GROUND PENETRATING RADAR (GPR) HERITAGE ASSESSMENT –

DODOMA PLACE (KENNEDY ROAD) HOUSING PROJECT, ERVEN 402-407 SPRINGFIELD, DURBAN, ETHEKWINI METROPOLITAN MUNICIPALITY, KWAZULU-NATAL

Ethekwini MM-HSU: PQ No. 7H-17381 / SAHRIS CaseID 4969 / AMAFA Ref: SAH14/4969

Barry Barnardt, Karen van Ryneveld & Duane Fourie
Terra Scan cc
7 December 2015

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NOTE:
It should be noted that Ground Penetrating Radar (GPR) and geophysical investigations and the interpretation of data from these investigations are inherently ambiguous. More than one source may have similar variations in the measured property, making interpretation difficult. A measured geophysical anomaly may have more than one interpretation and different physical sources may produce similar geophysical anomalies.

SPECIALIST DECLARATION OF INTEREST –

I, **Barry Barnardt**, declare that:

- I am suitably qualified to act as independent specialist in this application;
- I do not have any financial or personal interest in the application, its' proponent or any subsidiaries, aside from fair remuneration for specialist services rendered; and
- That work conducted has been done in an objective manner – and that any circumstances that may have compromised objectivity have been reported on transparently.

Signature –
Date: 7 December 2015

I, **Karen van Ryneveld**, declare that:

- I am suitably qualified to act as independent specialist in this application;
- I do not have any financial or personal interest in the application, its' proponent or any subsidiaries, aside from fair remuneration for specialist services rendered; and
- That work conducted has been done in an objective manner – and that any circumstances that may have compromised objectivity have been reported on transparently.

Signature –
Date: 7 December 2015

I, **Duane Fourie**, declare that:

- I am suitably qualified to act as independent specialist in this application;
- I do not have any financial or personal interest in the application, its' proponent or any subsidiaries, aside from fair remuneration for specialist services rendered; and
- That work conducted has been done in an objective manner – and that any circumstances that may have compromised objectivity have been reported on transparently.

Signature –
Date: 7 December 2015

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EXECUTIVE SUMMARY

Project Description and Background –

The project proponent, the eThekwini Metropolitan Municipality – Human Settlements Unit, is proposing to establish a housing development, the *Dodoma Place (Kennedy Road) Housing Project*, on the municipal owned erven 402-407 Springfield, Durban, eThekwini Metropolitan Municipal area, KwaZulu-Natal. The proposed development will comprise a low cost housing development with the proposed layout centred on the construction of 26 nodes of three-storeyed units, to provide accommodation for approximately 70 families.

The *Dodoma Place (Kennedy Road) Housing Project* component of the original 3-tiered housing application was exempted from EA by the KZN-DAEA in 2013. Development commenced upon the issue of the exemption from EA but on said date, 12 June 2013, the contractor was stopped by residents from Dodoma Avenue and the Gokul family, based on oral history pertaining to the presence of unmarked Hindu ancestral graves and a Hindu prayer site being situated on the property. On 22 January 2014 AMAFA issued a '*Stop Development Order*'. Based on faunal remains collected at the study site, and in retrospect with reference to the NHRA 1999, Section 38(1)(c)(ii) / Section 38(1)(c)(iii) AMAFA requested a Phase 1 AIA/HIA. The requested AIA/HIA has been submitted by eThembeni Cultural Heritage, but with heritage concerns, including verification of the area as a grave site being unresolved. The UP – Department of Anatomy confirmed faunal remains collected at the study site as non-human. In order to resolve grave related heritage concerns at the study site and provide a way forward for decision making AMAFA requested a GPR assessment to be conducted and associated report submitted to their office.

The Ground Penetrating Radar (GPR) Assessment –

Limitations to the GPR assessment include 2 exclusion areas, namely 'Exclusion Area 1' being the area proposed for construction of the show house and 'Exclusion Area 2' being the Hindu prayer site.

GPR isosurface analysis indicated the presence of Anomaly A, situated at ~S29°48'33.4"; E30°58'45.8", best visible in radargram #50. Anomaly A features on the surface of the site as fairly insignificant, increasing in attenuation reaching its maximum size of approximately 2m in diameter at 30cm bgl after which it decreases again towards 40cm bgl. No pertinent orientation can be identified. No dielectric variation indicative of background versus backfill seem to be present and no visible truncation is associated with the anomaly. The anomaly is identified only by a slight 'pull-down' effect in horizontal radargram section. The morphology of Anomaly A is not consistent with grave features. However, the possibility of it being grave related cannot be overruled.

Recommendations –

With reference to archaeological and cultural heritage compliance, as per the requirements of the KZNHA 2008 and the NHRA 1999, it is recommended that the proposed *Dodoma Place (Kennedy Road) Housing Project* proceed as applied for, provided the developer complies with the listed heritage compliance requirements.

- **Exclusion Areas –**

An amended development layout should accommodate both 'Exclusion Area 1' and 'Exclusion Area 2' within the development layout, unless supported by additional information (See General Recommendations).

- **Anomaly A –**

Development should be preceded by archaeological test pitting in the vicinity of Anomaly A in order to identify the GPR attenuation. Should Anomaly A be verified as a grave site, relevant recommendations for its conservation or relocation should be made in advance of any development impact.

- **General Recommendations –**

1) A grave(s) is reported to be situated within the south-eastern portion of 'Exclusion Area 1', underneath fill / rubble deposit. The developer may consider removal of the fill in order to facilitate a GPR assessment of the area for purposes of heritage compliance decision making.
2) The developer may consider negotiation of 'Exclusion Area 2' with the Hindu community. With reference to 'Exclusion Area 1', including the locality of a purported grave(s) site, and with reference to the possibility of Anomaly A being a grave site, consideration may be given to conservation of a single Hindu heritage area within the development framework based on conservation of 'Exclusion Area 1', associated with relocation of the Hindu prayer site to 'Exclusion Area 1'.

The AMAFA HIA Comment will state legal requirements for development to proceed, or reasons why, from a heritage perspective, development may not be further considered.

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1 – PROJECT DESCIPTION, BACKGROUND AND TERMS OF REFERENCE (ToR)

1.1 – PROJECT DESCRIPTION AND BACKGROUND

The project proponent, the eThekwini Metropolitan Municipality – Human Settlements Unit, is proposing to establish a housing development, the *Dodoma Place (Kennedy Road) Housing Project*, on the municipal owned erven 402-407 Springfield, Durban, eThekwini Metropolitan Municipal area, KwaZulu-Natal. The proposed development is situated at general development co-ordinate S29°48'35.90"; E30°58'45.45", with the study site comprising an approximate 0.6ha area. The *Dodoma Place (Kennedy Road) Housing Project* will comprise a low cost housing development with the proposed layout centred on the construction of 26 nodes of three-storeyed units, to provide accommodation for approximately 70 families. The development proposal includes necessary linear development such as pedestrian access, water, sanitation and power, with parking to be provided along Dodoma Avenue (Wahl & Van Schalkwyk 2014). Applicable consolidation, subdivision and rezoning for the development have been finalized.

Environmental enquiry for purposes of an Environmental Authorization (EA) for the *Dodoma Place (Kennedy Road) Housing Project* was submitted, as part of a proposed 3-tiered housing development, by Royal Haskoning DHV, on behalf of the project proponent, to the KwaZulu-Natal Department of Agriculture and Environmental Affairs (KZN-DAEA) in 2013. The *Dodoma Place (Kennedy Road) Housing Project* component of the submission was exempted from EA application based on relevant sections and listing notices of the National Environmental Management Act, No 107 of 1998 (NEMA 1998) and associated 2010 Regulations, with conditions, including amongst others prior consultation with existing surrounding communities and the inclusion of the project in the Environmental Management Programme Report (EMPr) of the Kennedy Housing Project (KZN-DAEA 2013).

Development, including partial vegetation clearing and levelling, commenced upon the issue of the exemption from EA application by the KZN-DAEA, but on said date, 12 June 2013, the contractor was stopped by residents from Dodoma Avenue and the Gokul family, based on oral history pertaining to the presence of unmarked Hindu ancestral graves and a Hindu prayer site being situated on the property (Mohun 2014a). Uncertainty exists with respect to the localities of the graves, being unmarked, but with at least 1 grave believed to be situated in the area earmarked for the show house (Wahl & Van Schalkwyk 2014) and the exact number of graves present on the property, with reports mentioning 6-8 graves (AMAFA 2015b, Van Schalkwyk & Wahl 2014). Hindu community opinion were supported by 2 affidavits ascertaining development impact, not only at the study site but directly impacting on graves, stating variously that 2 to 2-6 graves were removed by construction contractors (Gokul 2014, Singh 2014). Use of the locale as a Hindu prayer site was reported on as dating back more 80 years (Mohun 2014b), with the current prayer site having been constructed on 5 November 2013, post-dating development application and initial commencement of development at the site. On 22 January 2014 AMAFA a KwaZulu-Natali (AMAFA) issued a '*Stop Development Order*' (AMAFA 2015a). Based on faunal remains collected at the study site, and in retrospect with reference to the National Heritage Resources Act, No 25 of 1999 (NHRA 1999), Section 38(1)(c)(ii) / Section 38(1)(c)(iii) AMAFA requested a Phase 1 Archaeological (Heritage) Impact Assessment (AIA/HIA). The requested AIA/HIA has been submitted by eThembeni Cultural Heritage, but with heritage concerns, including verification of the area as a grave site being unresolved (Wahl & Van Schalkwyk 2014). The University of Pretoria (UP) – Department of Anatomy confirmed faunal remains collected at the study site as non-human (AMAFA 2015b).

Uncertainty seem to further exist with regards to ownership of the property, with references including early expropriation and the property being 'commonage' (Wahl & Van Schalkwyk 2014) – through ownership does not affect heritage significance of a site or property, issues relating to the recent construction of the Hindu prayer site may be affected. In the interim a revised development layout has been submitted by the project proponent, including conservation of the Hindu prayer site within the development framework. However, with reference to the authorized development, concerns relating to purported graves being situated on the property remain unaddressed and unresolved.

In order to resolve grave related heritage concerns at the study site and provide a way forward for decision making AMAFA requested a Ground Penetrating Radar (GPR) assessment to be conducted and associated report submitted to their office.

Map 1: General locality of the *Dodoma Place (Kennedy Road) Housing Project* study site, Durban, eThekwini Metropolitan Municipality, KwaZulu-Natal

Figure 1: Original layout of the *Dodoma Place (Kennedy Road) Housing Project* (courtesy – eThekwini MM-HSU)

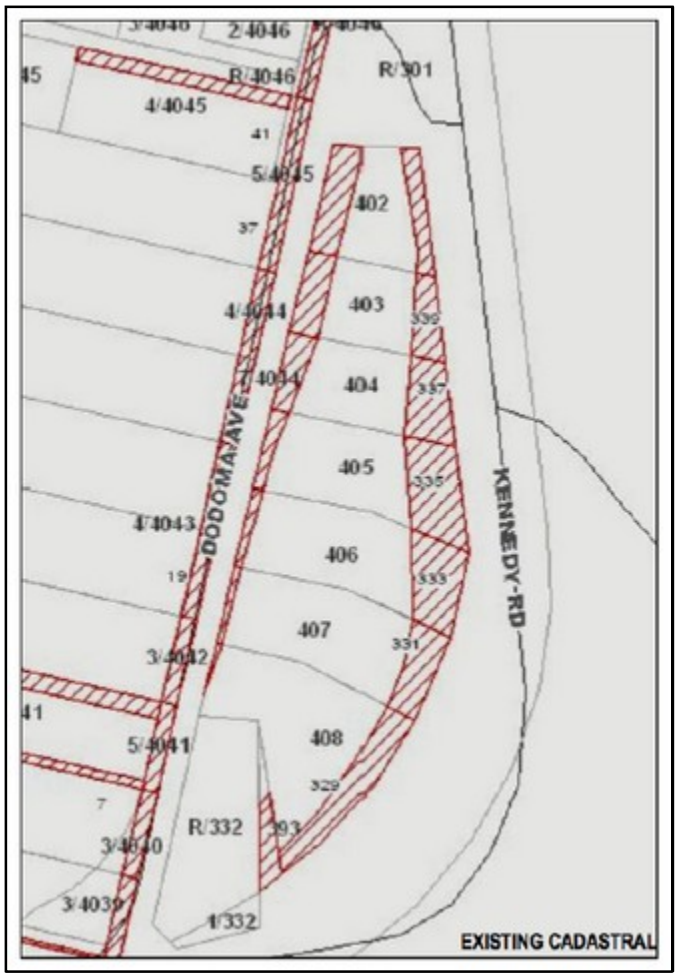


Figure 2: Original zoning of the *Dodoma Place (Kennedy Road) Housing Project* study site (courtesy – eThekwini MM-HSU)

1.2 – TERMS OF REFERENCE

Terms of Reference (ToR) for the GPR heritage assessment provided by the eThekwini Metropolitan Municipality – Human Settlements Unit include:

1. To conduct a GPR heritage assessment of the *Dodoma Place (Kennedy Road) Housing Project* study site focussing on the identification of anomalies that may be of heritage significance with specific reference to possible grave sites / human remains.
2. To conduct a Phase 1b archaeological ground truthing exercise to identify the presence / absence of surface indicators of grave sites / human remains or items or occurrences of heritage value.
3. To compile a GPR report with data and maps (including a full GPR map of the site and amplitude slice maps), including delineation of identified graves and a transect grid system with GPS co-ordinates for affected zones.
4. To provide a method of study inclusive of the use of international best practice methods and approved equipment. (The methodology should include the identification method for burial transects from hyperbolic geometry of caskets to vertical truncation of buried sediments in burial shafts.)
5. To maintain a strict adherence to heritage legislation and protocols including contacting the relevant authorities in the event of uncovering any graves or artefacts.

2 – GROUND PENETRATING RADAR (GPR) TECHNOLOGY AND THE APPLICATION THEREOF IN FORENSIC AND ARCHAEOLOGICAL GRAVE / CEMETERY SENSITIVE CONTEXTS

2.1 – GROUND PENETRATING RADAR (GPR) TECHNOLOGY

Ground Penetrating Radar (GPR) is a high frequency, shallow surface seismological technique: It is a non-invasive geophysical method used to investigate the shallow sub-surface of the earth with the capability to provide data / imagery of the subsurface associated with accurate depth estimates for many common sub-surface entities or soil horizons and buried objects (Pirnau *et. al.* 2014).

A GPR system is made up of a control unit, antenna, a power source, trolley cart and computer or data processor. GPR is described by Geophysical Survey Systems Inc. (GSSI) as (www.geophysical.com/whatisgpr.htm):

> *'The control unit contains the electronics which triggers the pulse of radar energy that the antenna sends into the ground. It also has a built-in computer and hard disk/solid state memory to store data for examination after fieldwork…*
>
> *The antenna receives the electrical pulse produced by the control unit, amplifies it and transmits it into the ground or other medium at a particular frequency while the antenna moves across the ground surface. Antenna frequency is one major factor in depth penetration. The higher the frequency of the antenna, the shallower into the ground it will penetrate. A higher frequency antenna will also 'see' smaller targets.*
>
> *GPR works by sending a tiny pulse of energy into a material and recording the strength and the time required for the return of any reflected signal. A series of pulses over a single area make up what is called a scan. Reflections are produced whenever the energy pulse enters into a material with different electrical conduction properties or dielectric permittivity from the material it left. The strength, or amplitude, of the reflection is determined by the contrast in the dielectric constants and conductivities of the two materials. This means that a pulse which moves from dry sand (dielectric of 5) to wet sand (dielectric of 30) will produce a very strong reflection, while moving from dry sand (5) to limestone (7) will produce a relatively weak reflection.*
>
> *While some of the GPR energy pulse is reflected back to the antenna, energy also keeps traveling through the material until it either dissipates (attenuates) or the GPR control unit has closed its time window. The rate of signal attenuation varies widely and is dependent on the properties of the material through which the pulse is passing. Materials with a high dielectric will slow the radar wave and it will not be able to penetrate as far. Materials with high conductivity will attenuate the signal rapidly. Water saturation dramatically raises the dielectric of a material, so a survey area should be carefully inspected for signs of water penetration.*
>
> *Metals are considered to be a complete reflector and do not allow any amount of signal to pass through. Materials beneath a metal sheet, fine metal mesh, or pan decking will not be visible.*
>
> *Radar energy is not emitted from the antenna in a straight line. It is emitted in a cone shape. The two-way travel time for energy at the leading edge of the cone is longer than for energy directly beneath the antenna. This is because the leading edge of the cone represents the hypotenuse of a right triangle.*
>
> *Because it takes longer for that energy to be received, it is recorded farther down in the profile. As the antenna is moved over a target, the distance between them decreases until the antenna is over the target and increases as the antenna is moved away. It is for this reason that a single target will appear in the data as a hyperbola, or inverted "U." The target is actually at the peak amplitude of the positive wavelet.'*

The post data recording or collection phase centres on data processing. A number of software programmes are available, including amongst others RADAN 7 from GSSI.

