of the kitchen provides evidence supporting the possibility.

Although there are no photographs of the house, there is a good alternative to achieve a likeness in one's mind. Forks of Cypress, a plantation home in Alabama, looks very similar to what Windsor would have while it stood, with its peristyle colonnade and dimensions similar to Windsor (Figure 9). The manor is a little older than Windsor, built in 1830, and without the ground floor basement, the cupola, and with Ionic columns instead of Corinthian, but with the colonnade, it can help with visualizations of the house when it stood. Forks of Cypress burned down in 1966 (Farris and Binkley 1997: 6).

The only evidence that exists of any room function is that collected from Smith Coffee Daniell IV (1885-1970), grandson of Smith Coffee Daniell II. He was born in the house and lived there for the first five years of his life. With an engineering background, he drew the basic floor plans as he remembered, but unfortunately, he left off any mention of the half story or the cupola (Figure 10) (Barnett 2002: 30-31).

Figure 9: Forks of Cypress in 1939. Image courtesy of the Library of Congress. Credit to Frances B. Johnston.

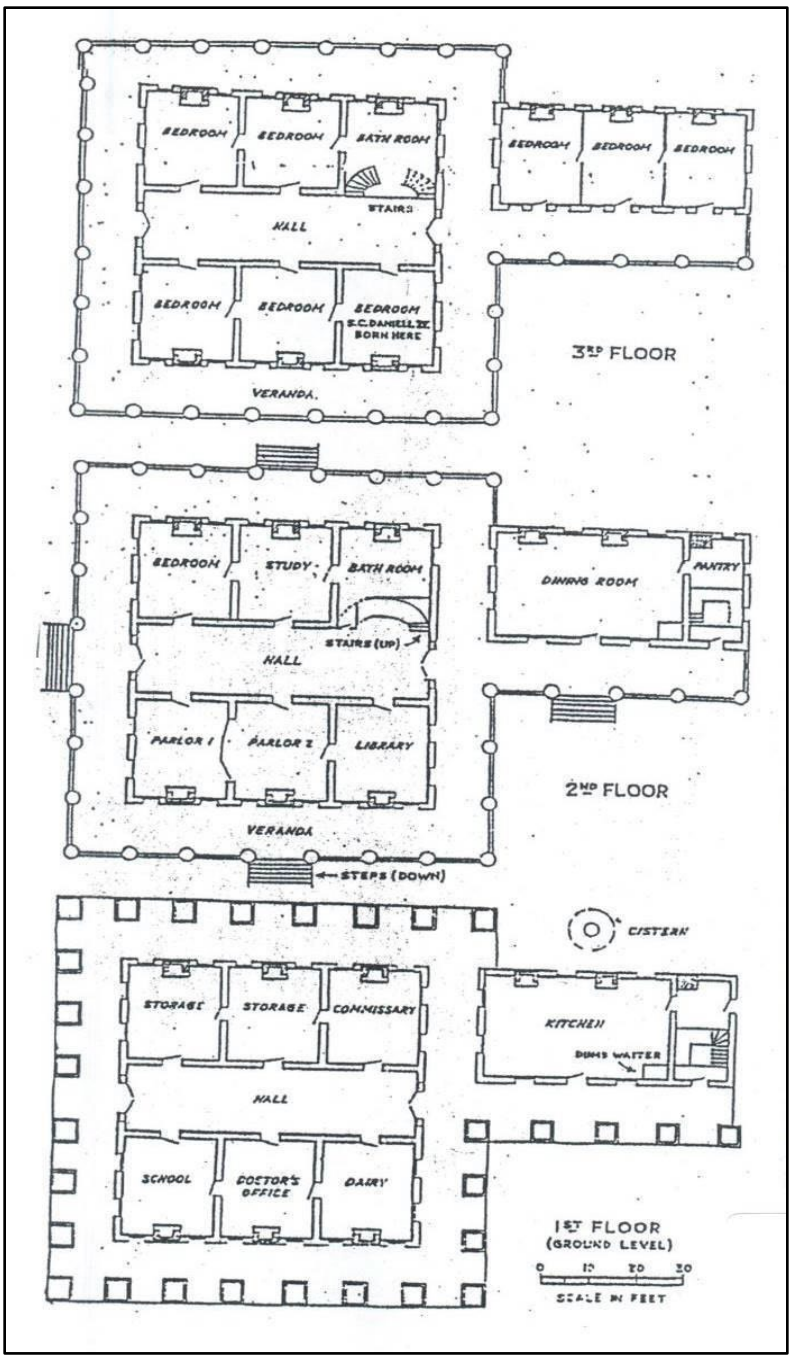


Figure 10: Smith Coffee Daniell's floor plan of Windsor. Image courtesy of MDAH.

Death, Debt, Fire, and War Come to Windsor

Smith Coffee Daniell II did not get to appreciate his home at Windsor for long. He passed away at the age of 34, just a month after moving into the home in 1861, from what appears to be

an illness he had suffered for several years. Not long after, creditors came to the house seeking debts that he had incurred in life. The legal litigation to divide his estate then took place over the next 18 years (Townsend et al. 1978: 14-15). The largest event to occur next was associated with the American Civil War. From several accounts, the Confederate troops would use the Windsor manor from time to time as a lookout, with its view of the river. That would change on May 1st, 1863 (Townsend et al. 1978: 15).

After months of trying to get a foothold into Mississippi, General Ulysses S. Grant of the United States Army finally made headway with a large amphibious landing at Bruinsburg, MS on the night of April 29th, 1863, with 22,000 troops. Their first stop along the way was Windsor. General Grant set up headquarters for that evening at the manor, one of his first in Mississippi during this leg of the campaign, and his troops set up on the grounds (Barnett 2002: 23; Townsend et al. 1978: 15, 22). During the Battle of Port Gibson, which cemented the US's foothold in the state, the house was used as a field hospital, treating up to 500 wounded, and for a time, some of the dead were buried on the premises, they were later relocated. The Daniell family were confined to the 3rd floor during this time. The United States Army also confiscated three steam gins, 165 horses and mules, and burned 3000 bales of cotton, according to the family (Barnett 2002: 23).

During reconstruction and the following years, the Daniell family and their descendants were able to keep in relative comfort, but not the opulence they had the years before, as much of their wealth during that time was because of the human beings they held in bondage. They leased out their land via the sharecropping system to the 150 freedmen who remained on their property after the war (Barnett 2002: 24). Their bad luck took another turn on February 17th, 1890, when a fire broke out in the attic during renovations and burned the manor to the ground. Fortunately, no

one was injured. The only remains of the manor that were left standing were the columns, and the cast iron staircases. Where originally 29 columns stood, 23 still remained by the1970s, with the plinths of another five remaining. Most of the stairs appear to have been either looted as souvenirs or broken, with one exception. One of the staircases was moved to the Oakland Memorial Chapel at Alcorn State University, where it is still used today. After the fire, the property was passed down the family lines, with sharecroppers and tenant farms still dotting the landscape until the family donated it to the Mississippi Department of Archives and History (MDAH) in 1974 (Townsend et al. 1978: 24-25).

Windsor Today

Over the years, the ruins became a popular attraction in Mississippi. The ruins were used as a setting for the 1957 movie, *Raintree Country*. In 1970, the first conservation effort of the columns took place, and in 1971, the manor was added to the National Register of Historic Places. MDAH was given the property in 1974. Unfortunately, the owners who donated the property used a front-end loader and backhoe to take a lot of debris from the house location and locate it as a debris push pile located approximately 35 m north of the columns in the tree line. In 1985, it was deemed a Mississippi Historical Landmark. The site appeared in its 2nd movie in 1996's *Ghosts of Mississippi* (Barnett 2002: 25, 32). The columns were restored again from 2016 to 2024, with new barriers erected, and a walking trail around the ruins created (see Figure 1). New interpretive signs were also erected at the site in March of 2025 (MDAH 2025). For the 51 years that MDAH has owned the site, the interpretations have changed significantly. Originally it was focused on the spectacle of the ruins, Smith Daniell II, and the manor itself while it stood. The interpretation has now shifted so that it is now more inclusive, establishing the stories of not

just the Daniells, but of the enslaved peoples who lived there and the tenant farmers who came after (Barnett 2002; Jefferies et al. 2024).

Previous Archaeological Investigations at Windsor

Four archaeological investigations transpired at the Windsor Ruins Site. The first, conducted in 1976, when John Milner & Associates, in a full archaeological, architectural, and historical analysis of the site, attempted to establish the floor plan and other features in and around the manor. The site ruins were divided into 10-foot squares, and overall, 18 units along with numerous trenches were excavated (Figure 11, Figure 12). During the course of these excavations, they reconstructed the floor plan of the manor, realizing that the foundation was split into two parts, with a central gallery. In addition, Milner & Associates were able to discover remnants of the utilities at Windsor. This included two drain boxes, each with three drains (of which two were connected), several pipes which were stacked on top of each other in some cases, two cisterns (one to the north of the service ell, and one to the southeast), and a connected "wooden trough" that led out to the northeast of the site, before emptying into a field. One of the only known outbuildings was also discovered in these excavations, with a smokehouse discovered right off of the service ell (Townsend et al. 1978: 33-59).

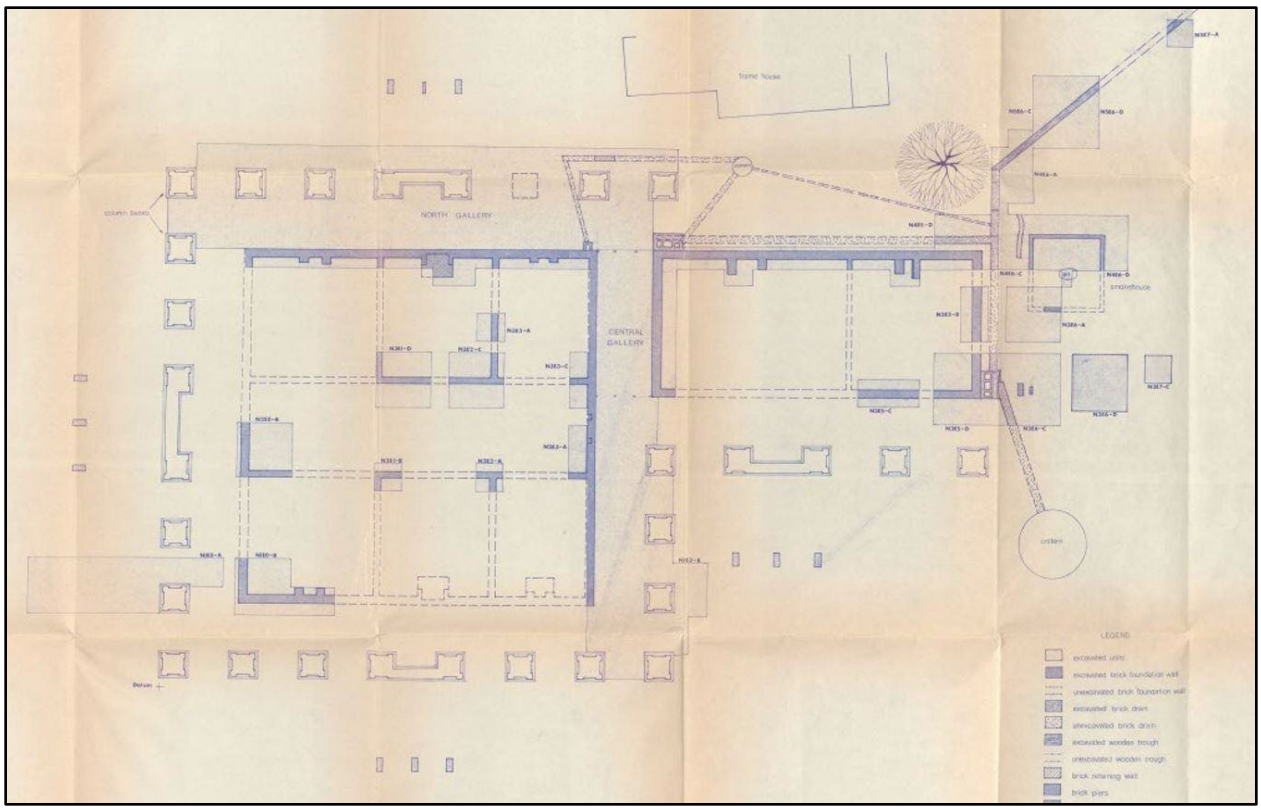


Figure 11: The excavation and floor plan map of the Windsor Ruins site by Townsend et al. 1978. Areas in blue were excavated, and foundations in dark blue were uncovered. Labeled as "Figure 9" in the report. Image courtesy of MDAH.

The second investigation, conducted in 2013 by Coastal Environmental Inc. conduct a series of investigations to establish the subsurface support of the columns, partially in preparation for proposed stabilization work for the columns. Two columns that are only partially intact were chosen to be excavated (Figure 12). They used Townsend's 1976 datum, and their grid system, while swapping back to metric for their units. After the excavations, it was shown that there was a massive continuous brick chain wall around the perimeter of the house, measuring approximately 1.44 m wide at the top and 2.10 m wide at the base. The depth varied on the column it was supporting, and the chain wall would widen at each column to accommodate it. Unexpectedly, it was discovered that the chain wall supporting the columns on

the north side of the house were originally too small for the monumental columns and had to be corrected in the field by adding an additional brick to the foundation. As such, the columns had a much stronger foundation than originally assumed (Hahn 2013).

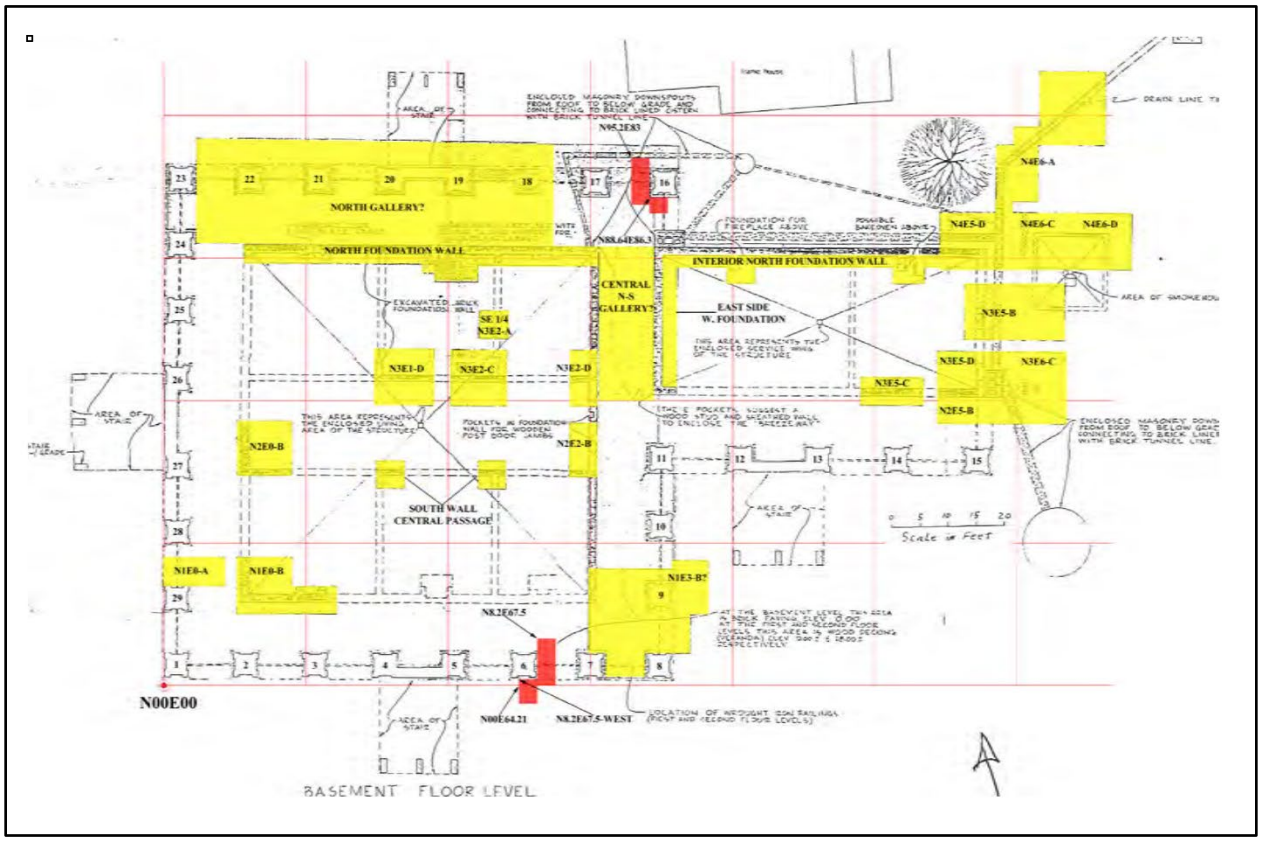


Figure 12: The 2013 excavation map. The spaces shaded yellow are from Townsend's 1976 study, while the red are from the 2013 excavation. Image courtesy of MDAH.

In 2022, a small shovel test survey was carried out around the footprint of the ruins to establish areas for a proposed restoration to use and to establish the areas for the machinery to avoid. In addition, a proposed laydown yard was investigated (Figure 13). A total of 12 shovel tests were planned, out of which 10 were successfully excavated. Two brick features were found and investigated, one in the laydown yard, and another just north of the northern staircase foundation. These features were most likely to be part of a brick path, either a patio walkway or driveway for the carriages. Due to the weak GPS signal at the site, they are listed as separate

spots in Figure 11, although they were located in proposed shovel tests. Both appear to be part of the old road or possibly a brick walkway or patio associated with the house. It was determined that although the features were present, the stabilization efforts for the site could proceed (Aasand 2022).

In 2024, after the stabilization efforts on the columns were successfully completed, the site received a new walking trail and interpretive signage. The area of the proposed walking trail was initially probed, and no features were found during that part of the investigation. During the monitoring of the construction of the trail, a brick structure was encountered behind the service ell. MDAH archaeologists visited the structure and realized during excavations that it was part of the smokehouse, and although it was the same building, it was most likely a different corner than the one found by the Milner & Associates crew in 1976. The smokehouse was uncovered and partially excavated by MDAH archaeologists. It was then photographed, recorded, and had a photogrammetric model created (Figure 14). Once recorded, the smokehouse was reburied to preserve the feature (Wendt et al 2024).

The history and the context around the house are vast but needed for any appreciation of the structure or the work done around it. The ruins and the plantation grounds still have a rich potential for archaeological and historical knowledge. MDAH will hopefully conduct additional work there to learn more about this fascinating site. To help show that there is still research potential at the site, this project should be thoroughly thought out with the data collected as meticulously as possible, the details of which will be provided in the next chapter.

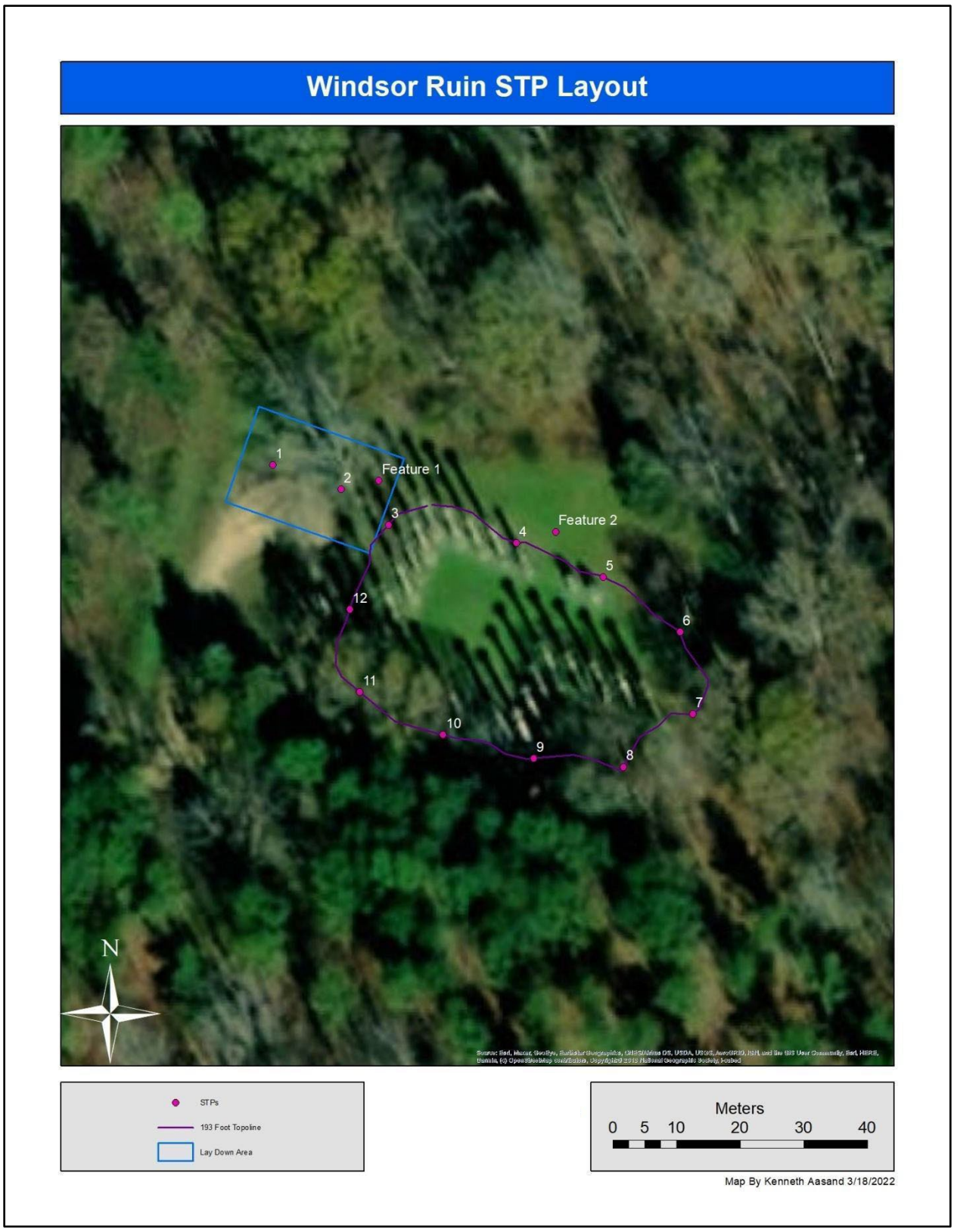


Figure 13: 2022 shovel test locations. Image original work of author.

