

Geospatial Data on Parade: The Results and Implications of GIS Analysis of Remote Sensing and Archaeological Excavation Data at Fort York's Central Parade Ground

Anatolijs Venovcevs, Blake Williams, John Dunlop, and Daniel Kellogg

1.0 Project Background

In July 2011, YAP Films retained Archaeological Services Inc. to carry out a research-based archaeological investigation to identify the remains of the Government House on the grounds of the Fort York National Historic Site (AjGu-26) located within the City of Toronto (Figure 1). The archaeological fieldwork was used to tie together the storyline of the documentary film, *Explosion 1812*, that was released in June of this year.

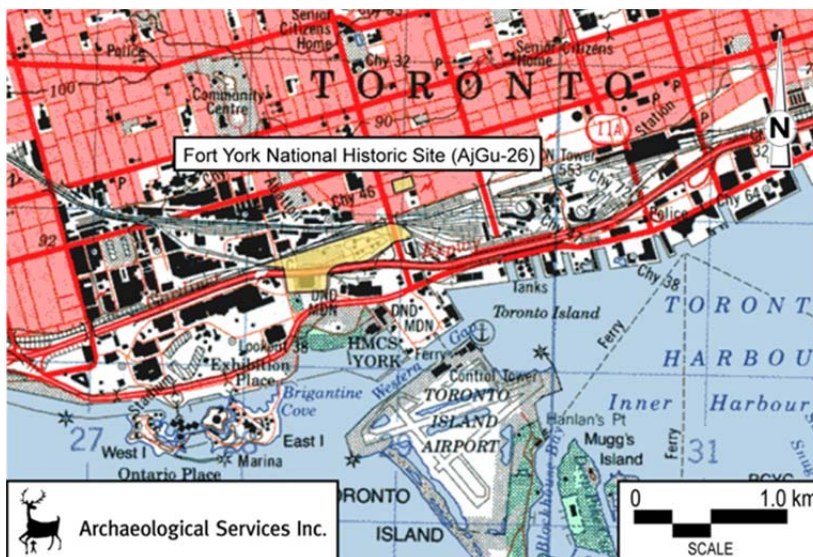


Figure 1: Fort York National Historic Site within the City of Toronto.

To locate the remains of the Government House, a ground penetrating radar survey was conducted within a 60 by 45 metre area over Fort York's central parade ground. In addition, a LiDAR survey was conducted throughout the entire Fort. This was then accompanied by the excavation of a two metre-wide, eight metre-long trench over a nine day period. As a result, this project produced almost four thousand artifacts, identified 27 individual lots, and helped further our understanding of the rich social and military history on one of Ontario's most important heritage sites.

The Government House was a one storey vice regal building, constructed between 1800 and 1802 to serve as the official residence of the lieutenant governor of Upper Canada (Figure 2). The first person to occupy the residence was Lieutenant General Peter Hunter, followed by Sir Francis Gore, Sir Isaac Brock, and Sir Roger Sheaffe, among others. Then, on May 1st, 1813 the Government House was looted and burned by the occupying American forces that captured the provincial capital in a raid four days previous.

While seven archaeological investigations carried out in the 1970s and 1980s identified structural remains or debris, the complex construction history within Fort York made the task of

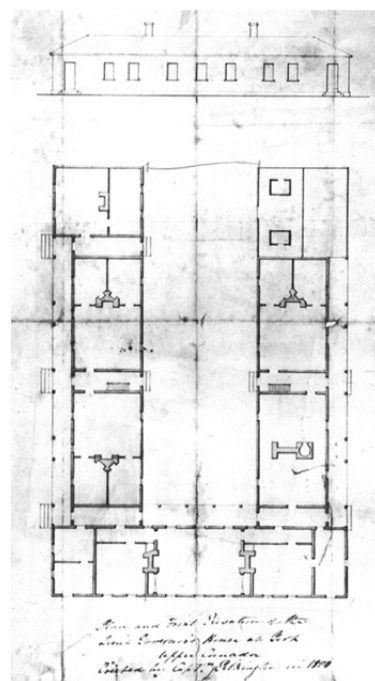


Figure 2: The Government House as depicted in a plan by Captain Pilkington in 1800.

identifying another segment of this significant 1800 structure very difficult. After the Americans withdrew, the British began rebuilding the fort on August 26, 1813. During the rebuilding process, the charred remains of the Government House were dismantled and its grounds were incorporated into the fort's central parade ground. However, in the first half of the nineteenth century a number of other buildings were constructed and then torn down in this location. These include an 1814-1815 Carpenter's Shop, an 1813-1822 Sappers' and Miners' Barracks, a series of splinter-proof soldiers' barracks, and a Cook House that extended along the south wall of the fort, which in turn were torn down in 1848. Furthermore, the remains of some of the 1793 "Simcoe Huts," log cabins constructed by John Graves Simcoe's Queen's Rangers, are known to be located somewhere within this area.