Annan (1999) suggests 4 consecutive phases for data processing: 1) Data editing; 2) Basic processing; 3) Advanced processing; and 4) Visual / Interpretation processing. Data editing involves data reorganization, file merging, adding header and background information, repositioning and correcting for topography. Basic processing comprises de-wowing, gaining and temporal and spatial filtering. Advanced processing includes trace attribute analysis, filtering, selective muting, normal move out correction, deconvolution, velocity semblance analysis, background removal, multiple frequency antennae mixing and polarization mixing. Visual / Interpretation processing normally comprises migration, event picking, subjective gain enhancement and amplitude analysis.

Conyers (2004) recommends a similar sequence for data processing where the 1st step centres on vertical and horizontal scale correction, through rubber-banding, distance normalization and static correction. The 2nd step includes removal of horizontal banding in reflection profiles through the use of background removal and high-pass filters. The 3rd step involves the removal of high frequency noise or 'snow' through the use of low-pass filters and the 4th step addresses the removal of multiple reflections through deconvolution. The 5th and final step involves the collapsing of point hyperbolas through migration. Conyers (2004) suggests that data may need to be gained, following background removal or filtering.

Many however warn against the use of too advanced processing steps: Certain data processing steps may affect the original or relative signal amplitude, creating pseudo anomalies and obscuring actual anomalies (Annan 1999; Cassidy 2009).

Three (3) primary display methods are used for GPR data representation (Conyers 2004):

- Reflection Profiles – Reflection profiles are 2 dimensional (2D) images produced in a vertical direction. They are constructed from sequentially stacked traces and display changes in wave velocity and amplitude in a vertical direction. Reflection profiles may also be displayed as 'wiggle traces', displaying individual traces and their associated amplitudes. Examined on their own reflection profiles can be difficult to interpret, but they can contain information that may not be present in slices and isosurfaces.
- Slices – These are computer generated 2D images produced in horizontal dimension, used to spatially map variations in electromagnetic (EM) wave amplitude at different times or depths below the surface. Slices are often regarded as the optimal method for imaging GPR detected spatial anomalies, in particular for large areas. Multiple slices can be stacked atop one another to produce a 3 dimensional (3D) image of the subsurface and can be cross-cut with reflection profiles to produce 3D fence diagrams.
- Isosurfaces – Isosurfaces are true 3D images representing interfaces of a constant amplitude value. Multiple isosurfaces of different amplitude value can be color-coded and displayed simultaneously, and even exported into Geographic Information Systems (GIS) programs. Isosurfaces are deemed the best method for imaging small areas in high detail.

2.2 – APPLICATION OF GROUND PENETRATING RADAR (GPR) TECHNOLOGY IN FORENSIC AND ARCHAEOLOGICAL GRAVE / CEMETERY SENSITIVE CONTEXTS

2.2.1 – Development of Geoscience and Geophysics as Investigative Method in Homicide Forensics

Hans Gross is frequently accredited as the '*founder of scientific criminal investigation*', with his AD1893 publication '*Handbuch fur Untersuchungsrichter*' ['*Handbook for Examining Magistrates*'] containing a section on forensic geology. Shortly after Gross' publication, geoscience firmly established itself as a key forensic discipline: In AD1904 George Popp, a German forensic scientist, used geological evidence to solve the murder of seamstress Eva Disch, strangled with her own scarf in a bean field. Popp used mineralogical evidence from a used handkerchief left at the crime scene and collected from underneath the suspects' finger nails as well as soil evidence from the suspect's trousers to solve the case (Ruffell & McKinley 2005). Following the Disch case, Popp again successfully used microscopic mineralogy to solve the homicide of Margarethe Filbert, murdered in AD1908 near Rockenhausen, Bavaria (Murray & Tedrow 1975; Ruffell & McKinley 2005).

Early success and recognition of geoscientific examination in forensic crime investigation was evidenced by the founding of numerous government and educational establishments with laboratories specializing in geological type forensic science throughout the first half of the 20th Century, across Europe, the United Kingdom (UK) and the United States of America (USA). Minerology, as one of the earliest applications of microscopic and micro geological employment in forensic science was soon followed by significant developments in geochemistry. But the potential of geosciences was not limited to the microscopic and micro sectors of forensic investigation. Geophysical exploration techniques soon emerged as contributory

on macro scale, including remote sensing as well as near or shallow surface geophysical exploration techniques (Ruffell & McKinley 2005) such as electromagnetism, resistivity, magnetometry and GPR, with GPR having had become the primary near surface geophysical tool in forensic applications (Pringle & Jervis 2010; Ruffell & McKinley 2005).

Prior to AD1992 GPR was used extensively in forensic investigations, but with studies seldom published. The latter part of the 1990s witnessed a stalemate in the application, but coinciding with significant technological advancement; including the development of shielded antennae, more flexible antennae and an expansion in the range of antennae strength, now available from 25-1,000MHz, coined with major progress in software development, not only on-screen, but transforming post-recording analysis and display. A rush of papers from AD2000 onwards reflect these advances and their application to actual forensic, historical and archaeological cases, with interpretation aided by notable contribution from experimental simulation studies (Ruffell & McKinley 2005).

2.2.2 – Principles in the Application of Ground Penetrating Radar (GPR) Technology in Forensic and Archaeological Grave / Cemetery Sensitive Cases

The common denominator in near surface geophysical survey, for purposes of this study specifically GPR in forensic and archaeological grave / cemetery contexts is the grave; finding the buried or hidden human remains remain the focal point of interest (Ruffell & McKinley 2005). The key contribution of archaeology is vested in its principle methodology – scientific excavation, including detailed recording and documentation of evidence to maximize the forensic or site specific interpretive potential of the scene (Menez 2015). The very method of excavation could be the deciding factor in the success of a project; in forensic application between prosecution and a free guilty party or in the case of archaeological grave / cemetery investigation the quality site interpretation and resultant recommendation where land-use changes may be affected.

But forensic geophysics and archaeology remain contributory in the search for clandestine graves and crime scene analysis, as component parts of an interdisciplinary investigation. They do not negate or replace conventional forensic methods such as ground truthing, victim recovery dogs (VRD) or metal probing (Pringle & Jervis 2010). When near surface geophysical exploration techniques are employed, a combination of two or more are preferred (Pringle & Jervis 2010; Ruffell & McKinley 2005), if time and finances allows. When considering a crime scene or archaeological grave / cemetery site, the purpose of GPR or associated near surface geophysical method are 2 fold in nature: Finding the actual location of the clandestine grave or graves, but success of the technology is extended to the elimination of suspect, or irrelevant areas to direct investigation, with the potential to save valuable time, and significant cost when compared to conventional methods of large scale sub-surface testing and excavation (Novo *et. al.* 2011).

Basic site conditions are central to the success of the geophysical survey: Topography, vegetation cover, soil moisture content, soil type and level of salinity. Additional necessary information pertains to the grave or graves directly, the date of internment, or inferred date of inhumation to determine the rate of tissue decay and skeletonization (Ruffell & McKinley 2005). Each clandestine grave scenario will be unique: In case specific intelligence and psychology, victim or deceased identity and characteristics, burial style, date and environment, orientation, size and depth of the grave, organic and anthropogenic grave content and body wrapping being only selected of the variables that may apply to any particular forensic or archaeological grave / cemetery case (Pringle & Jervis 2010).

2.2.3 – Selected Case Studies

Forensic Grave, Spain –
Novo *et. al.* (2011) reported on the search for a clandestine grave, approximately 10-20 years old, in a mountainous area in Spain, with the victim believed to have been buried with a metal pick. With investigation still ongoing at the time, the report highlighted site specific concerns: Site size (~0.4ha) with reference to topography – steep slopes covered with snow. The fact that the site was situated within an environmentally protected area, with limiting constraints to the forensic investigation and buried metal waste debris that resulted in many false positive indicators by both GPR and metal detectors.

Forensic Grave, Ireland –

In Northern Ireland investigation of a suspect grave, reported on by a member of the public, with reference to a missing person's report 18 months earlier, yielded false positive results, this time by GPR, metal detector and VRD. Archaeological excavation uncovered a pit, but excavated by mechanical excavator – a geotechnical test pit in advance of a future development, in basic size and morphology equitable to a clandestine grave. With the pit clearly indicated by GPR, false positive hyperbolic anomalies were ascribed to the presence of a large stone within the pit that produced the effect of a void / small water table. Two soft drink cans present in the pit resulted in further false positive readings by both GPR and metal detector. False positive indicators by VRD were ascribed to methane release as a result of the geotechnical cut in peaty soil (Ruffell *et. al.* 2009).

West End Cemetery, Townsville, Australia –

Three (3) geophysical techniques; GPR, resistivity and magnetometry, as well as archaeological test excavation, were employed in the assessment of Block E of the West End Cemetery, Townsville, Queensland, Australia. The West End Cemetery was established in AD1866, with the grounds seemingly in use from AD1868 onwards. In AD1872 Trustees were appointed to manage the cemetery and burial records were kept henceforth. In AD1902 a new cemetery was established; with the West End Cemetery officially closed in AD1925, but burial continued in family owned plots. Since closure the West End Cemetery fell into general disrepair, assumed largely the result of high maintenance costs. From the 1950s the Trustees requested financial assistance from the Townsville City Council for the upkeep of the cemetery. In AD1955 they applied, unsuccessfully, to the Queensland Land Department to sell Block E, so as to ease their financial burden, then indicating a known 36 burials (with 16 monuments) on the land. In AD1965 the Trustees requested the Townsville City Council to take over Block E with the view of subdividing it for residential purposes, this time with correspondence indicating only 26 identifiable graves, including the monuments on the property. In AD1994 the site was listed on the Queensland Heritage Register and in AD1996 the Townsville City Council commissioned a Conservation Strategy to provide guidelines for the care and maintenance of the cemetery grounds (Stanger & Roe 2007).

The West End Cemetery is divided into a western (Blocks A-D) and eastern (Block E) section by a deep natural gulley, with the blocks further distinguishable by pathway and vegetation maintenance regimes. Blocks A-D are also characterized by organized, arranged, formal burials, often with monuments, believed to have been used for the burial of Christian individuals of varying denominations, including distinct areas for Anglican, Catholic and Methodist. Block E was assumed to have been used for non-Christian burials, with an AD1900 map indicating the area as a 'Chinese cemetery' (Stanger & Roe 2007).

A total of 20 monuments (and monument foundations) were identified in Block E, marking the burials of 33 individuals, with 14 monuments associated with individuals of Christian faith, 3 with individuals of Jewish-Hebrew faith, 1 unidentified monument foundation was located and 2 monuments were dedicated to a Japanese sailor of unknown religious affiliation. In totality 65 graves were located in Block E, 32 having been unmarked. It was established that the burials in Block E belonged to Anglicans, Roman Catholics, Wesleyans, 'Heathens' and 'Pagans'. As part of the Conservation Strategy the 65 graves were marked with brass plaques mounted onto concrete plinths (Stanger & Roe 2007).

Though investigative opinion holds that magnetometry proved the most effective geophysical method used, the success thereof was largely due to the early customary use of metal grave markers in Queensland. With reference to GPR results, Stanger & Roe (2007) commented on the large number of anomalies identified, and with magnetometry signals closely having matched the positions of GPR subsurface anomalies.

Tabernacle (Yilki) Cemetery, Encounter Bay, Australia –

The Tabernacle (Yilki) cemetery and church were built and used by English settlers who arrived 1st in Adelaide, in AD1839, under the leadership of Rev Ridgway Newland. At the recommendation of then governor Colonel Gawler, Newland led his party to Encounter Bay. Initially the Tabernacle (Yilki) site comprised only a cemetery, with the 1st internment recorded to have been that of one John Jagger, dated AD1840, and with the church built in AD1846. The church is recorded to have been built in the south-western corner of the formerly fenced site, but the structure has in the interim been dismantled and remnants removed. The cemetery continued to be used until AD1860, when it was decided that no more plots could be sold, due to the establishment of the nearby Victor Harbour Cemetery (AD1855), but again occasional burial continued to take place with the last recorded internment at Tabernacle (Yilki) dating to AD1941. The cemetery however largely fell into disuse, with grave stones reported to have 'gone lost'. In totality 29 burials were recorded to comprise the historical Tabarnacle (Yilki) cemetery (Marshallsay *et. al.* 2012).

Geophysical techniques employed at the site include GPR and electromagnetic induction (EMI). Archaeological testing was not used. Geophysical assessment was hampered by large trees and vegetation; approximately 50% of the site was excluded from the assessment. GPR investigations yielded 25 probable and 16 possible grave sites, with the features distributed homogenously throughout the area accessible by GPR. Excellent correlation was achieved between GPR anomalies and graves where headstones were still in place, providing the primary interpretive proxy at the site. Non-formally marked GPR identified graves were in cases associated with topographic irregularities. No GPR anomaly was interpreted to represent a coffin, the absence of which may be due to the high water table, as suggested by the GPR, and the relative antiquity of the burials. The discovery of 41 possible or probable burials in approximately 50% of the cemetery area suggests that the listing of 29 burials in the historical record is probably erroneous (Marshallsay *et. al.* 2012).

Three (3) large stratigraphic identified features could represent the foundations of the former church, although locations don't match the description in historical records (Marshallsay *et. al.* 2012).

In the case of the Tabernacle (Yilki) cemetery assessment the EMI survey was not able to define grave sites on site (Marshallsay *et. al.* 2012).

African Cemetery at Higgs Beach, Key West, Florida, USA –

For approximately 3 months during the Spring and Summer of AD1860 Key West served as home to some 1,432 West-African refugees. Saved from the American-owned slave ships *Wildfire*, *William* and *Bagota,* destined for the slave markets of Cuba, refugees were delivered to United States (US) Marshal Fernando J. Moreno at Key West, being the nearest US port, where Moreno endeavoured to provide housing and hospital facilities to destitute refugees. Weakened by harsh shipboard conditions, 295 of the Africans died while at Key West; the majority being children between the ages of 10-16 years, with 224 recorded to have been males, 70 females and with no gender stated for 1 victim. All deaths occurred over a period of 85 days. Historical records indicate that the deceased were buried in unmarked graves along the southern shore of the island. The US Government and American Colonization Society negotiated survivors an opportunity back to Liberia, along the West-African coast, allowing liberated slaves the chance to start anew in their 'native' land. By July 19th, 1860, all surviving Africans were on board ships bound for various Liberian ports (Conyers & Malcom 2002).

The burial ground for Africans is only 1 of many scattered across the island of Key West, with the 1st Key West cemetery also recorded to have been located along the southern shore of the island. The African Cemetery is indicated on an AD1861 US Army Corps of Engineers' map, situated in the then uninhabited 'Tract 27' along the beach. It is labelled on the map as '*African Cemetery*', with 9 small x's indicated thereon inferred to represent the location of graves (Conyers & Malcom 2002).

Sometime later in the year (AD1861) the site was earmarked for the construction of 1 of 2 Martello towers. US Army Captain E.B. Hunt notified the then owners, George and Mary Emerson of Massachusetts of the presence of the graves, trying to persuade them not to sell the land and avoid development impact on the cemetery. But the Emerson's sold the land to the US Government and Hunt's objections were overruled. Construction of the Martello tower began in AD1862, with graves believed to have been encountered shortly thereafter. Additional impact on the African Cemetery probably occurred during construction of the military railroad to service the 2 Martello towers, whilst records also exists that 'many skeletons' were identified during the 1940s construction of a World War II (WWII) military barracks, situated in close proximity to the early mapped locale of the African Cemetery (Conyers & Malcom 2002).