Figure 14: Photo of smokehouse feature exposed in 2024. Image original work of author.

Chapter 4: Methods & Data Collection

In regards to the research questions proposed in Chapter 1, "if ground-penetrating radar (GPR) data collected at the Windsor Ruins site (22Cb602) reveal infrastructure that offered methods of modern comfort of the time that assists with determining, or establishing, new understandings of the house?", having good GPR data is paramount to the answering of the question, if the survey cannot be planned out, the data will be useless to analyze for any indicators of the items concerned about in the research question. This chapter will go into the survey methodology and specifics used in the data that were collected for these questions.

Pre-planning

Before any survey was conducted in the field, several hours of planning went into the endeavor. As a GPR survey needs to be conducted via transects collected in a grid, making sure that our grid was properly planned helped to optimize the resulting data. Deliberating on all the different methodologies and ways that the undertaking could be conducted, it was decided that the survey would be constructed into two survey grids. One of these would be the main house block consisting of a 25 x 25 m grid named Windsor Grid 1, while the other would be the service ell, which was a 13.5 x 20 m grid, named Windsor Grid 2 (Figure 15). It was also decided to have the main section of the grids be inside the columns, with their interior surface used as the boundary for the grid. Unfortunately, it was originally planned to have the grid outside of the columns, but technological restrictions constrained the survey to the interior areas of the columns.

For transects, it was determined that due to time and energy constraints, a 0.5 m transect interval would be adequate, although admittedly, a 0.25m transect interval might have resulted in clearer data. With the drainage systems discovered in the 1978 excavations that almost all appeared to run along a north/south axis, the transects would be running along the grid in east/west directions. Although it would be optimal for the grid to be in a diagonal orientation, because of the obstacles presented by the columns, the grid's cardinal directions were the best course of action for data collection. Lastly, it was determined for any large reflections of interest (ROI) that appeared to be largely metallic in nature, a Garret AT Pro metal detector would be brought in and used to confirm the metal and attempt to determine the type of metal involved.

Figure 15: Windsor Ruins survey grids, taken via a DJI Mavic Mini UAV. Image original work of author.

With a GPR survey, transects can be recorded in two different configurations, unidirectional and bidirectional (Figure 16). Unidirectional consists of the transects being conducted in the same direction every time. Bidirectional, also referred to as "zigzag", is when the transects are conducted from alternating sides, in a "back and forth" method. For example, the first transect would be from A to B, but rather than walking the unit back and conducting the next transect on A, the transect would be conducted from B to A, with the third transect being collected from A to B. Although bidirectional is faster and less demanding on the operator, it provides the user with potentially poorer quality data and can lead to other issues in data processing (Leach 2021: 42-43). As such, the transects for this survey were conducted in a unidirectional manner, with the centerline between the two grids acting as a starting point for the transects. For the grid, the y-axis is oriented with the grid north/south, and the grid east/west axis is the x-axis, although this was not fully recorded on the paperwork, it is important knowledge going forward.

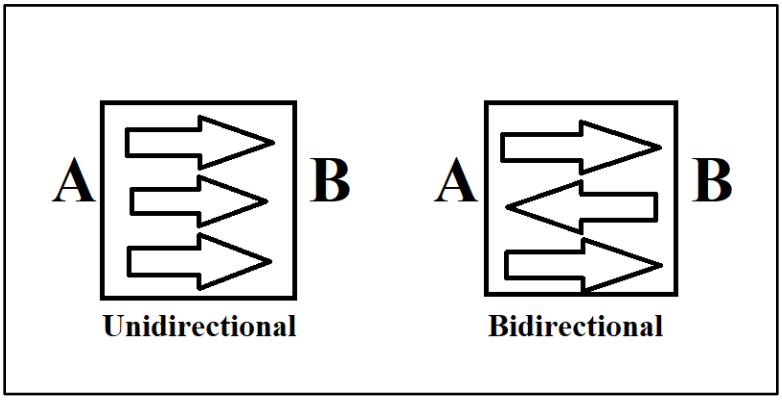


Figure 16: Unidirectional vs Bidirectional. Image original work of author.

The Survey

The survey itself was conducted over two days, October 2nd and 3rd, 2024. The first day consisted of Mississippi Department of Archives and History (MDAH) archaeologists Kenneth

"Kent" Aasand, LeeAnne Wendt, and Dakota Street. On the second day, MDAH contract worker Sarah Boone assisted with the data collection along with the team from October 3rd. A week beforehand, archaeologists inspected the site to double check measurements acquired from GIS and LiDAR data, and to check the state of the vegetation.

All GPR data were collected with a GSSI UtilityScan 350 MHz GPR unit with a Panasonic G2 Windows based tablet for recording the data. With the lawn environment, it was decided not to use the rugged cart but to go with the more traditional "lawnmower" setup. The GPS data were collected using an Emlid Reach RS2+ receiver unit, connected to either the UtilityScan unit or a Jupiter Cedar CT8X2 Android tablet running ESRI's Field Maps GIS data collection program. All points were then transferred and processed through ArcGIS Pro.

The first steps were to set up the GPR grids and stake the corners. This was done via the traditional method for the corners of the grid and confirmed with the hypotenuse method that is used in most archaeological excavations (Leach 2021). Fiberglass meter tapes were used to mark the grid boundaries, using plastic stakes so as not to interfere with the device readings. The four corner stakes' locations were collected via GPS, and then the machine was calibrated for both distance and dielectric constants. The unit was recalibrated for distance before scanning each grid (Figure 17). A dielectric constant of 8.2 was recorded for the soil, which translates to a speed of the signal to be about 10.47 cm/ns. This variable was used to calculate the depths of all reflections of interest. The starting and stopping distance for each transect was recorded. With the obstacle of the columns, the starting and stopping point had to be adjusted and recorded for accuracy and can be viewed via the paperwork located in Appendix A. Where possible, each transect was extended to the outer edge of the columns, with the longest transect extending to 26.87 m.

Figure 17: The author calibrates the GPR unit for distance. Image courtesy of Sarah Boone.

For Windsor Grid 1, which was conducted from grid east to west, a total of 51 transects were collected. Windsor Grid 2, running from west to east, was recorded on October 3rd, 2024, with a total of 28 transects. Any decoupling or any other issues during the survey were recorded in the field notes. Before any results were studied, they were processed and transferred to other software.

Post-survey Data Processing

Data Processing is exponentially more prominent and impressive in GPR surveys, especially in the 20th century. Although some of the data can be processed in the field, such as gain adjustment (boosting the dB), where the amplitude of the result waves are exaggerated to

heighten the distinction of features, many of the processes are better done with a copy of the data using a program such as Radan, GPR Process, GPR viewer or various other GPR data programs available (Conyers 2023: 118). Although some users will ultimately just follow a prescribed workflow of different methods, tools, and processes, knowing what is going on with some of the most common tools allows for much more flexibility and better results. Two main processes that were performed on the data here were bandpass filtering and background removal. Bandpass filtering techniques such as Infinite Impulse Response (IIR), are one of the most popular and easiest techniques, where a range of frequences are entered. Then, a large amount of noise outside of this range is filtered out (Leach 2019:3-4; Leach 2021: 26-27). Radan 7 comes with an option to view the radar data in a frequency spectrum. The spectrum view can be used to narrow down the frequencies that should be included on an IIR filter. Since GPR units run around a central frequency range, anything outside that range is likely to be outside interference. After which, the data can then be amplified via gain, but with the bonus of not accentuating a good amount of the noise, although this can remove wanted data (Leach 2019:3-4; Leach 2021: 26-27). If this does not remove the noise, then perhaps the background removal tool would work better. This method calculates the average pulse along the radargram and then removes it. Unfortunately, this can create false reflection positives or eliminate some linear features that may not need to be removed (Goodman and Piro 2013).

For this project, each individual transect was imported into GSSI's Radan 7 software. From there, a digital version of the GPR grid was created, with attention being observed to the stop and stop distances. This is a 3-D grid in the Radan program. Both grids were merged into a single 3-D file, so Grid 1 and 2 could be interpreted at the same time. After these data sets were merged, the raw transect data were passed through an IIR filter, then applied a Noise Band

Removal Algorithm (a type of background removal tool), and lastly, an eight-point exponential range gain was applied across the data. After visually inspections of the 2-D radargrams, it was reexamined as a top-down time-slice image, and cross checked with radargrams for reflections of interest (ROI). Any ROIs were also viewed in the GPR Viewer program to get a different perspective on them. The locations of any ROIs were recorded for ground investigation, which will hopefully occur at a later time.

Additionally, any time slices of interest were exported from Radan using a comma-separated values (csv) format ASCII table, giving x, y, and z coordinates and intensity values. These points were loaded into ArcGIS Pro GIS software using the table-to-point tool. The points were then reassembled into a raster image using the Kriging spatial analyst tool. The raster was then georeferenced with the data points taken in the field. The raster pixel color ranges could be reassigned as needed to highlight different aspects of the intensity for analysis. Once all the data has been collected and processed, the resulting data must be analyzed to gain any conclusions. The next chapter will give the results of the study, in just descriptions and locations of the reflections of interest observed. Chapter 6 contains the analysis of the items described in Chapter 5, as well as using them to answer the research questions posed earlier.

Chapter 5: Results

During the two days of survey by MDAH archaeologists at the Windsor Ruins site (22Cb602), a total of 79 GPR transects were collected. Of these, 51 were located in Windsor Grid 1 and 29 were contained in Windsor Grid 2 (Figure 15). The full-page scans of the paperwork for these transects can be found in Appendix A, and a list of the processing steps in Appendix B. Once the data from the two grids was combined into a single grid and processed, numerous reflections of features were apparent **(**Figure 18; Figure 19). A time-slice map depicting results from every 20 cm in depth from the surface to a depth of 3 m below surface is available in Appendix C. The most striking and eye-drawing of these reflections consists of several that come together to make an unmistakable image to anyone who is familiar with the site, the floor plan of the manor (Figure 19). It is almost as reported by the 1976 Milner & Associates excavations and of that by Coffee Smith Daniell IV's drawings. These reflections will be grouped together and discussed as a single entity.

Although numerous reflections were present, five reflections were noted as being substantial, as they relate to the research question, or suggest a significant change in the understanding of the site (Table 1, Figure 18). These reflections of interest (ROI) include unknown walls, large unknown features, or infrastructural items, with only one item, ROI 5, encountered or disturbed in previous investigations. Additionally, none of these reflections appear to be associated with looter pits. In this chapter, the descriptions and locations of the major reflections are discussed. They are analyzed in greater depth in Chapter 6.

Until ground-truthed, ROIs are only signatures of a feature that is located beneath the ground's surface. GPR data gives the individual reflections a signature based on the size and depth, and then an interpretation of the data is made. GPR interpretation requires a great

understanding of the science and archaeology of the region but there are limitations to what can be determined. Some features will be able to quickly and easily be identified correctly without doubt, such as the house foundations at this site, while others are not near as clear. Where clear interpretations are not possible, ground-truthing through excavation can provide both clarity and additional information that GPR alone cannot provide. Ground-truthing a reflection of interest is an intrusive process that impacts archeological deposits. They would also be able to expand on different items that GPR cannot, such as construction techniques, etc. The next step that should be taken at this site is ground-truthing several of the features listed below. Ground-truthing is reserved for future archaeological investigations at the site and was not carried out as part of the present study.

Finally, when viewing the data, it should be noted that the transect distance numbers shown at the top (x-axis) of the radargrams do not correlate to the feature locations on the time-slices images. The distance numbers on the top axis of the radargram refer to the distance along the transect, and not an x-axis position in the overall grid. All numbers discussed will be given as if the SW corner is the grid origin (0,0), as seen on the time-slice images. All depths are measured in meters below surface (mbs). Unless otherwise stated, the time-slice images that follow were taken at 1.67 mbs, and the thickness of all time-slices is 13 cm (7.5 cm above the target depth, and 7.5 cm below the mentioned depth).

Table 1: GPR Features and their locations

Name	Coordinates (Lat. Long.)	Grid	Feature Type
Reflection of Interest 1	31.9405770°N, 91.1295214°W	Windsor Grid 1	Unknown
Reflection of Interest 2	31.9405733°N, 91.1293793°W	Windsor Grid 1	Unknown
Reflection of Interest 3	31.9405742°N, 91.1293292°W	Windsor Grid 2	Wall
Reflection of Interest 4	31.9405278°N, 91.1292414°W	Windsor Grid 2	Intact Floor/Wall
Reflection of Interest 5	31.9405895°N, 91.1292085°W	Windsor Grid 2	Pipe

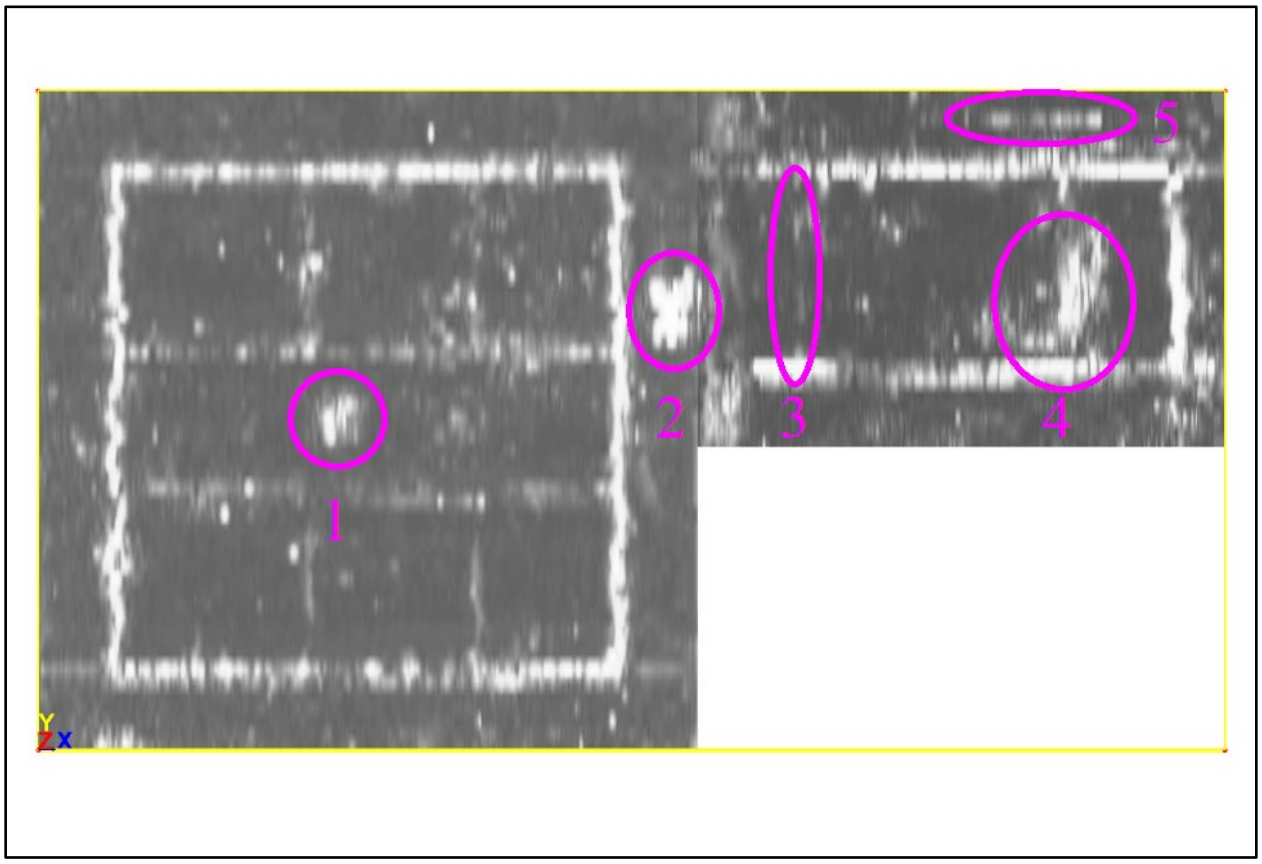


Figure 18: Time-slice overview image with the five major reflections of interest highlighted. The image is taken at approximately 1.67 mbs and has a thickness of 13 cm. Image original work of author.

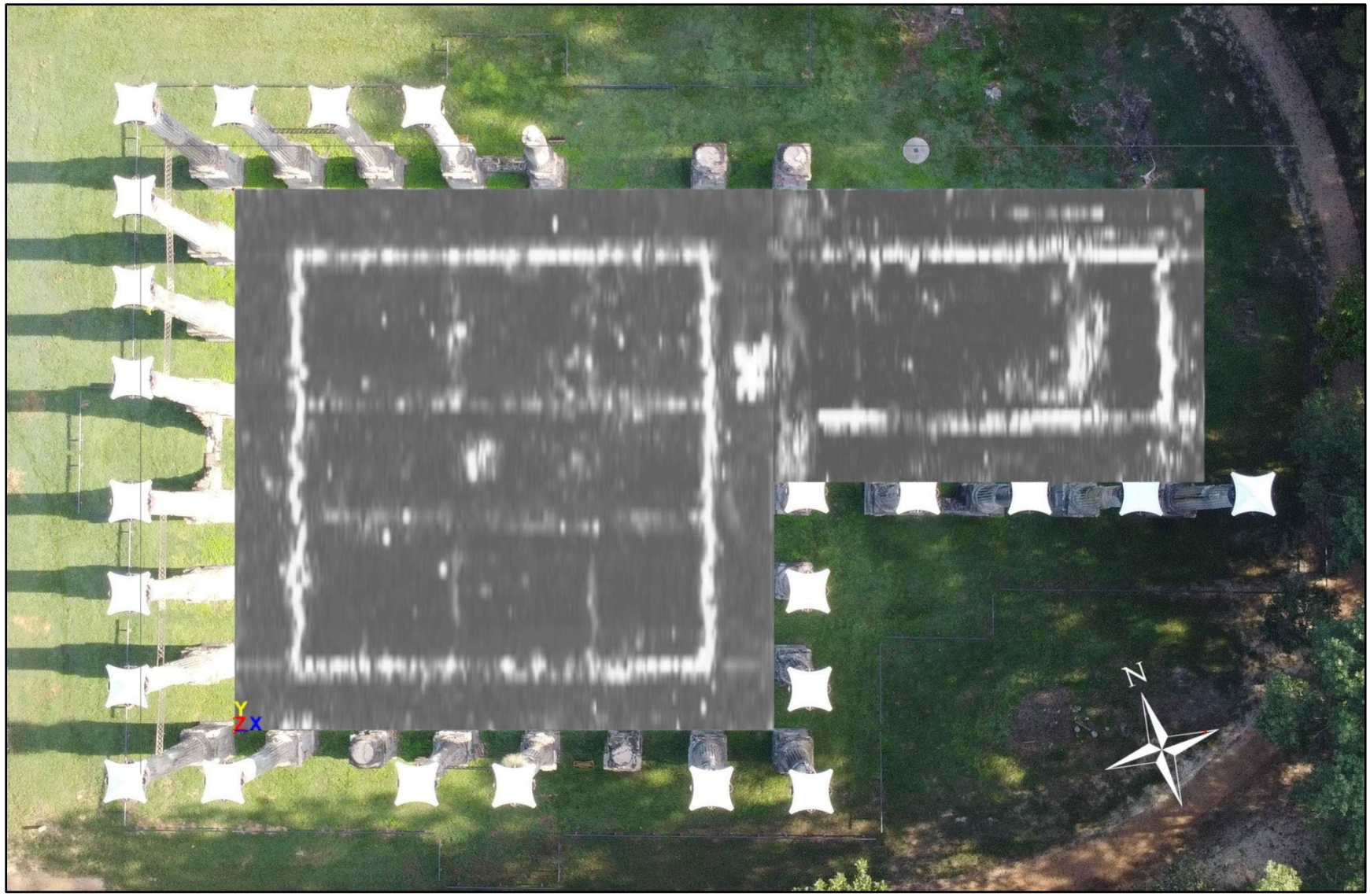


Figure 19: Time-slice overview of results of the Windsor Ruins Survey, overlaid on the survey grid aerial. Image original work of author.

Floor Plan Features

As stated above, when looking at the time-slice overview of the site, the floor plan of the manor is what immediately draws your eyes. As can be seen in Figure 20 (below), the floor plan is generally the same as described in the 1978 Milner & Associates report. It also aligns well with the drawings of Smith Coffee Daniell IV's recollections, who was born in the house in 1885, and lived there until it burned down in 1890. The sizes for the house as described in the Milner & Associates report also fit the image here. The main block of the house measures approximately 19.5 x 19.5 m (64 x 64 ft), with the service ell measuring approximately 18 x 8 m (59 x 26 ft). The foundations of the brick are clearly seen as stacked source point hyberpolas in the radargram (Figure 21), which are, as Milner & Associates reported, approximately 0.45 m or 18 inches wide. In the main block, the three rooms to either side of the central hallway are clear. The drain in the southeastern side of the service ell is also clear in both the Milner & Associates report and the GPR time-slice. Additionally in the service ell, the small outcroppings that are believed to be from the oven foundations are viewable in all three images. These foundations create a really distinct stacked set of point source parabolas in the radargram (Figure 22). Corroboration of the archaeological interpretation of the Windsor manor floorplan and archival descriptions of the house are a significant contribution of the GPR survey described in this thesis.

