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Recursive Use of GPR, Excavation, and Historical Maps at Gore Place, Waltham, Massachusetts

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Abstract

Gore Place is the early 19th-century house and estate of Massachusetts governor Christopher Gore and his wife Rebecca. The Gores were active in scientific agriculture and cultivated grains, fruits, and vegetables on the property. As part of the landscape restoration, the Gore Place Society wished to know the exact location and preservation status of Gore's stable and greenhouse. To determine these, we recursively combined historic map georeferencing, ground penetrating radar (GPR) survey, and excavation.

We used an initial GPR survey to guide our excavation, then using the GPR-slice images and data from the excavations, a series of historical maps were re-georeferenced, allowing for much better interpretation of the GPR-slice images. Interpreting GPR, excavation, and documentary data in this integrated, sequential package yields more information with less excavation than traditional methods.

Project Background

The Gore Place Society wanted to establish the location and layout of the structures with minimal excavation, so the area of the late 18th-century stable and the near-by, early 19th-century greenhouse was subjected to intensive archaeological, documentary, and geophysical research. The stable still stands, moved during the 1960s, and its location is shown on historical maps. The greenhouse was demolished by the mid-19th century and appears only on 1834 and 1841 maps. The maps are accurate and, at the same time, misleading. How can we better interpret the maps in light of the excavations and geophysics?

The GPR survey was conducted using a Måla 500 MHz unit. The transects were irregularly spaced and oriented with an average spacing of 50 cm. The GPR-slice images were created with 7 cm thick slices.

This poster illustrates four possible georeferences of the 1834 Lyman map and one of the 1935 HABS plan of the property.



Figure 1. Property-wide georeference of the 1834 Lyman map. The land plot and most building are oriented SSW while the greenhouse is oriented south.