Researchers overlaid the AD1861 map, an AD1865 map indicating the position of the Martello tower and modern day maps of Key West aiming to verify the actual locality of the African Cemetery. 'Track 27' was identified as the general area of Monroe County's Higgs Beach and its adjacent park land. Three (3) GPR study grid areas were identified for further investigation. Significant assumptions with reference to grave identification included: 1) That the graves were expedient; and 2) That the graves were probably fairly shallow; diggers would not have dug much further than the 1st hard member, therefore assuming that graves would appear on the GPR between 50-60cm below ground level (bgl). At Grid 1 an interesting pattern of higher amplitude reflections, between 40-60cm bgl, was identified, interpreted by Conyers & Malcom (2002) as: '*These reflection features in Grid 1 are aligned roughly east-west and patterned in a way consistent with burials. There appear to be at least nine burials, with some double reflection features indicating a very close spacing, with almost no room placed between some graves.*' An extension to Grid 1, from the nearby concrete sidewalk showed only very weak attenuation signals. Grid 2 was situated in a nearby park. A shallow hard sub-surface member characterized the area, leading to the conclusion that it was an unlikely locale for graves, or if originally present, most probably disturbed by construction. Grid 3 yielded 2 anomalies, neither of which were typical reflection hyperbolas from graves. An irregular grid of linear data was collected along the nearby Key West Garden Club nursery fence line, but with anomalies indicative of

construction disturbance rather than graves. Beach erosion may well have also impacted on the African Cemetery. The 9 probable burials identified by the GPR assessment may well be the only evidence left of the African Cemetery at Key West. Conyers & Malcom (2002) concluded: '*The African Cemetery, before known only from historical evidence, now appears from this study to be a physical reality… It is more than the remains of a curious incident from old Key West – it is a place that tells a unique story within a cruel system that worked to profoundly shape societies and cultures throughout the Atlantic and Caribbean basins.*'

American War Graves from the Island of Tarawa, Kiribati –

The island of Tarawa is 1 of 24 islets forming the Republic of Kiribati, Pacific Ocean. Until November AD1943 Tarawa was a major stronghold of the Japanese Imperial Army, characterized by an impenetrable network of bunkers and pillboxes for defence purposes. From as early as AD1919 the island was identified as a critical node by US military strategists for a possible invasion of Japan, under a plan then called '*War Plan Orange*'. After the Japanese attack on Pearl Harbour, 7 December AD1941, the US implemented their '*War Plan Orange*'; thereby enabling their military to establish airfields within B-29 striking distance from Tokyo. On 20 November AD1943 US Marines of the 2nd Marine Division attacked the Japanese stronghold on Betio Island, at the south-western end of the Tarawa atoll. The American invasion force was the largest assembled to date, comprising 17 aircraft carriers, 12 battleships, 8 heavy and 4 light cruisers, 66 destroyers and 36 transports to carry and supply a total of more than 35,000 soldiers and Marines. The battle lasted 72 hours. More than 1,677 Americans died and more than 2,296 were wounded. Only 17 of the Japanese defenders survived. Throughout the battle the chaplain responsible for grave registration kept meticulous records of who was buried, but Tarawa was only 1 step in the American campaign to reach Tokyo: US troops had more pressing matters to attend to than the bodies of the dead, and space was at a premium due to the need for an airfield on the island – many remains were lost in the shuffle (Michelsen 2012).

In AD2008 Mark Noah, History Flight, initiated the 1st GPR assessment together with members from WFi Research Group to locate the graves of the American war casualties at Tarawa. Many graves were dug by bulldozers in long trenches – GPR was used in cross-cut method and Global Positioning Systems (GPS) employed to record grave locations. According to Noah (Michelsen 2012): '*…it seemed like every time you turned around we found yet another burial location… As we soon found out, bodies were buried everywhere on that island in several individual unit cemeteries as well as combined cemeteries*'. At the end of the 1st fieldwork season 43 burial locations were identified, each containing from 1 to several sets of remains. After the 2nd fieldwork season, AD2008, with remains submitted to Joint Identification Lab, 139 sets of remains had been identified. Admittedly it would be impossible to find and identify every set of remains, many of the missing will probably never be found, including those that had gone lost in the waters of Tarawa. An AD2010 field season resulted in the identification of another estimated 100 burials, with efforts underway to exhume the remains. In response to the project Noah stated (Michelsen 2012): '*When this project started, we were concerned about contacting the families of those lost to let them know of finding their next-of-kin, but as the publicity about this project unfolded, many of these families have instead contacted us for information… These families have been waiting for their closure for more than 66 years… It is kind of an unwritten understanding that when a service member dies in combat, his body will be identified and buried with full military honours…*' Unidentified / unknown remains retrieved from Tarawa are buried at the National Memorial of the Pacific, Punchbowl, Hawaii.

Two Graves from Viking Age Medieval Churchyards, Skagafjördur, Iceland –

The study focussed on 2 Viking Age graves (AD970-1100), from separate medieval Christian churchyards, situated on the Stóra-Seyla farm in the Langholt region of Northern Iceland. In both cases the graves discussed were associated with further grave-like anomalies identified during the GPR assessments, as well as associated archaeological, including structural remains, but at each churchyard only a single grave was excavated for analytical and interpretive purposes (Damiata *et. al.* 2013).

Christianity was accepted as the official faith of Iceland in AD999/1000, replacing the earlier pagan 'Viking' beliefs. Accordingly Christian burial customs were adopted, recognizable in the archaeological record by east-west grave orientations and the lack of grave goods. Based on published grave and cemetery GPR work potentially detectable targets were listed as: 1) The burial bit (i.e. contrast between background and backfill material); 2) The burial container (i.e. contrast between container and backfill material); and 3) The skeletal remains (i.e. contrast between bone and backfill material). Cognisance was taken of the fact that a burial pit can be detected in a number of ways including differences in moisture content, homogeneity, or compaction between background and backfill material. It can also be identified through truncation of the natural stratigraphy, by subtle slumping of the ground surface, or via 'pull-ups' or 'pull-downs' indicating lateral changes in velocity. A burial pit may not necessarily provide a measurable contrast, either initially lacking or

attenuated with time, in which case the burial container, if present, or the skeletal remains, may still be detectable (Damiata *et. al.* 2013).

The 'lower' or earlier Viking Age churchyard is located just above the Skagafjördur valley bottom, with stratigraphic deposits dated to between AD871-1104 (Landham and Helka tephras). The 'upper' or later medieval churchyard lies approximately 80m to the south-west thereof, on top of a lateral moraine that forms an approximately 14m higher lying ridgeline, within a depositional stratigraphy that post-dates the Helka tephra fall at AD1104 (Damiata *et. al.* 2013).

At the 'lower' churchyard several graves were identified by GPR, situated within an approximate 16m in diameter buried turf enclosure wall, with GPR signatures from the area also attesting to the presence of the remains of a small church. GPR data for the grave study was recorded as radargram #4476, with the grave detected at 1.0-1.2m bgl. A number of hyperbolas were associated with the grave, with wider hyperbolas across the upper body region and narrower ones over the lower body (long bones). Several of the wider hyperbolas had banding with normal polarity, indicating a boundary towards increasing velocity. When the grave was excavated, soil around the ribcage of the skeleton collapsed, confirming the presence of an air-fill void within the chest cavity. Skeletal remains were exceptionally well preserved. Forward modelling indicated that hyperbolas observed were generated by the skeletal remains and not by the disturbed backfill or boundaries of the pit (Damiata *et. al.* 2013).

At the 'upper' churchyard the GPR assessment indicated no hyperbolic reflections in the area where graves were expected. A second, smaller grid was laid out; again no hyperbolas were recorded, but a zone of weak reflections associated with ground disturbance was identified and interpreted as a grave. Excavation confirmed the disturbance to be a grave, but only teeth, of the hardest skeletal remains, were retrieved. The overall poor preservation of the skeletal remains was ascribed to increasing contact with infiltrating groundwater from an overlying gravel layer with advanced hydraulic conductivity that was penetrated during the original digging of the grave (Damiata *et. al.* 2013).

The study highlighted the contrast in preservation of graves between the 2 nearby churchyards and the importance of the influence of localized conditions. While it is commonly assumed that bones are too small for sufficient contrast to be detectable by GPR, the study evidences the detection of bone, but highly dependable on post-depositional preservation conditions – and where favourable, as in the case of the 'lower' churchyard grave, successfully detected from an approximate 1,000 year old grave (Damiata *et. al.* 2013).

3 – THE DODOMA PLACE (KENNEDY ROAD) HOUSING PROJECT – GROUND PENETRATING RADAR (GPR) ASSESSMENT

3.1 – PROJECT METHODOLOGY

3.1.1 – Project Team, Time Frames and Equipment

The Terra Scan cc project team comprised Barry Barnardt (Project Director), Karen van Ryneveld (Archaeologist) and Duane Fourie (Geologist). The GPR assessment was conducted over a 4 week period (2015-11-09 to 2015-12-07) including fieldwork (data collection), data processing, analysis, interpretation and reporting. Fieldwork for the project was assisted by Micheal Sosibo and Zacks Nxumalo.

- Equipment –

Camera	: Pentax K20D
Global Positioning System (GPS)	: Garmin Montana 650 (Datum: WGS84)
Ground Penetrating Radar (GPR) system	: Geophysical Survey Systems Inc. (GSSI); UtilityScan SIR3000, Model No. DC-3000/2100, fitted on to rugged 3 wheel cart, Model no. 623 o Antenna – GSSI, 400MHz , Model No. 50400S (accuracy: 0-3m penetration depth); o Dielectric Constant: 8 o Time Range: 60ns o Gain Curve: Manual 5 positions o Filters: FIR low pass 800, FIR high pass 100 o Scans per unit/m: 50 o Scans per sec: 64
Radar Analysing Software	: GSSI – RADAN 7 Horizontal scans per unit = 50; Units per mark = 3 Processes – 3D batch of files: o Time zero surface position / range adjustment: -3.0ns o Filters: ➢ Horizontal background removal length = 401 units ➢ Vertical low pass = 600MHz ➢ Vertical high pass = 200MHz o Colour Table = 02 & 12 (Greyscale) o Colour Xform = 09 LM 4

3.1.2 – Site Description

The *Dodoma Place (Kennedy Road) Housing Project* study site, erven 402-407 Springfield, Durban, eThekwini Metropolitan Municpality, Durban, KwaZulu-Natal, is situated at general development co-ordinate S29°48'35.90"; E30°58'45.45". The site comprises a rough triangular shaped, approximate 0.6ha area, bordered to the east by Kennedy Road, to the west by Dodoma Avenue and to the south by an immediately adjoining private property.

Topographically the site slopes fairly heavily from the south-west down towards the north-east, with an approximate 25-30m drop along the rough 120m diagonal extent of the site [1:50;000 Topographic Map Ref: 2930DD]. Geologically the site is underlain by grey-brown shales, siltstones and subordinate sandstones of the Permian age Pietermaritzburg Formation, of the Ecca Group, which forms part of the Karoo Supergroup [1:250,000 Geological Map Ref: 2930 Durban]. The site was covered by olive-brown silty clay above the weathered bedrock, located approximately 50-80cm below ground level (bgl). The weathered zone was observed to be 30-50cm thick. The dip of the shale was east north-east, at approximately 15-20%, mirrored by the topography.

At the time of the Ground Penetrating Radar (GPR) assessment development had already impacted on the site. The rough northern half of the site had been graded, with an estimated 15-20cm topsoil removed. Soil (and rubble) were used to level

the very northern extremity of the site, the area where the show house is to be constructed, with the area having been raised a maximum 1.8-2m. A layer of fill / rubble, which may in places be between 1-1.5m thick was observed along the western boundary of the site, inferred to also be a result of levelling associated with the construction of Dodoma Avenue. The area where the Hindu prayer site is situated has been built up with rubble for levelling purposes.

The following assumptions were made with reference to potential graves at the site:

- That any number of graves, from 0 to the 6-8 reported graves or more could be present on site.
- That graves may include infant, child, adolescent or adult graves, with specific reference to grave size [A grave(s) is reportedly situated below the fill of the show house area].
- An east-west grave orientation was not necessarily inferred, based on known varying Hindu funerary practice.
- That graves may be informal, with or without wrapping or in caskets. Graves may / may not be associated with grave goods.
- Graves were expected to be fairly shallow; it is unlikely that manual digging would have penetrated below the shale member.
- That graves may be roughly aligned, or grouped, or may be infrequently scatted across the site.
- That grave age would not exceed a maximum 155 years, with reference to the first arrival of indentured Indians in South Africa in AD1860 (Kearney 2012).
- Grave sites may be associated with topographic (or other) surface indicators, limited to the southern virgin area of the study site.

3.1.3 – Study Site Preparation

GPR Assessment Sign Posting – Ten (10) A4 GPR assessment notice posters were attached at intervals along the rough boundary of the study site: Signage read: '*Dodoma Place (Kennedy Road) Housing Project, Durban. AMAFA requested Ground Penetrating Radar (GPR) assessment in progress by Terra Scan cc. Enquiries: Lihle Manqgalaza, eThekwini Municipality. 074 133 7033 / 031 311 2469*'.

Vegetation Clearing – Vegetation and site clearing was managed by Lindelani Chibiza (Phuma eJungle Co-operative). Grass, weeds and smaller shrubs were cut, collected and removed from the study site. No trees were removed from site. Surface rubble, excluding building debris was removed.

GPR Grid Establishment – The GPR grid was surveyed by Luke Wijnberg (Mark Wijnberg Land Surveyors). Forty (40) surveyed control points (CP) allowed for the establishment of 6 GPR assessment blocks, namely Blocks A-F (Block A: CP1-14-26-2; Block B: CP2-26-27-3; Block C: CP3-27-35-4; Block D: CP4-35-36-5; Block E: CP5-36-40-6; Block F: CP6-40-39-7), along a rough north north-east to south south-west (NNE-SSW) primary axis (CP1-2-3-4-5-6-7). GPR assessment blocks (excluding Block F) measured 25m along the primary axis. The primary axis and secondary grid lines were subdivided to facilitate 50cm interval radargram guide lines, allowing data collection per GPR assessment block in a rough north north-west to east south-east (NNW-ESE) orientation.

3.1.4 – Phase 1b Archaeological Ground Truthing

Phase 1b archaeological ground truthing, as specialist component to the GPR assessment, was preceded by a Phase 1 Archaeological (Heritage) Impact Assessment (AIA / HIA) conducted by the appointed heritage consultant for the *Dodoma Place (Kennedy Road) Housing Project*, eThembeni Cultural Heritage, on 26 February 2014. Thick grass and general vegetation cover obscured surface visibility at the time of the Phase 1 AIA. Whilst vegetation clearing had started a few days prior to the Phase 1 AIA, clearing was ceased due to reported on Hindu community concern with reference to impact on inferred unmarked grave sites. Resultantly the Phase 1 AIA neither confirmed nor excluded the presence of surface indicators of grave sites, or any other formally protected heritage resource, as defined and protected by the KwaZulu-Natal Heritage Act, No 4 of 2008 (KZNHA 2008) and the National Heritage Resources Act, No 25 of 1999 (NHRA 1999) (Wahl & Van Schalkwyk 2014).

Phase 1b archaeological ground truthing coincided with vegetation and site clearing, and continued throughout the course of fieldwork, with the aim to identify:

1) Any surface indicator of a grave, or possible grave site; and

2) To establish the surface presence of any formally protected heritage resource, site, occurrence, artefact or object as defined by relevant heritage legislation (KZNHA 2008 & NHRA 1999).

Localities of any surface heritage resources or sub-surface site indicators were to be geographically recorded with a Global Positions System (GPS), resources or indicators described and assigned a heritage site significance rating for interpretive and heritage compliance purposes, as a norm, within practice standards done according to the system prescribed by SAHRA (2007). Identified surface significant or sensitive areas were to be subjected to detailed GPS investigation.