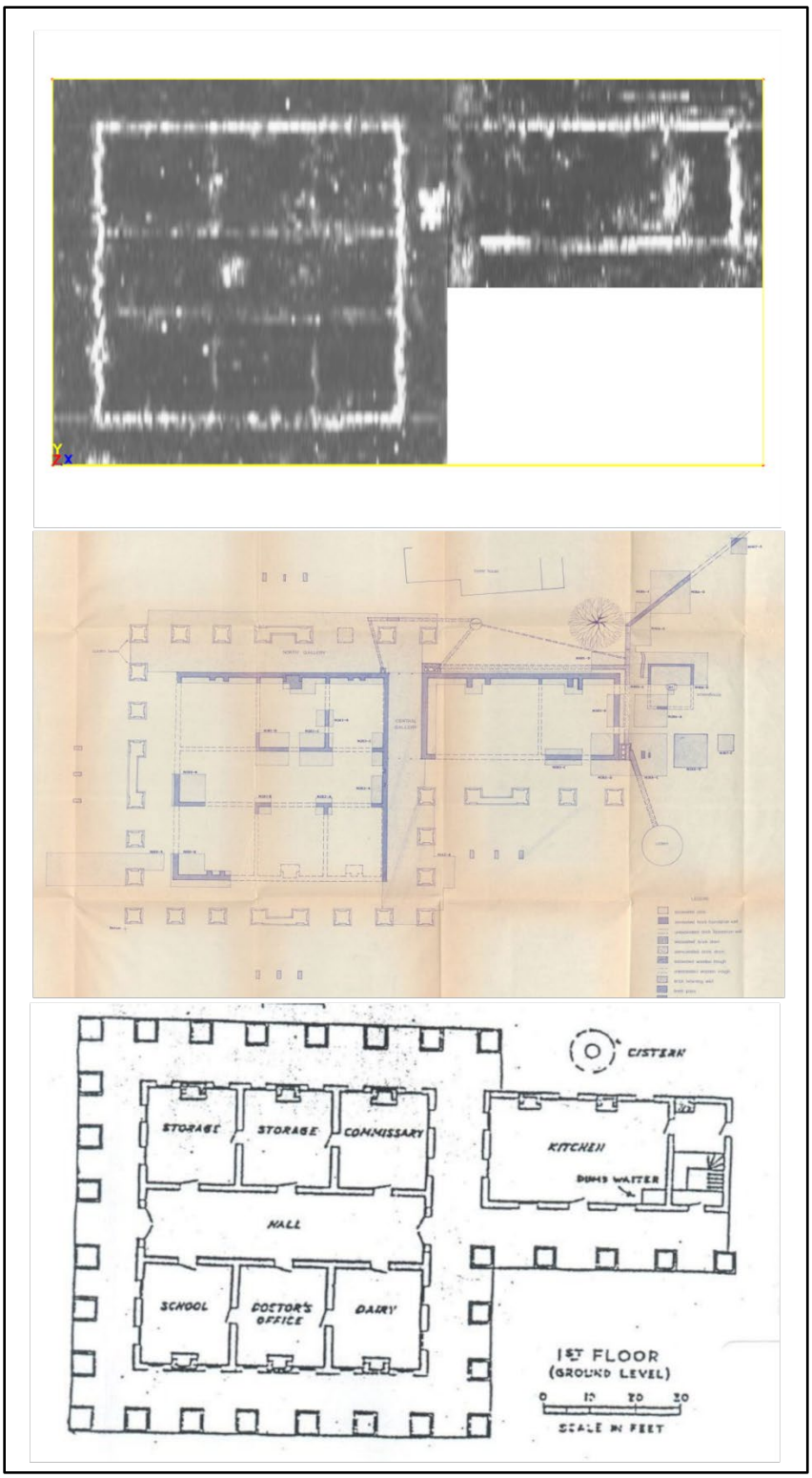


Figure 20: GPR time-slice with other Windsor floor plans. Top image original work of author. Center and bottom image courtesy of MDAH.

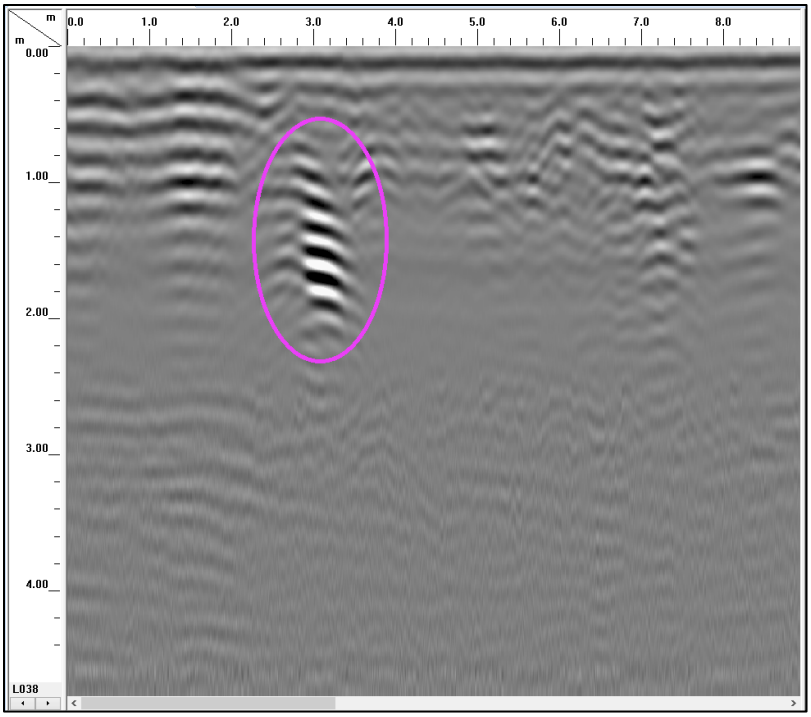


Figure 21: Radargram of the brick foundation. Image original work of author.

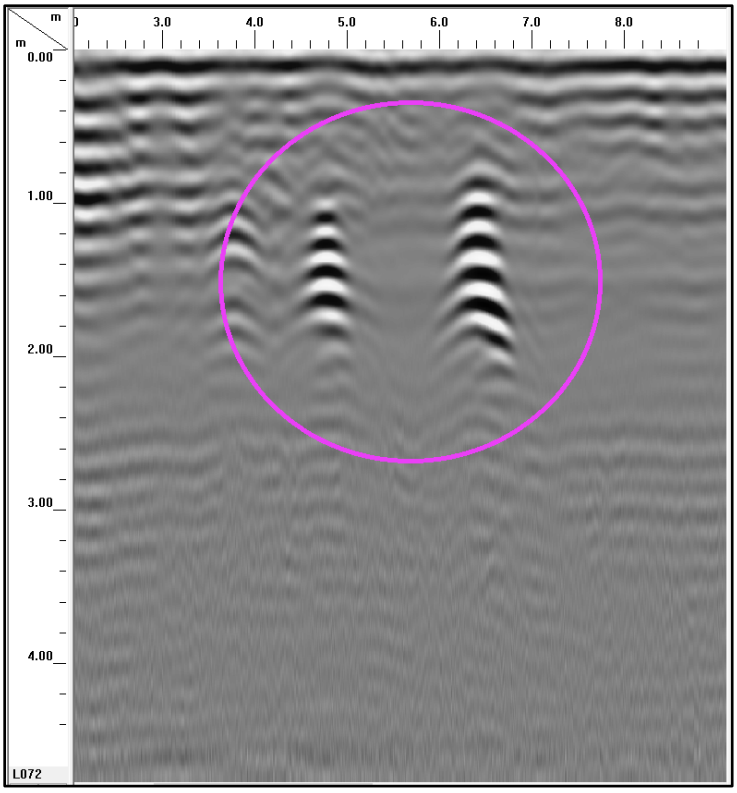


Figure 22: Radargram of oven foundations. Image original work of author.

Reflection of Interest 1

ROI 1 is a semi-circular feature located in the middle of Windsor Grid 1, the main section of the house, in almost the center of the hallway (Figure 23 and Figure 24). ROI 1 is approximately 2 m north-to-south, 1.38 m east-to-west, and 1.50 m vertically. It can first be seen on Transect 24 (11.5 m on the y-axis) and is last seen on Transect 28 (13.5 m). The feature starts at about 10.66 m and ends at around 12.04 m on the x-axis. It is located from 0.5 m below the surface to the 2 m mark. It depicts signs of multiple point source parabolas stacked on top of each other.

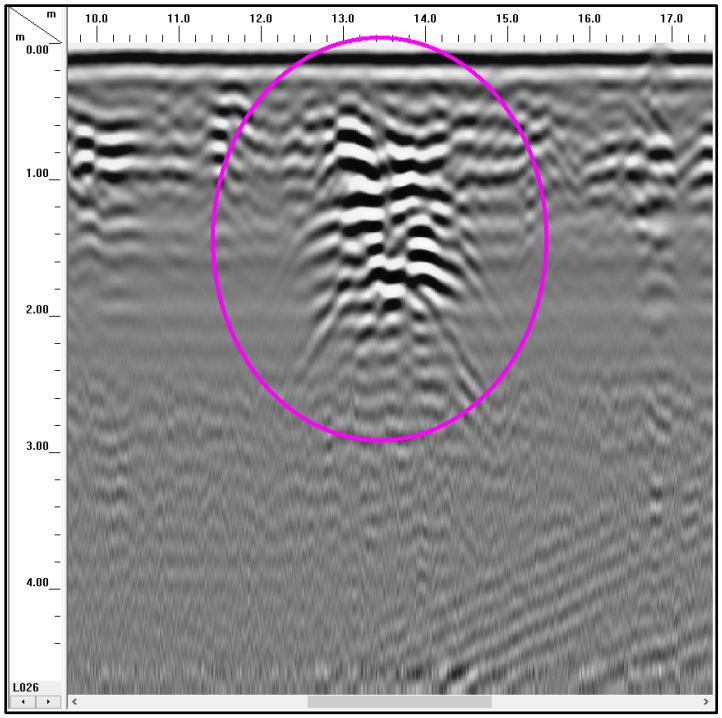


Figure 23: Radargram of Reflection of Interest 1, taken on Transect 26. Image original work of author.

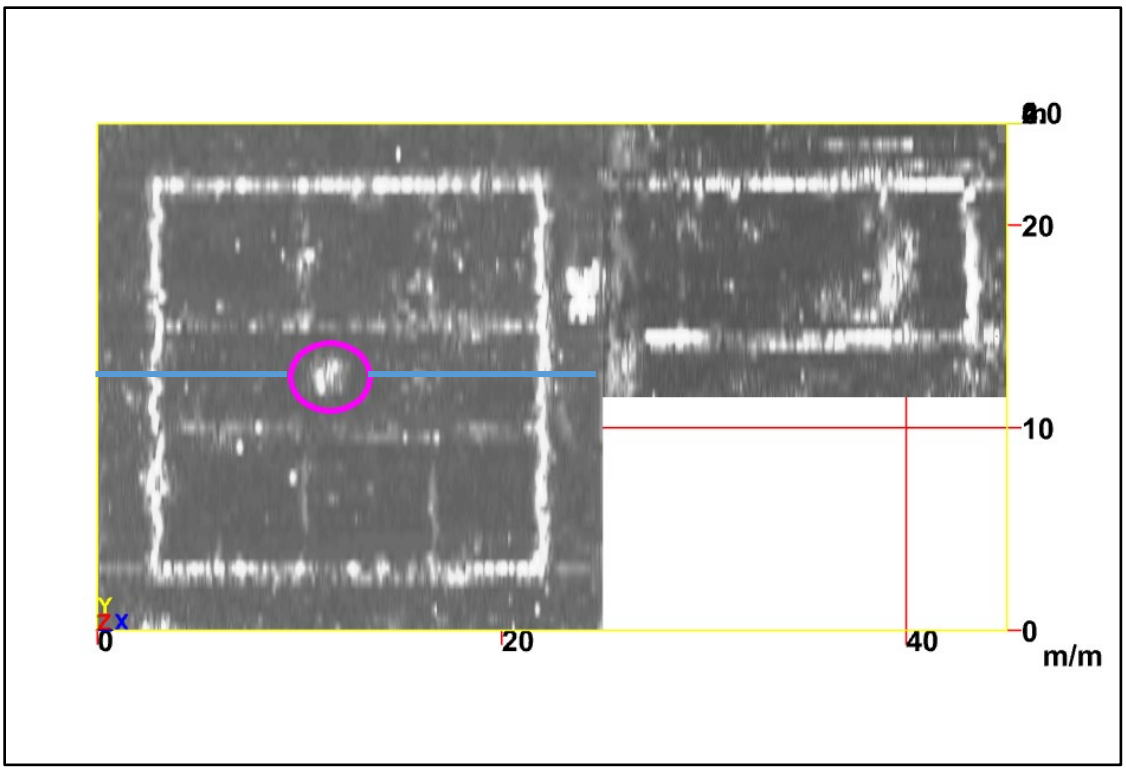


Figure 24: Time-slice map depicting Reflection of Interest 1, Transect 26 in blue. Image original work of author.

Reflection of Interest 2

ROI 2 is a rectangular reflection located on the edge of Windsor Grid 1, in what was described as the "Central Gallery" area between the main section of the house and the service ell (Figure 25, Figure 26, and Figure 27). It measures approximately 2.5 m east-to-west, 1.8 m north-to-south, and 3.5 m vertically. The feature starts at transect 32 (15.5 m on the y-axis) and is no longer present by transect 38 (18 m on the y-axis). It appears to start at 23.2 m and ends at 25 m. It is the deepest of the ROI's, going all the way down to 3.5 m below the surface. There are numerous planar reflections appearing in the radargram, with several vertical breaks between

them. Figure 26 depicts the breaks in the transect data where different materials were encountered. Due to the odd nature of this reflection, an extra step was taken with processing.

Since the ROI was already very strong at normal gain, it was decided to filter it again at a different bandwidth to get a better look at the core section of the ROI. The IIR filter was passed over the raw data at the range of 400-800 MHz to attempt to block out noise to see if the feature was still shown as a singular entity or as a broken-up entity (Figure 28). It appears to still be an entity in several parts, but still at large depth. This image depicts possible metal at ~0.20 mbs, and a highly reflective surface from 1.75 to 2.2 mbs, which could be metal or just reflective. After much speculation, a quick revisit to the site was conducted, but with an AT Garrett Pro metal detector. The feature registered immediately on the metal detector but varied in terms of its composition. Most of the recordings observed were detected to be on the higher end of iron and lower end of lead (36-45 reading on the metal detector), as well as occasional pings into the bronze/gold/silver ranges (60s and 70s on the machine).

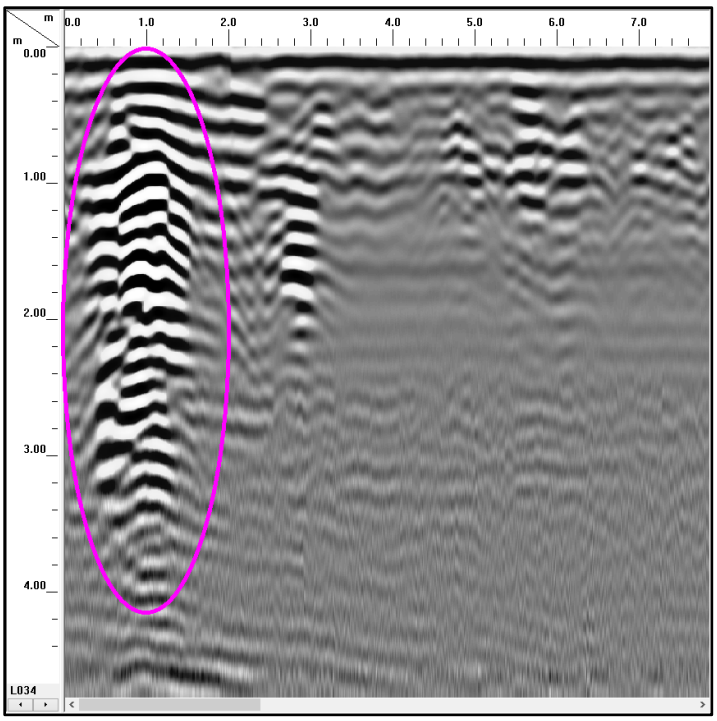


Figure 25: Radargram of Reflection of Interest 2. Image original work of author.

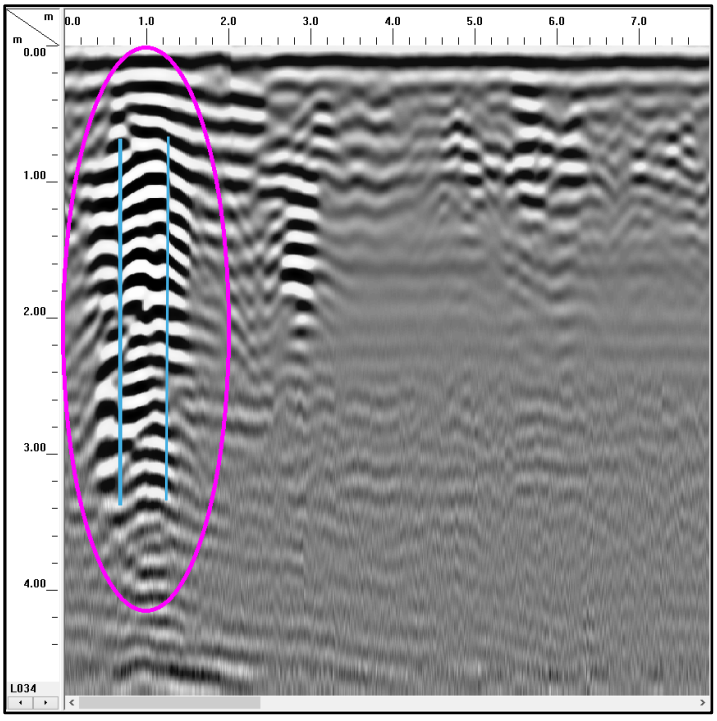


Figure 26: Radargram of Reflection of Interest 2, edited to depict breaks in feature data. Image original work of author.

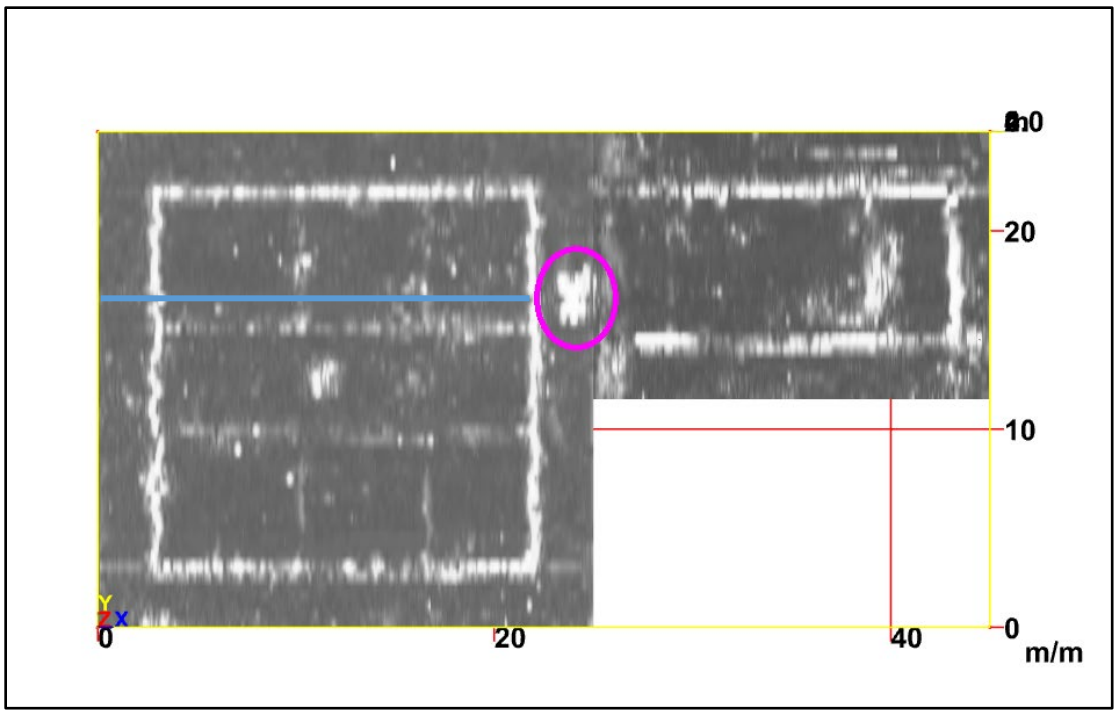


Figure 27: Time-slice map depicting Reflection of Interest 2, Transect 34 in blue. Image original work of author.

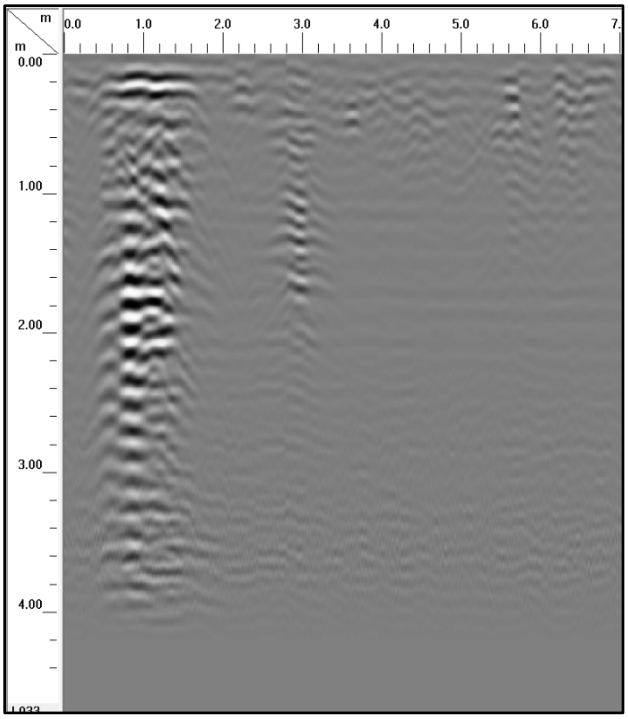


Figure 28: Radargram of Reflection of Interest 2 after IIR filter at 400-800 MHz. Image original work of author.