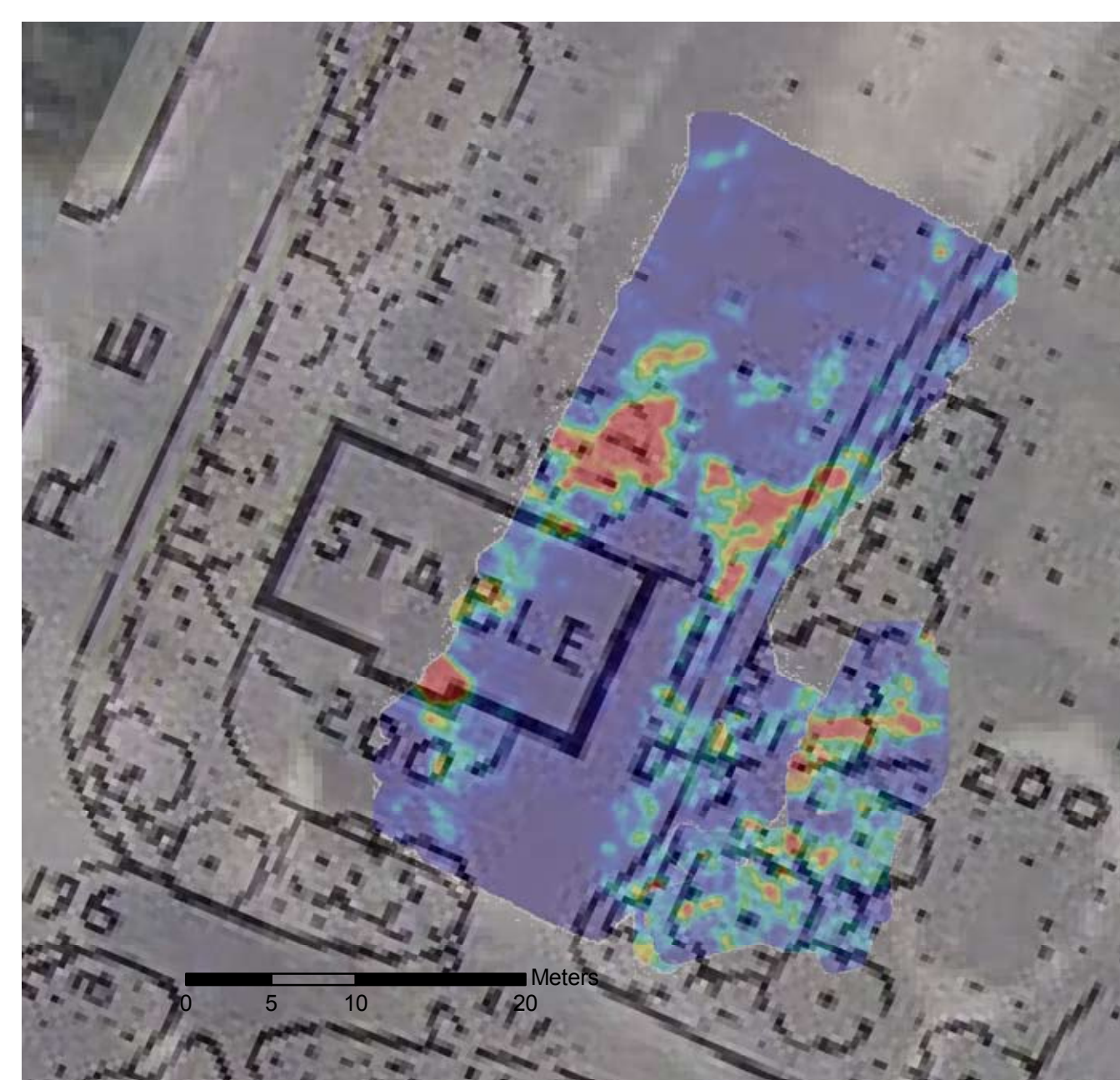


Figure 2. The 1935 HABS plan and the GPR results.

Stable

The plan of the property and accompanying building profiles drawn in 1935 by HABS illustrate that the carriage house had a sloping ramp on its east side leading down to a basement entrance. The HABS plan is not precise in drawing the stable's dimensions, and the building's location may not be accurate either. In fact, the overlay of the GPS and the locally georeferenced Lyman maps is clearer (Figs. 5-7). Although the ramp is not shown on the Lyman map, the ramp and cellar are spaces that are generally devoid of strong reflectors.

Greenhouse

While the 1834 Lyman map could be georeferenced to the whole property (Fig. 1), with GPR and excavation data in hand, was it possible to locally re-georeference the small section of the map showing the carriage house and the greenhouse?

The Lyman map is both accurate and inaccurate, and the various georeferences force us to think about what the salient features were that the map's author saw when he drew the buildings.