Given the complicated nature of the archaeological record within this area of the fort, the project relied heavily on the application of Geographical Information Systems (or GIS) software to organize data at every step of the investigation. Using GIS as a layered visualization tool for geospatial data helped guide the researchers in this project to better understand their findings within a complex cultural landscape.

2.0 Historical Map Review

Before any archaeological fieldwork was conducted, the researchers reviewed the known historical mapping for the fort. While a large variety of documentary sources exist, only one, the George William's 1813 map, provides an approximate location of the Government House (Figure 3). The Government House is presented on this map as a dotted line directly north of the circular battery, a feature that, with some modification, is still present at the fort today. The dotted line represents the former location of the structure after it was destroyed by the American forces earlier that May. As one can see, overlaying this map on the modern landscape is remarkably difficult given the scarcity of common anchor points to which this 1813 map can be georeferenced.

To overcome this difficulty, a method was employed to fit the Williams map on the modern topography using landscape elements that are still visible including the western ramparts, the circular battery, and the overall triangular shape of the fort itself. This confirmed the previous observations that the Government House was located somewhere within the central parade ground of the modern Fort York (Figure 4).



During the historic map review

Figure 3: The Government House of the Williams 1813 map.



Figure 4: Predicted Location of the Government House.

unchanged throughout Fort York's existence. These are the southeast corner of the Brick Magazine and the southwest corner of the Officers' Quarters.

It is important to note that the southern ramparts were not used in the georeferencing process. After their original construction in 1815-1816, they were modified and rebuilt at least thrice – once in 1838 as part of the Rebellion Crisis renovations, when the walls were shored up and rebuilt, and once more as part of the 1861-1862 Trent Affair, when embrasures were cut and a seven-gun battery was installed. The modern walls themselves are an artifact of the 1932 restoration of the rampart wall that saw the wall built up much higher than it would have ever been in its entire history.

The fluctuating location of the rampart wall is evident from the georeferenced historic maps where the location of the wall and its adjoining barracks is never in a single place and never conforms to the modern topography. Only in the 1846 map are the barracks actually in the survey area. The other structures, the 1814-1815 Carpenter's Shop and the 1813-1822 Sappers' and Miners' Barracks are on the far northern edge of the survey area. From these results, it was revealed that the main survey area on the central parade ground has been free of structures since the destruction of the Government House in 1813.

stage of the project, it was not only necessary to identify the location of the Government House itself but also to identify the locations of former structures that might be picked up by the ground penetrating radar survey or the excavation. As previously mentioned, these structures consist of the Carpenter's Shop, the Sappers' and Miners' Barracks, the splinter-proof soldiers barracks, and Cook House, as well as the possible inclusion of the remains from the 1793 "Simcoe Huts."

While the exact location of the Simcoe Huts is not known, various the historic maps show the location of the other former structures including Van Cortland's 1815, Gustavus Nicolls' 1816, Elias Durnford's 1823, and an 1846 map of the fort. Three of these, the 1815, 1816, and 1846 maps of Fort York were georeferenced on the modern orthoimagery of the fort (Figures 5 – 7). Two georeferencing control points were identified, which have remained



Figure 5: 1815 Map Overlay.



Figure 6: 1816 Map Overlay.

3.0 LiDAR Survey

To supplement the other sources of data, high definition LiDAR imagery was available for Fort York. To anyone who is unfamiliar with the method, LiDAR or Light Detection And Ranging is a remote sensing technology that uses pulses of light, often in the form of a laser, to measure distance as well as identify other properties of a target. LiDAR uses ultraviolet, near infrared or visible light to image objects or areas and it can be fitted to satellites, aircraft, vehicles or tripods (English Heritage 2010:3-4). LiDAR's two biggest benefits for archaeologists is its ability to create high-resolution digital elevation models (DEMs) to reveal micro-topographic features that would otherwise be indistinguishable on the ground and its ability to map features beneath forest canopies (English Heritage 2010:5-8).



Figure 7: 1846 Map Overlay.