Reflection of Interest 3

Reflection of Interest 3 is a linear feature located in the western part of Windsor Grid 2. This area would have been the kitchen during the occupation of the house (Figure 29; Figure 30). It measures approximately 6 m north-to-south, 0.5 m east-to-west, and 2 m vertically. It runs the full length between the foundations of the service ell. It can be viewed between Transect 59 (15 m on the y-axis) and Transect 71 (21 m on the y-axis). It starts around 28.49 m and ends around 29 m on the x-axis. Different sections of the ROI can be seen at varying depths, but the reflections start at the surface, with the most reflective section from 0.60 to 0.80 mbs. The ROI is absent from the data by 2 mbs. It consists of many source point parabolas stacked on top of each other throughout the feature.

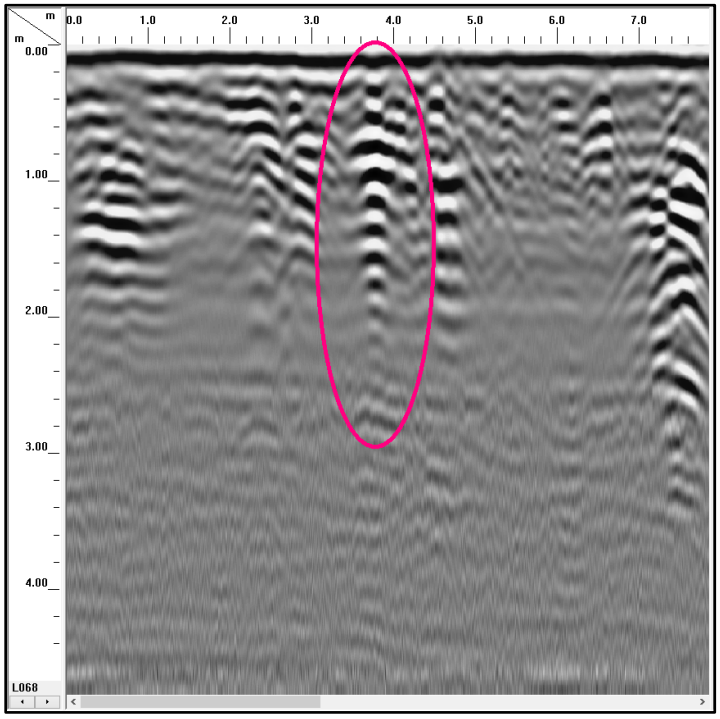


Figure 29: Radargram of Reflection of Interest 3. Image original work of author.

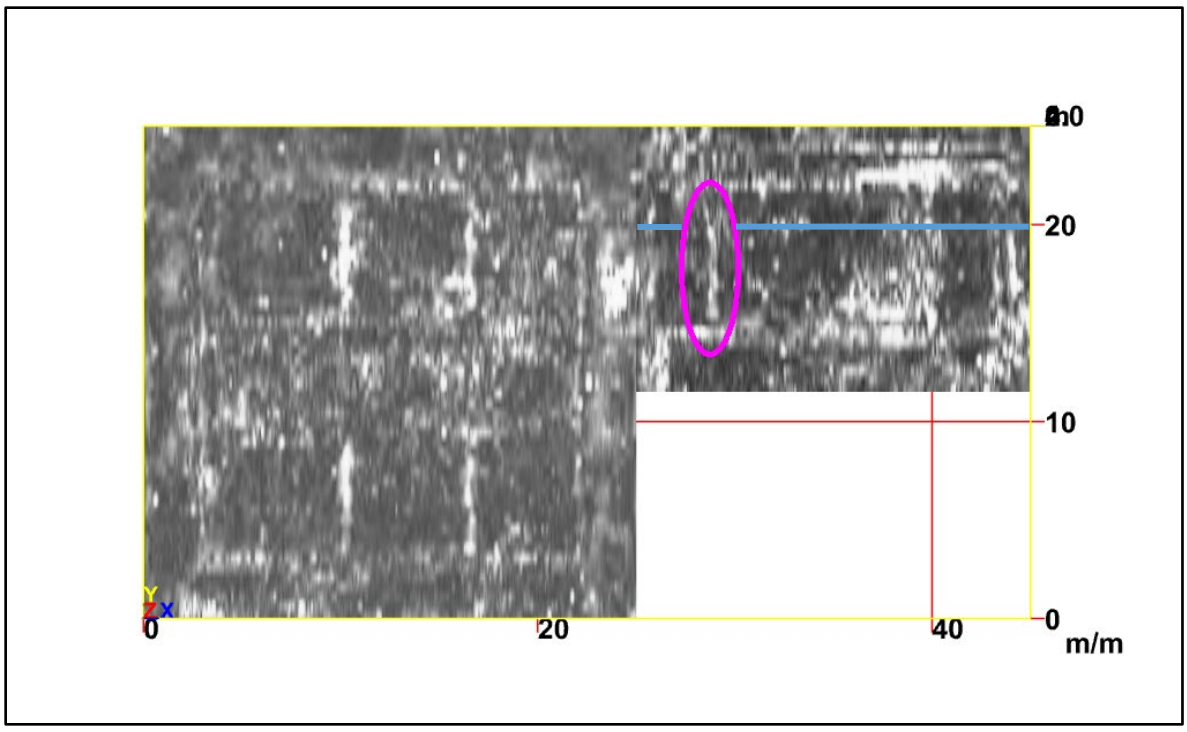


Figure 30: Time-slice map depicting Reflection of Interest 3 at 0.91 mbs, Transect 68 in blue. Image original work of author.

Reflection of Interest 4

ROI 4 is an oddly shaped feature located on the eastern side of Windsor Grid 2. It would have been located at the eastern edge of the kitchen, and the western edge of the stairwell pantry area (Figure 31; Figure 32). It measures approximately 5.57 m east-to-west, 5.5 m north-to-south, and 1.7 m vertically. ROI 4 is first seen in the data at about the 35.03 m mark to end at about 40.60 m on the x-axis. It then appears in the data on Transect 60 (15.5 m on the y-axis) and is no longer visible by Transect 71 (21 m on the y-axis). It can be observed on the radargram from about 0.3 mbs to 2 mbs in depth. It contains both flat planar reflections, metal, and point source parabolas.

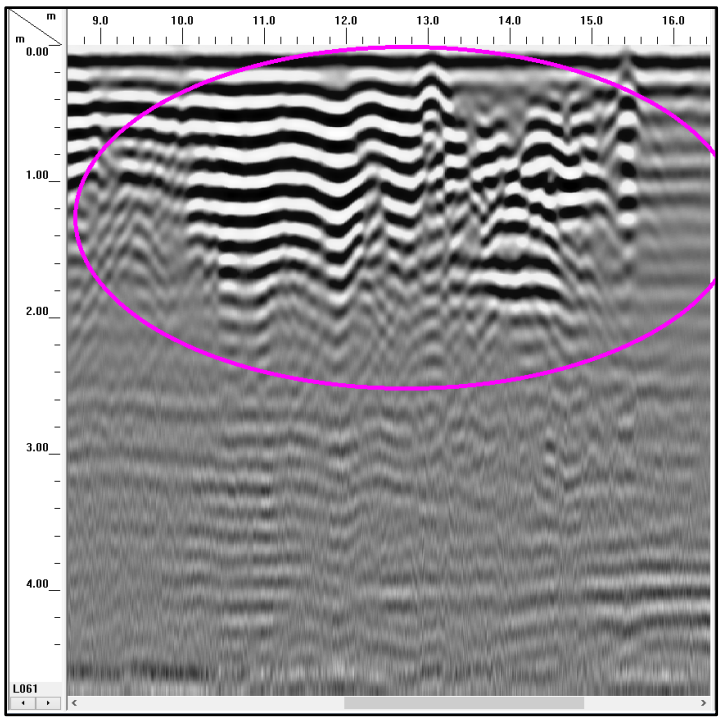


Figure 31: Radargram of Reflection of Interest 4. Image original work of author.

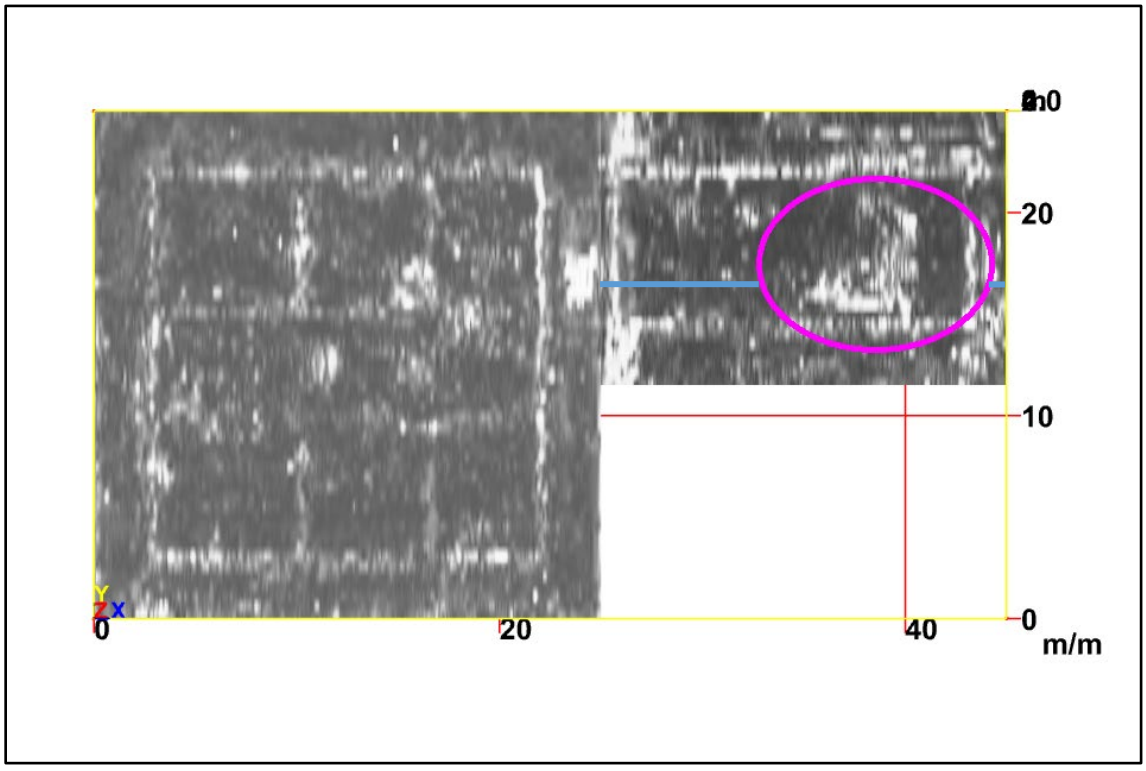


Figure 32: Time-slice map depicting Reflection of Interest 4 at 1.19 mbs, Transect 61 shown in blue. Image original work of author.

Reflection of Interest 5

ROI 5 is a linear reflection located to the north of the service ell foundation, parallel with the foundation, in Windsor Grid 2 (Figure 33; Figure 34). It only appears within a single transect (77, 24 m on the y-axis). It measures approximately 14.95 m long, going from 29.45 m to 44.4 m marks on the x- axis. The main portion of the feature is viewable from 0.46 mbs to 1 mbs but has several sections that extend down to 2.2 mbs. The vast majority of the features are flat planar reflections, with metal scattered throughout, which could cause the signal to appear more reflective than it is. The data were refined using the same procedure as ROI 2. It refined the main section of the ROI to appear at approximately 0.25mbs to 0.35 mbs, also given the size, this indicates that it is most likely metal (Figure 35).

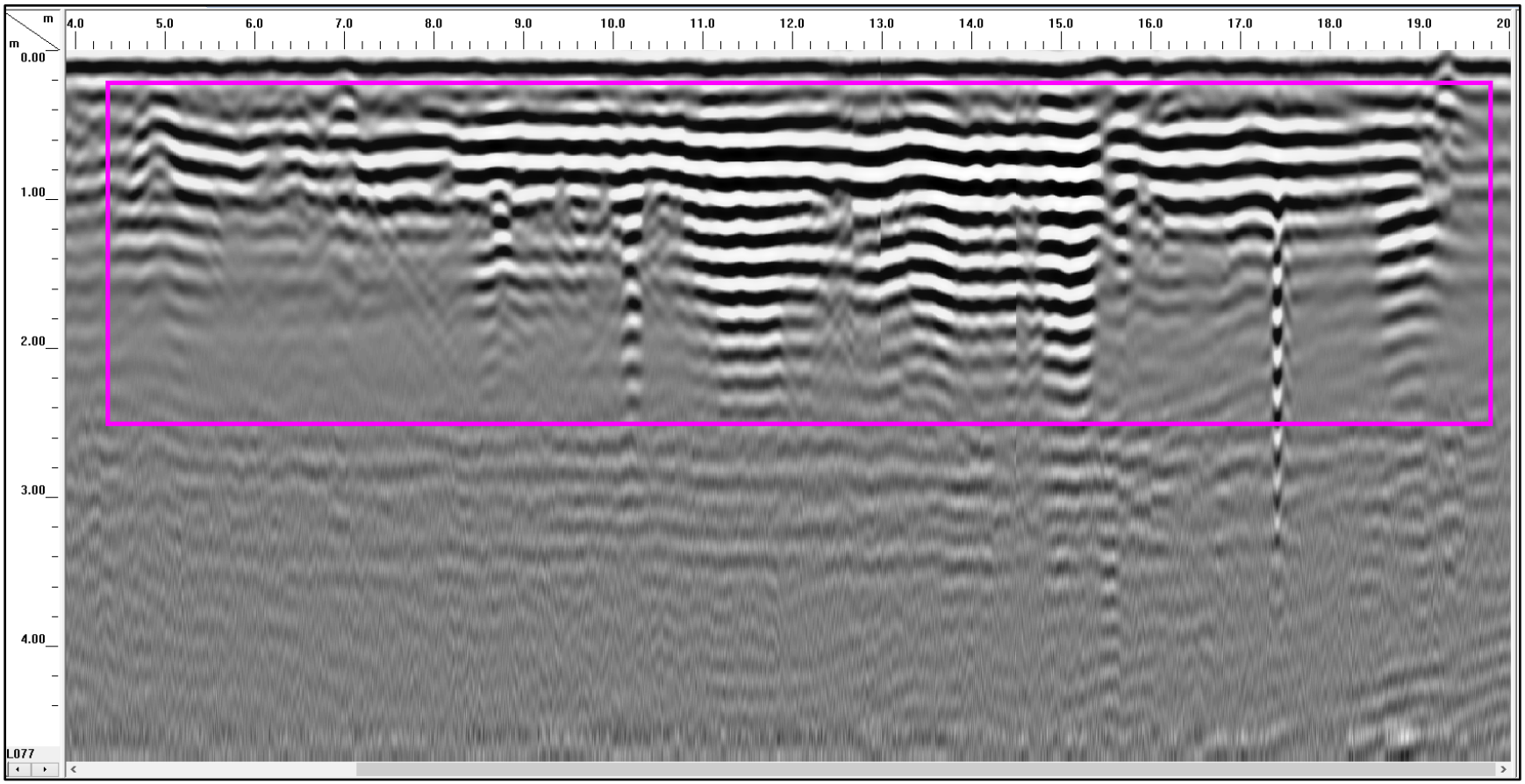


Figure 33: Radargram of Reflection of Interest 5. Image original work of author.

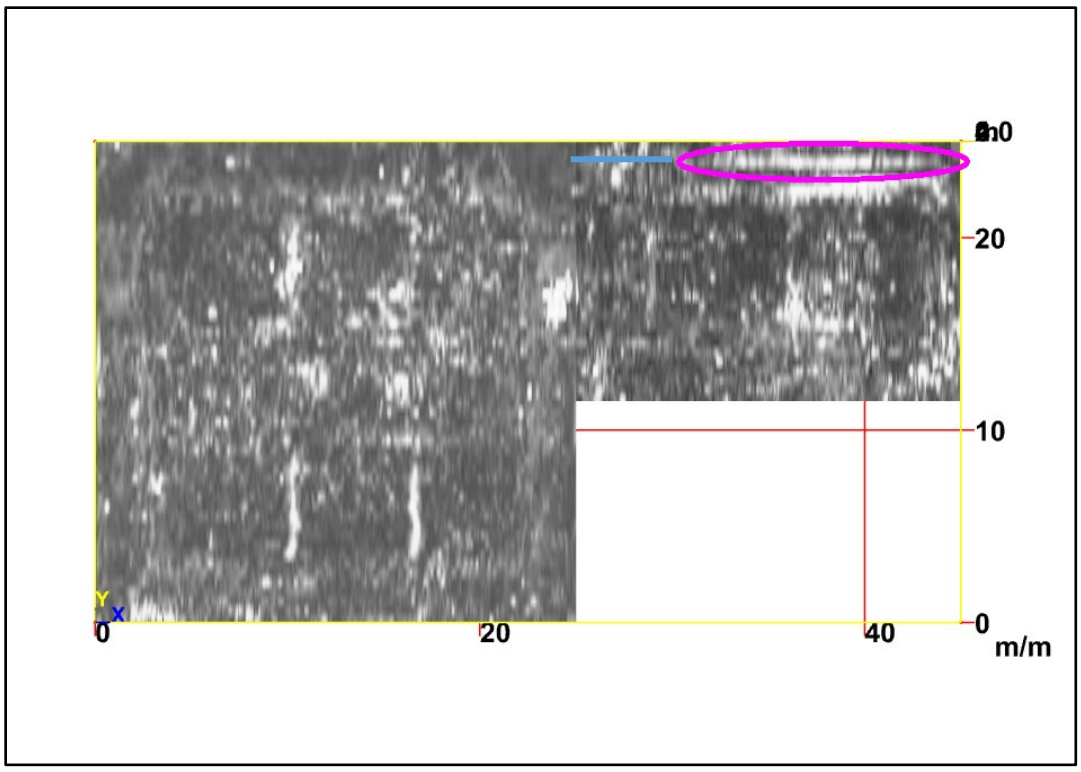


Figure 34: Time-slice map depicting Reflection of Interest 5 at 0.75 mbs, Transect 77 shown in blue. Image original work of author.

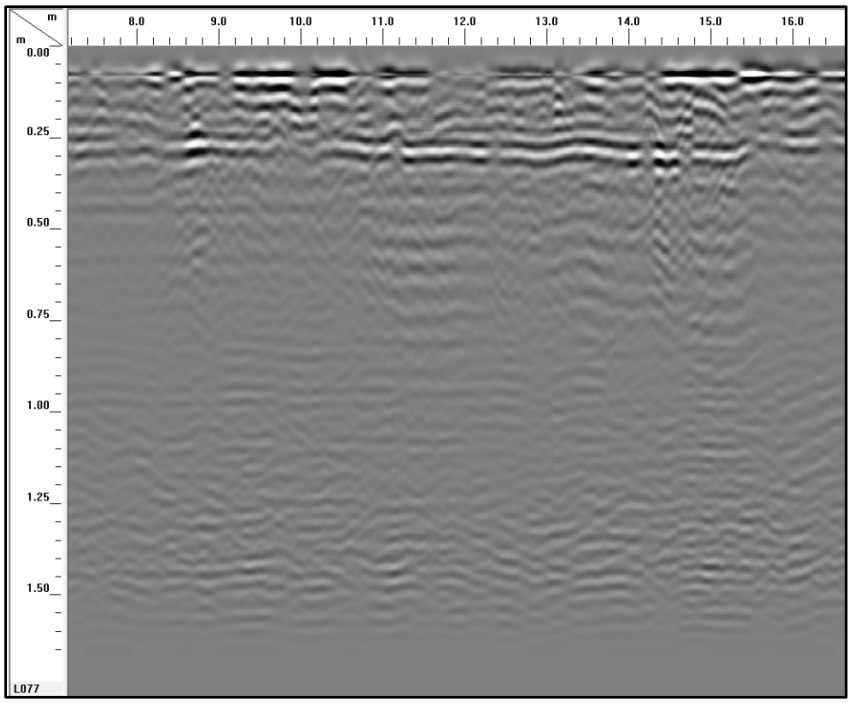


Figure 35: Alternative processed radargram of Reflection of Interest 5. Image original work of author.

The GPR data depicts numerous different reflections of interest that were collected from the Windsor Ruins site. The house foundation and the floor plan of the manor can be clearly seen from the data, reaffirming the Milner & Associates excavation and Smith Coffee Daniell IV drawing. Items such as the foundations for fireplaces or ovens (Figure *22*), and the drain at the southwest corner of the service ell can also be seen. In addition to the items that were already proposed or well known, 5 distinct reflections of interest were recognized that require further analysis and investigation. This chapter presents the descriptive data on the ROIs resulting from GPR survey, and the next chapter provides in-depth analysis and interpretation of each ROI, and how they relate to the research question and interpretation of the site.

Chapter 6: Analysis

In almost any inquisitive pursuit, knowledge is gained through the analysis and interpretation of the data. The more context and understanding of the material around the results, i.e. historical context, the better the analysis. The results collected at the Windsor Ruins site (22Cb602) are no different. This chapter will be divided into two parts. The first part looks at the five reflections of interest (ROI) described in the last chapter, while the second part looks at these ROI and their importance to different systems that the manor used to provide modern comforts of the time, even in a remote location.