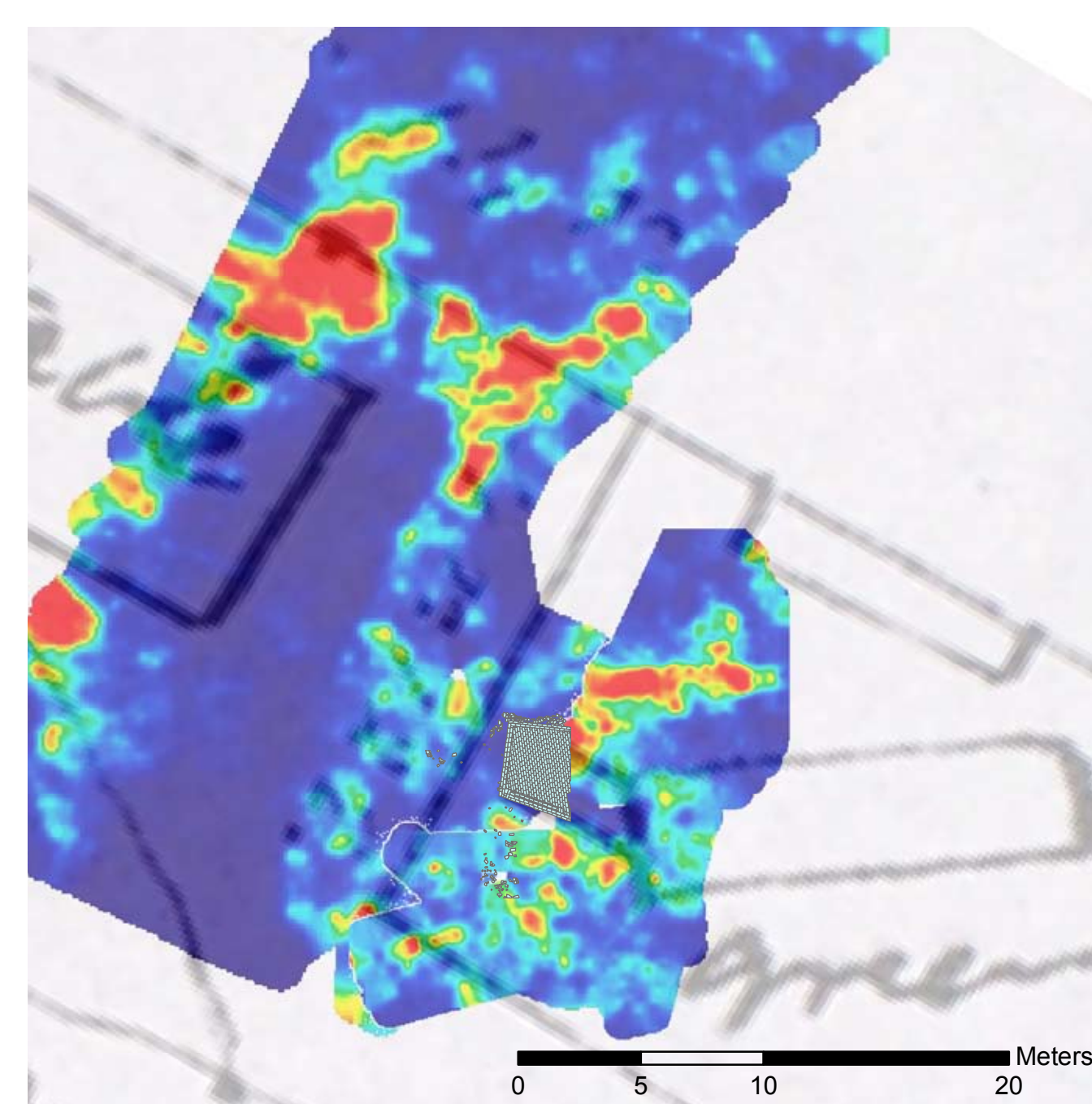


Figure 5. The 1834 Lyman map, GPR slice, and excavated brick floor.

- Georeferenced using the NE corner of the stable and the SW corner of the brick floor.
- Shifts the greenhouse south of the E-W geophysical anomaly interpreted as the north wall.
- Fronts of stable and greenhouse extension flush.