This LiDAR survey was commissioned from Optech by The Friends of Fort York Foundation. The data recovered from that survey and thus presented here was from a downward-looking, aircraft-mounted LiDAR. While the tremendous utility of this technique for archaeology has been proven around the world, this source of data did not provide any details on the location of historic buildings inside the fort. Instead, the LiDAR mapping shows a remarkably featureless, flat landscape within the walls of Fort York (Figure 8).

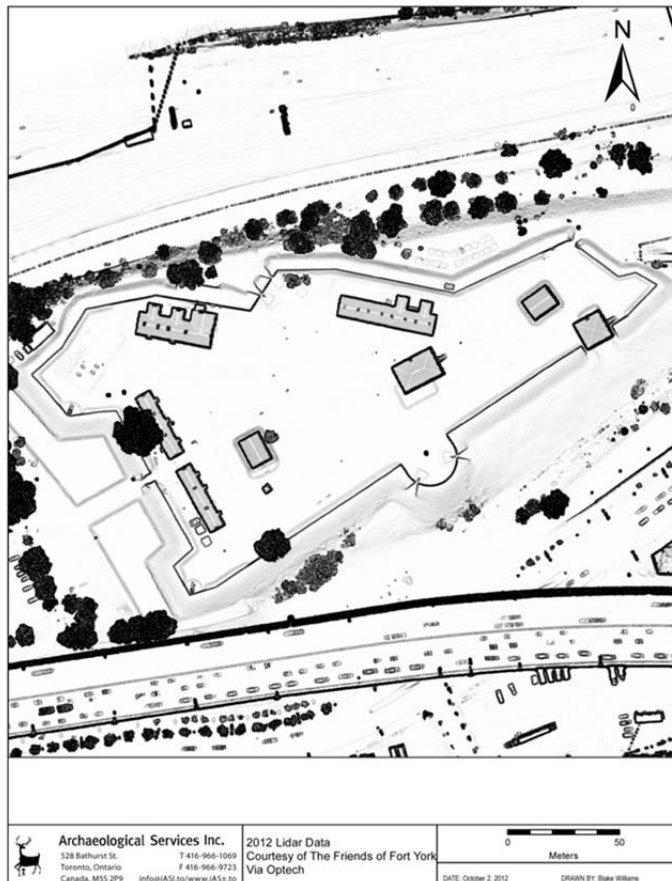


Figure 8: LiDAR Survey Results of Fort York.

the Government House was commissioned. Ground Penetrating Radar (GPR) was used because it was determined that the archaeological features identified in previous excavations were most likely detectable using this technique. Although other geophysical survey techniques, such as electrical resistivity which had previously been carried out within the fort by Claus Breede in the 1970s, are applicable, GPR was used because of its speed, accuracy and depth penetration capabilities.

In general, most GPR units look very similar to a lawnmower, but are comprised of a transmitting and receiving antenna instead of sharp blades. The transmitting antenna emits radio waves that travel through the subsurface (Plate 1). When a radio wave encounters an area of contrasting electrical and magnetic properties, such as interfaces of buried stratigraphic layers, objects, or features, the radio wave is reflected back to the surface and is recoded as an anomaly (Clark 1990). When conducting a survey over a preset grid, the recorded GPR data can be viewed in either individual line profiles, or as interpolated plan maps sliced at designated depths.

This is intriguing in itself. As Vito Vaccarelli (1997) had noted, the Fort York cultural landscape has been subjected to multiple landscape fill events that have removed all traces of the original topography. The scope of soil alteration has been so great that even a high precision remote sensing technique like LiDAR would not pick up most traces of the original topography and former standing structures.

Despite its lack of applicability to the current project, it should not be overlooked that the LiDAR survey's greatest contribution has been to digitally record all of the buildings at Fort York in full detail for the permanent record.

4.0 Ground Penetrating Radar Survey

Due to this lack of structural remains visible on the surface, a geophysical survey covering the documented area of



Plate 1: Blake Williams Conducting a GPR Survey at Fort York.

Viewing the data this way allows for anomalous areas to be displayed in their horizontal and vertical spatial context (Conyers 2006).

The technique works best for surveys over well drained soils and with a range of depth from 20 cm to 2 m (Conyers 2006). This was most useful in the search for the Government House, given the complex stratigraphy previously noted within the fort. Another consideration for using GPR in this instance was the physical nature of any remains of the Government House. As previously

stated, GPR wave reflection was strongest in cases of greater variability between subsurface materials. Therefore, detection of the brick and stone remains of the Government House would most effectively be detected using GPR. Similarly, some more ephemeral structures like the 1793 “Simcoe Huts,” that were built from green logs with few significant structural elements, or the short-lived Carpenter’s Shop would be less pronounced during this method of geophysical survey and would thus have less chance of interfering with the results of this survey.