Reflection of Interest 1

ROI 1 does not correspond with any known structural feature of the house, based on records of the architecture and the floor plan. When originally reviewing the GPR results, ROI1 was initially believed to be some sort of foundation for a possible staircase. This was because of its almost circular nature, and the depths of the feature being similar to several other foundations, and the lack of stairs in the basement, although it would have been climbing from ground level if it was indeed related to a staircase. During personal communication with an architectural historian and separately with an American Institute of Architects (AIA) licensed architect, this hypothesis was rejected because of the practicality of stairs in that location (being in the middle of the central hall and floor), as well as the observation that the foundation would not need to be reinforced as this interpretation of ROI 1 suggests. being directly under where the cupola of the house would have been located, ROI 1 may be somehow related to that part of the structure. The Henry Otis drawing, Figure 8, depicts the cupola and its location in the center of the house. Parts

of the cupola or other household features may have been forced into the basement as the house burned and collapsed. Additionally, Figure 21 in the 1978 Milner & Associates report depicts a possible reconstruction of the house that also has the cupola above the figure (Townsend et al. 1978: 79). The GPR profile appears to look like more of a man-made pit or deposit., contradicting this interpretation. There were some trees in the ruins at one point, so it could be related to their root systems. Ultimately this ROI would need to be excavated to determine the type and function of the feature.

Reflection of Interest 2

ROI 2 was the most puzzling of the ROIs. Consisting of a large, deep object in the center of the manor footprint raised a lot of questions, especially considering it had at least a metal sheet. According to the Daniell IV drawings, nothing was to be here (Figure 11). When excavated by Milner & Associates in 1978, the only items of note were tools from the attic renovation and as stated in the report, "large sheets of melted lead were found lying directly upon gallery paving, but the origin of this material is unknown" (Townsend et al. 1978: 45). Unfortunately, the position of these lead pieces was not recorded in greater detail. This lead is admittedly a good contender for part of this reflection but raises more questions. Is the lead and other metal associated with a feature before or post the burning at the house? What was its pre-fire function? Looking at the ROI in different perspectives on both Radan 7 and GPR Viewer depicted the two breaks on either side of the feature (Figure 26). When isolating the higher frequencies as seen in Figure 27, it is still an extremely large feature. With the size of the ROI (2.5 m long, 1.8 m wide, and 3.5 m deep), there are a few possibilities of what the feature could be, several of which are related to cisterns.

Cisterns were common in areas with brackish water, poor water sources, or no decent water source at all (McKee 2014: 1-2; 53). Additionally, in Peter Nicholson's 1854 dictionary of architecture, there are instructions to leave space between the cistern and any foundation walls, which can be seen in the GPR data (Nicholson 1854: 165-166). Having a cistern next to the kitchen would provide numerous benefits to the enslaved workers. It is also possible that the lead viewed by Milner & Associates was some sort of lid or accessory (Townsend et al. 1978: 45). The radar signatures picked up were similar, but not the same as the foundation brick could possibly be remains of the collapsed cistern. The only curiosity with this would be the two cisterns already on the property, one to the north of the service ell, and the other to the southeast of the manor.

After personal communication with the Chief Architectural Historian of MDAH, Jennifer Baughn, who also obtained the opinions of James Bridgeforth, also with MDAH, and Carter Burns, Executive Director of the Historic Natchez Foundation, it was confirmed that there are other historic properties that include cisterns in similar locations. In the Natchez area, one antebellum manor, Oakland, has two cisterns in a raised basement. Two others, Foster's Mound and Glen Aubin, have cisterns immediately adjacent on the back porch. Other houses in the state that would have had them in breezeways or raised basements can be found in Hinds, Sharkey, and Yazoo counties.

Another possibility that Reflection of Interest 2 is a feature associated with the remains of the attic cistern or holding tank. Normally, according to both McKee 2014 and the Nicholson 1854 dictionary, attic cisterns were large wooden boxes lined with lead and copper joints (McKee 2014: 53; Nicholson 1854: 166). With the low melting point of lead (621 degrees centigrade), it is entirely in the realm of possibilities that the lead lining of the massive wooden

cistern in the attic melted during the fire and seeped into the ground. The depth of the ROI is the largest problem in this hypothesis, although foundational cracks possibly allowed the lead to achieve the depths seen.

Reflection of Interest 3

ROI 3 is a linear feature located in the service ell. It appears that it is mostly likely a partition wall, separating out a possible second pantry or storage location for the kitchen. Looking at Figure 30, the items that correspond to the feature the most are the interior partition walls in the main section of the house. These partitional walls are not as visible on the GPR data as a foundational wall (Vergnano et al. 2025: 9-10). It must also be stated that it is odd that it would be so close to one of the ovens, with only a meter located between the two, although it could be something to put fuel for the oven. To stack onto the oddities, it is curious why no evidence for the wall was ever located in the Milner & Associates or Daniell IV drawings. Although it must be stated that no excavations were carried out in the area by Dr. Townsend, and the very young age of Daniell IV when the house burned, it may have just not been reported. Additionally, it is entirely possible that the wall could have been removed pre-1885, and that only the footprint remains, but that would be pure conjecture.

Reflection of Interest 4

ROI 4, as seen in Figure 31 and Figure 32, appears to have mostly flat planar reflections. The radargram additionally depicts some odd, pit like excavations throughout the transect lines. It is believed that the easternmost part of the feature would be with the partition wall between what Daniell IV labels the kitchen and the pantry, with the service stairs. The western part of the

ROI is unknown. It could be debris left over from the wall and stairs collapsing during the fire in addition to some metal, or something entirely else such as intact floor. Interestingly, ROI 4 is located in the immediate location of the dumbwaiter according to Daniell IV. Although the main part of the ROI is unknown, it still led to some resolutions between Daniell IV and Townsends floorplans.

When viewing the three different images put forth of Windsor, as seen in Figure 20, everything appears as if it agrees at first glance. After investigating the images, several discrepancies are noted, mostly in the kitchen of the service ell. In the Milner & Associates floor plan, the room is partitioned in an almost 60/40 percent split between the kitchen (left) and the pantry (right) (Townsend et al. 1978: Figure 9). In the Daniell IV drawing, he presents the partition wall being much farther to the west, in an approximate 80/20 percent split. One would normally take the Milner & Associates floor plan over the Daniell IV drawing, as it must be restated that the Smith Coffee Daniell IV, while having seen the house before it burned, was working off of almost 80-year-old recollections, not to mention that he was a month short of five years old when the house burned down (Barnett 2002: 30).

The GPR analysis conducted at Windsor supports the alternative that Daniell IV was correct in his drawings of Windsor, at least when it comes to the kitchen. ROI 4 does appear to contain a wall at the locations that Daniell IV described. The data also confirm the wall, and the points of confusion that led to the misrepresentation of the wall location. It is known that the kitchen had two ovens. It is possible that the Milner & Associates team misinterpreted one of the footings spots for the oven as that of the foundation for a wall, when both the GPR readings and Daniell IV show it being in approximately the same location (Townsend et al. 1978: 49-50). The

footings for a second oven were not noted in the GPR data, either via time slices or vertical profiles.

Reflection of Interest 5

Out of the five ROIs, ROI 5 was the easiest of the five to decipher. Looking at the 1978 Milner & Associates report, it clearly depicts a pipe that was located in the same area as ROI 5 (Figure 11; Figure 20). Due to the linear nature of the profile, and the location of the feature, it is highly probable that ROI 5 is this pipe. This pipe was believed by Milner & Associates to be slightly north of the service ell wall, used to connect a drain at the northwestern part of the service ell east, then combining with another pipe from the drain in the southeast corner, before draining out to a wooden trough in the northeastern corner of the manor area, bypassing the known cistern that is to the north of the service ell (Townsend et al. 1978: 48-50). It is currently unknown what this drain connected to, as the Daniell IV drawings did not contain anything above the basement in the service ell that would require drains. The pipe itself may have been connected to the bathrooms on the second and third floor to carry sewage to the northeastern field, but at this point it is just known to connect to the drain that was located in the northwestern corner (Townsend et al. 1978: 48). It raises questions about whether it has been used for the kitchen or dining room, and why the drain would not be connected to the kitchen? Were the pipes only used for bathtubs, as sinks were not regularly seen in bathrooms, but only kitchens until the early 20th century (Ierly 1999: 83-84; 141). The easiest answer is that the house had flushing commodes. With the wastewater from the bathtub coming down one pipe, sewage in the second, and cistern water in the third bracket. ROI 5 is inferred to be the pipe that carried the sewage and wastewater from the bathtub and commode to the northeastern field, while the closer pipe in the northeast corner of the main building carried water for the cisterns. Another item that

also helps with this case is the thickness of the pipe depicted in Figure 11, as compared to all of the surrounding water pipes, it is thicker and more robust. In short, the identification of ROI 5 tends to support the conclusion that the Windsor manor had flushing commodes inside the upper floors of the house.

It must be stated that there is a possibility two drains would be for the for the 2nd and the 3rd story bathrooms, but even so, the chances for the bathroom to include toilets is high, as even in the 1860s, bathrooms using both fixtures as one were not rare, and bathtubs, usually wooden, rarely had attached faucets until after the civil war (Ierly 1999: 150).

Tying Everything Together

Several intriguing reflections of interest were discovered during the survey for this project, including the full floor plan of the manor. How do they tie into the research question put forward at the beginning of this project, whether ground-penetrating radar (GPR) data collected at the Windsor Ruins site (22Cb602) will reveal infrastructure that offered methods of modern comfort of the time that assists with determining, or establishing, new understandings of the house? Several of the identified subsurface ROIs have already accomplished this, although not all are associated with the comfort the house provided. With the probable partition wall for ROI 3, the floor plan confirmation suggested by Smith Coffee Daniel IV with ROI 4 and then getting the confirmation of the pipe network explained in Townsend et al. 1978. All of these items confirm or expand our understanding of the manor. Going further, information that could infer larger modern conveniences can be taken from ROI 5, with the plumbing that was present in the manor. It is without question at this point that the manor contained running water, based on the presence of ROI 5 and the features identified in the Milner & Associates report (Townsend et al. 1978: 48-50). A house during this time, in a remote area equipped with indoor plumbing and

running water was definitely a luxury. Although at the time of the mansion's building it was already more commonplace in urban settings, in rural areas it was only common in extravagant homes (McKee 2014: 78; Vlach 1993: 36-37). Reexamination of the pipe displayed in the GPR data, along with the Milner & Associates excavation, it does appear that Windsor not only had running water, but also indoor flushing toilets. Flushing toilets were common in larger cities, but were not nearly as common in rural Mississippi, as privies were still in use in much of the state well into the 1900s and were a *cause célèbre* for southern sanitation reform when this changed in the 1960s (Nuwer 2002). As mentioned earlier, there is already a precedent for this with the Melrose toilets, completed in 1848, and Dunelith Inn, which had hot and cold water, along with indoor commodes by 1859 (NPS 2021; Shelton 2012).

Other ROIs leave the door open for more work to be conducted. ROI 1 and ROI 2, although fairly inconclusive, both suggest areas to investigate in future endeavors that could reveal more information on the manor. Although they could be unrelated, if they are indeed confirmed to be either cupola-related for ROI 1 or cistern-related for ROI 2, they may be able to solve some of the mysteries surrounding the complicated Windsor plumbing network, as well as answer questions that persist about the appearance of the manor.

Lastly, there was another question posed in the first chapter, about using GPR surveys on burned plantation homes in the state, which merits discussion. The data obtained during the October 2024 survey depicts that the survey method will be exceptionally useful in obtaining data for plantation homes in the state that have burned. The clarity of the floor plan alone, found through the GPR data depicted in Figure 19, should demonstrate this. The one caveat that must be mentioned is that some plantation manors were built on piers with raised wooden floors (Townsend et al.: 5). If utility infrastructure was present, there is a chance that they could still be

seen, but that was not always the case. These structures would not have much success with this sort of survey, but these limitations would be hopefully discovered in background research and accounted for, and load-bearing piers still support interpretation of interior floor plans.

In short, the GPR survey was able to determine new interpretations of the house through infrastructure reflections, even if some of the items were not related to comfort. These data demonstrate the applicability of GPR surveys to burned plantation manor sites

Chapter 7: Conclusion

Summary

The Windsor Ruins site is unrivaled as a historical landmark in Mississippi. Unfortunately, over the years, the grounds have only had a few archaeological investigations to potentially answer all the questions that remain of the site. It was proposed that a GPR survey could address one or two of the questions that linger about the manor or change the understanding or interpretation of such. The GPR Survey that was carried out in October 2024 was started as a first step into more investigations at Windsor, but with a research question that could hopefully be applied to burned manor sites across the state. Did GPR data collected at the Windsor Ruins site (22Cb602) reveal infrastructure that offered methods of modern comfort of the time that assists with determining, or establishing, new understandings of the house?

The investigation to answer the research question was conducted via a GPR survey using a 350Mhz GSSI UtilityScan receiver in October 2024, looking for reflections of features that would hopefully give some more information or context to the different utilities and infrastructure located at the manor. These data were processed and viewed in several programs, mainly Radan 7, ArcGIS Pro, and GPR Viewer. 79 transects were conducted with a substantial amount of time and effort dedicated to analyzing the data.

Conclusions on the Research Question

Out of the five significant reflections of interest that were seen in the data, three of them, ROIs 3, 4, and 5, were conclusive enough to attempt to answer the research question. ROI 3 is potentially a new wall partition that was previously unknown, although the function of the proposed new room is currently unknown. ROI 4 confirmed Daniell IV's drawing of the kitchen

wall in the manor, and that it was the size he described it as, and corrected misunderstanding in the Townsend et al. report. This is in addition to finding part of the collapsed structure of the walls and stairs. ROI 5 was likely a 10 cm or 4-inch pipe, probably made of metal, that was most likely used for sewage and not associated with rainwater collection and freshwater plumbing systems. Additionally, ROIs 1 and 2 are items that require further investigation and may solve some mysteries that remain of the manor. These data also demonstrate the potential for GPR surveys to be conducted on other burned plantation manors and their grounds in Mississippi.

The next step for this research would need to be ground-truthing these reflections of interest, preferably ROIs 1 and 2 first, then 3, 4, and 5 for confirmation of the interpretation and analysis given here. Townsend et al. ends their report stating that there is little more to gained from investigations into the big house, and that little evidence of anything to help with either the infrastructure or appearance of the house would have survived. These data demonstrated that with today's technology, sites such as Windsor should be revisited to see if new data can be obtained. In addition, this study shows that these burned manors can still be used as a focus of study. Although great care is critical in both the research and planning of any burned plantation site to make the most of the survey. Different aspects of the results and the structure of the house could unintentionally cause problems if not accounted for or known about beforehand.

Almost 50 years later, the second part of Townsend's recommendations have not been heeded, which is the same recommendation that the author gives here (Townsend et al. 1978: 85-86). The next large investigation should be that of the grounds themselves in an attempt to discover the rest of the outbuildings, any potential enslaved cemeteries, and evidence of other stories of the area, such as those of the tenant farms, should be explored. First a pedestrian survey for any structural remains should be conducted with a metal detector survey. This

methodology refines the survey area to an acceptable size. Where a GPR survey can be conducted to narrow down areas further of interest for more study and excavations in association with the descendent communities. It must be noted that if large areas of metal are found with the metal detector, special care needs to be taken with the GPR survey. Although GPR data are difficult to read in radargram form, using the time-slice imagery for structures and any found unknown cemeteries has the potential to greatly peak local interest and involvement.

Final Thoughts and Proposals.

Although plantation sites in the Natchez District have seen many more research projects in the last few years, such as those being carried out in Concord Quarters and Prospect Hill, it is an area of Mississippi archaeology that has been largely neglected. Looking back at Amy Young's 2004 article *The Beginning and the Future of African American Archaeology in Mississippi*, she stated three issues that impeded the "tremendous potential" for these sites in Mississippi. It is obvious to anyone working in archaeology in the state that the two largest of these issues have been rectified or at least made more approachable. The MDAH site file now works to help preserve these sites as well as to assist in their documentation. The communities appear to also be interested in working with archaeologists to have more stories told, which can be seen again looking at the community engagement in Concord Quarters and Prospect Hill. An MDAH presentation in December 2024 in Port Gibson on the current research ongoing at Windsor, which the author participated in, was filled to the point that it became standing room only. It shows that the community wants to be involved and have the stories told of not just Smith Coffee Daniell II, but of all the individuals that were involved with Windsor (Jeffries et al. 2024).

The GPR survey conducted in October 2024 that was introduced in Chapter 4, continuing on into Chapters 5 and 6 is hopefully the start of a new series of investigations of not only the plantation manor, but to the grounds themselves. More GPR surveys and investigations need to be conducted to look for the outbuildings at Windsor, and the archaeology needs to expand to tell the stories that have not been told there. This should be done with the full cooperation and engagement of the community surrounding Windsor, and the descendants of those who were forced to work there. Archaeologists in Mississippi today not only owe it to those enslaved peoples who were forced against their will to work endlessly, allowing men to make the fortunes required to construct these monuments of luxury that the enslaved were then forced to build, but also to their descendants who have been ignored by our profession for so many years.

Appendix A: Field Paperwork

GPR FORM

Date: 10/21

General Info:
Site Name: Windsor Grid Name: Windsor 1 s w Crew: KA, DS, LW

Description of Soil and Surface Conditions (uneven ground, rocks, roots/vegetation, moistness, and other obstructions.):

Unit Settings:
Default Wheels/Carriage/Other Signal Floor (depth):_____ Project #: _____ GPS / Total Station

Nanosecond Range: _____ DIEL: _____ Other Settings: _____

Grid Setup
Grid Dimensions: 25x25 m Transect Spacing: 0.50 Datum Corner (start): SE

Direction of Antenna: ☒ ↑↑↑ ☒ ↑↓↑ Orientation of GPR: ☐ S⟷N ☒ W⟷E Overview Photos ☐

This

Notes on Site:
(when discussing surface disturbance or anomalies, be sure to specify along which transects and map in roughly it's location on the gridded map. Show Datum ▲(Start Location) and direction of intial transects)

File#s	Direction	Note

23452

Key:

25 25 35.7 25 Supposed to be 35.35

North: Scale:

Use this grid to illustrate the location of your GPR study, landmarks, and objects, points mapped by TS/GPS and to help depict transects/file relationship. Use Datum (▲) to indicate start location

Collecting Data in the Y-Direction

MDAH MISSISSIPPI DEPARTMENT OF ARCHIVES & HISTORY

Project Name: Windsor ~~Bldg~~ 1 — Project # on GPR: Windsor 1 SW

Date: 10/02/24 — Crew: KA, DS, LW

Starting File #: 001 — Last File #:

X Length (m): 25m — Y Length (m): 25m

File#:	X0	Y0	Y1	Notes
001	0.00	0.00	25.00	30cm ~~offset~~ due to columns
002	0.50	0.00	25.00	
003	1.00	0.00	25.00	
004	1.50	0.00	25.00	
005	2.00	0.00	25.00	on the side of column
006	2.50	0.60	24.00	~~stopped~~ early due to column
007	3.00	0.60	24.00	" " "
008	3.50	0.60	24.00	" " "
009	4.00	0.00	26.66	open area between columns
010	4.50	0.00	26.66	open area " "
011	5.00	0.00	26.64	open area " "
012	5.50	0.00	26.64	" " " "
013	6.00	0.60	24.[illegible]	Columns
014	6.50	0.60	24.24	"
015	7.00	0.60	24.28	"
016	7.50	0.60	26.94	26.94 - 27.17 needs to be clipped. Columns not lining up the same; about to go
017	8.00	0.00	26.58	
018	8.50	0.00	26.69	
019	9.00	0.00	26.54	
020	9.50	0.00	24.60	Column
021	10.00	0.60	24.20	
022	10.50	0.60	24.21	
023	11.00	0.60	24.87	
024	11.50	0.60	25.09	Column + stairs
025	12.00	0.00	26.36	" " west over brick end
026	12.50	0.00	26.30	
027	13.00	0.00	25.61	
028	13.50	0.00	25.53	
029	14.00	0.00	24.70	Column
030	14.50	0.00	24.70	
031	15.00	0.00	24.70	
032	15.50	0.00	24.74	
033	16.00	0.00	26.65	
034	16.50	0.00	26.64	
035	17.00	0.00	26.86	

Additional Notes:

1st Grid of the day (10:32am). 25x25m grid on interior of columns. Going 0.50m intervals ~~bi-~~ unidirectional). Dielectric 8.2. Starting in SE corner & running East to West.