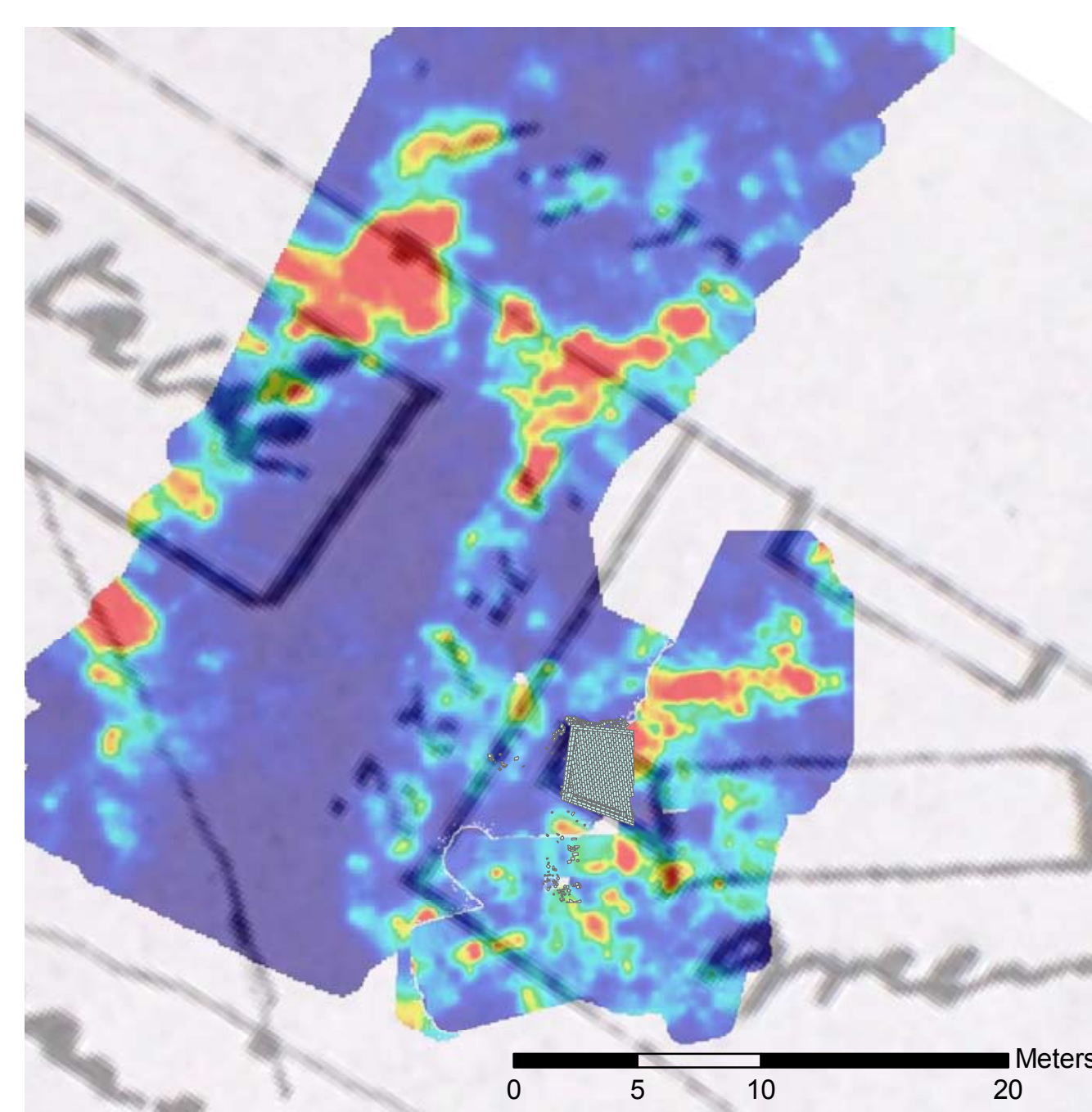


Figure 6. The 1834 Lyman map, GPR slice, and excavated brick floor.

- Georeferenced using the NE corner of the stable and the NW corner of the brick floor.
- Shifts the greenhouse south of the E-W geophysical anomaly interpreted as the north wall.
- Buildings appear approx. 86% of real size.

