



Forgotten Souls of the Dawn Settlement: A Multicomponent Geophysical Survey of Unmarked Graves at the British American Institute Cemetery

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Abstract The Dawn Settlement near Dresden in south-western Ontario was a mid-19th-century community of escaped slaves, or “freedom seekers,” from the United States. In this study, a multicomponent geophysical survey (ground-penetrating radar, magnetic gradiometry, and electrical resistivity) was conducted on the British American Institute Cemetery, one of the two cemeteries directly associated with the settlement, to document the location of freedom-seeker graves whose markers had been damaged, knocked over, or removed during the 1960s due to the neglect and forgotten history of these burials. All the techniques provided useful information contributing to site interpretations, although GPR was found to be the most useful in identifying possible graves. We discuss the significance of incorporating archaeogeophysics techniques into heritage-management strategies and our responsibility to protect historical black cemeteries. Our survey also

represents one of the first cemetery investigations related to the Underground Railroad in Canada.

Extracto El asentamiento Dawn cerca de Dresden, en el suroeste de Ontario, era una comunidad de esclavos fugitivos de mediados del siglo XIX, o “freedom seekers,”—traducido literalmente a “buscadores de la libertad”—de los Estados Unidos. En este estudio, se realizó el análisis geofísico multicomponente (radar de penetración en el suelo [GPR], gradiometría magnética y resistividad eléctrica) en el Cementerio del Instituto Británico Americano, uno de los dos cementerios directamente asociados con el asentamiento, para documentar la ubicación de las tumbas de los “freedom seekers” o buscadores de la libertad cuyos marcadores habían sido dañados, derribados o retirados durante la década de 1960 debido a la negligencia y la historia olvidada de estos entierros. Todas las técnicas usaron información útil que contribuyó a las interpretaciones del sitio, aunque se encontró que GPR era el más útil para identificar posibles tumbas. Discutimos la importancia de incorporar metodologías de arqueogeofísica en las estrategias de gestión del patrimonio y nuestra responsabilidad de proteger los cementerios históricos de afroamericanos. Nuestro estudio también representa una de las primeras investigaciones de cementerios relacionadas con el ferrocarril subterráneo en Canadá.

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Résumé L'établissement Dawn près de Dresden dans la région sud-ouest de l'Ontario était une communauté datant du milieu du 19^{ème} siècle comptant des esclaves

fugitifs, ou « chercheurs de liberté » provenant des États-Unis. Dans cette étude, une enquête géophysique à multiples composantes techniques (géoradar, gradiométrie magnétique et résistivité électrique) a été conduite dans le cimetière de l'Institut américano-britannique (British-American Institute Cemetery), l'un des deux cimetières directement associés à l'établissement. L'objectif était de documenter l'emplacement des tombes des chercheurs de liberté dont les pierres tombales avaient été endommagées, renversées ou enlevées au cours des années 1960 en raison de la négligence et de l'histoire oubliée de ces tombes. Toutes ces composantes techniques ont fourni des informations utiles ayant contribué à l'interprétation du site cependant c'est le géoradar qui s'est révélé le plus efficace pour identifier les emplacements potentiels de tombes. Nous discutons de valeur de l'incorporation de techniques d'archéogéophysique au sein de stratégies de gestion du patrimoine et de notre responsabilité quant à la protection des cimetières historiques des populations noires. Notre enquête représente également l'une des premières études de cimetières liées au chemin de fer clandestin (Underground Railroad) au Canada.

Keywords freedom seekers · geophysical survey · cemeteries · slavery · Underground Railroad · Josiah Henson

Introduction

Archaeologists have long drawn on geophysical techniques to aid in the nondestructive surveying of sites, e.g., Scollar (1974), Tsokas et al. (1994), Garrison (1996), Moffat et al. (2008), and Chase et al. (2011). Recent research into the use of geophysical and remote-sensing technologies to locate unmarked graves has yielded mixed results (Bevan 1991; J. King et al. 1993; Nobes 1999; Linford 2004a, 2004b; Conyers 2006; G. Jones 2008; Fiedler et al. 2009; Ruffell et al. 2009; Sutton and Conyers 2013; Hansen et al. 2014; Gaffney et al. 2015; Dick et al. 2017), sparking debate among archaeological geophysicists as to whether it is even possible to locate graves with current techniques (Gaffney et al. 2015). It is now generally agreed, however, that the use of a comparative suite of surveys has the greatest potential for locating unmarked graves (Gaffney et al. 2015). Although North America has seen a proliferation of unmarked-grave investigations in both

the professional and academic archaeological spheres, e.g., Ellwood (1990), Bevan (1991), Elwood et al. (1994), G. Jones (2008), Doolittle and Bellantoni (2010), Bigman (2012), and Conyers (2012), these investigations have focused primarily on European and indigenous burial grounds, and used one or two geophysical techniques. While the results of geophysical surveys of African American cemeteries have been presented in theses, edited volumes, newspaper articles, and at conferences, e.g., Lain et al. (2014), Meehan (2014), Amhara (2016), Ratini (2017), and Trainor (2017), we are aware of only one that has been published in a peer-reviewed journal, i.e., Bigman (2014). Our results, therefore, add to a relatively underexplored area of research.

In this article we present the results of a geophysical survey of a cemetery associated with the British American Institute (BAI) near Dresden, Ontario, Canada (Fig. 1). The BAI was a training academy that served the inhabitants of the Dawn Settlement, one of several freedom-seeker communities in southwest Ontario and a terminus on the Underground Railroad. “Freedom seekers” is a term, common in the Underground Railroad literature, that refers to enslaved African Americans who escaped to the Northern states, or to what is today Canada, where slavery had been abolished decades before, e.g., McQuinn (2015) and Frost and Tucker (2016). The cemetery itself is situated to the west of Uncle Tom’s Cabin Historic Site, owned by the Ontario Heritage Trust, and the adjacent Henson family cemetery (Fig. 2). While the Dawn Settlement (and ultimately the Underground Railroad movement) has been well researched (Hill 1981), little is known about the BAI Cemetery and its interments. In the 1960s, the graveyard was badly disturbed, and grave-marker layout was reconfigured to form a central monument (Fig. 3). Eastaugh (2008) conducted a magnetic-gradiometer survey at the BAI Cemetery in the hopes of locating the grave shafts, but results were inconclusive. The purpose of our geophysical survey was to use a wider range of techniques (ground-penetrating radar, magnetic gradiometry, and electrical resistivity) in an attempt to identify freedom-seeker graves, map their configuration, and locate the cemetery’s boundary. We also assess the efficacy of these three geophysical techniques in locating unmarked graves.

Our survey contributes a Canadian case study to the growing corpus of unmarked-grave studies and represents one of the first cemetery investigations directly related to the Underground Railroad in Ontario. We

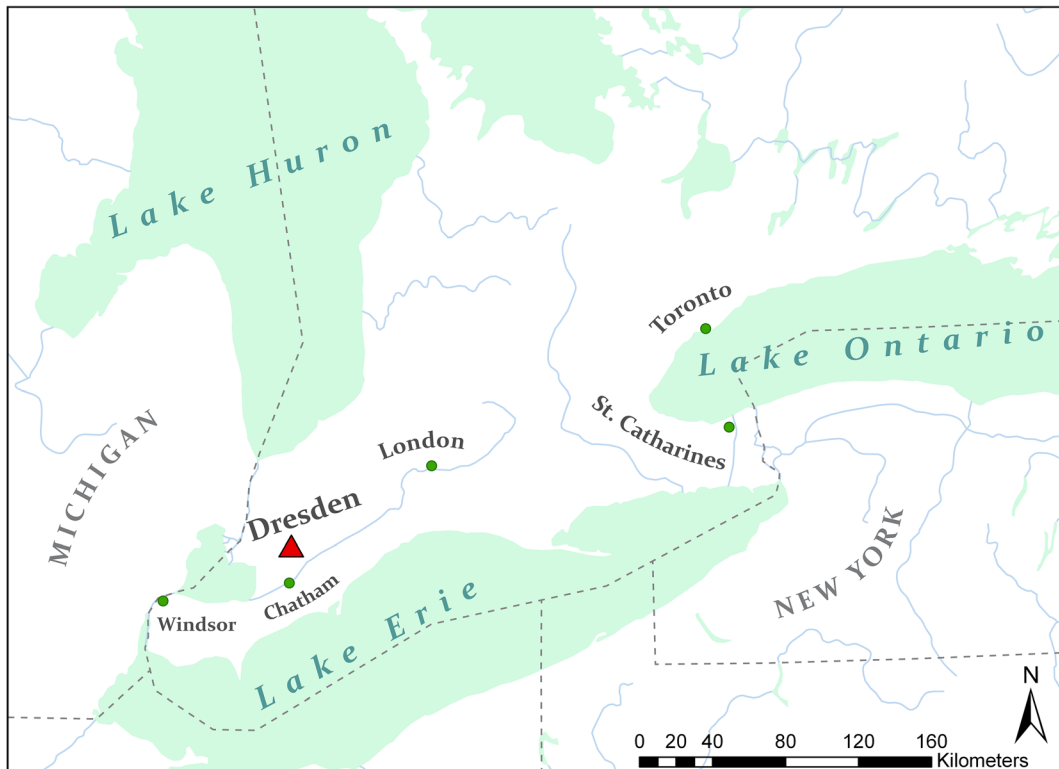


Fig. 1 A map of southern Ontario and adjacent U.S. states highlighting major settlements of freedom seekers who settled in Canada (circles). The Dawn Settlement, now Dresden, Ontario, (triangle) is just north of Chatham and on the banks of the

Sydenham River. (Map by William T. D. Wadsworth, 2018; created using data freely available from Natural Resources of Canada <<http://geogratis.gc.ca/>>.)

demonstrate that a combination of geophysical methods used in light of historical and archaeological information is more effective in locating unmarked graves and understanding the site processes that affect them than using each method in isolation. Our results will assist the Ontario Heritage Trust, an agency of the Ministry of Heritage, Sport, Tourism, and Culture Industries, in documenting the unmarked graves at this site, thereby protecting them from further disturbance as well as providing the Chatham-Kent municipality, which operates the two Dawn Settlement cemeteries, with information regarding the number of interments. Moreover, our work has the potential to contribute to future heritage-management and conservation strategies.