The GPR survey was conducted in a 60 by 45 metre area at 0.5 metre transect intervals. A 250 MHz antenna was used, transmitting waves every 2.5 cm. An optimal depth range of 25-125 cm was achieved. The orthoimagery that comes with the ESRI ArcGIS package was used to plot the GPR data on the modern topography.

The GPR survey recorded a lot of anomalies throughout the parade ground as the result of its continued use and alteration since the fort was built (Figure 9). A series of strong anomalies were recorded within the general area of the Government House from 45 cm to 80 cm below surface. No anomalies were recorded along the southern portion of the house, because that area has been heavily disturbed by modern utility trenching. It should also be noted that the GPR survey detected the buried remains of the barracks and cookhouse displayed along the southern rampart wall in the early historic plans (Figure 10). It should be noted that these buildings were detected during Claus Breede’s previous electrical resistivity survey in the mid-1970s; however the deposits relating to the Government House were not the focus of his study.

5.0 Archaeological Excavations

The final components to the GIS database are the previous excavations on the central parade ground. Prior to the 2011 excavation, seven trenches have been dug in this area and it was important to understand their results and their exact location in order to understand the complex site formation process of Fort York’s central parade ground and how it relates to relocating the Government House.



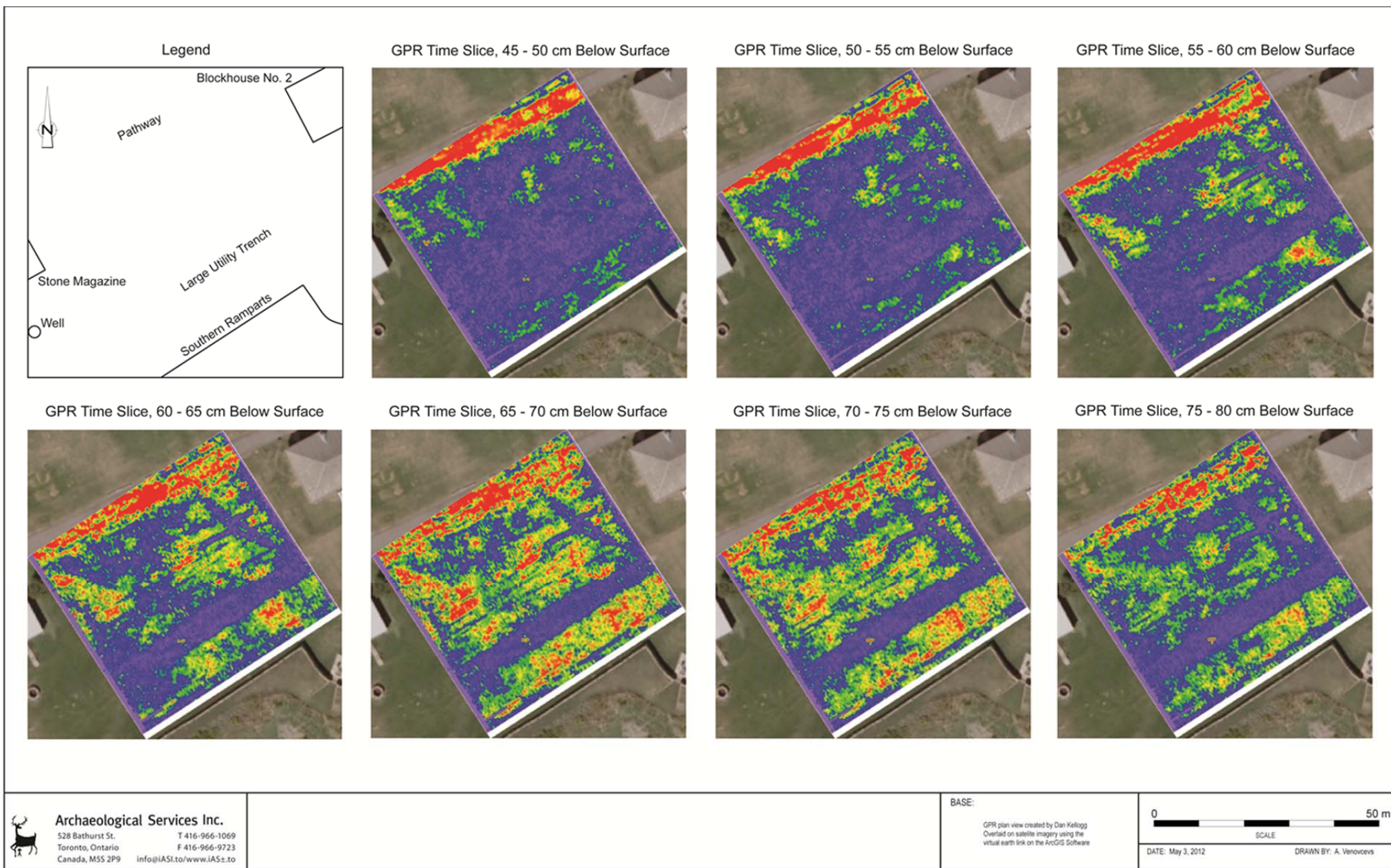


Figure 9: The Results of the GPR Survey at the Central Parade Ground at the Fort York National Historic Site (AjGu-26).

Of note for this study were Claus Breede's 1976 operations TT1 and TT4, the 1987 operation 1FY4, and the 1989 operations 1FY21, 1FY22, and 1FY25 (Figure 11). TT1 and TT4 identified one of the walls of the Cookhouse. Contrary to Breede's conclusions (Breede 1977), however, the GIS in this study suggests he found the north and not the south wall of the building. Of more interest to the location of the Government House itself, 1FY4 and 1FY22 contained burned areas that were attributed to the destruction of the vice-regal building while 1FY25 contained a possible stone foundation wall, though the later operation's small size makes interpretation difficult (Webb 1991).