SAHRA Archaeological and Cultural Heritage Site Significance Assessment			
Site Significance	**Field Rating**	**Grade**	**Recommended Mitigation**
High Significance	National Significance	Grade I	Site conservation / Site development
High Significance	Provincial Significance	Grade II	Site conservation / Site development
High Significance	Local Significance	Grade III-A	Site conservation or extensive mitigation prior to development / destruction
High Significance	Local Significance	Grade III-B	Site conservation or extensive mitigation prior to development / destruction
High / Medium Significance	Generally Protected A	Grade IV-A	Site conservation or mitigation prior to development / destruction
Medium Significance	Generally Protected B	Grade IV-B	Site conservation or mitigation / test excavation / systematic sampling / monitoring prior to or during development / destruction
Low Significance	Generally Protected C	Grade IV-C	On-site sampling, monitoring or no archaeological mitigation required prior to or during development / destruction

Table 1: SAHRA archaeological and cultural heritage site significance assessment ratings and associated mitigation recommendations

No archaeological or cultural heritage surface resources or sub-surface site or feature indicators, including possible grave sites, were identified during the Phase 1b archaeological ground truthing. Vegetation and site clearing resulted in the identification of high quantities of contemporary debris, including a vast amount of bottle glass, plastic and paper, infrequent crockery pieces and household items including, amongst others, a mattress, evidencing recent and possible continuing informal dwelling / recreation activities at the site. Building and renovation rubble and debris were concentrated along the south-western portion of the site, with fairly high densities in the vicinity of the Hindu prayer site. Infrequently scattered faunal remains were found across the surface of the site, with the highest concentration thereof observed towards the north-western part of the study site, along Dodoma Avenue, in the vicinity of the show house area. Faunal remains identified comprised exclusively of non-human remains, more than often directly associated with recreational use of the site, as evidenced by cut marks on the remains and including butchery cuts, testimony to them being primarily food remains. Remains of a number of small informal fireplaces (hearths) further confirmed use of the study site for informal dwelling / recreational purposes.

With no archaeological or cultural heritage surface resources or sub-surface site or feature indicators identified during the Phase 1b archaeological ground truthing, heritage site localities, descriptions and site significance assignations did not further applied to, or guided the GPR assessment.

3.1.5 – The Ground Penetrating Radar (GPR) Assessment

No practice guidelines or minimum standards exist for GPR heritage assessments in South Africa. Cognisance was taken of in house GSSI archaeological / forensic guidelines.

Two (2) GPR exclusion areas were identified:

1) 'Exclusion Area 1' being the filled-up area where the show house is to be situated along the northern extremity of the study site. Radargrams were taken across a portion of the area, excluding steep slopes. Backfill / rubble negatively impacted on GPR visibility, prohibiting assessment of the virgin surface. A brief GPR assessment in adjoining road sections confirmed the visible services that run underneath the area: Both active and inactive services were identified. 'Exclusion Area 1' comprises an area where a reputed grave(s) is situated.
2) 'Exclusion Area 2' constitutes the Hindu prayer site area. The Hindu prayer site and immediate surrounds were excluded from GPR assessment for various reasons, including: 1) That the site comprises a religious / spiritual site; 2) That the site has been levelled with rubble for construction purposes, making it unlikely that quality GPR data could be collected for interpretive purposes; 3) Building and renovation rubble strewn across the immediate

surrounds of the Hindu prayer site did not allow GPR data collection; and 4) Hindu community reporting indicate that the prayer site has been constructed on an area known not to contain graves.

Radargrams were collected sequentially throughout the 6 GPR assessment blocks, starting at Block A and ending at Block F, at 50cm intervals, with the 1st radargram taken at 7m from Datum Point 1 along the primary axis. Radargrams were taken along the longitudinal axis of the GPR assessment blocks, in a rough NNW-ESE direction, with a total of 259 radargrams recorded throughout the 6 GPR assessment blocks. An additional 28 detail radargrams were collected at attenuation points. Sub-surface visibility proved good to a level of 0.8-1m bgl, roughly coinciding with the shale member, being also the inferred anthropogenic basal member. Radargrams were analysed on site as they were collected. No on site identified hyperbola or attenuation was consistent with a typical grave site.

Close spacing of the radargrams facilitated slices to be merged into a 3 dimensional (3D) model or isosurface of the study site. Horizontal and vertical reflection profiles and slices were used in analysis of the 3D model. Contemporary disturbance proved easily visible, including dielectric variability between the southern virgin area of the study site as opposed to shallow surface impact across the northern part. Rubble fill was highly attenuated. The southern portion of the sewer line, situated above the shale member was visible as well as the remains of a contemporary fence line.

Isosurface analysis indicated the presence of Anomaly A, situated at ~S29°48'33.4"; E30°58'45.8", coinciding with adjoining, but best visible in radargram #50. Anomaly A features on the surface of the site as fairly insignificant, increasing in attenuation reaching its maximum size of approximately 2m in diameter at 30cm bgl after which it decreases again towards 40cm bgl. No pertinent orientation can be identified. No dielectric variation indicative of background versus backfill seem to be present and no visible truncation is associated with the anomaly. The anomaly is identified only by a slight 'pull-down' effect in horizontal radargram section. The morphology of Anomaly A is not consistent with grave features. However, the possibility of it being grave related cannot be overruled.

3.2 – CONCLUDNG REMARKS

The identity of Anomaly A could not be verified or excluded as a grave site by GPR data. Two (2) options for development purposes can be considered:

1) Archaeological test pitting preceding development impact, or
2) Archaeological monitoring during the course of construction impact.

With cognisance to current Hindu community sensitivity regarding development impact on purported grave sites and with specific reference to the potential of archaeological test pitting, being able to verify a grave site without necessarily impacting on the grave or skeletal remains and with cognisance to raised Hindu community concerns regarding grave relocation it is recommended that archaeological test pitting precede development impact. Should Anomaly A be verified as a grave site, suitable recommendations for conservation (or grave relocation) can be made in advance of the development, including for example conservation of the grave site within the development layout, or relocation thereof to a suitable locale on or off site.

It is important to note that dielectric variation in GPR data may not necessarily affect in a tangible or optical result, attenuations may be the result of moisture or other earth or natural processes not necessarily visible to the naked eye.

Both the project proponent and the Hindu community are reminded that grave / cemetery sites constitute tangible heritage resources. Any motivation for conservation of a cultural landscape associated with type resources is directly dependable on verification of the resource, in the case of the *Dodoma Place (Kennedy Road) Housing Development*, the grave or graves. Neither the South African Heritage Resources Agency (SAHRA), nor any Provincial Heritage Resources Authority (PHRA), can indefinitely protect a non-verified tangible resource. Any action that may be interpreted as such can be argued as the relevant agency / authority holding up development outside of their legal mandate. It is therefore imminent that verification of Anomaly A be prioritized without unnecessary interference or delay.

Plate 1: On-site vegetation clearing [1]

Plate 2: On-site vegetation clearing [2]

Plate 3: On-site vegetation clearing [3]

Plate 4: Contemporary artefact and non-human faunal remains – surface site assessment

Plate 5: Non-human faunal remains – surface site assessment

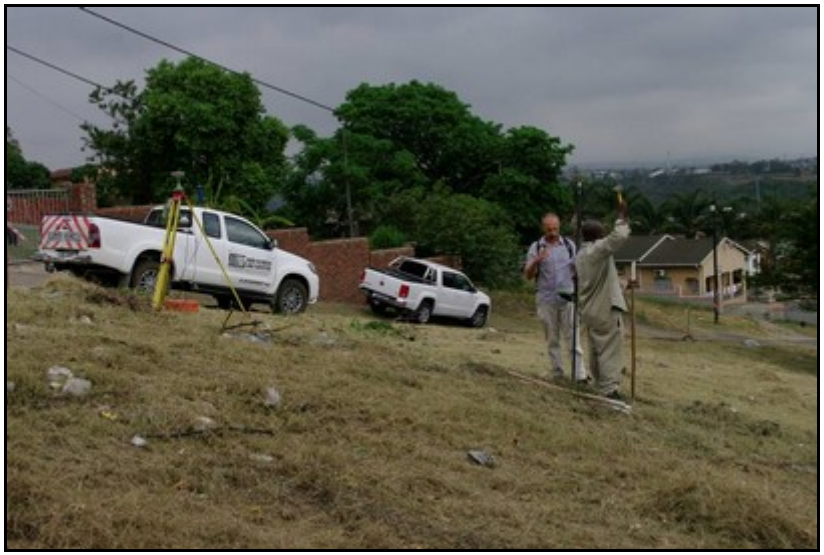


Plate 6: Surveying the GPR grid layout

Plate 7: Cleared site with surveyed grid

Plate 8: Rubble fill used for levelling of construction of the Hindu prayer site

Plate 9: GPR survey notice attached near the Hindu prayer site (Exclusion Area 2), Blocks E & F

Plate 10: Exposed geological shale member with approximate 1m overburden towards the immediate north of the site

Plate 11: Geological section towards the east of the study site, with approximate 1m overburden

Plate 12: Geological member towards the south-east of the study site with approximate 40cm overburden and 20-30cm fill

Dodoma Place (Kennedy Road) Housing Project – GPR Scan Grid											
CP	**[31]Y**	**X**	**CP**	**[31]Y**	**X**	**CP**	**[31]Y**	**X**	**CP**	**[31]Y**	**X**
1 (Datum Point)	2008.048	3298936.175	11	2013.139	3299011.712	21	2003.872	3299078.571	31	1995.563	3299080.292
2	2013.118	3298960.655	12	2008.069	3298987.232	22	2001.116	3299065.263	32	1987.768	3299081.906
3	2018.188	3298985.136	13	2002.999	3298962.751	23	1996.046	3299040.783	33	1985.012	3299068.598
4	2023.258	3299009.616	14	1997.930	3298938.271	24	1990.976	3299016.302	34	1979.942	3299044.118
5	2028.328	3299034.097	15	1992.451	3298964.936	25	1985.906	3298991.822	35	1974.872	3299019.637
6	2033.398	3299058.577	16	1997.521	3298989.416	26	1980.836	3298967.341	36	1971.710	3299045.823
7	2036.149	3299071.859	17	2002.591	3299013.897	27	1977.597	3298993.542	37	1976.780	3299070.303
8	2026.035	3299073.981	18	2007.661	3299038.377	28	1982.667	3299018.023	38	1979.536	3299083.611
9	2023.279	3299060.673	19	2012.731	3299062.858	29	1987.737	3299042.503	39	1971.280	3299085.321
10	2018.209	3299036.193	20	2015.487	3299076.166	30	1992.807	3299066.984	40	1968.524	3299072.031
Grid: South African; Datum: WGS84											

Figure 3: *Dodoma Place (Kennedy Road) Housing Project* – GPR scan grid (courtesy Mark Wijnberg Land Surveyors)

Plate 13: GPR scan grid – Grid datum Control Point (CP) 1

Plate 14: GPR identified services along Dodoma Avenue (Block A)

Plate 15: Close-up of service alignments – Dodoma Avenue [1]

Plate 16: Close-up of service alignments – Dodoma Avenue [2]

Plate 17: Close-up of service alignments – Dodoma Avenue [3]

Plate 18: GPR identified services - Dodoma Avenue-Kennedy Road intersection (Block A)

Plate 19: Close-up of service alignments – Dodoma Avenue-Kennedy Road intersection [1]

Plate 20: Close-up of service alignments – Dodoma Ave-Kennedy Road intersection [1]

Plate 21: Close-up of service alignments – Dodoma Avenue-Kennedy Road intersection [2]

Plate 22: View of the filled area (Exclusion Area 1), Block A

Plate 23: Service alignments running along the eastern portion of the study site

Plate 24: Block A – GPR scan in progress [1]

Plate 25: Block A – GPR scan in progress [2]

Plate 26: Block A – GPR scan in progress [3]

Plate 27: Block A – GPR scan in progress [4]

Plate 28: Block B – GPR scan in progress [1]

Plate 29: Block B – GPR scan in progress [2]

Plate 30: Block B – GPR scan in progress [3]

Plate 31: Block B – GPR scan in progress [4]

Plate 32: Block C – GPR scan in progress [1]

Plate 33: Block C – GPR scan in progress [2]

Plate 34: Block C – GPR scan in progress [3]

Plate 35: Block C – GPR scan in progress [4]

Plate 36: Block D – GPR scan in progress [1]

Plate 37: Block D – GPR scan in progress [2]

Plate 38: Block D – GPR scan in progress [3]

Plate 39: Block D – GPR scan in progress [4]

Plate 40: Block E – GPR scan in progress [1]

Plate 41: Block E – GPR scan in progress [2]

Plate 42: Block E – GPR scan in progress [3]

Plate 43: Block E – GPR scan in progress [4]

Plate 44: Block F – GPR scan in progress [1]

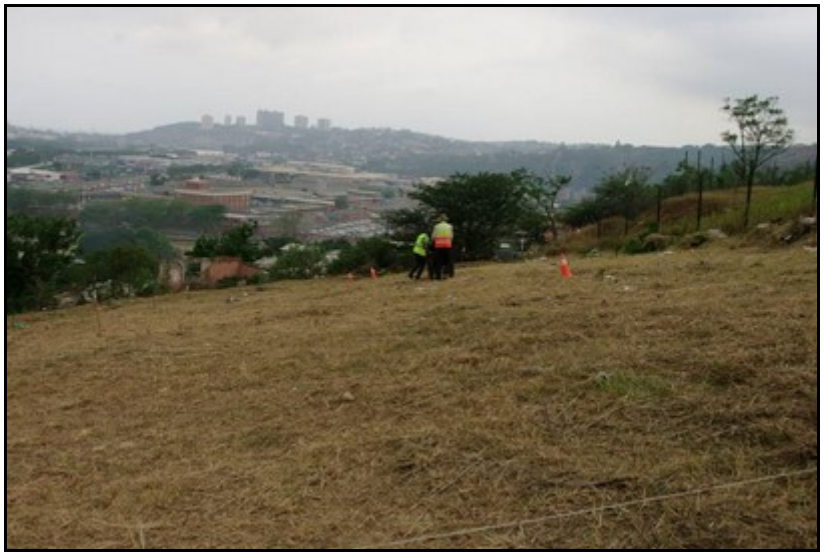
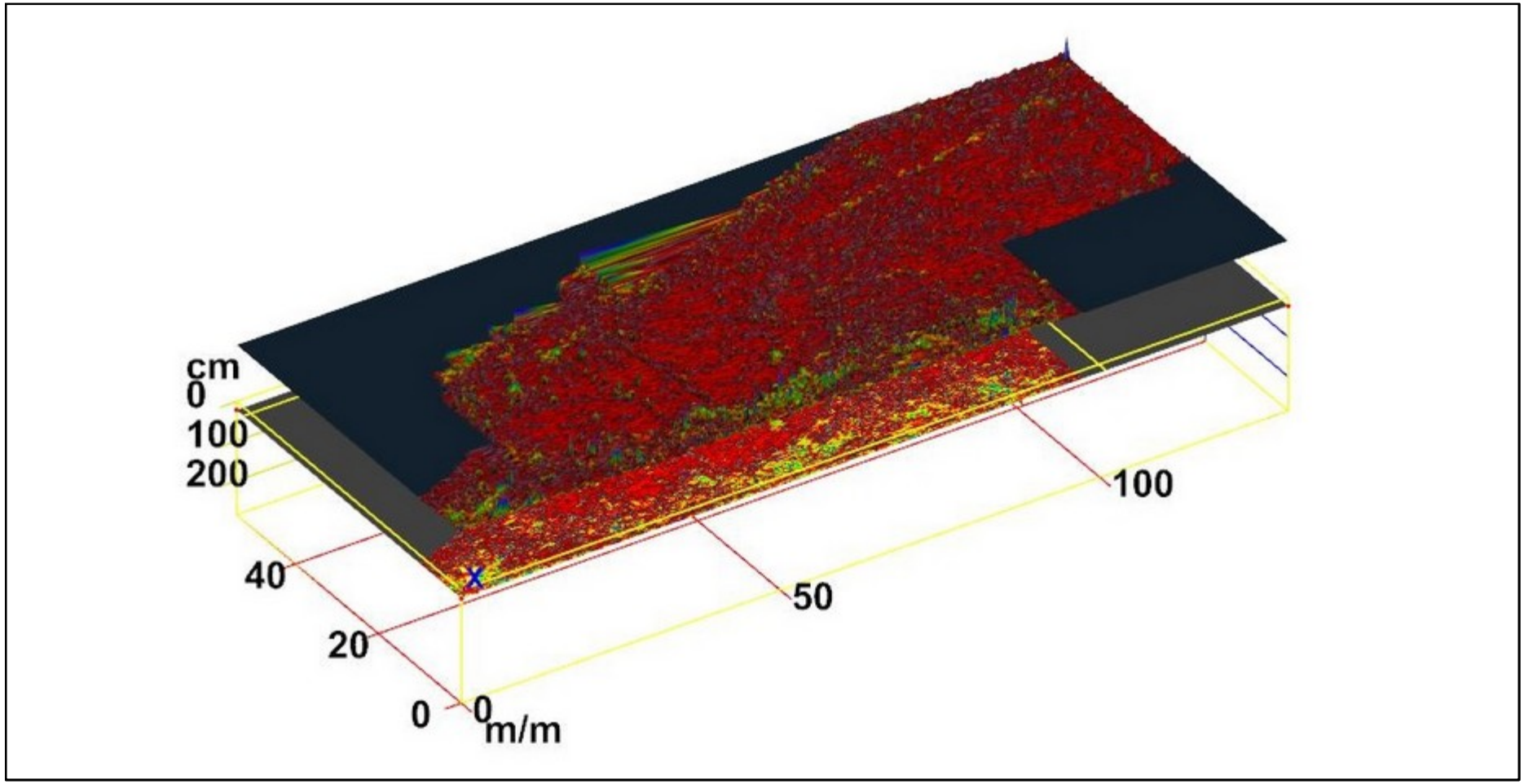