The BAI, the Dawn Settlement, and the Underground Railroad

The history of the Dawn Settlement is closely linked to the complex geopolitical relations associated with the

Detroit River borderland and the history of slavery in Canada and the United States (Frost and Tucker 2016). In the late 18th and early 19th centuries, the Detroit River was still a frontier in some respects, and enslaved African Americans seeking freedom crossed the border in both directions (Prince 2016; Tucker 2016). For example, during the American Revolutionary War, the British offered freedom to enslaved African Americans if they fought for the British Loyalists (Reese 2011). The 1793 *Act to Prevent the further Introduction of Slaves and to Limit the Terms of Contracts for Servitude within this Province* granted freedom to any enslaved child upon turning 25 and outlawed the condition of slavery in Upper Canada (Hepburn 2007; Reese 2011; LaRoche 2014). Many enslaved African Americans interpreted this law as a symbol of hope, believing that it offered freedom (Walker 1985; Prince 2016).

In the same year the United States Congress passed the first fugitive slave law, allowing slave owners to capture and reenslave those who had escaped north of the Ohio River (Reese 2011; Weik 2012:20). Slavery

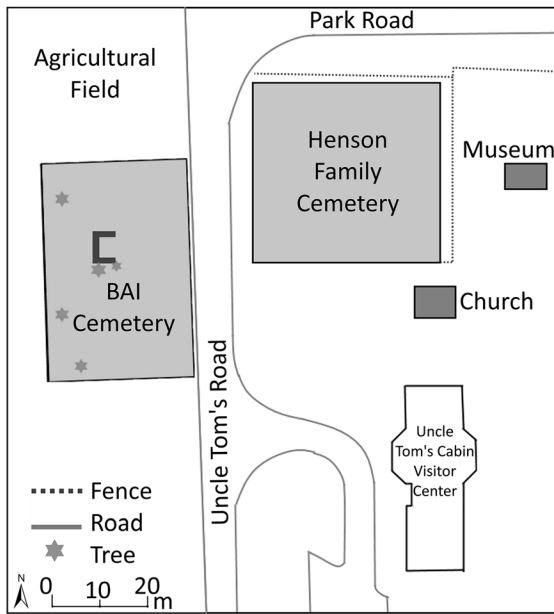


Fig. 2 (Top) Site map, redrawn from Eastaugh (2008), showing the BAI Cemetery in relation to the Uncle Tom’s Cabin visitors’ center and the Henson family cemetery. (Bottom) Satellite imagery overlaid with the survey grid system. The black lines indicate individual grids surveyed using GPR. Black numbers denote grids that were surveyed with both GPR and magnetic gradiometry (white numbers indicate only GPR was used). The light gray lines represent the four resistivity profiles. The ArcGIS PRO imagery base map was used in the creation of this figure and it draws data from Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS-User Community. (Figure by William T. D. Wadsworth, 2018.)

was abolished in colonial Canada in 1834, and, thereafter, Upper Canada passed laws to facilitate escape from the United States, as in the well-known case of Jesse



Fig. 3 The central monument created during the 1960s from the BAI gravestones. Aside from this reconstructed monument, there are no other grave markers at the site. (Photo by William T. D. Wadsworth, 2016.)

Happy (Walker 1985; Hepburn 2007). As a result, borderlands, such as Essex and Chatham-Kent counties in southwest Ontario, became important destinations for African Americans escaping captivity during the Underground Railroad era (Davis 2016). This network of abolitionists facilitated the escape of between 20,000 and 100,000 freedom seekers to Canada during the 1800s prior to the end of the American Civil War (Hepburn 2007; Reese 2011).

Upon entering Canada, most freedom seekers settled close to where they crossed the border (e.g., the Ontario towns of Amherstburg, Windsor, St. Catharines, and Toronto), but others traveled as far away as Vancouver Island and Nova Scotia (Walker 1985; Tobin and H. Jones 2008; Weik 2012; Davis 2016). This influx of people into Upper Canada led to the establishment of new communities of freed slaves, such as the Dawn Settlement (Farrell 1955; Hill 1981; Brock 2018).

The land that became the Dawn Settlement was purchased by the Crown from the Chippewa Nation in 1822 as part of Treaty 25 (Long Woods Treaty 1822; Surtees 1994; Bellfy 2010). According to Brock (2018:118,122), Dawn began attracting freedom seekers in the early 1820s and, by 1840, was a loose configuration of family farms. In 1823, for example, Levi Willoughby and Weldon Harris, both freedom seekers, had a farm at Dawn that they had purchased from the Crown, including the plot that would become the BAI Cemetery (Brock 2018:118). Over the next few decades many freedom seekers moved into the Dawn area in particular because of its good agricultural land and navigable river, which provided trade and transportation routes to Lake

Erie, the Atlantic, and markets south (Drew 1856; Carter 2014; LaRoche 2014). At its height, the Dawn Settlement had approximately 500 inhabitants who owned more than 1,500 ac. of land (Drew 1856; Hill 1981). The settlement's main infrastructure included a brickyard, sawmill, ropeyard, and school that were built and maintained by an executive committee (Hill 1981).

Although not the official administrative head of Dawn, Josiah Henson was the de facto leader of the settlement. He first purchased lands at Dawn in 1841, and he and his family remained in the area after BAI closed (Tanser 1943; Brock 2018:119–120). Henson's contributions to equality and freedom in Canada have made him a recognized historical figure and were the inspiration for the book *Uncle Tom's Cabin* (Stowe 1853). Born to enslaved parents in Maryland, Rev. Josiah Henson came to Upper Canada in 1830 as a freedom seeker (Pease and Pease 1982; Davis 2016:84); his dream was to build a school for African American refugees living in the area who were barred from attending the common schools with white children. Henson had also noted that, in order to become self-sufficient, many adult freedom seekers needed farming and financial skills in their new environment, and he had begun informal lecturing on those topics in southwest Ontario (Henson 1852:90). In 1836 Henson met Hiram Wilson, and together they raised funds for a manual-labor school where, as Henson (1852:91–92) wrote in his autobiography: “[O]ur children could be taught those elements of knowledge which are usually the occupations of a grammar-school.” In other words, the school would provide instruction in a mix of trades and more-academic subjects. The school's mandate was to enable self-sufficiency and independence, but it would also train the next generation of teachers for this and other freedom-seeker schools, “and we should thus gradually become independent of the white man for our intellectual progress, as we might be also for our physical prosperity” (Henson 1852:92). Henson (1852:92) notes also that this was particularly important because of the “insurmountable prejudices” of the citizens of southwestern Ontario. In keeping with other antislavery activists, Henson understood the place of education and literacy in emancipation (Henson 1852:94; Davis 2016:88; Leone and Jenkins 2017:xvi; Brock 2018:116–117,120), as well as the importance of being self-sufficient and owning land. In fact, by 1855, one-third of Dawn Settlement adults owned their own land (Drew 1856:309).

At its inception, BAI owned 300 ac. at Dawn, deeded to the school's trustees (Henson 1852:93; Drew 1856:309; Tanser 1943; Reese 2011; Brock 2018:116). Part of the school's mandate was also to provide temporary housing for freedom seekers when they first arrived in the area (Henson 1852:117), and, so, when the school opened, it had 14 boarders in residence (Drew 1856:311). The school's student population grew quickly, and by 1845 BAI had 70 students that were taught by the community's religious leaders and their wives (Hill 1981; Tobin and H. Jones 2008). In addition to teaching adults, Henson (1852:117) writes that white, black, and indigenous children all attended the school together. Drew (1856:308), writing in 1856, however, stated that the institute's trustees were affiliated with the common school system, which was segregated. Students spent half the day in the classroom and half working BAI lands, ensuring that Dawn inhabitants could provide for themselves and their families (Drew 1856; Tanser 1943).

BAI, however, struggled financially. Samuel May, an American abolitionist, visited the area, but deliberately chose not to visit Dawn because of the “many terrible things [he] heard about the management of the settlement” (May 1852:2). Under the auspices of the American Baptists Free Mission Society, Rev. William Newman took over management of BAI in 1845, but left a year later citing its poor financial accountability (Shadd 2016). Newman tried a second time to keep BAI afloat by bringing in the American Baptist Free Mission Society to manage the institute in 1850. For two years the institute seemed to prosper, but when John Scoble of the British and Foreign Anti-Slavery Society took over its management, the institute failed.

Financial mismanagement of the institute had a negative influence on the Dawn Settlement, and, by the 1860s, its inhabitants began to move away (Hepburn 2007). The committee that oversaw the Dawn Settlement disagreed on its leadership, which also had a negative impact on the community's financial condition (Hill 1981). At the same time, opinions began to change about the BAI school itself; many argued that a segregated school such as BAI fostered prejudice towards black Canadians (Hill 1981). As a result of these compounding factors, the confederation of the Canadian provinces, and the end of the American Civil War (Walker 1985), many families began to leave the Dawn Settlement (Hepburn 2007). Half of the families resettled in other Canadian freedom-seeker

communities, such as Buxton, and the others went back to the United States (Farrell 1955; Hepburn 2007). Ultimately, the committee elected to sell the school and its lands (including its cemetery) and use the money to set up the Wilberforce Educational Institute in Chatham, Ontario (Hill 1981). Fading into obscurity, the Dawn Settlement would be subsumed by the growing town of Dresden (Carter 2014), and BAI's cemetery largely forgotten.