Most pertinent to this study was the 1989 operation 1FY21. In this 10-metre trench the two northern-most sub-operations identified significant architectural remains consisting of charred wood debris including four possible beam segments and several floor boards that overlay a single course

of flat dry-laid stones representing a foundation wall (Webb 1991:73-74). The creamware and pearlware ceramics along with the New Brunswick Regiment button suggested that this material were the remains of the Government House (Webb 1991:77-78) (Figure 11). Interestingly, when the locations of all of these trenches are mapped on the GPR survey results, the operation 1FY21 is located within the most distinct anomaly in the centre of the parade ground (Figure 12).

Thus, through the use of GIS it was established that the 1989 operation 1FY21 identified the Government House within an area of high anomalous readings picked up by the ground penetrating radar survey in an area that was identified to be free of known former historical structures. This information allowed ASI to plot an eight by two metre trench in an area that had high potential for identifying the buried remains of the Government House (Figure 12).

The 2011 trench was divided into four two by two metre sub-operations labelled A, B, C, and D that descending southward alphabetically. While the nine-day stratigraphic excavation did not allow Archaeological Services Inc. to fully investigate sub-operations B and D, the northern-most sub-operation A revealed a robbed out foundation trench approximately 60 cm below the modern ground surface. The trench was observed as a reverse L-shaped deposit hugging the south and east walls of the sub-operation and containing organic soil, red bricks, and small flat shale fragments (Figure 13). While no artifacts were recovered from this context, the material

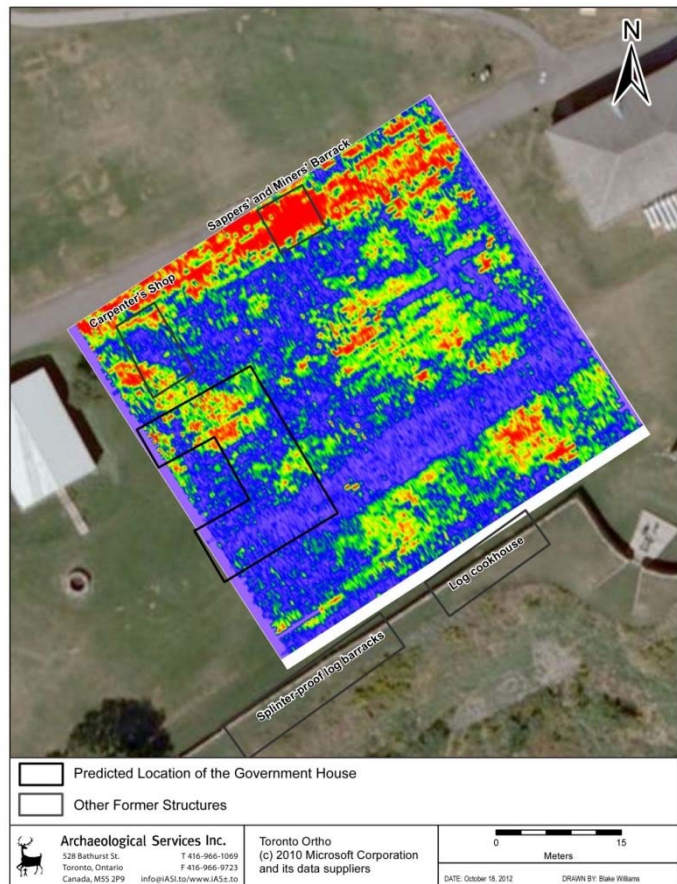


Figure 10: GPR Results at 60 cm at the Central Parade Ground.