Plate 45: Block F – GPR scan in progress [2]

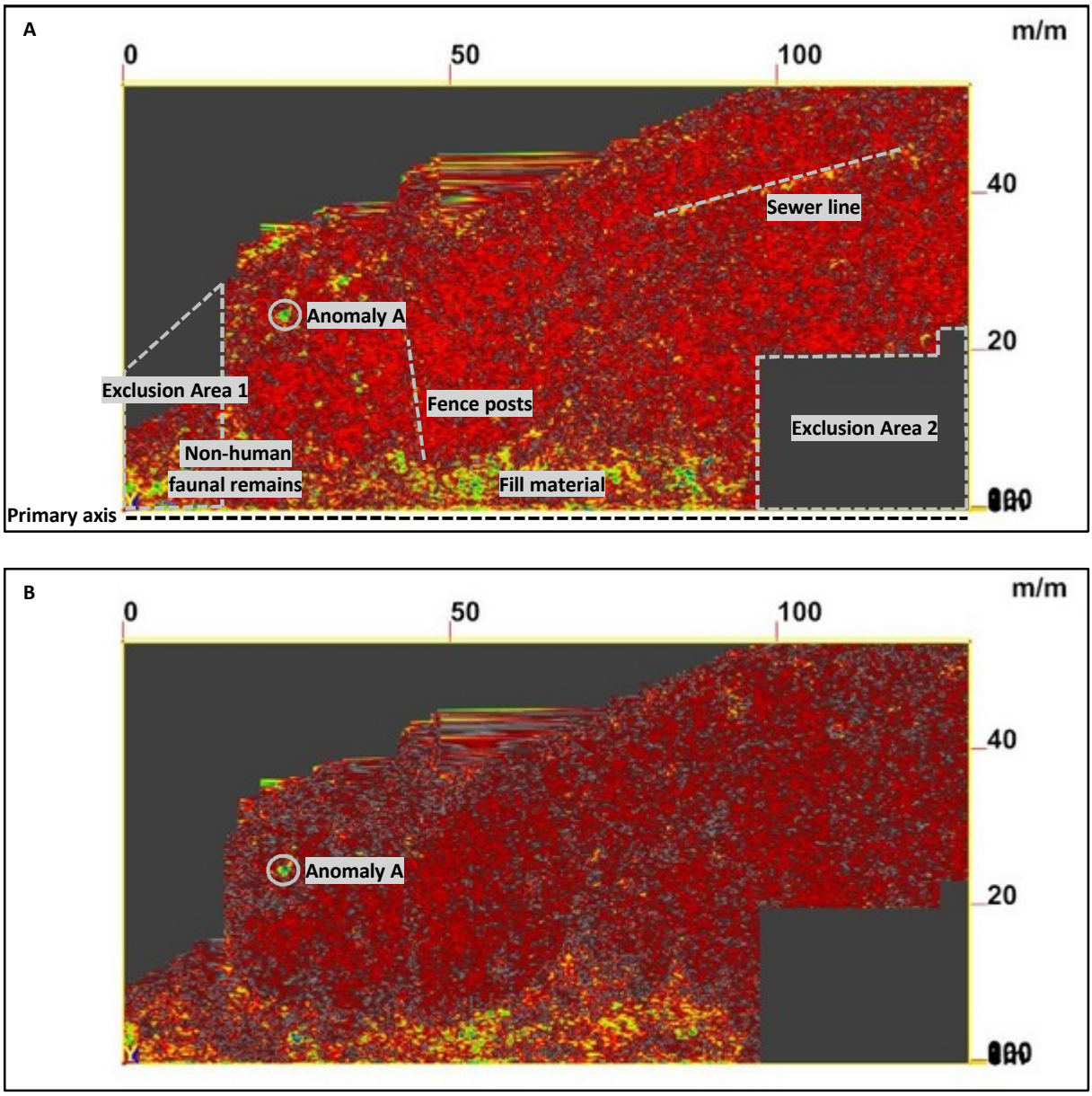
Plate 46: Block F – GPR scan in progress [3]

Plate 47: Block F – GPR scan in progress [4]

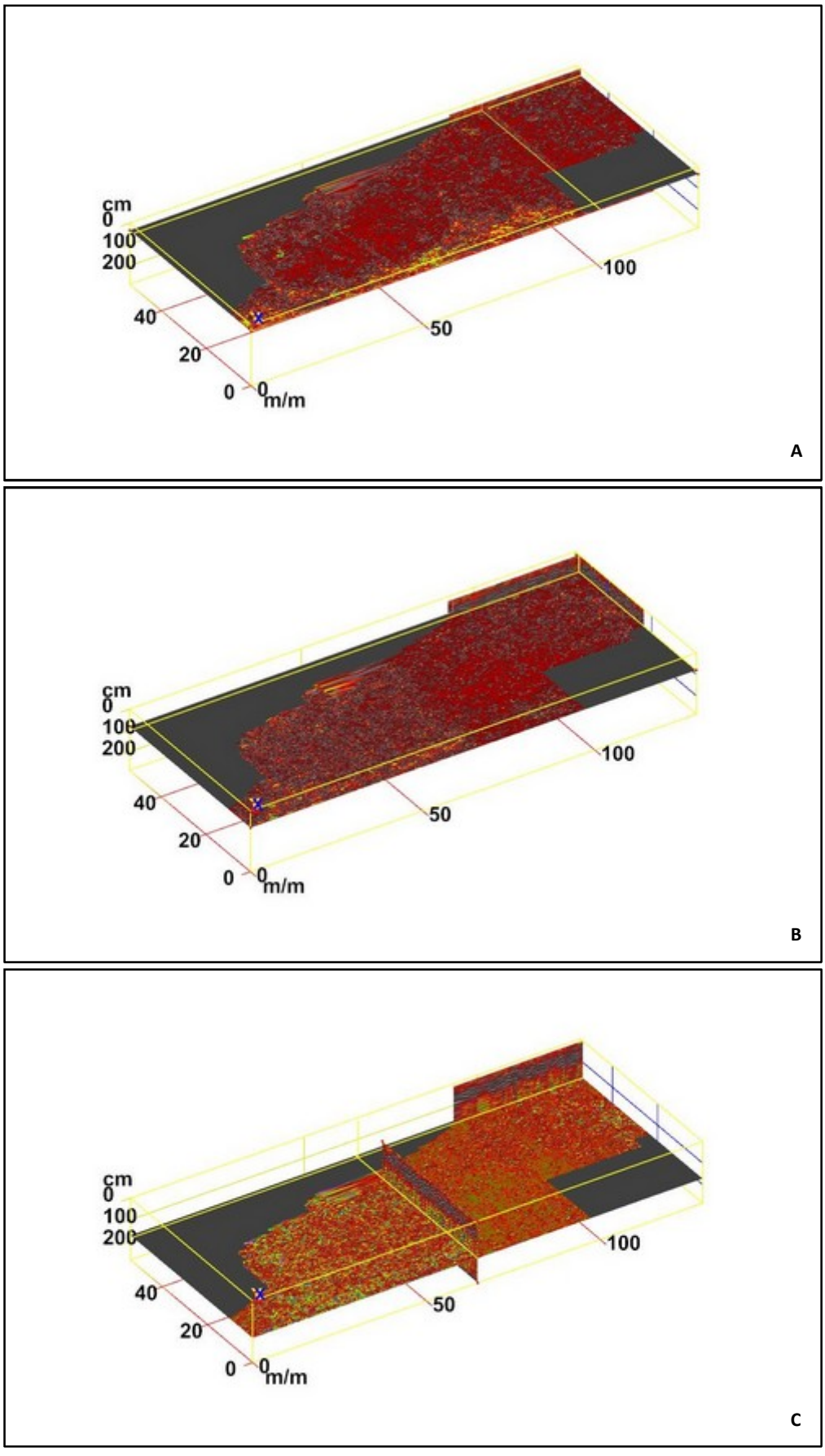
Map 2: The *Dodoma Place (Kennedy Road) Housing Project* – GPR assessment findings, indicating the localities of Anomaly A, Exclusion Area 1 and Exclusion Area 2 (white polygons)



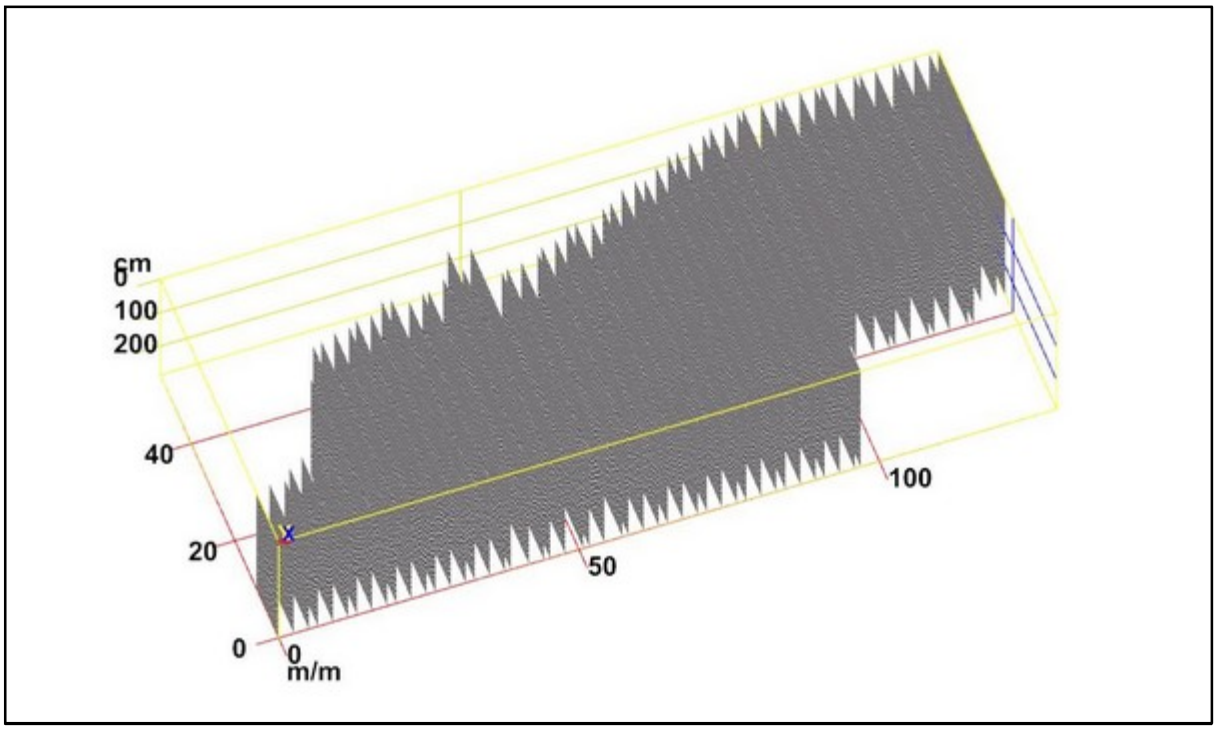
Data Image 1: *Dodoma Place (Kennedy Road) Housing Project* – GPR 3D model / isosurface with contour overlay



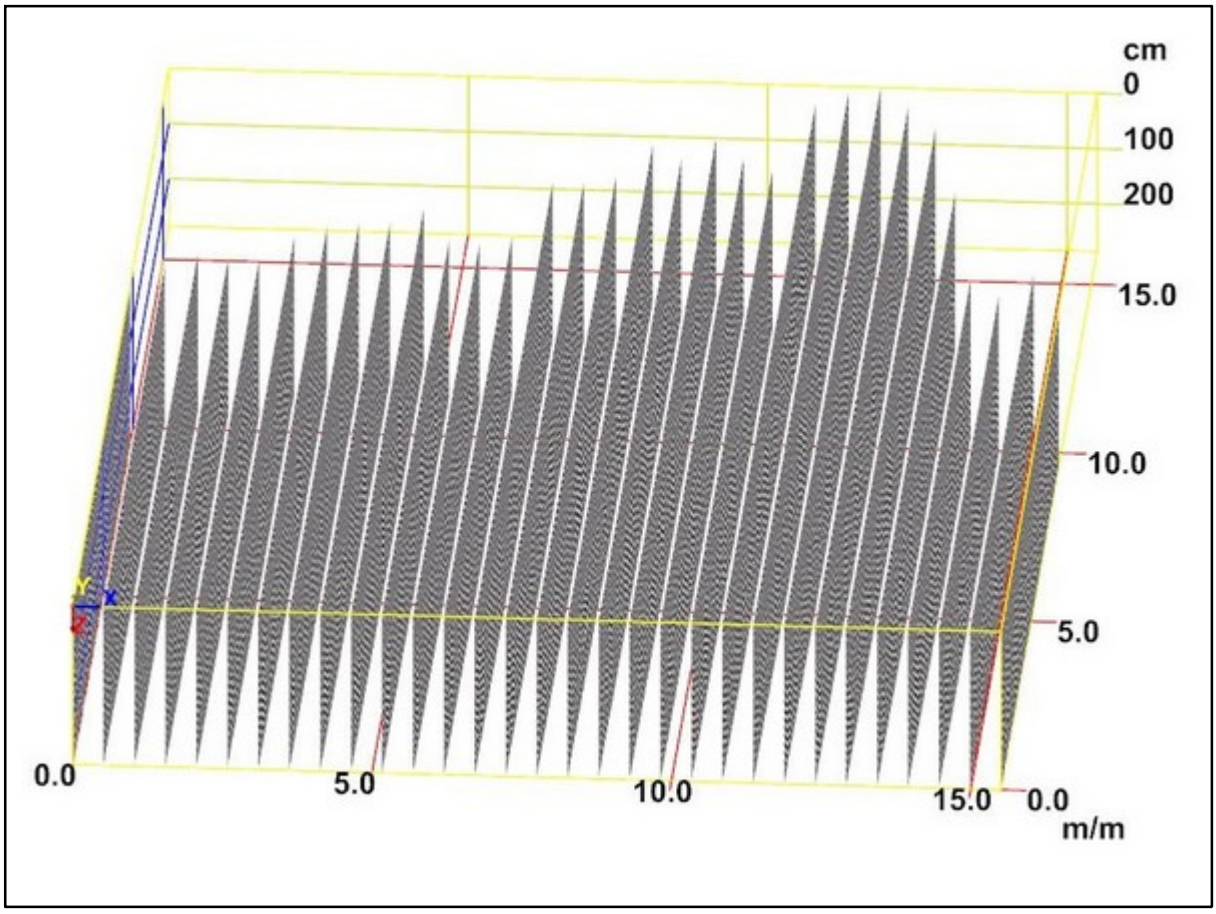
Data Image 2: *Dodoma Place (Kennedy Road) Housing Project* – GPR 3D model A) 33cm bgl & B) 50cm bgl