History of the BAI Cemetery

The BAI Cemetery plot is situated on Lot 3, Concession 3 in the township of Camden and Gore, immediately adjacent to the Henson family cemetery. Despite his close association with BAI, Henson was buried on his own property. Veit and Nonestied (2017:157) write that burial on family-owned lands was not uncommon among free African Americans in the greater Northeast in the mid-19th century, and that the practice served as a public comment on their freedom. The chronology of these two cemeteries is similar, and, as such, the Hensons' plot provides a good point of comparison with BAI's. While specifics of "site formation" between the two differ subtly, inhumations at both cemeteries began in the mid-19th century, and both were used by Dawn inhabitants and their descendants most intensively during the late 19th century; both cemeteries were also partially disturbed by recent road construction and likely exhibit similar soil profiles, given their proximity to each other. The Henson cemetery, however, is still open and used by Josiah's descendants. An important distinction between these cemeteries is that the BAI Cemetery was originally established in the town of Dresden around the same time as the school. According to county land records and provincial legislation, some of the interments were transferred to their present location during a cemetery relocation that started in 1874 (*Statutes of the Province of Ontario* 1874:576–577; Skakel 2014).

It is not known exactly when the BAI Cemetery was closed (Skakel 2014), but it would have postdated the most recent tombstone, dated 1909. At the same time, its closure likely predated the 1914 sale of the lands containing the BAI Cemetery and surrounding acreage to Levi C. Truesdale for C\$4,500.00 (Archives of Ontario 1975:26–42,137–159). In other words, the cemetery was likely closed between 1909 and 1914. It is possible

that the cemetery was eventually abandoned in part due to descendant families leaving the area, as well as increasing racism in Dresden, which, by the mid-20th century, had come under international scrutiny as a "segregationist enclave" in Ontario (Alexander and Glaze 1996).

The cemetery's land was held in private hands for almost half a century before being acquired by the Municipality of Chatham-Kent in the 1960s. Rev. Jennie Johnson noted in the late 1950s that her father was buried in the cemetery, which was uncared for and abandoned (Maroney 2013). At some point in the early 1960s, the cemetery was allegedly bulldozed to clear an infestation of poison sumac, although there is no documented record of this destructive episode (Marie Carter 2017, pers. comm.). In 1964, the county created a central monument from the cemetery's neglected grave-stones, leaving the BAI graves unmarked (Fig. 3). The BAI Cemetery was the only cemetery in Dresden, Ontario, to have its gravestone layout changed (Skakel 2014).

Little is known about the individuals interred in this cemetery, beyond the fact that they were associated with BAI. From the gravestones, Finlin (1979) compiled a list of names that showed many historically significant members of the town were buried at the BAI Cemetery. These include BAI trustees Rev. Samuel Davis and Peter B. Smith, and local merchants James Burkett and Robert Burnett with their families (Finlin 1979). Students that attended BAI were mostly Baptist or Methodist (Drew 1856:309), but those buried at the BAI Cemetery do not appear to be connected with a specific religious community. A local historian, however, suspects that most individuals interred there were Baptists (Marie Carter 2017, pers. comm.). Many grave markers have undoubtedly been lost to time and neglect, but there are still 58 names and dates on the surviving gravestones. The gravestone data provide an approximate estimate for how many graves should be expected in the BAI Cemetery.

With regard to the graves themselves, historical period African American and Canadian burial practices varied across the continent and changed through time (Jamieson 1995; McCarthy 1997). A variety of social and economic factors, including racist legislation (Arnold 2016:9–9–10), influenced the kinds of burial practiced by African Americans during the 19th and early 20th centuries, but pine-box interments were most common (Jamieson 1995). Interments at the early 19th-

century First African Baptist Church in Philadelphia, for example, were in wooden “pinch-toe” coffins; in all but two cases the coffins had decayed, leaving just the outline of the casket (Parrington and Roberts 1984). We were unable to determine the character of burial at the Dawn Settlement through archival records, but according to Jamieson (1995) coffin burials became increasingly common among African Americans throughout the 1800s, becoming the norm by the end of the century. A passage from Bishop Payne's (1888:319–320) memoirs, however, indicates that freedom seekers also practiced cremation, and that Hiram Wilson's wife, Hannah, was cremated, and her ashes deposited at the Henson family cemetery. As such, we propose that the dead at the BAI Cemetery were likely interred in wooden coffins, but several burial patterns are possible at the site. Nevertheless, the human remains and coffins at the BAI Cemetery have likely decayed over time.

Geophysical Methods: Promises and Limitations in Burial Contexts

Cemeteries and sacred places have become critical lines of evidence in the application of justice (Martindale 2014), and, as a result, archaeologists and (geo)forensic specialists are increasingly called upon to use geophysical techniques to identify graves (Ruffell and McKinley 2008; Fiedler et al. 2009; Gaffney et al. 2015). Although Gaffney et al. (2015) identified limitations of these methods, a number of studies have produced convincing results justifying the utility of some of the most common geophysical techniques, namely ground-penetrating radar (GPR), magnetometry, and electrical resistivity, which we use in this study.

The primary method for this study was a GPR survey. A GPR system works by sending radio waves at a set frequency from an antenna through the ground. In most surveys, an antenna attached to a computer console is dragged or pushed along the ground at regular intervals, or transects. As radio waves pass through the ground, any physical change below the surface (objects of a certain size or breaks in stratigraphy) will cause some energy to reflect back towards the surface. These reflections are recorded by a receiver and are then digitized, visualized, and stored in the computer console (Reynolds 2008; Conyers 2013). These data are recorded in two-way time (in nanoseconds [ns]), which is the time it takes for the radio wave to travel from the source,

reflect off the buried property, and travel back to the surface. During data processing, two-way time is then converted to depth, so that the analysts can see where the changes in subsurface composition and breaks in stratigraphy are (Conyers 2013). In our study, data “anomalies” recorded by GPR indicate these subsurface changes and are interpreted as possible burials, coffins, or grave shafts.

GPR has been shown to be very effective in the identification of unmarked graves (Bevan 1991; J. King et al. 1993; Nobes 1999; Linford 2004a; Conyers 2006; Fiedler et al. 2009; Sutton and Conyers 2013; Hansen et al. 2014), and the technique has become one of the main tools in the search for unmarked graves and buried human remains (Ruffell and McKinley 2008:78). Graves, however, are typically small targets at variable depths, requiring a priori assumptions about mortuary practices, since graves and grave shafts are often missed in typical large-scale surveys (Ruffell and McKinley 2008:78–79). Conyers (2012), for example, has found success locating graves in historical North American cemeteries, knowing that graves are at a roughly consistent depth of about 5–6 ft. Moreover, in formal cemeteries, coffin burials are typically arranged in rows (Leone et al. 2005; Conyers 2012), which assists in the interpretation of anomalies. However, some North American surveys have led to unclear results due to ground conditions and differential organic preservation of coffins and human remains (Fiedler et al. 2009; Eastaugh 2011; Conyers 2012, 2013). The 2016–2017 BAI survey sought to identify coffins, grave shafts, void spaces, and soil disturbances related to inhumations, as these types of anomalies have been convincingly located with GPR, whereas the actual human remains within these features have not (Conyers 2012).

In addition to GPR, we used a magnetic gradiometer, which works by locating changes or anomalies in the earth's magnetic field. This instrument has two sensors: one records the earth's background magnetic field (i.e., the magnetic field as it was in the Chatham, Ontario, area at the time of our survey), and the other records the near-surface magnetic field that includes objects already magnetized (e.g., metal objects, fired materials) (Oswin 2009). As with GPR surveys, researchers using a magnetic gradiometer to collect subsurface data cover an area by walking transects at regular intervals. During data processing, the difference between the values recorded by each sensor is taken, which effectively removes the Earth's background magnetic field from

analysis and provides a map of mostly magnetic anomalies, artifacts, and other objects of interest (Oswin 2009).

Recent European research has found magnetometry useful in locating historical graves (Linford 2004b; Schmidt et al. 2015). Magnetic techniques can be difficult to implement in forensic and archaeological contexts (Ruffell and McKinley 2008), but archaeologists have successfully used magnetometry to identify grave inclusions, coffin hardware, and other manmade materials that can indirectly suggest the location of graves. Burials of African descendants in the United States sometimes contain a variety of grave inclusions (Parrington and Roberts 1984; McCarthy 1997; Leone et al. 2005; C. King 2010; Arnold 2016:8), and by the late 19th century coffin hardware was common (Jamieson 1995) and can be identified during a magnetic gradiometry survey. In other words, this technique may be useful in gathering other contextual information about a site and burials.

In electrical-resistivity techniques, electricity, generated from a battery, is propagated through the ground between metal electrodes. A resistivity meter records the resistance (Ω m) of the subsurface between these electrodes. Metal objects, for example, produce low resistivity values because electricity travels through them easily, but resistivity techniques are also good for identifying voids as well as changes in sediment compaction and moisture levels. Resistivity, in other words, will register changes in subsurface deposits based on how resistant or nonresistant they are to the electrical current that passes through them. What results from a resistivity survey is a profile of resistance values that can be used to interpret the subsurface (Reynolds 2008; Ruffell and McKinley 2008; Oswin 2009). The depth and clarity of the profile is determined by the spacing of the electrodes: the more widely spaced the electrodes, the deeper the current can propagate through the subsurface. A deeper profile, however, can lack the clarity of those produced with more closely placed electrodes.

Resistivity surveys have also been found to be suitable for locating graves in cemeteries (Bevan 1991; Ruffell and McKinley 2008). Bevan (1991), for example, argued that high resistivity values may denote grave shafts in cemeteries, while low resistivity values can be indicative of metal, such as coffin plates. When using resistivity methods to identify graves and grave shafts, electrode spacing should be short in order to get as clear and

detailed a profile of subsurface features that can be assumed to be relatively shallow (<2 m below ground) (Schmidt et al. 2015).

We note that each of these geophysical techniques does not locate actual historical graves. Rather, by their definition, these surveys locate changes in the physical properties of the subsurface that could be related to cultural and natural disturbance events (Reynolds 2008). Disturbance events, such as the inhumation of human remains, may produce anomalies that can be interpreted by geophysicists (in this case) as potential graves. Therefore, our results will be expressed in terms of locating grave-shaped anomalies.