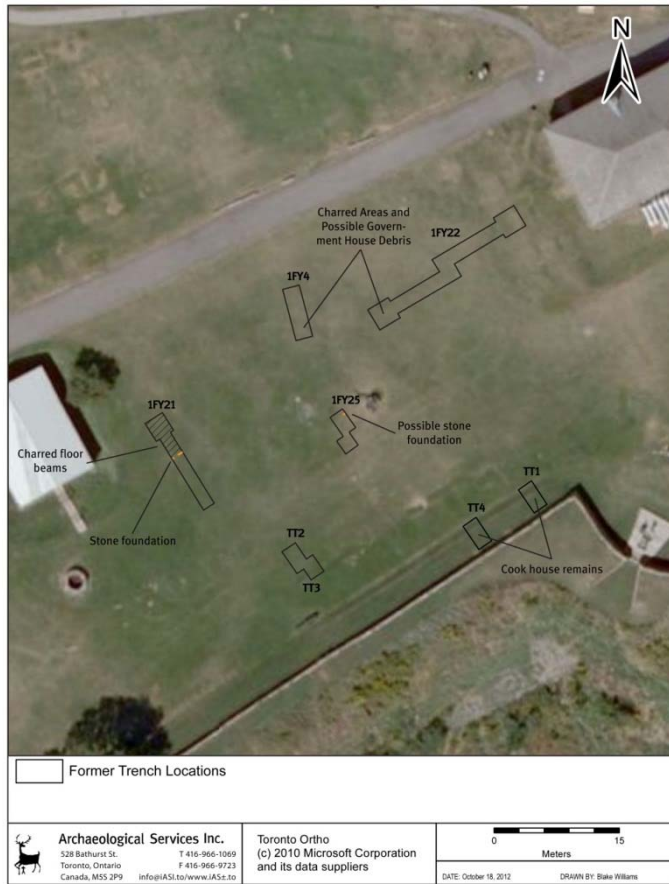


Figure 11: Previous Excavations at the Central Parade Ground.

the interior walls. It is important to reiterate that such a detailed conclusion could not be made without the application of GIS technology for this step of the process to provide effective and pinpoint accurate mapping that allowed the successful comparison of two different deposits that were identified 22 years apart from each other (Figure 14).

6.0 Discussion

To summarize, this project successfully employed Geographic Information Systems software to amalgamate four vastly different sources of data. It brought together historical mapping, LiDAR imagery, ground penetrating radar information, and the results of numerous excavations conducted within a 35 year period into one cohesive database that allowed for an effective and methodologically sound interpretation of one the most important archaeological sites in Ontario. Through this process, it was established that the archaeological remains uncovered within the 2011 trench dug at the central parade ground of the Fort York National Historic Site relate directly to an 1800 vice-regal building that served as home for some of the most important people in the early history of this province.

culture recovered from the upper strata of the sub-operation indicate that the robbed out foundation trench pre-dates the 1820s.

This deposit could not be explored further given the time limitations set on this project. Therefore, the robbed out foundation trench and any archaeological remains directly related to the Government House below it were left *in situ*. Thus, GIS helps once again with the interpretation of the archaeological remains. Comparing this robbed out foundation trench to the architectural material identified in 1FY21 one can see that the robbed out foundation trench feature discovered by ASI in 2011 lines up nicely with the dry laid stone foundation identified previously in 1989. What ASI uncovered in 2011 represents a continuation of that foundation which has to relate to the southern wall of the north wing on the building. The northward-running component of the robbed out foundation wall therefore would represent the support for one of