~~Survey wheel notes length 1324.50, not 25.00~~

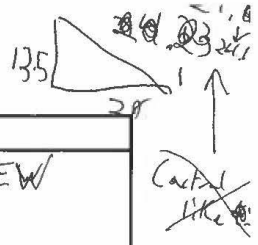
Collecting Data in the Y-Direction

MDAH MISSISSIPPI DEPARTMENT OF ARCHIVES & HISTORY

Project Name:	**Project # on GPR:**
Date:	**Crew:**
Starting File #:	**Last File #:**
X Length (m):	**Y Length (m):**

File#:	X0	Y0	Y1	Notes
036	17.50	0.00	26.67	
037	18.00	0.00	24.85	
038	18.50	0.00	24.83	
039	19.00	0.00	24.83	
040	19.50	0.00	26.63	
041	20.00	0.00	26.67	
042	20.50	0.00	26.63	
043	21.00	0.00	26.66	
044	21.50	0.00	24.86	
045	22.00	0.00	24.87	
046	22.50	0.00	24.70	
047	23.00	0.00	26.69	
048	23.50	0.00	26.67	
049	24.00	0.00	26.77	
050	24.50	0.00	26.75	
051	25.00	0.00	26.84	@ 24.75 b/c next to column
				End of Grid 1

Additional Notes:



Collecting Data in the Y-Direction

MDAH — Mississippi Department of Archives & History

Project Name: Windsor 1		**Project # on GPR:** Windsor2EW	
Date: 10/3/24		**Crew:** KEA; LJW; SB; DLS	
Starting File #: 1		**Last File #:**	
X Length (m): 13.5		**Y Length (m):** 20	

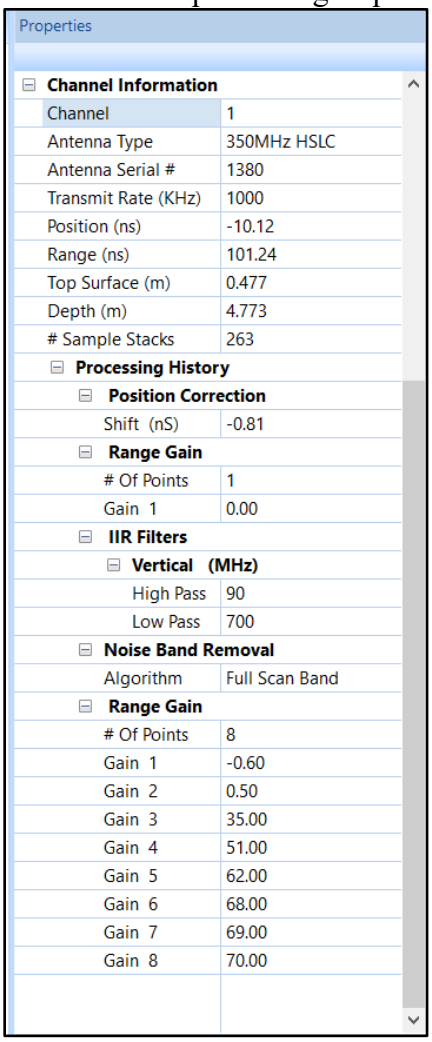
File#:	X0	Y0	Y1	Notes
~~001~~	~~11.73~~	~~0.00~~	~~20.00~~	~~Start @ 11.73m~~ DELETE FILE
002	11.73	0.00	19.56	
003	12.00	0.00	20.19	
004	12.50	0.00	19.86	
005	13.00	0.00	20.12	
006	13.50	0.00	20.05	
007	14.00	0.00	20.26	Decoupled @ around 15; foundation wall
008	14.50	0.00	41.01	~~Add on~~ Decoupled 18.5 due to Drain
009	15.00	0.00	19.87	Decoupled 18.7 due to drain
010	15.50	0.00	20.25	
011	16.00	0.00	20.11	
012	16.50	0.00	20.02	
013	17.00	0.00	20.24	
014	17.50	0.00	20.13	Decoupled @ 19 (possibly)
015	18.00	0.00	20.08	
016	18.50	0.00	20.19	
017	19.00	0.00	20.17	Decopled @ 14
018	19.50	0.00	20.00	
019	20.00	0.00	19.99	
020	20.50	0.00	20.15	
021	21.00	0.00	19.68	Numerous decoupling may have occured
022	21.50	0.00	19.98	
023	22.00	0.00	20.23	
024	22.50	0.00	19.87	
025	23.00	0.00	20.03	Decoupling ocurred in last meters
026	23.50	0.00	20.15	Possible Decoupling
027	24.00	0.00	20.001	
028	24.50	0.00	19.57	
029	25.00	0.00	19.49	Actual Start X is 24.8
				* End of Grid windsor 2 *

Additional Notes:

~~Short~~ Dielectric is 8.2. Unilateral.

Appendix B: GPR Data Processes

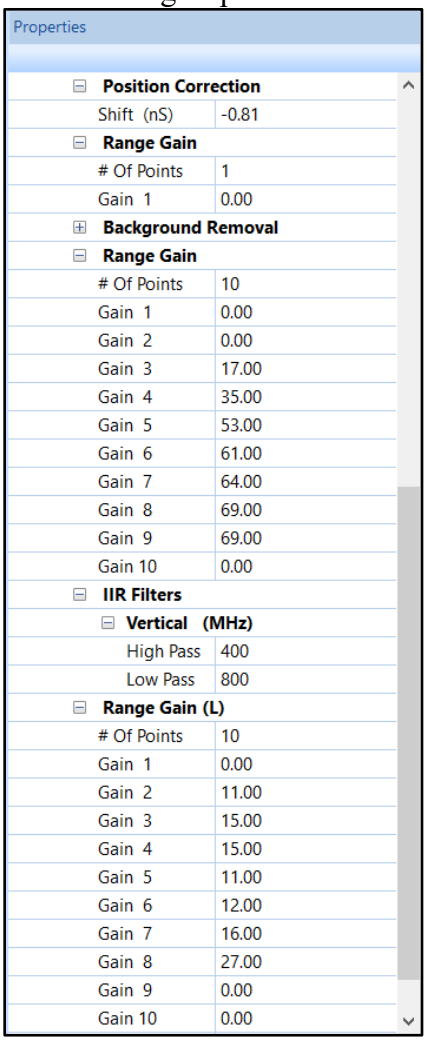
General data processing steps:



Properties

Channel Information	
Channel	1
Antenna Type	350MHz HSLC
Antenna Serial #	1380
Transmit Rate (KHz)	1000
Position (ns)	-10.12
Range (ns)	101.24
Top Surface (m)	0.477
Depth (m)	4.773
# Sample Stacks	263
Processing History	
Position Correction	
Shift (nS)	-0.81
Range Gain	
# Of Points	1
Gain 1	0.00
IIR Filters	
Vertical (MHz)	
High Pass	90
Low Pass	700
Noise Band Removal	
Algorithm	Full Scan Band
Range Gain	
# Of Points	8
Gain 1	-0.60
Gain 2	0.50
Gain 3	35.00
Gain 4	51.00
Gain 5	62.00
Gain 6	68.00
Gain 7	69.00
Gain 8	70.00

Processing steps for ROI 2:

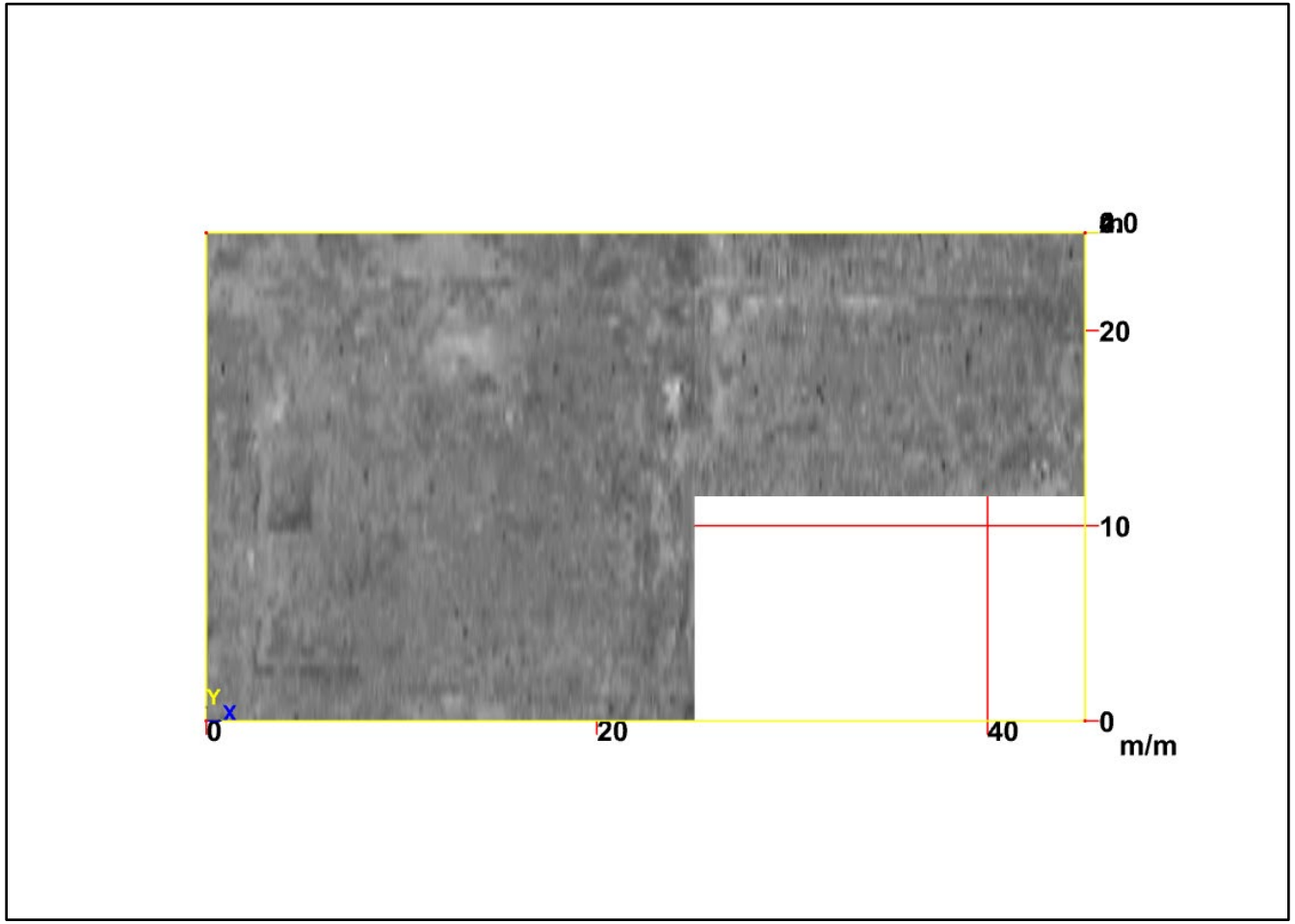


Properties

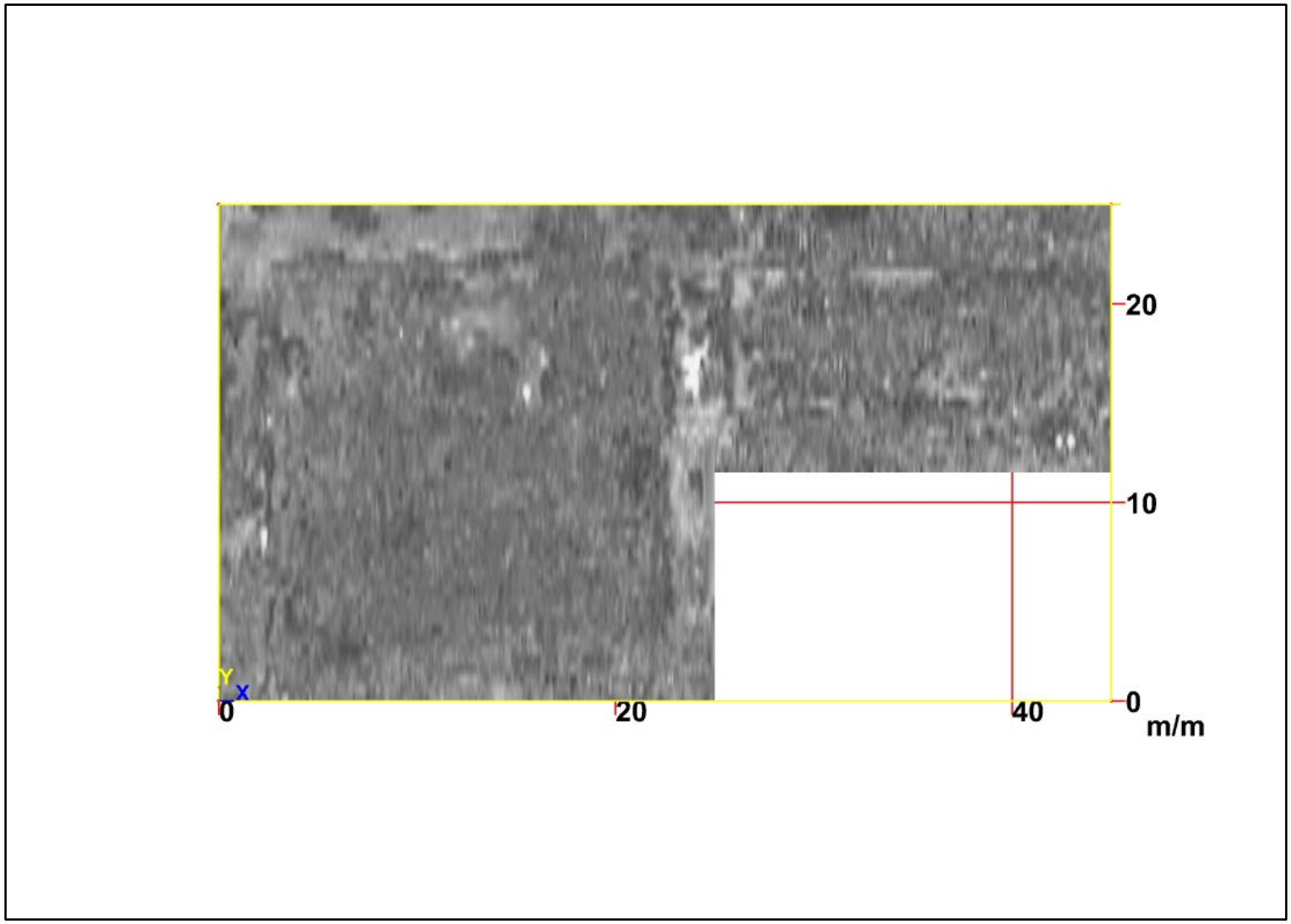
Position Correction	
Shift (nS)	-0.81
Range Gain	
# Of Points	1
Gain 1	0.00
Background Removal	
Range Gain	
# Of Points	10
Gain 1	0.00
Gain 2	0.00
Gain 3	17.00
Gain 4	35.00
Gain 5	53.00
Gain 6	61.00
Gain 7	64.00
Gain 8	69.00
Gain 9	69.00
Gain 10	0.00
IIR Filters	
Vertical (MHz)	
High Pass	400
Low Pass	800
Range Gain (L)	
# Of Points	10
Gain 1	0.00
Gain 2	11.00
Gain 3	15.00
Gain 4	15.00
Gain 5	11.00
Gain 6	12.00
Gain 7	16.00
Gain 8	27.00
Gain 9	0.00
Gain 10	0.00

Appendix C: GPR Time-Slices of Windsor.

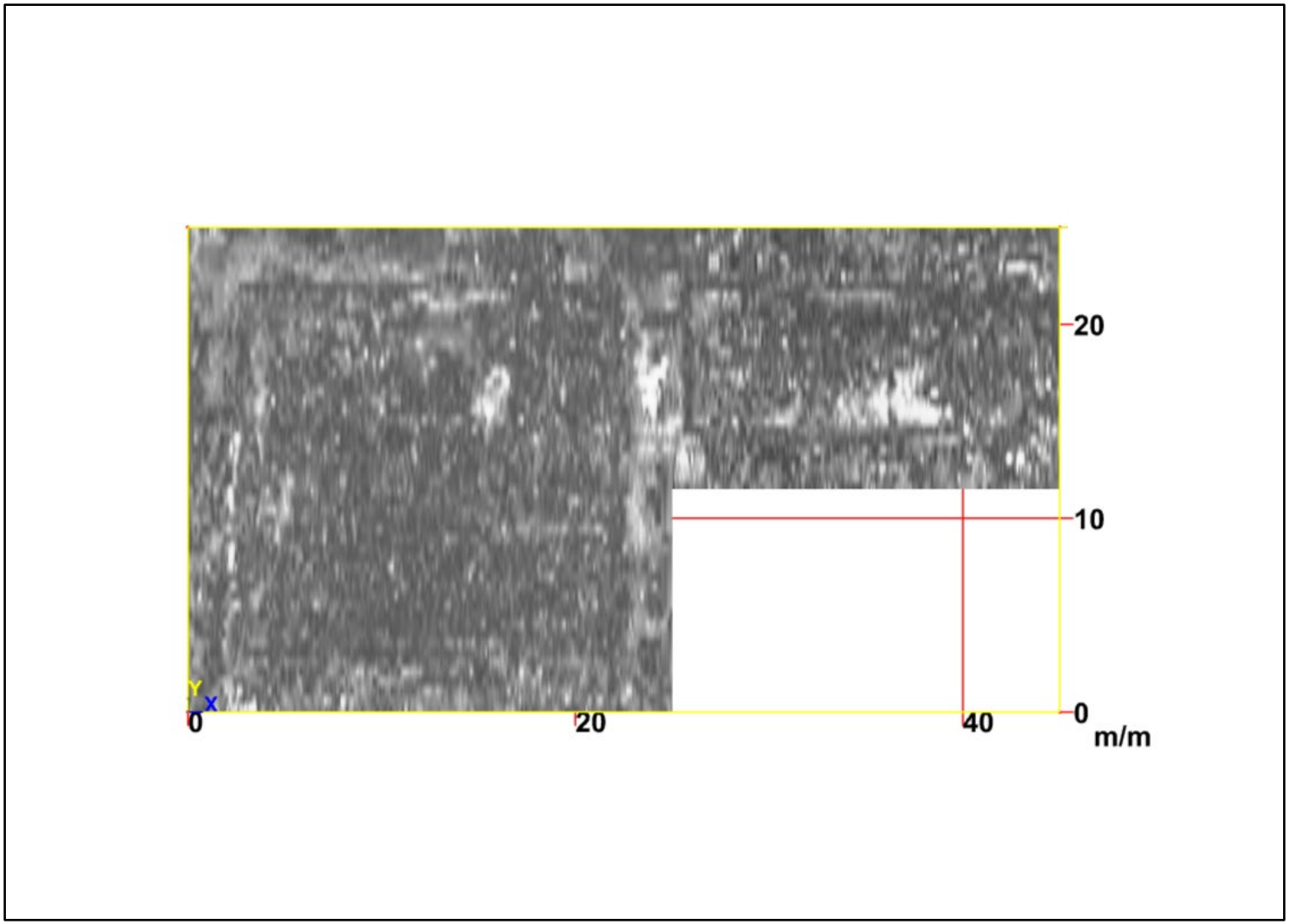
Time-slices every 0.2 m from 0 to 3 m, with a thickness of 0.13 cm. All images are original work of the author.



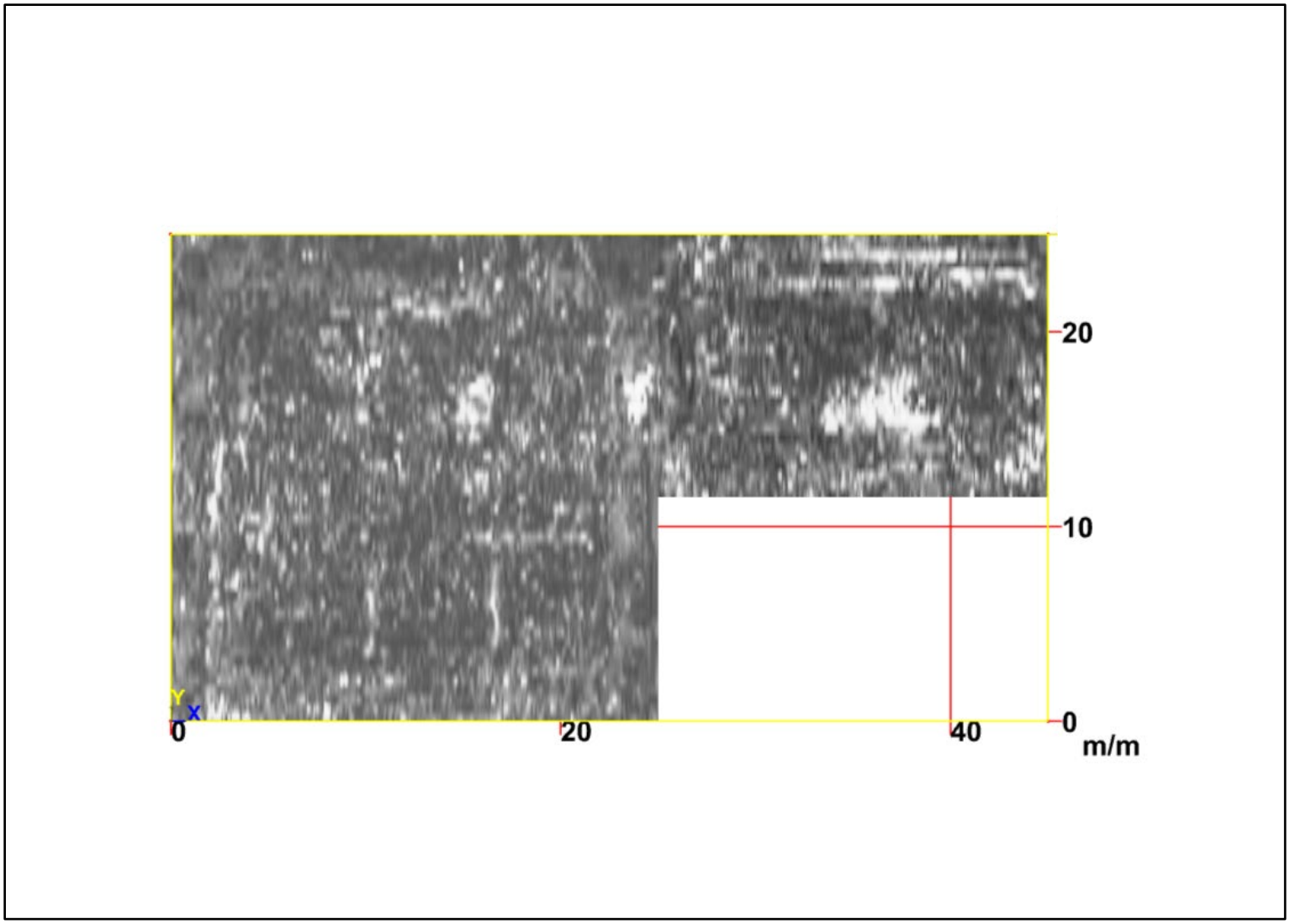
Surface Scan.