Previous Geophysical Surveys

The BAI Cemetery, as well as the neighboring Henson family cemetery, have already been the subjects of two geophysical surveys (Eastaugh 2008, 2011). Due to the difficulty in locating available plots for interring descendants in the present, these previous surveys attempted to identify the locations of unmarked graves and delineate site boundaries. Eastaugh (2008) conducted a magnetic-gradiometry walking survey of both cemeteries using a Geoscan FM256 fluxgate magnetometer. His report states that the Henson family cemetery showed some indications of potential graves that were largely “washed out,” or obscured, by extremely high anomalies and noise created by a metal fence and other obstructions. Likewise, the results for the BAI Cemetery were washed out by the central gravestone monument; only smaller anomalies far from the central monument were recorded (Eastaugh 2008). Although he concluded that these small anomalies were not indicative of graves, Eastaugh believed they could represent artifacts that were originally associated with the graves or a disturbance event. He was also able to identify a subsurface linear feature at the northwest corner of the BAI site that he interpreted as an old property boundary.

In 2011, at the request of Josiah Henson’s descendants, the Ontario Heritage Trust sponsored two GPR surveys of the Henson family cemetery (Eastaugh 2011). Eastaugh (2011) used a 400 MHz antenna attached to a GSSI SIR-3000 controller and ran transects 25 cm apart and oriented north–south. Readings were logged at a rate of 50 scans/m. His survey found subsurface anomalies that he interpreted as areas of high grave potential. Although Eastaugh could not delineate

specific graves, he suggested that the high-potential areas could contain up to 300 burials. In 2017, Timmins Martelle Heritage Consultants, Inc., conducted an additional GPR survey of two areas of the Henson family cemetery not covered by Eastaugh. Finally, before our 2016–2017 BAI survey, there had been no resistivity surveys conducted at either the BAI or the Henson family cemeteries.

Methodology

The BAI Cemetery is directly west of and across the road from the Uncle Tom's Cabin Historic Site. The cemetery site is approximately 50×30 m and consists of well-kept lawns maintained by the Ontario Heritage Trust and the Municipality of Chatham-Kent. Ground conditions offer only a few obstructions (i.e., a few trees and the central monument). Land-registry records in the Archives of Ontario suggest that, prior to the cemetery's move to its present location, this land was used primarily as farmland and had little intensive use (Archives of Ontario 1975:26–42,137–159). Typically, this area of southwestern Ontario has a simple stratigraphy consisting of relatively homogenous sandy-loam topsoil and subsoil layers underlain by clay (Doroszenko 2016). This site's assumed subsurface homogeneity was confirmed by Eastaugh (2011), who found that disturbances at the Henson family cemetery could be attributed mostly to inhumations. These attributes make the BAI Cemetery an optimal location in which to carry out an unmarked-grave geophysical study.

This study's methodology was modeled primarily after Eastaugh's (2008, 2011) surveys and other geophysical surveys of unmarked graves (Bevan 1991; Nobes 1999; Linford 2004a, 2004b; Schultz 2007; Fiedler et al. 2009; Conyers 2012; Sutton and Conyers 2013; Hansen 2014; Gaffney et al. 2015). The GPR survey was conducted over three days in November 2016, four days in April 2017, and two days in May 2017. The area was separated into grids of varying size, but each was typically 15×10 m. The survey began in the northeastern corner of the site, and GPR transects were conducted southwards every 25 cm, bisecting the east–west site axis to intersect graves (which were believed to run east–west) (Eastaugh 2011). The GPR survey incorporated the use of a GSSI SIR-3000 console with a 400 MHz antenna mounted on a survey cart, and data were recorded for 50 ns, as the

study was primarily concerned with relatively shallow layers (<2.5 m in depth). This survey produced high-resolution images, which would be needed if coffins had decayed quickly or if Dawn Settlement inhabitants practiced less geophysically obvious mortuary practices (e.g., shroud burials, in the sense used by Blakey [1998]). One grid was surveyed multiple times using a 400 MHz and a 200 MHz antenna, and at different configurations to collect comparative data because some authors have found other antenna frequencies more useful in identifying grave shafts (Hansen et al. 2014). Instead of the survey cart, a survey wheel was connected to the 200 MHz antenna, and the system was dragged across the ground in 50 cm intervals. Although only one grid was surveyed using the 200 MHz antenna; 400 MHz grids were conducted over the entire site.

Magnetic-gradiometry, resistivity, and total-station surveys were also carried out on the BAI Cemetery site as part of this multicomponent study. The magnetic survey was conducted on the north half of the site in order to compare data with Eastaugh's (2008) magnetic-gradiometer survey of the BAI Cemetery property. A GEM Systems GSM-19GW Overhauser gradiometer was used to collect gradient and total-field data. The sensors were set to 25 cm and 80 cm height, survey lines were spaced every 25 cm, and data were recorded at 20 cm intervals. The base-station magnetometer (a GEM Systems GSM-19T proton-precession magnetometer) was set up at the northwest corner of the site to apply diurnal variations in case we wanted to use the total-field data. A zero-mean transversing correction was applied to the gradient data to remove fluctuations caused by direction of travel. A resistivity survey was conducted using an IRIS Syscal Junior Switch-48, with 48 electrodes spaced 0.5 m apart spanning 23.5 m. A dipole–dipole (and one Wenner array) electrode array was used to obtain data from six resistivity lines. Both high- and low-resistivity values in cemeteries may denote grave shafts (Bevan 1991), thus both were taken into consideration when delineating graves. A total station (Topcon GTS-302D in November and Nikon NPL-322 in May) was used to record elevation changes and map all the points of the grid to fixed markers (such as the corners of the monument).

Besides field research, significant post-processing and archival work was required in this study. Data analysis took place at the University of Toronto using SIGKit, a MATLAB-based data-modeling and -processing software (Kruse et al. 2017), as well as Conyers and Lucius's (2010,

2016) GPR Process/GPR Viewer Software and Golden Software's Surfer 15 program. Graves were first identified in the collected GPR profiles. Hyperbolas on these profiles represent reflected radio waves. Those that could represent graves were high in amplitude (Conyers 2013:190) and sometimes paired, reflecting perhaps the tops and bottoms of coffins (Conyers 2012). If a hyperbola was identified as being "grave-shaped" in this way, but spanned fewer than three profiles (and thus less than 75 cm in length), it was recorded as a "possible" grave. If the anomaly spanned more than three profiles, it was recorded as a "probable" grave. Once the locations of these identified anomalies were recorded in a post map, we overlaid them on a collated time-slice amplitude map (from the depth at which graves were found in each grid). If the post-map and the amplitude locations matched with and made an approximately 1×2 m (roughly) rectangular shape, these anomalies were recorded as "likely" graves. This report works under the same assumption as Eastaugh (2011), that some time-slice amplitudes may not be rectangular due to coffin/grave-shaft decay. Afterward, the GPR results were compared to the modeled magnetic and resistivity data.

Results

Ground-Penetrating Radar

Originally, we identified grave-shaped anomalies based on their shape in the time slices, a common technique in archaeogeophysical analyses (Conyers 2013:chapter 7). Time slices, or amplitude maps, provide a plan view of the surveyed area that shows amplitudes of reflected waves at specified depths (Conyers 2013:166–167). Dr. Lawrence Conyers (2018, pers. comm.), however, has expressed concerns that time slices can be misleading, particularly for identifying unmarked graves. Our results, particularly those for Grid 5, appear to support Conyers's concerns. We recorded GPR data from Grid 5 at three different times of the year (November, April, and May), with different ground conditions, and using two different survey methods to test the impact of environmental changes and alternative survey approaches (Fig. 4). The 200 and 400 MHz antennas were used at each time of the year, and survey lines were run both north–south and east–west. During the May survey we also turned the 400 MHz antenna 90° clockwise and ran a series of

north–south lines across this grid. As a result, we have five datasets for this grid from this experimentation, and a comparison of them shows that the 400 MHz antenna with north–south lines provided the best resolution for identifying grave-shaped anomalies. The 200 MHz antenna also provided clear results, but the coarseness of the survey made it difficult to identify grave-shaped anomalies. Our time-slice/amplitude results, which varied considerably with each survey (Fig. 4a–e), were easiest to interpret when there was moisture in the ground (November), but potential graves were most clearly identified in the GPR profiles (Fig. 5) during the drier April conditions (Fig. 4) and thus confirmed the suspicion that time-slice or amplitude maps can be misleading when used in isolation.

As such, and as noted in the methodology, hyperbolas that we think are potential graves were first identified in each GPR profile, specifically those within 0.5–1.5 m of the surface and oriented east–west (Fig. 5). Although the orientations of these anomalies mirror what Eastaugh observed in his 2011 survey of the adjacent Henson cemetery, our survey found that BAI anomalies varied in depth. These hyperbolas were then plotted in a post map and compared to the overall GPR amplitudes from the site. The result of this process illustrates the location of 40 possible and 122 probable grave-shaped anomalies, and can be seen in Figures 6 and 7.

Out of the 122 probable anomalies, 68 were found to be reflected in the amplitude map also and were determined to be likely graves (Figs. 6, 7). These likely graves can also be grouped into roughly three or four loosely defined rows. There was a very high amplitude and change in GPR reflections inside the monument, which may represent disturbance from the creation of the monument. As such, we were hesitant to identify grave-shaped anomalies within the monument as anything more than probable graves. Root disturbance was also found to be reflected in the GPR data near modern trees. Again, few anomalies were identified as graves in these instances. In addition, the old boundaries of the cemetery appeared to extend beyond the modern Ontario Heritage Trust property, as anomalies seemed to continue north and west of our survey area. Although many gravestones have been lost, the GPR survey has produced a roughly consistent estimate of 68 likely graves (which could be composed of multiple interments), as compared to the 58 names that appear on the monument.