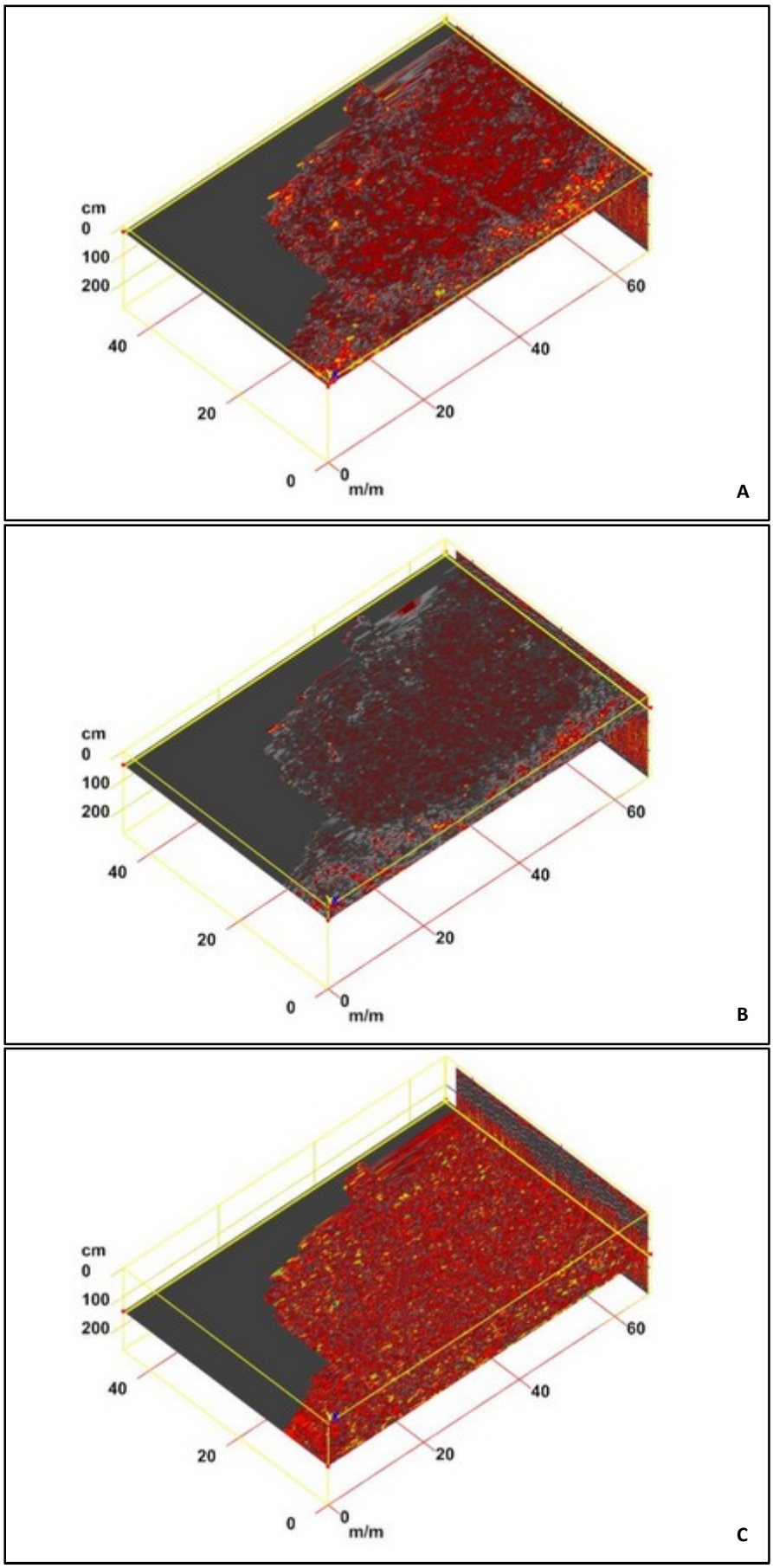
Data Image 3: *Dodoma Place (Kennedy Road) Housing Project* – GPR 3D model A) 33cm bgl; B) 75cm bgl & C) 110cm / 1.1m bgl



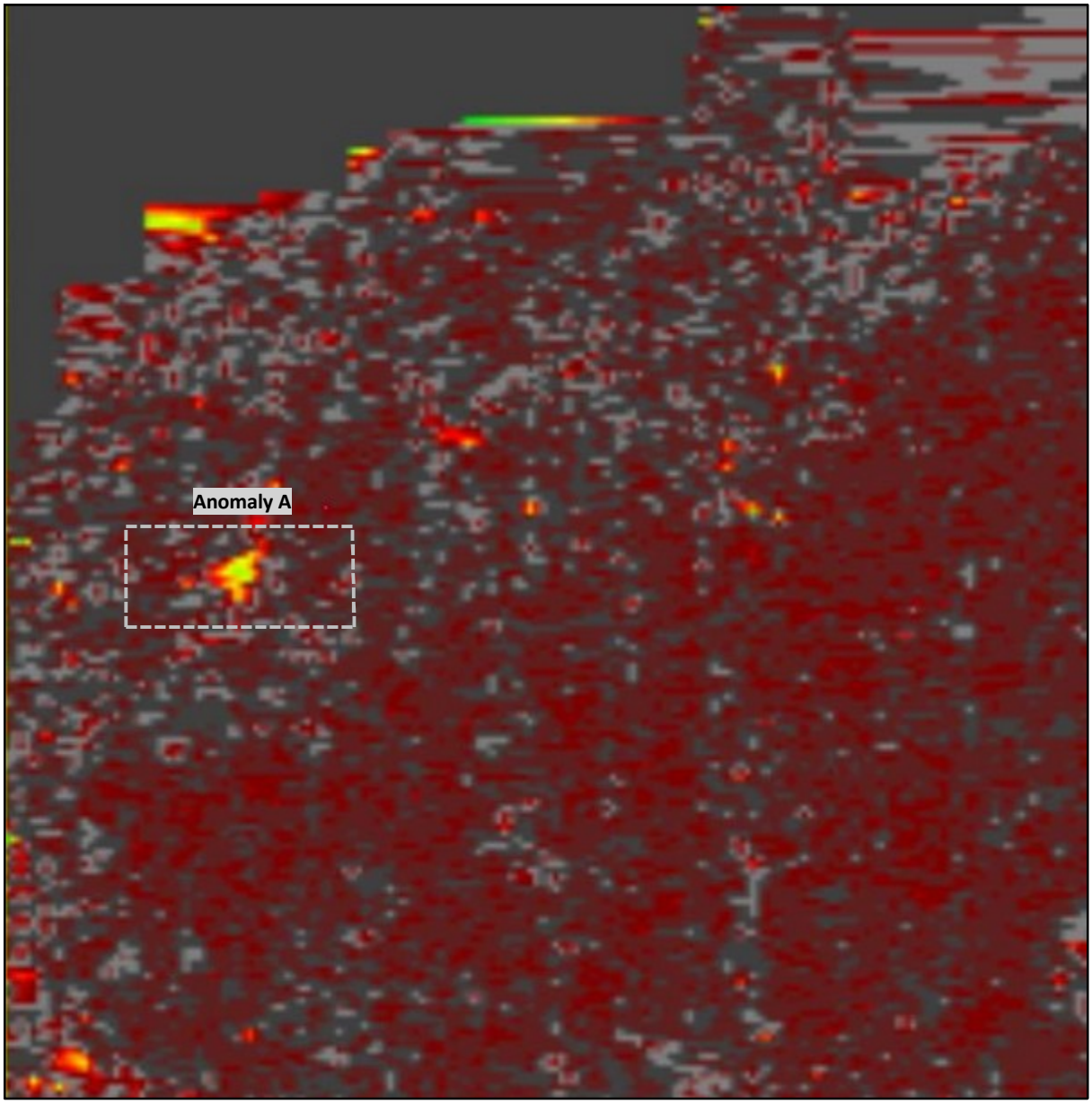
Data Image 4: GPR Amplitude slice-map of the *Dodoma Place (Kennedy Road) Housing Project* study site (selected slices for display purposes)



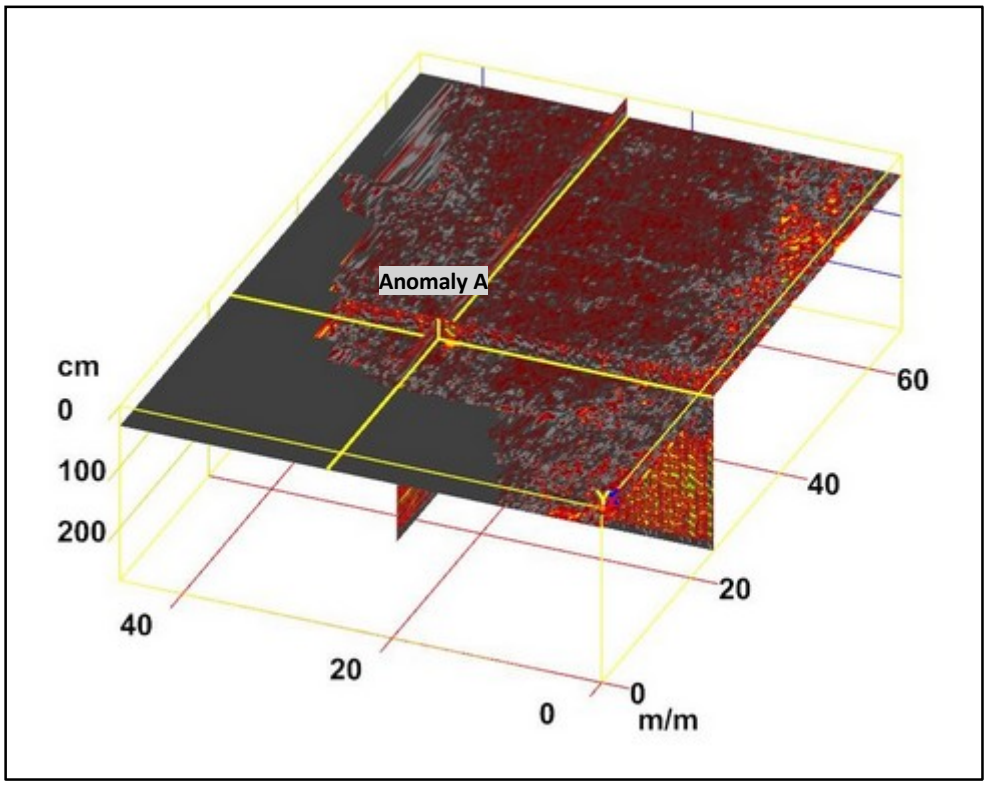
Data Image 5: GPR Amplitude slice-map – Block A (selected slices for display purposes)



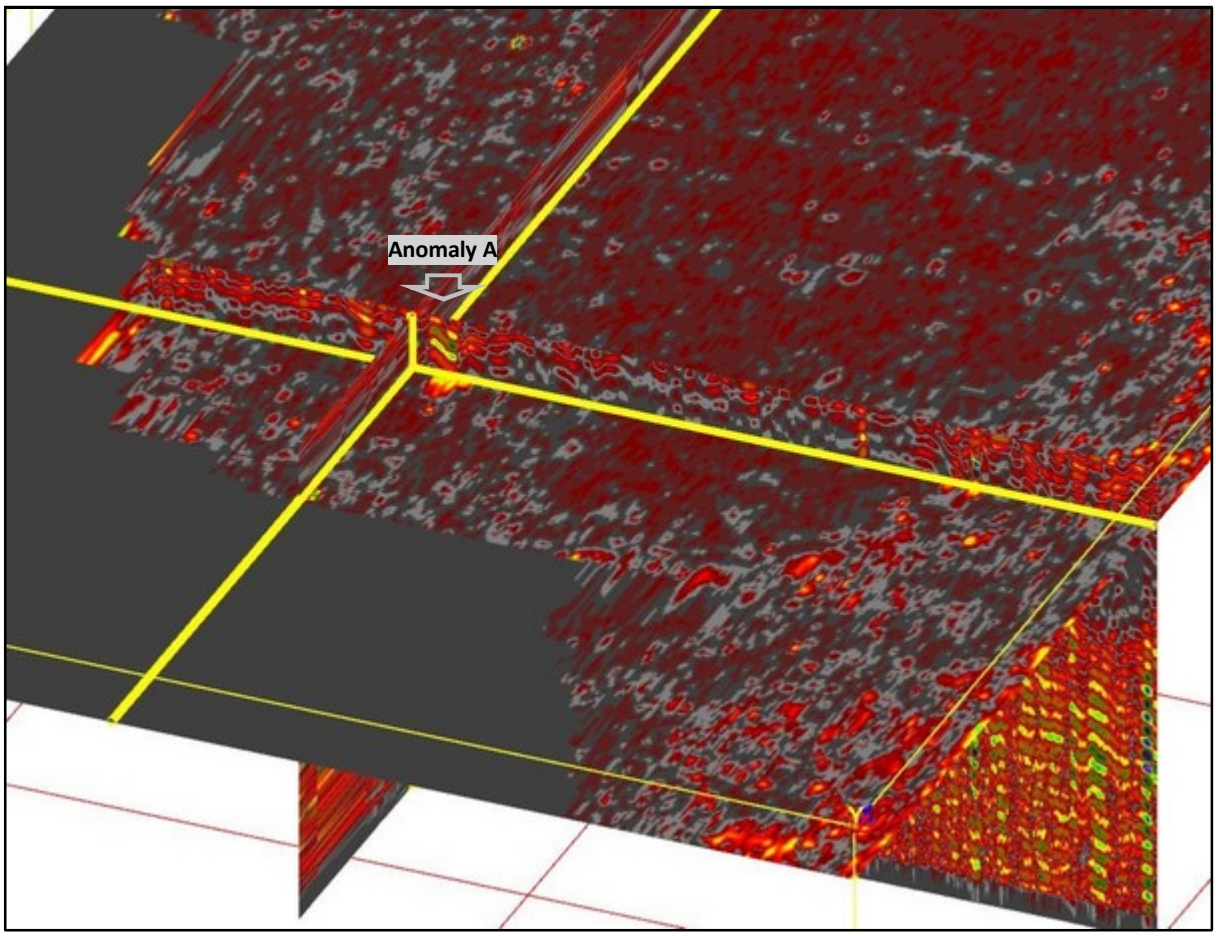
Data Image 6: Block A-C: 3D slice A) 19cm bgl; B) 46cm bgl & C) 150cm / 1.5m bgl



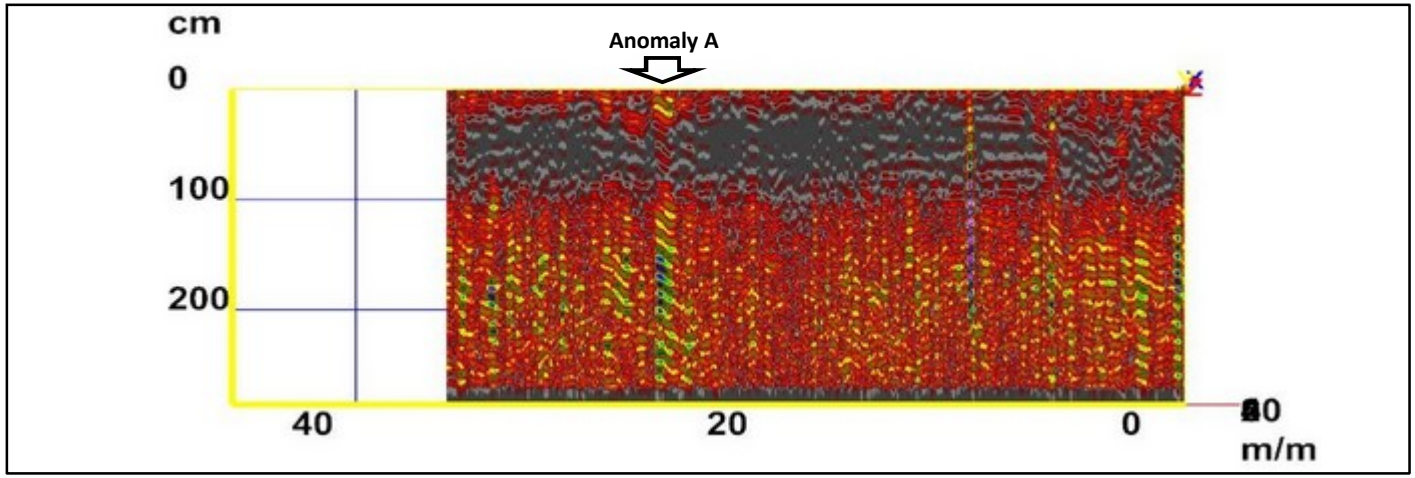
Data Image 7: Close-up of Anomaly A, Block B, in top down planar surface view, 30cm bgl.