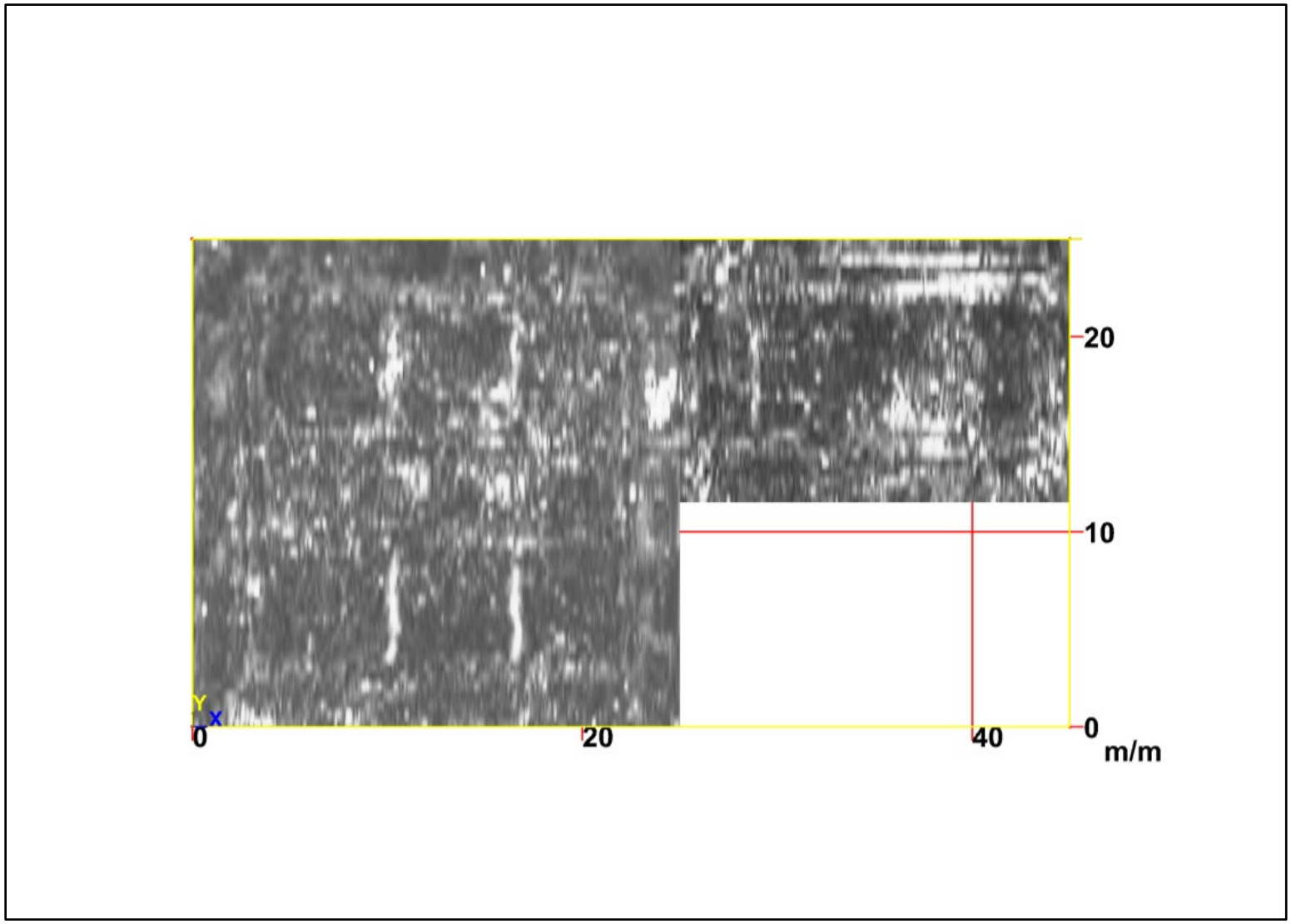
0.2 meters below surface



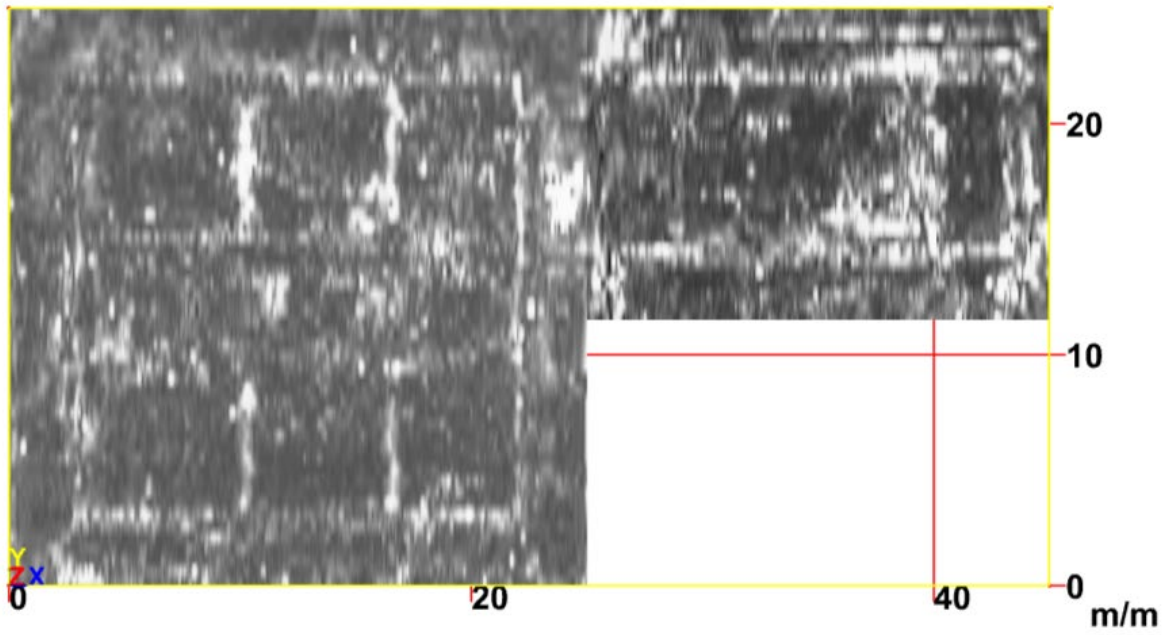
0.4 meters below surface



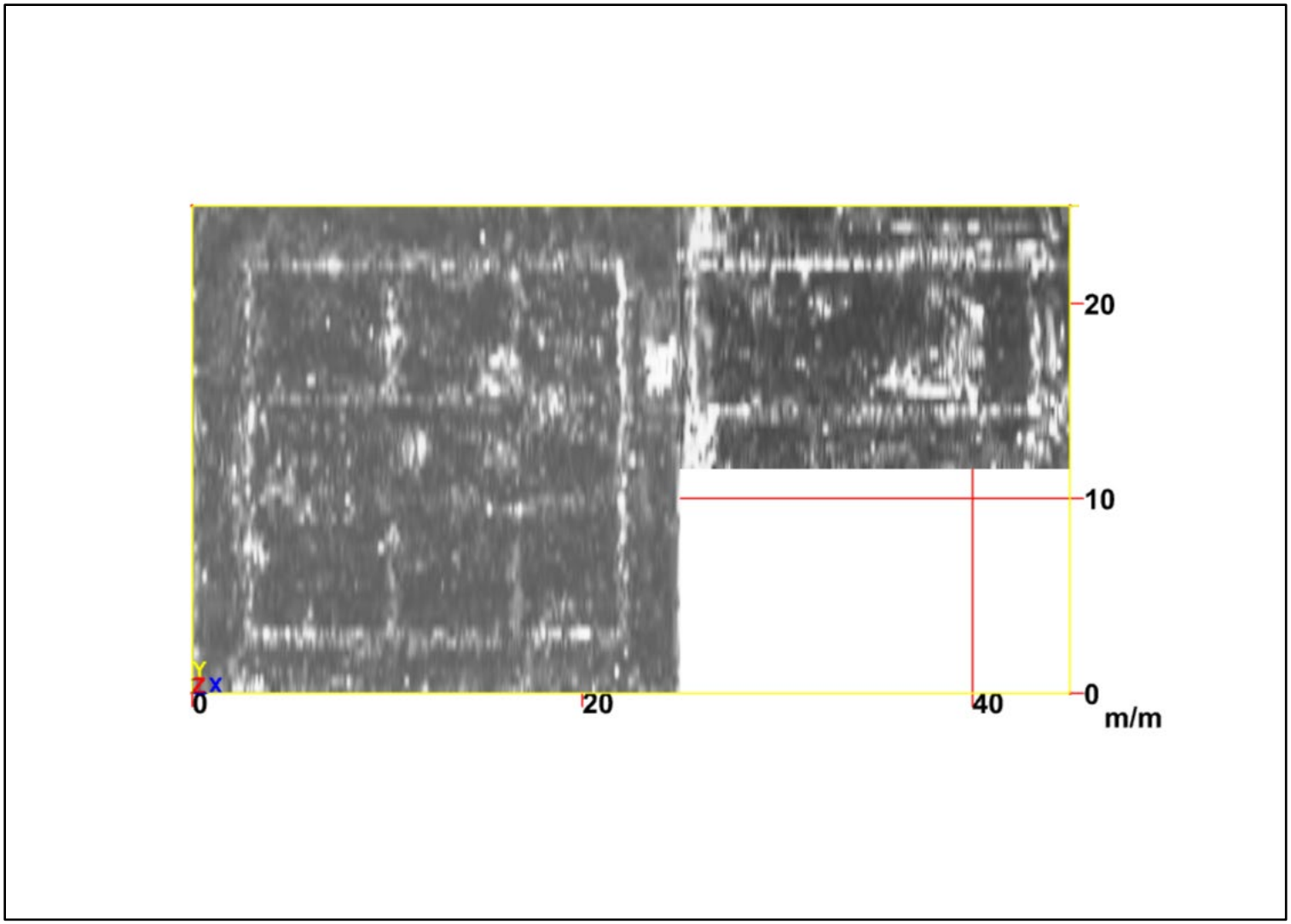
0.6 meters below surface



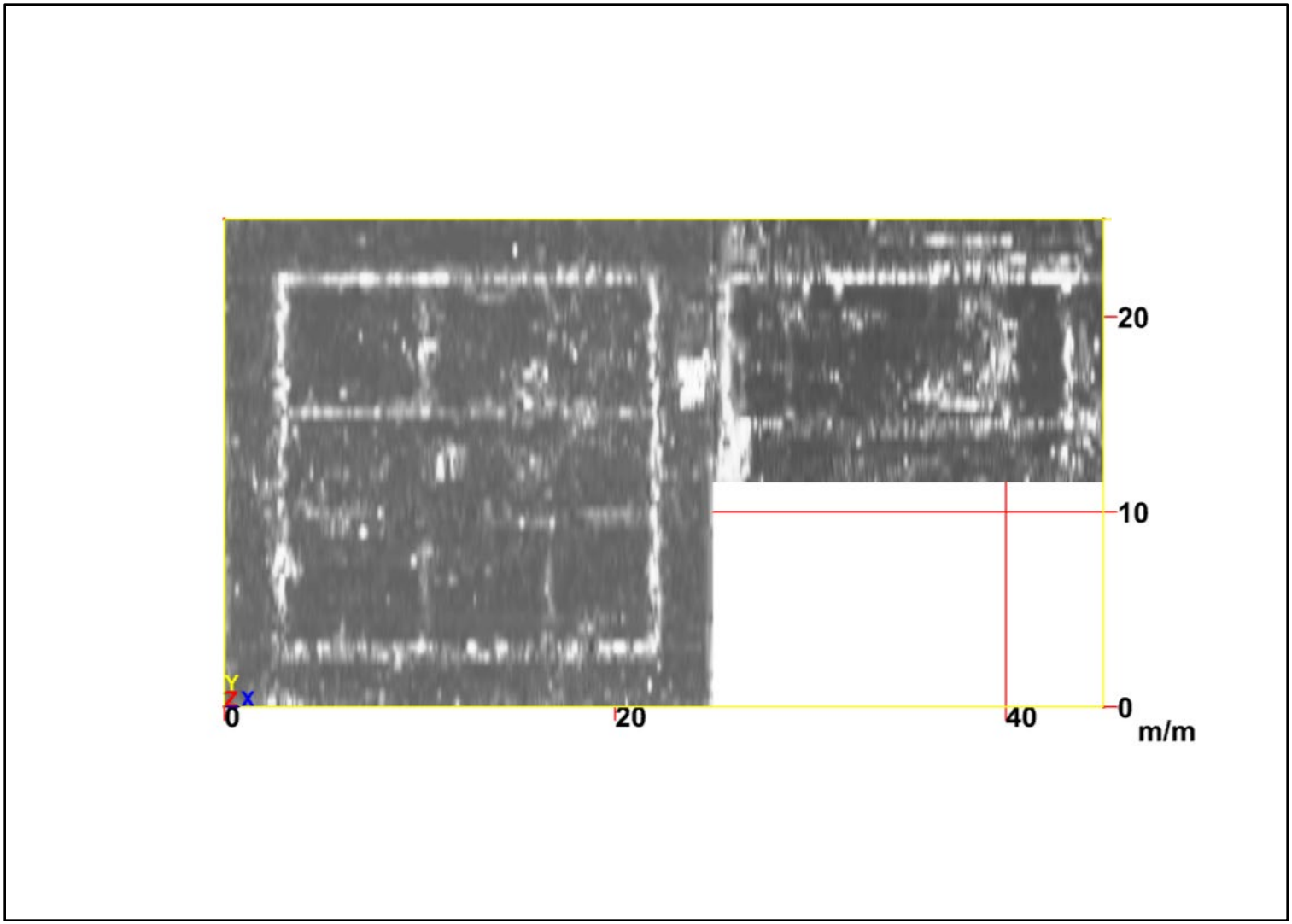
0.8 meters below surface



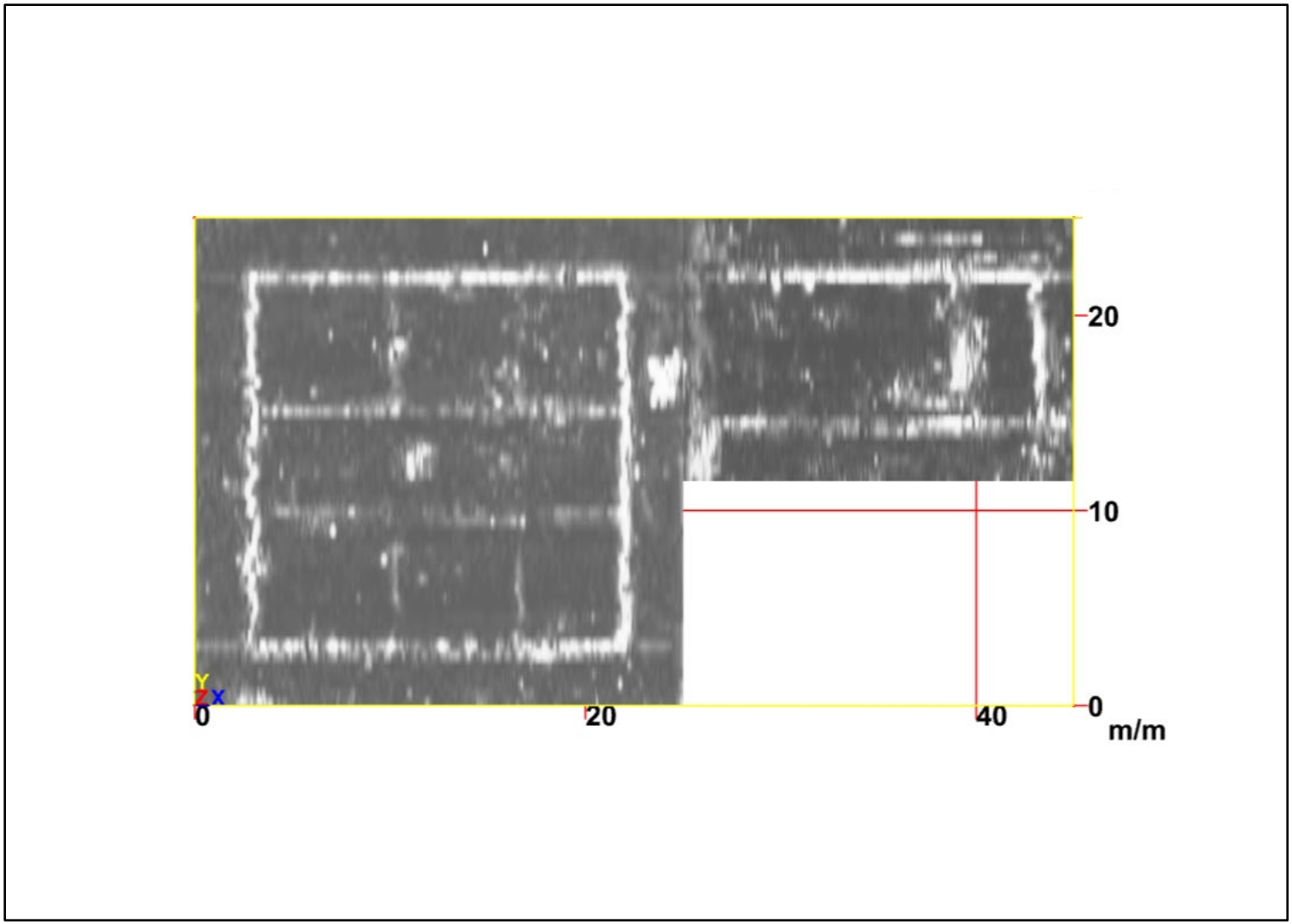
1.0 meters below surface



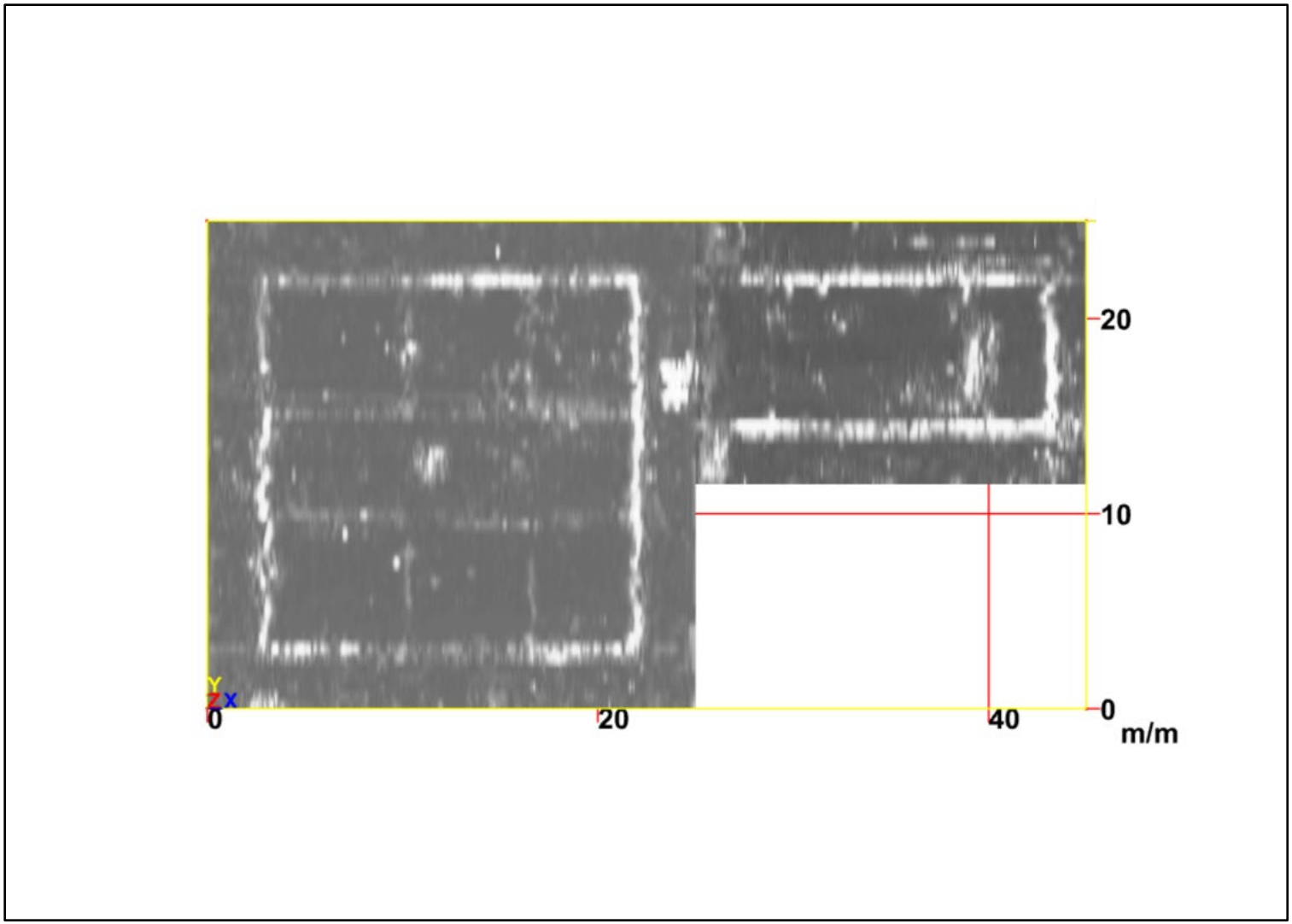
1.2 meters below surface



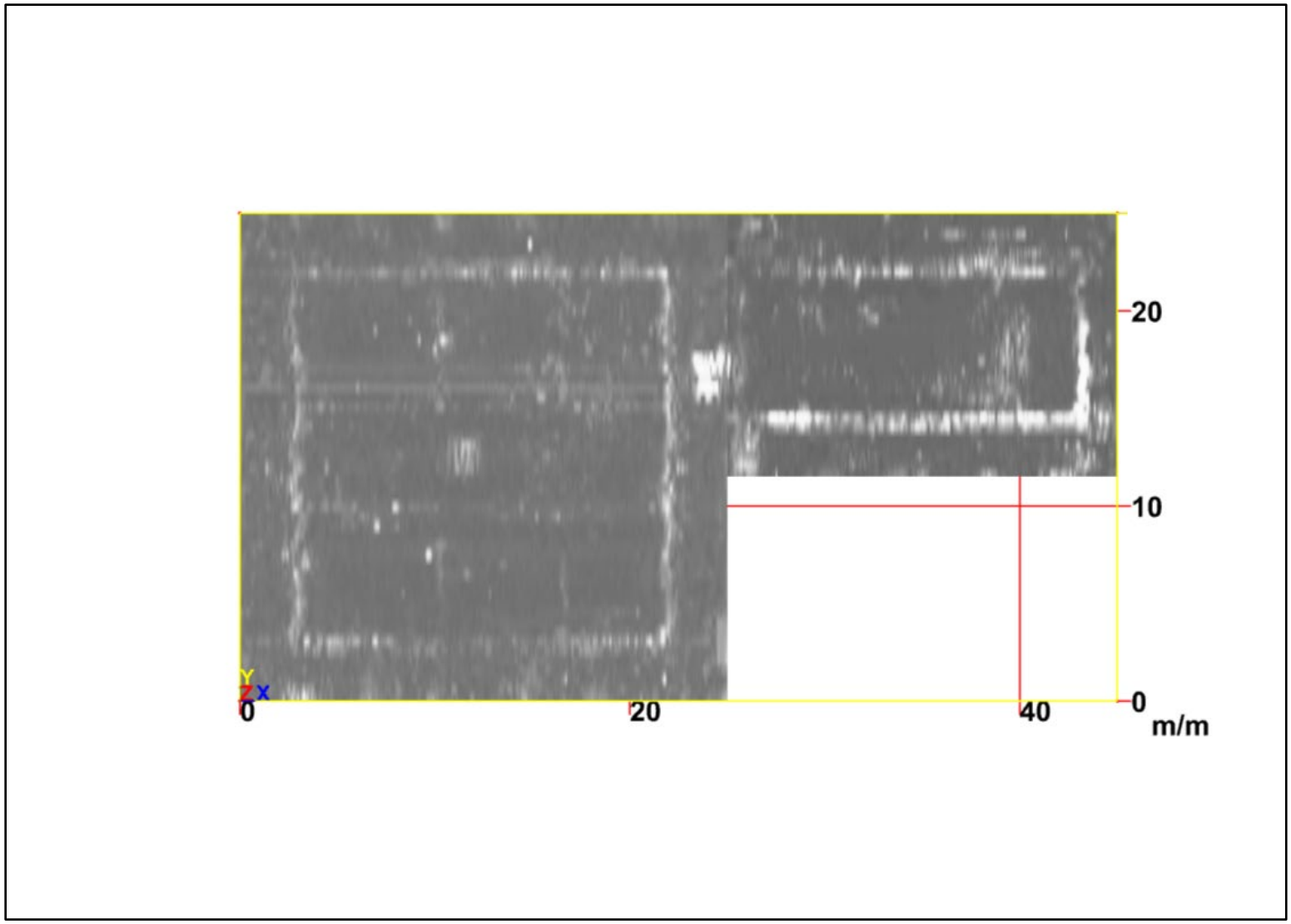
1.4 meters below surface