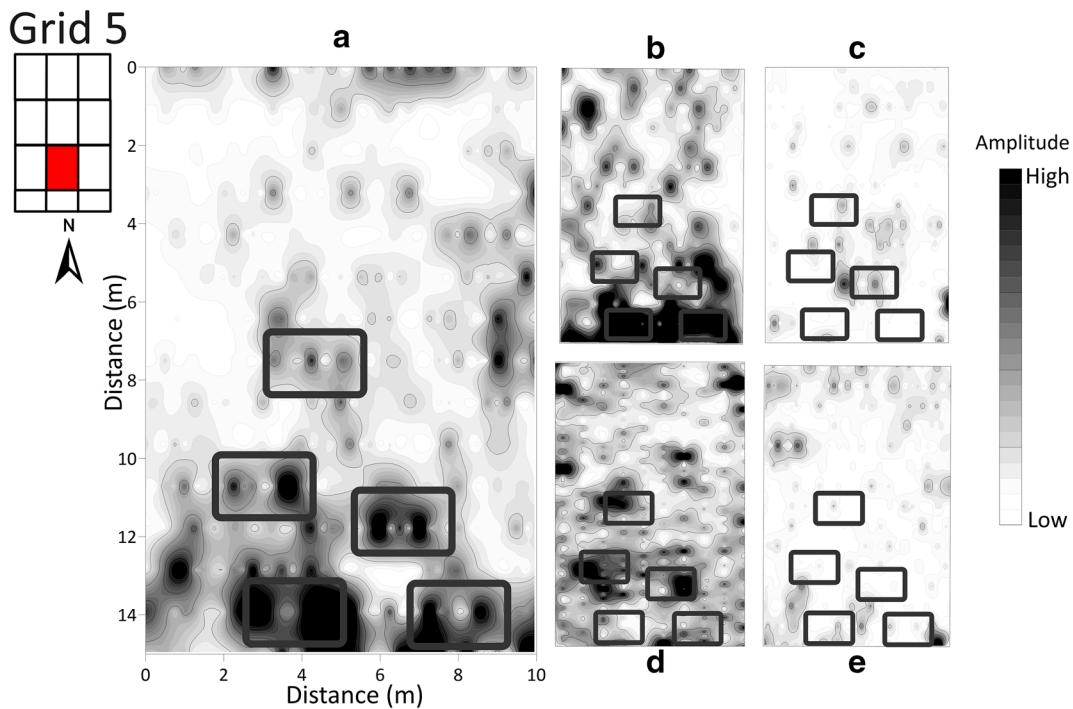


Fig. 4 Comparative GPR data was collected from one grid (Grid 5) and illustrates the ways different survey methods and changes in the environment can influence GPR results: (a) 400 MHz antenna with transect lines conducted north–south in November 2016, (b) 200 MHz antenna with transect lines conducted north–south in November 2016, (c) 400 MHz antenna with transect lines conducted north–south in April 2017, (d) 400 MHz antenna with transect lines conducted east–west along an extended grid in April

2017, and (e) 400 MHz antenna turned 90° clockwise and conducted north–south in May 2017. The black outlines denote where graves were identified by amplitude shape in the 400 Mhz November data (a) and were reproduced over each dataset. Notice how the GPR amplitudes change and cast doubt on identifying graves purely from time-slice maps. (Figure by William T. D. Wadsworth, 2018.)

Through our GPR analysis, we were able to identify likely grave-shaped anomalies and suggest that these are the locations of burials. In order to link these anomalies to graves conclusively, our results would need to be verified independently through test excavation. The feasibility of this possible next step will be discussed later.

Magnetometry

Although Eastaugh (2008) concluded that magnetometry at the BAI Cemetery produced poor and inconclusive results, our 2016–2017 survey produced some promising results and demonstrated the efficacy of magnetic techniques in cemetery research. Although both magnetic-gradient and total-field data were collected in this survey, only the gradient data was modeled for this research. Our results were able to duplicate and expand on the anomalies identified by Eastaugh (2008), although we only surveyed just over half of the BAI Cemetery. The strongest (largest) positive and negative

magnetic anomalies (Figs. 8, 9) can be attributed to rebar from the central monument and the metal sign to the east of it. Interestingly, there are also small localized magnetic anomalies scattered across the survey area. North of the monument especially, we find several small anomalies with high amplitudes. We modeled several of these magnetic anomalies using computer code by Singh (2002) to predict their approximate size, depth, and magnetic character; Figures 8 and 9 show three example profiles. It is important to mention that our computer models are just one possible magnetic solution to give an indication of the depth of an object. In our models, objects smaller than 0.30×0.30 m and confined to the top 0.5 m of the subsurface (Figs. 8a, 9a) were able to recreate/match the anomalies seen in our magnetic data. With regard to one anomaly (Figs. 8b, 9b), the positive/negative magnetic signature did not line up with magnetic north, meaning that it had an “off-north” magnetic signature and indicates the presence of a subsurface object or deposit different from the

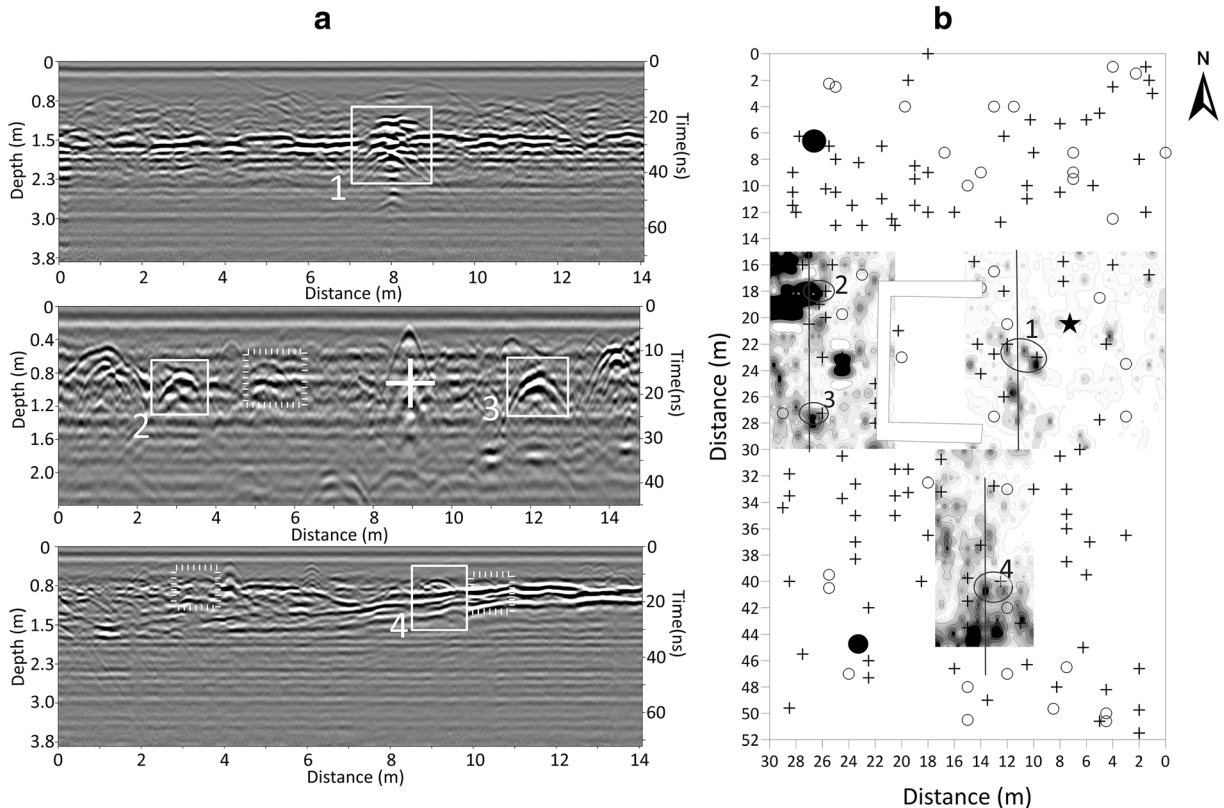


Fig. 5 Understanding that the creation of amplitude maps can be misleading, graves were first identified in GPR profiles (a) and recorded as XYZ data. Solid white squares denote the hyperbolas that were identified as probable coffins or grave shafts (for more examples, see Conyers [2012]). The dashed white squares denote possible graves. As indicated on the post map, there is supposed to be a grave at the location of the white cross. This grave begins in the next profile, while this profile has a reflection from an object near the surface. All other hyperbolas seen in the profiles that were not identified do not span more than a single profile. In the post

map of the overall site (b), circles (○) denote “possible” grave-shaped anomalies, and crosses (+) denote “probable” grave-shaped anomalies. The black star (★) indicates a likely grave-shaped anomaly that was identified in both the GPR and resistivity data. Post-map symbols from these radargram examples were superimposed on their respective amplitude maps from separate GPR grids. Notice the amplitude changes that correspond with probable grave-shaped anomalies; these were recorded as likely grave-shaped anomalies. (Figure by William T. D. Wadsworth, 2018.)

sounding soil. This anomaly also had high remnant magnetization, suggesting it likely represented small, magnetically susceptible (e.g., metal) objects that are too shallow to be associated with historical graves. Eastaugh (2008) believed that a high proportion of these shallow anomalies may have been created by building rubble. Although there is no evidence to suggest there was ever a building on the property, these small anomalies certainly could have been associated with disturbed materials, possibly from a destructive event. Finally, a thin linear anomaly appears across the northern portion of the cemetery; the larger wavelength allows for slightly deeper source (~1 m) (Figs. 8c, 9e). This anomaly was interpreted by Eastaugh (2008) as a potential

historical boundary of the cemetery, but both the GPR results and archival documents suggest that the cemetery continued north and west of this line. Drawing on historical and archival records and oral accounts, we suggest another interpretation for this anomaly, which we discuss and contextualize below.