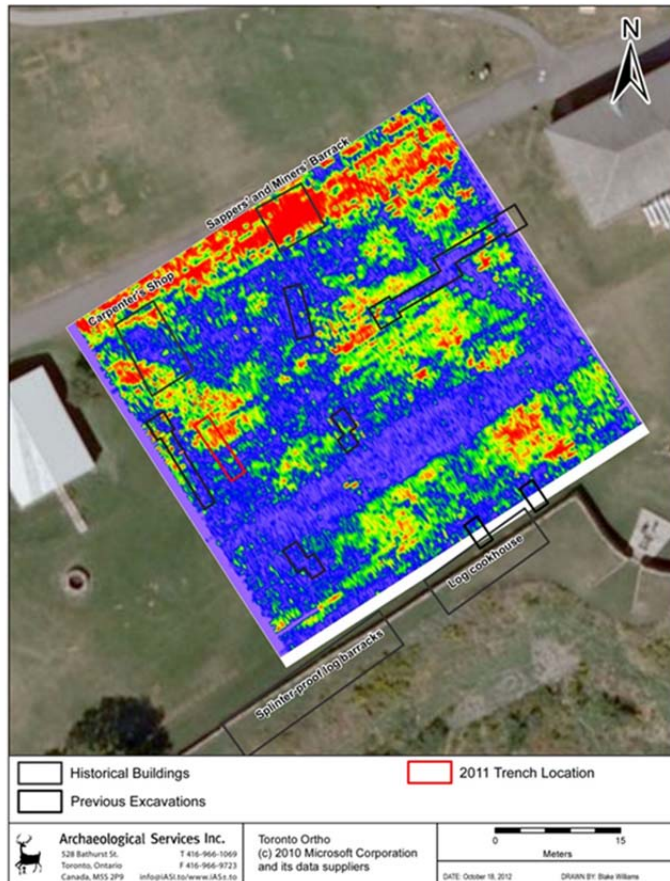


Figure 12: Previous Excavations with the 2011 Trench Location at the Central Parade Ground.

that a greater portion of the fort, a national historic site, remains preserved with other *in situ* deposits. These results provide a greater understanding of the archaeological record within Fort York whilst minimizing the amount of destructive excavation which would have formerly been the sole method of obtaining any information regarding the location of the Government House.

Using this method, archaeologists can answer broader questions about changes in the landscape, seek more specific answers about individual structures with complex built environments, and respond better to the quickly-changing demands for cultural heritage management within this province today.

This work builds on Vito Vaccarelli's work on the reconstruction of the original landscape within the historic fort (Vaccarelli 1997) and follows what has been done by Andrew Parkyn in England (Parkyn 2010) and Kenneth Kvamme and Stanley Ahler in the United States (Kvamme and Ahler 2007) in using geophysical survey often combined with field excavation and brought together within a GIS database to reconstruct a unique and detailed picture of a former landscape.

Archaeological investigations using such pluralistic methodologies allow for a more nuanced understanding of the subsurface archaeological deposits which in turn allow for a more accurate excavation. Through this approach, standard archaeological excavation becomes one method from many used for obtaining archaeological information, with the excavation results being accurately placed within a wider archaeological context. The result is

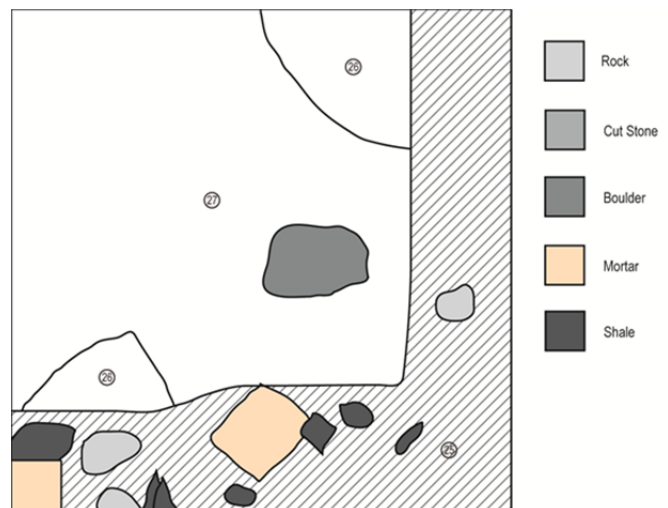


Figure 13: ASI 2011 Fort York Trench, Sub-Op A, Lot 25.