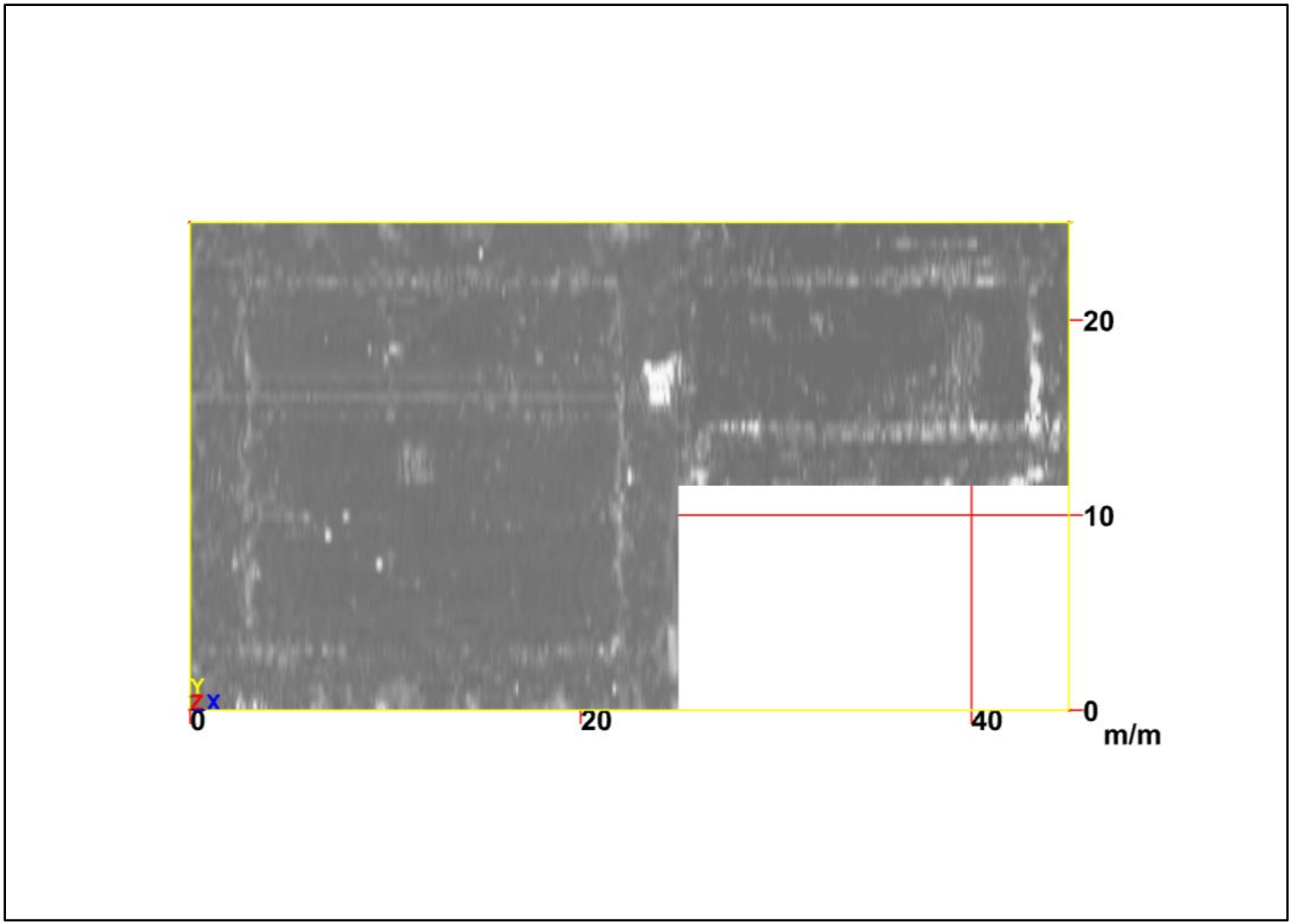
1.6 meters below surface



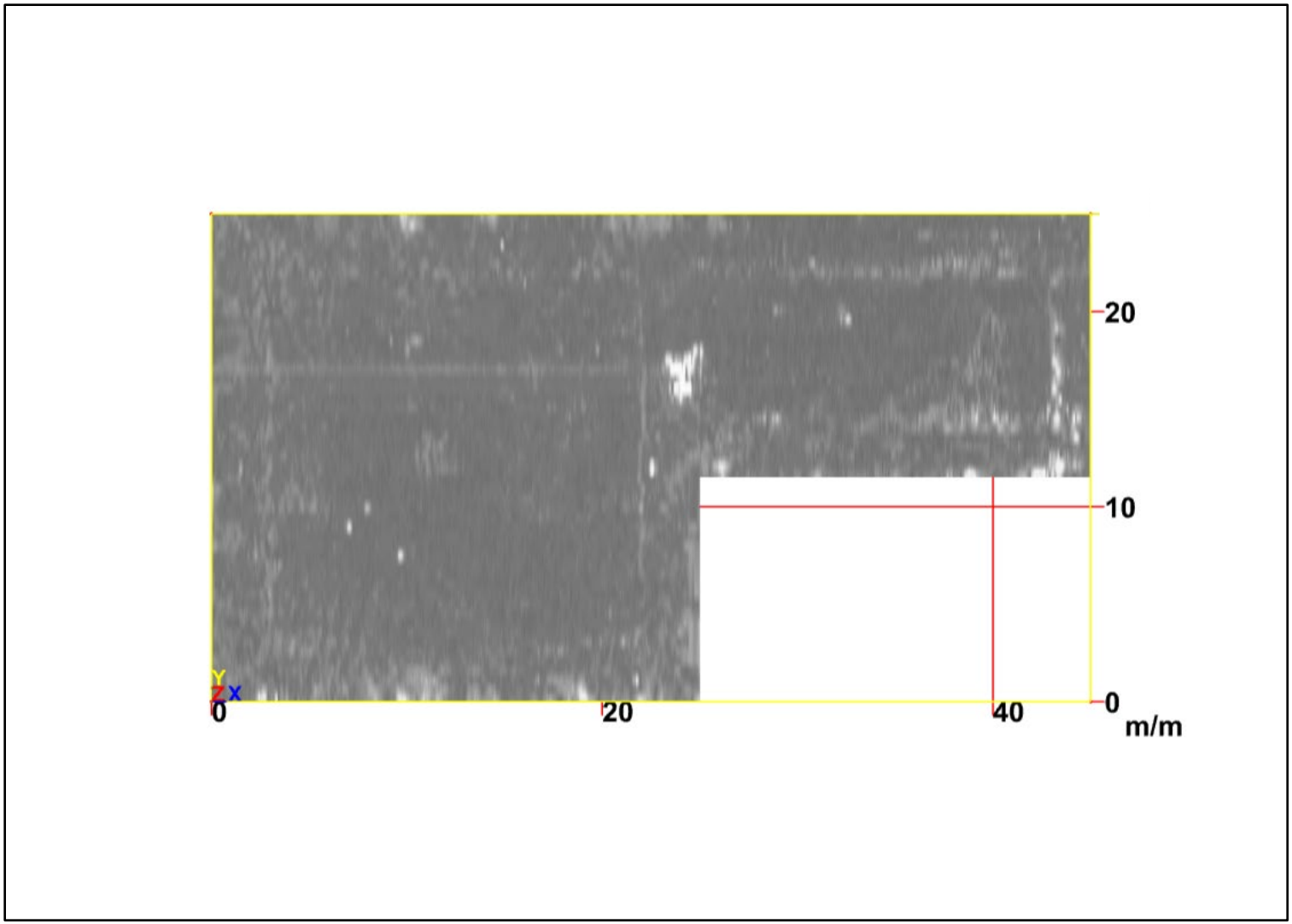
1.8 meters below surface



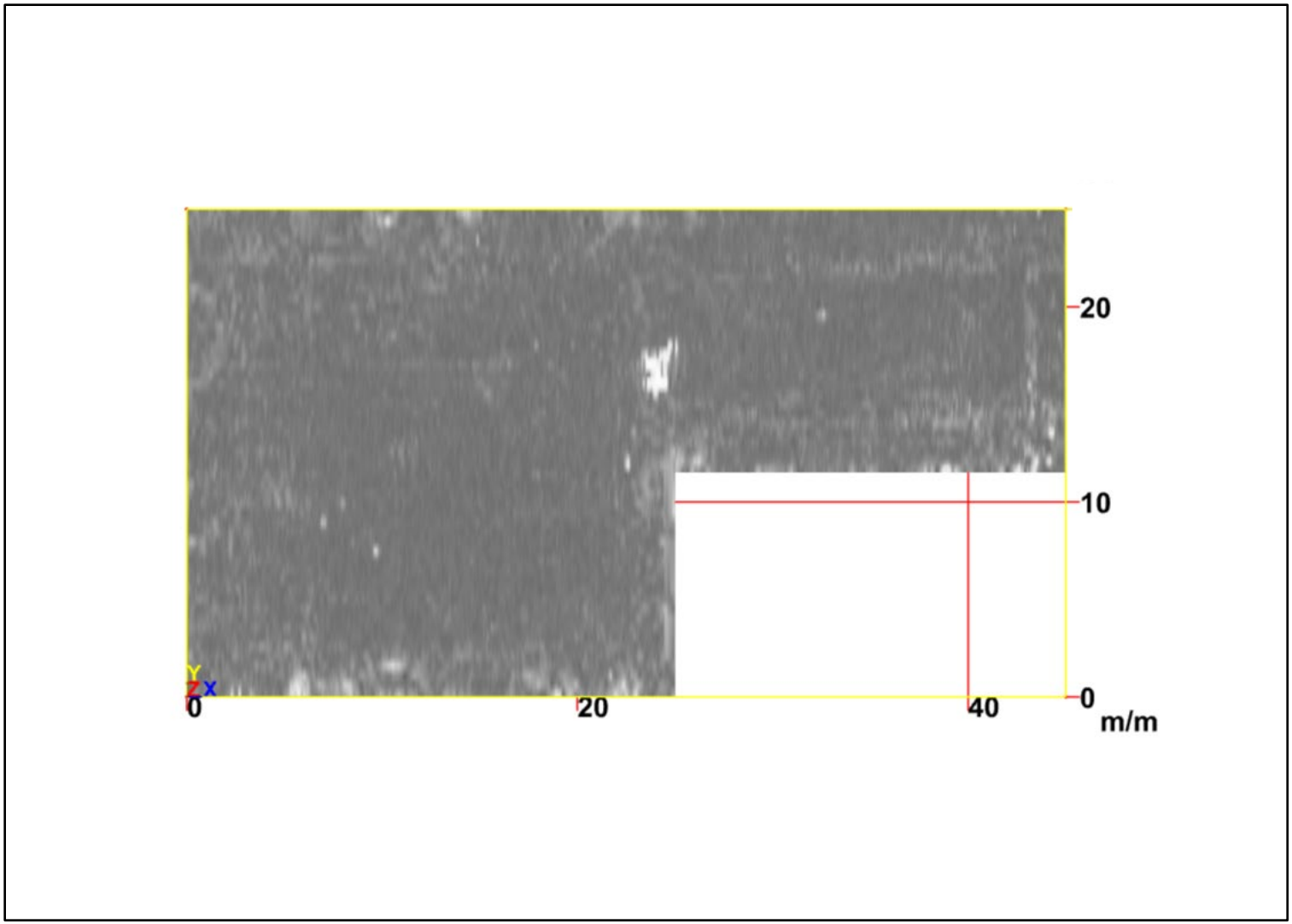
2.0 meters below surface



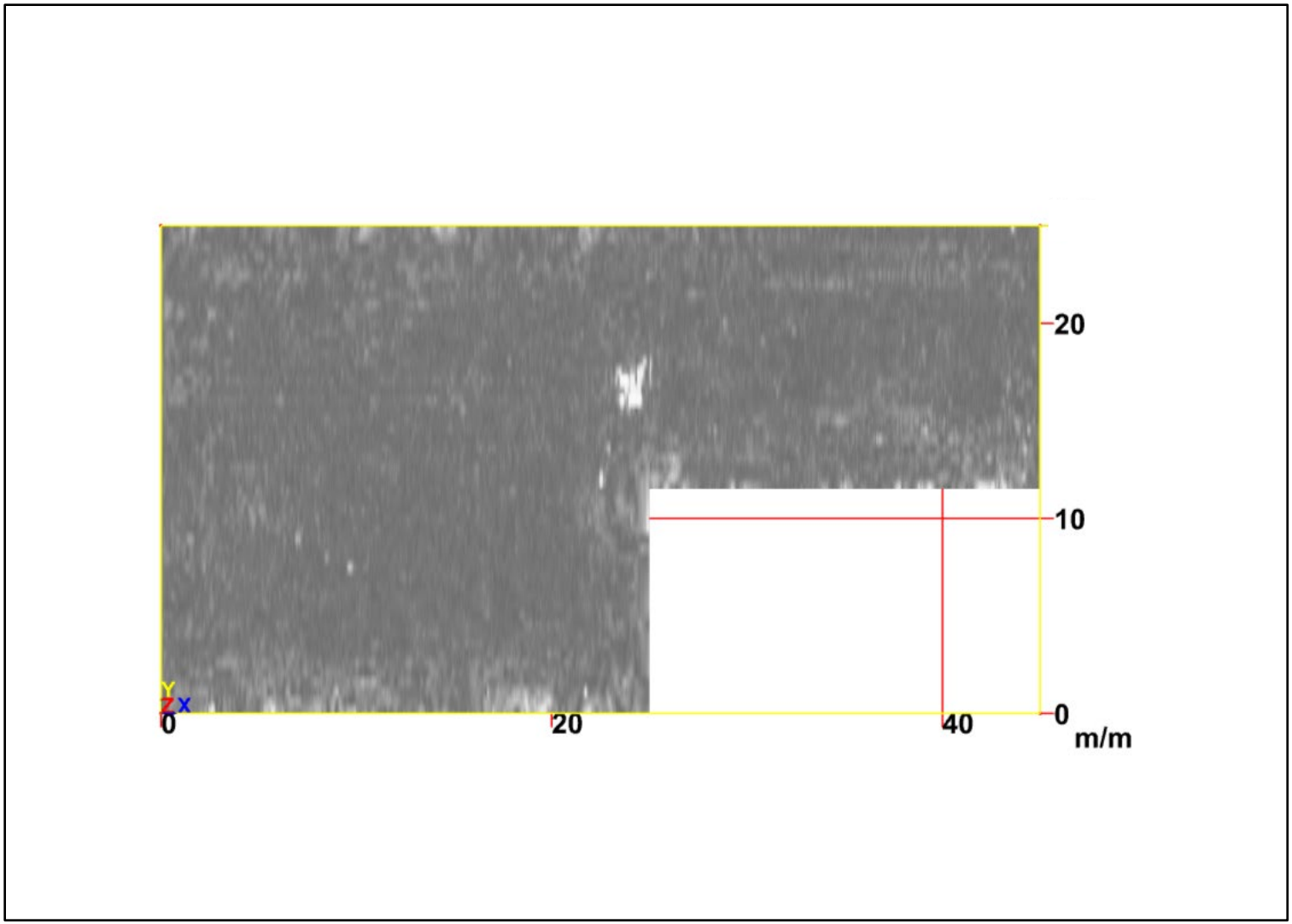
2.2 meters below surface



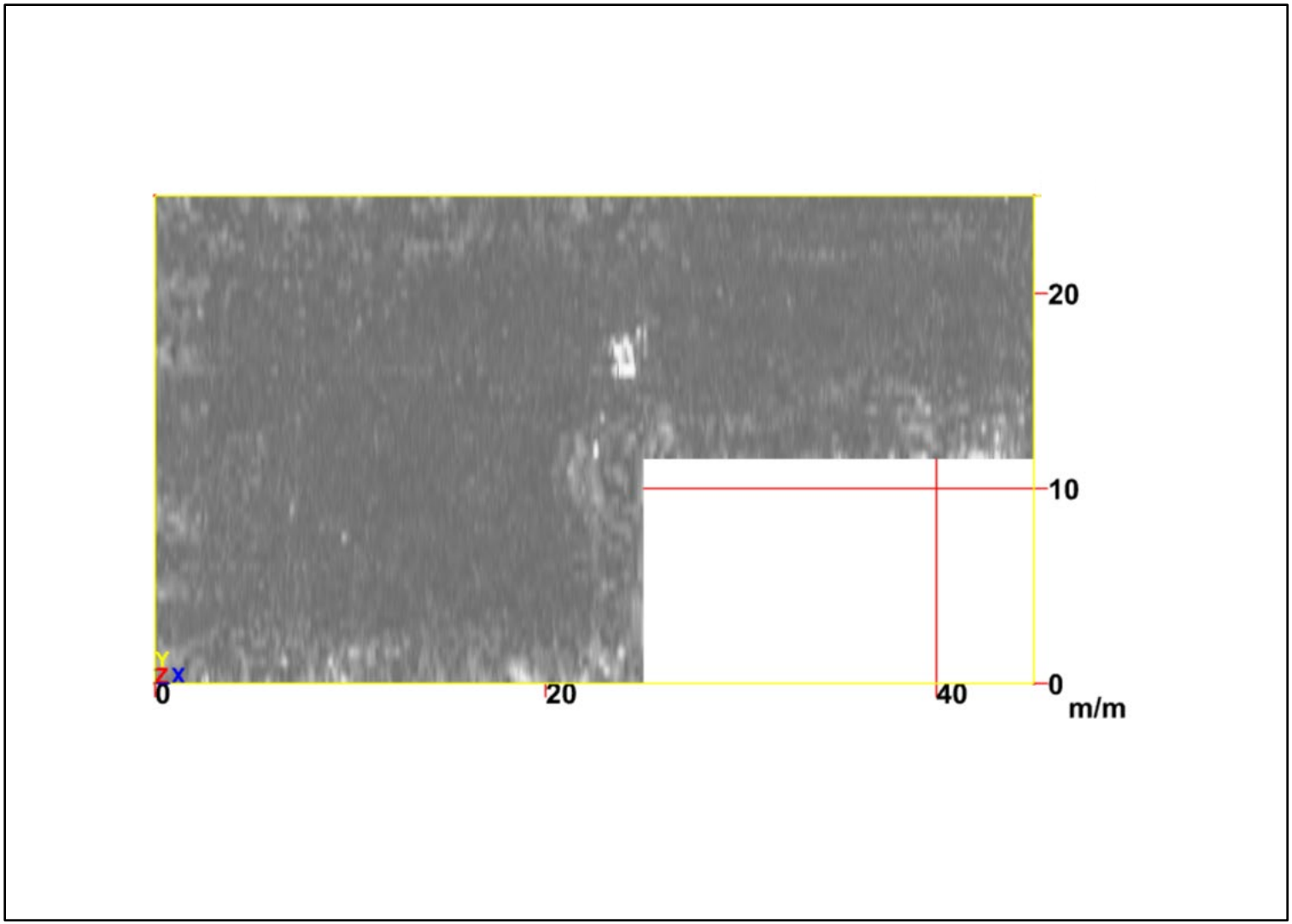
2.4 meters below surface



2.6 meters below surface



2.8 meters below surface



3.0 meters below surface

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