Electrical Resistivity

Electrical-resistivity surveys were conducted on the east portion of the cemetery (directly to the east of the monument) (Figs. 2, 10). Although primarily dipole-dipole array configurations were used, the Wenner results from our initial survey in November 2016 are also

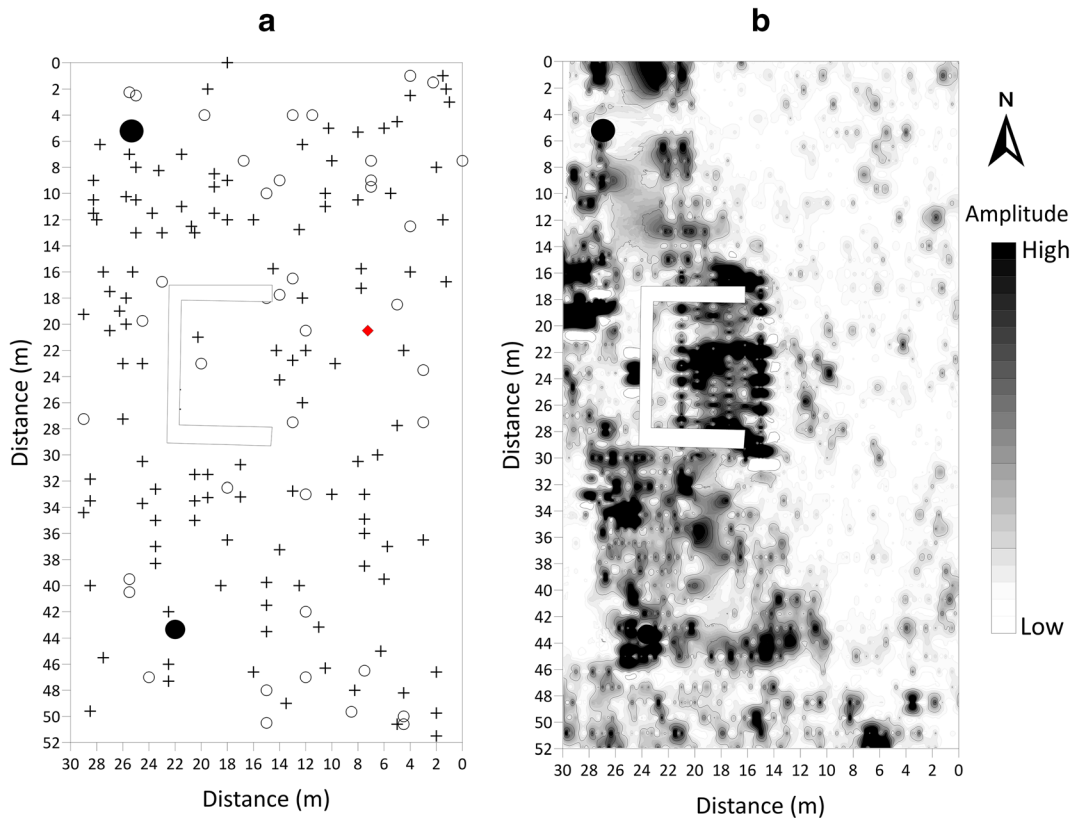


Fig. 6 Collated GPR results from the BAI Cemetery: The unsurveyed U-shaped area denotes the central monument, and the black circles are trees that obstructed the survey. (a) Post map of graves identified in GPR profiles: possible= \circ , probable= $+$,

and likely grave-shaped anomalies= \star . (b) The overall amplitude map at the correct grave-layer depth per grid (0.5–1.5 m). Axes record distance in meters. (Figure by William T. D. Wadsworth, 2018.)

included in this interpretation. We found that material differences in subsurface layers were clearly characterized by changes in resistivity. Resistivity values range from 500–700 Ω near the surface to 30–100 Ω at depth. The November 2016 survey found a box-shaped anomaly that appeared between the 8.5 and 10 m marks along the horizontal distance line (Fig. 10). Additional data from the April 2017 survey showed that this identified box-shaped anomaly correlated with anomalies found in adjacent resistivity lines (spanning 2 m). The resistance of this anomaly was approximately 300 Ω (i.e., moderately resistive) and appeared to be roughly 0.6–1.2 m below the surface. Our GPR results show a potential grave anomaly at approximately the same location (Figs. 6, 7, 10). The linearity, resistance, and depth of this anomaly suggests that some of the resistivity anomalies indicated potential graves or grave shafts. Interestingly, the box-shaped anomaly had a range of resistances from top to bottom of the supposed disturbance. Unlike GPR and magnetic gradiometry, the resistivity

data portrayed the subsurface as relatively homogenous, with little to no noise. As both our magnetic survey and Eastaugh suggest that there might be building rubble within the subsurface, resistivity might be useful for identifying possible graves without finding all the confounding debris that could skew results.

Discussion

As noted in the introduction, despite great work accomplished by recent studies in Europe, geophysics is still underutilized in North America (Thompson 2015), especially in regard to locating unmarked graves (Fiedler et al. 2009). Although results are strengthened when multiple geophysical methods are used in conjunction, we assessed individual as well as combined survey results. As previously discussed, North American ground conditions and differential organic preservation of coffins and human remains have led to unclear GPR

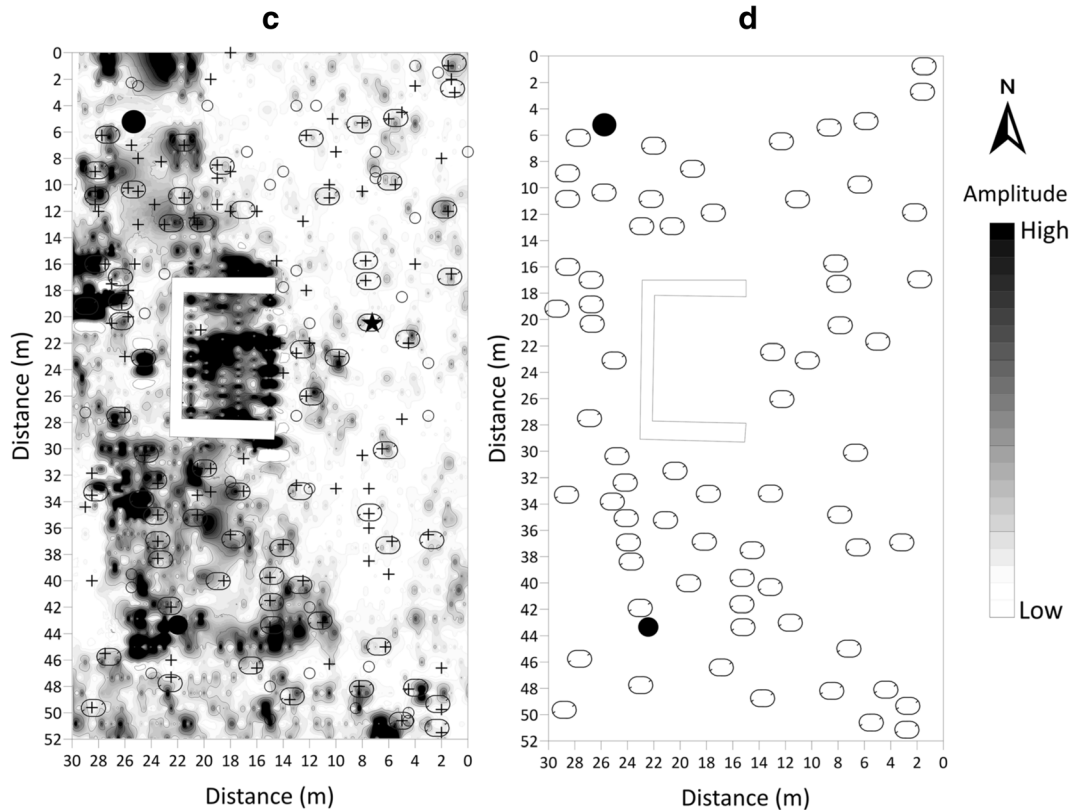


Fig. 7 Collated GPR results from the BAI Cemetery: The unsurveyed U-shaped area denotes the central monument, and the black circles are trees that obstructed the survey. (c) The BAI amplitude map overlaid by the post map, with hatched ellipses

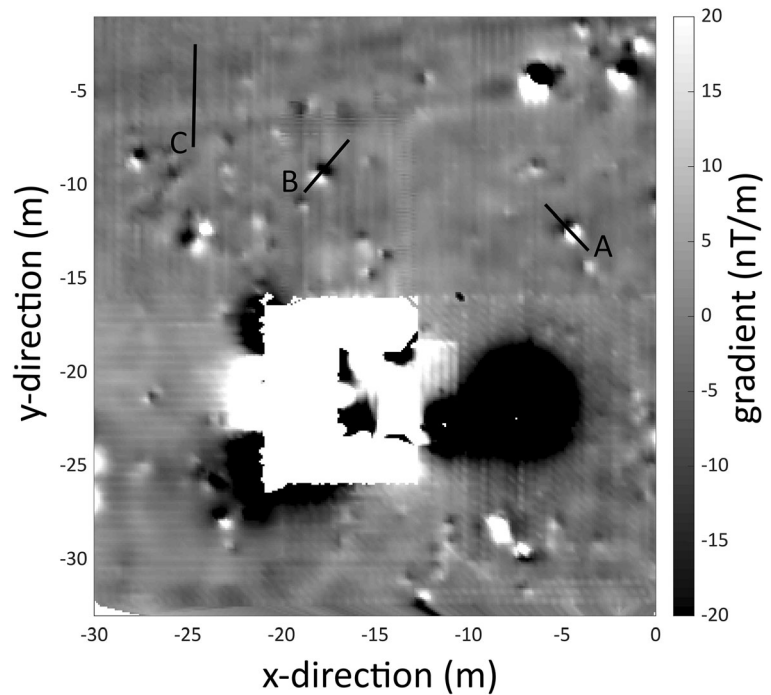
drawn to represent graves that were represented in both datasets. (d) Summary interpretation map of likely grave-shaped anomalies at the BAI Cemetery. Axes record distance in meters. (Figure by William T. D. Wadsworth, 2018.)

survey results in the past (Fielder et al. 2009; Doolittle and Bellantoni 2010; Eastaugh 2011; Conyers 2012, 2013). Although Hansen et al. (2014) found that the 200 MHz survey was better at identifying grave shafts, we preferred the higher resolution provided by the 400 MHz antenna. In fact, the higher-resolution survey identified more anomalies that likely represent graves than were anticipated from the number of gravestones in the BAI monument. Nevertheless, our survey produced far fewer grave-shaped anomalies than Eastaugh's (2011) survey of the adjacent Henson family cemetery. These discrepancies can perhaps be explained by the 1870s cemetery relocation; some interments might not have been removed to this location and, in some cases, coffins might have been stacked one on top of another. Multiple interments in a single grave were documented at the First African Baptist Church Cemetery in Philadelphia, for example (McCarthy 1997). It is also possible, however, that some gravestones were lost during a

destruction event that also obscured evidence for some grave shafts. Overall then, our findings are consistent with recent studies (Bevan 1991; Nobes 1999; Linford 2004a; Fielder et al. 2009; Sutton and Conyers 2013; Hansen et al. 2014) that have shown GPR to be incredibly useful in the identification of unmarked graves.