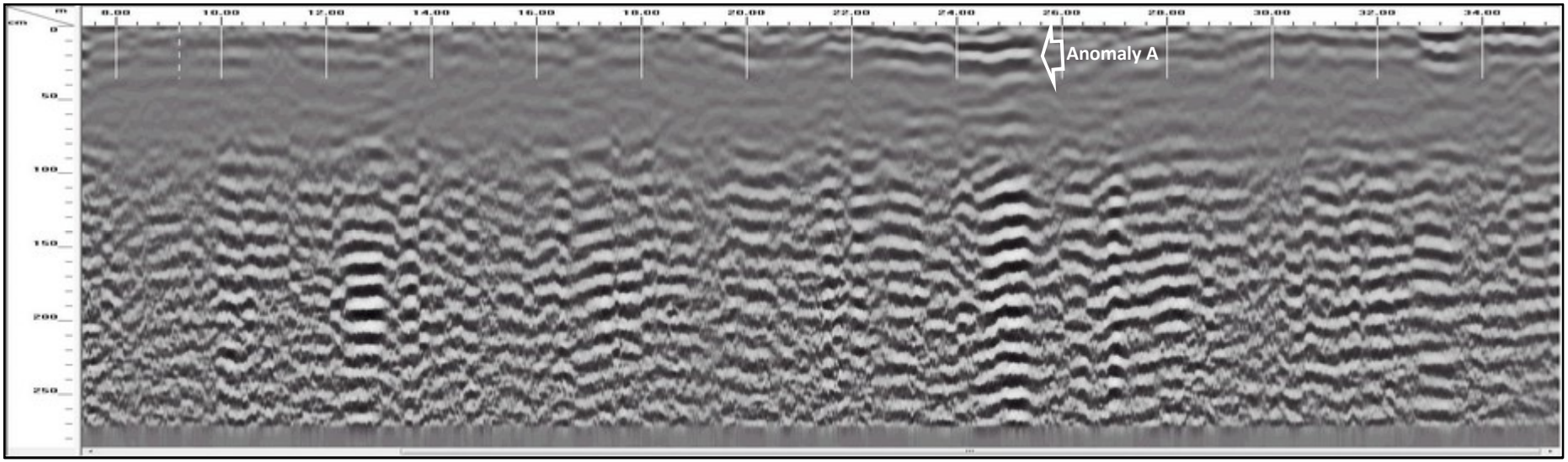
Data Image 8: Block A-C: Locality of Anomaly A (Block B)



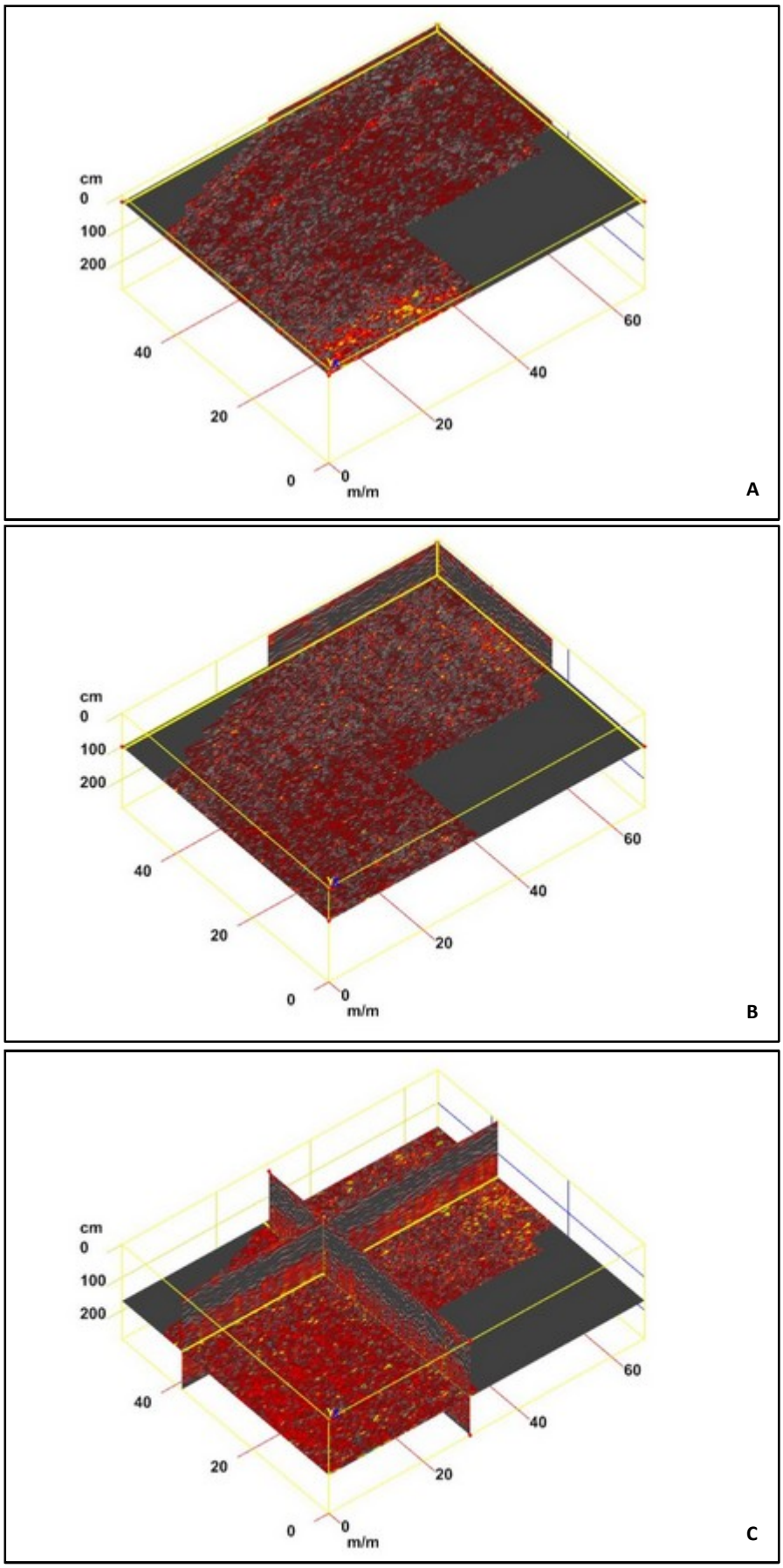
Data Image 9: Block A-C: Close-up of locality of Anomaly A (Block B)



Data Image 10: Radargram – Block B radargram #50 indicating the Anomaly A disturbance [1]



Data Image 11: Radargram – Block B radargram #50 indicating the Anomaly A disturbance [2]



Data Image 12: Block D-F: 3D slice A) 25cm bgl; B) 100cm / 1m bgl & C) 175cm / 1.75m bgl

4 – RECOMMENDATIONS

With reference to archaeological and cultural heritage compliance, as per the requirements of the KwaZulu-Natal Heritage Act, No 4 of 2008 (KZNHA 2008) and the National Heritage Resources Act, No 25 of 1999 (NHRA 1999), it is recommended that the proposed *Dodoma Place (Kennedy Road) Housing Project*, erven 402-407 Springfield, Durban, eThekwini Metropolitan Municipality, Durban, KwaZulu-Natal, proceed as applied for, provided the developer comply with the listed heritage compliance requirements.

Exclusion Areas –
An amended development layout should accommodate both 'Exclusion Area 1' and 'Exclusion Area 2' within the development layout (See Data Image 2 & Map 2), unless supported by additional information (See General Recommendations).

Anomaly A –
Development should be preceded by archaeological test pitting in the vicinity of Anomaly A in order to identify the Ground Penetrating Radar (GPR) attenuation. Should Anomaly A be verified as a grave site, relevant recommendations for its conservation or relocation should be made in advance of any development impact. Suitable recommendations may for example include conservation of the site within an amended development layout, or relocation of the grave to a suitable locale on or off site. Should Anomaly A be verified as not of heritage origin / significance, no further heritage compliance requirements would pertain to the anomaly.

- Archaeological test pitting should be done by a professional archaeologist, as per requirements stated by AMAFA aKwaZulu-Natali (AMAFA);
- A report on the archaeological test pitting should be submitted to AMAFA for purposes of compliance decision making.

General Recommendations –

1) A grave(s) is reported to be situated within the south-eastern portion of 'Exclusion Area 1', underneath fill / rubble deposit that resulted in inadequate GPR visibility. The developer may consider removal of the fill material on order to facilitate a GPR assessment of the area which should be able to verify the presence / absence of anomalies for purposes of heritage compliance decision making, and possible inclusion of the area within the development layout.

2) The developer may consider negotiation of 'Exclusion Area 2' with the Hindu community. The Hindu prayer site, reported to be developed on an area known not to contain any graves and in its current state constituting a recent AD2013 development, albeit with cognisance to reported on use of the general area for said purposes over generations. With reference to 'Exclusion Area 1', including the locality of a purported grave(s) site, and with reference to the possibility of Anomaly A being a grave site, consideration may be given to conservation of a single Hindu heritage area within the development framework based on conservation of 'Exclusion Area 1', associated with relocation of the Hindu prayer site to 'Exclusion Area 1' and in the event of a positive identification of Anomaly A as a grave site, relocation of the grave site to a suitable locale in 'Exclusion Area 1'.

This report is submitted, on behalf of the eThekwini Metropolitan Municipality – Human Settlements Unit, in fulfilment of the AMAFA request for a GPR assessment for the proposed *Dodoma Place (Kennedy Road) Housing Project*. The AMAFA Heritage Impact Assessment (HIA) Comment will state legal requirements for development to proceed, or reasons why, from a heritage perspective, development may not be further considered.

5 – REFERENCES

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6 – ACRONYMS

2D	: 2 dimensional
3D	: 3 dimensional
AD	: *Anno Domini* (the year 0)
AIA	: Archaeological Impact Assessment
AMAFA	: AMAFA aKwaZulu-Natali
bgl	: Below ground level
cm	: Centimetre(s)
CP	: Control Points
EM	: Electromagnetic
EMI	: Electromagnetic induction
ESE	: East south-east
GIS	: Geographic Information Systems
GPR	: Ground Penetrating Radar
GPS	: Global Positioning System
GSSI	: Geophysical Survey Systems Inc
ha	: Hectare(s)
HIA	: Heritage Impact Assessment
KZNHA 2008	: KwaZulu-Natal Heritage Act, No 4 of 2008
m	: meter(s)
MHz	: Megahertz
NHRA 1999	: National Heritage Resources Act, No 25 of 1999
NNE	: North north-east
NNW	: North north-west
ns	: Nanosecond(s)
PHRA	: Provincial Heritage Resources Authority
SAHRA	: South African Heritage Resources Agency
sec	: Second(s)
SSW	: South south-west
UK	: United Kingdom
UP	: University of Pretoria
US	: United States
USA	: United States of America
VRD	: Victim recovery dog(s)
WWII	: World War II

APPENDIX A:

Resumés of the Project Team

Resumé:
BARRY BARNARDT

Name:	Barry Barnardt		
Contact Details:	1)	Cell	073 302 8381
	2)	Fax	086 586 0870
	3)	E-mail	barry@terrascan.co.za
	4)	Postal address	P.O. Box 6871, Welgemoed, 7538
	5)	Website	www.terrascan.co.za
Company:	Terra Scan cc		
Occupation:	Owner and director of Terra Scan cc		
Qualification:	International courses: Ground Penetrating Radar and Underground Utility Locating		
Accreditation:	Certified GPR operator with GSSI – New Hampshire, USA		

Ground Penetrating Radar – Training

2012	**Geophysical Survey Systems, Inc (GSSI) – New Hampshire, United States of America** Theory and Practice of applying subsurface interface radar in Engineering and Geophysical investigations
2010	**The Survey School – Worcester United Kingdom** GPR theory and practice to locate underground utilities and detect voids

Ground Penetrating Radar – Employment history

2010/01-Present	Established Terra Scan as a GPR contracting and non-intrusive underground utility locating company.

GPR – Summary

After a 22 year career in the management of engineering, maintenance and construction projects in the retail and commercial sectors of the oil industry Barry identified the need for specialised Ground Penetrating Radar (GPR) services in the oil industry. Barry has been a GPR service provider since he established Terra Scan in 2010. Since its inception, Terra Scan has successfully completed more than 1000 projects involving GPR equipment in areas across Southern Africa including: South Africa, Namibia, Botswana, Lesotho and Mozambique.

The GPR investigations were undertaken for the following business sectors, oil and gas, construction, environmental management, archaeology, geology and nature conservation.

Interesting past projects involved grave site investigations in the Western and Northern Cape, bedrock investigations next to the Kunene glacier bed in North Namibia and meerkat burrow mapping in the Kalahari.

Company Profile

Company Name	Terra Scan cc
Registration Number	2010/011903/23
VAT Number	4300257146
Tax Number	9212928171
Accountant	Schoemans, Bellville
Members / Shareholders	Barry Barnardt (100%)
BBBEE Status	Exempted Micro Enterprise (EME)

Resumé:
KAREN VAN RYNEVELD

Name:	Karen van Ryneveld
Contact Details:	1) Cell 084 871 1064 2) E-mail karen@archaeomaps.co.za 3) Postal address Postnet Suite 239, Private Bag X3, Beacon Bay, 5205
Company:	ArchaeoMaps cc (for Terra Scan cc)
Occupation:	Archaeologist
Qualification:	MSc Archaeology (WITS University – 2003)
Accreditation:	1) Association of Southern African Professional Archaeologists (ASAPA) accredited Cultural Resources Management (CRM) practitioner [member nr – 163] • 2010 – ASAPA CRM Section: Principle Investigator – Stone Age • 2005 – ASAPA CRM Section: Field Director – Stone Age, Iron Age & Colonial Period 2) SAHRA, AMAFA, EC PHRA and HWC listed ASAPA accredited CRM archaeologist

Tertiary Education

2015-Present	**University of Fort Hare, East London** (*MPhil Environmental Studies*)
2010	**UNISA University, Pretoria** *(Project Management 501)*
2006-2007	**Nelson Mandela Metropolitan University, Port Elizabeth** *(Undergraduate Certificate in Geographical Information Systems)*
2001-2003	**WITS University, Johannesburg** *(MSc Archaeology)*
1999-2000	**University of Pretoria, Pretoria** *(BA Hons) Archaeology)*
1991-1993	**University of Pretoria, Pretoria** *(BA Archaeology & History of Art)*

Archaeology – Employment

2007/04-Present	ArchaeoMaps Archaeological Consultancy (Archaeologist – CRM)
2006/06-2007/03	National Museum, Bloemfontein (Archaeologist – CRM)
2005/04-2006/05	McGregor Museum, Kimberley (Archaeologist – Researcher / CRM)
2004/04-2005/01	AMAFA aKwaZulu-Natali, Pietermaritzburg (HoD – APM Unit)
2002/09-2004/03	McGregor Museum, Kimberley (Archaeologist – Researcher / CRM)

Archaeology – Summary

Karen has been involved in CRM archaeology since 2003 and has been the author (including selected co-authored reports) of approximately 300 Phase 1 AIA studies. Phase 1 AIA work is centred in South Africa, focusing on the Northern and Eastern Cape provinces and the Free State. She has also conducted Phase 1 work in Botswana (2006/2007). In 2007 she started ArchaeoMaps, an independent archaeological and heritage consultancy. In 2010 she was awarded ASAPA CRM Principle Investigator (PI) status based on large scale Phase 2 Stone Age mitigation work (De Beers Consolidated Mines – Rooipoort, Northern Cape – 2008/2009) and has also been involved in a number of other Phase 2 projects including Stone Age, Shell Middens, Grave / Cemetery projects and Iron Age sites.

In addition to CRM archaeology Karen has been involved in research, including the international collaborations at Maloney's Kloof and Grootkloof, Ghaap plateau, Northern Cape (2005/2006). Archaeological compliance experience includes her position as Head of the Archaeology, Palaeontology and Meteorites (APM) Unit at AMAFA aKwa-Zulu Natali (2004).