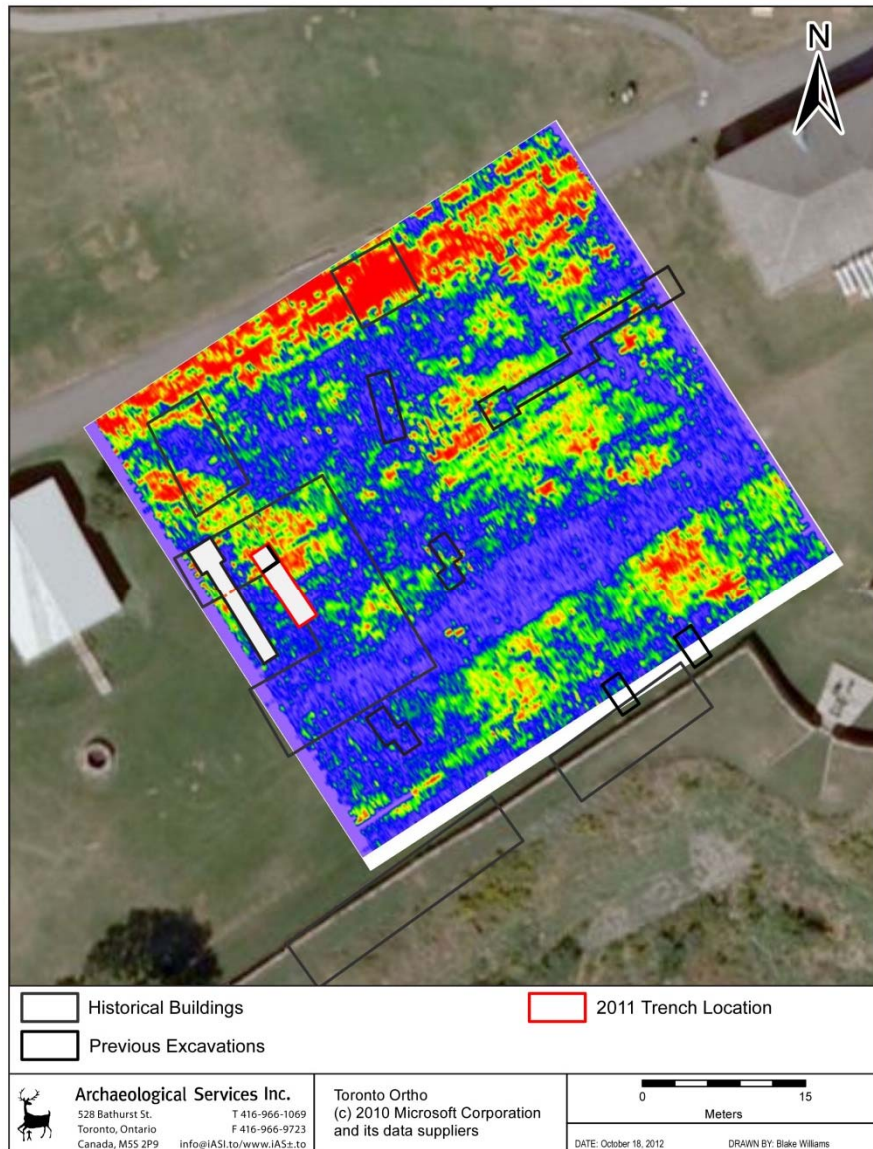


Figure 14: Final Results from the Fort York GIS Project.

Bibliography

Breede, Claus

- 1977 *Fort York Resistivity and Archaeology A Project Report 1976-1977*. Report on file, Fort York National Historic Site, Toronto.

Clarke, Anthony

- 1990 *Seeing Beneath the Soil: Prospecting Methods in Archaeology*. Routledge, New York.

Conyers, Lawrence B.

- 2006 Ground-Penetrating Radar. In *Remote Sensing in Archaeology: An Explicitly North American Perspective* edited by Jay K. Johnson. University of Alabama Press, Alabama, pp 131-159.

English Heritage

- 2010 *The Light Fantastic: Using airborne lidar in archaeological survey*. English Heritage Publishing, English Heritage. Accessed online from <http://www.english-heritage.org.uk/content/publications/publicationsNew/guidelines-standards/light-fantastic/light-fantastic.pdf>.

Kvamme, Kenneth L. and Stanley A. Ahler

- 2007 Integrated Remote Sensing and Excavation at Double Ditch State Historic Site, North Dakota. *American Antiquity* 72(3):539-561.

Parkyn, Andrew

- 2010 A Survey in the Park: Methodological and Practical Problems Associated with Geophysical Investigations in a Late Victorian Municipal Park. *Archaeological Prospection* 17:161-174.

Vaccarelli, Vito

- 1997 An Archaeological Narrative of York's Cultural Landscape, 1793-1998. *Ontario Archaeology* 64:81-111.

Webb, Catherine

- 1989 *Fort York Archaeology Programme 1989, Excavation and Preliminary Analysis Report*. Three Volumes. Toronto Historical Board, Toronto.