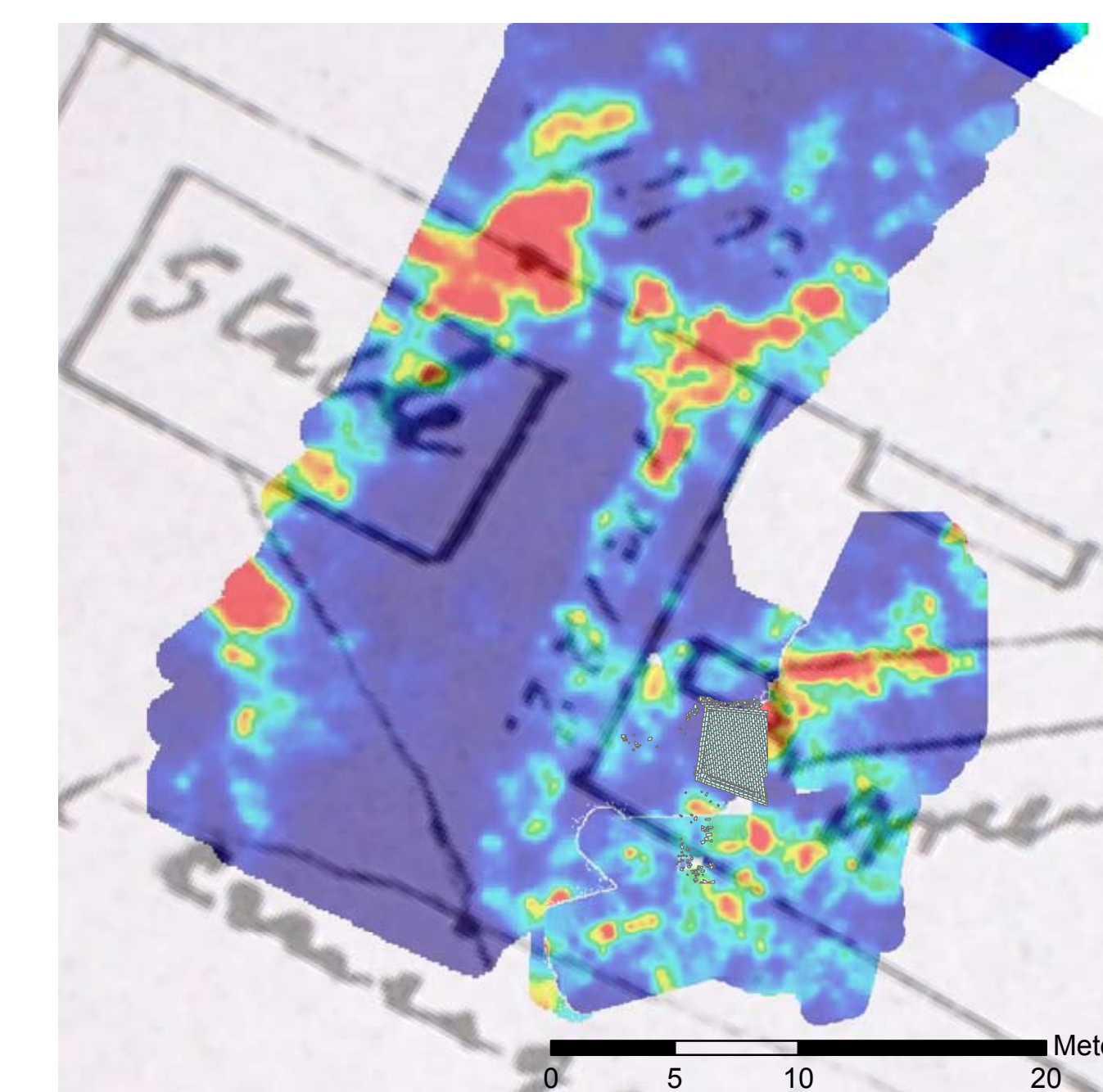
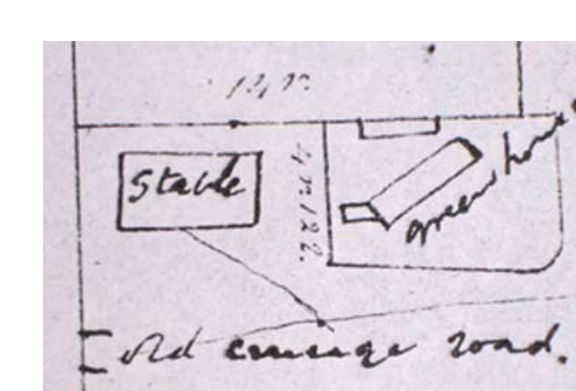


Figure 7. The 1834 Lyman map, GPR slice, and excavated brick floor.

- Georeferenced using the NE corner of the stable and aligning the E-W geophysical anomaly with the north wall of the greenhouse.
- Shrinks the buildings substantially.
- Takes the fronts of the stable and the greenhouse extension out of flush alignment.

Salient features of the Lyman map:



- The greenhouse was drawn at a different angle to all of the other built features on the property, oriented for maximum southern sun exposure.
- The greenhouse extension, on the other hand is flush with the front of the stable, creating a uniform façade of buildings as visitors entered the property.

- The map's author drew the greenhouse extension as rectangular, yet we know from excavation (Fig. 3) that the floor was trapezoidal, probably due to the problem of making the differently oriented buildings meet.

From excavation and GPR:

- The location of the corners of the greenhouse extension and the northeast corner of the stable were uncovered (Figs. 3, 4).

- We have interpreted the strong east-west reflector in the GPR at 35 to 40 cmbs as the north wall of the greenhouse (which would have been more substantial and could contain furnaces and flues).

Combinations of these known features were used for the different georeferences of the Lyman map.

Figure 3. Brick floor of the greenhouse extension, facing west.



Figure 4. NE corner of the stable foundation, facing north.



Figure 8. Reconstruction using elements of multiple georeferences.

- Uses true size of stable, geophysical void for placement of ramp and basement, and E-W reflector as north wall of greenhouse.
- Keeps stable flush with greenhouse extension.
- Extension is oriented SSW with the rest of the buildings on the lot, with the exception of the greenhouse which is oriented south.
- Greenhouse is wider than depicted on 1834 map.