Our magnetic survey produced a high-resolution map of the magnetic anomalies at the BAI Cemetery, but was unsuccessful in identifying specific graves. While Eastaugh's (2008) walking survey of the same cemetery was also unsuccessful in identifying graves, our data, collected at discrete grid points, allowed us to relocate nongrave features identified by Eastaugh and detect additional, small magnetic anomalies. Our modeling of some prominent anomalies showed that their probable causes were too shallow to be associated with graves. Many of the anomalies were also found to have a high remnant magnetization, which suggested that these objects were likely made of metal or other manmade or

Fig. 8 Magnetic gradiometry results (following zero-mean traversing correction) from the northern portion of the BAI Cemetery: The coordinates are in meters and the values in nanoteslas per meter (nT/m). Many clear anomalies are present, although there is little to suggest that they are related to grave activity. Substantial amounts of noise, or “washout” (large patches of black and white), were created by the monument (white C-shaped area was not surveyed) and the metal BAI signpost (large negative anomaly to the east of the monument). Three example anomalies were sampled along the lines in the map and modeled in Figure 9. (Figure by William T. D. Wadsworth, 2018.)



-altered materials (Reynolds 2008). We observed the gravestone monument consisted mainly of limestone and gabbro; while limestone would not produce a strong magnetic anomaly, gabbro does (Dunlop and Özdemir 1997), and thus these anomalies might represent gravestone fragments. Alternatively, these magnetic anomalies could represent artifacts associated with the interments, such as grave inclusions (McCarthy 1997) or coffin hardware (Jamieson 1995), that were disturbed by natural or cultural processes after the cemetery’s closure. Test excavation would need to be conducted

in order to determine the exact character of these anomalies. Despite recent research showing otherwise (Linford 2004b), our survey was unable to locate graves with magnetometry alone.

One grave was easily mapped by a linear box-shaped anomaly in the resistivity data. These findings support our GPR interpretations, as they bisect a potential GPR grave-shaped anomaly found in the same location. Compared to the GPR and magnetic gradiometry, resistivity detected less noise and, therefore, provided clearer results as a consequence of lower resolution. Although the clarity is

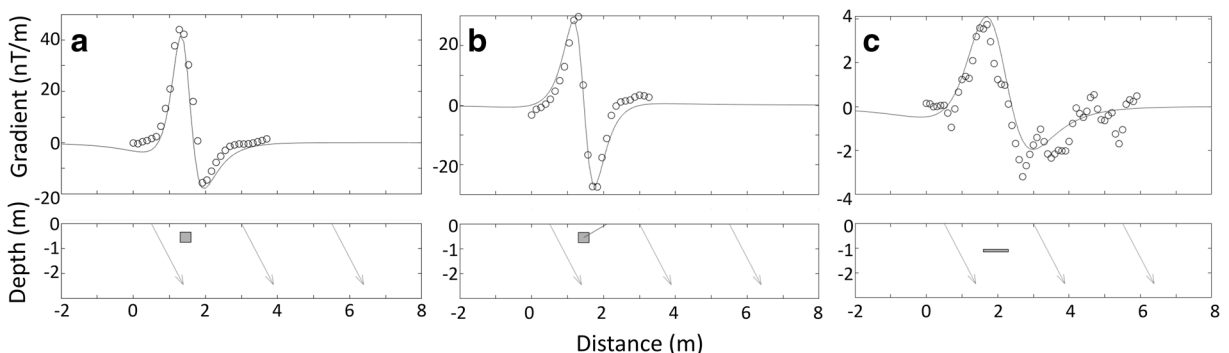


Fig. 9 Modeled magnetic anomalies: The line in the gradient data depicts the modeled magnetic gradient anomaly matched to the raw data (circles). The lower pane shows the estimated object and its depth, as well as the Earth’s ambient magnetic field (arrows). Anomalies *a* and *b* represent very shallow objects (within the top

50 cm of the soil), with model *b* also having remnant magnetization (small arrow on the object). Model *c* is broader and an order of magnitude smaller; it crosses a linear anomaly along the northern side and may be caused by a more deeply buried (~1 m) object. (Figure by William T. D. Wadsworth, 2018.)

convenient for unmarked-grave analysis, collecting resistivity data takes much time and the resistivity profiles' homogeneous layers contain less information about site processes. Interestingly, one would expect to find either high- or low-resistance values to indicate graves (Bevan 1991). Instead, this study found that grave shafts were a pocket of intermediate values ranging from high- to low-resistivity values between dichotomous top and bottom layers. These results may be reflective of a change in packing and/or water content between grave shafts and surrounding undisturbed soil (Pringle et al. 2012), and not much influenced by the metallic artifacts imaged by magnetometry in the upper layers.

In addition to locating anomalies that we interpret as graves or associated artifacts, the GPR and magnetic results support the idea that a destructive event occurred at this site. The 400 MHz data detected a lot of noise and reflection changes at shallow depths across the cemetery. Furthermore, although most of the graves clustered around 0.8 m below surface, our survey revealed that grave depth varied by as much as 1 m. Although Eastaugh had noted the potential for shallow (more recent) graves at the adjacent Henson family cemetery, we believe that something different was happening at the BAI Cemetery. Our total-station data also clearly showed a 1 m variation in the cemetery's topography

(Fig. 11). When elevations are compared, it is clear that the changes in surface topography match the changes seen in grave depth. Rather than reflecting differences in time, all the graves at BAI are historical (as the cemetery closed by ca. 1909) and the variations in topography could be related to the potential destructive event and construction of the road that would have disturbed and possibly removed some topsoil. This is supported by the fact that the changes in topography and grave depth are particularly evident near the edges of the cemetery and close to the road. The magnetic data also supported this interpretation, as many strong, shallow anomalies were found to represent artifacts or (more likely) broken gravestones. As noted, a local historian informed us that the cemetery had been bulldozed in the 1960s to rid the property of poison sumac, and we reason this was the cause of the disturbance found in our results. The BAI Cemetery, however, is not the only black cemetery to suffer this fate. Eighteenth- and nineteenth-century black cemeteries were ploughed over in the 1930s in Priceville, Ontario (Brown 2002), and in Saint-Armand, Quebec (Nelson 2018). Each case demonstrates the way in which the history of African descendants in Canada has been overlooked and physically erased from the landscape. Dresden, Ontario, in particular, was a notable hub of prejudice and racism in the mid-20th century

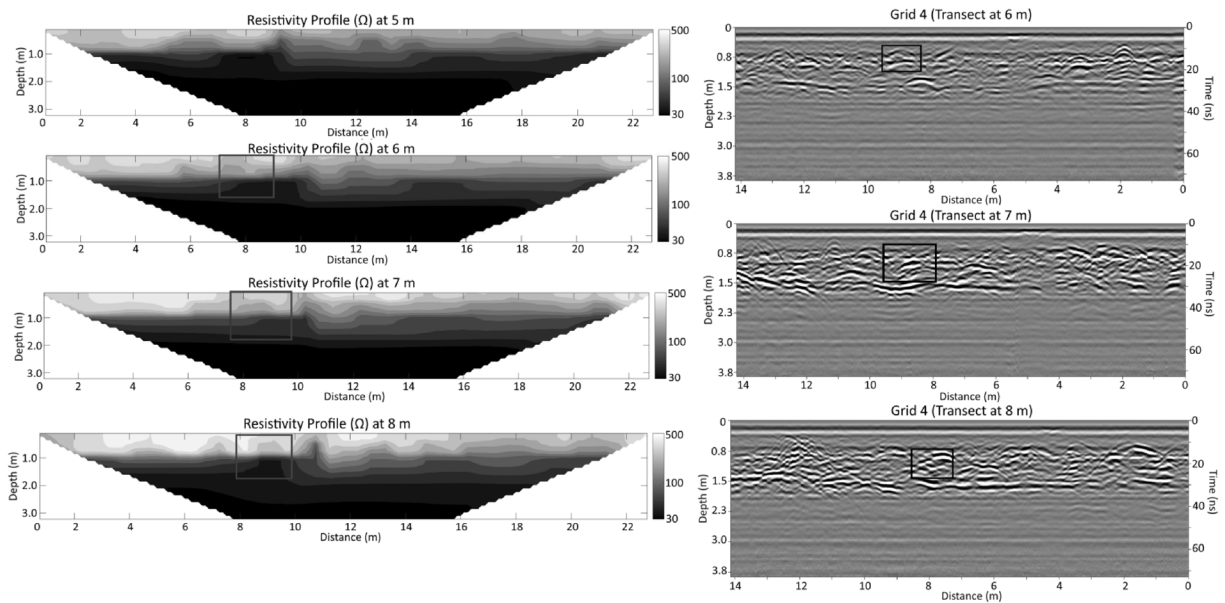


Fig. 10 April 2017 resistivity data (values displayed in ohms) from directly east of the monument. Intermediate (light gray) box-like features were interpreted as potential grave shafts (outlined by the dark gray box). Numbers indicate distance from beginning of

the line and depth in meters. The potential grave-shaft anomaly is also represented in the GPR profile data as the same shape and at the same depth (*right*), and is shown in the post map of Figures 5 and 6 as a black star. (Figure by William T. D. Wadsworth, 2018.)