Resumé:

DUANE FOURIE

Name:	Duane Fourie
Contact Details:	1) Cell 083 475 2096
	2) Fax 086 586 0870
	3) E-mail duane@terrascan.co.za
	4) Postal address P.O. Box 6871, Welgemoed, 7538
Company:	Terra Scan cc
Occupation:	Utility Location Surveyor, Terra Scan
Qualification:	MSc Geology (UCT University – 2010)
Accreditation:	N/A

Tertiary Education

2008-2010	**University of Cape Town** *(MSc Geology)*
2007	**University of Cape Town** *(BSc Hons. Geology)*
2004-2006	**University of Cape Town** (*BSc Geology & Oceanography)*

Employment

2015-Present	Terra Scan (GPR & Utility Location Surveyor)
2010-2015	Environmental Resources Management – ERM (Contaminated Site Management Team Consultant)
1999-2010	Geology Tutor, Commercial Diving, Yacht Deliveries and Land Surveyor Assistant

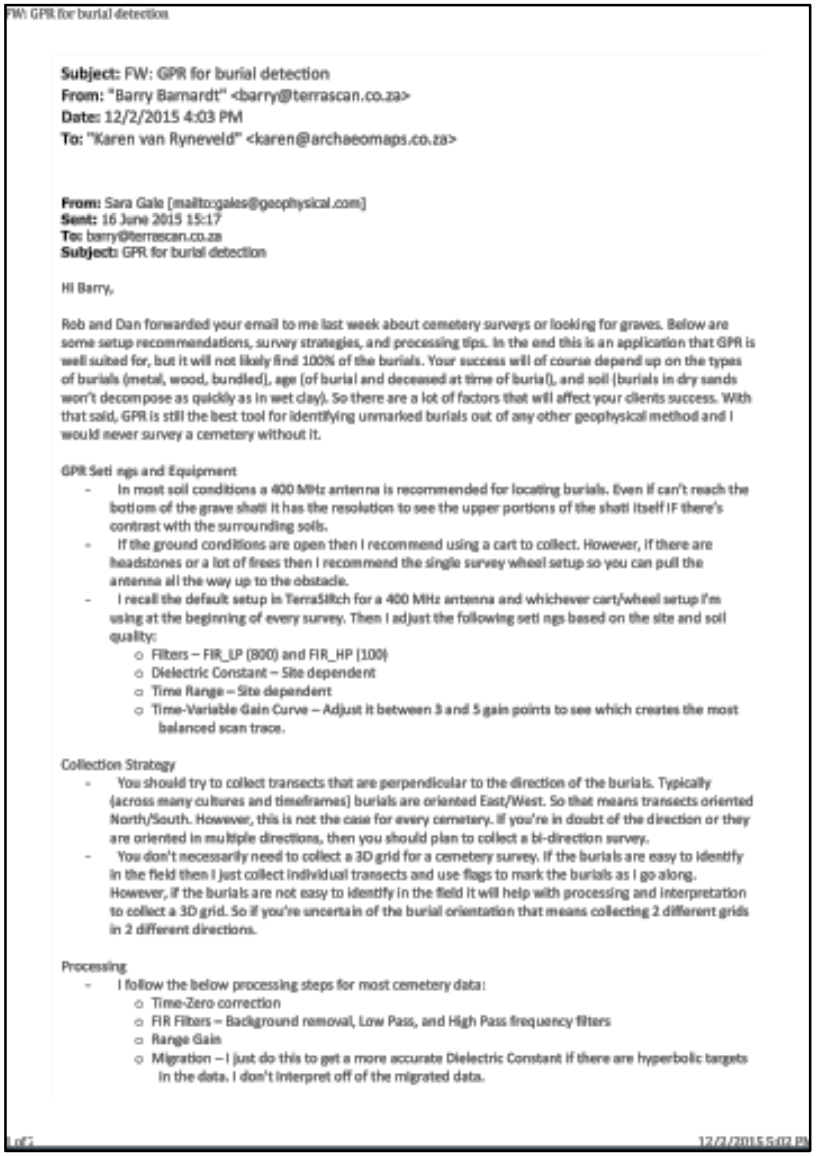
GPR – Summary

As geological professional Duane has been primarily involved with soil and groundwater investigations involving site assessments, laboratory data interpretation and reporting, comprehensive site characterizations as well as project management of soil and groundwater projects across South Africa.

Duane joined Terra Scan in 2015 – his comprehensive experience in the geological and environmental fields are applied to GPR technology and related project types, including the oil and gas sector, construction and environmental industries.

APPENDIX B:

GSSI-Terra Scan E-mail Communication – GPR for Burial Detection



FW: GPR for burial detection

Subject: FW: GPR for burial detection
From: "Barry Barnardt" <barry@terrascan.co.za>
Date: 12/2/2015 4:03 PM
To: "Karen van Ryneveld" <karen@archaeomaps.co.za>

From: Sara Gale [mailto:gales@geophysical.com]
Sent: 16 June 2015 15:17
To: barry@terrascan.co.za
Subject: GPR for burial detection

Hi Barry,

Rob and Dan forwarded your email to me last week about cemetery surveys or looking for graves. Below are some setup recommendations, survey strategies, and processing tips. In the end this is an application that GPR is well suited for, but it will not likely find 100% of the burials. Your success will of course depend up on the types of burials (metal, wood, bundled), age (of burial and deceased at time of burial), and soil (burials in dry sands won't decompose as quickly as in wet clay). So there are a lot of factors that will affect your clients success. With that said, GPR is still the best tool for identifying unmarked burials out of any other geophysical method and I would never survey a cemetery without it.

GPR Setti ngs and Equipment

- In most soil conditions a 400 MHz antenna is recommended for locating burials. Even if can't reach the botiom of the grave shafi it has the resolution to see the upper portions of the shafi itself IF there's contrast with the surrounding soils.
- If the ground conditions are open then I recommend using a cart to collect. However, if there are headstones or a lot of frees then I recommend the single survey wheel setup so you can pull the antenna all the way up to the obstacle.
- I recall the default setup in TerraSiltch for a 400 MHz antenna and whichever cart/wheel setup i'm using at the beginning of every survey. Then I adjust the following seti ngs based on the site and soil quality:
  - Filters – FIR_LP (800) and FIR_HP (100)
  - Dielectric Constant – Site dependent
  - Time Range – Site dependent
  - Time-Variable Gain Curve – Adjust it between 3 and 5 gain points to see which creates the most balanced scan trace.

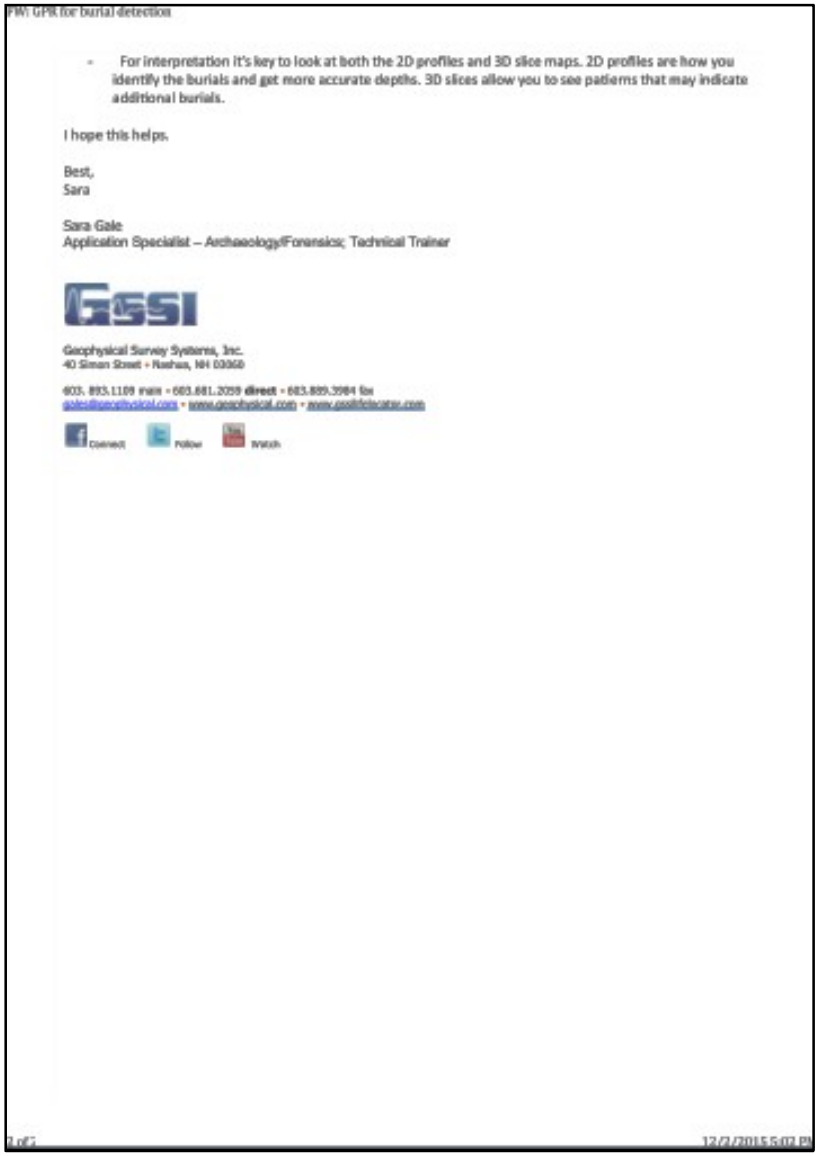
Collection Strategy

- You should try to collect transects that are perpendicular to the direction of the burials. Typically (across many cultures and timeframes) burials are oriented East/West. So that means transects oriented North/South. However, this is not the case for every cemetery. If you're in doubt of the direction or they are oriented in multiple directions, then you should plan to collect a bi-direction survey.
- You don't necessarily need to collect a 3D grid for a cemetery survey. If the burials are easy to identify in the field then I just collect individual transects and use flags to mark the burials as I go along. However, if the burials are not easy to identify in the field it will help with processing and interpretation to collect a 3D grid. So if you're uncertain of the burial orientation that means collecting 2 different grids in 2 different directions.

Processing

- I follow the below processing steps for most cemetery data:
  - Time-Zero correction
  - FIR Filters – Background removal, Low Pass, and High Pass frequency filters
  - Range Gain
  - Migration – I just do this to get a more accurate Dielectric Constant if there are hyperbolic targets in the data. I don't interpret off of the migrated data.

1 of 2 12/2/2015 5:02 PM



FW: GPR for burial detection

- For interpretation it's key to look at both the 2D profiles and 3D slice maps. 2D profiles are how you identify the burials and get more accurate depths. 3D slices allow you to see patierns that may indicate additional burials.

I hope this helps.

Best,
Sara

Sara Gale
Application Specialist – Archaeology/Forensics; Technical Trainer

Geophysical Survey Systems, Inc.
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APPENDIX C:

Heritage Protocol for Incidental Finds during the Construction Phase

HERITAGE PROTOCOL FOR INCIDENTAL FINDS DURING THE CONSTRUCTION PHASE

HERITAGE AUTHORITY (RELEVANT PHRA): AMAFA aKwaZulu-Natali
Contact person: Bernadet Pawandiwa (for Annie van de Venter-Radford)
Contact nr: 033 394 6543
E-mail: bernadetp@amafapmb.co.za

HERITAGE CONSULTANT: eThembeni Cultural Heritage
Contact person: Elizabeth Wahl / Len van Schalkwyk
Contact nr: 082 529 36566 / 082 655 9077
E-mail: thembeni@iafrica.com

Should any palaeontological, archaeological or cultural heritage resources, including human remains / graves, as defined and protected by the KZNHA 2008 and the NHRA 1999, be identified during the construction phase of development (including as a norm during vegetation clearing, surface scraping, trenching and excavation phases), it is recommended that the process described below be followed.

- **On-site Reporting Process:**

1. The identifier should immediately notify his / her supervisor of the find.
2. The identifier's supervisor should immediately (and within 24 hours after reporting by the identifier) report the incident to the on-site SHE / SHEQ officer.
3. The on-site SHE / SHEQ officer should immediately (and within 24 hours after reporting by the relevant supervisor) report the incident to the appointed ECO / ELO officer. [Should the find relate to human remains the SHE / SHEQ officer should immediately notify the nearest SAPS station informing them of the find].
4. The ECO / ELO officer should ensure that the find is within 72 hours after the SHE / SHEQ officers report reported on SAHRIS and that a relevant heritage specialist is contacted to make arrangements for a heritage site inspection. [Should the find relate to human remains the ECO / ELO officer should ensure that the archaeological site inspection coincides with a SAPS site inspection, to verify if the find is of forensic, authentic (informal / older than 60 years), or archaeological (older than 100 years) origin].
5. The appointed heritage specialist should compile a 'heritage site inspection' report based on the site specific findings. The site inspection report should make recommendations for the destruction, conservation or mitigation of the find and prescribe a recommended way forward for development. The 'heritage site inspection' report should be submitted to the ECO / ELO, who should ensure submission thereof on SAHRIS.
6. SAHRA / the relevant PHRA will state legal requirements for development to proceed in the SAHRA / PHRA Comment on the 'heritage site inspection' report.
7. The developer should proceed with implementation of the SAHRA / PHRA Comment requirements. SAHRA / PHRA Comment requirements may well stipulate permit specifications for development to proceed.
    - Should permit specifications stipulate further Phase 2 archaeological investigation (including grave mitigation) a suitably accredited heritage specialist should be appointed to conduct the work according to the applicable SAHRA / PHRA process. The heritage specialist should apply for the permit. Upon issue of the SAHRA / PHRA permit the Phase 2 heritage mitigation program may commence.
    - Should permit specifications stipulate destruction of the find under a SAHRA / PHRA permit the developer should immediately proceed with the permit application. Upon the issue of the SAHRA / PHRA permit the developer may legally proceed with destruction of the palaeontological, archaeological or cultural heritage resource.
    - Upon completion of the Phase 2 heritage mitigation program the heritage specialist will submit a Phase 2 report to the ECO / ELO, who should in turn ensure submission thereof on SAHRIS. Report recommendations may include that the remainder of a heritage site be destroyed under a SAHRA / PHRA permit.
    - Should the find relate to human remains of forensic origin the matter will be directly addressed by the SAPS: A SAHRA / PHRA permit will not be applicable.

    NOTE: Note that SAHRA / PHRA permit and process requirements relating to the mitigation of human remains requires suitable advertising of the find, a consultation, mitigation and re-internment / deposition process.

- **Duties of the Supervisor:**

1. The supervisor should immediately upon reporting by the identifier ensure that all work in the vicinity of the find is ceased.
2. The supervisor should ensure that the location of the find is immediately secured (and within 12 hours of reporting by the identifier), by means of a temporary conservation fence (construction netting) allowing for a 5-10m heritage conservation buffer zone around the find. The temporary conserved area should be sign-posted as a '*No Entry – Heritage Site*' zone.
3. Where development has impacted on the resource, no attempt should be made to remove artefacts / objects / remains further from their context, and artefacts / objects / remains that have been removed should be collected and placed within the conservation area or kept for safekeeping with the SHE / SHEQ officer. It is imperative that where development has impacted on palaeontological, archaeological and cultural heritage resources the context of the find be preserved as good as possible for interpretive and sample testing purposes.
4. The supervisor should record the name, company and capacity of the identifier and compile a brief report describing the events surrounding the find. The report should be submitted to the SHE / SHEQ officer at the time of the incident report.

- **Duties of the SHE / SHEQ Officer:**

1. The SHE / SHEQ officer should ensure that the location of the find is recorded with a GPS. A photographic record of the find (including implementation of temporary conservation measures) should be compiled. Where relevant a scale bar or object that can indicate scale should be inserted in photographs for interpretive purposes.
2. The SHE / SHEQ officer should ensure that the supervisors report, GPS co-ordinate and photographic record of the find be submitted to the ECO / ELO officer. [Should the find relate to human remains the SHE / SHEQ officer should ensure that the mentioned reporting be made available to the SAPS at the time of the incident report].
3. Any retrieved artefacts / objects / remains should, in consultation with the ECO / ELO officer, be deposited in a safe place (preferably on-site) for safekeeping.

- **Duties of the ECO / ELO officer:**

1. The ECO / ELO officer should ensure that the incident is reported on SAHRIS. (The ECO / ELO officer should ensure that he / she is registered on the relevant SAHRIS case with SAHRIS authorship to the case at the time of appointment to enable heritage reporting].
2. The ECO / ELO officer should ensure that the incident report is forwarded to the heritage specialist for interpretive purposes at his / her soonest opportunity and prior to the heritage site inspection.
3. The ECO / ELO officer should facilitate appointment of the heritage specialist by the developer / construction consultant for the heritage site inspection.
4. The ECO / ELO officer should facilitate access by the heritage specialist to any retrieved artefacts / objects / remains that have been kept in safekeeping.
5. The ECO / ELO officer should facilitate coordination of the heritage site inspection and the SAPS site inspection in the event of a human remains incident report.
6. The ECO / ELO officer should facilitate heritage reporting and heritage compliance requirements by SAHRA / the relevant PHRA, between the developer / construction consultant, the heritage specialist, the SHE / SHEQ officer (where relevant) and the SAPS (where relevant).

- **Duties of the Developer / Construction Consultant:**

The developer / construction consultant should ensure that an adequate heritage contingency budget is accommodated within the project budget to facilitate and streamline the heritage compliance process in the event of identification of incidental palaeontological, archaeological and cultural heritage resources during the course of development, including as a norm during vegetation clearing, surface scraping, trenching and excavation phases, when resources not visible at the time of the surface assessment may well be exposed.