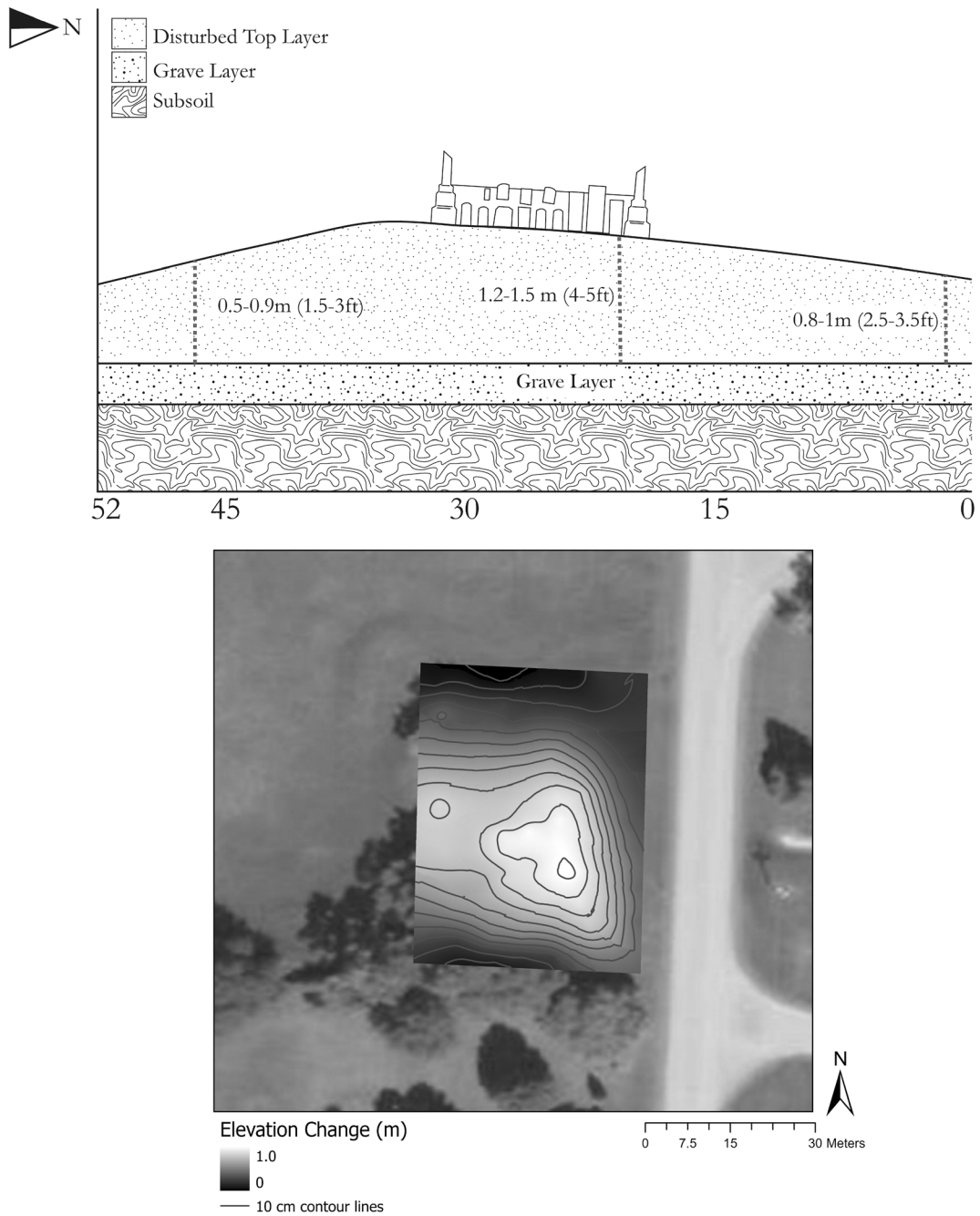


Fig. 11 Interpretation of the BAI Cemetery in cross-section (*top*). The depth to the grave layer reflects topographic changes at the site, rather than large variance in the depths of the graves. BAI Cemetery elevation data (collected by total station) with 10 cm contours is overlaid on the site (*bottom*). This map demonstrates a 1 m increase in elevation from the edges of the cemetery to its

center. The ArcGIS PRO imagery base map was used in the creation of this figure and it draws data from Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS-User Community. (Figure by William T. D. Wadsworth, 2018.)

(Alexander and Glaze 1996) and likely fostered a social environment in which black cemeteries, such as the BAI Cemetery, were allowed to fall into ruin and could be subject to destruction.

Among the topics raised by this research is the value of protecting historical black cemeteries, which have been largely neglected as a focus of scholarship and public commemoration in Canada (Nelson 2018). Recently, scholarly articles, governing policies, and legislation have focused primarily on the protection of indigenous graves and remains in archaeology (Ferris 2000; Doroszenko 2009). Although this pursuit is of the utmost importance, efforts to protect freedom-seeker graves have also been inadequate (Leone et al. 2005). In the United States there is no legal statute concerning working with or contacting descendant communities of freedom seekers similar to the Native American Graves Protection and Repatriation Act (Leone et al. 2005). In Canada, unregistered cemeteries have little legal protection and can be relocated with minimal notice (Ontario Historical Society 2018). Compared to the United States, there are fewer archaeological studies of freedom-seeker communities and this significant period in Canadian history. While the Dawn Settlement's inhabitants escaped enslavement, their descendants faced persistent systemic and personal discrimination in southwest Ontario, particularly during the mid-20th century (Walker 1985; Alexander and Glaze 1996). Archaeologists and various levels of government have a responsibility to protect freedom-seeker graves to preserve the memory of these lost communities, to educate the public on past prejudice, and to connect diasporic communities in the present (Leone et al. 2005). Visible reminders of these histories, such as the BAI Cemetery's central monument, reestablish it as an important place to which people can come, perhaps not to visit the dead, but to learn about a seminal piece of Canadian history. Moreover, the preservation and commemoration of historical black cemeteries can be part of what can be done to address difficult aspects of the past and to direct public attention to these often-forgotten aspects of public memory (Nelson 2018). The Ontario Heritage Trust has a vested interest in the protection of BAI and the Henson family, given their relationship to the history of the Dawn Settlement and Josiah Henson. The subsequent geophysical surveys since 2008 have provided information to inform the interpretation of the cemeteries at the Uncle Tom's Cabin Historic Site. The possibility of confirming the results through excavation at

both cemeteries is not a consideration for the immediate future. The Henson family cemetery is still open for interments, but will likely be closed in the next decade, and while the BAI Cemetery is legally closed, neither of the two cemeteries will be relocated. One possible future mechanism to provide protection of these two cemeteries by the municipality would be designation under the *Ontario Heritage Act* (2019).

Our findings also demonstrate the importance of archaeological and historical research when interpreting geophysical surveys, and further emphasize the necessity of multicomponent surveys when dealing with unmarked-grave investigations. This survey has demonstrated the utility of geophysical techniques to cemetery investigations and recommends that heritage organizations continue to incorporate geophysical field methods into preservation strategies. A review and expansion of policy concerning these techniques could play a vital role in the future protection of graves and cemeteries. While North America has not yet fully appreciated the utility of geophysics in surveying archaeological sites nondestructively (Thompson 2015), Europe has developed geophysics standards and guidelines that include cemetery research and preservation (Schmidt et al. 2015).

Conclusion

The combined geophysical survey at the BAI Cemetery was successful at locating evidence indicating freedom-seeker graves. Specifically, the 400 MHz ground-penetrating radar survey was able to delineate 68 grave-shaped anomalies and was determined to be the most effective, forming the crux of unmarked grave identification. The findings from our 2016–2017 BAI survey produced far fewer anomalies that could be interpreted as graves than the 2011 Henson family cemetery survey (Eastaugh 2011). There are, however, several factors that might explain this discrepancy: (1) the unique history of the BAI Cemetery, especially the possibility that fewer people might have been interred here after relocation in the 1870s, (2) the possibility of multiple, stacked interments within a single grave, and (3) evidence of a possible destructive event that was found in both the geophysical results and oral history of the site.

The magnetic-gradiometry survey results, however, were important for understanding site formation. Specifically the possibility of cemetery disturbance due to bulldozing. The resistivity survey located an individual,

linear box-shaped anomaly that was identified as a likely grave, as it coincided exactly with the location of a GPR anomaly. Most important, however, our results support the general consensus among archaeogeophysicists that a combined methodology can overcome the limitations of individual techniques.

Our results also suggest that heritage organizations charged with the mandate of preserving and protecting historical places would find multicomponent surveys, such as this one, helpful in management practices. The integration of multiple geophysical techniques as well as archaeological, archival, and oral-historical research reveal the history of a particular parcel of land without time-consuming, expensive, and, in the case of cemeteries, potentially controversial, largescale excavations. Knowledge of where the graves are likely to be found and their orientation will help to protect the BAI Cemetery against future incursions and development. In other words, multicomponent approaches can help to preserve the BAI Cemetery, which represents a small component of what was a monumental and significant period in Canadian history, worthy of academic study, commemoration, and public remembrance.

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Compliance with ethical standards

Conflicts of Interest On behalf of all the authors, the corresponding author states that there is no conflict of interest.

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